National Green Tribunal

Case Details

Back

Filing Number	070110200115/2018	Filing Date	01-02-2019
Party Name	MD. HAYATH UDDIN, S/O MD. BASHEER UDDIN VS UNION OF INDIA		
Petitioner Advocate(s)	SANJAY UPADHYAY	Respondent Advocate(s)	
Act			
Case Number	Appeal No. 20/2018	Registered On	01-02-2019
Last Listed	20-10-2020		
Case Status	DISPOSED		

⊟ All Parties

⊟ Listing History (Orders)

⊟ IA/MA

⊟ Connected Matters

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

APPEAL NO. 20 OF 2018

IN THE MATTER OF:

MD. HAYATH UDDIN ...APPLICANT

VERSUS

UNION OF INDIA & ORS. ...RESPONDENTS

NDOH: DISPOSED ON 20.10.2020

INDEX

Place: New Delhi
Dated: 29/4/23

Filed by:
Advocate for MoEF&CC
Atti N Shankar Rastogi
Adv.
Mob. No. 9811778900
Email Id:

(1)

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

APPEAL NO. 20 OF 2018

IN THE MATTER OF:

MD. HAYATH UDDIN ...APPLICANT

VERSUS

UNION OF INDIA & ORS. ...RESPONDENTS

NDOH: DISPOSED ON 20.10.2020

COMPLIANCE AFFIDAVIT ON BEHALF OF MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE i.e. RESPONDENT NO.1

MOST RESPECFULLY SHOWETH:

1. That I, Yogendra Pal Singh S/o D. P. Singh aged about 43 years currently working as Scientist 'E' in the Ministry of Environment, Forest and Climate Change (MoEF&CC), New Delhi, do hereby solemnly affirm and state as under: -

2. That I, in my official capacity of Scientist 'E' in the Ministry of Environment, Forest and Climate Change, New Delhi i.e. Respondent No. 1 in the above mentioned matter, am conversant with the facts and

NOTARY PUBLIC
MINATI RANI MOHAPATRA
Regd. 16971
Advocate
Exp. Dt. 1 Feb. 2025
DELHI
Govt. of India

circumstances of the case on the basis of official records, and as such authorized and competent to swear this affidavit.

3. That the applicant filed an appeal against an order dated 22.12.2017 of the Ministry of Environment, Forest and Climate Change (MoEF&CC) granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) project in Karimnagar District of Telangana by Irrigation & Command Area Development (I and CAD) Department, Government of Telangana.

4. That this Hon'ble Tribunal vide order uploaded on 20.10.2020 has directed Ministry of Environment, Forest and Climate Change to assess the extent of environmental damage on account of the project having been executed without prior EC and to identify the restoration measures that can be taken to prevent any adverse ecological impact. The operative extract of the order issued by the Hon'ble Tribunal is reproduced below:

"32. Accordingly, we direct the MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to go into the matter in light of observations hereinabove. It may assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures as necessary. Relief and Rehabilitation measures adopted and required to be

(3)

further adopted may also be looked into. In this regard, we also note that the EC was granted with reference to ToR based on Form-I submitted by the project proponent, without considering the changes which have taken place in the project subsequently. The Expert Committee may also examine effective implementation of EMP earlier 27 submitted by the project proponent based on which EC was granted and compliance of EC conditions. The Expert Committee may be constituted within one month and it may complete its exercise within six months thereafter. The progress may be finally monitored by the Secretary, MoEF&CC. Any affected party will be at liberty to make representation to the MoEF&CC within three weeks putting forward suggestions and grievances, which may be taken into the account by Committee. The MoEF&CC may consider measures to prevent recurrence of such violations where EC is sought ex post facto. This is particularly required when the projects are multipurpose projects and part of it requires EC, so that such requirement is not defeated on specious plea that the project was partly not covered by the Schedule, as has happened in the present case. For this purpose, instead of confining consideration merely to Form–I, a mechanism is required to be evolved and followed whereby physical verification of material particulars can be undertaken, wherever necessary."

NOTARY PUBLIC
MINATI RANI MOHAPATRA
Regd. No.
Advocate
Exp. Dt. 1 Feb. 2025
DELHI
Govt. of India

The copy of the aforesaid order of Hon'ble Tribunal is annexed as **Annexure R-1.**

5. That in light of the above direction, the MoEF&CC constituted a seven-member Expert Committee with relevant sectorial expertise to assess the extent of damage caused in going ahead with the project without EC (from 2007 to 2017) and identify the restoration measures necessary along with relief and rehabilitation measures adopted and required further to be adopted. The Committee comprised of:

i.	Sh. Balraj Joshi	Chairman
ii.	Sh. K Gowarappan	Member
iii.	Dr. Mukesh Sharma	Member
iv.	Dr. A.K. Malhotra	Member
v.	Sh. A.K. Singh	Member
vi.	Dr. J.A. Johnson	Member
vii.	Dr. Naryana Shenoy K.	Member

6. That in compliance of the order dated 20.10.2020 issued by this Hon'ble Tribunal, the Expert Committee after detailed deliberations and site visit of the project in question has finalized its report with specific recommendations w.r.t. ecological damage its restoration and rehabilitation measures in the matter.

NOTARY PUBLIC MINATI RANI MOHAPATRA Regd. - 18971 Advocate Exp. Dt. 1 Feb. 2025 DELHI Govt. of India

(5)

The copy of the Expert Committee Report dated 14.11.2022 is annexed as **Annexure R-2**.

7. Therefore, in view of the aforementioned facts and circumstances, this Hon'ble Tribunal may kindly be pleased to pass appropriate order(s).

DEPONENT
(योगेंद्र पाल सिंह)
(YOGENDRA PAL SINGH)
वैज्ञानिक 'ई'/Scientist 'E'
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Min.of Environment,Forest and Climate Change
भारत सरकार, नई दिल्ली
Govt. of India, New Delhi

IDENTIFIED

31 MAR 2023

VERIFICATION

Verified at New Delhi on this 31th day of March, 2023 that the contents of my affidavit are true and correct to my knowledge. No part of it is false and nothing material has been concealed therefrom.

31 MAR 2023

NOTARY PUBLIC
MINATI RANI MOHAPATRA
Regd. - 16971
Advocate
Exp. Dt. 1 Feb. 2025
DELHI
Govt. of India

ATTESTED
MINATI RANI MOHAPATRA
ADVOCATE (NOTARY)
Mob. No.: 8130128457

DEPONENT

(योगेंद्र पाल सिंह)
(YOGENDRA PAL SINGH)
वैज्ञानिक 'ई'/Scientist 'E'
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Min.of Environment,Forest and Climate Change
भारत सरकार, नई दिल्ली
Govt. of India, New Delhi

ATTESTED
NOTARY PUBLIC
GOVT. OF INDIA, DELHI

Item No. 09 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

Appeal No. 20/2018

Md. Hayath Udin Appellant

Versus

Union of India & Ors. Respondent

Date of hearing: 12.10.2020
Date of uploading: 20.10.2020

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE S. P. WANGDI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

ORDER

1. This appeal has been preferred against order dated 22.12.2017 of the Ministry of Environment, Forest and Climate Change (MoEF&CC) granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) project in Karimnagar District of Telangana by Irrigation & Command Area Development (I and CAD) Department, Government of Telangana.

Appellant's Case:

2. The case of the appellant is that he is resident of a village in District Siddipet and is a farmer affected directly by the instant project. KLIS is to irrigate 7,38,851 ha in upland areas of Adilabad, Karimnagar, Nizamabad Warangal, Medak, Nalgonda, and Rangareddy Districts of Telangana 'by diverting 180 TMC of water from River Godavari. The original budget of the project is Rs.80499.71 crores. The source point for

KLIS is near Medigadda Village, below the point of confluence of Pranahitha and Godavari Rivers about 20 km from Kaleshwaram.

The Project envisages construction of three barrages between Yellampally & Medigadda viz.

- Medigadda Barrage on Godavari near Medigadda (Kaleshwaram)
- Annaram Barrage on Godavari downstream of confluence of Manair River with Godavari river near Annaram.
- Sundilla Barrage on Godavari downstream of Yellampally barrage near Sundilla.

The project envisages diversion of about 180 TMC water from Godavari for Irrigation purpose (134.5 TMC), stabilization of existing command area (34.5 TMC), drinking water to Hyderabad (30 TMC) drinking water to en route villages (10 TMC) & for industrial uses (16 TMC). Thus, the main aim of the instant project is, irrigation in seven Districts of Telangana to support agriculture. The whole of KLIS is planned in seven "links", with the water conveyance system consisting of gravity canals, online storages and tunnels involving significant amounts of forest land estimated to be about 3221.2974 ha as per the Final EIA Report submitted by the project proponent to the MoEF. The infrastructure was being constructed prior to applying for Environmental Clearance. The tenders floated for the project show that the infrastructure was being constructed for a major irrigation project to improve agricultural productivity in the upland areas of Telangana. The lift irrigation scheme involves submergence of approximately 32000 ha of land in Telangana, 3211.2974 ha of forest land in Telangana and approximately 302 ha of land, including some forest land in Maharashtra as per pre-feasibility report. The two States formed an Inter State Board for Joint Irrigation Projects, of which one of the projects was KLIS.

As against the factual position depicted above, the project proponent wrongly claims that the project was not for lift irrigation but only for drinking water supply till grant of EC. The application for EC was made only January, 2017. EC was granted in December, 2017 but before that substantial work had already been undertaken. Thus, according to the appellant the impugned EC was *ex post facto*, in violation of EIA Notification, 2006.

3. Apart from the allegation of EC being after the substantial work of the project was completed, further challenge by the appellant is on the ground that the EC was granted without application of mind, overlooking the procedural irregularities as well as environmental aspects. The project, as proposed, underwent change by increase in capacity and inclusion of Mission Bhagiratha to provide drinking water to Hyderabad and certain villages of Telangana but no fresh scoping was done. The pre-feasibility report submitted in January, 2017 and draft of EIA report submitted in July, 2017 did not mention the Mission Bhagiratha which involved interlinking of the two projects. Feasibility of the change project was never evaluated while granting EC. Construction of pump houses started in February, 2017. There is discrepancy with regard to quantity of the forest land in the project. Different area is mentioned in the first application which was withdrawn from the area mentioned in the application filed in January, 2017. EIA report filed by the project proponent was not in consonance with the Terms of Reference (ToR). Baseline data relied upon in the EIA studies did not cover the winter

season. There is deliberate mis-representation of facts regarding proximity of the protected areas, such as National park, sanctuary, biosphere reserve etc. Final EIA report wrongly states that there is no national park for wildlife sanctuary within 10 km buffer. Drainage maps and soil maps are not properly covered by the EIA report. ToR has not been followed in the study of the forest areas. Samples of the baseline data are inadequate and not representative of the entire area. Part of the studies falling in the State Maharashtra have been ignored. Bio-diversity study has not been carried out by associating a suitable organization. Sampling methodology is deficient. EIA report is deficient on the account of inadequate study of flora and fauna in the region. Surprisingly, re-discovery of Cheetahs, which were declared extinct in India in 1952, is mentioned. The project is Seismic Zone 2 which has not been so mentioned. Such site is not suitable for the project. Public hearing was not conducted as per procedure prescribed in the EIA Notification. EIA was not available to the residents for the public hearing. Various environmental issues have not been dealt with in the EIA.

It is further submitted that even after the grant of EC, the project proponent did not follow the EC conditions. The lifting capacity is proposed to be enhanced without any further EC and enhancement of the capacity from 2 TMC/day to 3 TMC/day for the Medigadda Lift System, Annaram Lift System and the Sundilla Lift System will involve substantial modification in infrastructure.

4. To sum up, the objections are:-

a) Grant of EC is *ex post facto*.

b) Terms of reference not followed and fresh scoping not done after modification of the project by increasing the capacity and inclusion of Mission Bhagiratha etc.

c) EIA Notification procedure was not followed in making draft EIA report available to public. The baseline data was not properly conducted as winter season data was left out.

d) There is concealment of material facts including existence of protected areas within 10 km. of the site without wildlife clearance. It is wrongly mentioned that Cheetahs existed. The extent of forest has not been properly mentioned. The area is Seismic Zone –2 which was also not mentioned.

e) The EC condition of impact being studied after five years of commissioning is against the Precautionary principle.

f) There was no proper appraisal of the project.

Proceedings before the Tribunal

5. The appeal was filed on 16.02.2018. Notice was issued to the respondents on 19.02.2018. Parties have filed their pleadings. On 29.07.2019, delay was condoned. On 11.12.2019, application for amendment was allowed permitting objections in the light of the subsequent developments.

6. We may also mention that O.A. No. 113/2020, *Thummanappally Srinivas and Ors. v. UOI & Ors.* was filed before the Southern Zone, Chennai against the proposed increase of pumping capacity. In view of pendency of the appeal before the Principal Bench, the Southern Zone Bench suggested that the application be transferred to the Principal

Bench to be considered along with the appeal. Accordingly, the matter was taken up by the Principal Bench and registered as O.A. No. 204/2020 and directed to be listed for final hearing along with the appeal. The same is being disposed of by a separate order.

Proceedings before the Tribunal prior to EC

7. We may further mention that the appellant earlier filed O.A. No. 370/2017 on 30.05.2017 against the commencement of the project without EC mentioning that there were construction activities in forest area. The land was being sub-merged and huge construction was going on without EC. The project will also affect wildlife without requisite clearance. The project involved budget of more than Rs. 80,000 crores and involved construction of three barrages and diversion of water from the river for irrigation purposes as well as drinking purpose. The States of Maharashtra and Telangana are part of Inter-State Board for joint irrigation project though the responsibility under mutual arrangement for taking requisite clearance is of the State of Telangana. The project was infact 'River Valley' project falling under Entry 1(c) of the Schedule to the EIA Notification, 2006. It could not be commenced without prior EC. EC was applied only on 11.01.2017 and had still not been granted till the filing of the application. The project required 'in principle' clearance from the Central Water Commission (CWC) and Techno Economic Feasibility report. The project will adversely affect the eco system in a big way. The construction will be in forest area without Forest Clearance (FC).

Interim order dated 5.10.2017 by the Tribunal and modification thereof by the High Court at pre-EC stage

7. The Tribunal issued notice on 30.01.2017 and after hearing learned counsel for the parties vide order dated 05.10.2017, granted *ad interim*

injunction restraining States of Maharashtra and Telangana from carrying out any construction activities for the KLIS or activities like felling of trees, blasting and tunnelling in the forest areas in violation of the Forest (Conservation) Act, 1980, till statutory clearances are granted. The stand of the State of Telangana was that the project was irrigation project, conceived by the erstwhile State of Andhra Pradesh which also involved water supply to Hyderabad city and other places enroute Hyderabad. The Mission Bhagiratha was a part of the project to remedy the drought condition in the area. In the said area, ground water was contaminated by chloride. The project was earlier called Dr. BR Ambedkar Pranahita Chevalla Sujala Sravanthi Project, a multipurpose project, involving the States of Maharashtra and Telangana. There was agreement between the two States for the Inter-State Control Board and a Coordination Committee had been constituted. EC was applied on 10.11.2014. The project was redesigned and renamed as it involved submergence of land in Maharashtra. There was change of alignment on account of objections of the State of Maharashtra on which the application for EC was withdrawn and fresh application was filed on 13.01.2017. On the basis of these pleadings, the Tribunal observed that the project was primarily an irrigation project, covering seven districts of the State of Telangana and to such a project the drinking water scheme was also added. The State of Telangana had filed pre-feasibility report in the year 2014. Relevant observations are:-

> *"45 There are two legal issues which confront the State of Telangana. The first is for Kaleshwaram Lift Irrigation Project activity which is designed, conceived and sought to be implemented by the State of Telangana is a "Lift Irrigation Project". **It is primarily irrigation project though of course portion of water that may be harnessed is proposed to be utilized to supply drinking water to Districts en-route to Hyderabad and Hyderabad City. That does not take away the Kaleshwaram Lift Irrigation Project out of the Entry 1(c) of the EIA Notification, 2006 requiring prior Environmental Clearance.***

The second aspect is about Forest Clearance. We need not repeat, except to state that the State has admitted involvement of forest land and therefore in view of the decision of the Hon'ble Apex Court, apart from the Statutory Restriction under the provision of Section 2 of Forest (Conservation) Act, 1980, the project proponent cannot proceed with the project activity till requisite permission are obtained. It is further noticed that the contractor involved in the project is a company called L & T and it is alleged that the company had cleared large extent of forest land, cutting trees indiscriminately for construction of staff quarters for the its employees in the prime forest area. The letter of the Forest officer produced by the applicant substantiates this allegation that number of trees are felled by the contractor executing project and it is apprehended by the Applicant and all concerned that if the project actually proceeds to construct, it will destroy much more area.

46. The applicant has further produced the newspaper report to show that the project proponent was blasting the rocks and tunnels, during such activity an incident occurred in the recent past where, several construction workers died due to land slide, collapse of tunnel supporting structure etc. *The State of Telangana had not disputed the said incident but has brushed it aside as "Accident" beyond its control. We do not wish to record any finding on it. But it is necessary to take note of such incident to know whether the Respondent No. 2 and Respondent No. 4 are proceeding with construction activity after the project is properly evaluated and obtaining environmental clearance and other clearance under provision of Section 2 of the Forest (Conservation) Act, 1980.*

47. For the reasons discussed above, we are satisfied that a prima facie case has been made to injunct the project activity which is undoubtedly impermissible in view of the restrictions imposed by Section 2 of EIA Notification, 2006 and provisions of the Forest (Conservation) Act, 1980, without obtaining required permission."

8. Against the said order, the State of Telangana preferred *W.P. No. 34458/2017, State of Telangana & Anr. v. Md. Hayath Uddin & Ors.* before the Telangana High Court, which was decided on 08.11.2017[1]. The High Court set aside the order of the Tribunal on a preliminary ground that the Tribunal had not decided the objection about the application being beyond limitation laid down under Section 14(3) of the National Green Tribunal Act, 2010 and that the application could not be filed before the Principal Bench and was to be filed before the Southern

[1] 2017 SCC Online Hyd 356 : (2018) 1 ALD 247 (DB)

Bench. However, while leaving it open to the Tribunal to pass a fresh order, the High Court noted that without EC and FC the State of Telangana could not commence the irrigation component of the project and use the forest land for non-forest purposes. It was observed:-

> "75. *On the nature of relief to be granted, we must record our concern regarding certain incidents, referred to in the order of the NGT, which, if true, are indeed disturbing.* ***In its reasoned order, the NGT has noted that the State of Telangana had admitted involvement of forest land in the project, and has held that, in view of Section 2 of the Forest (Conservation) Act, 1980, the project proponent cannot proceed with the project activity till forest clearance is obtained. The NGT has also noted that the contractor, involved in the project, was alleged to have cleared large extents of forest land, cutting trees indiscriminately, for construction of staff quarters for its employees, in prime forest area; and that reliance was placed by the first respondent-applicant on the letter of the Forest Officer to substantiate the allegation that the contractor, executing the project, had felled a number of trees. Yet another incident, which the NGT has referred to in its reasoned order, is that the project proponent had blasted rocks and tunnels; during such activity several construction workers had died due to land slide, and collapse of the tunnel supporting structure, etc. The NGT has also noted that, while the State of Telangana had not disputed the incident, it was brushed aside as an accident beyond its control. It is for this among other reasons that the Principal Bench of the NGT, New Delhi had held that construction activity could only be undertaken after the project was properly evaluated, and environmental and forest clearances were obtained.***
>
> *76. In Vedire Venkata Reddy v. Union of India[2], a Division Bench of this Court held that it is not permissible for the State Government to proceed ahead with the implementation of the project till all clearances are obtained; the action of the State Government in implementation of the project, without obtaining environmental clearance, as envisaged under the provisions of the Environment (Protection) Act, 1986, the rules framed thereunder and the notification, is illegal and arbitrary; and the State Government should not proceed ahead in implementation of the project, and should not undertake any construction work, whether preliminary or otherwise, till environmental clearance is obtained.*
>
> *77. While the petitioner contends that environmental clearance is not required for construction of a drinking water project, they do not dispute that such permission is required for an irrigation project. Despite the assurance of the Learned Advocate-General for the*

[2] AIR 2005 AP 155

State of Telangana that, till final forest clearance is obtained from the Government of India, the petitioner would not fell even a single tree within the limits of the reserve forest, we are of the view that specific directions should be issued to the Government of Telangana in this regard.

*78. **Till orders are passed afresh by the Principal Bench, NGT, and till Final forest clearance is obtained from the Government of India, the petitioner shall henceforth neither encroach upon any part of the reserve forest in connection with the project, nor shall even a single tree therein be felled for the purposes of the project, or for any ancillary activity connected therewith. The State of Telangana shall also not commence construction of distributaries and channels, or undertake ancillary works relating to the irrigation component of the project without obtaining environmental clearance from the Union of India. Works if any undertaken by, and on behalf of, the State of Telangana shall be confined strictly to the drinking water component of the project. Violation of the aforesaid directions can be brought both to the notice of this Court, and to the NGT, by the first respondent-applicant. It would be open to the Principal Bench, NGT, even before it rules on its jurisdiction to entertain the O.A, to take necessary action against the petitioner for such violations, if any brought to its notice, including directing them to stop all construction activity even in relation to the drinking water component of the project.***

VI. CONCLUSION:

79. We are satisfied that failure of the Principal Bench, NGT, New Delhi to examine the jurisdictional issues raised by the petitioner i.e that the O.A. was filed beyond the period prescribed in Section 14(3) of the 2010 Act and its proviso, and it lacked territorial jurisdiction to entertain the present O.A, is fatal, for it is only if the Principal Bench of the NGT, New Delhi has jurisdiction to entertain the O.A, could it have granted the interim relief sought for by the first respondent-applicant.

80. Subject to the aforesaid observations, the Writ Petition is allowed, the impugned order is set aside and the matter is remanded to the Principal Bench, NGT, New Delhi, which shall consider the first respondent-applicant's request for grant of interim relief afresh, and in accordance with law. Miscellaneous Petitions, if any pending, shall also stand disposed of. No costs."

SLP against the High Court order was dismissed. The application was thereafter taken up by this Tribunal on 21.08.2018. This Tribunal noted that since EC stands granted which was subject matter of consideration in appeal No. 20/2018, the entire matter could be considered in the appeal. The application was disposed of.

Stand of the Respondents

9. We may now note the stand of the main contesting respondents i.e. MoEF&CC and the project proponent, the State of Telangana.

Stand of the MoEF&CC

10. The MoEF&CC in its affidavit dated 15.03.2018 stated that the project is for providing irrigation facility and also for providing drinking water facility. It falls under entry 1(c) of the Schedule to the EIA Notification, 2006. EC was granted subject to certain conditions and directions, as per law. Relevant averments are as follows:-

> "5. *That the Kaleshwaram Lift Irrigation Scheme (KLIS),* ***which envisages construction of a barrage across River Godavari near Medigadda Village in Karimnagar District of Telangana State for diversion of 180 TMC of water for providing irrigation facility in 7,38,851 hectares of area covering 7 Districts namely Adilabad, Karimnagar, Nizamabad, Warangal, Medak, Nalgonda and Rangareddy. The project is also proposed to provide drinking water facility to Hyderabad and Secunderabad. The total land requirement for the project is about 37,872 hectares, out of which 3168.1315 hectares is forest land. The total length of water canal system is about 1,832 km.***
>
> 6. ***That this project belongs to Schedule I (c) of Environmental Impact Assessment (EIA) Notification, 2006.*** *An application was submitted along with Environmental Impact Assessment Report and other relevant documents and reports. These reports were appraised and examined by Expert Appraisal Committee (EAC) constituted for River Valley & Hydropower Projects under the provisions of EIA Notification, 2006 to the satisfaction of the members who are experts in their domain fields.*
>
> *7. That as per the provisions of Section 2 of the Forest (C) Act read with Rule 6 of the Forest; (Conservation) Rules 2003, Every user agency (i.e. Project Proponent), who wants to use any forest land for non-forest purpose shall make his application to the concerned nodal officer of the state government authorized in this behalf for prior approval of U/s 2 of Forest (C) Act, 1980.*

8. That as per the decision of Supreme Court in T.N. GODAVARMAN VS. UNION OF INDIA & ORS and EIA Notification, 2006, public consultation is mandatory. In the light of aforesaid judgment, public hearings were conducted in 15 Districts in Telangana and 1 District in Maharashtra by Telangana State Pollution Control Board & Maharashtra State Pollution Control Board as per the extant norms on the subject.

The details are as follows:

Sl. No	***DISTRICTS***	***DATES***
i.	*Karimnagar, Nizamabad, Medchal-Malkajgiri, Yadagdri-Bhunanagiri in Telangana*	*22.8.2017*
ii.	*Peddapally, Nalgonda, Sangareddy, Kamareddy in Telangana*	*23.8.2017*
iii.	*Nirmal, Jagityal in Telangana*	*24.8.2017*
iv.	*Medak, Jayashankar-Bhupalapally Manchiryal, Rajanna Sircilla, Siddipet in Telangana*	*26.8.2017*
v.	*Gadchiroli in Maharashtra*	*27.9.2017*

It is relevant to mention here that main grievance of the local aggrieved persons were lack of irrigation facilities in the region, drinking water problem, compensation in land acquisition, water supply to arid zones etc. Majority expresses happiness over the implementation of the Project."

11. Further affidavit filed by the MoEF&CC is dated 26.09.2019 mentioning the steps taken in the grant of EC. Relevant paras thereform are extracted as follows:-

"3. It is submitted that the Kaleshwaram Lift Irrigation Scheme (KLIS) envisaged to construct a barrage across River Godavari to provide irrigation facility in 7,38,851 ha I 7 Districts of Telangana (Adilabad, Karimnagar, Nizambad Warngal, Medak, Nalgonda and Rangareedy) by diverting 180 TMC of water from River Godaveri. The project is also proposed to provide drinking water facility to Hyderabad and Secunderabad cities.

The total land requirement for the project is about 37,852 ha, out of which 3168.1315 ha is forestland and 34,684 ha is private land. ***The total submergence area is about 18,302 ha.*** *The project lies in the interstate boundary with submergence area of 174.37 ha of area in Maharashtra State.*

4. *It is submitted that the Project was considered by the Expert Appraisal Committee (EAC) in its meetings held on 30-31' January, 2017 and on 2-3rd March, 2017 for Scoping/ Terms of Reference (TOR) clearance. Based on the recommendations of the EAC the Ministry accorded TOR vide letter dated 31' March, 2017 for preparation of EIA / EMP and conduct of Public Hearing.*

5. *It is submitted that the EAC thoroughly examined the project before recommending the project for grant of environmental clearance as per the EIA Notification 2006 and amendments thereof. Further, it is submitted that after considering all the relevant facts of the project as presented by the project proponent, documents submitted by Project Proponent, clarification furnished in response to its observation, EAC recommended for the grant of Environmental Clearance for the project. The Ministry issued the Environmental Clearance (EC) vide letter dated 22/12/2017.*

6. *It is submitted that the minutes of Public Hearings were taken into consideration by the Expert Appraisal Committee (EAC) for River Valley & Hydro Power Sector while appraising the project for grant of Environmental Clearance (EC). The public hearing were conducted in 15Districts (i.e. Karimnagar on 22.8.2017, Nizambad on 22.8.2017, Medchal-Malkajgiri on 22.8.2017, Yadagiri-Bhunanagiri on 22.8.2017; Peddapally on 23.8.2017, Nalgonda on 23.8.2018, Sangareddy on 23.8.2017, Kamereddy on 23.8.2017; Nirmal on 24.8.2017, Jagityal on 24.8.2017, Medak on 24.8.2017; Jayashankar- Bhupalapally on 26.8.2017, Manchiryal on 26.8.2017, Rajanna Sircilla on 26.8.2017 & Siddipet on 26.8.2017) of Telangana and one District (Gadchiroli on 27.9.2017) of Maharashtra as per the provisions of EIA Notification, 2006.*

   Further, it is submitted that EAC has also taken into consideration all the issues raised during Public Hearings and the same is also recorded in the minutes of meeting of the EAC for River Valley & Hydro Power sector. The main issue raised during Public Hearings included - lack of irrigation facilities in the region, improving socio-economic conditions, stabilization of SRSP ayacut (command area), drinking water facility, resolving land acquisition issues at the earliest, rehabilitation benefits for SC/ST communities, R&R as per the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 and compensation at 10 times the basic value of land, filling up of tanks and increasing storage facility of Muraharipally village, provisions of water supply to semi-arid zones, giving employment in the villages, compensation as per Mallanasagar project and seeking reasons for redesigning the project & increasing the reservoir capacity, impact on environment, etc. The project proponent clarified all the queries/issues pertaining to them. Majority expressed happiness over the implementation of the project.

7. It is submitted that the Ministry accorded Stage-I Forest Clearance (FC) on 24.10.2017 and Stage-11 FC on 24.11.2017. The Stage-II FC for diversion of 3168.131 ha was accorded on the basis of the compliance report furnished by the State Government of Telangana for construction of canals, tunnels, lift systems, surge pool, delivery system and reservoir, etc. involved in the KLIS subject to the compliance of the conditions stipulated in State-II FC clearance on 24.11.2017. Therefore, the averments made by the Appellant are baseless and not maintainable.

8. It is submitted that the Ministry's OM dated 29' August, 2017, which inter-alia provides as under:-

> *"The baseline data used for preparation of EIA/EMP reports may be collected at any stage, irrespective of the request for ToR or the issue thereof However, such a baseline data and the public consultation should not be older than 3 years, at the time of submission of the proposal, for grant of Environmental Clearance, as per ToRs prescribed."*

It is submitted that the baseline data used by the Project Proponent for preparation of EIA/EMP report for the proposed project was not more than three-years and hence in conformity with the above said provision. Therefore, the averments made by the Appellant are baseless and not maintainable.

9. It is submitted that detailed flora and fauna study was conducted by the project proponent, and the same was incorporated in the EIA report. As per the EIA report and informed by project proponent, there was no endangered, threatened and endemic category of flora & fauna. Even the project area of both core and buffer zones do not have any breeding habitats, spawning grounds or migratory corridors for wildlife. During the period of survey, no endangered and threatened aquatic fauna have been found."

Stand of the Project Proponent

12. The stand of the project proponent is that the project is for providing water to the drought prone areas of the Telangana. It has two parts: drinking water and irrigation. **The project is primarily for water supply and water management project, which is not covered by the EIA Notification, 2006, in view of the amendment dated 25.06.2014.** With regard to the expansion, it is stated that the decision has been taken to increase drawl of water from 2 TMC/day to 3 TMC/day by the

Telangana govt. on 06.10.2019. **It is stated that the expansion does not alter the infrastructure plans. The State did not proceed with the irrigation component of the Kaleshwaram Project till the necessary and requisite clearances are obtained by them.** The High Court had permitted the answering Respondents to construct only components which would relate to supply drinking water.

It is denied that the EC is *ex post facto.* **The project was being constructed prior to grant EC only for drinking water for which EC was not required. The project started in the year 2008 with construction of series of barrages, reservoirs, pipelines and canals and pump houses to pump water from one reservoir to the other and is still continuing. Major part of the project had already been constructed. Environment Management Plan (EMP) envisages spending Rs. 16,000 crores.** There is no change in the project after filing of Form – 1. EIA report is in consonance with the ToR. EC has been accorded after verification of the study and recommendations and plans for conservation suggested in the EIA/EMP report. Public hearing was duly conducted. The project involves lifting of water from the river during monsoon season and its collection for supply to affected drought areas. It is for overall social welfare. Mission Bhagiratha is not a part of the project. The project will merely provide water to the Mission Bhagiratha which does not imply any change in the project. The Mission Bhagiratha is a different project and has a different project proponent i.e. Rural Water Supply and Sanitation Department. The line diagram is only illustrative and is not to the scale. Location of the pump house has been correctly described in the EIA Report.

Shamirpet tank was not shown in the 'bespoke' and not-to-scale 'line diagram' and the affidavit dated 03.10.2017 because the answering respondents were required to show only the main trunk of the project at that stage. The forest area has been correctly described and application for diversion of such area has been duly made. **Withdrawal of the earlier application for EC and filing of the subsequent application was on account of change in alignment of the project.** The baseline data has been properly compiled in 10 km radius of the main project. The data has been collected for 3 seasons pre-monsoon, monsoon and post monsoon by the Environment Protection Training and Research Institute (EPTRI) which has expertise on the subject. The wildlife clearance is to be taken subsequently. The EIA report contains all relevant studies, using 'Champion and Seth' method. Forest Working Plan has been included in the EIA Report. Reserved forest has been shown in the maps. FC Stage–II has been granted. Adequate number of samples were taken. 10 samples have been taken only for air quality index. There are samples for noise monitoring, water quality, soil quality, traffic data. There is also study about hydrology referring to rain fall data. There is information about the social environment like population density, literacy level, employment level. Anticipated impact and mitigation measures are also mentioned. Public consultation was conducted in 15 Districts of Telangana and one District of Maharashtra. Disclosure requirements have been fulfilled. Comprehensive ecology and biodiversity study have been undertaken. EIA is in conformity with ToR and contains all the relevant studies, data and maps. 3500 citizens attended the public hearing. Lifting of 3 TMC/day water as against 2 TMC/day is to fully utilize the capacity.

Reply of State of Maharashtra

13. We may also refer to the reply filed by the State of Maharashtra on 15.06.2018. It is stated that agreement dated 19.07.2013 was signed between the State of Maharashtra erstwhile Andhra Pradesh **to undertake joint irrigation projects, including the present irrigation project**. The State of Telangana agreed to abide by the existing agreement. Further agreement was signed on 08.03.2016 to form Inter-State Board for joint irrigation projects. The said Board is to resolve pre construction, construction and post construction issues. There is mechanism of joint action and responsibility. In terms of the agreement dated 23.08.2016, **the State of Telangana is to obtain statutory clearances for the project**.

Consideration of Rival Contentions

14. We have heard learned counsel for the appellant, MoEF&CC, CWC as well as the project proponent. At the conclusion of hearing on 12.10.2020, following order was passed:

> *"Hearing concluded.*
>
> *Order reserved. The order will be uploaded on the website on 20.10.2020. A note of written submission, if any, be filed on or before 16.10.2020.*
>
> *We have particularly asked learned counsel for the project proponent and the State of Telangana to respond to the averments in para 4 and 8 of the counter affidavit filed by the Secretary, Department of Water Resources, Ministry of Jal Shakti on 09.10.2020 which refers to a letter dated 07.08.2020 by the Ministry of Jal Shakti to the Chief Minister of Telangana not to proceed with the project without submitting DPR to Godavari River Management Board and without sanction of the Apex Council. The project for expansion has also to be submitted to the CWC, in absence of which we will have to issue directions to that effect."*

15. We have also considered the written submissions filed by the appellant in appeal and the applicant in the connected matter on 16.10.2020. The project proponent has also filed written submission on 17.10.2020 which is also reiteration of the submissions already made. However, the State of Telangana in its written submissions has mentioned in paragraph 32 that the Chief Minister has given reply dated 02.10.2020 to the Minister of Jal Shakti that the project is an old project before bifurcation of the State.

16. In view of the above rival contentions, the basic question is the validity of the impugned EC and in case there is infirmity in the EC, further remedial action. There is also an issue with regard to expansion of the project by way of increase of drawl of water from 2 TMC/day to 3 TMC/day in terms of the decision of the Telangana Government on 06.10.2019, without requisite EC, inspite of opposition by the Ministry of Jalshakti, Govt of India, taking the view that clearances are quired for the same.

17. As noted earlier, the stand of the appellant is that the impugned EC is invalid as the project proponent commenced the project prior to the application. The project was predominantly a river valley project. In support of challenge to the EC, procedural infirmities in failing to undertake fresh scoping when the project was modified after filing application for EC and in concealing material facts regarding existence of wildlife sanctuary. On the other hand, the stand of the MoEF&CC and Project Proponent is that EC has been duly granted. According to the Project Proponent the project is primarily for water supply and water management and is not covered by the EIA Notification, 2006, as initially conceived. The State did not proceed with the irrigation component in

the project till all the necessary clearances were obtained. Only components relating to supply of drinking water were constructed which did not require any EIA. According to State of Maharashtra, the project is irrigation project but taking clearance is responsibility of Telangana. The MoEF stand is that the project is Irrigation project but also involves water supply. No comment has been made about requirement of EC prior to undertaking substantial execution of the project from 2008 to 2017.

18. We are unable to accept the stand of the project proponent that primarily the project is for water supply and water management and that irrigation is subsidiary or incidental part of the project so as to hold that no EC was required prior to execution of the project from 2008 to 2017. We are also unable to agree that the State did not proceed with the irrigation component in the project till the clearances were granted and only constructed components relating to supply of drinking water. There is no basis for the submission that no part of execution of the project prior to EC related to Irrigation purpose as project is admittedly integral and inseparable. The argument, if accepted, will defeat the law.

19. It remains undisputed that the project involves budget of Rs. 80,000 Crores. EMP itself has a provision for Rs. 16,000 Crores. There is a provision for construction of three barrages. Irrigation for 7 lakhs hectares of land is envisaged. 18000 hectares of land is to be submerged as per the EC. Out of 180 TMC of water to be lifted and diverted from Godavari, 134.5 TMC is for Irrigation and 40 TMC is for drinking. The remaining is for other purposes, including Industrial as noted earlier. The project started in the year 2008 with construction of barrages, reservoirs, pipelines, canals and pump houses. Major part of the project

was constructed prior to EC. The stand of the project proponent that the project executed prior to EC is unrelated to irrigation is patently untenable and if accepted, will defeat the law. It is for this reason that prior to EC, this Tribunal and the High Court had to grant injunction against development of infrastructure after finding massive activities of construction of barrages involving blasting and other such activities. All such activities are clearly part of the Irrigation project which cannot be separated from other objectives. It is difficult to accept that all such activities are only for drinking purpose. The State has led no evidence in support of the plea that all earlier activities are exclusively for water supply. The State could produce documents like contracts to show that the infrastructure had no nexus for the irrigation. This plea is not shown to have been gone into by the MoEF while granting EC.

20. Even according to the project proponent, EC was applied earlier in the year 2014 but the application was withdrawn on account of change of alignment. This negates the plea that the project proponent was not contemplating seeking EC at that time. The project had serious implication in terms of environment. It was never exclusively a water supply project. Even in 2008, report filed by the project proponent with its affidavit, it is clearly mentioned that the project is a multipurpose project as apart from irrigation, it also involves drinking water supply. Thus, to say that from 2008 till December, 2017 when EC was granted, by which time project was almost completed, activities related only in relation to the drinking water supply and not with the irrigation and that the irrigation project activities commenced thereafter is difficult to accept. As already mentioned, the Tribunal as well as the High Court clearly found that the project proponent was illegally proceeding with

construction activities for the irrigation project and also diverting forest land for non- forest purposes without prior clearances. While injunction was granted by the High Court against such activities, the substantial activities had already been undertaken without prior EC. The MoEF&CC has not even adverted to this aspect either while granting EC or even in the reply filed before this Tribunal. It is not the case of the MoEF&CC that the project undertaken from 2008 to 2017 was only in relation to water supply and not in relation to irrigation infrastructure.

21. In *Hanuman Laxman Aroskar v. UOI*[3], the Hon'ble Supreme Court held that objective of the EIA was balancing of environmental and developmental concerns to give effect to the principle of Sustainable Development.[4] The development agenda of the Nation must be carried out in compliance with the norms for protection of environment. There is no trade-off between the two. Environment protection is an essential facet of development. The laid down procedure must be meticulously followed. The material information must be disclosed in Form-I. Mere substantial or proportionate compliance is not adequate. Strict standards must be complied with and burden of compliance rests on the project proponent.[5] Ecologically sensitive areas must be duly factored because of presence of flora and fauna. Environmental Rule of Law is based on pillars of Sustainable Development – economic, social, environment and peace. It has to .take precedence in the light of Stockholm Conference. This requires effective, accountable and transparent regime. The EIA Notification is a significant link in quest to pursue SDGs[6]. If there is a failure of due process in grant of EIA,

[3] (2019) 15 SCC 401
[4] Para 58
[5] Para 88
[6] Para 144, 169

remedial action has to be taken by requiring the EAC to revisit the recommendations for grant of EC.[7]

22. In *Alembic Pharmaceutical Ltd. V. Rohit Prajapati & Ors.*[8] the Hon'ble Supreme Court held, following the earlier view, that concept of *ex post facto* clearance is contrary to the requirement of prior EC.[9] Such concept is detrimental to the environment and can lead to irreparable degradation. EC can be issued only after various stages of decision-making process which are meant to ensure that all necessary safeguards are duly appraised by the experts before the project starts. *Ex post facto* EC will condone the violations and, in the process, irreparable harm may be caused to the environment. The Hon'ble Supreme Court upheld the quashing of circular of the MoEF dated 14.05.2002 permitting *ex post facto* EC. However, it was held that on failing to take prior EC, revocation of EC may not be the only option. The project proponent must be held accountable for non-compliance by way of requiring restitution and restoration.[10] Same view was taken in *Keystone Realtors Pvt Ltd. V. Anil V. Tharthare & Ors.*[11] it was observed that undertaking of expansion without prior EC denies opportunity to evaluate mitigation measures.[12]

23. In *Re: construction of Park at Noida near Okhla Bird Sanctuary v. UOI & Ors.*[13], the issue for consideration was whether EC was required for the project of setting up of a Memorial Complex at Noida near Okhla Bird Sanctuary. The stand of the project proponent was that the project was only development of a park while the contention in support of the

[7] Para 172, 175
[8] 2020 SCC OnLine SC 347
[9] Para 27
[10] Para 49
[11] (2020) 2 SCC 66
[12] Para 21
[13] (2011) 1 SCC 744

challenge to the project was that it involved building and construction. The Hon'ble Supreme Court held that 'dominant nature' test was required to be applied for determining whether EC was required and whether the project was covered by the Schedule to the EIA Notification, 2006[14]. It was further held that even if there was no laid down requirement of EC, environment protection being guaranteed under Article 21 of the Constitution, if there is any perceived harm to the environment, likelihood of such adverse impact must be duly examined[15]. Even after holding that EC was not required, the Hon'ble Supreme Court constituted Committees of experts which suggested protective and mitigation measures. The Hon'ble Supreme Court directed all such measures to be adopted.[16]

24. The issue relating to 'river valley projects' have been directly considered *inter-alia* in *Narmada Bachao Andolan v. UOI & Ors. (Sardar Sarovar Dam)* [17] *and N.D. Jayal & Anr.* v. UOI & Ors. (Tehri Dam)[18]

25. In *Narmada Bachao Andolan v. UOI & Ors.* one of the objections against the project was absence of proper EIA. The project proponent however defended the same as being in national and public interest particularly to provide drinking water in water scarce area. The project also provided for irrigation, industrial water supply, hydro-electric power and control of floods. The Hon'ble Supreme Court noted the studies undertaken on the subject at various levels and did not accept the plea that construction of the dam will have adverse ecological impact[19].

[14] Para 67
[15] Para 74
[16] Para 77-84
[17] (2000) 10 SCC 664
[18] (2004) 9 SCC 362
19 Para 119

Distinguishing the judgement in *Vellore Citizens' Welfare Forum v. UOI*[20] dealing with the 'Precautionary' and 'Polluter Pays' principles and special rule of burden of proof, it was observed that ecological disaster could not always be presumed from violation of procedure, if mitigative steps are taken[21]. Construction of dam was not at par with polluting industries or nuclear establishments which results in ecological degradation.[22] Thus, it was found that all due precautions had been taken and studies carried out. There were measures for relief and rehabilitation. The mitigation measures were being duly monitored. There was a Grievance Redressal Authority. The benefits for river valley projects in terms of food safety, water supply, energy supply, etc. were taken into account to offset the loss caused by displacement of persons, loss of forest and adverse impact on ecology.[23]

26. In *N.D. Jayal & Anr. v. UOI & Ors.*, while considering the Tehri Dam Project, it was observed that sustainable development is component of Right to Life. Thus, powers of the Environment Authorities were coupled with duty to enforce the guaranteed Right to Environment[24]. In the light of the said principle, directions were issued to monitor compliance of conditions for EC, apart from the existing mechanism under the MoEF&CC.

27. In the present matter, the project is predominantly for Irrigation though water supply is also involved. Plea to the contrary is untenable. Thus, the EC has been granted ex post facto in violation of legal

[20] (1996) 5 SCC 647
[21] Para 122 & 123
[22] Para 124
[23] Para 238-244
[24] Para 24-26

requirement for prior EC. Question is what consequences follow in the facts of the present case.

28. Right at the outset, we asked learned counsel for the appellant as to what was to be done if the project had already been substantially undertaken prior to grant of EC in violation of law. He fairly suggested that in such a situation what was required is to take suitable mitigation measures.

29. We find that inspite illegality found, it is neither possible nor desirable to undo what has happened but accountability needs to be fixed and remedial measures taken. As already noted, the MoEF&CC has not, in granting EC, gone into the issue whether the project had been substantially constructed without prior EIA and in the light of such factual position, what further safeguards were required and how the project proponent is be held accountable for violation of law and presenting *fait accompali*. Mere plea that the project was multi-purpose project and also had a component for which EC may not be required, was not sufficient for the project proponent to have gone ahead without the impact assessment and it is on that account that an injunction was issued by this Tribunal and by the High Court. Since we have found that there is major infirmity in EC being sought *ex post facto*, it is not necessary to go into other points. The fact remains that the project has been completed and only issue is of remedial action and future precautions.

30. We find that undoubtedly the project seeks to provide drinking water to the needy people and irrigation facilities to improve agricultural productivity which serves public interest. Also huge amount of public

money has been spent. At the same time, it is not necessary that for such development, damage to environment must be ignored and adequate safeguards are not to be adopted. Environmental rule of law need not be considered to be in conflict with the need for development but a facet of development. The development has to be sustainable and the light of principles which the country has accepted in the form of the frame work of legislation and best environmental practices.

31. Beyond submitting that there is damage to the environment on account of the project having been executed without prior EC, there is no tangible material before the Tribunal on the basis on which a specific direction for mitigations, restoration and rehabilitation measures can be directed. This exercise was expected from the experts recommending and the authorities granting EC. The project proponent should have been held accountable for the violations. This exercise may have to be undertaken now to enforce the rule of law.

32. Accordingly, we direct the MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to go into the matter in light of observations hereinabove. It may assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into. In this regard, we also note that the EC was granted with reference to ToR based on Form-I submitted by the project proponent, without considering the changes which have taken place in the project subsequently. The Expert Committee may also examine effective implementation of EMP earlier

submitted by the project proponent based on which EC was granted and compliance of EC conditions. The Expert Committee may be constituted within one month and it may complete its exercise within six months thereafter. The progress may be finally monitored by the Secretary, MoEF&CC. Any affected party will be at liberty to make representation to the MoEF&CC within three weeks putting forward suggestions and grievances, which may be taken into the account by Committee. The MoEF&CC may consider measures to prevent recurrence of such violations where EC is sought *ex post facto*. This is particularly required when the projects are multipurpose projects and part of it requires EC, so that such requirement is not defeated on specious plea that the project was partly not covered by the Schedule, as has happened in the present case. For this purpose, instead of confining consideration merely to Form–I, a mechanism is required to be evolved and followed whereby physical verification of material particulars can be undertaken, wherever necessary.

33. We are further of the view that the decision for expansion taken by the Telangana Govt. on 06.10.2019 is without EC and not tenable in view of stand taken by the CWC in O.A No.204/2020.[25] The stand of the State, that expansion of the project by extraction of 3 TMC/day instead of 2 TMC/day does not involve any infrastructural changes and therefore EC is not required, cannot be accepted. Extraction of more water certainly requires more storage capacity and also affects hydrology and riverine ecology of Godavari River. Such issues may have to be examined by the concerned statutory authorities. *Prima facie*, it is difficult to accept the plea that enhancement of capacity by one third will not require any infrastructural changes. In any case, this aspect needs to be

[25] Para 8

evaluated by the statutory expert Committees before the expansion is undertaken. The Minister of Jal Shakti vide letter dated 07.08.2020 addressed to the Chief Minister, Telangana has requested that the State may not proceed with the project without submitting DPRs to Godavari River Management Board (GRMB) and also without obtaining sanction of the Apex Council. CWC has also stated that no project proposal with respect to expansion of the project has been submitted to it as required. In these circumstances, the stand in the letter of the Chief Minister dated 02.10.2020 needs to be looked into by the Ministry of Jal Shakti and the State may proceed on the basis of such decision. The directions of the Central Government are binding and unless challenged and set aside. the same have to be followed.

The appeal stands disposed of in above terms.

Copies of this order be forwarded to MoEF&CC, Secretaries, Ministry of Jal Shakti and. Ministry of Power Govt. of India, CWC, State of Telangana, State PCB and GRMB by e-mail.

Adarsh Kumar Goel, CP

S. P. Wangdi, JM

Dr. Nagin Nanda, EM

October 20, 2020
Appeal No. 20/2018
A

Annexure 2

REPORT IN REFERENCE TO COURT CASE - APPEAL NO. 20 OF 2018 TITLED AS

MD. HAYATH UDDIN AND OTHERS VERSUS UNION OF INDIA AND ORS BEFORE

THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

INDEX

****

KALESHWARAM PROJECT

1. INTRODUCTION

BRIEF DESCRIPTION ABOUT THE PROJECT

Kaleshwaram project was formulated to irrigate 7,38,851 ha in thirteen districts in the project out of fifteen districts i.e., Jayashankar, Bhupalpalli, Peddapalli, Mancherial, Karimnagar, Jagityal. Nirmal, Nizamabad, Kamaraeddy, Rajanna Siricilla, Siddipet, Medak, Sangareddy, Yadadri-Bhongiri, Nalgonda and Medchal districts ofTelangana by diverting 180 TMC of water from River Godavari. Thesource point is near Medigadda Village, below the point of confluence of Pranahitha river with Godavari River, about 20 km from Kaleshwaram.

Central Water Commission (CWC) has assessed the availability of 282 TMC of water at Medigadda site. Out of which, about 180 TMC is proposed to be lifted for the Kaleshwaram project. The overall water availability for the project- including the yield from tanks, utilizable groundwater and additional water availability at Yellampally barrage - works out to be about 225 TMC. The project is formulated & designed after careful planning and realistic approach.

The project consists of various components like:

1. Three Barrages Across River Godavari Between Yellampally and Medigadda viz.

a. Medigadda Barrage (LAXMI) on Godavari near Medigadda (Kaleshwaram),
b. Annaram Barrage (SARASWATI)on Godavari downstream of the confluence of Manair River with Godavari River near Annaram
c. Sundilla Barrage (PARVATI) on Godavari downstream of Yellampally barrage near Sundilla.

2. Water Conveyance System Consisting of Gravity Canal.

The entire project has been divided into seven links. The total length of the canals is 1832 km.

3. Distributary Network System

It is proposed to provide distributary network to the command area of 7,38,851 ha (18,25,700 acres) covering thirteen districts to irrigate the entire area.

The utilization of 180 TMC of diverted Godavari water is utilized for drinking water to Hyderabad (30 TMC), drinking water to end route villages (10 TMC) & for industrial uses (16 TMC) and the additionally available 45 TMC enroute water along the conveyance system will be distributed for Irrigation purpose (134.5TMC), stabilization of existing command area (34.5 TMC). The Key Map and the line diagram showing project details link wise is given as Fig1.1 and Fig.1.2 respectively as below :-

Fig 1.1: Key Map

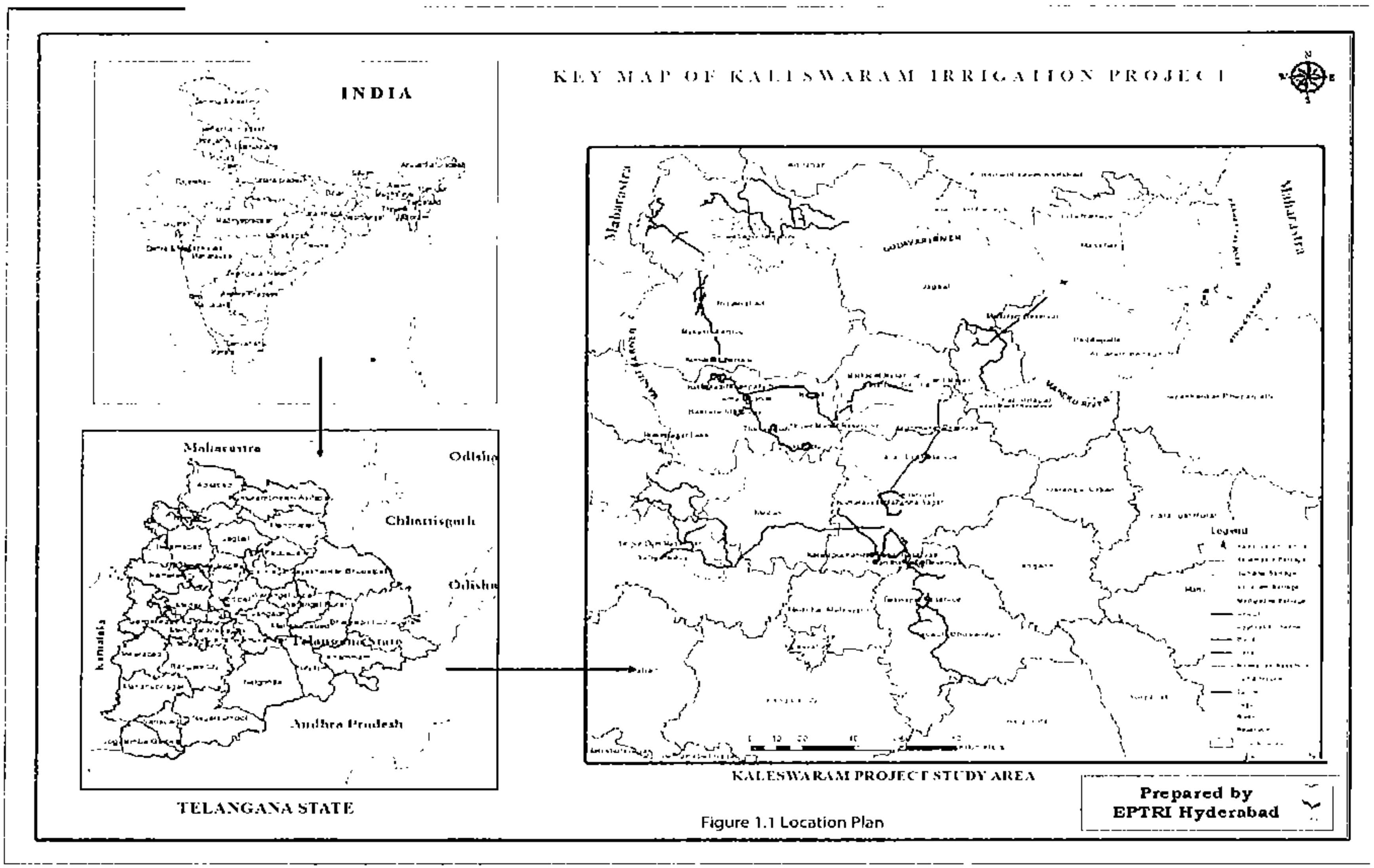


Figure 1.1 Location Plan

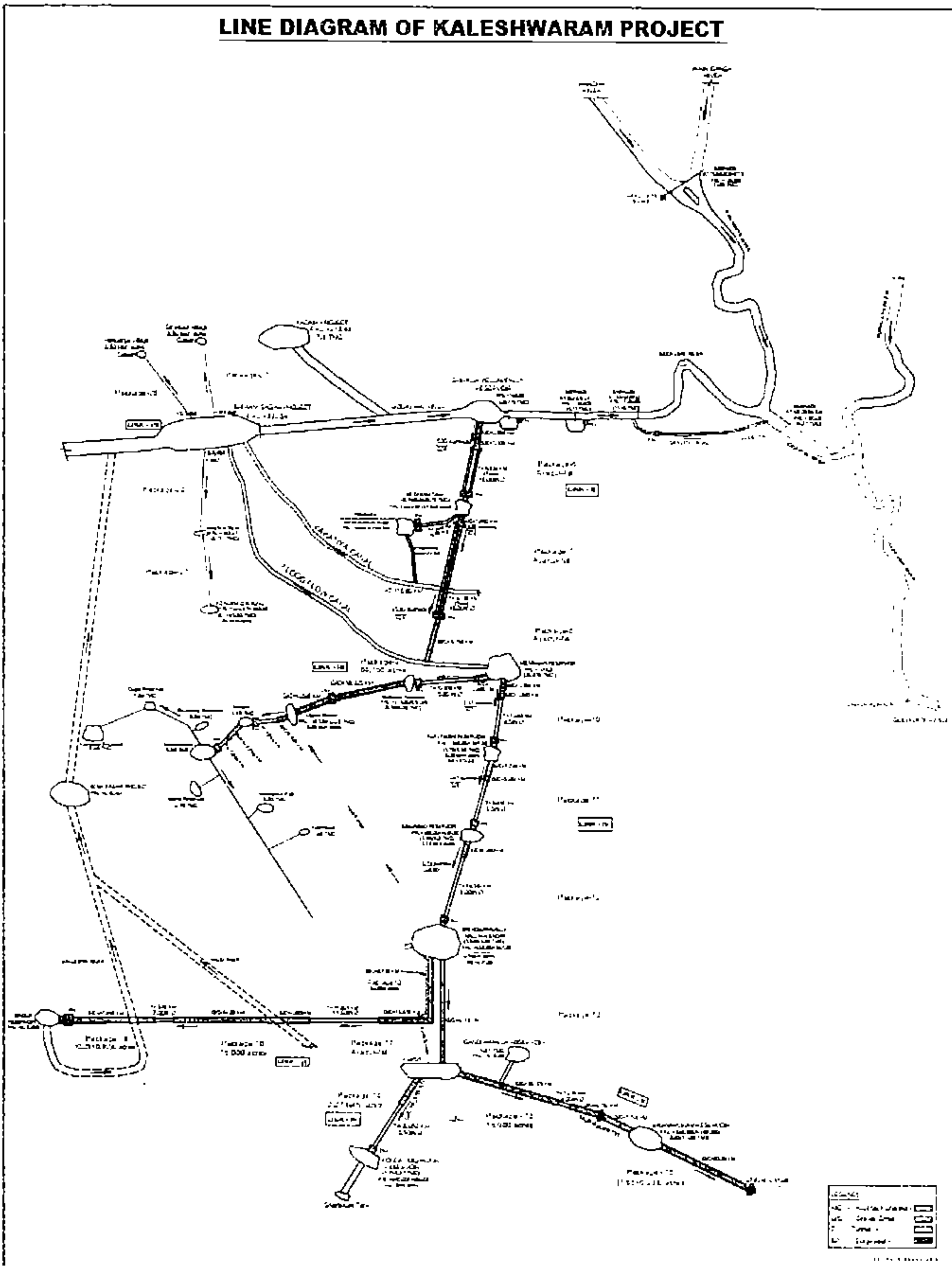


Fig 1.2

The details of the project components are discussed as following:

Transfer of water through lift schemes and conveying it to water deficient, upland regions of Telangana is a pressing need towards a more equitable development of water resources for drinking water supply, irrigation and other requirements. The total demand for these purposes works out to be 225 TMC. Lift irrigation in this region is of strategic importance as:

Diversion of 180 TMC of Godavari water to Sripada Rao Yellampally project and subsequently to Mid Manair Reservoir by lifting it to the lands on higher contour, to bring large extent of land in the basin under irrigation.

i. To create an additional irrigated area of about 7,38,851 ha (18,25,000 acres) in Peddapalli, Karimnagar, Jagityal, Nirmal, Nizamabad, Kamaraeddy, Rajanna Siricilla, Siddipet, Medak, Sangareddy, Yadadri-Bhongiri, Nalgonda and Medchal districts including drinking water to Hyderabad and Secunderabad, to the villages enroute and to meet the industrial requirements.

ii. To stabilize existing irrigated area under SRSP Stage-I & Stage-II, Flood Flow Canal project, Singur and Nizam Sagar projects.

iii. To recharge the groundwater by changing over from usage of groundwater for irrigation to usage of surface water and conjunctive use of groundwater.

2. SALIENT FEATURES

The Salient Features of Kaleshwaram Project is briefed as below:

KALESHWARAM PROJECT, TELANGANA		
SALIENT FEATURES		
SL.NO	**ITEMS**	**FEATURES**
1	**Name of the Project**	Kaleshwaram Project
2	**Type of Project**	Multipurpose
3	**Location**	Telangana, Karim Nagar District, Medigadda Village, near Kaleshwaram
3.1	**River Basin**	Godavari
	a) Name	Godavari
	b) Located in	Telangana, Karim Nagar District, Medigadda Village, near Kaleshwaram
3.2	**River**	Godavari
3.3	**State**	Telangana
	a) Reservoir	Telangana State, Karimnagar Districts
	b) Head work	Karimnagar District, Mahdevpur Mandal,
	c) Command Area	Karimnagar, Medak, Warangal, Nalgonda, Rangareddy, Nizamabad, Adilabad Districts

KALESHWARAM PROJECT, TELANGANA		
SALIENT FEATURES		
SL.NO	**ITEMS**	**FEATURES**
	d) Power House	NA
3.4	**Name of village near the Head-works**	Medigadda
3.5	**Location**	
	a) District	Karimnagar
	b) Latitude	Lat 80° - 04'-37" East
	c) Longitude	Long 18°-42'-48"North
	d) Lies in Earthquake Zoneno.	Zone III
3.6	**Projectarea referenceto**	Survey of India
	a) Degree Sheets	New - E44I-, E441-2, E44H-5, E44H-9, E44H-10, E44H-13, E44H-14 Old - 65B1, 65B2 . 56N13, 56 N/9, 56 N/10, 56N/14, 56N/5 , 56 N/9
	b) Index Plan	Index plan enclosed
3.7	**Access to the project**	

KALESHWARAM PROJECT, TELANGANA				
SALIENT FEATURES				
SL.NO	**ITEMS**	**FEATURES**		
	a) Airport	Hyderabad (280 km)		
	b) Rail head	Mancherial (55 km)		
	c) Road Head	Bhopalpattnam (50 km)		
	d) Sea Port	Vishakhapatnam and Kakinada		
4	**Estimated Life of the project (years)**	100 years		
5	**Irrigation (ha.)**			
	a) New CCA	7,38,851 ha	(18,25,700 acres)	
	b) Stabilising of existing CCA	7,62,0281 ha	(18,82,970 acres)	
6	**Flood control**	NA		
7	**Navigation**	NA		
8	**Water Supply**	Drinking water requirement of command area including requirement of Hyderabad & Secundrabad		
9	**Hydrology**			

KALESHWARAM PROJECT, TELANGANA				
SALIENT FEATURES				
SL.NO	**ITEMS**	**FEATURES**		
		Medigadda Barrage	**Annaram Barrage**	**Sundila Barrage**
	Catchements area at headwork site (sq.km)	225652	1, 17, 535	103482
	75% Annual Net Yield at the proposed site	7993.5MCM (282.3 TMC)	-	-
	Proposed utilization by the Project	6370.65 MCM (225TMC)	-	-
	Total proposed utilization by the project	**180 TMC from Medigadda (through two barrages Annaram and Sundila) plus 20 TMC from Sripada Yellampally barrage plus 25 TMC from ground water self yield of tanks**		
	Estimated flood (Cumec)			
a)	50 year return period	70000 Cumecs	-	-
b)	100 year return period	80000 Cumecs	65000 Cumecs	57000 Cumecs

KALESHWARAM PROJECT, TELANGANA				
SALIENT FEATURES				
SL.NO	**ITEMS**	**FEATURES**		
c)	500 year return period	100000 Cumecs	-	-
	Design flood (Cumec)			
	Dam	NA	NA	NA
	Weir / Barrage	80000 Cumecs	65000 Cumecs	57000 Cumecs
	Construction Diversion	NA	NA	NA
	Flood control works	NA	NA	NA
10	**Barrage Storage**			
a)	Water levels (EL – M)			
	High Flood level (HFL) in m	102.4	124.5	134.5
	Pond level (m)	100	120	130
	.Minimum draw down level	NA	NA	NA
	Dead storage level	NA	NA	NA
b)	Free board (m)	2	2	2

KALESHWARAM PROJECT, TELANGANA				
SALIENT FEATURES				
SL.NO	**ITEMS**	**FEATURES**		
c)	Wave height (m)	NA	NA	NA
d)	Live storage (M. Cum)	457.87	336.96	144.70
	Live storage (TMC)	16.17	11.9	5.11
		Medigadda Barrage	**Annaram Barrage**	**Sundila Barrage**
11	**Submergence**			
	Total Submergence (ha)	9365	2986	1355
	In Telangana (ha)	384	542	153
	In Maharasthra (ha)	302		
	River Area (ha)	8679	2444	1202
12	**Head Works**	.		
	Dam	No	No	No
	Barrage	Yes	Yes	Yes
	Location with respect to dam if any		60 KM Downstream of Sripad Sagar	About 25 KM Downstream of Sripad

KALESHWARAM PROJECT, TELANGANA				
SALIENT FEATURES				
SL.NO	**ITEMS**	**FEATURES**		
		200 KM Downstream of SRSP	(Yellampally Barrage)	Sagar (Yellampally Barrage)
	Total Length (m)	1632 m	1119 m	986 m
	Spillway bays	1308 m	909 m	785 m
	Sluice Bays	324 m	210 m	191 m
	Full pond level	100.00 m	120.00 m	130.00 m
	Free Board	2.00 m	2.00 m	2.00 m
	Maximum height of spillway crest above deepest foundation (m)	3.50	1.50	1.60
	Length of bay (m)	·15.00 clear	15.00 clear	15.00 clear
	Crest level (EL m) for Spillway	89 .00m	109.00m	120.00m
	Crest Level For Under Sluice	88 .00m	108.00m	119.00m

KALESHWARAM PROJECT, TELANGANA				
SALIENT FEATURES				
SL.NO	**ITEMS**	**FEATURES**		
	i) Number of gates in Spillway bays	68	47	41
	ii) Number of gates in Under Sluice bays.	17	11	10
13	**Type of gates**			
	Size of gate for Spillways (m)	15 x 14	15 x 15.50	15 x 14.50
	Size of gate for Under sluice (m)	15 x 15	15 x 16.50	15 x 15.50
	Type of energy dissipation arrangement	Hydraulic jump on cistern floor	Hydraulic jump on cistern floor	Hydraulic jump on cistern floor
	Maximum discharging capacity (Cumec)	80000	65000	57000
14	**Tail water (EL – M)**			

KALESHWARAM PROJECT, TELANGANA							
SALIENT FEATURES							
SL.NO	**ITEMS**	**FEATURES**					
	i) Maximum	102.4		124		133.7	
	ii) Minimum	91.3		108.6		120.6	
15	**Guide bunds**						
		Medigadda Barrage		**Annaram Barrage**		**Sundila Barrage**	
	Left Side	**Upstream**	**Down stream**	**Upstream**	**Down stream**	**Upstream**	**Down stream**
	Length m	2162	430	1119	336	1619	281
	Top Level m	105	104.5	127	126	136.7	135.7
	Right Side						
	Length m	2162	430	1119	336	1619	281
	Top Level m	105	104.5	127	126	136.7	135.7

KALESHWARAM PROJECT, TELANGANA							
SALIENT FEATURES							
SL.NO	**ITEMS**	**FEATURES**					
16	**Tie Bund**	**Length m**	**Top Elevation (EL) in m**	**Length m**	**Top Elevation (EL) in m**	**Length m**	**Top Elevation (EL) in m**
	Left Side	1070	105	1044	127	511	136.7
	Right Side	1595	105	864	127	1551.56	136.7
	Weir	NA		NA		NA	
	Head Regulator	One number on right		One number on right		One number on right side	
	Intake well	NA		NA		NA	
17	**Power**	No power generation					

KALESHWARAM PROJECT, TELANGANA		
SALIENT FEATURES		
SL.NO	**ITEMS**	**FEATURES**
	Total Length of the Conveyence System (km)	1832 Km
	Gravity Canal (km)	1531 km
	Tunnel Gravity (km)	203 km
	Pressure Main (km)	98 km
18	**Lift (no's)**	20
	Pump House (no's)	19
	Total Power required (MW)	4627.24 MW
	Energy required (million units)	13558 MU
19	**No of existing online balancing reservoirs**	5 nos
	New Proposed online	

KALESHWARAM PROJECT, TELANGANA		
SALIENT FEATURES		
SL.NO	**ITEMS**	**FEATURES**
	reservoirs (no's)	20 nos'
	Cost in crores	Rs 80, 499.71 Crores
	BC Ratio	1.55

As per the EIA notification, 2006, and its subsequent amendments, Kaleshwaram Project comes under River Valley Project category - schedule 1(c) "Category A", as it has more than 10,000 ha of Culturable Command Area (CCA). The project has the total culturable command area of 7,38,851 ha (18.25 lakh acres).

CHRONOLOGY OF THE PROJECT

Chronology of the project/ Events –Leading to this Report.

1) Ministry of Environment, Forest & Climate Change has issued the Terms of Reference (ToR) on 31st March 2017 vide Ref. No. J-12011/1/2017- IA- I(R) - (Annexure - I).

2) Ministry of Environment, Forest & Climate Change granted Environment Clearance on 22nd December 2017 vide Ref. No.: J-12011/1/2017-IA-I(R) – (Annexure - II).

3) Ministry of Environment, Forest & Climate Change granted Stage - I Forest Clearance vide F.NO 8-31/2017-FC Dt:24/10/2017 – (Annexure-III).

4) Ministry of Environment, Forest & Climate Change granted Stage – II Forest clearance vide F. No:8-31/2017FC Dt:24/11/2017 – (Annexure-IV)

5) Central Ground Water Board granted NOC Vide Lr No.: 4-1/CWC-PA/SML/CGWB/2017-1945 dated: 21/11/2017 – (Annexure-V).

6) Hon'ble NGT Order dated 20/10/20 in the matter of Md. Hayath Udin & Others Appeal no :20/2018 – (Annexure-VI).

7) The scientist from Southern Regional Office along with officers of Telangana Pollution Control Board and the project Authorities visited the project sites between 6/08/2017 and 09/08/2017 some of the abstracts of the referred Site Visit Report of R.O of Southern Regionto the Kaleshwaram projectsite vide letter No: EP/12.7/NGT(SZ)/21/2017 Dt:11/08/2017 is abstracted here below and the complete reportwith all annexures is enclosed – (Annexure-VII).

8) Constitution of an Expert Committee in Pursuance of Hon'ble NGT order dated 20/10/2020 as above referred – Order – (Annexure-VIII).

4. THE REPORT OF THE COMMITTEE

Introduction :

This report has been prepared by a committee constituted by the MoEF&CC in compliance with the directions of the Hon'ble NGT vide order dated 20.10.2020 in an appeal made in O.A. No. 372 of 2017 in the matter of Md. Hayath Uddin Vs Union of India and Ors. before Hon'ble NGT, New Delhi, which was against letter dated 22.12.2017 of the Ministry of Environment Forest and Climate Change (MOEF&CC) & EAC Granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) Project in Kaimnagar District of Telangana by Irrigation & Command area Development (I and CAD) department, Government of Telangana. Hon'ble NGT in the order ibid had directed MoEF&CC to Constitute a seven-member Expert committee preferably out of EAC members with relevant sectorial expertise to assess the extent of damage caused in going ahead with the project without (EC from 2008 to 2017) and identify the restoration measures necessary, Relief and Rehabilitation measures adopted and required to be further adopted may also be looked info.

It is pertinent to mention here that most of the project components of the project already stood constructed by the time the committee was constituted and therefore the committee was tasked to evaluate the environmental damage caused by the Project Proponent during the course of the execution of the project spanning 2008-2017 in the absence of environmental clearance which was granted by MoEF&CC vide letter dated 22.12.2017.

In view of the order dated 20.10.2020, Ministry constituted an Expert Committee comprises of following members to achieve the work specified by the Hon'ble NGT within the time frame of six months:

1.	Shri Balraj Joshi	:	Chairman
2.	Shri K. Gowarappan	:	Member
3.	Dr. Mukesh Sharma	:	Member
4.	Dr. A. K. Malhotra	:	Member
5.	Shri Amarendra Kumar Singh	:	Member
6.	Dr. Narayan Shenoy K	:	Member
7.	Dr. J. A Johnson	:	Member

Following are the terms of references that the committee has to refer to achieve the objective with in the schedule time:

1) Examination of DPR to ascertain the allocation of water for different usage like irrigation and drinking water etc.
2) Examination of relevant contractors /work orders since 2007

3) Examination of various court orders and other statutory clearances applicable and obtained by the project proponent.
4) Verification of kml file on DSS
5) Virtual meeting with the project Proponent for deliberation and the project and clarification from the project proponent. if any required
6) Site visit by the committee to physically verify the construction of the project.
7) Examination of the report on the compliance of EC Conditions by regional office MOEF & CC
8) Assessment of environmental damage and remedial measures.
9) Relief and rehabilitation measures adopted and required to be further adopted may also be looked into.
10) To examine the effective implementation of the EMP submitted by the PP to obtain the EC and status of compliance of EC conditions.
11) Any other additional terms of reference as deemed appropriate by the Expert committee in light of the order Hon'ble NGT

Some of the salient Paragraphs of Hon'ble NGT order dated 20/10/2020 are quoted below:

a) "We are unable to accept the stand of the project proponent that primarily the project is for water supply and water management and that irrigation is subsidiary or incidental part of the project so as to hold that no EC was required prior to execution of the project from 2008 to 2017. We are also unable to agree that the State did not proceed with the irrigation component in the project till the clearances were granted and only constructed components relating to supply of drinking water. There is no basis for the submission that no part of execution of the project prior to EC related to Irrigation purpose as project is admittedly integral and inseparable. The argument, if accepted, will defeat the law.

b) It remains undisputed that the project involves budget of Rs.80,000 Crores. EMP itself has a provision for Rs. 16,000 Crores. There is a provision for construction of three barrages.

c) Irrigation for 7 lakhs hectares of land is envisaged. 18000 hectares of land is to be submerged as per the EC. Out of 180 TMC of water to be lifted and diverted from Godavari, 134.5 TMC is for Irrigation and 40 TMC is for drinking. The remaining is for other purposes, including Industrial as noted earlier.

d) The project started in the year 2008 with construction of barrages, reservoirs, pipelines, canals and pump houses. Major part of the project was constructed prior to EC. The stand of the project proponent that the project executed prior to EC is unrelated to irrigation is patently untenable and if accepted, will defeat the law. It is for this reason that prior to EC, this Tribunal and the High Court had to grant injunction against development of infrastructure after finding massive activities of construction of barrages involving blasting and other such activities. All such activities are clearly part of the Irrigation project which cannot be separated from other objectives. It is difficult to accept that all such activities are only for drinking purpose.

e) The State has led no evidence in support of the plea that all earlier activities are exclusively for water supply. The State could produce documents like contracts to show that the infrastructure had no nexus for the irrigation. This plea is not shown to have been gone into by the MoEF while granting EC.

f) Even according to the project proponent, EC was applied earlier in the year 2014 but the application was withdrawn on account of change of alignment. This negates the plea that the project proponent was not contemplating seeking EC at that time. The project had serious implication in terms of environment. It was never exclusively a water supply project. Even in 2008, report filed by the project proponent with its affidavit, it is clearly mentioned that the project is a multipurpose project as apart from irrigation, it also involves drinking water supply. Thus, to say that from 2008 till December, 2017 when EC was granted, by which time project was almost completed, activities related only in relation to the drinking water supply and not with the irrigation and that the irrigation project activities commenced thereafter is difficult to accept. As already mentioned, the Tribunal as well as the High Court clearly found that the project proponent was illegally proceeding with construction activities for the irrigation project and also diverting forest land for non- forest purposes without prior clearances. While injunction was granted by the HighCourt against such activities, the substantial activities had already been undertaken without prior EC. The MoEF&CC has not even adverted to this aspect either while granting EC or even in the reply filed before this Tribunal. It is not the case of the MoEF&CC that the project undertaken from 2008 to 2017 was only in relation to water supply and not in relation to irrigation infrastructure.

g) In *N.D. Jayal & Anr. v. UOI & Ors.*, while considering the Tehri Dam Project, it was observed that sustainable development is component of Right to Life. Thus, powers of the Environment Authorities were coupled with duty to enforce the guaranteed Right to Environment24. In the light of the said principle, directions were issued to monitor compliance of conditions for EC, apart from the existing mechanism under the MoEF&CC.

h) In the present matter, the project is predominantly for Irrigation though water supply is also involved. Plea to the contrary is untenable. Thus, the EC has been granted ex post facto in violation of legal requirement for prior EC. Question is what consequences follow in the facts of the present case.

i) We find that in spite illegality found, it is neither possible nor desirable to undo what has happened but accountability needs to be fixed and remedial measures taken. As already noted, the MoEF&CC has not, in granting EC, gone into the issue whether the project had been substantially constructed without prior EIA and in the light of such factual position, what further safeguards were required and how the project proponent is be held accountable for violation of law and presenting *fait accompali.* Mere plea that the project was multi-purpose project and also had a component for which EC may not be required, was not sufficient for the project proponent to have gone ahead without the impact assessment and it is on that account that an injunction was issued by this Tribunal and by the High Court. Since we have found that there is major infirmity in EC being sought *ex post facto,* it is not necessary to go into other points. The fact remains that the project has been completed and only issue is of remedial action and future precautions.

j) We find that undoubtedly the project seeks to provide drinking water to the needy people and irrigation facilities to improve agricultural productivity which serves public interest. Also, huge amount of public money has been spent.

k) At the same time, it is not necessary that for such development, damage to environment must be ignored and adequate safeguards are not to be adopted. Environmental rule of law need not be considered to be in conflict with the need for development but a facet of development. The development has to be sustainable and the light of principles which the country has accepted in the form of the frame work of legislation and best environmental practices.

l) Beyond submitting that there is damage to the environment on account of the project having been executed without prior EC, there is no tangible material before the Tribunal on the basis on which a specific direction for mitigations, restoration and rehabilitation measures can be directed. This exercise was expected from the experts recommending and the authorities granting EC. The project proponent should have been held accountable for the violations. This exercise may have to be undertaken now to enforce the rule of law.

m) Accordingly, we direct the MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to go into the matter in light of observations hereinabove. It may assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into. In this regard, we also note that the EC was granted with reference to ToR based on Form-I submitted by the project proponent, without considering the changes which have taken place in the project subsequently.

n) The Expert Committee may also examine effective implementation of EMP earlier submitted by the project on which EC was granted and compliance of EC conditions. The Expert Committee may be constituted within one month and it may complete its exercise within six months thereafter. The progress may be finally monitored by the Secretary, MoEF&CC. Any affected party will be at liberty to make representation to the MoEF&CC within three weeks putting forward suggestions and grievances, which may be taken into the account by Committee. The MoEF&CC may consider measures to prevent recurrence of such violations where EC is sought ex post facto. This is particularly required when the projects are multipurpose projects and part of it requires EC, so that such requirement is not defeated on specious plea that the project was partly not covered by the Schedule, as has happened in the present case. For this purpose, instead of confining consideration merely to Form–I, a mechanism is required to be evolved and followed whereby physical verification of material particulars can be undertaken, wherever necessary."

The Expert committee had held four VC meetings on 11/01/21, 13/04/21, 11/06/21, 31/07/21 and one meeting (Hybrid Mode) on 07/06/2022 respectively out of which two meetings were attended by the Project Proponent and one meeting was also attended by their EIA consultant M/S. EPTRI.

In these meetings the requirements of various kinds of data that are required for assessing the damages and mitigation as mandated by Hon'ble NGT was discussed besides questionnaires, tables, formats through various letters from the Ministry which included KML files, Agreement copies and work order copies, paper reports, etc.

As may be noted from the mandate of MOEF&CC, one of the terms of reference was to visit the site, but the visit could not happen due to prevailing pandemic situation due to 2nd wave and accordingly Hon'ble NGT, allowed three more months extension of time i.e. upto 17th September 2021 to submit the report. (Order enclosed vide-Annexure-IX)

Then with the improved situation for travel, the visit of the committee could happen between 25/08/21 and 28/08/21 by visiting only a few of the components of the project namely:

1) Laxmi Barrage,
2) 680 MW Laxmi Pump House near Medigadda.
3) A stone Quarry near Nandi Power House,
4) Gravity canal feeding Gayatri pump Hose,
5) Gayathri Pump House
6) Sri Ranganayaka Sagar Reservoir,
7) Underground Pump House at Sri Ranganayaka Sagar Reservoir
8) Konda pochamma pump house,
9) Konda pochamma Gravity Canal
10) Konda pochammaSagar Tank.

A tour report was prepared by the Committee and furnished to MoEF& CC. The report is annexed at Annexure IX- As briefed in the tour report, considering the amount of work involved after receipt of adequate data as required by the Committee, it was proposed that MOEF&CC may please approach Hon'ble NGT for extension of further period and accordingly Hon'ble NGT, accorded extension of time for submission of the report, enclosed vide Annexure-X.

Previous site inspection report

It is pertinent to mention here that an an existing site inspection report on the status of Proposed Kaleswaram Project during construction by **M/s Irrigation & CAD Department, Govt. of Telangana** was used a starting point for further exercise undertaken by this committte.

The report is reproduced below:

"Site Inspection Report on The Status of Proposed Kaleshwaram Project"

"Subject: Site inspection of proposed Kaleshwaram project in the State of Telangana by M/s Irrigation & CAD Department, Govt. of Telangana in connection with O.A. No. 372 of 2017 in the matter of Md. Hayath Uddin Vs Union of India and Ors. before Hon'ble NGT, New Delhi.

"According to the project authority, the utilization of 225 TMC out of which 180 TMC diverted from River Godavari includes - 30 TMC for drinking water to Hyderabad, 10 TMC for drinking water to en route villages, 134.5TMC for Irrigation, 34.5 TMC for stabilization of existing command area, and 16 TMC for industrial uses.

Status of Statutory requirements:

During the discussion held with the project authority and Officers of TSPCB, the status of the aforesaid project and details of the statutory requirements obtained from the competent authority were sought.

From the deliberation, it is learnt that for the aforesaid project, the project authority has obtained only Terms of Reference (TOR) from the MoEF&CC vide letter No. J-12011/1/2017-IA-I(R) dated 31/03/2017 and no environmental clearance / Consent for Establishment (CFE) was obtained from the competent authority.

It is also learnt that Project Authority has submitted their proposal for the diversion of 3168.131 ha. (revised from 3221.2974 ha.) of Forest land covering 8 different forest divisions of Telangana. Forestry Clearance yet to be obtained from the competent authority.

Further, as informed by the project authority, no National parks, Sanctuaries and Biospheres are involved within 12 km radius of the project area and thus the requirement of Clearance / NOC from NBWL does not arise. As per available records, the proposed project is an interstate project, since boundary of project, partly adjoining to the State of Maharashtra.

Status of construction / commencement of project activity:

During the visit, the inspection was carried-out from the point of confluence of Pranahitha and Godavari River to the en-route of the proposed project, which interalia include the following locations:

Sl. No.	*Location*	*District*	*Factual Status on site*
1.	*Medigadda Barrage*	*Bhuballapally*	*Excavation / construction activities / Civil works are under progress.*
2.	*Kannepally Pump House*	*Warangal*	*Excavation / construction activities / Civil works are under progress.*
3.	*Annaram Barrage*	*Warangal*	*Excavation / construction activities / Civil works are under progress.*
4.	*Sundilla Barrage*	*Peddapalli*	*Excavation / construction activities / Civil works are under progress.*
5.	*Annaram Pump House*	*Peddapalli*	*Excavation / construction activities / Civil works are under progress.*
6.	*Goliwada Pump House*	*Peddapalli*	*Excavation / construction activities / Civil works are under progress.*
7.	*Tukkapur Pump House*	*Siddipet*	*Excavation / construction activities / Civil works are under progress.*
8.	*Yellareddypet*	*Siddipet*	*Excavation / construction activities / Civil works are under progress.*
9.	*Manchippa*	*Nizamabad*	*Excavation / Civil works are under progress.*

It appears Project authority has awarded the contracts for construction, operation and maintenance of different utilities to the different external agencies viz. M/s L&T Ltd., M/s Navayuga Engineering Company Ltd. and M/s Meghà Engineering & Infrastructures Ltd. etc., who are executing the Civil and other construction activities of the project.

During the visit, it has been observed that in the aforesaid locations Project authority reportedly commenced their excavation / civil works / construction activities from the month of January - February, 2017 and is being continued. In the aforesaid project locations heavy machineries, vehicles and equipment's are deployed, earth workings and other civil construction works are being carried-out. Further, temporary houses for the workers have been made in the respective project sites. All the aforesaid project activities appear to be carried-out in the non-Forest area. In support of the aforesaid ongoing project activities, relevant photographs which are taken during the site inspection is placed as ***Annexure – I to Annexure – VII.***

Status of alleged construction / commencement of project activity in the Forest Land:

As desired by the MoEF&CC, for the proposed diversion of Forest land for this project, APCCF(Central), Regional Office of MoEF&CC at Chennai carried out site inspection during 26th to 29th April, 2017 and submitted the report vide letter No. 4-TSA072/2017-CHN/0808 dated 26/05/2017 to the ADG(FC), MoEF&CC, wherein it has been reported that contractor has committed violation of small stretch at Ambatpally Village, Suraram Block in Mahadevpur RF by constructing small camp office, for which State Forest Department compounded and subsequently removed the constructed camp office. Further, it has been reported that violation was noticed by the State Forest Department for the area of 3.9694 ha. for construction of surge pool and other structure. Reportedly notices were issued by the Department concerned

Observation and concluding Remarks:

a) Project authority has commenced and continuing construction activities / Civil works on the selected locations of the non-forest area of their proposed project, without obtaining prior environment clearance from the MoEF&CC and 'Consent for Establishment' from the Telangana State PCB. However, project authority claimed that the present ongoing Civil works / project activities are being undertaken for providing only drinking water supply to the people of Telangana, where prevailing acute shortage of drinkin water."

Availability of data

The present committee ,subsequent to the site visit and after consistent persuasion , could receive most of the required data from the project proponent in December 2021, whereafter the work on the report was taken up by the committee . The details submitted by the PP through various correspondences are appended as below, Annexure - I, II, III, IV statements with annexure -III is appended at page No: 134.

Methodology of damage assessment :

As directed and concluded by Hon'ble NGT, the project activities that were undertaken by the PP from 2008 to 2017, until the EC was obtained were declared as a clear case of violation and the method and procedure to be followed in assessing the environmental damage is defined by the Notification no: S.O 804(E) dated 14th March 2017 (vide: Annexure-XI). The data requirement was worked on the basis of these notifications as also on the basis of the CPCB guide lines for treating the violation cases. Depending on the time of execution of the activity i.e. before and after the accord of the Environmental Clearances granted by MoEF&CC, various avoided costs and the cost for the remedial measures caused to the environment have been worked out. The cost provisions made in the EMP report have been relied upon and has served as an important input for working out the compensation cost. The item wise avoided and compensation costs have been worked out in the report and finally an abstract has been arrived at. The total damage cost is worked for the integrated project which comprises of Drinking and Industrial water facilty to an extent of 46.6 TMC water and 134.4 TMC water for lift Irrigation purpose out of the total project outlay of 180 TMC.

Therefore, we propose 75% of the total damage cost i.e Rs.447.00 Cr shall be considered as prorate damage and the budget for Remediation/ Restoration, Natural and Community Resources Augmentation Plan revised accordingly.

A phasing of this expenditure has also been suggested to be spent on various activities in addition to the provisions already made in the EMP, during the next 4-5 years in order to compensate for the damages caused. Finally some engineering recommendations alongwith sketches have been given for undoing some of the damages caused particularly in the quarry area and muck dumping sites.

The final conclusions and recommendations in detail are given at Chapter 15 of the report alongwith the break up of the cost and phasing.

(Balraj Joshi)
Chairman of the committee

ANNEXURE-I

DETAILS PERTAINING TO KALESHWARAM PROJECT AS ON 24-03-2021

INPUTS FOR DAMAGE ASSESSMENT

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
	BARRAGE										
1	Laxmi Barrage (Medigadda)	26-08-2016	Completed, Water impounded	100%	1281	662399	105619	827999	1655998	Aggregate Feeder-2, Ambulance-3, Backhoe Loader-5 Batching Plant (60 Cum/hr= 1 no., 90 Cum/hr= 1 no., 120 Cum/hr= 6 no.)-8, Boom Lift-26, Boom Placer-15 Camper-16, Cement Conveyor-1, Cement Pump-2 Cement Silo-1, Chilling Plant-14, Compressor-16 Concrete Mixer 0.75Cum / Batch-1, Concrete Pump-12 Crane-88, Crusher Plant-5, Dewatering Pump-159 Diesel Tanker-4, Dozer-7, Dumper-67, Excavator-61, Flat Bed Truck-2, Fuel Bowser-8 Grader-2, Ice Plant-5, Loader-22 Mini Batching Machine-1, Mini Bus-2 Mini Truck-6, Mobile Service Van-1 Passenger Vehicle-2, Pick & Carry Crane-38 Pickup Van-6, Piling Rig-4, Power Generator-34 Roller-1, Soil Compactor-3, Tipper-3 Total Station-3, Tractor Dozer-6, Trailer-19 Transit Mixer-278, Water Tanker-14, Weigh Bridge-32	2969370
2	Saraswathi Barrage (Annaram)	26-08-2016	Completed, Water impounded	100%	1095	439140	55027	854215	2005977	Dumpers-100, Excavators-40, Loaders - 8, Rollers-15, Batching plant-7, Transit miller-45, Crane-20, Boom Placers-8 , water tankers-15, Crushers-4 DG set-25	1058501

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
3	Parvathi Barrage (Sundilla)	15-07-2016	Completed. Water impounded	93%	1237	418053	48170	764812	1392598	1.Excavators -27, Dumpers-85, Piling Rigs-10, Batching Plant -05, Crusher - 01, Transit Mixture-30, Bhoom Placer-08, Tele Belt -01, Loader-05, JCB-02, Cranes(250/80/50/10T-)27, Chilling Plant 03, Dozer- 03, Grader-03, Roller-06, Water Tanker-07, Blade Tracor-05, DG Set(5500/250/62KV)- 24, Lifter- 01, Gantry Crane (250T)-01, Camber 05, De Watering Pumps-45	1057500
	WATER CONVEYOR SYSTEM, LIFTS & RESERVOIRS										
1	Laxmi(Medigadda) Lift	27-08-2016	• Works completed for 2 TMC per day • Successfully commissioned and water lifted from Lakshmi barrage to Saraswathi barrage	100%	1584	532132	43734	762735	1568437	Batching Plant - 8,Bed Paver -10,Excavator - 60 Dozer BD65-15,Soil Compactor-12 Wheel Loader-14, Tyre mounted crane -10, TRX crane 14T-40 DG Set-25,Air Compressor 450-150 -9,Concrete Pump(SP1800)-8,Boom Placer-6,Lighting Tower-25 Trailer - 15,Tipper-200,Transit Mixer -60 Water Tanker - 16,JCB-3,Diesel Browser-709-6 DCM Van-11,LMV-18,Crawler Crane-6 Drilling ROC - 10,Rig M/c-1,Boomer - 1 Tower Crane - 5,Gantry crane - 6 Shotcreting Machine - 2	1604340
2	Saraswathi (Annaram) Lift	27-08-2016	• Works completed for 2 TMC per day • Successfully commissioned and water lifted from Saraswathi barrage to Parvathi barrage.	100%	1584	334786	20624	371519	838362	Transit Mixers-19,Boom Placers-2 ,Tippers-29,Concrete placers-2,Concrete pump-2, Batching Plants-3,Pavers-4, Hydras-7, Cranes- 19, Trailers-12, Dozers-7 , Water Tankers-3, Excavators-16,JCB-2 , Loaders-2,DG sets-14,Tower Cranes-3,LMVehicles- 20,Air Compressors-2	1244300

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials: Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)	Details of Equipments	Total No. of Manpower involved
1	Parvathi (Sundilla Lift	27-08-2016	• Works completed for 2 TMC per day. • Successfully commissioned and water lifted from Parvathi barrage to SYP	100%	1551	300886	25135	560685	753521	Tippers/Dumpers - 120, Excavators - 48, Transit Mixers - 28, Batching Plant - 3, Crusher - 2, Cranes - 16, Trailers - 7, Water Tankers - 5, Dozers - 10, LMV - 9, Drilling ROC - 1, Boomplacers- 3, Concrete Pumps - 3, DG sets - 21, Compressors - 2, Roller- 1, Grader - 2, DCM - 3, Water Tanker - 4	1454275
PACKAGEWISE DETAILS											
1	Package-6	11-12-2008	• Works completed • Successfully commissioned and water lifted upto Medaram reservoir	100%	2600	264575	17516	773618	1543061	Tippers/Dumpers - 30, Excavators - 10, Transit Mixers - 15, Batching Plant - 3, Crusher - 3,Wheel Loaders - 2, Boomers - 5, Water Tankers - 5, Dozers - 2, LMV - 10, Drilling ROC - 2, Jack Hammers - 2, Hydra Cranes - 4, DG sets - 15, Boom Placer - 1,Shotcrete Machine - 1	960000
2	Package-7	12-11-2008	• Works completed • Successfully commissioned and water lifted.	100%	2650	244307	2483	305579	607158	Tippers/Dumpers - 30, Excavators - 10, Transit Mixers - 15, Batching Plant - 3, Crusher - 3, Wheel Loaders - 2, Boomers - 4, Water Tankers - 3, Dozers - 2, LMV - 5, Drilling ROC - 3, Jack Hammers - 2, Hydra Cranes - 4, DG sets - 12, Boom Placer - 1, Shotcrete Machine - 1	715000
3	Package-8	17-11-2018	• Workscompleted. • Successfullycommissionedandwater liftedtoSriRaja Rajeshwara Reservoir (MidManair reservoir)	100%	2650	176582	10071	391470	782930	Tippers/Dumpers-30, Excavators-8, TransitMixers-15, BatchingPlant-2, Crusher- 1, WheelLoaders- 2, Boomers-3,Water Tankers-5,Rollers-1,Dozers-2,LMV-8,DrillingROC-2, JackHammers-2, HydraCranes-2, DGsets-10, BoomPlacer-1, ShotcreteMachine -1	915000
1	Medaram Reservoir	17-11-2008	• Workscompleted. • Waterimpounded.	100%	450	15117	70	104534	45106	Dumpers-20, Excavators10, Loaders-2, Rollers-3, BatchingPlant-1, TransitMillers- 3, MotorGrader-2, BoomPlacer-1, WaterTanker-5, Crusher-1, DGset-1	112500

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
5	Package-9	17-11-2018	Workinprogress	60.68%	4320	37008	949	185000	98853	Excavators-20,Dewatering Pumps-26,Aircompressors-4,Dumpers-16,Dozers-1,WaterTankers-19,Showels-7,TransitMixers-17,Tippers-10,Vibromaxrollers-2,Batching Plant-5,Wagondrills-1,Stone Crusher-2,DGSet-21 ConcreteMixers-6,Gantries-6,ConcreteSelfloaders-12,Pavers-5,Crane-4,Vibrators-17	377430
6	Malakpet(Reservoir(Pkg-9)	15-09-2017	Workinprogress	74.36%	1181	12818	769	115962	76238	Excavators-34,DewateringPumps-9,AirCompressors-3,Dozers-13,WaterTankers-30,Transitmixers-2,Tippers-91,Vibromaxrollers-13,DGset-1,ConcreteMixers-2,Sheepfootroller-1,Grader-1,Concreteselfloaders-6,Vibrators-3	409050
7	Package-10	24-7-2009	• Main trunk works completed • Annapurna(Ananthagiri) Reservoir works completed. • Successfully commissionedandwaterliftedto Annapurna(Ananthagiri)reservoir. • Worksofdistributorynetworkare inprogress.	93%	3537	335784	4087	295150	308922	EC-25,Dumpers-75,Telebelt-1,BoomPlacer-2,TM-25,Dozer-5,WaterTanker-10,Drilling Eqipment-5	1061100
8	Ananthagiri Reservoir	27-12-2016	• Workcompleted • About2.78TMCofwaterisimpounded.	100%	3537	82200	358	126756	252080	EC-40, Dumpers-100, Telebelt-1, Boom Placer-2, TM-20, Dozer-5,Compactors-10, Graders-5, Water Tanker-15	442125

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
9	Package-11	24-03-2009	• Maintrunkworkscompleted. •Successfullycommissionedandwater filledto SriRanganayaka Sagar. • WaterreleasedintoRight&LeftMainCanals. • Worksofdistributorynetworkare inprogress.	95.08%	3200	243760	3300	254840	509680	ExcavatorsL&TPC-2008Nos,Loaders-4Nos,250KVA DgSetCummins- 1Nos,Dumpers/Tippers- 6Nos,Water Tankers 1Nos,AIR COMPRESSORS -1Nos,Paver Finishers-1Nos,TransitMixers-4Nos,Rock BreakerAttachments-1Nos,SandvikD1820,AtlasCopco Bencher,SandvikDe120,ExcavatorsL&T PC-300-3Nos,KubotaMiniExcavator - 1 No 320 KVA Dg Set Kirloskar - 1Nos,250KVA Dg SetCummins-1Nos,100KVA DgSetCummins-5Nos,25KVA Dg SetCummins-5Nos,40 Feet Trailor - 1 No ,EOT Crane, Tools & TacklesandElectrical Instruments	960000
10	SriRanganayakaSagar	09-10-2017	• Workscompleted. • About2.301TMCofwaterisimpoundedinSriRanganayaka SagarReservoir.	100%	1502	23510	810	627723	233374	Excavator-200-26Nos,Excavator-300-5Nos,Dumpers-58Nos,Rollers-6Nos,WaterTanker-9Nos,Graders-5Nos,TransitMixers-6Nos,RockBreaker Attachments-4Nos	400000
11	Package-12	25-03-2009	• Maintrunkworkscompleted. • Successfulwetruncompleted • Water releasedto AkkaramPumpHouseandMarkookPumpHousethroughFeederchannel. • Worksofdistributorynetworkare inprogress	87.23%	3191	128586	8185	275542	587824	ExcavatorsL&TPC-2008Nos,Loaders-4Nos,250KVA DgSetCummins- 1Nos,Dumpers/Tippers- 6Nos,Water Tankers-1Nos,AIR COMPRESSORS -1Nos,Paver Finishers-1Nos, TransitMixers-4Nos,Rock BreakerAttachments-1Nos,SandvikD1820,AtlasCopco Bencher,SandvikDe120,ExcavatorsL& T PC-300-3Nos,KubotaMiniExcavator - 1 No,320 KVA Dg Set Kirloskar - 1Nos,250KVA Dg SetCummins-1Nos,100KVA DgSetCummins-5Nos,25KVA Dg SetCummins-5Nos,40 Feet Trailor - 1 No ,EOT Crane, Tools &TacklesandElectrical Instruments	1257300
12	Sri Komarelli Mallanna SagarReach-1	01-05-2018	Workinprogress	93.27%	1080	61150	12003	1000000	1600000	Tippers-21,Excavators-24,Graders-1,SoilCompactors-13,Dozers-23,Generators-6, WaterTankers-13,Loaders-13,Trailers-1 Others-46	678000

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
13	Sri Komarelli Mallanna SagarReach-2	01-05-2019	Workinprogress	84.18%	1080	7058	0	1100000	9000003	Tippers-116,Excavators-94,Graders-9,SoilCompactors-36,Dozers-21,Generators-11,Water Tankers-14,Loaders-4,Trailers-2Others-11	546000
14	Sri Komarelli Mallanna SagarReach-3	27-04-2019	Workinprogress	91.45%	1080	7590	0	1000000	1200000	Tippers-428Nos,Excavators-124Nos,Graders-18No,Soil Compactors-53Nos,Dozers-34Nos,Generators-15Nos,WaterTankers-17Nos,Loaders-7Nos,Trailers-5No,Others-56Nos	546000
15	Sri Komarelli Mallanna SagarReach-4	12-05-2018	Workinprogress	81.63%	1080	13767	200	800000	600000	Tippers-125,Excavators-115,Graders-13,SoilCompactors-35,Dozers-24,Generators-19,WaterTankers-36,Loaders-2,Trailers-2 Others-51	546000
16	Package-13	26-11-2017	Workinprogress	79.26%	1200	87350	6650	131815.23	229395	Dumpers-45,TM-20,Dozer-24WaterTanker-14,DrillingEqipment-5,Excavator-25	285000
17	Package-14	07-11-2017	• Workscompleted • SuccessfullycommissionedtheAkkaram andMarkook Pump houses • WaterliftedtoKondapochammaSagar	99.41%	1037	301132	15145	443458	938348	PlateBendingmachine-8,ElectricWinchMachine-2,Compressorandsandblastingequipment-2,Generators-41, Lorry-6,Cargo-1,DCM-1,Cranes-9,Tractor-23,ConcretePumps-8,ConcreteMixers-55,BatchingUnits6,Roller-4,NeedleVibrators-200,Platevibrators-100,CubeTestingMachines-6,Excavators-52,JCB-20,WeighingBatchMachine-15,Tippers-51,Dozers-9,Dumpers-15,DrillingMachines-6,MillerMixer-7,LatchMachines-6,Cementinliningmachine-6,Hydramachines-6,Inspectionvehicles-207,Gascuttingequipments-130,Weldingequipment-123,DewateringPump-25,Pipeliningequipment-15,Radiographycamera-13,UltrasonicMachine-1,Watertankers-45,Testingequipment-25,Hydraulicjacks-40,Piperollingmachines-39	554400
18	KondapochammaSagar Reach-1	19-11-2017	• Workscompleted. • About7.83TMCofwaterisimpounded inreservoir.	97.81%	1050	12810	1262	676242	357003	EC-54,Dumpers-146,TM-5,Dozer-9,Compactors-20,Graders-5,WaterTanker-10,Generators-9	198000
19	KondapochammaSagar Reach-2	22-11-2017	Workinprogress	99.13%	1050	15321	1445	6150000	3380000	Dumpers-100,Compactors-9,Excavators-33,Dozers-6,Grader-1,WaterTankers-6,Transitmixers-3,Batching Plant-1	200000

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
20	GajwelCanal	10-12-2018	Workinprogress	51.43%	1530	61870	1357.9	96200	186373	EC-2,Dumpers-15,TM-5,Dozer-2,WaterTanker-5,DrillingEquipment-10,Excavator-6	267750
22	JagdevpurCanal	11-08-2018	Workinprogress	53.92%	1030	39360	820	84427	123454	EC-2,Dumpers-10,TM-5,Dozer-2,WaterTanker-6,DrillingEquipment-5,Excavator-7	178000
23	TurkapallyCanal	08-08-2018	Workinprogress	55.01%	889	55326	1183	39271	65836	ExcavatorsNos10,DRILLINGEquipment-8,DgSet-6Nos,Dumpers/Tippers-10Nos,WaterTankers-5Nos,Dozers-3Nos,PaverFinishers-3Nos,TransitMixers-8Nos,Rock BreakerAttachments-1Nos	109200
24	M Turkapally Canal	13-10-2018	Workinprogress	21.92%	1030	4608	136	7251	13015	EC-2,Dumpers-10,TM-5,Dozer-2,WaterTanker-6,DrillingEquipment-5,Excavator-5	30000
25	RamayampetCanal	09-08-2018	Workinprogress*	39.12%	960	28815	2352	57902	99680	Dumpers-10,TM-17,Dozer-2,WaterTanker-11,DrillingEquipment-5,Excavator-22	122400
26	ShankarampetCanal	10-08-2018	Workinprogress	22.48%	920	8616	263	7869	19487	Dumpers-15,TM-6,Dozer-3,WaterTanker-6,DrillingEquipment-2,Excavator-4	70000
27	UpparpallyCanal	17-08-2018	Workinprogress	30.06%	900	4760	107	6769	14006	Dumpers-8,TM-3,Dozer-2,WaterTanker-6,DrillingEquipment-2,Excavator-5	22500
28	KistapurCanal	05-08-2018	Workinprogress	14.35%	900	1323	56	2149	4223	Dumpers-10,Dozer-1,WaterTanker-6,Drilling Equipment-4,Excavator-4	25000
29	Sangareddy CanalReach-I	12.06.2019	Workinprogress	9.25%	235	7868	683	9680	18940	Excavators-10,Dumpers-25,Dozers-8,SoilCompactors-5,DrillingEquipment-2	10600
30	Sangareddy CanalReach-II	16.11.2019	LandAcquisitioninprogress	-	-	-		-	-	-	-
31	Ravalkole TankCanalSystem	24.07.2019	Workinprogress	6.76%	615	3565	61	5216	11626	Tippers-18,Machines-12,TransitMillers-4&otherMiscillaneous	10200

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
32	Package-15	21-02-2009	- Workinprogress	58.83%	4391	34711	3515	95650	148500	Excavators35,Cranes2,JCB's5,Batching,Plant5, Dumpers85,BoomPlacer1,Dozzer/Rollers20, Transmixers15,Crusher1,WheelLoaders5,Water Tankers15,LMV 12,DrillingROC6,JackHammers 20,PaverFinishers10,RockBreakers2,DGSets20	563254
33	Gandhamalla Reservoir	-	• Workstobetakenup • Landacquisitiontobedone		-	-	-	-	-	-	-
34	Package-16	11.02.2009	Workinprogress	54.08%	4426	40860	3600	67055	134109	Excavators33,Cranes2,JCB's5,Batching,Plant5, Dumpers85,BoomPlacer1,Dozzer/Rollers20, Transmixers15,Crusher1,WheelLoaders5,Water Tankers14,LMV 12,DrillingROC6,JackHammers 20,PaverFinish15	342864
35	Nrusimha Sagar(Baswapur Reservoir)	10.11.2017	• Worksinprogress. • R &R-Villagestobeshifted:Timmapur,Changalnayakuditthanda&Laxminayaka Thanda	53.80%	1232	7732	1186	373927	286026	Excavators-30,DewateringPumps-9,AirCompressors-3,Dozers-13,Water Tankers-30,Transitmixers- 2,Tippers-91,Vibromaxrollers- 15,DGset-1,ConcreteMixers-2,Sheepfootroller-1,Grader -1,Vibrators-4	420000
36	Package-17	12-08-2013	Workinprogress	21.51%	1470	3715	270	7875	14657	Excavator -15 Dumpers/Tippers- 40Dozzer / Rollers-5 Transmixtures-3Crusher Plant -1Crusher - 1 Boomer- 2 Jumbovehicles-4	195000
37	Package-18	12-10-2018	Workinprogress	28.32%	962	6098	547	9724	26597	Excavator-15,Dumpers/Tippers- 55,Dozzer/Rollers -5, BatchingPlant-2,BlastingEquipment-6,Boomer , Normet-2	160000
38	Package-19	29-10-2018	Workinprogress	8.50%	907	1555	130	3012	6024	1No.BatchingPlant,Pump,5NosTransitMixers,15Tippers,1No.500Excavator,1No.210Excavator,1No.370 Excavator	25000

Sl.No.	Structure Description	Date of Commencement	Present Status of Project	% Completion	Total days of Construction	Details of Construction Materials				Details of Equipments	Total No. of Manpower involved
						Cement (MT)	Steel (MT)	FA (CUM)	CA (CUM)		
39	Package-20	24-10-2012	Workinprogress	83.45%	4477	14756	130	22626	45252	Boom Placer-1,Excavators-7,Dumpers-10,TowerCranes-2,TransitMillers-6,Loader-1,JCB-1,Escort-1,Gensets-10	280000
40	Package-21	20-11-2008	Workinprogress	60.76%	4477	14756	130	22626	45252	Boom Placer-1,Excavators-7,Dumpers-10,TowerCranes-2,TransitMillers-6,Loader-1,JCB-1,Escort-1,Gensets-10	280000
41	Package-21A	13-04-2008	Workinprogress	55.97%	2080	6506	3527	17280	26926	Excavators-20,Cranes-20,JCB's-35,BatchingPlant-2,JointingM/C-25 Boom Placer-1,Transitmillers-4	581620
42	Kondem Cheruvu(Pkg-21A)	-	-	-	-	-	-	-	-	-	-
43	Package-22	20-11-2008	Workinprogress	17.12%	4380	2910	106	3880	8730	Excavator-9,RigHammer-4,Dumpers-12 Boomer-1	150000
44	Bhimpal lyreservoir(Pkg22)	20-11-2018	Workinprogress	70.00%	4380	49	1.2	22393	2739	Excavator-1Dumpers-2	43800
45	Package-27	24-02-2009	Workinprogress	63.46%	1370	25680	960	39192	78384	DGsets-23,DoublePiston-15,Singlepiston-10,WeldingMachines-23,Drillingmachines-3,Concretepump-2,Shotcreatingmachines-1,AZAX-10,JCB-2,Aircompressor-2,Batchingplant-1,Boomer-1,Hydra-1,Excavators-14,Campers-10,Inspectionvehicles-8,Tippers&Dumpers-50,Diesel Tankers-3,WaterTankers-5	300000
46	Package-28	25-02-2009	Workinprogress	48.37%	1370	2728	95	4183	8367	DGSets-4,WeldingMachines-10,DrillingMachines-2,ConcretePump-1,ShotcreatingMachines-1,AZAX-2,JCB-2,AirCompressor-2,Boomer-1,Excavators-3,Campers-2,Car-1,Tippers&Dumpers-4,Water Tankers-2	300000

ANNEXURE-II

DETAILS PERTAINING TO KALESHWARAM PROJECT AS ON 24-03-2021

ENVIRONMENT ATTRIBUTE DETAILS

Sl. No.	STRUCTURE DESCRIPTION	AIR		WATER & WASTE WATER		
		LOCATION OF QUARRY'S	LEAD DISTACE (Km)	CONSUMPTION FOR CONSTRUCTION (Litres)	LABOUR CAMP-DOMESTIC CONSUMPTION (Litres)	LABOUR CAMP-WASTE WATER MANAGEMENT (STP / SOAK PIT)
1	Laxmi Barrage (Medigadda)	Godavari	5	303389385	386018100	STP
2	Saraswathi Barrage (Annaram)	Godavari	5	201756390	142897635	STP
3	Parvathi Barrage (Sundilla)	Godavari	5	181523565	142762500	STP
4	Laxmi(Medigadda) Lift	Godavari	5	246786240	208584200	STP-I
5	Saraswathi (Annaram) Lift	Godavari	4.5	154577085	167980500	STP-I
6	Parvathi (Sundilla) Lift	Godavari	5	155413706	196327125	STP
7	Pkg-6	Godavari	5	Underground Seepage water during execution of Tunnel, SP & Pump house is used for construction purpose	421200000	STP
8	Pkg-7	Godavari	5		250425000	STP
9	Pkg-8	Godavari	5		393525000	STP
10	Medaram Reservoir	Godavari	5	36000000	15187500	Soak Pit
11	Pkg-9	Thangalapally	28	16500000	50953050	Soak Pit

Sl. No.	STRUCTURE DESCRIPTION	AIR		WATER & WASTE WATER		
		LOCATION OF QUARRY'S	LEAD DISTACE (Km)	CONSUMPTION FOR CONSTRUCTION (Litres)	LABOUR CAMP-DOMESTIC CONSUMPTION (Litres)	LABOUR CAMP-WASTE WATER MANAGEMENT (STP / SOAK PIT)
12	Malakpet Reservoir (Pkg-9)	Tangalapally	22	5434500	55221750	Soak Pit
13	Pkg-10	Manair River	21	167892	226368000	Soak Pit-5
14	Ananthagiri Reservoir	Manair River	21	41100	56592000	Soak Pit-2
15	Pkg-11	Mid Manair	37	746	198000	STP-1
16	Sri Ranganayaka Sagar	Mid Manair	37	24800000	76950	STP-1
17	Pkg-12	Tukkapur	1.1	64293293	565785	Soak Pits - 9
18	Sri Komarelli Mallanna Sagar Reach - 1	Mid Manair	76	23121000	19450	Soak Pit
19	Sri Komarelli Mallanna Sagar Reach - 2	Mid Manair	76	25794000	23000	Soak Pit
20	Sri Komarelli Mallanna Sagar Reach - 3	Mid Manair	65	31357500	28250	Soak Pit
21	Sri Komarelli Mallanna Sagar Reach - 4	Mid Manair	63	21834000	26000	Soak Pit
22	Pkg-13	Mid Manair	76	43674785000	124800000	Soak Pits - 8

		AIR		WATER & WASTE WATER		
Sl. No.	STRUCTURE DESCRIPTION	LOCATION OF QUARRY'S	LEAD DISTACE (Km)	CONSUMPTION FOR CONSTRUCTION (Litres)	LABOUR CAMP-DOMESTIC CONSUMPTION (Litres)	LABOUR CAMP-WASTE WATER MANAGEMENT (STP / SOAK PIT)
23	Pkg-14	Mid Manair	87	152066000	248880000	Soak Pits - 16
24	Kondapochamma Sagar Reach-1	Mid Manair	95	6405161	117600000	STP
25	Kondapochamma Sagar Reach-2	Mid Manair	98	7660520	126000000	STP
26	Gajwel Canal	Chinthalathana	94	440969259	25515000	Soak Pits - 3
27	Sanga Reddy canal Km. 0.000 to Km. 3.700	Chinthalathana	94	168293092	12150000	Soak Pits - 2
28	Jagdevpur Canal	Kothapally	121	19680000	75808000	Soak Pits - 5
29	Turkapally Canal	Maner	125	27663000	35524440	Soak Pits - 6
30	M.Turkapally Canal	Kothapally	121	15488000	49440000	Soak Pits - 6
31	Ramayampet Canal	Maner	115	14422	47923200	Soak Pits - 6
32	Shankarampet Canal	Maner	118	4308000	22080000	Soak Pits - 4
33	Upparpally Canal	Mid Maner	91	2380000	6480000	Soak Pits - 1
34	Kistapur Canal	Mid Maner	110	661500	7200000	Soak Pits - 1

Sl. No.		AIR		WATER & WASTE WATER		
	STRUCTURE DESCRIPTION	LOCATION OF QUARRY'S	LEAD DISTACE (Km)	CONSUMPTION FOR CONSTRUCTION (Litres)	LABOUR CAMP-DOMESTIC CONSUMPTION (Litres)	LABOUR CAMP-WASTE WATER MANAGEMENT (STP / SOAK PIT)
35	Pkg-15	Mid Maner	140	15000000	91250000	Soak Pits - 1
36	Gandhamalla Reservoir	-	-	-	-	-
37	Pkg-16	Mid Maner	130	29155200	224221500	Soak Pits - 2
38	Baswapur Reservoir	Mid Maner	130			Soak Pit
39	Sangareddy Canal Reach-I	Kothapally	101	4065500	3046000	Soak Pits - 1
40	Sangareddy Canal Reach-II'	Kothapally	134	-	-	-
41	Ravalkole Link Canal System	Manjeera River Water	102	2465433	2648000	Soak Pits - 1
42	Pkg-17	Manair	100	44100000	51948000	Soak Pit-6
43	Pkg-18	Manair	-	40650000	57575700	Soak Pit-6
44	Pkg-19	Manair	-	1309619	2902400	Soak Pit-6
45	Pkg-20	Pothangal	20	38000000	22800000	Soak Pit
46	Pkg-21	Naleshwar	55	12000000	14365000	Soak Pit
47	Pkg-21A	Lingapur	47	31105090	59217600	Soak Pit
48	Kondem Cheruvu (Pkg-21A)	-	-	-	-	-

Sl. No.		AIR		WATER & WASTE WATER		
	STRUCTURE DESCRIPTION	LOCATION OF QUARRY'S	LEAD DISTACE (Km)	CONSUMPTION FOR CONSTRUCTION (Litres)	LABOUR CAMP-DOMESTIC CONSUMPTION (Litres)	LABOUR CAMP-WASTE WATER MANAGEMENT (STP / SOAK PIT)
49	Pkg-22	Palwancha	45	1287750	2190000	Soak Pit
50	Bhumpally reservoir (Pkg22)	Palwancha	45	1287750	2190000	Soak Pit
51	Pkg-27	Pedda Vagu	56	42600000	6000	Soak Pit
52	Pkg-28	Pedda Vagu	88	4547055	2000	Soak Pit

KALESHWARAM PROJECT

DETAILS TO BE SUBMITTED TO EXPERT COMMITTEE (ANNEXURE-IV)

Sl.No.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use (Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project Implemented area (forest, herbaceous/grassland, shrubland, developed, agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Generated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
1	Laxmi Barrage (Medigadda)	-	-	-	-	2,500	All types	Agricultural	Part of land used for sub- station and control room	Agricultural	After construction, the ground water table and ayacut of 30000 Ac developed	
2	Laxmi Pump House (Medigadda Lift)	-	-	-	-	39,300	Nilagiri Mexican Grass - 46187 Sqm, Conacarpus, Ficus Panda, Ornamental Kale Hybrid	Agricultural	Part of land used for sub- station and control room	Agricultural		
3	Saraswathi Barrage (Annaram)	-	-	-	-	1,500	All types	Agricultural	Part of land used for sub- station and control room	Agricultural		
4	Saraswathi Pump House (Annaram Lift)	-	-	-	-	5,176	Cycus, Ficus Long island, Foxtail Palm, Ornamental Kale Hybrid, Conacarpus, Grass turfing - 45328 Sqm	Agricultural	Part of Land used for construction of Pump House, approach channel and gravity canal	Agricultural		
5	Parvathi Barrage (Sundilla)	-	-	-	-	1,350	All types	Agricultural	Part of Land used for construction of Pump House, approach channel and gravity canal	Agricultural		
6	Parvathi Pump House (Sundilla Lift)	-	-	-	-	10,753	Carpet grass - 17792 Sqm Ficus plants - 136 Foxtial plants - 173 Border plants - 4748 Cycas plants - 11 Ornamental plants - 216	Agricultural	Part of Land used for construction of Pump House, approach channel and gravity canal	Agricultural		

Sl.No.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use(Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project implemented area (forest, herbaceous/grassland, shrubland, developed,agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Genetrated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
							Conocarpus plants - 5369					
7	6	68,10,565	31,45,474	-	-	1,590	Osiri, Kanuga, Nandivardanam, Gulmor, Mango etc..	Agriculture and Barren land	Part of land used for Canal, Substation, Delivery Cistern & Lead Channel	Link-II consists of Water conveyor system from SYP to MMR to serve ayacut beyond MMR under Kaleshwaram Project. There is no direct ayacut under Link - 2. However, due to continuous availability of water, Ground water is getting recharged. Thereby, agricultural and fisheries development is taking place in surrounding villages of foreshore of SYP and Medaram reservoir		
8	7	57,63,358	21,76,430	-	-	250	Osiri, Kanuga, Nandivardanam, Gulmor, Mango etc..	Agriculture and Barren land	Part of land used for Reservoir & Canal			
9	8	27,38,135	12,01,811	-	-	1,500	Osiri, Kanuga, Nandivardanam, Gulmor, Mango etc..	Agriculture and Barren land	Part of land used for Substation, Delivery Cistern & Canal			
10	9	11,12,888	6,17,920	-	-	-	-	Agricultural	Agricultural	Forest, agricultural, wet lands, dry lands, barren lands	Forest, agricultural	
11	10	14,20,379	11,50,000	Garbage from kitchen,plastic covers,water bottles etc.	Disposal of Solid Waste to Dump yard	1,000	Badham, Ravi, Chinta, Kanuga, Vepa, Gulmor etc	Agricultural	Part of Land used for Substation, Control room	Agriculture	After Construction of this project gorund water table increased and ayacut developed under canals and tanks	
	Annapurna Reservoir (Ananthagiri Reservoir)	-	-	Garbage from kitchen,plastic covers,water bottles etc	Disposal of Solid Waste to Dump yard	200	Badham, Ravi, Chinta, Kanuga, Vepa, Gulmor etc	Agricultural	Part of Land under submergence and ayacut is developed under this reservoir	Agriculture	After Construction of this project gorund water increased and ayacut of 30,000 Ac developed under canals and tanks	
				Garbage from kitchen,plastic					Part of Land is used for construction of Substation, CPump		After Construction of this project gorund water table increased and ayacut	

SI.N o.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use(Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project implemented area (forest, herbaceous/grassland, shrubland, developed,agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Genetrated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
12	11	31,37,000	21,95,900	covers,water bottles etc.	Disposal of Solid Waste to Dump yard	48,000	Cronocorpas, Badham, Ravi, Chinta, Kanuga, Allaneradu, Vepa, Gulmor, Mamdi etc	Agricultural	House, approach channel, gravity canal and delivery cistern	Agriculture	developed under canals and tanks	
13	Sri Ranganayaka Sagar	-	-	Garbage from kitchen,plastic covers,water bottles etc.	Disposal of Solid Waste to Dump yard	7,000	Cronocorpas, Badham, Ravi, Chinta, Kanuga, Allaneradu, Vepa, Gulmor, Mamdi etc	Agricultural	Part of Land under submergence and ayacut is developed under this reservoir	Agriculture	After Construction of this project gorund water increased and ayacut of 1,10,000 Ac developed under canals and tanks	
14	12	23,77,000	16,14,000					Agricultural	Part of Land is used for construction of Substation, CPump House, approach channel, gravity canal and delivery cistern	Agriculture	After Construction of this project gorund water increased and ayacut of 1,25,000 Acres will be developed under canals and tanks	
15	Sri Komaravelli Mallanna Sagar	-	-	-	-	-	-	Agricultural	Work under progress	Agricultural	Work under progress	
16	13	-	-	-	-	-	-	Agricultural	Part of Land used for construction of approach channel and gravity canal	Agricultural	After Construction of this project gorund water increased and ayacut of 39,000 Ac developed under canals and tanks	
17	14	-	-	-	-	-	-	Agricultural	Part of Land used for construction of Pump House, approach channel, gravity canal and delivery cistern	Agricultural	After Construction of this project gorund water increased	

Sl.No.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use(Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project implemented area (forest, herbaceous/grassland, shrubland, developed,agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Genetrated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
18	Konda Pochamma Sagar Reach-I	-		-	-	-	-	Agriculture and Barren land	Part of Land under submergence	Agriculture	After Construction of this project gorund water increased	
19	Konda Pochamma Sagar Reach-2	-	-	-	-	-	-					
20	Ramayampet Canal	-	-	-	-	-		Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 41203 Ac will be developed	
21	Shankarampet Canal	-	-	-	-	-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 19152 Ac will be developed.	
22	Jagadevpur Canal	-	-	-		-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 12838 Ac will be developed.	
23	Turkapally Canal	-	-	-			-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 27167 Ac will be developed.	
24	M. Turkapally Canal	-		-	-		-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 18775 Ac will be developed.	
	Kishtapur Canal		-	-	-	-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 13024 Ac will be developed.	

SI.No.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use(Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project implemented area (forest, herbaceous/grassland, shrubland, developed,agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Generated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
25												
26	Upparpally Canal	-	-	-	-	-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 12978 Ac will be developed.	
27	Gajwel Canal	-	-			-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 20748 Ac will be developed	
28	Sangareddy Canal	-		-	-	-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 99095 Ac will be developed.	
29	Ravalkole Canal System	-	-	-	-	-	-	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agriculture	After construction of canals, ayacut of 20000 Ac will be developed.	
30	15	0	0	0	0	0	0	Agricultural	Part of land under costruction of Canal (Work Under Progress)	Agricultural	After construction, an ayacut of 63,300 Ac will be developed under the canals and tanks	
31	Gandhamallareservoir	0	0	0	0	0	0	Workhotyetstarted				
32	16	Nil	1,34,109	Nil	Nil	Nil.		Agricultural	Partoflandundercostructionof Canal(WorkUnderProgress)	Agricultural	Afterconstruction,anayacutof 1,88,500Acwillbedeveloped underthecanalsandtanks	

Sl.No.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use(Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project implemented area (forest, herbaceous/grassland, shrubland, developed,agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Genetrated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
33	Sri NrusimhaSagar(Baswapurre servoir)	3,976	2,860	Nil	Nil	NIL		Agricultural	Part ofLandundersubmergence	Agricultural	AfterConstructionofthisprojectgroundwaterincreased	
34	17	33,02,356	10,10,000			-	-	Agriculture	PartoflandunderconstructionofIrrigationCanal/TunnelDumpyard	Agriculture/Dry	IrrigationCanal	
35	18	66,00,000	0					Agriculture	Part of land under construction of Irrigation Canal	Agriculture	After construction, an ayacut of 15000 Ac will be developed under the canals and tanks	
36	19	27,47,000	0	-		-	-	Agriculture	Part of land under construction of Irrigation Canal	Agriculture	After construction, an ayacut of117000 Ac will be developed under the canals and tanks	
37	20	21,85,000	17,54,103		-	nil	nil	Agricultural land	Part of land under Adit openings- 4 Nos, Sarala Camp Office, Surge Pool Pump House, switchyard, Errakunta reservoir and spoil banks at adits and pump houses,.	Agricultural land	After Construction of this project gorund water table increased	
38	21	2,20,625	1,76,500		-	nil	nil	Agricultural land	Part of land under Construction of pump house, adit opening, dumping yards, approach Channel	Agricultural land	After construction, an ayacut of 199428 Ac will be developed under the canals and tanks	
39	22	42,33,861	21,16,930	Garbage from kitchen, plastic covers, water bottles etc.	Disposal of Solid Waste to Dump yard	550		Agricultural	Part of Land used for canals, Pumphouse etc	Agriculture, Dry lands	After Construction of this project gorund water table increased and ayacut of 200000 Ac developed under canals and tanks	
								Agriculture	Assured water for		Fertile lands. After Construction of this project gorund water table	

SL No.	Pkg No.	Solid waste management details				Progressive Plantation Details		Details of Land Use (Agricultural, residential, transportation, institutional and public buildings, commercial and industrial)		Details of Land Cover in Project implemented area (forest, herbaceous/grassland, shrubland, developed,agriculture, wetlands, and other (includes ice/snow, barrenareas, and open water)		Remarks
		Total Muck Genetrated (Cum)	Quantity of muck utilized (Cum)	Other Solid Waste Generated	Disposal of Solid Waste	No. Planted	Types/ Names of saplings planted	Before Construction	After Construction	Before Construction	After Construction	
40	27	1,50,843	1,20,674	-	-	-	-	Dry lands - 50000 Acres	Agriculture - 50000 Acres	Shrubs, Dry lands	increased and ayacut of 50000 Ac developed under canals and tanks	
41	28	40,926	20,463	0	0	545	1)Grass carpets around the pump house-29,575 Sft 2) Royal farms -150 3) Croton Plants -200 4) Fiscus Yellow plants -150 5) fruits types & flowers types- 45	Agriculture	Agriculture	Agriculture	developed, open water After Construction of this project gornud water table increased and ayacut of 50000 Ac developed under canals and tanks	1) Excavation will be done by means of Excavators, Manual blasting etc, the land is acquired for dumping yard to dump the excavated muck/soils for Pumphouse of Kanakapur village of Lokeshwar mandal, Nirmal Dist. 2) As there is no disposal of waste in this package, hence there is no change in land quantity.
TOTAL		4,28,43,912	1,90,51,174			1,21,214						

STATEMENT-1

Sl. No	Name of Package	Cement in Mt	Steel in Mt	Sand (FA) Cum	Aggregates (CA) Cum	Manpower	Machinery / Equipment details
1	Laxmi Barrage	51062	[illegible]	[illegible]	[illegible]	257000	[illegible] Backhoe Loader 5, Batching [illegible] [illegible] 8, Boom Lift 26, [illegible] Compactor 15, Cement Conveyor [illegible] Cement Silo 1, Chilling Plant 14, Compressor [illegible] Concrete Mixer 0.75Cum / Batch 1, Concrete Pump 12, Crane 88, Crusher Plant-5, Dewatering Pump 159 [illegible] Dozer 7, [illegible] 67, Excavator 51, Flat Bed Truck 2, [illegible] Grader 2 Ice Plant 5, Loader 22, Mini Batching Machine-1, Mini Bus-2, [illegible] Truck-6, Mobile Service Van-1 Passenger Vehicle-2, Pick & Carry Crane-36, Pickup Van-6, Piling Rig-4, Power Generator-54, Roller-1, Soil Compactor-3, Tipper-3, Total Station-3, Tractor Dozer-6, Trailer-19, Transit Mixer-278, Water Tanker-14, Weigh Bridge-32
2	Saraswathi Barrage	177956	28010	[illegible]	[illegible]	456000	Dumpers-100, Excavators 40, Loaders - 8, Rollers 15, Batching plant-7, Transit miller-45, Crane 20, Boom Placers 8, water tankers-15, Crushers-4, DG set-25, Piling Rigs-6 Nos, JCB 10 Nos, Chilling Plant -03 Nos, Dozer-0 8 Nos, Grader-03 Nos, Boom Lifter- 45 No, Dewatering Pumps - 75 Nos, Silos - 6 Nos
3	Parvathi Barrage	132488	22142	181318	354720	410000	Excavators 27, Dumpers 85, Piling Rigs 10, Batching Plant -05, Crusher - 01, Transit Mixers-30, Bhoom Placer-08, Tele Belt -01, Loader-05, JCB-02, Cranes(250/80/50/10T-)27, Chilling Plant -03, Dozer-03, Grader-03, Roller 06, Water Tanker-07, Blade Tracor 05, DG Set(5500/250/62KV)- 24, Lifter- 01, Gantry Crane (250T)-01, Camber 05, Dewatering Pumps 45
4	Laxmi PH	85877	6940	115142	230285	242000	Batching Plant - 8,Bed Paver -10,Excavator - 60, Dozer BD65-25,Soil Compactor-12, Wheel Loader-14,Tyre mounted crane -10,TRX crane 14T-10, DG Set-25,Air Compressor 450-150 - 9,Concrete Pump(SP1800)-8 Boom Placer-6,Lighting Tower-25, Trailer - 15,Tipper-200,Transit Mixer 60, Water Tanker - 16,JCB-3,Diesel Browser-709-6 DCM Van-11,LMV-18,Crawler Crane-6, Drilling ROC - 10,Rig M/c 1,Boomer - 1, Tower Crane - 5,Gantry crane - 6,Shotcreting Machine - 2
5	Saraswathi PH	63450	5560	79413	156826	260000	Transit Mixers-19 Boom Placers 2 , Tippers-29,Concrete placers-2,Concrete pump-2, Batching Plants-3 Pavers 4, Hydras-7, Cranes-19 Trailers-12, Dozers-7, Water Tankers-3, Excavators-16 JCB 2, Loaders 2,DG sets-14 Tower Cranes 3,LMVehicles 20,Air Compressors 2
6	Parvathi PH	35428	3982	39454	38771	182000	Tippers/Dumpers - 129, Excavators - 43, Transit Mixers - 28, Batching Plant - 3, Crusher - 2, Cranes - 16, Trailers - 7, Water Tankers - 5, Dozers - 10, LMV - 9, Drilling ROC - 1 Boomplacers - 3, Concrete Pumps - [illegible] DG sets - 21, Compressors - 2, Roller - 1, Grader - 2, DCM - 3, Water Tanker - 4
7	Package 6	153287	8750	320809	771531	768400	Tippers/Dumpers - 30, Excavators - 10, Transit Mixers - 15, Batching Plant - 3, Crusher - 3, Wheel Loaders - 2, Boomers - 5, Water Tankers - 5, Dozers - 2, LMV - 10, Drilling ROC - 2, Jack Hammers - 2, Hydra Cranes - 4, DG sets - 15, Boom Placer - 1, Shotcrete Machine - 1
8	Package 7	73252	745	91074	152147	459000	Tippers/Dumpers - 30, Excavators - [illegible], Transit Mixers - 15, Batching Plant - 3, Crusher - 3, Wheel Loaders - 2, Boomers - 4, Water Tankers - 3, Dozers - 2, LMV - 5, Drilling ROC - 3, Jack Hammers - 2, Hydra Cranes - 4, DG sets - 12, Boom Placer - 1, Shotcrete Machine - 1
9	Medaram reservoir	1511	7	10455	4510	140000	Dumpers -20 nos, Excavators 10 nos, Loaders 2 Nos, Rollers -3 Nos, Batching Plant 1 No, Transit Millers - 3 Nos, Motor Grader 2 Nos, Boom Placer - 1 No, Water Tanker-5 Nos, Crusher 1 No, DG set - 1 no
10	Package-8	98255	5936	105735	251470	722700	Tippers/Dumpers - 30, Excavators - 9, Transit Mixers - 15, Batching Plant - 2, Crusher - 1, Wheel Loaders - 2, Boomers - 3, Water Tankers - 5, Rollers - 1, Dozers - 2, LMV - 8, Drilling ROC - 2, Jack Hammers - 2, Hydra Cranes - 2, DG sets - 10, Boom Placer - 1, Shotcrete Machine - 1

Sl. No.	Name of Package	Cement in (MT)	Steel in (MT)	Sand (FA) Cum	Aggregates (CA) Cum	Manpower	Machinery / Equipment Details
[illegible]	Package 9	522	[illegible]	[illegible]	18551	[illegible]	[illegible] Dumpers, 2 [illegible] Batching Plant [illegible] 4 Cranes [illegible] Pavers [illegible] Vibrator [illegible]
12	Malakpet reservoir	126	0	72191	4817	200	Excavators 16, Dewatering Pumps 3, Air Compressors 6, Dozers 8, Water Tankers 16, Transit mixers 0, Tippers 50, Vibromax rollers 8, DG set 6, Concrete Mixers 0, Sheep foot roller 4, Grader 3, Concrete Sc Loaders 0, vibrators 3
13	Package 10 (incl Ananthagiri reservoir)						EC 25, Dumpers-75, Telebelt 1, Boom Placer-2, TM 25, Dozer 5, Water Tanker 10, Drilling Equipment-5
14	Package 11	246	3300	257840	509560	802088	Excavators L&T PC 200 8 Nos, Loaders 4 Nos, 250 KVA Dg Set Cummins 1 Nos, Dumpers/Tippers 6 Nos, Water Tankers 1 Nos, AIR COMPRESSORS - 1 Nos, Paver Finishers - 1 Nos, Transit Mixers - 4 Nos, Rock Breaker Attachments - 1 Nos, Sandvik DI820 Atlas Copco Rencher, Sandvik Dc 120, Excavators L&T PC 300 3 Nos, Kubota Mini Excavator 1 No, 320 KVA Dg Set Kirloskar - 1 Nos, 250 KVA Dg Set Cummins 1 Nos, 100 KVA Dg Set Cummins 5 Nos, 25 KVA Dg Set Cummins - 5 Nos, 40 Feet Trailer 1 No, EOT Crane, Tools & Tackles and Electrical Instruments
15	Sri Ranganayaka Sagar	-			-	1000	Excavator-200 - 5 Nos, Excavator 300 - 2 Nos, Dumpers - 20 Nos, Rollers - 1 Nos, Water Tanker - 2 Nos, Rock Breaker Attachments - 1 Nos
15	Package-12	39148	97.26	41471	82942	319375	Boomers 05 nos, Dumpers 42nos, Excavators 25 nos, Dozers 07 nos, Batching plants 05nos, Crusher 01nos, Transit mixers 20nos, Water Tankers 05nos
16	Sri Komaravelli Mallanna Sagar	-	-	-	-	-	----
17	Package-15	34711	3515	95050	148580	563754	Ajax - 25, Backhoe Loader-6, Batching Plant-5, Boom Placer 1, Campers-4, Cement Pump 2, Cement Silo-4, Compressor-22, Compactor-8, Concrete Pump 2, Cranes-2, Crusher Plant-1, Dewatering Pump-20, Diesel Tanker 2, , Dozer-12, Drilling Equipment-6, Dumpers-85, DG Set-20, Excavators 35, Grader-3, JCB-5, Mobile Service Van 3, Pickup Van-2, Paver finisher-10, Rock breaker attachment 2, Roller 10, Tractor Dozer-5, Trailer 2, Transit Mixers-15, Two Wheelers 12, Water Tanker 15, Welding Machines-5, Weigh bridge-1
18	Gandhamalla reservoir	-	-	-	-	-	----
19	Package 16	49860	3500	67055	134109	547589	Batching Plant 1, Campers-14, DG Set-9, Excavators-6, JCB 4, Paver finisher-4, Roller 3, Transit Mixers 8, Water Tanker-14
20	Baswapur reservoir	-	-	-	-	-	----
21	Package-17	1011	55	1517	525	105850	Excavator - 10, Dumpers/Tippers 12, Dozer / Rollers 2, Transmixtures - 2, Crusher Plant - 1, Crusher - 1, Boomer - 6, Jumbo vehicles - 4, Shotcrete machine - 0, Ventilation Fans - 3, DG Sets 13
22	Package-18	0	0	0	0	0	
23	Package-19	0	0	0	0	0	--
24	Package-20	-		-	-	175200	Boom Placer 1, Excavators 7, Dumpers -10, Tower Cranes 2, Transit Millers -6, Loader 1, JCB 1, Escort 1, Gensets -10
25	Package-21		-			11000	Boom Placer 1, Excavators 7, Dumpers -10, Tower Cranes 2, Transit Millers -6, Loader 1, JCB 1, Escort -1, Gensets -10

Sl. No	Name of Package	Cement in MT	Steel in MT	Sand (FA) Cum	Aggregates (CA) Cum	Manpower	Machinery / Equipment details
26	Package 26	[illegible]	106	[illegible]	[illegible]	[illegible]	Excavator [illegible] [illegible] Dumpers [illegible] [illegible]
27	Package 27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 10 No's, Drilling Machine 2 No's, Concrete Pump 1 No's, Wet Shotcreting Machine 1 No's, Arax [illegible] No's, [illegible] No's, Air Compressor 2 No's, Boomer 1 No's, Excavators(210) 2 No's, Excavators (110) 1 No's, Camper's 2 No's, Cars 1no's, Two Wheelers 4 No's, Tippers & Dumpers 4 No's, Water Tankers-2 No's
28	Package 28	2728	95	4183	8367	131400	Dg Sets 180 Kva 1 No's, 62.5 Kva 2 No's, 20 Kva 1 No's, Three Phase Welding Machines 10 No's, Drilling Machine-2 No's, Concrete Pum-1 No's, Wet Shotcreting Machine-1 No's Arax-2 No's, Jcb-2 No's Air Compressor-2 No's, Boomer-1 No's, Excavators(210) 2 No's, Excavators (110) 1 No's, Camper's-2 No's, Cars-1no's Two Wheelers-4 No's, Tippers & Dumpers 4 No's, Water Tankers-2 No's

Engineer-in-Chief (Irrigation),
Gajwel, Siddipet District.

KALESHWARAM PROJECT - STATEMENT-2

(Rs. in Crores)

Sl. No	Package No	Contract value	Amount spent upto Dec-2017	Amount spent till date	Balance amt to be spent
1	Medigadda barrage	4613.00	248.49	3484.96	1128.04
2	Medigadda LIS	4877.18	723.89	4516.64	360.54
3	Annaram Barrage	2734.21	610.79	2194.88	539.93
4	Annaram LIS	3875.40	658.17	3301.87	573.53
5	Sundilla Barrage	2225.00	471.54	1733.20	491.80
6	Sundilla LIS	3399.25	594.13	3132.46	266.79
7	Package-6	5047.96	3596.44	4612.14	435.82
8	Package-7 (incl Medaram)	1446.15	1058.80	1424.48	21.67
9	Package-8	4900.40	3482.09	4489.74	410.65
10	Package-9	996.01	253.44	705.16	290.86
11	Malakpet Reservoir	513.13	17.13	386.49	126.63
12	Package-10	2798.91	1637.69	2694.51	104.40
13	Package-11	3127.58	1853.20	3061.14	66.44
14	Sri Ranganayaka Sagar	493.65	31.67	465.19	28.46
15	Package-12	3348.00	1457.29	3230.92	117.08
16	Sri Komaravelli Mallanna Sagar-R1	1893.68	0.00	1336.30	557.38
17	Sri Komaravelli Mallanna Sagar-R2	1546.65	0.00	677.99	868.66
18	Sri Komaravelli Mallanna Sagar-R3	2118.27	0.00	1423.22	695.05
19	Sri Komaravelli Mallanna Sagar-R4	1482.75	0.00	674.64	808.11
20	Package-13	556.11	0.00	431.44	124.67
21	Package-14	2553.55	0.00	2378.81	174.74
22	Kondapochamma Sagar R1	999.03	0.00	977.58	21.45
23	Kondapochamma Sagar R2	707.14	0.00	654.09	53.05
24	Ramayampet canal	373.22	0.00	171.00	202.22
25	Shankarampet Canal	154.87	0.00	41.95	112.92
26	Jagdevpur canal	107.57	0.00	57.62	49.95
27	Upparpally Canal	60.50	0.00	21.62	38.88
28	Thurkapally Canal	164.78	0.00	98.61	66.17
29	M. Thurkapally Canal	87.13	0.00	22.27	64.86
30	Gajwel canal	184.90	0.00	98.93	85.97
31	Kishtapur Canal	69.99	0.00	10.40	59.59
32	Sangareddy Canal Reach-1	363.713	0.00	26.05	337.66
33	Sangareddy Canal Reach-2	372 915	0 00	0.00	372.92
34	Sangareddy Canal Reach-3	426.79	0.00	0.00	426.79

Sl. No	Package No	Contract value	Amount spent upto Dec-2017	Amount spent till date	Balance amt to be spent
35	Ravalkole Link Canal	363.83	0.00	27.07	336.76
36	Package-15	844.69	173.89	462.37	382.32
37	Gandhamalla Reservoir	486.04	0.00	0.00	486.04
38	Package-16	1102.65	554.83	507.07	595.58
39	Baswapur Reservoir	1578.57	0.00	494.66	1083.91
40	Package-17	986.18	86.87	338.80	647.38
41	Package-18	758.07	20.59	218.20	539.87
42	Package-19	762.47	10.58	62.36	700.11
43	Package-20	892.67	538.25	815.00	77.67
44	Package-21	610.06	276.15	401.11	208.95
45	Package-21A	2568.94	0.00	1512.68	1056.26
46	Package-22	1446.48	145.03	281.89	1164.59
47	Package-27	714.00	124.52	447.26	266.74
48	Package-28	486.68	228.31	225.04	261.64

20/07/21
Engineer-in-Chief (Irrigation),
Gajwel, Siddipet District.

KALESHWARAM PROJECT - CAPITAL COSTS (Sl. No. iv)

(Rs. in Crores)

Sl. No	Package No	Capital Cost (Contract value)	Amount spent upto Dec-2017	Items/Components on which amount spent
1	Medigadda barrage	4613.00	248.49	Barrage works etc
2	Medigadda LIS	4877.18	723.89	FB, PH, EM, HM items, etc
3	Annaram Barrage	2734.81	610.79	Barrage works etc
4	Annaram LIS	3875.40	658.17	FB, PH, EM, HM items, etc
5	Sundilla Barrage	2225.00	471.54	Barrage works etc
6	Sundilla LIS	3399.25	594.13	FB, PH, EM, HM items, etc
7	Package-6	5047.96	3596.44	S&I, AC, GC, Regulator, Twin Tunnel, SP, PH, EM,HM items, IBC etc
8	Package-7 (incl Medaram)	1446.15	1058.80	S&I, AC, GC, Regulator, Twin Tunnel, SP, IBC etc
9	Package-8	4900.40	3482.09	S&I, GC, Twin Tunnel, Regulator, SP, DT, PH, EM,HM items, DM,DC, IBC etc
10	Package-9	996.01	250.02	S&I, GC, Tunnel, Reservoir improvements, Lift system (Civil), Battala cheruvu, IBC etc
11	Malakpet Reservoir	569.99	17.27	
12	Package-10	2798.91	1637.69	S&I, AC, GC, Tunnel, Regulator, SP, DT, PH, EM,HM items, DM, DC, IBC etc
13	Package-11	3127.58	1853.20	S&I, AC, GC, Tunnel, Regulator, SP, DT, PH, EM,HM items, DM, DC, IBC etc
14	Sri Ranganayaka Sagar	493.65	31.67	Formation of reservoir works
15	Package-12	3348.00	1457.29	S&I, AC, GC, Tunnel, Regulator, SP, DT, PH, EM,HM items, DM, DC, IBC etc
16	Sri Komaravelli Mallanna Sagar-R1	1893.68	0.00	
17	Sri Komaravelli Mallanna Sagar-R2	1546.65	0.00	
18	Sri Komaravelli Mallanna Sagar-R3	2118.27	0.00	
19	Sri Komaravelli Mallanna Sagar-R4	1482.75	0.00	
20	Package-13	556.11	0.00	
21	Package-14	2553.55	0.00	
22	Kondapochamma Sagar R1	999.03	0.00	
23	Kondapochamma Sagar R2	707.14	0.00	
24	Ramayampet canal	373.22	0.00	
25	Shankarampet Canal	154.87	0.00	
26	Jagdevpur canal	107.57	0.00	
27	Upparpally Canal	60.50	0.00	
28	Thurkapally Canal	164.78	0.00	
29	M. Thurkapally Canal	87.13	0.00	
30	Gajwel canal	184.90	0.00	

Sl. No	Package No	Capital Cost *(Contract value)*	Amount spent upto Dec-2017	Items/Components on which amount spent
31	Kishtapur Canal	69.99	0.00	
32	Sangareddy Canal Reach-1	363.713	0.00	
33	Sangareddy Canal Reach-2	372.915	0.00	
34	Sangareddy Canal Reach-3	426.79	0.00	
35	Ravalkole Link Canal	363.83	0.00	
36	Package-15	844.69	173.89	S&I, GC, CD&CM works, IBC etc
37	Gandharnalla Reservoir	486.04	0.00	
38	Package-16	1102.65	554.83	S&I, GC, CD&CM works, IBC etc
39	Baswapur Reservoir	1578.57	0.00	
40	Package-17	986.18	83.20	S&I, IBC, Tunnel etc
41	Package-18	758.07	20.59	S&I, IBC etc
42	Package-19	762.47	10.58	S&I, IBC etc
43	Package-20	892.67	538.25	S&I, AC, Tunnel, PH, EM & HM items, etc
44	Package-21	610.06	276.15	S&I, AC, Tunnel, PH, EM & HM items, DC etc
45	Package-21A	2568.94	0.00	
46	Package-22	1446.48	145.03	S&I, AC, Tunnel, PH, EM & HM items, etc
47	Package-27	714.00	124.52	S&I, AC, PH, EM & HM items, etc
48	Package-28	486.68	228.31	S&I, AC, PH, EM & HM items, DC etc

S&I = Survey & Invetsigation
PH = Pump House
EM&HM = Electro-mechanical and Hydro-mechanical
DC = Delivery cistern
DM = Delivery mains
FB = Forebay
IBC = Insurance & Bankers charges

30/07/21
Engineer-In-Chief (Irrigation),
Gajwel, Siddipet District.
30/07/21

Sl. No	Package No	Capital Cost (Contract value)	Amount spent upto Dec-2017	Items/Components on which amount spent
31	Kishtapur Canal	69.99	0.00	
32	Sangareddy Canal Reach-1	363.713	0.00	
33	Sangareddy Canal Reach-2	372.915	0.00	
34	Sangareddy Canal Reach-3	426.79	0.00	
35	Ravalkole Link Canal	363.83	0.00	
36	Package-15	844.69	173.89	S&I, GC, CD&CM works, IBC etc
37	Gandhamalla Reservoir	486.04	0.00	
38	Package-16	1102.65	554.83	S&I, GC, CD&CM works, IBC etc
39	Baswapur Reservoir	1578.57	0.00	
40	Package-17	986.18	83.20	S&I, IBC, Tunnel etc
41	Package-18	758.07	20.59	S&I, IBC etc
42	Package-19	762.47	10.58	S&I, IBC etc
43	Package-20	892.67	538.25	S&I, AC, Tunnel, PH, EM & HM items, etc
44	Package-21	610.06	276.15	S&I, AC, Tunnel, PH, EM & HM items, DC etc
45	Package-21A	2568.94	0.00	
46	Package-22	1446.48	145.03	S&I, AC, Tunnel, PH, EM & HM items, etc
47	Package-27	714.00	124.52	S&I, AC, PH, EM & HM items, etc
48	Package-28	486.68	228.31	S&I, AC, PH, EM & HM items, DC etc

S&I = Survey & Invetsigation
PH = Pump House
EM&HM = Electro-mechanical and Hydro-mechanical
DC = Delivery cistern
DM = Delivery mains
FB = Forebay
IBC = Insurance & Bankers charges

30/07/21
Engineer-in-Chief (Irrigation),
Gajwel, Siddipet District.

SL No.	Pkg No/Structure Description	Working(in Hrs) Fuel(in KL)	Project Area in Ha	% Date Of Completion	Total Days of Construction/ Man power	Details of Construction Materials: Cement (MT)	Steel (MT)	FA(CUM) Sand	CA(CUM)	Details of Equipments	Location of Quarrys & Lead Distance (KM)	Water Consumption for Construction (KL)	Labour Camp-Domestic Consumption(KL)	Labour Camp-Waste Water Management(STP/	TOP SOIL(CUM)	Total Muck Generated(Cum)	Quantity of muck utilized(Cum)	Other Solid Waste Generated	Disposal of Solid Waste	Yearwise Plantation(Ha) /No.	Remarks
1	Laxmi Barrage (Medigadda)	26/08/16 27/02/2017	281.2	99.70% 4611Cr	1071/ 1980511	679178	137731	841142	2249783	Aggregate Feeder-2,Ambulance-3,Backhoe Loader-5Batching Plant (60 Cum/hr= 1 no , 90 Cum/hr= 1 no.,120 Cum/hr= 6 no)-8, Boom Lift-26, Boom Placer-15Camper-16, Cement Conveyor-1, Cement Pump-2Cement Silo-1, Chilling Plant-14, Compressor-16ConcreteMixer0.75Cum/Batch-1,ConcretePump-12Crane-88, Crusher Plant-5, Dewatering Pump-159Diesel Tanker-4, Dozer-7, Dumper-67, Excavator-61,FlatBedTruck-2,FuelBowser-8 Grader-7,IcePlant-5,Loader-22 MiniBatchingMachine-1,MiniBus-2MiniTruck-6,MobileServiceVan-1 Passenger Vehicle-2, Pick & Carry Crane-38 PickupVan-6 PilingRig-4,PowerGenerator-13Roller-1,SoilCompactor-3,Tipper-3 TotalStation-10,TractorDozer-6,Trailer-19 TransitMixer-120,WaterTanker-14,WeighBridge-6	Steel 55kmcement 55kmAggregates 101km sand 5km	316491	198031	STP-6	581426	18799451	3575997	3240Cum	SPT	2,500	
		UptoDec17WorkingHrs=1000 Fuel=443		5.04% 232.77Cr	257/ 170334	51533	9984	60163	165863	Aggregate Feeder-2, Ambulance-3, Backhoe Loader-5Batching Plant (60 Cum/hr= 1 no , 90 Cum/hr= 1 no.,120 Cum/hr= 4 no)-6, Boom Lift-4, Boom Placer-6Camper-6, Cement Conveyor-1, Cement Pump-2CementSilo-1, Chilling Plant-6, Compressor-6ConcreteMixer 0.75Cum / Batch-1, Concrete Pump-2 Crane-25,Crusher Plant-3, Dewatering Pump-120, Diesel Tanker-4, Dozer-5, Dumper-40, Excavator-15, Flat Bed Truck-2,Fuel Bowser-4 Grader-1,IcePlant-3,Loader-12	Steel 55kmcement 55kmAggregates 101km sand 5km	23890	17033	STP-2	85022	2719056	Nil	75Cum	NPT	0	
2	Laxmi Pump House (Medigadda Lift)	27/08/16/ 30/12/2016	515.07	100%	1584/ 1601310	572132	41734	762735	1568437	BatchingPlant-8,BedPaver-10,Excavator-60Dozer BD65-25,SoilCompactor-12WheelLoader-14,Tyre mountedcrane-10,TRXcrane14T-10 DGSet-25,AirCompressor450-150-9,Concrete Pump(SP1800)-8,BoomPlacer-6,LightingTower-25Trailer-15,Tipper-200,TransitMixer-60 WaterTanker-16,JCB-3,DieselBowser-709-6DCMVan-11,LMV-18,CrawlerCrane-6DrillingROC-10,RigMVc-1,Doomer-1TowerCrane-5,Gantrycrane-6,ShotcretingMachine-2	Steel-55kmcement-55kmAggregates-101km sand-5km	246786	208361	STP-1	1000000	25928348	245043	802.17Tonnes	Deposited in Earthpit	19,300Nos	
		UptoDec17WorkingHrs-7500 FUEL-108		14.85% 723.89CR	367/ 247000	85877	6910	115142	230285	BatchingPlant-8,BedPaver-10 Excavator-60DozerBD65-25,Soil Compactor-12 Wheel Loader-14,Tyremountedcrane-10,TRXcrane14T-10 DG Set-25,Air Compressor 450-150 -9,ConcretePump(SP1800)-8,BoomPlacer-6,LightingTower-25Trailer-15,Tipper-200,TransitMixer-60 WaterTanker-16,JCB-3,DieselBowser-709-6DCMVan-	Steel-55kmcement-55kmAggregates-101km sand-5km	36313	31460	STP	194000	6266821	0	121Tonnes	Deposited in Earthpit	7500Nos 5Ha	
3	Saraswathi Barrage(Annaram)	26/08/16/ 16/11/16.	945.3	100% 2109.44CR	967/ 1071701	438167	53660	851214	1726804	Dumpers-100, Excavators-40, Loaders - 8, Rollers-15,Batching plant-7, Transit miller-45, Crane-20, BoomPlacers-8,watertankers-15,Crushers-1DG set-25	Steel-50km cement-50km Aggregates-96km sand-5km	183657	144680	SOAKPIT	1000000	12470371	NIL	NIL	NIL	0	
		UptoDec17/6880/ 10633		28.96% 610.79CR	344/ 413608	178361	24249	198137	446031	Dumpers-80,Excavators-25,Loaders-8,Batchingplant-7, Transit miller-45, Crane-20, Boom Placers-8 , watertankers-4, Crushers-4 DG set-25 Pilling Rigs -6 Nos,Chillingplant03Nos,TractorDozer01Nos Grader01 Nos BoomLifter-20Nos,DewateringPumps-60Nos, Silos6Nos		74410	39887	SOAK PIT	1000000	2017419	Nil	Nil	Nil	Nil	
4	SaraswathiPumpHouse(AnnaramLift)	27/04/2016 03/12/2016	183.18	100%	1584/ 1244300	314786	20624	371319	838362	TransitMixers-19,BoomPlacers-2,Tippers-45,Concreteplacers-2,Concretepump-2,BatchingPlants-3,Pavers-4,Hydras-7, Excavators-20, JCB-5,Dozers-2, Trailors-10,DGs-12	1)Metal @ Gudepadu(V) WarangalDist. Lead-96KM 2) CementandSteel@ Manthani(M) Lead-50KM 3) Sand @ GodavariRiver, Lead-5KM	151577	167981	STP-1	137883	4179772	4010567	31.108Tonnes	31.108Tonnes	5176	
		Up to Dec 17WORKINGHRS-3520		16.98% 658.17CR	326/ 269000	63450	5566	79313	158826	Transit Mixers-19,Boom Placers-2 ,Tippers-45,Concreteplacers-2,Concrete pump-2, Batching Plants-3,Pavers-4,Hydras-7,Excavators-20,JCB-5,Dozers-2,Trailors-10,	1) Metal @Gudepadu(V),Warangal Dist.	35601	36315	STP-1	43961	7967783	0	67.250Tonnes	67.250Tonnes	51760	

SL No.	Pkg No/Structure Description	Working Hrs/Fuel(InKL)	Project Area In Ha	% Date Of Completion	Total Days of Construction/ Man power	Details of Construction Materials: Cement (MT)	Steel (MT)	FA(CUM) Sand	CA(CUM)	Details of Equipments	Location of Quarry&Lead Distance(KM)	Water Consumption for Construction(KL)	Labour Camp-Domestic Consumption(KL)	Labour Camp-Waste Water Management(STP)	TOP SOIL(LAKH CUM)	Total Muck Generated(Cum)	Quantity of muck utilized(Cum)	Other Solid Waste Generated	Disposal of Solid Waste	Yearwise Plantation(Ha)/No.	Remarks
5	Parvathi Barrage(Sundilla)	15/07/2016 21/01/2017	559.54	93%	1237/ 1058501	381692	46239	764812	1086245	Excavators27,Dumpers-85,PillingRigs-10,Batching Plant-03,Crusher-01,TransitMixture30,BoomPlacer-08 Tale Belt - 01, Loader -05,JCB-02,Cranes(250/80/50/107-)27ChillingPlant-03Mixer 03Roller06WaterTanker07BladeTracor-05,DG	Steel-9km cement-9kmAggregates-51km sand-5km	181324	142898	STP-4	206760	3510073	1821768	Nil	Nil	Nil/1350 (LinearPlantation)	
		UptoDec17601 1 Fuel-258		21.19% 471.51CR	314/ 285570	132488	20075	18137	451720	Excavators 27, Dumpers-85,Pilling Rigs-10,BatchingPlant-05,Crusher-01,TransitMixture30,BoomPlacer-08TaleBelt-01,Loader-03,JCB-02,Cranes(250/80/50/107-)27ChillingPlant-01Dozer 03Roller06WaterTanker07BladeTracor-05,DG	Steel-9kmcement-9kmAggregates-51km sand-5km	60698	38552	STP-5	12000	402126	Nil	Nil	Nil	Nil/Nil	
6	Parvathi(Sundilla) Lift		228.23	100%	1551/ 1451275	300886	25135	560685	753521	Tippers/Dumpers-120,Excavators-48,TransitMixers-28,BatchingPlant-3,Crusher-2,Cranes-16,Trailers-7,WaterTankers-5,Dozers-10,LMV-9,DrillingROC-1,Boomplacers-3,ConcretePumps-3,DGsets-21, Compressors-2,Roller-1,Grader-2,DCM-3,Water Tanker-4	Steel-9kmcement-9kmAggregates-45km sand-5km	149344	196327	STP-7 SoakPit-1	2000000	259133	11332527	2421392	364Tonnes	Disposalofsolid wastetoDumpYard	
		Up to Dec 17WORKINGH RS-6660 FUEL-396		17.47% 591.13CR	370/ 182000	35428	4205	39454	88771	Tippers/Dumpers-120,Excavators-48,TransitMixers-28 BatchingPlant-3,Crusher-2 Cranes-16,Trailers-7,WaterTankers-5,Dozers-10,LMV-9,DrillingROC-1,Boomplacers-3 ConcretePumps-3,DGsets-21,	Steel-9kmcement-9kmAggregates-	17216	24570	STP-4	Nil	259433	8811192	Nil	461onnes	DisposalofsolidwastetoDumpYard	
7	Package6	12/11/2008 25/10/2011 Working Hrs - 37200 Fuel-171415	190.18	100%	2600/ 960000	264575	17516	773618	1513061	Tippers/Dumpers-30 Excavators-10,TransitMixers-15, Batching Plant - 3 , Crusher - 3,Wheel Loaders - 2 Boomers - 5, Water Tankers - 5, Dozers - 2, LMV - 10,DrillingROC-2,JackHammers-2,HydraCranes-4,DGsets-15 BoomPlacer-1 ShotcreteMachine-1	Sand - Antherganon29 KM Metal-5KM crushed fromexcavated rock	Underground Seepagewater during excavation of Tunnel, SP&Pumphouses used for construction purpose	129600	STP		6810565	3145374	480000.00	480000.00	13.91Ha/1590 nos	Link-IIconsistsofconveyorsystem ofwaterfrom SYPtoMMRreservoirsubayoandMMR underKaleshwaramProject There isno directlyacutand etLink-II However the economicalavailability ofwater,Groundwater rechargedthereby agricultural andfisheries development istakingplace inthesurroundings
		Up to Dec 17Working Hrs -31140 Fuel-141990		71.24% 3396.41CR	1870/ 788400	137287	8750	386809	771531	Tippers/Dumpers-30,Excavators-10,TransitMixers-15, Batching Plant - 3 , Crusher - 3,Wheel Loaders - 2,Boomers - 5, Water Tankers - 5, Dozers - 2, LMV - 10 DrillingROC-2,JackHammers-2,HydraCranes-1,DGsets-15,BoomPlacer-1,ShotcreteMachine-1	Sand - Antherganon29 KM Metal - 5 KMcrushedfrom excavatedrock		106131	STP		6129509	2201832	393200.00	394200.00	0	
8	Package7	17/11/2008 03/12/2011 Working hrs - 58300 Fuel-51307	285.47	100%	2650/ 715000	244307	22244	303634	582624	Tippers/Dumpers-60,Excavators-29 TransitMixers-30,BatchingPlant-5,Crusher-4,WheelLoaders-9, Boomers - 8, Water Tankers - 1, Dozers - 4, LMV - 10,DrillingROC-4 JackHammers-7,HydraCranes-8 DGsets-35,BoomPlacer-1,ShotcreteMachine-2, ConcretePumps-24,BedPavers-2	Sand - Antherganon47 KM Metal - 5 KMcrushedfrom excavatedrock		96525	STP		5761358	2176330	35750.00	35750.00	2.5Ha/250 nos	
		UptoDec17 WORKINGHRS - 42240 Fuel-40701		74.47% 1007.82CR	1920/ 459900	63709	582	77288	129930	Tippers/Dumpers-60,Excavators-29,TransitMixers-30,BatchingPlant-5,Crusher-4,WheelLoaders-9, Boomers-8,WaterTankers-4,Dozers-4,LMV-10, DrillingROC-4,JackHammers-7,HydraCranes-8,DG sets-35,BoomPlacer-1,ShotcreteMachine-2, ConcretePumps-24 BedPavers-2	Sand- Antherganon47 KM Metal-5KM crushedfrom excavatedrock		62087	STP		1033351	761751	229950.00	229950.00	0	
9	Package8	17/11/2008 12/03/2012 Working Hrs - 57040 Fuel-144164	252.93	100%	2852/ 915000	176382	10071	391470	782940	Tippers/Dumpers-30 Excavators-8,TransitMixers-15,BatchingPlant-2,Crusher-1,WheelLoaders-2, Boomers-3 WaterTankers-5,Rollers-1,Dozers-2 LMV - 8 Drilling ROC - 2, Jack Hammers - 2, HydraCranes-2 DGsets-10,BoomPlacer-1 Shotcrete Machine-1	Sand - Koduropaka(manair)-55KMMetal - 5 KMcrushed fromexcavatedrock		123525	STP		2738135	1201811	457500.00	457500.00	15Ha/1500 nos	
		UptoDec17 WORKING Hours-43010 FUEL-111380		71.05% 3382.09CR	2172/ 722700	88295	5036	195735	391470	Tippers/Dumpers - 30, Excavators - 8, Transit Mixers - 15, Batching Plant - 2, Crusher - 1, Wheel Loaders - 2, Boomers - 3, Water Tankers - 5, Rollers - 1, Dozers - 2, LMV - 8, Drilling ROC - 2, Jack Hammers - 2, Hydra Cranes - 2, DG sets - 10, Boom Placer - 1, Shotcrete Machine - 1	Sand- Koduropaka (manair)-55KM Metal-5KM crushedfrom excavatedrock		97363	STP		2601228	841268	361350.00	361350.00		
		17/11/2008 23/10/2017 WorkingHours-9900 Fuel-1329		100%	450/ 112500	15117	70	101534	45106	Dumpers -20, Excavators 10, Loaders -2, Rollers -3,Batching Plant -1, Transit Millers - 3, Motor Grader -2,BoomPlacer-1,WaterTanker-5,Crusher-1,DGset-1NO	Sand - Antherganon Metal-35KMcrushedfrom Excavatedrock	36000	15188	STP		1120000	101000	56250.00	56250.00		

SL No.	Pkg No/Structure Description	Working(in Hrs) Fuel(in KL)	Project Area in Ha	% Date Of Completion	Total Days of Construction/ Man power	Details of Construction Materials: Cement(MT)	Steel(MT)	FA(CUM) Sand	CA(CUM)	Details of Equipments	Location of Quarry & Lead Distance(KM)	Water Consumption for Construction(KL)	Labour Camp-Domestic Consumption(KL)	Labour Camp-Waste Water Management(STP/	TOP SOIL(LAKH CUM)	Total Muck Generated(Cum)	Quantity of muck utilized(Cum)	Other Solid Waste Generated	Disposal of Solid Waste	Yearwise Plantation(Ha)/No.	Remarks
10	Reservoir	Up to Dec 17WORKING HRS-660 FUEL-879	265 26	66.14% 50.96Cr	30/ 14000	1511	7	10455	4510	Dumpers -20, Excavators 10, Loaders -2, Rollers - 3,Batching Plant -1, Transit Millers - 3, Motor Grader - 2,BoomPlacer-1,WaterTanker-5,Crusher-1,DGset-1NO	Sand - Anthergaon- 35KM Metal-5KM crushed fromexcavate drock	9600	1890	STP		420000	29300	7000,00	7000 00	-	villages offoreshoreof SripadaYellampal
11	Package9	17/11/2008 10/07/2013 workinghours 53882 hrsFuel ltrs	658 72	60.68%	2939/ 244917	37008	949	185000	98853	Excavators-20,DewateringPumps-26,Aircompressors -4,Dumpers-16,Dozers-1,WaterTankers-19,Showels - 7,Transit Mixers - 17,Tippers - 10,Vibromax rollers - 2,Batching Plant - 5,Wagond drills - 1,Stone Crusher - 2,DGSet-21ConcreteMixers-6,Gantries-6,ConcreteSelfloaders-12,Pavers-5,Crane-4,Vibrators-17	sand: Sircilla/Padira/ Padira 19/28/36km, Metal Nagaram/Thimmapur/ Dammannapet: 14/15/20 km	16500	33064	SoakPit	49116	1179264	671373	12200	Dump yardandsoakpit	150	
		Up to Dec 17WORKING HRS -29920 FUEL		25.44% 253 44	1632/ 13600	5228	313	16393	14954	Excavators-5,DewateringPumps-5,AirCompressors-0,Dumpers -2,Dozers -0,Water Tankers -5,Showels -0,Transit Mixtures -2, Tippers -9,Vibromax rollers -2,Batching Plant -1,Wagond drills -1,Stone Crusher -1,DG Set -5,Concrete self Loaders -4,Pavours-0, Crane0,Vibrators-5	sand Sircilla/Padira/Padira 19 /28/36km, Metal:Nagaram/Thimmapur/ Dammannapet: 14/15/20 km	2438.00	1836	SoakPit	40996	534056 0 0	53406	6800	Dump yardandsoakpit	Nil	
12	Malakpet (Reservoir(Pkg-9)	15/09/2017 15/09/2017 workinghours 25982 hrsFuel:1300 0	503.98	85.09%	1181/ 409050	13558	826	470818	127466	Excavators-34,DewateringPumps-9,AirCompressors -3,Dozers-13,WaterTankers-30,Transitmixers-2,Tippers-91,Vibromaxrollers-13,DGset-1,ConcreteMixers - 2, Sheep foot roller - 1, Grader - 1, Concreteselfloaders-6,Vibrators-3	sand Anupuram 22 km,Metal: Agraharam 16km	5434	55222	SoakPit	687304	398224	101592	204525	Dump yardandsoakpit	100	
		Up to Dec 17WORKING HRS- -1440 FUEL-320		7.93% 37.44CR	72/ 2120	138	0	71291	4817	Excavators-10DewateringPumps-3,AirCompressors-5, Dozers - 8, Water Tankers - 10, Transit mixers - 0,Tippers - 50 Vibromax rollers - 8, DG set - 5, ConcreteMixers-0,Sheepfootroller-4,Grader-3,Concrete selfloaders-0,Vibrators-0	sand Anupuram 22 km,Metal Agraharam 16km	7853 00	286	SoakPit	344592	517291	15207	1060	Dump yardandsoakpit	Nil	
13	Package10	02/12/2008 03/01/2012to TillDate	396.78	92.00%	2390/ 119300	12180 6	5906	171420	342840	EC-25, Dumpers-75, Telebelt-1, Boom Placer-2, TM-25,Dozer-5, Water Tanker-10, Drilling Eqipment-10,Dewatering Pumps - 5, Air Compressors - 2, Dozers - 2,Loaders-2Nos,BatchingPlants-5Nos,Boomers-5Nos,Shotcrete Machines -2 Nos, Mobile Cranes - 5Nos, Dgsets-5nos,Transitmixers-20,	ManairRiver-21Km for FineAggregate	121806	16133	SoakPit-5	0	3247245	479977	47800 00	Disposal ofSolidWaste to Dumpyard	1000	
		Up to Dec 17WORKING HRS-35200 FUEL-- 23085		63 12% 1637.69CR	1600/ 80000	30172	467	24814	67637	EC-25, Dumpers-75, Telebelt-1, Boom Placer-2, TM-25,Dozer-5, Water Tanker-10, Drilling Eqipment-10,Dewatering Pumps - 5, Air Compressors - 2, Dozers - 2,Loaders-2Nos,BatchingPlants-5Nos,Boomers-5Nos,Shotcrete Machines -2 Nos, Mobile Cranes - 5Nos, Dgsets-5nos,Transitmixers-20,	ManairRiver-21Km for FineAggregate	30172	10800	SoakPit-3	0	3192816	94691	32000,00	Disposal ofSolidWaste to Dumpyard	0	
13	Annapurna Reservoir	02/12/2008 01/11/2016to TillDate	1133.13	100.00%	1128/ 112800	79883	162	378379	273545	EC-6, Dumpers-100, Dozer-6, Water Tanker-15, DrillingEqipment-4, Dewatering Pumps - 3,Batching Plants-2Nos,Dgsets-2nos,Transitmixers-3,Vibromaxrollers-4,Sheepfootroller-2,Grader-1,	ManairRiver-21Km for FineAggregate	79883	15228	SoakPit-2	0	494800	729237	56400	56400	200Nos	
		Up to Dec 17WORKING HRS-6760 FUEL--3055		45 00%	338/ 33800	45755	0	163043	159039	EC-6, Dumpers-100, Dozer-6, Water Tanker-15, DrillingEqipment-4, Dewatering Pumps - 3,Batching Plants-2Nos,Dgsets-2nos,Transitmixers-3,Vibromaxrollers-4,Sheepfootroller-2,Grader-1,	ManairRiver-21Km for FineAggregate	45755	4563	SoakPit-2	0	494800	251427	16900	16900	-	
		From03-02-2012toUpto 24-03-2020 WORKINGHRS-44224 FUEL-- 60181		0.6278	2764/16 5 840	18775 3	2535 8	193921.7 8	387844.5 6	Excavators L&T PC-200 8 Nos,Loaders - 4 Nos,250 KVADgSetCummins-1Nos,Dumpers/Tippers-6Nos,Water Tankers - 1 Nos, AIR COMPRESSORS - 1 Nos,Paver Finishers - 1 Nos, Transit Mixers - 4 Nos, RockBreakerAttachments-1Nos,SandvikDT820,AtlasCopcoBencher,SandvikDe12 0,ExcavatorsL&TPC-3003 Nos, Kubota Mini Excavator - 1 No, 320 KVA Dg SetKirloskar- 1Nos, 250 KVADgSet Cummins-1Nos,100 KVADgSetCummins-5Nos,25KVADgSetCummins-	MidManair-37	187753	22188	STP-2 SoakPit-10	253937	1287690	128184 3	229190,8 8	229190 8 8	9.3/31801	

SL No.	Pkg No/StructureDescription	WorkingHours) Fuel(inKL)	Project Areain Ha	% Date OfCompletion	TotalDays ofConstruction/ Man power	DetailsofConstructionMaterials Cement(MT)	Steel(MT)	FA(CUM) Sand	CA(CUM)	DetailsofEquipments	Location ofQuarry& LeadDistance(KM)	WaterConsumption forConstruction (KL)	LabourCamp-DomesticConsumption (KL)	LabourCamp-WasteWater Management (STP/	TOP SOIL(LAKH CUM)	Total MuckGenerated (Cum)	Quantity of muckutilized(Cum)	Other SolidWasteGenerated	DisposalofSolidWaste	YearwisePlantation(Ha) /No.	Remarks
14	Package11	From03-02-2012toUpto Dec 17WORKINGHRS-43680 FUEL—39126	741.59	43.25% 1503.36	837/5022 0	94817	645 8 7	88104 04	176209.08	ExcavatorsL&TPC-200-6Nos,Loaders-3Nos,250KVADg Set Cummins - 1 Nos, Dumpers/Tippers -8 Nos,Water Tankers - 4 Nos, AIR COMPRESSORS - 3 Nos,Paver Finishers - 1 Nos, Transit Mixers - 4 Nos, RockBreakerAttachments-1Nos,SandvikDT820,AtlasCopcoBoomer,SandvikDe120,ExcavatorsL&TPC-3006 Nos, Kubota Mini Excavator - 1 No, 320 KVA Dg SetKirloskar - 1 Nos, 250 KVA Dg Set Cummins - 1 Nos, 100KVA Dg Set Cummins - 5 Nos, 25 KVA Dg Set Cummins -5Nos,40FeetTrailor-1No,EOTCrane,Tools&TacklesandElectricalInstrumentsCrusher-1BatchingPlant2	MidManair-37	94817	6780	STP-2 SoakPit-10	174768	1114442	299160	21017.07	21017 07	-	
14	Package12	24/11/2008 From04/01/2013 till dateWORKINGHRS-56836 FUEL-83813	646.34	87.23%	2813/ 386012	201018	8485	208048	416097	Excavators-20Nos,Loaders-4Nos,DewateringPump-200 HP, Ventilation Fan - 310 HP, 250 KVA Dg Set - 3Nos, 500 KVA Dg Set - 2 Nos, Dumpers - 15 Nos,WaterTankers - 4 Nos, AIR COMPRESSORS - 9 Nos. PaverFinishers - 2 Nos. Transit Mixers - 15 Nos, MiniExcavator - 2 Nos, 320 KVA Dg Set - 1 No, 100 KVA DgSet - 5 Nos, 25 KVA Dg Set - 5 Nos, Boomers - 5Nos ,BatchingPlant-CP30-3Nos ,BatchingPlant-CP60-1 No	Metal Venkatapur-3Km & 18 KmTukkapur-1.1 Sand Chinthaltana-48Km &70Km	20101 8	35397	SoakPits-9	876176	9448949	8226217	238000	23800	350	
		Up to Dec 17WORKINGHRS-35992 FUEL-45351		43.25% 1457.29	1636/ 196320	56095	97	42884	85767	Excavators-12Nos,Loaders-4Nos,DewateringPump-200 HP, Ventilation Fan - 310 HP, 250 KVA Dg Set - 3Nos, 500 KVA Dg Set - 2 Nos, Dumpers - 15 Nos, WaterTankers - 4 Nos. AIR COMPRESSORS - 7 Nos, TransitMixers-15Nos,Boomers-3Nos ,BatchingPlant-CP30-3Nos	Metal Venkatapur-3Km Sand Chinthaltana-48Km &70Km	56095	26503	SoakPits-4	355110	4103316	142945	98160	98160	250	
15	Package13	21/02/2009 14/06/2012 tilldate	699.7	62.78%	2430/ 1579500	######	3,963	1,78,099	2,94,089	Excavators35,Cranes2,JCB's5,BatchingPlant5, Dumpers85,BoomPlacer1,Dozer/Rollers20, Transmixers15,Crusher1,WheelLoaders5,Water Tankers15,LMV12,DrillingROC6,JackHammers20, Paver Finishers 10, Rock Breakers 2, DG Sets 20,WeldingMachines-5,WeighBridge-1,Dewateringpumps-20,DieselTanker-2,Trailers-2	MidManer-140	75	213233	SoakPits-15	505600	2077990	55000	473850	Dumpingyard&GramPanchayat	700	
		Up to Dec 17WORKINGHRS-24000 FUEL—3394		20.58% 171.89CR	1500/ 950000	202	14	225	417	Campers-4,Compressor22,Compactor8,DewateringPump-20, Diesel Tanker -2,Dozer -17,Drillingequipments-6,Dumper 85,DG set 20,Excavators-35,Grader 3,JCB-5 Mobile Service van-3,Pickup van-2,RockBreakerattachement-2Roller-10,TractorDozer-5,Trailer-2,TwoWheeler-12,WaterTanker-15, WeldingMachines-5,WeighBridge-1	MidManers 140	0 29	121250	SoakPits-25	200350	604000	0	550	Dumpingyard&GramPanchayat	700	
16	Package16	11/02/2009 14/08/2012 Till DateWORKINGHRS-21916 FUEL—1496	453.65	55.17% 1059.75cr	2493/ 590840	44146	5958	127981	153143	Excavators33,Cranes2,JCB's5,Batching, Plant5, Dumpers85,BoomPlacer1,Dozer/Rollers20, Transmixers15,Crusher1,WheelLoaders4,Water Tankers14,LMV12,DrillingROC6,JackHammers20,PaverFinish15	Sand MidManair-130Km Metal -10KmCanal spoil	79763	79763	SoakPits-2	255000	2497235	153143	29542	DumpyardofDaswapurvillage	Nil	
		Up to Dec 17WORKINGHRS-28480 FUEL—924		43.74% 410.91CR	1540/ 364980	26485	2785	99803	96602	BatchingPlant- 1, Campers-14,DGSet9,Excavators-6,JCB-4,PaverFinished-4Roller-3,TransitMixures-8,WaterTanker14	Sand MidManair-130Km Metal .10KmCanal spoil	49272	49272	SoakPits-2	222000	2157870	96602	11249	DumpyardofDaswapurvillage	Nil	
	Package17	(Till date)19/02/2009	155.29	33.57% 331.07Cr	1248 401800	7974	430	12543	19494	Excavator-21 Dumpers/Tippers-58,Dozer/Rollers-3, Transmixture-2,CusherPlant-1,Crusher1,Boomer-3,Jumbo vechiles -4, Shotcrete Machine -1, VentilationFans-3,DGsets-11	Sand,Manair-100	94500	34243	SoakPit-6	361068	3283248	1010000	-	-	Nil	- Dry &rockyuplands
		Up to Dec 17WORKINGHRS-9540 hrFUEL-2973		8.10% 86.84Cr	477 138330	1011	37	1517	1175	Excavator-10,Dumpers/Tippers-32,Dozer/Rollers-3, Transmixture-2,CusherPlant-1,Crusher1,Boomer-0,Jumbo vechiles -4, Shotcrete Machine-0, VentilationFans-3,DGsets-13	Sand Manair-101	12700	18675	SoakPit-4	58435	867811	-	-	-	Nil	1109.41 Ha DryLandinlandtillDec-
		20/11/2008 05/11/2011		83.45%	2420 402000	285442	3871 7	131303 35	262606 7	BoomPlacer-1,Excavators-7,Dumpers-10,Tower Cranes-2,TransitMillers-6,Loader-1,JCB-1,Escort-1,Gensets-6	Pothanpal-20KM	38000 000	750	Letoutto nearby byfarmfields	-	2185000	1754103	-	430897	Nil	

Sl. No.	Pkg No/Structure Description	Working(in Hrs) Fuel(in KL)	Project Area in Ha	% Date Of Completion	Total Days of Construction/ Man power	Details of Construction Materials: Cement (MT)	Steel (MT)	FA(CUM) Sand	CA(CUM)	Details of Equipments	Location of Quarry&Land Distance(KM)	Water Consumption for Construction(KL)	Labour Camp-Domestic Consumption (KL)	Labour Camp-Waste Water Management (STP)	TOP SOIL(LAKH CUM)	Total Muck Generated(Cum)	Quantity of muck utilized(Cum)	Other Solid Waste Generated	Disposal of Solid Waste	Year wise Plantation(Ha) /No.	Remarks
	Package20	Up to Dec 17WORKINGHRS-16200 FUEL-2500	267.87	60.29% 538.25CR	1610 320000	47,150	1027	52867	105714	Boom Placer - 1, Excavators - 7, Dumpers -10, TowerCranes-2,TransitMillers-6,Loader-1,JCB-1,Escort-1,Gensets-6	Pothangal-20KM	28732	500	Let out tonearby farmfields	-	19,35,000	1654000	-	115000	-	
	Package21	20/11/2008 01/07/2012	89.04	60.76%	4477/ 280000	14756	130	22626	45252	Boom Placer - 1, Excavators - 7, Dumpers -10, TowerCranes-2,TransitMillers-6,Loader-1,JCB-1,Escort-1,Gensets-10	Naleshwar-55	12000000	14165000	SoakPit		220625	176500	-	-	Nil	
		Up to Dec 17WORKINGHRS-21766 FUEL-3000		45.26% 276.15	3286/ 11000	-	-	-	-	Boom Placer - 1, Excavators - 7, Dumpers -10, TowerCranes-2,TransitMillers-6,Loader-1,JCB-1,Escort-1,Gensets-10	Naleshwar-55	1807611	10543531	SoakPit		220625	176500	-	-	Nil	
	Package21 A	17/04/2018 05/5/2018	323.57	55.97%	2080/ 581620	6506	3577	17210	26926	Excavators-20,Cranes-20,JCB's-35,BatchingPlant-2,JointingM/C-25BoomPlacer-1,Transitmillers-4	Lingapur-47	31105090	59217600	SoakPit							
		Up to Dec 17WORKINGHRS-0 FUEL-0		0	0	0	0	0	0	-	-	0	0	-	-	-	-	-	-	-	
	Package22	20/11/2008 25/01/2013	505.07	17.12% 247.69CR	1840/ 110400	1600	150	2453	4905	Boom Placer - 2, Excavator -4, Dumpers-8, TowerCranes - 1, Loader-1, JCB-2, Escort-2, Gensets-3,Welding Machines-3,Hydra-1,Drilling Machines-1,Campers-4	Birkur-55	37169	14904	SoakPit	-	1906561	126750	134	Panchayatiracorcomes tocollect thewaste, Usedby farmersas compost		
		UptoDec17 WORKING HRS-11680FUEL -1312		9.63% 139.309CR	710/ 43800	1020	70	1564	3128	Excavator-4,Dumpers-8,TowerCranes-1,JCB-2,Gensets-1,Welding Machines-3,Hydra-1,DrillingMachines-1,Campers-2	Birkur-56	25975	5913	SoakPit	-	1232655	104000	48	Panchayatiracorcomes tocollect thewaste, Usedby farmersas compost		
	Package27	24/02/2009 03/03/2013 WORKINGHRS-12000FUEL-740	643.86	63.00%	1560/ 360000	47522	4458	39192	78384	DGsets-23,DoublePiston-15,Singlepiston-10,WeldingMachines-23, Drilling machines-3, Concrete pump-2,Shotcreating machines-1, AZAX-10, JCB-2, Aircompressor-2,Batchingplant-1,Boomer-1,Hydra	Peddavagu-56Km	42600	39000	STP	500000	6712000	250000	0	-	-	
		UptoDec17 WORKINGHRS-9000FUEL -585		46.03%	1260/ 43800	33482	3152	29192	52770	DGsets180KVA-2No's62.5Kva-No'sThreePhase Welding Machine 10 Nos Drilling Machine -2 No'sConcrete Pump -1 No's,We shotcriting Machine -1 No'sAzar 2 No's Campers-2 No's Boomer 1 No's Excavators(210)2 No's Excavtors (110)1 No's cars - 1no's Twowheeler1no's,Tippers&Dumpers-4no'sWatertankers -2No's	Peddavagu-56Km	35000	5913	STP	370000	5000000	200000	0	-	-	
	Package28	25/02/2009 06/10/2012	225.81	48.37% 235.41CR	1969/ 306000	2728	95	4183	8367	DGSets-4,WeldingMachines-10,DrillingMachines	Sand:PeddaVagu-88 Metal: Nirmal-53	4547	40500	SoakPit	345500	1149175	480000	0	0	1) Grasscarpets around the pumphouse-79575sft. 2) Royalfarms-150 3) Crotonplants-200 4) Ficusyellowplants-150 5) fruit types&flowertypes 45	
		UptoDec17 WORKING HRS-12352FUEL -1650		46.91% 228.31CR	1544/ 171400	2728	95	4183	8367	DG sets 180 KVA-2 No's 62.5 Kva-No's Three PhaseWelding Machine 10 Nos Drilling Machine -2 No'sConcretePump-1No's,WeshotcritingMachine-1No'sAzar2No'sCampers-2No'sBoomer1No'sExcavators(210)2No'sExcavtors(110)1No's,cars-1no's Two	Sand:PeddaVagu-88 Metal Nirmal-54	4547	17739	SoakPit	143000	920000	480000	0	0	nil	

MOEF LETTERS

GOVERNMENT OF TELANGANA
IRRIGATION & CAD DEPARTMENT

From
Sri. B. Hariram, B.Tech., F.I.E.,
Engineer-In-Chief (I),
Integrated Office Complex,
Sangapoor Road, Gajwel,
Siddipet District – 502 278.

To
The Member Secretary,
River valley & Hydroelectric Projects,
MoEF & CC, 2nd Floor, Vayu wing,
Indira Paryavaran Bhavan, Jor Bagh Road,
New Delhi – 110 003.

Letter No. ENC (I)/GJL/DCE/DEE-1/AEE-8/NGT EC/2021/1856 Dt:01-12-2021.

Sir,

Sub:- Hon'ble NGT Order Dt: 20.10.2020 in the matter of Md. Hayathuddin verses UoI & Ors (Appeal No.20/2020) – 4th meeting of the Expert Committee & Site visit - Information submitted – Regarding.

Ref:- 1. Hon'ble NGT Order, dt:20-10-2020.
2. Minutes of 4th Meeting of the Expert Committee held on 31-07-2021 communicated through e-Mail dt:15-08-2021.
3. e-Mail from MoEF & CC dt:17-11-2021.
4. e-Mail from ENC (I), Gajwel dt:24-11-2021.

* * * *

With reference to the above, clarification related to the Land Use and Land Cover details in Annexure-A alongwith the supporting kml/kmz files are herewith enclosed for favour of information and taking necessary action.

Encl: As above.

Yours faithfully

01/12/21
Engineer-In-Chief (Irrigation),
Gajwel, Siddipet District.

1/12/21

S.No	PROJECT NAME	PROJECT AREA (Ha)			EXPLANATION
		AS PER EXCEL	AS PER KML / LULC	DIFFERENCE (+/-)	
1	Laxmi Barrage (Medigadda)	263.2	446.79	163.59	
2	Laxmi Pump House (Medigadda Lift)	515.07	539	23.93	
3	Saraswathi Barrage (annaram)	321.08	417	95.92	Additional area is area covered barrage across the river and guide bunds
4	Saraswathi Pump House (Annaram Lift)	200	190.83	-9.17	
5	Parvathi Barrage (Sundilla)	205	238.69	33.69	Additional area is area covered barrage across the river and guide bunds
6	Parvathi (Sundilla) Lift	220	200.2	-19.8	
7	Package 6	138.96	NA	137.3	
8	Package 7	159.72	NA		
9	Package 8	215.23	NA		
10	Medaram Reservoir	302.54	475.51	172.97	pl. check it is now 298.0
11	Package 9	398.7	427.68	28.98	
12	Malakpet Reservoir (Pkg-9)	509.18	509.18	0	
13	Package 10	390.53	390.53	0	
14	Annapurna Reservoir / Anathagiri	893.16	893.16	0	
15	Package 11	169.99	NA		Pl. check the kml. North of reservoir is pump house its area is 76.92 ha + canal south of reservoir is 61.5ha equal to 138.42 ha. (But the reservoir area is Reservoir area is 825ha)
16	Package 12	229.79	NA		
17	Package 15	205.5	205.5	0	
18	Package 16	281.12	313.63	32.51	
19	Package 17	251.75	258.42	6.67	
20	Package 20	267.67	NA		
21	Package 21	89.04	NA		
22	Package 21 A	324.57	129	-195.57	
23	Package 22	121.53	22.45	-99.08	Pl. check kml Package 22 Bhumpally reservoir and canal
24	Package 27	262.34	262.35	0.01	
25	Package 28	235.1	235.08	-0.02	
		7190.97			

01/12/21
Engineer-in-Chief (Irrigation)
Gajwel, Siddipet District.
1/12/21

As directed and concluded by Hon'ble NGT, the project activities that were undertaken by the PP from 2008 to 2017, until the EC was obtained is declared as a clear case of violation and the method and procedure to be followed is defined by the Notification no: S.O 804(E) dated 14th March 2017 (vide: Annexure-XI) and some of the extracts of the referred notification is quoted below which shall be the guideline for assessing the damages and mitigation measures:

Para no (6): "The expert appraisal committee shall stipulate the implementation of Environment Mangement Plan, comprising remediation plan and natural and community resources augmentation plan corresponding to the ecological damage assessed and economic benefit derived during violation"

In the instant case the committee will comply with the terms of reference mandated by Hon'ble NGT, as briefed above.

As mentioned above, as per the committee's requirement explained in the meetings and also during the site visit, The PP has progressively submitted the above reports in tabular forms and also some of the agreement copies (3 nos), besides KML files till 2nd week of December as depicted below:

ANNEXURE I TO V AND STATEMENTS:

The Kaleshwaram project consists of 48 sub projects viz, three barrages, three connected pump houses,17 resevoirs –some of them integrated with the packages,28 packages and work orders, tenders are awarded accordingly. Out of the 48 projects ,24 projects have commenced work prior to grant of EC i, e 22nd December 2017.

Out of these projects,6 no projects comprising of three barrages and their connected three pump houses have commenced work from July/August 2016. Out of the balance 18 packages,11 packages commenced work from 2008/9 onwards and the balance 7 packages between 2011 and 2013.

The total capital cost incurred for these violation projects till 2020/21 is Rs:43243.91 crores out of the total project cost of 53887.6 cr, whereas capital cost incurred till December 2017 for these projects is Rs:18853.6 cr and the % age of completion ranges from a minimum of 1.4% to a maximum of 73.21upto Dec,2017. Package details, date of commencement, amount spent till Dec-17 and till date is furnished in the the following Table-1 :

Table-1

Links and Package Details under Violation

S.NO	LINK	PACKAGES	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	Capex spent update cr	Capex up to dec 17 cr
1	LINK 1	Laxmi Medigatta	Barrage at medigadda - FRL+100-16.17 TMC	26-08-2016	1 Yr	9.6	3484.96	334.6
2		Laxmi Pumphouse	Gravity canal Pump House	27-08-2016	1 Yr	12.9	4516.64	723.89
3		Saraswathi	Barrage at annaram - FRL120-11.90 TMC	26-08-2016	1 Yr	18.2	2194.88	610.79
4		Saraswathi (PH)	Canal pump house	27-08-2016	1 Yr	16.98	3301.87	658.17
5		Parvathi(Sundilla)	Barrage at sundilla - FRL 130 -5.11 TMC	15-07-2016	1 Yr	21.19	1733.2	471.54
6		Parvathi (P H)	canal, pump house	27-08-2016	1 Yr	17.47	3132.46	594.13
7	LINK - 2	Package 6	AC : 2.580 KM , G/C : 1.100 KM, Tunnel - 9.534KM, Pump House (Medram Tank Reservior)226/231,0.78 TMC	25-10-2011	9 yrs	71.24	4612.14	3596.44

S.NO	LINK	PACKAGES	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	Capex spent update cr	Capex up to dec 17 cr
8		Package 7	AC :1.950KM,Tunnel (Twin)4.133 KM	17-11-2008	9yrs	73.21	1424.48	1058.8
9		Package 8	GC:5.750 KM, Pump House	17-11-2008	9 yrs	71.05	4489.74	3482.09
10	LINK-3	Package 9	AC:2.10KM , T:12.035KM , FRL - 423/432,3.0TMC,PH GE-18.325 KM, PH GC;6.596 KM	17-11-2008	1yrs	25.44	705.16	253.44
11	LINK - 4	Package 10	Midmanair Reservior FRL-318,25.875 TMC,AC1.15 5KM, G/C2.380 KM,T7.465 KM,(Anathagiri Reservior) FRL390/397,3.90 TMC)	17-11-2008	6yrs	58.51	2694.51	1637.69
12		Package 11	AC:1.748 KM,GC:0.454 KM<T:8.590 KM, PH (IMAMABAD	17-11-2008	6yrs	59.25	3061.14	1853.2

S.NO	LINK	PACKAGES	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	Capex spent update cr	Capex up to dec 17 cr
			Reservior) FRL 480/490,3.0 TMC					
13		Malkapet Reservior	Malkapet reservior FRL423/432,30.TMC	17-11-2017	1 yrs	3.33	386.49	17.13
14		Package 12	AC 4.40,T:16.180 KM, PH , Komarawalli Mallasagar FCT535/557,50 TMC	24-11-2008	6yrs	43.5	3230.92	1457.29
15	LINK-5	Package 15	Gandharnadha reservior 9.87 TMC, 510.00, GC:301.75KM, T:1275 KM,GC:4.752 KM	21-02-2009	6 yrs	20.59	462.37	173.89
16		Package 16	GC7.748 KM,Baswapuran Reservior ,453/490, 11.39 TMC , GC:50.05 KM	12-08-2012	6 yrs	50.35	554.83	554.81
17	LINK 6	Package 17	GC:11.670 KM, T:11.525KM, GC:2.505 KM	19-05-2013	5 yrs	8.8	338.8	86.87

S.NO	LINK	PACKAGES	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	Capex spent update cr	Capex up to dec 17 cr
18	LINK 7	Packagr 18	GC :2.505 KM, GC:34.00 KM, T.365 KM	25-02-2009 /2018	1yrs	1.4	62. 36	10.58
19		Packagr 19	GC 37.90 KM, PH	25-02-2009 /2018	1yrs	2.71	218.2	20.59
20		Package 20	SRS Project , Masani Tank , GC :0.131 TML	05-11-2011/2008	7 yrs	60.3	815	538.25
21		Package 21	Konderm cheruva 445/457, 3.50 TMC	20-11-2008	6yrs	45.24	401.11	276.15
22		Package 22	Kadam Project FRL 213.10, 7.6 TMC	25-01-2013	5Yrs	10.33	281.89	145.03
23		Package 27	Diwapur Village CISTORN	20-11-2018/2013	5yrs	17.43	447.26	124.52
24		Package 28	CISTORN	25/02/2009/2012	6yrs	46.97	228.31	228.31
			Total				43243.91	18853.76
						35.0882		
			Project cost			53887.6 Cr		

5. ANTICIPATED IMPACTS DUE TO CONSTRUCTION OF DAMS, BARRAGES, AND OTHER INFRA ACTIVITIES LIKE TUNNELS, PUMP HOUSES, CANALS AND RESERVOIRS:

A) Influence of Dams/barrages on River Ecosystem:

Dam construction is an important engineering measure to deal with the the relationship between water and human being. The damming of a river creates a reservoir upstream and the water spills out to the surrounding environ submerging vast areas, flooding the natural habitats that existed before besides disturbing the ecosystem of the river. The impacts on the downstream again causing physical changes and their biological consequences including changes in floodplain hydrology, sediment movement, acts as barriers for movement of habitats and migratory animals. Dammed rivers reduce flood rates and has negative consequences on the flood plains on the downstream that depend upon seasonal waters for survival. This changes the marsh landscape by reducing the same vis-à-vis leading to biodiversity derogation and degenerated ecological function. It leads to holding back not only sediment but also debris thus overall loss of nutrients and habitat for most animals in the downstream side.

Dam construction which is helpful to humans, has two sides of coin, one is negative and the other is beneficial and implementing it with an ultimate aim of improving the ecosystem and sustainable development will end up in better dam construction.

Anticipated Impacts-Negative and Beneficial (Positive) of Kaleshwaram project:

Impacts during the construction period:

Any construction/infra project of this size shall cause an adverse impact on the environment and in the absence of an Environmental clearance wherein the EMP submitted at the time of evaluating the project contains the prediction of adverse impacts and specifies the mitigation and control measures to be adhered to during construction and operation of the project by the Project Authorities either to completely mitigate or if it is not possible to minimize the impacts to the extent possible so that the project becomes sustainable. In this case approximately about 35% of the construction in 24 projects out of 48 projects have taken place between 2008 and end 2017 without Environment Clearance i,e without EMP/control measures in place.

The major ecological and environmental impacts of the project pertain to the command and catchment areas, reservoirs, barrages and canals and pump houses, labour camps, etc of both spatial and temporal nature.

The impacts are broadly a) related to atmosphere, terrestrial and aquatic b) Impacts related to land, surface and ground water c) Related to sudden population ingress, health, asthetic (visual intrusion) and excess load on infra and lively hood.

The impact during construction is temporary in nature depending upon the period of construction but all adverse impacts need to be addressed.

The impacts during operation is of longer duration and needs to be carefully examined and addressed with adequate mitigation measures in the Environment management plan of the project.

During the construction phase there will be impact due to the following activities: (Negative):

1) Land and Submergence:

The project needed large extent of land for the construction of various facilities such as three barrages, canals covering a length of about 1531 km, 17 reservoirs to store 147.71 TMC of water, tunnels over a length of 203 km, large pumping facility to lift the water, and other minor facilities. The private land to an extent of 34684 ha has to be acquired which will have to be suitably compensated so that they have not adversely affected families due to the project.

It has been assessed that 279 villages (268 in Telangana and 11 in Maharashtra state) will come under submergence making it obligatory to give them rehabilitation and resettlement benefits. Hence all land issues have to be carefully examined, there impact assessed and management plans formulated to mitigate the adverse impacts. Even during the public hearing, the majority of the people were questioning on the payment of adequate land compensation and, therefore, it has to be fully assessed and compensated. The details of the R&R package and the status of settlements so far completed is narrated in the relevant chapter.

2) Site clearance, construction of sheds and other facilities for camp labour and project functionaries:

providing camping facilities such as water, electricity, sanitation, cooking gas, etc. Approach road to the identified construction locations for the movement of men and machinery, transportation of constructional material at different sites will all have adverse impact and which is to be assessed.

3) **Excavation of earth for the construction** of barrages, canals, approach road to tunnels and tunnelling activities, digging for pump houses, etc. will generate lot of muck that has to be assessed for its impact and method of safe disposal has to be found.

Details of impacts due to various parameters is explained as below:

1) Air Environment:

Sources of air pollution affecting the project area are mainly from excavation, loading/unloading operations, vehicular traffic, stocking, drilling and blasting and dust arising from unpaved roads and domestic fuel burning. The air environment in and around project site remains significantly polluted due to added fugitive emissions and therefore, ambient air quality is not quite good in and around the project area. Vehicular movement, quarrying and running of construction equipment will impact air quality at the construction site. The burning of municipal solid waste from the labour colonies will also affect air quality. Construction workers at the project site may use firewood to meet their daily requirements and this will cause air pollution.

Changes in ambient and ground level concentrations due to total emissions from point, line and area sources.

2) Effect on soil, material, vegetation and human health:

The air emissions from the project during construction phase will have moderate adverse effect on the soil, vegetation and human health during construction of barrages, reservoirs and digging of canals due to dust emission from the site, fugitive emissions from vehicles and equipment's

3) Impact of emissions on air environment from DG set used for power generation during the construction

The DG sets need diesel as fuel. The major pollutants which are emitted as gaseous pollutants at the project sites. Hence these would have some temporary impacts on the ambient air quality in the area, like SO2, NOx and SPM. The gaseous emissions from DG sets will cause minor significant impact on the people. Pollution due to fuel combustion in equipment and vehicles

4) Fugitive emissions from various sources:

The vehicular movement, handling and storage of construction materials are prime sources for fugitive emissions. Since the project area is spread over a vast area the emissions are also spread over a large area. There may be moderately concentrated emission posing danger to human health. The impact of the vehicle movements and running of various machines are studied by modelling and quantum assessed for damage assessment during violation period.

5) Water Environment:

The environmental consequences due to construction of barrages are numerous and varied, and includes direct impacts to the biological, chemical and physical properties of rivers and riparian environments.

Another significant and obvious impact is the transformation upstream of the barrage from a free- flowing river ecosystem to an artificial slack-water barrage habitat. Changes in temperature, chemical composition, dissolved oxygen levels and the physical properties of a barrage are often not suitable to the aquatic plants and animals that evolved with a given river system

The impacts in water regime is also explained by way of impacts of Dam construction on ecosystem

The total quantity of water required during construction period will be huge and It is mainly for the construction activity and domestic purpose. **The water will be used from the nearby available source.**

- Water Logging and soil salinity development can occur due to heavy losses of water due to seepage from canals, distributaries and water courses.
- Inadequate drainage and poormaintenance of existing drainage system can result in poor application efficiencies.
- Water quality may be affected by aquatic weeds and biomass decay, turbidity and pollution from agricultural, industrial and human waste.
- Water pollution due to disposal of sewage/labour camps and washing requirement
- Developmental activities such as construction of online storages, canals, tunnels, etc. results in chocking of natural drainage.
- During construction phase sewage discharge from the labour camps or colonies nearby construction site will have an impact.

- Pollution due to runoff from construction sites and impacts due to discharge of effluent from the crusher can be anticipated.
- Due to the construction of barrages and online storages - impoundment, damming, culverting, realignment changes to the hydrology of watercourses or aquifers is envisaged.
- Proliferation of water weeds can increase disease vectors, affect water quality, fisheries and clog irrigation structures.

Adverse impact on land stability, catchment of soil erosion, reservoir sedimentation

Due to the construction of barrages on the River Godavari and due to impoundment of water along the river course it is anticipated that there would be river bank erosion and reservoir sedimentation.

6) Change in Land use / land cover:

The area required for construction of proposed Kaleshwaram project involves submergence of about 37852 ha of land which includes forest, homesteads, buildings, structures and agricultural land in thirteen districts of Telangana State.

7) Biological Environment:

Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc

It will also adversely impact the production and harvesting of non-timber forest products on which the livelihood of local people, especially tribal people, depends.

There will be lot of disturbance to the surrounding flora and fauna. Moreover, to approach the construction site, road had to be constructed for the movement of men and material. Most of these roads are temporary and kutcha roads. The movement of large number of vehicles in the dry season will create lot of dust and noise pollution affecting the flora and fauna. Moreover, the flow of water in the canal is likely to attract the people to occupy the adjacent land causing encroachment of the forest land.

Pressure on existing Natural Resources

The project involves construction of various facilities requiring 37,852 ha

The construction activities, including movement of vehicles, men and material, camping places for the labor, storage of construction waste, etc. will have direct impact on the existing natural resources.

Impact on fish migration and habitat degradation due to decreased flow of water The free flow of fish in the Godavari River will be obstructed due to the construction of barrages.

Impact on breeding and nesting grounds of animals and fish

Due to the construction of barrages, there is bound to be some disturbance in the river water and this will have adverse impact on spawning of fish. However, this will be for a short period and will be more than compensated on the completion of the construction as water will be impounded into the barrages from River Godavari to maintain sufficient water level throughout the year.

As regards the nesting grounds for birds and wild life there will be some disturbance during the construction of canals passing through the forest. This will be compensated in due course of time due to the canal bank plantation and green belt along the periphery of the reservoirs.

8) Anticipated Impacts on Noise Environment

- During construction phase, noise will be generated as a result of operation of construction equipment such as engines, ventilation plant, crushers.
- Noise during construction stage will be increased due to excavation works, machines / equipment's operation and vehicular movement.
- During construction phase - due to blasting, drilling and piling activity there will be increase in noise and vibration
- Noise generation due to vehicular movement for transportation of construction materials.

9) Socio-Economic Environment:

Impact on local community including demographic profile

- The addition of migrant population in the project area will lead to enhanced demand for local produce which will generate additional avenues of income generation for local population

- The locals would also be beneficiaries of all the infrastructural facilities like schools, roads, hospitals, etc. provided by the project authorities
- The project may have an impact on agricultural land, homestead land or residential structures because of land acquisition
- Displacement of population and their resettlement attracts major significance amongst negative impacts

Temporary labour camps

- Temporary labour camps built during the construction period become potential site of endemic diseases.
- The labour may unscrupulously disturb the ecosystem by cutting trees and the damaging the green cover in search of their fuel wood.

Impact on human health due to water /vector borne diseases

Positive Impacts:

1. There is a provision of 10 TMC of water allocation towards drinking water purpose for the en route villages.
2. There is a provision of 30 TMC of water allocation towards Drinking water requirements of twin cities of Secunderabad and Hyderabad
3. There is a provision of 16 TMC of water towards industrial use in and around vicinity of the project command area.
4. Telangana is contemplating to set up many power plants. This helps in industrial development.
5. Dependable Irrigation facilities will be extended by this project to a command area of about 7,38,851 ha over the 7 districts,
6. The project enhances recharge of groundwater thus helping the cultivation done by other resources such as minor irrigation tanks, small lift irrigation schemes in the vicinity of the project command area.
7. The yield of the crops will enormously increase and the cultivation becomes a profitable one.
8. It gives employment for the agricultural labour and other labour who are directly or indirectly depending upon the agricultural activities.
9. It effects positively on other allied occupations such as transport, livestock, marketing, loans etc

10.By providing irrigation facilities the total cropped area in each of the increase cultivable land which was hitherto left barren and uncultivable will be brought seven districts will get additional water facilityunder cultivation thereby increasing the efficiency of land utilization.

11.From the tables it can be seen that a major population of SC and ST are existing in the command area. The livelihood will increase with the proposed project during construction stage and more so after the completion of this project.

12.There will be all-round development of the people in literacy, per-capita income, and employment with this proposed project.

13.The proposed project improves the livelihood of the people by providing irrigation water, drinking water for the en route villages; industrial and domestic requirements of twin cities, etc. Thus, the project will have a positive effect on the welfare of people e.g., by improving the living conditions.

14.There are no National parks, Sanctuaries and Biospheres within the study area. There is no submergence of Archaeological monuments, historical monuments and tourism infrastructure. The project may have a minimal effect on the vulnerable group of people like hospital patients, children, the elderly etc.,

15. Major benefits of the reservoirs and barrage are enhanced water availability, improvement of vegetation, improvement of micro climatic conditions and ecological security.

16.The reservoirs and rim plantations will become places of tourist attraction the department of tourism can further develop the area for the promotion of tourism as already done in many other places where water is available for the enjoyment of the people.

17.With the availability of water in large number of reservoirs the possibility of improving the fish production for the benefit of the local fisheries communities will be very high. Fingerlings can be released in all the water bodies, as it is already being done by the fisheries department, to improve the fish production.

18.The reservoirs and barrages will also act to contain the flood water by its storage in the water bodies.

19. As the primary objective of the project is to provide drinking water to the villages through the flagship scheme of Mission Bhagiratha to supply piped drinking water to each house hold. It will improve the sanitation in the

villages due to safe drinking water and also to be used for bathing and flushing purposes.

20. In areas that are water deficient, the provision of surface water and the enhancement of groundwater because of canals can significantly improve water availability, sanitation and hygiene. Therefore, improved access to clean water is a major benefit of the project.
21. By repairing and laying of new roads the local population can get immense advantages directly or indirectly due to increase in transport facilities. Due to which, it is possible there shall be some industrial growth such as agriculture produce processing and cottage industries will also develop. The project sets a precedent for subsequent development in the form of improved agriculture and its allied activities in the region.
22. The project will generate direct employment during construction phase as preference shall be given to local population. It will also generate indirect employment in service sectors like transportation, hospitality, automobile, etc.

The most important benefit from the project is providing irrigation facility for a command area of 738851ha.

In addition to agriculture there will be improvement in horticulture plantations providing more income to the people.

The water availability will also improve the fodder production and boost animal husbandry activities.

In general, the project will improve the socio-economic condition of the people and bring a marked improvement in the life of the people benefited from the project.

Cost Saved in Approved Environment Management Plan:

One of the main features of the Violation Notification S.O No:804(e) Dated 14/03/2017 is that of Economic benefits accrued during the violation period which comprises the following:

A) Profits accrued during the violation period due to commercial activity: In this case, it is not applicable since there is no commercial activity involved excepting that 16 TMC water is supplied for industrial use at a price.

B) Cost Saved in Budget commitment enumerated in the EMP/EMP Expenses (statutory) during the violation period.

Further reference is drawn to The CPCB report on Environmental compensation of March, 2018 as directed by NGT and Hon'ble SC as briefed below which specifies the environment compensation for the cost saved on various non compliances of provisions of EC / Consent. (Enclosed vide Annexure - XII)

6. ABSTRACTS OF CPCB REPORT

Background

"The Hon'ble National Green Tribunal (NGT), Principal Bench in the matter of OA No. 593/2017 (WP (CIVIL) No. 375/2012, Paryavaran Suraksha Samiti & Anr. Vs. Union of India & Ors. directed Central Pollution Control Board (CPCB) that:

"The CPCB may take penal action for failure, if any, against those accountable for setting up and maintaining STPs, CETPs and ETPs. CPCB may also assess and recover compensation for damage to the environment. Such action plan may be prepared by the CPCB within three months".

Cases considered for levying Environmental Compensation (EC):

Discharges in violation of consent conditions, mainly prescribed standards / consent limits

✓ Not complying with the directions issued, such as direction for closure due to non- installation of OCEMS, non-adherence to the action plans submitted etc.

✓ Intentional avoidance of data submission or data manipulation by tampering the Online Continuous Emission / Effluent Monitoring systems.

✓ Accidental discharges lasting for short durations resulting into damage to the environment

✓ Intentional discharges to the environment -- land, water and air resulting into acute injury or damage to the environment.

✓ Injection of treated/partially treated/ untreated effluents to ground water.

The Hon'ble Supreme Court in its order dated 22.02.2017 in the matter of Paryavaran Suraksha Samiti and another v/s Union of India and others (Writ Petition (Civil) No. 375 of 2012), directed State Governments (including the concerned Union Territories) to set-up Sewage Treatment Plants (STPs), which are already under implementation, within the time lines already postulated. Further, the STPs, which are yet to set-up, to be completed within a period of three years, from today, i.e. by 22.02.2020.

Since failure of preventing the pollutants being discharged in water bodies (including lakes) and failure to implement solid and other waste management rules are too frequent and widespread, the CPCB must lay down specific guidelines to deal with the *same, throughout India, including the scale of compensation to be recovered from different individuals/authorities, in addition to or as alternative to prosecution. The scale may have slabs, depending on extent of pollution caused, economic viability, etc. Deterrent effect for repeated wrongs may also be provided."*

Environmental Compensation Formula

1. Cost saved/benefits achieved by the concerned individual/authority by not having proper waste/sewage management system; and
2. Cost to the environment (environmental externality) due to untreated/partially treated waste/sewage because of insufficient capacity of waste/sewage management/treatment facility.

Cost saved/benefits achieved by not having proper waste/sewage management system includes the interest on capital cost of the waste/sewage management facility and daily operation and maintenance (O&M) cost associated with the facility.

The Committee suggested that annual interest rate as 10% on loan amount, borrowed by concerned individual/authority for setting-up waste/sewage management facility, may be assumed as Capital Cost Factor for calculation of environment compensation. Further, as whole O&M cost is saved by concerned individual/authority for not managing required waste/sewage management system, 100% of the O&M cost saved may be considered as O&M cost factor.

EC = Capital Cost Factor x Marginal Average Capital Cost for Establishment of Waste or Sewage Management or Treatment Facility x (Waste or Sewage Management or Treatment Capacity Gap) + O&M Cost Factor x Marginal Average O&M Cost x (Waste or Sewage Management or Treatment Capacity Gap) x No. of Days for which facility was not available + Environmental Externality

Sewage Treatment Capacity Gap (MLD)	Marginal Cost of Environmental Externality (Rs. per MLD/day)	Minimum and Maximum value of Environmental Externality recommended by the Committee (Lacs Rs. Per Day)
Up to 200	75	Min. 0.05, Max. 0.10
201-500	85	Min. 0.25, Max. 0.35

501 and above	90	Min. 0.60, Max. 0.80

Class of the City/Town	Mega-City	Million-plus City	Class-I City/Town and others
Minimum and Maximum values of EC (Total Capital Cost Component) recommended by the Committee (Lacs Rs.)	**Min. 2000** **Max. 20000**	**Min. 1000** **Max. 10000**	**Min. 100** **Max. 1000**
Minimum and Maximum values of EC (O&M Cost Component) recommended by the Committee (Lacs Rs. /day)	**Min. 2** **Max. 20**	**Min. 1** **Max. 10**	**Min. 0.5** **Max. 5**

Municipal Solid Waste Management Capacity Gap (TPD)	**Marginal Cost of Environmental Externality (Rs. per ton per day)**	**Minimum and Maximum value of Environmental Externality recommended by the Committee (Lacs Rs. Per Day)**
Up to 200	15	Min. 0.01, Max. 0.05
201-500	30	Min. 0.10, Max. 0.15
501-1000	35	Min. 0.25, Max. 0.35
1001-2000	40	Min. 0.50, Max. 0.60
Above 2000	Max. 0.80	

Class of the City/Town	Mega-City	Million-plus City	Class-I City/Town and others
Minimum and Maximum values of EC (Capital Cost Component) recommended by the Committee (Lacs Rs.)	Min. 1000 Max. 10000	Min. 500 Max. 5000	Min. 100 Max. 1000
Minimum and Maximum values of EC (O&M Cost Component) recommended by the Committee (Lacs Rs./day)	Min. 1.0 Max. 10.0	Min. 0.5 Max. 5.0	Min. 0.1 Max. 1.0

As per the survey, it is estimated that solid waste generated in small, medium and large cities and towns is about 0.1 kg (Class-III), 0.3-0.4 kg (Class-II) and 0.5 kg (Class-I) per capita per day respectively. The committee opined that 0.6 kg/day, 0.5 kg/day and 0.4 kg/day per capita waste generation may be assumed for mega-cities, million-plus UAs/towns and Class-I UA/Towns respectively for calculation of environmental compensation purposes. Based on these assumptions, Environmental Compensation to be levied on concerned ULB may be calculated with the following formula

EC = Capital Cost Factor x Marginal Average Cost for Waste Management x (Per day waste generation-Per day waste disposed as per the Rules) + O&M Cost Factor x Marginal Average O&M Cost x (Per day waste generation-Per day waste disposed as per the Rules) x Number of days violation took place + Environmental Externality x N

In this case the compensation approach is applicable to Domestic waste water generation and domestic solid waste generation in the Construction employees' colonies of different projects which are under violation besides other activities as budgeted in the EMP Viz., CAT PLAN, GB PLAN, Rservoir Rim Treatment Plan, WLC plan, Fishery management plan, CA plan, etc."

7. DETAILS OF EXISTING ENVIRONMENT CLEARANCE

The Ministry of Environment, Forest & Climate Change accorded environmental clearance for Kaleshwaram project as per provisions of Environment Impact Assessment Notification, 2006 and its subsequent amendment in 2009, vide letter dated 22/12/2017 and the subject EC was granted after evaluation of the EIA and EMP and other relevant documents including PH proceedings submitted by the PP which contains in one of the Chapter - 9 outlining the Environment Management Plan with budgetary provisions including time line to be implemented during construction and operation period for various control and mitigation activities by the PP and salient conditions of the referred EC in particular reference to EMP is quoted below for ready reference and consideration for cost saved in EMP cost.

8. EC CONDITIONS

Part A-Specific Conditions:

I. The Catchment Area Treatment (CAT) plan as has been proposed in the chapter 9 of EMP (9.1-CAT Plan; November 2017) shall be implemented in consultation with the Telangana state forest Department. The allocated grant of Rs.362.04 Crores for this purpose should be fully utilized and not be diverted for any other purpose. As per plan the area CAT is 32.83 Sq km.

II. The Project involves acquisition of 34,684 ha of land. The R&R benefits for the land losing will have to comply with right to fair compensation and transparency in land acquisition, Rehabilitation & Resettlement Act, 2013 or any other act Which would be beneficial to the project Oustees. Adequate publicity of the compensation package should be Circulated In the affected villages. All R&R Issues shall be Completed on Commissioning of the project.

III. All Commitment made during the public hearing should be fulfilled Completely by the project proponent and record maintained, if any.

IV. The Command Area Development (CAD) Plan as proposed in the EIA/EMP report (November,2017) report shall be strictly implemented.

V. Consolidation and compaction of the generated muck should be carried out in the muck dumping sites. As Proposed in the muck disposal plan, out of 1480 lakh M3 Muck generated, the entire to be utilized for service road & Inspection paths, embankments, land Leveling, filling trenchers, and construction material for CD works, road etc. and restoration works for canal banks should be strictly adhered. The Muck disposal sites shall be reclaimed / restored with vegetation once capacity is utilized. Allocated amount of RS.32.79 crores for the purpose should be fully utilized and not be diverted for any other purpose.

VI. The Proposed compensatory afforestation programme in 5333.817 ha of degraded forest area with twenty-two (22) local plant species identified for the programme shall be undertaken strictly in consultation with state forest department. The allocated amount of Rs.722.30 Crores for this purpose should be fully utilized and not to be diverted for any other purpose.

VII. To Enhance the environment of the project site, greenbelt, as proposed in the EIA/EMP report (November, 2017) shall be developed. The proposed greenbelt shall be developed in the barrages of the project and reservoirs periphery of 111.20 km and canal bank of 116.334 km of the project proposed with the local plant species in the consultation with the state forest department should be taken

-up strictly. The Allocated grant of Rs.19.21 Crores should be fully utilized this purpose and not be diverted for any other purpose.

VIII. The Fisheries Development plan as proposed in the EIA/EMP (November,2017) for the Conservation of fish in the river & reservoir shall be implemented completely in consultation state fisheries department. A Budget of Rs;485 Crores provided for fisheries development plan should be utilized fully for this purpose and not to be diverted for any other purpose.

IX. The proposed Biodiversity Conservation and management plan as proposed in the EIA/EMP Report (November 2017) should be implemented in consultation with state forest Department. The allocated grant of Rs.3.36 crores should be fully utilized for this purpose and not to be diverted for any other purpose.

X. Water user Association's (WUAS)/cooperative shall be formed and involvement of the whole community for disciplined use of available water shall be ensured.

XI. Conjunctive use of surface water shall be planned to check water logging as well as to increase productivity.

XII. The Equipment likely to generate high noise levels during the construction period or otherwise shall meet the ambient noise level standards as notified under the noise pollution (regulation and control) Rules ,2000, as amended in 2010 under the Environment Protection Act (EPA) ,1986. Ambient Noise level monitoring shall be conducted on a monthly basic during the period of construction at suitable locations, and copy the test reports to be submitted to regional office, MOEF & CC, Chennai on six Monthly basis

XIII. Occurrence of stagnant pools/slow moving water channels during construction and operation of the project providing breeding source of vector mosquitoes and other parasites. It will be responsibility of project authorities to take all steps i.e., residual insecticidal spray in all the project area and surrounding 3 km area keeping the flight range of mosquitoes in consideration.

XIV. Plans of greenbelt development and reservoir rim treatment have to be made in consultation with state forest Department. Preference shall also be given to plant local indigenous species.

XV. Solid waste generated; especially plastic waste should not be disposed of as landfill material. It should be treated with scientific approach and recycled.

XVI. Six monthly compliance reports shall be submitted to regional office, MOEF & CC, Chennai util completion of the modernization works.

Part-General Conditions:

I. Adequate arrangements for providing free fuel like LPG shall be made at the project cost for the labour engaged in the construction work so that indiscriminate felling of tress is prevented.

II. Medical facilities as well as recreational facilities shall also be provided to the labourers.

III. Water sprinkling arrangement shall be made to suppress the fugitive emissions and on monthly basis, ambient air quality to be monitored during the period of construction.

IV. Potable drinking water and proper sanitary facilities shall be provided for the labour force.

V. Restoration of construction area including dumping sites of excavated materials shall be ensured by levelling, filling up of borrow pits, landscaping etc. The area should be properly treated with suitable plantation.

VI. Environmental parameters shall be monitored and six-monthly monitoring reports shall be submitted the concerned regional office of the ministry, Chennai.

9. Besides the above stated conditions, the project proponent shall also implement all environmental safeguards, as proposed in the EIA/EMP report and other reports from time to time. The regional office of the ministry, Chennai Shall monitor the implementation of EMP at regular intervals.

10. The Environmental management plan (EMP) shall be strictly adhered to and a sum of 16230.43 crores, the budgetary provisions for the implementation of EMP shall be fully utilized and not to be diverted to any other purpose. In Case of revision of the project cost or due to price level change, the cost of EMP shall also be updated proportionately.

17. After, 5 years of the commissioning of the project, a study shall be undertaken regarding impact of the project on the environment and downstream ecology. The Study shall be undertaken by independent agency, decide in consultation with the ministry.

18.The project proponent shall also submit six monthly reports on the status of compliance of stipulated EC conditions including the result of monthly monitored data (both in hard copies as well as by email) to the respective regional office of MoEF & CC Chennai.

Keeping in view of the above Specific and General conditions of the EC and also the guideline note of CPCB for environmental compensation besides the direction enlisted in the Violation notification of MOEF&CC dt:14/03/2017 (cost saved in EMP), the relevant management plan (EMP) comprising mitigation and control measures with budgetary provision submitted by the PP which has been considered for the EC is detailed below.

9. ENVIRONMENTAL MANAGEMENT PLAN (ABSTRACTS FROM THE EMP CONSIDERED FOR EC)

The EMP identifies the main environmental issues across the the project activities at the time of construction and during operation and provides strategies to be adopted efficiently and manage them suiting to site conditions, dealing mainly to ensure that the project is implemented in an enviro-friendly system and sustainable manner by taking adequate mitigative measures to reduce negative ecological impacts with adequate finance earmarked for the same.

The EMP outlines existing and potential problems that would impact the environment andrecommends corrective measures wherever required on the following lines:

Aspects of Environmental Management Plan

- Catchment Area Treatment Plan,
- Command Area Development Plan,
- Compensatory Afforestation Plan
- Biodiversity and wildlife Conservation & Management Plan,
- Resettlement & Rehabilitation,
- Green Belt Development Plan,
- Fisheries Conservation and Management Plan,
- Reservoir Rim Treatment Plan,
- Muck management Plan including Land scaping and beutification in consideration of visual intrusion and other impacts due to washoff, etc.
- Restoration Reclamation of quarry sites,
- Study of Design Earthquake parameters
- Dam Break Analysis and Disaster Management Plans
- Water, Air and Noise Management Plans
- Groundwater Management Plan
- Agricultural Improvement Plan
- Public health delivery Plan,
- Sanitation and Solid Waste Management Plan-Overall
- Local Area Development plan.
- Environment safe guards during construction activities including road construction and other construction related activities. Occupational health Management system for all the employees during construction and operation.
- Energy conservations Measures during construction and operation.
- River bank stabilization

Environmental Management Plan Cost:

The consolidated cost for environmental management plan is about Rs.16351.64 Crores which includes cost of CAT plan, CAD plan, Compensatory Afforestation, Biodiversity & Wildlife Management Plan, R&R plan, Greenbelt Development Plan, Fisheries Conservation and Management Plan, Reservoir Rim Treatment Plan, Muck management plan and restoration & Quarry sites, Water , Air , Noise Management Plan, Public Health Delivery Plan, Sanitation & Solid waste Management Plan and Local Area Development Plan is given in Table 9.1

Table 9.1 Consolidated Cost for EMP

S.No	Components	Total Cost (Rs. Crores)
1	Catchment Treatment Plan	125.29
2	Command Area Development Plan	1326.86
3	Compensatory Afforestation	722.3
4	Biodiversity & Wildlife Management Plan	3.36
5	Greenbelt Development Plan	19.21
6	Fisheries Conservation and Management Plan	485
7	Reservoir Rim Treatment Plan	236.75
8	Muck management Plan	32.79
9	Plan for restoration & Quarry sites	23.16
10	Water, Air ,Noise Management Plan	25.93
11	Public Health Delivery Plan	10.35
12	Sanitation & Solid waste Management Plan	16.40
13	Local Area Development Plan	28.24
	Total (a)	**3055.64**
14	Resettlement & Rehabilitation Plan	13296
	Total (b)	**13296**
	Grand Total	**16351.64**

On perusal of the above, it is noted that the above budgetery estimate of Rs.16351 64 Cr stands corrected to Rs.28592.37Cr which includes CAT Plan budget of Rs:11593.86 Cr, for medium, low and very low priority watershed areas needing action under CAT Plan at later stages within ten years. Thus the revised and corrected EMP budget of PP works out to Rs:16998.51 Cr excepting CAT Plan for medium and low category areas.

The revised and corrected budget along with the status of compliance by the PP till Dec 2017 and till date (Remarks) is given in the following Table:

CORRECTED EMP BUDGET AND COMPLIANCE STATUS BY PP

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spentTill 23rd December 2017	Amount Spent till now	Remarks
1a.	*Catchment Area Treatment plan for High/ Very High Priority	125.29	319.63	----	----	As per EMP to be spent in 10 years
1b.	*Catchment Area Treatment plan for Medium / Low Priority	-------	11593.86	----	----	As per EMP to be spent in 10 years for medium,low, v.low.
2	Command area Development Plan	1326.86	1326.86	----	129.33 Cr	The Works of Distributary network system were not taken up till Dec -2017 Pkg 10-Pkg 11 =129.33 crs

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spentTill 23rd December 2017	Amount Spent till now	Remarks
3	Compensatory Afforestation plan	722.3	722.3	----	722.30	(Transferred to Forest Dept) – To be confirmed
4	Biodiversity and wildlife conservation & Management	3.36 per year	3.36 per year	----	---	----
5	Resettlement & Rehabilitation	13296.00	13296.00	2600.27 Cr	6238.37 Cr Cumulative	Includes LA and R&R
6	Green Belt Development	19.21	36.499	----	----	The details of plantation were furnished earlier. However, the details of amount spent are being collected and will be furnished after receipt from the concerned duly consolidating the same

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spentTill 23rd December 2017	Amount Spent till now	Remarks
7	Fisheries conservation and Management plan	485.00	485.00	----	----	Dealt by Fisheries Dept – To be confirmed from Fisheries Dept for Fund Transfer and progress
8	Reservoir Rim Treatement plan	236.75	236.75	----	----	The details are being collected and will be furnished after receipt from the concerned duly Consolidating the Same
9	Muck Management & Restoration of Quarry site	55.95	55.95	-----	-----	----
10	Water, Air and Noise Management Monitoring	25.93	25.93	-----	-----	The Details are being collected and will be furnished
11	Public health Delivery plan	10.35	10.35	----	----	The details are being collected and will be

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spentTill 23rd December 2017	Amount Spent till now	Remarks
						furnished after receipt from the concerned duly Consolidating the Same
12	Santation and solid waste Management plan	16.4	16.4	----	----	The details of STP and Soak pits etc. Were Furnished earlier however the details of amount spent are being collected and will be furnished after receipt from concerned duly consolidating the same
13	Local Area Development Plan	28.24	28.24	----	----	The details are being collected and will be furnished after receipt from the concerned duly

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spentTill 23rd December 2017	Amount Spent till now	Remarks
						Consolidating the Same
14	Enviroment safe guards & EHS – Construction	-----	-----	-----	-----	-----
15	Energy Conservation Measures (During Construction)	-----------	435.25	----	----	The details are being collected and will be furnished after receipt from the concerned duly Consolidating the Same
16	River bank stabilisation	-----	-----	-----	-----	-----
TOTAL		16351.64	28592.37	-------	7090.00	
Less R&R		13296.00	13296.00		6238.37	
*Less (CAT for medium, Low & Very Low)		----	*11593.86			
Net		3055.64	3702.51		851.63	

*As per EIA/EMP expenditure under CAT plan for medium, low & very low areas works out to Rs.11593.86 Cr which is to be spent in 10 years.

9.1 CATCHMENT AREA TREATMENT PLAN

It is a well-established fact that reservoirs formed on rivers are subjected to sedimentation. The deposition of sediment in Reservoir basin reduces the capacity drastically.

The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the agricultural production. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above-mentioned adverse process of soil erosion leading to subsequent reservoir sedimentation.

The Catchment Area Treatment (CAT) plan highlights the management techniques to control erosion in the catchment area. Life span of a reservoir in case of a seasonal storage dam/barrage is greatly reduced due to erosion in the catchment area. Therefore, for sustainable life of irrigation projects with least negative impact on the environment, watershed management plays a pivotal role. In order to minimize the siltation, an action plan/programme involving extensive soil conservation measures in the catchment area needs to be taken right from the construction stage with adequate budget allocation.

The Catchment Area Treatment (CAT) Plan mainly focuses on:

- Mitigation measures for the erosion of the catchment and landslip hazards resulting from the irrigation project activities
- The problem of silt and debris load to river from the susceptible areas of the catchment.
- Checking the sediment load from the tributaries directly discharging into the reservoir. Protecting the directly draining catchment from scouring / sloughing and slips.
- The Kaleshwaram project catchment receives precipitation in the form of rainfall. Generally, the factors responsible for siltation are slope of the land together with the surface run-off, underlying rock/soil characteristics, vegetation aspects, etc.
- Various factors that are responsible for soil erosion are the drainage pattern in the area, slope, soil type and the land use/land cover, etc. which have been studied for the formulation of the catchment area treatment.

9.1.3 Area identified for Catchment area treatment

The catchment area of Kaleshwaram project is 36,35,437 ha of which 35,24,394ha is part of Godavari River basin and 1,11,043ha is part of of Krishna River basin.

About 81,220 ha of area is observed to be in very high and high priority sub watersheds which need immediate attention for soil conservation works in Kaleshwaram project catchment area. Catchment Area Treatment (CAT) is proposed for Kaleshwaram project area for very high and high and high medium in the threshold of high index on priority sub watersheds. 87,48,453 ha of area is found to be the balance area comprising of low medium, low and very low priority sub-watersheds. Tables 9.1.2 and 9.1.3 of EIA illustrates the areas referred.

The following figures 9.1.4 and 9.1.5 shows the watershed prioritization areas of Kaleshwaram catchment area from which the specific areas which falls under violation have been identified.

Figure 9.1.4

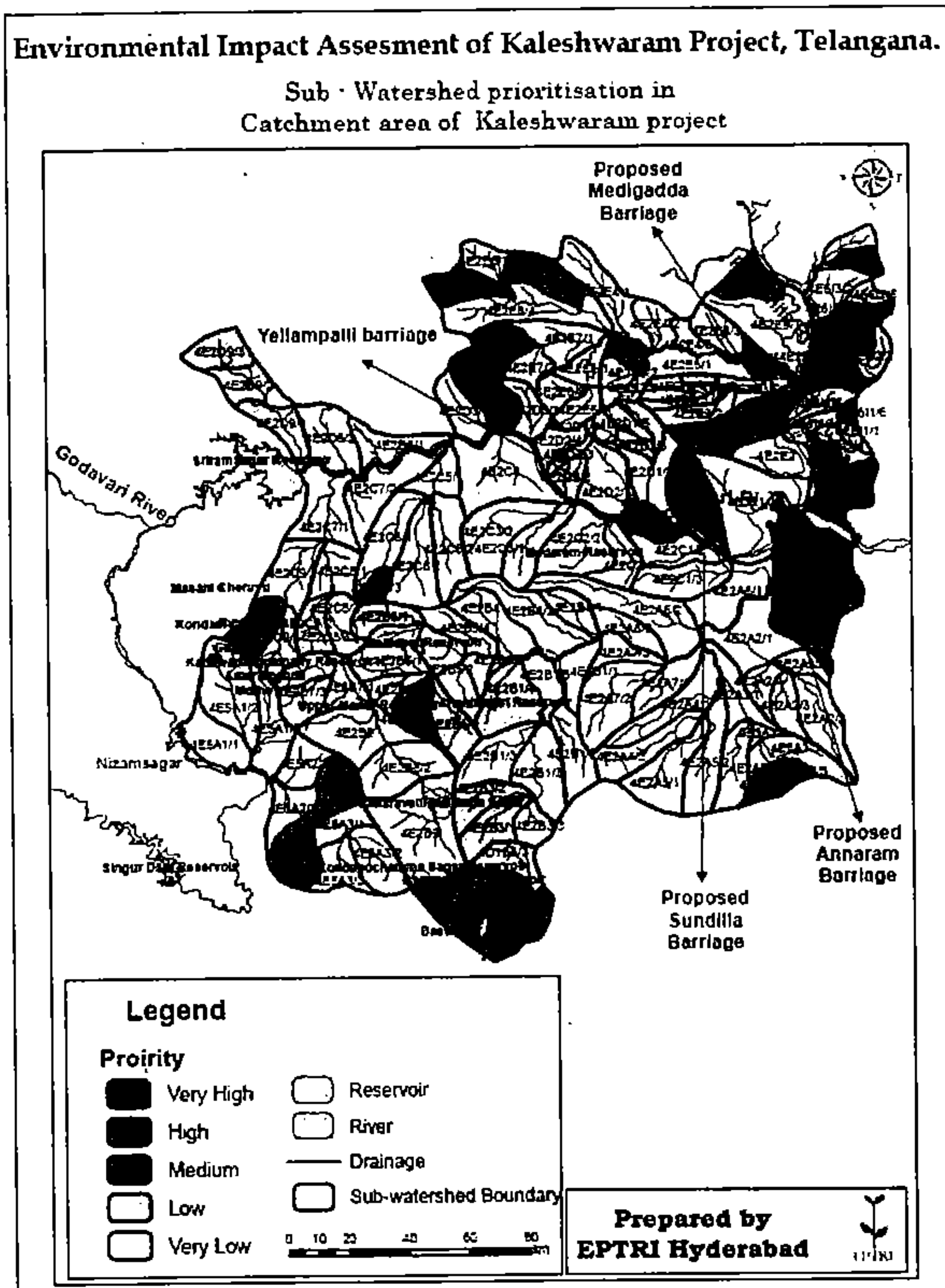
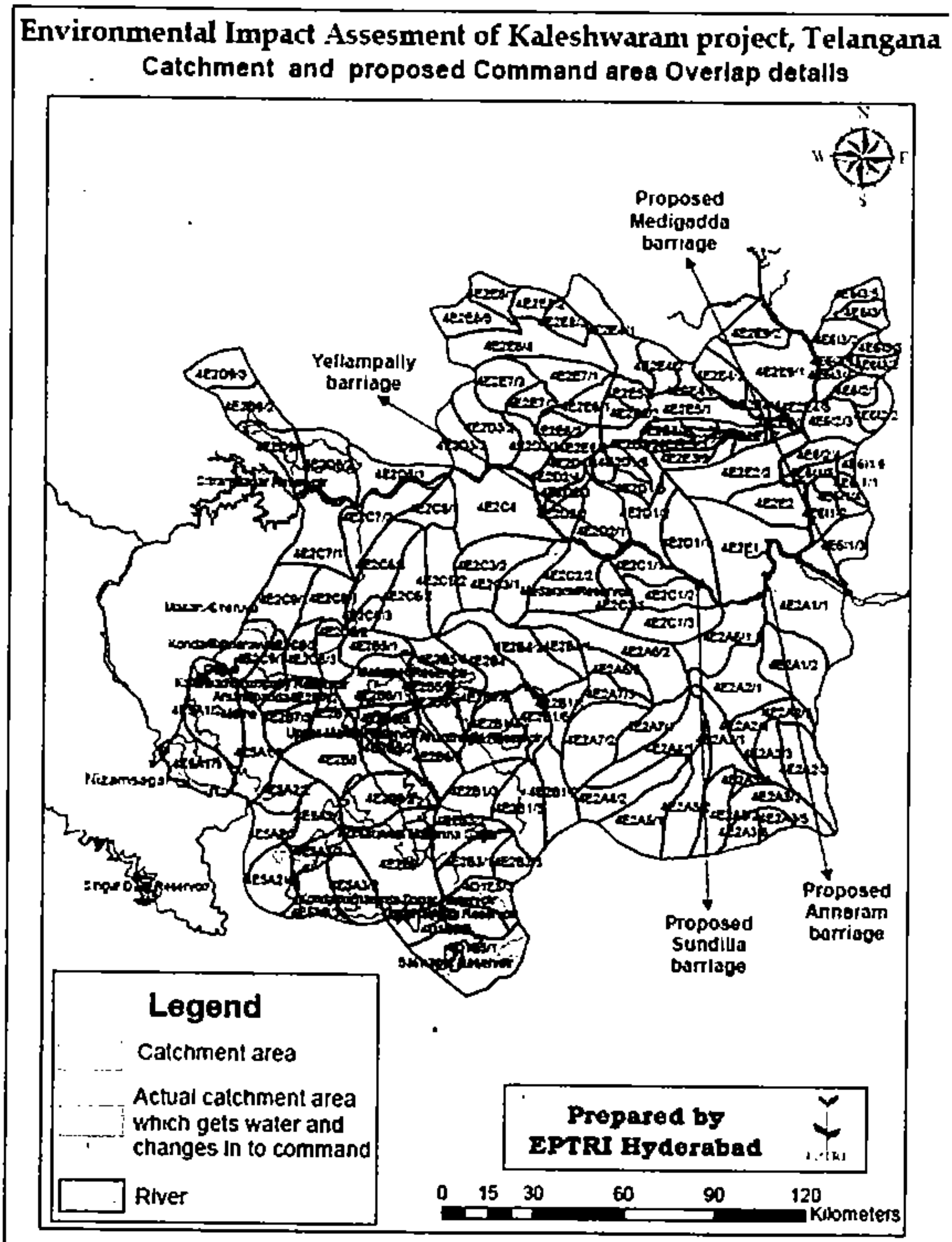

Environmental Impact Assesment of Kaleshwaram Project, Telangana.
Sub - Watershed prioritisation in
Catchment area of Kaleshwaram project
Proposed Medigadda Barriage
Yellampalli barriage
Godavari River
Nizamsagar
Proposed Annaram Barriage
Proposed Sundilla Barriage
Legend
Proirity
Very High
High
Medium
Low
Very Low
Reservoir
River
Drainage
Sub-watershed Boundary
0 10 20 40 60 80
Prepared by
EPTRI Hyderabad

Figure 9.1.5


Environmental Impact Assesment of Kaleshwaram project, Telangana
Catchment and proposed Command area Overlap details
Proposed Medigadda barriage
Yellampally barriage
Proposed Sundilla barriage
Proposed Anneram barriage
Legend
Catchment area
Actual catchment area which gets water and changes in to command
River
Prepared by EPTRI Hyderabad
0 15 30 60 90 120 Kilometers

Various engineering and bio-engineering measures like:

- Rock fill dams /brushwood check dams and gully plugging
- contour bunding,
- gabion structures,
- loose boulder check dams are suggested for the severe and moderate erosion intensity areas.

In addition, biological measures like plantation of shrubs and trees are also suggested for these areas.

About 24,190 ha of the total area of sub watersheds shall treated by means of afforestation / plantation.

Cost estimate is worked out for all the engineering measures to abate soil erosion in the critical areas viz., Contour bunding, Rock fill dams/BWCD and gully plugging and LBCD, etc.

Biological measures such as plantation of trees /shrubs in the sub watersheds wherever soil quality permits, with local varieties with the concurrence of Forest Dept.

Table 9.1.6 Very High and High

Sub Watershed	No. of Rock fill dams	Cost for Rock fill dams @Rs. 12,000	No. of Brush wood dams	Cost for Brush wood dams @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder check dam	Cost for Loose boulder check dam @ Rs.14,000 each	Contour Bunding @ Rs.15000 per ha	Plantation @ Rs.39000 ha	Social forestry/ pasture development@ Rs.70,000
4E6I1/2	285	3414293	171	17071464	114	1138098	948	13277805	101901900		
4E6I3/1	165	1982469	99	9912347	66	660823	551	7709603	82567875		
4E2E8/2	164	1964814	98	9824070	65	654938	546	7640943			
4E6I1/6	60	724499	36	3622494	24	241500	201	2817495			
4E2C6/3	112	1341303	67	6706516	45	447101	373	5216179			
4E2E7/3	267	3198397	160	15991983	107	1066132	888	12438209	122835000		
4E2E4/5	24	282071	14	1410356	9	94024	78	1096944			
4E6I3/7	236	2836132	142	14180660	95	945377	788	11029402			
4E2A3/6	95	1145988	57	5729941	38	381996	318	4456621	88005000		
4E2A3/5	64	771455	39	3857274	26	257152	214	3000102	65040000		
4E2E8/5	295	3538518	177	17692589	118	1179506	983	13760903	109290000		
4E6I3/3	705	8463628	423	42318140	282	2821209	2351	32914109			

Sub Watershed	No. of Rock fill dams	Cost for Rock fill dams @Rs. 12,000	No. of Brush wood dams	Cost for Brush wood dams @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder check dam	Cost for Loose boulder check dam @ Rs.14,000 each	Contour Bunding @ Rs.15000 per ha	Plantation @ Rs.39000 ha	Social forestry/ pasture development@ Rs.70,000
4E2D3/2	407	4881333	244	24406663	163	1627111	1356	18982960			
4E2E4/4	107	1289824	64	6449118	43	429941	358	5015981			
4E6I3/4	128	1540909	77	7704547	51	513636	428	5992426	70233450		
4E6I1/3	419	5025693	.251	25128466	168	1675231	1396	19544362	223403925		
4E2D3/3	364	4363807	218	21819033	145	1454602	1212	16970359			
4E2C1/1	294	3524458	176	17622289	117	1174819	979	13706225			
4E2D1/1	268	3212338	161	16061692	107	1070779	892	12492427			
4E2A1/2	371	4454430	223	22272152	148	1484810	1237	17322785			
4E6I2/3	122	1458009	73	7290045	49	486003	405	5670035		943440030	
	Total	**5,94,14,367.9**		**29,70,71,839.8**		**1,98,04,789.3**	**16504**	**23,10,55,87**	**86,32,77,150**	**94,34,40,030**	**0**
	Cost in lakhs Rs.	**594.14**		**2970.71**		**198.05**		**2311**	**8633**	**9434**	

Priority Sub-watershed-wise break-up of cost estimate for the implementation of the CAT Plan

***Table 9.1.9 Total cost of Treatment**

S.No	Particulars	Cost Rs. Crores
1	CAT Measures	94.34
2	Administrative charge, salaries etc for 5 years	13.28
3	Sub total	107.62
4	Contingency charges 1% above	1.07
5	Monitoring & Evaluation including maintenance for 3 years	16.60
	Grand Total	**125.29**

Table 9.1.9A Total cost of Catchment Area Treatment (as per EMP and corrected)

S.No	Particulars	Cost Rs. Crores	
		(as per EMP	CORRECTED
1	CAT Measures	94.34	**241.4**
2	Administrative charge, salaries etc for 5 years	13.28	**33.79**
3	Sub total	107.62	**275.19**
4	Contingency charges 1% above	1.07	**2.75**
5	Monitoring & Evaluation including maintenance for 3	16.6	**41.69**
	years		
	Grand Total	**125.29**	**319.63**

Table 9.1.6 of EMP provides the breakup of cost estimate of CAT plan measures for the priority areas- high and very high and the total amount gets corrected to Rs.319.63 cr instead of Rs.125.29whereas Table 9.1.6.A and 9.1.6 B provides the cost estimate with reference to the different packages of the project as derived from Fig 9.1.2 and 9.1.3.

These identified projects are covered under violation.

Table 9.1.6. A

Description	Sub Watershed	No. of Rock fill dams	Cost for Rock fill dams @Rs. 12,000	No. of Brush wood dams	Cost for Brush wood dams @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder check dam	Cost for Loose boulder check dam @ Rs.14,000 each	Contour Bunding @ Rs.15000 per ha	Plantation @ Rs.39000 ha	Social forestry/ pasture development @ Rs.70,000
Medaram Reservior	**4E6I1/2**	285	3414293	171	17071464	114	1138098	948	13277805	101901900		
Medaram Reservior	**4E6I3/1**	165	1982469	99	9912347	66	660823	551	7709603	82567875		
Sundilla	**4E2E8/2**	164	1964814	98	9824070	65	654938	546	7640943			
Medaram Reservior	**4E6I1/6**	60	724499	36	3622494	24	241500	201	2817495			
Sundilla	**4E2C6/3**	112	1341303	67	6706516	45	447101	373	5216179			
Sundilla	**4E2E7/3**	267	3198397	160	15991983	107	1066132	888	12438209	122835000		
Ananthagiri Reservoir	**4E2E4/5**	24	282071	14	1410356	9	94024	78	1096944			
Medaram Reservior	**4E6I3/7**	236	2836132	142	14180660	95	945377	788	11029402			
Ananthagiri Reservoir	**4E2A3/6**	95	1145988	57	5729941	38	381996	318	4456621	88005000		
Ananthagiri Reservoir	**4E2A3/5**	64	771455	39	3857274	26	257152	214	3000102	65040000		
Sundilla	**4E2E8/5**	295	3538518	177	17692589	118	1179506	983	13760903	109290000		
Medaram Reservior	**4E6I3/3**	705	8463628	423	42318140	282	2821209	2351	32914109			
Sundilla	**4E2D3/2**	407	4881333	244	24406663	163	1627111	1356	18982960			

Description	Sub Watershed	No. of Rock fill dams	Cost for Rock fill dams @Rs. 12,000	No. of Brush wood dams	Cost for Brush wood dams @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder check dam	Cost for Loose boulder check dam @ Rs.14,000	Contour Bunding @ Rs.15000	Plantation @ Rs.39000 ha	Social forestry/ pasture development @ Rs.70,000
									each	per ha		
Ananthagiri Reservoir	4E2E4/4	107	1289824	64	6449118	43	429941	358	5015981			
Medaram Reservior	4E6I3/4	128	1540909	77	7704547	51	513636	428	5992426	70233450		
Medaram Reservior	4E6I1/3	419	5025693	251	25128466	168	1675231	1396	19544362	223403925		
Sundilla	4E2D3/3	364	4363807	218	21819033	145	1454602	1212	16970359			
Sundilla	4E2C1/1	294	3524458	176	17622289	117	1174819	979	13706225			
Sundilla	4E2D1/1	268	3212338	161	16061692	107	1070779	892	12492427			
Ananthagiri Reservoir	4E2A1/2	371	4454430	223	22272152	148	1484810	1237	17322785			
Medaram Reservior	4E6I2/3	122	1458009	73	7290045	49	486003	405	5670035		943440030	
		Total	5,94,14,367.90		29,70,71,839.80		1,98,04,789.30	16504	23,10,55,87	86,32,77,150	94,34,40,030	0
		Cost in Lakhs Rs.	594.14		2970.71		198.05		2311	8633	9434	241.40 Cr.
GRAND TOTAL INCLUDING OTHERS 319.6												

Table 9.1.6.B Medium, Low and Very low Priority Sub-watershed-wise break-up of cost estimate for the implementation of the CAT Plan

Description	Sub Watershed	No. of Rock fill dams	Cost for Rock fill dams @Rs. 12,000	No. of Brush wood dams	Cost for Brush wood dams @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder checkdam	Cost for Loose boulder check dam @ Rs.14,000 each	Contour Bunding @ Rs.15000 per ha	Plantation @ Rs.39000 ha	Social forestry/ pasture development@ Rs.70,000
Medaram Reservior	4E2E9/2	323	3879536	194	1939768	129	1293179	1078	15087086	67170000		
Medaram Reservior	4E2E2/2	225	2702102	135	1351051	90	900701	751	10508173			
Medaram Reservior	4E2E8/3	170	2035325	102	1017663	68	678442	565	7915155			
Kondam Cheruva	4E2C9/3	248	2976595	149	1488297	99	992198	827	11575647	890208930		
Ananthagiri Reservoir	4E2A1/1	738	8860449	443	4430224	295	2953483	2461	34457300			
Sundilla	4E5A2/4	254	3052524	153	1526262	102	1017508	848	11870925	1140212190		
Medaram Reservior	4E6I2/1	114	1371345	69	685673	46	457115	381	5333009			
Kondem cheruva	4D1E5/2	362	4346648	217	2173324	145	1448883	1207	16903630	527635950		
Sundilla	4E2E5/3	495	5944136	297	2972068	198	1981379	1651	23116084	31950000		

Description	Sub Watershed	No. of Rock fill dams	Cost for Rock fill dams @Rs. 12,000	No. of Brush wood dams	Cost for Brush wood dams @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder checkdam	Cost for Loose boulder check dam @ Rs.14,000 each	Contour Bunding @ Rs.15000 per ha	Plantation @ Rs.39000 ha	Social forestry/ pasture development@ Rs.70,000
Kondem cheruva	4D1E5/1	156	1867712	93	933856	62	622571	519	7263326	3864865900		
Kondem cheruva	4E2B6/2	177	2125116	106	1062558	71	708372	590	8264338	177210000		
Ananthagiri Reservoir	4E5A3/3	170	2035807	102	1017903	68	678602	566	7917026			
Medaram Reservior	4E6I3/6	80	960294	48	480147	32	320098	267	3734479			
Malkapet Reservior	4E2B5/1	296	3556459	178	1778230	119	1185486	988	13830675			

Table 9.1.8 Year wise estimate of costs on different treatment works –EMP of PP.

Very High and High Priority Sub-watersheds:

Year	No. of Rock filled dams	Cost for Rock filled dams @Rs. 12,000	No. of Brush wood dam	Cost for Brush wood dam @ Rs.10,000	No. of gully plugging	Cost for gully plugging @ Rs.10,000	No. of Loose boulder check dam	Cost for Loose boulder check dam @ Rs.14,000 each	Contour Bunding @ Rs.15000 per ha	Plantation @ Rs.39000 ha
1st	495	5941437	297	29707184	198	1980479	1650	23105588	86327715	94344003
2nd	668	8020940	401	40104698	267	2673647	2228	31192543	116542415	127364404
3th	743	8912155	446	44560776	297	2970718	2476	34658381	129491573	141516005
4th	384	4604614	230	23023068	153	1534871	1279	17906830	66903979	73116602
5th	186	2228039	111	11140194	74	742680	619	8664595	32372893	35379001
6th	495	5941437	297	29707184	198	1980479	1650	23105588	86327715	94344003
7th	668	8020940	401	40104698	267	2673647	2228	31192543	116542415	127364404
8th	743	8912155	446	44560776	297	2970718	2476	34658381	129491573	141516005
9th	384	4604614	230	23023068	153	1534871	1279	17906830	66903979	73116602
10th	186	2228039	111	11140194	74	742680	619	8664595	32372893	35379001
Total	4951	59414368	2971	297071840	1980	19804789	16504	231055875	863277150	943440030
Cost in lakhs Rs.		594.14		2970.71		198.04		2310.55	8632.7715	9434.40
										Grand Total 319.63 Cr

The plan needs to be implemented in a phased manner so as to attain the goals set successfully. Keeping in view the local topography and climate, it is proposed to complete the CAT programme in ten years. (As committed by PP in EMP)

The year wise break-up of the CAT work in different sub watersheds for very high and high priority subwater-sheds is given in Table 9.1.8 as above.

COST ESTIMATE (AS PER THE EMP OF PP):

The total expenditure on the catchment area treatment plan to be implemented over a period of ten years is estimated to be Rs. 9443.4 lakhs which gets corrected to Rs.319.63 Cr as given in table no 9.1.9.A and likewise the total cost estimate for CAT Plan including Low, Medium, very low works out to a total budget of Rs.11593.86 Cr. as detailed below in the tables:

Total cost of CAT for medium and low vide table9.1.7

SI NO		No Of RFD	Cost of RFD rs in lakhs		No of BWD	Rs in lakhs cost BWT	No of G. P	Rs in Lakhs Cost GP	NO of LBCD	Cost of LBCD	Cost of Contour	Plantation	Social forestry
1	Total	94394	11327		56637	5664	37758	3776	3114648	44051	204903	181369	408035

Total Cost of CAT as per (1)	**859122**	**Lakhs**
	8591.22	**Cr**
Admin,Sa,etc for 5 years	**1202.77**	**Cr**
Sub total	**9793.99**	**Cr**
Contingency Charges 1	**9.74**	
Monitoring Evaluation Maintains for 3 years @15%	**1470.45**	
Total	**11274.18**	
Total capital cost for CAT for 10 years	**11593.86**	**Cr**

Table 9.1.10 A Year wise estimate of costs on different treatment works

Very High and High Priority Sub -Watersheds

Year	No Of Rock Filled dams	Cost for Rock Filled Rams @ Rs.12000	No Of Brush wood dam	Cost for brush wood dam @ Rs 10000	No of Gully Plugging	Cost for Gulling @ Rs 10000	No Of Loose Boulder check dam	Cost for Loose Boulder check dam @ Rs 14000 Each	Contour Bunding @ Rs 15000 Per ha	Plantation @ Rs 39000 ha
1st	495	5941437	297	29707184	198	1980479	1650	23105588	86327715	94344003
2nd	668	8020940	401	40104698	267	2673647	2228	31192543	116542415	127364404
3rd	743	8912155	446	44560776	297	2970718	2476	34658381	129491573	141516005
4th	384	4604614	230 ·	23023068	153	1534871	1279	17906830	66903979	73116602
	Total	27479146		137395726		9159715		106863342	399265682	436341014

Total	111.65.	Lakh
Contingency	1.11	
Total	112.76	
Admin, Monitory air Evolution	32.70	
Total	145.46	Cr

PP Should have to spent for CAT in the high / very high Priority areas as scheduled In the EMP as per Table 9.1.10 **Rs 145.46 Cr up to 2021 (4years)**

Abstract:

The total expenditure on the catchment area treatment plan to be implemented over ten-year period is corrected and summarized as following:

CAT budget for high and very high priority areas -319.63cr to be completed in 10 years as per EMP.

Amount to be spent till 2021(4yrs) ----------------- -145.46 cr

CAT budget for medium, low and very low watershed area to be spent over a period as corrected ---------------------11593.86 cr

Details of cost saved in CAT Plan for the violation projects.:

Soil erosion in the catchment area is assessed by using Sediment (SILT) Yield Index Model (SYI)and the weightage value depends on many factors like Slope,LU/LC,soil parameters, delivery ratio ,etc. for sub water shed(hydrologic units) and the prioritization is arrived based on the Sediment Yield Indices and as per the guideline, the sub water shed areas having SYI ranging from 1200 +above are high and very high priority areas and SYI ranging from1100+above are falling in Medium to high category and the total area covered as per the sub water shed codes is 337391 Ha for very high and high priority areas and 347385 ha for medium to High priority areas respectively consisting of three barrages and 4 reservoirs as detailed below: needing high priority attention for implementation of CAT plan as per the budgetary estimates provided in the following paragraphs. and these sub water shed areas are mentioned in the following Tables 9.1.2 A and 9.1.3 A (part) And reference is drawn to Figure 9.1.3 (Soil Erosion Intensity Map of Catchment area.)

Table 9.1.2.A very high and high priority sub watershed wise statistics

S. NO	Description	Sub – Watershed code	Area (ha)	Sediment yield index (SYI)	Priority
1	Medaram Reservoir	4E6I1/2	13586.92	1721	Very high
2	Medaram Reservoir	4E6I3/1	11009.05	1685	Very high
3	Sundilla	4E2E8/2	12640.04	1627	Very high
4	Medaram Reservoir	4E6I1/6	3929.79	1619	Very high
5	Sundilla	4E2C6/3	8433.09	1570	Very high
6	Sundilla	4E2E7/3	25261.23	1557	Very high
7	Ananthagiri Reservoir	4E2E4/5	2634.33	1544	Very high
8	Medaram Reservior	4E6I3/7	10916.23	1542	Very high
9	Ananthagiri Reservoir	4E2A3/6	5867	1466	Very high
10	Ananthagiri Reservoir	4E2A3/5	4336	1441	Very high
11	Sundilla	4E2E8/5	7286	1434	Very high
12	Medaram Reservoir	4E6I3/3	6905.74	1427	Very high
13	Sundilla	4E2D3/2	31729.96	1408	Very high
14	Ananthagiri Reservoir	4E2E4/4	6124.76	1404	Very high
15	Medaram Reservoir	4E6I3/4	9364.46	1386	Very high

S. NO	Description	Sub – Watershed code	Area (ha)	Sediment yield index (SYI)	Priority
16	Medaram Reservoir	4E6I1/3	29787.19	1380	Very high
17	Sundilla	4E2D3/3	22529.42	1361	Very high
18	Sundilla	4E2C1/1	19638.25	1359	Very high
19	Sundilla	4E2D1/1	38284.3	1310	Very high
20	Ananthagiri Reservoir	4E2A1/2	42936.46	1270	High
21	Medaram Reservoir	4E6I2/3	24190.77	1244	High
	Total		**337391**	**30755**	

Table 9.1.3.A Area Statistics of Medium, Low and Very low priority sub watersheds

S.NO	Description	Sub Watershed code	Area (in ha)	Sediment yield index (SYI)	Priority
1	Medaram Reservoir	4E2E9/2	4478	1193	Medium
2	Medaram Reservoir	4E2E2/2	48710.89	1173	Medium
3	Medaram Reservoir	4E2E8/3	13474.48	1171	Medium
4	Kondam Cheruva	4E2C9/3	22825.87	1168	Medium
5	Ananthagiri Reservoir	4E2A1/1	67331.27	1167	Medium
6	Sundilla	4E5A2/4	29236.21	1164	Medium
7	Medaram Reservoir	4E6I2/1	11919.86	1155	Medium
8	Kondem cheruva	4D1E5/2	35175.73	1142	Medium
9	Sundilla	4E2E5/3	2130	1133	Medium
10	Kondem cheruva	4D1E5/1	55212.37	1125	Medium
11	Kondem cheruva	4E2B6/2	11814	1123	Medium
12	Ananthagiri Reservoir	4E5A3/3	21879.12	1111	Medium
13	Medaram Reservoir	4E6I3/6	2753.09	1102	Medium
14	Malkapet Reservoir	4E2B5/1	18842.98	1018	Low
	Total		**345783.87**	**15945**	

Figure 9.1.3

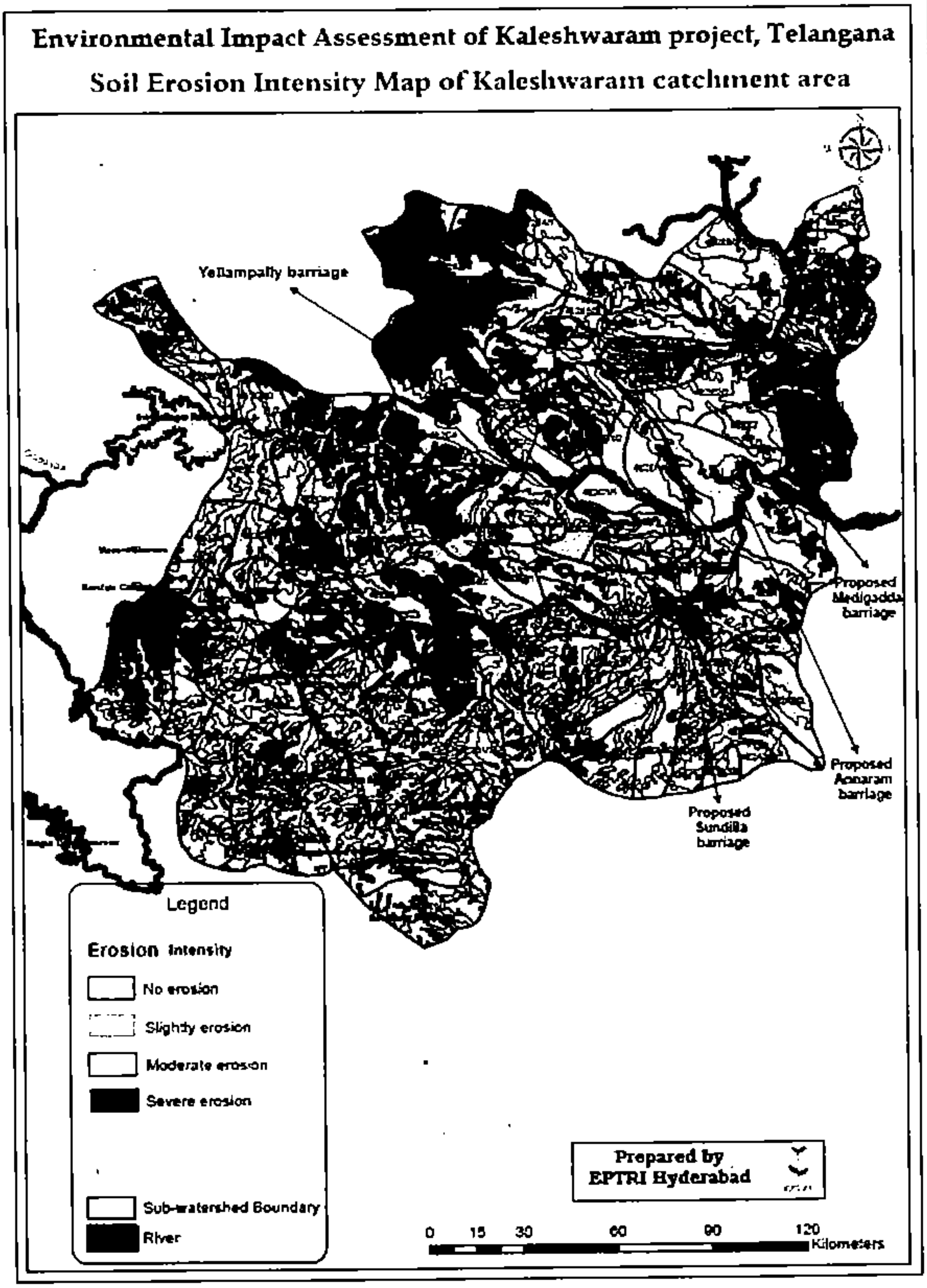


FIGURE 9.1.3

The priority areas as per the sub water shed codes referred in the above tables and figures refers to the following areas/projects:

1) Laxmi barrage
2) Parvati barrage
3) Saraswathi barrage
4) Ananthagiri Reservoir
5) Kondem cheruvu,
6) Malkapet Rservoir
7) Medaram reservoir.

The above cover a watershed area of 664327 Ha.

(337391+326936=664327 Ha)

All the barrages have commenced construction from 08/2016 and whereas the reservoirs commenced constructions in 2008/2016 respectively prior to the grant of EC.

Complying with the CPCB guideline of Environment compensation- cost saved for non-implementation of CAT plan during the violation period for all the three barrages namely Laxmi, Parvati and Saraswathi and four reservoirs namely, Ananthagiri, Kondem chervu, Malkapet and Medaram. Cost saved in Catchment Area Treatment plan is detailed vide Tables 1 to 4 as below:

Table-1 Catchment area Treatment Plan

S. NO	Description	Sub WS	RFD Rs.Lacs	BWD Rs.lacs	GP Rs.lacs	LBCD Rs.lacs	CB Rs.lacs	Total Rs.Lacs.
1	**Medigadda**	4E611/2	34.14	170.71	11.38	132.77	1019.01	1368.01
	08/16-12/17	4E613/1	19.82	99.12	6.6	77.098	825.67	1028.308
		4E611/6	7.24	36.22	2.41	28.17		74.04
		4E613/7	28.36	141.8	0.94	10.96		182.06
		4E613/3	84.63	423.18	28.21	329.14		865.16
		4E613/4	15.4	77.04	5.13	59.92	702.33	859.82
		4E611/3	50.25	251.28	16.75	195.44	2234.01	2747.73
		4E612/3	14.58	72.9	4.86	5.67		98.01
		4E2 E9/2	38.79	19.39	12.93	150.86	671.7	893.67
		4E2 E2/2	29.02	13.5	9	105.08		156.6
		4E2 E8/3	2035	10.17	6.78	79.15		2131.1
		4E612/1	13.71	6.85	4.57	53.33		78.46
		4E613/6	9.6	4.5	3.2	37.34		54.64
	Total		**2380.54**	**1326.66**	**112.76**	**1264.928**	**5452.72**	**10537.608**
	Ten-year plan as per EMP and hence for 1 year 4 Months =10537.608*1.3/10							**1369.89**

Table-2 Catchment Area Treatment plan

S. No	Description	SUB WS	RFD	BWD	GP	LBCD	CB	Plantation	Total Rs.Lacs
1	Sundilla Barrage (Paravathi) 15/07/16 to 27/12/17	4E2C6/3	13.41	67.05	4.47	52.16			137.09
		4E2E7/3	31.98	159.91	10.66	124.38	1228.4		1555.3
		4E2E8/5	35.38	176.92	11.79	137.6	1092.9		1454.6
		4E2E8/2	19.64	98.24	6.54	76.4			200.82
		4E2E8/2	48.81	244.06	16.27	189.82			498.96
		4E2D3/3	43.63	218.19	14.54	169.7			446.06
		4E2C1/1	35.24	176.22	11.74	137.06			360.26
		4E2D1/1	32.12	160.21	11.74	124.92			328.99
		4E5A2/4	30.52	15.26	10.7	118.7		11402.1	11577
		4E2E5/3	59.44	29.72	10.17	231.16			330.49
	Total		**350.17**	**1345.8**	**108.62**	**1361.9**	**2321.3**	**11402**	**16890**

TABLE-3

S. No	Description	SUB WS	RFD	BWD	GP	LBCD	CB	Plantation	Total Rs.lacs	
1	Annaram Barrage(Saraswathi) 27/08/2016 to 27/12/17	4E2 A3/1	11.45	57.29	3.81	44.56	880.55		997.66	
		4E2 A3/5	7.71	38.57	2.57	30	650.4		729.25	
		4E2 E4/4	12.89	64.49	4.29	50.15			131.82	
		4E2A1/2	44.54	222.72	14.84	173.22			455.32	
		4E2A1/1	88.6	44.3	29.53	344.57			507	
	Total		165.19	427.37	55.04	642.5	1531		2821.1	
	Sundilla Barrage 1 year 4 Month =1690*1.3								2195.7	lacs
	annaram Barrage -1year 4 month =2821*1.3								366.73	lacs

S.NO	Description	Sub WS	RFD	BWD	GP	LBCD	CB	Total	Percentage completion in Violation period
1	Ananthagiri Reservoir	4E2B6/2	21.25	10.62	7.08	82.64	1772.1	**1893.69 Lakhs**	**100%**
	1/12/2008 to 1/11/2016								
2	Kondam cheruvu	4E2C9/3	29.76	14.88	9.92	115.75	8902.08	**9072.39 Lakhs**	**56%**
	13/04/2008-55.97%								
3	Malkapet Reservoir	4E2 B5/1	35.56	17.78	11.85	138.31	1253.64	**1457.14**	**3.40%**
	17-11-2008	4E2 B5/3	21.41	10.7	7.13	96.67		**135.91**	
		4E2 B5/4	49.46	24.73	16.48	192.36	1349.85	**1632.88**	
		4E2 B5/1	35.56	17.78	11.85	138.3		**203.49**	
		4E2 B6/1	55.18	27.59	18.39	214.61		**315.77**	
	Total		**197.17**	**98.58**	**65.7**	**780.25**	**2603.49**	**3745.19 Lakhs**	
4	Medaram Reservoir	4E2C2/1	34.79	17.39	11.59	135.31		**199.58**	**73.21%**
	17/11/2008-73.21	4E2C2/2	51.25	25.62	19.08	199.31		**292.36**	
	Total		**86.04**	**43.01**	**30.67**	**334.62**		**491.84 Lakhs**	

Table - 4

Summary of cost saved in CAT PLAN:	
1)Laxmi Barrage	1369.81 lacs
2)Parvati Barrage	2195.70 lacs
3)Saraswati Barrage	366.73 lacs
4)Ananthagiri reservoir	1704.32 lacs
5)Kondem Cheruvu	5080.54 lacs
6)Malkapet Resevoir	127.34 lacs
7)Medaram reservoir	360.08 lacs.
Total cost saved	**Rs.11204.51 lacs (Rs:112.04 Cr)**

9.2 COMMAND AREA DEVELOPMENT PLAN.

The important aspects of the plan are as following:

It is aimed at development of an efficient irrigation system with minimum cost to get optimum yields. Detailed study is involved in respect of soil erosion, land shaping, levelling, grading and ON FARM DEVELOPMENT WORKS related to water management –water delivery system comprising the following.

Creation of field channels, levelling, drainage system, reclamation, etc. These development works involve deep studies which is a time taking process and it has to be aligned with the commissioning of the project after completion.

Hence in view of the above factors, the environmental compensation for the cost saved is not considered under this plan. However, the PP has to submit a compliance report on the progress of the studies and the time bound implementation scheme though the PP has enjoyed sizable saving in not spending this amount so far as per the compliance status submitted by them vide Table attached in the initial page of this report.

Proposed outlay

The total cost of the command area development programme is estimated at an amount Rs.1326.86 Cr as is shown in Table 9.2.2 and year wise breakup is given in Table 9.2.3, considering the total amount to be spent in five years as per the EMP of PP.

Table 9.2.2 Total cost of command area development (EMP-PP)

S.No	Particulars	Rs.in lakhs
1	On farm development for irrigated crops	1,23,506
2	Drainage	8,407
3	Conjunctive use of ground water	703
4	Reclamation of saline soils	70
	Total	132686
	Total in Crores	**1326.86**

Table 9.2.3 Year-wise phasing of financial cost for command area development plan

S.No	Particulars	Cost (Rs. In lakhs)				
		1st year	2nd year	3rd year	4th year	5th year
1	On farm Development	24680	33317	37019	18885	9220
2	Drainage	1592	2150	2388	1445	597
3	Conjunctive use of ground water	265	358	398	206	100
4	Reclamation of saline soils	-	-	-	35	35
	Total	26537	35825	39806	20566	9951

The project has since been commissioned in 2019 and operating in majority of the sectors and in three years (2019-2021), The PP should have spent 1021.68 crores and the table submitted by PP does not indicate the same. However, we will put a condition that the PP will give an undertaking for spending this amount of Rs.1326.86 Cr in three years (2022-2025) and financial closure and the status will be submitted to MOEF&CC and Regional office periodically.

9.3 COMPENSATORY AFFORESTATION PLAN

As per the Forest Conservation Act (1980) Compensatory Afforestation (CA) is one of the most important conditions stipulated by the Central Government while approving proposals for de-reservation or diversion of forest land for non-forest uses.

The Kaleswaram irrigation project acquired forest land to an extent of 3168.131 hectares for the construction of canals, tunnels, pump houses and reservoirs. As per the norms, the MoEFCC clearance has been obtained for the diversion of forest land to an extent of 3168.131 ha in 8 different forest divisions

Kaleshwaram project (MoEFCC clearance reference: F. No.8- 31/2017- FC Dated 24th October, 2017 is placed at Annexure 9.3.1.1).

Table – 9.3.1: Division wise, Package wise extent of Forest land acquired for theProject of EMP provide the same.

S.No.	District	Division	Package no.	Forest land acquired for the project (ha)
1	Prof. Jayashanker Bhupalpally	Mahadevpur (Medigadda barrage & Lift system)	Medigadda barrage & Lift system	338.4826
2	Rajanna sircilla	Karimnagar + Siricilla	9,10	445.9565
3	Siddipet	Siddipet	10,12,14,15	1407.439
4	Yadadri Bhongir	Yadadri	14,15	109.5738
5	Medak	Medak	18	194.0711
6	Nizamabad	Nizamabad	21,22	323.3667
7	Kamarddy	Banswada	22	26.6844
8	Nirmal	Nirmal	27	322.5574
	Total			**3168.1315**

Penal CA has been levied by MOEF&CC for 8 Ha for having utilsed about 4 Ha of Forest land without FC.

The Forest Department is supposed to prepare a plan of action to utilize the water potential available nearby for the benefit of forest crop and also to the wild animals. The water shall be provided from the reservoir to the Forest Department for raising and maintenance of plantations and nurseries around the site whenever required, free of chargeas per EMP.

The budgetary provision of 722.3 crores for Compensatory Afforestation as per EMP is understood to have been entrusted to State Forest dept. The District Forest officers of respective districts wherever this land is identified have been entrusted with close monitoring of implementing this scheme and hence, this has not been considered for Environmental compensation unlike other EMP expenditure provisioned by PP. However, in the absence of the status of the progress mentioned by PP, it is recommended that the exact status and this CA shall be completed in three years (2022-2025) and an undertaking to this effect has to be submitted by PP.

9.4 BIODIVERSITY AND WILDLIFE CONSERVATION & MANAGEMENT PLAN

In the proposed project significant impacts are anticipated as a result of construction and operation of the proposed irrigation project. The impacts are likely to arise as a result of submergence of forest area for construction of reservoirs, canals, pump houses, etc resulting in dumping of excavated material/muck on land and biological resources. Thus, Biodiversity Conservation and Management plan for proposed project area has been proposed.

Biodiversity Management Plan

Biodiversity plays a major role as it provides the fundamental building blocks for the many goods and services which provide a healthy environment to lead our life.

Wildlife Management Plan and Bio diversity management plan:

Wildlife conservation Plan is proposed for the Kaleshwaram Project. Under this plan the user agency would assist the State Forest Department to strengthen the infrastructure facilities at the study area.

The cost for Forest Protection Plan and Improvement of Habitat is given in Table 9.4.2.

Table – 9.4.2: Cost for Forest Protection Plan and Improvement of Habitat

S.No	Expenditure	Cost (Rs. Crore)
1.	Forest Protection Plan (anti-poaching kits,purchase of survey equipment, etc.,)	0.20
2.	Construction of Base Camp	0.30
3.	Protection Watchers	0.02
4.	Provision of drinking water facility for thewildlife by constructing small pits /ponds /tanks.	0.50
5.	Plantation of fruit bearing trees to attractavifauna which will also be useful for roosting,breeding and hiding cover for migratory birdsetc.	0.20
6.	Removal of weeds.	0.50

The cost for habitat improvement for avi-fauna is given in Table 9.4.3

Table 9.4.3 Cost of Habitat improvement for avi-fauna

S No.	Particulars	Cost in (Rs. Crore)
	Non-recurring Cost	
1	Erection of Standard Iron stands with three layers at wetlands 200 iron stands with @1500/stand	0.3
2	Cost of nests of different sizes (10"x10" to 20"x20"; averagecost Rs. 1000 per wooden box) and installation of 2000wooden boxes	0.2
3.	Repair and maintenance of the nests	0.08
	Recurring Cost (for 5 years)	
4.	Salary for 7 skilled persons @ Rs. 23,000 per month forimplementation and data collection for 5 years	0.96
5.	Contingencies (including avifaunal biodiversityawarenessprogramme for the local inhabitants)	0.3
	Total	**1.84**

An amount of Rs. 1.84 crore has been earmarked for this purpose.

Budget for Biodiversity Conservation and Management Plan

A total provision of Rs. 3.36 Crore has been earmarked for Biodiversity & Wildlife Conservation Management Plan consisting of Forest Protection Plan, Habitat Improvement and measures to Improve Habitat of Avifauna Against the above provision of 3.36 crores budgeted for WLC and Protection plan, the cost saved on this account is computed as following:

As per the provision of WLC Act and MOEF Guideline, the PP needs to get The Biodiversity and Wild life conservation plan approved by Chief Wild Life Warden of the State and in this case the required approval has not been obtained and the scheme has not been implemented with the planned expenditure. Therefore, the following amount(cost) saved has been considered for Environmental Compensation as following:

A) Capital Expenditure for conservation and protection and habitat improvement provision in the EMP -----------2.10 crores.

B) Recurring expenditure per year ----1.26 crores. -4years=5.01cr

Hence cost saved @10% per year for 4 years---5.01x40%=2.01 cr.

The total cost saved under Biodiversity and WLC is 4.11 crores.

9.5 REHABILITATION AND RESETTLEMENT PLAN:

The construction and operation of Kaleshwaram Project will require large extent of land that would impact the social and human environments in the project area. In certain cases, it would involve the shifting ofvillages where people will not only lose their land but all their present assets and livelihood.

Similarly, when the lands of the local people are acquired for the project it not only adversely affects the livelihood of the land owners but also the population that were dependent on that land to earn their daily wages. The purpose of Rehabilitation and Resettlement plan (R&R) is, therefore, to ensure that all Project Affected Persons (PAPs) are identified, all adverse impacts are fully investigated and an R&R plan drawn to provide adequate compensation and relief to all PAPs to re-establish their livelihoods.

As per the available information from the PP vide Annx-III there are 21 villages coming under submergence of the reservoirs that need to be shifted, affecting 10403 families. In addition, total land required for the project is 37852 ha out of which private land is 34684 ha, tentatively 12419 persons aregetting affected and the forest land requirement is 3168 ha.

The compensation needs to be offered as per /in line with RFCTLARR.Act 2013 and whereas the State govt has Amended it by the Telangana Amendment Act, 2016 (Act No.21 of 2017). The Resettlement and Rehabilitation Plan has been prepared to comprehensively address the issues arising out of shifting of villages

Land requirement

As discussed above, total land requirement for the project has been assessed as 37852 ha, comprising of 34684 ha of private land and 3168 ha of forest land. As regards the forest land the user agency has identified more land for compensatory afforestation and after inspection forest department has identified 5334 ha of land for compensatory afforestation. Stage -1 and II clearances have been obtained from MOEF&CC by 20/11/2017.

Table 9.5.1 Tentative Land requirement for Kaleshwaram Project

S.No	District /State	land required (ha)	land acquired (ha)	land to be acquired (ha)
		Telangana State		
1.	Jayashankar Bhupalpalli	475.59	171.02	304.56
2.	Pedapalli	309.79	58.76	251.03
3.	Mancherial	739.84	155.71	584.13
4.	Nizambad	2597.70	2597.70	0.00
5.	Nirmal	52.13	52.13	0.00
6	Kamareddy	1895.61	383.91	1511.70
7	Karimnagar	994.99	774.87	220.12
8	Rajanna Sircilla	8980.51	1341.90	7638.60
9	Siddipet	11634.02	7073.05	4560.97
10	Sangareddy	98.77	38.90	59.87
11	Medak	227.88	0.00	227.88
12	Yadadri – Bhongiri	6273.87	439.40	5834.46
13	Nalgonda	320.30	0.00	320.30
14	Medchal – Malkajgiri	26.05	0.00	26.05

S.No	District /State	land required (ha)	land acquired (ha)	land to be acquired (ha)
Telangana State Total	34627	34627	13087	21540
Maharashtra State				
15	Gadchiroli	57	0.00	57

Comparison of Entitlement Matrix

S.No	Elements of & EntitlementsR R	Entitlement Provision as per the RFCTLARR, Act 2013	Rehabilitationand Resettlement lump sum package under the RFCTLARR (Telangana Amendment) Act, 2016 (ActNo.21 of 2017)
1.	Provision of housing units in case of displacement	(1) If a house is lost in rural areas, a constructed house shall be provided as per the Indira Awas Yojana specifications. If a house is lost in urban areas, a Constructed house shall be provided, which will be not less than 50 sq.m in plinth area. (2) The benefits listed aboveshall also be extended to any affected family which is without homestead land and which has been residing in the area .continuously for a period of not less than three years preceding the date of notification of the affected area and which has been involuntarily displaced from such area: Provided that any such family in urban areas which opts not to take the house offered, shall get a one-time financial assistance for house construction, which shall not be less than one lakh fifty thousand rupees: Provided further that if any affected family in rural areas so prefers, the equivalent cost of the house may be offered in lieu of the constructed house: Provided also that no family affected by acquisition shall be given more than one house under the provisions of this Act. *Explanation.*—The houses in urban areas may, if necessary, be provided in multi-storiedbuilding complexes.	Rs.5.04 lakhs (equivalent to a house as per the two-bed room housing policy of the State Government) will be paid in case of displacement of a family living together. Or Rs. 1.25 lakhs will be paid to single family (equivalent to Indira Awas Yojana , IAY) (Family includesa person, widow / widower, his or her spouse, minor children, minor brothers and minor sisters dependent on him / her)
2.	Choice Annuity or Employmentof	The appropriate Government shall ensure that the affected families are provided with thefollowing options:	(a) Onetime payment of Rs.5.00lakhs for theaffected family;OR

S.No	Elements of & EntitlementsR R	Entitlement Provision as per the RFCTLARR, Act 2013	Rehabilitationand Resettlement lump sum package under the RFCTLARR (Telangana Amendment) Act, 2016 (ActNo.21 of 2017)
		(a) where jobs are created through the project, after providing suitable training and skill development in the required field, make provision for employment at a rate not lower than the minimum wages provided for in any other law for the time being in force, to at least one member per affected family in the project or arrange for a job in such other project as may be required; or (b) onetime payment of five lakhs rupees per affected family; or (c) Annuity policies that shall pay not less than two thousand rupees per month per family for twenty years, with appropriate indexation to the Consumer Price Index for Agricultural Labourers.	(b) Rs.3,000/- per month as annuity will be paid for an affected family in case of SC and ST for a period of 20 years. OR (c) Rs.2,500/- per month as annuity will be paid for an affected family in case of other than SC and ST for a period of 20 years. (d) The annuities mentioned above will be with appropriate Indexation to the consumer price index.
3.	Subsistence grant for Displaced families for a period of one year	Each affected family which is displaced from the land acquired shall be given a monthly subsistence allowance equivalent to three thousand rupees per month for a period of one year from the date of award. In addition to this amount, theScheduledCastesandtheScheduledTribesdisplacedfrom ScheduledAreasshallreceive an amount equivalent tofifty thousand rupees. In cases of displacementfromtheScheduledAreas, asfaraspossible, theaffectedfamiliesshallberelocatedinasimilarecologicalz one, soastopreservethe economic opportunities, language, culture andcommunitylifeofthetribalcommunities.	A total of Rs.40,000/- will be paid per family as a subsistence grant for one year. In addition to above, an amount of Rs.60,000/-as a one-time grant will be paid for the affected family belonging to SC and ST in the scheduled Areas.

S.No	Elements of & EntitlementsR R	Entitlement Provision as per the RFCTLARR, Act 2013	Rehabilitationand Resettlement lump sum package under the RFCTLARR (Telangana Amendment) Act, 2016 (ActNo.21 of 2017)
4.	Transportation cost for displacedfamilies	Eachaffectedfamilywhichis displaced shall get a onetime financial assistance of fifty thousand rupees as transportation cost for shifting of the family, building materials. belongings and cattle.	Rs.60,000/- as a onetime transportgrantwillbepaidtoeach affected family in case ofdisplacement.
5.	Cattleshed/pettyshopscost	Eachaffectedfamilyhavingcattleorhavingapettyshopshallg etone-timefinancialassistanceofsuchamountastheappropriateGo vernmentmay, bynotification, specify subject to a minimum of twenty-fivethousandrupeesforconstructionofcattleshedor pettyshopasthecasemaybe.	Rs.25,000/-asaonetimefinancial assistance will be paidfor each affected family havingcattleorapettyshopforconstructionofcattleshedorpetty shopasthe casemaybe.
6.	One time granttoartisan,smalltraders andcertainothers	Each affected family of an artisan, small traderorselfemployed person or an affectedfamilywhichownednon-agricultural land or commercial,industrial or institutional structure in the affected area, andwhichhasbeeninvoluntarilydisplaced from the affected areadue to land procurement, shallget onetime financial assistanceofsuchamountastheappropriateGovernmentmay , by notification, specify subject toaminimumoftwenty-five thousandrupees.	Rs.30,000/- as a onetime grantwill be paid to artisans, smalltrader or self-employed personoranaffectedfamilywhichowned non-agricultural land orcommercial,industrialorinstitutionalstructureintheaffecte darea.
7.	One-timeResettlementAllowance	Eachaffectedfamilyshallbegivena a l l o w a n c e one-rupeesonly.	Rs.60,000/- will be paid to eachaffectedfamilyasonetimeresettlementassistance.
8.	Fishingrights	In cases of irrigation or hydelprojects, theaffectedfamiliesmay be allowed fishing rights inthe reservoirs, in such mannerasmaybeprescribedbythe appropriateGovernment.	Fishingrightsforthe affectedfamiliesifstoragetanksarecreatedandfishingisfeasibl e.

S.No	Elements of & EntitlementsR R	Entitlement Provision as per the RFCTLARR, Act 2013	Rehabilitationand Resettlement lump sum package under the RFCTLARR (Telangana Amendment) Act, 2016 (ActNo.21 of 2017)
9.	StampdutyAnd registrationfee	(1) Thestampdutyandotherfeespayableforregistrationo fthe land or house allotted to theaffectedfamiliesshallbebornebytheProcuring Agency. (2) Thelandforhouseallottedtotheaffectedfamiliesshallbef reefromallencumbrances. (3) The land or house allottedmaybeinthejointnamesofwife and husband of theaffectedfamily.	The stamp duty and otherfees payable for registration ofthe land or house allotted to theaffected families shall be bornebytheProcuringAgency. The land for house allotted to the affected families shall be free from all encumbrances. The land or house allotted may be in the joint names of
10.	Financialassistance inlieu ofspecifiedbenefits		Rs.7,50,000/-.An option will begivenincaseajointfamilywithallmembers living togetherdecidestosetupaself-financed scheme or anenterprisebasedontheirownchoiceorforanyotherincomegenerating activity. Such afamily will be paid a lump sumamount of Rs.7.5 lakhs towardsfinancialassistanceinlieuofthespecifiedbenefitslistedin Items2-7above.

On comparison the State of Telangana has proposed a better compensation for the PAFs as compared to the Central Act especially in the areas like land compensation, financial assistance to start MSME'S and resettlement allowance etc. The entitlement package implemented for Kaleswaram project is described above vide Table 9.5.2 comparing with the Central Act.

A budgetary provision of Rs.1355 crores has been made for developing infrastructure facilities for resettlement areas as per the EMP.

The district collectors are still in the process of finalizing the land compensation and details R&R packages amount in accordance with the RFCTLARR Act of 2013 of GoI and TSRFCTLARR Rules 2014. Govt. of Telangana has given commitment to the PAFs to provide the best possible deal so that all would be benefited and none would be a loser.

The PP has submitted the status of R&R achieved so far till date with the amount spent so far towards this as appended below Annexure-III:

ANNEXURE-III

STATUS OF STRUCTURES PAYMENT AND R&R OF RESERVOIRS

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
		Ananthagiri (V), Ellanthakunta (M), Rajanna Sircilla (Dist)	837	834	1135	837	0	837	-	1135	1135	0	Yes	R&R colonies have been developed at Ananthagiri (V) outskirts and Thangalapalli (V), Sircilla District. Land and amount for construction given to PDFs. Houses constructed by the individuals as per their request.

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
1	Ananthagiri Reservoir	Kochaguttapally (V) Chinnakodur (M) Siddipet (Dist)	101	101	151	101	0	101	-	151	151	0	Yes	R&R colonies have been developed at Singareddypalli (V), Siddipet District. Houses constructed by the department.
		Chelkalapally(V) Chinnakodur (M) Siddipet (Dist)	2	2	4	2	0	2	-	4	4	0	Yes	R&R colonies have been developed at Chelkalapally (V), Siddipet District. Houses constructed by the department.
		Allipur(V) Chinnakodur (M) Siddipet (Dist)	12	13	16	12	0	12	-	16	16	0	Yes	R&R colonies have been developed at Allipur (V), Siddipet District. Houses constructed by the department.
		Sub-Total (4 No.s)	952	950	1306	952	0	952	-	1306	1306	0	-	-
		Rampur (V),												

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
		Thogutta (M), Siddipet Dist	228	242	256	228	0	228	-	256	256	0	Yes	
		Brahman Banjerupally (V),												
		Thogutta (M), Siddipet Dist	172	229	314	172	0	172	-	314	314	0	Yes	
		Lakshmapur (V),	.											
		Thogutta (M), Siddipet Dist	205	311	419	205	0	205	-	419	419	0	Yes	
		Etigadda Kistapur (V),												
2	Sri Komaravelli Mallanna sagar Reservoir	Thogutta (M), Siddipet Dist	705	961	1293	705	0	705	-	1293	1293	0	Yes	R&R colony being developed at Mutrajpally (V), Gajwel (M), Siddipet District by the department.
		Vemulghat (V), Thogutta (M), Siddipet Dist	754	1012	1434	754	0	754	-	1434	1434	0	Yes	
		Pallepahad (V),												
		Thogutta (M), Siddipet Dist	511	806	1083	511	0	511	-	1083	1083	0	Yes	
		Singaram (V),												

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
		Kondapak (M), Siddipet Dist	213	241	241	213	0	213	-	241	241	0	Yes	
		Yerravally (V),												
		Kondapak (M), Siddipet Dist	659	795	795	659	0	659	-	795	795	0	Yes	
		Sub-Total (8 No.s)	3447	4597	5835	3447	0	3447	-	5835	5835	0	-	-
3	Konda Pochamma Sagar	Mamidyala, Mulugu (M), Siddipet Dist	435	669	889	435	0	435	-	889	889	0	Yes	R&R colony developed at Tuniki Bollaram (V), Mulug (M), Medak District. Land and amount for construction given to PDFs. Houses constructed by the individuals as per their request.

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
		Bhailampur (V), Mulugu (M), Siddipet Dist	294	539	679	294	0	294	-	679	679	0	Yes	
		Thanedarpally (V), Mulugu (M), Siddipet Dist	148	230	292	148	0	148	-	292	292	0	Yes	
		Sub-Total (3 No.s)	877	1438	1860	877	0	877	-	1860	1860	0	-	
4	Gandhamalla Reservoir	Gandhamalla (V), Turkapally (M), Yadadri-Bhongir Dist	1145	2290	2290	Nil	1145	1145	Work not grounded because of LA Issue	2290	Nil	2290	No	Work not grounded because of LA Issue
		Tettakunta thanda, Turkapally (M), Yadadri-Bhongir Dist												

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
		Indra Nagar thanda, Turkapally (M), Yadadri-Bhongir Dist												
		Sub-Total (3 No.s)	1145	2290	2290	0	1145	1145		2290	Nil	2290		
5	Baswapur Reservoir	Thimmapur (V), Bhongir (M), Yadadri-Bhongir Dist.	591	858	858	0	591	591	Structure valuation reports to be prepared by R & B department	-	-	-	No	R & R proposals to be submitted to the Government
		Laxminayakudi Thanda, Yadagirigutta (M), Yadadri-Bhongir Dist.	75	150	150	0	75	75	Socio Economic Survey conducted	-	-	-	No	R & R proposals to be submitted to the Government
		Chongalnayakudi Thanda, M. Turkapalli (M), Yadadri-Bhongir Dist.	60	120	120	0	60	60	Socio Economic Survey conducted	-	-	-	No	R & R proposals to be submitted to the Government
		Sub-Total (3 No.s)	726	1128	1128	0	726	726	-	-	-	-	-	-

Sl. No.	NAME OF THE RESERVOIR	NAME OF THE VILLAGE	No. OF HOUSES	No. OF FAMILIES	No. OF PDFs	STATUS OF STRUCTURE PAYMENT				STATUS OF R&R PACKAGE			VILLAGE SHIFTED	
						Payments Made (Nos)	Balance (Nos)	Total (Nos)	Remarks/ Reasons for Delay	Proposed (Nos)	Cheques issued (Nos)	Balance (Nos)	Yes/ No	Remarks/ Reasons for Delay
	TOTAL	21	7147	10403	12419	5276	1871	7147	-	11291	9001	2290		

As noted from the annexure referred above, the status as on date is summarized as below:

The compensation is paid as per the Telengana State G. O Ms. Duly following the RFCTLARR Act ,2016(Act no:21 of 2017) which is better than the entitlement Provision under central act RFCTLARR, Act,2013 (LARR-2013) as mentioned above.;

1)Total no of structures required to be settled	:	7147
Total no of structures so far settled	:	5276
Balance to be settled –under progress	:	1871
2)R&R Packages-total to be settled	:	11291
3)Total, settled so far	:	9001
4)BALANCE UNDER PROGRESS	:	2290

5)As far as R&R COLONIES ARE CONCERNED maximum numbers have been developed and evacuees settled excepting in Baswapur and Kondamallanna sagar areas.

6)Though the number of villages affected/submerged and evacuation requirement indicated in the EMP is on the higher side, the actual differs as per the ground situation and accordingly the budgetary provision also differs.

7)The amount spent as on date as submitted by PP for the above packages stands at:RS:6238.37 crs which includes LA and R&R expenditures.

9.6 GREENBELT DEVELOPMENT PLAN

Green belt development plays a crucial role in river valley projects. Once the project commences, a lot of dust is generated due to excavation works, crushing of material, etc.

In addition to that air pollution also takes place due to vehicular movement during construction and operation phases. The need for green belt is most essential, not only for aesthetic purposes but also for the fulfilment of ecological functions.

The main objective of having greenbelt development is to mitigate dust pollution, fugitive emissions, to control noise pollution and to improve landscape and local ecosystem and also to arrest soil erosion.

The selected species has the potentiality to respond to pollution, act as wind breakers, helps in noise attenuation and arrest the soil erosion besides having an aesthetic appeal.

Planting should be done as per the CPCB Guidelines which is 2500 plants per Ha of native species covering an area of not less than 33% of the project area.

The green belt at the periphery of the reservoir is to reduce the sedimentation, control soil erosion, dust and siltation and to ensure protection of the reservoir area from any other human activity that could result in the reservoir catchment damage. The green belt shallstart from the immediate vicinity of the reservoir rim for 110.020 ha.

Canal bank plantations

Due to irrigation projects, the canals are dug up and the excavated earth is heaped on both the sides, these banks are poor in their fertility. They need to be protected from erosion.

Tree growth protects the bank and also prevents evaporation of the water in the canal. Canal bank plantation also serves as shelter belts to many fields adjoining the canals. The total length of the canal system is 116.334 km.

Table -9.6.1: Estimated cost for plantation along periphery of Reservoir and Canals for Kaleshwaram Project (2018-19 to 2023-2024)

S. No.	District	Diyision	Area proposed for diversion in ha	Canal Bank plantation			Plantation along periphery of reservoirs				Total Amount Rs. In Lakhs
				Length in km	No of plants	Amount Rs. In Lakhs	Periphery in km	Area in ha	No of plants	Amount Rs. In Lakhs	
1	2	3	4								
1	Bhupalpally	Mahadevpur	338.4826	13.000	15600	**105.41062**		0	0	**0.00000**	**105.41062**
2	Rajanna - Sircilla	Karimnagar-Sircilla	445.9565	0.000	0	**0.00000**	**39.910**	35.92	39910	**258.05734**	**258.05734**
3	Siddipet	Siddipet	1407.4390	8.000	9600	**80.58333**	**34.000**	30.6	34000	**219.38663**	**299.96996**
4	Yadadri Bhuvanagiri	Yadadri Bhuvanagiri	109.5738	3.334	5334	**39.61027**		4.5	5000	**31.91995**	**71.53022**
5	Nizamabad	Nizamabad	323.3667	0.000	0		**5.000**	39	43333	**279.61407**	**279.61407**
6	Kamareddy	Banswada	26.6844	8.000	9600	**63.98742**	**43.330**	0	0	**0.00000**	**63.98742**
7	Medak	Medak	194.0711	55.000	66000	**551.23056**		0	0	**0.00000**	**551.23056**
8	Nirmal	Nirmal	322.5574	29.000	34800	**291.78280**		0	0	**0.00000**	**291.78280**
		Total	**3168.1315**	**116.334**	**140934**	**1132.60499**	**122.240**	**110.020**	**122243**	**788.97799**	**1921.58298**

The estimated cost for plantation along periphery of reservoir and canals for kaleshwaram project (2018-19 to 2023-2024) is given in Table 9.6.1 as per EMP of PP.

Budget

The cost is worked out by adopting present F.S.R. OF 2017-18, Government of Telangana, Forest Department, which works out to Rs.645/: per plant.

Table - 9.6.2 : Cost estimation for greenbelt development		
Component	**Area in Ha**	**Financial (Rs.In lakhs)**
Plantation along periphery of Reservoir (110.020 ha @1111 plants / ha (122240 plants)		
Physical (Nos) @1111 plants / ha	110.020	788.977
Canal bank plantation (116.334) km		
No. of plants for 116.334 km @ 2631/km on either side (total no. of plants 274756 on either side)	116.334	1132.604
	Total	**1921.582**
Total cost in Crores		**19.21**

The estimated number of plants per Ha for canal bank and periphery of reservoir as per Table 9.6.1 and 9.6.2 of the EMP as above works out 1111 plants per Ha whereas this needs to be corrected as per CPCB and MOEF guideline as 2500 plants per Ha i,e One plant per every 4 sq mtr consisting of native species.

Accordingly, the total no of plants to be planted works out to 290835 plants for canal bank plantation and for periphery of reservoirs works out to 275050 plants.

Hence the total cost will get revised to:

a) Plantation along Periphery of reservoir (110.020ha@2500plants/ha (@Rs.645/: per plant (as per FSR of 2017/18) works out to rs:1774.07 lacs.(275050@Rs 645/: per plant)
b) Plantation along canal bank (116.334@2500 plants/ha =290835 plants and @645 per plant(as per FSR of 2017/18) , amount works out to Rs:1875.88lacs (290835@rs.645 per plant)

Therefore the total revised cost works out to a total of Rs:36.499 crores instead of Rs.19.21Cr which is tobe spent between 2018/19 to 2023/24 as per the provision in the EMP.

The revised Table of cost estimation vide 9.6.1a and 9.6.2a is appended here below:

Table -9.6.1 A: Estimated cost for plantation along periphery of Reservoir and Canals for Kaleshwaram Project (2018-19 to 2023-2024)

S. No.	District	Division	Area proposed for diversion in ha	Canal Bank plantation			Plantation along periphery of reservoirs				Total Amount Rs. In Lakhs
				Length in km	No of plants	Amount Rs. In Lakhs	Periphery in km	Area in ha	No of plants	Amount Rs. In Lakhs	
1	2	3	4								
1	Bhupalpally	Mahadevpur	338.4826	13	32500	20962500		0	0	0	105.41062
2	Rajanna - Sircilla	Karimnagar- Sircilla	445.9565	0	0	0	39.91	35.92	89800	57921000	258.05734
3	Siddipet	Siddipet	1407.439	8	20000	12900000	34	30.6	76500	49342500	299.96996
4	Yadadri Bhuvanagiri	Yadadri Bhuvanagiri	109.5738	3.334	8335	5376075		4.5	11250	7256250	71.53022
5	Nizamabad	Nizamabad	323.3667	0	0	0	5	39	97500	62887500	279.61407
6	Kamareddy	Banswada	26.6844	8	20000	12900000	43.33	0	0	0	63.98742
7	Medak	Medak	194.0711	55	137500	88687500		0	0	0	551.23056
8	Nirmal	Nirmal	322.5574	29	72500	46762500		0	0	0	291.7828
		Total	3168.1315	116.334	290835	1875.88	122.24	110.02	275050	1774.07	36.499

Table - 9.6.2 A : Cost estimation for greenbelt development

Component	Area in Ha	Financial (Rs. In lakhs)
Plantation along periphery of Reservoir (110.020 ha @2500 plants / ha (275050 plants)		
Physical (Nos) @2500plants / ha	110.02	1774.07
Canal bank plantation (116.334) km		
No. of plants for 116.334 km @ 2500/km on either side (total no. of plants 290835 on either side)	116.334	1875.88
	Total	**3649.95**
Total cost in Crores		**36.4995**

As explained above in the foregoing paragraphs ,24 no of projects have been considered under violation and with various periods ranging from 1.4 years in case of 3barrages ,3 pumphouses and ranging from 5 to 9 years in case of other 18 packages (5 reservoirs and canals) having incurred a total capital cost of about Rs: 53887 Cr till date which is 74.6% of the total cost of 72228 Cr for the overall projects of 48 packages.

And amount spent during the violation period i.e till Dec 2017 is Rs: 18853 Cr for 24 packages which works out to 35.14% of the total cost incurred for the projects under violation.

Hence considering the commitment of PP to spend Rs. 36.499 cr, in 5 years i.e upto 2023/24 and about 35% of the project cost has been incurred during the violation period, in the absence of unit wise description actuals v/s plan for canal and reservoir plantation and in line with the CPCB guideline it is estimated that the cost saved on this account as per the guidelines works out to Rs.12.77 crores.

As far as gaps are concerned in plantation coverage for the violation projects as per the guidelines, the damage is assessed project wise separately as explained in the relevant chapters. Therefore, cost saved on account of canal bank length of 116.334km and periphery reservoir length of 110.02 km works out to Rs: 12.77 cr.

9.7 FISHERIES CONSERVATION AND MANAGEMENT PLAN

A water resources project may have adverse or beneficial effects on the fish fauna, depending upon the particular situation and the fish fauna inhabiting the concerned river. Similarly, it has various impacts on the people, the livelihood of which depends on the fish. The construction of the dam leads the fragmentation of habitat, modification in hydrologicregime and may have adverse effects on the indigenous and migratory fish.

9.7.8 Cost Estimates

Based on the Department of Fisheries, Government of Telangana the cost estimate for fisheries management in fifteen districts of Kaleshwaram project is prepared. The total cost for fish management is Rs.485 Crores as mentioned in the EMP.

Details of various components:

Enhancing Seed production	:	(Total Outlay - Rs 99.07 Cr)
Enhancing Fish production	:	(Total Outlay - Rs 93.98 Cr)
Harvesting Support	:	(Total Outlay - Rs 39.68 Cr)
Marketing Support	:	(Total Outlay - Rs 179.08 Cr)
Infrastructure development	:	(Total Outlay - Rs 64.62 Cr)
Encouraging innovative projects	:	(Total Outlay - Rs 2.42 Cr)
Capacity building	:	(Total Outlay - Rs 5.02 Cr)

The present status of fund allocation and amount spent so far is to be Ascertained from the PP for the total budgetary amount of Rs.485 Cr as based on the fisheries Dept estimate. However, we recommend that Rs 485cr as estimated shall be incurred by PP between 2022-2025 over a period of three years with a firm commitment.

9.8 RESERVOIR RIM TREATMENT PLAN

9.8 Reservoir Rim Treatment Plan

The construction of the reservoir at dam at Medaram, Anantagiri, Sri RanganayakaSagar (Imambad reservoir), Sri KomaravelliMallannaSagar, Gandhamalla reservoir, Basawapuram reservoir, Malakpet reservoir, Upper Manair reservoir, Issaipet reservoir, Gujjal reservoir will result in ponding of water. The rim length of reservoir is given in the following Table 9.8.1.

Table 9.8.1 Rim length of reservoir

S.No	RESERVOIR NAME	RIM-LENGTH(m)
1	Battala Cheruvu	1076.36
2	Kachapur	1707.44
3	Maisamma Cheruvu	1775.63
4	Malkapet Reservoir	2553.37
5	Bhumpally Reservoir	3037.16
6	Thimakapali	3802.04
7	Amarlabanda	7416.02
8	Isaipet	7715.12
9	Mothe	9088.94
10	Imambad Reservoir	11471.00
11	Singasamudrum Cheruvu	12125.40
12	KondapochammaSagarReservoir	13392.50
13	Ananthagiri Reservoir	17548.70
14	Gujjul	17914.70
15	Baswapur Reservoir	26048.30
16	Kattewadi	30033.90
17	Gandhamalla Reservoir	30251.00
18	Kondam Cheruvu	30970.10
19	Komaravelli MallannaSagar	33782.0

The reservoir rim treatment plan is formulated to mitigate the geo-environmental hazards in the project areas especially reservoir area resulting in catastrophic losses of property, income and lives.

Biological and engineering remedial measures for protection of the reservoir rim is essential to protect the reservoir from sedimentation and to mitigate against siltation and to augment life of the reservoir. Provision of check dams, rock fill dams and vegetation /plantation cover are essential to mitigate.

Total budget for reservoir rim treatment plan as per EMP of PP is Rs. 236.75 Crores. The breakup of cost estimate is given in the following Table 9.8.2.

Table 9.8.2 Breakup of cost estimation

Measures	**Unit cost**	**Area/Nos.**	**Amount in Rs. Crores**
Coir geo-textilebags work	Rs. 900/m2	2609413	234.84
Plantation(Per ha)	Rs. 60,000/- Perha	261	1.56
Maintenance (Per Annum)	2,00,000 per reservoir	17	0.34
Total Cost	**236.75**		**236.75**

Cost saved –Environment Compensation; -

A total of 19 reservoirs having a total Rim length of 260941 meters have been assessed in the EMP and considering 10-meter width for every running meter, the area works out to 2609410 sq.mtr which needs to be provided with Geo Texturing followed by plantation and subsequently maintenance with a total cost outlay of 236.75 cr.

Out of the 19 reservoirs, 9 reservoirs as listed in the following table no:9.8.3 were constructed prior to EC with no: of years of violation varying from 1 to 6 years.

Table 9.8.3 Reservoir Rim treatment plan -violation					
S. NO	**Reservior**	**Nos years violation**	**Rim length**	**Total cost Lacs**	**Cost saved 10 % Per year**
1	Malkapet Reservior	1	2553.37	229.7	22.94
2	Imambad	6	11471	1032.3	619.38
3	Anathagiri	6	17548	1579.3	947.88
4	Basawapur	6	26048.3	2344.2	1406.4
5	Gandhamalla	6	30251	2722.5	1633.5
6	Kondem cheruva	5	30970	2787.3	1393.65
7	Komarvalli mallawa sagar	6	33782	3040.3	1824.18
			152623.67	**13735.6**	**7847.93**
	Total cost @236.75 cr for -2609413 M2 / 260941 M Length				
	Rate Per Meter Length -0.090 Lacs				
	Total Cost saved due to Non Compliance Reservoir Rim treatment plan = **Rs in Cr - 78.47**				

In line with the CPCB and MOEF Guidêline, with the total rim length of 152623.67 mtr estimated under violation and the total cost works out to Rs. 137.35cr and net cost saved works out to Rs.78.47 cr.

9.9 MUCK MANAGEMENT & RESTORATION OF QUARRY SITES

Dumping of muck and its rehabilitation is a real challenge in the river valley projects as a huge quantity of muck is excavated from different structural units. All ancillary activities of muck dumping like excavation, transportation, relocation and rehabilitation have adverse impacts on the life support system and landscapes. Therefore, among all mitigation measures, relocation and rehabilitation of muck are addressed primarily in EIA studies. A muck management plan would take the calculation of muck to be generated, swelling factors, reutilization of muck, dumping areas and their characteristics, mitigation measures includingengineering and biological and their uses, if possible, into account.

About 1480 lakh m3 of muck is anticipated to be disposed at suitable locations in respect of Kaleshwaram project as per the EMP, wheras the total muck qty of-316.41 lakh cum is assessed for the violation projects as derived from the info submitted bythe PP

Rejuvenating muck dumping sites include:

- utilize the maximum quantity of muck for different project activities.
- protect the dumping sites from soil erosion.
- develop muck dump sites as parks, with greenery, etc. in harmony with the landscape of the project

Impacts due to muck management

The process of muck dumping and restoration of these muck management sites are to

- protect and control soil cover and muck erosion
- create greenery in the muck management areas
- improve and develop the sites into recreational sites
- ensure maximum utilization of muck for the construction purpose
- develop the muck management sites/ dumping yards to blend with the surrounding landscape
- minimize damages due to the spoilage of muck in the project area

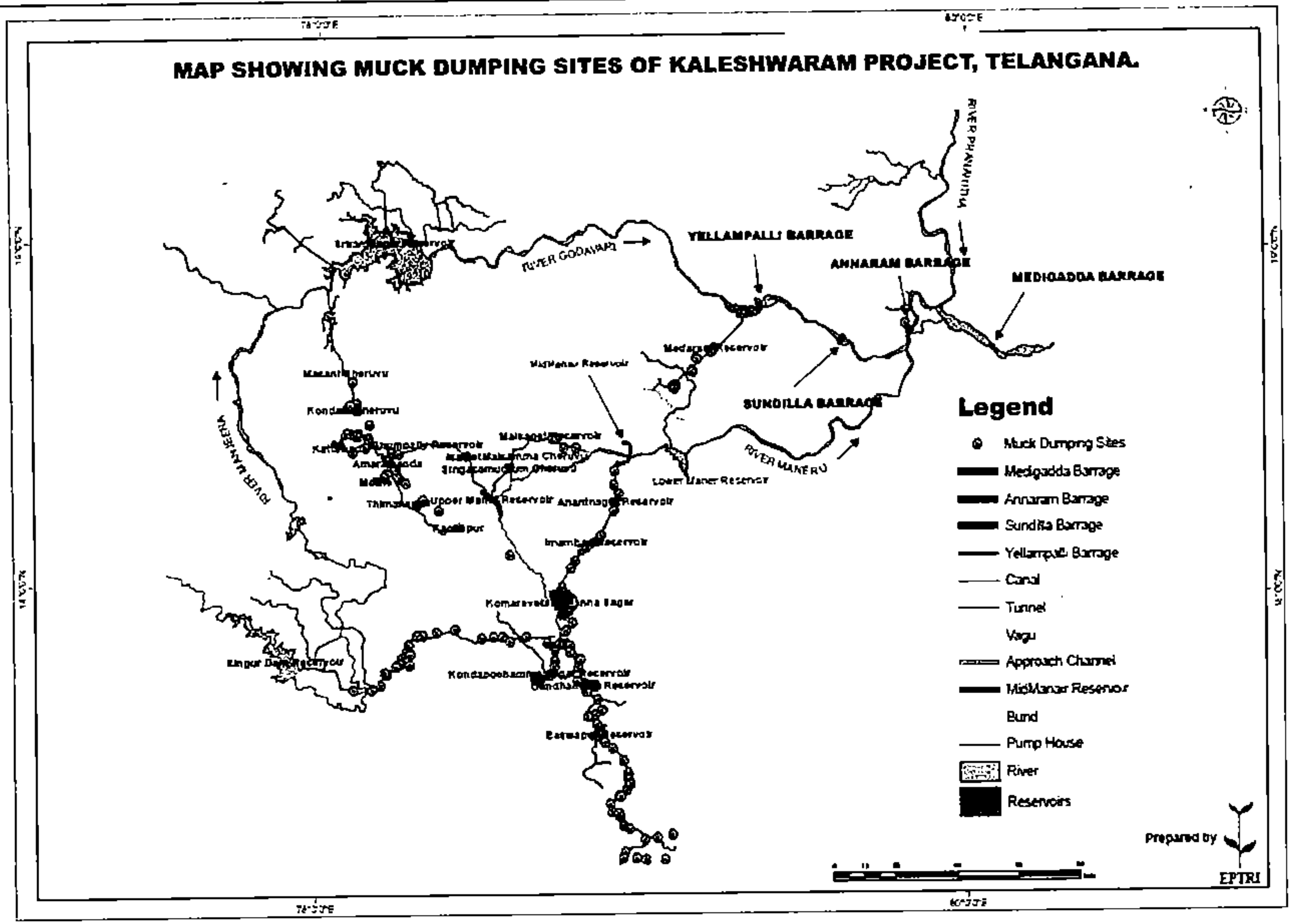

MAP SHOWING MUCK DUMPING SITES OF KALESHWARAM PROJECT, TELANGANA.
RIVER GODAVARI
RIVER PRANAHITHA
YELLAMPALLI BARRAGE
ANNARAM BARRAGE
MEDIGADDA BARRAGE
SUNDILLA BARRAGE
RIVER MANERU
RIVER MANJEERA
Lower Maner Reservoir
Komaravelli Malla Sagar
Legend
Muck Dumping Sites
Medigadda Barrage
Annaram Barrage
Sundilla Barrage
Yellampalli Barrage
Canal
Tunnel
Vagu
Approach Channel
MidManar Reservoir
Bund
Pump House
River
Reservoirs
Prepared by
EPTRI

Figure 9.9.2

The cost for muck management is given in Table 9.9.1. The total cost for muck management is assessed to be Rs. 32.79 Crores.

Table 9.9.1 Cost Estimate for Muck management

S.No	Item of work	Unit cost Rs.	Quantity	Cost in Lakhs
Along the Canal				
1	Muckmanagement on spoil bank, levelling and sloping (m^3)	750	**147968**	**1109.76**
2	Jute geotextile as a part of bio-engineering and biological measures (m^2)	150	**147968**	**221.952**
3	Plantation per hectare	39000	3062	**1194.18**
4	Watering and maintenance for 44 weeks for seven years per hectare	92400	4	**3.696**
5	Watch and Ward for 4 persons per link for 4 years (except monsoon)	420000	32	**134.4**
Dumping sites				
6	Muckmanagement on spoil bank, levelling and sloping (m^3)	750	2000	**15**
7	Landscaping, restoration, levelling and dressing of dump site	60000	1000	**600**
8	Watering and maintenance for 4 years per hectare	20000	4	**0.8**
Total Cost in Crores				**32.79**

The damage due to muck disposal and management is estimated project wise considering the area occupied in each project as well as subsequent damages accrued due to wind erosion, wash offs, non provision of other control measures as detailed above besides noncompliance of management provisions as per the EMP and as per guidelines is furnished under relevant projects. Further the above budgetary provision 32.79 Cr is very much meagre for mitigating/managing 1481 lac cum (As per EMP) of muck even though partially some quantity has been utilsed for back filling and reclamation.

QUARRY SITE RESTORATION PLAN:

The material required for the construction of barrages, approach/gravity canal, pump houses and other works is planned to be obtained from the muck generated during excavation of tunnels since the rock is found suitable as coarse aggregate in cement concrete and other works. Additional quantities of coarse aggregate for concrete works are obtained from seven no: quarries.

The quarries for fine aggregate/ sand are proposed from Godavari River. Restoration of the quarries is needed for the quarries located outside the river bed.

After extraction of required construction materials is completed, the quarries need to be back filled and stabilized by means of applying engineering and biological measures.

- Stone guards to check soil erosion in the area and prevent loss of land due to possible landslips.
- Pits formed due to quarrying need to be filled with useful rock boulders, spalls, waste sand and finally with farm yard manure.
- Grass slabs will be placed to stabilize and check the erosion due to surface runoff.

The details of costs for the quarry stabilization and the measures are furnished in Table 9.9.2.

Sl. No.	Details of Expenditure	Approx. Quantity m3	Unit cost Rs.	Total (Rs. Lakhs)
1	Guard walls construction	50000	600	30000000
2	Back filling	36992	75	2774400
3	Green manure		500000	500000
4	Pillars and wire fencing	10000	1500	15000000
6	Plants and planting	2,25,000	800	180000000
7	Weed clearance, watch and ward for 4 years after project @ Rs. 10000 per month, per quarry (total 7 quarries)		LS	3360000
Total				231634400
Total cost in Crores Rs.				**23.16**

The above budgetary provision in EMP does not commensurate with the following Quarrying guidelines:

1) Quarry Leases.
2) Approved mine plans
3) Environment clearance
4) Other statutory clearances like land rights, explosive license, NOC for water consumption, DGMS, etc.

Coarse Aggregates have been sourced from 6 no quarries located with varying distances of 55 to 110 km from the project sites 24 nos under violation. Fine aggregates, sand have been sourced from closer vicinities distance varying from 5 to 27 km. The damage assessment for the quantities supplied to these projects with varying period of 1.4 to 9.0 years has been assessed quarry wise which includes cost saved due to reclamation and rehabilitation of quarry sites apart from damages assessed for the following attributes:

1) Air pollution impact due to various activities including transportation.
2) Water –surface &ground
3) LU/LC
4) Ecology and bio diversity including Green Belt and Plantation.
5) Solid waste
6) OHMS.
7) Reclamation and rehabilitation.

In view of the above, the EMP budget provided in EIA has not been considered and damage assessment is worked out exclusively for quarries and provided under damage assessment report.

9.12 WATER, AIR AND NOISE MANAGEMENT PLAN

WATER, AIR AND NOISE MANAGEMENT PLANS

The construction activities of the project emit substantial quantum of pollutants to the environment. During construction period generation and release of effluents from adits at tunnel, sewage disposal from labour camp, blasting and other land clearing activities, washing of oil, grease and other chemical from diesel generator sets, vehicles and other machinery etc. cause water pollution and affect the quality of surface as well ground water.

The major air pollutants, which could be generally, released during various construction activities of hydroelectric projects and vehicular movements are SPM, SOx and NOX. In addition to that the construction activities also generatenoise due to the use of heavymachinery, heavy vehicles, blasting, etc. which has serious impacts on humans as well as the wildlife of the area.

Water after usage shall be treated and treated effluent only shall be discharged in these water bodies, which are not used for meeting domestic water requirement.

The runoff from construction site will contain high suspended solid which require treatment prior to disposal

SEWAGE TREATMENT

The labour population is proposed to be situated in existing colonies. One community toilet needs to be provided for 20 persons. The sewage from the community toilets can be treated in a Sewage Treatment plant (STP) comprising of aerated lagoon and secondary settling tank. The treated effluent can be used for meeting irrigation requirements of areas being afforested undergreenbelt development and canal bank plantation.

IMPLEMENTING AGENCY

Various management measures need to be implemented for Control of Various pollution control need to be included in the Tender Document for the Contractor involved in construction activities. The same shall be monitored on a regular basis by the project proponents. The cost estimate for air pollution management is given in Table 9.12.3.

Table 9.12.3 Air Pollution Management cost

S.No.	Component	Rs.	Persons	Total	Cost in Crores
1	Nose masks 500 No's - Rs. 25/- each	25	5000	125000	0.0125
2	Road wetting (Sprinklers_@ 1 Ltr/ Sq.m. and waste dump settling (1/4 of wetting & wet drilling) - 5000 Ltrs tank @ Rs. 300/-	600	262800	157680000	15.768
3	240 Drivers for Water Sprinkling for 3 years	10,000	240	86400000	8.64
4	3 Traffic Manager Rs. 12000/month for 3 years	15000	3	2160000	0.216
5	15 sweeper Rs. 6000/month for 3 years	6000	4	1080000	0.108
6	6 No. DG set Monitoring for Quarterly (Rs. 3000)	221	4	7956000	0.7956
7	Vehicle emission checking (4350 No. of vehicles) for every six months (approx. each Rs. 150)	4350	2	3915000	0.3915
Total Cost					**25.93 Cr**

Air and Noise:

The damages due to air and noise pollution of all the projects under violation are assessed project wise and hence cost saved and relevant Environment compensation is not worked out collectively since the above budget covers total projects and their exact status amount spent on these items is not indicated by the PP.

Cost saved in monitoring of all parameters as per MOEF guideline is addressed in the following Table

Table EMP COST SAVED FOR, BASELINE MONITORING –

for all the projects of all radicals and submission of 6 Monthly reports.

S.No	Projects	Period From	Period to	No Of Years	Budget Rs.Lacs	Saved Rs.lacs
1	Laxmi Medigatta	26-08-2016	31-12-2017	1	2.5	2.5
2	Laxmi Pumphouse	27-08-2016	31-12-2017	1	2.5	2.5
3	Saraswathi	26-08-2016	31-12-2017	1	2.5	2.5
4	Saraswathi (PH)	27-08-2016	31-12-2017	1	2.5	2.5
5	Parvathi(Sundilla)	15-07-2016	31-12-2017	1(1/2)	3.75	3.75
6	Parvathi (P H)	27-08-2016	31-12-2017	1.4	3.25	3.25
7	Package 6	25-10-2011	21-12-2017	6	12	12
8	Package 7	17-11-2008	31-12-2017	9	18	18
9	Package 8	17-11-2008	31-12-2017	9	18	18
10	Medaram Reserovoir	17-09-2017	31-12-2017	9	18	18

11	Package 9	17-11-2008	31-12-2017	9	18	18
12	Malkapet Reservoir	17-11-2008	31-12-2017	1	2	2
13	Package 10	02-12-2008	31-12-2017	9	18	18
14	Anathagiri Reservoir	02-12-2008	31-12-2017	9	18	18
15	Package 11	24-11-2008	31-12-2017	9	18	18
16	Package 12	24-11-2008	31-12-2017	9	18	18
17	Package 15	21-02-2009	31-12-2017	9	18	18
18	Package 16	11-02-2009 12-08-2012	31-12-2017	8	16	16
19	Package 17	19-02-2009 19-05-2013	31-12-2017	5	10	10
20	Package 18	28-02-2009	31-12-2018	1	2.5	2
21	Package 19	28-02-2009	31-12-2018	1	2.1	2
22	Package 20	20-11-2008 05-11-2011	31-12-2017	4.5	9	9
23	Package 21 + (Kondam cherawa)	20-11-2008	31-12-2017	9	18	18
24	Package 22	25-01-2013	31-12-2017	5	10	10

25	Package 27	20-11-2008 25-01-2013	31-12-2017	5	10	10
26	Package 28	25-02-2009 06-10-2012	31-12-2017	5	10	10
				290.2	**290**	**290**
	Saving @10 %					**29.02Lacs**

9.15 PUBLIC HEALTH DELIVERY PLAN

About 11000 labour and technical staff (As per EMP) were likely to be deployed during the peak construction phase. But however as per the collected data about about 8200 labour and technical staff have been employed during the violation period by the PP.

Team	Number
Doctor	1
Auxiliary Nurse	2
Helper	1
Ambulance Driver	1

COST ESTIMATES

Table 9.15.2 Estimated Cost of public health centre in each district as per EMP:

Designation	Districts	Nos.	Salaries per month in Rs.	Total per year in Rs.
Doctors	15	1	40,000	6,00,000
Nurses	15	2	18,000	5,40,000
Attendants	15	1	12,000	1,80,000
Drivers	15	1	12,000	1,80,000
Ambulance	15	1	1200000	1,80,00,000
Furniture	15	1	4,00,000	60,00,000
			Total	**2,55,00,000**
			In Crores	**2.55**

Cost for medicines and other medical contingences during three years of construction period is Rs.2,00,000/- per month in one district.

Total for 15 districts = Rs.30,00,000/-

Per year Rs. 30,00,000 *12*3 = Rs.3.6 Crores

An amount of Rs. 1,00,000/- can be earmarked for construction of first aid at major construction sites.

Total for 15 districts: Rs.15,00,000/-

Per Annum: Rs. 15,00,000 *12*3 = Rs.1.8 Crores

The total expenditure for implementation of various public health measures are about Rs.9.6 crore

Budget for Public Heath Delivery System

The total budget earmarked for Public Health delivery system shall be Rs. 10.35crore. The details are given as below

- Public Health Delivery System: Rs. 9.6 crore
- Disposal of Bio-medical waste: Rs. 0.75 crore
- Total: Rs. 10.35 crore

In the absence of the status of expenditure incurred by PP so far, this has not been considered in cost saving.

9.16 SANITATION AND SOLID WASTE MANAGEMENT PLAN

9.16.1 CONSTRUCTION PHASE

Table 9.16.1 Cost estimate for sanitation facilities in labour camps

The total cost estimated for sanitation facilities is Rs.15,00,000/- per camp.

It is expected that about 20 such labour camps need to be provided with sanitation facilitieswhich is estimated as Rs. 3,00,00,000/- (Rs.3 Crores).

9.16.2 Provision of community kitchen and free fuel. The total cost required for provision of fuel works out to Rs. 13.11 crores .

Table 9.16.2 Cost estimate for LPG distribution

No.of labour	**Actual req.@1cylinder per family per month**	**Total cost perannum Rs.**	**Costescalationif any@10%per year**	
1st year	1833	690	1,51,77,240	
2nd year	3667	759	3,33,99,036	834
3rd year	5500	834	1,83,44,664	918
		Total	**9,72,83,700**	
		Rounded to (Rs. in Crores)	**9.73**	

In the absence of LPG cylinders, it is assumed that kerosene will be provided in the labourcamps and the following in the estimated cost.

Table 9.17.3 Cost estimate for kerosene distribution

No. of labours	**Actual req.@15 litres per family per month**	**Total cost**	**Cost escalation if any @ 10 % per year**	
1st year	1833	225	49,49,100	
2nd year	3667	247.5	1,08,90,990	16.5
3rd year	5500	272.25	1,79,68,500	18.5
Total	**3,38,08,590**			
Rounded to (Rs. in Crores)	**3.38**			

9.16.3 SOLID WASTE MANAGEMENT

Substantial amount of solid waste is expected to be generated from labour camps. In view of the conditions that normally in the labour exist camps of such projects. The solid wastes is likely to contain vegetable matters followed by paper cans and glasses. About 11000 labour are likely to reside during the construction phase at various construction sites resulting ingeneration of about 3.3 tonnes/day. Proper facilities for collection and conveyance of solid waste generated to the disposal site need to be developed.

Budget for Environmental Management in Labour Camps

Domestic waste and waste water management:

The construction workers and staff colonies located in different locations need to have facilities like proper transport and decentralized STP s of adequate capacity as per the guidelines and non-provision of this facility attracts Environmental compensation as detailed in the above paras vide CPCB guideline as briefed below:

Environmental Compensation Formula-Cost saved in STP/waste management system as per CPCB is explained overleaf.

As per the above guideline, the amount of cost saved for STP and Solid waste is detailed out as per the following tables:

Table 9.16.1

Environmental comperstation formula as per CPCB **A) 10 % of capex per year** **B) 10% of capex as O&M Charges Per Year**	**Cost saved due to Non provision of waste water treatment facility**
Enviromental Externality as per CPCB	
Up to 200 MLD -Rs Per/day Min -0.05 Max -0.10 for 100 KLD and others -500/10= 500 Per Day	

S.NO	Pkg/Project	NO Of Labour / days	STP Capacity	No Of day	No Of Years	Capex	Rs in Lakhs 10 % Of Capex	Rs in Lakhs O&M	Enviro Externality Rs In Lacs	Total Rs in Lakhs
1	Laxmi	730	100	257	1	75	7.5	7.5	1.285	**16.285**
2	Laxmi (PH)	730	100	367	1	75	7.5	7.5	1.835	**16.835**
3	Saraswathi	142	200	344	1	150	15	15	1.725	**31.725**

4	Saraswathi (PH)	900	126	326	1	130	13	13	1.63	**27.63**
5	Parvathi	975	137	334	1	140	13.5	13.5	1.67	**28.67**
6	Parvathi (PH)	540	75	370	1	93	9.3	9.3	1.85	**20.45**
7	Package 6	465	65	1870	9	82	73.8	73.8	9.35	**156.95**
8	Package 7	265	40	1920	9	50	45	45	9.6	**99.6**
9	Package 8	375	55	2122	9	68	61.2	61.2	10.61	**133.01**
10	Medaram Reservior	505	70	30	1	87.5	8.75	8.75	0.15	**17.65**
11	Package 9	90	15	1632	6	22.5	2.5	3.6	8.16	**14.26**
12	Malkapet	30	-	72	1	-			0.36	**0.36**
13	Package 10	50	10	1600	6	20	12	21.6	8	**41.6**
14	Anathagiri Reeervior	110	20	338	2	30	6	7.2	1.69	**14.89**
15	Package 11	70	10	837	6	20	12	21.6	4.18	**37.78**
16	Package 12	135	20	1636	6	30	18	21.6	8.18	**47.78**
17	Package 15	700	100	1500	6	75	45	45	7.5	**97.5**
18	Package 16	260	40	1540	6	60	36	45	7.7	**88.7**
19	Package 17	320	45	477	2	67.5	33.75	37.75	2.385	**73.885**
20	Package 18	-	-	-	-	-	-	-	-	-

21	Package 19	-	-	-	-	-	-	-	-	-
22	Package 20	220	35	1600	7	52.5	36.75	36.75	8	**81.5**
23	Package 21	70	10	3286	5	20	12	21.6	16.43	**50.03**
24	Package 22	65	10	730	6	20	10	18	3.65	**31.65**
25	Package 27	40	10	1260	5	20	10	22.5	6.3	**38.8**
26	Package 28	90	15	1544	6	30	18	21.6	7.72	**47.32**
	Total	**7877**	**1308**	**25992**	**104**	**1418**	**506.55**	**578.35**	**129.96**	**1214.86**
Total saving in capex (10% Intrest rate)				**506.55**						
Total Saving in O&M				**578.35**						
	Enviroment Externality			**129.96**						
	Grand Total Rs in Lakhs			**1214.86**						
Cost saved due waste water treatment facility for the violation projects works out to: Rs. 12.14 cr.										

Table 9.16.2 SOLID WASTE MANAGEMENT

S.No	Non-Provision of PPE Kits	Man Power	Days	Per day	No Of Yrs.	
1	Laxmi	170334	257	662	1	
2	Laxmi (PH)	242000	367	660	1	
3	Saraswathi	443608	344	1290	1	
4	Saraswathi (PH)	269000	329	818	1	
5	Parvathi	285570	334	885	1	
6	Parvathi (PH)	182000	370	492	1	
7	Package 6	788400	1870	422	9	
8	Package 7	459900	1920	240	9	
9	Package 8	722100	2122	340	9	
10	Medaram Reservoir	14000	30	467	1	
11	Package 9	13600	1632	83	1	
12	Malkapet	2120	72	30	1	
13	Package 10	8000	1600	50	6	
14	Anathagiri Reservoir	33800	338	100	2	
15	Package 11	50200	837	60	6	
16	Package 12	196320	1636	120	6	
17	Package 15	950000	1500	634	6	

S.No	Non-Provision of PPE Kits	Man Power	Days	Per day	No Of Yrs.	
18	Package 16	364980	1540	237	6	
19	Package 17	138330	477	290	5	
20	Package 18					
21	Package 19					
22	Package 20	320000	1600	200	7	
23	Package 21 (Kondem cheruva)	210000	3286	64	6	
24	Package 22	43800	730	59	5	
25	Package 27	219000	1260	174	5	
26	Package 28	234000	1544	152	6	
	Total	6433184	25995	8499		
	(6433184 & 8499) =10% Absent 643318→850 (6433184+643318)=7076502.4 (8499+850) =9350					
	Total Man Days =7076503*0.30 for S/W Calculation					**2122951**
	Damage due to -Solid waste disposal as per SW Rules =2122951*25 /@Rs.25/Kg					**530.73**

As Per CPCB and MSW 2016 rules guideline, the Per capital domestic solid wastage is 0.300 gm day and accordingly total disposal quantity works out to 2122.951 tons for the total man-days of 7076502 of projects under violation. The Total damage cost workouts to Rs 5.30 cr.

9.17 LOCAL AREA DEVELOPMENT PLAN

Infrastructure Development and Public utilities

In addition to the provisions under R & R benefits for the Project Affected Families, project proponent would aim at the improvement in the livelihood standards of inhabitants in the project area. Project helps to develop infrastructure in the area.

Skill Development ProgrammeSports and Recreational ActivitiesFree powerto affected familiesEncouragement of Horticultural and Agricultural Activities.

Total budget for Local area development plan

An amount of **Rs. 28.24 Crores** is being made for implementation of activities; local area development plan as shown in the following Table

Budget for implementation of Local Area Development Plan

S.No	Item	Cost in Crores
1	Upgradation of Infrastructure facilities	6.1
2	Up-gradation of existing schools	5.5
3	Scholarships to students in the Study Area	0.36
4	Budget for up-gradation of PHCs	16.28
Total		28.24 Cr

The status of the amount spent against local area development is being collected and worked out by PP and hence this has not been considered for environmental compensation as cost saved.

9.18 SAFETY MANAGEMENT SYSTEM AND ENVIRONMENT HEALTH SYSTEM

Chapter 9.18 of EMP deals with the above systems and PP's EHS organization to monitor, implement, oversee all the safety practices during construction, fire protection in laborcamps, staff colonies besides imparting training.

However,.EMP does not describe about The Occupational Health and Safety Management System applicable to contractors and their employees despite the fact that The Tender Conditions stipulate this activity by the contractors.

The damage caused during the violation period for the relevant projects is assessed as per the principle of cost saved as per CPCB and MOEF guidelines under damage Assesment report. Below is the quote from EMP:

"EHS Department is responsible for providing required training. Budget Implementation of this plan will be mandatory for all contractors. Requirements of this plan will be part of contract agreement."

9.19 ENERGY CONSERVATION PLAN

Energy Conservation Measures

Energy Conservation during Construction Phase (As per EMP)

The following energy conservation measures would be undertaken during construction works:

- Efficient work scheduling and methods that minimize equipment idle time and double handling of material
- Throttling down and switching off construction equipment when not in use
- Switching off truck engines while they are waiting to access the site and while they are waiting to be loaded and unloaded
- Switching off site office equipment and lights and using optimum lighting intensity for security and safety purposes
- Careful design of temporary roads to reduce transportation distance
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency
- The specification of energy efficient construction equipment

It is estimated that the cost during construction would be Rs.453.25 Crores.

The status of amount spent on Energy conservation measures and energy saved during construction will be submitted by PP in due course as per their report.

ENVIRONMENTAL MANAGEMENT PLAN COST:

The consolidated cost for environmental management plan is about Rs.16351.64 Crores which includes cost of CAT plan, CAD plan, Compensatory Afforestation, Biodiversity & Wildlife Management Plan, R&R plan, Greenbelt Development Plan, Fisheries Conservation and Management Plan, Reservoir Rim Treatment Plan, Muck management plan and restoration & Quarry sites, Water. Air, Noise Management Plan, Public Health Delivery Plan, Sanitation & Solid waste Management Plan and Local Area Development Plan which is corrected to Rs. 16998.51 Crores and the relevant table is as following:-

10. CORRECTED EMP BUDGET AND COMPLIANCE STATUS BY PP

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spent Till 23rd December 2017	Amount Spent till now	Remarks
1a.	*Catchment Area Treatment plan for High/ Very High Priority	125.29	319.63	----	----	As per EMP to be spent in 10 years
1b.	*Catchment Area Treatment plan for Medium / Low Priority	------- .	11593.86	----	----	As per EMP to be spent in 10 years
2	Command area Development Plan	1326.86	1326.86	----	129.33 Cr	The Works of Distributary network system were not taken up till Dec -2017 Pkg 10-Pkg 11 =129.33 crs
3	Compensatory Afforestation plan	722.3	722.3	----	722.30	(Transferred to Forest Dept) – To be confirmed
4	Biodiversity and wildlife conservation & Management	3.36 per year	3.36 per year	----	---	----
5	Resettlement & Rehabilitation	13296	13296	2600.27 Cr	6238.37 Cr Cumulative	Includes LA and R&R

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spent Till 23rd December 2017	Amount Spent till now	Remarks.
6	Green Belt Development	19.21	36.499	----	----	The details of plantation were furnished earlier. However, the details of amount spent are being collected and will be furnished after receipt from the concerned duly consolidating the same
7	Fisheries conservation and Management plan	485	485	----	----	Dealt by Fisheries Dept – To be confirmed from Fisheries Dept for Fund Transfer
8	Reservoir Rim Treatment plan	236.75	236.75	----	----	The details are being collected and will be furnished after receipt from the concerned duly Consolidating the Same
9	Muck Management & Restoration of Quarry site	55.95	55.95	-----	-----	----
10	Water, Air and Noise Management Monitoring	25.93	25.93	-----	-----	The Details are being collected and will be furnished

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spent Till 23rd December 2017	Amount Spent till now	Remarks
11	Public health Delivery plan	10.35	10.35	----	----	The details are being collected and will be furnished after receipt from the concerned duly Consolidating the Same
12	Sanitation and solid waste Management plan	16.4	16.4	----	----	The details of STP and Soak pits etc. Were Furnished earlier however the details of amount spent are being collected and will be furnished after receipt from concerned duly consolidating the same
13	Local Area Development Plan	28.24	28.24	----	----	The details are being collected and will be furnished after receipt from the concerned duly Consolidating the Same
14	Environment safe guards & EHS – Construction	-----	-----	-----	-----	-----

S.No	EMP ACTIVITY	Proposed amount as per EIA (Rs Cr.)	Corrected Amount as Per EIA (Rs. Cr)	Amount spent Till 23rd December 2017	Amount Spent till now	Remarks
15	Energy Conservation Measures (During Construction)	-----------	435.25	----	----	The details are being collected and will be furnished after receipt from the concerned duly Consolidating the Same
16	River bank stabilisation	-----	-----	-----	-----	-----
TOTAL		**16351.64**	**28592.37**	-------	**7090.00**	
Less R&R		**13296.00**	**13296.00**		**6238.37**	
***Less (CAT for medium, Low & Very Low)**		----	***11593.86**			
Net		**3055.64**	**3702.51**		**851.63**	

*As per EIA/EMP expenditure under CAT plan for medium, low & very low areas works out to Rs.11593.86 Cr which is to be spent in 10 years.

11. CORRECTED EMP BUDGET (Ref EIA of PP) VS COST SAVED IN EMP

S.No	EMP ACTIVITY	Corrected Amount as Per EIA (Rs. Cr)	Amount Spent till now	Cost Saved in EMP	Remarks
1a.	*Catchment Area Treatment plan for High/ Very High Priority	319.63	----	112.04	----
1b.	*Catchment Area Treatment plan for Medium / Low Priority	11593.86	----	----	----
2	Command area Development Plan	1326.86	129.33 Cr	----	----
3	Compensatory Afforestation plan	722.3	722.30	----	The funds supposed to have been transferred to State forest Dept and status to be updated.
4	Biodiversity and wildlife conservation & Management	3.36 per year	---	4.11	----
5	Resettlement & Rehabilitation	13296	6238.37 Cr Cumulative	----	----
6	Green Belt Development	36.499	----	12.77	----

7	Fisheries conservation and Management plan	485	----	----	Fund spent status to be ascertained.----
8	Reservoir Rim Treatment plan	236.75	----	78.47	----
9	Muck Management & Restoration of Quarry site	55.95	-----	Damage Assessed Separately	----
10	Water, Air and Noise Management Monitoring	25.93	-----	0.29	----
11	Public health Delivery plan	10.35	----	----	Status N.A.----
12	Sanitation and solid waste Management plan	16.4	----	17.44	----
13	Local Area Development Plan	28.24	----	----------	Status N.A.----
14	Environment safe guards & EHS – Construction	-----	-----	Damage Assessed Separately	----
15	Energy Conservation Measures (During Construction)	435.25	----	-----	Status N.A----

16	River bank stabilisation	-----	-----	-----	-----
TOTAL		28592.37	7090.00	225.12	----
Less R&R		13296.00	6238.37	----	----
*Less (CAT for medium, Low & Very Low)		*11593.86	----	----	----
Net		3702.51	851.63	225.12 Cr	----

***As per EIA/EMP expenditure under CAT plan for medium, low & very low areas works out to = Rs.11593.86 Cr which is to be spent in 10 years.**

TOTAL COST SAVED IN EMP Rs. 225.12 Cr., which will be part of and added to Damage assessment amount.

12. KALLESWARAM LIFT IRRIGATION PROJECT – GUIDING PRINCIPLE FOR DAMAGE ASSESMENT

1) INTRODUCTION:

The report involves assessment of ecological damage. preparation of remediation plan and natural & community resource augmentation plan. This applies to projects which have started the work on site, expanded the production beyond the limit of environmental clearance or changed the product mix without obtaining prior environmental clearance under the Environment Impact Assessment Notification, 2006.

The Expert Committee, as per the mandate of Hon'ble NGT and MOEF&CC, for assessing the environmental damage caused by the Kalleswaram Lift Irrigation Project has appraised by considering the potential damage which the project activity may have caused, due to non-existence of prior EC vis- a- vis a proper Environment Management Plan (EMP) in place, to various environmental attributes such as Air, Water, Land, Noise, Ecology/Biodiversity, Energy Conservation and Socio-Economic Environment.

It has been evolved, in the form of the guidelines, below mentioned methodology which permits to quantify the damage cost based on the appraisal of projects on case-to-case basis. The environment damage cost may vary from sector to sector based on location (example: Urban setting, forest setting and ecologically sensitive areas), period of violation, resources consumed, receptor damages etc. The economic benefits accrued by way of net profit and the cost saved on account of non-provision of EMP (Capital and Recurring), during the violation period are also taken into the consideration while arriving at the damage assessment cost.

1.1. GENERAL APPROACH:

Following references from international acts and rules and WHO Guidelines are referred

1. US Comprehensive Environmental response, Compensation and Liability Act, dealing mainly Hazardous waste site clean up requiring resource damage assessment.
2. In Europe, European Environment Agency, in its report assessed the damage costs to health and the environment resulting from pollutants emitted from industrial facilities. It is based on the latest information namely for 2009, and validated to 2020, vide its EEA technical report has the damage caused as briefed below:
    a. Air pollution continues to harm human health and our environment.
    b. Concentrations of certain air pollutants still pose a threat to human health

c. This report investigates the use of a simplified modelling approach to quantify, in monetary terms, the damage costs caused by emissions of air pollutants from industrial facilities.
d. This study also employs other existing models and approaches used to inform policymakers about the damage costs of pollutants.
e. The methods are used to estimate the impacts and associated economic damage caused by a number of pollutants emitted from industrial facilities, including: the regional and local air pollutants: ammonia (NH_3), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), particulate matter (PM_{10}) and sulphur oxides (SO_x); carbon dioxide (CO_2).
f. Each of these pollutants can harm human health, the environment or both. Certain of them also contribute to forming ozone and particulate matter in the atmosphere Air pollutants included in this study and their effects on human health and the environment- Nitrogen oxides (NO_X), Sulphur dioxide (SO_2), Non-methane volatile organic compounds (NMVOCs), Carbon dioxide (CO_2).

1.2. METHODOLOGY USED FOR ECONOMIC EVALUATION / QUANTIFICATION OF ENVIRONMENTAL DAMAGE ASSESSMENT

After having reviewed the available methodologies from CPCB and European Environmental Agency, and EU hand book-28, as well as based on brain storming and learnings from appraisal of a number of projects, **a methodology** which has wider application and encompasses all the sectors appraised under violation projects is proposed. **Attribute wise details which formed the input for quantifying damage assessment equivalent to remediation cost, natural and community resources augmentation cost areas under: (Refer –Annexures — XIII & XIV)**

1.2.1. INPUTS FOR AIR ENVIRONMENT:

Prior to assessing the damages, the following details has been assimilated for such exercise:

i. Construction site / surrounding / nature (Land Use/ Land Cover) (LULC)
ii. Total Construction completed, BUA etc.
iii. Total cost of the project/ cost already incurred without EC
iv. Date of commencement and % completion status
v. Violation period

vi. No. of years/ days of violation as of consideration date
vii. Consumables utilised and manpower and machinery employed

All the above details are perused from the various details submitted by PP.

1.2.1.1. AIR POLLUTION DAMAGE ASSESSMENT AS PER EUROPEAN ENVIRONMENT AGENCY (EEA):

- The impact on air environment due to heavy construction activity, surface mining and transportation of materials are arrived using emission factors as per US EPA AP 42 and ARAI Booklet for vehicular emissions.
- The arrived quantity of emissions based on different activities are then converted into monetary compensation using following.
    - As per European Environment Agency Damage (in Indian currency @ Rs 80 per euro) per tonne emission estimates for PM10 in 2020 (2005 prices) for PM_{10}, $PM_{2.5}$, NO_2 and SO_2 are Rs. 17.02 lakhs, Rs. 26.21 lakhs, Rs. 4.79 lakhs and Rs. 8.25 lakhs respectively. These values as per the assessment of EEA are updated upto 2020.

➢ For Indian conditions, damage cost / tonne can be reduced to 20% of the annual rate considered for UK/Europe since the cost of living / medical expenses are approximately 1/5th of the European cost on an average, accepting the fact that the density of population is much higher than European countries. In case of severely polluted areas/ cities, these damages cost can be considered @ 50% of the EEA Rates viz:

➢ Damage (@ EEA Rate) cost Per Kg/day for PM_{10}, $PM_{2.5}$, NO_x and SO_2, at the 20% of EEA rates are as: PM_{10} – Rs. 340.00 per kg / day; $PM_{2.5}$ – Rs 524.00 per kg / day; NO_x – Rs. 96.00 per kg / day & SO_2 – Rs. 165.00 per kg / day

Table 1 Damage (@ 20% EEA Rate) cost Per Kg/day as following:

PARAMETERS	PER YEAR/TON RS. IN LAKHS	PER DAY (RS/KG)	PER KG/DAY (RS.)
PM_{10}	3.40	Rs. 933.00/2.74 kg	340
$PM_{2.5}$	5.24	Rs. 1436.00/2.74 kg	524
NO_x	0.96	Rs. 263.00/2.74 kg	96
SO_2	1.65	Rs. 452.00/2.74 kg	165

1.2.2. INPUTS FOR WATER ENVIRONMENT:

Followed Guidelines to regulate and control ground water extraction in India as per Ministry of Jal Shakthi S.O-3289 (E), Dated- 24/09/2020. It covers exhaustively water environment addressing ground water. The following impacts / damages are envisaged due to construction and mining activity, if not properly managed and mitigated:

1.2.2.1. Ground Water:

- Usage of Ground water for construction and mining activities.
- Obstruction of rainwater percolation due to ground cementing.
- Percolation of contaminated ground water near the building boundary.
- Pumping of ground water while basement excavation /construction.
- Obstruction of rainwater percolation / destruction of lineaments (leading to main aquifers) and micro watershed impacts.
- Contamination of ground water.
- Depletion of ground water level may result in water shortage in nearby villages during dry seasons.
- Wastewater from workshop/service building.
- Domestic effluent discharge.
- Mine Drainage water discharge.
- Wash out from waste dump/stack piles.

I) Environmental Compensation for Ground Water (EC_{GW})

The CPCB committee has proposed the following formula for calculation of Environmental Compensation for Ground Water consumption (EC_{GW}):

EC_{GW} = Water Consumption per Day x No. of Days x Environmental Compensation Rate for illegal extraction of ground water (ECGW) (Either without NOC from statutory authority or under violation)

Where water Consumption is in m^3/day and ECRGW in Rs. /M^3

As per CGWA, safe, semi-critical, critical and over-exploited areas are categorized from the ground water resources point of view (CGWA, 2017). List of safe, semi-critical, critical and over-exploited areas are available on the website of CGWA.

Building & Infra Sector

Construction/Operation Phase:

a) **GW abstraction / Restoration Charges for Drinking & Domestic use**

Quantum of GW Withdrawal (CuMtr)	**Rate of GW abstraction Charges (Rs./CuMtr)**
0-25	No charge
26-50	1.00
>50	2.00

b) **ECR for Mining / Infrastructure Projects**

Damage Rate Rs/M^{3}Category	**Water Consumption Per Day CuMtr**			
	<200	**200 to <1000**	**1000 to <5000**	**5000 & Above**
	Environmental Compensation Rate in Rs./ CuMtr			
Safe	15	21	30	40
Semi-critical	30	45	60	75
Critical	45	60	85	115
60O85v115er Exploited	60	90	120	150

c) **Sewage Treatment: Environmental Compensation /Damages for partially treated/ untreated:**

This is applicable for the projects under operation and not for the incomplete projects where the STP/ETP construction is under progress. For the operating projects, where there is a gap (partial) / Non-Provision, the Environmental Damage will be calculated based on the capex of different STPs:

100 KLD: 60.0 lakhs

500 KLD: 90/95 Lakhs

1 MLD: 150/175 lakhs

O & M around: 15-17% of Capex

d) Solid Waste Management

As per SWM Rules 2016. and CPCB report its guideline referred earlier. non-compliance / partial compliance will be applicable for construction and operating projects only. As per the industry average: cost of collection/processing per house is Rs 12.00 per day for 4 persons and waste: 1.5-2.0 kg i.e Rs 6.0 per kg per day for a colony of not less than 30000 to 100000 population. In construction stage for the workers. the overhead will be minimum of 4 times per kg since to deal with minimum numbers and also it has to be carted to a distant place of availability. Hence it is taken as Rs 25/- per kg.

Ecology and Bio diversity:

Wild life conservation plan and management:

e) CPCB Guide line for Green Belt:

Building & Infra Sector

- 33% of Project Area to be planted with average density of 2500 Trees per Hectare @ Rs.300/Per Tree.
- For every tree cut - 5 trees to be planted in the project boundary or other areas @ 300/Per Tree.

f) Risk Hazard/Occupation Health & Safety

The risk factor associated during construction and operation activity has to be calculated by the consultant using applicable and available computational modeling tools. If the probability of risk so calculated is in the high-risk zone leading to loss of life, penalty as applicable as per the Government norms will be levied. **In the zone of moderate and low risk committee will decide penalty on the study (Annexure-XV)** of the reports prepared by the consultant. However, this parameter is to be assessed by the EAC due diligence to arrive at damage cost to this factor.

g) Damage Due to Noise and Vibration:

CPCB Noise rules 2000 &2010. (Annexure-XVI)

Damage to Land use and land cover:

LULC Analysis by using Google Maps

Dump ad top soil management

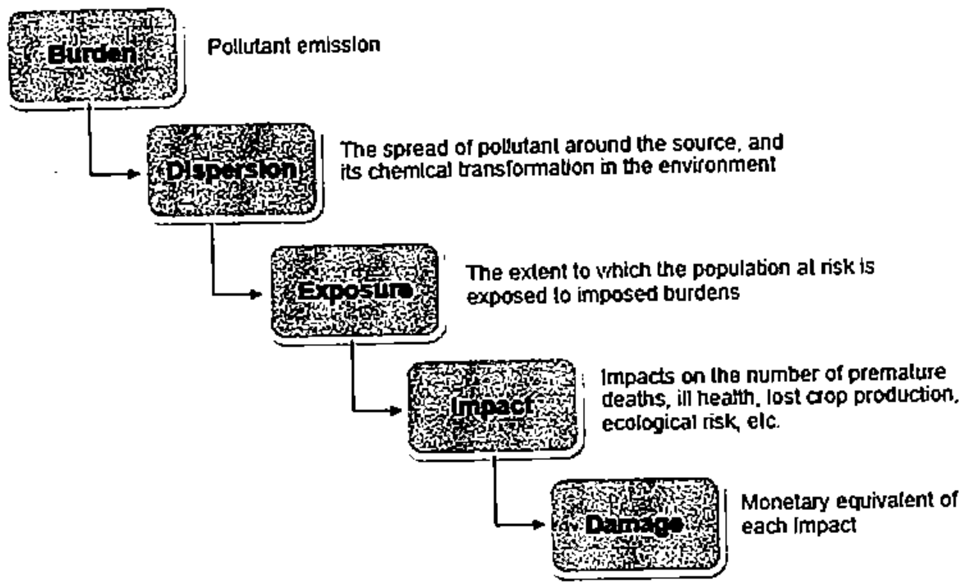
i) Economic Benefits Accrued during violation

- The economic benefits comprise of two parts: -1. Cost and expenditure saved by the PP during the violation period for not spending on EMP.2.Profit earned during violation period.
- A maximum of 10 % of EMP capital and recurring cost as computed will be added to the total damage cost and will be used for community resource augmentation.

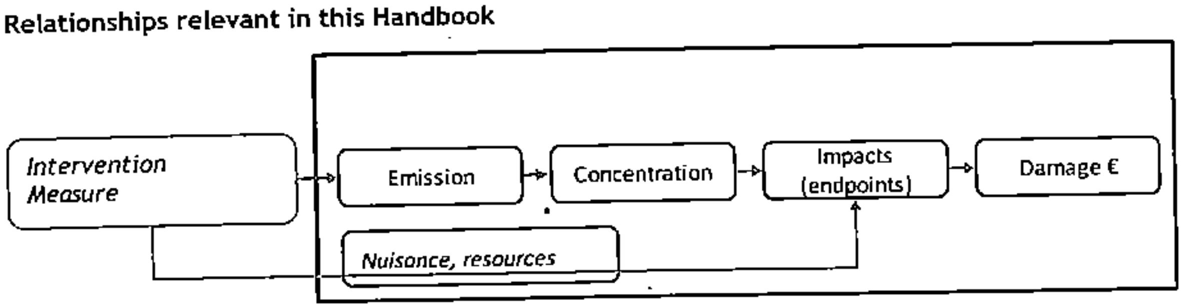
SYNOPSIS OF EEA & EU28 HANDBOOK

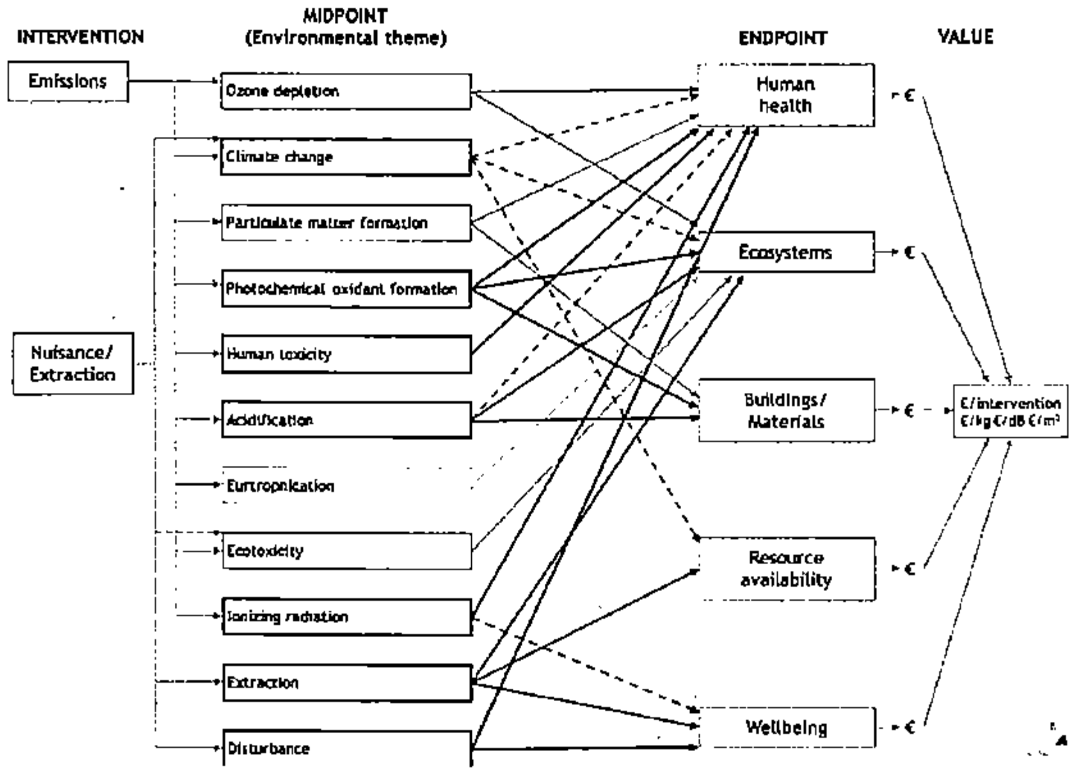
- All the environmental prices presented in this Handbook relate to pollutant emissions (or other environmental interventions) in 2015 from the EU28 territory. All prices are expressed in €/kg emission (etc.), in 2015 prices (abbreviated to €2015). These prices are average values for emissions from an average source in Europe in 2015.
- The overall framework is given below
- Overall it covers activities leading to impact on human health (morbidity, i.e. sickness and disease, a premature mortality), ecosystem services (Including agriculture), buildings and materials resource availability, wellbeing (aesthetic & ethical values).
- All the environmental prices and weighting factors presented here are (ultimately) expressed as upper, lower and central values.
- The central value is the recommended value for use by industry and estimate includes the damages that are certain

Impact assessment Pathway.



Relationships relevant in this Handbook





MONETARY EVALUATION OF ECOLOGICAL DAMAGE

1) Air Damage Assessment.
2) Water Damage Assessment.
   Ground Water
   Surface Water /Tunnel Seepage Water
3)Lu/Lc Damage Assessment
4)Noise and Vibration Damage Assessment.
5)Ecology and Bio Diversty Damage Assessment.
6)Solid Waste Management Damage Assessment.
7)Sewage Water Damage Assessment.
8)Ohms Damage Asse4ssment.
9)Economic Benefit Accrued.
   A) Cost Saved in Emp.
   B) Net Profit Accrued.

Consolidated Damage Cost and Action Plan for:
Remediation /Restoration,
Natural Resources Augmentation Plan
Community Resources Augmentation Plan.

13. DAMAGE ASSESSMENT

The assessment of damages for the violation projects are computed as below:

Details Project Wise under violation for Damage Assessment					
S.No	**Particulars**	**Units**	**Laxmi Barrage**	**Laxmi Pumphouse**	**Saraswathi Barrage**
1	Project Area	Ha	283.2	515.07	321.08
2	Work Order Date	Date	26-08-2016	27-08-2016	16-08-2016
3	Commencement Date	Date	27-02-2017	30-12-2016	16-11-206
4	Voilation Period	Year & Month	1 Year	1 Year	1Year
5	Capital Cost as per W/O	Rs Cr	Rs 4613	4877.18	2734.81
6	Cost Incurred till Dec 2017	Rs Cr	Rs.248.49	723.89	610.79
7	Cost Incurred till July 2021	Rs Cr	Rs.3484 .96	4516.64	2194.88
8	Percentage Work Completed during Voilation period	%	5.5	14.84	22.33
9	No Of Days Worked	No	257	367	344
10	**Total Mandays**	No	**170334 (662/Day)**	**242000 (660/Day)**	**443608 (1290/Day)**

Details Project Wise under violation for Damage Assessment					
S.No	**Particulars**	**Units**	**Laxmi Barrage**	**Laxmi Pumphouse**	**Saraswathi Barrage**
11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	51533-(55 Km)	85877-(55 Km)	178361-50 (Km)
13	Steel	MT	9984-55 (Km)	6940-55 (Km)	242249-50(Km)
14	Sand (FA)	CUM	60163-5 (Km)	115142-5 (Km)	198237-5(Km)
15	C.Aggregate	CUM	16584-101 (Km)	230285 -101 (Km)	446034-96(Km)
16	Water consumption for Construction	CUM	23890	36513	74410
17	Water Consumption for Domestic	CUM	17033	31460	59887
18	Plantation Requried up to Dec 2017	Nos	42798	99169	60506
19	Planted Till 2021	Nos	2500	7500	0
20	Quantity Of Muck Pile	Lac. CUM	27.49/ Lac	64.58	35.683
21	**Total Domestic Waste till Dec 2017**	**TS**	**42.583 TS**	**121**	**133.08**

Details Project Wise under violation for Damage Assessment					
S.No	Particulars	Units	Laxmi Barrage	Laxmi Pumphouse	Saraswathi Barrage
DAMAGE COST ASSESSMENT					
1.	Damage To Land Environment	Rupees In Lacs	₹ 587.59	₹ 569.75	₹ 604.09
2.	Damage To Air Environment	Rupees In Lacs	₹ 430.38	₹ 678.64	₹ 998.65
3.	Damage To Water Environment	Rupees In Lacs	₹ 3.75	₹ 5.79	₹ 11.76
4.	Damage Due To Noise & Vibration	Rupees In Lacs	₹ 3.52	₹ 5.03	₹ 4.71
5.	Damage To Ecology & Bio Diversity	Rupees In Lacs	₹ 171.61	₹ 373.44	₹ 216.17
6.	Solid Waste Management	Rupees In Lacs	₹ 12.78	₹ 18.15	₹ 33.27
7.	Occupational, Health & Safety	Rupees In Lacs	₹ 10.10	₹ 29.60	₹ 25.00
	TOTAL	**RUPEES IN LACS**	**₹ 1,219.73**	**₹ 1,680.40**	**₹ 1,893.65**
TOTAL IN CRORE			**₹ 95.88**		

Details Projectwise under voilation for Damage Assessment

S.No	Particulars	Units	Sarawathi Pumphouse	Parvathi Barrage	Parvathi Pumphouse
1	Project Area	Ha	200	205	220
2	Work Order Date	Date	27-08-2016	15-07-2016	27-08-2016
3	Commencement Date	Date	16-11-2016	23-01-2017	19-12-2016
4	Voilation Period	Year & Month	1 Year	1 Year	1 Year
5	Capital Cost as per W/O	Rs Cr	3875.4	2225	3399.25
6	Cost Incurred till Dec 2017	Rs Cr	658.17	471.54	594.13
7	Cost Incurred till July 2021	Rs Cr	3301.87	1733.2	3132.46
8	Percentage Work Completed during Voilation period	%	16.98	21.19	1.47
9	No Of Days Worked	No	326	334	370
10	**Total Mandays**	No	**269000 (826/Day)**	**285570 (855/Day)**	**18000(487/Day)**

11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	63450-50(KM)	132488 -9 (Km)	35428-9(Km)
13	Steel	MT	5566-50 (KM)	20075-9(Km)	4205-9 (Km)
14	Sand (FA)	CUM	79413-5 (KM)	18137 -(5Km)	39454-5(Km)
15	C.Aggregate	CUM	158826-96	354720-(51Km)	88771-45(Km)
16	Water consumption for Construction	CUM	35604	60698	17246
17	Water Consumption for Domestic	CUM	36315	38552	24570
18	Plantation Requried up to Dec 2017	Nos	36125	39282	45283
19	Planted Till 2021	Nos	0	0	0
20	Quantity Of Muck Pile	Lac. CUM	80.137	18.95	90.7
21	**Total Domestic Waste till Dec 2017**	**TS**	**67.25**	**85.67**	**46**

DAMAGE COST ASSESSMENT					
1.	Damage To Land Environment	Rupees In Lacs	₹ 577.19	₹ 576.10	₹ 587.74
2.	Damage To Air Environment	Rupees In Lacs	₹ 573.37	₹ 481.25	₹ 437.27
3.	Damage To Water Environment	Rupees In Lacs	₹ 5.70	₹ 9.49	₹ 2.83
4.	Damage Due To Noise & Vibration	Rupees In Lacs	₹ 4.47	₹ 4.58	₹ 5.07
5.	Damage To Ecology & Bio Diversity	Rupees In Lacs	₹ 233.02	₹ 124.17	₹ 269.47
6.	Solid Wate Management	Rupees In Lacs	₹ 20.18	₹ 21.42	₹ 13.65
7.	Occupational, Health & Safety	Rupees In Lacs	₹ 26.90	₹ 19.30	₹ 24.30
	Total	**Rupees In Lacs**	**₹ 1,440.82**	**₹ 1,236.30**	**₹ 1,340.33**
TOTAL IN CRORE - ₹ 80.35					

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 6**	**Package 7**	**Package -8**
1	Project Area	Ha	138.96	159.72	215.23
2	Work Order Date	Date	12-11-2008	17-11-2008	17-11-2008
3	Commencement Date	Date	25-10-2011	12-03-2012	12-03-2012
4	Voilation Period	Year & Month	7 Years	7 Years	7 years
5	Capital Cost as per W/O	Rs Cr	5047.96	1446.15	4900
6	Cost Incurred till Dec 2017	Rs Cr	3596.44	1058.8	3482.09
7	Cost Incurred till July 2021	Rs Cr	4612.14	1424.48	4489.71
8	Percentage Work Completed during Voilation period	%	71.24	73.21	71.05
9	No Of Days Worked	No	1870	1920	2122
10	**Total Mandays**	No	**788400(422/Day)**	**459900 (240/Day)**	**722700 (341/Day)**

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 6**	**Package 7**	**Package -8**
11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	133287-9(Km)	63709-5(Km)	88295-5(Km)
13	Steel	MT	8750-9(Km)	582-5(Km)	5036-5(Km)
14	Sand (FA)	CUM	386809-29(Km)	7788-47(Km)	195735-55(Km)
15	C.Aggregate	CUM	771531-5(Km)	129930-5(Km)	391470-5(Km)
16	Water consumption for Construction	CUM	96404	62087	97565
17	Water Consumption for Domestic	CUM	106434	64386	101178
18	Plantation Required up to Dec 2017	Nos	63899	76296	117162
19	Planted Till 2021	Nos	0	0	0
20	Quantity Of Muck Pile	Lac. CUM	43.218	35.02	21.21
21	**Total Domestic Waste till Dec 2017**	**TS**	**236.52**	**137.97**	**216.81**

Details Projectwise under voilation for Damage Assessment					
S.No	Particulars	Units	Package 6	Package 7	Package -8
DAMAGE COST ASSESSMENT					
1.	DAMAGE TO LAND ENVIRONMENT	RUPEES IN LACS	₹ 566.59	₹ 559.09	₹ 587.96
2.	DAMAGE TO AIR ENVIRONMENT	RUPEES IN LACS	₹ 910.74	₹ 264.63	₹ 540.47
3.	DAMAGE TO WATER ENVIRONMENT	RUPEES IN LACS	₹ 15.52	₹ 13.35	₹ 9.26
4.	DAMAGE DUE TO NOISE & VIBRATION	RUPEES IN LACS	₹ 25.62	₹ 26.30	₹ 29.07
5.	DAMAGE TO ECOLOGY & BIO DIVERSITY	RUPEES IN LACS	₹ 253.07	₹ 280.02	₹ 378.98
6.	SOLID WATE MANAGEMENT	RUPEES IN LACS	₹ 59.13	₹ 34.49	₹ 54.20
7.	OCCUPATIONAL, HEALTH & SAFETY	RUPEES IN LACS	₹ 147.00	₹ 43.40	₹ 142.00
	TOTAL	RUPEES IN LACS	₹ 1,977.67	₹ 1,221.28	₹ 1,741.95
TOTAL IN CRORE₹ 98.82					

Details Projectwise under voilation for Damage Assessment

S.No	Particulars	Units	Package -9	Package-10	Malkapet Reservior
1	Project Area	Ha	302.54	39.53	509.18
2	Work Order Date	Date	17-11-2008	02-12-2008	15-09-2017
3	Commencement Date	Date	10-07-2013	03-01-2012	15-09-2017
4	Voilation Period	Year & Month	6 Years	6 Years	1 Year
5	Capital Cost as per W/O	Rs Cr	996.01	2798.91	513.13
6	Cost Incurred till Dec 2017	Rs Cr	253.44	1637.69	37.44
7	Cost Incurred till July 2021	Rs Cr	705.16	2694.51	386.49
8	Percentage Work Completed during Voilation period	%	25.44	58.51	7.93
9	No Of Days Worked	No	1632	1600	72
10	**Total Mandays**	No	**136000(84/Day)**	**80000(50/Day)**	**2120(30/Day)**

Details Projectwise under voilation for Damage Assessment

S.No	Particulars	Units	Package -9	Package-10	Malkapet Reservior
11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	5228-5(Km)	30172-5 (Km)	138-5(Km)
13	Steel	MT	313-5(Km)	467-5 (Km)	0
14	Sand (FA)	CUM	16393-28(Km)	24814-21(Km)	71291-22(Km)
15	C.Aggregate	CUM	14954-20(Km)	67637-50(Km)	4817-16(Km)
16	Water consumption for Construction	CUM	2438	30172	7853
17	Water Consumption for Domestic	CUM	19040	10800	286
18	Plantation Requried up to Dec 2017	Nos	196562	140196	25142
19	Planted Till 2021	Nos	0	0	0
20	Quantity Of Muck Pile	Lac. CUM	5.28	31.294	8.77
21	**Total Domestic Waste till Dec 2017**	**TS**	**40.8**	**24**	**0.63**

Details Projectwise under voilation for Damage Assessment					
S.No	Particulars	Units	Package -9	Package-10	Malkapet Reservior
DAMAGE COST ASSESSMENT					
1.	DAMAGE TO LAND ENVIRONMENT	RUPEES IN LACS	₹ 535.99	₹ 614.14	₹ 564.38
2.	DAMAGE TO AIR ENVIRONMENT	RUPEES IN LACS	₹ 75.42	₹ 164.75	₹ 46.87
3.	DAMAGE TO WATER ENVIRONMENT	RUPEES IN LACS	₹ 1.68	₹ 9.50	₹ 1.51
4.	DAMAGE DUE TO NOISE & VIBRATION	RUPEES IN LACS	₹ 22.36	₹ 21.92	₹ 0.99
5.	DAMAGE TO ECOLOGY & BIO DIVERSITY	RUPEES IN LACS	₹ 597.32	₹ 469.00	₹ 84.35
6.	SOLID WATE MANAGEMENT	RUPEES IN LACS	₹ 1.02	₹ 6.00	₹ 0.16
7.	OCCUPATIONAL , HEALTH & SAFETY	RUPEES IN LACS	₹ 67.10	₹ 0.05	₹ 75.90
	TOTAL	RUPEES IN LACS	₹ 1,300.89	₹ 1,285.36	₹ 774.15
TOTAL IN CRORE₹ 67.21					

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 11**	**Medaram Reservoir**	**AnnaPurna Reservior**
1	Project Area	Ha	169.99	-	893.16
2	Work Order Date	Date	17-11-2008	15-03-2017	21-12-2008
3	Commencement Date	Date	03-12-2012	15-03-2017	01-11-2016
4	Voilation Period	Year & Month	5 year	1 Year	1 Year
5	Capital Cost as per W/O	Rs Cr	3127.58	493.65	1133.13
6	Cost Incurred till Dec 2017	Rs Cr	1833.2	31.67	338
7	Cost Incurred till July 2021	Rs Cr	3061.14	465.19	1128
8	Percentage Work Completed during Voilation period	%	58.61	6.41	29.83
9	No Of Days Worked	No	837	70	338
10	**Total Mandays**	No	**50220 (60/Day)**	**2200(30/Day)**	**33800(100/Day)**

11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	94817-5 (Km)	NA	4575-(Km)
13	Steel	MT	645.87-5(Km)	NA	0
14	Sand (FA)	CUM	8810404-37 (Km)	NA	163043-21(Km)
15	C.Aggregate	CUM	176209.-37 (Km)	NA	159043-22(Km)
16	Water consumption for Construction	CUM	94817	NA	45755
17	Water Consumption for Domestic	CUM	6780	308	4563
18	Plantation Requried up to Dec 2017	Nos	39496		130192
19	Planted Till 2021	Nos	0	0	0
20	Quantity Of Muck Pile	Lac. CUM	10.11	NA	2.6
21	**Total Domestic Waste till Dec 2017**	**TS**	**15.06**	**0.66**	**10.14**

DAMAGE COST ASSESSMENT					
1.	DAMAGE TO LAND ENVIRONMENT	RUPEES IN LACS	₹ 572.26	₹ 565.58	₹ 694.33
2.	DAMAGE TO AIR ENVIRONMENT	RUPEES IN LACS	₹ 247.11	₹ 24.64	₹ 215.98
3.	DAMAGE TO WATER ENVIRONMENT	RUPEES IN LACS	₹ 19.30	₹ 1.61	₹ 7.07
4.	DAMAGE DUE TO NOISE & VIBRATION	RUPEES IN LACS	₹ 11.47	₹ 0.41	₹ 4.63
5.	DAMAGE TO ECOLOGY & BIO DIVERSITY	RUPEES IN LACS	₹ 131.77	₹ 25.39	₹ 394.38
6.	SOLID WATE MANAGEMENT	RUPEES IN LACS	₹ 3.77	₹ 1.05	₹ 2.54
7.	OCCUPATIONAL , HEALTH & SAFETY	RUPEES IN LACS	₹ 0.70	₹ 10.30	₹ 59.70
	TOTAL	**RUPEES IN LACS**	**₹ 986.38**	**₹ 628.97**	**₹ 1,378.62**
TOTAL IN CRORE₹ 59.88					

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 12**	**Package 15**	**Package 16**
1	Project Area	Ha	229.79	205.50	281.12
2	Work Order Date	Date	24-11-2008	21-12-2009	11-02-2009
3	Commencement Date	Date	04-01-2013	14-06-2012	14-08-2012
4	Voilation Period	Year & Month	5 1/2 Years	6 Years	6 years
5	Capital Cost as per W/O	Rs Cr	3348	844.69	1102.65
6	Cost Incurred till Dec 2017	Rs Cr	1457.29	173.89	554.83
7	Cost Incurred till July 2021	Rs Cr	3230.29	462.37	907.07
8	Percentage Work Completed during Voilation period	%	43.5	20.59	503.35
9	No Of Days Worked	No	1636	1500	1540
10	**Total Mandays**	No	**196320(120/Day)**	**95000(634/Day)**	**364980(237/ Day)**

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 12**	**Package 15**	**Package 16**
11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	56095-5(Km)	202 -5 (Km)	26485-5(Km)
13	Steel	MT	97-3(Km)	14-5(Km)	2785-5(Km)
14	Sand (FA)	CUM	42884-59 (Km)	225-140(Km)	99894-130(Km)
15	C.Aggregate	CUM	87567-70(Km)	417	96602-10(Km)
16	Water consumption for Construction	CUM	77268	0.29	49272
17	Water Consumption for Domestic	CUM	26503	128250	51097
18	Plantation Required up to Dec 2017	Nos	93450	71669	103436
19	Planted Till 2021	Nos	250	700	0
20	Quantity Of Muck Pile	Lac. CUM	44.13	8.05	24.95
21	**Total Domestic Waste till Dec 2017**	**TS**	**58.89**	**285**	**109.49**

Details Projectwise under voilation for Damage Assessment					
S.No	Particulars	Units	Package 12	Package 15	Package 16
DAMAGE COST ASSESSMENT					
1.	DAMAGE TO LAND ENVIRONMENT	RUPEES IN LACS	₹ 574.06	₹ 561.12	₹ 594.45
2.	DAMAGE TO AIR ENVIRONMENT	RUPEES IN LACS	₹ 228.21	₹ 62.42	₹ 254.01
3.	DAMAGE TO WATER ENVIRONMENT	RUPEES IN LACS	₹ 15.03	₹ 1.28	₹ 7.88
4.	DAMAGE DUE TO NOISE & VIBRATION	RUPEES IN LACS	₹ 22.41	₹ 20.55	₹ 21.10
5.	DAMAGE TO ECOLOGY & BIO DIVERSITY	RUPEES IN LACS	₹ 342.59	₹ 222.97	₹ 343.21
6.	SOLID WATE MANAGEMENT	RUPEES IN LACS	₹ 14.72	₹ 71.25	₹ 27.37
7.	OCCUPATIONAL , HEALTH & SAFETY	RUPEES IN LACS	₹ 7.10	₹ 22.70	₹ 3.50
	TOTAL	RUPEES IN LACS	₹ 1,204.12	₹ 962.28	₹ 1,251.52
	TOTAL IN CRORE₹ 68.36				

Details Projectwise under voilation for Damage Assessment

S.No	Particulars	Units	Package 17	Package 20	Package 21
1	Project Area	Ha	251.75	267.87	89.04
2	Work Order Date	Date	19-02-2017	20-11-2008	20-11-2008
3	Commencement Date	Date	19-05-2019	05-11-2011	01-07-2012
4	Voilation Period	Year & Month	5 Years	7 Years	9 Years
5	Capital Cost as per W/O	Rs Cr	981.18	892.67	610.06
6	Cost Incurred till Dec 2017	Rs Cr	86.87	538.25	276.15
7	Cost Incurred till July 2021	Rs Cr	338.30	815	401.11
8	Percentage Work Completed during Voilation period	%	8.80	60.3	45.24
9	No Of Days Worked	No	477.00	1600	3286
10	**Total Mandays**	No	**138330(29/Day)**	**32000(200/Day)**	**207018 (63/Day)**

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 17**	**Package 20**	**Package 21**
11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	1011-5(Km)	47350-5(Km)	-
13	Steel	MT	57- (5Km)	1027-5(Km)	-
14	Sand (FA)	CUM	1517 -(101KM)	52867-5(Km)	-
15	C.Aggregate	CUM	1175-20 (Km)	105734-20(Km)	-
16	Water consumption for Construction	CUM	12700	287.32	8807683
17	Water Consumption for Domestic	CUM	18675	44800	28982
18	Plantation Requried up to Dec 2017	Nos	20967	105738	73458
19	Planted Till 2021	Nos	0	0	0
20	Quantity Of Muck Pile	Lac. CUM	9.26	6.16	0.5
21	**Total Domestic Waste till Dec 2017**	**TS**	**41.49**	**96**	**62.1**

Details Projectwise under voilation for Damage Assessment					
S.No	Particulars	Units	Package 17	Package 20	Package 21
DAMAGE COST ASSESSMENT					
1.	DAMAGE TO LAND ENVIRONMENT	RUPEES IN LACS	₹ 570.73	₹ 535.99	₹ 535.99
2.	DAMAGE TO AIR ENVIRONMENT	RUPEES IN LACS	₹ 38.65	₹ 159.79	₹ 81.30
3.	DAMAGE TO WATER ENVIRONMENT	RUPEES IN LACS	₹ 2.24	₹ 6.94	₹ 1,427.63
4.	DAMAGE DUE TO NOISE & VIBRATION	RUPEES IN LACS	₹ 6.53	₹ 21.92	₹ 45.01
5.	DAMAGE TO ECOLOGY & BIO DIVERSITY	RUPEES IN LACS	₹ 76.64	₹ 321.61	₹ 234.00
6.	SOLID WATE MANAGEMENT	RUPEES IN LACS	₹ 10.37	₹ 24.00	₹ 0.83
7.	OCCUPATIONAL , HEALTH & SAFETY	RUPEES IN LACS	₹ 0.80	₹ 0.40	₹ 22.00
	TOTAL	RUPEES IN LACS	₹ 705.98	₹ 1,070.65	₹ 2,346.76
TOTAL IN CRORE₹ 82.47					

Details Projectwise under voilation for Damage Assessment

S.No	Particulars	Units	Package 22	Package 27	Package 28
1	Project Area	Ha	121.53	262.34	235.10
2	Work Order Date	Date	20-11-2008	24-02-2009	25-02-2009
3	Commencement Date	Date	25-01-2013	03-05-2013	06-10-2012
4	Voilation Period	Year & Month	3 Years	5 Years	6 Years
5	Capital Cost as per W/O	Rs Cr	1446.48	714	486.68
6	Cost Incurred till Dec 2017	Rs Cr	145.03	124.52	225.34
7	Cost Incurred till July 2021	Rs Cr	261.89	447.26	228.31
8	Percentage Work Completed during Voilation period	%	10.33	17.43	46.97
9	No Of Days Worked	No	730	1260	1544
10	**Total Mandays**	No	**43800(60/Day)**	**242300(192/Day)**	**131400/85 (Day)**

Details Projectwise under voilation for Damage Assessment					
S.No	**Particulars**	**Units**	**Package 22**	**Package 27**	**Package 28**
11	**Details of Construction material consumed During Voilation Period**				
12	Cement	MT	1020-5Km)	33482-5(Km)	2728-5(Km)
13	Steel	MT	70-5(Km)	3152-5(Km)	195-5(Km)
14	Sand (FA)	CUM	1504-55(Km)	29192-56 (Km)	4183-88Km)
15	C.Aggregate	CUM	3128-56(Km)	52770-56(Km)	8367-53(Km)
16	Water consumption for Construction	CUM	25975	35000	4547
17	Water Consumption for Domestic	CUM	5913	33922	17739
18	Plantation Required up to Dec 2017	Nos	25265	97429	116325
19	Planted Till 2021	Nos	0	0	0
20	Quantity Of Muck Pile	Lac. CUM	11.28	55.7	14.6
21	**Total Domestic Waste till Dec 2017**	**TS**	**13.14**	**72.69**	**39.42**

Details Projectwise under voilation for Damage Assessment					
S.No	Particulars	Units	Package 22	Package 27	Package 28
DAMAGE COST ASSESSMENT					
1.	DAMAGE TO LAND ENVIRONMENT	RUPEES IN LACS	₹ 562.90	₹ 578.22	₹ 570.04
2.	DAMAGE TO AIR ENVIRONMENT	RUPEES IN LACS	₹ 46.17	₹ 193.51	₹ 134.11
3.	DAMAGE TO WATER ENVIRONMENT	RUPEES IN LACS	₹ 4.00	₹ 6.32	₹ 0.86
4.	DAMAGE DUE TO NOISE & VIBRATION	RUPEES IN LACS	₹ 10.00	₹ 17.26	₹ 62.29
5.	DAMAGE TO ECOLOGY & BIO DIVERSITY	RUPEES IN LACS	₹ 93.43	₹ 368.44	₹ 887.84
6.	SOLID WATE MANAGEMENT	RUPEES IN LACS	₹ 3.29	₹ 3.29	₹ 9.86
7.	OCCUPATIONAL , HEALTH & SAFETY	RUPEES IN LACS	₹ 11.30	₹ 5.90	₹ 5.10
	TOTAL	RUPEES IN LACS	₹ 731.08	₹ 1,172.94	₹ 1,670.09
TOTAL IN CRORE₹ 71.48					

14. DAMAGE ASSESSMENT OF QUARRYS

1. INTRODUCTION:

The Kalleswaram Lift irrigation project has utilized a total of 32.50 Lac CuMtr of crushed aggregate and 16.64 Lac CuMtr of fine aggregate till December 2017 for a total of 24 nos project considered under violation. As per EIA and data received from PP, 7 quarries in total were used for obtaining crushed aggregate and fine aggregate were extracted from nearby river beds from respective project site.

For damage assessment the quantity of crushed aggregate extracted from these respective quarries and within site area are considered, which had caused damage to various environmental attributes like air, water, land, ecology, etc during the course of operation during the violation period.

2. ASSUMPTIONS

Since details of environmental regulatory clearances were not submitted from PP, the following assumptions are considered while calculating damage for quarrying process:

- For Air environment damage 5% of CA is taken as topsoil quantity
- For all damages 40% of working days till December 2017 is considered
- For air impact, Internal transport lead taken at 5 KM for waste and CA
- Dump height considered is 12 meters except for tunnels
- Manpower for quarrying calculated at 1 for every 8.0 tonnes (OMS)
- The damage cost for GW withdrawal is against safe zone category
- For construction of Toe walls & Toe drains the 90% of perimeter is considered for damage under surface water management

3. DETAILS OF QUARRY:

The details of quarry as received from client and same identified from KML files are as follows: -

SL. NO	PROJECT NAME	SAND		METAL	
		DISTANCE	LOCATION	DISTANCE	LOCATION
1	Laxmi Barrage (Medigadda)	5	GODAVARI RIVER	96	1. RACHAPALLY JAYYARAM CRUSHER CUM QUARRY 2. GUDEPADU (v)
2	Laxmi Pump House (Medigadda Lift)	5			
3	Saraswathi Barrage (annaram)	5			
4	Saraswathi Pump House (Annaram Lift)	5			
5	Parvathi Barrage (Sundilla)	5			
6	Parvathi (Sundilla) Lift	5			
7	Package 6	29	ANTHERGAON	5	CRUSHED STONE AVAILABLE WITHIN SITE AREA
8	Package 7	47		5	
9	Package 8	55	Kodurupaka (manair)	5	
10	Medaram Reservoir	35	ANTHERGAON	5	
11	Package 9	19/28/36	Sircilla/Padira/Padira	14/15/20	Nagaram/Thimmapur/Dammannapet
12	Malakpet Reservoir (Pkg-9)	22	ANUPURAM	16	AGRAHARAM
13	Package 10				CRUSHED STONE AVAILABLE WITHIN SITE AREA
14	Ananthagiri reservoir				
15	Package 11				
16	Package 12	48/70	CHINTALTHANA	3	VENKATAPUR
17	Package 15				CRUSHED STONE AVAILABLE WITHIN SITE AREA
18	Package 16			10	CANAL SPOIL
19	Package 17				CRUSHED STONE AVAILABLE WITHIN SITE AREA
20	Package 20	20	Pothangal		
21	Package 21	55			
22	Package 22	56	BIRKOOR		
23	Package 27	56	PEDDAVAGU		
24	Package 28	88		54	NIRMAL

4. IMPACT ON AIR ENVIRONMENT

The impact of pollutants emission into the air atmosphere is assessed upto December 2017. For the assessment, full production is taken till December, 2017 and corresponding emissions and damage cost is calculated.

Activities considered for air emissions quantification during the production is mentioned below:

- Topsoil removal (Except for tunnel)
- Drilling & Blasting
- Loading & Unloading of Aggregate & Waste
- Internal Transport of waste (Except for Tunnel) and aggregate on unpaved haul road
- Wind erosion from waste dumps.

Table 2 THE ACTIVITY WISE EMISSIONS WITHOUT CONTROL MEASURES DURING VIOLATION PERIOD

SL. NO	PROJECT NAME	TOPSOIL REMOVAL		DRILLING		BLASTING		LOADING & UNLOADING		WIND EROSION		INTERNAL TRANSPORT (CA & WASTE)			
		All emissions in KG/Day													
		PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	PM 2.5	PM 10	NOX	SOX
1	Laxmi Barrage (Medigadda)	0.11	0.90	4.63	20.84	6.44	32.20	1.30	8.83	0.04	1.04	99.84	306.93	1579.19	0.0184
2	Laxmi Pump House (Medigadda Lift)	0.11	0.88	4.50	20.26	8.83	44.14	1.26	8.58	0.06	1.45	97.02	298.25	1535.37	0.0179
3	Saraswathi Barrage (annaram)	0.23	1.81	9.30	41.87	15.78	78.89	2.61	17.74	0.11	2.80	203.41	625.30	3172.66	0.0370

4	Saraswathi Pump House (Annaram Lift)	0.09	0.68	3.50	15.73	7.21	36.05	0.98	6.66	0.04	1.00	74.95	230.40	1192.12	0.0139
5	Parvathi Barrage (Sundilla)	0.19	1.48	7.62	34.29	13.45	67.25	2.14	14.53	0.09	2.23	165.95	510.14	2598.68	0.0303
6	Parvathi (Sundilla) Lift	0.04	0.34	1.72	7.75	4.09	20.46	0.48	3.28	0.02	0.56	36.39	111.87	587.06	0.0069
7	Package 6	0.00	0.00	2.96	13.32	6.31	31.57	0.83	5.64	0.00	0.00	63.26	194.47	1009.55	0.0118
8	Package 7	0.00	0.00	0.49	2.19	1.49	7.43	0.14	0.93	0.00	0.00	10.01	30.76	165.59	0.0019
9	Package 8	0.00	0.00	1.32	5.96	3.32	16.58	0.37	2.52	0.00	0.00	27.83	85.57	451.41	0.0053
10	Medaram Reservoir	0.03	0.21	1.08	4.85	2.81	14.07	0.30	2.06	0.00	0.03	91.29	280.62	367.85	0.0043
11	Package 9	0.00	0.00	0.07	0.30	0.30	1.50	0.02	0.13	0.00	0.00	1.30	4.00	22.42	0.0003
12	Malakpet Reservoir (Pkg-9)	0.01	0.09	0.48	2.16	1.47	7.36	0.13	0.92	0.00	0.03	9.89	30.41	163.70	0.0019
13	Package 10	0.00	0.00	0.30	1.36	1.02	5.10	0.09	0.58	0.00	0.00	6.19	19.04	103.44	0.0012
14	Ananthagiri reservoir	0.08	0.66	3.38	15.19	7.01	35.06	0.95	6.44	0.04	1.00	72.34	222.36	1151.33	0.0134
15	Package 11	0.00	0.00	1.51	6.80	3.69	18.43	0.42	2.88	0.00	0.00	31.85	97.90	515.13	0.0060
16	Package 12	0.00	0.00	0.38	1.69	1.21	6.06	0.11	0.72	0.00	0.00	7.71	23.71	128.28	0.0015
17	Package 15	0.00	0.00	0.00	0.01	0.02	0.09	0.00	0.00	0.00	0.00	0.04	0.11	0.68	0.0000
18	Package 16	0.04	0.28	1.45	6.54	3.57	17.86	0.41	2.77	0.02	1.96	9.26	28.47	153.49	0.0018
19	Package 17	0.00	0.00	0.01	0.02	0.04	0.20	0.00	0.01	0.00	0.00	0.34	1.05	6.03	0.0001
20	Package 20	0.00	0.00	0.23	1.04	0.82	4.10	0.06	0.44	0.00	0.00	9.77	30.03	161.70	0.0019
21	Package 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
22	Package 22	0.00	0.00	0.02	0.08	0.11	0.53	0.00	0.03	0.00	0.00	0.60	1.84	10.48	0.0001
23	Package 27	0.00	0.00	0.08	0.37	0.36	1.81	0.02	0.16	0.00	0.00	6.13	18.86	102.48	0.0012
24	Package 28	0.00	0.00	0.01	0.06	0.08	0.42	0.00	0.03	0.00	0.05	0.25	0.78	4.50	0.0001

Table 3 DAMAGE COST FOR QUARRYING ACTIVITIES

SL. NO	PROJECT NAME	DAMAGE COST (Rs)				TOTAL IN LACS
		PM 2.5	PM 10	NOX	SOX	
1	Laxmi Barrage (Medigadda)	₹ 60,56,246.66	₹ 1,29,58,223.91	₹ 1,55,84,669.90	₹ 303.27	₹ 345.99
2	Laxmi Pump House (Medigadda Lift)	₹ 86,05,013.51	₹ 1,86,45,126.23	₹ 2,16,37,701.42	₹ 421.06	₹ 488.88
3	Saraswathi Barrage (annaram)	₹ 1,66,99,169.17	₹ 3,59,49,532.35	₹ 4,19,09,592.52	₹ 815.55	₹ 945.59
4	Saraswathi Pump House (Annaram Lift)	₹ 59,32,314.38	₹ 1,28,80,910.18	₹ 1,49,23,375.67	₹ 290.40	₹ 337.37
5	Parvathi Barrage (Sundilla)	₹ 1,32,70,369.27	₹ 2,86,13,613.84	₹ 3,33,29,680.38	₹ 648.59	₹ 752.14
6	Parvathi (Sundilla) Lift	₹ 33,17,838.34	₹ 72,58,399.56	₹ 83,40,970.50	₹ 162.31	₹ 189.17
7	Package 6	₹ 2,87,55,124.68	₹ 6,23,07,961.85	₹ 7,24,93,464.24	₹ 1,410.70	₹ 1,635.58
8	Package 7	₹ 48,75,743.25	₹ 1,07,86,078.31	₹ 1,22,08,292.10	₹ 237.57	₹ 278.70
9	Package 8	₹ 1,46,08,552.31	₹ 3,19,25,363.11	₹ 3,67,82,729.98	₹ 715.78	₹ 833.17
10	Medaram Reservoir	₹ 6,00,580.82	₹ 12,31,535.09	₹ 4,23,762.01	₹ 8.25	₹ 22.56
11	Package 9	₹ 5,76,843.58	₹ 13,14,979.06	₹ 14,05,085.82	₹ 27.34	₹ 32.97
12	Malakpet Reservoir (Pkg-9)	₹ 1,81,000.71	₹ 4,01,189.56	₹ 4,52,607.89	₹ 8.81	₹ 10.35
13	Package 10	₹ 25,49,232.00	₹ 56,75,375.00	₹ 63,55,208.59	₹ 123.67	₹ 145.80
14	Ananthagiri reservoir	₹ 59,40,393.34	₹ 1,29,03,879.44	₹ 1,49,43,389.26	₹ 290.79	₹ 337.88
15	Package 11	₹ 65,73,058.08	₹ 1,43,43,553.20	₹ 1,65,56,699.13	₹ 322.19	₹ 374.74
16	Package 12	₹ 32,25,632.05	₹ 71,60,010.55	₹ 80,58,713.06	₹ 156.82	₹ 184.45
17	Package 15	₹ 18,579.83	₹ 45,726.13	₹ 40,226.38	₹ 0.78	₹ 1.05
18	Package 16	₹ 14,91,937.71	₹ 37,55,412.48	₹ 28,11,442.78	₹ 54.71	₹ 80.59
19	Package 17	₹ 1,30,078.99	₹ 2,79,470.07	₹ 3,70,326.63	₹ 7.21	₹ 7.80
20	Package 20	₹ 74,96,125.68	₹ 1,59,12,743.34	₹ 2,04,03,642.80	₹ 397.05	₹ 438.13
21	Package 21	₹ 0.00	₹ 0.00	₹ 0.00	₹ 0.00	₹ 0.00
22	Package 22	₹ 1,92,280.49	₹ 4,25,926.67	₹ 5,07,294.21	₹ 9.87	₹ 11.26
23	Package 27	₹ 62,93,623.77	₹ 1,31,12,638.88	₹ 1,78,93,157.16	₹ 348.20	₹ 373.00
24	Package 28	₹ 3,41,831.50	₹ 8,24,731.33	₹ 7,86,167.78	₹ 15.30	₹ 19.53
TOTAL		₹ 13,77,31,570.13	₹29,87,12,380.12	₹ 34,82,18,200.23	₹ 6,776.22	₹ 7,846.69

5. IMPACT ON WATER ENVIRONMENT

The impact on water environment is assessed based on following modes of its availability,

- Ground Water
- Surface Water

Impact on Ground Water:

Assuming that the mining activities did not intersect the GW table, the impact on ground water is calculated for following activities: -

- Usage of GW for domestic usage
- Non availability of GW NOC from concerned department
- Usage of GW for mine development and EMP activities like dust suppression, plantation, etc

Table 4 DAMAGE COST FOR IMPACT ON GROUND WATER

Sl. No.	Package No.	MINES MANPOWER	DOMESTIC WATER USAGE @ 45 LPCD (KL)	AREA CONSIDERED FOR DUST SUPPRESSION (Ha)	DUST SUPPRESSION USAGE @ 1 LITRE PER SQMTR	DOMESTIC WATER USAGE COST @ Rs.15 per KL	DUST SUPPRESSION USAGE COST @ Rs.2 per KL
1	Medigadda Barrage	50	232.10	1.27	12.71	₹ 3,481.56	₹ 19,599.92
2	Medigadda Lift	70	460.18	1.76	17.65	₹ 6,902.73	₹ 38,859.81
3	Annaram Barrage	135	835.46	3.42	34.18	₹ 12,531.86	₹ 70,549.73
4	Annaram Lift	48	281.93	1.22	12.17	₹ 4,228.91	₹ 23,807.19
5	Sundilla Barrage	107	645.10	2.72	27.18	₹ 9,676.57	₹ 54,475.49
6	Sundilla Lift	27	178.84	0.68	6.80	₹ 2,682.64	₹ 15,102.26
7	6	233	7855.84	5.91	0.00	₹ 1,17,837.67	₹ 0.00
8	7	39	1358.34	1.00	0.00	₹ 20,375.10	₹ 0.00
9	8	118	4523.16	3.00	0.00	₹ 67,847.37	₹ 0.00
10	Medaram Reservoir	1	0.74	0.03	0.35	₹ 11.05	₹ 62.21
11	9	5	132.88	0.11	0.00	₹ 1,993.27	₹ 0.00
12	Malakpet	1	1.89	0.04	0.37	₹ 28.33	₹ 159.47
13	10	20	589.25	0.52	0.00	₹ 8,838.80	₹ 0.00
14	Ananthagiri reservoir	48	292.70	1.22	12.19	₹ 4,390.45	₹ 24,716.63
15	11	53	803.07	1.35	0.00	₹ 12,046.00	₹ 0.00
16	12	26	764.01	0.66	0.00	₹ 11,460.21	₹ 0.00
17	15	0	3.50	0.00	0.03	₹ 52.45	₹ 295.27
18	16	29	250.90	0.74	7.40	₹ 3,763.51	₹ 21,187.20
19	17	0	10.24	0.01	0.09	₹ 153.55	₹ 864.42
20	20	32	1891.82	0.81	0.00	₹ 28,377.32	₹ 0.00
21	21	0	0.00	0.00	0.00	₹ 0.00	₹ 0.00
22	22	1	21.46	0.02	0.00	₹ 321.90	₹ 0.00
23	27	16	1306.50	0.40	0.00	₹ 19,597.52	₹ 0.00
24	28	3	207.15	0.06	0.64	₹ 3,107.30	₹ 17,492.98
TOTAL		**1064**	**22647.07**			**₹ 3,39,706.09**	**₹ 2,87,172.57**

Impact on ground water quality

Since the data pertaining to GW quality is unavailable, the damage for same is not calculated.

Impact on Surface Water

Assuming that the mining activities did not intersect any surface water features like ponds, lakes, nallahs, etc, the impact on surface water is calculated for following activities,

- **Non provision of toe walls (DIMENSION H- 2 X W-0.25) and toe drains (DIMENSION W- 1 X H-0.5) around dump areas**
- **Non Provision of plantation at 2500 trees per hectare**

Table 5 COST SAVED FROM NON IMPLEMENTATION OF SURFACE WATER MANAGEMENT

Sl. No.	Package No.	AREA In Ha	PLANTATION COUNT NOS	COST FOR PLANTATION @ Rs.300 per plant	PERIMETER (METERS)	TOE DRAIN COST @Rs.150 Per CuMtr	TOE WALL COST @Rs.600 Per CuMtr
1	Medigadda Barrage	1.27	3177.68	₹ 9,53,303.34	405.87	₹ 30,440.28	₹ 1,21,761.13
2	Medigadda Lift	1.76	4411.88	₹ 13,23,563.04	478.24	₹ 35,867.86	₹ 1,43,471.43
3	Annaram Barrage	3.42	8545.27	₹ 25,63,580.42	665.57	₹ 49,917.93	₹ 1,99,671.74
4	Annaram Lift	1.22	3042.84	₹ 9,12,852.44	397.17	₹ 29,787.46	₹ 1,19,149.83
5	Sundilla Barrage	2.72	6795.84	₹ 20,38,753.20	593.55	₹ 44,515.93	₹ 1,78,063.72
6	Sundilla Lift	0.68	1700.70	₹ 5,10,211.32	296.93	₹ 22,269.38	₹ 89,077.53
7	6	5.91	14781.25	₹ 0.00	0.00	₹ 0.00	₹ 0.00
8	7	1.00	2489.24	₹ 0.00	0.00	₹ 0.00	₹ 0.00
9	8	3.00	7499.91	₹ 0.00	0.00	₹ 0.00	₹ 0.00
10	Medaram Reservoir	0.03	86.40	₹ 25,921.23	66.93	₹ 5,019.51	₹ 20,078.02
11	9	0.11	286.49	₹ 0.00	0.00	₹ 0.00	₹ 0.00
12	Malakpet	0.04	92.29	₹ 27,685.71	69.17	₹ 5,187.53	₹ 20,750.14
13	10	0.52	1295.81	₹ 0.00	0.00	₹ 0.00	₹ 0.00
14	Ananthagiri reservoir	1.22	3046.92	₹ 9,14,076.65	397.43	₹ 29,807.42	₹ 1,19,229.69
15	11	1.35	3375.87	₹ 0.00	0.00	₹ 0.00	₹ 0.00
16	12	0.66	1643.15	₹ 0.00	0.00	₹ 0.00	₹ 0.00
17	15	0.00	7.99	₹ 2,396.71	20.35	₹ 1,526.30	₹ 6,105.21
18	16	0.74	1850.73	₹ 5,55,220.00	309.75	₹ 23,230.88	₹ 92,923.52

19	17	0.01	22.51	₹ 6,753.31	34.16	₹ 2,562.07	₹ 10,248.29
20	20	0.81	2025.69	₹ 0.00	0.00	₹ 0.00	₹ 0.00
21	21	0.00	0.00	₹ 0.00	0.00	₹ 0.00	₹ 0.00
22	22	0.02	59.93	₹ 0.00	0.00	₹ 0.00	₹ 0.00
23	27	0.40	1010.99	₹ 0.00	0.00	₹ 0.00	₹ 0.00
24	28	0.06	160.30	₹ 48,089.33	91.16	₹ 6,836.87	₹ 27,347.49
TOTAL			**67409.69**	**₹ 98,82,406.68**	**3826.26**	**₹ 573939.00**	**2295756.00**

Impact on surface water quality

Since the data pertaining to SW quality is unavailable, the damage for same is not calculated.

Impact due to Non-Provision of Rainwater harvesting structure

- By law it's mandatory to have a Rain water harvesting structure. This will help augment ground water recharge to the extent possible and also will restore the groundwater regime.
- Since the actual mine area details are not available, its assumed that no RWH structure was available and 2 Nos of RWH at Rs.5,00,000 per unit is considered as damage

Table 6 COST SAVED FROM NON PROVISION OF RWH STRUCTURES

Sl. No.	Package No.	MINE LOCATION	COST OF RWH STRUCTURE @ Rs.2.5 Lacs Per Unit
1	Medigadda Barrage	1. RACHAPALLY JAYYARAM CRUSHER CUM QUARRY 2. GUDEPADU (v)	₹ 5,00,000.00
2	Medigadda Lift		₹ 5,00,000.00
3	Annaram Barrage		₹ 5,00,000.00
4	Annaram Lift		₹ 5,00,000.00
5	Sundilla Barrage		₹ 5,00,000.00
6	Sundilla Lift		₹ 5,00,000.00
17	15	AGRAHARAM	₹ 5,00,000.00
18	16		₹ 5,00,000.00
19	17	VENKATAPUR	₹ 5,00,000.00
24	28	NIRMAL	₹ 5,00,000.00
TOTAL			**₹ 50,00,000.00**

6. IMPACT DUE TO NOISE AND GROUND VIBRATIONS:

The impact due to noise and vibration on surrounding environment is assumed moderate, and damage for same is calculated as per latest CPCB guideline as directed by NGT. The damage cost considered is Rs.50,000/- per month from onset of project till December, 2017.

Table 7 DAMAGE COST FOR IMPACT DUE TO NOISE & VIBRATION

SL. NO.	PACKAGE NO.	YEARS OF VIOLATION	DAMAGE COT @RS.50,000 PER MONTH (Rs in Lac)
1	Medigadda Barrage	0.70	₹ 3.52
2	Medigadda Lift	1.01	₹ 5.03
3	Annaram Barrage	0.94	₹ 4.71
4	Annaram Lift	0.89	₹ 4.47
5	Sundilla Barrage	0.92	₹ 4.58
6	Sundilla Lift	1.01	₹ 5.07
7	Package 6	5.12	₹ 25.62
8	Package 7	5.26	₹ 26.30
9	Package 8	5.81	₹ 29.07
10	Medaram Reservoir	0.08	₹ 0.41
11	Package 9	4.47	₹ 22.36
12	Malakpet	0.20	₹ 0.99
13	Package 10	4.38	₹ 21.92
14	Ananthagiri reservoir	0.93	₹ 4.63
15	Package 11	2.29	₹ 11.47
16	Package 12	4.48	₹ 22.41
17	Package 15	4.11	₹ 20.55
18	Package 16	4.22	₹ 21.10
19	Package 17	1.31	₹ 6.53
20	Package 20	4.38	₹ 21.92
21	Package 21	9.00	₹ 45.01
22	Package 22	2.00	₹ 10.00
23	Package 27	3.45	₹ 17.26
24	Package 28	12.46	₹ 62.29
TOTAL			**₹ 397.19**

7. IMPACT ON ENVIRONMENT DUE TO IMPROPER WASTE MANAGEMENT

The damage is calculated considering the MSW 2016 rules compliance. In this case, it is considered 100% non-compliance and damage for same is taken at Rs. 25,000 per ton for complete management.

Table 8 COST SAVED FROM NON COMPLIANCE OF SWM RLES 2016

Sl. No.	Package No.	DOMESTIC MANPOWER	QTY (In Tonnes)	COST @ Rs.25,000 Per Tonne
1	Medigadda Barrage	50	1.55	₹ 0.39
2	Medigadda Lift	70	3.07	₹ 0.77
3	Annaram Barrage	135	5.57	₹ 1.39
4	Annaram Lift	48	1.88	₹ 0.47
5	Sundilla Barrage	107	4.30	₹ 1.08
6	Sundilla Lift	27	1.19	₹ 0.30
7	Package 6	233	52.37	₹ 13.09
8	Package 7	39	9.06	₹ 2.26
9	Package 8	118	30.15	₹ 7.54
10	Medaram Reservoir	1	0.00	₹ 0.00
11	Package 9	5	0.89	₹ 0.22
12	Malakpet	1	0.01	₹ 0.00
13	Package 10	20	3.93	₹ 0.98
14	Ananthagiri reservoir	48	1.95	₹ 0.49
15	Package 11	53	5.35	₹ 1.34
16	Package 12	26	5.09	₹ 1.27
17	Package 15	0	0.02	₹ 0.01
18	Package 16	29	1.67	₹ 0.42
19	Package 17	0	0.07	₹ 0.02
20	Package 20	32	12.61	₹ 3.15
21	Package 21	0	0.00	₹ 0.00
22	Package 22	1	0.14	₹ 0.04
23	Package 27	16	8.71	₹ 2.18
24	Package 28	3	1.38	₹ 0.35
Total in Lacs				₹ 37.75

8. IMPACT ON LABOURS OHS

The impact of same is calculated considering supply of PPE and medical assessments periodically. Since no data was available, it is considered that cost is saved from same and damage cost taken is Rs.1000 per Head for every two years.

Table 9 COST SAVED FROM NON PROVISION OF PPE AND PERIODICAL MEDICAL CHECKUP

Sl. No.	Package No.	DOMESTIC MANPOWER	Damage cot @Rs.1000 per head
1	Medigadda Barrage	50	₹ 0.50
2	Medigadda Lift	70	₹ 0.70
3	Annaram Barrage	135	₹ 1.35
4	Annaram Lift	48	₹ 0.48
5	Sundilla Barrage	107	₹ 1.07
6	Sundilla Lift	27	₹ 0.27
7	Package 6	233	₹ 4.67
8	Package 7	39	₹ 0.79
9	Package 8	118	₹ 2.37
10	Medaram Reservoir	1	₹ 0.03
11	Package 9	5	₹ 0.09
12	Malakpet	1	₹ 0.03
13	Package 10	20	₹ 0.41
14	Ananthagiri reservoir	48	₹ 0.96
15	Package 11	53	₹ 1.07
16	Package 12	26	₹ 0.52
17	Package 15	0	₹ 0.00
18	Package 16	29	₹ 0.58
19	Package 17	0	₹ 0.01
20	Package 20	32	₹ 0.64
21	Package 21	0	₹ 0.00
22	Package 22	1	₹ 0.02
23	Package 27	16	₹ 0.32
24	Package 28	3	₹ 0.05
Total in Lacs			₹ 16.92

9. SUMMARY OF TOTAL DAMAGE COST ASSESSED DURING VIOLATION PERIOD FOR REMEDIATION PLAN AND NATURAL AND COMMUNITY RESOURCE AUGMENTATION PLAN

Damage Cost of different activities is as follows.

Table 10 CONSOLIDATED DAMAGE COST

S.No	ENVIRONMENTAL ACTIVITIY	DAMAGE COST Rs. lacs.
1	AIR ENVIRONMENT	₹ 7846.69
2	WATER ENVIRONMENT	₹ 84.94
3	ECOLOGY (GREEN BELT)	₹ 98.82
4	NOISE AND VIBRATION	₹ 397.19
5	OHMS	₹ 16.92
6	WASTE MANAGEMENT	₹ 37.75
	TOTAL	**₹ 8482.23**

- The total cost derived for ecological damage assessment is **₹ 8482.23 Lacs**

15. SUMMARY AND CONCLUSION

Hon'ble NGT in its Order dated 20.10.2020, directed MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into.

In view of the Order dated 20.10.2020, Ministry constituted an Expert Committee comprises of following members to achieve the work specified by the Hon'ble NGT within the time frame of six months:

(i)	Shri Balraj Joshi	:	Chairman
(ii)	Shri K Gowrappan	:	Member
(iii)	Dr. Mukesh Sharma	:	Member
(iv)	Dr. A.K. Malhotra	:	Member
(v)	Shri A.K. Singh	:	Member
(vi)	Dr. Narayan Shenoy K	:	Member
(vii)	Dr. J.A. Johnson	:	Member

Following are the Terms of References for the Committee:

(i) Examination of DPR to ascertain the allocation of water for different usage like drinking and irrigation purposes, etc.

(ii) Examination of relevant contracts / work orders since 2007.

(iii) Examination of various Court orders and other statutory clearances applicable and obtained by the Project Proponent.

(iv) Verification of. kml file on DSS

(v) Virtual meeting with the Project Proponent for deliberation on the project and clarification from the Project Proponent, if any required.

(vi) Site visit by the committee to physically verify the construction of the project.

(vii) Examination of Regional Office, MoEFCC report on the compliance of EC conditions.

(viii) Assessment of environmental damage and remedial measures.

(ix) Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into.

(x) Any other additional Terms of Reference as deemed appropriate by the Expert Committee in light of the order of Hon'ble NGT.

Compliance of terms of reference by Hon'ble NGT and MOEF&CC:

Examination of DPR: The contents of DPR I to VII are as following:

Vol: I: - Project Report.

Vol: II: - Project Hydrology

Vol: III: - Project Design Report and Annexures

Vol: IV: - Drawings

Vol: V: - Irrigation Planning

Vol:VI: - Project Cost Estimates.

The Salient features of the project as per DPR are as following:

Kaleshwaram project is a Multi-Purpose Project located on the river Basin of Godavari in Medigadda village near Kaleshwaram with reservoirs in Karim nagar District and the command area consisting of Karimnagar, Medak, Warangal, Nalgonda, Rangareddy, Nizamabad, Adilabad Districts.

Total Water proposed utilization by the project: 180 TMC from Medigadda (Three Barrages), plus 20 TMC from SRY barrage and plus 25 TMC from ground water self-yield of tanks.

Out of 180 TMC, 30 TMC for Drinking Water requirement of Hyderabad/ Secunderabad,1 0 TMC for supply enroute villages and 16 TMC for Industrial water needs which includes Drinking water for industries.

Total length of conveying system is 1832 km. (GC: 1531km, tunnel: 203 km and pressure main: 98 km)

Existing BALANCING RESEVOIRS	:	5 NOS
Pump houses	:	19
Proposed reservoirs	:	20
Project cost in Crores	:	80499.71
Benefit Cost Ratio	:	1.55

S. NO	LINK	PACKAGES	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	capex spent update (in cr)	Capex up to dec 17 (in cr)
1	LINK 1	Laxmi Medigatta	Barrage at medigadda -FRL+100-16.17 TMC	26-08-2016	1 Yr	9.6	3484.96	334.6
2		Laxmi Pumphouse	Gravity canal Pump House	27-08-2016	1 Yr	12.9	4516.64	723.89
3		Saraswathi	Barrage at annaram -FRL120-11.90 TMC	26-08-2016	1 Yr	18.2	2194.88	610.79
4		Saraswathi (PH)	Canal pump house	27-08-2016	1 Yr	16.98	3301.87	658.17
5		Parvathi(Sundilla)	Barrage at sundilla -FRL 130 -5.11 TMC	15-07-2016	1 Yr	21.19	1733.2	471.54
6		Parvathi (PH)	canal, pump house	27-08-2016	1 Yr	17.47	3132.46	594.13
7	LINK - 2	Package 6	AC : 2.580 KM , G/C : 1.100 KM, Tunnel -9.534KM, Pump House (Medram Tank Reservior)226/231,0.78 TMC	25-10-2011	9 yrs	71.24	4612.14	3596.44
8		Package 7	AC :1.950KM,Tunnel (Twin)4.133 KM	17-11-2008	9yrs	73.21	1424.48	1058.8
9		Package 8	GC:5.750 KM, Pump House	17-11-2008	9 yrs	71.05	4489.74	3482.09

S. N O	LINK	PACKAGE S	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	capex spent update (in cr)	Capex up to dec 17 (in cr)
10	LINK-3	Package 9	AC:2.10KM , T:12.035KM , FRL - 423/432,3.0TMC,PH GE-18.325 KM, PH GC;6.596 KM	17-11-2008	1yrs	25.44	705.16	253.44
11	LINK - 4	Package 10	Midmanair Reservior FRL-318,25.875 TMC,AC1.15 5KM, G/C2.380 KM,T7.465 KM,(Anathagiri Reservior) FRL390/397,3.90 TMC)	17-11-2008	6yrs	58.51	2694.51	1637.69
12		Package 11	AC:1.748 KM,GC:0.454 KM<T:8.590 KM, PH (IMAMABAD Reservior) FRL 480/490,3.0 TMC	17-11-2008	6yrs	59.25	3061.14	1853.2
13		Malkapet Reservior	Malkapet reservior FRL423/432,30.TMC	17-11-2017	1 yrs	3.33	386.49	17.13
14		Package 12	AC 4.40,T:16.180 KM, PH , Komarawalli Mallasagar FCT535/557,50 TMC	24-11-2008	6yrs	43.5	3230.92	1457.29
15	LINK-5	Package 15	Gandharnadha reservior 9.87 TMC, 510.00, GC:301.75KM, T:1275 KM,GC:4.752 KM	21-02-2009	6 yrs	20.59	462.37	173.89
16		Package 16	GC7.748 KM,Baswapuran Reservior ,453/490, 11.39 TMC , GC:50.05 KM	12-08-2012	6 yrs	50.35	554.83	554.81

S. NO	LINK	PACKAGES	Description	Commence Date	Period violation up to dec 17	Completion up to dec 17 %	capex spent update (in cr)	Capex up to dec 17 (in cr)
17	LINK 6	Package 17	GC:11.670 KM, T:11.525KM, GC:2.505 KM	19-05-2013	5 yrs	8.8	338.8	86.87
18		Packagr 18	GC :2.505 KM, GC:34.00 KM, T.365 KM	25-02-2009 /2018	1yrs	1.4	62. 36	10.58
19		Packagr 19	GC 37.90 KM, PH	25-02-2009 /2018	1yrs	2.71	218.2	20.59
20	LINK 7	Package 20	SRS Project , Masani Tank , GC :0.131 TML	05-11-2011/2008	7 yrs	60.3	815	538.25
21		Package 21	Konderm cheruva 445/457, 3.50 TMC	20-11-2008	6yrs	45.24	401.11	276.15
22		Package 22	Kadam Project FRL 213.10, 7.6 TMC	25-01-2013	5Yrs	10.33	281.89	145.03
23		Package 27	Diwapur Village CISTORN	20-11-2018/2013	5yrs	17.43	447.26	124.52
24		Package 28	CISTORN	25/02/2009 /2012	6yrs	46.97	228.31	228.31
			Total			**765.99**	**42778.72**	**18908.2**
						35.08		
			Project cost			**53887.6 Cr**		

ABSTRACT:

Total Contract value of the projects	:	Rs .72881.19 Cr
Capex spent till date	:	Rs.64530 14.Cr.
Total contract value of violation projects (25)	:	Rs.53887.60 Cr.
Total capex spent till date for violation projects	:	Rs.43243.91 cr.

Cost incurred for violation projects till Dec,2017: Rs.18853.56 Cr.

II. Examination of contracts and work orders:

Total contract documents of 4 no. projects have been scrutinized and for the remaining work orders numbering 21 Relevant details collected and verified with the PP, during the meetings and also during the site visit.

III: Statutory clearances applicable and obtained by the PP:

SI No	Name of Directorate Ministry/Board	STATUS OF CLEARANCE
1	Hydrology (S)	**Clearance received** from CWC vide Lr.F.No .6 /231/2017-PA(S)1327-28,**Dt:30-10-2017**
2	Inter State matters (ISM)	**Clearance received** from CWC vide Clearance Lr. No. U.No 4/2 TEL./ISM/2017/927-928 D:03-11-2017 & Lr No. U.No.4/2/TEL./ISM-I/2017/974,**DT:30-11-2017**
3	Construction Machinery Consultancy (CMC)	**Clearance received** from CWC Vide U.O.No.21/Telangana/02/2017-CMC/432, **dt:24-11-2017**
4	Irrigation Planning (S)	**Clearance received** CWC ID NO: 2/1478/IP(S)2013/272 **Dt: 13-04-2018** and B>C Ratio Finalized vide CWCID No:2/1481/IP(S)2013/320, **Dt:11-05-2018**
5	Ministry of Agriculture & Farmers welfare (MoA&FW)	
6	Cost Appraisal (I)	**Finalized Cost Received** firm CWC Vide ID No 10-A/27/2017CA(I)-2/77, **dt:01-05-2018**

Sl No	Name of Directorate Ministry/Board	STATUS OF CLEARANCE
7	Central soil & Materials Research Station (CSMRS)	**Clearance received** from CSMRS Vide U.O No .29/36/ Kaleshwaram /RM-I/CSMRS/2017/308, **dt:21-05-2018**
8	Ministry of Environment, Forest and Climate Change (MOEF & CC)	**1) Environmental Clearance: Environmental clearance received** from MOEF vide Lr. No.J-12011/1/2017-IA-I(R) **Dt: 22-12-2017**
		2) Forest Clearance: Stage -I Clearance received from MOEF vide F. N 8-31/2017-FC **Dt :24-10-2017** **Stage -II Clearance** received from MOEF vide F.No 8-31/2017-FC **Dt : 24-11-2017**
9	Central Ground Water Board (CGWB)	**Clearance Received** Vide Lr No: 4-1/CWC-PA/SMLCGWB/2017 1945 **Dt :21-11-2017**
10	Technical Advisory Committee (TAC)	**Acceptance** of Kaleshwaram Project in the **136th TAC** Meeting held on **06-06-2018** Communicated by CWC through **Minutes** vide Lr.No 16/7/2018-PA (N)939-70 **Dt:14-06-2018**
11	CGWB/ State WRD Dept: NOC for ground water abstraction,	No Clearance.
12	Domestic and Construction water Consumption	No Clearance.
13	NOC from CHIEF WID LIFE Warden -STATE for wild life conservation Plan	Clearance yet to be received
14	License from PESO for use of Explosive to and petroleum Products	Clearance received
15	Environment Clearance for 7 No. stone Quarries and mine plans	No Clearance

SI No	Name of Directorate Ministry/Board	STATUS OF CLEARANCE
16	CFE	Not Available
17	CFO	Not Available

VI: Verification of KML files with DSS: Have been complied with during the course of the meetings and the PP has submitted all the relevant KML files as required by the Committee.

V.: Four virtual meetings and One hybrid meeting held since the notification of the committee in Nov'20 as explained in the introductory pages and out of that three were attended by the PP and their EIA consultant. All the datas and information were sought from the PP thru periodical correspondences till Dec 2021 wherein the PP has submitted most of the details sought by the committee.

VI.: Site visit by the committee:

Ten project sites were visited by the committee between 25th August and 28th August, besides having a detailed interactive meeting with the project officials. The short details of the tour report is briefed in the introductory pages above and enclosed vide Annexure XVIII:-

Sites visited:

1) Laxmi Barrage at Medigadda.
2) 680 Mw Laxmi Pump House near Medigadda.
3) A stone quarry near Nandi power House.
4) Gravity Canal feeding Gayatri Pump House.
5) Gayathri Pump House.
6) Sri Rnaganayaka Sagar Reservoir
7) UG Pump house near Ranganayaka Sagar.
8) Konda pochamma Pump House.
9) Konda Pochamma Gravity Canal.
10) Konda Pochamma Sagar Tank (Highest Elevation)

VII.: Examination by Regional office:

The Officer from Regional office, Hyderabad had visited the site between 8th and 9th of Feb, 2022 and his observations are enclosed vide Annx. No. XVII.

VIII.Assessment of Environmental Damages and remediation:

Assessment of damages for all the ecological parameters computed as per the following models and guidelines;

Economic benefits accrued and cost saved during violation period: EIA Notification on violation and CPCB Guideline manual.

Air: As per EEA and EU Handbook 28 as followed by EAC and CPCB in cases referred by Hon'ble NGT.

Water: CPCB (2018)/CGWA Notification dt 30/09/20 (latest).

Ecology and Biodiversity: CPCB and Moef guideline and WLC Act.

Noise and Vibration: CPCB/MOEF notification 2000.

Solid waste and Domestic Sewage: CPCB guideline manual (2018)

Occupational health and management system: Guideline manual.

ABSTRACTS OF COST SAVED/ ENVIRONMENTAL COMPENSATION AND DAMAGE ASSESSMENT FOR ALL THE VOILATION PROJECTS AND THE QUARRIES:

1 **Economic benefits accrued during violation:**

i. Profit gained during violation period: Nil since this is an integrated project of lift irrigation and drinking water supply for domestic as well as for industrial use which is supplied for a price and this benefit is not considered in the saving since this is implemented after the grant of EC.

ii. Environmental compensation (cost saved in EMP Expenditure)-vide MOEF guideline/Notification and CPCB.

1	Catchment Area Treatment Plan	Rs.112.04 Cr.
2	Wild life conservation and Management Plan	Rs.4.11 Cr.
3	Green belt Development Reservoir/Canal	Rs.12.77 Cr.
4	Reservoir rim treatment plan	Rs.78.77 .Cr
5	Base line monitoring(Water,Air.Noise ,etc.)	Rs.00.29 Cr.
6	Sanitation and Solid waste Management	Rs.17.44 Cr.
	Total	Rs.225.12 Cr

Damage Assessment:

DAMAGE COST ASSESSMENT ABSTRACT

S.No.	Projects / Quarry	Land Env	Air Env	WaterEn v	Noise & Vibration	Ecology& BioDivers ity	SolidWaste Management	Occupational, Health & Safety	Total
1	LAXMI BARRAGE	₹ 587.59	₹ 430.38	₹ 3.75	₹ 3.52	₹ 171.61	₹ 12.78	₹ 10.10	₹ 1,219.73
2	LAXMI PUMPHOUSE	₹ 569.75	₹ 678.64	₹ 5.79	₹ 5.03	₹ 373.44	₹ 18.15	₹ 29.60	₹ 1,680.40
3	SARASWATHI BARRAGE	₹ 604.09	₹ 998.65	₹ 11.76	₹ 4.71	₹ 216.17	₹ 33.27	₹ 25.00	₹ 1,893.65
4	Sarawathi Pumphouse	₹ 577.19	₹ 573.37	₹ 5.70	₹ 4.47	₹ 233.02	₹ 20.18	₹ 26.90	₹ 1,440.82
5	Parvathi Barrage	₹ 576.10	₹ 481.25	₹ 9.49	₹ 4.58	₹ 124.17	₹ 21.42	₹ 19.30	₹ 1,236.30
6	Parvathi Pumphouse	₹ 587.74	₹ 437.27	₹ 2.83	₹ 5.07	₹ 269.47	₹ 13.65	₹ 24.30	₹ 1,340.33
7	PACKAGE 6	₹ 566.59	₹ 910.74	₹ 15.52	₹ 25.62	₹ 253.07	₹ 59.13	₹ 147.00	₹ 1,977.67
8	PACKAGE 7	₹ 559.09	₹ 264.63	₹ 13.35	₹ 26.30	₹ 280.02	₹ 34.49	₹ 43.40	₹ 1,221.28

S.No.	Projects / Quarry	Land Env	Air Env	WaterEnv	Noise & Vibration	Ecology& BioDiversity	SolidWaste Management	Occupational, Health & Safety	Total
9	**PACKAGE 8**	₹ 587.96	₹ 540.47	₹ 9.26	₹ 29.07	₹ 378.98	₹ 54.20	₹ 142.00	₹ 1,741.95
10	**PACKAGE 9**	₹ 565.58	₹ 24.64	₹ 1.61	₹ 0.41	₹ 25.39	₹ 1.05	₹ 10.30	₹ 628.97
11	**PACKAGE 10**	₹ 535.99	₹ 75.42	₹ 1.68	₹ 22.36	₹ 597.32	₹ 1.02	₹ 67.10	₹ 1,300.89
12	**Malkapet Reservior**	₹ 564.38	₹ 46.87	₹ 1.51	₹ 0.99	₹ 84.35	₹ 0.16	₹ 75.90	₹ 774.15
13	**PACKAGE 11**	₹ 614.14	₹ 164.75	₹ 9.50	₹ 21.92	₹ 469.00	₹ 6.00	₹ 0.05	₹ 1,285.36
14	**Ranganayaka sagar**	₹ 694.33	₹ 215.98	₹ 7.07	₹ 4.63	₹ 394.38	₹ 2.54	₹ 59.70	₹ 1,378.62
15	**AnnaPurna Reservior**	₹ 572.26	₹ 247.11	₹ 19.30	₹ 11.47	₹ 131.77	₹ 3.77	₹ 0.70	₹ 986.38
16	**PACKAGE 12**	₹ 574.06	₹ 228.21	₹ 15.03	₹ 22.41	₹ 342.59	₹ 14.72	₹ 7.10	₹ 1,204.12
17	**PACKAGE 15**	₹ 561.12	₹ 62.42	₹ 1.28	₹ 20.55	₹ 222.97	₹ 71.25	₹ 22.70	₹ 962.28
18	**PACKAGE 16**	₹ 594.45	₹ 254.01	₹ 7.88	₹ 21.10	₹ 343.21	₹ 27.37	₹ 3.50	₹ 1,251.52
19	**PACKAGE 17**	₹ 570.73	₹ 38.65	₹ 2.24	₹ 6.53	₹ 76.64	₹ 10.37	₹ 0.80	₹ 705.98
20	**PACKAGE 20**	₹ 535.99	₹ 159.79	₹ 6.94	₹ 21.92	₹ 321.61	₹ 24.00	₹ 0.40	₹ 1,070.65
21	**PACKAGE 21**	₹ 535.99	₹ 81.30	₹ 1,427.63	₹ 45.01	₹ 234.00	₹ 0.83	₹ 22.00	₹ 2,346.76
22	**PACKAGE 22**	₹ 562.90	₹ 46.17	₹ 4.00	₹ 10.00	₹ 93.43	₹ 3.29	₹ 11.30	₹ 731.08
23	**PACKAGE 27**	₹ 578.22	₹ 193.51	₹ 6.32	₹ 17.26	₹ 368.44	₹ 3.29	₹ 5.90	₹ 1,172.94
24	**PACKAGE 28**	₹ 570.04	₹ 134.11	₹ 0.86	₹ 62.29	₹ 887.84	₹ 9.86	₹ 5.10	₹ 1,670.09
	Projects Total	**₹ 13,846.27**	**₹ 7,288.33**	**₹ 1,590.33**	**₹ 397.19**	**₹ 6,892.88**	**₹ 446.77**	**₹ 760.15**	**₹ 31,221.92**
	Quarry Total		**7846.69**	**84.94**	**98.82**	**397.19**	**16.92**	**37.75**	**8482.31**
	Grand Total	₹ 13,846.27	₹ 15,135.02	₹ 1,675.27	₹ 496.01	₹ 7,290.07	₹ 463.69	₹ 797.90	₹ 39,704.23

Summary of Damages Assessed		:	Rs. Cr.
1)	Land Environment Damage	:	138.46
2)	Air Environment Damage	:	151.35
3)	Water Environment Damage	:	16.75
4)	Noise and Vibration damage	:	4.96
5)	Ecology & Bio Diversity damage	:	72.90
6)	Solid Waste Management Damage	:	4.64
7)	O.H.M.S Damage	:	7.98

Economic benefits accrual:

1) Net profit:	Nil
2) Cost Saved in EMP:	225.12
Total Damage Cost:	622.16

The total damage cost is worked for the integrated project which comprises of Drinking and Industrial water facilty to an extent of 46.6 TMC water and 134.4 TMC water for lift Irrigation purpose out of the total project outlay of 180 TMC.

Therefore, we propose 75% of the total damage cost i.e Rs.447.00 Cr shall be considered as prorate damage and the budget for Remediation/ Restoration, Natural and Community Resources Augmentation Plan revised accordingly.

The total amount of Rs: 447.00 Cr as per the above Damage assessment report, shall be spent towards the following, as per the mandate and guideline of Voilation notification of MOEF&CC:

1) Remediation and Restoration Plan,
2) Natural Resources Augmentation Plan,
3) Community Resources Augmentation Plan.

The objective of remediation /Restoration plan is to implement control measures to prevent deterioration of Air Quality, noise quality and waterquality with cost apart from suggesting control measures for keeping community safe from adverse effects of the same and to improve environment.

Natural and community resources Augmentation Plan will include various activities to be taken for augmentation of natural resources like water, land vegetatative cover in a time bound manner.

The main activities for augmenting community resources:

Physical structures/places like school, hospital, library, community centre and other community services like public transportation, community forest, park, ponds and training centres besides activities that provides jobsand supports the local economy.

The activities year wise with aprox cost allocation is furnished in the following table which is to be implemented within three years and these activities would be monitored by the Environment monitoring Organaisation along with relevant District collectors and stake holders, nominated by the State Govt.

The PP should engage consultant who has already conducted Socio-economic studies for preparation of EIA; shall further conduct need basis study of the affected area and activities to be revised accordingly with final budget as suggested below. The said study should be completed within a span of 3 months.

Remediation/restoration Plan:

S.No.	Environment Component	Activity Description	Total Budgetary Provision in Rs. In Crores			
			1st Year	2nd Year	3rd Year	Total
1	Land Environment	i) Assitance to farmers – seedings, manure etc. ii) RCC sheds for storage of products iii) Encouring Agri & Horticulture activities iv) Providing agri tools assistance v) Assistance for Cooperative Irrigation Facility	20.00	20.00	20.00	60.00
2	Air Environment	i) Community plantation wind barriers with 20% fruit bearing trees. ii) Avenue plantation iii) Air purifiers for community halls, schools, centres etc. iv) Battery operated road sweeping machine for major panchayats v) Providing E Rickshaws for Hospitals	20.00	25.00	30.00	75.00
3	Water Environment	i) D/W purifiers (RO Systems) common use ii) Toilets (common) in public / schools iii) Solar powered Boreweels iv) Rain water hearvesting ponds v) Sedimentation Tanks vi) Renovation & Ponds / Desilting vii) Drip irrigation system	15.00	10.00	10.00	35.00

S.No.	Environment Component	Activity Description	Total Budgetary Provision in Rs. In Crores			
			1st Year	2nd Year	3rd Year	Total
4	Noise Environment	i) Health camp for Audimetry Tests ii) Distribution of Air aids iii) Plantation between projects & habitation	1.50	2.00	1.50	5.00
5	Biological Environment	i) Development of fruit orchards/ plantation / grazing lands/ parks ii) Fauna conservation iii) Conservation of Aqualife fauna in the river/ ponds	10.00	5.00	5.00	20.00
TOTAL			66.5	62.00	66.50	195.00

Natural resources Augmentation Plan:

S.No.	Proposed Activities	Budget Rs.			
		1st Year	2nd Year	3rd Year	Total
1	Provision waste converters/ Solid waste management facilities - centralized	10.00	10.00	15.00	35.00
2	• Renovation of community walls • Drainage system development for the villages	12.00	12.00	13.00	37.00
3	• Provision of solar lamp, street lights, pumps etc. • Assistance to farmers, training for soil classification and important agri practices	15.00	20.00	22.00	55.00
Total		37.00	42.00	48.00	127.00

Community Resources Augmentation Plan:

S.No.	Proposed Activities	Budget Rs.			
		1st Year	2nd Year	3rd Year	Total
1	• Infra Development – Black topping of roads, community centres renovation, bus shelters etc.	10.00	10.00	10.00	30.00
2	• Skill development, Training, Assisting / funding, Self help groups • Sports & Recreation – Clubs/ Playgrounds	10.00	10.00	7.00	27.00
3	Upgradation of Educational facilities / schools i) schools 2) colleges →computers, Toilets, Auditoriums, sanitization etc. • Scholarships, infra development in colleges, public buildings.	15.00	11.00	12.00	33.00
4	• Public health facility – Upgradation – PHC • Renovation of Hospitals, furnitures, solar lighting, equipments	20.00	25.00	10.00	55.00
Total		50.00	56.00	39.00	145.00

Our Observations and Recommendations:

1) The Restoration, Natural and Community Reources augmentation plan of Rs.447.00 Cr shall be implemented within a period of three years as per the above tables.

2) EMP and Action Plan: The total budget of Rs.3240.97 Cr excluding Rehabilitation and Resettlement plan, shall be spent for the relevant activity as envisaged in the EMP within a period of 3/5 years as per the following table:

EMP COST AND ACTION PLAN

S.No	EMP ACTIVITY	Proposed Amount as Per EIA (Rs. Cr)	Phasing in Years I	Phasing in Years II	Phasing in Years III	Phasing in Years IV	Phasing in Years V	Remarks
1	Catchment Area Treatment plan for High/ Very High Priority	319.63	65	65	65	65	59.63	
2	Command area Development Plan	1326.86	442	442	442.96	-	-	
3	Compensatory Afforestation plan	722.3	242.3	240	240	-	-	
4	Biodiversity and wildlife conservation & Management	3.86 per year x 5yrs 19.3	3.86	3.86	3.86	3.86	3.86	
5	*Resettlement & Rehabilitation	7057	1400	1400	1400	1400	1457	To Be Completed Expeditiously at actuals
6		36.49	18.49	18		-	-	-

	Green Belt Development							
7	Fisheries conservation and Management plan	485	125	90	90	90	90	
8	Reservoir Rim Treatment plan	236.75	79	79	78.75	-	-	-
9	**Muck Management & Restoration of Quarry site	55.95	20	18	17.95	-	-	-
10	Public health Delivery plan	10.35	10.35	-	-	-	-	-
11	Local Area Development Plan	28.24	18.24	10	-	-	-	-
	Total	**3240.97**	**1024.24**	**965.86**	**938.52**	**158.86**	**153.49**	

*At Actuals than Proposed to be Considered and hence the budgeted amount is not Considered.

- NB: Catchment Area Medium/Low/V. Low-11593.86 Cr to be spent in 10 Years

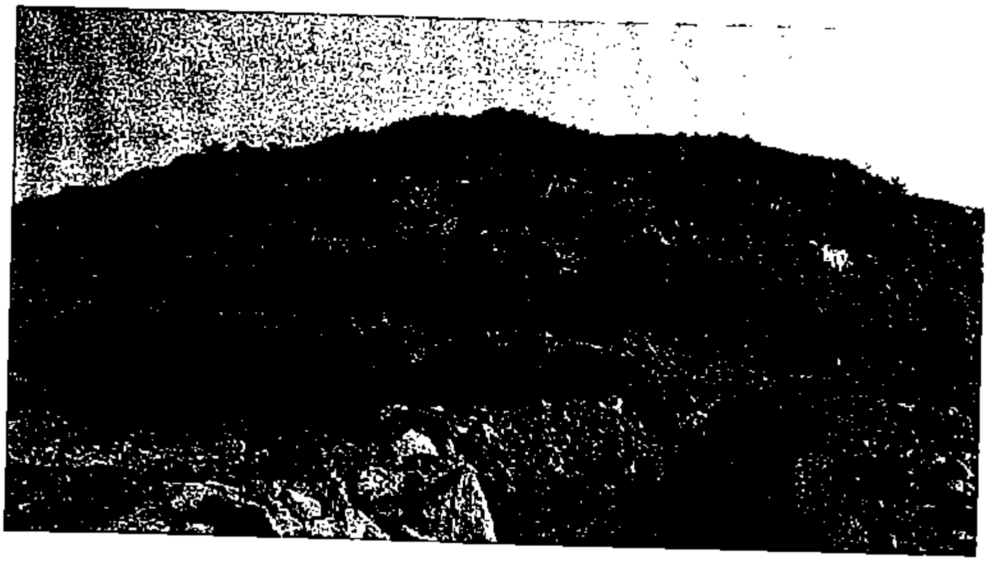
**Muck management and restoration of Quarry sites:

The environmental control and restoration measures required to be implemented on priority for the exposed dumps to the tune about 300 mln cum spread over in the project sites and all along the canals against Wind Erosion, Wash off'sand silting of water bodies, canals, etc.

The photograph shown below illustrates as to how a muck dump needs to be restored withscaping, geo texturing at required places followed by Toe Walls and Toe drains, etc.

The abandoned Quarry sites also requires rectification, restoration and reclamation with plantation and other surface water structures as shown in the Photographs:

Photo showing dump management with retaining wall followed by garland drains at the to pumps.



The Above EMP budget shall be implemented with the active coordination of different State Departments like Project, Forest, Fishery, etc by the Environment Mangement Organisation and also by inducting relevant District collectors and officials.

1) The Environment Monitoring Organaisation under the chairmanship of Chief Engineer as needs to be made effectively functional and this organaisation needs to be reorganised, initiated and periodical meetings shall be conducted to take stock of the timely implementation of EMP Budget Plan enumerated above

Statutory clearances viz:

1) Wild life conservation plan approval by Chief Wild Life warden and implementation of the plan.

2) Relevant NoC for supply of industrial water.

3) Consent to Establish and Consent to Operate from SPCB, shall be obtained by PP expeditiously.

Having presented its report as above, the members of the committee are unanimous in their opinion that Kaleshwaram Project which will make available 30 tmc of drinking water to Hyderabad city, 10 tmc for villages on route, 16 tmc for industrial use and 45 tmc of water along the conveying system will be distributed for irrigation purposes is a project of National Importance.

By its size and the amount of benefits projected to flow from it, it is undoubtedly one of the biggest project in the country. If all the environmental conservation measures as per EMP are carried out faithfully by the project authorities, this project has a potential to be a shining example of sustainable development.

******

16. WRITTEN CONSENT OF EXPERT MEMBERS ON THE REPORT

Email **Yogendra Pal Singh**

KALESHWARAM DAMAGE ASSESMENT REPORT.

From : gowrappanmail@gmail.com Tue, Jul 12, 2022 01:20 PM
Subject : KALESHWARAM DAMAGE ASSESMENT REPORT.
To : Yogendra Pal Singh <yogendra78@nic.in>, Sarvesh Narwal <sarvesh.narwal@gov.in>
Cc : ajitkumarmalhotra463@gmail.com, jaj@wii.gov.in, kn shenoy <kn.shenoy@manipal.edu>, mukesh@iitk.ac.in, Saurabh Upadhyay <saurabh.upadhyay85@gov.in>

Dear Mr.Y.P.Singh,
This is in reference to the notification of MOEF&CC,forming the sub committee in compliance to the order of Hon'ble NGT to submit a report in reference to court case -appeal no.20.of 2018.
This is to declare that I have perused the referred report and it is found to be in order.
This report can be submitted to Hon'ble NGT,Principal Bench,New delhi.
Thanks.
Gowrappan.

Email **Yogendra Pal Singh**

From : Yogendra Pal Singh <yogendra78@nic.in> Mon, Jul 18, 2022 09:47 AM

Subject : Re: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

To : mukesh@iitk.ac.in

okay Sir.

----- Original Message -----
From: mukesh@iitk.ac.in
To: "Yogendra Pal Singh" <yogendra78@nic.in>
Sent: Monday, July 18, 2022 7:49:35 AM
Subject: Re: Fwd: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

Dear Sir:

I agree with the report and overall findings.

- Mukesh Sharma
Fellow National Academy of Engineering
Member WHO Advisory Group on Air Pollution and
UN Sustainable Goals
Professor of Civil Engineering
Indian Institute of Technology (IIT) Kanpur
Kanpur 208016, India
Phone: +91-512-259-7759
e-mail:mukesh@iitk.ac.in
url: http://home.iitk.ac.in/~mukesh/

>
>
> Dear Sir,
> In continuation to my previous email sent today please find the
> attachments of annexures (along with Index) to the report in the above
> mentioned subject.
>
> With Regards,
>
> Yogendra Pal Singh
> Scientist 'E'
> M/o Environment, Forest and Climate Change
> Room No. 236, 2nd Floor, Vayu Wing

Email **Sarvesh Narwal**

Fwd: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

From : Yogendra Pal Singh <yogendra78@nic.in> Thu, Jul 21, 2022 02:58 PM

Subject : Fwd: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

To : Sarvesh Narwal <sarvesh.narwal@gov.in>, Saurabh Upadhyay <saurabh.upadhyay85@gov.in>, ishanvi <ishanvi.m@govcontractor.in>, Sourabh Kumar <sourabh.9@govcontractor.in>

From: ajitkumarmalhotra463@gmail.com
To: "Yogendra Pal Singh" <yogendra78@nic.in>
Sent: Thursday, July 21, 2022 1:49:44 PM
Subject: Re: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

I agree with the contents of the report and therefore convey my approval for the same.
Dr.A.K.Malhotra

On Thu, Jul 21, 2022 at 1:40 PM Yogendra Pal Singh <yogendra78@nic.in> wrote:
Dear Sir

May please see the trailing mail and provide necessary consent/ concurrence on the contents of the report attached herewith in the aforesaid matter.
Due to space problem **Annexures** to the report are being sent through subsequent email.

With Regards

From: "Yogendra Pal Singh" <yogendra78@nic.in>
To: gowrappanmail@gmail.com, mukesh@iitk.ac.in, "CE EMO" <ceenvtmgmt@cwc.delhi.nic.in>, ajitkumarmalhotra463@gmail.com, balrajjoshi@gmail.com, balrajjoshi@hotmail.com, "CE EMO" <ceenvtmgmt@nic.in>, jaj@wii.gov.in, "kn shenoy" <kn.shenoy@manipal.edu>
Cc: "Saurabh Upadhyay" <saurabh.upadhyay85@gov.in>, "Sarvesh Narwal" <sarvesh.narwal@gov.in>, "Sourabh Kumar" <sourabh.9@govcontractor.in>, "ishanvi" <ishanvi.m@govcontractor.in>
Sent: Thursday, June 30, 2022 7:16:10 PM
Subject: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

Dear Sir,
Please find the attachments w.r.t to the above mentioned subject. Due to space problem **Annexures** to the report are being sent through subsequent email.

With Regards,

Yogendra Pal Singh
Scientist 'E'
M/o Environment, Forest and Climate Change
Room No. 236, 2nd Floor, Vayu Wing
Indira Paryavaran Bhawan
Jor Bagh, New Delhi-110003
Tele-fax: 011-20819364

L-11011/4/2018-IA.I(R)

804953/2022/IA_I

Email **Sarvesh Narwal**

Fwd: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

From : Sarvesh Narwal <sarvesh.narwal@gov.in> Fri, Jul 22, 2022 12:01 PM

Subject : Fwd: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

To : Yogendra Pal Singh <yogendra78@nic.in>

Cc : Saurabh Upadhyay <saurabh.upadhyay85@gov.in>

Respected Sir

Please find the approval of Amrendra Sir towards approval of report in the instant matter.

Thanks and Regards

From: "amrendra bahra" <amrendra_bahra@yahoo.co.in>
To: "Sarvesh Narwal" <sarvesh.narwal@gov.in>
Sent: Monday, July 11, 2022 2:25:11 PM
Subject: Re: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

I concur the content of the Report as a Member of the Committee.

Amrendra Kumar Singh
9434043620/8918249717

On Monday, 11 July, 2022 at 12:03:49 pm IST, Sarvesh Narwal <sarvesh.narwal@gov.in> wrote:

Respected Sir,

Please find the attachments w.r.t to the above mentioned subject. Due to space problem **Annexures** to the report are being sent through subsequent email.

With Regards,

From: "Yogendra Pal Singh" <yogendra78@nic.in>
To: gowrappanmail@gmail.com, mukesh@iitk.ac.in, "CE EMO" <ceenvtmgmt@cwc.delhi.nic.in>, ajitkumarmalhotra463@gmail.com, balrajjoshi@gmail.cpm, balrajjoshi@hotmail.com, "CE EMO" <ceenvtmgmt@nic.in>, jaj@wii.gov.in, "kn shenoy" <kn.shenoy@manipal.edu>
Cc: "Saurabh Upadhyay" <saurabh.upadhyay85@gov.in>, "Sarvesh Narwal" <sarvesh.narwal@gov.in>, "Sourabh Kumar" <sourabh.9@govcontractor.in>, "ishanvi" <ishanvi.m@govcontractor.in>
Sent: Thursday, June 30, 2022 7:16:10 PM
Subject: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

Dear Sir,
Please find the attachments w.r.t to the above mentioned subject. Due to space problem **Annexures** to the report are being sent through subsequent email.

With Regards,

Yogendra Pal Singh
Scientist 'E'
M/o Environment, Forest and Climate Change
Room No. 236, 2nd Floor, Vayu Wing
Indira Paryavaran Bhawan
Jor Bagh, New Delhi-110003
Tele-fax: 011-20819364

Email **Yogendra Pal Singh**

RE: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

From : kn shenoy <kn.shenoy@manipal.edu> Tue, Jul 12, 2022 04:28 PM

Subject : RE: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg. 1 attachment

To : Yogendra Pal Singh <yogendra78@nic.in>

Dear Yogendra Pal Singh ji,

I have gone through the report circulated on 30th June 2022. I am agree with the content of the report.

With regards

Dr Narayana Shenoy K

From: Yogendra Pal Singh <yogendra78@nic.in>
Sent: Thursday, June 30, 2022 7:35 PM
To: gowrappanmail@gmail.com; mukesh@iitk.ac.in; CE EMO <ceenvtmgmt@cwc.delhi.nic.in>; ajitkumarmalhotra463@gmail.com; balrajjoshi@gmail.com; balrajjoshi@hotmail.com; CE EMO <ceenvtmgmt@nic.in>; jaj@wii.gov.in; Narayana K. Shenoy [MAHE-MIT] <kn.shenoy@manipal.edu>
Cc: Saurabh Upadhyay <saurabh.upadhyay85@gov.in>; Sarvesh Narwal <sarvesh.narwal@gov.in>; Sourabh Kumar <sourabh.9@govcontractor.in>; ishanvi <ishanvi.m@govcontractor.in>
Subject: Re: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

Dear Sir,
In continuation to my previous email sent today please find the attachments of annexures (along with Index) to the report in the above mentioned subject.

With Regards,

Yogendra Pal Singh
Scientist 'E'

Email **Sarvesh Narwal**

From : jaj@wii.gov.in Tue, Jul 12, 2022 03:30 PM

Subject : Re: Appeal No. 20 of 2018 titled as Md. Hayath Udin and others versus Union of India and Ors before the Hon'ble National Green Tribunal, Principal Bench, New Delhi - reg.

To : Yogendra Pal Singh <yogendra78@nic.in>

Cc : gowrappanmail@gmail.com, mukesh@iitk.ac.in, Ashok Kumar Kharya <ceenvtmgmt@cwc.delhi.nic.in>, ajitkumarmalhotra463@gmail.com, balrajjoshi@gmail.com, balrajjoshi@hotmail.com, Ashok Kumar Kharya <ceenvtmgmt@nic.in>, kn shenoy <kn.shenoy@manipal.edu>, Saurabh Upadhyay <saurabh.upadhyay85@gov.in>, Sarvesh Narwal <sarvesh.narwal@gov.in>, Sourabh Kumar <sourabh.9@govcontractor.in>, ishanvi <ishanvi.m@govcontractor.in>

Dear Yogendra Pal Singh ji
I have gone through the final report circulated on 30 June 2022. I am fine and agree with the content of the report.
With regards
JA Johnson

On 30-06-2022 19:16, Yogendra Pal Singh wrote:
> Dear Sir,
>
> Please find the attachments w.r.t to the above mentioned subject. Due
> to space problem Annexures to the report are being sent through
> subsequent email.
>
> With Regards,
> Yogendra Pal Singh
> Scientist 'E'
>
> M/o Environment, Forest and Climate Change
> Room No. 236, 2nd Floor, Vayu Wing
> Indira Paryavaran Bhawan
> Jor Bagh, New Delhi-110003
> Tele-fax: 011-20819364
>
> [1]
>
>
> Links:
> ------
> [1] https://amritmahotsav.nic.in/

--
Dr. J.A. Johnson
Scientist - E
Wildlife Institute of India (WII)

Autonomous Institute of MoEFCC
Dehradun - 248001, Uttarakhand, India
Member, MoEFCC EAC (Hydro & River valley Project)
Member, IUCN - Freshwater Fish Specialist Group
Faculty-in-charge, Research Laboratory, WII
Member, Internal Complaint Committee of WII (ICC, under PoSH Act)
Research Advisory Committee Member, Uttarkhand Biodiversity Board
https://wii.gov.in/ja_johnson
https://www.researchgate.net/profile/Jeyaraj-Johnson
https://loop.frontiersin.org/people/1085150/overview

PART – II

ANNEXURE TO THE REPORT

INDEX (ANNEXURES)

****

ANNEXURE – I

Ministry of Environment, Forest & Climate Change has issued the Terms of Reference (ToR) on 31st March 2017 vide Ref.No. J-12011/12017- IA- I(R)-Vide Annx-1

No.J-12011/1/2017-IA-I (R)
Ministry of Environment, Forest & Climate Change
Government of India
[IA-1 Division]

Indira ParyavaranBhavan
3rdFloor, Vayu Wing
Jor Bagh Road
New Delhi -110 003

Date: 31st March, 2017

To
Shri. B.Hariram
Chief Engineer
Kaleshwaram Project,
1st Floor, Jalasoudha Building
Errumanzil,
Hyderabad - 500082.

Subject: Kaleshwaram Project in Karimnagar District of Telangana by Irrigation & CAD Department, Government of Telangana - for TOR - regarding

Sir,

This has reference to your letter No. CE/KPH/DCE-3/AEE-9/EIA&EMP/2016/1637 dated 22.12.2016 and 22.2.2017 on the above mentioned subject.

2. The above referred proposal was considered by the Expert Appraisal Committee (EAC) for River Valley and Hydroelectric Projects (RV&HEP) in its meetings held on 30-31st January, 2017 and 2-3rd March, 2017. The comments and observations of EAC on the project may be seen in the Minutes of the meeting which are available on the web-site of this Ministry.

3. The project envisages construction of a barrage across River Godavari near Medigada village across River Godavari in Karimnagar District of Telangana state for diversion of 180 TMC of water for providing irrigation facility in 7,38,851 ha covering 7 Districts. The project is also proposes to provide drinking water facility for Hyderabad & Secunderabad cities. Total land requirement is about 32,000 ha, out of which 2866 ha is forest land. The total submergence area is about 13,706 ha. In addition to Medigadda barrage, 2 more barrages between Medigadda and Sripada Yellampally projects are likely to be constructed i.e. one at Annaram and other at Sundilla. The total length of water canal system is about 1,832 Km. This is an Interstate project and boundary of the project is nearer to Maharashtra state and 302 ha of area is likely to be submerged in Maharashtra. Total estimated cost of the project is about Rs. 80,499.71 Crores and proposed to be completed in 3 years.

4. Based on recommendations of the EAC, the Ministry of Environment & Forests hereby accords a fresh clearance for pre-construction activities at the proposed site as per the provisions of the Environmental Impact Assessment Notification, 2006 and subsequent amendment, 2009 along with the following Terms of Reference (TOR) for preparation of EIA/EMP reports:

(a) The EIA/ EMP report should contain the information in accordance with provisions & stipulations as given in the **Annexure-I**.

(b) The Consultant engaged for preparation of EIA/EMP report has to be registered with Quality Council of India (QCI)/NABET under the scheme of Accreditation & Registration of MoEF & CC. This is a pre-requisite.

(c) Consultants shall include a "Certificate" in EIA/EMP report regarding portion of EIA/EMP prepared by them and data provided by other organization(s)/ laboratories including status of approval of such laboratories.

(d) The draft EIA/EMP report prepared as per the Annexure-I should be submitted to the State Pollution Control Board/ Committee concerned for conducting Public Consultation as per the provisions stipulated in EIA Notification of 2006. Public Hearing which is a component of Public Consultation shall be held district wise at the site or in its close proximity as prescribed in Appendix (IV) of EIA Notification, 2006. The draft EIA/EMP report is to be submitted to SPCB etc sufficiently before the expiry of the ToR validity so that necessary amendments in EIA/EMP can be undertaken based on public hearing and the same is submitted to MoEF & CC before expiry of validity.

(e) All issues discussed in the Public Heating/Consultations should be addressed and incorporated in the EIA/EMP Report. Final EMP report should be submitted to the Ministry for Environmental Clearance only after incorporating these issues before the expiry of validity of ToR.

(f) The ToR will remain valid for a period of 4 years from the date of issue of this letter for submission of EIA/EMP report along with public consultation. The ToR will stand lapsed on completion of 4 year time in case final EIA/EMP is not submitted and the validity is not extended.

(g) In case of any change in the Scope of the Project such as capacity enhancement, shifting of dam site, change in submergence etc., fresh seeping clearance has to be obtained by the project proponent.

(h) Approval of Forest Clearance Stage-I for the forest area involved in the project is one of the mandatory pre-requisite for grant of Environmental Clearance.

(i) The PP shall submit a copy of TEC of the DPR from CWC along with EIA/EMP report.

(j) Information pertaining to Corporate Environmental Responsibility and Environmental Policy shall be provided in the EIA/EMP Report as per this Ministry's OM No.J-11013/25/2014-IA-I dated 11.8.2014 **(Reference as Annexure-II)**

(k) The EIA/EMP Report must contain an Index showing details of compliance of all ToR conditions. The Index will comprise of page no. etc., vide which compliance of a specific ToR is available. It may be noted that. Without this index, EIA/EMP report will not be accepted.

(l) In case the validity is to be extended, necessary application is to be submitted to Regulatory Authority before expiry of validity period together with an updated Form-I based on proper justification.

This has approval of the Competent Authority.

Yours faithfully,

(Dr S. Kerketta)
Director

Copy to:
1. The Secretary, Ministry of Water Resources, Shram Shakti Bhawan, Rafi Marg-, New Delhi -1.
2. The Principal Secretary (Irrigation), Government of Telangana, Secretariat, Hyderabad - 500 001.
3. The Secretary, Department of Environment & Forests, Government of Telangana, Secretariat Hyderabad - 500 022.
4. The Chief Engineer, Project Appraisal Directorate, Central Water Commission, SewaBhawan, R. K. Puram, New Delhi - 110 066.
5. The Addl. PCCF (C), Ministry of Environment, Forest and Climate Change, Regional Office (SEZ), 1st and 2nd Floor, Handloom Export Promotion Council, 34, Cathedral Garden Road, Nungambakkam, Chennai – 600034
6. The Member Secretary, Telangana State Pollution Control Board, Payavaran Bhawan, Industrial Estate, Sanath Nagar, Hyderabad.
7. NIC Cell - for upload on the MOEF website.
8. PPS to JS(GB)/Director(SKK)/S. Prabhu (Sci-C)
9. Guard File.

(Dr.S.Kerketta)
Director

Annexure-I

TERMS OF REFERENCE FOR CONDUCTING ENVIRONMENT IMPACT ASSESSMENT STUDY FOR 'A' CATEGORY RIVER VALLEY PROJECTS AND INFORMATION TO BE INCLUDED IN EIA/EMP REPORT

(1) Scope of EIA Studies

The EIA Report should identify the relevant environmental concerns and focus on potential impacts that may change due to the construction of proposed project. Based on the baseline data collected for three (3) seasons (Pre-monsoon, Monsoon and winter seasons), the status of the existing environment in the area and capacity to bear the impact on this should be analyzed. Based on this analysis, the mitigation measures for minimizing the impact shall be suggested in the EIA/EMP study.

(2) Details of the Project and Site

- General introduction about the proposed project.
- Details of project and site giving L-sections of all U/S and D/S projects of River with all relevant maps and figures. Connect such information as to establish the total length of interference of Natural River and the committed unrestricted release from the site of diversion into the main river.
- A map of boundary of the project site giving details of protected areas in the vicinity of project location.
- Location details on a map of the project area with contours indicating main project features. The project layout shall be superimposed on a contour map of ground elevation showing main project features (viz, location of dam, Head works, main canal, branch canals, quarrying etc.) shall be depicted in a scaled map.
- Layout details and map of the project along with contours with project components clearly marked with proper scale maps of at least a 1:50,000 scale and printed at least on A3 scale for clarity.
- Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed and presented on a map with distinct distances from the project components.
- Drainage pattern and map of the river catchment up to the proposed project site.
- Delineation of critically degraded areas in the directly draining catchment on the basis of silt Yield Index as per the methodology of All India Soil and Land Use Survey of India.
- Soil characteristics and map of the project area.
- Geological and seismo-tectonic details and maps of the area surrounding the proposed project site showing location of dam site and canal site.
- Remote Sensing studies, interpretation of satellite imagery, topographic sheets along with ground verification shall be used to develop the land use/land cover pattern of the study using overlaying mapping techniques viz. Geographic Information System (GIS), False Color composite (FCC) generated front satellite data of project area.

- Land details including forests, private and other land.
- Demarcation of snow fed and rain fed areas for a realistic estimate of the water availability.

(3) Description of Environment and Baseline Data

To know the present status of environment in the area, baseline data with respect to environmental components air, water, noise, soil, land and biology &biodiversity (flora & fauna), wildlife, socio-economic status etc. should be collected with 10 km radius of the main components of the project/site i.e. dam site and power house site. The air quality and noise are to be monitored at such locations which are environmentally & ecologically more sensitive in the study area. The baseline data should be collected for 3 seasons (Pre-Monsoon, Monsoon and Post Monsoon seasons). Flora/fauna in the catchment area and command area should be documented. The study area should comprise of the following:

- Catchment area up-to the darn site.
- Submergence Area
- Project area or the direct impact area should comprise of area within 10 km radius of the main project components like dam, canal etc.
- Downstream upto 10 km from tip of reservoir.

(4) Details of the Methodology

- The methodology followed for collection of base line data along with details of number of samples and their locations in the map should be included.
- Study area should be demarcated properly on the appropriate scale map.
- Sampling sites should be depicted on map for each parameter with proper legends.
- For forest classification, Champion and Seth (1968) classification should be followed.

(5) Methodology for collection of Biodiversity Data

- The number of sampling locations should be adequate to get a reasonable idea of the diversity and other attributes of flora and fauna. The guiding principles should be the size of the study area (larger area should have larger number of sampling locations) and inherent diversity at the location, as known from secondary sources (e.g. eastern Himalayan and low altitude sites should have a larger number of sampling locations owing to higher diversity).

- The entire area should he divided in grids of 5km X 5km preferably on a GIS domain. There after 25% of the grids should be randomly selected for sampling of which half should be in the directly affected area (grids including project components such as reservoir, clam, powerhouse, tunnel, canal etc.) and the remaining in the rest of the area (areas of influence in 10 km radius form project components). At such chosen location, the size and number of sampling units (e.g. quadrats in case of flora/transects in case of fauna) must be decided by species area curves and the details of the same (graphs and cumulative number of species in a tabulated form) should be provided in the EIA report. Some of the grids on the edges may not be completely overlapping with the study area boundaries. However these should be counted and considered for selecting 25% of the grids. The number of grids to be surveyed may come out as a decimal number (i.e. it has an integral and a fractional part) which should he rounded to the next whole number.

- The conventional sampling is likely to miss the presence of rare, endangered and threatened (R.E.T.) species since they often occur in low densities and in case of faunal species are usually secretive in behavior. Reaching the conclusion about the absence of such species in the study area based on such methodology is misleading. It is very important to document the status of such species owing to their high conservation value. Hence likely presence of such species should be ascertained from secondary sources by a proper literature survey for the said area including referring to field guides which are now available for many taxonomic groups in India. Even literature from studies/surveys in the larger landscapes which include the study area for the concerned project must he referred to since most species from adjoining catchments is likely to be present in the catchments in question. In fact such literature form the entire state *can* be referred to. Once a listing of possible R.E.T. species form the said area is developed, species specific methodologies should he adopted to ascertain their presence in the study area which would be far more conclusive as compared to the conventional sampling. If the need *be,* modern methods like camera trapping can be resorted to, particularly for areas in the eastern Himalayas and for secretive/nocturnal species. A detailed listing of the literature referred to, for developing lists of R.E.T. species should be provided in the EIA reports.
- The R.E.T. species referred to in this point should include species listed in Schedule I and II of Wildlife (Protection) Act, 1972 and those listed in the red data books (BSI, ZSI and IUCN).

(6) Components of the EIA Study

Various aspects to be studied and provided in the EIA/EMP report are as follows:

A. Physical and Chemical Environment

(i) Geographical, Geological & Geophysical Aspects and Seismo-Tectonics:

- Physical geography, Topography, Regional Geological aspects and structure of the Catchment.
- Tectonics, seismicity and history of past earthquakes in the area. A site specific study of the earthquake parameters will be done. The results of the site specific earthquake design shall be sent for approval of the NCSDP (National committee of Seismic Design Parameters, Central water commission, New Delhi. for large dams.
- Landslide zone or area prone to landslide existing in the study area should be examined.
- Presence of important economic mineral deposit, if any.
- Justification for location & execution of the project in relation to structural components (darn height).
- Impact of project on geological environment.

(ii) Meteorology, Air and Noise:

- Meteorology (viz. Temperature, Relative humidity, wind speed/ direction etc.) to be collected from nearest MID station.
- Ambient Air Quality with parameters viz. suspended particulate matter (SPM), respirable suspended particulate matter (RSPM) i.e. suspended particulate matter <10 microns, sulphur dioxide (SO_2) and oxide of Nitrogen (NO_x) in the study area at 10 locations.
- Existing noise levels and traffic density in the study area at 10 locations.

(iii) Soil Characteristics

- Soil classification, physical parameters (viz., texture, porosity, bulk density and water holding capacity) and chemical parameters (viz. pH, electrical conductivity, magnesium, calcium, total alkalinity, chlorides, sodium, potassium, organic carbon, available potassium, available phosphorus, SAR, nitrogen and salinity, etc.) (35 locations).

(iv) Remote sensing and GIS Studies

- Generation of thematic maps viz., slope map, drainage map, soil map, land use **and** land cover map, etc. Based on these, thematic maps, an erosion intensity map should be prepared.
- New configuration map to be given in the EIA Report.

(v) Water Quality

- History of the ground water table fluctuation in the study area.
- Water quality for both surface water and ground water for (i) Physical parameters (pH, temperature, electrical conductivity, TSS); (ii) Chemical parameters (Alkalinity, Hardness, BOD, COD, NO2, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & Grease, phenolic compounds, residual sodium carbonate); (iii) Bacteriological parameter (MPN, Total conform) and (iv) Heavy Metals (Pb, As, Fig, Cd, Cr-6, total Cr, Cu, Zn, Fe) (35 locations).
- Delineation of sub and micro-watersheds, their locations and extent based on the All India Soil and Land Use Survey of India (AISLUS), Department of Agriculture, Government of India. Erosion levels in each micro-watershed and prioritization of micro-watershed through silt yield index (SYI) method of AISLUS

B. Water Environment and Hydrology

- Hydro-Meteorology of the project viz. precipitation (snowfall, rainfall), temperature, relative humidity, etc. Hydro-meteorological studies in the catchment area should be established along-with real time telemetry and data acquisition system for inflows monitoring.
- Run off, discharge, water availability for the project, etc.
- Basin characteristics.
- Catastrophic events like cloud bursts and flash floods, if any, should be documented.
- For estimation of Sedimentation Rate, direct sampling of river flow is to be done during the EIA study. The study should be conducted for minimum 1 year actual silt flow rate to be expressed in ha-in km^2 year-1.

- Sedimentation data available with CWC may be used to find out the loss in storage over the years.
- Set-up G&D monitoring station in the catchment area for collecting data during the investigation.
- Flow series, 10 daily with 90%, 75% and 50% dependable years discharges.
- A table of 10 daily water discharge in 75% dependable year showing the intercepted discharge at the barrage, diversion for irrigation, environmental and other flow releases downstream of the barrage shall be included in the EIA report.
- Norms for release of Environmental flows, i.e. 30% in monsoon season, 20% in lean season and 25% in non-monsoon & non-lean season to be followed corresponding to 90%dependable year. A site specific study on minimum environment flow should be carried out
- Hydrological studies/data as approved by CWC shall be utilized in the preparation of ETA/EMP report. Actual hydrological annual yield may also be given in the report.
- A minimum of 1 km distance from the tip of the reservoir to the tail race tunnel should be maintained between upstream and downstream projects.

C Biological Environment

Besides primary studies, review of secondary data/literature published for project area on flora & fauna including RET species shall be reported in EIA/EMP report

(i) Flora

- Characterization of forest types (as per Champion and Seth method) in the study area and extent of each forest type as per the Forest Working Plan.
- Documentation of all plant species i.e. Angiosperm, Gymnosperm, Pteriodophytes, Bryophytes (all groups). All species list should be provided.
- General vegetation profile and floral diversity covering all groups of flora including *lichens* and orchids. A species wise list may be provided.
- Assessment of plant species with respect to dominance, density, frequency, abundance, diversity index, similarity index, importance value index (WI) , Shannon Weiner index etc. of the species to be provided. Methodology used for calculating various diversity indices along with details of locations of quadrates, size of quadrates etc. to be reported within the study area in different ecosystems.
- Existence of National park, Sanctuary, Biosphere Reserve etc in the study area, if any, should be detailed.
- Economically important species like medicinal plants, timber, fuel wood etc.
- Details of endemic species found hi the project area.
- Flora under RET categories should be documented using International Union for the Conservation of Nature and Natural Resources (IUCN) criteria and Botanical Survey of India's Red Data list along-with economic significance. Species diversity curve for RET species should be given.
- Cropping pattern and Horticultural Practices in the study area.
- Biodiversity study shall be carried out by associating a reputed organization as per the list of such institutes is available on MoRF & CC website.

(ii) Fauna:

- Fauna study and inventorisation should be carried out for all groups of animals in the study area. Their present status along with Schedule of the species.
- Information (authenticated) on Avi-fauna and wildlife in the study area.
- Status of avifauna their resident/ migratory/ passage migrants etc.
- Documentation of butterflies, if any, found in the area.
- Details of endemic species found in the project area.
- RET species-voucher specimens should be collected along-with GPS readings to facilitate rehabilitation. RET faunal species to be classified as per IUCN Red Data list and as per different schedule of Indian Wildlife (Protection) Act, 1972.
- Existence of barriers and corridors, if any, for wild animals.
- Compensatory afforestation to compensate the green belt area that will be removed, if any, as part of the proposed project development and loss of biodiversity.
- Collection of primary data on agricultural activity, crop and their productivity and irrigation facilities components.

D Aquatic Ecology

- Documentation of aquatic fauna like macro-invertebrates, zooplankton, phytoplantkton, benthos etc.
- Fish and fisheries, their migration and breeding grounds.
- Fish diversity composition and maximum. length& weight of the measured populations to be studies for estimation of environmental flow.
- Conservation status of aquatic fauna.

E Socio-Economic

- Collection of baseline data on human settlements, health status of the community and existing infrastructure facilities for social welfare including sources of livelihood, job opportunities and safety' and security of workers and surroundings population.
- Collection of information with respect to social awareness about the developmental activity in the area and social .welfare measures existing and proposed by project proponent.
- Collection of information on sensitive habitat of historical, cultural and religious and ecological importance.
- The socio-economic survey/ profile within 10 km of the study area for demographic profile; Economic Structure; Developmental Profile; Agricultural Practices; Infrastructure, education facilities; health and sanitation facilities; available communication network etc.
- Documentation of demographic, Ethnographic, Economic Structure and development profile of the area.
- Information on Agricultural Practices, Cultural and aesthetic sites, Infrastructure facilities etc.
- Information on the dependence of the local people on minor forest produce and their cattle grazing rights in the forest land.
- List of all the Project Affected Families with their name, age, educational qualification, family size, sex, religion, caste, sources of income, land &house holdings, other properties, occupation, source of income., house/land to be

acquired for the project and house/land left with the family, any other property, possession of cattle, type of house etc.

- In addition to socio-economic aspects of the study area, a separate chapter on socio-cultural aspects based upon study on Ethnography of the area should be provided.

(7) Impact Prediction and Mitigation Measures

The adverse impact due to the proposed project should be assessed and effective mitigation steps to abate these impacts should be described,

(i) Air Environment

- Changes in ambient and ground level concentrations due to total emissions from point, line and area sources.
- Effect on soil, material, vegetation and human health.
- Impact of emissions from DG set used for power during the construction, if any, on air environment.
- Pollution due to fuel combustion in equipment and vehicles
- Fugitive emissions from various sources
- Impact on micro-climate

(ii) Water Environment

- Changes in surface and ground water quality
- Steps to develop pisci-culture and recreational facilities
- Changes in hydraulic regime and downstream flow.
- Water pollution due to disposal of sewage
- Water pollution from labour colonies/ camps and washing equipment.

(iii) Land Environment

- Adverse impact on land stability, catchment of soil erosion, reservoir sedimentation and spring flow (if any) (a) due to considerable road construction / widening activity (b) interference of reservoir with the inflowing stream (c) blasting_ for commissioning of HRT, TRT and some other structures.
- Changes in land use / land cover and drainage pattern
- Immigration of labour population
- Quarrying operation and muck disposal
- Changes in land quality including effects of waste disposal
- River bank and their stability
- Impact clue to submergence.

(iv) Biological Environment

- Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc.
- Pressure on existing natural resources
- Deforestation and disturbance to wildlife, habitat fragmentation and wild animal's migratory corridors
- Compensatory afforestation-identification of suitable native tree species for compensatory afforestation and green belt.
- Impact on fish migration and habitat degradation due to decreased flow of water

- Impact on breeding and nesting grounds of animals and fish.

(v) Socio-economic aspects

- Impact on local community including demographic profile.
- Impact on socio-economic status
- Impact on economic status.
- Impact on human health due to water / vector borne disease
- Impact on increase traffic
- Impact on Holy Places and Tourism
- Impacts of blasting activity during project construction which generally destabilize the land mass and. leads to landslides, damage to properties and drying up of natural springs and cause noise population will be studies. Proper record shall be maintained of the baseline information in the post project period.
- Positive and negative impacts likely to be accrued due to the project are listed.

(8) Environmental Management Plans

- **Catchment Area Treatment (CAT)** Plan should be prepared micro-watershed wise. Identification of free draining/ directly draining catchment based upon Remote Sensing and. Geographical Information System (GIS) methodologyand Sediment Yield Index (SYI) method of SLUSOI coupled with ground survey. Areas or watersheds falling under 'very severe' and 'severe' erosion categories are required to be treated. Both biological as well as engineering measures should be proposed in consultation with State Forest Department. Year-wise schedule of work and monetary allocation should be provided. Mitigation measures to check shifting cultivation in the catchment area with provision for alternative and better agricultural practices should be included.
- **Command Area Development (CAD) Plan** giving details of implementation schedule with a sample CAD plan.
- **Compensatory Afforestation** shall be prepared by the State Forest. Department in lieu of the forest land proposed to be diverted for construction of the project as per the Forest (Conservation) .Act, 1980. Choice of plants for afforestation should include native and RET species, if any.
- **Biodiversity and Wildlife Conservation and Management Plan** for the conservation and preservation of rare, endangered or endemic floral/ faunal species or some National Park/Sanctuary/ Biosphere Reserve or other protected area is going to get affected directly or indirectly by construction of the project, then suitable conservation measures should be prepared in consultation with the State Forest Department.
- **Resettlement and Rehabilitation** (R&R) **Plan** need to be prepared with consultation of the project affected families and the State Government: Detailed budgetary estimates are to be provided. Resettlements site should be identified. The plan will also incorporate community development strategies.*Land acquisition for the project whose land is to be acquired should be suitably compensated in accordance with the law of the land and prevailing guidelines. R&R Plan is to be formulated as per new Act, 2013 which came into force w.e.f. 1.1.2014.*

- **Green Belt Development Plan** along the periphery of the reservoir, approach roads around the colonies and other project components, local plant species must be suggested with physical and financial details. Local plant species suitable for greenbelt should be selected.

- **Fisheries Conservation and ManagementPlan** – Fish fauna inhabiting the affected stretch of river, a specific fisheries management plan should be prepared for river and reservoir. If any migratory fish species is getting affected then the migratory routes, time/season of upstream and downstream migration, spawning grounds etc will be discussed in details.

- **Reservoir Rim Treatment Plan** for stabilization of land slide/ land slip zones, if any, around the reservoir periphery is to be prepared based on detailed survey of geology of the reservoir rim area. Suitable engineering and biological measures for treatment of identified slip zones to be suggested with physical and financial schedule.

- **Muck Disposal Plan** suitable sites for dumping of excavated materials should be identified in consultation with State Pollution Control Board and State Forest Department. All muck disposal sites should be minimum 30 in away from the HFL of river. Plan for rehabilitation of muck disposal sites should also be given. The L-section/cross section of muck disposal sites and approach roads should be given. The plan shall have physical and financial details of the measures proposed.

- **Plan forRestoration of quarry sites** and landscaping of colony areas, working areas, roads etc. Details of the coarse/fine aggregate/clay etc. required for construction of the project and the rock/clay quarries/river shoal sites identified for the project should be discussed along-with the engineering and Biological measures proposed for their restoration with physical and financial details.

- **Study of Design Earthquake Parameters**: A site specific study of earthquake parameters should be done. Results of the site specific earthquake design parameters should be approved by National Committee of Seismic Design Parameters, Central Water commission (NCSDP), New Delhi.

- **Dam Break Analysis and Disaster Management Plan**The outputs of dam break model should be illustrated with appropriate graphs and maps clearly bringing out the impact of Dam Break scenario. The action plan will include Emergency Action and Management plan including measures like preventive action notification, warning procedure and action plan for co-ordination with various authorities.

- **Water, Air and Noise Management Plans** to be implemented during construction and post-construction periods.

- Mitigation measures due to blasting on the structures in the vicinity

- **Groundwater management plan**

- **Public Health Delivery Plan** including the provisions of drinking water supply for local community.

- **Sanitation and Solid waste management plan** for domestic waste from colonies and labour camps etc.

- **Local Area Development Plan** to be formulated in consultation with the Revenue Officials and. Village Pancahayats. Local skill development schemes should be given. Details of various activities undertaken along with its financial outlay should be provided.
- Environmental safeguards during construction activities including Road Construction.
- **Energy Conservation Measures**
- **Environmental Monitoring Programme**with physical & financial details covering all the aspects of EMP. A summary of cost e estimates for all the plans, cost of implementing all the Environmental Management Plans.

(9) In the EMP, please include a sample CAD plan for a distributary outlet command. Such a plan is to show the alignment of irrigation and drainage channels. The components of the OFD works to be undertaken may be clearly mentioned along with a time schedule for their completion vis-&-vis the progress of irrigation development.

*****

Annexure A-II 17

No.J-11013/25/2014-IA.I
Government of India
Ministry of Environment & Forests

Indira ParyavaranBhawan,
JorBagh Road, Ali Ganj,
New Delhi-11003

Dated the 11th August, 2014

OFFICE MEMORANDUM

Subject: Environment sustainability and CSR related issues-guidelines

The Environment Impact Assessment (EIA) Notification 2006, issued under the Environment (Protection) Act 1986, as amended from time to time, prescribes the process for granting prior environment clearance (EC) in respect of certain development projects / activities listed out in the Schedule to the notification.

2. Sustainable development has three components, viz., social, economic and environmental. All the three components are closely inter-related and mutually re-enforcing. Considering this, the general structure of EIA document, under Appendix-III to the notification, prescribes inter-alia public consultation, social impact assessment and R&R action plan besides environment management plan (EMP).

3. It is noticed that while there is clarity on the guidelines on EMP, as regards sustainability related issues, different formulations have been prescribed in the conditions in EC letters for the projects under different sectors listed out in Schedule to the EIA Notification, 2006. Thus, there is a need to issue guidelines on the subject.

4. Section 135 of the Companies Act, 2013 deals with corporate social responsibility and Schedule-VII of the Act lists out the activities which may be included by companies in their CSR Policies. The activities relating to "ensuring environmental sustainability", are listed in this schedule. Further, Ministry of Corporate Affairs has also notified the Companies (Corporate Social Responsibility Policy) Rules, 2014.

5. The concept of CSR as provided for in the Companies Act, 2013 and covered under the Companies (Corporate Social Responsibility Policy) Rules, 2014 comes into effect only in case of companies having operating projects and making net profit as also subject to other stipulations contained in the aforesaid Act and Rules. The environment clearance given to a project may involve a situation where the concerned company is yet to make any net profit and / or is not covered under the purview of the aforesaid Act and Rules. Obviously, in such cases, the provisions of aforesaid Act and Rules will not apply.

6. The matter has been further examined in the Ministry of Environment, Forests & Climate Change (MoEF&CC). It has been decided that in respect of valid concerns expressed during the public consultations, mitigation issues emerging from social impact assessment and R&R Plan, the project proponents, in EIA / EMP report will clearly state the activity-wise costs involved (both capital as well as recurring costs), the phasing of these activities along with costs and also as to how such expenditure would be met. The costs and the timelines for various activities as prepared by the project proponent may be looked into by the concerned Expert Appraisal Committee (EAC) for their reasonableness and appropriate recommendations in the matter reflected in the minutes of EAC meeting. In case these activities (or some of these activities) are proposed to be covered by the project proponent under CSR activities, the project proponent should commit providing for the same. In either case, the position regarding the agreed activities, their funding mechanism and the phasing should be clearly reflected in the EC letter.

7. The obligation on part of the project proponents, as mentioned in para5 above, should be stated at the TOR stage itself as one of the TORs for the project.

8. All Sectoral EACs will follow the aforesaid procedure on environment sustainability and CSR related issues while appraising the projects and do away with the existing practices being followed on the subject, if any.

9. These guidelines will apply mutatis mutandis to SEACs/SEIAAs.

10. This issues with the approval of the Component Authority.

11/8/14

(Dr. Satish C.Garkoti)
Scientist 'F'

To

1. All the Officers of IA Division
2. Chairpersons / Member Secretaries of all the SEIAAs / SEACs
3. Chairman, CPCB
4. Chairpersons / Member Secretaries of all SPCBs / UTPCCs

Copy to:

1. PS to MEF
2. PPS to Secretary (EF&CC)
3. PPS to AS(SS)
4. PPS to JS(AT)
5. Website of MoEF&CC
6. Guard File

Issued by Speed Post
19/8/14

ANNEXURE – II

Ministry of Environment, Forest & Climate Change granted Environment Clearance on 22nd December 2017 vide Ref.No. J-12011/1/2017-IA-I(R) Vide Annx-

No. J-12011/1/2017-IA-I(R)
Government of India
Ministry of Environment, Forest & Climate Change
[IA.I - Division]

Indira Paryavaran Bhavan
3rd Floor, Vayu Wing
Jor Bagh Road
New Delhi —110 003

Dated: 22nd December, 2017

To,

Shri B. Hariram
The Chief Engineer
Kaleshwaram Project
1st Floor, Jalasoudha Building
Errumanzil
Hyderabad - 500082.

Subject: Kaleshwaram Project in Karimnagar District of Telangana by I & CAD Department, Government of Telangana - Environmental Clearance (EC) - regarding.

Sir,

This has reference to your letter No.CE/KPH/DCE-3/DEE-3/AEE-9/EIA&EMP/Vol.II/2017 dated 16.11.2017 and 26.11.2017 on the above mentioned subject.

2. The above referred proposal was considered by the Expert Appraisal Committee (EAC) for River Valley & Hydroelectric Projects in its meeting held on 5.12.2017. The comments and observations of EAC on the project may be seen in the Minutes of the meeting which are available on the web-site of this Ministry.

3. The Public Hearings were conducted in 15 Districts (i.e. Karimnagar on 22.8.2017, Nizamabad on 22.8.2017, Medchal-Malkajgiri on 22.8.2017, Yadagdri-Bhunanagiri on 22.8.2017; Peddapally on 23.8.2017, Nalgonda on 23.8.2017, Sangareddy on 23.8.2017, Kamareddy on 23.8.2017; Nirmal on 24.8.2017, Jagityal on 24.8.2017, Medak on 26.8.2017, Jayashankar-Bhupalapally on 26.8.2017, Manchiryal on 26.8.2017, Rajanna Sircilla on 26.8.2017 & Siddipet on 26.8.2017) of Telangana and 1 District (Gadchiroli on 27.9.2017) of Maharashtra as per the provisions of EIA Notification, 2006.

4. The project envisages construction of a barrage across River Godavari in near Medigadda village in Karimnagar District of Telangana for diversion of 180 TMC of water for providing irrigation facility in 7,38,851 ha covering 7 Districts namely Adilabad, Karimnagar, Nizamabad, Warangal, Medak, Nalgonda and Rangareddy Districts. It is also proposed to stabilize the existing command area of 7,62,028 ha of area. The project is also proposes to provide drinking water facility for Hyderabad and Secunderabad cities. Total land requirement is about 37,852 ha. Out of which

3168.1315 ha is forest land and 34,684 ha is private land. The total submergence area is about 18,302 ha. In addition to Medigadda barrage, 2 more barrages between Medigadda and Sripada Yellampally Project are likely to be constructed, one at Annaram and the other at Sundilla. The total length of water canal system is about 1,832 km. This project lies in the interstate boundary with submergence of 174.37 ha of area in Maharashtra State. Total estimated cost of the project is about Rs. 80,499.71 Crores and proposed to be completed in 3 years.

5. It was noted that the project involves (i) diversion of 180 TMC water from Godavari river, (ii) additional 20 TMC water will be drawn from Yellampally barrage, (iii) 10 TMC of water from self-yield tanks and (iv) 25 TMC of water from utilizable groundwater; put together 225 TMC of net water availability. Out of this, 30 TMC of water will be used for providing drinking water facility for twin cities of Hyderabad and Secunderabad, 10 TMC of water to en-route villages, 16 TMC of water for Industrial purpose, 134.5 TMC for irrigation facility in 7,38,851 ha of new command area and 34.5 TMC of water for stabilization of 7,62,028 ha of area. The CWC has cleared water availability vide letter No. 6-231/2017-PA(S)/1327-28 dated 30.10.2017 for the project.

6. The Expert Appraisal Committee, after due consideration of the relevant documents submitted by the project proponent and clarification furnished in response to its observations, have recommended for grant of Environmental Clearance for the project mentioned above. Accordingly, the Ministry of Environment, Forest & Climate Change hereby accords necessary environmental clearance for the above project as per the provisions of Environment Impact Assessment Notification, 2006 and its subsequent amendment in 2009, subject to compliance of following conditions:

Part – A - Specific Conditions:

i. The Catchment Area Treatment (CAT) Plan as has been proposed in the Chapter-9 of EMP (9.1 - CAT Plan; November, 2017) shall be implemented in consultation with the Telangana State Forest Department. The allocated grant of Rs. 362.04 Crores for this purpose should be fully utilized and not be diverted for any other purpose. As per plan, the area of CAT is 32.83 Sq.km.

ii. The project involves acquisition of 34,684 ha of land. The R&R benefits for the land losing will have to comply with the Right to Fair Compensation and Transparency in land acquisition, Rehabilitation & Resettlement Act, 2013 or any other act which would be beneficial to the project oustees. Adequate publicity of the compensation package should be circulated in the affected villages. All R&R issues shall be completed before commissioning of the project.

iii. Construction work to be carried-out after following due procedure of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 as applicable to the State of Telangana (21/2017) as amended by Act.

iv. A Monitoring Committee for R&R shall be constituted which shall include representatives of project affected persons including representative from SC/ST category and a woman beneficiary.

v. All commitment made during the public hearing should be fulfilled completely by the project proponent and record maintained, if any.

vi. The Command Area Development (CAD) Plan as proposed in the EIA/EMP report (November, 2017) report shall be strictly implemented.

vii. Consolidation and compaction of the generated muck should be carried-out in the muck dumping sites. As proposed in the muck disposal plan, out of 1480 lakh m^3 muck generated, the entire to be utilized for service road & inspection paths, embankments, land leveling, filling trenches, and construction material for CD works, road etc. and restoration works for canal banks should be strictly adhered. The muck disposal sites shall be reclaimed/ restored with vegetation once capacity is utilized. Allocated amount of Rs.32.79 crores for this purpose should be fully utilized and not be diverted for any other purpose.

viii. The proposed compensatory afforestation programme in 5333.817 ha of degraded forest area with twenty two (22) local plant species identified for the programme shall be undertaken strictly in consultation with State Forest Department. The allocated amount of Rs. 722.30 Crores for this purpose should be fully utilized and not to be diverted for any other purpose.

ix. To enhance the environment of project site, greenbelt, as proposed in the EIA/EMP report (November, 2017) shall be developed. The proposed greenbelt shall be developed in the barrages of the project and reservoirs periphery of 110.20 km and canal bank of 116.334 km of the project proposed with local plant species in consultation with State Forest Department should be taken-up strictly. The allocated grant of Rs. 19.21 Crores should be fully utilized this purpose and not be diverted for any other purpose.

x. The Fisheries Development Plan as proposed in the EIA/EMP (November, 2017) for the conservation of fish in river & reservoir shall be implemented completely in consultation State Fisheries Department. A budget of Rs. 485 Crores provided for fisheries development plan should be utilized fully for this purpose and not to be diverted for any other purpose.

xi. The proposed Biodiversity Conservation and Management Plan as proposed in the EIA/EMP report (November, 2017) should be implemented in consultation with State Forest Department. The allocated grant of Rs. 3.36 Crores should be fully utilized this purpose and not be diverted for any other purpose.

xii. Water User Association's (WUAs) / Co-operative shall be formed and involvement of the whole community for disciplined use of available waters shall be ensured.

xiii. Conjunctive use of surface water shall be planned to check water logging as well as to increase productivity.

xiv. The equipment likely to generate high noise levels during the construction period or otherwise shall meet the ambient noise level standards as notified under the Noise Pollution (Regulation and Control) Rules, 2000, as amended in 2010 under the Environment Protection Act (EPA), 1986. Ambient Noise level monitoring shall be conducted on a monthly basis during the period of construction at suitable locations and copy of the test reports to be submitted to Regional Office, MoEF & CC, Chennai on six monthly basis.

xv. The On Farm Development (OFD) works shall be completed and WUAs (Water User Associations) shall be made functional before commencement of irrigation.

xvi. Occurrence of stagnant pools/slow moving water channels during construction and operation of the project providing breeding source for vector mosquitoes and other parasites. The river should be properly channelized so that no small pools and puddles are allowed to be formed. Even after taking precautions, due to un-foreseen situations, breeding of mosquito and resultant malaria or mosquito borne diseases can increase. If such a situation arises, it will be the responsibility of project authorities to take all steps i.e. residual insecticidal spray in all the project area and surrounding 3 km area keeping the flight range of mosquitoes in consideration.

xvii. Any other clearance from any other organization/department if required should be obtained.

xviii. The submergence area is very large, micro-climatic change conditions in the project area during construction/post-construction period to be brought-out/reported at regular intervals.

xix. Plans for greenbelt development and reservoir rim treatment have to be made in consultation with State Forest Department. Preference shall also be given to plant local indigenous species.

xx. Solid waste generated, especially plastic waste should not be disposed of as landfill material. It should be treated with scientific approach and recycled.

xxi. Six monthly compliance reports shall be submitted to Regional Office, MoEF & CC, Chennai until completion of the modernization works.

Part - **B. General Conditions:**

i. Adequate arrangements for providing free fuel like LPG shall be made at the project cost for the labour engaged in the construction work so that indiscriminate felling of trees is prevented.

ii. Medical facilities as well as recreational facilities shall also be provided to the labourers.

iii. The labourers to be engaged for construction works shall be thoroughly examined by health personnel and adequately treated before issuing them work permit.

iv. Water sprinkling arrangements shall be made to suppress the fugitive emissions and on monthly basis, ambient air quality to be monitored during the period of construction.

v. Potable drinking water and proper sanitary facilities shall be provided for the labour force.

vi. Restoration of construction area including dumping sites of excavated materials shall be ensured by leveling, filing up of borrow pits, landscaping etc. The area should be properly treated with suitable plantation.

vii. Environmental parameters shall be monitored and six monthly monitoring reports shall be submitted to the concerned Regional Office of the Ministry, Chennai.

7. The Project Proponent shall provide full cooperation and all required documents / data to the Officials from concerned Regional Office of the Ministry, Chennai who would be monitoring the implementation of environmental safeguards.

8. The responsibility of implementation of environmental safeguards and carrying out environmental monitoring rests fully with Irrigation & CAD Department, Government of Telangana.

9. Besides the above stated conditions, the Project Proponent shall also implement all environmental safeguards, as proposed in the EIA/EMP report and other reports from time to time. The Regional Office of the Ministry, Chennai shall monitor implementation of EMP at regular intervals.

10. The Environmental Management Plan (EMP) shall be strictly adhered to and a sum of Rs. 16230.43 crores, the budgetary provisions for the implementation of EMP, shall be fully utilized and not to be diverted to any other purpose. In case of revision of the project cost or due to price level change, the cost of EMP shall also be updated proportionately.

11. In case of change in the scope of the project, the same shall be intimated to the Ministry and fresh approval, if required, shall be taken from the Ministry.

12. The Ministry reserves the right to add additional safeguard measures subsequently, if found necessary and to take action including revoking of the clearance under the provisions of the Environment (Protection) Act, 1986, to ensure effective implementation of the suggested safeguard measures in a time-bound and satisfactory manner.

13. This clearance letter is valid for a period of 10 years from the date of issue of this letter for commencement of construction work of the project.

14. A copy of the clearance letter shall be marked to concerned Panchayat/Zilla Parishad/ Municipal Corporation, Urban local body and local NGO, if any, from whom any suggestion/representations were received while processing the proposal. The clearance letter shall also be put on website by the project proponent.

15. State Pollution Control Board / Committee shall display a copy of the clearance letter at the Regional Office, District Industries Centre and Collector's / Tehsildar's Office for 30 days.

16. The project proponent should advertise at least in two local newspapers widely circulated in the region around the project, one of which shall be in vernacular language of the locality concerned informing that the project has been accorded environmental clearance and copies of clearance letters are available with the State Pollution Control Board / Committee and may also be seen at Website of the Ministry of Environment, Forest & Climate Change at http://www.moef.nic.in .

17. After 5 years of the commissioning of the Project, a study shall be undertaken regarding impact of the project on the environment and downstream ecology. The study shall be undertaken by an independent agency, decided in consultation with the Ministry.

18. The project proponent shall also submit six monthly reports on the status of compliance of stipulated EC conditions including the results of monthly monitored data (both in hard copies as well as by email) to the respective Regional Office of MoEF&CC, Chennai.

19. Any appeal against this environmental clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days from the date of issue, as prescribed under Section-16 of the National Green Tribunal Act, 2010.

Yours faithfully,

Kerketta

o/c

(Dr.S. Kerketta)
Director

Copy to:

1. The Secretary, Ministry of Water Resources, RD & GR, Shram Shakti, Bhawan, Rafi Marg, New Delhi 1.
2. The Special Chief Secretary, Irrigation & CAD Department, Government of Telangana, 5th Floor, B- Block, Secretariat, Hyderabad – 500 001.
3. The Principal Secretary, Environment, Forests, Science and Technology Department, Government of Telangana, 3rd Floor, D- Block, Secretariat, Hyderabad-500 001.
4. The Chief Engineer, Project Appraisal Directorate, Central Water Commission, Sewa Bhawan, R.K. Puram, New Delhi-110066.
5. The Addl. PCCF (Central), Regional Office (SR), Ministry of Environment, Forest & Climate Change, Regional Office (SEZ), 1st and 2nd Floor, Handloom Export Promotion Council, 34, Cathedral Garden Road, Nungambakkam, Chennai - 600034.
6. The Member Secretary, Telangana State Pollution Control Board, Payavaran Bhawan, Industrial Estate, Sanath Nagar, Hyderabad.
7. Guard file/Notice Board.

Kerketta

(Dr.S. Kerketta)
Director

Issued
22/12/17

ANNEXURE – III

Ministry of Environment, Forest & Climate Change granted Stage-1 Forest Clearance vide F.NO8-31/2017-FC Dt:24/10/2017-Annx-3

F. No. 8-31/2017-FC
Government of India
Ministry of Environment, Forests and Climate Change
(Forest Conservation Division)
****

Indira Paryavaran Bhawan
Aliganj, Jorbagh Road
New Delhi – 110 003
Dated: 24th October, 2017

To

The Principal Secretary to the Government of Telangana
Environment, Forests, Science & Technology Department
Telangana Secretariat
Hyderabad.

Sub: Diversion of 3168.131 hectares (revised from 3221.2974 ha) of forest land in 8 different forest divisions viz. Mahadevpur, Karimnagar-Sircilla, Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal Forest Divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc involved in Kaleshwaram project in different district of Telangana State in favour of Chief Engineer, Kaleshwaram project under TDWSP.

Sir,

I am directed to refer to the State Government of Telangana's letter No. 3747/For.I (1)/2014 dated 27.03.2017 on the above mentioned subject, wherein prior approval of the Central Government for diversion of 3168.131 hectares (revised from 3221.2974 ha) of forest land in 8 different forest divisions viz. Mahadevpur, Karimnagar-Sircilla, Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal Forest Divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc involved in Kaleshwaram project in different district of Telangana State in favour of Chief Engineer, Kaleshwaram project under TDWSP, was sought in accordance with section 2 of the Forest (Conservation) Act, 1980. The said proposal has been examined by the Forest Advisory Committee constituted by the Central Government under Section-3 of the aforesaid Act.

2. After careful consideration of the proposal of the State Government and on the basis of the recommendations of the Forest Advisory Committee, ***in-principle/Stage – I approval*** of the Central Government is hereby granted for diversion of 3168.131 hectares (revised from 3221.2974 ha) of forest land in 8 different forest divisions viz. Mahadevpur, Karimnagar-Sircilla, Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal Forest Divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc involved in Kaleshwaram project in different district of Telangana State in favour of Chief Engineer, Kaleshwaram project under TDWSP, subject to the following conditions:-

(i) Legal status of the diverted forest land shall remain unchanged;

(ii) Compensatory afforestation over the non-forest land equal in extent to the forest land being diverted shall be raised on identified land within a period of three years with effect from the date of issue of Stage-II clearance and maintained thereafter in accordance with the approved plan in consultation with the State Forest Department at the cost of the user agency;

(iii) The non-forest land identified for raising compensatory afforestation shall be transferred and mutated in favour of the State Forest Department before issue of the Stage-II clearance;

(iv) Non-forest land to be transferred and mutated in favour of the State Forest Department for raising Compensatory Afforestation shall be notified as reserved Forest under Section-4 or Protected Forest under Section-29 of the Indian Forest Act, 1927 or under the relevant Section(s) of the local Forest Act. The Nodal officer must report compliance within a period of 6 month from the date of grant of final approval and send a copy of the notification declaring the revenue land under Section 4 or Section 29 of the Indian Forest Act, 1927, or under the relevant section of the local Forest Act as the case may be, to this Ministry for information and record.

(v) The land identified for the purpose of CA shall be clearly depicted on a Survey of India topo sheet of 1:50,000 scale;

(vi) The User Agency shall transfer the cost of raising and maintaining the compensatory afforestation at the current wage rate in consultation with State Forest Department in the account of Ad-hoc Campa of the concerned State **through online portal**. The scheme may include appropriate provision for anticipated cost increase for works scheduled for subsequent years.

(vii) The User Agency shall transfer the funds for the Net Present Value (NPV) of the forest land being diverted under this proposal from the User Agency as per the orders of the Hon'ble Supreme Court of India dated 28.03.2008, 24.04.2008 and 09.05.2008 in Writ Petition (Civil) No. 202/1995 and the guidelines issued by this Ministry vide its letter No. 5-3/2007-FC dated 05.02.2009 through online portal of Ad-hoc CAMPA account of the State Concerned.

(viii) At the time of payment of the Net Present Value (NPV) at the then prevailing rate, the User Agency shall furnish an undertaking to pay the additional amount of NPV, if so determined, as per the final decision of the Hon'ble Supreme Court of India;

(ix) Any fund received from the user agency under the project, except the funds realized for regeneration/ demarcation of safety zone, shall be transferred to Ad-hoc CAMPA through online portal of Ad-hoc CAMPA account of the State Concerned;

(x) **The State Govt. shall obtain clearance from the Standing Committee of NBWL of the proposed area falls in ESZ;**

(xi) **Since the proposed area for CA is refractory in nature, the CA shall be revised and atleast1600 tall plants per hectare (3168.131 hectares x 1600 = 5069010 plants) shall be planted over identified non-forest land. CA will be carried out in large size pits (0.60 m x 0.6 m x 0.6 m). Good soil will be brought to replace existing inert soil dug out from the pits and at least 2 years old tall plants will be planted with provision for ten years on subsequent maintenance.**

(xii) **25% of revised CA cost will be deposited extra by the user agency for soil and moisture conservation (SMC) activities on the CA land.**

(xiii) **Penal compensatory afforestation shall be done over 8.0 ha which is double the area of 3.9694 ha used by the user agency in violation on degraded forest land in the state and deposit the required fund in compensatory afforestation fund maintained by CAMPA.**

(xiv) **The civil structures recommended in the project shall be designed in such a way to allow smooth passage of the wild animals. The Forest Department shall prepare a Plan of Action to utilize the water potential available nearby for the benefit of forest crop and also to the wild animals.**

(xv) **Though the proposed area does not involve protected areas notified under Wildlife Protection Act 1927, due to rapid infrastructure development leading to fragmentation of landscape, there is a greater need to protect the wildlife habitat in the forest area. The state government shall take appropriate measures for the following in the project area to increase the fodder availability in the forest for wildlife, desilting of tanks and water holes in the forest areas to increase the water availability for wildlife, anti-poaching strategy and Anti-encroachment strategy, provision of salt licks and launching of public awareness programmes.**

(xvi) **The works in the areas falling in the eco-sensitive zone shall be carried out after getting due permission form competent authority.**

(xvii) **Some parts of the proposals are falling within 10 km radius of the Wildlife Sanctuary / Protected Area. The State Government officials stated that the draft notification for eco-sensitive zone has been prepared and submitted to MoEF and the said project area was outside the boundaries of eco-sensitive zone proposed in the draft notification and therefore should be treated as falling outside the eco-sensitive zone.The State Govt. shall follow the regulation on eco-sensitive zone, if applicable.**

(xviii) **The order of the NGT and other courts, which may be pending against this proposal, may be complied by the state government;**

(xix) A Catchment area treatment plan as approved by State Government be implemented by/or under the supervision of State Forest Department at the project cost;

(xx) The User Agency shall provide fuels preferably alternate fuels to the labourers and the staff working at the site so as to avoid any damage and pressure on the nearby forest areas;

(xxi) The boundary of the diverted forest land, mining lease and safety zone, as applicable, shall be demarcated on ground at the project cost, by erecting four feet high reinforced cement concrete pillars, each inscribed with its serial number, forward and back bearing ,distance from pillar to pillar and GPS co-ordinates;

(xxii) The layout plan of the proposal shall not be changed without the prior approval of the Central Government;

(xxiii) The forest land shall not be used for any purpose other than that specified in the proposal;

(xxiv) The forest land proposed to be diverted shall under no circumstances be transferred to any other agency, department or person without prior approval of the Central Government;

(xxv) The water shall be provided from the reservoir to the Forest Department for raising and maintenance of plantations and nurseries around the site whenever required, free of charge. The quantity and time of supply of water shall be as decided by the Forest Department.

(xxvi) The User Agency shall undertake afforestation along the periphery of the reservoir and canals (as applicable).

(xxvii) The User Agency shall carry out muck disposal at pre-designated sites in such a manner so as to avoid its rolling down.

(xxviii) The dumping area for muck disposal shall be stabilized and reclaimed by planting suitable species by the User Agency at the cost of project under the supervision of State Forest Department. Retaining walls and terracing shall be carried out to hold the dumping material in place. Stabilization and reclamation of such dumping sites shall be completed before handing over the same to the State Forest Department in a time bound manner as per Plan.

(xxix) The user agency shall implement the R&R Plan as per the R&R Policy of State Government in consonance with National R&R Policy, Government of India before the commencement of the project work. The said R&R Plan will be monitored by the State Government/concerned Regional Office of MoEF &CC along with indicators for monitoring and expected observable milestones

(xxx) The State Government and the User Agency shall ensure that the trees available between full reservoir level (FRL) and FRL-4 meters are not felled;

(xxxi) A plan for conservation of wildlife will be made by the User Agency in consultation with the PCCF (Wildlife) to be implemented at the cost of User Agency.

(xxxii) The State Government shall complete settlement of rights, in terms of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, if any, on the forest land to be diverted and submit the documentary evidence as prescribed by this Ministry in its letter No. 11-9/1998-FC (Pt.) dated 03.08.2009 read with 05.07.2013, in support thereof;

(xxxiii) The User Agency shall submit the annual self-compliance report in respect of the above conditions to the State Government and to the concerned Regional Office of the Ministry regularly:

(xxxiv) Any other condition that the concerned Regional Office of this Ministry may stipulate, from time to time, in the interest of conservation, protection and development of forests & wildlife; and

(xxxv) The User Agency and the State Government shall ensure compliance to provisions of the all Acts, Rules, Regulations, Guidelines, and relevant Hon'ble Court Order (s), if any, pertaining to this project for the time being in force, as applicable to the project.

3. After receipt of a report on compliance to the conditions stipulated in paragraph-2 above, from the Government of Telangana, stage-II/final approval of the Central Government, in accordance with section 2 of the Forest (Conservation) Act, 1980 will be issued by this Ministry. Till receipt of the said final approval of the Central Government for diversion of the said forest land from this Ministry, transfer of forest land to the User Agency shall not be effected by the State Government.

Yours faithfully,

(Nisheeth Saxena)
Sr. Assistant Inspector General of Forests (FC)

Copy to:

1. Principal Chief Conservator of Forests, Telangana, Hyderabad.
2. Nodal Officer, the Forest (Conservation) Act, 1980, Government of Telangana, Hyderabad.
3. Addl. Principal Chief Conservator of Forests (Central), Regional Office (Southern Eastern Zone), Chennai.
4. User Agency.
5. Monitoring Cell, FC Division, MoEF & CC, New Delhi.
6. Guard File.

(Nisheeth Saxena)
Sr. Assistant Inspector General of Forests (FC)

o/c

ANNEXURE – IV

Ministry of Environment, Forest &Climate Change granted Stage –II Forest clearance VideF.No:8-31/2017FC Dt:24/11/2017 –Annx-4

F. No. 8-31/2017-FC
Government of India
Ministry of Environment, Forests and Climate Change
(Forest Conservation Division)
****

Indira ParyavaranBhawan,
JorBagh Road, Aliganj
New Delhi – 110 003

Dated: 24th November, 2017

To,

The Special Secretary to Government,
Environment, Forests, Science
& Technology Department, Secretariat,
Government of Telangana,
Hyderabad.

Sub: **Diversion of 3168.131 hectares (revised from 3221.2974 ha) of forest land in 8 different forest divisions viz. Mahadevpur, Karimnagar-Sircilla, Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal Forest Divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc involved in Kaleshwaram project in different district of Telangana State in favour of Chief Engineer, Kaleshwaram project under TDWSP.**

Sir,

I am directed to refer to the Government of Telangana's letter No. 3747/For.I (1)/2014 dated 27th March, 2017 on the above mentioned subject, wherein prior approval of the Central Government for diversion of 3168.131 hectares (revised from 3221.2974 ha) of forest land in 8 different forest divisions viz. Mahadevpur, Karimnagar-Sircilla, Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal Forest Divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc involved in Kaleshwaram project in different district of Telangana State in favour of Chief Engineer, Kaleshwaram project under TDWSP, was sought, in accordance with Section-2 of the Forest (Conservation) Act, 1980. After careful consideration of the proposal by the Forest Advisory Committee constituted under Section-3 of the said Act, ***In-principle/ Stage-I*** approval for diversion of the said forest land was accorded by the Ministry vide its letter of even number dated 24.10.2017 subject to fulfillment of certain conditions. The State Government has furnished compliance report in respect of the conditions stipulated in the stage-I approval and has requested the Central Government to grant final approval.

2. In this connection, I am directed to say that on the basis of the compliance report furnished by the State Government of Telangana's letter No. 3747/For.I (1)/2014 dated 13th November 2017, ***Final approval/Stage-II clearance*** of the Central Government is hereby granted under Section-2 of the Forest (Conservation) Act, 1980 for diversion of 3168.131 hectares (revised from 3221.2974 ha) of forest land in 8 different forest divisions viz. Mahadevpur, Karimnagar-Sircilla, Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal Forest Divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc involved in Kaleshwaram project in different district of Telangana State in favour of Chief Engineer, Kaleshwaram project under TDWSP, subject to the following conditions:-

(i) Legal status of the diverted forest land shall remain unchanged;
(ii) 5069010 plants will be planted as Compensatory Afforestation (CA) over 3367.1389 ha. Non-forest land and 617.254 ha. on degraded forest land in lieu of proposed diversion of 3168.131 ha., following site specific planting techniques with additional measures as per approved CA Scheme, on the identified land within three years from the date of Stage – II Clearance and maintained thereafter by the State Forest Department from the funds already provided by the user agency;
(iii) *The State Government shall ensure that the penal compensatory afforestation of 8*.00 ha. shall also be raised on the identified degraded forest land within three years from the date of Stage –II Clearance and maintained thereafter by the State Forest Department from the funds already provided by the user agency;
(iv) The State Government shall ensure that the State Forest Department shall implement the approved soil and moisture conservation (SMC) activities on the CA land from the funds provided by the User Agency;
(v) 3367.1389 ha. of non-forest land which is transferred and mutated in favour of the State Forest Department for the purpose of compensatory afforestation shall be declared as Reserved Forest under Section-4 or Protected Forest under Section-29 of the Indian Forest Act, 1927 or under the relevant Section(s) of the local Forest Act;
(vi) The State Government shall ensure that the civil structures recommended in the project shall be designed in such a way to allow smooth passage of the wild animals and the user. The Forest Department shall prepare a Plan of Action to utilize the water potential available nearby for the benefit of forest crop and also to the wild animals at the cost of user agency.
(vii) The user agency shall pay the additional amount of NPV, if so determined, as per the final decision of the Hon'ble Supreme Court of India and transfer the same to the ad-hoc CAMPA under intimation to this Ministry;
(viii) *The State Government / User Agency shall ensure to* obtain the Environment Clearance as per the provisions of the Environmental (Protection) Act, 1986;
(ix) *The State Government / User Agency shall ensure to* raise afforestation along periphery of the reservoirs and canals;
(x) *The State Government / User Agency shall ensure that* the trees available between full reservoir level (FRL) and FRL—4 meters are not felled;
(xi) *The State Government / User Agency shall ensure to* provide free water for the forestry related projects;

(xii) The State Government / User Agency shall obtain clearance from the Standing Committee of NBWL for areas falling in the protected area and its Eco-Sensitive Zone before commencement of work;

(xiii) The State Government shall take appropriate measures in the project area to increase the fodder availability in the forest for wildlife, desilting of tanks and water holes in the forest areas to increase the water availability for wildlife, anti-poaching strategy and Anti-encroachment strategy, provision of salt licks and launching of public awareness programmes.

(xiv) The State Govt. shall follow the regulation on eco-sensitive zone, if applicable.

(xv) The order of the NGT and other courts, which may be pending against this proposal, may be complied by the state government;

(xvi) The State Government shall ensure that the approved Catchment Area Treatment (CAT) plan is implemented by the State Forest Department from the funds provided by the user agency;

(xvii) The State Government shall ensure that the Wildlife Conservation Plan duly approved by PCCF (Wildlife) is implemented by the State Forest Department from the funds provided by the user agency;

(xviii) The State Government and the user agency shall implement the approved R&R Plan as per the R&R Policy of State Government in consonance with National R&R Policy, Government of India before the commencement of the project work. The said R&R Plan will be monitored by the State Government/concerned Regional Office of MoEF& CC, GoI along with indicators for monitoring and expected observable milestones;

(xix) The State Government shall ensure that the User Agency provides fuels preferably alternate fuels to the labourers and the staff working at the site so as to avoid any damage and pressure on the nearby forest areas;

(xx) The State Government shall ensure that the boundary of the diverted forest land, mining lease and safety zone, as applicable, has been demarcated on ground at the project cost, by erecting four feet high reinforced cement concrete pillars, each inscribed with its serial number, distance from pillar to pillar and GPS co-ordinates of each pillar;

(xxi) The State Government shall ensure that the layout plan of the proposal shall not be changed without the prior approval of the Central Government;

(xxii) The State Government shall ensure that the forest land is not used for any purpose other than that specified in the proposal;

(xxiii) The State Government shall ensure that the forest land proposed to be diverted shall under no circumstances be transferred to any other agency, department or person without prior approval of the Central Government;

(xxiv) The State Government shall ensure that the water is provided from the reservoir and canals to the Forest Department for raising and maintenance of plantations and nurseries around the site whenever required, free of charge. The quantity and time of supply of water shall be as decided by the Forest Department;

(xxv) The State Government shall ensure that the User Agency carries out muck disposal at pre-designated sites in such a manner so as to avoid its rolling down and the dumping area for muck disposal shall be stabilized and reclaimed by planting suitable species by the User Agency at the cost of project under the supervision of State Forest Department. Retaining walls and terracing shall be carried out to hold the dumping material in place.

Stabilization and reclamation of such dumping sites shall be completed before handing over the same to the State Forest Department in a time bound manner as per Plan;

(xxvi) The State Government shall ensure that the User Agency submits the annual self-compliance report in respect of the above conditions to the State Government and to the concerned Regional Office of the Ministry regularly:

(xxvii) Any other condition that the concerned Regional Office of this Ministry may stipulate, from time to time, in the interest of conservation, protection and development of forests & wildlife;

(xxviii) The State Government and the User Agency shall ensure compliance to provisions of the all Acts, Rules, Regulations, Guidelines, and relevant Hon'ble Court Order (s), if any, pertaining to this project for the time being in force, as applicable to the project;

(xxix) **Before commencement of work in the forest area, the State Government will ensure implementation of complete process for identification and settelement of rights under the FRA 2006 for the entire 322.557 ha. of forest area in Nirmal District and 323.3667 ha. of forest area in Nizamabad District. Further, as resolved by the District Level Committee of Nirmal District that forty three owners of RoFR title deeds have to be dispossessed only after following due procedure of law, including payment of appropriate compensation as per the Right to Fair Compensation and Transperency in Land Acqustion, Rehabilitation and Ressettlement Act, 2013 and the Compensation also must be granted for loss of income, from the collection of Beedi leaves, if any in the affected area; and**

(xxx) As per para 3.4 (iii) of Ministry's Guidelines issued under Forest (Conservation) Act, 1980, a Monitoring Committee shall be constituted with a nominee of the Central Government to monitor the conditions being stipulated, including those pertaining to compensatory plantation are carried out;

Yours faithfully,

(NisheethSaxena)
Sr. Assistant Inspector General of Forests

Copy to:

1. The Principal Chief Conservator of Forests, Government of Telangana, Hyderabad.
2. The Nodal Officer (FCA), Office of the PCCF, Government of Telengana, Hyderabad.
3. The Addl. Principal Chief Conservator of Forests (Central), Regional Office (Southern Eastern Zone), Chennai.
4. The Addl. Director General of Forests (WL),MoEF&CC, New Delhi.
5. The Joint Seceretary (IA),MoEF&CC, New Delhi.
6. User Agency.
7. Monitoring Cell, FC Division, MoEF&CC, New Delhi.
8. Guard File.

(NisheethSaxena)
Sr. Assistant Inspector General of Forests

ANNEXURE – V

Central Ground Water Board granted NOC Vide Lr No;4-1/CWC-PA/SML/CGWB/2017-1945 Dt:21/11/2017-Annx-5

No.4-1/CWC-PA/SML-CGWB/2017- 1945
Central Ground Water Board
West Block-II, Wing-3, Sector-1
R.K.Puram, New Delhi-66

Dated: 21 NOV 2017

To
The Chief Engineer
Kaleshwaram Project, 1st floor
Jalasoudha Building
Erramanzil, Hyderabad.

Sub: Kaleshwaram Project, Telangana -reg.
Ref : Lt. no. CE/KPH/DCE/DEE-3/AEE-9/CWC/2017/ 1826 dated 13.11.2017

Sir,

With reference to above, it is to certify that water logging is not a significant issue in the command area of the project at present. It is expected that implementation of the project would augment the groundwater resources in the area. Measures for prevention of water logging in the command area, including conjunctive management of surface water and groundwater have been suggested.

Yours faithfully

21.11.17

(K.C. Naik)
Member (CGWA)

Copy to:

1. The Director, Project Appraisal (South) Directorate, Central Water Commission, 410(S), Sewa Bhawan, R.K.Puram, New Delhi-66 for information.

/

(K.C. Naik)
Member (CGWA)

ANNEXURE – VI

Hon'ble NGT Order dated 20/10/20 in the matter of Md. HayathUdi&Others Appeal no :20/2020—Vide Annx-6

Item No. 09 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

Appeal No. 20/2018

Md. Hayath Udin Appellant

Versus

Union of India & Ors. Respondent

Date of hearing: 12.10.2020
Date of uploading: 20.10.2020

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE S. P. WANGDI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

ORDER

1. This appeal has been preferred against order dated 22.12.2017 of the Ministry of Environment, Forest and Climate Change (MoEF&CC) granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) project in Karimnagar District of Telangana by Irrigation & Command Area Development (I and CAD) Department, Government of Telangana.

Appellant's Case:

2. The case of the appellant is that he is resident of a village in District Siddipet and is a farmer affected directly by the instant project. KLIS is to irrigate 7,38,851 ha in upland areas of Adilabad, Karimnagar, Nizamabad Warangal, Medak, Nalgonda, and Rangareddy Districts of Telangana 'by diverting 180 TMC of water from River Godavari. The original budget of the project is Rs.80499.71 crores. The source point for

KLIS is near Medigadda Village, below the point of confluence of Pranahitha and Godavari Rivers about 20 km from Kaleshwaram.

The Project envisages construction of three barrages between Yellampally & Medigadda viz.

- Medigadda Barrage on Godavari near Medigadda (Kaleshwaram)
- Annaram Barrage on Godavari downstream of confluence of Manair River with Godavari river near Annaram.
- Sundilla Barrage on Godavari downstream of Yellampally barrage near Sundilla.

The project envisages diversion of about 180 TMC water from Godavari for Irrigation purpose (134.5 TMC), stabilization of existing command area (34.5 TMC), drinking water to Hyderabad (30 TMC) drinking water to en route villages (10 TMC) & for industrial uses (16 TMC). Thus, the main aim of the instant project is, irrigation in seven Districts of Telangana to support agriculture. The whole of KLIS is planned in seven "links", with the water conveyance system consisting of gravity canals, online storages and tunnels involving significant amounts of forest land estimated to be about 3221.2974 ha as per the Final EIA Report submitted by the project proponent to the MoEF. The infrastructure was being constructed prior to applying for Environmental Clearance. The tenders floated for the project show that the infrastructure was being constructed for a major irrigation project to improve agricultural productivity in the upland areas of Telangana. The lift irrigation scheme involves submergence of approximately 32000 ha of land in Telangana, 3211.2974 ha of forest land in Telangana and approximately 302 ha of land, including some forest land in Maharashtra as per pre-feasibility report. The two States formed an Inter State Board for Joint Irrigation Projects, of which one of the projects was KLIS.

As against the factual position depicted above, the project proponent wrongly claims that the project was not for lift irrigation but only for drinking water supply till grant of EC. The application for EC was made only January, 2017. EC was granted in December, 2017 but before that substantial work had already been undertaken. Thus, according to the appellant the impugned EC was *ex post facto,* in violation of EIA Notification, 2006.

3. Apart from the allegation of EC being after the substantial work of the project was completed, further challenge by the appellant is on the ground that the EC was granted without application of mind, overlooking the procedural irregularities as well as environmental aspects. The project, as proposed, underwent change by increase in capacity and inclusion of Mission Bhagiratha to provide drinking water to Hyderabad and certain villages of Telangana but no fresh scoping was done. The pre-feasibility report submitted in January, 2017 and draft of EIA report submitted in July, 2017 did not mention the Mission Bhagiratha which involved interlinking of the two projects. Feasibility of the change project was never evaluated while granting EC. Construction of pump houses started in February, 2017. There is discrepancy with regard to quantity of the forest land in the project. Different area is mentioned in the first application which was withdrawn from the area mentioned in the application filed in January, 2017. EIA report filed by the project proponent was not in consonance with the Terms of Reference (ToR). Baseline data relied upon in the EIA studies did not cover the winter

season. There is deliberate mis-representation of facts regarding proximity of the protected areas, such as National park, sanctuary, biosphere reserve etc. Final EIA report wrongly states that there is no national park for wildlife sanctuary within 10 km buffer. Drainage maps and soil maps are not properly covered by the EIA report. ToR has not been followed in the study of the forest areas. Samples of the baseline data are inadequate and not representative of the entire area. Part of the studies falling in the State Maharashtra have been ignored. Bio-diversity study has not been carried out by associating a suitable organization. Sampling methodology is deficient. EIA report is deficient on the account of inadequate study of flora and fauna in the region. Surprisingly, re-discovery of Cheetahs, which were declared extinct in India in 1952, is mentioned. The project is Seismic Zone 2 which has not been so mentioned. Such site is not suitable for the project. Public hearing was not conducted as per procedure prescribed in the EIA Notification. EIA was not available to the residents for the public hearing. Various environmental issues have not been dealt with in the EIA.

It is further submitted that even after the grant of EC, the project proponent did not follow the EC conditions. The lifting capacity is proposed to be enhanced without any further EC and enhancement of the capacity from 2 TMC/day to 3 TMC/day for the Medigadda Lift System, Annaram Lift System and the Sundilla Lift System will involve substantial modification in infrastructure.

4. To sum up, the objections are:-

a) Grant of EC is *ex post facto*.

b) Terms of reference not followed and fresh scoping not done after modification of the project by increasing the capacity and inclusion of Mission Bhagiratha etc.

c) EIA Notification procedure was not followed in making draft EIA report available to public. The baseline data was not properly conducted as winter season data was left out.

d) There is concealment of material facts including existence of protected areas within 10 km. of the site without wildlife clearance. It is wrongly mentioned that Cheetahs existed. The extent of forest has not been properly mentioned. The area is Seismic Zone –2 which was also not mentioned.

e) The EC condition of impact being studied after five years of commissioning is against the Precautionary principle.

f) There was no proper appraisal of the project.

Proceedings before the Tribunal

5. The appeal was filed on 16.02.2018. Notice was issued to the respondents on 19.02.2018. Parties have filed their pleadings. On 29.07.2019, delay was condoned. On 11.12.2019, application for amendment was allowed permitting objections in the light of the subsequent developments.

6. We may also mention that O.A. No. 113/2020, *Thummanappally Srinivas and Ors. v. UOI & Ors.* was filed before the Southern Zone, Chennai against the proposed increase of pumping capacity. In view of pendency of the appeal before the Principal Bench, the Southern Zone Bench suggested that the application be transferred to the Principal

Bench to be considered along with the appeal. Accordingly, the matter was taken up by the Principal Bench and registered as O.A. No. 204/2020 and directed to be listed for final hearing along with the appeal. The same is being disposed of by a separate order.

Proceedings before the Tribunal prior to EC

7. We may further mention that the appellant earlier filed O.A. No. 370/2017 on 30.05.2017 against the commencement of the project without EC mentioning that there were construction activities in forest area. The land was being sub-merged and huge construction was going on without EC. The project will also affect wildlife without requisite clearance. The project involved budget of more than Rs. 80,000 crores and involved construction of three barrages and diversion of water from the river for irrigation purposes as well as drinking purpose. The States of Maharashtra and Telangana are part of Inter-State Board for joint irrigation project though the responsibility under mutual arrangement for taking requisite clearance is of the State of Telangana. The project was infact 'River Valley' project falling under Entry 1(c) of the Schedule to the EIA Notification, 2006. It could not be commenced without prior EC. EC was applied only on 11.01.2017 and had still not been granted till the filing of the application. The project required 'in principle' clearance from the Central Water Commission (CWC) and Techno Economic Feasibility report. The project will adversely affect the eco system in a big way. The construction will be in forest area without Forest Clearance (FC).

Interim order dated 5.10.2017 by the Tribunal and modification thereof by the High Court at pre-EC stage

7. The Tribunal issued notice on 30.01.2017 and after hearing learned counsel for the parties vide order dated 05.10.2017, granted *ad interim*

injunction restraining States of Maharashtra and Telangana from carrying out any construction activities for the KLIS or activities like felling of trees, blasting and tunnelling in the forest areas in violation of the Forest (Conservation) Act, 1980, till statutory clearances are granted. The stand of the State of Telangana was that the project was irrigation project, conceived by the erstwhile State of Andhra Pradesh which also involved water supply to Hyderabad city and other places enroute Hyderabad. The Mission Bhagiratha was a part of the project to remedy the drought condition in the area. In the said area, ground water was contaminated by chloride. The project was earlier called Dr. BR Ambedkar Pranahita Chevalla Sujala Sravanthi Project, a multipurpose project, involving the States of Maharashtra and Telangana. There was agreement between the two States for the Inter-State Control Board and a Coordination Committee had been constituted. EC was applied on 10.11.2014. The project was redesigned and renamed as it involved submergence of land in Maharashtra. There was change of alignment on account of objections of the State of Maharashtra on which the application for EC was withdrawn and fresh application was filed on 13.01.2017. On the basis of these pleadings, the Tribunal observed that the project was primarily an irrigation project, covering seven districts of the State of Telangana and to such a project the drinking water scheme was also added. The State of Telangana had filed pre-feasibility report in the year 2014. Relevant observations are:-

> *"45 There are two legal issues which confront the State of Telangana. The first is for Kaleshwaram Lift Irrigation Project activity which is designed, conceived and sought to be implemented by the State of Telangana is a "Lift Irrigation Project". **It is primarily irrigation project though of course portion of water that may be harnessed is proposed to be utilized to supply drinking water to Districts en-route to Hyderabad and Hyderabad City. That does not take away the Kaleshwaram Lift Irrigation Project out of the Entry 1(c) of the EIA Notification, 2006 requiring prior Environmental Clearance.***

The second aspect is about Forest Clearance. We need not repeat, except to state that the State has admitted involvement of forest land and therefore in view of the decision of the Hon'ble Apex Court, apart from the Statutory Restriction under the provision of Section 2 of Forest (Conservation) Act, 1980, the project proponent cannot proceed with the project activity till requisite permission are obtained. It is further noticed that the contractor involved in the project is a company called L & T and it is alleged that the company had cleared large extent of forest land, cutting trees indiscriminately for construction of staff quarters for the its employees in the prime forest area. The letter of the Forest officer produced by the applicant substantiates this allegation that number of trees are felled by the contractor executing project and it is apprehended by the Applicant and all concerned that if the project actually proceeds to construct, it will destroy much more area.
46. The applicant has further produced the newspaper report to show that the project proponent was blasting the rocks and tunnels, during such activity an incident occurred in the recent past where, several construction workers died due to land slide, collapse of tunnel supporting structure etc. *The State of Telangana had not disputed the said incident but has brushed it aside as "Accident" beyond its control. We do not wish to record any finding on it. But it is necessary to take note of such incident to know whether the Respondent No. 2 and Respondent No. 4 are proceeding with construction activity after the project is properly evaluated and obtaining environmental clearance and other clearance under provision of Section 2 of the Forest (Conservation) Act, 1980.*

47. For the reasons discussed above, we are satisfied that a prima facie case has been made to injunct the project activity which is undoubtedly impermissible in view of the restrictions imposed by Section 2 of EIA Notification, 2006 and provisions of the Forest (Conservation) Act, 1980, without obtaining required permission."

8. Against the said order, the State of Telangana preferred *W.P. No. 34458/2017, State of Telangana & Anr. v. Md. Hayath Uddin & Ors.* before the Telangana High Court, which was decided on 08.11.2017[1]. The High Court set aside the order of the Tribunal on a preliminary ground that the Tribunal had not decided the objection about the application being beyond limitation laid down under Section 14(3) of the National Green Tribunal Act, 2010 and that the application could not be filed before the Principal Bench and was to be filed before the Southern

[1] 2017 SCC Online Hyd 356 : (2018) 1 ALD 247 (DB)

Bench. However, while leaving it open to the Tribunal to pass a fresh order, the High Court noted that without EC and FC the State of Telangana could not commence the irrigation component of the project and use the forest land for non-forest purposes. It was observed:-

> "75. *On the nature of relief to be granted, we must record our concern regarding certain incidents, referred to in the order of the NGT, which, if true, are indeed disturbing.* ***In its reasoned order, the NGT has noted that the State of Telangana had admitted involvement of forest land in the project, and has held that, in view of Section 2 of the Forest (Conservation) Act, 1980, the project proponent cannot proceed with the project activity till forest clearance is obtained. The NGT has also noted that the contractor, involved in the project, was alleged to have cleared large extents of forest land, cutting trees indiscriminately, for construction of staff quarters for its employees, in prime forest area; and that reliance was placed by the first respondent-applicant on the letter of the Forest Officer to substantiate the allegation that the contractor, executing the project, had felled a number of trees. Yet another incident, which the NGT has referred to in its reasoned order, is that the project proponent had blasted rocks and tunnels; during such activity several construction workers had died due to land slide, and collapse of the tunnel supporting structure, etc. The NGT has also noted that, while the State of Telangana had not disputed the incident, it was brushed aside as an accident beyond its control. It is for this among other reasons that the Principal Bench of the NGT, New Delhi had held that construction activity could only be undertaken after the project was properly evaluated, and environmental and forest clearances were obtained.***
>
> *76. In Vedire Venkata Reddy v. Union of India[2], a Division Bench of this Court held that it is not permissible for the State Government to proceed ahead with the implementation of the project till all clearances are obtained; the action of the State Government in implementation of the project, without obtaining environmental clearance, as envisaged under the provisions of the Environment (Protection) Act, 1986, the rules framed thereunder and the notification, is illegal and arbitrary; and the State Government should not proceed ahead in implementation of the project, and should not undertake any construction work, whether preliminary or otherwise, till environmental clearance is obtained.*
>
> *77. While the petitioner contends that environmental clearance is not required for construction of a drinking water project, they do not dispute that such permission is required for an irrigation project. Despite the assurance of the Learned Advocate-General for the*

---

[2] AIR 2005 AP 155

State of Telangana that, till final forest clearance is obtained from the Government of India, the petitioner would not fell even a single tree within the limits of the reserve forest, we are of the view that specific directions should be issued to the Government of Telangana in this regard.

*78. **Till orders are passed afresh by the Principal Bench, NGT, and till Final forest clearance is obtained from the Government of India, the petitioner shall henceforth neither encroach upon any part of the reserve forest in connection with the project, nor shall even a single tree therein be felled for the purposes of the project, or for any ancillary activity connected therewith. The State of Telangana shall also not commence construction of distributaries and channels, or undertake ancillary works relating to the irrigation component of the project without obtaining environmental clearance from the Union of India. Works if any undertaken by, and on behalf of, the State of Telangana shall be confined strictly to the drinking water component of the project. Violation of the aforesaid directions can be brought both to the notice of this Court, and to the NGT, by the first respondent-applicant. It would be open to the Principal Bench, NGT, even before it rules on its jurisdiction to entertain the O.A, to take necessary action against the petitioner for such violations, if any brought to its notice, including directing them to stop all construction activity even in relation to the drinking water component of the project.***

VI. CONCLUSION:

79. We are satisfied that failure of the Principal Bench, NGT, New Delhi to examine the jurisdictional issues raised by the petitioner i.e that the O.A. was filed beyond the period prescribed in Section 14(3) of the 2010 Act and its proviso, and it lacked territorial jurisdiction to entertain the present O.A, is fatal, for it is only if the Principal Bench of the NGT, New Delhi has jurisdiction to entertain the O.A, could it have granted the interim relief sought for by the first respondent-applicant.

80. Subject to the aforesaid observations, the Writ Petition is allowed, the impugned order is set aside and the matter is remanded to the Principal Bench, NGT, New Delhi, which shall consider the first respondent-applicant's request for grant of interim relief afresh, and in accordance with law. Miscellaneous Petitions, if any pending, shall also stand disposed of. No costs."

SLP against the High Court order was dismissed. The application was thereafter taken up by this Tribunal on 21.08.2018. This Tribunal noted that since EC stands granted which was subject matter of consideration in appeal No. 20/2018, the entire matter could be considered in the appeal. The application was disposed of.

Stand of the Respondents

9. We may now note the stand of the main contesting respondents i.e. MoEF&CC and the project proponent, the State of Telangana.

Stand of the MoEF&CC

10. The MoEF&CC in its affidavit dated 15.03.2018 stated that the project is for providing irrigation facility and also for providing drinking water facility. It falls under entry 1(c) of the Schedule to the EIA Notification, 2006. EC was granted subject to certain conditions and directions, as per law. Relevant averments are as follows:-

> *"5. That the Kaleshwaram Lift Irrigation Scheme (KLIS),* ***which envisages construction of a barrage across River Godavari near Medigadda Village in Karimnagar District of Telangana State for diversion of 180 TMC of water for providing irrigation facility in 7,38,851 hectares of area covering 7 Districts namely Adilabad, Karimnagar, Nizamabad, Warangal, Medak, Nalgonda and Rangareddy. The project is also proposed to provide drinking water facility to Hyderabad and Secunderabad. The total land requirement for the project is about 37,872 hectares, out of which 3168.1315 hectares is forest land. The total length of water canal system is about 1,832 km.***
>
> *6.* ***That this project belongs to Schedule I (c) of Environmental Impact Assessment (EIA) Notification, 2006.*** *An application was submitted along with Environmental Impact Assessment Report and other relevant documents and reports. These reports were appraised and examined by Expert Appraisal Committee (EAC) constituted for River Valley & Hydropower Projects under the provisions of EIA Notification, 2006 to the satisfaction of the members who are experts in their domain fields.*
>
> *7. That as per the provisions of Section 2 of the Forest (C) Act read with Rule 6 of the Forest; (Conservation) Rules 2003, Every user agency (i.e. Project Proponent), who wants to use any forest land for non-forest purpose shall make his application to the concerned nodal officer of the state government authorized in this behalf for prior approval of U/s 2 of Forest (C) Act, 1980.*

8. That as per the decision of Supreme Court in T.N. GODAVARMAN VS. UNION OF INDIA & ORS and EIA Notification, 2006, public consultation is mandatory. In the light of aforesaid judgment, public hearings were conducted in 15 Districts in Telangana and 1 District in Maharashtra by Telangana State Pollution Control Board & Maharashtra State Pollution Control Board as per the extant norms on the subject.

The details are as follows:

Sl. No	***DISTRICTS***	***DATES***
i.	*Karimnagar, Nizamabad, Medchal-Malkajgiri, Yadagdri-Bhunanagiri in Telangana*	*22.8.2017*
ii.	*Peddapally, Nalgonda, Sangareddy, Kamareddy in Telangana*	*23.8.2017*
iii.	*Nirmal, Jagityal in Telangana*	*24.8.2017*
iv.	*Medak, Jayashankar-Bhupalapally Manchiryal, Rajanna Sircilla, Siddipet in Telangana*	*26.8.2017*
v.	*Gadchiroli in Maharashtra*	*27.9.2017*

It is relevant to mention here that main grievance of the local aggrieved persons were lack of irrigation facilities in the region, drinking water problem, compensation in land acquisition, water supply to arid zones etc. Majority expresses happiness over the implementation of the Project."

11. Further affidavit filed by the MoEF&CC is dated 26.09.2019 mentioning the steps taken in the grant of EC. Relevant paras thereform are extracted as follows:-

"3. It is submitted that the Kaleshwaram Lift Irrigation Scheme (KLIS) envisaged to construct a barrage across River Godavari to provide irrigation facility in 7,38,851 ha I 7 Districts of Telangana (Adilabad, Karimnagar, Nizambad Warngal, Medak, Nalgonda and Rangareedy) by diverting 180 TMC of water from River Godaveri. The project is also proposed to provide drinking water facility to Hyderabad and Secunderabad cities.

The total land requirement for the project is about 37,852 ha, out of which 3168.1315 ha is forestland and 34,684 ha is private land. ***The total submergence area is about 18,302 ha.*** *The project lies in the interstate boundary with submergence area of 174.37 ha of area in Maharashtra State.*

4. *It is submitted that the Project was considered by the Expert Appraisal Committee (EAC) in its meetings held on 30-31' January, 2017 and on 2-3rd March, 2017 for Scoping/ Terms of Reference (TOR) clearance. Based on the recommendations of the EAC the Ministry accorded TOR vide letter dated 31' March, 2017 for preparation of EIA / EMP and conduct of Public Hearing.*

5. *It is submitted that the EAC thoroughly examined the project before recommending the project for grant of environmental clearance as per the EIA Notification 2006 and amendments thereof. Further, it is submitted that after considering all the relevant facts of the project as presented by the project proponent, documents submitted by Project Proponent, clarification furnished in response to its observation, EAC recommended for the grant of Environmental Clearance for the project. The Ministry issued the Environmental Clearance (EC) vide letter dated 22/12/2017.*

6. *It is submitted that the minutes of Public Hearings were taken into consideration by the Expert Appraisal Committee (EAC) for River Valley & Hydro Power Sector while appraising the project for grant of Environmental Clearance (EC). The public hearing were conducted in 15Districts (i.e. Karimnagar on 22.8.2017, Nizambad on 22.8.2017, Medchal-Malkajgiri on 22.8.2017, Yadagdri-Bhunanagiri on 22.8.2017; Peddapally on 23.8.2017, Nalgonda on 23.8.2018, Sangareddy on 23.8.2017, Kamereddy on 23.8.2017; Nirmal on 24.8.2017, Jagityal on 24.8.2017, Medak on 24.8.2017; Jayashankar- Bhupalapally on 26.8.2017, Manchiryal on 26.8.2017, Rajanna Sircilla on 26.8.2017 & Siddipet on 26.8.2017) of Telangana and one District (Gadchiroli on 27.9.2017) of Maharashtra as per the provisions of EIA Notification, 2006.*

   Further, it is submitted that EAC has also taken into consideration all the issues raised during Public Hearings and the same is also recorded in the minutes of meeting of the EAC for River Valley & Hydro Power sector. The main issue raised during Public Hearings included - lack of irrigation facilities in the region, improving socio-economic conditions, stabilization of SRSP ayacut (command area), drinking water facility, resolving land acquisition issues at the earliest, rehabilitation benefits for SC/ST communities, R&R as per the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 and compensation at 10 times the basic value of land, filling up of tanks and increasing storage facility of Muraharipally village, provisions of water supply to semi-arid zones, giving employment in the villages, compensation as per Mallanasagar project and seeking reasons for redesigning the project & increasing the reservoir capacity, impact on environment, etc. The project proponent clarified all the queries/issues pertaining to them. Majority expressed happiness over the implementation of the project.

7. It is submitted that the Ministry accorded Stage-I Forest Clearance (FC) on 24.10.2017 and Stage-11 FC on 24.11.2017. The Stage-II FC for diversion of 3168.131 ha was accorded on the basis of the compliance report furnished by the State Government of Telangana for construction of canals, tunnels, lift systems, surge pool, delivery system and reservoir, etc. involved in the KLIS subject to the compliance of the conditions stipulated in State-II FC clearance on 24.11.2017. Therefore, the averments made by the Appellant are baseless and not maintainable.

8. It is submitted that the Ministry's OM dated 29' August, 2017, which inter-alia provides as under:-

> *"The baseline data used for preparation of EIA/EMP reports may be collected at any stage, irrespective of the request for ToR or the issue thereof However, such a baseline data and the public consultation should not be older than 3 years, at the time of submission of the proposal, for grant of Environmental Clearance, as per ToRs prescribed."*

It is submitted that the baseline data used by the Project Proponent for preparation of EIA/EMP report for the proposed project was not more than three-years and hence in conformity with the above said provision. Therefore, the averments made by the Appellant are baseless and not maintainable.

9. It is submitted that detailed flora and fauna study was conducted by the project proponent, and the same was incorporated in the EIA report. As per the EIA report and informed by project proponent, there was no endangered, threatened and endemic category of flora & fauna. Even the project area of both core and buffer zones do not have any breeding habitats, spawning grounds or migratory corridors for wildlife. During the period of survey, no endangered and threatened aquatic fauna have been found."

Stand of the Project Proponent

12. The stand of the project proponent is that the project is for providing water to the drought prone areas of the Telangana. It has two parts: drinking water and irrigation. **The project is primarily for water supply and water management project, which is not covered by the EIA Notification, 2006, in view of the amendment dated 25.06.2014.** With regard to the expansion, it is stated that the decision has been taken to increase drawl of water from 2 TMC/day to 3 TMC/day by the

Telangana govt. on 06.10.2019. **It is stated that the expansion does not alter the infrastructure plans. The State did not proceed with the irrigation component of the Kaleshwaram Project till the necessary and requisite clearances are obtained by them.** The High Court had permitted the answering Respondents to construct only components which would relate to supply drinking water.

It is denied that the EC is *ex post facto*. **The project was being constructed prior to grant EC only for drinking water for which EC was not required. The project started in the year 2008 with construction of series of barrages, reservoirs, pipelines and canals and pump houses to pump water from one reservoir to the other and is still continuing. Major part of the project had already been constructed. Environment Management Plan (EMP) envisages spending Rs. 16,000 crores.** There is no change in the project after filing of Form – 1. EIA report is in consonance with the ToR. EC has been accorded after verification of the study and recommendations and plans for conservation suggested in the EIA/EMP report. Public hearing was duly conducted. The project involves lifting of water from the river during monsoon season and its collection for supply to affected drought areas. It is for overall social welfare. Mission Bhagiratha is not a part of the project. The project will merely provide water to the Mission Bhagiratha which does not imply any change in the project. The Mission Bhagiratha is a different project and has a different project proponent i.e. Rural Water Supply and Sanitation Department. The line diagram is only illustrative and is not to the scale. Location of the pump house has been correctly described in the EIA Report.

Shamirpet tank was not shown in the 'bespoke' and not-to-scale 'line diagram' and the affidavit dated 03.10.2017 because the answering respondents were required to show only the main trunk of the project at that stage. The forest area has been correctly described and application for diversion of such area has been duly made. **Withdrawal of the earlier application for EC and filing of the subsequent application was on account of change in alignment of the project**. The baseline data has been properly compiled in 10 km radius of the main project. The data has been collected for 3 seasons pre-monsoon, monsoon and post monsoon by the Environment Protection Training and Research Institute (EPTRI) which has expertise on the subject. The wildlife clearance is to be taken subsequently. The EIA report contains all relevant studies, using 'Champion and Seth' method. Forest Working Plan has been included in the EIA Report. Reserved forest has been shown in the maps. FC Stage–II has been granted. Adequate number of samples were taken. 10 samples have been taken only for air quality index. There are samples for noise monitoring, water quality, soil quality, traffic data. There is also study about hydrology referring to rain fall data. There is information about the social environment like population density, literacy level, employment level. Anticipated impact and mitigation measures are also mentioned. Public consultation was conducted in 15 Districts of Telangana and one District of Maharashtra. Disclosure requirements have been fulfilled. Comprehensive ecology and biodiversity study have been undertaken. EIA is in conformity with ToR and contains all the relevant studies, data and maps. 3500 citizens attended the public hearing. Lifting of 3 TMC/day water as against 2 TMC/day is to fully utilize the capacity.

Reply of State of Maharashtra

13. We may also refer to the reply filed by the State of Maharashtra on 15.06.2018. It is stated that agreement dated 19.07.2013 was signed between the State of Maharashtra erstwhile Andhra Pradesh **to undertake joint irrigation projects, including the present irrigation project**. The State of Telangana agreed to abide by the existing agreement. Further agreement was signed on 08.03.2016 to form Inter-State Board for joint irrigation projects. The said Board is to resolve pre construction, construction and post construction issues. There is mechanism of joint action and responsibility. In terms of the agreement dated 23.08.2016, **the State of Telangana is to obtain statutory clearances for the project**.

Consideration of Rival Contentions

14. We have heard learned counsel for the appellant, MoEF&CC, CWC as well as the project proponent. At the conclusion of hearing on 12.10.2020, following order was passed:

> *"Hearing concluded.*
>
> *Order reserved. The order will be uploaded on the website on 20.10.2020. A note of written submission, if any, be filed on or before 16.10.2020.*
>
> *We have particularly asked learned counsel for the project proponent and the State of Telangana to respond to the averments in para 4 and 8 of the counter affidavit filed by the Secretary, Department of Water Resources, Ministry of Jal Shakti on 09.10.2020 which refers to a letter dated 07.08.2020 by the Ministry of Jal Shakti to the Chief Minister of Telangana not to proceed with the project without submitting DPR to Godavari River Management Board and without sanction of the Apex Council. The project for expansion has also to be submitted to the CWC, in absence of which we will have to issue directions to that effect."*

15. We have also considered the written submissions filed by the appellant in appeal and the applicant in the connected matter on 16.10.2020. The project proponent has also filed written submission on 17.10.2020 which is also reiteration of the submissions already made. However, the State of Telangana in its written submissions has mentioned in paragraph 32 that the Chief Minister has given reply dated 02.10.2020 to the Minister of Jal Shakti that the project is an old project before bifurcation of the State.

16. In view of the above rival contentions, the basic question is the validity of the impugned EC and in case there is infirmity in the EC, further remedial action. There is also an issue with regard to expansion of the project by way of increase of drawl of water from 2 TMC/day to 3 TMC/day in terms of the decision of the Telangana Government on 06.10.2019, without requisite EC, inspite of opposition by the Ministry of Jalshakti, Govt of India, taking the view that clearances are quired for the same.

17. As noted earlier, the stand of the appellant is that the impugned EC is invalid as the project proponent commenced the project prior to the application. The project was predominantly a river valley project. In support of challenge to the EC, procedural infirmities in failing to undertake fresh scoping when the project was modified after filing application for EC and in concealing material facts regarding existence of wildlife sanctuary. On the other hand, the stand of the MoEF&CC and Project Proponent is that EC has been duly granted. According to the Project Proponent the project is primarily for water supply and water management and is not covered by the EIA Notification, 2006, as initially conceived. The State did not proceed with the irrigation component in

the project till all the necessary clearances were obtained. Only components relating to supply of drinking water were constructed which did not require any EIA. According to State of Maharashtra, the project is irrigation project but taking clearance is responsibility of Telangana. The MoEF stand is that the project is Irrigation project but also involves water supply. No comment has been made about requirement of EC prior to undertaking substantial execution of the project from 2008 to 2017.

18. We are unable to accept the stand of the project proponent that primarily the project is for water supply and water management and that irrigation is subsidiary or incidental part of the project so as to hold that no EC was required prior to execution of the project from 2008 to 2017. We are also unable to agree that the State did not proceed with the irrigation component in the project till the clearances were granted and only constructed components relating to supply of drinking water. There is no basis for the submission that no part of execution of the project prior to EC related to Irrigation purpose as project is admittedly integral and inseparable. The argument, if accepted, will defeat the law.

19. It remains undisputed that the project involves budget of Rs. 80,000 Crores. EMP itself has a provision for Rs. 16,000 Crores. There is a provision for construction of three barrages. Irrigation for 7 lakhs hectares of land is envisaged. 18000 hectares of land is to be submerged as per the EC. Out of 180 TMC of water to be lifted and diverted from Godavari, 134.5 TMC is for Irrigation and 40 TMC is for drinking. The remaining is for other purposes, including Industrial as noted earlier. The project started in the year 2008 with construction of barrages, reservoirs, pipelines, canals and pump houses. Major part of the project

was constructed prior to EC. The stand of the project proponent that the project executed prior to EC is unrelated to irrigation is patently untenable and if accepted, will defeat the law. It is for this reason that prior to EC, this Tribunal and the High Court had to grant injunction against development of infrastructure after finding massive activities of construction of barrages involving blasting and other such activities. All such activities are clearly part of the Irrigation project which cannot be separated from other objectives. It is difficult to accept that all such activities are only for drinking purpose. The State has led no evidence in support of the plea that all earlier activities are exclusively for water supply. The State could produce documents like contracts to show that the infrastructure had no nexus for the irrigation. This plea is not shown to have been gone into by the MoEF while granting EC.

20. Even according to the project proponent, EC was applied earlier in the year 2014 but the application was withdrawn on account of change of alignment. This negates the plea that the project proponent was not contemplating seeking EC at that time. The project had serious implication in terms of environment. It was never exclusively a water supply project. Even in 2008, report filed by the project proponent with its affidavit, it is clearly mentioned that the project is a multipurpose project as apart from irrigation, it also involves drinking water supply. Thus, to say that from 2008 till December, 2017 when EC was granted, by which time project was almost completed, activities related only in relation to the drinking water supply and not with the irrigation and that the irrigation project activities commenced thereafter is difficult to accept. As already mentioned, the Tribunal as well as the High Court clearly found that the project proponent was illegally proceeding with

construction activities for the irrigation project and also diverting forest land for non- forest purposes without prior clearances. While injunction was granted by the High Court against such activities, the substantial activities had already been undertaken without prior EC. The MoEF&CC has not even adverted to this aspect either while granting EC or even in the reply filed before this Tribunal. It is not the case of the MoEF&CC that the project undertaken from 2008 to 2017 was only in relation to water supply and not in relation to irrigation infrastructure.

21. In *Hanuman Laxman Aroskar v. UOI*[3], the Hon'ble Supreme Court held that objective of the EIA was balancing of environmental and developmental concerns to give effect to the principle of Sustainable Development.[4] The development agenda of the Nation must be carried out in compliance with the norms for protection of environment. There is no trade-off between the two. Environment protection is an essential facet of development. The laid down procedure must be meticulously followed. The material information must be disclosed in Form-I. Mere substantial or proportionate compliance is not adequate. Strict standards must be complied with and burden of compliance rests on the project proponent.[5] Ecologically sensitive areas must be duly factored because of presence of flora and fauna. Environmental Rule of Law is based on pillars of Sustainable Development – economic, social, environment and peace. It has to take precedence in the light of Stockholm Conference. This requires effective, accountable and transparent regime. The EIA Notification is a significant link in quest to pursue SDGs[6]. If there is a failure of due process in grant of EIA,

---

[3] (2019) 15 SCC 401
[4] Para 58
[5] Para 88
[6] Para 144, 169

remedial action has to be taken by requiring the EAC to revisit the recommendations for grant of EC.[7]

22. In *Alembic Pharmaceutical Ltd. V. Rohit Prajapati & Ors.*[8] the Hon'ble Supreme Court held, following the earlier view, that concept of *ex post facto* clearance is contrary to the requirement of prior EC.[9] Such concept is detrimental to the environment and can lead to irreparable degradation. EC can be issued only after various stages of decision-making process which are meant to ensure that all necessary safeguards are duly appraised by the experts before the project starts. *Ex post facto* EC will condone the violations and, in the process, irreparable harm may be caused to the environment. The Hon'ble Supreme Court upheld the quashing of circular of the MoEF dated 14.05.2002 permitting *ex post facto* EC. However, it was held that on failing to take prior EC, revocation of EC may not be the only option. The project proponent must be held accountable for non-compliance by way of requiring restitution and restoration.[10] Same view was taken in *Keystone Realtors Pvt Ltd. V. Anil V. Tharthare & Ors.*[11] it was observed that undertaking of expansion without prior EC denies opportunity to evaluate mitigation measures.[12]

23. In *Re: construction of Park at Noida near Okhla Bird Sanctuary v. UOI & Ors.*[13], the issue for consideration was whether EC was required for the project of setting up of a Memorial Complex at Noida near Okhla Bird Sanctuary. The stand of the project proponent was that the project was only development of a park while the contention in support of the

[7] Para 172, 175
[8] 2020 SCC OnLine SC 347
[9] Para 27
[10] Para 49
[11] (2020) 2 SCC 66
[12] Para 21
[13] (2011) 1 SCC 744

challenge to the project was that it involved building and construction. The Hon'ble Supreme Court held that 'dominant nature' test was required to be applied for determining whether EC was required and whether the project was covered by the Schedule to the EIA Notification, 2006[14]. It was further held that even if there was no laid down requirement of EC, environment protection being guaranteed under Article 21 of the Constitution, if there is any perceived harm to the environment, likelihood of such adverse impact must be duly examined[15]. Even after holding that EC was not required, the Hon'ble Supreme Court constituted Committees of experts which suggested protective and mitigation measures. The Hon'ble Supreme Court directed all such measures to be adopted.[16]

24. The issue relating to 'river valley projects' have been directly considered *inter-alia* in *Narmada Bachao Andolan v. UOI & Ors. (Sardar Sarovar Dam)* [17] *and N.D. Jayal & Anr.* v. UOI & Ors. (Tehri Dam)[18]

25. In *Narmada Bachao Andolan v. UOI & Ors.* one of the objections against the project was absence of proper EIA. The project proponent however defended the same as being in national and public interest particularly to provide drinking water in water scarce area. The project also provided for irrigation, industrial water supply, hydro-electric power and control of floods. The Hon'ble Supreme Court noted the studies undertaken on the subject at various levels and did not accept the plea that construction of the dam will have adverse ecological impact[19].

[14] Para 67
[15] Para 74
[16] Para 77-84
[17] (2000) 10 SCC 664
[18] (2004) 9 SCC 362
19 Para 119

Distinguishing the judgement in *Vellore Citizens' Welfare Forum v. UOI*[20] dealing with the 'Precautionary' and 'Polluter Pays' principles and special rule of burden of proof, it was observed that ecological disaster could not always be presumed from violation of procedure, if mitigative steps are taken[21]. Construction of dam was not at par with polluting industries or nuclear establishments which results in ecological degradation.[22] Thus, it was found that all due precautions had been taken and studies carried out. There were measures for relief and rehabilitation. The mitigation measures were being duly monitored. There was a Grievance Redressal Authority. The benefits for river valley projects in terms of food safety, water supply, energy supply, etc. were taken into account to offset the loss caused by displacement of persons, loss of forest and adverse impact on ecology.[23]

26. In *N.D. Jayal & Anr. v. UOI & Ors.*, while considering the Tehri Dam Project, it was observed that sustainable development is component of Right to Life. Thus, powers of the Environment Authorities were coupled with duty to enforce the guaranteed Right to Environment[24]. In the light of the said principle, directions were issued to monitor compliance of conditions for EC, apart from the existing mechanism under the MoEF&CC.

27. In the present matter, the project is predominantly for Irrigation though water supply is also involved. Plea to the contrary is untenable. Thus, the EC has been granted ex post facto in violation of legal

---

[20] (1996) 5 SCC 647
[21] Para 122 & 123
[22] Para 124
[23] Para 238-244
[24] Para 24-26

requirement for prior EC. Question is what consequences follow in the facts of the present case.

28. Right at the outset, we asked learned counsel for the appellant as to what was to be done if the project had already been substantially undertaken prior to grant of EC in violation of law. He fairly suggested that in such a situation what was required is to take suitable mitigation measures.

29. We find that inspite illegality found, it is neither possible nor desirable to undo what has happened but accountability needs to be fixed and remedial measures taken. As already noted, the MoEF&CC has not, in granting EC, gone into the issue whether the project had been substantially constructed without prior EIA and in the light of such factual position, what further safeguards were required and how the project proponent is be held accountable for violation of law and presenting *fait accompali*. Mere plea that the project was multi-purpose project and also had a component for which EC may not be required, was not sufficient for the project proponent to have gone ahead without the impact assessment and it is on that account that an injunction was issued by this Tribunal and by the High Court. Since we have found that there is major infirmity in EC being sought *ex post facto,* it is not necessary to go into other points. The fact remains that the project has been completed and only issue is of remedial action and future precautions.

30. We find that undoubtedly the project seeks to provide drinking water to the needy people and irrigation facilities to improve agricultural productivity which serves public interest. Also huge amount of public

money has been spent. At the same time, it is not necessary that for such development, damage to environment must be ignored and adequate safeguards are not to be adopted. Environmental rule of law need not be considered to be in conflict with the need for development but a facet of development. The development has to be sustainable and the light of principles which the country has accepted in the form of the frame work of legislation and best environmental practices.

31. Beyond submitting that there is damage to the environment on account of the project having been executed without prior EC, there is no tangible material before the Tribunal on the basis on which a specific direction for mitigations, restoration and rehabilitation measures can be directed. This exercise was expected from the experts recommending and the authorities granting EC. The project proponent should have been held accountable for the violations. This exercise may have to be undertaken now to enforce the rule of law.

32. Accordingly, we direct the MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to go into the matter in light of observations hereinabove. It may assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into. In this regard, we also note that the EC was granted with reference to ToR based on Form-I submitted by the project proponent, without considering the changes which have taken place in the project subsequently. The Expert Committee may also examine effective implementation of EMP earlier

submitted by the project proponent based on which EC was granted and compliance of EC conditions. The Expert Committee may be constituted within one month and it may complete its exercise within six months thereafter. The progress may be finally monitored by the Secretary, MoEF&CC. Any affected party will be at liberty to make representation to the MoEF&CC within three weeks putting forward suggestions and grievances, which may be taken into the account by Committee. The MoEF&CC may consider measures to prevent recurrence of such violations where EC is sought *ex post facto*. This is particularly required when the projects are multipurpose projects and part of it requires EC, so that such requirement is not defeated on specious plea that the project was partly not covered by the Schedule, as has happened in the present case. For this purpose, instead of confining consideration merely to Form–I, a mechanism is required to be evolved and followed whereby physical verification of material particulars can be undertaken, wherever necessary.

33. We are further of the view that the decision for expansion taken by the Telangana Govt. on 06.10.2019 is without EC and not tenable in view of stand taken by the CWC in O.A No.204/2020.[25] The stand of the State, that expansion of the project by extraction of 3 TMC/day instead of 2 TMC/day does not involve any infrastructural changes and therefore EC is not required, cannot be accepted. Extraction of more water certainly requires more storage capacity and also affects hydrology and riverine ecology of Godavari River. Such issues may have to be examined by the concerned statutory authorities. *Prima facie*, it is difficult to accept the plea that enhancement of capacity by one third will not require any infrastructural changes. In any case, this aspect needs to be

[25] Para 8

evaluated by the statutory expert Committees before the expansion is undertaken. The Minister of Jal Shakti vide letter dated 07.08.2020 addressed to the Chief Minister, Telangana has requested that the State may not proceed with the project without submitting DPRs to Godavari River Management Board (GRMB) and also without obtaining sanction of the Apex Council. CWC has also stated that no project proposal with respect to expansion of the project has been submitted to it as required. In these circumstances, the stand in the letter of the Chief Minister dated 02.10.2020 needs to be looked into by the Ministry of Jal Shakti and the State may proceed on the basis of such decision. The directions of the Central Government are binding and unless challenged and set aside, the same have to be followed.

The appeal stands disposed of in above terms.

Copies of this order be forwarded to MoEF&CC, Secretaries, Ministry of Jal Shakti and, Ministry of Power Govt. of India, CWC, State of Telangana, State PCB and GRMB by e-mail.

Adarsh Kumar Goel, CP

S. P. Wangdi, JM

Dr. Nagin Nanda, EM

October 20, 2020
Appeal No. 20/2018
A

Item No. 02 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

M.A. No. 40/2021
In
Appeal No. 20/2018

Md. Hayath Udin Appellant

Versus

Union of India & Ors. Respondent(s)

Date of hearing: 17.06.2021

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MR. JUSTICE M. SATHYANARAYANAN, JUDICIAL MEMBER
HON'BLE MR. JUSTICE BRIJESH SETHI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Applicant: Mr. G.G.C. George, Advocate in M.A. No. 40/2021

ORDER

1. This application seeks extension of time to comply with the order of this Tribunal dated 20.10.2020 in Appeal No. 20/2018, *Md. Hayath Udin v. UOI & Ors.* The Tribunal found that the Kaleshwaram Lift Irrigation Scheme (KLIS) Project had been executed in the State of Telangana without requisite prior EC and a joint Committee was directed to be constituted to examine the safeguards required and the manner of fixing accountability for such violations.

2. The application states that the Committee has been duly constituted and the work is in progress which will take time.

3. We find that having regard to the urgency of the issue, the matter needs to be expedited. The progress so far does not appear to be adequate.

Accordingly, while granting further extension of three months from today we expect that the Committee will complete its work expeditiously and not seek any further extension.

The application is disposed of.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

M. Sathyanarayanan, JM

Brijesh Sethi, JM

Dr. Nagin Nanda, EM

June 17, 2021
M.A. No. 40/2021 In
Appeal No. 20/2018
A

Item No. 02 (Court No. 1)

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

M. A. No. 62/2021
IN
Appeal No. 20/2018

Md. Hayath Udin Applicant

Versus

Union of India & Ors. Respondent(s)

....

Ministry of Environment, Forest and Climate Change Applicant in MA 62/2021

Date of hearing: 22.09.2021

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MR. JUSTICE BRIJESH SETHI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Applicant: Mr. G.G.C. George, Advocate for applicant in MA 62/2021

ORDER

1. This application seeks extension of time for further three months for compliance of order of this Tribunal dated 20.10.2020, in Appeal No. 20/2018, *Md. Hayath Udin v. Union of India & Ors.* The appeal was preferred against order dated 22.12.2017 of the Ministry of Environment, Forest and Climate Change (MoEF&CC) granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) project in Karimnagar District of Telangana by Irrigation & Command Area Development (I and CAD) Department, Government of Telangana. The same was dealt with vide order dated 20.10.2020 and inter-alia following direction was issued:

" xxx ....xxx xxx

32. Accordingly, we direct the MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to go into the matter in light of observations hereinabove. It may assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into. In this regard, we also note that the EC was granted with reference to ToR based on Form-I submitted by the project proponent, without considering the changes which have taken place in the project subsequently. The Expert Committee may also examine effective implementation of EMP earlier submitted by the project proponent based on which EC was granted and compliance of EC conditions. The Expert Committee may be constituted within one month and it may complete its exercise within six months thereafter. The progress may be finally monitored by the Secretary, MoEF&CC. Any affected party will be at liberty to make representation to the MoEF&CC within three weeks putting forward suggestions and grievances, which may be taken into the account by Committee. The MoEF&CC may consider measures to prevent recurrence of such violations where EC is sought ex post facto. This is particularly required when the projects are multipurpose projects and part of it requires EC, so that such requirement is not defeated on specious plea that the project was partly not covered by the Schedule, as has happened in the present case. For this purpose, instead of confining consideration merely to Form–I, a mechanism is required to be evolved and followed whereby physical verification of material particulars can be undertaken, wherever necessary."

2. The application states that the MoEF&CC constituted seven-member Committee in terms of above which has already held four meetings and also undertaken site visit. However, two of the members were affected by Corona due to which the task could not be accomplished within the specified time of six months.

3. Having regard to the averments in the application, extension sought is granted with the hope and expectation that the Committee will complete its task strictly in terms of the order of this Tribunal expeditiously.

The application is disposed of.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

Brijesh Sethi, JM

Dr. Nagin Nanda, EM

September 22, 2021
M. A. No. 62/2021
IN Appeal No. 20/2018
DV

ANNEXURE – VII

The scientist from Southern Regional Office along with officers of Telangana Pollution control Board and the project Authorities visited the project sites between 6/08/2017 and 09/08/2017 some of the abstracts of the referred Site Visit Report of R.O of Southern Region to the Kaleshwaram project site vide letter No:EP/12.7/NGT(SZ)/21/2017 Dt:11/08/2017 Is abstracted here below and the complete report with all annexures is enclosed Vide Annx-7

476427/2021/IA_I

A - 45

COURT MATTER / BY SPEED POST / E-mail

F. No. EP/12.7/NGT(SZ)/21/2017/TS/1280

Government of India

Ministry of Environment, Forest & Climate Change

Regional Office, Chennai

1st and 2nd Floor, HEPC Building,
No. 34, Cathedral Garden Road,
Nungambakkam,
Chennai – 600 034,
Tele No.: +91-44-28222325,
Dated 11th August, 2017.

To

Dr. S. Kerketta,
Scientist – F & Member Secretary,
River Valley & HE Sector, IA Division,
Ministry of Environment, Forest & Climate Change,
Indira Paryavaran Bhavan,
Jorbagh Road, Aliganj,
New Delhi – 110 003
Telefax: 011- 24695314
(E-mail: s.kerketta66@gov.in ; suna1466@rediffmail.com).

Subject: Site inspection of proposed Kaleshwaram project in the State of Telangana by M/s Irrigation & CAD Department, Govt. of Telangana in connection with O.A. No. 372 of 2017 in the matter of Md. Hayath Uddin Vs Union of India and Ors. before Hon'ble NGT, New Delhi regarding.

Reference: (1). Letter No.J-11011/10/2017-IA.I(R) dated 26/07/2017 of IA division of MoEF&CC.
(2). Letter No. EP/12.7/NGT(SZ)/21/2017/TS/1196 dated 31/07/2017 of RO, MoEF&CC, Chennai.
(3). E-mail communication dated 01/08/2017 of IA division of MoEF&CC.

Sir,

Reference is invited to the letter No.J-11011/10/2017-IA.I(R) dated 26/07/2017 and e-mail communication dated 01/08/2017 of IA division of MoEF&CC, New Delhi, wherein it was directed the Regional Office of MoEF&CC at Chennai to verify the factual status regarding alleged illegal construction activities for the proposed Kaleshwaram Lift Irrigation Scheme (KLIS) in the State of Telangana.

2. As directed by the Competent Authority, the site inspection of the aforesaid project was carried out by the undersigned along with Officers of Regional Offices of Telangana State Pollution Control Board from 06/08/2017 to 09/08/2017 in presence of the project authority.

3. During the inspection, it has been observed that Project Proponent has already commenced and continuing the construction activities / Civil works at the locations of the proposed Kaleshwaram project without obtaining prior environment clearance from the MoEF&CC and 'Consent For Establishment' from the State PCB. However, during the visit, project authority claimed that the present ongoing Civil works are being undertaken forproviding only drinking water supply to the people of Telangana, where prevailing acute shortage of drinking water. The site visit report along with supporting documents is enclosed herewith for kind perusal and further needful action.

This issues with the approval of the APCCF(C) vide diary No. 1154 dated 11/08/2017.

Yours faithfully,

(Dr. M.T. Karuppiah)
Scientist - D

Encls: As above

476427/2021/IA_I

A - 46

Copy to: Shri. Gyanesh Bharti, Joint Secretary, River Valley Sector, IA Division, Indira Paryavaran Bhavan, Ministry of Environment, Forest & Climate Change, Jorbagh Road, Aliganj, New Delhi – 110 003, (Telefax: 011-24695288; E-mail: gyanesh.bharti@ias.nic.in) – *w.r.t. letter No. J-11011/10/2017-IA.I(R) dated 26/07/2017 and email communication dated 01/08/2017 of IA division of MoEF&CC.*

(Dr. M.T. Karuppiah)
Scientist – D

Government of India
Ministry of Environment, Forest and Climate Change (MoEF&CC)
Regional Office – South Eastern Zone
Nungambakkam, Chennai – 600034.

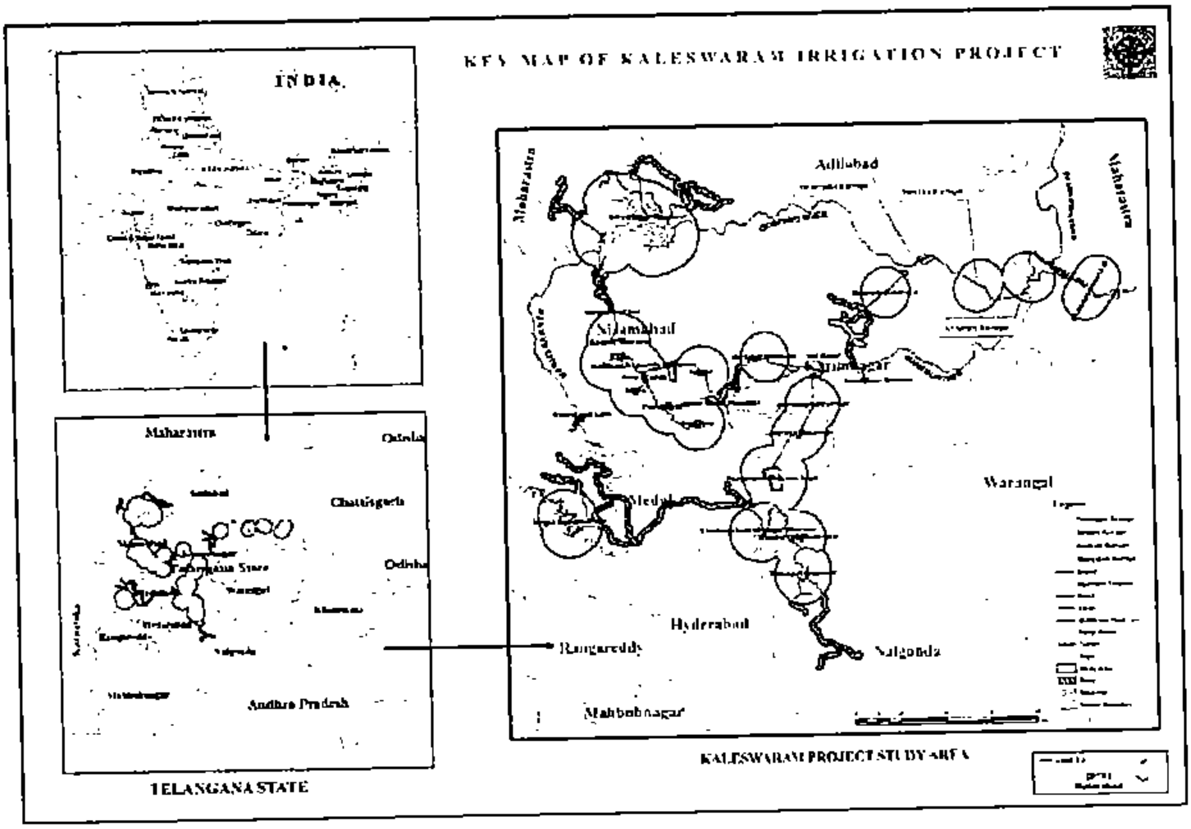
Site Inspection Report

F. No. EP/12.7/NGT(SZ)/21/2017/TS/1280

1		Project Type: River valley /Mining/Industry/Thermal / Nuclear/Other Specify.	:	River valley
2		Name of the project	:	Kaleshwaram Project in the State of Telangana by M/s Irrigation & CAD Department, Govt. of Telangana.
3		Status of Statutory Requirements:		
	(a).	Environmental Clearance letter(s)/OM No. and date	:	Environmental Clearance has not been accorded by the MoEF&CC. The Project authority has obtained only Terms of Reference (TOR) from the MoEF&CC vide letter No. J-12011/1/2017-IA-I(R) dated 31/03/2017.
	(b).	Forestry Clearance letter	:	Project authority submitted their proposal for the diversion of 3168.131 ha. of Forest and clearance yet to be obtained.
	(c).	Consent & Authorizations accorded	:	Consent to Establishment has not been obtained.
4		Locations :		It is an inter-state project comprising the Project area covered in 7undivided Districts of Telangana (presently 13 districts of Telangana).
	a.	Districts	:	Karimnagar, Warangal, Nizamadbad, Adilabad, Medak, Ranga Reddy and Nalgonda. (presently in the districts of Peddapalli, Karimnagar, RajannaSircilla, Siddipet, Medak, Yadadri Bhuvanagiri, Nalgonda, Sangareddy, Nizamadbad, Jagtial, Kamareddy, Nirmal and Medchal).
	b.	State (s)		Telangana

5		Address for correspondence	:	Shri. Hariram Bhookya, Chief Engineer, O/O the Chief Engineer, Kaleshwaram Project, Irrigation & CAD Department, Govt. of Telangana, 1st Floor, Jalasoudha Building, Erum Manzil, Hyderabad – 500 082. (Ph. 040-23329948; E-mail: cekph.ts.gov@gmail.com)
	a.	Address of concerned project Chief Engineer (with Pin Code & telephone/telex/fax numbers	:	Shri. N. Venkateshwarlu, Chief Engineer, Irrigation & CAD Department, Kaleshwaram Project, LMD Colony, Karimnagar – 550 527 E-mail: venkatnallame61@gmail.com
6		Break up of the project area	:	Details of the Total area and its breakup has not been made available by the PA. As per available records, the proposed project is an interstate project and boundary of project, partlyadjoining to the State of Maharashtra. As per ToR accorded by MoEF&CC, total land requirement of the proposedproject is about 32,000 ha., which comprising of 2866 ha. of Forest land.However, as per available records in this Office, project authority submitted their proposal to the competent authority for diversion of 3168.131 ha.(revised from 3221.2974 ha.) of Forest land in 8 different forest divisions of Telangana. Forestry clearance yet to be obtained.
7		Financial Details:		
	a	Project cost as originally planned	:	Rs. 80,499.71 Crores (As per Project Authority)
8		Status of construction :		
	a	Date of commencement		January & February, 2017 (As informed by the Project Authority)
	b	Date of completion (actual and/or planned)		Construction activities / Civil works are under progress.
9		Date of site visit:		
		Date of site visit for this site inspection report	:	06/08/2017 to 09/08/2017.

Location map of the proposed Kaleshwaram Project and layout of the project area is shown below in Figure 1:



SITE INSPECTION REPORT ON THE STATUS OF PROPOSED KALESHWARAM PROJECT

Subject: Site inspection of proposed Kaleshwaram project in the State ofTelangana by M/s Irrigation & CAD Department, Govt. of Telangana in connection with O.A. No. 372 of 2017 in the matter of Md. Hayath Uddin VsUnion of India and Ors. before Hon'ble NGT, New Delhi.

MoEF&CC, New Delhi vide letter No.J-11011/10/2017-IA.I(R) dated 26/07/2017 and subsequent e-mail communication dated 01/08/2017 of IA division requested the Regional Office of MoEF&CC at Chennai to verify the factual status regarding alleged illegal construction activities in the Forest and non-Forest area for the proposed Kaleshwaram Lift Irrigation Scheme (KLIS) in the State of Telangana. In this regard, as directed by the APCCF(Central) the undersigned along with Officers from the Regional Offices of Telangana State Pollution Control Board at Warangal, Ramagundam, R.C. Puram and Nizamabad inspected the proposed Kaleshwaram project site from 06/08/2017 to 09/08/2017 in presence of project authority. During the visit on behalf of project authority Shri. N. Venkateshwarlu, Chief Engineer and other concerned Officers of Irrigation & CAD Department, Govt. of Telangana, concerned project Engineers of M/s L&T Ltd., M/s Navayuga Engineering Company Ltd. and M/s Megha Engineering & Infrastructures Ltd. were present.

2. Description of the project:

Kaleshwaram Project has been proposed by Government of Telangana through Irrigation & CAD Department to meet the need of drinking water requirements and for irrigating the dry lands in the command area. The proposed Kaleswaram Project was formulated for irrigation of about 7,38,851 ha. in Karimnagar, Rajanna, Siricilla, Siddipet, Medak, Yadadri, Nalgonda, Sangareddy, Nizamabad, Jagityal, Kamareddy, Nirmal, Medchal and Peddapalli districts of Telangana by diverting 180 TMC of water from River Godavari. The source point is near Medigadda Village in the district of Bhubalapally, below the point of confluence of Pranahitha and Godavari River about 20 km downstream of Kaleshwaram. Central Water Commission has assessed the availability water as 282 TMC at Medigadda site, out of which, about 180 TMC is proposed to be lifted for the Kaleshwaram project and additional water availability at Yellampally barrage- is about 225TMC.

According to the project authority, the utilization of 225 TMC out of which 180 TMC diverted from River Godavari includes - 30 TMC for drinking water to Hyderabad, 10 TMC for drinking water to en route villages, 134.5TMC for Irrigation, 34.5 TMC for stabilization of existing command area, and 16 TMC for industrial uses.

3. **The components of the project have been broadly classified as under**:

(i). Three barrages across River Godavari between Yellampally and Medigadda.
Three barrages proposed on River Godavari are Medigadda, Annaram & Sundilla.

(ii). Water Conveyor System consisting of Gravity Canals and Tunnels.
The entire project system has been divided into seven links. The water conveyor system is again divided into gravity canals and tunnels comprising of 1832 km length. Water will be delivered to different command areas by constructing 19 pumphouses through 7 Links.

(iii). Online storages.
In order to utilize the diverted water of Godavari river, it has been proposed to have enough online storages in the scheme. Accordingly, 17 online storages have been proposed which interalia include five existing online storages having overall capacity of 56 TMC and new online storages in the en-route having overall capacityof around 148 TMC.

(iv). **Distributary Network System.**

It has been proposed to provide irrigation facilities to the command area of about 7,38,851 ha covering thirteen districts of Telangana.

The line diagram of the proposed Kaleshwaram project and schematic diagram of linking of Meddigadda, Annaram and Sundilla Barrages to Yellampally Reservoir is shown below as **Figure 3**.

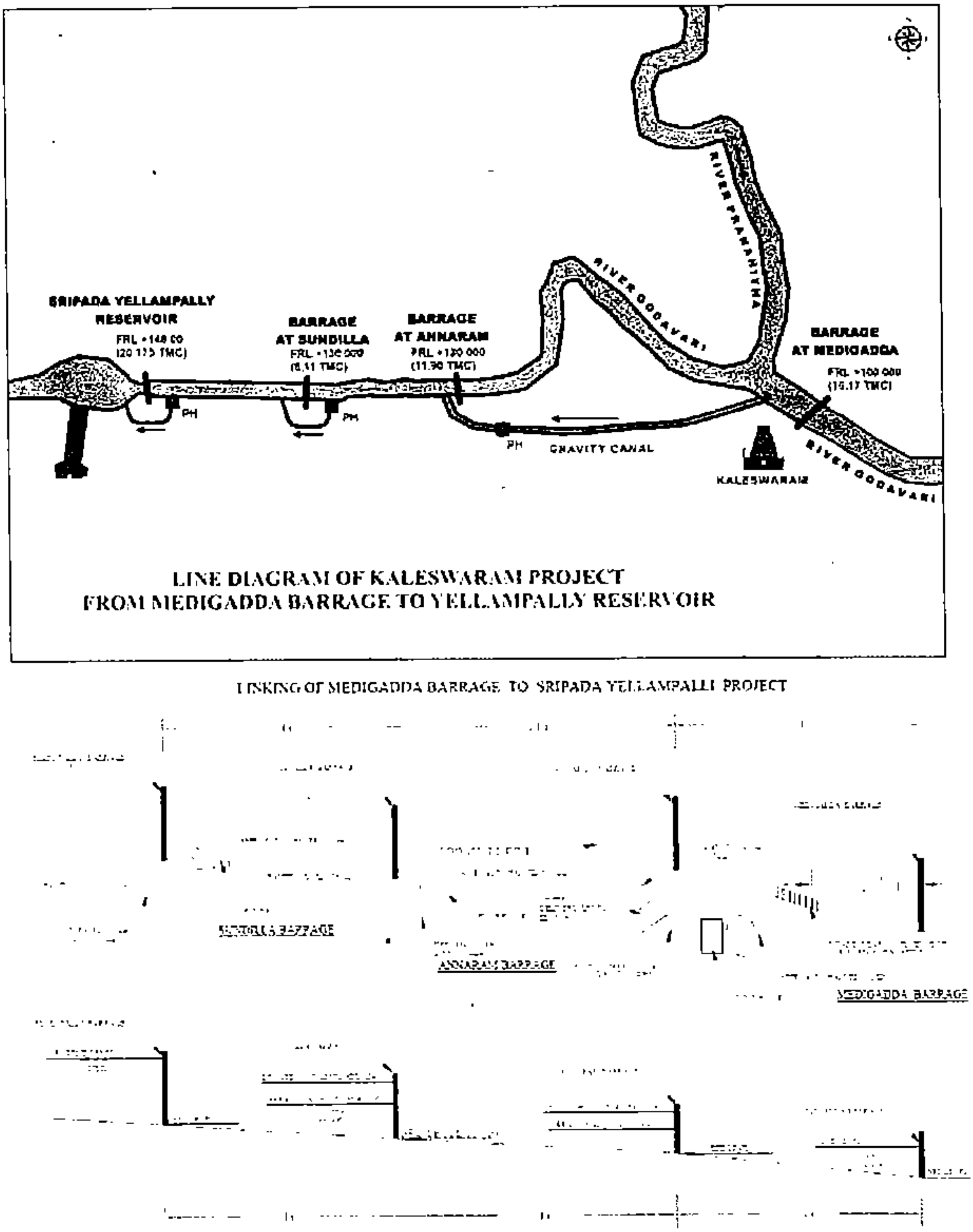


Fig.3. Line diagram of the project & linking of proposed Barrages to Yellampally Reservoir.

4. Status of Statutory requirements:

During the discussion held with the project authority and Officers of TSPCB, the status of the aforesaid project and details of the statutory requirements obtained from the competent authority were sought. From the deliberation, it is learnt that for the aforesaid project, the project authority has obtained only Terms of Reference (TOR) from the MoEF&CC vide letter No. J-12011/1/2017-IA-I(R) dated 31/03/2017 and no environmental clearance / Consent For Establishment (CFE) was obtained from the competent authority. It is also learnt that Project Authority has submitted their proposal for the diversion of 3168.131 ha. (revised from 3221.2974 ha.) of Forest land covering 8 different forest divisions of Telangana. Forestry Clearance yet to be obtained from the competent authority. Further, as informed by the project authority, no National parks, Sanctuaries andBiospheres are involved within 12 km radius of the project area and thus the requirement of Clearance / NOC from NBWL does not arise. As per available records, the proposed project is an interstate project, since boundary of project, partly adjoining to the State of Maharashtra.

As informed by the Telangana State PCB, project authority has completed their EIA Studies and submitted their draft EIA & EMP report for the project to the competent authorities. Necessary steps are being taken by the project authority and State PCB for conducting Public consultation processes at different locations interalia including in the State of Maharastra, since the project is inter-state project. Project authority informed that major part of land acquisition is already completed.

5. Status of construction / commencement of project activity:

During the visit, the inspection was carried-out from the point of confluence of Pranahitha and Godavari River to the en-route of the proposed project, which interalia include the following locations:

Sl. No.	Location	District	Factual Status on site
1.	Medigadda Barrage	Bhuballapally	Excavation / construction activities / Civil works are under progress.
2.	Kannepally Pump House	Warangal	Excavation / construction activities / Civil works are under progress.
3.	Annaram Barrage	Warangal	Excavation / construction activities / Civil works are under progress.
4.	Sundilla Barrage	Peddapalli	Excavation / construction activities / Civil works are under progress.
5.	Annaram Pump House	Peddapalli	Excavation / construction activities / Civil works are under progress.
6.	Goliwada Pump House	Peddapalli	Excavation / construction activities / Civil works are under progress.
7.	Tukkapur Pump House	Siddipet	Excavation / construction activities / Civil works are under progress.
8.	Yellareddypet	Siddipet	Excavation / construction activities / Civil works are under progress.
9.	Manchippa	Nizamabad	Excavation / Civil works are under progress.

It appears Project authority has awarded the contracts for operation and maintenance of different utilities to the different external agencies viz. M/s L&T Ltd., M/s Navayuga Engineering Company Ltd. and M/s Megha Engineering & Infrastructures Ltd. etc., who are executing the Civil and other construction activities of the project.

6. During the visit, it has been observed that in the aforesaid locations Project authority reportedly commenced their excavation / civil works / construction activities from the month of January - February, 2017 and is being continued. In the aforesaid project locations heavy machineries, vehicles and equipments are deployed, earth workings and other civil construction works are being carried-out. Further, temporary houses for the workers have been made in the respective project sites. All the aforesaid project activities appears to be carried-out in the non-Forest area. **In support of the aforesaid ongoing project activities, relevant photographs which are taken during the site inspection is placed as Annexure – I to Annexure – VII.**

Though the construction activities / Civil work is being continued, during the visit project authority claimed that the present ongoing Civil works are being undertaken for providing only drinking water supply to the people of Telangana, where prevailing acute shortage of drinking water.

7. <u>Details of the Directions issued, if any</u>:

As informed by the project authority as well as Officers of Telangana State PCB, so far no direction was issued to the above project under Air and Water Act.

8. <u>Status of alleged construction / commencement of project activity in the Forest Land:</u>

As desired by the MoEF&CC, for the proposed diversion of Forest land for this project, APCCF(Central), Regional Office of MoEF&CC at Chennai carried out site inspection during 26th to 29th April, 2017 and submitted the report vide letter No. 4-TSA072/2017-CHN/0808 dated 26/05/2017 to the ADG(FC), MoEF&CC, wherein it has been reported that contractor has committed violation of small stretch at Ambatpally Village, Suraram Block in Mahadevpur RF by constructing small camp office, for which State Forest Department compounded and subsequently removed the constructed camp office. Further, it has been reported that violation was noticed by the State ForestDepartment for the area of 3.9694 ha. for construction of surge pool and other structure. Reportedly notices were issued by the Department concerned.

Further, State Forest Department, Govt. Telangana vide letter No. 1704/2017/FCA-1 dated 09/06/2017 submitted their report to the MoEF&CC, wherein it is reported that in Villages Goliwada, Sripuram and Kasipeta of Peddapally District, Tukkapur, Yellareddypet of Siddipet District some construction activities, temporary structures and mobilization of heavy machinery was noticed, which are not falling in the reserved forest areas. Copy of the letter dated 09/06/2017of State Forest Department, Telangana is enclosed as **Annexure – VIII**.

9. <u>Observation and concluding Remarks</u>:

(a).Project authority has commenced and continuing construction activities / Civil works on the selected locations of the non-forest area of their proposed project, without obtaining prior environment clearance from the MoEF&CC and 'Consent For Establishment' from the Telangana State PCB. However, project authorityclaimed that the present ongoing Civil works / project activities are being undertaken for providing only drinking water supply to the people of Telangana, where prevailing acute shortage of drinking water.

(b).As per the Inspection report dated 26/05/2017 of Regional Office of MoEF&CC at Chennai reported that contractor has committed violation of small stretch at

Ambatpally Village, Suraram Block in Mahadevpur RF by constructing small camp office, for which State Forest Department compounded and subsequently removed the constructed camp office. Further, it has been reported that violation wasnoticed by the State Forest Department for the area of 3.9694 ha. for constructionof surge pool and other structure. Reportedly notices were issued by the Department concerned. Further, State Forest Department, Govt. Telangana vide letter No. 1704/2017/FCA-1 dated 09/06/2017 submitted their report to the MoEF&CC, wherein it is reported that in Villages Goliwada, Sripuram and Kasipeta of Peddapally District, Tukkapur, Yellareddypet of Siddipet District some construction activities, temporary structures and mobilization of heavy machinery was noticed, which are not falling in the reserved forest areas.

This issues with the approval of Competent Authority vide diary No.1154 dated 11/08/2017.

(Dr. M.T. Karuppiah)
Scientist – D

1

GOVERNMENT OF TELANGANA
FOREST DEPARTMENT

From
Sri P.K. JHA, IFS,
Prl. Chief Conservator of Forests
(Head of Forest Force),
Telangana, "AranyaBhavan",
Saifabad, Hyderabad

To
The Director General of Forests & Special Secretary to the Government,
Ministry of Environment and Forests and Climate Change,
Indira Paryavarana Bhawan,
Jorbagh Road,
New Delhi – 110003.

Ref.No.1704/2017/FCA-1 Dated: 09 .06.2017

Sir,

Sub: TSFD - Forest (Conservation) Act, 1980 - Petition - Execution of works for **Kaleswaram Lift Irrigation Project** at Tukkapur, Yellareddypet, Goliwada, Siripuram, Kasipeta and Ramchandrapuram villages without obtaining Environmental Clearance and forest clearance - Violation of guidelines issued under Forest (Conservation) Act, 1980 - Detailed report Furnished Regarding.

Ref:
1. Petition from Md.Hayath Uddin R/o.Siddipet Lr.No.nil dt.23.01.2017.
2. PCCF's Ref. No. 1704/2016/FCA-I, dt. 04.02.2017
3. PCCF's Ref. No. 2514/2017/FCA-I dt. 27.03.2017
4. Govt. Lr. No. 3747/For.I(1)/2014, dt. 27.03.2017
5. MoEF &CC Regional Office, Chennai F.No. A 14026/I/ROSEZ/CHN/2016/Complaints/0644, dt. 24.04.2017
6. MoEF & CC, New Delhi F.No.11-31/2017-FC dated 12.02.2017.
7. PCCF's Ref.No. 1704/2016/FCA-1, dt. 02.05.2017
8. MoEF & CC, Regional Office, Chennai F.No.11.6/FCA/COMPLAINTS/ 2017/890 dated 08.06.2017
9. DFO Siddipet Lr. No. 27/SA/2016, Dt. 07.05.2017
10. [illegible]

Kind attention is invited to the references cited.

Vide ref 5th, 6th and 8th cited, it has been requested to enquire into the complaint made by Sri Hayathuddin S/o Md Basheeruddin on execution of works pertaining to **Kaleswaram Lift Irrigation Project** at Tukkapur, Yellareddypet, Goliwada, Siripuram, Kasipeta and Ramchandrapuram villages without obtaining Environmental Clearance and forest clearance violating guidelines issued under Forest (Conservation) Act, 1980

In this regard, it is submitted that the detailed reports have been obtained from the concerned field officers vide ref 9th and 10th cited (Copies enclosed).

Cont'd....2

:: 2 ::

It is reported that in villages Golwada, Siripuram and Kasipeta of Peddapally District some construction activity is going on. Temporary structures like camping sheds, sites are noticed in the villages. Heavy machinery is also mobilized. However, these areas are not falling in any of the Reserved Forests of the District. Further, in villages of Tukkapur, Yellareddypet of Siddipet District also no works are being carried out in the reserved forest areas, but some temporary structures like sheds are constructed at camp site and machinery kept at camp site, outside Reserved Forests of the District.

Further, it is submitted that the User Agency has submitted the proposal for diversion of 3168.1315 ha of forest land under Forest (Conservation) Act, 1980 in different forest divisions viz. Mahadevpur, Karimnagar [illegible], Siddipet, Yadadri, Medak, Nizamabad Banswada and Nirmal divisions for construction of canals, tunnels, lift system, surge pool, delivery cistern, and reservoirs etc. involved in **Kaleshwaram project** in different districts of Telangana State. The proposals have been processed and submitted to the Government vide ref. [illegible] cited. The Govt. of Telangana processed and recommended the proposal to MoEF & CC, GOI, New Delhi vide reference 4th cited. The proposed forest areas and non forest land for CA have been inspected by the Regional Officer and Dy. Conservator of Forests, [illegible] and the Site Inspection Report submitted to MoEF & CC. The User Agency has also applied for Environmental Clearance under E(P)Act, 1986 and the [illegible] number at Ministry's portal is IA/TG/RIV/0125/2016.

Encl: (As above)

Yours faithfully,
Sd/- [illegible] JHA
Principal Chief Conservator of Forests
& Head of Forest Force.

Copy Submitted to

The Addl. [illegible] Chief Conservator of Forests [illegible] MoEF&CC, RO, South Eastern Zone, Nungambakkam, Chennai for favour of information and necessary action.

The Spl. Chief Secretary to Government, Environment, Forests, Science & Technology Department, Telangana Secretariat, Hyderabad for favour of information and necessary action.

// True Copy //

for Principal Chief Conservator of Forests
& Head of Forest Force

****

Location map of the proposed Kaleshwaram Project and layout of the project area is shown below in Figure 1:

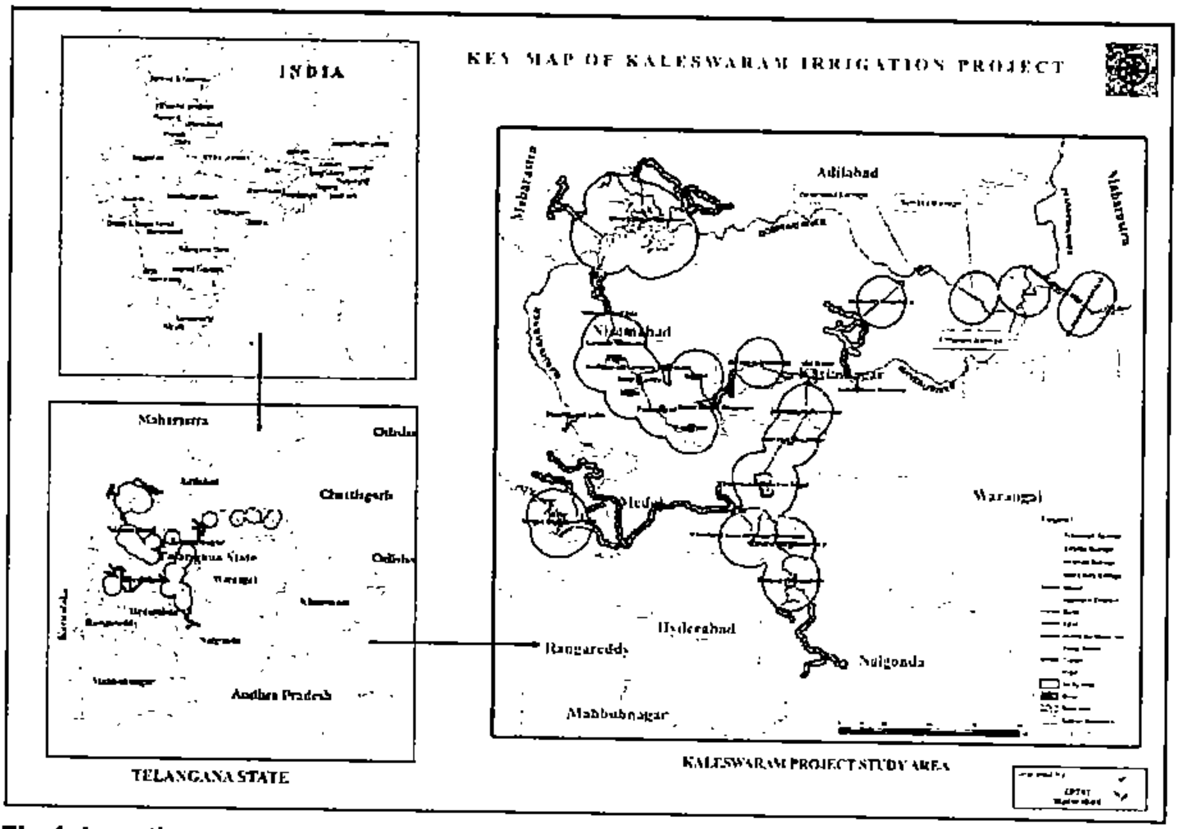


Fig.1. Location map of the proposed Kaleshwaram Project and layout of the project area

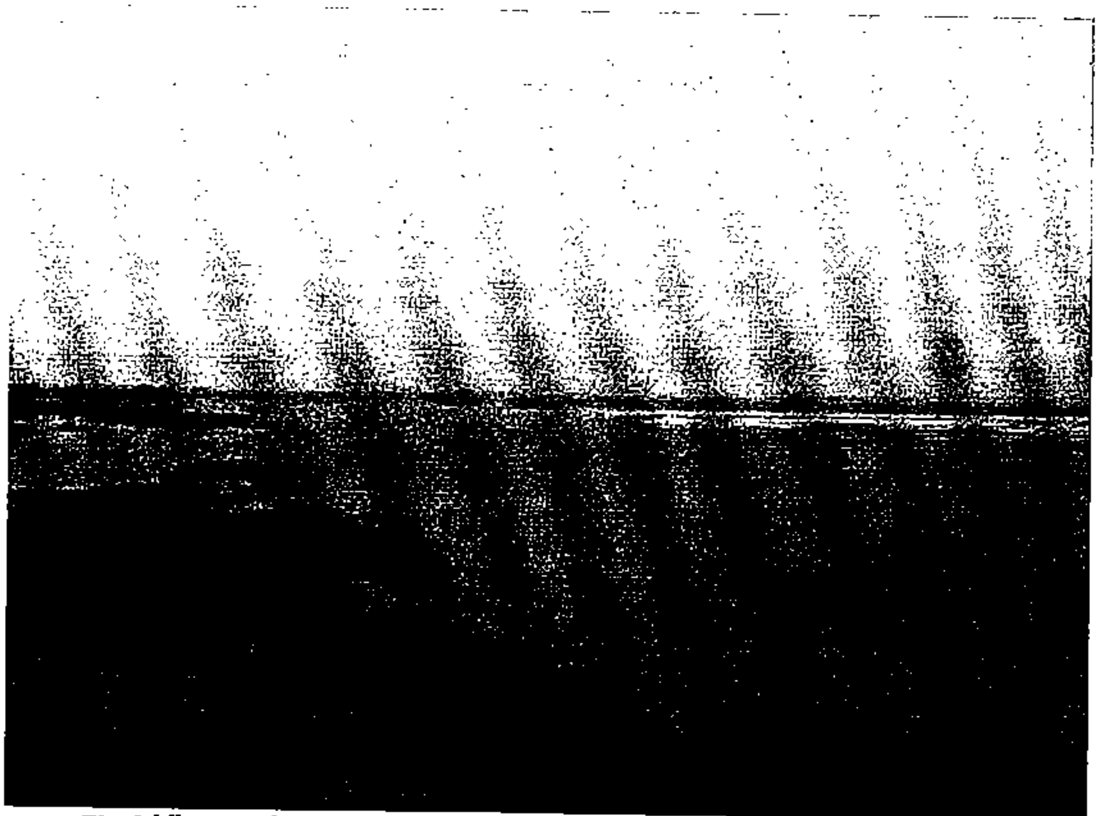
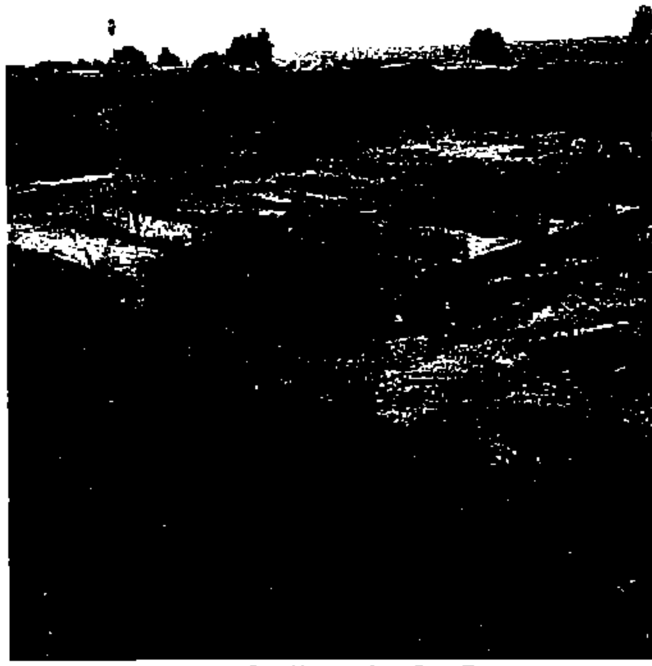


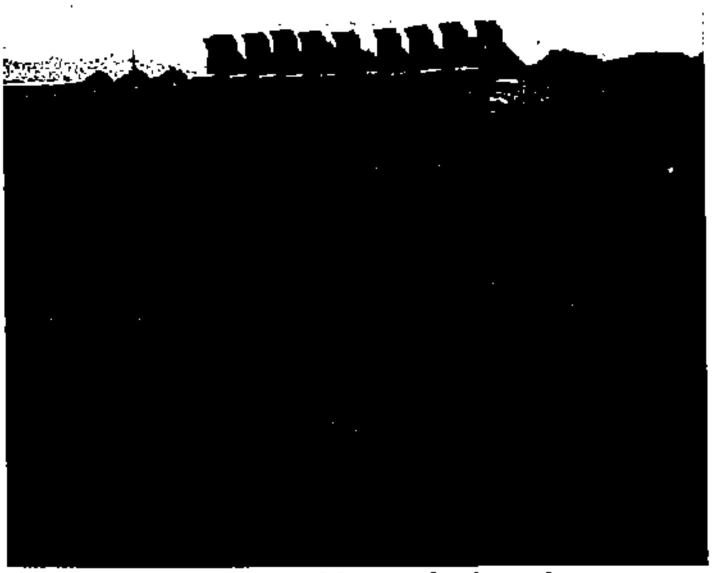
Fig.2. View point of confluence of Pranahitha and Godavari River

Annexure – I

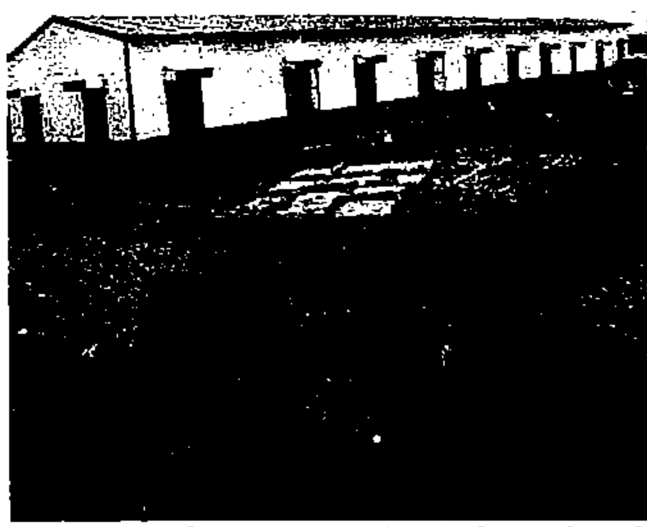
Panoramic view of the proposed Medigadda Barrage with various construction / project activities / Civil works are in progress.



Ongoing Civil works for Barrage



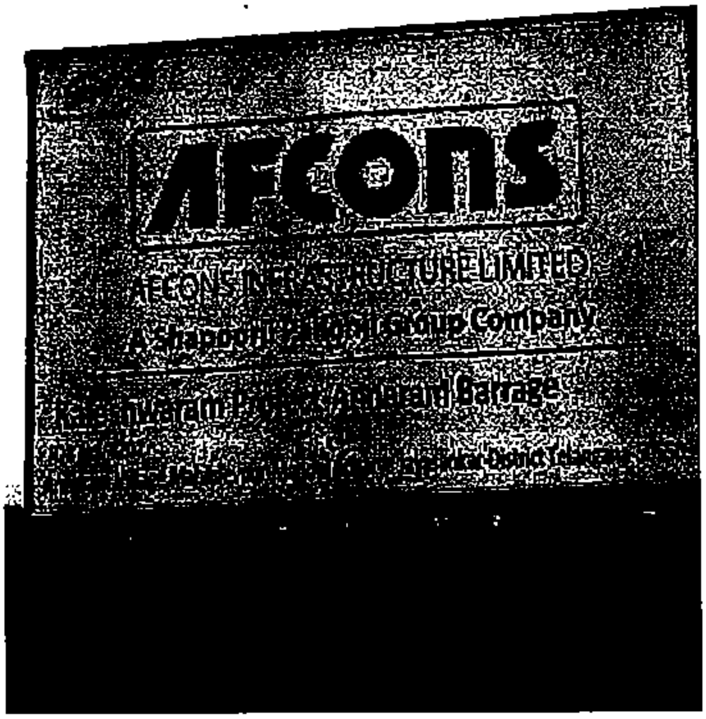
Heavy machinery deployed

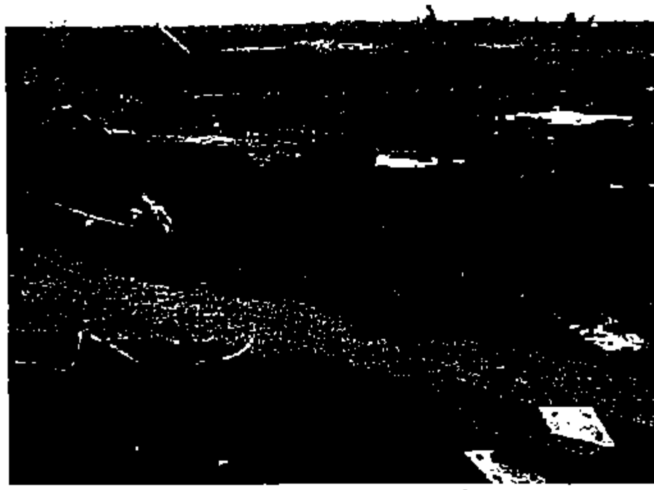


Temporary houses constructed on the sit for workers

Annexure – II

Panoramic view of the proposed Annaram Barrage with various construction / project activities / Civil works are in progress.





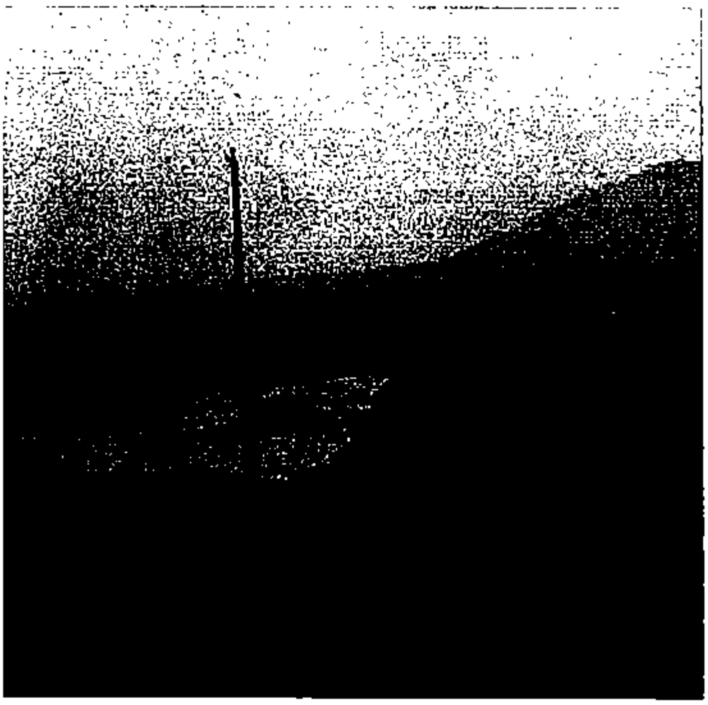
Ongoing excavation works for Barrage

View of patching plant installed

Heavy machinery deployed

Annexure – III

Panoramic view of the proposed Sundilla Barrage with various construction / project activities / Civil works are in progress.



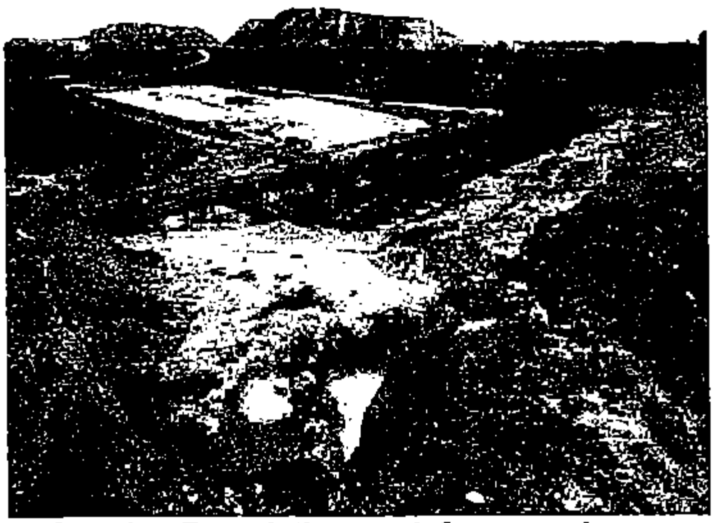
Ongoing Civil works for Barrage

View of patching plant installed for mixing of concrete

Stacked excavated earth materials

Annexure – IV

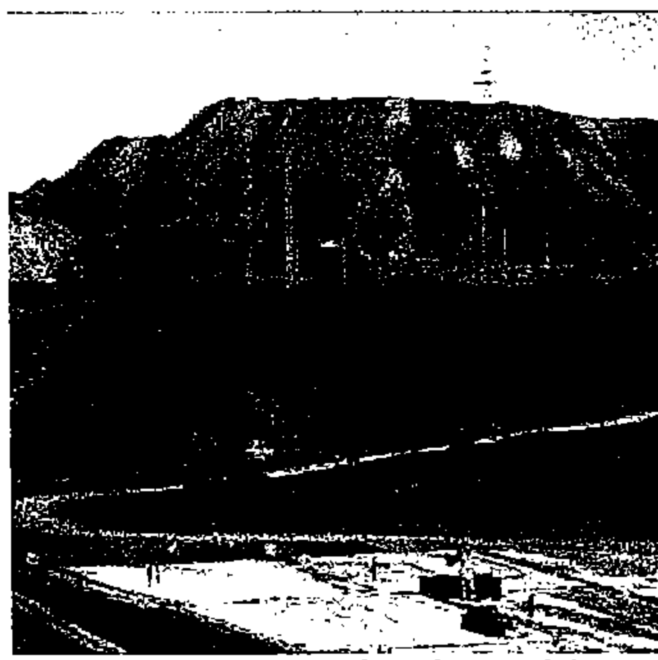
Panoramic view of the proposed Kannepally Pump House with various on-going project activities



Ongoing Foundation work for pump house

Temporary houses constructed on the site for workers

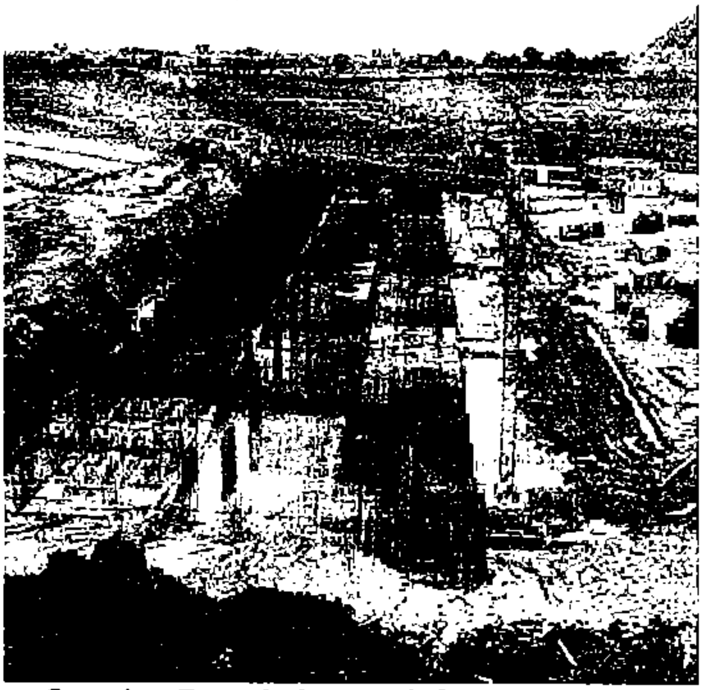
Material Storage yard



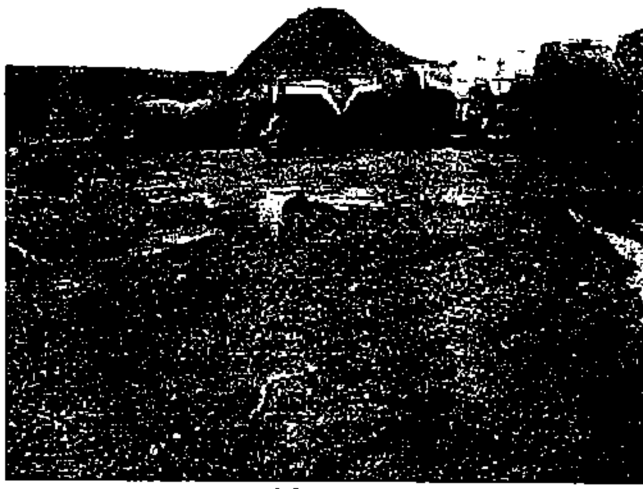
Stacked excavated earth materials

Annexure – V

Panoramic view of the proposed Annaram Pump House with various on-going project activities

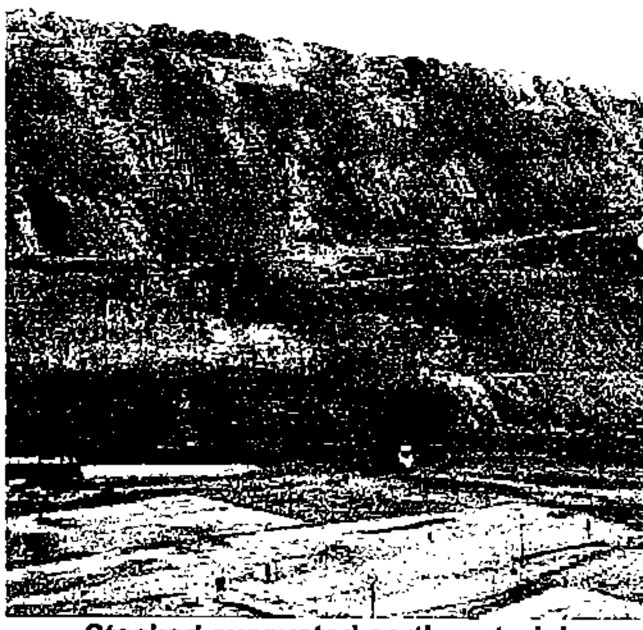


Ongoing Foundation work for pump house



Heavy machineries in the yard

Erection of Electrical Transformers



Stacked excavated earth materials

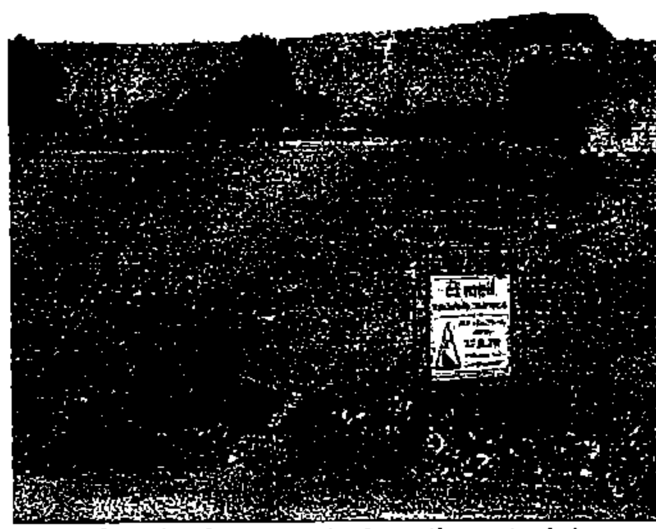
Annexure – VI

Panoramic view of the proposed Goliwada Pump House with various on-going project activities

Ongoing excavation work for pump house

Heavy machineries deployed for excavation

Material storage yard and Temporary houses constructed



Stacked excavated earth materials

Annexure – VII

Panoramic view of the proposed Tukkapur - Yellareddypet Pump House with various on-going project activities

Ongoing excavation work for pump house & tunnel

Provision made for circulation of oxygen to the tunnel

Stacked excavated material with heavy vehicles deployed

Sand stacked for construction of tunnel

ANNEXURE – VIII

Constitution of an Expert Committee in Pursuance of Hon'ble NGT order dated 20/10/2020 as above referred-order-Vide Annx-8

L-11014/4/2018-IA I (R)
Government of India
Ministry of Environment, Forest & Climate Change
Impact Assessment Division, Hydro

3rd Floor, Vayu Wing,
Indira Paryavaran Bhawan,
Jorbagh Road,
New Delhi-110 003
E-mail: s.kerketta66@gov.in
Tele: 011-24365314

Dated: 20th November, 2020

ORDER

Sub: Constitution of an Expert Committee in pursuance of Hon'ble NGT Order dated 20.10.2020 in the matter of Md. Hayath Udin versus UoI & Ors (Appeal no. 20/2020).

An appeal was made against letter dated 22.12.2017 of the Ministry of Environment, Forest and Climate Change (MoEF&CC) granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) project in Karimnagar District of Telangana by Irrigation & Command Area Development (I and CAD) Department, Government of Telangana.

2. Hon'ble NGT in its Order dated 20.10.2020, directed MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into.

3. Above Order was deliberated in the 3rd Expert appraisal Committee (EAC) meeting held on 29.10.2020. EAC opined that let Ministry take up the matter separately for constitution of the Committee however, it was suggested that one additional member from the Expert Appraisal Committee dealing with Violation cases in the Ministry, may also be included in the Committee to complete the work specified by the Hon'ble NGT within the time frame.

4. In view of the Order dated 20.10.2020, Ministry hereby constitutes an Expert Committee comprises of following members to achieve the work specified by the Hon'ble NGT within the time frame of six months:

1.	Shri Balraj Joshi	:	Chairman
2.	Shri K. Gowarappan	:	Member
3.	Dr. Mukesh Sharma	:	Member
4.	Dr. A. Malhotra	:	Member
5.	Shri Amarendra Kumar Singh	:	Member
6.	Dr. Narayan Shenoy K.	:	Member
7.	Dr. J.A. Johnson	:	Member

5. Following are the Terms of References that the Committee may refer to achieve the objective within the scheduled time:

- (i) Examination of DPR to ascertain the allocation of water for different usages like irrigation and drinking water etc.
- (ii) Examination of relevant Contracts/work orders since 2007.
- (iii) Examination of various Court orders and other statutory clearances applicable and obtained by the Project Proponent.
- (iv) Verification of *.kml* file on DSS
- (v) Virtual meeting with the Project Proponent for deliberation on the project and clarification from the Project Proponent, if any required.
- (vi) Site visit by the committee to physically verify the construction of the project.
- (vii) Examination of the report on the compliance of EC conditions by Regional Office, MoEF&CC.
- (viii) Assessment of environmental damage and remedial measures.
- (ix) Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into.
- (x) Any other additional Terms of Reference as deemed appropriate by the Expert Committee in light of the order of Hon'ble NGT.

6. Ministry of Environment, Forest and Climate Change shall facilitate and Coordinate with the Expert Committee and State Government of Telangana to meet the objective. Expenses, if any, incurred by the Committee in achieving the assigned work will be met out of the Budget head-Environmental Impact Assessment 3451.00.090.29.05.11-Domestic Travel Expenses (DTE) under demand number 25 for year 2020-21 (Plan).

7. This issues with an approval of the Competent Authority.

S Kerketta

(Dr S. Kerketta)
Director (IA I)

To,

Shri Balraj Joshi, Chairman, Expert Committee
/ All Members Expert Committee

Copy to:

1. PPS to Secretary
2. PPS to AS (RA)
3. PPS to JS (GM)
4. Guard file

ANNEXURE – IX

From the mandate of MOEF&CC, one of the terms of reference was to visit the site ,but the visit could not happen due to prevailing pandemic situation due to 2nd wave and accordingly Hon'ble NGT,allowed three more months extension of time i,e upto 17th September 21to submit the report.(Order enclosed vide-Annx-9)

Item No. 02 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

M.A. No. 40/2021
In
Appeal No. 20/2018

Md. Hayath Udin Appellant

Versus

Union of India & Ors. Respondent(s)

Date of hearing: 17.06.2021

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MR. JUSTICE M. SATHYANARAYANAN, JUDICIAL MEMBER
HON'BLE MR. JUSTICE BRIJESH SETHI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Applicant: Mr. G.G.C. George, Advocate in M.A. No. 40/2021

ORDER

1. This application seeks extension of time to comply with the order of this Tribunal dated 20.10.2020 in Appeal No. 20/2018, *Md. Hayath Udin v. UOI & Ors*. The Tribunal found that the Kaleshwaram Lift Irrigation Scheme (KLIS) Project had been executed in the State of Telangana without requisite prior EC and a joint Committee was directed to be constituted to examine the safeguards required and the manner of fixing accountability for such violations.

2. The application states that the Committee has been duly constituted and the work is in progress which will take time.

3. We find that having regard to the urgency of the issue, the matter needs to be expedited. The progress so far does not appear to be adequate.

Accordingly, while granting further extension of three months from today we expect that the Committee will complete its work expeditiously and not seek any further extension.

The application is disposed of.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

M. Sathyanarayanan, JM

Brijesh Sethi, JM

Dr. Nagin Nanda, EM

June 17, 2021
M.A. No. 40/2021 In
Appeal No. 20/2018
A

Tour Report

A team comprising of the members of a sub-committee visited Kaleswaram Project in Telangana from 25th -28th for ascertaining violations by the PP in going ahead with the project without EC (2008-2017). The list of the names of the members is inter-alia given in Annex-I. During the visit, the committee physically examined various structures of the project and the surroundings as detailed herein. The tour bears the sanction order no: F.no. L-11011/4/2018-IA.I(R) dated 18.8.2021 of MoEF&CC.

Background

Kaleswaram Lift Irrigation Scheme is situated in the state of Telangana and is billed to be the largest such project in the world and is designed to lift upto 2 TMC water of the Godavari water per day by about 530 meters in height. It consumes about 4600 Mw of power for pumping with the largest single pumping unite being of 139 Mw. Spread over a distance of about 500 Km., the project consists of 7 Links with 22 pump houses and 20 reservoirs. The total length of the water conductor system is 1850 meters which comprises of Canals, pipe lines and tunnels. The major components of the project already stand completed, and only some distributary canals and minors etc. are under execution.

The EC for the project was granted in Dec. 2017. However the project had come into scrutiny by the Hon'ble NGT due to alleged environmental violations during the construction of the project as appealed by one Mr. Md. Hayathuddin of Sidipet, Telangana, who inter-alia had charged that the work was started before the grant of EC. In this regard the Hon'ble NGT, asked the MoEF&CC to constitute a seven-member committee to go into various alleged violations and assess the damage caused to the environment, before the issuance of the EC. The said committee was formed by the MoEF & CC. vide no. L-11014/4/2018-IA I(R) dated 20th November 2020. The committee was allowed six months' time for carrying out necessary inspection and studies and submit the report. As such the committee was supposed to submit its report on or before 20th May 2021. The detailed order is attached hereto as Annexure –I. The committee has held 4 meetings thus far, out of which two meetings were also attended by the PP and one was attended by their Environmental consultant namely M/s EPTRI. In these meetings the requirements of various kind of data required for assessing the requisite damage was discussed. The requisitions for various kind of data were given to the PP in the shape of proper formats, through three letters and some of the data was infact received from them. However, still a sizeable data was found missing and accordingly a comprehensive statement showing the balance data requirement was sent to the PP, the information on which is still awaited. A list of the data required is attached herewith as Annex-II.

As may be seen from the order of constitution of the committee, one of the terms of reference of the committee was to visit the site, but the visit could not be held due to the prevailing pandemic conditions (2nd wave) in the country and accordingly, Hon'ble NGT allowed an extension of 3 months from the date of the order, for submission of the report i.e. by 17th Sept. 2021.

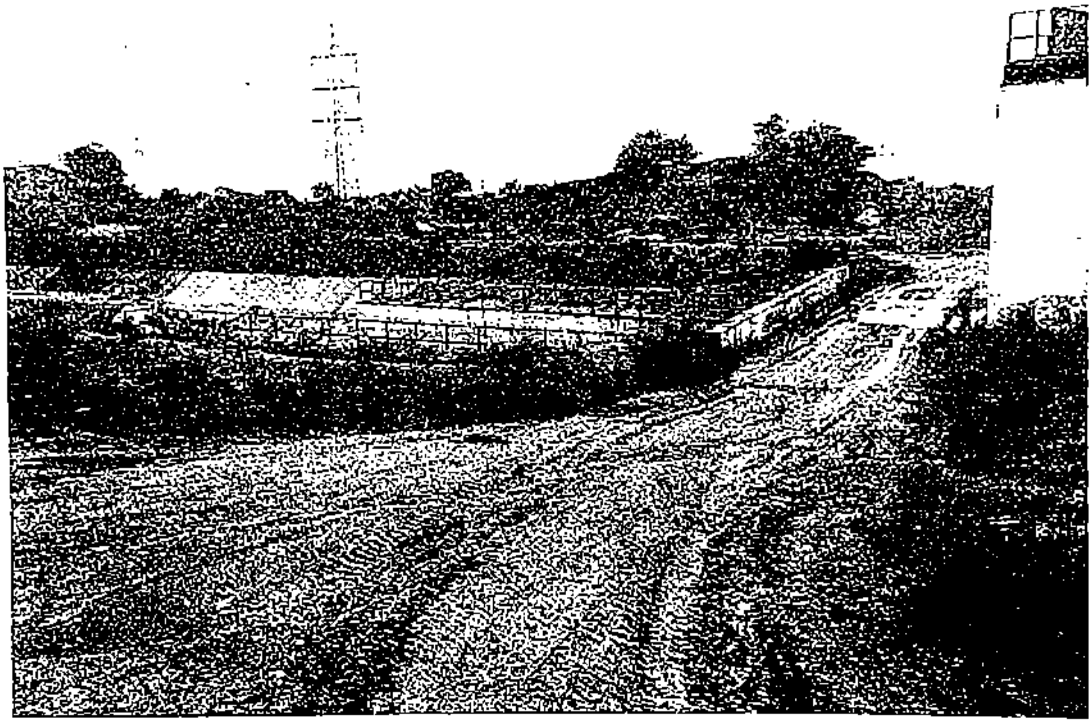
Now, with the amelioration in the Pandemic situation, various travel restrictions have been eased and accordingly the visit of the committee could be held w.e.f. 25th August to 28th August 2021. The detailed itinerary of the visit is appended as Annex-II.

Observations during the visit

During the visit only a few of the components of the project could be seen, namely:

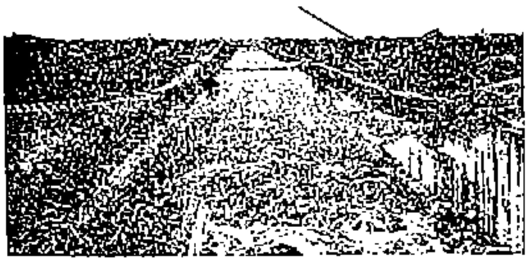
1. Laxmi barrage at Medigadda (Elevation wise lowest structure)
2. 680 Mw Laxmi Pump house near Medigadda
3. A stone quarry near Nandi Power house
4. Gravity Canal feeding Gayathri Pump house
5. Gayathri Pump house
6. Sri Ranganayake Sagar reservoir
7. Underground pump house at Sri Ranganayake Sagar reservoir.
8. Konda Pochhama pump house
9. Konda Pochhama gravity canal
10. Konda Pochhama sagar tank. (Elevation wise at the highest structure)

As on the date of the visit, all the above works were complete and commissioned. On the way to Konda Pochhama pump house, some work was seen under progress on the canal regulator structures.

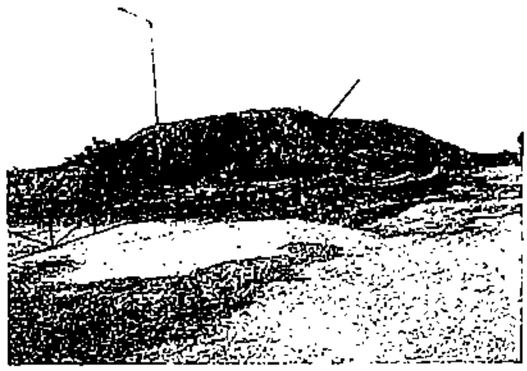


Muck disposal

It was observed that the overall muck management was poor. The muck was found dumped haphazardly in the vicinity of component structures. The terracing of the muck was not proper and there was virtually no turfing done to avoid rain cuts and loss of material from the dumps. The slope of the dumps was quite steep and therefore the muck had slid down, sometimes finding its way into the canals. There were no toe walls and drains at the toe of the dumps to maintain their integrity. A few glimpses of the same are given below:



Dumps on the sides of canal



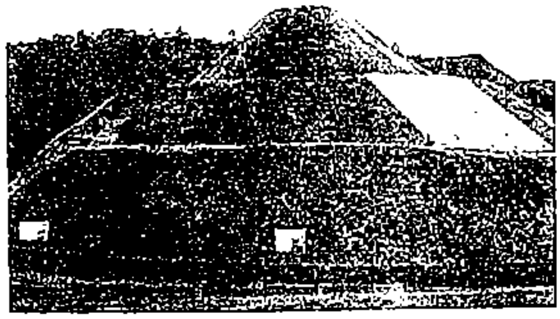
Muck mounds near barrage

No toe wall and /or drain

Surface degradation

These dumps need to be re-worked, shaped up and protected so that they do not contribute either to the fugitive dust or enter the water courses which could be detrimental for consumption by humans and cattle. Also the places where these dumps are located near the agricultural land, the damage to such agricultural land also needs to be ascertained and quantified as per the extant norms.

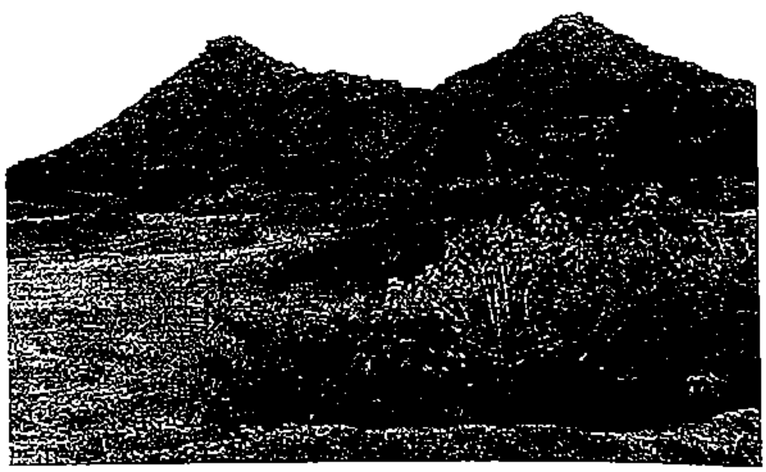
The requisite methodology of muck management consists of disposing off the material in layers with compaction and dressing the same to a stable slope. The slopes are then planted with live sods for turfing to avoid surficial damages due to rain and wind. The dump should be supported at the toe with a toe wall with weep holes which should discharge the accumulated as well as surface water in a toe-drain lined appropriately to maintain its integrity. The dump and the surrounding area is then covered with plantation to merge the same with the surrounding landscape. A sample of what should an ideal dump look like is given below:



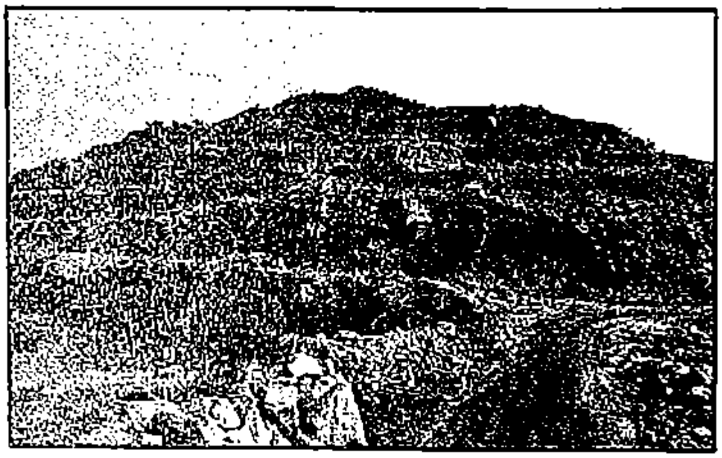
Required measures for dump management – retaining walls,drains and turfing

Rehabilitation of Quarries

It was observed that the quarries have been closed after completion of the project work and have been left on as-is-where-is basis with large scarred hills prone to weathering and deterioration over a period of time. In the absence of any protection and drainage arrangements, these quarries are prone to get further loosened and may collapse. A photo of the quarry near Pedapalli as closed is given below:



Quarry left as it is – crusher location in the foreground



Required benches in a quarry – Vegetation is planted on benches

Afforestation and green belt

The PP intimated that the work of afforestation is being done by the state forest department with whom the necessary amount as envisaged in the EMP has been deposited. It was seen that in some locations luxuriant plantation was growing, whereas in yet other areas the plantation is yet to be taken up. Now, defining the extent of these areas for working out the damage that the non-afforestation in time would have been caused to the environment in respect of the air quality is a cumbersome exercise which needs use of computer modelling and analysis thereof. The data of such areas with their locations and co-ordinates for working out the damage is still awaited.

a. A meeting was held by the committee with the PP headed by E-In-Cs of the project on 27.8.2021 and it was brought out that the data as projected is essential for assessing the damage caused to the environment without taking required safeguards as envisaged in the EC. It was recalled that various inputs required for the requisite assessment as intimated earlier during the should be expeditiously submitted. The requirement was reiterated again outlining submission of ADS other than details sought earlier vide Annexures I, II, III & IV. Following points came up for discussion :

b. The PP shall urgently supply the following data :

    i. Distance of coffer dam from each barrage and details of dimensions

ii. List of quarries project wise (Barrage, Pump house, canals, etc) with its EC details, area, excavation of OB & ROM, aggregate with lead details and line diagram of transport route
iii. Status of WLCP submitted to PCCF and its approval
iv. Post project Bi annual monitoring / EC compliance report submission to SEIAA / MoEFCC regional office was not done and same was confirmed by EIA consultant.

c. The PP is yet to establish Environment monitoring cell and same was agreed by PP.
d. In line with the mandate of the committee as ordered by Honourable NGT, the committee may also examine the "effective implementation of EMP earlier submitted by PP based on which EC was granted and compliance of EC conditions".
e. It appeared that many of the activities enumerated in specific and general conditions of EC of Dec 2017 to comply with EMP & EC have not been initiated so far. For example, - Activities proposed under EMP for CAT, CAD, GB/plantation, muck management, Quarry reclamation and restoration, Bio &WLC, Water, Air, Noise monitoring and management plan, local area development plan etc.
f. In view of the above it was suggested to initiate visit from RO of MoEF &CC for submission of latest EC compliance report of all the components of the project

Conclusion:

During the visit, it was observed that muck management has been handled shoddily and the quarries have also not been rehabilitated. The mounds of dumped muck adjacent to the structures like canals, as also the agricultural land is a cause of concern. For assessing the damage incurred as a result of taking up the work without taking adequate safe guards as contained in the EC, a sizeable data is still required to be supplied by the PP as brought out herein above. In this regard it is pertinent to mention that before the visit, a meeting of the committee was held on 31st July, in which besides the PP, their EIA consultant viz. M/s EPTRI was also present. The data requirements were intimated to them in the meeting and later a consolidated proforma requesting for the balance information was sent to the PP, so that the same could be made available during the visit. However, the proforma could not be filled by the PP and at the close of the visit they have requested for 15 days more time for submitting the information.

In view of the above and also considering that the scrutiny of the data, modelling and other analysis based on the above requirement would take at two- three months' time it is proposed that we may request the Hon'ble NGT for allowing 3 more months for the submission of the report. Accordingly, the matter may please be taken up by MoEF &CC with the Hon'ble NGT.

Balraj Joshi
Chairman Expert committee

Member- Secy EAC

End: Annex-I

Annex -I

The sub-committee comprises of the following member :

1. Sh. Balraj o hi	EX CMD NHPC	Member EAC(RVP)
2. Dr. K. Gowrappan	Ex Member Violation committee, MoEF& CC	
3. Dr. Mukes Sharma	Profes or IIT Kanpur	Member EAC(RVP)
4. Dr. A.K. Malhotra	IFoS (Retd.)	Member EAC(RVP)
5. Sh. Amrendra K. Singh	Chief Engineer (CWC)	Member EAC(RVP)
6. Dr. .A. Jo n on	Wild life instt. of India	Member EAC(RVP)
7. Sh. Y.P. Sing	Scientist – E	Mem er Se retary - EAC(RVP)

- Dr. K.N Shenoy Member EAC, could not join due to his pre-occupations

BLANK PAGE

ANNEXURE – X

As briefed in the tour report, considering the amount of work involved after receipt of adequate data as required by the Committee, it was proposed that MOEF&CC may please approach Hon'ble NGT for extension of further period and accordingly Hon'ble NGT, accorded extension of time for submission of the report, enclosed vide Annx-10

REMINDER
COURT MATTER

F. No. L-11011/4/2018-IA.I (R)
Government of India
Ministry of Environment, Forest and Climate Change
(IA Division)

2nd floor, Vayu Block.
Indira Paravaran Bhawan.
Aliganj, Jor Bagh.
New Delhi- 110 003
Dated: 18th October, 2021

To,

The Chief Engineer
Kaleshwaram Project
1st Floor, Jalasoudha Building
Errumanzil, Hyderabad - 500082.
Email: encgjl.irr@gmail.com

Sub: Hon'ble NGT (PB) order dated 20.10.2020 in the matter of Md. Hayath Udin versus UoI & Ors (Appeal no. 20/2018) – 4th meeting of Expert Committee - furnishing information - reg.

Madam/ Sir,

This has reference to this Ministry's communication dated 15th August, 2021 (copy enclosed) wherein it was requested to furnish the information as desired in the 4th meeting of the Committee constituted by the MoEF&CC in reference to Appeal no. 20 of 2018 titled as Md. Hayath Uddin and others versus Union of India and Ors. pending before the Hon'ble National Green Tribunal, Principal Bench, New Delhi, held on 31st July, 2021.

2. In this context it is to inform that the requisite information is still awaited in the Ministry. While considering the application filed by the Ministry for grant of extension of time for submitting the final recommendations of the committee, Hon'ble NGT vide order dated 22nd September, 2021 (copy enclosed) has directed that the Committee will complete its task strictly in terms of the order of this Tribunal expeditiously.

3. In view of the aforesaid, it is once again requested to furnish the information (soft copy and physical copy) as enumerated in the Minutes of 4th meeting (copy enclosed) of Expert Committee with a copy to this Ministry on urgent basis to enable the Committee to meet the objective within the time specified by the Hon'ble NGT.

Yours faithfully,

Encl.: as above

(Yogendra Pal Singh)
Scientist 'E'
Email: yogendra78@nic.in
Telefax: 011-24695365

Email **Sarvesh Narwal**

Approved MOM of 4th meeting of committee APPEAL NO. 20 OF 2018 TITLED AS MD. HAYATH UDDIN AND OTHERS VERSUS UNION OF INDIA AND ORS BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

From : Yogendra Pal Singh <yogendra78@nic.in> Sun, Aug 15, 2021 05:16 AM

Subject : Approved MOM of 4th meeting of committee APPEAL NO. 20 OF 2018 TITLED AS MD. HAYATH UDDIN AND OTHERS VERSUS UNION OF INDIA AND ORS BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

2 attachments

To : encgjl irr <encgjl.irr@gmail.com>

Cc : Munna Kumar Shah <munna.shah@gov.in>, Sarvesh Narwal <sarvesh.narwal@gov.in>

MOST IMMEDIATE
NGT MATTER

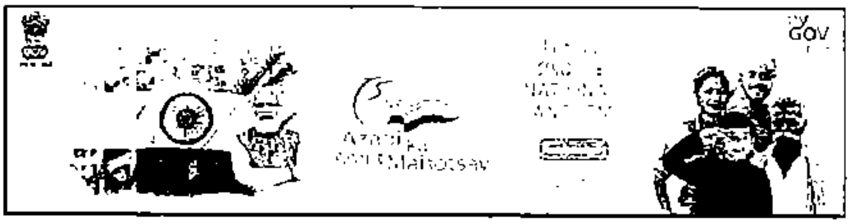
Dear Sir,

Please find attached herewith the MOM of 4th meeting of the Committee constituted by the Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road New Delhi in reference to Appeal no. 20 of 2018 titled as Md. Hayath Uddin and others versus Union of India and Ors pending before the Hon'ble National Green Tribunal, Principal Bench, New Delhi, held on 31st July, 2021 through video conference, under the Chairmanship of Shri Balraj Joshi.

It is requested to go through the MOM and provide information, in prescribed format, by return email without any further delay.

With Regards,

Yogendra Pal Singh
Scientist 'E'
M/o Environment, Forest and Climate Change
Room No. 236, 2nd Floor, Vayu Wing
Indira Paryavaran Bhawan
Jor Bagh, New Delhi-110003
Tele-fax: 011-24695365



- **approved_MoM of 4th meeting of Kaleshwaram.docx**
  33 KB

- **Yogendra Pal Singh.vcf**
  433 B

Item No. 02 (Court No. 1)

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

M. A. No. 62/2021
IN
Appeal No. 20/2018

Md. Hayath Udin Applicant

Versus

Union of India & Ors. Respondent(s)

....

Ministry of Environment, Forest and Climate Change Applicant in MA 62/2021

Date of hearing: 22.09.2021

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MR. JUSTICE BRIJESH SETHI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Applicant: Mr. G.G.C. George, Advocate for applicant in MA 62/2021

ORDER

1. This application seeks extension of time for further three months for compliance of order of this Tribunal dated 20.10.2020, in Appeal No. 20/2018, *Md. Hayath Udin v. Union of India & Ors.* The appeal was preferred against order dated 22.12.2017 of the Ministry of Environment, Forest and Climate Change (MoEF&CC) granting Environmental Clearance (EC) for Kaleshwaram Lift Irrigation Scheme (KLIS) project in Karimnagar District of Telangana by Irrigation & Command Area Development (I and CAD) Department, Government of Telangana. The same was dealt with vide order dated 20.10.2020 and inter-alia following direction was issued:

" xxx ....xxx xxx

32. Accordingly, we direct the MoEF&CC to constitute a seven-member Expert Committee preferably out of EAC members with relevant sectorial expertise to go into the matter in light of observations hereinabove. It may assess the extent of damage caused in going ahead with the project without EC (from 2008 to 2017) and identify the restoration measures necessary. Relief and Rehabilitation measures adopted and required to be further adopted may also be looked into. In this regard, we also note that the EC was granted with reference to ToR based on Form-I submitted by the project proponent, without considering the changes which have taken place in the project subsequently. The Expert Committee may also examine effective implementation of EMP earlier submitted by the project proponent based on which EC was granted and compliance of EC conditions. The Expert Committee may be constituted within one month and it may complete its exercise within six months thereafter. The progress may be finally monitored by the Secretary, MoEF&CC. Any affected party will be at liberty to make representation to the MoEF&CC within three weeks putting forward suggestions and grievances, which may be taken into the account by Committee. The MoEF&CC may consider measures to prevent recurrence of such violations where EC is sought ex post facto. This is particularly required when the projects are multipurpose projects and part of it requires EC, so that such requirement is not defeated on specious plea that the project was partly not covered by the Schedule, as has happened in the present case. For this purpose, instead of confining consideration merely to Form-I, a mechanism is required to be evolved and followed whereby physical verification of material particulars can be undertaken, wherever necessary."

2. The application states that the MoEF&CC constituted seven-member Committee in terms of above which has already held four meetings and also undertaken site visit. However, two of the members were affected by Corona due to which the task could not be accomplished within the specified time of six months.

3. Having regard to the averments in the application, extension sought is granted with the hope and expectation that the Committee will complete its task strictly in terms of the order of this Tribunal expeditiously.

The application is disposed of.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

Brijesh Sethi, JM

Dr. Nagin Nanda, EM

September 22, 2021
M. A. No. 62/2021
IN Appeal No. 20/2018
DV

MINUTES OF THE 4TH MEETING OF THE COMMITTEE IN REFERENCE TO COURT CASE - APPEAL NO. 20 OF 2018 TITLED AS MD. HAYATH UDDIN AND OTHERS VERSUS UNION OF INDIA AND ORS BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI - HELD ON 31ST JULY, 2021 FROM 10:30 AM – 12:00 PM THROUGH VIDEO CONFERENCING- REGARDING.

The 4th meeting of the Committee constituted by the Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road New Delhi in reference to Appeal no. 20 of 2018 titled as Md. Hayath Uddin and others versus Union of India and Ors pending before the Hon'ble National Green Tribunal, Principal Bench, New Delhi, was held on 31st July, 2021 through video conference, under the Chairmanship of Shri Balraj Joshi. The list of members present in the meeting is at **Annexure I.**

[B] After welcoming remarks by the Chairman, the Committee noted that the Ministry has sent communication to Project authorities vide letter dated 23rd June 2021 regarding the details sought by the Committees members during its 3rd meeting held on 11th June 2021. Also, as recommended by the committee, the Ministry has sent a letter dated 24th June. 2021 to the Addl. Principal Chief Conservator of Forests (C), Regional Office (SEZ), Chennai for providing the copy of the certified compliance report of RO, MoEF&CC dated 16.08.2017. It was also noted that along with Project authorities their EIA consultant who was engaged in the preparation of EIA/EMP "EPTRI" also present in the meeting. In order to appreciate the ground conditions, the possibility of a site visit, which had been held back so far due to Covid restrictions, was also discussed. and PP agreed that the site visit is feasible now. The Chairman then requested the members to indicate their availability so as to undertake a site visit during the ensuing month itself.

The Committee thereafter deliberated on the details submitted by the project authorities vide email dated 30th July 2021 in response to the observations raised by the Committee during its previous meeting held on 11th June 2021. It was noted that despite follow up by the Ministry the details were submitted to ministry a day before the commencement of meeting, therefore committee was not able to evaluate the details. It was observed that the project authorities have provided the details partially as sought by the Committee, therefore the committee asked the project authorities to submit the information on following points:

1. The action taken report on the action points by the Irrigation and CAD department was not submitted.
2. The video/images submitted did not have Pre-construction images of the project site and also did not cover all 28 packages covered under 7 Links.
3. The declaration provided by Project Authorities about the project components, built before granting of EC and after the grant of EC, are not satisfactory. It has not included complete details in a form of a list of the structure covering all 7 links and 28 packages.
4. The statement showing the date of actual work commencement does not tally with the dates mentioned in Anx-1/2/4 submitted earlier in case of packages -9,10, Ananthagiri reservoir,11,12,17,20 and 21.A.
5. Agreement copy of Medaram reservoir is not enclosed.
6. Link wise surface plan consisting of all the surface features including the Quarries.
7. Revised LU/LC table as of Pre/post dec 2017/present as briefed in the meeting.
8. The KML files sent by the PP is of screen shots which cannot serve the purpose, the project authorities need to submit the KML files with project wise boundaries(lat/long-coordinates). Details of the area breakup of package/ project shall be submitted.
9. Baseline data submitted in EIA at time of grant of EC and monitoring data carried out for sixth month compliance report till date needs to be submitted.
10. Contour plan and Topo sheet of all packages/projects within 10km of the area, including following impacts caused by the construction activities:
    a) Modification of the drainage pattern.

b) Impact on the habitat of the surrounding area.
c) Impact on air, water, soil, agricultural land and noise.

11. Prepare compliance of EMP budget and compare with spent amount till date. Also intimate the amount spent on EMP before grant of Clearance (before 2017).
12. Wild Life management plan with approval from Chief Wild life warden shall be submitted.
13. Further it was decided to ask the PP to provide the balance information as already asked for and annexed herewith as Annexure II and III.

The committee was of the opinion that in order to evaluate the resulting damages, proper modelling on a scientific basis would require to be done which in itself is a time consuming exercise. However owing to the non-availability of the requisite information, as per the extant guide lines, even at this stage,the committee would require at least three more months to conclude its recommendations. Accordingly, MoEF&CC may request the Hon'ble tribunal to grant an extension of time for submission of the Damage Assessment Report for three more months. The Committee also decided that if details are not provided urgently then environmental damage due to violation will be calculated as per the available data only

The Meeting ended with a vote of thanks to the participants .

*****

Annexure I

ATTENDANCE LIST

S.No.	Name	Role	Attendance
1.	Shri Balraj Joshi	Chairman	P
2.	Shri K Gowarappan	Member	P
3.	Dr. Mukesh Sharma	Member	P
4.	Dr. A.K. Malhotra	Member	P
5.	Shri A.K. Singh	Member	P
6.	Dr. J.A. Johnson	Member	P
7.	Dr. Narayan Shenoy K.	Member	P

Annexure II

S.No.	EMP ACTIVITY	PROPOSED AMOUNT AS PER EIA (Rs in crores)	AMOUNT SPENT TILL 23RD DECEMBER 2017	AMOUNT SPENT TILL NOW
1.	Catchment Area Treatment Plan	125.29		
2.	Command Area Development Plan	1326.86		
3.	Compensatory Afforestation Plan	722.3		
4.	Biodiversity and wildlife Conservation & Management Plan	3.36 per year		
5.	Resettlement & Rehabilitation,	13296.00		
6.	Green Belt Development Plan	19.21		
7.	Fisheries Conservation and Management Plan,	485.00		
8.	Reservoir Rim treatment Plan	236.75		
9.	Groundwater Management Plan			
10.	Agricultural Improvement Plan			
11.	Public health delivery Plan	10.35		
12.	Sanitation and Solid waste Management plan	16.40		
13.	Local Area Development plan	28.24		
14.	Environment safe guards during construction activities including road construction			
15.	Energy conservations Measures	435.25 (during construction)		
16.	River bank stabilisation			
17.	Air pollution management cost	25.9316		

Annexure III

S.No.	EAC query	Project Authorities Reply
1.	Status of completion of works as on 23/12/2017 since inception of construction for Laxmi Barrage, Sarasvati barrage & Parvati barrage.	
2.	Total working days since inception of construction till 23/12/2017 for Laxmi Barrage, saraswati barrage & Parvati barrage.	
3.	Total Working hours and Annual consumption of fuel for all equipment since the inception of construction till 23/12/2017 for Laxmi Barrage, Saraswati barrage & Parvati barrage.	
4.	The equipment list against Saraswati Barrage (Annaram) is not complete, details of chiller, silos, dozers, etc are not covered.	
5.	Details of manpower, machinery, construction materials consumed viz., cement, steel, sand, aggregates, etc for all barrages, water conveyor systems, lifts and reservoir and all packages since inception till 23/12/2017	
6.	The particulars for the packages commenced construction after obtaining EC & CTE need not be included again	
	S.No. 7-10 to be submitted till December 2017	
7.	The lead distance mentioned in Annexure II is 5 km, whereas the distance between Medigadda & Annaram and from annaram to Sundilla is Project Authoritiesrox. 50 km and 35 km respectively. Specify, exact lead distance one-way from quarry to construction site for all the works (Barrages, lifts, water conveyor systems, reservoir and packages)	
8.	List of quarry's with year-wise Individual excavated quantity, transported quantity, valid EC details of quarry, etc	
9.	Excavation details of all 3 barrages (Topsoil, earth, etc)	
10.	Different R & R Packages category wise w.r.t PAF's, PDF's & Land losers (Total & partial) and how they are comparable with RFCTLARR Act, 2013 & TSRFCTLARR Rules & subsequent Amendment (GO.Ms 120) in detail to be submitted.	
11.	Details of litigation pending related to acquisition and settlement.	

12.	Details of amount spent up to 23rd December , 2017, till date and balance pending amount to be submitted in tabular form.	
	As per Annexure – IV submitted S.No. 13-20 need to be submitted:	
13.	Details missing in S.No-1 to 6 to be furnished	
14.	Details missing in S No-7 to 10 with details of other solid waste and disposal to be furnished.	
15.	Details missing in SNo.-15 to 31 with details of muck, quantity, other solid waste and disposal to be furnished.	
16.	Split-up of muck details w.r.t Topsoil, earth, etc	
17.	Split-up of Topsoil used and disposal	
18.	Total muck generated is 428.43 Lac CuM and utilized 190.51 Lac CuM leaving balance muck of 291.92 for which dump management details to be furnished and further it is observed that there is a huge difference between 1480 Lac CuM as mentioned in EIA / EMP and the submitted figure. The figures to be revised and clarified.	
19.	Details of LULC pre-construction, as of 23rd December 2017 and as of now, shall be furnished in the tabular form separately for all the land categories, viz., agriculture land, fallow/ wasteland, quarry lands, BUA's (Residential & Industrial), project area, forest (all types included)	
20.	Satellite image comparison of all works project-wise (project boundary clearly demarked) of LULC	

ANNEXURE – XI

Until the EC was obtained is declared as a clear case of violation and the method and procedure to be followed is defined by the Notification no:S.O 804(E) dated 14th March 2017 (vide: Annx-11)

A - 90 (I)

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (ii)
PART II—Section 3—Sub-section (ii)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 723] नई दिल्ली, मंगलवार, मार्च 14, 2017/फाल्गुन 23, 1938
No. 723] NEW DELHI, TUESDAY, MARCH 14, 2017/PHALGUNA 23, 1938

पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 14 मार्च, 2017

का.आ. 804(अ).—पर्यावरण (संरक्षण) नियम 1986 के नियम 5 के उपनियम (3) की अपेक्षानुसार, पर्यावरण (संरक्षण) अधिनियम 1986 (1986 का 29) की धारा 3 की उपधारा (1) और उपधारा (2) के खंड (v) के अधीन भारत के राजपत्र, असाधारण, भाग II, खंड 3, उपखंड (ii) में अधिसूचना सं. का.आ. 1705(अ) तारीख 10 मई, 2016, पर्यावरणीय अनापत्ति के निदेश निबंधनों को अनुदत्त करने के लिए परियोजनाओं के मूल्यांकन की प्रक्रिया को पूरा करने के लिए, जिनमें स्थल पर कार्य आरंभ कर दिया है, पर्यावरणीय अनापत्ति की सीमा से परे उत्पादन का विस्तार किया है या पर्यावरण संघात अधिसूचना 2006 के अधीन पूर्व पर्यावरण अनापत्ति अभिप्राप्त किए बिना उत्पाद मिश्रण में परिवर्तन किया है, द्वारा उन सभी व्यक्तियों से, जिनके उससे प्रभावित होने की संभावना थी, उस तारीख से जिसको उस राजपत्र की प्रतियां, जिसमें यह अधिसूचना अंतर्विष्ट है, उपलब्ध करा दी जाती हैं, साठ दिन की अवधि के भीतर आक्षेप और सुझाव आमंत्रित करते हुए एक प्रारूप अधिसूचना प्रकाशित की गई थी ;

2. और उक्त राजपत्र की प्रतियां जनता को 10 मई, 2016 को उपलब्ध करा दी गई थीं ;

3. और पूर्वोक्त वर्णित प्रारूप अधिसूचना पर प्राप्त सभी सुझावों या आक्षेपों पर केंद्रीय सरकार द्वारा सम्यक्तः विचार कर लिया गया है ;

4. पर्यावरण (संरक्षण) अधिनियम, 1986 के उपबंधों के अध्यधीन, अधिनियम की धारा 3 की उपधारा (1) के अधीन केंद्रीय सरकार को ऐसे सभी उपाय करने की शक्ति है, जो वह पर्यावरण की क्वालिटी के संरक्षण और सुधार तथा पर्यावरण प्रदूषण को रोकने, नियंत्रित करने और समाप्त करने के प्रयोजनों के लिए आवश्यक और समीचीन समझती है ;

5. पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 5 केंद्रीय सरकार को निदेश देने के लिए सशक्त करती है, जो इस प्रकार है "केंद्रीय सरकार किसी अन्य विधि में किसी बात के होते हुए भी, किन्तु इस अधिनियम के उपबंधों के अधीन रहते हुए इस अधिनियम के अधीन अपनी शक्तियों के प्रयोग और अपने कृत्यों के निर्वहन में किसी व्यक्ति, अधिकारी या प्राधिकरण को लिखित निदेश दे सकेगी और ऐसा व्यक्ति, अधिकारी या प्राधिकरण ऐसे निदेशों का अनुपालन करने के लिए आबद्ध होगा ;

6. पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय ने उल्लंघन के मामलों में पर्यावरणीय अनापत्ति अनुदत्त करने के लिए प्रक्रिया स्थापित करने के लिए तारीख 12.12.2012 और तारीख 27.06.2013 को एक कार्यालय ज्ञापन जारी किया है ;

7. हिन्दुस्तान कापर लिमिटेड बनाम भारत संघ के मामले में 2014 की रिट याचिका (सिविल) सं0 2364 में माननीय झारखंड उच्च न्यायालय के तारीख 28 नवंबर, 2014 के आदेश के अनुसरण में माननीय न्यायालय ने यह अभिनिर्धारित किया कि तारीख 12 दिसंबर, 2012 के कार्यालय ज्ञापन के अधीन पैरा सं0 5(i) और पैरा सं0 5(ii) की शर्तें अवैध और असंवैधानिक थीं और न्यायालय ने यह और अभिनिर्धारित किया कि अभिकथित अतिक्रमण की कार्रवाई स्वतंत्र कार्यवाही और पृथक् कार्यवाही होगी और इसलिए पर्यावरण अनापत्ति के लिए प्रस्ताव पर विचार करने के लिए परियोजना प्रस्तावक के विरुद्ध कार्रवाई आरंभ करने की प्रतीक्षा नहीं की जा सकती । माननीय न्यायालय ने यह व्यवस्था और दी कि पर्यावरण अनापत्ति के प्रस्ताव की परीक्षा इसके गुणागुण, पर्यावरण विधियों के अभिकथित अतिक्रमण के लिए किसी प्रस्तावित कार्रवाई से मुक्त आधार पर की जानी चाहिए ;

8. और राष्ट्रीय हरित अधिकरण की प्रधान न्यायपीठ ने 2015 के मूल आवेदन सं0 37 तथा 2015 के मूल आवेदन सं0 213 में तारीख 7 जुलाई, 2015 के अपने आदेश द्वारा यह अभिनिर्धारित किया कि पर्यावरण (संरक्षण) अधिनियम, 1986 या पर्यावरण समाधात निर्धारण अधिसूचना, 2006 तथा तटीय विनियमन जोन अधिसूचना, 2011 के अतिक्रमणों वाले निर्देश के निबंधनों या पर्यावरण अनापत्ति या तटीय विनियमन जोन अनापत्ति के प्रस्तावों पर विचार के विषय पर तारीख 12 दिसंबर, 2012 और 24 जून, 2013 के कार्यालय ज्ञापन पर्यावरण समाघात निर्धारण अधिसूचना, 2006 के उपबंधों को परिवर्तित या संशोधित नहीं कर सकते थे और अधिकरण ने उसे अपास्त कर दिया था ;

9. और पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय तथा राज्य पर्यावरण समाघात निर्धारण प्राधिकरण को कतिपय प्रस्ताव, निर्देशों के निबंधनों और पर्यावरणीय अनापत्ति के लिए पर्यावरण समाघात निर्धारण अधिसूचना, 2006 के अधीन ऐसी परियोजनाओं के लिए प्राप्त हो रहे हैं, जिन्होंने स्थल पर कार्य आरंभ कर दिया है, पर्यावरणीय अनापत्ति की सीमा से परे उत्पादन का विस्तार किया है या पूर्व पर्यावरणीय अनापत्ति को प्राप्त किए बिना उत्पाद मिश्रण में परिवर्तन कर दिया है ;

10. पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय ने पर्यावरण की क्वालिटी के संरक्षण और उसमें सुधार के प्रयोजन के लिए और पर्यावरणीय प्रदूषण का उपशमन करने के लिए यह आवश्यक समझा कि वह सभी निकाय, जो पर्यावरण संघात निर्धारण अधिसूचना, 2006 के अधीन पर्यावरण विनियम का अनुपालन नहीं कर रहे हैं, को समीचीन रीति में पर्यावरणीय विधियों की अनुपालना के लिए उसके अंतर्गत लाया जाए ;

11. और पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय ऐसी परियोजनाओं और क्रियाकलापों को शीघ्रतम पर्यावरणीय विधियों की अनुपालना के अधीन लाना आवश्यक समझता है न कि उन्हें अविनियमित और बिना किसी जांच के छोड़ना, जो पर्यावरण के लिए अधिक नुकसानदायक होगा तथा इस उद्देश्य को अग्रसर करने के लिए भारत सरकार ऐसी सत्ताओं को, जो अननुपालक थे, अनुपालक बनाने के लिए समुचित रक्षोपायों के साथ पर्यावरणीय अनापत्ति प्रदान करना आवश्यक समझती है, प्रक्रिया ऐसी होनी चाहिए, जो पर्यावरण समाघात निर्धारण अधिसूचना, 2006 के उपबंधों के उल्लंघन पर रोक लगाए, जिससे अननुपालना और अननुपालना के धनीय लाभ भयोपरित हों तथा पर्यावरण के नुकसान के लिए समुचित रूप से प्रतिकर हो ;

12. और माननीय उच्चतम न्यायालय ने इंडियन काउंसिल फार एन्वायरो-लीगल एक्शन बनाम भारत संघ (बिछड़ी गांव औद्योगिक प्रदूषण का मामला) में 13 फरवरी, 1996 को निर्णय देते समय विधि के सभी सुसंगत उपबंधों का विश्लेषण किया और यह निष्कर्ष दिया कि पर्यावरण (संरक्षण) अधिनियम, 1986 के अधीन नुकसानी की वसूली की जा सकती है (1996(3) एससीसी 212) । माननीय न्यायालय ने यह संप्रेक्षित किया कि पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 3 केंद्रीय सरकार (या, यथास्थिति, उसके प्रतिनिधि) को "ऐसे सभी उपाय करने, जो वह पर्यावरण की क्वालिटी के संरक्षण और सुधार के प्रयोजन के लिए आवश्यक या समीचीन समझे........................." अभिव्यक्त रूप से सशक्त करती है । धारा 5 केंद्रीय सरकार (या उसके प्रतिनिधि) को अधिनियम के उद्देश्यों को प्राप्त करने के लिए निदेश जारी करने की शक्ति प्रदान करती है । धारा 2(क), धारा 3 और धारा 5 में "पर्यावरण" की विस्तृत परिभाषा के अनुसार केंद्रीय सरकार को ऐसी सभी शक्तियां हैं, जो "पर्यावरण की क्वालिटी के संरक्षण और सुधार के प्रयोजन के लिए आवश्यक या समीचीन" हैं । केंद्रीय सरकार, ऐसे सभी उपाय करने और ऐसे सभी निदेश जारी करने के लिए सशक्त है, जो पूर्वोक्त प्रयोजन के लिए आवश्यक हो । इस मामले में उक्त शक्तियों के अंतर्गत गाढे कीचड़ को हटाने, उपचारिक उपाय करने और उपचारिक उपाय करने की लागत को उल्लंघन करने वाले उद्योग पर अधिरोपित करने की शक्ति भी है तथा इस प्रकार वसूल की गई रकम का, उपचारिक उपायों को कार्यान्वित करने के लिए उपयोग करना भी है । माननीय न्यायालय ने यह और संप्रेक्षित किया है कि उपचारिक उपायों को कार्यान्वित करने के लिए अपेक्षित लागत का उद्ग्रहण धारा 3 और धारा 5 में अंतर्निहित है, जिसे अत्यधिक विस्तृत और व्यापक भाषा में व्यक्त किया गया है । पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 3 और धारा 5 जल और वायु अधिनियमों के अन्य उपबंधों के अतिरिक्त सरकार को ऐसे सभी निदेश करने के लिए और ऐसे सभी उपाय करने के लिए सशक्त करते हैं, जो "पर्यावरण" के संरक्षण और संवर्धन के लिए आवश्यक या समीचीन हों, जिस अभिव्यक्ति को पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 2(क) में अत्यधिक विस्तृत और व्यापक शब्दों में परिभाषित किया गया है । इस शक्ति के अंतर्गत किसी उद्योग कि निकट किसी क्रियाकलाप को प्रतिषिद्ध करने, उपचारिक उपायों को कार्यान्वित करने का निदेश देने और जहां कहीं आवश्यक हो, उल्लंघन करने वाले उद्योग पर उपचारिक उपायों

की लागत अधिरोपित करने की शक्ति भी है। प्रत्यर्थियों के उपचारिक उपायों की लागत की अदायगी के दायित्व का प्रश्न दूसरे दृष्टिकोण से भी देखा जा सकता है, जिसे अब सार्वभौमिक रूप से ठोस सिद्धांत के रूप में स्वीकार किया गया है, जैसे "प्रदूषणकर्ता संदाय करता है" का सिद्धांत। "प्रदूषणकर्ता संदाय करता है, सिद्धांत की यह मांग है कि प्रदूषण द्वारा कारित नुकसान को रोकने या उसका उपचार करने की वित्तीय लागत इस वचनबंध, कि जो प्रदूषण कारित करता है या ऐसे माल का उत्पादन करता है, जो प्रदूषण कारित करता है, के साथ होती है।"

13. (1) इसलिए अब, केंद्रीय सरकार, पर्यावरण (संरक्षण) नियम, 1986 के नियम 5 के उपनियम (3) के खंड (घ) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 3 की उपधारा (1) और उपधारा (2) के खंड (i) के उपखंड (क) और खंड (v) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए निदेश देती है कि परियोजना या क्रियाकलाप या विद्यमान परियोजनाओं का विस्तार या आधुनिकीकरण या क्रियाकलाप, जिनके द्वारा पर्यावरण संघात निर्धारण अधिसूचना, 2006 के अधीन पूर्व पर्यावरणीय अनापत्ति अपेक्षित है भारत के किसी भाग में, यथास्थिति, केंद्रीय सरकार द्वारा उक्त अधिनियम की धारा 3 की उपधारा (3) के अधीन गठित केंद्रीय सरकार या राज्य स्तरीय पर्यावरण संघात निर्धारण प्राधिकरण से पूर्व पर्यावरणीय अनापत्ति प्राप्त किए बिना, जिसमें प्रक्रिया या प्रौद्योगिकी में परिवर्तन के साथ क्षमता में वर्धन या दोनों को शामिल किया गया है, को पर्यावरण संघात निर्धारण अधिसूचना, 2006 के उल्लंघन का मामला माना जाएगा और उससे निम्नलिखित रीति में विनिर्दिष्ट प्रक्रिया के अनुसार व्यौहार किया जाएगा ;

(2) उस दशा में, जब पर्यावरण समाघात निर्धारण अधिसूचना, 2006 के अधीन संबंधित विनियामक प्राधिकरण से पूर्व पर्यावरणीय अनापत्ति की अपेक्षा वाली परियोजनाएं या क्रियाकलाप संनिर्माण कार्य आरंभ करने के पश्चात् पर्यावरणीय अनापत्ति के लिए लायी जाती हैं या जिन्होंने पूर्व पर्यावरणीय अनापत्ति के बिना विस्तार, आधुनिकीकरण और उत्पाद मिश्रण में परिवर्तन किया है, उन परियोजनाओं को अतिक्रमण के मामले के रूप में समझा जाएगा और ऐसे मामलों में यहां तक कि प्रवर्ग ख की परियोजनाएं, जिन्हें पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 3 की उपधारा (3) के अधीन गठित राज्य पर्यावरण संघात निर्धारण प्राधिकरण द्वारा पर्यावरणीय अनापत्ति अनुदत्त की गई है, का पर्यावरणीय अनापत्ति अनुदत्त करने के लिए विशेषज्ञ मूल्यांकन समिति द्वारा ही मूल्यांकन किया जाएगा और पर्यावरणीय अनापत्ति केंद्रीय स्तर पर अनुदत्त की जाएगी।

(3) उल्लंघन के मामलों में पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 19 के उपबंधों के अधीन संबंधित राज्य या राज्य प्रदूषण नियंत्रण बोर्ड द्वारा परियोजना प्रस्तावक के विरुद्ध कार्रवाई की जाएगी और इसके अतिरिक्त परियोजना को पर्यावरण अनापत्ति अनुदत्त किए जाने तक प्रचालन करने के लिए या अधिभोग प्रमाणपत्र जारी किए जाने के लिए अनुमति नहीं दी जाएगी।

(4) पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 3 की उपधारा (3) के अधीन गठित संबंधित क्षेत्र विशेषज्ञ मूल्यांकन समिति द्वारा उल्लंघन के मामलों का यह मूल्यांकन करने के लिए निर्धारण किया जाएगा कि परियोजना का ऐसे स्थल पर संनिर्माण किया गया है जो लागू विधियों के अधीन अनुज्ञेय है और विस्तार किया गया है, जिसको पर्याप्त पर्यावरणीय सुरक्षोपायों के साथ पर्यावरणीय मानकों की अनुपालना के अधीन धारणीय रूप से चलाया जा सकता है ; और उस दशा में जहां विशेषज्ञ मूल्यांकन समिति का निष्कर्ष नकारात्मक है, विधि के अधीन अन्य कार्रवाईयों के साथ परियोजना को बंद करने की सिफारिश की जाएगी।

(5) उस दशा में जहां पूर्वोक्त उप पैरा (4) के बिन्दु पर विशेषज्ञ मूल्यांकन समिति के निष्कर्ष सकारात्मक हैं, इस प्रवर्ग के अधीन परियोजनाओं को पर्यावरण संघात निर्धारण करने और पर्यावरणीय प्रबंधन योजना तैयार करने के लिए समुचित निदेश निबंधनों के साथ विहित किया जाएगा। इसके अतिरिक्त विशेषज्ञ मूल्यांकन समिति पारिस्थितिकीय नुकसान, सुधारकारी योजना और प्राकृतिक तथा सामुदायिक संसाधन आवर्धन योजना के निर्धारण पर परियोजना के विशिष्ट निदेश निबंधनों को विहित करेगी और उनको प्रत्यायित परामर्शदाताओं द्वारा पर्यावरण संघात निर्धारण रिपोर्ट में एक स्वतंत्र अध्याय के रूप में तैयार किया जाएगा। पारिस्थितिकीय नुकसान, सुधारकारी योजना तैयार करने और प्राकृतिक तथा सामुदायिक संसाधन आवर्धन योजना के निर्धारण के लिए डाटा का संग्रहण और विश्लेषण, पर्यावरण (संरक्षण) अधिनियम, 1986 के अधीन सम्यकतः अधिसूचित प्रयोगशाला या राष्ट्रीय जांच और अंशांकन प्रत्यायन बोर्ड द्वारा प्रत्यायित प्रयोगशाला या वैज्ञानिक और औद्योगिक अनुसंधान परिषद् की पर्यावरण के क्षेत्र में कार्य कर रही प्रयोगशाला द्वारा किया जाएगा।

(6) विशेषज्ञ मूल्यांकन समिति, पर्यावरणीय प्रबंधन योजना, सुधारकारी योजना और प्राकृतिक तथा सामुदायिक संसाधन आवर्धन योजना से मिलकर बनने वाली पर्यावरणीय प्रबंधन योजना को उपदर्शित करेगी, जो कि मूल्यांकन किए गए पर्यावरणीय नुकसान और पर्यावरणीय अनापत्ति की शर्त के उल्लंघन के कारण उद्भूत आर्थिक फायदे की तत्स्थानी होगी।

(7) परियोजना प्रस्तावक से सुधारकारी योजना और प्राकृतिक तथा सामुदायिक संसाधन आवर्धन योजना की रकम के समतुल्य बैंक प्रत्याभूति को राज्य प्रदूषण नियंत्रण बोर्ड के पास प्रस्तुत करने की अपेक्षा होगी और मात्रा की सिफारिश विशेषज्ञ मूल्यांकन समिति द्वारा की जाएगी और इसको विनियामक प्राधिकरण द्वारा अंतिम रूप दिया जाएगा तथा बैंक प्रत्याभूति को पर्यावरणीय अनापत्ति अनुदत्त करने

से पूर्व जमा किया जाएगा और उसे मंत्रालय के प्रादेशिक कार्यालय, विशेषज्ञ मूल्यांकन समिति तथा विनियामक प्राधिकरण के अनुमोदन के पश्चात् सुधारकारी योजना और प्राकृतिक तथा सामुदायिक संसाधन आवर्धन योजना के सफलतापूर्वक कार्यान्वयन के पश्चात् निर्मुक्त किया जाएगा।

14. ऐसी परियोजनाएं और क्रियाकलाप, जो इस अधिसूचना की तारीख को उल्लंघनकारी हैं, इस अधिसूचना के अधीन पर्यावरणीय अनापत्ति के लिए आवेदन करने के पात्र होंगे और परियोजना प्रस्तावक इस अधिसूचना के अधीन पर्यावरणीय अनापत्ति के लिए केवल इस अधिसूचना की तारीख से छह मास के भीतर ही आवेदन कर सकते हैं।

[फा. सं. 22-116/2015-आईए-III]

मनोज कुमार सिंह, संयुक्त सचिव

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE
NOTIFICATION

New Delhi, the 14th March, 2017

S.O. 804(E).—Whereas, a draft notification under sub-section (1), and clause (v) of sub-section (2) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986) was published in the Gazette of India, Extraordinary, Part II, Section 3, sub-section (ii), *vide* number S.O. 1705(E), dated the 10th May, 2016, as required by sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, for finalising the process for appraisal of projects for grant of Terms of Reference and Environmental Clearance, which have started the work on site, expanded the production beyond the limit of environmental clearance or changed the product mix without obtaining prior environmental clearance under the Environment Impact Assessment Notification, 2006 inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the date on which copies of Gazette containing the said notification were made available to the public:

2. And whereas, copies of the said notification were made available to the public on the 10th May, 2016;

3. And whereas, all objections and suggestions received in response to the above mentioned draft notification have been duly considered by the Central Government.

4. Whereas, subject to the provisions of the Environment (Protection) Act, 1986, under sub-section (1) of section 3 of the Act, the Central Government has the power to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling, and abating environment pollution;

5. Whereas, section 5 of the Environment (Protection) Act, 1986 empowers the Central Government to give directions which reads as "Notwithstanding anything contained in any other law but subject to the provisions of this Act, the Central Government may, in the exercise of its powers and performance of its functions under this Act, issue directions in writing to any person, officer or any authority and such person, officer or authority shall be bound to comply with such directions;

6. Whereas the Ministry of Environment, Forest and Climate Change issued Office Memoranda dated 12.12.2012 and 27.06.2013 to establish a process for grant of environmental clearance to cases of violation.

7. Whereas, the Hon'ble High Court of Jharkhand had passed an order dated the 28th November, 2014 in W.P. (C) No. 2364 of 2014 in the matter of Hindustan Copper Limited *Versus* Union of India in which the High Court held that the conditions laid down under Office Memorandum dated 12th December, 2012 in paragraph No. 5 (i) and 5 (ii) were illegal and unconstitutional and had further held that action for alleged violation would be an independent and separate proceeding and therefore, consideration of proposal for environment clearance could not await initiation of action against the project proponent. The Hon'ble Court further ruled that the proposal for environment clearance must be examined on its merits, independent of any proposed action for alleged violation of the environmental laws;

8. And whereas, Hon'ble National Green Tribunal, Principal Bench *vide* its order dated 7th July, 2015 in Original Application No. 37 of 2015 and Original Application No. 213 of 2015 had also held that the Office Memoranda dated 12th December, 2012 and 24th June, 2013 on the subject of consideration of proposals for Terms of Reference or Environment Clearance or Coastal Regulation Zone Clearance involving violations of the Environment (Protection) Act, 1986 or Environment Impact Assessment Notification, 2006 Coastal Regulation Zone Notification, 2011 could not alter or amend the provisions of the Environment Impact Assessment notification, 2006 and had quashed the same;

9. And whereas, the Ministry of Environment, Forest and Climate Change and State Environment Impact Assessment Authorities have been receiving certain proposals under the Environment Impact Assessment Notification, 2006 for grant of Terms of References and Environmental Clearance for projects which have started the work on site, expanded the production beyond the limit of environmental clearance or changed the product mix without obtaining prior environmental clearance;

10. Whereas, the Ministry of Environment, Forest and Climate Change deems it necessary for the purpose of protecting and improving the quality of the environment and abating environmental pollution that all entities not complying with environmental regulation under Environment Impact Assessment Notification, 2006 be brought under compliance with in the environmental laws in expedient manner;

11. And whereas, the Ministry of Environment, Forest and Climate Change deems it necessary to bring such projects and activities in compliance with the environmental laws at the earliest point of time, rather than leaving them unregulated and unchecked, which will be more damaging to the environment and in furtherance of this objective, the Government of India deems it essential to establish a process for appraisal of such cases of violation for prescribing adequate environmental safeguards to entities and the process should be such that it deters violation of provisions of Environment Impact Assessment Notification, 2006 and the pecuniary benefit of violation and damage to environment is adequately compensated for;

12. And whereas, Hon'ble Supreme Court in *Indian Council for Enviro-Legal Action Vs. Union of India* (the Bichhri village industrial pollution case), while delivering its judgment on 13th, February, 1996, analyzed all the relevant provisions of law and concluded that damages may be recovered under the provisions of the Environment (Protection) Act, 1986 (1996 [3] SCC 212). The Hon'ble Court observed that ...... section 3 of the Environment (Protection) Act, 1986 expressly empowers the Central Government [or its delegate, as the case may be] to "take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of environment.........". Section 5 clothes the Central Government [or its delegate] with the power to issue directions for achieving the objects of the Act. Read with the wide definition of "environment" in Section 2 (a), Sections 3 and 5 clothe the Central Government with all such powers as are "necessary or expedient for the purpose of protecting and improving the quality of the environment". The Central Government is empowered to take all measures and issue all such directions as are called for the above purpose. In the present case, the said powers will include giving directions for the removal of sludge, for undertaking remedial measures and also the power to impose the cost of remedial measures on the offending industry and utilize the amount so recovered for carrying out remedial measures........ Hon'ble Court has further observed that levy of costs required for carrying out remedial measures is implicit in Sections 3 and 5 which are couched in very wide and expansive language. Sections 3 and 5 of the Environment (Protection) Act, 1986, apart from other provisions of Water and Air Acts, empower the Government to make all such directions and take all such measures as are necessary or expedient for protecting and promoting the 'environment', which expression has been defined in very wide and expansive terms in Section 2 (a) of the Environment (Protection) Act. This power includes the power to prohibit an activity, close an industry, direct to carry out remedial measures, and wherever necessary impose the cost of remedial measures upon the offending industry. The question of liability of the respondents to defray the costs of remedial measures can also be

looked into from another angle, which has now come to be accepted universally as a sound principle, viz., the "Polluter Pays" Principle. "The polluter pays principle demands that the financial costs of preventing or remedying damage caused by pollution should lie with the undertakings which cause the pollution, or produce the goods which cause the pollution".

13 (1). Now, therefore, in exercise of the powers conferred by sub-section (1) and sub clause (a) of clause (i) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986, read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986; the Central Government hereby directs that the projects or activities or the expansion or modernisation of existing projects or activities requiring prior environmental clearance under the Environment Impact Assessment Notification, 2006 entailing capacity addition with change in process or technology or both undertaken in any part of India without obtaining prior environmental clearance from the Central Government or by the State Level Environment Impact Assessment Authority, as the case may be, duly constituted by the Central Government under sub-section (3) of Section 3 of the said Act, shall be considered a case of violation of the Environment Impact Assessment Notification, 2006 and will be dealt strictly as per the procedure specified in the following manner:-

(2) In case the projects or activities requiring prior environmental clearance under Environment Impact Assessment Notification, 2006 from the concerned Regulatory Authority are brought for environmental clearance after starting the construction work, or have undertaken expansion, modernization, and change in product- mix without prior environmental clearance, these projects shall be treated as cases of violations and in such cases, even Category B projects which are granted environmental clearance by the State Environment Impact Assessment Authority constituted under sub-section (3) Section 3 of the Environment (Protection) Act, 1986 shall be appraised for grant of environmental clearance only by the Expert Appraisal Committee and environmental clearance will be granted at the Central level.

(3) In cases of violation, action will be taken against the project proponent by the respective State or State Pollution Control Board under the provisions of section 19 of the Environment (Protection) Act, 1986 and further, no consent to operate or occupancy certificate will be issued till the project is granted the environmental clearance.

(4) The cases of violation will be appraised by respective sector Expert Appraisal Committees constituted under sub-section (3) of Section 3 of the Environment (Protection) Act, 1986 with a view to assess that the project has been constructed at a site which under prevailing laws is permissible and expansion has been done which can be run sustainably under compliance of environmental norms with adequate environmental safeguards; and in case, where the finding of the Expert Appraisal Committee is negative, closure of the project will be recommended along with other actions under the law.

(5) In case, where the findings of the Expert Appraisal Committee on point at sub-para (4) above are affirmative, the projects under this category will be prescribed the appropriate Terms of Reference for undertaking Environment Impact Assessment and preparation of Environment Management Plan. Further, the Expert Appraisal Committee will prescribe a specific Terms of Reference for the project on assessment of ecological damage, remediation plan and natural and community resource augmentation plan and it shall be prepared as an independent chapter in the environment impact assessment report by the accredited consultants. The collection and analysis of data for assessment of ecological damage, preparation of remediation plan and natural and community resource augmentation plan shall be done by an environmental laboratory duly notified under Environment (Protection) Act, 1986, or a environmental laboratory accredited by National Accreditation Board for Testing and Calibration Laboratories, or a laboratory of a Council of Scientific and Industrial Research institution working in the field of environment.

(6) The Expert Appraisal Committee shall stipulate the implementation of Environmental Management Plan, comprising remediation plan and natural and community resource augmentation plan corresponding to the ecological damage assessed and economic benefit derived due to violation as a condition of environmental clearance.

(7) The project proponent will be required to submit a bank guarantee equivalent to the amount of remediation plan and Natural and Community Resource Augmentation Plan with the State Pollution Control Board and the quantification will be recommended by Expert Appraisal Committee and finalized by Regulatory Authority and the bank guarantee shall be deposited prior to the grant of environmental clearance and will be released after successful implementation of the remediation plan and Natural and Community Resource Augmentation Plan, and after the recommendation by regional office of the Ministry, Expert Appraisal Committee and approval of the Regulatory Authority.

14. The projects or activities which are in violation as on date of this notification only will be eligible to apply for environmental clearance under this notification and the project proponents can apply for environmental clearance under this notification only within six months from the date of this notification.

[F. No. 22-116/2015-IA-III]

MANOJ KUMAR SINGH, Jt. Secy.

Uploaded by Dte. of Printing at Government of India Press, Ring Road, Mayapuri, New Delhi-110064 and Published by the Controller of Publications, Delhi-110054.

BLANK PAGE

GUIDELINES FOR ENVIRONMENTAL DAMAGE ASSESSMENT COST FOR VIOLATION CASES SUBMITTED UNDER THE MINISTRYS NOTIFICATION NO. S.O 804 (E) DATED 14.03.2017

PREAMBLE:

The projects or activities which are requiring prior environmental clearance under the Environment Impact Assessment Notification, 2006 from the concerned Regulatory Authority but are brought for environmental clearance after starting the construction work, or have undertaken expansion, modernization, and change in product- mix without prior environmental clearance, such projects are treated as cases of violations as per the Notification S.O 804 (E) dated 14.03.2017. The objective of this notification is to protect and improve the quality of environment and abate environmental pollution and bring all such violation cases under compliance within the environmental laws in an expedient manner.

The notification has established a process for appraisal of such cases of violation for prescribing adequate environmental safeguards to all such entities and the process provides for a deterrent to all such violations under the Environment Impact Assessment Notification, 2006 and also the pecuniary benefit of violation and damage to environment.

The Expert Appraisal Committees (EACs/SEACs) constituted at the Central and the State level appraise all such violation projects for grant of EC. The Expert Appraisal Committees prescribe specific Terms of Reference for such projects on assessment of ecological damage, remediation plan and natural and community resource augmentation plan and it shall be prepared as an independent chapter in the Environment Impact Assessment report by the accredited consultants.

The EACs/SEACs on due diligence will recommend the quantum of damage assessment equivalent to the amount of remediation plan and Natural and Community Resource Augmentation Plan and the same has to be submitted as a bank guarantee with the State Pollution Control Board prior to the grant of environmental clearance and the same will be released after successful implementation of the remediation plan and Natural and Community Resource Augmentation Plan, and after the recommendation by regional office of the Ministry, Expert Appraisal Committee and approval of the Regulatory Authority

GUIDELINES FOR QUANTIFICATION OF ENVIRONMENTAL DAMAGE ASSESSMENT

The Expert Appraisal Committee(EAC/SEAC), for assessing the environmental damage caused by various sectors of the project *viz* Industry, Infrastructure, Mining and project of any other sector, appraises each project by considering the potential damage which the project activity may have caused, due to non-existence of prior EC vis- a- vis a proper Environment Management Plan(EMP) in place, to various environmental attributes such as Air, Water, Land, Noise, Ecology/Biodiversity, Energy Conservation and Socio-Economic Environment. The Committee deliberated on the methodology at the inception stage and later modified based on the learnings while appraising various projects.

It has been evolved, in the form of the guidelines, below mentioned methodology which permits to quantify the damage cost based on the appraisal of projects on case to case basis.

The environment damage cost may vary from sector to sector depending upon Environment setting and its n location (example: Urban setting, forest setting and ecologically sensitive areas), period of violation, resources consumed, receptor damages etc. The economic benefits accrued by way of net profit and the cost saved on account of non-provision of EMP (Capital and Recurring), during the violation period are also taken into the consideration while arriving at the damage assessment cost.

The following guidelines are to be used by the project proponent through Accredited Environmental Consultants for calculating the damage assessment cost, remediation cost, natural resource & community resource augmentation cost while conducting the EIA studies of a project using factual information and historical data for the project under consideration under specific ToRs issued by the committee. EACs/SEACs will do due diligence for assessment and evaluation of the damage cost so calculated due to violation.

I. Review of Methodology: CPCB methodology for Environmental Compensation

Environmental Compensation (EC) as derived by CPCB:-

EC = PI x N x R x S x LF

Where,

- PI= Pollution Index
- N=Number of days of violation took place
- R=Rupee factor for EC
- S= Scale of Operation factor
- LF= Location Factor

i. Industrial sectors have been categorized based on Pollution Index range 60 to 100 means Red, 41 to 59 Orange, 21 to 40 Green.

ii. The period between the day of violation observed/due date of direction's compliance and the date of verification by CPCB/SPCB is considered as number of days violation took place.

iii. Factor in rupees is minimum 100 and maximum 500 so it is suggested to consider R as 250, as the Environmental Compensation in cases of violation / damage.

iv. Scale of Operation in terms of 0.5 for micro or small / 1.0 for medium / 1.5 for large units.

v. Location in terms of proximity to the large habitations and industry unit. For the industrial unit located within Municipal Boundary or upto 10km distance from the boundary of the city/ town.

vi. CPCB has delineated various factors such as S-factor, based on size of operation for buildings, mining and other industries as given in the **Annexure I.**

CPCB methodology for calculating environmental compensation is based on three attributes viz air pollution score, water pollution score and hazardous waste generation score. While computing environmental compensation specific weightage for each score has not been defined. This method also does not cover calculation of environmental compensation cost for ecological damage, health impact due to air pollution, land, noise, ecology/biodiversity, Energy Conservation and Socio-Economic Environment. Accrued economic benefits during violation period are also not considered in CPCB's methodology.

II. European Environmental Agency

EAC having noted the shortcomings of the CPCB methodology reviewed other available international methodologies which are in practice in Europe and other developed Nations.

In European Environmental agency's methodology (Enclosed – Ref_Doc-1 -- EEA Technical report No 15/2011), it was noted by EAC that this methodology addresses more comprehensively the estimation of impacts and associated economic damages including health impacts caused by number of pollutants emitted from industrial facilities including regional and local air pollutants; particulate matter (PM_{10}, PM2.5) and sulphur dioxide, nitrogen oxide.

The European Environment Agency (EEA) report assesses the damage costs to health and the environment resulting from pollutants emitted from industrial facilities. It is based on the latest information, updated for 2020.

Air pollution continues to harm human health and our environment.

This report investigates the use of a simplified modelling approach to quantify, in monetary terms, the damage costs caused by emissions of air pollutants from industrial facilities.

III. Methodology Proposed

After having reviewed the available methodologies from CPCB, European Environmental Agency and other International agencies, as well as based on brain storming and learnings from appraisal of a number of projects, a **methodology** which has wider application and encompasses all the sectors appraised under violation projects is proposed. Prior to assessing the damages, details have to be assimilated as mentioned in the **Annexure II** to compute the damage cost. Attribute wise details which formed the input for quantifying damage assessment equivalent to remediation cost, natural and community resources augmentation cost areas under:

A) <u>AIR ENVIRONMENT:</u>

Following details have to be assimilated for such exercise:

- **<u>Buildings / Construction Projects:</u>**
  - (i) Construction site / surrounding / nature (Land Use/ Land Cover) (LULC)
  - (ii) Total Construction proposed, Built Up Area (BUA), etc. as per EC
  - (iii) Construction completed, BUA etc.
  - (iv) Total cost of the project/ cost already incurred without EC
  - (v) Date of commencement and % completion status
  - (vi) Violation period (**Annexure III**)
  - (vii) No. of years/ days of violation as of consideration date
  - (viii) Whether a Virgin site or Demolition of old construction

However, all the above details can be perused from the various details submitted by PP as aforesaid.
For other projects, same as above and in addition,

(ix) Production details

(x) Process details

(xi) Operating or Non-operating and period, etc.,

(xii) Raw material consumed/ waste generation / handling, etc.

Air pollution damage assessment as per European Environment Agency (EEA):-

As per European Environment Agency Damage (in Indian currency @ Rs 80 per euro) per tonne emission estimates in 2020 (Referencing 2005 prices) for PM_{10}, $PM_{2.5}$, NO_2 and SO_2 are Rs. 17.02 lakhs, Rs. 26.21 lakhs, Rs. 4.79 lakhs and Rs. 8.25 lakhs respectively. These values as per the assessment of EEA are updated up to 2020.

Damage (EUR) per tonne emission estimates (EUR/tonnes of emissions)				
Updated to 2020	**PM2.5**	**PM10**	**NOx**	**SO2**
UK	32764	21275	5999	10309
France	32330	20994	10291	11105

Reference:
Table (A1.7 / 1.8 / 1.9 / 1.10) Damage (EUR) per tonne emission estimates for 2020 (2005 prices) in Reference Document – (Ref_Doc-1 -- EEA Technical Report No 15/2011)

- For Indian conditions, damage cost / tonne can be reduced to 20% of the annual rate considered for UK/Europe since the cost of living / medical expenses are approximately 1/5th of the European cost on an average, accepting the fact that the density of population is much higher than European countries.

- Damage (@ 20% EEA Rate) cost Per Kg/day for PM_{10}, $PM_{2.5}$, NO_x and SO_2, at the 20% of EEA rates are as: PM_{10} – Rs. 340.00 per kg / day; $PM_{2.5}$ – Rs 524.00 per kg / day; NO_x – Rs. 96.00 per kg / day & SO_2 – Rs. 165.00 per kg / day

Table for Damage (@ 20% EEA Rate) cost Per Kg/day

Parameters	Per year/Ton (Rs. in lakhs)	Per day (Rs/kg)	Per Kg/day (Rs.)
PM_{10}	3.40	Rs. 933.00/2.74 kg	340
$PM_{2.5}$	5.24	Rs. 1436.00/2.74 kg	524
NO_x	0.96	Rs. 263.00/2.74 kg	96
SO_2	1.65	Rs. 452.00/2.74 kg	165

- In case of Severely polluted areas where the baseline value plus predicted impact value exceeds the threshold limits of PM_{10}, $PM_{2.5}$ or SO_2, NO_x, damage cost Per Kg per day @ 50% of EEA rates are as: PM_{10} – Rs. 851.00 per kg / day $PM_{2.5}$ – Rs 1310.00 per kg / day; NO_2 – Rs. 240.00per kg / day and SO_2 – Rs. 412.00 per kg / day

Table for Damage (@ 50% EEA Rate) cost Per Kg/day

Parameters	Per year/Ton (Rs. in lakhs)	Per day (Rs/kg)	Per Kg/day (Rs.)
PM_{10}	8.51	Rs. 2332/2.74 kg	851
$PM_{2.5}$	13.10	Rs. 3591.00/2.74 kg	1310
NO_x	2.40	Rs. 657.00/2.74 kg	240
SO_2	4.12	Rs. 1130.00/2.74 kg	412

➢ **Let's take following Sample Calculation for an Example:**

Environment Damage cost for BUA (m^2) 27354 in severely polluted area having period of violation 370 days with PM_{10} EF of 0.1552 (gm/sec) can be calculated as:

- **Kg per day emission of PM_{10}:** 0.1552x3600x12*= 6.7 kg/day
- **Damage cost per day:** 6.7x851= Rs. 5701
- **Total damage cost during violation period:** 370x5701= Rs. 21.09 lakhs

*Based on the 12 hr working. This may vary depending upon the activity in consideration.

On Comparing the parameters between Europe and India, the following factors have been considered. We have UK/France of Europe to India.

CPCB vide report dated 19/02/20 has adopted the following rates in a specific case of Stone quarries in compliance of NGT order and 20% of these rates can be considered for stone quarries and minor mineral quarries where there is a cluster.

Pollutant	Environmental Price for average atmospheric Emissions (/kg Emissions, 2015)
Environmental Price for Average Particulate Emissions (Rs. /kg. Emission) = Environmental Price per Kg Emission x Exchange Rate x inflation factor	
Particulate Matter (PM10)	26.6x79.59x1.19=Rs.2519.34/Kg Emission
Particulate Matter (PM 2.5)	38.7x79.5 9x1.19=3665.36/Kg Emission
Particulate Matter (NOx)	14.8x79.59x1.19=1331.29/Kg Emission
Particulate Matter NO2)	11.5x79.59x1.19=1089.19/Kg Emission

At 20% of the above rates for Severely polluted areas		
S.No.	Pollutant	Rates
1	PM2.5	Rs. 504/-

2	**PM10**	Rs. 733/-
3	**NOx**	Rs. 218/-
4	**SO2**	Rs. 280/-

The following factors like Morbidity cost (QALY), Annual medical expenditure, average annual income, population density and major medical treatment cost have been taken into consideration between European Union (UK/France) and India vide the table following. And the damage cost of EU(UK) has been considered 20% of the EEA cost of damages. Sources are given below:

S. No.	Factors	EU Rates
1	Morbidity QALY (Quality Adjusted Life Years	75000 Euros (Rs.59.25 Lacs)
2	Annual Medical Expenditure	4620 Euros (Rs.32.34 Lacs)
3	Average Annual Income	3703 Euros (Rs.24.4 Lacs)
4	Population Density	195 / Sq.KM
5	Major Medical Treatment Cost (By Pass Surgery)	10687 Euros (Rs.8.55 Lacs)

Sources Enclosed:

Ref_DocNo.3 -- EU28 – Page 6

Ref_DocNo.6 -- List of countries by total health expenditure per capita – Wikipedia

Ref_DocNo.7 -- List of European Union member states by average wage - Wikipedia

Ref_DocNo.8 -- List of states and union territories of India by population – Wikipedia

Ref_DocNo.9 -- Area and population of European countries – Wikipedia

Ref_DocNo.10 — Daily Wages In India Doubled In 18 Years, But Wage Inequalities Grow

Bypass Surgery in India: https://www.medifee.com/treatment/bypass-surgery-cost/

Bypass Surgery in UK: https://www.statista.com/statistics/686738/cost-of-heart-procedures-on-the-nhs-united-kingdom-uk/

The following table of EU 28 Handbook has been considered by CPCB as mentioned above.

Table 5 Environmental prices for key atmospheric emissions (€2015 per kg emission) Reference Enclosed (Ref_Doc – 3 – EU 28) – Page34		
Pollutant		**Environmental price (€/kg emission)**
		Average
Carbon dioxide2	CO2	€ 0.06
Chlorofluorocarbons2	CFC11	€ 306
Fine particulates, 2.5 μ or less	PM2.5	€ 38.70

Coarse particulates, 10 µ or less	PM10	€ 26.60
Nitrogen oxides	NOx	€ 14.80
Sulphur dioxide	SO2	€ 11.50
Ammonia	NH3	€ 17.50
Volatile organic compounds	NMVO C	€ 1.15
Carbon monoxide	CO	€ 0.05
Methane2	CH4	€ 1.74
Cadmium	Cd	€ 589
Arsenic	As	€ 862
Lead	Pb	€ 5,367
Mercury	Hg	€ 34,490
Formaldehyde	CH20	€ 12.30

The following table(4.1) is also taken into account for discounting the EEA rates to 20%

TABLE 4.1 Share of Morbidity Costs in Total Health Costs from Ambient Air Pollution, World Bank Studies *(continued)*

Country	Year studied	Morbidity share of total costs (%)	Morbidity cost components	Source
India	2009	7	*Disutility costs:* YLDs valued using VSLY (as part of DALYs) *Resource costs:* Medical treatment costs from previous studies and consultations with medical providers, costs of chronic bronchitis and COPD taken over 20-year period *Opportunity costs.* 75% average wage x days of illness	World Bank (2013a)

Apart from above, in addition for mining sectors if any active agriculture land or local habitation is present inside the mine lease area or in its vicinity. The damage to be assessed for Local population health loss and crop damage or loss of yield. The following methodology can be adopted for assessing the dame for same. The following methodology has been developed by referencing "Mechanism developed by CPCB for assessment of damage to the air quality, public health and agriculture production loss dated 19/02/2020" (Enclosed: Ref_DocNo.2 -- REPORT BY CPCB IN OA NO. 739 of 2018)

DAMAGE ASSESSMENT OF HEALTH ISSUES:

The major health issues associated with the pollution caused by mining activities / crushing units are respiratory infections which on regular exposure aggravates into respiratory diseases. This again becomes one of determining factor of Mortality & Morbidity of the population in the affected area.

The impact of PM 10 & 2.5 has higher impact on population present within & in the vicinity of such mines / crushing units. In such cases, the damaged is assessed by referring the local medical data (Can be obtained from local health centres serving the population) or the Project proponent need to conduct health survey in such impacted areas with the help of questionnaire to have the realistic data of the affected people.

From the data, the damage is assessed in two steps. First the cost of illness is calculated using the formula 1* followed by total damage in the affected area*.

1. Cost of Illness in affected area ($COI_{\text{Affected Area}}$) $=$ Cost of Illness per person in the State capital area ($COI_{\text{State Capital}}$) $\times$ $\dfrac{\text{Per Capita Income in the affected Area } (INC_{\text{Affected Area}})}{\text{Per Capita Income in the State capital area } (INC_{\text{State Capital}})}$

2. Damage to health due to respiratory disease in affected area ($Damage_{H}$) in **INR** $=$ No Of Cases reported in Affected Area $\times$ Cost of Illness in affected area ($COI_{\text{Affected Area}}$)

NOTE:

1. The data taken to support the cost of illness and per capita income to be inflated to present year, while calculating the cost for both city capital and affected area.
2. In case the sites / area of mining and crushing units are co-existing with other industry, the % contribution of pollution load may be calculated by source apportionment studies. The contribution of violated industry then can multiply the contribution factor with **$Damage_H$**.

DAMAGE ASSESSMENT OF AGRICULTURE LOSSES:

Model sensitivity studies carried out in India has identified NOx as the key pollutant causing as much as 93% of crop loss. The major activity releasing NOx in mining / crushing sectors is from movement of vehicles, machinery run on combustion fuels, ore / mineral Processing & Handling units. Apart from this the damage is also caused by particulate matters (10 & 2.5), where surficial deposition of PM on the vegetation affects its growth or other natural synthesis pathways.

For the damage assessment the overall maximum contribution due to NOx, PM 2.5 & PM 10 can be taken as 60%#. Here again the damage is calculated in three step, first the total yield loss is calculated using the formula 1, then its converted in terms of monetary using formula 2 and final damage is calculated using formula 3 in the affected area.

1. Total Yield Loss ($Loss_{Yld}$) = (Avg. production yield for Crop A in Tonnes/Acre ($Yield_{Avg\ Crop\ A}$) - Actual production yield for Crop A in Tonnes/Acre ($Yield_{Act\ Crop\ A}$)) X Affected Area in Acres

2. Agriculture Production Loss ($APL_{Crop\ A}$) = $Loss_{Yld}$ X Minimum sale Price of Crop A ($MSP_{Crop\ A}$)

3. Agriculture Production Loss of Crop A by NoX, PM 10 & 2.5 ($APL_{NoX\ \&\ PM\ Crop\ A}$) = $APL_{Crop\ A}$ X % Contribution as per #

To estimate the Agricultural Productivity Loss (APL), following steps have been taken:

•Estimation of shortfalls in annual crop yield with respect to Average yield for each year for individual crop. (Ref. Website of Ministry of Agriculture and Farmers Welfare)

•Estimation of total shortfall in the Agriculture Production Loss in impact area using the latest MSP values for individual crops for all the years

•Estimation of Projects percentage contribution in yield loss

NOTE:

1. #- The percentage of contribution may vary depending on location of agriculture land within ML area or in its vicinity. The data taken to support the cost of illness and per capita income to be inflated to present year , while calculating the cost for both city capital and affected area.
2. In case the sites / area of mining and crushing units are co-existing with other industry, the % contribution of pollution load may be calculated by source apportionment studies. The contribution of violated industry then can multiply the contribution factor with **Damage$_H$.**

EXAMPLES FOR ABOVE CASES:

Calculation of Damage Assessment of Health Issues:

Formula: Damage$_H$: No. of cases Reported (X) x $COI_{Affected\ area}$Eq

Let us assume that the damage is to be calculated for the year 2018.

Per Capita Income of the of Mumbai (**Inc** $_{\textbf{Mumbai}}$)for 2017-18 as per Economic Survey of Maharashtra 2018-19 is Rs. 176102.

Cost of Illness per person in Mumbai area (**COI_{Mumbai}**).: Rs. 14378 as of 1997

Cost of Illness per person in Mumbai area (**COI_{Mumbai}**) inflated to 2018 is Rs. 54202 (Average Inflation rate 6.52%)

Let us assume Per capita Income of affected area (**$Inc_{Affected\ area}$**) for the year 2018 Is Rs. 50000

$\mathbf{COI}_{\text{Affected area}}$ = 54202 x 50000/176102 =15389/= (Say Rs. 15390/=)

Let us further assume the no. of cases of respiratory illness/diseases reported based on the data obtained from Medical facilities serving the affected area and health survey: 30

So, the damage to Health due to Respiratory diseases (Damage_H):

Damage_H (Rs): No. of cases Reported (X) x $\text{COI}_{\text{Affected area}}$

Damage_H (Rs):30 x 15390 = 461700/=

Let us assume that 10 stone crushers having same capacity were found to be non-compliant in the affected area and that the contribution of stone crushers in air quality in affected site as calculated from the source apportionment study is 25%

So, the damage to Health due to Respiratory diseases (Damage_H) recoverable from each stone crusher : (461700x 25/100)/10 = 115425/10 = Rs. 11543/- (2)

12

Calculation Agriculture Production Loss:

Formula: $APL_{PMCropA} = APL_{CropA} \times 10\%$

Let us assume crop in the affected area during damage period is wheat.

Let us further assume that:

i) Average production yield for wheat in the affected area **($Yield_{AvgWheat}$)** is 2Tonnes/acre

ii) Actual Yield of Crop A in the Affected area in Tonnes/Acre **($Yield_{ActWheat}$)** is 1.60 Tonnnes/acre

iii) Affected Area in Acres **($Area_{Acr}$)** is 50 acres

So, Total Yield Loss ($Loss_{Yld}$)= (2– 1.6) x 50 = 20 tonnes

Let us assume that minimum Sale Price of Wheat **(MSP_{Wheat})** in the affected area is Rs. 18000/- per ton

Agriculture Production Loss of Wheat (APL_{Wheat}) in affected area : $Loss_{Yld}$ × MSP

So, Agriculture Production Loss of Wheat (APL_{Wheat}) in affected area:20x 18000 = Rs. 360000

Estimated Percentage Contribution of Stone Crushers in Yield Loss: 10%

Agriculture Production Loss of Wheat crop by PM_{10} and $PM_{2.5}$ in affected area by stone crushers ($APL_{PM\text{-}Wheat}$) = $APL_{CropA} \times 10\%$ **i.e 360000 x 10/100= 36000**

Let us assume that 10 stone crushers having same capacity were found to be non-compliant in the affected area.

So, the agriculture production loss recoverable from each stone crusher : 36000/10 = Rs. 3600/- (3)

Therefore, Total damage recoverable from each non-compliant stone crusher in the affected site for damage to air quality, public health and agriculture production loss : $Damage_{AQ}$ ***(1)*** + $Damage_{H}$ ***(2)*** + $APL_{PM\text{-}Wheat}$ ***(3)*** *i.e*

***Total damage recoverable from each non-compliant stone crusher in the affected area* 48780 +11543+ 3600 = Rs. 63923**

B) WATER ENVIRONMENT:

Followed CPCB methodology as it covers exhaustively water environment addressing ground water and surface water. However, Committee augmented it further adding rainwater harvesting and treated sewage.

The following impacts / damages are envisaged due to construction and mining / other industrial activity, if not properly managed and mitigated:

- **Surface Water:**
  - Generation of suspended solids in storm water run-offs during monsoon season
  - Wastewater generation during construction
  - Washable construction material
  - All surface runoffs from the plant leading to increase in Suspended Solids concentrations of Natural Water bodies.
  - Wastewater generation during mining operation.
  - All surface runoffs from the mine lead to increase in Suspended Solids concentrations of Natural Water bodies.

- **Ground Water:**
  - Usage of Ground water for construction and mining activities.
  - Obstruction of rainwater percolation due to ground cementing.
  - Percolation of contaminated ground water near the Building boundary.
  - Pumping of ground water while basement excavation /construction.
  - Obstruction of rainwater percolation / destruction of lineaments (leading to main aquifers) and micro watershed impacts.
  - Contamination of ground water.
  - Depletion of ground water level may result in water shortage in nearby villages during dry seasons.
  - Wastewater from workshop/service building.
  - Domestic effluent discharge.
  - Mine Drainage water discharge.
  - Wash out from waste dump/stack piles.

- **Rainwater Harvesting:**
  - Wastage of rainwater into surface runoff / into storm water drains
  - Stagnation of rainwater in the nearby area to construction/ Industrial site.
  - Overflow of storm water drains
  - Stagnation of water will be a breeding place for water borne disease to nearby inhabitants and workers at site.

➢ Environmental Compensation for Ground Water (ECGW)

The CPCB committee has proposed the following formula for calculation of Environmental Compensation for Ground Water consumption (ECGW):

ECGW = Water Consumption per Day x No. of Days x Environmental Compensation Rate for illegal extraction of ground water (ECGW) (Either without NOC from statutory authority or under violation)

Where water Consumption is in m^3/day and ECRGW in Rs./M^3

As per CGWA, safe, semi-critical, critical and over-exploited areas are categorized from the ground water resources point of view (CGWA, 2017). List of safe, semi-critical, critical and over-exploited areas are available on the website of CGWA.

Sector wise damage assessment with respect to Ground water utilization without NOC shall be calculated as per the formula suggested by the CPCB

❖ **Building & Infra Sector**

❖ **Construction/Operation Phase:**

Table for compensation cost for GW used without NOC for construction/ Domestic

Damage Rate Rs/M^3 Category	<= 25 M^3 /day	>25 M^3 / day
Safe	8	10
Semi-critical	16	20
Critical	26	30
Over Exploited	36	40

- STP water used for construction without NOC = Rs.50/M^3

For Mining Sector:

(a) Water consumption (M^3 per day)

Water consumption M^3 day				
Level Category	<200	200 to 1000	>1000 to 5000	>5000
Damage cost in Rs/M3				
Safe	15	21	30	40
Semi Critical	30	45	60	75
Critical	45	60	85	115
Over Exploited	60	90	120	150

(b) **Water** discharge **M³ day** : CGWA has considered vide their notification dated 12th Dec 2018 WCF (Water Conservation Fees) for mining and dewatering projects by considering cost of implementation of recharging structures, and other rainwater management systems including Roof RWH for implementing the same as per NOC conditions as per polluter pays principle, the EAC has formulated the following rates for Discharge of either GW/SW to the surface or natural streams under violation and the quantum shall be decided by the EAC based on the status submitted by the PP.

Water discharge M^3 day				
Level Category	<200	200 to 1000	>1000 to 5000	>5000
Damage cost in Rs/M_3				
Safe	2.00	4.00	5.00	6.00
Semi Critical	4.00	5.00	6.00	8.00
Critical	6.00	8.00	10.00	12.00
Over Exploited	8.00	10.00	12.00	14.00

For Industries Sector:

Water consumption M^3 day				
Level Category	<200	200 to 1000	>1000 to 5000	>5000
Damage cost in Rs/M_3				
Safe	20	30	40	50
Semi Critical	40	60	80	100
Critical	60	80	110	150
Over Exploited	80	120	160	200

For Industries located within Industrial areas/estates:

The Rate of damage/compensation will be equal to the rate/M^3 charged by the authority at total consumption during violation period.

Water consumption M^3 day			
Level Category	<200	200 to ≤1000	>1000
Damage cost in Rs/M_3			
Safe	1 x Rate of IA	1.5 times of IA	2 times of IA
Semi Critical	2 x Rate of IA	2.5 times of IA	3 x rate of IA
Critical	3 x rate of IA	3.5 x rate of IA	4 x rate of IA
Over Exploited	4 x rate of IA	4.5 x rate of IA	5 x rate of IA

*IA- Industrial Area/Estate

II) Environmental Compensation Surface Water (ECsw)

For Industry and Mining sector:

Total Quantity assessed by GEC 2015 and neither fully or nor partially governed / managed by the industry / mining sectors, the damage cost will be as following as per the due diligence of the EAC on case to case basis:

Water consumption M^3 day				
Level Category	<200	200 to 1000	>1000 to 5000	>5000
Damage cost in Rs/M3				
Safe	10	15	20	25
Semi Critical	20	30	40	50
Critical	40	60	80	100
Over Exploited	10	15	20	25

For Construction Sector:

Rs. 100/ Cu.M/day irrespective of the area category. If partially manage with proof, the quantity will be assessed accordingly and damage assessed.

Note: Cost includes damage costs for water quantity and quality and is further taken care by adding cost in EMP saving to total damage cost.

III)RWH: (Roof + Surfaces) RWH pits / boreholes / Tanks are Not Provided, either as per requirement of GEC 2015 / CGWA guidelines or partially provided:

For Non-provision of Rainwater harvesting (RWH) and recharge bore wells and tanks with proper system. Compensation / remediation amount will be calculated for the Nos. to be provided and their cost. RWH – Recharge Borewell @ Rs.3.5 lacs / per borewell / tanks. One recharging bore well at every 5000 Sq m of builtup area to be setup. Cost of rainwater harvesting pit shall @ Rs 30000/pit. (Pit dimension varies as per the annual rainfall and normally it will be about 60 cum cap and with 5x4x3 m dimension @500/; per cum.)

The total quantity as per GEC 2015 computation that is impacted during construction/operation phase shall be assessed and compensation at the rate of Rs.10/per cum shall be computed for safe /Semi-critical areas and for critical/ overexploited @ Rs.20/- Per cum shall be considered for remediation.

IV) Sewage Treatment: Environmental Compensation /Damages for partially treated/ untreated: This is applicable for the projects under operation and not for the incomplete projects where the STP/ETP construction is under progress. For the operating projects, where there is a gap (partial) / Non-Provision, the Environmental Damage will be calculated based on the capex of different STPs:

- 100 KLD: 60.0 lakhs
- 500 KLD: 90/95 Lakhs

- 1 MLD: 150/175 lakhs
- & M around: 15-17% of Capex

C) **Noise and Vibration**

Increase in Noise level due to either construction, Industrial or mining activities mainly due to machinery movement and operation, impact on operators, howling and honking by vehicles, noise generation and running of generators., etc, Vibration beyond the permissible limits cause damage to the structures nearby especially by blasting and heavy equipment movements.

Damage due to noise will be assessed based on the LEQ day/ night and the impact on core zone workers – cost of PPE's, the cost of barricades and additional green belt cost surrounding the project as noise barrier will be considered on case to case basis depending upon the proximity of habitation and core zone workers prolonged exposure in the project, etc

Noise Monitoring and impact must be assessed by proper modelling:

Damage Assessment: Based on the impact exceeding the threshold values on neighborhood and core zone, the project will be assessed:

- Provision of PPE's to employees: Provision of PPE: Rs. 1000 / head x No. of employees
- Provision of Noise barrier, while the habitations are in close proximity: Perimeter x height = Sq.Mtrs x Rs. 400 / sq. Mtrs as damage cost by either providing barriers / Green belt to be affected.
- In case of non-provision of either partial/ full Green Belt (noise attenuation) as required, the damage will be assessed as following:
- **GB = Three tier at Rs. 1100/ per tree in case of NCR, Metropolitan cities and for others @Rs. 300 per tree.**
  This covers cost of the plant, planting and maintenance for 3 years in NCR and metropolitan cities. For Others are 300/tree includes plant, planting and maintenance cost for 3 years.

D) **Land Environment**

Land Use and Land Cover Analysis:-

For Building & Infra Sector:

LULC analysis will reveal a change from pre-construction to post construction and the impact. In Building projects, removal of Earth, Top soil and its percentage utilization shall be calculated. The damage caused due to non-utilization/improper management shall be calculated @ 20/per cum for earth and Rs.50/cum for Top Soil (thickness 30cm).

a) **The rate of 25 Rs/cu.m is considering thickness of 3 centimetres which works out to 3000 cu.m/ hectare. The handling cost of talking ad resuming works out to Rs.25/cu.m**
b) **Its top soil partially used and partially wasted the damage cost will be Rs.12.5 / cu.m**
   Reference: ***publication 'Cost estimation of Soil Erosion and Nutrient Loss from a Watershed of the Chotanagpur Plateau, India (Gulati and Rai, 2015; Current science, 107(4):670-674, August 2014)***

For Mining & Other Industries:-

Damage to agricultural, grazing and community lands will be calculated at the beneficial cost/ Market values of the extent of the land /water bodies so impacted for remediation. Topsoil Mismanagement will be assessed @ 50/- per cum of Qty not utilized.

Cost of rectification for proper slope, plantation on non-active dumps, other surface water control measures shall be assessed by the committee based on the area estimated and damage / remediation cost to be computed for non/ partial provision of Garland drains, toe drains, toe walls, check dams, settling tanks and plantation of different types over the inactive area of dumps

E) Solid Waste Management

For Infra/Industry Sector:-

- As per SWM Rules 2016, non-compliance / partial compliance will be applicable for operating projects only.
- As per the industry average: cost of collection/processing per house is Rs 12.00 per day for 4 persons and waste: 1.5-2.0 kg i.e Rs 6.0 per kg per day for a colony of not less than 30000 to 100000 population.
- In construction stage for the workers, the overhead will be minimum of 4 times per kg since to deal with minimum numbers and also it has to be carted to a distant place of availability. Hence it is taken as Rs 25/- per kg.

Reference: SWM Rules 2010, 2016 and Municipal Act.

Pper capita waste generation rate as per CPCB ranges from 0.2-0.6 and taking an average of 0.4/kg / person / day for a family of four, it works out to 1.5-2kg / day and as per the same guideline and CPHEEO and the general standard on average of Rs.6/kg is spent for collection and processing.(CPCB has considered 170 gm percapita SW generation in one report which almost compares with the above.)

As per SWM Rule 2016, one worker to cover 150 households for collection only. To comply with **municipal solid waste management manual of CPHEEO** and CPCB guideline and SWM Rules 2016 considering collection at the rate of one persons for 150 houses and further segregation and processing in total works out to Rs.12/day for family of 4persons and per capita waste generation as per CPCB. Reference of Indore Municipality, Kalpakkam Municipality, Neyveli Municipality and there rates are considered for Rs.12/day/house of 4 persons.

During the construction stage, in the absence of proper arrangement the cost of handling will be doubled due to minimum quotation and overheads cost by the collector apart from carting it to further distance and hence the cost/ kg of handling has to be taken at 25Rs. Towards the damages. Since with no arrangement leads to cost savings.

F) Green Belt

For Infra/Building /Area Developement:-

GB to bwe peovided @one tree for every 80sq.mtr as per MOEF/National Buiding Code:

- 3 Times the requirement as per norms to be planted in the neighborhood @ Rs.1100/Per Tree.

- For every tree cut - 5 trees to be planted in the project boundary or other areas @ 1100/Per Tree.
- In NCR for every tree cut - 10 trees to be planted in the project boundary or other areas @ 1100/Per Tree.

<u>For Mining & Other Industries:-</u>

<u>GB has to be provided for 33% of the Plot/Lease Area.</u>

Above 3 points also applicable to Mining & Other Industries and apart from that below points to be considered.

- Green Belt is to be provided all along the ML boundary for a minimum width of 7.5M and also in the safety zone @ 7.5M width besides provision of GB along the water courses at 50M boundary on either side. Plantation on minimum active dumps and other non-operational areas.
- EAC will assess the non or partial provision of these and compensation will be estimated for the gap quantity @ 1500 nos / Ha. In case of Industry as min of 33% of the plot area is to be covered under GB and plantation. The environmental damage will be assessed accordingly @ ~~1500~~ 2500 plants/Ha for the deficiency. EAC mat use the advanced technology viz Decision supporting system (DSS) using KML file for assessment of green Belt.

G) <u>Wildlife Conservation Plan</u>

- Any Schedule-I species are found in the buffer zones (within 10 km of the project site), requiring wild life conservation plan, Damage will be assessed and damage cost will be levied based on due diligence by EAC up to **10%** of the approved cost of the conservation plan approved by concerned CWLW/PCCF per year during the entire violation period for infrastructure projects.
- In case of mining and industry projects damage cost will be levied per year due diligence by EAC up to(10%to 20%) of the approved cost of the conservation plan approved by concerned PCCF for year during entire violation period based on the sensitivity of the area.

H) <u>Energy Conservation (Examples given in Annexure IV)</u>

<u>For Infra/Industry Sector:-</u>

The cost of compliance under different conditions shall be assessed as following:

- If the project is under operation and partially complies guidelines of Energy Conservation Building code (ECBC 2017) with building envelope is in place, there impact will be assessed on prorata basis and cost of damage will be levied on excess energy consumption.
- If construction is under completion stage and the envelope is not provided with ECBC conditions, the PP will be directed to comply with ECBC conditions.
- The damage cost will be assessed in operating projects where ECBC is partially complied excepting the building envelope. The percentage of energy saving will be assessed on pro-rata basis (Capex for provision of ECBC is around 7%-10% of the project cost and saving in energy is in the order of 20-30% as compared with conventional provision.

- The committee will assess the cost of impact considering the excess energy consumption on pro-rata basis and the remediation will be assessed accordingly for the period for violation. Solar power generation at the rate of 1% of maximum demand to be provided, the damage cost will be assessed based on the gap and its Capex. The excess energy consumption will be assessed and the energy cost levied as damage / remediation during violation period.
- In addition to above, in case of commercial buildings, 20% of water heating by solar system is mandatory and non-provision of this will also attract the damage cost.

I) <u>Risk Hazard/Occupation Health & Safety (Examples given in Annexure V)</u>

- The risk factor associated during construction and operation activity has to be calculated by the consultant using applicable and available computational modeling tools as mentioned in Annexure V.
- If the probability of risk so calculated is in the high risk zone leading to loss of life, damage cost as applicable as per the Government norms will be levied.
- In the zone of moderate and low risk, committee will decide penalty on the study of the reports prepared by the consultant.
- However, this parameter is to be assessed by the EAC through due diligence to arrive at damage cost on this account as per the examples s given in the Annexure V.

J) <u>Economic Benefits out of Violation (Example is given in Annexure VI)</u>

<u>The Economic benefits comprise of two parts:</u>

1. Cost and expenditure saved by the PP during the violation period for not spending on EMP.This cost will be arrived as per submission of details by the project proponent in the EIA/EMP report. **(In case of Mining / Industry projects)**
2. Net profit earned due to operation of **Mining /Industry/Infra projects** during violation period (Net Profit will be certified by CFO of the company / Independent Auditor of the company)
3. A maximum of 3.0% of the Economic benefits earned will be added to the damage cost and will be used for community resource augmentation

<u>For Infra/Industry Sector:-</u>

a. **If the building is operational,** 20% of the capital cost can be considered as profit earned.
b. **If the building is not operational** with the completed / incomplete construction, then 10% of the cost of construction for the completed portion can be considered as the profit earned.
c. Total environmental damage assessment cost **(Building / Infra Sector)** = 3% of the Economic benefits accrued + cost towards Remediation, Natural and Community Resource Augmentation plan.

<u>For Mining & Other Industries:-</u>

a. Economic benefits accrued = [Capital cost of EMP + Recurring EMP cost saved during violation period + Net profit during violation period]
b. A maximum of 3.0% of the Economic benefits accrued as computed will be added to the damage cost and will be used for community resource augmentation

c. Total environmental damage assessment cost **(Mining /Industries)** = 3% of the Economic benefits accrued + cost towards Remediation, Natural and Community Resource Augmentation plan.

Conclusion:

This methodology will be used to calculate the environmental damage assessment cost for prescribing remediation as well as natural and community resource augmentation plan. The EAC would also give due consideration to the inputs received from the project proponent and would compute the potential damages that would have been caused during construction and operation phases, due to violation. The economic benefits accrued during violation period will also be added to the environmental damage assessment cost and shall be used for Community Resource Augmentation Plan.

****

ANNEXURE I

CPCB guidelines for location Factor and S Factor

Location in terms of proximity to the large habitations and industry unit. For the industrial unit located within Municipal Boundary or upto 10km distance from the boundary of the city/ town.

Location factor Values

S. No	Population* (million)	Location Factor (LF)
1	1 to <5	1.25
2	5 to <10	1.5
3	10 and above	2.0

Population of the city / town as per the latest census of India.
 # LF will be 1.0 in case unit is located >10km from municipal boundary
LF is presumed as 1 for city/town having population less than one million

S=Factor for scale of operation
S could be based on small/Medium /Large Industry categorization, which may be 0.5 for micro or small, 1.0 for medium and 1.5 large unit

ANNEXURE II

- **FOR BUILDING PROJECT** .

S. NO.	PARTICULARS	UNIT	PHASE 1	PHASE 2	TOTAL	REMARK
1	**Plot Area**	sqm				
2	**Construction Period**	--				
3	**Status**	--				
4	**Built up area**	sqm				
5	**Cost of Project**	Rs. (in crore)				
6	**Cost on construction**	Rs. (in crore)				
7	**Cost on plant & Machinery**	Rs. (in crore)				
8	**Air Impact dust emission quantity**		**CONSTRUCTION**	**OPERATION**		
	PM_{10}	gm/sec kg/day				
	$PM_{2.5}$	gm/sec kg/day				
	No_2	gm/sec kg/day				
	SO_2	gm/sec kg/day				
9	**Water Environment**					
	STP Water	KLD				
	Surface Water	KLD				
	Waste water Generated	KLD				
	STP provided vs Gap	KLD				
	Fresh Water – Groundwater / Bore well	KLD				
	No. of RWH Pits required / No. Of RWH pits less provided	KLD				
10	**Soil Environment**					
	Total Excavated Soil	sqm				
	Top Soil Quantity	sqm				
	Soil utilised %					
	Top Soil Utilised %					

11	**Noise Impact**					
	Day / Excess by Night					
	Noise barrier less provided					
12	**Ecology and Biodiversity**					
	No. of trees to be planted	No.				
	No. of trees planted	No.				
	No. of Less Trees planted vs No. Of Trees Cut	No.				
	LULC impact in Ha.					
	Less Agriland	Ha.				
	Less Grazing Land	Ha.				
	Less other land	Ha.				
13	**No. of Labours**	No.				
14	**No. of Trucks/Day**	No.				
15	**No. of Construction Days**	No.				
16	**Machinery Used**					
	DG Sets	kVA				
	RMC	Trips				
	JCB	No.				
	Loader	No.				
	Excavator	No.				
17	**Raw Material Used**					
	Cement (50 kg bag)	Bags				
	Sand	MT				
	Aggregate	MT				
	Reinforcement	MT				
	Stone Cladding	Sqm				
	Bricks	Nos				
18	**Green Area**	sqm				
	Existing	sqm				
	Less provided as required	sqm				
	Proposed	sqm				
19	**Socio Economic benefits (CSR)**					
	31.03.__ (Year ended)	Rs. (in Lakhs)				
	31.03. (Year ended)	Rs. (in Lakhs)				

	31.03. (Year ended)	Rs. (in Lakhs)				
	31.03. (Year ended)	Rs. (in Lakhs)				
20	**ECBC**					
	Conservation Measures	-				
	Solar Energy required	KW				
	Less provided					
	Water heating (20%) (Commercial Buildings)					
	Other Less conservation measures provided					
	Excess Energy consumed by non-compliance of ECBC	KWH/days				
21	**Conservation Cost fixed by DFO**	Rs. (in Lakhs)				
22.	Economic Benefits					
	a) EMP cost saved per year	No. of Years				
	b) profit accrued per year	No. of Years				
		Total				

- **FOR MINING & INDUSTRIES PROJECT**

BASELINE DATA DETAILS

1. **Air**

a. **Construction / Pre-Mining**

Criteria Pollutants	Unit		Minimum value		Maximum Value		98 percentile value		Prescribed standard
	gm/sec	µg/m³	gm/sec	µg/m³	gm/sec	µg/m³	gm/sec	µg/m³	µg/m³
PM10									
PM2.5									
SO2									
NOx									

b. Operation

Criteria Pollutants	Unit		Minimum value		Maximum Value		98 percentile value		Prescribed standard
	gm/sec	$\mu g/m^3$	gm/sec	$\mu g/m^3$	gm/sec	$\mu g/m^3$	gm/sec	$\mu g/m^3$	$\mu g/m^3$
PM10									
PM2.5									
SO2									
NOx									

Criteria Pollutants: (PM10, PM2.5, SO2, NOx, Other parameters specific to sector)
Unit: (Micro gram per meter cube, nano gram per meter cube, milli gram per meter cube, etc.)

2. WATER

a. Details of Ground / Surface Water

Criteria of Pollutants as per standards	Pre-construction / Mining	Post Construction / Mining	Post Operation / Mining	Remarks
PH				
DO				
BOD				
COD				
TDS				
TSS				
Heavy Metals				
Chlorides				
Fluorides				
Other				

A - 118

b. Water Consumption:

Description	Construction / Mine development	Operation	Remarks(NOC / No NOC)
STP Water / Other in KLD			
Ground Water /Borewell in KLD			
Surface Water as per GEC 2015 in KLD			
Fresh Water (Domestic)			
No. of RWH pits required			
No. of RWH Pits less provided			
GW Instersection (level)			

3. <u>NOISE:</u>

Location	Parameter	Maximum	Minimum	Threshold Value	Remarks
Industrial	Leq Day				
	Leq Night				
Residential	Leq Day				
	Leq Night				

4. <u>ECOLOGY / BIODIVERSITY / LU/LC</u>

❖ **LULC Impact In Ha:**

1. **For Building / Industry & Others :-** Comparison of pre/post construction / operation
    1. Less Agriland –
    2. Less Grazing Land –
    3. Less Forest Land –

2. **For Mining Sector:**- Comparison of pre/present / Post
   - Less Agriland –
   - Less Grazing Land –
   - Less Forest Land –

- **GREENBELT AREA: For No. Of trees to be planted,**
   - No. Of Trees less planted –
   - Plantation Required -
   - No. Of Trees less planted –
  1. **For Building Sector :** 1 tree per 80 M^2 & minimum of 33% of total Plot area.
  2. **For Mining Sector :** At 1500 trees / Hectare & Minimum 33% of Total Lease Area including Boundary (Periphery), dumps, safety zones, water bodies (Surrounding or along the path) ,etc
  3. **For Industry & Other Sectors :** Minimum 33% total plot area including the boundary plantation

- **SOIL:**
1. Top Soil: ___Qty(M3)
2. Qty les used: ____(M^3)

- **WILDLIFE CONSERVATION PLAN (WCP):**

  a. Status of WCP if Approved/ Not approved.
  b. Details / Budget of Approved

5. **WASTE MANAGEMENT:**
  a. **SOLID WASTE MANAGEMENT**
     1. Qty Generated - __________
     2. SWM Rules 2016 – Complied / Not Complied
     3. If complied – Details
        i. Gap Capacity - _________

  b. **OB / WASTE MANAGEMENT**
     1. Details as per Form '2'

PARAMETERS	UNITS	REQUIRED	PROVIDED	LESS PROVIDED
Garland Drain,	Mtrs			
Toe Drains	Mtrs			
Toe Walls	Nos.			
Check Dams	Nos.			
Settling Tanks/ Ponds	Sq. M			
Plantation	Sq. mtr			

2. For Rare Minerals / CRZ related – Details from Form '2' - Adequate.
3. For Mining of Coal/ Non Coal / Rare Minerals – Form '2' - is adequate for assessing the impacts apart from the above.

6. **ENERGY SAVING MEASURES:**

- Requirement of ECBC of colony within project area.
- Other Energy saving measures

7. **RH/ OHS/ DISASTER MANAGEMENT/ SMP:**

- Requirement – Industry Specific
- Deficiency – details / compliance plan

8. **SOCIO ECONOMIC BENEFITS :**

31.03.__ (Year ended)	Rs. (in Lakhs)
31.03.__ (Year ended)	Rs. (in Lakhs)
31.03.__ (Year ended)	Rs. (in Lakhs)
31.03.__ (Year ended)	Rs. (in Lakhs)

9. **ECONOMIC BENEFITS ACCRUAL:**

1. Saving in EMP Cost / years under violation.
2. Net profit earned – Years under violation.

Dr S. R Wate
Chairman, EAC (V)

Annexure-III

Violation Case and Period of Violation:

- The projects or activities requiring prior environmental clearance under Environment Impact Assessment Notification, 2006 from the concerned Regulatory Authority are brought for environmental clearance after starting the construction work, or have undertaken expansion, modernization, and change in product- mix.
- In any of above case, if the project proponent fails to obtain prior environmental clearance, these projects shall be treated as case of violation.

Period of Violation:

Below are two Common condition considered for all Sectors,

1. Not obtaining EC Prior as per above definition.
2. EC obtained and violating the EC conditions pertaining to expanded the production /project area beyond limit as specified in prior EC.

In reference to above title, Violation Period can be defined as follows for different sectors,

Scenarios for Condition No 1: (Projects operating with out prior EC)

1. For Building & Infra sector, the period of violation will be accounted from the day of onset of construction of boundary wall till obtaining EC/stopping of activity which is earlier.
2. For mining sector, mines which are under operation prior to 1993-94. As per common cause judgement the period of violation will be accounted from 1993-94. Difference in quantity over and above the baseline production of the year 1993-94 will be considered under violation until obtaining EC/ year of stopping of Industry or Mine which Eis earlier.

Scenario for Condition No 2: (Non comliance of earler EC)

1. Common to all sectors, if the project proponent has violated EC condition pertaining to excess production or area (BUA/project area), modernization and change in product mix. The period of violation will be the actual year in which such violation has happened until issue of EC/year in which production is bring down with in earlier EC cpacity, which ever is earlier.

Annexure-IV

ENERGY CONSERVATION & BUILDING CODE DAMAGE ASSESSMENT

General Condition:

1. Keeping the table given below as reference for all cases, damage will be assessed and damage cost will be calculated based on total weightage and in reference to the base rules*.
2. Apart from ECBC compliance, as per MoEFCC guideline 1% of total energy demand (Working Load) to be from renewable source like solar panels, etc. This is mandatory for all sectors.
3. For all commercial buildings 20% of heated water requirement should be from solar based installation / solar water heaters.

Base rules:

1. Cost for usage of excess energy is INR 8 Per KwH
2. Capex for provision of ECBC is around 7%-10% of the project cost
3. Saving in energy is in the order of 20-30% as compared with conventional provision.
4. Mandatory Requirements - The mandatory requirements are described in CGECBC under sections 3.2.1, 4.2, 5.2, 6.2 and 7.2 of the CGECBC code.

WEIGHTAGE TABLE OF ATTRIBUTES FOR COMPLIANCE OF ECBC PROVISION

S.No	ATTRIBUTES CONSIDERED FOR DAMAGE ASSESSMENT UNDER ECBC COMPLIANCE	TOTAL WEIGHTAGE
1	BUILDING ENVELOPE • ROOF – 5% • EXTERNAL WALLS – 5% • FENESTRATION – 10%	20%
2	MECHANICAL SYSTEMS & EQUIPMENTS INCLUDING HVAC	30%
3	LIGHTING • INTERNAL – 10% • EXTERNAL – 10%	20%
4	ELECTRICAL POWER & MOTORS • PUMPS- 5% • MOTORS- 10% • PNEUMATICS LIKE LIFTS- 5%	20%
5	IMPLEMENTION / INSTALLTION OF RENEWABLE SYSTEMS	10%

<u>CASE NO-1:</u>

Let's consider a Building / infra project with capital cost of 100 Crores, total energy requirement is 1000 KwH and the project is under operation for 3 years till date. With ECBC complied except building envelope.

<u>Example for calculation of cost of damage for Case 1-</u>

<u>Brief Note:</u>

- In this case the provision for Building envelope is not in compliance with ECBC, whereas rest of attributes are fully complied.
- Here as per above table damage under Building envelope provision will be fully taken, which is 20%.

<u>Damage Cost Calculation:</u>

- The energy requirement is 1000 KWH, as per base rule assuming the maximum savings that can achieved by compliance of ECBC is 30%. In terms of consumption it will be 300 KwH out of 1000 KwH.
- Out of this 300 KwH, 60 KwH will be considered as excess energy been utilized due to non-compliance of Building envelope attribute, with reference to 20% weightage mentioned in above table for Building envelope.
- **<u>Formula for Final cost of damage = Damage Assessed (in KwH) X Working Hour Per Day X No of Days of Operation X Unit Cost per KwH</u>**
- **<u>Final Damage Cost For above case = 60 X 10 X 1095 X 8 = INR 52,56,000/-*</u>**

<u>CASE NO-2:</u>

- Let's consider a Building / infra project with capital cost of 100 Crores, total energy requirement is 1000 KwH and the project is under operation for 3 years till date. With ECBC complied except for Mechanical Systems & Equipment's, where it is not completely complied.

<u>Example for calculation of cost of damage for Case 2-</u>

<u>Brief Note:</u>

- In this case the provision for Mechanical Systems & Equipment's is partially complied, whereas rest of attributes are fully complied.
- Here first we have to gather data from PP and the impact of excess energy consumption will be assessed on prorata basis and cost of damage will be levied. For assessment of same, the above table will be taken as reference for calculation of targeted saving.

<u>Damage Cost Calculation:</u>

- In order to assess the impact of excess energy on pro-rata basis for mechanical systems and equipment's, information to be taken from project proponent in the prescribed format as shared by the committee. The total saving or excess usage will be represented in terms of KWH.
- Let us calculate the damage cost for this case, by assuming following data as sent by project proponent.

ASSUMED DATA FROM PROJECT PROPONENT

S. No	ATTRIBUTES CONSIDERED FOR DAMAGE ASSESSMENT UNDER ECBC COMPLIANCE*	WORKING LOAD AS PER CONVENTIONAL DESIGN (in KwH)*	LOAD AFTER ECBC COMPLIANCE (in KwH)*	ACTUAL SAVING (in KwH)*	TARGET SAVING AS PER WEIGHTAGE (in KwH)*
1	MECHANICAL SYSTEMS & EQUIPMENTS	400	350	50	120
			Total	**50**	**120**

- Formula for Damage assessed as per above input is due to ECBC Partial Compliance = Target Saving – Actual Savings (Same applies for assessment of other attributes)
- Damage assessed = (120 – 50) = 70 KwH
- **Formula for Final cost of damage = Damage Assessed (in KwH) X Working Hour Per Day X No of Days of Operation X Unit Cost per KwH**
- **Final Damage Cost For above case = 70 X 10 X 1095 X 8 = INR 61,32,000/-***

CASE NO-3:

- The project proponent has complied with ECBC but failed to comply with MoEFCC guideline of substituting 1% of total energy demand to solar panel.

Brief Note:

- Let's consider the total energy demand of the project to be 2000 KW. 1% of same is 20 KW, which is to be substituted by solar panels.

Damage Cost Calculation:

- For this case, let's consider two scenarios. In first scenario the project proponent has not provided solar panel installation at all and second scenario, the project proponent has installed partial capacity (i.e) 10 KW.
- In first scenario, the damage will be taken for failure to install complete 20 KW and for second scenario the difference in installation will be taken, which is 10 KW.
- **For both the cases , Formula to be used for arriving at final cost of damage = Damage Assessed (in KW) X Working Hour Per Day X No of Days of Operation X Unit Cost per KwH**
- **Final Damage Cost For first scenario = 20 X 12 X 1095 X 8 = INR 21,02,400/-**
- **Final Damage Cost For second scenario = 10 X 12 X 1095 X 8 = INR 10,51,200/-**

CASE NO-4:

- The project proponent has failed to install / substitute 20% of their total hot water demand with solar water heater.

Brief Note:

- Let's consider the total hot water demand is 2000 litres and 20% of same is 400 Litres. For which the demand to be met by installation of solar powered water heaters. .

Damage Cost Calculation:

- For this case, let's consider two scenarios. In first scenario the project proponent has not provided solar water heater installation at all and second scenario, the project proponent has installed partial capacity of solar water heaters (i.e) 200 Litres..
- In first scenario, the damage will be taken for failure to install complete 400 Litres and for second scenario the difference in installation will be taken, which is 200 Litres.
- To arrive at final damage cost calculation the requirement in litres to be converted in terms of energy consumed (i.e) KW. For which, let's assume The Backup Power requirement is considered at 8 Kw per 1000 Litres. Accordingly it will be approx. 4 KW & 2 KW for respective scenarios.
- **For both the cases , Formula to be used for arriving at final cost of damage = Damage Assessed (in KW) X Working Hour Per Day X No of Days of Operation X Unit Cost per KwH**
- **Final Damage Cost For first scenario = 4 X 4 X 1095 X 8 = INR 1,40,160/-**
- **Final Damage Cost For second scenario = 2 X 4 X 1095 X 8 = INR 70,080/-**

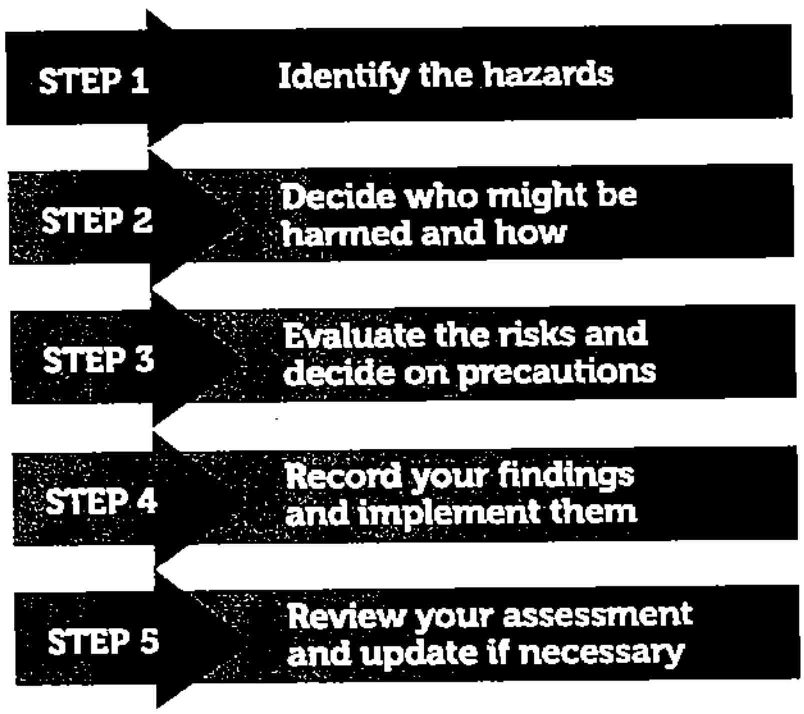
Annexure-V

DAMAGE ASSESSEMENT FRAMEWORK FOR RISK ASSEMENT(RA)

Definitions:

- Hazard: the property of a substance or situation with the potential for creating damage
- Risk: the likelihood of a specific effect within a specified period
- Risk assessment: It can be defined as a set of systematic methods to Identify hazards, quantify risks, determine components, safety measures and/or human interventions important for plant safety. It is an continuous process.
- Risk Analysis: It is done by bringing together experts with different backgrounds to analyze various parameters like chemicals, process equipment, human error pertaining to particular type of industry or process.

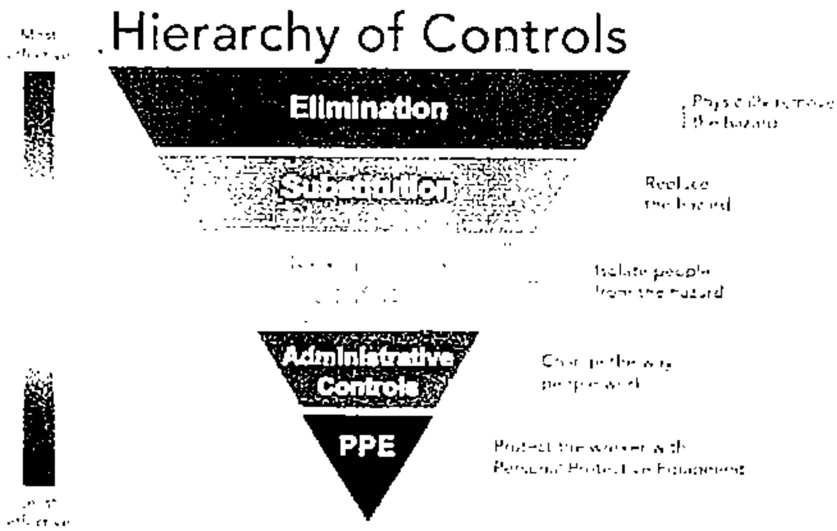
Steps in Risk Assessment



Different types of workplace hazard considered in RA :

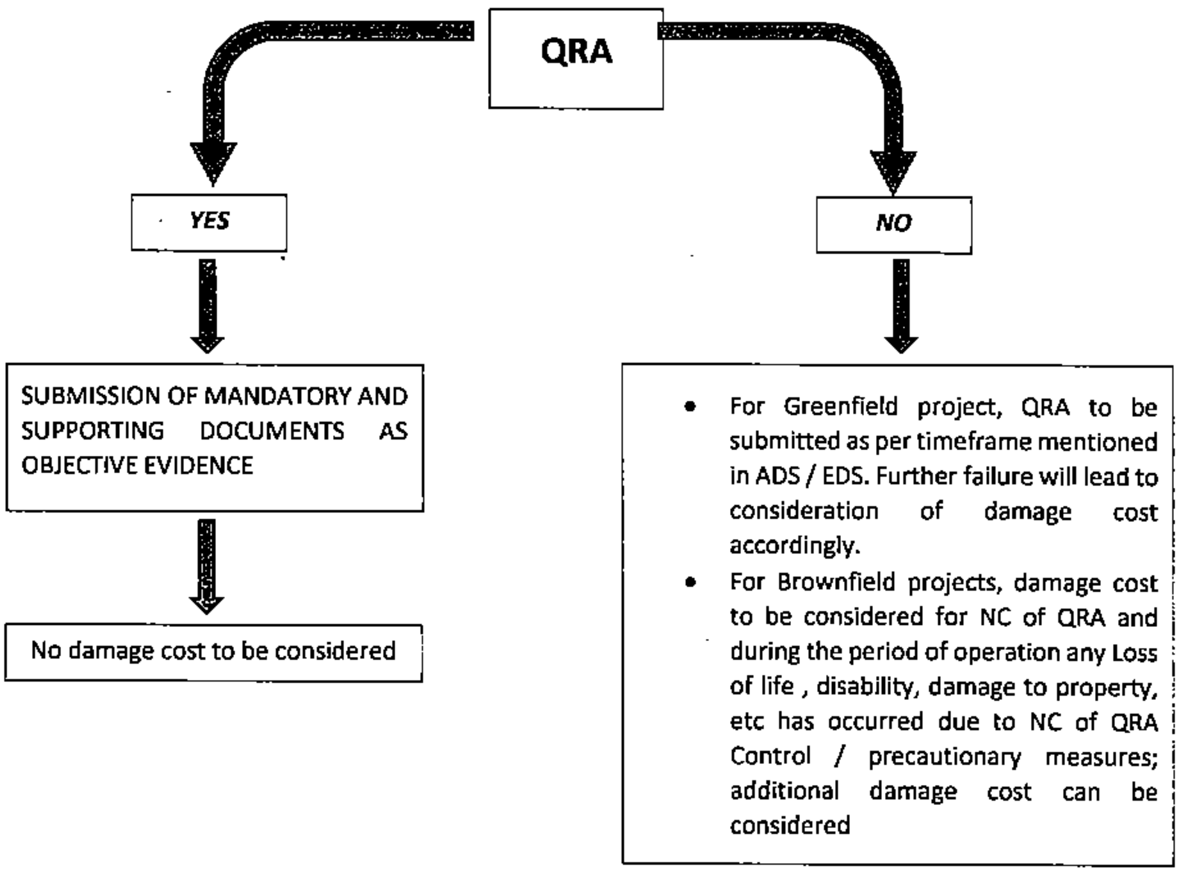
- Chemical – Gases, dusts, fumes, vapours, liquids.
- Biological- Infectious bacteria, viruses, parasites, etc
- Physical – Noise, vibration, lighting, electrical, Hot & Cold, Fire & Explosion.

- Ergonomic- Poor design of tools & equipment's, job/task, workstation, manual handling (Lifting, carrying, desk work, etc)
- Psychological – Stress, shifts work, harassment, discrimination, etc
- Radiation- X-rays, gamma rays, microwaves, ultraviolet, IR, Lasers, etc



Damage Assessment approach:

The damage will be assessed based on type of violation. However, the initial assessment will be as below:



Maandatory documents for both greenfield & brownfield:

1.Quantitative risk assement report (prepared by external expert)
2.Disaster managemnt plan
3.Emergency prepardness plan (onsite & offsite)

Other supporting documents for brownfield:

1.Latest status of QRA appraised by any accrediated professional agencies
2.internal audit reports (QRA)
3.Risk Registars
4.HAZOP reports

Basic template for damage assessment

- Based on above RA approach the project proponent is asked to fill the outcome of QRA report In the template given below.

S.No	location	Activity	Hazard identified with safety or control measures	Status of implementation			Remarks (To assess Damage)
				YES	NO	PARTIA	

RA for chemical industry (Ammonia)

Location	Activities	Safety systems to be provided	Provided	Partially Provided	Not provided	Remarks (To asses Damage
Ammonia bullet storage	Storage	**Electrical Safety-** Flame proof electrical fittings, fixtures and equipment shall be provided				
		Electrical Safety- Double				
		Fire Safety- Fire hydrant system shall be installed all around the ammonia bullet storage facility, preferably fire monitors should be installed				

		Fire Safety- Adequate number of fire extinguishers shall be provided as per PESO approval.				
		Vapour Cloud Explosion - Leak detection sensor / system with connection to alarm and auto sprinkler system				
		General Safety- Warnings signage for fire and electrical safety should be displayed in Hindi, English and local language				

Location	Activities	Safety systems to be provided	Provided	Partially Provided	Not provided	Remark (To assess Damage
Ammonia bullet storage	**PPE & Trai ning**	**1. Fire Safety-** Safety shower shall be installed near the entry of the ammonia bullet storage area. **2. General Safety-** SCBA set shall be provided in the close proximity of ammonia bullet storage area. **3. General Safety-** Required PPEs shall be provided				

	Calibration of sensors	The PRV, PT, LT, TG, PG, ammonia gas detectors shall be inspected and calibrated periodically as per manufacturer's recommendation and record should be maintained.				
	Tank lorry unloading	**Detection & Alarm-** Leak detection sensor				
		Electrical Safety- Flame proof electrical				
		Electrical Safety- Double static earthing shall be provided to tankers.				
		Dyke wall of adequate capacity shall be provided with double drain valve.				

Location	Activities	Safety systems to be provided	Provided	Partially Provided	Not provided	Remark (To asse Damage
Production Block	Ammonia Receiver in plant	**Venting-** Installation of pressure release Value to prevent damage due to increase in pressure				
		Boiling liquid expanding vapour explosion (BLEVE) - Adequate measures taken to prevent jet fire like placing Flame proof electrical fittings, fixtures and equipment, fire hydrants, etc				

RA for pharma industry (API)

Location	Activities	Safety systems to be provided	Provided	Partially Provided	Not provided	Remarks (To assess Damage)
Decantation point	Tank lorry unloading	**Fire& General Safety-** Manual Isolation valve, Hydrants/ Foam Monitors, Hand held extinguisher				
Bulk Storage Tank Farms	Inlet line to storage tanks	**Fire & General Safety-**NRV, Manual valve,Hydrants /Foam Monitors				
	Outlet line from storage tanks	**Fire & General Safety-** Manual valve, Hydrants/Foam Monitors,				

	Dyke	**Fire Safety-** Hydrants/Foam Monitors, Hand held extinguisher				
	AG Tank Dormant/ Receipt mode / Unloading	**Fire&General Safety-** Hydrants/Foam Monitors, Flame Arrestor on vent & Heat exchanger with chilled water Circulation				
	UG Tank Dormant/ Receipt mode / Unloading	**Fire & General Safety** - Hydrants/Foam Monitors, Flame Arrestor on vent & Heat Exchanger with Chilled water Circulation				

Location	Activities	Safety systems to be provided	Provided	Partially Provided	Not provided	Remarks (To assess Damage)
IBC Tank Filling Shed	Loading and dispatch of Solvent	Fire & General Safety- Manual valve, Hydrants/Foam Monitors, Hand held extinguisher				

	Safe Operating Procedures	**Fire & General Safety**- proper hot-work procedures such as obtaining a hot work permit, having a fire watch and fire extinguishing equipment present, and proper testing for explosivity; **Venting** - covering and sealing all drains, vents, man-ways, open flanges and all sewers.				

	PPE & Training to operators:	**General Safety** - Operators should be specially trained and equipped to handle solvent fires and products spills. **Fire & General Safety-** Special attention given to handling of material that is sensitive to the presence of water (acids, alkalies, etc.)				

Examples for RA damage assement for different scenarios

Case 1- greenfield project in constrcution phase, violation due to no prior ec

- Step 1- Confirm whether the manufacturing product falling under any category / schedule as per manufacture, storage & import of hazardous chemicals (amendment) rules, 2000 (MSIHC).
- Step 2- Preparation / Submission of QRA
- Step 3- Transfer of information from QRA in given below template

S.No	Location	Activity	Hazard identified with safety or control measures	status of implementation			Remarks (To assess Damage)
				YES	NO	PARTIAL	
1							

•Step 4- As per above table adequacy may be appraised by Expert members and Gap identified will be considered as violation and damage will be assessed and levied

Case 2- Greenfield project in operation phase, violation due to no prior EC

•Step 1- Confirm whether the manufacturing product falling under any category / schedule as per manufacture, storage & import of hazardous chemicals (amendment) rules, 2000 (MSIHC).

•Step 2- Preparation / Submission of QRA

•Step 3- Transfer of information from QRA in given below template

S.No	Location	Activity	Hazard identified with safety or control measures	status of implementation			Remarks (To assess Damage)
				YES	NO	PARTIAL	
1							

Step 4- AAs per above table adequacy may be appraised by Expert members and Gap identified will be considered as violation and damage will be assessed and levied for total no of days of violation from construction phase till date of operation.

- Same approach to be followed for brownfield project with no prior EC type of violation.

Case 3- Brownfield **project in operation phase, violation of EC condition**

•Step 1- Here lets assume that the PP has submitted QRA, however any gap or deficiency observed will be considered under violation pertaining to EC condition and the damage levied will be on pro-rata basis

•Step 2- If the PP claims the existing control / risk abatement measures implemented as per old QRA is sufficient, the same shall be appraised by third part expert and submission of additional document is mandatory.

•Step 3- As per above table adequacy appraised by third party Expert and Gap identified will be considered as violation and damage will be assessed for total no of days of violation from construction phase till date of operation.

Recommendation for spending damage cost assesed from RA

- The Damage Cost Which Is Assessed Due To Non-compliance Of RA can be spent against following activities,

  – Reconstruction of damaged properties

  – For rehabilitation of persons affected

  – Improvement of safety provisions as mentioned in EPP (Offsite)

  – As per DMP precautionary control measures by engineering or construction against the potential calamities (Natural).

Annexure-VI

Economic benefits Accrued

Economic benefits Accrued=Net profit during violation period +capital cost saved for EMP during violation period+ Recurring cost saved during violation period

Example:

Net profit due to violation =Rs 100 Crores

Capital cost saved for EMP during violation period=Rs 10 Crores

Recurring cost saved during violation period = Rs 2 Crores

Economic benefits accrued= Rs 100+Rs 10+Rs 2=Rs 112 Crores

Economic benefits accrued=3%xRs112=Rs 3.36 Crore

The above economic benefit cost of Rs 3.3 Crores will be added to the cost of Community augmentation plan

ANNEXURE - XII

Further reference is drawn to The CPCB report on Environmental compensation of March,2018 as directed by NGT and Hon'ble SC as briefed below which specifies the environment compensation for the cost saved on various non compliances of provisions of EC/Consent. (Enclosed vide Annx-12)

Report of the CPCB In-house Committee on Methodology for Assessing Environmental Compensation and Action Plan to Utilize the Fund

CENTRAL POLLUTION CONTROL BOARD
"Parivesh Bhawan", East Arjun Nagar,
Delhi-110032

Table of Contents

Abstract

Environmental compensation is a policy instrument for the protection of the environment which works on the Polluter Pay Principal. Environmental compensation has already been implemented in various countries, although limited in scope. Experiences from these implementations are mixed and tend to stress the importance of certain principles in order to achieve the overall objective of protection of the environment.

The Hon'ble National Green Tribunal through its various judgments has empowered the Central Pollution Control Board to lay down the methodology to assess and recover compensation for damage to the environment and utilize such amount in terms of an action plan for protection of the environment.

An attempt has been made by the CPCB in-house Committee to develop a methodology for assessing environmental compensation to be levied on concerned industry, authority, individual etc. for the protection of environment. Expert institutions/ NGOs like The Energy and Resources Institute, Centre for Science and Environment-India, Institute of Economic Growth etc. were also consulted to finalize the report. Overall objective is to develop self-sense of responsibility towards the environment and to make defaulters realize their mistake by imposing compensation, which will be utilized for the protection/restoration of the environment.

Although, this is the first attempt in India towards development of methodology for assessing environmental compensation, however, efforts have been made to simplifying the process so that regulatory institutions can easily adopt the methodology for implementation.

Chapter-I: Environment Compensation to be levied on Industrial Units

1.1 Background

The Hon'ble National Green Tribunal (NGT), Principal Bench in the matter of OA No. 593/2017 (WP (CIVIL) No. 375/2012, Paryavaran Suraksha Samiti & Anr. Vs. Union of India & Ors. directed Central Pollution Control Board (CPCB) that:

> *"The CPCB may take penal action for failure, if any, against those accountable for setting up and maintaining STPs, CETPs and ETPs. CPCB may also assess and recover compensation for damage to the environment and said fund may be kept in a separate account and utilized in terms of an action plan for protection of the environment. Such action plan may be prepared by the CPCB within three months"* **(Annexure-I).**

1.2 Constitution of the Committee

In this context, Chairman, CPCB constituted a Committee under the Chairmanship of Shri A. Sudhakar, I/c WQM-I with Shri A. K. Vidyarthi, I/c WQM-II, Shri P. K. Gupta, I/c IPC-VI, Shri Nazimuddin I/c IPC-II and Dr. S. K. Paliwal, Scientist 'D' as members. The Committee was asked to deliberate on this issue and come up with a draft formulation before 15.9.2018.

1.3 Methodology for Assessing Environmental Compensation

The Committee discussed the issue on 4.9.2018, 13.9.2018,17.9.2018 and 09.10.2018. A meeting was also held with Senior Officers of CPCB Head Office and Regional Directorates through video conferencing on 28.09.2018 to discuss the draft report and to seek comments/feedbacks. The comments/feedbacks received and deliberations of the Committee on the same are given in **Annexure-II.**

As per the Hon'ble NGT suggestion, CPCB has invited comments of 3 expert institution, namely, Centre for Science and Environment (CSE), Institute of Economic Growth (IEG) and The Energy Research Institute (TERI). A meeting to incorporate the comments of the expert institutions and to finalize the report, was held on 27/03/2019. The CPCB in-house committee on Environmental Compensation has deliberated on the comments and finalized the report accordingly. The Committee's deliberations are attached as **Annexure-III.**

It was deliberated for developing a formula for imposing environmental compensation on industrial units for violation of directions issued by regulatory bodies and this is the first attempt made. The committee discussed that environmental compensation should be based on "Polluter Pay Principle". The Committee decided to list the instances for taking cognizance of cases fit for violation and levy environmental compensation.

Cases considered for levying Environmental Compensation (EC):

a) Discharges in violation of consent conditions, mainly prescribed standards / consent limits.
b) Not complying with the directions issued, such as direction for closure due to non-installation of OCEMS, non-adherence to the action plans submitted etc.
c) Intentional avoidance of data submission or data manipulation by tampering the Online Continuous Emission / Effluent Monitoring systems.
d) Accidental discharges lasting for short durations resulting into damage to the environment.
e) Intentional discharges to the environment -- land, water and air resulting into acute injury or damage to the environment.
f) Injection of treated/partially treated/ untreated effluents to ground water.

1.3.1 In the instances as mentioned at *a, b and c* above, Pollution Index may be used as a basis to levy the Environmental Compensation. CPCB has published guidelines for categorization of industries into Red, Orange, Green and White based on concept of Pollution Index (PI). The Pollution Index is arrived after considering quantity & quality of emissions/ effluents generated, types of hazardous wastes generated and consumption of resources. Pollution Index of an industrial sector is a numerical number in the range of 0 to 100 and can be represented as follows:

$$PI = f\,(\text{Water Pollution Score, Air Pollution Score \& HW Generation Score})$$

Pollution Index is a number from 0 to 100 and increasing value of PI denotes the increasing degree of pollution *hazard from the industrial sector.*

CPCB has issued directions to all SPCBs/PCCs on 07.03.2016 to adopt the methodology and follow guidelines prepared by CPCB for categorization of industrial sectors into Red, Orange, Green and White.

The concept of Pollution Index, which was deliberated widely with all stakeholders and agreed, shall be used for calculating Environmental Compensation. This may help in implementation of such provision throughout the country, a successful initiative in vital field of industrial pollution control.

After considering various factors including the policy implementation issues, Committee has come up with following formula for levying the Environmental Compensation in instances as mentioned at a, b and c including non-compliance of the environmental standards / violation of directions.

The Environmental Compensation shall be based on the following formula:

$$\boxed{EC = PI \times N \times R \times S \times LF}$$

Where,

EC is Environmental Compensation in ₹
PI = Pollution Index of industrial sector
N = Number of days of violation took place
R = A factor in Rupees (₹) for EC
S = Factor for scale of operation
LF = Location factor

The formula incorporates the anticipated severity of environmental pollution in terms of Pollution Index, duration of violation in terms of number of days, scale of operation in terms of micro & small/medium/large industry and location in terms of proximity to the large habitations.

Note:

a. The industrial sectors have been categorized into Red, Orange and Green, based on their Pollution Index in the range of 60 to 100, 41 to 59 and 21 to 40, respectively. It was suggested that the average pollution index of 80, 50 and 30 may be taken for calculating the Environmental Compensation for Red, Orange and Green categories of industries, respectively.
b. N, number of days for which violation took place is the period between the day of violation observed/due date of direction's compliance and the day of compliance verified by CPCB/SPCB/PCC.
c. R is a factor in Rupees, which may be a minimum of 100 and maximum of 500. It is suggested to consider R as 250, as the Environmental Compensation in cases of violation.
d. S could be based on small/medium/large industry categorization, which may be 0.5 for micro or small, 1.0 for medium and 1.5 for large units.
e. LF, could be based on population of the city/town and location of the industrial unit. For the industrial unit located within municipal boundary or up to 10 km distance from the municipal boundary of the city/town, following factors (LF) may be used:

Table No. 1.1: Location Factor Values

S. No.	Population* (million)	Location Factor# (LF)
1	1 to <5	1.25
2	5 to <10	1.5
3	10 and above	2.0

**Population of the city/town as per the latest Census of India*
#LF will be 1.0 in case unit is located >10km from municipal boundary
LF is presumed as 1 for city/town having population less than one million.

For notified Ecologically Sensitive areas, for beginning, LF may be assumed as 2.0. However, for critically Polluted Areas, LF may be explored in future.

f. In any case, minimum Environmental Compensation shall be ₹ 5000/day.
g. In order to include deterrent effect for repeated violations, EC may be increased on exponential basis, i.e. by 2 times on 1st repetition, 4 times on 2nd repetition and 8 times on further repetitions.
h. If the operations of the industry are inevitable and violator continues its operations beyond 3 months then for deterrent compensation, EC may be increased by 2, 4 and 8 times for 2nd, 3rd and 4th quarter, respectively. Even if the operations are inevitable beyond 12 months, violator will not be allowed to operate.
i. Besides EC, industry may be prosecuted or closure directions may be issued, whenever required.

A sample calculation for Environmental Compensation (without deterrent factor) is given at Table No. 1.2. It can be noticed that for all instances, EC for Red, Orange and Green category of industries varies from 3,750 to 60,000 ₹/day.

Table No. 1.2: A sample calculation for Environmental Compensation

Industrial Category	**Red**	**Orange**	**Green**
Pollution Index (PI)	60-100	41-59	21-40
Average PI	80	50	30
R-Factor	250		
S-Factor	0.5-1.5		
L-Factor	1.00-2.00		
Environmental Compensation (₹/day)	**10,000-60,000**	**6,250-37,500**	**5,000-22,500**

1.3.2 In other instances i.e. *d, e and f*, the environmental compensation may contain two parts – one requires providing immediate relief and other long-term measures such as remediation. In all these cases, detailed investigations are required from expert institutions/organizations based on which environmental compensation will be decided. CPCB shall list the expert institutions for this purpose.

In such cases, comprehensive plan for remediation of environmental pollution may be prepared and executed under the supervision of a committee with representatives of SPCB, CPCB and expert institutions/organizations.

1.4 Action Plan for Utilization of Environmental Compensation Fund

The Committee discussed about the utilization of funds, which will be received by imposing Environmental Compensation. The following Action Plan is proposed to utilize the fund for protection of the environment.

1.4.1. *When Environmental Compensation is calculated through the Pollution Index:*

The amount received by imposing the Environmental Compensation to the industries / organization non-complying with the environmental standards / violating any CPCB's directions shall be deposited in a separate bank account. The amount accumulated will be utilized for Protection of Environment. The following schemes were identified, which may be considered for utilization of Environmental Compensation Fund:

a. Industrial Inspections for compliance verification
b. Installation of Continuous water quality monitoring stations / Continuous ambient air quality monitoring stations for strengthening of existing monitoring network
c. Preparation of Comprehensive Industry Documents on Industrial Sectors / clean technology
d. Investigations of environmental damages, preparation of DPRs
e. Remediation of contaminated sites
f. Infrastructure augmentation of Urban Local Bodies (ULBs) /capacity building of SPCBs/PCCs

The above proposed list may include other schemes also, depending upon the requirement.
Considering the availability of accumulated funds, CPCB will finalize the scheme, keeping in mind the priority, to utilize the funds of Environmental Compensation.

1.4.2. *When Environmental Compensation is assessed based on actual damage to the environment by Expert Organization/ Agency:*

The amount of Environmental Compensation under this case will be remediation costs, measures requiring immediate and short-term actions, compensation towards loss of ecology, etc., and will be utilized exclusively for the purpose at specific site, based on the detailed investigations by the Expert Organizations/ agencies.

1.5 Recommendations

The Committee made following recommendations:

1.5.1 To begin with, Environmental Compensation may be levied by CPCB only when CPCB has issued the directions under the Environment (Protection) Act, 1986. In case of a, b and c, Environmental Compensation may be calculated based on the formula "EC = PI x N x R x S x LF", wherein, PI may be taken as 80, 50 and 30 for red, orange and green category of industries, respectively, and R may be taken as 250. S and LF may be taken as prescribed in the preceding paragraphs.

1.5.2 In case of d, e and f, the Environmental Compensation may be levied based on the detailed investigations by Expert Institutions/Organizations.

1.5.3 The Hon'ble Supreme Court in its order dated 22.02.2017 in the matter of Paryavaran Suraksha Samiti and another v/s Union of India and others (Writ Petition (Civil) No. 375 of 2012), directed that all running industrial units which require "consent to operate" from concerned State Pollution Control Board, have a primary effluent treatment plant in place. Therefore, no industry requiring ETP, shall be allowed to operate without ETP.

1.5.4 EC is not a substitute for taking actions under EP Act, Water Act or Air Act. In fact, units found polluting should be closed/prosecuted as per the Acts and Rules.

*****

Chapter-II: Environmental Compensation to be levied on all violations of Graded Response Action Plan (GRAP) in NCR.

2.1 Background

The CPCB In-house Committee also discussed that the EC shall also be levied on all violations of Graded Response Action Plan (GRAP) in NCR. The implementing agencies for each activity have been identified and the EC will be levied on these agencies. These violations attract graded amounts of EC depending on the state of ambient air quality, which is given in table below:

Table No. 2.1: Environmental Compensation to be levied on all violations of Graded Response Action Plan (GRAP) in Delhi-NCR.

Activity	State Of Air Quality	Environmental Compensation ()
Industrial Emissions	Severe +/Emergency	Rs 1.0 Crore
	Severe	Rs 50 Lakh
	Very Poor	Rs 25 Lakh
	Moderate to Poor	Rs 10 Lakh
Vapour Recovery System (VRS) at Outlets of Oil Companies		
i. Not installed	Target Date	Rs 1.0 Crore
ii. Non-functional	Very poor to Severe +	Rs 50.0 Lakh
	Moderate to Poor	Rs 25.0 Lakh
Construction sites (Offending plot more than 20,000 Sq.m.)	Severe +/Emergency	Rs 1.0 Crore
	Severe	Rs 50 Lakh
	Very Poor	Rs 25 Lakh
	Moderate to Poor	Rs 10 Lakh
Solid waste/ garbage dumping in Industrial Estates	Very poor to Severe +	Rs 25.0 Lakh
	Moderate to Poor	Rs 10.0 Lakh
Failure to water sprinkling on unpaved roads		
a) Hot-spots	Very poor to Severe +	Rs 25.0 Lakh
b) Other than Hot-spots	Very poor to Severe +	Rs 10.0 Lakh

2.2 Action Plan for Utilization of Environmental Compensation Fund

EC levied on all violations of Graded Response Action Plan (GRAP) in Delhi NCR will be deposited in the same fund and will be utilized in the same manner as mentioned in para 1.4.1 of Chapter-I of this report.

******

Chapter-III: Environmental Compensation to be levied in case of failure of preventing the pollutants being discharged in water bodies and failure to implement waste management rules

3.1 Background

The Hon'ble Supreme Court in its order dated 22.02.2017 in the matter of Paryavaran Suraksha Samiti and another v/s Union of India and others (Writ Petition (Civil) No. 375 of 2012), directed State Governments (including the concerned Union Territories) to set-up Sewage Treatment Plants (STPs), which are already under implementation, within the time lines already postulated. Further, the STPs, which are yet to set-up, to be completed within a period of three years, from today, i.e. by 22.02.2020.

The Hon'ble NGT in its order dated 06.12.2018 **(Annexure-III)** in the matter of Court of its own motion v/s State of Karnataka (Original Application No. 125/2017 and M.A. No. 1337/2018) has given following directions:

> *"Since failure of preventing the pollutants being discharged in water bodies (including lakes) and failure to implement solid and other waste management rules are too frequent and widespread, the CPCB must lay down specific guidelines to deal with the same, throughout India, including the scale of compensation to be recovered from different individuals/authorities, in addition to or as alternative to prosecution. The scale may have slabs, depending on extent of pollution caused, economic viability, etc. Deterrent effect for repeated wrongs may also be provided."*

3.2 Ideology of Environmental Compensation Formula

In compliance of the directions of the Hon'ble Tribunal, the Committee deliberated on the issue of environmental compensation to be recovered from individuals/authorities in case of failure of preventing the pollutants being discharged in water bodies and failure to implement solid and other waste management rules. The Committee has suggested that environmental compensation in these cases should be comprised of two components i.e.

1. Cost saved/benefits achieved by the concerned individual/authority by not having proper waste/sewage management system; and
2. Cost to the environment (environmental externality) due to untreated/partially treated waste/sewage because of insufficient capacity of waste/sewage management/treatment facility.

Cost saved/benefits achieved by not having proper waste/sewage management system includes the interest on capital cost of the waste/sewage management facility and daily operation and maintenance (O&M) cost associated with the facility.

The Committee suggested that annual interest rate as 10% on loan amount, borrowed by concerned individual/authority for setting-up waste/sewage management facility, may be assumed as Capital Cost Factor for calculation of environment compensation. Further, as whole O&M cost is saved by concerned individual/authority for not managing required waste/sewage management system, 100% of the O&M cost saved may be considered as O&M cost factor.

Therefore, generalized formula for Environmental Compensation may be described as:

EC= Capital Cost Factor x Marginal Average Capital Cost for Establishment of Waste or Sewage Management or Treatment Facility x (Waste or Sewage Management or Treatment Capacity Gap) + O&M Cost Factor x Marginal Average O&M Cost x (Waste or Sewage Management or Treatment Capacity Gap) x No. of Days for which facility was not available + Environmental Externality

Cost to the environment due to untreated/partially treated waste/sewage discharge by concerned individual/authority may be assumed as recommended by the committee, which is mentioned below:

Table No. 3.1: Environmental externality for untreated/partially treated sewage discharge

Sewage Treatment Capacity Gap (MLD)	Marginal Cost of Environmental Externality (Rs. per MLD/day)	Minimum and Maximum value of Environmental Externality recommended by the Committee (Lacs Rs. Per Day)
Up to 200	75	Min. 0.05, Max. 0.10
201-500	85	Min. 0.25, Max. 0.35
501 and above	90	Min. 0.60, Max. 0.80

Table No. 3.2: Environmental externality for improper municipal solid waste management

Municipal Solid Waste Management Capacity Gap (TPD)	Marginal Cost of Environmental Externality (Rs. per ton per day)	Minimum and Maximum value of Environmental Externality recommended by the Committee (Lacs Rs. Per Day)
Up to 200	15	Min. 0.01, Max. 0.05
201-500	30	Min. 0.10, Max. 0.15
501-1000	35	Min. 0.25, Max. 0.35
1001-2000	40	Min. 0.50, Max. 0.60
Above 2000	Max. 0.80	

The Committee further decided to fix a cap for minimum and maximum cost for capital and O&M component for Environmental Compensation, which are given in below tables:

Table No. 3.3: Minimum and Maximum EC to be levied for untreated/partially treated sewage discharge

Class of the City/Town	Mega-City	Million-plus City	Class-I City/Town and others
Minimum and Maximum values of EC (Total Capital Cost Component) recommended by the Committee (Lacs Rs.)	Min. 2000 Max. 20000	Min. 1000 Max. 10000	Min. 100 Max. 1000
Minimum and Maximum values of EC (O&M Cost Component) recommended by the Committee (Lacs Rs./day)	Min. 2 Max. 20	Min. 1 Max. 10	Min. 0.5 Max. 5

Table No. 3.4: Minimum and Maximum EC to be levied for improper municipal solid waste management

Class of the City/Town	Mega-City	Million-plus City	Class-I City/Town and others
Minimum and Maximum values of EC (Capital Cost Component) recommended by the Committee (Lacs Rs.)	Min. 1000 Max. 10000	Min. 500 Max. 5000	Min. 100 Max. 1000
Minimum and Maximum values of EC (O&M Cost Component) recommended by the Committee (Lacs Rs./day)	Min. 1.0 Max. 10.0	Min. 0.5 Max. 5.0	Min. 0.1 Max. 1.0

The application of formula for calculation of EC may be further understood with the example of two typical cases.

3.3 Environment Compensation for Discharge of Untreated/Partially Treated Sewage by Concerned Individual/Authority:

BIS IS-1172:1993 suggests that for communities with population above 100,000, minimum of 150 to 200 lpcd of water demand is to be supplied. Further, 85% of return rate (CPHEEO Manual on Sewerage and Sewage Treatment Systems, 2013), may be considered for calculation of total sewage generation in a city. CPCB Report on "Performance evaluation of sewage treatment plants under NRCD, 2013", describes that the capital cost for 1 MLD STP ranges from 0.63 Cr. to 3 Cr. and O&M cost is around Rs. 30,000 per month. After detail deliberations, the Committee suggested to assume capital cost for STPs as Rs. 1.75 Cr/MLD (marginal average cost). Further, expected cost for conveyance system is assumed as Rs. 5.55 Cr./MLD (marginal average cost) and annual O&M cost as 10% of the combined capital cost. Population of the city may be taken as per the latest Census of India. Based on these assumptions, Environmental Compensation to be levied on concerned ULB may be calculated with the following formula:

EC= Capital Cost Factor x [Marginal Average Capital Cost for Treatment Facility x (Total* Generation-Installed Capacity) + Marginal Average *Capital Cost for Conveyance Facility* x *(Total Generation -Operational Capacity)] + O&M Cost Factor x Marginal Average O&M Cost x (Total Generation- Operational Capacity) x No. of Days for which facility was not available + Environmental Externality x No. of Days for which facility was not available

Alternatively;

EC (Lacs Rs.) = [17.5(Total Sewage Generation – Installed Treatment Capacity) + 55.5(Total Sewage Generation-Operational Capacity)] + 0.2(Sewage Generation-Operational Capacity) x N + Marginal Cost of Environmental Externality x (Total Sewage Generation-Operational Capacity) x N

Where; N= Number of days from the date of direction of CPCB/SPCB/PCC till the required capacity systems are provided by the concerned authority

Quantity of Sewage is in MLD

Table No. 3.5: Sample calculation for EC to be levied for discharge of untreated/partial treated Sewage

City	Delhi	Agra	Gurugram	Ambala
Population (2011)	1,63,49,831	17,60,285	8,76,969	5,00,774
Class	Mega-City	Million-plus City	Class-I Town	Class-I Town
Sewage Generation (MLD) *(as per the latest data available with CPCB)*	4195	381	486	37
Installed Treatment Capacity (MLD) (as per the latest data available with CPCB)	2500	220	404	45.5
Operational Capacity (MLD) (as per the latest data available with CPCB)	1900	140	300	24.5
Treatment Capacity Gap (MLD)	2295	241	186	12.5
Calculated EC (capital cost component for STPs) in Lacs Rs.	29662.50	2817.50	1435.00	0.00
Calculated EC (capital cost component for Conveyance System) in Lacs. Rs.	127372.50	13375.50	10323.00	693.75
Calculated EC (Total capital cost component) in Lacs Rs.	157035.00	16193.00	11758.00	693.75
Minimum and Maximum values of EC (Total Capital Cost Component) recommended by the Committee (Lacs Rs.)	Min. 2000 Max. 20000	Min. 1000 Max. 10000	Min. 100 Max. 1000	Min. 100 Max. 1000
Final EC (Total Capital Cost Component) in Lacs Rs.	**20000.00**	**10000.00**	**1000.00**	**693.75**
Calculated EC (O&M Component in Lacs Rs./day	459.00	48.20	37.20	2.50
Minimum and Maximum values of EC (O&M Cost Component) recommended by the Committee (Lacs Rs./day)	Min. 2 Max. 20	Min. 1 Max. 10	Min. 0.5 Max. 5	Min. 0.5 Max. 5
Final EC (O&M Component) in Lacs. Rs./Day	**20.00**	**10.00**	**5.00**	**2.50**
Calculated Environmental Externality (Lacs Rs .Per Day)	2.0655	0.2049	0.1395	0.0094
Minimum and Maximum value of Environmental Externality recommended by the Committee (Lacs Rs. Per Day)	Min. 0.60 Max. 0.80	Min. 0.25 Max. 0.35	Min. 0.05 Max. 0.10	Min. 0.05 Max. 0.10
Final Environmental Externality (Lacs Rs. Per day)	**0.80**	**0.25**	**0.10**	**0.05**

3.4 Environment Compensation to be Levied on Concerned Individual/Authority for Improper Solid Waste Management:

It is known that estimated MSW generation is approximately 1.5 lakh MT/Day in India (MoHUA Report-2016). As per the principles of SWM Rules, 2016 and PWM Rules 2016, as amended in 2018, the total cost of Municipal Solid Waste management in a city/town includes cost for door to door collection, cost of segregation at source, cost for transportation in segregated manner, cost for processing of MSW and disposal through facility like composting, biomethanation, recycling, co-processing in cement kilns etc.

In view of above, it is estimated that the total cost of processing and treatment of MSW for a city having population size of 1 lakh and generating approximately 50 tons/day of MSW is Rs.15.5 Crores, including capital cost (one time) and O & M cost for one year. The expenditure for subsequent years would be only Rs. 3.5 crores/annum.

CPCB sponsored a survey to ascertain the status of municipal solid waste disposal in 59 cities/towns of India. The survey was conducted by the Environment Protection Training Research Institute (EPTRI), Hyderabad. As per the survey, it is estimated that solid waste generated in small, medium and large cities and towns is about 0.1 kg (Class-III), 0.3-0.4 kg (Class-II) and 0.5 kg (Class-I) per capita per day respectively. The committee opined that 0.6 kg/day, 0.5 kg/day and 0.4 kg/day per capita waste generation may be assumed for mega-cities, million-plus UAs/towns and Class-I UA/Towns respectively for calculation of environmental compensation purposes. Based on these assumptions, Environmental Compensation to be levied on concerned ULB may be calculated with the following formula:

EC = Capital Cost Factor x Marginal Average Cost for Waste Management x (Per day waste generation-Per day waste disposed as per the Rules) + O&M Cost Factor x Marginal Average O&M Cost x (Per day waste generation-Per day waste disposed as per the Rules) x Number of days violation took place + Environmental Externality x N

Where;

Waste Quantity in tons per day (TPD)

N= Number of days from the date of direction of CPCB/SPCB/PCC till the required capacity systems are provided by the concerned authority

Simplifying;

EC (Lacs Rs.) = 2.4(Waste Generation - Waste Disposed as per the Rules) +0.02 (Waste Generation - Waste Disposed as per the Rules) x N + Marginal Cost of Environmental Externality x (Waste Generation - Waste Disposed as per the Rules) x N

Table No. 3.6: Sample calculation for EC to be levied for improper management of Municipal Solid Waste

City	Delhi	Agra	Gurugram	Ambala
Population (2011)	1,63,49,831	17,60,285	8,76,969	5,00,774
Class	Mega-City	Million-plus City	Class-I Town	Class-I Town
Waste Generation (kg. per person per day)	0.6	0.5	0.4	0.4
Waste Generation (TPD)	9809.90	880.14	350.79	200.31
Waste Disposal as per Rules (TPD) *(assumed as 25% of waste generation for sample calculation)*	2452.47	220.04	87.70	50.08
Waste Management Capacity Gap (TPD)	7357.42	660.11	263.09	150.23
Calculated EC (capital cost component) in Lacs. Rs.	17657.82	1584.26	631.42	360.56
Minimum and Maximum values of EC (Capital Cost Component) recommended by the Committee (Lacs Rs.)	Min. 1000 Max. 10000	Min. 500 Max. 5000	Min. 100 Max. 1000	Min. 100 Max. 1000
Final EC (capital cost component) in Lacs. Rs.	**10000.00**	**1584.26**	**631.42**	**360.56**
Calculated EC (O&M Component) in Lacs. Rs./Day	147.15	13.20	5.26	3.00
Minimum and Maximum values of EC (O&M Cost Component) recommended by the Committee (Lacs Rs./Day)	Min. 1.0 Max. 10.0	Min. 0.5 Max. 5.0	Min. 0.1 Max. 1.0	Min. 0.1 Max. 1.0
Final EC (O&M Component) in Lacs. Rs./Day	**10.00**	**5.00**	**1.00**	**1.00**
Calculated Environmental Externality (Lacs Rs. Per Day)	2.58	0.18	0.03	0.02
Minimum and Maximum value of Environmental Externality recommended by the Committee (Lacs Rs. per day)	Max. 0.80	Min. 0.25 Max. 0.35	Min. 0.01 Max. 0.05	Min. 0.01 Max. 0.05
Final Environmental Externality (Lacs Rs. per day)	**0.80**	**0.25**	**0.03**	**0.02**

3.3 Action Plan for Utilization of Environmental Compensation Fund

EC levied in case of failure of preventing the pollutants being discharged in water bodies and failure to implement waste management rules will be deposited in the same fund and will be utilized in the same manner as mentioned in para 1.4.1 of Chapter-I of this report.

3.4 Recommendations

1. The Committee recommended that to begin with, Environmental Compensation to be recovered from individuals/authorities in case of failure of preventing the pollutants being discharged in water bodies and failure to implement solid waste management rules may be calculated with the methodology described in the report.
2. If mixing of Bio-medical Waste or Hazardous Waste is found in Municipal Solid Waste than capital cost component of EC may be increased by a multiplication factor of 1.5.

3. In order to include deterrent effect for continuous violations, component of O&M and Environmental Externality in EC formula may be increased on exponential basis by 2, 4, and 8 times after every six-months, beyond the time prescribed by authority for ensuring complete treatment of sewage/waste of the city/town.

******

Chapter-IV: Environmental Compensation in Case of Illegal Extraction of Ground Water

4.1 Background

The Hon'ble National Green Tribunal (NGT), Principal Bench in the matter of Shailesh Singh v/s Central Ground Water Board & Ors. (Original Application No. 327/2018) vide order dated 03/01/2019 **(Annexure-V)** directed Central Pollution Control Board (CPCB) that:

> *"CPCB may constitute a mechanism to deal with individual cases of violation of norms, as existed prior to Notification of 12/12/2018, to determine the environment compensation to be recovered or other coercive measures to be taken, including prosecution, for past illegal extraction of ground water, as per law."*

4.2 Constitution of the Committee

In compliance to Hon'ble NGT dated 03/01/2019, CPCB constituted a committee under the Chairmanship of Shri A. Sudhakar, DH, WQM-I Division with Shri P. K. Gupta, DH, IPC-VI, Shri Vishal Gandhi, Sc. D, UPC-I Division and Smt. Suniti Parashar, Scientist B, WQM-I Division as members. The committee was asked to deliberate on this issue and come up with draft formulation of mechanism to determine the Environmental Compensation for illegal extraction of ground water.

4.3 Methodology for Assessing Environmental Compensation

The committee discussed the issue on 07/02/2019, 07/03/2019 and 20/3/2019. The committee deliberated on the issue of Environmental Compensation to be recovered from individuals/industries such as domestic, packaging drinking water units, mining & infrastructure projects and industrial units in case of illegal extraction of ground water. The Guidelines/Criteria for evaluation of proposals/requests for Ground Water Abstraction, 2015 were also discussed and based on this further formulation to levy Environmental Compensation has been evolved.

4.4 Ideology of Environmental Compensation w.r.to illegal extraction of ground water

Ground water is becoming an increasingly scarce resource because of its unabated and indiscriminate over-exploitation. Growth in ground water exploitation, however, has led to a steep fall in water table in several parts of the country. Use of ground water is becoming unsustainable day by day. The falling water table is a matter of special concern since it tends to reduce the accessibility of the resource to small and marginal farmers due to increase in costs of extractions.

Specific conditions applicable in Notified/Non-Notified areas for various users, as mentioned in Guidelines/Criteria for evaluation of proposals/requests for Ground Water Abstraction, 2015 are given below:

For Notified Areas:

1. Permission to abstract ground water through any energized means will not be accorded for any purpose other than drinking water.

2. Central Ground Water Authority (CGWA) so far has notified 162 areas, in the country for the purpose of regulation of ground water development.
3. Regulation of Ground Water development in Notified areas is through District Administrative Heads assisted by Advisory Committees under the provisions of Section 4 of the Environment (Protection) Act, 1986.
4. In Notified areas, ground water use in individual houses, infrastructure complexes like group housing societies, hospitals, schools etc. and drinking water requirements of workers in industries can be allowed.
5. NOC for ground water withdrawal will be considered only if Water Supplying Department is not providing adequate water in the area/premises. Proof for this is to be produced from the concerned authority by the applicant.
6. For individual houses, the maximum diameter of the tube-well should be restricted to 4 inch only and the capacity of the pump should not exceed 1HP. For infrastructure projects, maximum diameter of the ground water abstraction structures should be restricted to 150 mm (6 inches) only and capacity of the pump should not exceed 5 HP.
7. Any violation of the above conditions will attract legal action under Section 15 of the Environment (Protection) Act, 1986.

For Non-Notified Areas:

NOC for ground water withdrawal will be considered for industries/infrastructure/packaging as per safe, semi critical, critical and over-exploited criteria.

4.5 Formula for Environmental Compensation for illegal extraction of ground water

The committee decided that the formula should be based on water consumption (Pump Yield & Time duration) and rates for imposing Environmental Compensation for violation of illegal abstraction of ground water. The committee has proposed following formula for calculation of Environmental Compensation (EC_{GW}):

EC_{GW}	**=**	**Water Consumption per Day x No. of Days x Environmental Compensation Rate for illegal extraction of ground water (ECR_{GW})**

Where water Consumption is in m^3/day and ECR_{GW} in Rs./m^3

Yield of the pump varies based on the capacity/power of pump, water head etc. For reference purpose, yield of the pump may be assumed as given in **Annexure-VI.**

Time duration will be the period from which pump is operated illegally.

In case of illegal extraction of ground water, quantity of discharge as per the meter reading or as calculated with assumptions of yield and time may be used for calculation of EC_{GW}.

4.6 Environmental Compensation Rate (ECR_{GW}) for illegal use of Ground Water

The committee decided that the Environmental Compensation Rate (ECR_{GW}) for illegal extraction of ground water should increase with increase in water consumption as well as water scarcity in the area. Further, ECR_{GW} are kept relaxed for drinking and domestic use as compared to other uses, considering the basic need of human being.

As per CGWB, safe, semi-critical, critical and over-exploited areas are categorized from the ground water resources point of view (CGWB, 2017). List of safe, semi-critical, critical and over-exploited areas are available on the website of CGWB and can be accessed from- http://cgwa-noc.gov.in/LandingPage/NotifiedAreas/CategorizationOfAssessmentUnits.pdf#ZOOM=150.

Environmental Compensation Rates (ECR_{GW}) for illegal use of ground water (ECR_{GW}) for various purposes such as drinking/domestic use, packaging units, mining and industrial sectors as finalized by the committee are given in tables below:

4.6.1 ECR_{GW} for Drinking and Domestic use:

Drinking and Domestic use means uses of ground water in households, institutional activity, hospitals, commercial complexes, townships etc.

Sl. No.	Area Category	Water Consumption (m^3/day)			
		<2	2 to <5	5 to <25	25 & above
		Environmental Compensation Rate (ECR_{GW}) in Rs./m^3			
1	Safe	4	6	8	10
2	Semi Critical	12	14	16	20
3	Critical	22	24	26	30
4	Over-Exploited	32	34	36	40
Minimum EC_{GW}=Rs 10,000/- (for households) and Rs. 50,000 (for institutional activity, commercial complexes, townships etc.)					

4.6.2 ECR_{GW} for Packaged drinking water units:

Sl. No.	Area Category	Water Consumption (m^3/day)			
		<200	200 to <1000	1000 to <5000	5000 & above
		Environmental Compensation Rate (ECR_{GW}) in Rs./m^3			
1	Safe	12	18	24	30
2	Semi critical	24	36	48	60
3	Critical	36	48	66	90
4	Over-exploited	48	72	96	120
Minimum EC_{GW}=Rs 1,00,000/-					

4.6.3 ECR_{GW} for Mining, Infrastructure and Dewatering Projects

Sl. No.	Area Category	Water Consumption (m^3/day)			
		<200	200 to <1000	1000 to <5000	5000 & above
		Environmental Compensation Rate (ECR_{GW}) in Rs./m^3			
1	Safe	15	21	30	40
2	Semi critical	30	45	60	75
3	Critical	45	60	85	115
4	Over-exploited	60	90	120	150
Minimum EC_{GW}=Rs 1,00,000/-					

4.6.4 ECR_{GW} for Industrial Units:

Sl. No.	Area Category	Water Consumption (m^3/day)			
		<200	200 to <1000	1000 to <5000	5000 & above
		Environmental Compensation Rate (ECR_{GW}) in Rs./m^3			
1	Safe	20	30	40	50
2	Semi critical	40	60	80	100
3	Critical	60	80	110	150
4	Over-exploited	80	120	160	200
Minimum EC_{GW}=Rs 1,00,000/-					

For better understanding of implementation of EC_{GW} policy, some example calculations are given below:

Example No. 1 (For drinking and domestic Use):

It is observed that a household in safe zone is extracting ground water illegally from past 2 year and 3 months with the help of 1 HP pump, dia 4 inches and head as 25 meter. It is assumed that the house-owner runs the pump for 0.5 hr/day. What Environmental Compensation (EC_{GW}) will be charged to the owner?

Solution: Pump Yield *(Please refer Annexure-VI)* = 3 m^3/hr

Daily Consumption = 3 x 0.5 =1.5 m^3

ECR_{GW} = 4 Rs./m^3 *(Please refer para 4.6.1)*

EC to be levied = 4 x 1.5 = 6 Rs./day

Total time period = 820 days

Then, EC_{GW}= 6 x 820

Calculated EC_{GW}= 4,920 Rs.

EC_{GW} to be levied = 10,000 Rs. (minimum prescribed EC_{GW}, *please refer para 4.6.1*)

Example 2 (For Industrial Units):

It is observed that an industry in critical zone is extracting ground water illegally from past 1 year with the help of 5 HP pump, dia 6 inches and head as 50 meter. It is assumed that the industry runs the pump for 3 hrs/day. What Environmental Compensation (EC_{GW}) will be charged to the owner?

Solution: Pump Yield *(Please refer Annexure-VI)* = 12 m^3/hr

Daily Consumption = 12 x 3 =36 m^3/day

ECR_{GW} = 60 Rs./m^3 *(Please refer para 4.6.4)*

EC to be levied = 60 x 36 = 2,160 Rs./day

Total time period = 365 days

Then, EC_{GW}= 2,160 x 365

EC_{GW}= 7,88,400 Rs.

4.7 Relaxation

Central Ground Water Authority (CGWA) reserves to right to relax or interpret these mechanisms in case of any exigency or situation of National strategic importance, as per Guidelines/Criteria for evaluation of proposals/requests for Ground Water Abstraction, 2015.

4.8 Recommendations

The committee has given following recommendations:

- The minimum Environmental Compensation for illegal extraction of ground water for domestic purpose will be Rs. 10,000, for institutional/commercial use will be 50,000 and for other uses will be 1,00,000.
- In case of fixation of liability, it always lies with current owner of the premises where illegal extraction is taking place.
- Time duration may be assumed to be one year in case where no evidence for period of installation of bore well could be established.
- For Drinking and Domestic use, where metering is not present but storage tank facility is available, minimum water consumption per day may be assumed as similar to the storage capacity of the tank.
- For industrial ground water use, where metering is not available, water consumption may be assumed as per the consent conditions. Further, where in case industry is operating without consent, water consumption may be calculated based on the plant capacity (on the recommendation of SPCB/PCC, if required). SPCB/PCC may bring the issue of illegal extraction of ground water in industries in to the notice of CGWA for appropriate action by CGWA.
- Authorities assigned for levy EC and taking penal action are listed below:

S. No.	Actions	Authority
1.	To seal the illegal bore-well/tube-well to stop extraction of water and further closure of project	District Collector
2.	To levy EC_{GW} as per prescribed method	District Collector, CGWA
3.	To levy EC on water pollution, as per the method prescribed in report of CPCB- "EC on industrial pollution"	CPCB/SPCB/PCC
4.	Prosecution of violator	CGWA under EP Act
		SPCB/PCC under Air and Water Act

- CGWA may maintain a separate account for collection and utilization of fund, collected through the prescribed methodology in this report.

****

Annexure-I

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 593/2017
(W.P. (Civil) No. 375/2012)

In the matter of:

Paryavaran Suraksha Samiti & Anr.
Vs.
Union of India & Ors.

CORAM : HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE DR. JUSTICE JAWAD RAHIM, JUDICIAL MEMBER
HON'BLE MR. JUSTICE S.P. WANGDI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Present:	Applicant:	Mr. Rohit Prajapati, Applicant in person
	Amicus Curiae:	Mr. Jai A. Dehadrai, Adv.
	Respondent Nos.	Mr. Nishe Rajan Shonker, Adv. for State of Kerala Mr. Tarunvir Singh Khehar, Ms. Guneet Khehar Mr. Sandeep Mishra Advs. for GNCTD Mr. Anil Shrivastava Mr Rituraj Biswas and Ms. Sujaya Bardhan, Advs. for State of Arunachal Pradesh Mr. Jogy Scaria, Ms. Beena Victor, Advs. for Kerala State Pollution Control Board Mr. Avijit Roy, Adv. for Assam Pollution Control Board Mr. Leishangthem Roshmani Kh, Ms. Maibam Babina, Advs. for State of Manipur Mr. Nikhil Nayyar, Mr. Dhananjay Baijal, Advs. for APPCB and TSPCB Mr. Mukesh Verma, Adv. Mr. Tarunvir Singh Khehar, Adv., Mr. Sandeep Mishra and Ms. Guneet Khehar, Adv. Mr. Dinesh Jindal, LO for DPCC Ms. Aruna Mathur, Mr. Avneesh Arputham, Ms. Simran Jeet and Ms. Anuradha Arputham, Advs for State of Sikkim Mr. Raja Chatterjee, Mr. Piyush Sachdev, Ms. Abhinandini Yadav, Advs. and Advs. for State of WB Mr. Edward Belho, AAG, Mr. K. Luikang Michael and Ms. Hoineithiam, Advs. for State of Nagaland Ms. Zusioli Sema, Adv. for State of Nagaland and Pollution Control Board Mr. M. Paikaray and Mr. A.K. Panda, Advs. for SPCB, Odisha Mr. Dhruv Pal, Adv. for State of Gujarat Mr. V.K. Shukla, Adv. for State of MP Mr. Jayesh Gaurav, Adv. for R-47 Mr. Tayenjam Momo Singh, Adv. for Meghalaya Pollution Control Board Mr. Shiek Chandra And Mr. Ritesh Kumar Sharma, Advs. Mr. Gautam Singh and Mr. Shoeab Alam, Advs. for State of Bihar Ms. Aprajita Mukherjee, Adv. Ms. G. Indira, Adv. for UT of Andaman & Nicobar Mr. Balendu Shekhar, Mr. Srinath Prakash and Mr. Rajkumar Maurya, Advs. for Ministry of Environment, Forest and Climate Change Ms. Puja Kalra, Adv. for SDMC & NDMC Mr. Anil Grover, AAG, Mr. Rahul Khurana and Mr. Nishal Vij, Advs. for State of Haryana and HSPCB

Ms. Yogmaya Agnihotri, Adv. and Ms. Prity, Adv. for CECB
Ms. Sakshi Popli, Adv. for Ministry of Environment, Forest and Climate Change
Mr. Shuvodeep Roy, Adv. and Mr. Rituraj Biswas, Adv. for State of Tripura & Tripura Pollution Control Board
Mr. Shashank Bajpai and Mr. Shakun S. Shukla, Advs. for State of Odisha
Ms. Asha Nayar Basu and Ms. Aradhita Ghosh Mandal, Advs.
Ms. Priyanka Sinha, Adv. for State of Jharkhand
Mr. Rajul Shrivastav, Adv. for MPPCB
Mr. Pradeep Misra and Mr. Daleep Dhyani Advs. for UPPCB
Mr. R. Rakesh Sharma and Mr. V. Mowli, Advs. for State of TN & TNPCB
Mr. Shubham Bhalla, Adv.
Mr. Shiv Mangal Sharma, AAG, Mr. Saurabh Rajpal, Mr. Adhiraj Singh, Ms.Shikha Sandhu and Mr. Vikramjeet singh, Advs. for State of Rajasthan and Pollution Control Board
Mr. G. M. Kawoosa, Adv. for State of J & K
Mr. Divya Prakash Pande, Adv. For HPSPCB
Mr. Manish Kumar, Adv.

Date and Remarks	Orders of the Tribunal
Item No. 12 August 03, 2018 A	1. This matter was taken by this Tribunal in furtherance to the orders of the Hon'ble Supreme Court dated 22.02.2017 *Paryavaran Suraksha Samiti Vs. Union of India* (2017) 5 SCC 326, establishment and functioning of ETPs/CETP/STPs. 2. Vide order dated 25.05.2017, Notice was issued to Central Pollution Control Board and all the States Pollution Control Boards/Committees and the Ministry of Environment, Forest and Climate Change. They were directed to file status-cum-compliance report in terms of the orders of the Hon'ble Supreme Court. Accordingly, various status reports have been filed. An affidavit has been filed by the Ministry of Environment, Forest and Climate Change dated 04th July, 2017 stating as follows: *"1. That the answering Respondent is engaged in policy formulation, prescribing standards and its implementation through the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) for UTs. This Ministry has written to all SPCBs and PCCs as well as to CPCB to ensure compliance of the judgment of the Hon'ble Supreme Court and to submit detailed compliance report.*

2

Item No. 12 August 03, 2018 A	

*5. That the CPCB has also followed up with all SPCBs and PCCs through letters and review meetings to ensure compliance of the aforementioned judgment and that the matter was also discussed in the 62nd Conference of the Chairmen and Member Secretaries of SPCBs and PCCs held on 27.06.2017. That 26 SPCBs/PCCs have submitted the compliance report, which has been summarized at **Annexure-I**.*

6. That the CPCB has also carried out inspections of 17 categories of industries to verify compliance with its directions issued on online effluent/emission monitoring system and to cross-verify online results with manual sampling. During February-June, 2017, 64 industries were inspected and directions under section 5 of the Environment (Protection) Act, 1986 have been issued to 24 non-complying industries; 18 industries were complying; 8 were found closed and inspection reports of 14 industries are under process.

7. That the CPCB and NMCG through 11 technical institutions, inspected 751 industries located in the River Ganga main stem during March-April, 2017 to verify the status of installation and connectivity of industries discharging effluents as well as their compliance with the standards. Closure directions have been issued to 154 industries; show cause notices issue to 36 industries; 149 industries were found complying and direction issued to 91 self-closed Grossly Polluting Industries (GPI) to remain closed; 93 GPI units were found closed as per directions; 38 GPI units found operational in violation of closure directions and inspection reports of 190 industries are under process".

3. We have heard learned Amicus Curiae Sh. Jai A. Dehadrai and the learned counsel for Ministry of Environment, Forest and Climate Change, Central Pollution Control Board, various State Pollution Control Boards and the Pollution Control Committees.

4. Learned Amicus Curiae has drawn our attention to orders dated 04.07.2017, 18.09.2017 and 11.10.2017 of the Tribunal directing the State Pollution Control Boards to file a statement as to how many Industrial Units discharging trade effluents or causing emissions exist in the State, how many are having their own STPs, ETPs and/or connected to Common Effluent Treatment Plant

3

	Item No. 12 August 03, 2018 A	(CETP), whether any such CETP or ETP or STP is properly functioning and treating the effluents as per prescribed limits or not. 5. Learned Amicus Curiae submitted that contamination of water due to industrial effluents can lead to various diseases and adverse consequences on the aquatic organism due to decreased level of oxygen. The use of technology can help reduction of adverse consequences. However, the best solution is to prevent pollution by soil conservation and proper disposal of toxics and chemicals which may include chemical recycling. 6. Having monitored the matter for the last more than one year on several dates, we are of the view that the matter requires continuous monitoring by statutory authorities as per directions which we proceed to issue today. (i) We direct the Central Pollution Control Board (CPCB) to forthwith prepare an action plan after looking into all the status reports. The action plans must have mechanism to ensure compliance or all the directions in the order of the Hon'ble Supreme Court. To enable this to be done, a Nodal officer must be identified to deal with the issue of CETPs/ ETPs/STPs. (ii) A representative of the Ministry of Environment, Forest and Climate Change may be associated with the Nodal Officer of the CETP for monitoring. The Monitoring by the said two officers- the representative of the MoEF and the Nodal Officer of the CPCB must be held atleast once in a month and on the basis of such meeting and the feedback taken further follow up action must be taken and

4

	Item No. 12 **August 03, 2018** A	appropriate directions issued. This process may be a continuous process. (iii) It must be ensured that STPs, CETPs and ETPs are functional and meet the requisite standards. (iv) There is already a direction in the above judgment under which 50% of the funds for the purpose are to be provided by the Central Government, 25% by the States and remaining 25% to be arranged by way of loans which is to be re-paid by the user industries. Local bodies and the States have duties as clearly stipulated in the judgment. There has to be online monitoring system by each State to display emission levels in public domain in terms of paragraph 17 of the order of the Hon'ble Supreme Court. (v) A report of the steps taken may be placed on the website of the Central Pollution Control Board atleast once in three months. Deficiencies if any may also be so displayed. (vi) The Central Pollution Control Board may take penal action for failure, if any, against those accountable for setting up and maintaining STPs, CETPs and ETPs Central Pollution Control Board may also assess and recover compensation for damage to the environment and the said fund be kept in a separate account and utilized in terms of an action plan for protection of the environment. Such action plan may be prepared by the Central Pollution Control Board within three months from today. (vii) A compliance report in terms of the above order may be furnished to this Tribunal within four months from today by e-mail at filing.ngt@gmail.com.

5

Item No. 12 August 03, 2018 A	(7) Proceedings are disposed of. However, the report received from the Central Pollution Control Board may be placed for consideration before this Tribunal on 04.09.2018. We place on record our appreciation for the services rendered by the learned Amicus Curiae. ...., CP (Adarsh Kumar Goel) ...., JM (Dr. Jawad Rahim) ....JM (S.P. Wangdi) ....EM (Dr. Nagin Nanda) 03.08.2018

6

Annexure-II

Comments Received from Various RDs on Draft Report for Environmental Compensation

Annexure-II

S. No.	Item	RD Kolkata	RD Vadodara	RD Bengaluru	RD Lucknow	Committee Deliberations
1	Case- a, b & c	Bypassing of effluent/emission should be given special consideration. EC levied on ROG categories of Industries should be on the basis of inspection by CPCB, complaint verification and routine inspection.	Instead of "Compensation", "Penalty" word should be used. In case common facilities like CETPs, factor may be introduced based on member industries. Clarify the applicability of penalty in addition to closure directions for pro-longed and gross non-compliance.			The Committee discussed that the points highlighted by RD Kolkata are already the part of cases fit for violation and levy environmental compensation. However, as mentioned by RD Vadodara, word "Penalty" may be used for case a, b and c. For CETPs, a factor may be considered in future based on the capacity of the plant.
2	Case- d, e & f	Higher rates for irreparable damages crop, soil, health etc. Leakages/spillage should have different compensation value.	It should be mentioned that instances d, e & f shall be dealt for environmental compensation in line with the polluter pays principle, besides of environmental penalty for cases a, b and c.	Similar to 'Guidelines on Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty', Guidelines may be prepared.		Suggestions made by RD Kolkata and Vadodara has already been taken care. Concept of environmental compensation is based on the philosophy of "polluters pay" and for grieve injury to environment, compensation will be charged as per the assessment of remediation cost, on case to case basis.
3	Pollution Index (PI)			Instead of average PI, Actual PI may be used.		Committee suggested that to make the implementation of EC simple and easy, use of average PI may be considered for calculation of EC.
4	R-factor	Should be based on pollution load. For ex. Amount of BOD/NOx etc. discharged.		May be classified based on the contribution of pollution load based on quantity of effluent, concentration, emissions	May be as per the category of industry, for ex. Red-500, Orange-300, Green-100.	As PI is based on the pollution load, suggestion of RDs are already taken care in the formula.
5	L-factor			May be redefined based on the features, activities involved and habitation.		L-factor may be covered in future as already indicated in the report.

S. No.	Item	RD Kolkata	RD Vadodara	RD Bengaluru	RD Lucknow	Committee Deliberations
6	Defining period of violations for which EC will be levied		Duration of violations needs more clarity.	For industry having OCEMS, no. of days may be counted based on the recorded data. Industry without OCEMS-based on break down of ETP/APCD, disturbance of power supply or any failure of auxiliary machineries w.r.t. control system.	May be clearly defined as the period between the day of violation observed and the day of compliance verified by CPCB/SPCB/PCC.	The committee agreed that period of violation for which EC may be levied will be the period between the day of violation observed and the day of compliance verified by CPCB/SPCB/PCC.
7	Repeated Violations		Some number of days may be specified after which the penalty amount may get a factor of 1.5 or 2.		Multiplying factor for repeated violations may be included. For ex. 1st Repetition- 25% 2nd Repetition- 50% 3rd Repetition- 100%	For habitual offenders, higher amount of penalty/compensation may be charged in future.
8	Utilization of fund	An environmental damage assessment cell may be created. Expertise in the field may be achieved by involving scientist/engineers and providing them training in country/abroad.	Amount should not be utilized for a) Industrial Inspections for compliance verification, b) Installation of Continuous water quality monitoring stations / Continuous ambient air quality monitoring stations for strengthening of existing monitoring network, c) Preparation of Comprehensive Industry Documents on Industrial Sectors / clean technology f) Funding to financially weaker municipalities for installation of STPs The amount should be utilized solely for damage assessment, remediation of affected sites, orphan contaminated sites and creating awareness. The purpose should not get inclined towards revenue generation.			RD Vadodara suggested that amount should be utilized only for remediation purpose. However, committee discussed that the proposal for utilization of fund is prepared considering the other aspects (i.e. direct and indirect) for protection of environment, which include research, monitoring etc. Suggestion of RD Kolkata may be considered in future.

			Thus, the functional fabric of CPCB shall remain intact.			
9	Others	Higher EC for non-installation of pollution control measures. Expected sources should have different scoring methodology based on their weightage.				The committee discussed that CPCB is already taking appropriate action including closure direction against the industries found operating without pollution control measures.

Annexure-III

Comments Received from Various Expert Institutions on the Report on Environmental Compensation

As per the Hon'ble NGT suggestion, CPCB has invited comments of 3 expert institution, namely, Centre for Science and Environment (CSE), Institute of Economic Growth (IEG) and The Energy Research Institute (TERI). The CPCB in-house committee on Environmental Compensation has deliberated on the comments and finalized the report accordingly. The Committee's deliberations are summarized in table below:

S. No.	Item	Comments from TERI	Comments of CSE	Comments of IEG	Committee's Deliberations
1	Cases d, e and f	Distinction between categories "a, b, c" and "d, e, f" is not clear. Case specific investigations should be minimized. Proposed cases deals separately with intentional and accidental cases but sometimes they are not easy to establish	-	Why cases 'e' and 'f' are left for later remediation and study?	There may be a varied damage to the environment as considered in cases 'e' and 'f'. Such damage assessment requires detailed case specific study and remediation measures. Therefore, whenever such case comes into the notice, Environmental Compensation may be levied based on the detailed Investigation made by Expert Institutions/Organizations.
2	R-factor	-	R-factor should be Rs. 1,000/day.	Why R-factor is kept as 250, although the value ranges between 100 to 500?	In the Environmental Compensation policy, average value of the R-factor as 250 is recommended, keeping in view both its practicability as well as to make it significantly deterrent, which may be further revised in future.
3	L-factor	-	L-factor should be based on the population density of surroundings, instead of population of the nearby city/town. For critically polluted areas/ ecologically fragile areas LF should be considered as 2.	For nearby city, having population less than 1 million, the LF is 1. This implies that we care only for populated regions only. Industries located in critically polluted and ecologically fragile area should be closed down.	Population density for surrounding of industrial units will be complex because it will vary depending on area used in calculation of population density as industrial units are generally away from population. More weightage is given to the higher population exposure to the risk. In case the industry is located in the city of population less than one million than the LF Factor will be 1. Depending on the local environmental conditions, the restrictions on expansion and modernization of industries in critically polluted areas are imposed as per the prevailing policy of the Government of India. Similarly, industries in ecologically fragile areas are permitted after careful examination, as per prevailing policy of MoEFCC/SPCB. The Committee agreed that for notified ecologically fragile areas, LF may be considered as 2. However, LF for critically polluted areas may be explored in future.

S. No.	Item		Comments of CSE	Comments of IEG	Committee's Deliberations
4	S-factor	Classification of Industries should be based on profit/ turnover basis.	S-factor should be based on the turn-over of the industrial unit.	-	Presently Industrial units are classified into small, medium and large category (MSME Act, 2006) based on the data of assets/infrastructure available with them. The data for **profit**/turnover of industrial units are not available with SPCBs/PCCs and S-factor based on **profit**/turnover will complicate the procedure for calculation of EC. This may be considered in future when SPCBs/PCCs will have such type of data.
5	Level of non-compliance	Pollution Index does not measure the level of pollution. Further, averaging PI eliminates the variation in the nature/ impact of pollution that PI tries to capture. Further, the Red Category itself is too wide and some sort of sub-classification should be undertaken The rate of the penalty should increase with the period of violation. The penalty should increase exponentially in case of repeated violations. The objective should be that units should choose to shut down operations when violations cannot be brought under control in the specified time.	For different level of non-compliance such as gross, moderate and low, a factor for 'intensity of violation', IV-factor should be incorporated in the formula.	-	Pollution Index (PI) itself covers the potential of environmental pollution as its calculation considers variation in pollution load. The industrial sectors have been categorized into Red, Orange and Green, based on their Pollution Index in the range of 60 to 100, 41 to 59 and 21 to 40, respectively. As PI is not available for all the industrial sectors, calculating PI for rest of the sectors will delay the processing. Therefore, for calculating the Environmental Compensation average PI as 80, 50 and 30 may be used for Red, Orange and Green category of industries, respectively. To keep the formula simple for better implementation, the IV factor may not be considered as there are different environmental parameters such as environmental standards and for each standard calculation of level of violation and its weightage will be a tedious task, which may bring difficulty in implementation of EC concept. The Committee has agreed that in order to include deterrent effect for repeated violations, EC may be increased on exponential basis, i.e. by 2, 4 and 8 times on each similar violation. Further, if the violator continues its operations beyond 3 months then EC may be increased by 2, 4 and 8 times for 2^{nd}, 3^{rd} and 4^{th} quarter, respectively. Besides EC, industry may be prosecuted or closure directions may be issued, whenever required. EC is not a substitute for taking actions under EP Act, Water Act or Air Act. In fact, units found polluting should be closed/prosecuted as per the Acts.
6	Utilization of fund	Funds may be utilized for building monitoring and enforcement capacity of SPCBs and strengthening the pollution compliance especially in the MSME sector.	-	Incentives to regulators where no violations are observed and Incentives to public for reporting violations may be provided.	Scheme of Infrastructure augmentation of Urban Local Bodies (ULBs) /capacity building of SPCBs/PCCs is already covered in the report Further, schemes such as Incentives to regulators where no violations are observed and Incentives to public for reporting violations may be considered separately.

S. No.	Item		Comments of CSE	Comments of IEG	Committee's Deliberations
7	GRAP	-	-	Size of the construction sites more than 20,000 sqm. area are considered for EC. Although, small sites cumulatively impact significantly. Illegal dumping of municipal solid waste regardless of the place should be penalized.	As per the EIA Notification, 2006, building construction projects more than 20,000 sqm. area are required to have environmental clearance, therefore, the same cut-off is maintained here. Issue of illegal dumping of municipal solid waste is being covered in separate report of EC.
8	Others: (a)	Severity of violations should be measured in terms of hours of violation because for some pollutants even a few hours of violation can have serious environmental and health consequences. This would require continuous monitoring of stacks, which is not the case presently for most units. Therefore, continuous monitoring should be implemented urgently, to begin with for all red and orange categories.	-	-	Currently, online continuous effluent/emission monitoring system (OCEMS) is installed in only in 17 categories of highly polluting industries and some other industrial sectors. Further, in current practice the compliance of industries is only verified by physical monitoring and compensation may be imposed based on the manual testing. The idea of measurement of violation on hourly basis may be considered in future, when OCEMS is widely installed and included in policy.
	(b)	CETP should be categorized under Red Category of industries. Some sub-classification should be undertaken under red categories of industries.	-	-	CETPs are already categorized under Red Category of Industries
	(c)	Based on the spirit behind the proposed charge, it should therefore be called an "environmental penalty" rather than "environmental compensation".	-	-	The power of imposing "Penalty" lies in the jurisdiction of the Hon'ble Courts and NGT only. The CPCB is empowered to levy environmental compensation by the Hon'ble NGT in its order dated 03.08.2018 (OA No.593/2017). Therefore, term "Environmental Penalty" is avoidable.

Annexure-IV

Item Nos. 01 & 02 | Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 125/2017
(M.A. No. 1337/2018)
With
Original Application No. 217/2017
(M.A. Nos. 761/2017, 1073/2017,
1098/2017 & 1471/2017)

Court on its own Motion		Applicant(s)
	Versus	
State of Karnataka		Respondent(s)
With		
D. Kupendra Reddy		Applicant(s)
	Versus	
State of Karnataka		Respondent(s)

Date of hearing: 06.12.2018

CORAM: **HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON**
HON'BLE MR. JUSTICE S.P. WANGDI, JUDICIAL MEMBER
HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Original Application No. 125/2017
(M.A. No. 1337/2018)

For Applicant(s):	Mr. Sajan Poovayya, Sr. Advocate and Mr. Saransh Jain, Advocate for impleaded applicant – Namma Bengaluru Foundation Mr. Vikram Hegde, Advocate for impleaded applicant
For Respondents (s):	Mr. Devraj Ashok, Advocate Mr. Rajkumar, Advocate and Ms. Sonia, LA Ms. Nidhi Mehrotra, Advocate

Original Application No. 217/2017
(M.A. Nos. 761/2017, 1073/2017,
1098/2017 & 1471/2017)

For Applicant(s):	Ms. Guneet Khehar, Mr. Tarunvir Singh Khehar, Mr. P. Ramaprakash and Mr. Sandeep Mishra, Advocates
For Respondents (s):	Dr. Abhishek Atrey, Advocate Mr. Rajkumar, Advocate and Ms. Sonia, LA

ORDER

1. The issue for consideration in the two matters, one initiated by the Tribunal on its own motion and the other filed by an individual relates to contamination of water bodies at Bengaluru - Bellandur lake, Agara lake and Varthur lake *inter-alia*, on account of discharge of untreated sewage and other effluents from

their performance should be recorded and considered favourably or otherwise for their career progression.

xv. Similar exercise as (xiv) may be undertaken to identify officers responsible for failure in the past. Such exercise may be completed within three months from today.

xvi. Since failure of preventing the pollutants being discharged in water bodies (including lakes) and failure to implement solid and other waste management rules are too frequent and widespread, the CPCB must lay down specific guidelines to deal with the same, throughout India, including the scale of compensation to be recovered from different individuals/authorities, in addition to or as alternative to prosecution. The scale may have slabs, depending on extent of pollution caused, economic viability, etc. Deterrent effect for repeated wrongs may also be provided.

xvii. MoEF&CC may specify limit for phosphorus in soaps and detergents to prevent damage to the environment and public health.

27. The above amount in the present case has been determined having regard to the estimated cost of setting up of STPs, based on the data available, which has been assessed with the assistance of the learned Counsel for the parties.

28. We have nominated Justice Santosh Hegde on information being provided during the hearing that he is agreeable to undertake the above job.

29. Justice Hegde will be entitled to a token honorarium of Rs. 2.5 Lakh per month from the date he assumes the charge. Justice Hegde will be entitled to assistance of persons of his choice for which remuneration will be paid by the SPCB, Karnataka as may be determined by Justice Hegde.

Annexure-V

Item Nos. 1 to 11 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 176/2015
(M.A. No. 1332/2015)
&
Original Application No. 59/2012
(M.A. No. 34/2016 & M.A. No. 190/2016)
&
Original Application No. 108/2013
(M.A. No. 489/2015)
&
Original Application No. 179/2013
(M.A. No. 866/2014 & M.A. NO. 644/2015)
&
Appeal No. 67/2015
(M.A. No. 652/2015)
And

Original Application No. 484/2015
(M.A. No. 155/2017, M.A. No. 567/2017
& M.A. No. 927/2017)
And
Original Application No. 327/2018
(M. A. No. 1282/2018)
And
Original Application No. 115/2017
(M.A. No. 442/2017)
And
Original Application No. 411 of 2018
And
Original Application No. 613/2017
And
Original Application No. 614/2017

Shailesh Singh	Respondent(s)
Versus	
Hotel Holiday Regency, Moradabad & Ors.	Applicant(s)
With	
Legal Aid, National Green Tribunal Bar Association	Applicant(s)
Versus	
NCT of Delhi & Ors.	Respondent(s)
With	
Raj Hans Bansal	Applicant(s)
Versus	
Ministry of Water Resources & Ors.	Respondent(s)
With	
Apex Chambers of Commerce and Industries of N.C.T. of Delhi & Ors.	Applicant(s)
Versus	
Govt. of NCT Delhi & Ors.	Respondent(s)
With	
Vikrant Tongad	Applicant(s)

Versus

Union of India & Ors. Respondent(s)

With
Shailesh Singh Applicant(s)
Versus
Hotel The Oberoi Amarvilas & Ors. Respondent(s)
With
Shailesh Singh Applicant(s)
Versus
Panchsheel Buildtech Pvt. Ltd. & Ors. Respondent(s)
With
Shailesh Singh Applicant(s)
Versus
Central Ground Water Board & Ors. Respondent(s)
With
M/s A-One Mineral Water Industry Applicant(s)
Versus
Central Ground Water Authority & Ors. Respondent(s)
With
Mohd. Javed Asghar Applicant(s)
Versus
M/s Upper Ganges Sugar and Industries Ltd. (Distillery Unit) & Ors. Respondent(s)
With
Mohd. Javed Asghar Applicant(s)
Versus
State of U.P. & Ors. Respondent(s)

Hearing concluded on: 18.12.2018
Order uploaded on: 03.01.2019

CORAM: **HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON**
HON'BLE MR. JUSTICE S.P. WANGDI, JUDICIAL MEMBER
HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

For Applicant(s): Mr. Raj Pajwani, Senior Advocate and Mr. Rahul Choudhary, Advocate (In O.A. Nos. 59/2012 & 108/2013)
Ms. Preeti Singh, Mr. S. Porwal, Mr. Shivam Jaiswal, Advocates (In O.A. Nos. 176/2015, 484/2015, 327/2018 & 115/2017)
Mr. Amrendra Kumar Dubey, Advocate (O.A. No. 411/2018

For Respondent (s): Ms. Sakshi Popli, Advocate for DJB (O.A. No. 59/2012)
Mr. Sumeet Pushkarna, Mr. Devanshu, Advocates with Mr. Sudhir Chauhan, E.E., Delhi Jal Board (O.A. No. 108/2013)
Mr. Ajay Jain, Advocate for GNCTD
Mr. Ardhendumauli Kumar Prasad, Mr. Shashank Saxena, Ms. Diksha Gera, Mr. Amritesh Raj, Advocates for CGWA
Mr. Pradeep Mishra, Mr. Daleep Dhyani, Advocates for UPPCB
Ms. Sakshi Popli, Advocate for NDMC
Mr. Amit Tiwari, Mr. Rohit Pratap Singh, Advocates for State of UP

appropriate mechanism can be introduced consistent with the needs of environment.

29. The MoEF&CC is directed to constitute an Expert Committee by including representatives from IIT Delhi, IIT Roorkee, IIM Ahmedabad, CPCB, NITI Ayog and any other concerned agency or department to examine the issue of appropriate policy for conservation of ground water with a robust institutional mechanism for surveillance and monitoring with a view to enhance access to ground water for drinking purposes in OCS areas by way of appropriate replenishment practices which can be properly accounted and measured for as well as to sustain the floodplains of rivers in terms of e-flows and other water bodies. The MoEF & CC and MoWR may finalize the issue of subject remain *inter-se* with regard to ground water reserve and its quality.

30. The Committee may be constituted in two weeks and report of the Committee may be furnished to the MoEF &CC and this Tribunal in two months by e-mail at ngt.filing@gmail.com.

31. The Committee may also indicate the projection of its impact study in light of projected data for the next 50 years (in phased manner with action plan for each decade). Thereafter, fresh guidelines be issued by the concerned Ministry and the report furnished to the Tribunal on or before 30.04.2019.

32. The CPCB may constitute a mechanism to deal with individual cases of violations of norms, as existed prior to Notification of 12.12.2018, to determine the environment compensation to be recovered or other coercive measures to be taken, including prosecution, for past illegal extraction of ground water, as per

law. All the matters relating to illegal extraction of ground water by individuals are disposed of with these directions.

33. The Expert Committee report, the new policy and challenge to orders of authorities, if any, will be considered on the next date.

The matter be put up for above consideration in the first week of May, 2019.

Adarsh Kumar Goel, CP

S.P. Wangdi, JM

K. Ramakrishnan, JM

Dr Nagin Nanda, EM

January 03, 2019
Original Application No. 176/2015
(M.A. No. 1332/2015) and other connected matters
AK

Annexure-VI

CRITERIA TO CALCULATE WATER CONSUMPTION

Table 1: Discharge of 4" Dia and 1 HP Pump

Sl. No.	Depth (Meter)	Discharge	
		LPM	m^3/hr
1	25	50	3
2	43	40	2.4
3	59	30	1.8
4	69	20	1.2
5	77	10	0.6

Table 2: Discharge of 4" Dia and 2 HP Pump

Sl. No.	Depth (Meter)	Discharge	
		LPM	m^3/hr
1	60	50	3
2	98	40	2.4
3	124	30	1.8
4	141	20	1.2
5	165	10	0.6

Table 3: Discharge of 6" Dia and 3 HP Pump

Sl. No.	Depth (Meter)	Discharge	
		LPM	m^3/hr
1	17	200	12
2	29	175	10.5
3	41	150	9
4	50	130	7.8
5	62	100	6

Table 4: Discharge of 6" Dia and 5 HP Pump

Sl. No.	Depth (Meter)	Discharge	
		LPM	m^3/hr
1	26	225	13.5
2	50	200	12
3	70	175	10.5
4	86	150	9
5	92	140	8.4

References

1. Bureau of Indian Standards. 1993. IS1172:1993 (Reaffirmed 2002). *Code of Basic Requirements for Water Supply, Drainage and Sanitation (Fourth Revision)*. New Delhi: BIS.
2. Census of India. 2011. Census of India's website. [Online]. [Accessed 15 February 2019]. Available from: http://censusindia.gov.in/2011-prov-results/paper2/data_files/India2/1.%20Data%20Highlight.pdf.
3. Central Pollution Control Board. 2013. *Performance Evaluation of Sewage Treatment Plants under NRCD. Delhi*: CPCB.
4. Central Pollution Control Board. 2016. *Graded Response Action Plan for Delhi & NCR*. Delhi: CPCB.
5. Central Pollution Control Board. 2016. *Final Document on Revised Classification of Industrial Sectors Under Red, Orange, Green and White Categories*. Delhi: CPCB.
6. CGWA. 2015. *Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction*. New Delhi-Central Ground Water Authority, Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India.
7. CGWB. 2017. *Categorisation of Assessment Units* [Online]. [Accessed 20 February 2019]. Available from: http://cgwa-noc.gov.in/LandingPage/NotifiedAreas/CategorizationOfAssessmentUnits.pdf#ZOOM=150.
8. CGWB. 2017. *Dynamic Ground Water Resources of India*. Faridabad-Central Ground Water Board, Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India.
9. CPHEEO. 2013. *Manual on Sewerage and Sewage Treatment Systems – 2013, New* Delhi: Ministry of Urban Development, Government of India.
10. CPHEEO. 2016. *Manual on Municipal Solid Waste Management – 2016. New* Delhi: Ministry of Urban Development, Government of India.
11. Ministry of Micro, Small and Medium Enterprises. 2006. T*he Micro, Small and Medium Enterprises Development Act, 2006. 2nd October, 2006, vide notification No. S.O. 1154(E) dated 18th July, 2006, see Gazette of India, Extraordinary Part II sec.3(ii)*, Government of India.
12. *Plastic Waste Management Rules, 2016*. (G.S.R. 320 (E) [18-03-2016]). New Delhi: Ministry of Environment Forest and Climate Change, Government of India.
13. *Solid Waste Management Rules, 2016*. (S.O. 1357(E) [08-04-2016]). New Delhi: Ministry of Environment Forest and Climate Change, Government of India.
14. WILO. 2017. *Building Service Residential Selection Booklet*. Pune- WILO Mather and Platt Pumps Pvt. Ltd.

ANNEXURE – XIII

European Environmental Agency

A 187

EEA Technical report | No 15/2011

Revealing the costs of air pollution from industrial facilities in Europe

ISSN 1725-2237

European Environment Agency

Revealing the costs of air pollution from industrial facilities in Europe

European Environment Agency

Cover design: EEA
Layout: EEA/Henriette Nilsson

Information about the European Union is available on the Internet. It can be accessed through the Europa server (www.europa.eu).

Luxembourg: Publications Office of the European Union, 2011

ISBN 978-92-9213-236-1
ISSN 1725-2237
doi:10.2800/84800

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark
Tel.: +45 33 36 71 00
Fax: +45 33 36 71 99
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

Contents

Acknowledgements

This report was compiled by the European Environment Agency (EEA) on the basis of a technical paper prepared by its Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM, partner AEA Technology, United Kingdom).

The lead authors of the ETC/ACM technical paper were Mike Holland (EMRC) and Anne Wagner (AEA Technology). Other contributors to the report were Joe Spadaro (SERC) and Trevor Davies (AEA Technology). The EEA project manager was Martin Adams.

The authors gratefully acknowledge the technical support received from Agnes Nyiri (Air Pollution Section, Research Department, Norwegian Meteorological Institute) for providing information from the EMEP chemical transport model.

The authors also acknowledge the contribution of numerous colleagues from the EEA and the European Commission's Directorates-General for the Environment and Climate Action for their comments on draft versions of this report.

Executive summary

This European Environment Agency (EEA) report assesses the damage costs to health and the environment resulting from pollutants emitted from industrial facilities. It is based on the latest information, namely for 2009, publicly available through the European Pollutant Release and Transfer Register (E-PRTR, 2011) in line with the United Nations Economic Commission for Europe (UNECE) Aarhus Convention regarding access to environmental information.

Air pollution continues to harm human health and our environment. One of the main findings of the EEA's *The European environment — state and outlook 2010* report (EEA, 2010) was that, despite past reductions in emissions, air quality needs to further improve. Concentrations of certain air pollutants still pose a threat to human health. In 2005, the European Union's Clean Air for Europe (CAFE) programme estimated that the cost to human health and the environment from emissions of regional air pollutants across all sectors of the EU-25 economy equalled EUR 280–794 billion in the year 2000.

This report investigates the use of a simplified modelling approach to quantify, in monetary terms, the damage costs caused by emissions of air pollutants from industrial facilities reported to the E-PRTR pollutant register. In using E-PRTR data, this study does not assess whether the emissions of a given facility are consistent with its legal requirements. Nor does it assess the recognised economic and social benefits of industry (such as producing goods and products, and generating employment and tax revenues etc.).

The approach is based on existing policy tools and methods, such as those developed under the EU's CAFE programme for the main air pollutants. The CAFE-based methods are regularly applied in cost-benefit analyses underpinning both EU and international (e.g. UNECE) policymaking on air pollution. This study also employs other existing models and approaches used to inform policymakers about the damage costs of pollutants.

Together, the methods are used to estimate the impacts and associated economic damage caused by a number of pollutants emitted from industrial facilities, including:

- the regional and local air pollutants: ammonia (NH_3), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), particulate matter (PM_{10}) and sulphur oxides (SO_x);
- heavy metals: arsenic, cadmium, chromium, lead, mercury and nickel;
- organic micro-pollutants: benzene, dioxins and furans, and polycyclic aromatic hydrocarbons (PAHs);
- carbon dioxide (CO_2).

Each of these pollutants can harm human health, the environment or both. Certain of them also contribute to forming ozone and particulate matter in the atmosphere (Box ES.1).

There are differences between the selected pollutants in terms of the extent of current knowledge about how to evaluate their impacts. Understanding is most advanced in evaluating the health impacts of the major regional air pollutants, and builds on previous peer-reviewed analysis such as that undertaken to inform the CAFE Programme. This report's analysis for these pollutants thus extends to quantifying crop and building material damage but does not include ecological impacts.

Impacts of heavy metals and persistent organic compounds on human health are also quantified, primarily in terms of additional cancer incidence. In some cases this requires analysis of exposure through consumption as well as through inhalation. Again, ecological damage is not accounted for and it should be noted that the health impact estimates for these pollutants have been subject to less scientific review and debate than those generated under CAFE.

Finally, a different approach was used to quantify the damage costs arising from CO_2 emissions, based on estimated marginal abatement cost. Estimating the magnitude of costs associated with future climate change impacts is very uncertain. This uncertainty is unavoidable, as the extent of damage will be dependent on the future development of society, particularly with respect to population and economic growth, but also how much value is attached to future events. The approach used in this report, based on marginal abatement cost, is based on the existing approach used for public policy appraisal in the United Kingdom.

Box ES.1 Air pollutants included in this study and their effects on human health and the environment

Nitrogen oxides (NO_x)
Nitrogen oxides are emitted from fuel combustion, such as from power plants and other industrial facilities. NO_x contributes to acidification and eutrophication of waters and soils, and can lead to the formation of particulate matter and ground-level ozone. Of the chemical species that comprise NO_x, it is NO_2 that causes adverse effects on health; high concentrations can cause airway inflammation and reduced lung function.

Sulphur dioxide (SO_2)
Sulphur dioxide is emitted when fuels containing sulphur are burned. As with NO_x, SO_2 contributes to acidification, with potentially significant impacts including adverse effects on aquatic ecosystems in rivers and lakes, and damage to forests. High concentrations of SO_2 can affect airway function and inflame the respiratory tract. SO_2 also contributes to the formation of particulate matter in the atmosphere.

Ammonia (NH_3)
Ammonia, like NO_x, contributes to both eutrophication and acidification. The vast majority of NH_3 emissions — around 94 % in Europe — come from the agricultural sector. A relatively small amount is also released from various industrial processes.

Non-methane volatile organic compounds (NMVOCs)
NMVOCs, important ground-level ozone precursors, are emitted from a large number of sources including industry, paint application, road transport, dry-cleaning and other solvent uses. Certain NMVOC species, such as benzene (C_6H_6) and 1,3-butadiene, are directly hazardous to human health.

Particulate matter (PM)
In terms of potential to harm human health, PM is one of the most important pollutants as it penetrates into sensitive regions of the respiratory system, and can cause or aggravate cardiovascular and lung diseases. PM is emitted from many sources and is a complex mixture comprising both primary and secondary PM; primary PM is the fraction of PM that is emitted directly into the atmosphere, whereas secondary PM forms in the atmosphere following the release of precursor gases (mainly SO_2, NO_x, NH_3 and some volatile organic compounds (VOCs)).

Heavy metals
The heavy metals arsenic (As), cadmium (Cd), chromium (Cr) lead (Pb), mercury (Hg) and nickel (Ni) are emitted mainly as a result of various combustion processes and from industrial activities. As well as polluting the air, heavy metals can be deposited on terrestrial or water surfaces and subsequently buildup in soils and sediments, and can bio-accumulate in food chains. They are typically toxic to both terrestrial and aquatic ecosystems.

Organic micro-pollutants
Benzene, polycyclic aromatic hydrocarbons (PAHs), and dioxins and furans are categorised as organic pollutants. They cause different harmful effects to human health and to ecosystems, and each of these pollutants is a known or suspected human carcinogen; dioxins and furans and PAHs also bioaccumulate in the environment. Emissions of these substances commonly occur from the combustion of fuels and wastes and from various industrial processes.

Carbon dioxide (CO_2)
Carbon dioxide is emitted as a result of the combustion of fuels such as coal, oil, natural gas and biomass for industrial, domestic and transport purposes. CO_2 is the most significant greenhouse gas influencing climate change.

Key findings

The cost of damage caused by emissions from the E-PRTR industrial facilities in 2009 is estimated as being at least EUR 102–169 billion. A small number of industrial facilities cause the majority of the damage costs to health and the environment (Figure ES.1 and Map ES.1). Fifty per cent of the total damage cost occurs as a result of emissions from just 191 (or 2 %) of the approximately 10 000 facilities that reported at least some data for releases to air in 2009. Three quarters of the total damage costs are caused by the emissions of 622 facilities, which comprise 6 % of the total number.

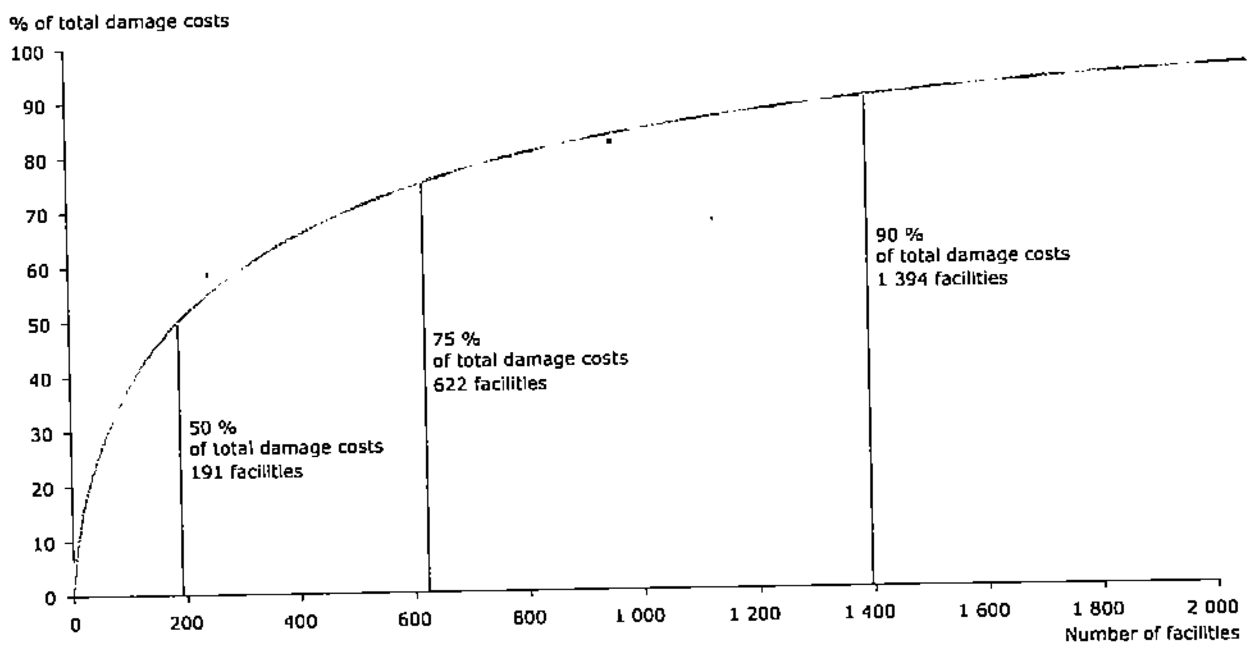
The report lists the top 20 facilities identified as causing the highest damage. Not surprisingly, most of the facilities with high emission damage costs are among the largest facilities in Europe, releasing the greatest amount of pollutants.

The ranking of individual facilities is likely to be more certain than the absolute damage costs in euros estimated for each facility. Furthermore, the reporting of data to the pollutant register appears more complete for certain facilities and countries than for others, potentially underestimating damage costs at some facilities.

Ranking according to aggregate emission damage costs provides little indication of the efficiency of production at a facility. A large facility could be more efficient than several smaller facilities that generate the same level of service or output. Equally, the opposite could be true.

One weakness of the pollutant register E-PRTR is that it does not provide production or fuel consumption data, so a direct assessment of environmental efficiency is not possible. This report nevertheless seeks to illustrate the potential differences in facility efficiencies by using CO_2 emissions as a proxy for fuel consumption. The most obvious difference when damage costs from individual facilities are normalised by CO_2 emissions is that more facilities from eastern Europe appear at the top of the results, suggesting that they contribute more damage cost per unit of fuel consumption. They are less environmentally efficient, in other words.

Figure ES.1 Cumulative distribution of the 2000 E-PRTR facilities with the highest damage costs



Map ES.1 Location of the 191 E-PRTR facilities that contributed 50 % of the total damage costs estimated for 2009

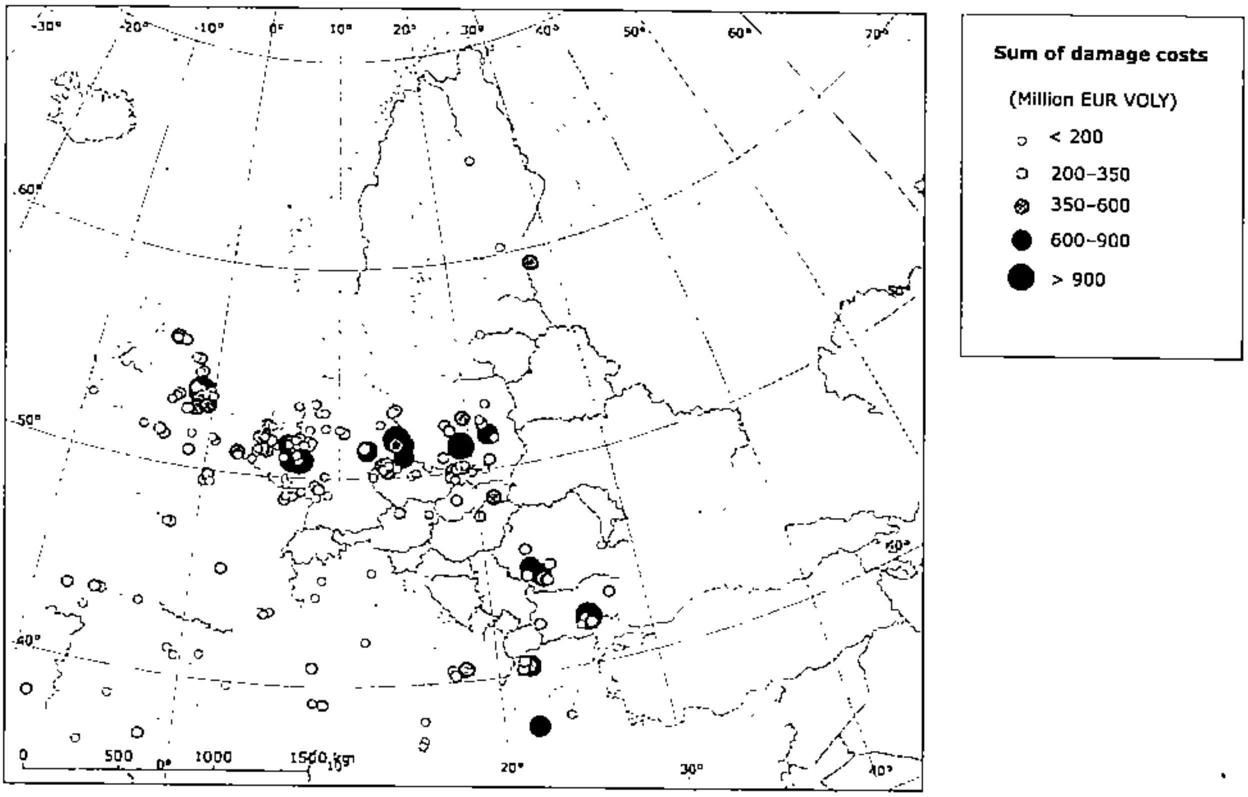
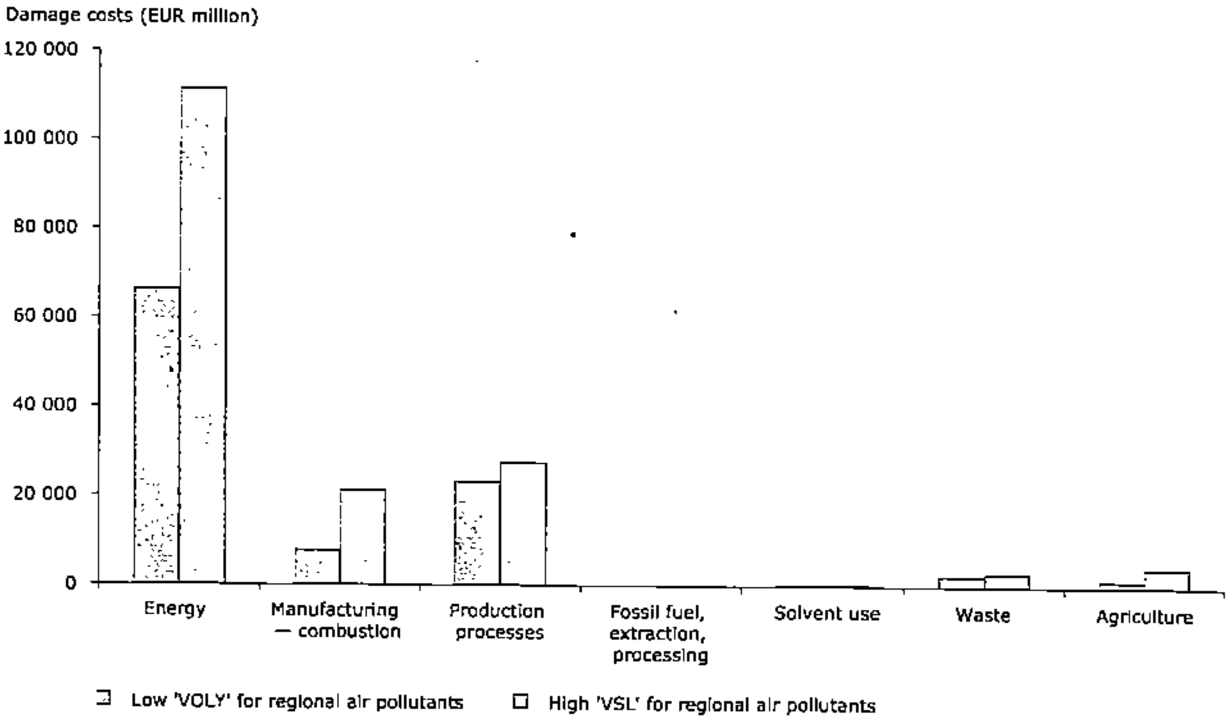


Figure ES.2 Aggregated damage costs by sector (2005 prices)



Note: The low-high range shows the differing results derived from the alternative approaches to mortality valuation for the regional air pollutants.

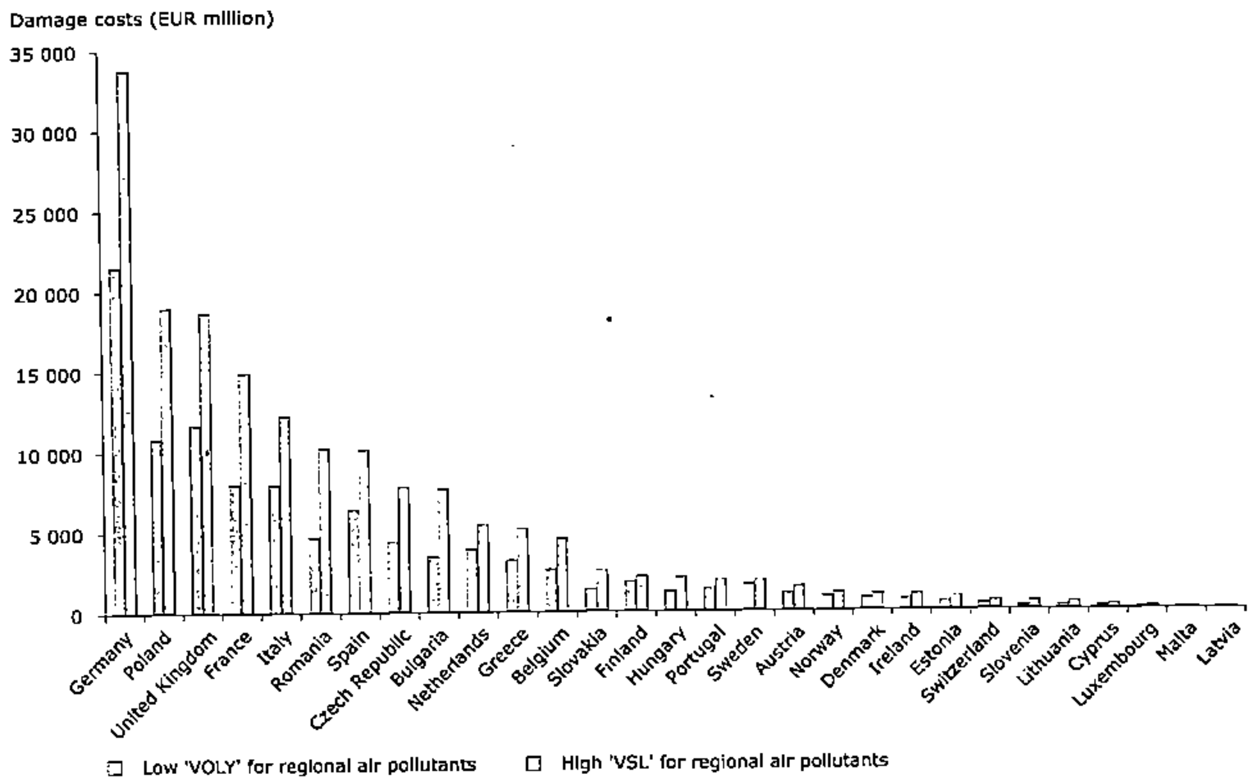
Of the industrial sectors included in the E-PRTR pollutant register, emissions from the power generating sector contribute the largest share of the damage costs (estimated at EUR 66–112 billion), (Figure ES.2). Excluding CO_2, the estimated damage costs from this sector are EUR 26–71 billion. Sectors involving production processes and combustion used in manufacturing are responsible for most of the remaining estimated damage costs.

Care is needed in interpreting the sectoral results. The E-PRTR Regulation (EU, 2006) defines the industrial sectors that must report information to the Register. In addition, for these sectors, the Regulation includes reporting thresholds for both pollutants and activities. Only those facilities with an activity rate exceeding the defined threshold and emissions exceeding the pollutant-specific thresholds have to report information to the register. Thus the E-PRTR's coverage of each sector's pollutant emissions can vary significantly. For example, whereas the E-PRTR inventory should cover most power generating facilities, it covers only a small fraction of agricultural emissions.

Results aggregated by country are shown in Figure ES.3. Countries such as Germany, Poland, the United Kingdom, France and Italy, which have a high number of large facilities, contribute the most to total estimated damage costs.

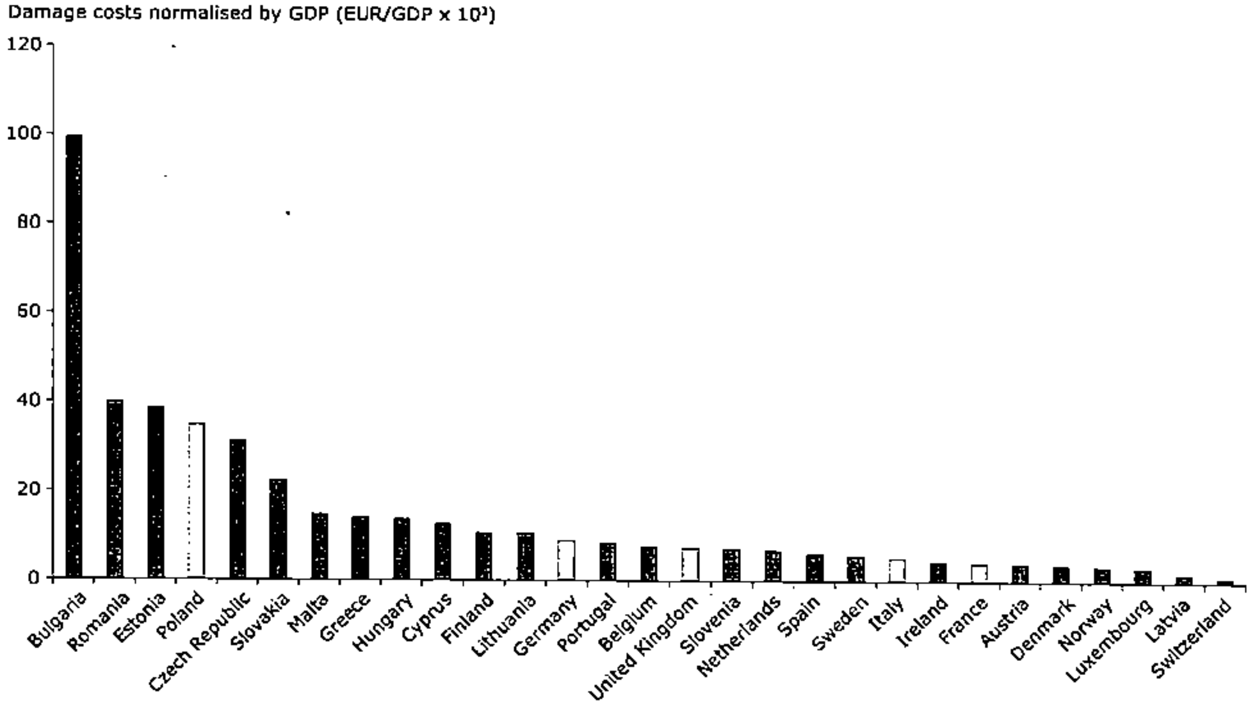
A contrasting view, offering further insights, is to incorporate a measure of the efficiency of production across the different industrial facilities. As described above, the E-PRTR does not provide facility production or fuel consumption data. As a second proxy measure, GDP was used as an indicator of national production to normalise the damage costs aggregated by country against the respective level of services provided/generated by the national economies. This alternative method of ranking countries is shown in Figure ES.4, and shows that the ordering of countries then changes significantly. Germany, the United Kingdom, France and Spain drop significantly down the ranking, whilst a number of eastern European countries (Bulgaria, Romania, Estonia, Poland and the Czech Republic) rise in position.

Figure ES.3 Aggregated damage costs by country, including CO_2



Note: The low-high range shows the differing results derived from the alternative approaches to mortality valuation for the regional air pollutants.

Figure ES.4 Aggregated damage costs by country normalised against GDP



Note: The orange bars highlight the countries with the highest damage costs in Figure ES.2.

Discussion

This report only addresses damage costs derived from emissions reported by facilities to the pollutant register E-PRTR. The total cost of damage to health and the environment from all sectors of the economy (including e.g. road transport and households) and from all pollutants will therefore be higher than the estimates presented here.

Certain types of harm to health and the environment are also outside the scope of this study. For example, the model framework underpinning the assessment of regional air pollutants needs to be extended to include valuation of ecological impacts and acid damage to cultural heritage.

Since this study was completed, the available impact assessment and valuation methodologies have improved. Further refinements are expected over coming years, not least through the continuing analysis to support the revision of EU air pollution policy. While the methods employed here are therefore subject to change, it is not anticipated that the results will change substantially in terms of the relative importance of individual sectors and pollutants.

At the same time, there are acknowledged uncertainties in assessing damage costs. These extend from the scientific knowledge concerning the impact of a given pollutant, to the exposure methods applied and the models used. The report therefore highlights a number of instances where caution is needed in interpreting the results.

For example, there is no single method available to estimate the damage costs for the pollutant groups addressed in the study (i.e. the regional air pollutants, heavy metals, organic micro-pollutants and carbon dioxide). Aggregating results from the different approaches therefore poses challenges, given differences in levels of uncertainty and questions about methodological consistency. For greenhouse gases in particular, a wider debate is required on how best to estimate the economic impacts of emissions on environment and health. The report at various places addresses the uncertainty by providing damage cost estimates that have been aggregated both with and without the estimated greenhouse gas damage costs.

While caution is urged in interpreting and using estimates that are aggregated across different pollutants, it is worth underlining that there is significant value in combining damage costs based on a common (monetary) metric. Such aggregated figures provide an insight into the costs of harm to health and the environment caused by air pollution.

Finally, the report identified several important ways in which the E-PRTR might be improved for use in assessment studies. These include:

- **Providing information on the fuel consumption or productive output of individual facilities.** This would enable the efficiency of facilities to be calculated in terms of estimated damage costs per unit of production or fuel consumption.
- **More complete reporting of emissions from individual facilities.** Ideally national regulators could further improve the review of facility information before it is reported to the E-PRTR, particularly to identify outlying values and address completeness of data. The latter clearly biases any ranking of facilities on the basis of damage costs against facilities whose operators have been more conscientious in reporting complete data.
- **Improved traceability of facilities.** Comparing the present study's results with those of previous studies on a facility-by-facility basis was difficult. While some older facilities may have closed since these earlier studies were performed, part of the problem relates to differences in the annual E-PRTR datasets received by the EEA. Facilities often change ownership, name, and/or national facility identification code, creating difficulties in linking the annually reported emissions.

In summary, this report presents a simplified methodology that allows for the estimation of damage costs caused by emissions of selected pollutants from industrial facilities included in the E-PRTR. It demonstrates that, compared to using emissions data alone, these methods provide additional insights and transparency into the costs of harm caused by air pollution. Such insights are particularly valuable in the context of current discussions in Europe on how best to move towards a resource-efficient and low-carbon economy. Moreover, the analysis can be further strengthened by integrating efficiency and productivity data for individual facilities into the analysis of damage costs.

1 Introduction

1.1 Background

The European Pollutant Release and Transfer Register (E-PRTR), established by the E-PRTR Regulation (EU, 2006), provides information on releases of 91 different pollutants to air, water and land from around 28 000 industrial facilities in the 27 EU Member States, Iceland, Liechtenstein, Norway and, from 2010, Serbia and Switzerland (E-PRTR, 2011). For the EU, the Register implements the UNECE (United Nations Economic Commission for Europe) PRTR Protocol to the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters.

The E-PRTR register thus provides environmental regulators, researchers and the public across Europe with information about pollution released from industrial farms, factories and power plants, and demonstrates that national regulators are aware of the size of emissions from specific facilities within their jurisdictions. By focusing on releases to the environment, the E-PRTR addresses potential burdens on health and the environment in a way that can be measured directly using well-established methods. A further strength is that data is annually updated; consistency in measuring and reporting emissions should permit comparisons across years for individual facilities so that the public can see whether emissions are rising or falling.

Knowledge of the magnitude of emissions does not in itself provide information on the impacts of air pollution on human health and the environment, however, or the associated monetary costs of such damage. Significant research has been undertaken in recent years to develop scientific modelling frameworks and economic methods that allow the impacts and damage costs associated with air pollution to be estimated. Such methods have been developed through research funded by the European Commission and Member States since the early 1990s, for example, under the under the European Commission's Clean Air For Europe (CAFE) programme (Holland et al., 2005a and 2005b; Hurley et al., 2005) and have been subject to international peer review (e.g. Krupnick et al., 2005).

In 2005, the CAFE programme, for example, estimated that the annual cost to human health and the environment from emissions of regional air pollutants across all sectors of the then EU-25 economy was EUR 280–794 billion for the year 2000.

In addition to the CAFE programme, such methods have been applied to inform the development of a considerable amount of European environmental legislation and a number of international agreements, including:

- The National Emission Ceilings Directive (EU, 2001b), setting total emission limits for SO_2, NO_x, NH_3 and NMVOCs for EU Member States, and the related Gothenburg Protocol to the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP Convention) (UNECE, 1999; Pye et al., 2007, Holland et al., 2011);
- The Air Quality Directives (EU, 2004a and 2008), setting concentration limits for pollutants in the ambient air (AEA Technology, 1997; Holland and King, 1998, Entec, 2001; Holland et al., 2001; Holland et al., 2005c);
- The Titanium Dioxide Directives (EU, 1978, 1982 and 1992) and the Large Combustion Plant Directive (EU, 2001a), feeding into the Industrial Emissions Directive (EU, 2010; Stewart et al., 2007);
- The Fuel Quality Directives (EU, 1999 and 2003; Bosch et al., 2009);
- Investigations of economic instruments for pollution control (e.g. Lavric et al., 2010).

There are acknowledged uncertainties in the scientific knowledge and modelling framework that underpins the assessment of damage costs. For example, it cannot yet provide quantification for all types of damage, particularly those relating to ecosystems. Methods are also still evolving, so calculated estimates of damage costs are not considered to be as 'accurate' as the emissions data. However, it is nevertheless possible to quantify a number of impacts and subsequent damage costs for a range of pollutants.

Box 1.1 General principles in assessing environmental externalities

In order to account for the external costs of air pollution, an individual pollutant's adverse impacts on human health and the environment are expressed in a common metric (a monetary value). Monetary values have been developed through cooperation between different scientific and economic disciplines, linking existing knowledge in a way that allows external costs to be monetised.

Damage costs incorporate a certain degree of uncertainty. However, when considered alongside other sources of information, damage costs can support decisions, partly by drawing attention to the implicit trade-offs inherent in decision-making.

1.2 Objectives

The present report describes a simplified modelling approach developed to assess, in monetary terms, the cost of damage to health and the environment from selected air pollutants released in 2009 from industrial facilities reporting to the pollutant register E-PRTR. The approach developed is based upon existing models and tools used to inform policymakers. The pollutants included within the scope of study include:

- the main regional and local air pollutants;
- certain heavy metals and organic micro-pollutants;
- the main greenhouse gas — carbon dioxide.

Applying the methodology to the E-PRTR dataset used in this study makes it possible to address various questions, for example:

- which industrial sectors and countries contribute most to air pollution's estimated damage costs in Europe?
- how many facilities are responsible for the largest share of estimated damage costs caused by air pollution?
- which individual facilities reporting to the E-PRTR pollutant register are responsible for the highest estimated damage costs?

On the last point, it is clear that some facilities will have high damage cost estimates simply because of their size and production or activity levels. It is possible that a large facility may be more efficient and cleaner than a number of smaller facilities that together deliver the same level of service or output. The opposite may also be true. However, as the E-PRTR does not routinely provide information on output by facilities it is not possible to use it to assess the environmental efficiency of production directly. To try to address this problem, the report investigates the use of proxy data to normalise the estimated damage costs per unit of production.

Finally, in using E-PRTR data and calculating damage costs from individual facilities, the report does not assess whether the emissions of a given facility are consistent with its legal conditions for operating. Furthermore, while presenting the damage costs for human health and the environment from industrial facilities, the report does not assess the recognised benefits of industrial facilities (such as the production of goods and products, and generating employment and tax revenues etc.). It is important that such benefits of industrial activity are also properly recognised.

2 Methods

This chapter provides an overview of the methods used and further detail on the approaches employed to quantify the benefits of reducing emissions of regional air pollutants, heavy metals and organic compounds, and greenhouse gases.

There has been extensive past debate about the methods used to estimate impacts and associated damage costs of regional air pollutants under the CAFE Programme, and some consensus (though not universal) has been reached in this area. There has been less debate, however, about the approach used for the heavy metals, trace organic pollutants and CO_2, so the methodology for these pollutants may be considered less robust.

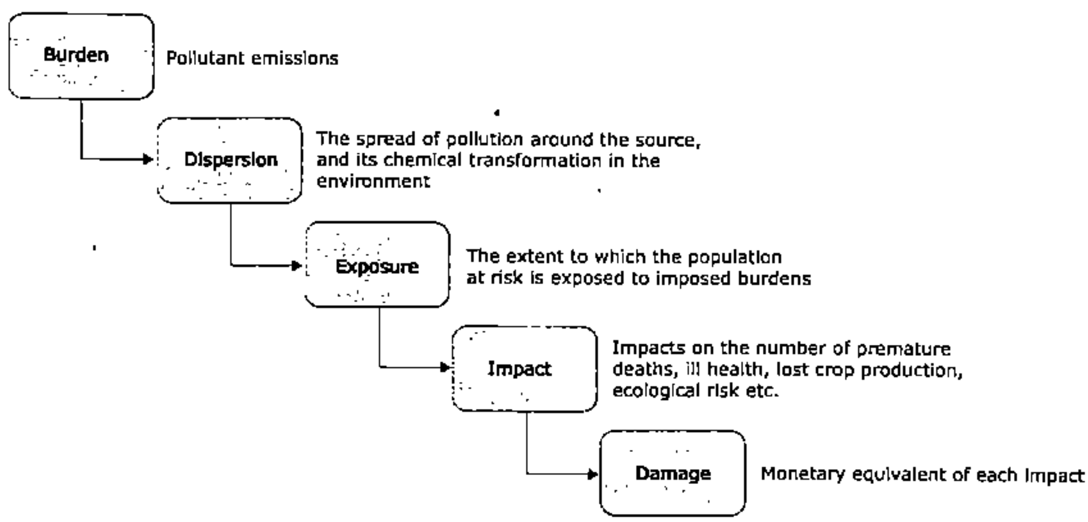
2.1 The impact pathway approach

The analysis presented here for all pollutants except CO_2 is based on the Impact Pathway Approach (IPA). This was originally developed in the 1990s in a collaborative programme, ExternE, between the European Commission and the US Department of Energy to quantify the damage costs imposed on society and the environment due to energy use (e.g. Bickel and Friedrich, 2005). It follows a logical, stepwise progression from pollutant emissions to determination of impacts and subsequently a quantification of economic damage in monetary terms (Figure 2.1).

Some pathways are fully characterised in a simple linear fashion as shown here. A good example concerns quantification of the effects on human health of particulate matter emissions, for which inhalation is the only relevant exposure route. In this case, it is necessary to quantify the pollutant emission, describe its dispersion and the extent to which the population is exposed, apply a concentration-response function and finally evaluate the economic impact. Pathways for other pollutants may be significantly more complex.

Figure 2.2 illustrates the case for pollutants such as some heavy metals and persistent organic

Figure 2.1 The impact pathway approach



compounds, where estimating total exposure may require information not just on exposure to pollutant concentrations in air but also on consumption of various types of food and drinks. In these cases it is possible that the inhalation dose may be only a small part of the total, with most impact associated with exposure through consumption.

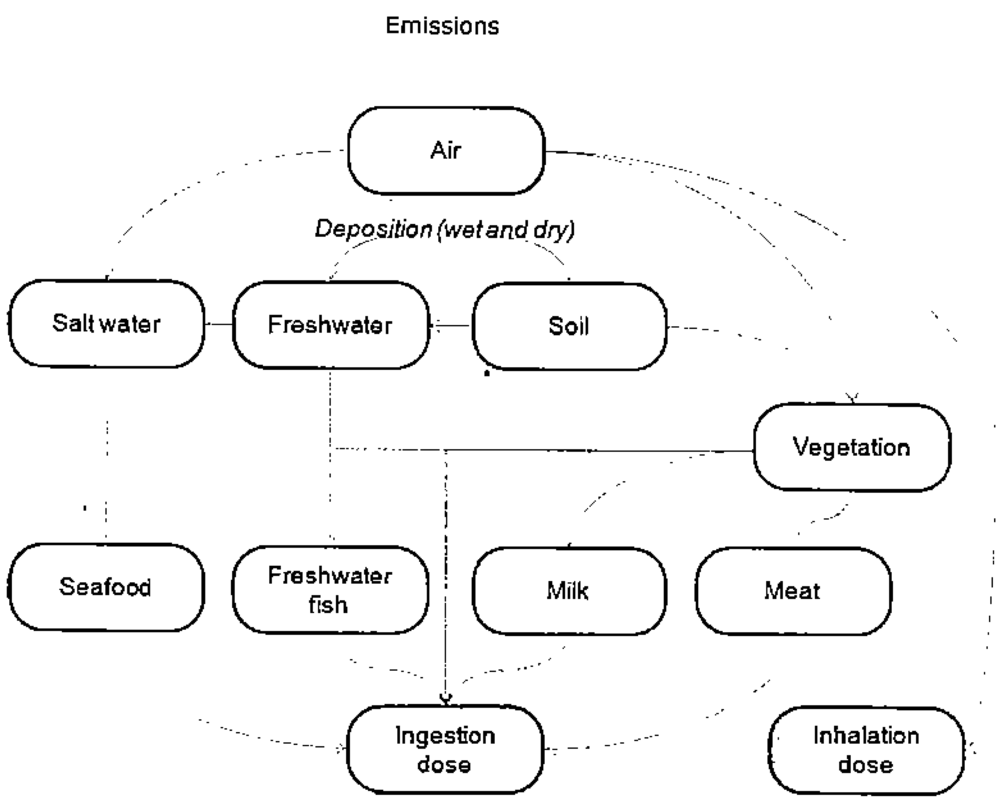
2.2 E-PRTR emissions data

The damage costs determined in this report are based upon the emissions to air of selected pollutants reported by 9 655 individual facilities to the pollutant register E-PRTR for the year 2009. The most recent version of the E-PRTR database available at the time of writing was used in the study (EEA, 2011). The pollutants selected were:

- the regional and local air pollutants: ammonia (NH_3), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), particulate matter (PM_{10}) and sulphur oxides (SO_x);
- heavy metals: arsenic, cadmium, chromium, lead, mercury and nickel,
- organic micro-pollutants: benzene, dioxins and furans, and polycyclic aromatic hydrocarbons (PAHs [1]);
- carbon dioxide (CO_2).

The E-PRTR register contains information for 32 countries — the 27 EU Member States and Iceland, Liechtenstein, Norway, Serbia and Switzerland. Country-specific damage costs (see Section 2.3) were not available for Iceland or Serbia, and so information for these countries was not included in the analysis.

Figure 2.2 Pathways taken into account for estimating health impacts of toxic air pollutants



(1) The derived damage costs for PAHs assume that PAH emissions are available as benzo-a-pyrene (BaP)-equivalents. In actuality, the E-PRTR Regulation (EU, 2006) requires emissions to be estimated for 4 PAH species, including BaP, on a mass basis.

The reliability of E-PRTR data is considered in Chapter 4, particularly with respect to completeness of information from facilities. One data point from the E-PRTR database was corrected prior to analysis as it appeared to have been reported incorrectly by three orders of magnitude when compared to the reported emissions of the other pollutants from the facility. This was the value for SO_x emissions from the 'Teplárna Strakonice' plant (facility ID 14301) in the Czech Republic for which the reported estimate of 1 250 000 tonnes of SO_x was taken to be 1 250 tonnes.

As described in Chapter 1, the E-PRTR provides information from specific industrial facilities. The E-PRTR Regulation (EU, 2006) defines the industrial sectors that must report information to the register. In addition, for this defined list of sectors, the Regulation includes reporting thresholds for both pollutants and activities. Facilities only have to report information to the register if their rate of activity exceeds the defined threshold and emissions of a given pollutant exceed the pollutant-specific thresholds.

In practice, this means that many smaller facilities do not report emissions to E-PRTR, and all facilities regardless of their size need only report emissions of those pollutants that exceed the respective thresholds. The E-PRTR register is therefore not designed to capture all emissions from industrial sectors.

To provide an illustration of the 'completeness' of the E-PRTR register, Table 2.1 provides a comparison of the aggregated emissions data for the selected pollutants in 2009 reported to E-PRTR, with the national total emissions for the same year reported by countries to the UNECE LRTAP Convention (UNECE, 1979) and for CO_2 under the EU Greenhouse Gas Monitoring Mechanism (EU, 2004b). The national totals include emission estimates for those sectors not included in E-PRTR, such as small industrial sources as well as 'diffuse' sources such as transport and households. Sources such as these, not included in the E-PRTR, can make a very substantial contribution to the overall population exposure. With the exception of SO_2, Table 2.1 shows that for most pollutants other sources not included in E-PRTR produce the majority of emissions. The damage costs estimated in this study therefore clearly do not represent the total damage costs caused by air pollution across Europe.

Table 2.1 Comparison of the emissions data reported to E-PRTR that were used in this study with national total emissions reported for the year 2009 by countries to the UNECE LRTAP Convention and, for CO_2, under the EU Greenhouse Gas Monitoring Mechanism

Pollutant	Emissions reported to E-PRTR (tonnes)	Aggregated national total emissions (tonnes)	% E-PRTR emissions of national totals
CO_2 (*)	1 881 831 000	42 568 284 670	44 %
NH_3	189 100	3 862 436	5 %
NMVOC	504 695	7 992 914	6 %
NO_x	2 567 861	9 631 276	27 %
PM_{10}	146 715	2 040 806	7 %
SO_x	3 360 553	5 044 091	67 %
Arsenic	31	188	16 %
Cadmium	13	96	14 %
Chromium	80	323	25 %
Lead	315	2 083	15 %
Mercury	31	75	41 %
Nickel	298	998	30 %
Benzene	3 477	N.A. (°)	–
PAHs	85	1 463	6 %
Dioxins and furans	0.00086	0.0020	43 %

Notes: (*) CO_2 reported to E-PRTR by facilities must include emissions from both fossil fuel and biomass. The value for the aggregated national total of CO_2 reported by countries to UNFCCC has thus had biomass CO_2 emissions added. These latter emissions are reported separately by countries, but are not included in the official national total values.

(°) 'N.A.' denotes 'not available'.

2.3 General approach

It is possible to model the pollution impacts arising from specific industrial facilities in detail. The ExternE Project has undertaken this type of work extensively since the early 1990s (CIEMAT, 1999). However, such intensive analysis would be extremely resource intensive and costly if the aim were to model simultaneously and in detail the individual emissions, dispersion and impacts from the approximately 10 000 facilities covered by the E-PRTR. Some methodological simplification is thus necessary.

The simplified analysis developed in this study applies the following approach:

1. Damage costs per tonne of each pollutant were quantified as a national average;
2. Factors to account for any systematic variation in damage cost per tonne between the national average and specific sectors were developed (e.g. to account for differences in the height at which emissions are released, which will affect dispersion and hence exposure of people and ecosystems);
3. E-PRTR emissions data for each facility were multiplied by the national average damage cost per tonne estimates for each reported pollutant, with the sector-specific adjustment factors applied where available.

The main modelling work undertaken in this study addressed the first of these steps. A detailed description of the modelling undertaken to develop national average damage costs per tonne of pollutant is provided in Annex 1 (for the regional and local air pollutants) and Annex 2 (for the heavy metals and organic micro-pollutants).

For the regional air pollutants NH_3, NO_x, NMVOCs, $PM_{2.5}$, and SO_2, the first step followed the approach described by Holland et al. (2005d) in developing marginal damage costs for inclusion in the BREF of Economics and Cross Media Effects (EIPPCB, 2006). Results in terms of damage cost per tonne of pollutant emission are different to those calculated earlier by Holland et al. (2005d), as updated dispersion modelling from the EMEP model has been used in the present analysis (see Annex 1).

The second step — introduction of sector-specific factors — used information from the Eurodelta II study (Thunis et al., 2008). Eurodelta II compared air quality modelling results from a number of European-scale dispersion models, including assessment of emission sources by sector. This enabled derivation of adjustment factors for four countries: France, Germany, Spain and the United Kingdom. For the present study, therefore, country-specific adjustment factors were applied to these four countries, and a sector-specific average value used to make adjustment for the other countries. This requires that the E-PRTR facilities are mapped onto the sector descriptions used by Eurodelta II. Further details are provided in Annex 3.

The Eurodelta II analysis is subject to certain limitations, for example:

- the geographic domain of the models used does not cover the full area impacted by emissions from countries included in the E-PRTR;
- assumptions on stack height for the different sectors appear simplistic.

However, using the Eurodelta II national sector adjustment values in this report addresses the concern that a blanket application of national average data would overestimate the damage costs attributed to industrial facilities.

In the final step — multiplying emissions data by the estimates of damage cost per tonne to quantify the total damage costs — PM_{10} data from the E-PRTR are converted to $PM_{2.5}$ by dividing by a factor of 1.54. This conversion is necessary for consistency with the damage functions agreed under the CAFE programme and the dispersion modelling carried out by EMEP.

Uncertainty is explicitly accounted for with respect to two main issues. The first concerns the method used for valuing mortality resulting from the regional and local pollutants. The second relates to inclusion or exclusion of damage cost estimates for CO_2. While there are numerous other uncertainties that could be accounted for these two issues are considered dominant for the present assessment.

Sections 2.3.1–2.3.3 describe in more detail the approaches used to determine the country-specific damage costs for the regional and local air pollutants, heavy metals and organic micro-pollutants, and CO_2. For the former two pollutant groups, additional methodological details are provided in the annexes to this report.

2.3.1 *Regional and local air pollutants*

Analysis of the impacts of regional and local air pollutant emissions (NH_3, NO_x, PM, SO_2 and NMVOC) (hereafter referred to as the regional pollutants) addresses effects on human health, crops and building materials assessed against exposure to $PM_{2.5}$, ozone and acidity. The health effects of SO_2, NO_x, NH_3 and NMVOCs result from the formation of secondary particulate matter and ozone through chemical reactions in the atmosphere. The possibility of direct health effects occurring as a result of direct exposure to NO_x and SO_2 is not ruled out but such effects are considered to be accounted for by quantifying the impacts of fine particulate matter exposure. Quantifying them separately would therefore risk a double counting of their effects.

An important assumption in the analysis is that all types of particle of a given size fraction (e.g. $PM_{2.5}$ or PM_{10}) are equally harmful per unit mass. Alternative assumptions have been followed elsewhere (e.g. in the ExternE project) but here the approach used in the CAFE analysis was employed, following the recommendations of the Task Force on Health (TFH) coordinated by WHO Europe under the Convention on Long-range Transboundary Air Pollution (LRTAP Convention). Some support for the TFH position comes from a recent paper by Smith et al. (2009), which suggested significant effects linked to sulphate aerosols.

This report does not quantify certain types of impact, for example ecosystem damage from acidic and nitrogen deposition and exposure to ozone, and acid damage to cultural heritage such as cathedrals and other fine buildings. This should not be interpreted as implying that they are unimportant. Rather, they are not quantified because of a lack of data at some point in the impact pathway.

Included in the estimation of damage costs of regional air pollutants is an extensive list of health impacts, ranging from mortality to days with respiratory or other symptoms of ill health. In economic terms the greatest effects concern exposure to primary and secondary particulate matter leading to mortality, the development of bronchitis and days of restricted activity including work-loss days.

Recognising methods developed elsewhere, a sensitivity analysis has been performed using two commonly applied methods for the valuing mortality — the value of statistical life (VSL) and the value of a life year (VOLY). The former is based on the number of deaths associated with air pollution while the latter is based upon the loss of life expectancy (expressed as years of life lost, or YOLLs). The values used in this report for VOLY and VSL are consistent with those used in the earlier CAFE programme. Use of the two methods follows the approach developed and discussed with stakeholders during the CAFE programme and used in the best available techniques reference document (BREF) on economics and cross media effects (EIPPCB, 2006).

The debate about the correct approach to use for mortality valuation does not extend to the other pollutants considered here — heavy metals and organic micro-pollutants. For these two pollutant groups, it is considered that exposure causes the onset of cancers or other forms of serious ill health that lead to a more substantial loss of life expectancy per case than for the regional air pollutants and hence that the use of the value of statistical life is fully appropriate.

The analysis of crop damage from exposure to ozone covers all of the main European crops. It does not, however, include assessment of the effects on the production of livestock and related products such as milk. Material damage from deposition of acidic or acidifying air pollutants was one of the great concerns of the acid rain debate of the 1970s and 1980s. Analysis here accounts for effects of SO_2 emissions on a variety of materials, the most economically important being stone and zinc/galvanised steel. Rates of damage have, however, declined significantly in Europe in recent decades in response to reduced emissions of SO_2, particularly in urban areas. Unfortunately it is not yet possible to quantify the damage costs caused by air pollution's impact on monuments and buildings of cultural merit.

Analysis of the effects of these regional pollutants is performed using the ALPHA-2 model, which is used elsewhere to quantify the benefits of European policies such as the Gothenburg Protocol and National Emission Ceilings Directive (e.g. Holland et al., 2005c; Holland et al., 2011). Further information on the methods used to quantify the effects of the regional air pollutants is given in Annex 1.

2.3.2 *Heavy metals and organic micro-pollutants*

As is the case for the major regional pollutants, assessment of the damage costs of heavy metals and organic micro-pollutants is incomplete, particularly with respect to quantifying ecosystem damage costs. Direct analysis for these pollutants focuses on health effects, particularly cancers but also, for lead and mercury, neuro-toxic effects leading to IQ loss and subsequent loss of earnings potential. The RiskPoll model has been adopted for this part of the work (Spadaro and Rabl, 2004, 2008a, 2008b). Further details of this part of the analysis are given in Annex 2. The Annex contains information on a more extensive list of pollutants than those covered in this report, demonstrating that the methods can be extended beyond the current scope of work.

Where appropriate, the analysis takes account of the types of cancer identified for each pollutant in developing the impact pathways for each. Exposure only comprises inhalation where lung cancer is the only observed effect of a particular substance. For others it is necessary to estimate total dose through consumption of food and drink as well as inhalation as shown in Figure 2.2. The valuation process takes account of the proportion of different types of cancer being fatal and non-fatal.

A complication arises because many of these pollutants are associated with particulate matter upon release. By taking account only of their carcinogenic and neuro-toxic properties and ignoring their possible contribution to other impacts of fine particulate matter it is possible that the total impact attributed to heavy metal and organic micro-pollutant emissions is underestimated. However, quantifying effects of particulate matter and some effects of the trace pollutants separately may imply a risk of double counting, at least with respect to fatal cancers [2]. This issue is discussed further in Chapter 4, where it is concluded that the overall effect of any double counting on the final results is very small, and that knowledge of the carcinogenic impact of these pollutants is useful.

2.3.3 *Greenhouse gases*

Monetisation of greenhouse gas emissions follows a different approach to that adopted for the other pollutants considered, using an estimate of marginal abatement costs. There are two reasons for using a control cost approach for greenhouse gas (GHG) emissions:

1. There are concerns over the very high uncertainty in estimates of climate costs. This uncertainty is unavoidable as damage is dependent on the future development of society, particularly with respect to population and economic growth, neither of which can be forecast with great confidence, and the extent to which value is attached to future events.
2. Where national emission ceilings effectively exist for GHGs (as under the Kyoto Protocol), the marginal effect of a change in emissions is not to alter the amount of damage that is done to health, infrastructure and the environment, but to change the cost of reaching the national ceiling. To assume otherwise assumes that countries are very willing to exceed the agreed emission reduction targets (abating emissions more than they are legally required to do). The difficulty in gaining international consensus on effective GHG controls suggests that this is unlikely at present.

There are issues with this approach in that the marginal costs of abatement for GHGs are subject to their own significant uncertainties, and that they are specific to a certain level of emission control. However, the use of an approach involving use of marginal abatement costs can be considered a pragmatic response to the problems faced in this part of the analysis.

The valuation adopted here for CO_2 emissions is EUR 33.6 per tonne, based on a methodology developed by the UK government for carbon valuation in public policy appraisal. The latest update of this methodology provides a central short-term traded price of carbon of GBP 29 per tonne CO_2-equivalent in 2020 (DECC, 2011). The present day exchange rate was used to convert the value in GBP to EUR. A value for the year 2020 was selected rather than, for example, the current spot trading price for carbon, to remove one element of uncertainty with respect to short-term price fluctuations affecting the value of the marginal abatement cost. The year 2020 is also the end of the phase III period of the EU Emissions Trading System. While it is stressed that this figure reflects the views of the United Kingdom government rather than a consensus-based estimate widely recognised across Europe, it is considered reasonably representative and consistent with other figures that have been discussed, either in relation to damage costs or abatement costs. For illustrative purposes, the UK methodology further recommends an increased value of carbon by 2030, with a central price of GBP 74 per tonne CO_2-equivalent.

(2) This does not apply to damage from neuro-toxic effects or the non-mortality costs of cancers related to healthcare, pain and suffering and loss of productivity.

As an illustration of the valuation for CO_2 used in this report with other approaches based upon the social cost of carbon (SCC), in its fourth assessment report, the Intergovernmental Panel on Climate Change (IPCC, 2007) highlighted both the uncertainties associated with estimating SCC and the very wide range of values that is available in the present literature. They identified a range for SCC between USD 4–95 per tonne CO_2 (equivalent at present-day exchange rates to approximately EUR 3–70 per tonne CO_2). The valuation adopted in this report of EUR 33.6 per tonne, reflecting the marginal costs of abatement, is therefore around mid-range of the IPCC's suggested range even through the two valuations are based on very different valuation approaches.

Recognising the uncertainties surrounding the valuation of damage costs from CO_2, the results in Chapter 3 are therefore presented both with and without CO_2-related impacts. One advantage of doing this is that it gives better recognition of operators that have taken action to reduce emissions of other air pollutants, such as acidic gases, particulate matter and heavy metals. It is clear, however, that a wider debate is required on how better to estimate the economic impacts of greenhouse gas emissions on the environment and health.

3 Results

The results of this work are described in three parts. The first set of results (Section 3.1) describes the national damage cost per tonne of emission determined for each of the selected pollutants. These results are the stepping stone linking emissions and the final damage cost estimates. Section 3.2 presents the damage cost estimations at the level of individual facilities. Section 3.3 then provides results aggregated in various ways, for example by pollutant, sector and country.

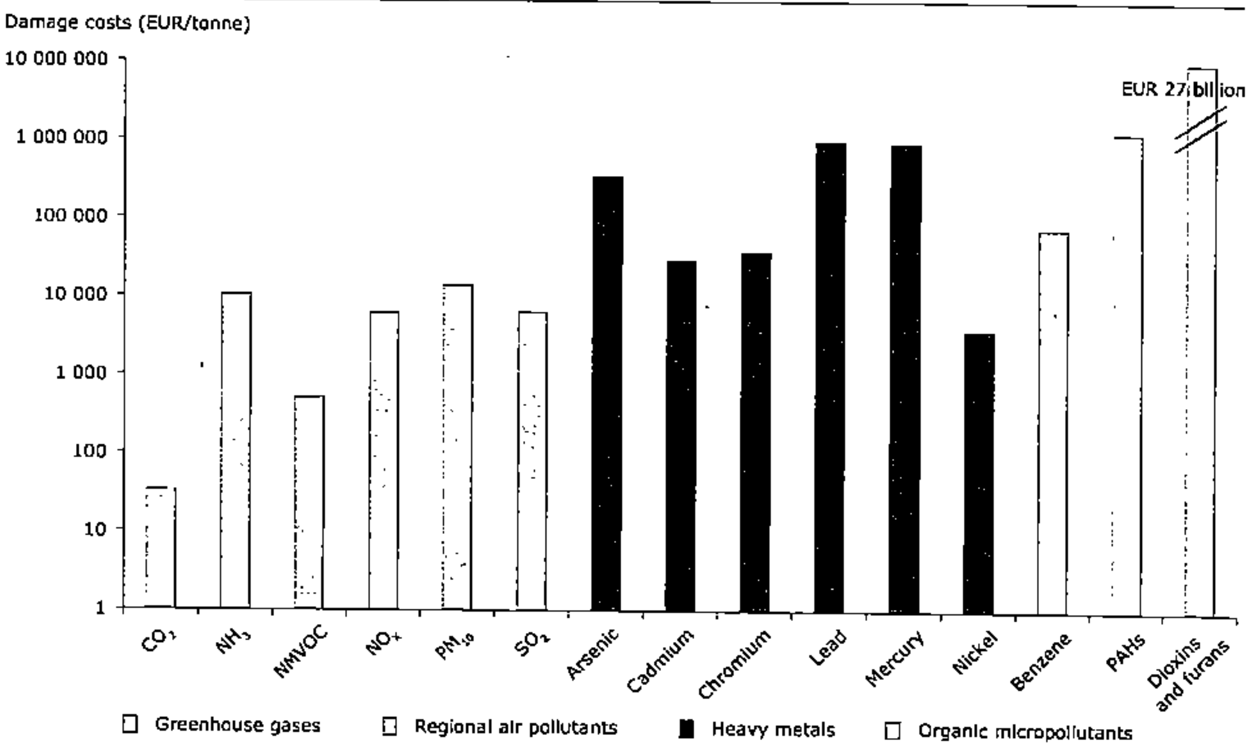
3.1 Damage cost per tonne of pollutant

This section provides an overview of the average damage cost per tonne of pollutant emitted from each country. Full results for each country are provided in Annexes 1 and 2.

Figure 3.1 shows how the quantified damage costs per unit of emission vary between pollutants. For illustrative purposes, data have been averaged across countries for those pollutants where the location of release strongly influences the damage caused (i.e. for all of the selected pollutants except CO_2, lead and mercury).

Taking the logarithmic scale into account, Figure 3.1 shows, not surprisingly, that the damage cost per tonne emitted values vary substantially between pollutants with nine orders of magnitude difference between the values for CO_2 and dioxins. There is a rough ordering of the different pollutant groups, with the organic micro-pollutants the most hazardous per unit of emission, followed by the heavy metals, regional pollutants, and finally CO_2. Issues relating to the scale of the damage per tonne estimates for arsenic, cadmium, chromium and nickel, relative to estimates for fine particulate matter, are discussed further in Chapter 4.

Figure 3.1 Estimates of the European average damage cost per tonne emitted for selected air pollutants (note the logarithmic scale on the Y-axis)



For several pollutants, the country-specific estimated damage costs per unit of emission provided in Annexes 1 and 2 vary significantly among emitting countries for various reasons. For example:

- The density of sensitive receptors (people, ecosystems) varies significantly around Europe. Finland, for example, has a population density of 16 people/km², compared to Germany with 229/km².
- Some emissions disperse out to sea and do not affect life on land, an issue clearly more prominent for countries with extensive coastlines such as the United Kingdom or Ireland compared to landlocked countries such as Austria or Hungary.

For some pollutants the site of release is relatively unimportant in determining the magnitude of damage costs. Persistent pollutants, CO_2 and mercury are good examples, although their impacts are differ greatly.

Figure 3.2 illustrates these issues, showing variation in the average damage costs attributed to PM_{10} in each country, with a factor six difference between the country with the lowest damage cost per tonne (Estonia) and the highest (Germany). The countries with the lowest damage cost per tonne estimates tend to be at the edges of Europe, particularly the eastern edge, while the countries with the highest damage costs are close to the centre of the continent.

Figure 3.2 also shows the sensitivity of results to the methods (VOLY and VSL) used for valuing mortality — producing a factor 2.8 difference between the two sets of values.

3.2 Damage cost estimates for E-PRTR facilities

Using the country-specific damage costs per unit emission as described in the preceding section, it is possible to quantify the damage costs caused by each facility reported under the E-PRTR by multiplying the emissions of the selected pollutant from each facility by the respective damage cost per tonne for each pollutant.

Table 3.1 lists the 20 facilities estimated to cause the greatest damage costs for the selected pollutants. All facilities are categorised within E-PRTR as being

Figure 3.2 Variation across Europe in national average damage cost per tonne PM_{10} emission and illustrating the alternative approaches used for valuing mortality

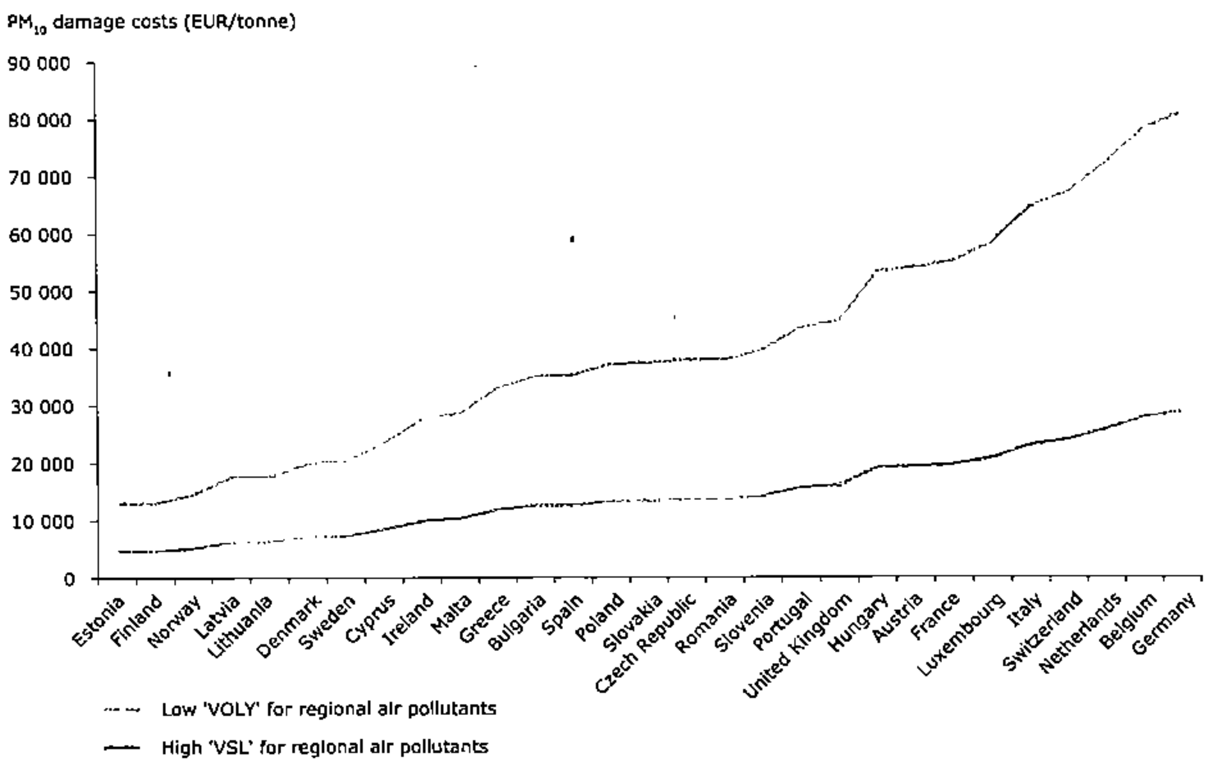


Table 3.1 The top 20 E-PRTR facilities (all of which are power generating facilities) estimated as having the greatest damage costs from emissions of selected pollutants to air, based on data for 2009

No	E-PRTR facility ID	Facility name	Country	Emissions (tonnes)				Estimated damage cost per pollutant group (million EUR)				Aggregated damage cost (million EUR)	
				CO_2	NO_x	SO_x	PM_{10}	CO_2	Regional air pollutants VOLY low	Regional air pollutants VSL high	Heavy metals and organic micro-pollutants	VOLY low	VSL high
1	1298	PGE Elektrownia Bełchatów S.A.	Poland	29 500 000	42 900	50 700	1 810	991	557	1 525	1.9	1 550	2 518
2	99010	TETs Maritsa Iztok 2, EAD	Bulgaria	9 630 000	11 700	290 000	N.R.	324	1 108	3 015	N.R.	1 432	3 339
3	143123	Vattenfall Europe Generation AG Kraftwerk Jänschwalde	Germany	23 600 000	18 200	21 400	675	793	439	1 209	0.3	1 232	2 002
4	140663	RWE Power AG Bergheim	Germany	26 300 000	15 400	6 420	440	884	246	676	0.4	1 130	1 560
5	13777	Drax Power Limited	United Kingdom	20 500 000	38 400	27 800	362	689	337	935	0.2	1 026	1 625
6	149935	Complexul Energetic Turceni	Romania	6 070 000	15 400	106 000	1 320	204	684	1 878	0.4	889	2 082
7	140709	RWE Power AG Eschweiler	Germany	19 200 000	12 300	3 360	396	645	178	490	0.3	824	1 135
8	140418	RWE Power AG Kraftwerk Neurath	Germany	17 900 000	12 300	3 630	281	601	180	493	0.2	781	1 095
9	140358	RWE Power AG Kraftwerk Frimmersdorf	Germany	16 800 000	10 500	5 280	289	564	177	487	0.2	742	1 051
10	198	PGE Elektrownia Turów S.A.	Poland	11 700 000	11 800	40 600	1 400	393	329	906	N.R.	722	1 299
11	144585	Vattenfall Europe Generation AG Kraftwerk Boxberg	Germany	15 300 000	9 790	8 170	180	514	198	545	0.5	713	1 059
12	14192	PPC S.A. SES Megalopolis A'	Greece	4 460 000	3 090	184 000	5 590	150	541	1 459	1.0	692	1 609
13	4951	Elektrownia 'Kozienice' S.A.	Poland	10 900 000	21 200	32 200	711	366	320	878	1.6	688	1 246
14	144664	Vattenfall Europe Generation AG Kraftwerk Lippendorf	Germany	12 800 000	8 590	14 000	95.3	430	245	675	1.9	677	1 107
15	14245	PPC S.A. SES Agioy Dhmhtrioy	Greece	12 900 000	24 800	58 000	471	433	194	509	1.8	629	944
16	149936	Complexul Energetic Rovinari	Romania	5 110 000	11 800	63 500	2 400	172	439	1 204	0.3	611	1 376
17	12825	Elektrárny Prunéřov	Czech Republic	9 070 000	17 100	15 800	628	305	236	644	0.7	541	949
18	118084	Centrale Termoelettrica Federico II (BR Sud)	Italy	13 000 000	7 300	6 540	473	437	99	270	0.4	536	707
19	155619	Longannet Power Station	United Kingdom	7 390 000	15 200	32 200	459	248	278	769	0.4	527	1 018
20	143135	Vattenfall Europe Generation AG Kraftwerk Schwarze Pumpe	Germany	10 700 000	4 190	8 200	91.1	360	135	371	0.3	495	731

Notes: 'N.R.' denotes 'not reported'.
For the regional air pollutants, the low-high range shows the differing results derived from the alternative approaches to mortality valuation.
Heavy metal and organic micro-pollutants are not shown. Two facilities in the top 20 list, 'TETs Maritsa Iztok 2, EAD' and 'PGE Elektrownia Turów S.A.' did not report emissions of these pollutants; all other facilities reported emissions of at least one of the individual pollutants within these categories.
Emissions of NMVOC and NH3 not shown. Just two facilities,' Drax Power Limited' and 'Elektrownia KOZIENICE S.A.' reported emissions of these pollutants. It is noted, however, that emissions of these pollutants from power generating facilities may not always be above the E-PRTR reporting threshold.

thermal power stations (i.e. power plants generating electricity and or heat). Eight of these facilities are located in Germany, three in Poland, two each in Greece, Romania and the United Kingdom, and one in Bulgaria, the Czech Republic and Italy. Emissions data confirm that all of the facilities listed are large, with CO_2 emissions of between 4.4 million and 30 million tonnes per year.

It is also clear from Table 3.1 that the facilities do not always appear to be reporting complete emissions data to E-PRTR. For example, the Bulgarian facility ranked second in terms of its overall damage costs, 'TETs Maritsa Iztok 2, EAD', has not reported emissions of PM_{10} to E-PRTR for the year 2009; all other facilities did. Similarly of the top 20 facilities, neither 'TETs Maritsa Iztok 2, EAD' nor 'PGE Elektrownia Turów S.A.' reported emissions of the individual heavy metals or organic micro-pollutants, despite all other facilities having reported emissions for at least one pollutant within these groups. Likely omissions such as these clearly bias any ranking of facilities against facilities whose operators have been more conscientious in reporting complete data.

Table 3.2 shows that these 20 facilities were among the total of only 69 facilities that emitted more than 4.5 million tonnes in 2009 (of the 2 204 facilities that reported CO_2 emissions within the E-PRTR). All 14 facilities emitting more than ten million tonnes of CO_2 per year are included in the list of the 20 facilities with highest damage costs. Their presence in this top 20 list is therefore attributable in significant part to their size.

Table 3.2 Distribution of CO_2 emissions reported in the E-PRTR for the 20 facilities with the highest damage costs

Emission (tonne)	Number of the 20 facilities with the highest damage costs	Total number from the 2 204 facilities reporting CO_2 in E-PRTR
> 4.5 million	20	69
> 10 million	14	14
> 15 million	8	8
> 20 million	4	4
> 25 million	2	2

Figure 3.3 Cumulative distribution of damage costs for the 2 000 E-PRTR facilities with the highest estimated damage costs (including CO_2)

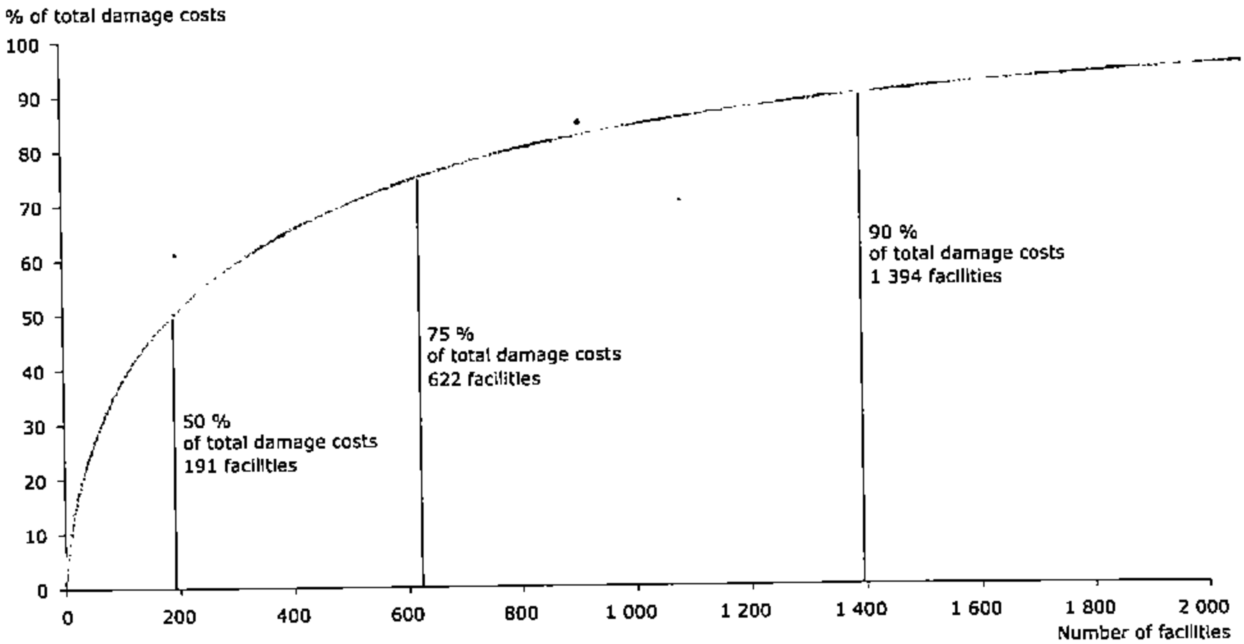


Figure 3.3 shows the cumulative distribution of the estimated damage costs for the 2 000 E-PRTR facilities with the highest estimated damage costs. A small number of individual facilities cause the majority of the damage costs. Fifty per cent of the total damage cost occurs as a result of emissions from just 191 (or 2 %) of the approximately 10 000 facilities that reported data for releases to air.

Map 3.1 shows the geographical distribution of these 191 facilities. Three quarters of the total damage costs are caused by the emissions of 622 facilities, which is 6 % of the total number, and 90 % of damage costs are attributed to 1 394 facilities.

Another factor that needs to be considered to gain a proper understanding of these results is the efficiency of production at different sites. The E-PRTR does not provide production or fuel consumption data so a direct assessment of the environmental efficiency of facilities relative to output (or fuel consumption) is not possible. For the purposes of the present report, CO_2 emissions are taken to be a proxy for fuel consumption because (accepting that efficiency will vary between facilities) CO_2 emissions will have a closer relationship with power production and productivity than any of the other data available.

Table 3.3 presents the same 20 facilities as before, ordered according to the estimated damage costs per tonne of CO_2. The most obvious difference between the rankings in Table 3.1 and Table 3.3 is that all except one of the eight German facilities now fall into the lower half of the second table, suggesting that they contribute less damage cost per unit fuel consumption or, in other words, they are more environmentally efficient within this group of 20 facilities. Conversely, more facilities from Eastern Europe now appear among the 10 facilities with the highest damage costs.

Map 3.1 Location of the 191 E-PRTR facilities that contributed 50 % of the total damage costs estimated for 2009

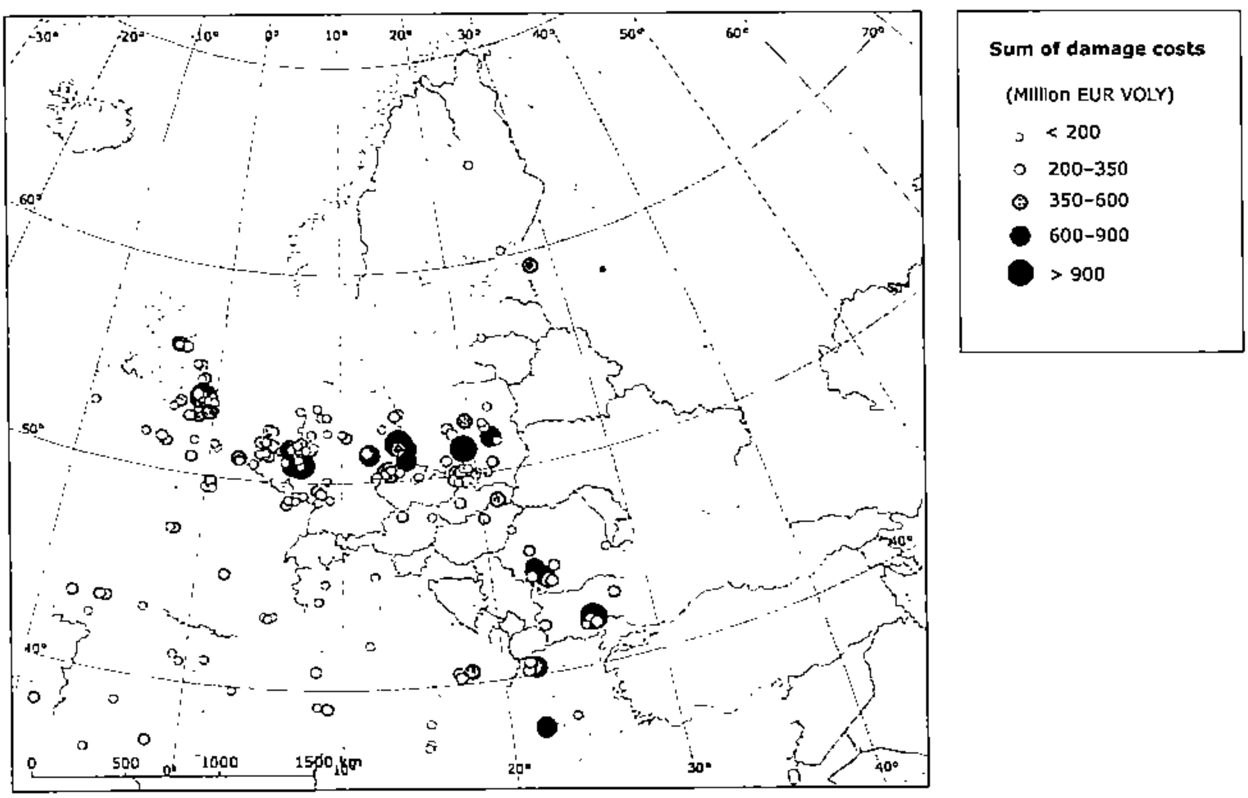


Table 3.3 Aggregated damage costs by facility for the top 20 facilities normalised per unit CO_2 emission (as a proxy for output)

No	E-PRTR facility ID	Facility	Country	Aggregated damage cost per tonne CO_2 (EUR/tonne CO_2)	
				VOLY low	VSL high
1	14192	PPC S.A. SES Megalopolis A'	Greece	155	361
2	99010	TETs Maritsa Iztok 2 – EAD	Bulgaria	149	347
3	149935	Complexul Energetic Turceni	Romania	146	343
4	149936	Complexul Energetic Rovinari	Romania	120	269
5	155619	Longannet Power Station	United Kingdom	71	138
6	4951	Elektrownia Kozienice S.A.	Poland	63	114
7	198	PGE Elektrownia Turów S.A.	Poland	62	111
8	12825	Elektrárny Prunéřov	Czech Republic	60	105
9	144664	Vattenfall Europe Generation AG Kraftwerk Lippendorf	Germany	53	86
10	1298	PGE Elektrownia Bełchatów S.A.	Poland	53	85
11	143123	Vattenfall Europe Generation AG Kraftwerk Jänschwalde	Germany	52	85
12	13777	Drax Power Limited, Drax Power Ltd	United Kingdom	50	79
13	14245	PPC S.A. SES Agioy Dhmhtrioy	Greece	49	73
14	144585	Vattenfall Europe Generation AG Kraftwerk Boxberg	Germany	47	69
15	143135	Vattenfall Europe Generation AG Kraftwerk Schwarze Pumpe	Germany	46	68
16	140358	RWE Power AG Kraftwerk Frimmersdorf	Germany	44	63
17	140418	RWE Power AG Kraftwerk Neurath	Germany	44	61
18	140663	RWE Power AG	Germany	43	59
19	140709	RWE Power AG	Germany	43	59
20	118084	Centrale Termoelettrica Federico II (BR SUD)	Italy	41	54

Table 3.4 Aggregated damage costs for all E-PRTR facilities normalised per unit CO_2 emission (as a proxy for output)

No	E-PRTR facility ID	Facility	Sector	Country	Aggregated damage cost per tonne CO_2 (EUR/tonne CO_2)	
					VOLY low	VSL high
1	13067	Hanson Building Products Limited, Whittlesey Brickworks	Manufacture of ceramic products incl. tiles, bricks, etc.	United Kingdom	526	1 385
2	7831	Centrale électrique de pointe des carrières	Power generation	France	307	764
3	7689	Central de Escucha	Power generation	Spain	285	722
4	143993	Aurubis AG	Production of smelting of non-ferrous crude metals	Germany	263	641
5	99009	TETs 'Maritsa' AD Dimitrovgrad	Power generation	Bulgaria	241	598
6	4884	EDF — Centrale Thermique du PORT	Power generation	France	236	574
7	132431	Central Diesel de Melilla	Power generation	Spain	218	511
8	98893	Gorivna instalatsias nominalna toplinna moshtnost	Power generation	Bulgaria	216	530
9	7808	Centrale De Jarry-Nord	Power generation	France	210	506
10	99021	TETs 'Republika'	Power generation	Bulgaria	207	514
11	7832	Centrale De Bellefontaine	Power generation	France	197	473
12	149940	Regia Autonoma Pentru Activitati Nucleare — Sucursala Romag Termo	Power generation	Romania	197	482
13	149945	SC CET Govora SA	Power generation	Romania	185	449
14	149973	SC Electrocentrale Oradea SA	Power generation	Romania	179	434
15	4930	Centrale thermique de Lucciana	Power generation	France	171	401
16	149951	SC CET ARAD SA — pe lignit	Power generation	Romania	170	410
17	138430	Arcelormittal Upstream sa (Coke Fonte)	Production of pig iron or steel	Belgium	166	363
18	11124	Rafinérie Litvínov	Mineral oil and gas refineries	Czech Republic	162	386
19	5166	Guardian Orosháza Kft.	Manufacture of glass	Hungary	162	381
20	143642	Euroglas GmbH	Manufacture of glass	Germany	160	381

Table 3.5 The 20 facilities with the highest estimated damage costs from emissions to air (excluding CO_2)

No	Number of facility in Table 3.1	E-PRTR facility ID	Facility name	Country	Emissions (tonnes)			Estimated damage cost per pollutant group (million EUR)			Aggregated damage cost (million EUR)	
					NO_x	SO_x	PM_{10}	Regional air pollutants VOLY low	Regional air pollutants VSL high	Heavy metals and organic micro-pollutants	VOLY low	VSL high
1	2	99010	'TETs Maritsa Iztok 2' EAD	Bulgaria	11 700	290 000	N.R.	1 108	3 015	N.R.	1 108	3 015
2	6	149935	Complexul Energetic Turceni	Romania	15 400	106 000	1 320	684	1 878	0.4	685	1 878
3	1	1298	PGE Elektrownia Bełchatów S.A.	Poland	42 900	50 700	1 810	557	1 525	1.9	559	1 527
4	12	14192	PPC S.A. SES Megalopolis A'	Greece	3 090	184 000	5 590	541	1 459	1.0	542	1 460
5	3	143123	Vattenfall Europe Generation AG Kraftwerk Jänschwalde	Germany	18 200	21 400	675	439	1 209	0.3	440	1 209
6	16	149936	Complexul Energetic Rovinari	Romania	11 800	63 500	2 400	439	1 204	0.3	439	1 204
7	5	13777	Drax Power Limited, Drax Power Ltd	United Kingdom	38 400	27 800	362	337	935	0.2	337	936
8	10	198	PGE Elektrownia Turów S.A.	Poland	11 800	40 600	1 400	329	906	N.R.	329	906
9	13	4951	Elektrownia 'Kozienice' S.A.	Poland	21 200	32 200	711	320	878	1.6	322	880
10		149940	Regia Autonoma Pentru Activitati Nucleare – Sucursala Romag Termo	Romania	2 580	49 800	777	290	798	0.1	290	798
11	19	155619	Longannet Power Station	United Kingdom	15 200	32 200	459	278	769	0.4	278	770
12		149932	Sucursala Electrocentrale Isalnita	Romania	3 520	44 800	1 210	273	750	N.R.	273	750
13		98893	Gorivna Instalatsias nominalna toplinna moshtnost	Bulgaria	1 490	70 700	N.R.	264	719	N.R.	264	719
14		140394	ThyssenKrupp Steel Europe AG Werk Schwelgern	Germany	5 280	10 300	1 060	235	648	25.0	260	673
15		9701	Slovenské elektrárne a.s. – Elektrárne Nováky, závod	Slovakia	3 820	32 400	N.R.	255	703	0.2	255	703
16	14	144664	Vattenfall Europe Generation AG Kraftwerk Lippendorf	Germany	8 590	14 000	95.3	245	675	1.9	247	677
17	4	140663	RWE Power AG Bergheim	Germany	15 400	6 420	440	246	676	0.4	246	676
18		99007	TETs 'Bobov dol'	Bulgaria	4 840	53 100	3 850	239	651	N.R.	239	651
19	17	12825	Elektrárny Prunéřov	Czech Republic	17 100	15 800	628	236	644	0.7	236	644
20		149956	SC Electrocentrale Deva SA	Romania	10 400	26 200	1 200	221	605	N.R.	221	605

Note: Shaded cells indicate those facilities also included in Table 3.1.

'N.R.' denotes 'not reported'.

If this analysis is extended to all E-PRTR facilities and not just to the list of those 20 facilities with the highest estimated aggregated damage costs then the ranking alters significantly (Table 3.4). When all facilities have their damage costs normalised by CO_2 emissions, the facilities that were previously included in the top 20 now appear a long way down the ranking. To illustrate, the top five facilities shown in Table 3.3 would appear in positions 24, 29, 32, 59, and 290 if Table 3.4 were extended to include all facilities.

It is also useful to consider the ranking of facilities when emissions of CO_2 are not included, because this will highlight the extent to which operators have reduced what might be termed the 'traditional' air pollutants. Table 3.5 shows the facilities having the highest estimated damage costs when CO_2 is not included.

Seven facilities that were not in the original list of the 20 facilities with the highest aggregated damage costs (Table 3.1) now appear in the new listing (these are the non-shaded entries in Table 3.5). The clearest difference between the tables is the reduction in facilities from Germany (down from eight to four) and the increase in facilities from Romania (up to five from two) and Bulgaria (from one to three). The presence of so many facilities from Bulgaria and Romania in the list is perhaps not surprising given that these countries are the newest entrants to the EU and hence may still have been in the process of fully implementing relevant legislation. At least for some facilities, action to further reduce emissions from these sites is understood to be under way, so it is possible that significant improvements will be seen in the data reported to E-PRTR in the future.

3.3 Aggregated damage costs

Total emissions of each pollutant from the E-PRTR are shown in Figure 3.4. The emissions of differing pollutants vary in scale by twelve orders of magnitude. Emissions are dominated by CO_2, followed by the regional pollutants and heavy metals. Reported emissions of organic micro-pollutants are so small (under 2 kg for dioxins) they are not visible on the graph. The ordering of pollutants by emission is roughly the reverse of the ordering by damage cost per tonne as shown in Figure 3.1. Thus, those pollutants that are most hazardous per unit emission tend to be emitted in the smallest quantities.

Figure 3.4 Aggregated annual emissions to air of selected pollutants from E-PRTR in 2009 (note the logarithmic scale on the Y-axis)

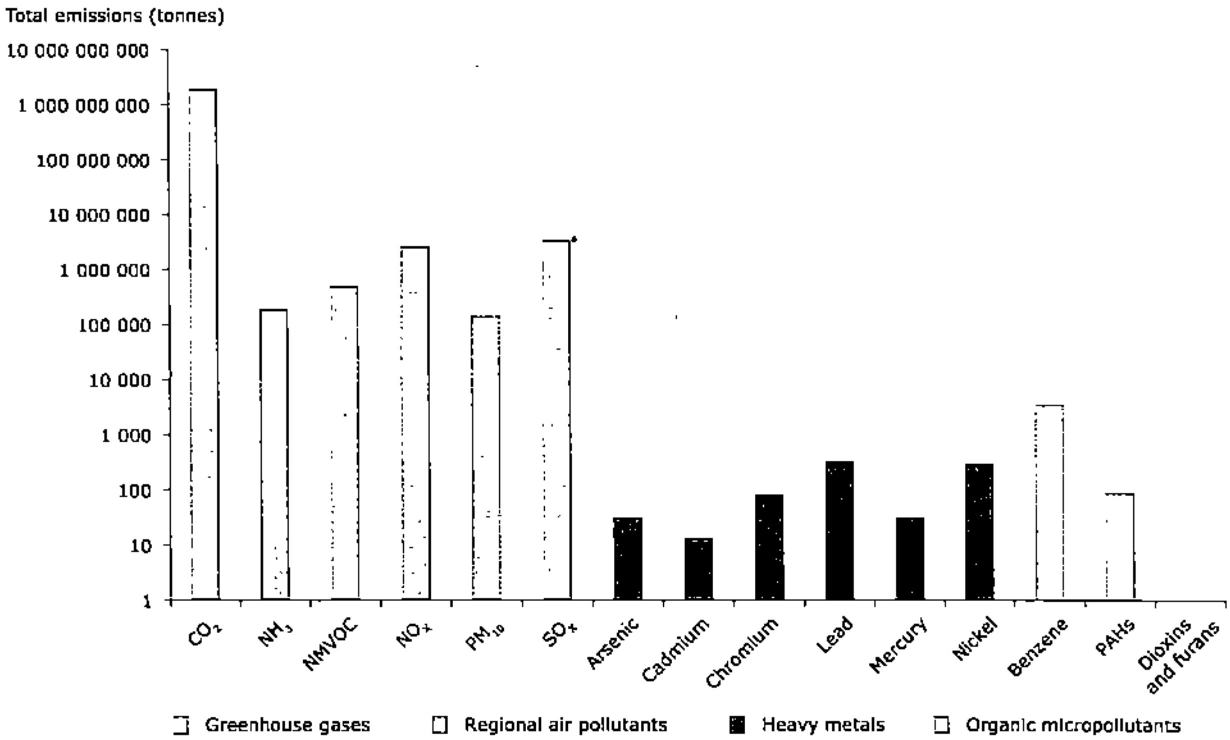
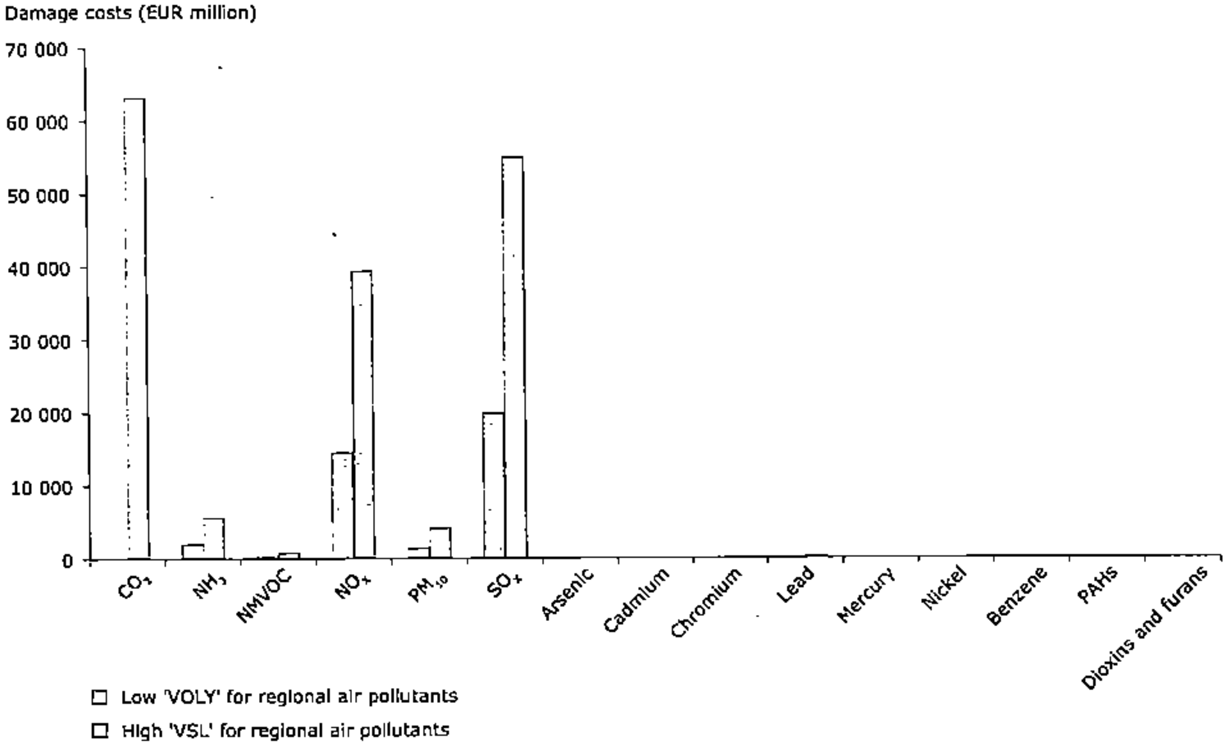


Figure 3.5 Aggregated damage costs by pollutant



Note: The blue bars for the regional pollutants represent the lower bound figures for the valuation of mortality calculated using the VOLY approach, green bars are for cases where the VSL approach has been applied to mortality valuation.

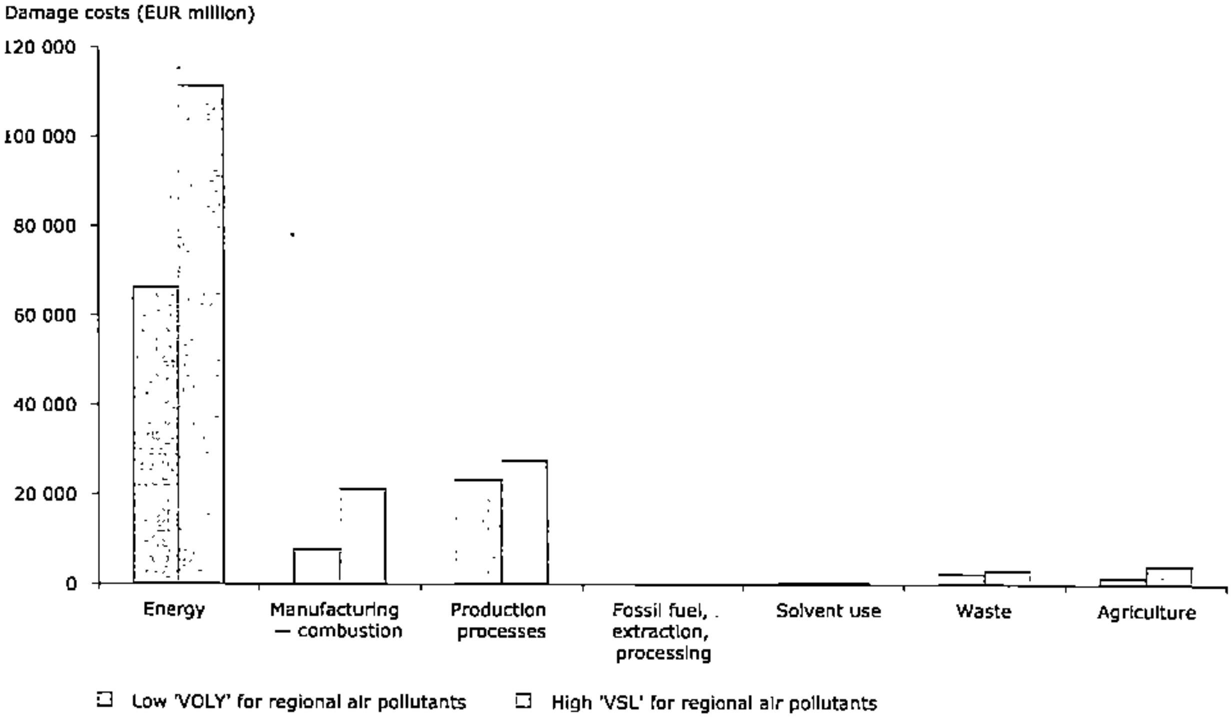
Table 3.6 Estimated damage costs aggregated by pollutant group (2005 prices)

Pollutant group	Aggregated damage cost (billion EUR)
CO_2	63
Regional air pollutants (NH_3, NO_x, PM_{10}, SO_2, NMVOCs)	38–105
Heavy metals (As, Cd, Cr, Hg, Ni, Pb)	0.35
Organic micro-pollutants (benzene, dioxins and furans, PAHs)	0.13

Multiplying the country-specific estimates of damage cost per tonne of pollutant, corrected where appropriate to account for differences between sectors, by the E-PRTR emissions generates the total damage cost estimates by pollutant presented in Figure 3.5 and Table 3.6. The order of pollutants by damage cost is CO_2, SO_2, NO_x, PM_{10}, NH_3 and NMVOC, followed by the heavy metals and then the organic micro-pollutants. Quantified damage costs from the metals and organics is small relative to the other pollutants.

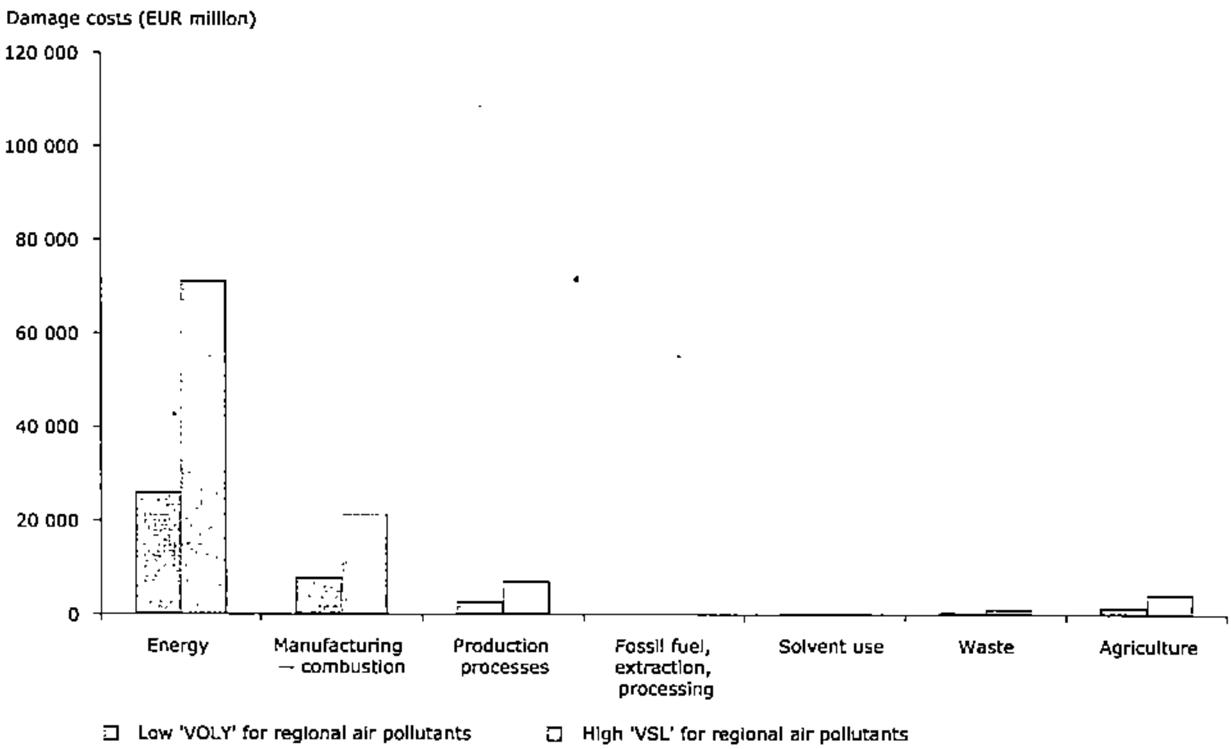
Figures 3.6 and 3.7 illustrate which sectors generate the largest damage costs (with and without the damage cost arising from CO_2 emissions). The low/high ranges reflect the variation in results from the alternative approaches to valuing mortality for the regional air pollutants (NH_3, NO_x, PM_{10}, SO_2 and NMVOCs) in line with the CAFE methodology. Other sources of uncertainty are not considered. The dominant sectors contributing the highest aggregated damage costs are energy and then manufacturing and production processes.

Figure 3.6 Damage costs aggregated by sector including CO_2



Note: The low-high range shows the differing results derived from the alternative approaches to mortality valuation for the regional pollutants.

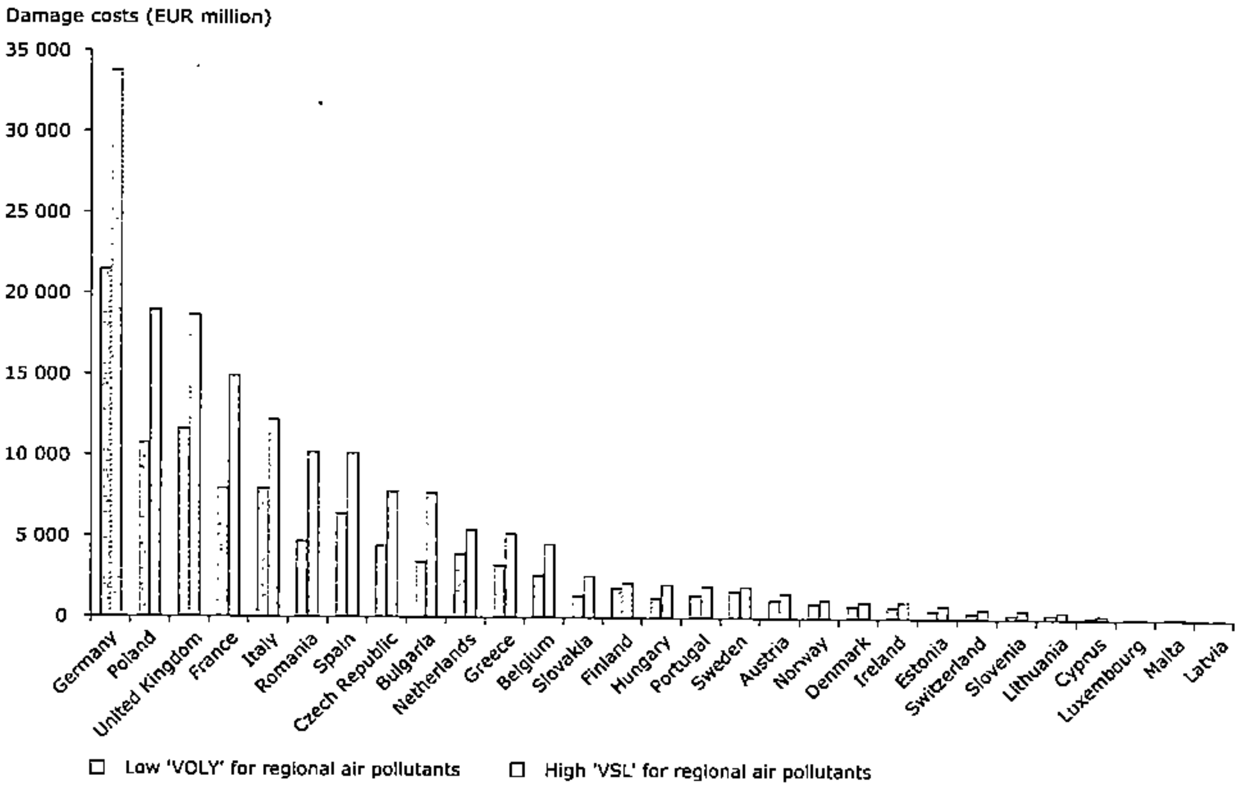
Figure 3.7 Damage costs aggregated by sector excluding CO_2



Note: The low-high range shows the differing results derived from the alternative approaches to mortality valuation for the regional pollutants.

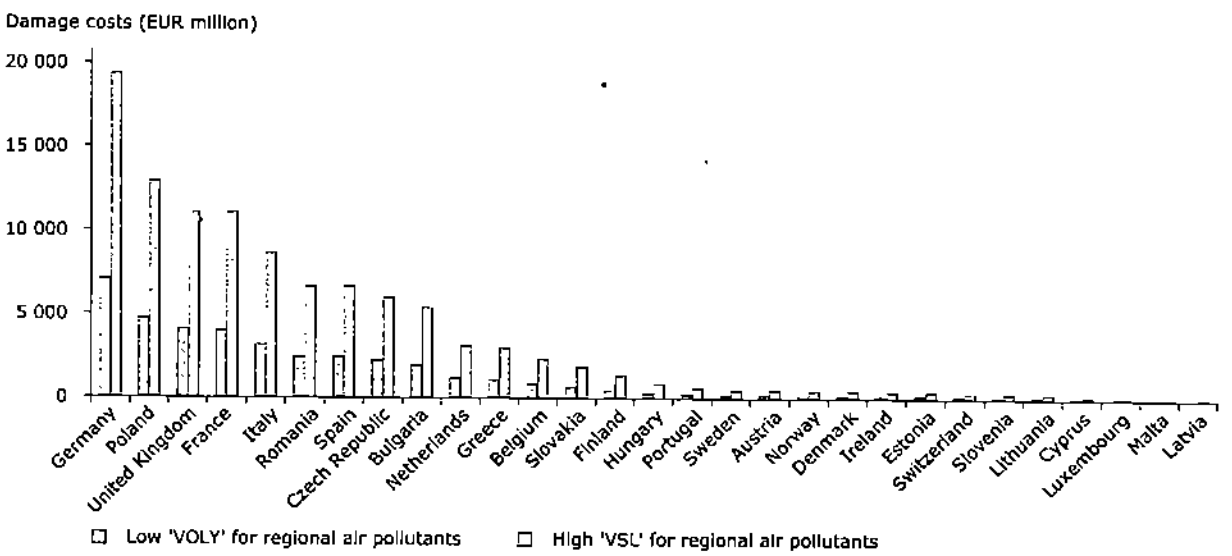
Results are aggregated by country (with and without CO_2) in Figures 3.8 and 3.9. The highest aggregate damage costs are, unsurprisingly, attributed to the larger countries and those with more polluting facilities.

Figure 3.8 Aggregated damage costs by country, including CO_2



Note: The low-high range shows the differing results derived from the alternative approaches to mortality valuation for the regional pollutants.

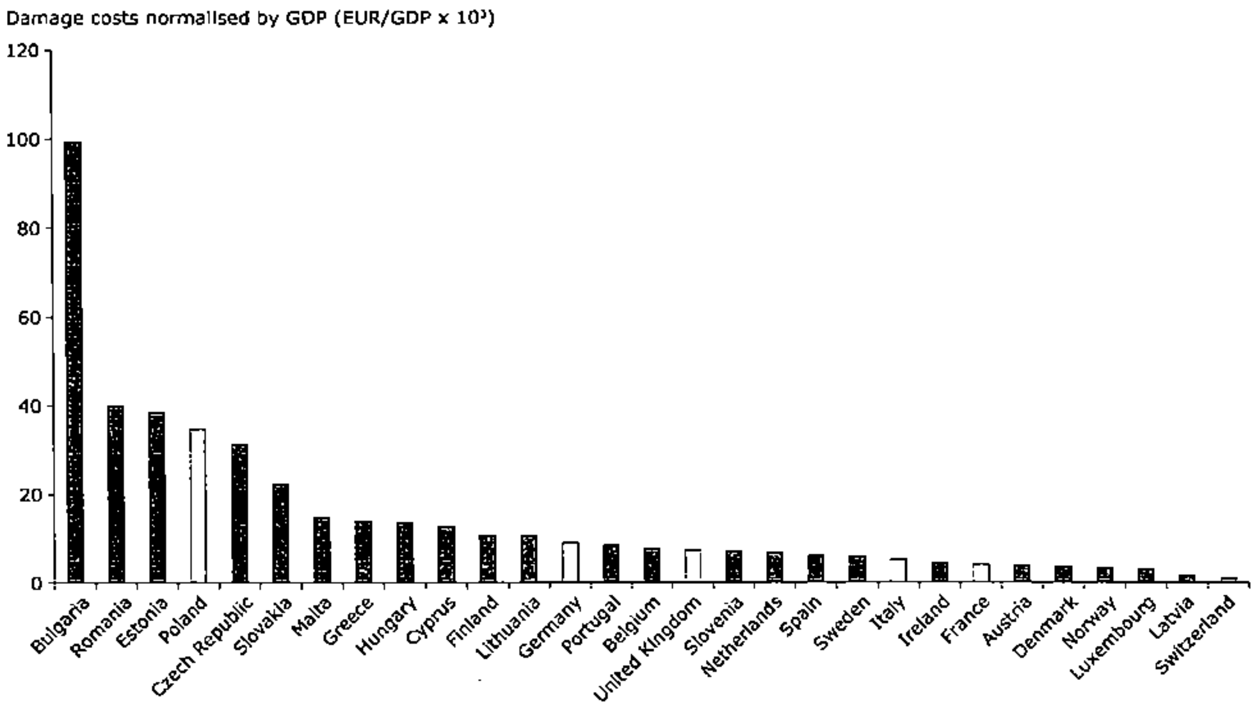
Figure 3.9 Aggregated damage costs by country, excluding CO_2



Note: The low-high range shows the differing results derived from the alternative approaches to mortality valuation for the regional pollutants.

An alternative way to rank countries is to normalise the estimated damage costs by introducing the concept of efficiency into the analysis, similar to the approach taken for individual facilities in Table 3.3. Normalising the damage costs by gross domestic product (GDP) to reflect the output of national economies results in significant changes in the ordering of countries. Certain countries previously listed as having the highest damage costs — Germany, the United Kingdom, France and Spain — drop significantly down the ranking, while Bulgaria, Romania, Estonia and the Czech Republic rise to the top (Figure 3.10).

Figure 3.10 Aggregate damage costs by country normalised against GDP



Note: The orange bars highlight the countries with the highest damage costs from Figure 3.8.

4 Discussion

The preceding chapters described the development and application of a simplified methodology to determine damage costs to human health and the environment arising from emissions to air that industrial facilities report to the E-PRTR. Various issues were identified that introduce potential uncertainties into the results and can therefore affect the robustness of analysis. These are explored further in this chapter, grouped under the following themes:

- suitability of the methodology employed;
- areas in which the analysis could be improved;
- ways in which the E-PRTR might be improved for this type of assessment; and
- interpretation of the results from this report.

4.1 Suitability of the methods used

4.1.1 Main regional air pollutants

The methods presented for assessing emissions of the major regional air pollutants (SO_2, NO_x, NMVOCs, NH_3 and fine particulate matter, ozone from emissions of NO_x and NMVOCs) have been developed over many years. They have been extensively discussed at the European level by researchers, European institutions, European and member state policymakers, NGOs and industry. For these pollutants the methods used are therefore reasonably mature, although important questions persist, notably in attributing effects to secondary inorganic particulate matter (ammonium sulphate and ammonium nitrate).

It is to be expected that different types of particulate matter will vary in their effect on health. Some previous studies (e.g. ExternE) have introduced some factors to differentiate between $PM_{2.5}$, PM_{10}, sulphate aerosols and nitrate aerosols. These factors constitute expert judgement within the ExternE team based on evidence of the likely effect of different pollutants. However, other expert groups (e.g. the Task Force on Health convened by WHO under the Convention on Long-Range Transboundary Air Pollution) have concluded that there is no empirical evidence on which to differentiate, so currently suggest that it should not be done.

The analysis in this report presumes consistent health impacts per unit of exposure in different parts of Europe. The information presented in Section 4.3 below shows a recent development in mortality assessment that challenges this view. If response functions for mortality were derived nationally it would cause the estimated damage costs to increase significantly in some countries and decrease in others.

Overall, however, the magnitude of quantified damage costs for the main regional air pollutants seems unlikely to be challenged in the near future, so the methods for these pollutants are deemed fit for purpose.

4.1.2 Heavy metals and organic micro-pollutants

There is greater uncertainty in the treatment of heavy metals and organic micro-pollutants. The effects of most of the metals, dioxins and furans is conveyed in terms of extra cases of cancer. It is possible that their true impact is greater than shown here because of their association with particulate matter and hence with other health impacts such as mortality and morbidity resulting from respiratory and circulatory disease. While this would be accounted for in the results for $PM_{2.5}$ and PM_{10} it would imply underestimation of the damage costs when focusing only on the metals.

Epidemiological research is continuing into the toxicological effects of heavy metals. Recent preliminary findings indicate damage costs may be larger in magnitude than those previously estimated under ExternE. This suggests that there may be significant increases in the unit damage costs estimates for these pollutants in the near future. Nevertheless, much of the impact pathway would be unchanged, for example the quantification of exposure via air and ingestion. It would also be surprising if a revision meant that the impacts from heavy metals and dioxins and furans would be substantial relative to those reported here for the regional pollutants and CO_2. As such, changes in methods may have little impact on the answers to the questions posed in this analysis.

4.1.3 Carbon dioxide

For CO_2 it has already been noted that the estimate of damage cost per tonne emitted is based on a different methodology (marginal abatement costs) to that used for the other pollutants and is thus subject to a number of questions. However, the value selected is considered to be in a reasonable range relative to other available estimates for greenhouse gases. Thus, while the figure could be changed, it would be unlikely to alter the conclusion that the damage costs of CO_2 emissions from E-PRTR facilities are likely to be very significant.

Nevertheless, as recommended in Chapter 2, it is clear that a wider debate is required on how better to estimate the economic impacts of greenhouse gas emissions on the environment and health.

4.1.4 Valuing mortality

In general, the most important issues with respect to valuation centre on valuing mortality, specifically the question of whether to employ the value of statistical life (VSL) or the value of a life year (VOLY).

The response functions for effects of acute exposure provide an estimated number of deaths, while those for chronic exposure provide (most robustly) an estimate of the number of life years lost. This may appear to make the choice of when to apply the VSL and when to apply the VOLY quite straightforward. Indeed, this would be in line with the OECD guidance on environmental cost benefit analysis (OECD, 2006). However, it is widely considered that the effects of acute exposures on mortality lead to a shorter loss of life per case than chronic exposures. Further to this, acute exposures seem likely to affect people who are already sick, possibly primarily as a result of exposure to air pollution, but more probably from smoking, diet, age and so on. Attribution of a full VSL to the acute cases is thus very questionable, and for these reasons, acute ozone deaths in CAFE were valued only using the VOLY.

Overall, therefore, it is considered that the methods used here are fit for purpose. They can certainly be improved but conclusions based on the current formulations should be reasonably robust.

4.1.5 Combining damage cost estimates for different pollutants

Combining the damage cost values for different pollutants to give an estimate of total damage from a facility, sector or country, may be seen as inappropriate in view of:

- the varying maturity of assessment methodologies for the different pollutants, bearing in mind that quantifying impacts of the major regional air pollutants (SO_2, NO_x, NH_3, PM and NMVOCs) has been debated much more thoroughly than the quantification of the other pollutants;
- the differences between the general methodologies, noting that particular caution is needed in including estimates of greenhouse gas damage costs, which are based on the cost of marginal abatement rather than damage costs;
- specific methodological questions, such as previous decisions (e.g. by the WHO Task Force on Health that advised CAFE) to quantify impacts of NO_x and SO_2 on health only in terms of their contribution to secondary inorganic aerosol levels.

There are therefore some arguments for keeping damage cost estimates for the different pollutants separate. However, this overlooks one of the main purposes of monetisation, which is to bring data together in a common metric that weights emissions according to the severity of their effects. While caution is advised in interpreting and using estimates that are aggregated across different pollutants, it is nevertheless considered that such estimates also provide additional and useful insights into the overall burdens generated by facilities, sectors, etc. Accordingly, the estimated damage costs presented in this report are in various instances presented both separately for the pollutant groups and aggregated.

4.2 Potential future improvements to the methods employed

Several potential refinements to the methods employed in this study might be implemented in the future based on continuing scientific work. For example, the dispersion modelling that underpins analysis of the regional pollutants could be improved. Similarly, the country-specific pollutant damage costs can be developed when new source-receptor matrices are generated by the EMEP chemical transport model. The matrices used for the present work date back to 2006 and the EMEP model has since been refined. This revision of the matrices might not, however, be done until 2012–2013 due to the demands of other work presently being undertaken by EMEP.

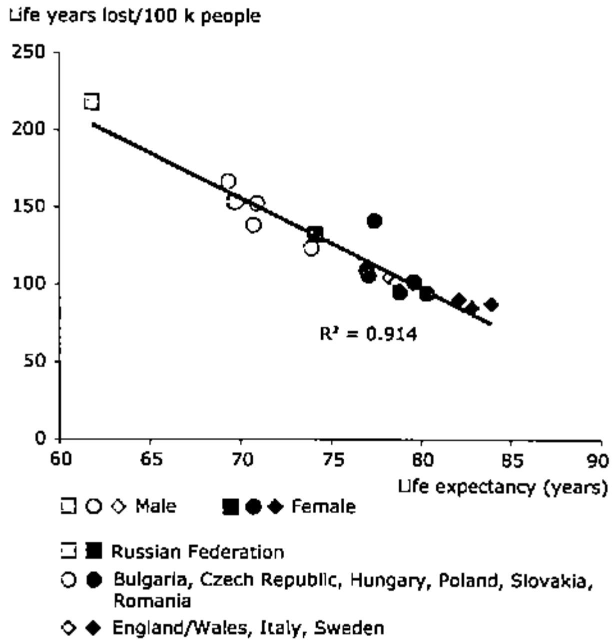
The response functions for quantifying the **impacts of the major regional pollutants** are under regular review. The European Commission is presently undertaking a review of the EU air quality legislation to be completed by 2013 and in this context will ask the Task Force on Health led by WHO-Europe under the LRTAP Convention (UNECE, 1979) to consider in detail modifications to the current set of functions.

Further to the analysis presented in this report, the Institute of Occupational Medicine in Edinburgh has performed additional life-table analysis to inform cost-benefit analysis such as that being used in the current revision to the Gothenburg Protocol under the LRTAP Convention (Miller et al., 2011). The study considered the sensitivity of national populations to a unit change in exposure to fine particulate matter. Initial analysis for Italy and Sweden suggested that there was little error associated with basing European analysis on results for the population of England and Wales. The England and Wales results were used in the mortality analysis for fine particulate matter in terms of loss of longevity presented in the CAFE work and also used in the present report.

However, subsequent analysis for Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia and the Russian Federation showed that the populations in those countries were more sensitive than those in the countries originally considered, perhaps due to differences in life expectancy (Figure 4.1). Results were particularly significant for the Russian Federation, reflecting especially the very limited life expectancy of Russian men (the top left data point in Figure 4.1).

These results were discussed at the May 2011 meeting of the WHO Task Force on Health, which concluded that they should be factored into analysis immediately. Unfortunately this has not been possible for the present report, which probably implies a bias toward underestimation of damage costs here.

Figure 4.1 Relationship between life expectancy and life years lost per 100 000 people from a one-year change in exposure to $PM_{2.5}$ of 1 $\mu g.m^{-3}$



Further methodological refinements that might be introduced during the next year or so concern:

- quantifying chronic effects of $PM_{2.5}$ exposure on mortality against cause-specific death rates rather than, as at present, total death rates;
- quantifying possible effects of chronic exposure to ozone on mortality, based on the work of Jerrett et al. (2009);
- revising the quantification of chronic bronchitis impacts linked to $PM_{2.5}$ exposure, based on results of the Swiss SAPALDIA study (Schindler et al., 2009).

The most important of these changes may concern chronic exposure to ozone and its effects on mortality. The other changes may not make a great deal of difference to analysis for the European population, whereas inclusion of chronic effects on mortality could greatly increase the overall significance of ozone impacts.

Quantifying the **impacts of regional air pollutants on ecosystems** may be possible in the medium term through studies using the 'ecosystem services' approach. Some advances have been made in this area recently through work by Jones et al. (2011) and Mills et al. (2011). A possible halfway step to this goal would be to use the pollution transfer matrices to assess the contribution of E-PRTR facilities to exceedance of critical loads and levels across Europe.

Quantifying the damage costs associated with **heavy metals** raises uncertainties because data on deposition suggest much higher emissions than are accounted for in available inventories (Fowler et al., 2006). This may in part be linked to instances where facilities included in the E-PRTR emit below the respective reporting thresholds for heavy metals or simply fail to report emissions of some pollutants.

For **greenhouse gases** it would be useful to have a wider European debate on the values used in analysing damage costs (e.g. whether to use damage costs or, as in this report, an estimate of marginal abatement costs). Some useful information should be forthcoming from the European Commission-funded ClimateCost project, which is due to report in late 2011. Until such information or agreement is available, a pragmatic approach, as implemented here, is to report damage costs both with and without including greenhouse gases.

One improvement for the **sectoral analysis** presented here would be to supplement the point-source data from the E-PRTR with information from national emission inventories that summarise total emissions from each sector. This would at least partially address concerns that not all facilities report all emissions and the lack of data from facilities that are not required to report to the E-PRTR. This extension of the analysis would be particularly useful for the agriculture sector, since it accounts for the vast majority of NH_3 emissions in Europe and most operators are unlikely to be included under the E-PRTR.

4.3 Changes to the E-PRTR to facilitate assessments

As highlighted in preceding sections, there are some ways to improve the E-PRTR register to facilitate its use in assessments like the present report. The following are considered to be the most important:

- **Providing information on the fuel consumption or productive output of individual facilities.** This would enable the efficiency of facilities to be calculated in terms of estimated damage costs per unit of production or fuel consumption. At present, such information is not reported to the E-PRTR so this type of analysis cannot be done. This reduces the value of the analysis as regulators, for example, cannot assess the merits of controlling a few large facilities over a larger number of smaller facilities. It also limits the usefulness of the register for members of the public, as a lack of information on facility capacity or production limits the potential for fair comparisons. There is some limited information publicly available at the European level which provides information on, for example, fuel combustion by certain large combustion plants in most, but not all, Member States. This report did not investigate using such data to augment the data available from the E-PRTR. This is a potential task that could be undertaken in the future.

  In this study CO_2 emissions were used as an indicator for power output from individual facilities (Tables 3.3 and 3.4) and GDP as an indicator of national production (Figure 3.10) to normalise damage costs against service provided. However, the deficiencies of these proxy outputs are recognised and it would be far better to base the normalisation on actual fuel consumption or productive output. Barrett and Holland (2008) normalised against facility capacity but this is also problematic as it implies that all facilities are operating at full capacity.

- **More complete reporting of emissions from individual facilities.** Review of the facilities with the highest estimated damage costs reveals significant variation in the completeness of reporting of heavy metals and other pollutants. The most notable single potential omission is undoubtedly the lack of PM_{10} emissions data for the Bulgarian plant ranked as having the second highest damage costs of all facilities. Omissions like this clearly bias any ranking of facilities by the damage costs that they generate against facilities whose operators have been more conscientious in reporting data.

- **More extended data checking.** Recognising the need to improve the quality of data reported to the E-PRTR register, the EEA has initiated an annual data review process in recent years, providing feedback to the competent authorities in each country responsible for compiling facility data (e.g. ETC/ACC, 2010). Nevertheless, it is considered that consideration be given to further checking by national regulators before data are reported to the E-PRTR, particularly to address completeness of data and to identify outlying values. Such checking is to some extent facilitated by the annual updating of the E-PRTR, which allows the identification of facilities whose emissions vary significantly between years.

- **Improved traceability of facilities.** It proved difficult to compare the results calculated for the present study with those from previous works (Holland, 2006; Barrett and Holland, 2008) on a facility-by-facility basis. Part of the problem relates to differences in the annual E-PRTR datasets received by the EEA, in which facilities may change ownership, name and/or national facility identification code. In addition, locational references can also change over time, from a village location to the nearest town or district for example.

While these suggestions are put forward for potentially improving E-PRTR, the register is nevertheless recognised as an extremely useful resource for researchers and members of the public interested in the transparency of environmental information.

4.4 Interpreting the results of this study

The E-PRTR already provides substantial useful information for a variety of users. For example, emissions data show how the major polluters in Europe contribute to the overall pollution burden, and changes in emissions from these facilities provide an indication of the effectiveness of legislation to reduce the pollutant burdens imposed on society by industry.

The progress in reducing emissions is apparent if the results generated here are compared with those of past studies by Holland (2006) and Barrett and Holland (2008) based on the E-PRTR's predecessor, the European Pollutant Emissions Register (EPER). This comparison reveals significant changes in the list of most polluting facilities, presumably as a result of either facility closure or modernisation (but perhaps also due to a change of facility name, as noted in Section 4.3). It is important to note that the report does not in any way assess whether the emissions of a facility are consistent with its legal requirements for operating.

The main insight provided by this report is the expression of pollution problems in terms of what really matters to people — the impacts and damage costs that pollution causes. The knowledge that a given quantity of pollution released to air from a particular location will cause a quantifiable increase in mortality and various kinds of morbidity (e.g. new incidence of chronic bronchitis, restrictions to normal activity, use of medication), along with the associated costs, helps convey the real nature of pollution problems in a way that a simple measure of emissions cannot. This is the reality even though the analysis is incomplete, especially with respect to quantification of ecosystem damage.

Quantifying effects in monetary terms provides information relevant to cost-benefit analysis of pollution controls. Information regarding the size of pollution damage can easily be coupled with ball-park estimates of the costs of abatement for a preliminary cost-benefit analysis (see Barrett and Holland, 2008). In this context, it is important that the benefits of industrial facilities (such as producing goods and products, and generating employment and tax revenues) are properly recognised, and not just the costs. These benefits are not addressed in this report.

It is also useful to recognise that pollution impacts vary depending on the site of release, as this may imply that different control strategies should be employed in different areas. In recommending differentiated control strategies, however, it is important to ensure that impact assessments take account of ecological effects.

The analysis also suggests which pollutants and sectors should be prioritised for future control. This is complicated by the lack of data in areas such as ecological impacts and emissions not reported to the E-PRTR. These issues can be factored in separately, however, for example using multi-criteria analysis if needed.

In summary, this report has presented a simplified methodology that allows for the estimation of damage costs caused by emissions of selected pollutants from industrial facilities included in the E-PRTR. It demonstrates that, compared to using emissions data alone, these methods provide additional insights and transparency into the costs of harm caused by air pollution. Such insights are particularly valuable in the context of current discussions in Europe on how best to move towards a resource-efficient and low-carbon economy. Moreover, the analysis can be further strengthened by integrating efficiency and productivity data for individual facilities into the analysis of damage costs.

References

AEA Technology, 1997, *Economic evaluation of air quality targets for CO and benzene*, report for the European Commission (http://ec.europa.eu/environment/enveco/air/pdf/benzene.pdf and http://ec.europa.eu/environment/enveco/air/pdf/benzene_annex.pdf) accessed 1 December 2010.

Baes, C. F., Sharp, R. D., Sjoreen, A. L. and Shor, R. W., 1984, *A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture*, Oak Ridge National Laboratory, ORNL 5786. September 1984.

Barrett, M. and Holland, M., 2008, *The costs and health benefits of reducing emissions from power stations in Europe: Air Pollution and Climate Series 20* (http://www.airclim.org/reports/APC20_final.pdf) accessed 10 December 2010.

Bickel, P. and Friedrich, R. (eds), 2005, *ExternE: externalities of energy — methodology 2005 update* (http://www.externe.info/brussels/methup05a.pdf) accessed 12 December 2010.

Bosch, P., Coenen, P., Fridell, E., Astrom, S., Palmer, T. and Holland, M., Wagner, A., and Palmer, T., 2009, *Cost-benefit analysis to support the impact assessment accompanying the revision of Directive 1999/32/EC on the sulphur content of certain liquid fuels*, Report for European Commission DG Environment (http://ec.europa.eu/environment/air/transport/pdf/CBA_of_S.pdf) accessed 22 November 2010.

CIEMAT, 1999, *ExternE externalities of energy: volume X: national implementation* (http://www.externe.info/reportex/vol10.pdf) accessed 10 December 2010.

DECC, 2011, *Update short term traded carbon values for UK public policy appraisal*, Department of Energy and Climate Change, October 2011 (http://www.decc.gov.uk/assets/decc/11/cutting-emissions/carbon-valuation/3137-update-short-term-traded-carbon-values-uk.pdf) accessed 28 October 2011.

EEA, 2010, *The European Environment — State and Outlook 2010*, European Environment Agency (http://www.eea.europa.eu/soer) accessed 9 November 2011.

EEA, 2011, 'The European Pollutant Release and Transfer Register (E-PRTR) Dataset version 3.2 (17 October 2011)' (http://www.eea.europa.eu/data-and-maps/data/member-states-reporting-art-7-under-the-european-pollutant-release-and-transfer-register-e-prtr-regulation-4) accessed 1 November 2011.

EIPPCB, 2006, *BREF on economics and cross media effects*, European Integrated Pollution Prevention and Control Bureau, Seville (http://eippcb.jrc.es/reference/ecm.html) accessed 28 November 2010.

EMEP, 2005, Transboundary acidification, eutrophication and ground level ozone in Europe in 2003, European Monitoring and Evaluation Programme (EMEP) Report 1/2005, (http://www.emep.int/publ/reports/2005/status_report_1_2005_ch5-8_app.pdf), accessed 28 October 2011.

EMEP, 2008, Transboundary acidification, eutrophication and ground level ozone in Europe in 2006, European Monitoring and Evaluation Programme (EMEP) Report 1/2008, (http://www.emep.int/publ/reports/2008/status_report_1_2008.pdf), accessed 28 October 2011.

Entec, 2001, *Economic evaluation of air quality targets for heavy metals*, report for European Commission DG Environment (http://ec.europa.eu/environment/enveco/air/pdf/report_heavy_metals.pdf) accessed 1 December 2010.

EPA, 1994, *Estimating exposure to dioxin-like compounds – Volume: executive summary*, US Environmental Protection Agency, Office of Health and Environmental Assessment, EPA600-6-88-005Ca.

EPA, 1997, *Exposure Factors Handbook*, US Environmental Protection Agency, EPA-600-P-95-002Fa-c.

EPA, 2002, *Child-Specific Exposure Factors Handbook*, US Environmental Protection Agency, EPA-600-P-00-002B.

EPA, 2005, *Human health risk assessment protocol for hazardous waste combustion facilities*, US Environmental Protection Agency, Office of Solid Waste, EPA530-R-05-006.

E-PRTR, 2011, 'E-PRTR — The European Pollutant Release and Transfer Register' (http://prtr.ec.europa.eu) accessed 2 November 2011.

ETC/ACC, 2010, *E-PRTR Review Report 2010 covering the 2008 E-PRTR dataset*, European Topic Centre on Air and Climate Change report for the European Environment Agency (http://air-climate.eionet.europa.eu/docs/ETCACC_TP_2010_5_RevRep_2008_E-PRTRdata.pdf) accessed 2 December 2010.

ETSU/Metroeconomica, 1995, *ExternE: externalities of energy – volume 2: methodology* (http://www.externe.info/reportex/vol2.pdf) accessed 10 December 2010.

EU, 1978, Council Directive 78/176/EEC of 20 February 1978 on waste from the titanium dioxide industry, Official Journal L 054 , 25/02/1978 pp. 19–24 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31978L0176:en:HTML) accessed 2 November 2011.

EU, 1982, Council Directive 82/883/EEC of 3 December 1982 on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry, Official Journal L 378 , 31/12/1982 pp. 1–14 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31982L0883:en:HTML) accessed 2 November 2011.

EU, 1992, Council Directive 92/112/EEC of 15 December 1992 on procedures for harmonizing the programmes for the reduction and eventual elimination of pollution caused by waste from the titanium dioxide industry, Official Journal L 409, 31/12/1992 pp. 11–16 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0112:en:HTML) accessed 2 November 2011.

EU, 1999, Council Directive 1999/32/EC of 26 April 1999 relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC, OJ L 121, 11.5.1999, p. 13–18 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0032:EN:NOT) accessed 27 July 2011.

EU, 2001a, Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants, OJ L 309, 27.11.2001, p. 1–21 (http://eur-lex.europa.eu/Notice.do?val=261603:cs&lang=en&list=496647:cs,261603:cs,&pos=2&page=1&nbl=2&pgs=10&hwords=2001/80/EC~) accessed 27 July 2011.

EU, 2001b, Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309, 27.11.2001 (http://eur-lex.europa.eu/Notice.do?val=261604:cs&lang=en&list=576968:cs,573314:cs,548466:cs,489472:cs,485090:cs,471128:cs,468193:cs,405222:cs,261604:cs,414663:cs,&pos=9&page=1&nbl=11&pgs=10&hwords=Directive%202001/81/EC~) accessed 27 July 2011.

EU, 2003, Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels, OJ L 76, 22.3.2003, p. 10–19 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32003L0017:EN:NOT) accessed 27 July 2011.

EU, 2004a, Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, OJ L 23, 26.1.2005 (http://eur-lex.europa.eu/Notice.do?val=393964:cs&lang=en&list=547852:cs,393964:cs,413804:cs,497555:cs,&pos=2&page=1&nbl=4&pgs=10&hwords=DIRECTIVE%202004/107/EC~) accessed 27 July 2011.

EU, 2004b, Decision 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol, Official Journal of the European Communities, L 49/1, 19.2.2004.

EU, 2006, Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European pollutant Release and Transfer Register and amending Council Directives 91/689/EEA and 96/61/EC. Official Journal of the European Union, L33/1, 4.2.2006.

EU, 2008, Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, OJ L 152, 11.6.2008 (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF) accessed 27 July 2011.

EU, 2010, Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control), OJ L 334, 17.12.2010, p. 17–119 (http://eur-lex.europa.eu/Notice.do?val=553885:cs&lang=en&list=572494:cs,553885:cs,571912:cs,&po

s=2&page=1&nbl=3&pgs=10&hwords=Directive%20 2010/75/EU~) accessed 27 July 2011.

Fowler, D., McDonald, A. G., Crossley, A., Nemitz, E., Leaver, D., Cape, J. N., Smith, R. I., Anderson, D., Rowland, P., Ainsworth, G., Lawlor, A. J., Guyatt, H. and Harmens, H., 2006, *UK Heavy Metal Monitoring Network* (http://www.uk-pollutantdeposition.ceh.ac.uk/sites/uk-pollutantdeposition.ceh.ac.uk/files/UK_HeavyMetals_Final_report_2006_final_version.pdf) accessed 15 December 2010.

Holland, M., 2006, *Health impacts of emissions from large point sources (second edition)*, Air Pollution and Climate Series 19 (http://www.airclim.org/reports/APC19SE.pdf) accessed 10 December 2010.

Holland, M. and King, K., 1998, *Economic evaluation of air quality targets for tropospheric ozone, Part C: economic benefit assessment*, report for the European Commission DG Environment (http://ec.europa.eu/environment/enveco/air/pdf/tropozone-c.pdf) accessed 1 December 2010.

Holland, M., Berry, J. and Forster, D., 1999, ExternE: externalities of energy – volume 7: methodology 1998 update (http://www.externe.info/reportex/vol7.pdf) accessed 10 December 2010.

Holland, M., Jones, H., Berdowski, J., Bleeker, A. and Visschedijk, A, 2001, *Economic evaluation of air quality targets for PAHs*, report for the European Commission DG Environment (http://ec.europa.eu/environment/enveco/air/pdf/pah_report.pdf) accessed 1 December 2010.

Holland, M., Hunt, A., Hurley, F., Navrud, S. and Watkiss, P., 2005a, *Development of methodology for the CBA of the Clean Air For Europe (CAFE) Programme, Volume 1: overview of methodology*, report for the European Commission DG Environment (http://cafe-cba.aeat.com/files/CAFE%20CBA%20Methodology%20Final%20Volume%201%20v4e.pdf) accessed 1 December 2010.

Holland, M., Hurley, F., Hunt, A., and Watkiss, P., 2005b, *Development of methodology for the CBA of the Clean Air For Europe (CAFE) Programme, Volume 3: uncertainty in the CAFE CBA: methods and first analysis*, report for the European Commission DG Environment (http://cafe-cba.aeat.com/files/cba_method_vol3.pdf) accessed 1 December 2010.

Holland, M., Watkiss, P., Pye, S., de Oliveira, A., and van Regemorter, D., 2005c, *Cost Benefit Analysis of policy option scenarios for the Clean Air For Europe Programme*, report for the European Commission DG Environment (http://www.cafe-cba.org/assets/thematic_strategy_scenario_v4.pdf) accessed 1 December 2010.

Holland, M., Pye, S., Watkiss, P., Droste-Francke, B. and Bickel, P., 2005d, *Cost per tonne emission of PM2.5, NH3, SO2, NOx and VOCs from each EU-25 Member State (except Cyprus) and surrounding seas*, report for the European Commission DG Environment (http://cafe-cba.aeat.com/files/CAFE%20CBA%20marginal%20damage%20March%202005%20final_vsc.doc) accessed 1 December 2010.

Holland, M., Hogg, D. and Ballinger, A., 2010, *Use of damage cost data for BAT decision making*, contract report for the Environment Agency for England and Wales.

Holland et al., in preparation, *Cost Benefit Analysis for the Revision of the National Emission Ceilings Directive: Policy Options for revisions to the Gothenburg Protocol to the UNECE Convention on Long-Range Transboundary Air Pollution*, for the European Commission DG Environment.

Hurley, F., Hunt, A., Cowie, H., Holland, Miller, B., Pye, S., and Watkiss, P., 2005, *Development of methodology for the CBA of the Clean Air For Europe (CAFE) Programme, Volume 2: health impact assessment*, report for the European Commission DG Environment (http://cafe-cba.aeat.com/files/CAFE%20CBA%20Methodology%20Final%20Volume%202%20v1h.pdf) accessed 1 December 2010.

IAEA, 1982, *Generic models and parameters for assessing the environmental transfer of radionuclide from routine releases*, Safety Series No.57, International Atomic Energy Agency, Vienna, Austria.

IAEA, 1994, *Handbook of parameters values for the prediction of radionuclide transfer in temperate environments*, Technical Series 364, International Atomic Energy Agency, Vienna, Austria.

IAEA, 2001, *Generic models for use in assessing the impacts of discharges of radioactive substances to the environment*, Safety Reports Series No.19, International Atomic Energy Agency, Vienna, Austria.

ICP Mapping and Modelling, 2004, *Manual on methodologies and criteria for modelling and mapping critical loads and levels and air pollution effects, risks and trends*, International Cooperative Programme on Modelling and Mapping of Critical Loads and Levels and Air Pollution Effects, Risks and Trends, (http://www.rivm.nl/en/themasites/icpmm/manual-and-downloads/manual-english/index.html), accessed 12 October 2011.

IPCC, 2007, *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 2007. Metz, B., Davidson, O. R., Bosch, P. R., Dave, R. and Meyer, L.A., (eds), Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jerrett, M., Burnett, R., Pope, A. C., Ito, K. and Thurston, G., 2009, 'Long-term ozone exposure and mortality', *N Engl J Med* 360 (11) 1 085–1 095.

Jones, M. L. M., Provins, A., Harper-Simmonds, L., Holland, M., Mills, G., Hayes, F., Emmett, B. A., Hall, J., Sheppard, L. J., Smith, R., Sutton, M., Hicks, K., Ashmore, M., Haines-Young, R., in preparation, *Using the ecosystems services approach to value air quality*, report to Department for Environment Food and Rural Affairs (Defra).

Krupnick, Ostro, B. and Bull, K., 2005, *Peer review of the methodology of cost-benefit analysis of the Clean Air For Europe Programme* (http://www.cafe-cba.org/assets/cafe_peer_review.pdf) accessed 28 December 2010.

Lavric et al., 2010, *Assessment of the possible development of an EU-wide NO_x and SO_2 trading scheme for IPPC installations*, report for the European Commission DG Environment (http://circa.europa.eu/Public/irc/env/ippc_rev/library?l=/emissions_trading/final_report_first&vm=detailed&sb=Title) accessed 22 November 2010.

Mills, G., Hayes, F., Norris, D., Hall, J., Harmens, H., Coyle, M., Simpson, D., Cambridge, H., Cinderby, S., Abbott, J., Cooke, S., Murrells, T. and Posch, M., in preparation, *Quantifying the threat from ozone pollution to food security: UK and Europe*.

Miller, B., Hurley, F. and Shafrir, A., *Health Impact Assessment for the National Emissions Ceiling Directive (NECD) – Methodological Issues*, research report TM/11/03, Institute of Occupational Medicine, Edinburgh, United Kingdom.

OECD, 2006, *Cost-Benefit Analysis and the Environment Recent Developments*, Organisation for Economic Co-operation and Development, Paris, France.

Pye, S., Holland, M. and Watkiss, P., 2007, *Analysis of the costs and benefits of proposed revisions to the National Emission Ceilings Directive*, NEC CBA Report 2, CBA of TSAP and EP target optimisation model runs, report for the European Commission DG Environment (http://www.cafe-cba.org/assets/necdcba2.pdf) accessed 22 November 2010.

Rabl, A. and Spadaro, J. V., 2006, A dose-response function for health impacts of lead, ARMINES/Ecole des Mines de Paris, 60 Boulevard St-Michel, F-75272, Paris, France.

Schindler, C., Keidel, D., Gerbase, M. W., Zemp, E., Bettschart, R., Brändli, O., Brutsche, M. H., Burdet, L., Karrer, W., Knöpfli, B., Pons, M., Schwartz, J., Rapp, R., Liu, L. J. S., Bayer-Oglesby, L., Künzli, N., Ackermann-Liebrich, U. and Rochat, T., 2009, 'Improvements in PM10-exposure and reduced rates of respiratory symptoms in a cohort of Swiss adults (SAPALDIA-study)', *Am J Respir Crit Care Med.*, 179, 579-87. Epub 2009 Jan 16.

Schoof, R. A., Yost, L. J., Eickhoff, J., Crecelius, E. A., Cragin, D. W., Meacher, D. M. and Menzel, D. B., 1999, 'A market basket survey of inorganic arsenic in food', *Food and Chemical Toxicology* 37:839–846.

Smith, K. R., Jerrett, M., Anderson, H., Burnett, R., Stone, V., Derwent, R., Atkinson, R., Cohen, A., Shnokoff, S., Krewski, D., Pope III, C. A., Thun, M. and Thurston, G., 2009, 'Public health benefits of strategies to reduce greenhouse-gas emissions: Health implications of short-lived greenhouses pollutants' *The Lancet*, 374, 2 091–2 103.

Spadaro, J. V. and Rabl, A., 2004, 'Pathway analysis for population-total health impacts of toxic metal emissions', *Risk Analysis*, 25(5).

Spadaro, J. V. and Rabl, A., 2008a, 'Global health impacts and costs due to mercury emissions', *Risk Analysis*, 28(3).

Spadaro, J. V. and Rabl, A., 2008b, 'Estimating the uncertainty of damage costs of pollution: a simple transparent method and typical results', *Environmental Impact Assessment Review*, 28:166–183.

Stewart, R., Lawrence, H., Leonard, A., Holland, M., van Hyfte, A., Algoet, A. and de Smet, L., 2007, *Analysis of the simplification of the titanium dioxide directives*, report for the European Commission DG Environment (http://ec.europa.eu/environment/waste/pdf/tio2_simplification_report_iss3.pdf) accessed 22 November 2010.

Thunis, P., Cuvelier, C., Roberts, P., White, L., Post, L., Tarrason, L., Tsyro, S., Stern, R., and

Kerschbaumer, A., Rouill, L., Bessagnet, B., Bergstrom, R., Schaap, M., Boersen, G. A. C. and Builtjes, P. J. H., 2008, *Eurodelta II, evaluation of a sectoral approach to integrated assessment modelling including the Mediterranean Sea* (http://aqm.jrc.it/eurodelta/publications/EDII_finalreport.pdf) accessed 8 November 2011.

UBA, 2008, *Economic valuation of environmental damage: methodological convention for estimates of environmental externalities,* Umweltbundesamt (http://www.umweltdaten.de/publikationen/fpdf-l/3482.pdf) accessed 12 December 2010.

UNECE, 1979, *Convention on Long-range Transboundary Air Pollution* (http://unece.org/env/lrtap), accessed 11 October 2011.

UNECE, 1999, Convention on Long-range Transboundary Air Pollution — Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (http://live.unece.org/env/lrtap/multi_h1.html) accessed 27 July 2011.

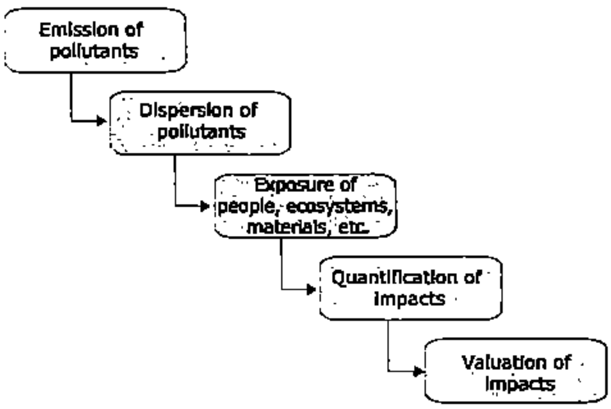
WHO, 1999, *Guidelines for air quality,* World Health Organization, Geneva, Switzerland.

WHO, 2004, *Health aspects of air pollution — Results from the WHO project 'Systematic review of health aspects of air pollution in Europe'* (http://www.euro.who.int/__data/assets/pdf_file/0003/74730/E83080.pdf) accessed 24 October 2011.

Annex 1
Determination of country-specific damage cost per tonne estimates for the major regional air pollutants

A1.1 Overview

This annex addresses the methods for quantifying damage costs for the major regional pollutants: NH_3, NO_x, PM_x, SO_2 and VOCs. Analysis follows the impact pathway methodology developed in the ExternE Project funded by European Commission's DG Research (ETSU, Metroeconomica, 1995; Holland et al., 1999; Bickel and Friedrich, 2005) with further refinement from the CAFE Programme (Holland et al., 2005a and 2005b; Hurley et al., 2005). The pathway described by the analysis is as follows:



The dispersion modelling tracks pollutants through the atmosphere and follows their chemical reactions, enabling quantification of effects linked to emissions, not simply to the atmospheric concentration of the pollutant in the chemical state in which it was released. An important consequence is that effects caused by secondary particulates are not assigned to $PM_{2.5}$ but to the primary pollutant from which they are formed (e.g. SO_2 for sulphate aerosol, NO_x for nitrate aerosol and NH_3 for ammonium aerosol). It also enables accounting for less obvious interactions between air pollutants, for example the effects of NMVOC emissions on inorganic particle concentrations, or the effects of NO_2 and NH_3 emissions on ground-level (tropospheric) ozone formation.

The price year used here is 2005, for consistency with, for example, the pollution control data used in the GAINS model of the International Institute for Applied Systems Analysis (IIASA).

A1.2 Impacts considered and omitted from the analysis

The impacts that have been quantified for this report are listed in Table A1.1. It is important not to forget those effects that remain unquantified as a result of limitations in the availability of data on response functions and / or valuation. These are listed in Table A1.2, which shows that a large number of effects have not been quantified.

To interpret the information presented in the two tables it is important to be aware that:

1. the effects that have been quantified are substantial;

2. several of the effects that have not been quantified here are likely to be negligible (e.g. direct effects of SO_2 and NO_x on crops) and would not lead to a significant increase in damage per tonne of emissions;

3. the value of certain ecosystem effects (not quantified in this report) may also be substantial.

In summary, while omitting any impact leads to a bias to underestimate damages and some of the omitted effects are undeniably important, the results generated here quantify a large fraction of total damages for most of the pollutants considered. The most serious omissions probably apply with respect to NMVOCs because of the failure to account for organic aerosols and, possibly, a failure to account for impacts associated with long-term (chronic) exposure to ozone, should they exist.

The effect of omitting impacts has to be seen in the context of the full range of uncertainties in the assessment. While it clearly biases towards underestimation, the full set of uncertainties, including also model assumptions and statistical uncertainties, may push the results either up or down. More information on these uncertainties is provided in the third volume of the CAFE CBA methodology (Holland et al., 2005c).

Table A1.1 Quantified impacts for the major regional pollutants

Burden	Effect
Human exposure to $PM_{2.5}$	Chronic effects on: Mortality Adults over 30 years Infants Morbidity Bronchitis Acute effects on: Morbidity Respiratory hospital admissions Cardiac hospital admissions Consultations with primary care physicians Restricted activity days Use of respiratory medication Symptom days
Human exposure to ozone	Acute effects on: Mortality Morbidity Respiratory hospital admissions Minor restricted activity days Use of respiratory medication Symptom days
Exposure of crops to ozone	Yield loss for: barley, cotton, fruit, grape, hops, millet, maize, oats, olive, potato, pulses, rapeseed, rice, rye, seed cotton, soybean, sugar beet, sunflower seed, tobacco, wheat
SO_2 effects on utilitarian buildings	Degradation of stone and metalwork, particularly zinc, galvanised steel

Table A1.2 Effects omitted from the analysis of major regional pollutants

Effect	Comments
Health	
Ozone chronic – mortality chronic – morbidity	No information on possible chronic effects, suspected but not proven
Direct effects of SO_2, NO_x, NMVOCs	
Effects of NMVOCs through the formation of secondary organic particulate matter	Not currently included in the EMEP model
Social impacts	Limited data availability
Altruistic effects	Reliable valuation data unavailable
Agricultural production	
Direct effects of SO_2 and NO_x	Negligible according to past work
N deposition as crop fertiliser	Negligible according to past work
Visible damage to marketed produce	Locally important for some crops
Interactions between pollutants, with pests and pathogens, climate etc.	Exposure-response data unavailable
Acidification/liming	Negligible according to past work
Materials	
Effects on cultural assets, steel in re-inforced concrete	Lack of information on the asset stocks at risk and valuation data
PM and building soiling	
Effects of O_3 on paint, rubber	
Ecosystems	
Effects on biodiversity, forest production, etc. from excess O_3 exposure, acidification and nitrogen deposition	Valuation of ecological impacts is currently considered too uncertain
Visibility	
Change in visual range	Impact of little concern in Europe.
Drinking water supply and quality	
	Limited data availability

A1.3 Other uncertainties considered

In addition to the uncertainty arising from omitting a number of impacts from the analysis, the earlier analysis by Holland et al. (2005c) specifically addressed some other key uncertainties and sensitivities:

- valuation of mortality using the value of statistical life (VSL) and value of a life year (VOLY) approaches;
- quantifying ozone effects on health with and without a 'cut-point' (effectively, the assumption of a threshold at 35 ppb).
- separating health impacts into a 'core' set of functions that are determined to be most robust and a 'sensitivity' set of functions that are less robust.

A conclusion drawn from the earlier work was that the uncertainty in mortality valuation was dominant, and so this is the main quantified uncertainty carried into the present study.

An important issue that has not been addressed relates to uncertainty in apportioning impacts to each pollutant. This is most problematic for quantifying the impacts of fine particulate matter, which are typically described by epidemiological studies in terms of PM_{10} or $PM_{2.5}$ rather than the constituent species of particulate matter (e.g. sulphate aerosol, combustion particulate matter, natural material). The review of health aspects of air pollution in Europe performed by WHO (2004), did not attempt to differentiate between particulate matter.

A1.4 Development of source-receptor relationships

Source-receptor relationships define the link between the site of emission and the site of impact. These have been developed using data provided from the EMEP chemical transport model (³).

'Source-receptor (SR) matrices give the change in various pollution levels in each receptor country (or grid square) resulting from a change in anthropogenic emissions from each individual emitter. Such matrices are generated by reducing emissions for each emitter of one or more precursors by a given percentage (15 % in this case), running the EMEP model with these reduced emissions, and comparing the resulting output fields with the base simulation, i.e. a simulation without any emission reduction. The reason for this procedure is to keep the chemical conditions as close to the original conditions as possible.'

Source: EMEP, 2005.

These data cover a variety of pollutants, the primary species emitted and their reaction products. For each EMEP model run the analysis adjusts by 15 % the emissions of one pollutant in one country for one baseline year. This is repeated until all combinations of pollutants, countries and baseline year have been modelled. For the purpose of the present analysis, the change in pollutant concentration or deposition is then divided by the quantity of pollutant adjusted in each model run, to derive a change per tonne of emission.

The steps undertaken for the present study were as follows:

1. Each 15 % reduction file was subtracted from the baseline to provide the difference in concentration per grid cell by substance, reduced pollutant and emitting country;
2. The concentration in each grid cell was multiplied by the population (population by grid cells taken from EMEP data) in that grid cell to generate a population-weighted average change in concentration.

(³) http://www.emep.int/index_model.html.

3. The change in concentration in each grid cell was divided by the total 2010 (or 2020) emissions for each country to generate the change in concentration per tonne emission of each of the five emitted pollutants (SO_2, NO_x, NMVOCs, NH_3 and $PM_{2.5}$). The total 2010 and 2020 emissions where provided by EMEP.

4. Thee population-weighted values were multiplied by the health concentration-response functions and the values associated with each type of health impact according to the CAFE methodology;

5. These country-specific damage costs were then multiplied by the E-PRTR facility emissions data to provide the estimated damage costs from each E-PRTR facility.

An initial option investigated was using the latest EMEP source-receptor (SR) matrices available at the time of this study (which were based on the meteorological situation in 2006). Previous SR runs are generally based on five consecutive metrological years with the average taken for the matrices. The EMEP 2008 status report (EMEP, 2008) describes 2006 as a particularly warm year with the highest temperatures for the spring months (April, May) ever recorded. Hence the wider applicability of the source receptor data for that year is not good, due to the strong correlation between meteorological conditions and the distribution of pollutants as described in the 2005 EMEP report. Hence, this study used the earlier EMEP runs generated for the revision of the National Emission Ceilings Directive and the Gothenburg Protocol which were based on five meteorological years selected in terms of their climatological representation over the last 30 years. It should be noted that these data do not reflect recent improvements to the EMEP model. Due to the time frame of this study not all five meteorological years were analysed. The year 1998 was chosen because it is considered reasonably representative of all five years run within the EMEP model.

When generalising such results there may be problems from non-linearity of some of the atmospheric processes, most notably those dealing with ozone and hence linked to emissions of NO_x and NMVOCs. However, these are not considered too problematic here for several reasons. Most importantly, ozone effects generate only a small amount of the overall pollution damage, with effects of fine particulate matter being far more significant. Recent analysis for the Gothenburg Protocol suggests that over 95 % of health damage from regional pollutants is attributable to particulate matter. It may be argued that the role of ozone is being underestimated, perhaps through the omission of some types of effect, but ozone-related damage would need to increase very markedly for this to be a problem. An indication of the importance of these non-linearities can be gained from comparing the results in Section A1.7 for 2010 and 2020, as the difference between the years is entirely attributable to differences in the emission scenarios used.

A1.5 Quantification of health damages

The data used for quantifying health damages, based on information from the UN health statistics and data, functions and valuations presented in Volume 2 of the CAFE-CBA methodology report (Hurley et al., 2005), are given in Table A1.3 for effects of exposure to $PM_{2.5}$ and Table A1.4 for effects of exposure to ozone. The values used for VOLY and VSL are consistent with those used in the earlier CAFE programme. It should be noted that:

- chronic mortality estimates for $PM_{2.5}$ based on VSL/VOLY or median/mean estimates are not additive but are used as alternatives in sensitivity analysis;
- similarly, for the VOLY mean and median valuations listed for ozone;
- several effects listed in the CAFE-CBA methodology report volume 2 (Hurley et al., 2005) have not been included in the quantification as further validation of incidence data is required, specifically:
  - upper-bound estimates for chronic bronchitis, recommended for inclusion in the sensitivity functions for $PM_{2.5}$;
  - respiratory medication use and lower respiratory symptoms among children, recommended for inclusion in the core functions for ozone;
  - consultations for allergic rhinitis in adults and children, recommended for inclusion in the sensitivity functions for ozone;
- valuation of ozone mortality impacts using the VOLY approach assumes an average loss of life expectancy amongst those affected of one year;
- the 'pollution factors' and 'population factors' convert from units (etc.) defined in the

CAFE-CBA methodology report volume 2 (Hurley et al., 2005) to units that match the population-weighted pollution metrics that form the basis of the quantification;

- population factors are specific to 2010;
- valuation data refer to the year 2000.

Concerning the parameters in Table A1.3 and Table A1.4, note that in any column a figure of 1 is a default value, given that quantification simply multiplies all of the variables shown together:

- Population factor 1: This factor accounts for most functions applying to only part of the population. For example, the chronic mortality function (deaths) is applicable only to those aged over 30, who account for 62.8 % of the population in the modelled domain. While the table provides European average figures, the modelling undertaken to generate the results that follow used national data.
- Population factor 2: This factor accounts for some functions being expressed per thousand or per hundred thousand of population.

Incidence rate, response functions and valuation data are all given by Hurley et al. (2005).

For ozone, effects are typically quantified against the metric SOMO35 for European analysis (sum of mean ozone over 35 parts per billion).

A1.6 Quantification of ozone crop damage

The analysis of crop damage included here is based on the use of AOT40 relationships, combined with EMEP estimates of change in AOT40 on a 50 x 50 km grid. The functions and pollution data have been adjusted as follows:

- The AOT40 outputs from EMEP are for the period May–July. These have been adjusted by country-specific factors derived from earlier EMEP model runs to better represent the growing season for each country.
- The EMEP data are generated for a height of three metres. This has been adjusted to canopy height for each crop based on default relationships in the ICP Mapping and Modelling Manual (ICP Modelling and Mapping, 2004).

Functions and other data are shown in Table A1.5. Valuation data are based on world market prices reported by the United Nations Food and Agriculture Organization. The height factor accounts for variation in ozone concentration with height and is based on default estimates in ICP Mapping and Modelling Manual (2004).

Table A1.3 Incidence data, response functions and valuation data for quantification of health damages linked to PM exposure for 2010 (2005 prices)

Effect	Population factor 1	Population factor 2	Incidence rate	Response functions	Valuation (EUR)
Core functions					
Chronic mortality (deaths, VSL valuation)	0.628	1	1.61 %	0.60 %	2 080 000
Chronic mortality (life years lost, VOLY valuation)	1	1.00E-05	1	65.1	54 000
Infant mortality (1–12 months)	0.009	1	0.19 %	0.40 %	1 530 000
Chronic bronchitis, population aged over 27 years	0.7	1	0.378 %	0.70 %	208 000
Respiratory hospital admissions, all ages	1	1.00E-05	617	0.114 %	2 364
Cardiac hospital admissions, all ages	1	1.00E-05	723	0.06 %	2 364
Restricted activity days (RADs) working age population	0.672	1	19	0.475 %	97
Respiratory medication use by adults	0.817	0.001	4.50 %	90.8	1
Respiratory medication use by children	0.112	0.001	20 %	18.0	1
Lower respiratory syndromes (LRS), including cough, among adults with chronic symptoms	0.817	1	0.3	0.130	42
LRS (including cough) among children	0.112	1	1	0.185	42

Note: ERF units: Impact per 10 ug.m^{-3} 8 hour daily average ozone. Response function expressed as change in incidence (rate, if as %) per µg.m^{-3} $PM_{2.5}$.

Table A1.4 Incidence data, response functions and valuation data for quantification of health damages linked to ozone exposure for 2010 (2005 prices)

Effect	Population factor 1	Population factor 2	Incidence rate	Response functions	Valuation
Core functions					
Acute mortality (life years lost, VOLY median valuation)	1	1	1.09 %	0.30 %	54 000
Acute mortality (life years lost, VOLY mean valuation)	1	1	1.09 %	0.30 %	125 000
Respiratory hospital admissions, ages over 65	1	1.00E-05	617	0.30 %	2 364
Minor restricted activity days, ages 18–64	0.64	1	7.8	1.48 %	42
Respiratory medication use by adults	0.817	0.001	4.50 %	730	1

Note: Response function units: impact per 10 ug.m^{-3} 8 hour daily average ozone.

Table A1.5 Functions and associated factors for quantification of ozone damage to crop production

Crop	Value (EUR)	Function	Height (m)	Height factor
Barley	120	0	1	0.88
Fruit	680	0.001	2	0.93
Grapes	360	0.003	1	0.88
Hops	4 100	0.009	4	0.96
Maize	100	0.004	2	0.93
Millet	90	0.004	1	0.88
Oats	110	0	1	0.88
Olives	530	0	2	0.93
Potatoes	250	0.006	1	0.88
Pulses	320	0.017	1	0.88
Rapeseed	240	0.006	1	0.88
Rice	280	0.004	1	0.88
Rye	80	0	1	0.88
Seed cotton	1 350	0.016	1	0.88
Soybeans	230	0.012	1	0.88
Sugar beets	60	0.006	0.5	0.81
Sunflower seed	240	0.012	2	0.93
Tobacco leaves	4 000	0.005	0.5	0.81
Wheat	120	0.017	1	0.88

Note: The function shows proportional change in yield per ppm.hour.

A1.7 Results

The tables below present the estimated damage of pollution, expressed as euros/tonne of emissions of NH_3, NO_x, $PM_{2.5}$, PM_{10}, SO_2 and NMVOCs, for countries throughout Europe. The baseline years for pollution climate are 2010 (used in this study) and 2020.

For information, country-specific damage costs were determined for both 2010 and 2020. This is because a further source of variation arises for the regional pollutants from modelled results for different years. The EMEP data used in this study provide information for scenarios for both 2010 and 2020. Emissions of SO_2, NO_x and NMVOCs (and to a lesser extent for PM and NH_3) are expected to decline significantly over this period as a result of European legislation that has yet to have its full effect. A good example concerns legislation on vehicle emissions, which will not be fully effective until the current vehicle fleet is fully replaced.

The change in the overall pollution load of the atmosphere will in the future affect the chemical reactions between pollutants. This, in turn, affects the formation of secondary aerosols and ozone, and hence calculated levels of damage. The effect appears particularly marked for ammonia and NMVOCs (Figure A1.1). It is possible that the true effect will not be so pronounced, particularly for NMVOCs, as it could be an artefact of model calibration at the time that model runs were performed, particularly for 2020. The results do, however, demonstrate the need to take the overall pollution climate into account and not simply assume that damage/tonne emission will be constant over time.

Figure A1.1 European average damage costs per tonne of emission in 2010 and 2020 normalised against damage in 2010 for ammonia, NO_x, PM_{10}, SO_2 and NMVOCs

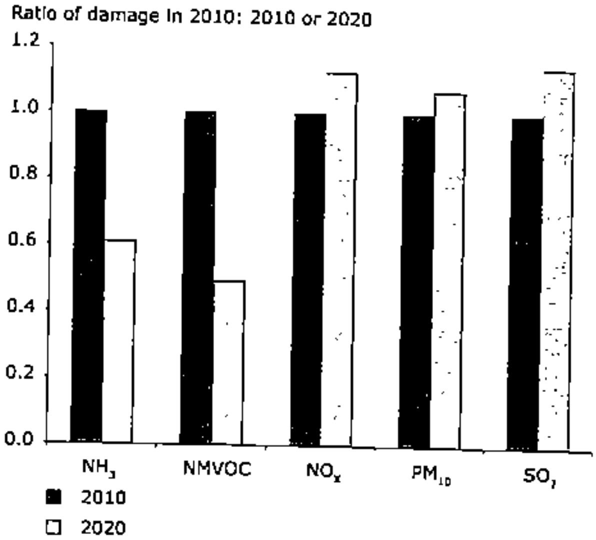


Table A1.6 Damage (EUR) per tonne emission estimates for NH_3 in 2010 and 2020 (2005 prices)

Country code	Country	NH_3 2010		NH_3 2020	
		Low VOLY	High VSL	Low VOLY	High VSL
AL	Albania	3 496	9 790	3 496	9 790
AT	Austria	15 269	42 746	9 064	25 376
BA	Bosnia and Herzegovina	14 989	41 964	8 543	23 918
BE	Belgium	27 218	76 193	18 596	52 059
BG	Bulgaria	6 382	17 869	4 060	11 366
BY	Belarus	9 187	25 718	5 428	15 193
CH	Switzerland	10 519	29 449	6 582	18 429
CY	Cyprus	1 335	3 742	741	2 080
CZ	Czech Republic	19 786	55 387	11 879	33 256
DE	Germany	20 541	57 504	13 082	36 625
DK	Denmark	7 793	21 819	3 937	11 023
EE	Estonia	6 791	19 014	4 366	12 222
EL	Greece	5 072	14 205	2 789	7 815
ES	Spain	5 297	14 830	1 970	5 518
FI	Finland	4 513	12 636	3 233	9 052
FR	France	10 581	29 620	6 608	18 501
HR	Croatia	17 091	47 847	10 168	28 466
HU	Hungary	16 727	46 824	10 217	28 602
IE	Ireland	2 354	6 593	1 327	3 715
IT	Italy	13 129	36 759	7 239	20 273
LT	Lithuania	5 761	16 128	2 971	8 317
LU	Luxembourg	23 247	65 078	15 330	42 916
LV	Latvia	5 721	16 017	3 346	9 367
MD	Moldova	7 041	19 711	4 777	13 374
MK	the former Yugoslav Republic of Macedonia	7 023	19 663	4 151	11 623
MT	Malta	7 857	22 013	3 056	8 576
NL	Netherlands	19 765	55 329	13 872	38 835
NO	Norway	1 905	5 345	1 045	2 936
PL	Poland	12 945	36 238	7 418	20 767
PT	Portugal	4 675	13 089	1 635	4 576
RO	Romania	7 512	21 029	4 689	13 127
SE	Sweden	6 338	17 747	3 385	9 478
SI	Slovenia	17 421	48 770	10 428	29 194
SK	Slovakia	18 368	51 419	10 761	30 124
TR	Turkey	4 583	12 835	3 319	9 296
UA	Ukraine	9 439	26 423	6 613	18 512
UK	United Kingdom	15 159	42 436	10 457	29 277

Table A1.7 Damage (EUR) per tonne emission estimates for NO_x in 2010 and 2020 (2005 prices)

Country code	Country	NO_x 2010		NO_x 2020	
		Low VOLY	High VSL	Low VOLY	High VSL
AL	Albania	3 546	8 945	3 416	8 437
AT	Austria	12 046	32 709	13 306	36 019
BA	Bosnia and Herzegovina	6 465	16 997	7 099	18 611
BE	Belgium	8 332	23 589	11 561	32 388
BG	Bulgaria	5 768	15 127	5 843	15 254
BY	Belarus	5 316	14 247	6 515	17 537
CH	Switzerland	18 795	51 580	18 279	49 837
CY	Cyprus	647	1 610	737	1 804
CZ	Czech Republic	8 645	23 377	10 758	29 018
DE	Germany	13 924	38 145	15 209	41 426
DK	Denmark	3 812	10 324	4 159	11 171
EE	Estonia	1 901	4 934	2 600	6 839
EL	Greece	1 648	3 793	1 783	4 053
ES	Spain	3 346	8 489	2 551	6 054
FI	Finland	1 430	3 726	2 005	5 303
FR	France	10 343	27 549	10 291	27 098
HR	Croatia	8 767	23 409	9 252	24 549
HU	Hungary	11 480	30 957	14 287	38 540
IE	Ireland	3 997	10 565	3 574	9 250
IT	Italy	8 394	22 723	8 376	22 399
LT	Lithuania	4 574	12 114	5 357	14 254
LU	Luxembourg	12 203	33 417	14 151	38 501
LV	Latvia	3 022	7 865	3 762	9 878
MD	Moldova	7 245	19 225	7 945	21 079
MK	the former Yugoslav Republic of Macedonia	3 557	9 061	3 722	9 389
MT	Malta	572	1 234	999	2 258
NL	Netherlands	7 752	22 155	9 732	27 583
NO	Norway	1 990	4 997	1 985	4 922
PL	Poland	6 618	17 890	9 450	25 607
PT	Portugal	1 352	3 419	1 247	2 989
RO	Romania	9 004	24 107	9 320	24 869
SE	Sweden	2 306	5 955	2 688	6 960
SI	Slovenia	10 028	27 030	11 105	29 765
SK	Slovakia	10 197	27 402	12 937	34 857
TR	Turkey	1 918	4 485	2 135	5 000
UA	Ukraine	5 621	14 979	6 637	17 745
UK	United Kingdom	5 181	14 520	5 999	16 663

Table A1.8 Damage (EUR) per tonne emission estimates for $PM_{2.5}$ in 2010 and 2020 (2005 prices)

Country code	Country	Primary $PM_{2.5}$ 2010		Primary $PM_{2.5}$ 2020	
		Low VOLY	High VSL	Low VOLY	High VSL
AL	Albania	19 809	55 447	20 892	58 479
AT	Austria	29 737	83 236	30 902	86 499
BA	Bosnia and Herzegovina	17 809	49 851	19 298	54 018
BE	Belgium	43 179	120 862	50 623	141 700
BG	Bulgaria	19 270	53 938	18 898	52 899
BY	Belarus	11 425	31 979	12 811	35 859
CH	Switzerland	37 057	103 726	39 825	111 473
CY	Cyprus	12 926	36 182	10 777	30 167
CZ	Czech Republic	20 846	58 350	22 494	62 962
DE	Germany	44 612	124 873	50 957	142 635
DK	Denmark	10 925	30 581	13 140	36 781
EE	Estonia	7 129	19 954	7 959	22 278
EL	Greece	18 214	50 982	20 551	57 524
ES	Spain	19 391	54 277	20 170	56 459
FI	Finland	7 134	19 968	6 862	19 207
FR	France	30 388	85 058	32 330	90 495
HR	Croatia	26 839	75 125	28 079	78 596
HU	Hungary	29 372	82 216	29 199	81 731
IE	Ireland	15 230	42 629	16 229	45 426
IT	Italy	35 604	99 661	34 697	97 122
LT	Lithuania	9 706	27 168	8 793	24 611
LU	Luxembourg	32 179	90 071	35 212	98 562
LV	Latvia	9 689	27 122	9 559	26 757
MD	Moldova	21 708	60 763	21 529	60 262
MK	the former Yugoslav Republic of Macedonia	11 765	32 933	13 123	36 732
MT	Malta	15 828	44 303	15 238	42 652
NL	Netherlands	39 864	111 583	45 991	128 733
NO	Norway	7 964	22 291	8 290	23 205
PL	Poland	20 446	57 230	22 268	62 332
PT	Portugal	23 972	67 102	23 574	65 986
RO	Romania	20 864	58 399	18 605	52 077
SE	Sweden	11 208	31 371	11 383	31 863
SI	Slovenia	21 852	61 166	25 250	70 678
SK	Slovakia	20 587	57 625	22 853	63 968
TR	Turkey	19 113	53 499	21 454	60 051
UA	Ukraine	20 974	58 708	22 346	62 549
UK	United Kingdom	24 632	68 948	32 764	91 710

Table A1.9 Damage (EUR) per tonne emission estimates for PM_{10} in 2010 and 2020 (2005 prices)

Country code	Country	Primary PM_{10} 2010		Primary PM_{10} 2020	
		Low VOLY	High VSL	Low VOLY	High VSL
AL	Albania	12 863	36 005	13 566	37 973
AT	Austria	19 310	54 050	20 066	56 168
BA	Bosnia and Herzegovina	11 565	32 371	12 531	35 076
BE	Belgium	28 038	78 482	32 872	92 013
BG	Bulgaria	12 513	35 025	12 272	34 350
BY	Belarus	7 419	20 766	8 319	23 285
CH	Switzerland	24 063	67 354	25 860	72 385
CY	Cyprus	8 394	23 495	6 998	19 589
CZ	Czech Republic	13 536	37 890	14 606	40 885
DE	Germany	28 969	81 086	33 089	92 620
DK	Denmark	7 094	19 858	8 533	23 884
EE	Estonia	4 629	12 957	5 168	14 466
EL	Greece	11 827	33 105	13 345	37 353
ES	Spain	12 591	35 245	13 098	36 662
FI	Finland	4 632	12 966	4 456	12 472
FR	France	19 732	55 233	20 994	58 763
HR	Croatia	17 428	48 783	18 233	51 037
HU	Hungary	19 073	53 387	18 960	53 072
IE	Ireland	9 889	27 681	10 538	29 498
IT	Italy	23 120	64 715	22 531	63 066
LT	Lithuania	6 303	17 642	5 709	15 981
LU	Luxembourg	20 895	58 488	22 865	64 001
LV	Latvia	6 292	17 612	6 207	17 374
MD	Moldova	14 096	39 457	13 980	39 131
MK	the former Yugoslav Republic of Macedonia	7 640	21 385	8 521	23 852
MT	Malta	10 278	28 768	9 895	27 696
NL	Netherlands	25 885	72 456	29 864	83 593
NO	Norway	5 171	14 475	5 383	15 068
PL	Poland	13 277	37 163	14 460	40 475
PT	Portugal	15 567	43 572	15 308	42 848
RO	Romania	13 548	37 922	12 081	33 816
SE	Sweden	7 278	20 371	7 392	20 690
SI	Slovenia	14 190	39 718	16 396	45 895
SK	Slovakia	13 368	37 419	14 840	41 538
TR	Turkey	12 411	34 740	13 931	38 994
UA	Ukraine	13 619	38 122	14 511	40 616
UK	United Kingdom	15 995	44 772	21 275	59 552

Table A1.10 Damage (EUR) per tonne emission estimates for SO_2 in 2010 and 2020 (2005 prices)

Country code	Country	SO_2 2010		SO_2 2020	
		Low VOLY	High VSL	Low VOLY	High VSL
AL	Albania	4 252	11 757	4 505	12 476
AT	Austria	9 819	26 791	11 212	30 752
BA	Bosnia and Herzegovina	5 107	14 119	5 475	15 165
BE	Belgium	11 082	30 379	14 041	38 704
BG	Bulgaria	4 183	11 405	4 396	12 008
BY	Belarus	6 031	16 673	6 838	18 953
CH	Switzerland	13 534	37 449	14 867	41 253
CY	Cyprus	1 402	3 876	1 564	4 335
CZ	Czech Republic	8 456	23 281	10 245	28 355
DE	Germany	12 306	33 973	14 666	40 639
DK	Denmark	4 703	12 923	5 601	15 473
EE	Estonia	4 235	11 775	4 680	13 045
EL	Greece	3 149	8 476	3 571	9 663
ES	Spain	5 314	14 602	5 586	15 393
FI	Finland	2 942	8 176	3 229	8 995
FR	France	9 624	26 359	11 105	30 550
HR	Croatia	7 188	19 881	7 832	21 721
HU	Hungary	8 161	22 608	9 633	26 775
IE	Ireland	5 797	16 067	6 107	16 958
IT	Italy	7 994	21 986	8 304	22 901
LT	Lithuania	4 979	13 833	5 823	16 221
LU	Luxembourg	9 962	27 405	11 783	32 543
LV	Latvia	4 445	12 359	5 040	14 049
MD	Moldova	6 217	17 182	6 541	18 103
MK	the former Yugoslav Republic of Macedonia	3 250	8 984	3 532	9 782
MT	Malta	2 846	7 873	2 846	7 873
NL	Netherlands	12 821	35 320	15 365	42 482
NO	Norway	2 390	6 654	2 661	7 427
PL	Poland	7 330	20 239	8 928	24 754
PT	Portugal	3 582	9 794	4 177	11 476
RO	Romania	6 151	16 950	6 780	18 731
SE	Sweden	3 117	8 622	3 560	9 880
SI	Slovenia	8 132	22 481	8 830	24 491
SK	Slovakia	7 961	22 048	9 207	25 585
TR	Turkey	3 064	8 465	3 398	9 405
UA	Ukraine	6 759	18 678	7 531	20 857
UK	United Kingdom	7 814	21 530	10 309	28 571

Table A1.11 Damage (EUR) per tonne emission estimates for NMVOCs in 2010 and 2020 (2005 prices)

Country code	Country	NMVOC 2010		NMVOC 2020	
		Low VOLY	High VSL	Low VOLY	High VSL
AL	Albania	132	221	14	– 84
AT	Austria	790	1,835	312	556
BA	Bosnia and Herzegovina	120	25	– 53	– 424
BE	Belgium	1 926	4,336	1 133	2 176
BG	Bulgaria	– 128	– 505	– 162	– 576
BY	Belarus	375	827	77	45
CH	Switzerland	814	1 623	371	455
CY	Cyprus	– 47	– 163	– 59	– 184
CZ	Czech Republic	485	930	143	66
DE	Germany	1 248	2 713	705	1 301
DK	Denmark	715	1 463	342	485
EE	Estonia	208	435	39	– 10
EL	Greece	60	15	14	– 89
ES	Spain	294	542	133	132
FI	Finland	246	546	77	97
FR	France	995	2 218	461	803
HR	Croatia	368	642	52	– 186
HU	Hungary	262	467	51	– 58
IE	Ireland	625	1 372	281	464
IT	Italy	625	1 279	196	160
LT	Lithuania	440	1 062	96	143
LU	Luxembourg	1 781	4 007	1 070	2 109
LV	Latvia	370	836	74	57
MD	Moldova	433	1 014	170	305
MK	the former Yugoslav Republic of Macedonia	189	372	48	5
MT	Malta	274	419	42	– 168
NL	Netherlands	1 393	2 969	897	1 597
NO	Norway	278	544	108	107
PL	Poland	565	1,271	220	363
PT	Portugal	322	662	159	241
RO	Romania	157	250	32	– 72
SE	Sweden	371	807	155	233
SI	Slovenia	503	986	63	– 165
SK	Slovakia	286	521	75	– 11
TR	Turkey	8	– 118	– 39	– 234
UA	Ukraine	525	1 227	271	545
UK	United Kingdom	979	2 089	510	840

Annex 2
Determination of country-specific damage cost per tonne estimates for heavy metals and organic micro-pollutants

A2.1 Objective

The RiskPoll model was used to predict the health impacts and damage costs due to air emissions of the heavy metals arsenic, cadmium, chromium, lead, mercury and nickel and the organic compounds 1,3 butadiene, benzene, diesel particulates, dioxins/furans, formaldehyde and polycyclic aromatic hydrocarbon.

There are alternatives to using RiskPoll, for example the approach and results of the ESPREME project (4). Further debate on the differences in methodology between estimates for heavy metal damages is to be welcomed as the models have not been subject to the same degree of scrutiny as the analysis of the regional pollutants. The modelling of exposure to metals is far more complex, however, requiring a focus on ingestion (in particular), as well as inhalation. Further issues arise, for example the probability of surviving cancers caused by different pollutants.

A2.2 Atmospheric dispersion

Air concentrations are calculated using the Uniform World Model (UWM) methodology, described in Spadaro and Rabl (2004). A key parameter of the analysis is the bulk or total pollutant deposition velocity, which includes air removal by dry and wet mechanisms. Continental estimates of deposition velocities for Europe are 0.34 cm/s for arsenic and lead, and 0.57 cm/s for all the other pollutants, except mercury. Country-specific deposition velocities can vary a lot about mean regional estimates. In Europe, for example, the deposition velocity for arsenic ranges from 0.26 to 0.54 cm/s, while for dioxins/furans, the range is 0.43–0.89 cm/s. In both cases, the coefficient of variation is approximately 20 %.

The deposition velocity for mercury is much smaller than for other chemical species, at around 0.023 cm/s, owing to its long atmospheric residence time (one to two years). Mercury is a global pollutant. Global and regional estimates of the impact and damage cost of mercury air emissions (due to ingestion of methyl-mercury in contaminated fish products) have been carried out by Spadaro and Rabl (2008a).

Table A2.1 Country-specific depletion velocities (cm/s) for arsenic and lead (for all other pollutants multiply by 5/3)

Austria	0.35
Balkans	0.29
Belgium	0.40
Bulgaria	0.29
Cyprus	0.26
Czech Republic	0.36
Denmark	0.52
Estonia	0.37
Finland	0.37
France	0.27
Germany	0.31
Greece	0.29
Hungary	0.34
Ireland	0.36
Italy	0.42
Latvia	0.37
Lithuania	0.37
Luxembourg	0.40
Malta	0.27
Netherlands	0.40
Norway	0.54
Poland	0.34
Portugal	0.32
Romania	0.34
Slovakia	0.35
Slovenia	0.34
Spain	0.30
Sweden	0.52
Switzerland	0.36
United Kingdom	0.36

(4) http://espreme.ier.uni-stuttgart.de/.

A2.3 Pollutant transport and environmental fate analysis in soil and water

Environmental concentrations are calculated using the methodology developed by the USEPA for assessing multimedia transport in soil and freshwater bodies (EPA, 2005). For the seawater compartment, the pollutant mass is computed assuming a first order process. Namely, the rate of change of mass in the compartment is equal to net change in the mass inflow and outflow. The outflow mass identifies the sink (pollutant settling to the bottom of the ocean), while the inflow mass is the source (mass flow into the ocean from freshwater bodies).

Environmental fate analysis comprises various stages:

- first, pollutant emissions to air;
- second, atmospheric dispersion and removal by deposition onto land and water surfaces or by chemical transformation;
- third, environmental accumulation, transport and estimation of concentrations in soil and water compartments;
- fourth, uptake by plants and animals;
- finally, passage through the human body on the way to its ultimate environmental disposal, which may involve, for example, soil fixation (the pollutant is trapped well below the surface layer in soils, making it no longer bio-available) or settling on water bed sediment.

At present, RiskPoll does not deal with discharges to water and soil, although the same methodology developed for air emissions may be extended to analyse these cases as well.

There are several routes of potential exposure to a pollutant, including inhalation, consumption of contaminated tap water, agricultural crops and animal products, such as fish, meat, milk, fruits and vegetables, and grains and cereals. All these pathways are addressed in RiskPoll. The inhalation dose depends very much on local conditions, especially the deposition velocity and the size of the population at risk. It contributes at most a few per cent of the total intake dose but this does not imply that associated health impacts are negligible. The ingestion dose, on the other hand, is much less sensitive to local conditions because of food trade between different countries and regions. The ingestion dose is much more uniform than the inhalation dose (see Table A2.2).

Other avenues of exposure that are not addressed in RiskPoll include groundwater contamination,

Table A2.2 Ingestion dose by compound property

Compound property	As	Cd	Cr	Ni	Pb
Soil-water partition factor (m^3/kg_{soil})	0.029	0.075	0.019	0.065	0.9
Suspended sediment-water partition factor (m^3/kg_{sed})	25	2	50	100	200
Plant-soil bio-concentration (root uptake, kg_{soil}/kg_{DW})					
Fruits and green vegetables	6.33E-03	1.25E-01	4.88E-03	9.31E-03	1.40E-02
Root vegetables	8.00E-03	6.40E-02	4.50E-03	8.00E-03	9.00E-03
Grains and cereals	4.00E-03	6.20E-02	4.50E-03	6.00E-03	9.00E-03
Animal feed	3.60E-02	3.64E-01	7.50E-03	3.20E-02	4.50E-02
Animal feed to cattle meat biotransfer factor (day/kg)	2.00E-03	1.20E-04	5.50E-03	6.00E-03	3.00E-04
Animal feed to cattle milk biotransfer factor (day/L)	6.00E-05	6.50E-06	1.50E-03	1.00E-03	2.50E-04
Freshwater fish bioaccumulation factor (L/kg_{fish})	300	200	200	100	300
Seawater fish bioaccumulation factor (L/kg_{fish})	1 000	1 000	200	1 000	200
Shellfish bioaccumulation factor (L/kg_{fish})	2 000	20 000	800	2000	1 000

Sources (compound properties, human risk factors, and other useful information):
Human Health Risk Assessment Protocol (http://www.epa.gov/osw/hazard/tsd/td/combust/riskvol.htm#volume2).
Risk Assessment Information System (http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=chem).
Integrated Risk Information System (http://cfpub.epa.gov/ncea/iris/index.cfm).
Adaptive Risk Assessment Modeling System (http://el.erdc.usace.army.mil/arams).
International Toxicity Estimates for Risk (http://www.tera.org/ITER/).
Baes et al., 1984; IAEA, 1982, 1994 and 2001.

dermal contact and soil ingestion. Of these pathways, groundwater contamination could be of concern, but the remaining two items are usually negligible. Finally, it should be noted that the ingestion dose computed in RiskPoll represents a conservative estimate because no adjustment has been made to account for losses or reductions from food preparation and implementation of remedial strategies, other than specifying an efficiency of filtration for tap water consumption.

Table A2.3 Human and cattle dietary intake rates and population densities

Food consumption rates for European population (annual intake)			
	General population	**Infants (~ 1 % of population)**	
Drinking water (tap)	600	120	L
Fruits and above ground vegetables	88	86.3	kg_{FW}
Root vegetables	76	17.3	kg_{FW}
Grains and cereals	60	34.0	kg_{FW}
Beef meat	56	12.5	kg_{FW}
Fresh milk and other dairy products	101	275	L
Freshwater fish	3.6	0.32	kg_{FW}
Saltwater fish	6.0	0.55	kg_{FW}
Shellfish	1.8	0.21	kg_{FW}

Food consumption rates for beef and dairy cattle (daily intake)			
	Beef cattle	**Dairy cattle**	
Water intake	40	75	L
Forage	8.8	13.2	kg_{DW}
Silage	2.5	4.1	kg_{DW}
Grains	0.47	3	kg_{DW}
Soil ingestion	0.5	0.4	kg_{Soil}

Note: L = liters, kg_{FW} = kg of fresh weight, kg_{DW} = kg of dry weight, kg_{Soil} = kg of soil.

Sources: DAFNEsoft package (http://www.nut.uoa.gr/dafnesoftweb/), EPA (2002 and 2005), IAEA (1994).

Population density estimates for an unknown source location in Europe

The continental population density is 80 persons/km², population averaged uniformly over land and water surface areas. This value is used for estimating the population total (collective) ingested dose, namely the total pollutant intake through diet. For the collective inhalation dose calculations, the regional population density is 112 persons/km². The exposed population is normalised by a surface area with a radius of 1 000 km, centred at the hypothetical source location. This value is a weighted average of country-specific population density estimates (see below).

Country-specific population density estimates for an unknown source location in that country

Regional population density (persons/km²) varies by country of emission

Austria	110	Germany	152	Norway	43
Balkans	73	Greece	55	Poland	97
Belgium	214	Hungary	106	Portugal	62
Bulgaria	53	Ireland	59	Romania	73
Cyprus	56	Italy	150	Slovakia	106
Czech Republic	116	Latvia	40	Slovenia	110
Denmark	83	Lithuania	52	Spain	55
Estonia	33	Luxembourg	138	Sweden	75
Finland	36	Malta	33	Switzerland	139
France	105	Netherlands	228	United Kingdom	122

A2.4 Impacts on human health

Pollutants that are carcinogenic via inhalation only include cadmium, chromium (valence state VI, which comprises roughly 20 % of chromium air emissions), nickel, 1,3 butadiene, diesel particulate matter, and formaldehyde. Inorganic arsenic, benzene, polycyclic aromatic hydrocarbon (PAH) compounds, such as benzo-a-pyrene (BaP), and dioxins/furans also act via the ingestion pathway. These pollutants are known human carcinogens. Oral exposure is particularly important for PAHs and dioxins/furans, contributing more than 98 % of the total impact on human health. Generally, oral exposure to inorganic arsenic accounts for about two thirds of the total damage cost. About 80 % of total arsenic in air is assumed to be inorganic, 50 % in tap water, 50 % in fruits and vegetables, and 25 % in grains (Schoof et al., 1999; see also Health Canada (http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/index-eng.php)).

Lead and mercury (acting via methyl-mercury, MeHg, chemical transformation) are neurotoxins, which contribute to IQ loss in children, among other health impacts.

Inhalation unit risk factors [URF, lifetime excess cancer risk per μg/m³]

- 4.3E-3 for (inorganic) As, 1.8E-3 for Cd, 1.2E-2 for Cr-VI, 2.4E-4 for Ni, 3E-5 for 1,3 butadiene, 4.14E-6 for benzene, 3.37E-5 for diesel particulate matter, and 1.3E-5 for formaldehyde.

Oral slope factors [SF, lifetime excess cancer risk per μg/(kgbw-day)]

- 1.5E-3 for (inorganic) As, 7.3E-3 for BaP, and 200 for dioxins/furans.

Dose response functions [DRF, Infant IQ loss per μg/day]

- 00.0416 for Pb and 0.036 for MeHg.

  Dose response relationships vary linearly with dose and do not have a 'no-effect' threshold value (i.e. impact is always positive for any intake dose).

Dose response functions [DRF, annual impact per person per μg/m³]

- DRF = URF/70 or DRF = SF/70 x ICf, assuming a lifetime exposure of 70 years. The parameter ICf is the intake to concentration factor; its value depends on the share of adult males and females and children in the exposed population (i.e. receptors), and on the mean breathing rates and body weights (kgbw) appropriate for each group of individuals. For Europe, ICf = 0.21 m3 per (kgbw-day). The population weighted mean breathing rate and mean body weight estimates are 12.6 m3/day and 64.3 kg, respectively. The mean breathing rate for an infant is 5.65 m3/day.

Sources: EPA (1994, 1997 and 2002), Rabl and Spadaro (2006), Spadaro and Rabl (2008a), WHO (1999), IRIS (Integrated Risk Information System) database (http://cfpub.epa.gov/ncea/iris/index.cfm), NEEDS (http://www.needs-project.org/) and MethodEX (http://www.methodex.org/) projects of the European Commission.

A2.5 Monetary valuation

Damage costs are calculated by multiplying the physical impacts (cancer cases or IQ points lost) by the appropriate unit cost (euros per incident). The default unit costs in RiskPoll are as follows (2005 euros): EUR 2 000 000 for a fatal cancer, EUR 500 000 for a non-fatal cancer incident and EUR 9 300 for the loss of an IQ point. The cancer unit cost includes medical expenses (cost of illness), wage and productivity losses, and the willingness to pay to avoid the pain and suffering inflicted by the disease (welfare loss). Non-fatal cancers refer to incidents where the survival probability is greater than five years from the time of diagnosis. It is assumed that between 10 % and 20 % of cancer cases are non-fatal. The share is even greater for dioxins/furans, where up to 50 % of cancer cases are non-fatal. The unit cost of non-fatal cancers does not include welfare loss. The unit cost of an IQ point includes expenses associated with remedial learning and loss in potential lifetime earnings (Spadaro and Rabl, 2008a).

Costs are discounted at 3 % but without consideration given to increases in willingness to pay with economic growth in future years.

Table A2.4 Country-specific marginal damage costs for heavy metals, EUR/kg$_{emission}$ (based on RiskPoll, Ver. 2.0)

	Arsenic		Cadmium		Chromium		Nickel	
	Marginal damage cost	*68 % confidence interval*	**Marginal damage cost**	*68 % confidence interval*	**Marginal damage cost**	*68 % confidence interval*	**Marginal damage cost**	*68 % confidence interval*
Austria	345	*33–528*	27.5	*5–45*	36.7	*7–60*	3.7	*0.7–6.0*
Balkans	326	*31–499*	21.7	*4–36*	28.9	*5–47*	2.9	*0.5–4.7*
Belgium	407	*39–623*	47.0	*9–77*	62.6	*11–103*	6.3	*1.1–10.3*
Bulgaria	307	*29–470*	15.7	*3–26*	21.0	*4–34*	2.1	*0.4–3.4*
Cyprus	318	*30–487*	19.1	*3–31*	25.5	*5–42*	2.5	*0.5–4.2*
Czech Republic	347	*33–531*	28.2	*5–46*	37.6	*7–62*	3.8	*0.7–6.2*
Denmark	302	*29–462*	14.0	*3–23*	18.6	*3–31*	1.9	*0.3–3.1*
Estonia	282	*27–432*	7.8	*1–13*	10.4	*2–17*	1.0	*0.2–1.7*
Finland	284	*27–435*	8.5	*2–14*	11.3	*2–19*	1.1	*0.2–1.9*
France	365	*35–558*	31.0	*6–56*	45.4	*8–74*	4.5	*0.8–7.4*
Germany	393	*38–601*	42.4	*8–70*	56.6	*10–93*	5.7	*1.0–9.3*
Greece	309	*30–473*	16.2	*3–27*	21.7	*4–36*	2.2	*0.4–3.6*
Hungary	344	*33–526*	27.1	*5–44*	36.1	*7–59*	3.6	*0.7–5.9*
Ireland	303	*29–464*	14.3	*3–24*	19.1	*3–31*	1.9	*0.3–3.1*
Italy	355	*34–543*	30.7	*6–50*	40.9	*7–67*	4.1	*0.7–6.7*
Latvia	287	*27–439*	9.4	*2–15*	12.5	*2–20*	1.2	*0.2–2.0*
Lithuania	296	*28–453*	12.1	*2–20*	16.1	*3–26*	1.6	*0.3–2.6*
Luxembourg	353	*34–543*	30.2	*6–50*	40.2	*7–66*	4.0	*0.7–6.6*
Malta	292	*28–453*	10.8	*2–18*	14.4	*3–24*	1.4	*0.3–2.4*
Netherlands	417	*40–638*	50.0	*9–82*	66.7	*12–109*	6.7	*1.2–10.9*
Norway	279	*27–428*	6.9	*1–11*	9.2	*2–15*	0.9	*0.2–1.5*
Poland	335	*32–513*	24.5	*4–40*	32.6	*6–54*	3.3	*0.6–5.4*
Portugal	310	*30–475*	16.5	*3–27*	22.1	*4–36*	2.2	*0.4–3.6*
Romania	317	*30–485*	18.6	*3–31*	24.9	*5–41*	2.5	*0.5–4.1*
Slovakia	342	*33–523*	26.5	*5–43*	35.3	*6–58*	3.5	*0.6–5.8*
Slovenia	347	*33–531*	28.2	*5–46*	37.5	*7–62*	3.8	*0.7–6.2*
Spain	308	*29–471*	15.8	*3–26*	21.1	*4–35*	2.1	*0.4–3.5*
Sweden	297	*28–455*	12.6	*2–21*	16.8	*3–27*	1.7	*0.3–2.7*
Switzerland	364	*35–557*	33.4	*6–55*	44.6	*8–73*	4.5	*0.8–7.3*
United Kingdom	352	*34–539*	29.8	*5–49*	39.7	*7–65*	4.0	*0.7–6.5*

Notes: Cost estimates (mean values) apply to air emissions, and include intake by inhalation and ingestion pathways. Generally, the ingestion dose tends to be uniform because of food transport between countries. Only carcinogenic impacts have been evaluated. The damage cost range assumes a lognormal distribution (Spadaro and Rabl, 2008b), with a geometric standard deviation of four for arsenic and three for the other heavy metals (presently, considered toxic only via the inhalation route).

Only inorganic arsenic and chromium in valence state VI are considered carcinogenic. About 80 % of total arsenic in air is assumed to be inorganic, 50 % in tap water, 50 % in fruits and vegetables, and 25 % in grains. Typically, 20 % of chromium air emissions occur as chromium VI.

Table A2.5 European marginal damage costs for heavy metal emissions to air (based on RiskPoll, Ver. 2.0)

	Intake fraction (ppm)	Health impact endpoint	Marginal damage cost ($EUR/kg_{emission}$)	*68 % confidence interval ($EUR/kg_{emission}$)*
Arsenic	890 (as arsenic) 160 (as inorganic As)	Cancer	**349**	*30–530*
Cadmium	2270	Cancer	**29**	*5.2–47*
Chromium	150	cancer	**38**	*7.0–63*
Lead	440 (entire population) 1.1 (infants only)	IQ loss	**965**	*90–1 480*
Mercury	870 (as mg Hg in methyl-Hg per kg Hg emission)	IQ loss	**910** (European estimate) **2 860** (global estimate)	*80–1 360* *240–4 290*
Nickel	550	Cancer	**3.8**	*0.7–6.3*

Notes: The intake fraction is the amount of pollutant intake by the exposed population per unit emission rate. 'ppm' stands for 'parts per million', or equivalently, pollutant intake in mg per kg emission to air. Intake from inhalation is less than 1 % of the total.

Inorganic arsenic and chromium VI (about 20 % of chromium emissions) are carcinogenic. The share of inorganic arsenic varies by food product. About 80 % of total arsenic in air and 50 % in tap water is assumed to be inorganic. For lead computations, the infant intake fraction is the appropriate dose for estimating the IQ loss.

Mercury is a global pollutant, with a one- to two-year atmospheric residence time. The cost estimate for Europe corresponds to the impact (IQ loss) suffered by European citizens only. By contrast, the global assessment value applies to the worldwide population. The intake fraction is the mass of mercury (in mg) passing through the human body in the chemical form of methyl-mercury per unit air emission of mercury in kg.

Cost estimates (mean values) include intake by inhalation and ingestion pathways, and apply to a source of unknown location and characteristics (e.g., source stack height). Uncertainty intervals are based on a geometric standard deviation of 3 for cadmium, chromium and nickel, 4 for arsenic and lead, and 4.2 for mercury (Spadaro and Rabl, 2008a and 2008b).

Table A2.6a Country-specific marginal damage costs for organics, EUR/$kg_{emission}$ (based on RiskPoll, Ver. 2.0)

	1, 3 Butadiene		Benzene		PAH (as BaP equivalent)	
	Marginal damage cost	*68 % confidence interval*	Marginal damage cost	*68 % confidence interval*	Marginal damage cost	*68 % confidence interval*
Austria	0.49	*0.09–0.81*	0.075	*0.014–0.12*	1 279	*122–1 957*
Balkans	0.38	*0.07–0.62*	0.059	*0.011–0.10*	1 273	*122–1 948*
Belgium	0.82	*0.15–1.34*	0.120	*0.022–0.20*	1 296	*124–1 982*
Bulgaria	0.27	*0.05–0.45*	0.045	*0.008–0.07*	1 268	*121–1 940*
Cyprus	0.33	*0.06–0.54*	0.053	*0.010–0.09*	1 271	*122–1 945*
Czech Republic	0.49	*0.09–0.80*	0.074	*0.014–0.12*	1 279	*122–1 957*
Denmark	0.24	*0.04–0.40*	0.040	*0.007–0.07*	1 266	*121–1 938*
Estonia	0.14	*0.02–0.22*	0.026	*0.005–0.04*	1 261	*121–1 929*
Finland	0.15	*0.03–0.24*	0.027	*0.005–0.04*	1 261	*121–1 930*
France	0.59	*0.11–0.97*	0.088	*0.016–0.15*	1 284	*123–1 965*
Germany	0.74	*0.13–1.21*	0.109	*0.020–0.18*	1 292	*124–1 976*
Greece	0.28	*0.05–0.46*	0.046	*0.008–0.08*	1 268	*121–1 941*
Hungary	0.47	*0.09–0.77*	0.072	*0.013–0.12*	1 278	*122–1 955*
Ireland	0.25	*0.05–0.41*	0.041	*0.008–0.08*	1 267	*121–1 938*
Italy	0.53	*0.10–0.87*	0.081	*0.015–0.13*	1 281	*123–1 960*
Latvia	0.16	*0.03–0.27*	0.029	*0.005–0.05*	1 262	*121–1 931*
Lithuania	0.21	*0.04–0.34*	0.036	*0.007–0.06*	1 265	*121–1 935*
Luxembourg	0.52	*0.10–0.86*	0.079	*0.014–0.13*	1 281	*122–1 960*
Malta	0.19	*0.03–0.31*	0.033	*0.006–0.05*	1 263	*121–1 933*
Netherlands	0.87	*0.16–1.43*	0.127	*0.023–0.21*	1 298	*124–1 987*
Norway	0.12	*0.02–0.20*	0.024	*0.004–0.04*	1 260	*121–1 928*
Poland	0.42	*0.08–0.70*	0.066	*0.012–0.11*	1 276	*121–1 952*
Portugal	0.29	*0.05–0.47*	0.047	*0.008–0.08*	1 269	*121–1 941*
Romania	0.32	*0.06–0.53*	0.052	*0.009–0.08*	1 270	*121–1 944*
Slovakia	0.46	*0.08–0.75*	0.070	*0.013–0.12*	1 277	*122–1 955*
Slovenia	0.49	*0.09–0.80*	0.074	*0.014–0.12*	1 279	*122–1 957*
Spain	0.27	*0.05–0.45*	0.045	*0.008–0.07*	1 268	*121–1 940*
Sweden	0.22	*0.04–0.36*	0.037	*0.007–0.06*	1 265	*121–1 936*
Switzerland	0.63	*0.11–1.03*	0.094	*0.017–0.15*	1 286	*123–1 968*
United Kingdom	0.52	*0.09–0.85*	0.078	*0.014–0.13*	1 280	*122–1 959*

Notes: Cost estimates (mean values) apply to air emissions, and include intake by inhalation and ingestion pathways. Generally, the ingestion dose tends to be uniform because of food transport between countries (for PAH, inhalation accounts for 2 % of total intake dose). Only carcinogenic impacts have been evaluated. The damage cost range assumes a lognormal distribution (Spadaro and Rabl, 2008b), with a geometric standard deviation of 3 for 1, 3 butadiene and benzene (presently, considered toxic only via the inhalation route), and 4 for the polycyclic aromatic hydrocarbons (PAH).

BaP = Benzo-a-pyrene.

Table A2.6b Country-specific marginal damage costs for organics (RiskPoll, Ver. 2.0)

	Diesel particulate matter EUR/$kg_{emission}$		Formaldehyde EUR/$kg_{emission}$		Dioxins/furans million EUR/$kg_{emission}$ (PCDD and PCDF)	
	Marginal damage cost	*68 % confidence interval*	Marginal damage cost	*68 % confidence interval*	Marginal damage cost	*68 % confidence interval*
Austria	0.56	*0.10–0.91*	0.21	*0.04–0.35*	27.0	*1.5–37.0*
Balkans	0.42	*0.08–0.69*	0.16	*0.03–0.27*	26.9	*1.5–36.8*
Belgium	0.92	*0.17–1.5*	0.35	*0.06–0.58*	27.3	*1.5–37.4*
Bulgaria	0.31	*0.06–0.50*	0.12	*0.02–0.19*	26.8	*1.5–36.7*
Cyprus	0.37	*0.07–0.61*	0.14	*0.03–0.24*	26.9	*1.5–36.8*
Czech Republic	0.55	*0.10–0.90*	0.21	*0.04–0.35*	27.0	*1.5–37.0*
Denmark	0.27	*0.05–0.45*	0.11	*0.02–0.17*	26.8	*1.5–36.7*
Estonia	0.15	*0.03–0.25*	0.06	*0.01–0.10*	26.7	*1.5–36.5*
Finland	0.17	*0.03–0.27*	0.06	*0.01–0.10*	26.7	*1.5–36.5*
France	0.66	*0.12–1.1*	0.26	*0.05–0.42*	27.1	*1.5–37.1*
Germany	0..83	*0.15–1.4*	0.32	*0.06–0.52*	27.2	*1.5–37.3*
Greece	0.32	*0.06–0.52*	0.12	*0.02–0.20*	26.8	*1.5–36.7*
Hungary	0.53	*0.10–0.87*	0.20	*0.04–0.33*	27.0	*1.5–37.0*
Ireland	0.28	*0.05–0.46*	0.11	*0.02–0.18*	26.8	*1.5–36.7*
Italy	0.60	*0.11–0.98*	0.23	*0.04–0.38*	27.0	*1.5–37.0*
Latvia	0.18	*0.03–0.30*	0.07	*0.01–0.12*	26.7	*1.5–36.6*
Lithuania	0.24	*0.04–0.39*	0.09	*0.02–0.15*	26.7	*1.5–36.6*
Luxembourg	0.59	*0.11–0.97*	0.23	*0.04–0.37*	27.0	*1.5–37.0*
Malta	0.21	*0.04–0.35*	0.08	*0.01–0.13*	26.7	*1.5–36.6*
Netherlands	0.98	*0.18–1.6*	0.38	*0.07–0.62*	27.4	*1.5–37.5*
Norway	0.14	*0.02–0.22*	0.05	*0.01–0.09*	26.7	*1.5–36.5*
Poland	0.48	*0.09–0.78*	0.18	*0.03–0.30*	26.9	*1.5–36.9*
Portugal	0.32	*0.06–0.53*	0.12	*0.02–0.20*	26.8	*1.5–36.7*
Romania	0.36	*0.07–0.60*	0.14	*0.03–0.23*	26.9	*1.5–36.8*
Slovakia	0.52	*0.09–0.85*	0.20	*0.04–0.33*	27.0	*1.5–36.9*
Slovenia	0.55	*0.10–0.90*	0.21	*0.04–0.35*	27.0	*1.5–37.0*
Spain	0.31	*0.06–0.51*	0.12	*0.02–0.20*	26.8	*1.5–36.7*
Sweden	0.25	*0.04–0.40*	0.09	*0.02–0.16*	26.8	*1.5–36.6*
Switzerland	0.71	*0.13–1.2*	0.27	*0.05–0.45*	27.1	*1.5–37.2*
United Kingdom	0.58	*0.11–0.95*	0.22	*0.04–0.37*	27.0	*1.5–37.0*

Notes: Cost estimates (mean values) apply to air emissions, and include intake by inhalation and ingestion pathways. Only carcinogenic impacts have been evaluated. The damage cost range assumes a lognormal distribution, with a geometric standard deviation of 3 for diesel particulates and formaldehyde (presently, considered toxic only via inhalation), and 5 for the polychlorinated dibenzo-dioxins (PCDD) and dibenzo-furans (PCDF). For dioxins/furans, the inhalation exposure accounts for less than 2 % of the total intake dose. Generally, the ingestion dose tends to be uniform because of food transport between countries. Although the marginal damage cost for dioxins/furans is very high, the air emission rate is many orders of magnitude smaller than source emissions of the classical pollutants (e.g., primary particulate matter and secondary aerosols) and the heavy metals (total cost = marginal cost * emission rate).

Table A2.7 European marginal damage costs for organic emissions to air (RiskPoll, Ver. 2.0)

	Intake fraction (ppm)	Health impact endpoint	Marginal damage cost (EUR/$kg_{emission}$)	*68 % confidence interval (EUR/$kg_{emission}$)*
1,3 butadiene	2.9	Cancer	0.50	*0.09–0.82*
Benzene	3.2	Cancer	0.076	*0.014–0.12*
PAH (BaP equivalent)	140	Cancer	1279	*120–1,960*
Diesel particulates	2.9	Cancer	0.56	*0.10–0.92*
Formaldehyde	2.9	Cancer	0.22	*0.04–0.36*
Dioxins and furans	160	Cancer	27 million EUR/kg	*1.5–37 million EUR/kg*

Notes: The intake fraction is the amount of pollutant intake by the exposed population per unit emission rate. 'ppm' stands for 'parts per million', or equivalently, pollutant intake in mg per kg emission to air. Intake from inhalation is less than 2 % of total (applies only to PAH and dioxins/furans).

Cost estimates (mean values) include intake by inhalation and ingestion pathways, and apply to a source of unknown location and characteristics (e.g., source stack height). Uncertainty ranges are based on a geometric standard deviation of 3 for 1,3 butadiene, benzene, diesel particulate matter and formaldehyde, 4 for PAH, and 5 for dioxins/furans.

Annex 3
Sectoral adjustment

The methods used in this study recognise that the dispersion of emissions from point sources partly depends on characteristics specific to the emitting sector, such as stack height and flue gas temperature. Use of national average estimates of damage per tonne will introduce some error into the analysis if it ignores this issue. This Annex describes the methods used to adjust damage estimates for the regional pollutants by sector using the results of the Eurodelta II study (Thunis et al., 2008). This first requires conversion of E-PRTR sectors to the Selected Nomenclature for sources of Air Pollution (SNAP) sectors used in Eurodelta II.

A3.1 E-PRTR to SNAP Conversion

Activities reported under the E-PRTR Regulation (EU, 2006) are grouped into nine categories:

1. energy;
2. production and processing of metals;
3. mineral industry;
4. chemical industry;
5. waste and waste water management;
6. paper and wood production and processing;
7. intensive livestock production and aquaculture;
8. animal and vegetable products from the food and beverage sector;
9. other activities.

Sector-specific correction factors developed under the Eurodelta II study (see Section 2.3) are applied to account for the differences in pollutant dispersion between specific sectors, as well as the all-sector averages computed through the available EMEP source-receptor matrices.

The emissions data analysed in the Eurodelta II study were reported in a different reporting format to the one used under E-PRTR. In order to apply correction factors the facility/operator emissions need to be converted from E-PRTR to SNAP format. E-PRTR categories, however, are more aggregated than SNAP. For example, E-PRTR code 1C 'Thermal power stations and other combustion installations' covers:

- power stations (SNAP1);
- commercial/public sector plants (SNAP2);
- industrial facilities (SNAP3).

Operators need to report their emissions under E-PRTR at facility level. While facilities can report multiple activities they must indicate their main activity. To illustrate, the reported emissions of NMVOC from Audi's facility at Ingolstadt were considered. This facility carries out three different activities (combustion, solvent use, waste disposal). The primary activity at the Audi factory was fixed as 'combustion' (E-PRTR 1.1). However, it is probable that the NMVOC emissions are actually released from solvent use (i.e. painting of cars). Hence based on the main activity, all of the NMVOC emission would be assigned to SNAP 3 (Industrial combustion) rather than to SNAP 6 (Solvent and other product use).

In total the E-PRTR database lists approximately 10 000 facilities for the reporting year 2009. It was not within the scope of this study to go through each facility and assign the SNAP code based on the different activities reported. Hence it is assumed that the majority of emissions by facility are indeed associated with its main activity.

As an example, a previous analysis undertaken using E-PRTR data for the year 2008 checked the default main activity SNAP allocation for each UK facility against the overall facility emissions (Table A3.1), to establish whether the main activity captures the majority of emission for each site. It found that 32 % of emissions allocated to SNAP 4 would be better placed under the SNAP 1 or 5 because the main activity is not the most representative activity for these facilities. For example, UK Coal PLC's main activity is 'Underground mining and related operations' which is allocated to SNAP 4. However consultation with UK experts showed that the main activity at that facility is combustion which would be allocated to SNAP 1. The opposite case may occur for other sites where emissions are allocated to SNAP 1 but the actual site activity would be allocated to SNAP 4.

It is acknowledged that the assignment of SNAP sectors by main activity introduces an additional element of uncertainty. Due to the large number of sites under E-PRTR it is not possible to conduct a review of each facility. Nevertheless, it is believed that the overall sum for each SNAP code gives a representative estimate.

A3.2 Eurodelta II correction factors

The key results from the Eurodelta II report are presented in the following three tables. They show the ratio of 'sector efficiency' to 'all sectors efficiency' with respect to exposure of the European population to fine particulate matter (health impacts of emissions of SO_2 and NO_x are estimated in terms of their contribution to sulphate and nitrate aerosols respectively) for emissions from France, Germany, Spain and the United Kingdom.

Where the ratio of sector efficiency to all sectors efficiency is less than one, control in the sector of interest is less effective in reducing population exposure per unit emission reduction than the average across all sectors. This tends to be the case for large industrial facilities, as typically tall stacks aid dispersion away from large centres of population. Where the ratio is greater than one,

Table A3.1 UK emissions in tonnes (2008) from the E-PRTR

	Emissions (tonnes)						
Pollutants/SNAP	**1**	**3**	**4**	**5**	**6**	**9**	**10**
As and compounds	0.9	0.33	0.16				
Cd and compounds	0.1	0.2	0.19				
Cr and compounds	1.9	1.8	5.0			0.39	
Hg and compounds	2.1	1.2	0.43			0.029	
NH_3	36	987	3 700		240	105	10 329
Ni and compounds	14	6.6	2.4			0.13	
NMVOC	65 998	3 959	61 592	10 251	18 900	184	
NO_x	446 214	73 766	3 148			6 633	
Pb and compounds	3.8	17	18				
PCDD+PCDF (dioxins+furans)		0.00012	0.00001				
PM10	9 508	7480	2 580	74		100	918
SO_x	370 619	90 582	16 871				
Total	**892 398**	**176 801**	**87 917**	**10 325**	**19 140**	**7 022**	**11 247**
Tonnes allocated to different SNAP	78 058	7 726	27 851	0	0	0	1 111
% of total	9 %	4 %	32 %	0 %	0 %	0 %	10 %

Table A3.2 Relative efficiency of sectoral SO_2 reductions for $PM_{2.5}$ impacts on Europe

	Sector efficiency/all sectors efficiency		
	1 Public power	**3 Industrial**	**8 Other transport**
France	0.74	1.06	
Germany	0.86	1.03	
Spain	1.01	1.03	1.06
United Kingdom	0.86	0.96	
Average	0.87	1.02	1.06
Range	± 0.14	± 0.06	

control in the sector of interest is more effective than the average, as is particularly the case for road transport (5).

In the case of sulphur dioxide the relative efficiency of emission reductions for the public power sector is generally below 1 (Spain providing the exception) with an average of 0.87 and a range of ± 0.14. For the industrial sector values are in all cases close to 1 with a small range of ± 0.06.

In the case of NO_x the relative efficiency of emission reductions for the public power sector is below 1 in all cases with an average of 0.78 and a range of ± 0.13. For the industrial sector the average is 0.86 with a range of ± 0.07. For the road traffic sector the value is greater than 1 in all cases, with an average of 1.12 and a range of ± 0.09. The absence of urban factors in the dispersion modelling will bias results significantly for this sector.

The level of variation for $PM_{2.5}$ impacts is greater than for SO_2 and NO_x, with average factors relative to the ALL SECTOR efficiency being around – 50 % for sectors 1 and 3 and +20 % for sectors 2, 4 and 7. For most sectors the variation around these averages is greater than 20 % at one or both ends.

Results from the preceding tables clearly show that there would be some level of error when applying an all-sector transfer factor. The most problematic of the three pollutants is primary $PM_{2.5}$ as its transfer

Table A3.3 Relative efficiency of sectoral NO_x reductions for $PM_{2.5}$ impacts on Europe

	Sector efficiency/all sectors efficiency		
	1 Public power	3 Industrial	7 Road traffic
France	0.91	0.87	1.05
Germany	0.80	0.84	1.06
Spain	0.65	0.93	1.15
United Kingdom	0.74	0.79	1.21
Average	0.78	0.86	1.12
Range	± 0.13	± 0.07	± 0.09

Table A3.4 Relative efficiency of sectoral primary PM reductions for $PM_{2.5}$ impacts on Europe

	Sector efficiency/all sectors efficiency				
	1 Public power	2 Industrial/ commercial	3 Industrial	4 Production processes	7 Road traffic
France	0.64	1.03	0.63	1.08	1.26
Germany	0.51	1.07	0.55	1.38	1.05
Spain	0.39	1.78	0.52	0.84	1.09
United Kingdom	0.47	1.04	0.58	1.31	1.51
Average	0.50	1.23	0.57	1.15	1.23
Range	± 0.14	– 0.20 to + 0.55	± 0.06	– 0.31 to + 0.23	– 0.18 to + 0.28

(5) Results for the road transport sector are not of great relevance to this work as the sector is not included in the E-PRTR. However, they are included here to show how the reduction in transfer factors for sectors like public power relative to the all sector factors is balanced by increases elsewhere.

factors depart from the all sector averages by a much greater degree than those for SO_2 and NO_x. However, available results from past external costs analysis suggest that emissions of $PM_{2.5}$ from most modern industrial facilities are sufficiently low compared to emissions of SO_2 and NO_x that this is likely to be of rather limited importance.

To investigate this, information from 141 analyses of the external costs of power plants in Europe of different designs and using different fuels were investigated. Fifty-seven of these cases could be considered relevant here [6]. The external costs of NO_x and SO_2 combined outweigh those of $PM_{2.5}$ by an average factor of 14 (and a median factor of six). This is despite the fact that the version of the ExternE methodology used gives higher weight to primary $PM_{2.5}$ than the CAFE benefits methodology. For only two facilities (both biomass) were the external costs of primary $PM_{2.5}$ estimated to be larger than those of SO_2 and NO_x combined.

A3.3 Limitations of Eurodelta II

In the course of the present study a number of limitations of the Eurodelta analysis have been identified including:

1. Analysis focuses on emissions from only four countries. The representativeness of these countries is questionable. This could clearly generate uncertainty if the Eurodelta II results were extrapolated more widely across Europe. While it is understood that an additional four countries are to be considered in the near future these data were not available for the present work.

2. One of the objectives of Eurodelta is to compare the results of different European-scale models. With this in mind it was necessary to define a common modelling domain between the five models used in Eurodelta. The effect of this is to limit the overall area of the domain. A number of EU Member States fall wholly or partially outside the modelled domain: Bulgaria, Cyprus, Estonia, Finland, Ireland, Malta (possibly), northern Scotland and much of Latvia, Lithuania, Romania and Sweden. Countries further east (e.g. Ukraine, Moldova and Russia) are also excluded. The results will therefore under-predict exposure to ozone and $PM_{2.5}$ [7].

3. No account is taken of enhanced urban exposures, though for the emission sources relevant to E-PRTR this is unlikely to be of great importance.

4. The limitation of most importance may well relate to the treatment of stack height and the effective height of release. This appears to be discussed only in Section B5 of the Eurodelta II report (p. 96/106) which references a single Croatian report. It is not clear how representative the assumptions made here are of emission sources in the various SNAP sectors in the countries considered. Hence, while the assumptions made may be useful for demonstrating that there is an issue that should be addressed in analysis to support of policymaking, it is unclear how relevant the results of that modelling are to facilities across the EU, taking into account different attitudes to stack height calculation and (e.g.) different emissions linked to the use of different fuels. This is most important for SNAP sectors 1 (public stations), 3 (industrial plants) and 9 (waste) [8], which are those of most relevance to the E-PRTR.

A3.4 Approach adopted for this study

There are several ways of responding to the Eurodelta II results:

1. apply existing damage-per-tonne factors without adjustment for sector;

2. adjust by sector using the average of available sector/all sector transfer factors applied to all countries;

(6) The studies excluded from consideration here covered fuels for which emissions of $PM_{2.5}$ are very low or non-existent, such as nuclear, natural gas and most renewables (biomass excluded); small facilities that are not relevant to E-PRTR; and studies prior to 1998 (the time when chronic mortality impacts were brought fully into the ExternE Project methodology).

(7) The results presented in the Eurodelta II report were derived using only one of the five models, understood to be the EMEP model. Results should therefore be available to extend the exposure assessment well beyond the Eurodelta II modelling domain. This would clearly require additional effort, either from the EMEP modelling team or from (e.g.) AEA who could process the EMEP-generated files. Were this to be done, the concern about limitation of the modelling domain would be very largely addressed.

(8) SNAP sector 9 (Waste) was not considered in the Eurodelta II report.

3. adjust by sector using country-specific sector/all sector transfer factors.

Option 1 would be followed if it were considered that the identified limitations were so great that they negated the value of the Eurodelta II results. However, while recognising these problems it is logical that there will be some degree of sector-to-sector variation, and it would be better to take this into account than not to do so. At the other extreme, option 3 is only available for four countries, so could not be applied universally. An intermediate position has been taken, between options 2 and 3, applying country-specific data where they are available, and an average of country-specific factors for countries currently not covered by the analysis.

A3.5 Impacts of Eurodelta II on this study

The following conclusions were drawn from a review of Eurodelta II performed at the start of the present study:

1. Inter-sector variation for country-to-country pollutant transfer factors is significant, particularly for primary $PM_{2.5}$.
2. The method for estimating external costs should therefore be adapted to account for differences in transfer factors between sectors.
3. It is recommended that the work be started with a view to using the average sector-specific transfer factors from Eurodelta II, where country-specific factors are not yet available. There is sufficient consistency across countries for the sectors of most interest for the E-PRTR that associated errors should be manageable.
4. This position should be reviewed when further results become available that cover more countries.
5. The uncertainty associated with inter-sector differences is not great compared to some of the uncertainties that have been successfully addressed in past externalities work. It is also not great compared to the observed variation in transfer factors between the countries of Europe.
6. Ideally the sector-specific transfer factors would be calculated using the whole EMEP domain, rather than the restricted domain used in Eurodelta II.

European Environment Agency

Revealing the costs of air pollution from industrial facilities in Europe

2011 — 72 pp. — 21 x 29.7 cm

ISBN 978-92-9213-236-1
ISSN 1725-2237
doi:10.2800/84800

HOW TO OBTAIN EU PUBLICATIONS

Free publications:
- via EU Bookshop (http://bookshop.europa.eu);
- at the European Union's representations or delegations. You can obtain their contact details on the Internet (http://ec.europa.eu) or by sending a fax to +352 2929-42758.

Priced publications:
- via EU Bookshop (http://bookshop.europa.eu).

Priced subscriptions (e.g. annual series of the *Official Journal of the European Union* and reports of cases before the Court of Justice of the European Union):
- via one of the sales agents of the Publications Office of the European Union (http://publications.europa.eu/others/agents/index_en.htm).

A - 260

TH-AK-11-015-EN-N
doi:10.2800/84800

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel.: +45 33 36 71 00
Fax: +45 33 36 71 99

Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

ISBN 978-92-9213-236-1

9 789292 132361

Publications Office

European Environment Agency

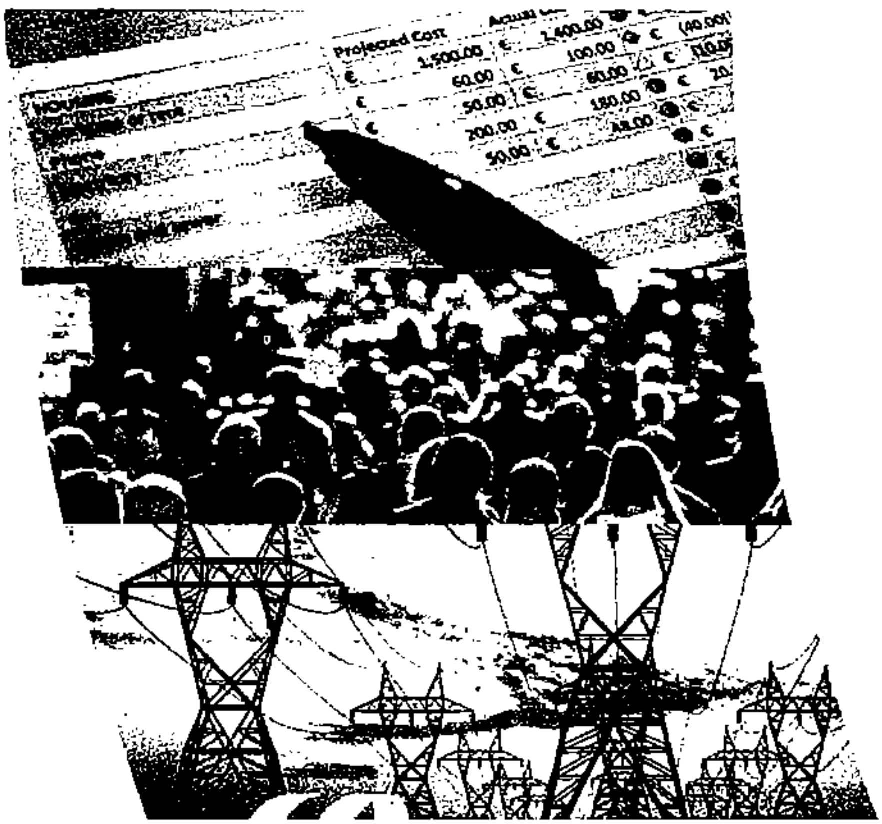
ANNEXURE – XIV

- EU hand book-28

A - 262

Environmental Prices Handbook

EU28 version



CE Delft

itted to the Environment

Environmental Prices Handbook

EU28 version

Authors:
Sander de Bruyn
Marijn Bijleveld
Lonneke de Graaff
Ellen Schep
Arno Schroten
Robert Vergeer
Saliha Ahdour

Delft, CE Delft, October 2018

Publication code: 18.7N54.125

Appraise / Evironment / Effects / Emissions / Economic factors / Measuring methode

CE Delft
Committed to the Environment

Through its independent research and consultancy work CE Delft is helping build a sustainable world. In the fields of energy, transport and resources our expertise is leading-edge. With our wealth of know-how on technologies, policies and economic issues we support government agencies, NGOs and industries in pursuit of structural change. For 40 years now, the skills and enthusiasm of CE Delft's staff have been devoted to achieving this mission.

Contents

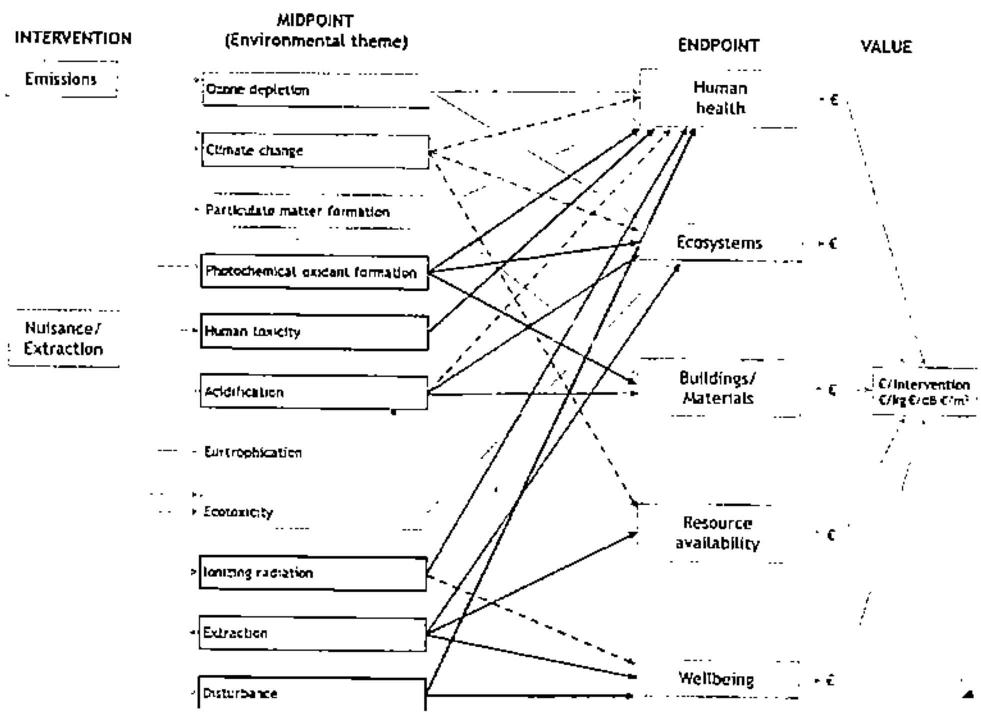
Summary

Environmental prices are constructed prices for the social cost or pollution, expressed in Euros per kilogram pollutant. Environmental prices thus indicate the loss of economic welfare that occurs when one additional kilogram of the pollutant finds its way into the environment. These prices can also be calculated for immaterial forms of pollution such as noise nuisance and ionizing radiation. In such cases the environmental price is expressed in Euros per unit of nuisance or exposure (in decibels, for example).

Environmental prices in this handbook provide average values for the EU28, for emissions from an average emission source at an average emission site in the year 2015. In this Handbook these prices are presented at three levels:
1. At pollutant level: a value for emissions of environmentally damaging substances.
2. At midpoint level: a value for environmental themes such as climate chage or acidification.
3. At endpoint level: a value for the impacts of environmental pollution, such as damage to human health or ecosystem services.

The methodology used in this Environmental Prices Handbook is designed to harmonize the values at pollutant, midpoint and endpoint level, to achieve consistent valuation of the impacts or pollution in the EU28.
Figure 1 provides an overview or the relationships covered in this Handbook, with each arrow representing a relationship that has been mapped.

Figure 1 **The relationships mapped in this Environmental Prices Handbook**



Note: Dashed lines represent relationships examined and (partly) quantified in the context or this Handbook, dotted lines relationships that were not directly quantified because a different approach was adopted for quantifiying impacts.

Results: pollutant level environmental prices

Prices at pollutant level, giving information on the cost of environmental pollution, are the ones most frequently used in analyses. This Handbook and the associated webtool provide such environmental prices for over 2,500 pollutants. Table 1 lists the values or the substances most commonly encountered in the context of air pollution and climate change.

Table 1 Environmental prices for average atmospheric emissions in the EU28 (€$_{2015}$/kg emission)

Stof		Lower	Central	Upper
Carbon dioxide*	CO_2	€ 0.022	€ 0.057	€ 0.094
Chlorofluorocarbons*	CFC_{11}	€ 130	€ 306	€ 504
Ultra-fine particulate matter	$PM_{2,5}$	€ 27.7	€ 38.7	€ 59.5
Particulate matter	PM_{10}	€ 19	€ 26.6	€ 41
Nitrogen oxides	NO_x	€ 9.97	€ 14.8	€ 22.1
Sulphur dioxide	SO_2	€ 8.3	€ 11.5	€ 17.9
Ammonia	NH_3	€ 10	€ 17.5	€ 25.2
Volatile organic compounds	NMVOC	€ 0.84	€ 1.15	€ 1.84
Carbon monoxide	CO	€ 0.0383	€ 0.0526	€ 0.0918
Methane*	CH_4	€ 0.673	€ 1.74	€ 2.91

* The value for greenhouse gas emissions includes VAT and increases by 3.5% per annum relative to the 2015 values, as detailed in Section 6.3.

The upper and lower pollutant level values are recommended for use in social cost-benefit analyses, the central values in other applications.

Results: Environmental prices at the midpoint level

The midpoint level environmental prices relate to the familiar set of environmental themes like climate change and eutrophication. They can be used as a weighting factor in life cycle assessment (LCA) or for calculating the external cost of particular materials or products. Table 2 lists the values to be used as external costs or weighting factors.

Table 2 Midpoint level environmental prices (€$_{2015}$/unit)

Theme	Unit	External cost	Weighting factor
Climate change	€/kg CO_2-eq.	€ 0.0566	€ 0.0566
Ozone depletion	€/kg CFC-eq.	€ 30.4	€ 123
Human toxicity	€/kg 1,4 DB-eq.	€ 0.0991	€ 0.0894
Photochemical oxidant formation	€/kg NMVOC-eq.	€ 1.15	€ 1.15
Particulate matter formation	€/kg PM_{10}-eq.	€ 39.2	€ 39.2
Ionizing radiation	€/kg kBq U235-eq.	€ 0.0461	€ 0.0461
Acidification	€/kg SO_2-eq.	€ 4.97	€ 7.48
Freshwater eutrophication	€/kg P-eq.	€ 1.86	€ 1.86
Marine eutrophication	€/kg N	€ 3.11	€ 3.11
Terrestrial ecotoxicity	€/kg 1,4 DB-eq.	€ 8.69	€ 8.69
Freshwater ecotoxicity	€/kg 1,4 DB-eq.	€ 0.0361	€ 0.0361
Marine ecotoxicity	€/kg 1,4 DB-eq.	€ 0.00739	€ 0.00739
Land use	€/m^2*year	€ 0.0845	€ 0.126
Noise >60dB*	€/dB/person	€52-€228	-

* Valuation of noise varies with noise levels and source of noise, see Chapter 6.
External costs are characterized based on an individualist perspective, weighting factors based on a hierarchist perspective. For explanation, see Chapter 3 and Annex A.

Endpoint level

This Handbook reports monetary values for the endpoint impacts human health (mortality and morbidity), ecosystem services, damage to buildings and materials, resource availability and (noise and visual) nuisance. These values form a pivotal element of this Handbook, as they are used to derive the values assigned to midpoint impacts. Table 3 provides an overview or the values adopted.

Table 3 Endpoint level environmental prices

Impact	Indicator/method	Value (lower-upper)
Human health		
Acute mortality	VOLY	€ 50,000-110,000
Chronic mortality	VOLY	€ 50,000-110,000
Morbidity	QALY*	€ 50,000-100,000
Ecosystem services		
Productive ecosystem services**	Crop productivity losses (as a proxy)	
Biodiversity loss	PDF	€ 0.08-0.65/PDF/m²/yr
Buildings and materials		
Buildings and materials	Restoration costs**	
Resource availability		
Environmental benefits	Environmental prices	
Scarcity and security or supply	Further study**	
Nuisance		
Noise nuisance	Source- and level-specific	
Visual nuisance	Location-specific	

* Besides QALYs other quantifications were also used, such as IQ loss (€ 17,500/lost IQ-point).

** Not fully quantified in this Handbook.

Abbreviations: VOLY: Value or Life Years; QALY: Quality Adjusted Life Years, PDF: Potentially Disappeared Fraction.

Using environmental prices

Environmental prices can be used as a calculation tool in studies and practical applications by government and industry. There are three basic uses:

1. In social cost-benefit analysis (SCBA). Environmental prices are used to assign a value to the environmental impacts of a particular measure or action. For use in this application, the upper and lower values of the pollutant level price are recommended.
2. In the context of corporate social responsibility (CSV) and benchmarking. Companies can use environmental prices to quantify their environmental footprint as well as for preparing environmental annual reports, social business cases and ecological profit-and-loss accounts. In these applications the central pollutant level value is recommended.
3. In life cycle assessment (LCA). LCA practitioners can use environmental prices to weight the calculated environmental impacts to produce a 'single score'. Companies can determine which materials have the least average environmental impact, for example, key information for optimizing the environmental footprint or their operations.

Environmental prices are average prices for average emissions in the EU28 and are consequently less suitable for site-specific studies and applications. When considering particular situations involving toxic substances, as with lead soil pollution or hazards relating to plastic coatings on packaging cans, for example, it is not therefore recommended to use environmental prices. In such cases it is better to perform a dedicated study to determine the environment dispersal of the pollutant, its uptake in humans, animals and/or plants, and the effects of uptake on human health and/or ecosystem services. Working with environmental prices in these kinds or situation is too coarse a methodology, given the uncertainties involved.

Reading guide

This Handbook has a three-part structure. Part 1, Chapters 1 to 3, is a User Guidel. After a general introduction, the procedures adopted in the underlying study are justified and the principal assumptions discussed. The environmental prices for the main pollutants are then presented and their use in different contexts explained. Part 2, Chapters 4 to 6 is a detailed elaboration of how the environmental prices were calculated for each environmental theme and endpoint. Here we provide accountability for the choices made in this Handbook and discuss the relevant literature. The third part comprises two Appendices. The first provides some theoretical background on valuation procedures, the second the environmental prices of emissions or over 250 air, soil and water pollutants. All in all, environmental prices for over 2,500 pollutants were calculated in the study underlying this Handbook. These can be looked up alphabetically as well as under the relevant pollutant code (CAS code) at the Environmental prices Handbook website, www.cedelft.eu/en/environmental-prices which is online in since September 2017.

PART 1: USER GUIDE

1 Introduction

1.1 Background

In modern societies, ever more goods and services are traded in the marketplace. Whenever we go into a shop we see countless articles with a price tag. Based on these prices we decide whether to buy Product A or B, or both, or leave the shop with no purchase at all. A shop can be viewed as a market. It is not only shops where prices play a key role, though. On stock markets, too, prices are what enable trading in companies, goods, physical products and financial products like derivatives. Online, billions of prices are available at any given moment and are used by traders, investors, corporations, consumers and producers to decide on whether to buy or sell.

Market prices are thus a key variable steering the economic process, reflecting what consumers are prepared to pay for a given product or service. If the price goes up, fewer consumers will generally want to buy the product. For the marginal consumer, the price reflects precisely the amount of income he or she is willing to spend on the product or service. In principle, then, prices indicate the value that society, at the margin, thinks the product or service is worth.

Not all goods or services are traded in the marketplace. Many things, such as safety, decency, dykes, leisure time, natural beauty and a clean environment, are not traded directly in markets. But although these things do not have a direct 'price', everyone will agree they are important for the wellbeing of a country's citizens. An unsafe country, with no standards of decency, where nobody has any leisure time, where floods occur in heavily polluted areas and where there is no nature left begins to approximate Dante's inferno.

While environmental quality is to the good of human wellbeing and prosperity, then, it is unpriced. Since every society makes daily use of economic tools for analysing investments and efficiency, for weighing up costs and benefits and for a host of other purposes, a need arises to express the benefits to human welfare of a clean environment in a price, too, so these can be duly accounted for in economic decisions. This is what environmental prices do: they put a monetary value on environmental quality, by looking at what people would be willing to pay for that quality *as if* there were a market for it.

Environmental prices are implicit prices: the price of environmental quality cannot be determined directly in the marketplace and must therefore be calculated. From the late 1960s onwards, numerous studies have sought to put a price on air pollution and noise nuisance (for a review of Dutch studies see (Hoevenagel & De Bruyn, 2008)). In doing so, most such studies take as their point of departure the *damage* caused by pollution and other forms of environmental intervention. Environmental quality is then valued on the basis of the estimated damage arising as a result of emissions and other changes in the Earth's natural capital.

Since 1997 CE Delft has been publishing 'shadow prices' expressing the value of the environment, calculating it in terms of the marginal costs of securing standing environmental policy targets (CE Delft, 1997; CE Delft, 1999; CE Delft, 2002; CE Delft, 2010). In the latest edition of the Shadow Prices

Handbook, dating from 2010, this set of prices was extended to include an estimate of the *damage* caused by pollution and other interventions, with shadow prices being provided for air, soil and water pollution by over 400 environmentally hazardous substances as well as for noise and land use. The Handbook provided damage cost estimates for both the Netherlands and the EU28.

This 2010 Handbook has been widely used for preparing environmental annual reports (e.g. (NS, 2014)), quantifying environmental impacts in cost-benefit analyses (see e.g. (Buck Consultants, 2012), (ECN; SEO, 2013)), estimating external costs (see e.g. (Allacker & Nocker, 2012)), quantifying environmental issues in, for example, corporate mergers (Kloosterhuis & Mulder, 2013) and creating tools to increase environmental awareness in the SME sector, as with the Environmental Barometer (Stimular, 2016).

Now in 2087, however, the prices reported in the 2010 Shadow Prices Handbook (CE Delft, 2010) are no longer up-to-date for two main reasons. First, the revised General Guidelines for Social Cost-Benefit Analysis in the Netherlands have been published (CPB; PBL, 2013) alongside new advice from the Discount Rate Working Group of the Dutch Ministry of Finance (Ministerie van Financiën, 2015), providing a new framework against valuation of environmental amenities in the Netherlands needs to take place. Second, new research has been published on the impacts of pollution and other environmental interventions on public health and other issues of relevance for social welfare that necessitates an update of the old Handbook.

For these reasons the Dutch Ministry of Infrastructure and Environment commissioned CE Delft in 2016 to prepare an update of the 2010 Shadow Prices Handbook, setting out the subject matter in a manner accessible to a wide range of readers. In 2017, CE Delft published the new environmental prices handbook which developed a comprehensive set of environmental prices for over 2,500 pollutants to use in the Netherlands and the methodological framework employed to develop them. Because of the international use of the handbook in calculations related to Natural Capital, the Dutch Ministry of Agriculture, Nature and Food Quality issed an extension to develop an international set of environmental prices at the level of the EU28.

1.2 What are environmental prices?

Environmental prices are indices that calculate the social marginal value of preventing emissions, or interventions like noise and land-use changes, expressing it in Euros per kilogram pollutant or per decibel, for example. Environmental prices thus indicate the loss of welfare due to one additional kilogram of pollutant or decibel of noise being emitted to the environment. In this sense, environmental prices are often the same as external costs

Because a market for environmental quality is lacking, environmental prices cannot be observed directly, i.e. empirically, but must be calculated using the results of studies on human preferences for avoiding the impacts of pollution. This new Environmental Prices Handbook provides a research framework and methodology for putting a numerical price on the value that society attaches to environmental quality.

1.3 Using environmental prices

Environmental prices are used in a wide variety of studies and practical applications by, or commissioned by, government, industry and NGOs for many purposes. Three main areas of application can be distinguished:

1. **Social cost-benefit analysis (SCBA).** Environmental impacts play a key role in economic decision-making in countless areas. A typical example is road construction, where it is not only the cost-effectiveness of the transport link that needs considering, but also pollution impacts and land-use changes. By assigning a value to these impacts using environmental prices, these impacts can be numerically compared with financial-economic data, to establish whether or not the overall impacts of road construction lead to net gains in economic welfare.
2. **Corporate Social Responsibility (CSR) and benchmarking.** Companies and other organizations do not operate as islands, but are embedded in society as a whole. In recent years companies have come under growing pressure to put a numerical value on their impact on the wider environment and for this purpose, too, environmental prices are a useful tool. In environmental annual reports they can be used for social or ecological profit and loss accounts. Environmental prices can also be used to benchmark the environmental performance of a company or organization against that of competitors or other organizations, as with the Environmental Barometer referenced above.
3. **Weighting in Life Cycle Assessment (LCA).** In LCAs and other kinds of environmental analysis such as Environmental Impact Assessments (EIAs) the impacts of a product are expressed at 'midpoint' or 'endpoint' level, the former referring to environmental themes like climate change or ecotoxicity, the latter to the issues affected, like human health or ecosystems. Environmental prices allow midpoint impacts to be summed to a single figure. This involves an implicit 'weighting' of midpoint and/or endpoint impacts[1]. This provides companies with a quantitative handle for improving the lifecycle environmental impact of their products and factoring in the environment in procurement and production strategies.

1.4 Aim and scope

1.4.1 Aim

The study underpinning the present Handbook had a threefold objective:

1. To develop a set of scientifically robust and consistent environmental prices for the EU28 for pollutant emissions and environmental impacts at midpoint and endpoint level, based on the earlier handbook for the Netherlands.
2. To make this set of values as comprehensive as possible in terms of types of impact and number of pollutants included.
3. To make this set of values applicable for use in SCBA, CSR and LCA and, where necessary, adjust them specifically for use in these domains.

---

1 The ISO standard 14040-44 for LCA does not support weighting for comparative LCAs. The recommendation is to compare at midpoint level.

1.4.2 Scope

The environmental prices reported here are based on damage costs.
By calculating and valuing the damage caused by environmental pollution (or other such interventions) with respect to a range of endpoints, a value can be assigned to the *additional* overall damage caused by a additional kilogram of a given emission (or equivalent).

The environmental prices reported here are *average* prices for the year 2015 per kilogram emission (and other units for land use and noise) from an *average* source at an *average* location (with average population density and average income, for example). Environmental prices are thus rough-and-ready estimates that are not necessarily valid in specific situations. For particulate matter and noise, specific values are also reported for traffic. In principle, these prices represent the social value of environmental pollution for 2015 emissions. For use in future years, specific guidelines are provided (see Chapters 3 and 5).

1.4.3 Application

This Handbook reports four sets of environmental prices:

- A+B): An upper and lower value of estimates derived according to the economic principles employed in SCBA and elsewhere. The ranges in these estimates reflect the uncertainties in people's valuation of environmental quality, and should be explicitly included in SCBAs, as laid down in the new Dutch General SCBA Guidelines (CPB; PBL, 2013).
- C): A central value calculated according to standard economic principles, suitable for use by companies in CSR settings.
- D): A central value that can be used as a weighting factor in LCA. This value is very similar to C, but impacts for future generations are discounted at a lower rate and thus count for more.[2]

1.5 Limitations

This Handbook, the EU28 version, presents sets of environmental prices and weighting factors for use as indices in economic and environmental analysis. These prices are average values for emissions from an average source in Europe in 2015. The Handbook provides guidelines on *which* set of environmental prices or weighting factors are to be used in a given context, distinguishing three analytical settings: (i) External cost estimates and Social Cost-Benefit Analysis; (ii) Life Cycle Assessment; and, (iii) Tools like benchmarking used in the context of Corporate Social Responsibility.
This Handbook is not concerned with the design of such analyses, though. There is thus no discussion of characteristic issues like system boundaries, sensitivity analyses, distribution effects, allocation and so on. For cost-benefit analyses, readers are referred to the General SCBA Guidelines in the Netherlands (CPB; PBL, 2013) and the specific SCBA Guidelines for Environment (CE Delft, 2017b) or various international guidelines available at the level of the OECD (2018) or several domains within the European Union (European Union, 2015).

---

2 This value is included because in LCA characterization is usually from a 'hierarchist' perspective, with most impacts included over an undiscounted time frame of 100 years, while economic valuation corresponds more with an 'individualist' perspective. See also Annex A.

Nor is this document to be regarded as an all-inclusive manual for valuing environmental goods or as a textbook for weighting environmental impacts. The aim of this project was to create concrete and consistent sets of environmental prices and weighting factors that can be used in day-to-day practice. The price estimates have been drawn up by CE Delft based on the best available scientific understanding. They have been put to and discussed with an Advisory Committee comprising representatives of the Netherlands Bureau for Economic Analysis (CPB) and the Netherlands Environmental Protection Agency (PBL) and other scientific experts, and adjusted as necessary in reponse to their remarks (cf. Section 1.8). In choosing our methods we based ourselves on what is currently held to be *mainstream opinion* in the sciences of environmental valuation, characterization and weighting — with some preference for the most *recent* findings. This means there are *alternative* valuation and weighting methods which, while mentioned here (along with references), are discussed only briefly in terms of how they compare with the methodology adopted here. Given the very extensive literature on valuation and weighting, it would indeed be unfeasible to summarize all the methods in current use. Those using the environmental prices or weighting factors developed in this Handbook must therefore themselves judge whether the figures presented here are preferable to those cited in other publications.

Unless otherwise stated, the environmental prices presented here are expressed in €/kg emission.[3] These prices have been calculated as average values for the EU28 (situation 2015). Users should make their own judgment as to whether these averages can be used in a particular application like SCBA or LCA. As justification for such choices will always depend on the specific issue for which the environmental prices are being used, the question of whether use of national averages is justified cannot be answered by us here. Local circumstances like population density, existing pollution levels and local pollution limits may mean the data presented here cannot always be applied at the local level (e.g. municipal or provincial). Nor can additional impacts in other countries, including developing nations, be determined using these environmental prices.[4] Finally, use of these environmental prices is also highly contingent on the pollution source or sources involved: transport emissions are far more damaging to human health than average emissions, for example, because they occur closer to the ground. Using these average values for determining the damage due to transport emissions will consequently always lead to an underestimate. We consider these important issues when using environmental prices and in this Handbook we therefore assess the implications of using the figures in transport contexts in Chapter 6.

All the environmental prices and weighting factors presented here are (ultimately) expressed as upper, lower and central values. We are all too aware that this implies a degree of quasi-certainty. The environmental prices themselves have been calculated on the basis of multitude of uncertain factors. The formal treatment of uncertainty (see Annex C) shows variations to be very substantial — so substantial that use of environmental prices should in fact be discouraged in the first instance. This holds not only for the prices developed here but also for other methods for valuing and weighting environmental goods (few of which include any formal treatment of uncertainty, it may be added). It is a question of choosing the lesser evil, though: either one refrains from using environmental prices, which means

3 Voor noise nuisance, ionizing radiation and resource depletion other units are used.

4 For this purpose CE Delft has developed the Benefito model (CE Delft, 2011).

financial data cannot be compared with environmental impacts and those impacts cannot be mutually compared, or one does use them, but recognizes that the results have a degree of uncertainty. This choice will depend in part on the issue for which the environmental prices are being used and how rock-solid one wants the final results to be. In some cases sensitivity analyses can help make the uncertainties more transparent.

1.6 Relation to other environmental valuation methods

1.6.1 The 2010 Shadow Prices Handbook

The values in the present Environmental Prices Handbook 2017 replace those in the old Shadow Prices Handbook from 2010. The principal changes compared with the previous Handbook are as follows:
- Just one environmental pricing method is now used, based mainly on damage costs. The use of abatement costs for standing policy targets has been abandoned, except for climate change.[5]
- This method is designed to cater for the three perspectives of SCBA, CSR and LCA.
- This handbook contains lower, central and upper values instead of just one central value. For SCBA, one may want to use the lower and upper values in line with the recommendations of the General SCBA Guidelines in the Netherlands. For corporate CSR calculations and LCA weighting the central value will suffice.
- For health impacts the prices have been assumed to remain constant over time in real terms. In other words, positive income elasticity is no longer deemed relevant for environmental quality. This is in line with the recommendations of the Netherlands' Discount Rate Working Group, which we follow here. The possibly higher value assigned to health in light of income is thus cancelled out by the increased 'supply' of health owing to technological advance[6].
- Health impacts have now been fully aligned with the WHO (2013) guidelines.
- Damage to agricultural crops has been added to valuation of nature rather than valuation of damage to buildings, as was previously the case. Irreversible impacts on nature have been assumed to have a relative price rise of 1% per annum, in line with the recommendations of the Discount Rate Working Group.
- Two additional endpoints have been included: mineral resource availability and nuisance. While these endpoints are described and the valuation methods explained, no characterization factors for these endpoints are provided here establishing a relationship between production processes, emissions and endpoint impacts. In SCBAs or valuations of resource savings by industry these should therefore be independently quantified.
- In this Handbook the valuation method used for biodiversity has been adapted to include a range of possible valuation. The valuation from the old Handbook Shadow Prices for land use and land occupation is now considered to be an upper value.

---

5 This is in line with the General SCBA Guidelines (CPB; PBL, 2013) and the recommendations of the Discount Rate Working Group (Ministerie van Financiën, 2015).

6 According to the Discount Rate Working Group it is unkown which impact is greater. Alternatively, one can also say that demand for health has decreasing marginal utility: the more health there is available, the lower the marginal utility of an additional unit. This reasoning could give another justification for not factoring in a positive income elasticity of demand.

- Values for ecotoxicity have been calculated at midpoint level, while the characterization factor for land use has been recalculated and adjusted to the midpoint characterization factor.

In addition, all the environmental prices have been thoroughly revised and adjusted to incorporate the latest findings on environmental damage reported in the literature and adjusted for inflation to give 2015 price levels.

1.6.2 Handbook on External Costs of Transport

Under the umbrella of the IMPACT project, in 2008 CE Delft and partners were commissioned by the European Commission to produce the Handbook on External Costs of Transport (CE Delft; INFRAS; Fraunhofer-ISI; University of Gdansk, 2008), which was updated in 2014 by Ricardo-AEA and partners (Ricardo-AEA; DIW econ; CAU, 2014) and is presently undergoing a 2018 update by CE Delft and INFRAS. The aim of these Handbooks was to review the methods recommended for valuing the external costs associated with transportation and provide a list of environmental prices to be used for the impacts concerned. Included in this publication are recommended prices for air-pollutant emissions (particulate matter, NO_x, SO_2, NMVOC), greenhouse gas emissions (CO_2) and noise.

For air-pollutant emissions from traffic and noise, the values in the present handbook are completely congruent with the upcoming update of the European handbook. For CO_2 emissions and land use, values chosen in this handbook are slightly different. The European handbook also contains differentiation towards individual country (and ocean regions) values for traffic related pollutants of $PM_{2.5}$, PM_{10}, NO_x, SO_2, NH_3 and NMVOS. These values have not been used in this handbook.

1.6.3 The concepts of true cost, true price and true value

Over the last few years, industries have begun to show major interest in use of environmental prices. One area of application is assessing the environmental consequences of alternative investments using financial parameters. This is in line with increasingly common application of Corporate Social Responsibility, with companies quantifying their environment impact and taking this on board in decision-making. Environmental prices are also used to obtain numerical data for use in social and environmental annual reports. There are currently numerous agencies advising companies on their social impact and putting a value on the environmental damage they cause. The results of such analysis are published in reports for third parties (KPMG, 2015); (True Price, 2017).

The methods adopted for quantifying environmental impacts are by no means always transparent and in many cases no tangible link with specific environmental prices can be established. It is therefore impossible to compare the results obtained using our methods and the methods used in these other reports.

1.7 Reading guide

1.7.1 Environmental price units

All the environmental prices presented in this Handbook relate to pollutant emissions (or other environmental interventions) in 2015 from the EU28 territory. All prices are expressed in €/kg emission (etc.), in 2015 prices (abbreviated to $€_{2015}$) and, unless otherwise specified, can be considered to include (average) VAT.[7]

Some fraction of the emissions occurring on the European territory will cross the border and impact other countries. Impacts on populations there have been valued the same as for the European population. Certain impacts will take time to manifest themselves. The health impacts of today's air-pollutant emissions will only emerge after several years or decades, for example, while for carbon emissions the impacts will extend over many generations. All future impacts of today's emissions have been implicitly and explicitly discounted in our calculations, with a 3% p.a. discount rate being employed in explicit discounting, in line with the recommendations of the Dutch Discount Rate Working Group (Ministerie van Financiën, 2015).

1.7.2 Rounding of values

The environmental prices reported in this Handbook have been rounded to three decimal places when expressed in floating-point notation.[8]
The suggested degree of precision is obviously illusory. However, as these prices will be used in settings like cost-benefit analysis, where they will often need to be multiplied by a million or more, we leave it to users to decide how the results obtained using these prices should be rounded, depending on the application concerned. We feel this is more appropriate than our recommending a preferred degree of rounding.

1.7.3 Structure of this Handbook

This report consists of two parts. Part 1, comprising Chapters 1 to 3, is the User Manual. It explains and justifies the methodology adopted, discusses the main premises and presents the environmental prices for key pollutants. Chapter 2 discusses the general methodological background. Chapter 3 provides concrete advice on when and how the reported prices can be used by specific user groups, distinguishing between use in SCBAs, use as weighting factors in LCAs and use by companies in a CSR context.

Part 2 of this study, Chapters 4 to 6, looks in more detail at the methods employed to calculate these environmental prices. Chapter 4 is an overall review of the changes relative to the 2010 Shadow Prices Handbook, in both general terms and for specific calculations. The value estimates for endpoint and midpoint impacts are then elaborated in more detail in Chapters 5 and 6, respectively. Chapter 5 considers valuation of impacts on the endpoints human health, ecosystem services, buildings and materials, resource availability and nuisance, discussing the premises underlying valuation and how these sometimes differ from those adopted in 2010. Chapter 6 then indicates, for each environmental theme like acidification, eutrophication and noise, how our environmental prices have been constructed.

7 This is because the prices are based on consumers' willingness-to-pay, which they express in prices inclusive of VAT. For further discussion, and explanation of the exception, see Section 3.4.3. This does not mean, however, that 'net' environmental prices may be estimated by deducting a VAT percentage.

8 Rounded to three decimals 145; 14.5; 1.45; 0.145 then all have the same degree of precision when written in floating-point notation.

The original Dutch language report had nine annexes on a wide range of issues. This English translation has just four. Annex A is a brief introduction to the perspectives adopted from cultural theory in modelling environmental impacts and is a shortened version of the Dutch Annex A. Annex B contains some in-depth information on estimation of the various impacts and is an abridged version of Annex C in the original Dutch handbook. The section on health related impacts is newly written and corresponds with CE Delft and INFRAS (2018). Annex C contains an analysis of the allocation mechanisms used in constructing the environmental prices and uncertainty that is involved in the estimation. Annex D, finally, lists the environmental prices for emissions of over 250 pollutants to air, water and soil and is similar to Annex J in the Dutch handbook.

1.8 Accountability

1.8.1 Supervision and support

The research and writing for the Dutch Handbook were carried out between January 2016 and April 2017: the extension for EU28 calculations were performed between December 2017 and September 2018. The original project was under the overall supervision of the project principal, the Dutch Ministry of Infrastructure and Environment (I&E), represented by Karel Zeldenrust, Robin Hamerlinck and Mark Overman. The EU extension was supervised by Martin Lok of the Dutch Ministry of Agriculture, Nature and Food Quality.

The study was regularly discussed and commented on by an Advisory Group, who provided oral and written comments on draft versions of all texts. This group comprised Karel Zeldenrust, Mark Overman, Robin Harmlinck and Frans Duinhouwer (I&E), Joop van Bodegraven and Marcel Klok (Ministry of Economic Affairs), Eric Drissen and Gusta Renes (Netherlands Environmental Assessment Agency, PBL), Gerbert Romijn (Netherlands Bureau for Economic Policy Analysis, CPB), Marian Bertrums, Rob van de Veeren and Anna Krabbe Lugner (Directorate-General for Public Works and Water Management, *Rijkswaterstaat*), Rob Maas (National Institute for Public Health and the Environment, RIVM) and Martin Linssen (Ministry of Finance).

Besides the Advisory Group, a formal expertise group was also appointed, consisting of Mark Goedkoop (PRé Consultants) and Bert van Wee (Delft Technological University), who contributed by providing helpful comments and suggestions. The European version benefitted from a workshop held in London 23 May.

We are very grateful to the supervisors, the members of the Advisory Group and the experts for all their work and input. It goes without saying, though, that we alone bear ultimate responsibility for the ideas and results presented here.

1.8.2 Expertise

While this Handbook derives most of its underlying information from literature study, we were unable to find all relevant data in this way. In elaborating the numerous issues involved we therefore also made grateful use of information provided by (international) experts in this field, often via email. In the framework of this study the following people furnished us with important data:
- Prof. dr. Ari Rabl, ARMINES/*Ecole de Mines*;
- Prof. Ståle Navrud, Agricultural University or Norway;
- Prof. dr. Christopher Murray;
- Daniel Sutter, INFRAS, Zurich;
- Till Bachman, Jonathan van der Kamp, EIFER, Karlsruhe, Germany;
- Kees Peek, RIVM;
- Rob Aalbers, CPB;
- Hans Nijland, Hans Hilbers, Gerben Geilenkirchen and Arjan Ruijs, PBL;
- Milan Scasny, Charles University, Prague.

We thank them all for their willingness to answer our questions and discuss our premises. Again, though, they bear no responsibility for the results presented here.

1.8.3 EU28 version

This EU28 version of the English-language version rests partly on the Dutch Handbook, which was translated into English by Nigel Harle. Nigel does not carry responsibility for this EU28 version that includes new pieces that have not been translated by him.

The present handbook contains some differences with the Dutch handbook of environmental prices. The main differences are:
- CO_2 emissions have been valued differently because valuation in the Netherlands was prescribed by the Working Group on the Discount Rate. Since Europe has not prescribed a CO_2 price, we have taken a different route in determining the relevant prices for CO_2 in this study.
- For health related impacts an in-depth and more formal investigation has been undertaken between the differences of the WHO (2013) guidelines and the NEEDS recommended values for impacts. This investigation can be found in Annex B.3 and has resulted in more adaptations of the various CRF values compared to the Dutch 2017 handbook. This results in general in only minor changes in valuation compared to the Dutch handbook except for NO_2, where the calculation of the damage costs resulted in estimations about 20% lower than would have been calculated using the approach in the Dutch handbook. We notice here that a 20% change still falls within the lower and upper level estimates from the Dutch handbook. The approach taken in this study is similar with the approach taking in the upcoming IMPACT handbook of the European Commission (CE Delft and INFRAS, 2018, forthcoming).
- For land use we have revised the valuation ground after we discovered some inconsistencies in the reported indicators (which was already present in some of the documents in the NEEDS project). Correcting for this mistakes leads to an enlargement of the uncertainty range in the valuation of land use where the indicator for restoration costs now makes up the lower end of the range for valuing land use changes.

Most of the text in the original Dutch handbook has been translated and used in the adaptation to this version on environmental prices for the EU28. However, some of the annexes have not been translated, or have been abridged in the EU28 version.

Table 4 summarizes which annexes have been translated and which have been omitted. In general, we have omitted those annexes with a literature review concerning valuation of specific endpoints, since the issues concerned are already elaborated in Chapters 5 and 6 — though far more briefly. Some of the annexes included in this EU28 version have been elaborated in slightly more detail, as with the treatment of uncertainty and the impact-pathway modelling used in this handbook.

Table 4 Indication of annexes that have been translated and which once have been omitted from the English language version

Annex in Dutch version	Translated into English?
Annex A Characterization	Largely included in Annex A
Annex B Valuation of human health	Not translated
Annex C Impact pathway modelling	Largely included in Annex B
Annex D Valuation of raw material scarcity	Not translated
Annex E Valuation of biodiversity	Not translated
Annex F Valuation of noise	Not translated
Annex G Assignment of damage estimates to midpoints	Some parts included in Annex C
Annex H Treatment of uncertainty	Some parts included in Annex C
Annex I Overview of environmental prices	Included in Annex D

1.8.4 Erratum

Compared to the original version that was published in October 2018 the following updates have been made available.
March 2020: Removed conflicting statements about the use of VAT.
For carbon prices we have included VAT with an average rate of 18%.

2 Methodological framework

2.1 Introduction

Environmental prices are indices expressing the willingness-to-pay for less environmental pollution in Euros per kilo pollutant. Environmental prices thus indicate the loss of economic welfare that occurs when one additional kilo of the pollutant enters the environment. In many cases they equal external costs. These prices can also be calculated for immaterial forms of pollution like noise nuisance and ionizing radiation, then being expressed in Euros per unit nuisance or exposure (in decibels and kBecquerel, respectively, for example).

In this chapter we discuss the main aspects of the methodological framework of calculation and use of environmental prices. As an introduction, in Section 2.2 we first consider the economic and environmental significance of these prices. Then, in Section 2.3, we set out the basic framework employed here for valuation. In Section 2.4 we consider the use of environmental prices in more detail.

2.2 Introduction to environmental prices

2.2.1 Significance in welfare economics

Valuation of environmental quality means expressing the value society assigns to that quality in monetary terms. Since in many cases that value cannot be directly established — via market prices, for example — it must be calculated.

Research on financial valuation of environmental impacts goes back to the 1930s, when US citizens sought compensation in the courts for the sulphur dioxide emissions of a Canadian mining company (Read, 1963). In the Netherlands, valuation of environmental impacts was first carried out by academics in the 1970s in the context of noise nuisance (see Opschoor, 1974). Since then, valuation has become an integral part of environmental economic research, with a great deal of work being undertaken on both methodological development and numerical valuation (Hoevenagel & De Bruyn, 2008).

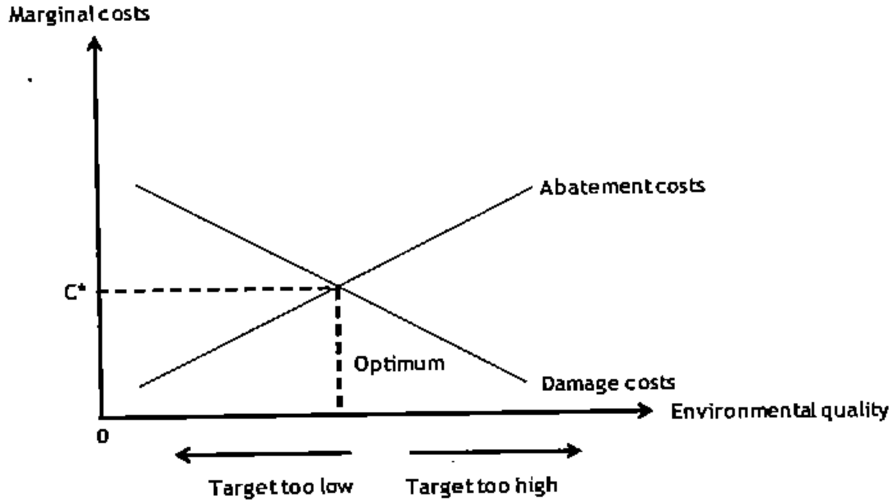
In economic terms, most environmental services cannot be provided through market mechanisms. Clean air, biodiversity and avoidance of environmental risks are not things that can be bought in the supermarket. Such services are nonetheless scarce, given their limited availability and the numerous impacts of our consumption and production patterns on that availability (Hueting, 1980). In economic terminology, we are faced with negative external impacts: side-effects of production and consumption that affect the welfare of others without them receiving financial compensation for their loss of welfare.

2.2.2 Environmental prices as equilibrium prices

It is instructive to imagine that a market for environmental services did exist. How much clean air would we then buy? According to standard economic theory, society would arrive at a point where the benefits of one additional unit of clean air equal the cost of an additional unit of pollution reduction. In other words, the moment pollution abatement becomes more expensive than the value assigned to clean air, we have reached the 'optimum' pollution level. In economic terms, this level of pollution is referred to as Pareto-

optimal, or Pareto-efficient, because there is no pollution level with a higher level of welfare, defined as the sum of producer and consumer surplus.
The associated marginal costs are known as the equilibrium price of the environmental impact category concerned. They indicate the value assigned by society to the impact in question. At this point, marked C* in Figure 2, the marginal abatement costs equal the marginal damage costs of pollution.

Figure 2 Optimum pollution level and associated equilibrium environmental price according to standard economic theory



Note that as environmental quality improves, marginal abatement costs rise; this reflects the general tendency for pollution control to become increasingly costly the further it goes. At the same time, damage costs decline as more environmental quality becomes available. This downward trend illustrates the declining marginal utility deriving from improvements to environmental quality.

This optimum pollution level and the associated equilibrium price obviously differ depending on the pollutant involved. This is due in the first place to abatement costs differing for the various categories of environmental impact. A 50% reduction in SO_2 emissions, causing acid rain, for example, is cheaper to achieve than the same reduction in CO_2 emissions, causing climate change. This is due to the different costs of the abatement technologies required. Secondly, society values different environmental impacts differently, perhaps viewing climate disruption as more important than acid rain, implying that the marginal damage of climate change is greater than that of acidification. The consequence of this (hypothetical) reasoning would be that society attaches greater value to reducing CO_2 emissions than to reducing SO_2 emissions.[9]

2.2.3 Environmental prices as (external) damage costs

Equilibrium prices express the true economic value of pollution *if all external impacts were internalized*. Although these prices could in principle be calculated and used to assign a value to emissions, this is not generally done. The main reason is that such prices indicate the external cost to society of a

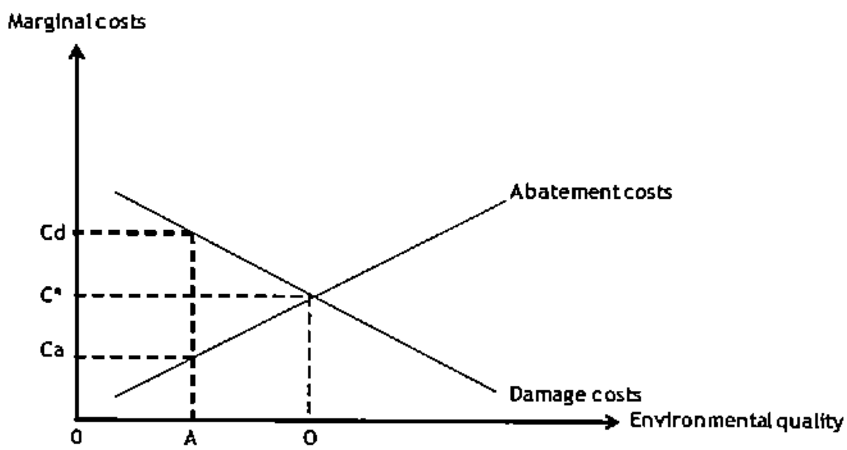
---

[9] Under the assumption of linear marginal damage cost functions.

particular project *only if* the pollution level at the time is 'optimum'. The more the actual situation deviates from the optimum, however, the less correct the estimates of the extra cost will be. In most cases, actual environmental quality wil be 'suboptimal' as a result of insufficiently effective environmental policy. The damage costs will therefore generally be higher than the abatement costs (for a comparison of damage and abatement costs see (CE Delft, 2010)).

This is illustrated in Figure 3. Imagine that environmental quality is currently at level A as a result of environmental policy with a marginal abatement cost Ca. The current level of environmental quality (interpreted here as the inverse of pollution) is below the optimum, marked O. The marginal damage cost associated with the current situation is therefore Cd. In this case the damage cost Cd indicates the value to be assigned to a small change in environmental quality. It represents the marginal cost of the infinitely small increase (decline) in damage resulting from an infinitely small decline (increase) in environmental quality.[10]

Figure 3 **Price of environmental quality at a suboptimal pollution level**



Environmental prices thus indicate the value of emissions relative to one another and relative to other goods in society. In addition, environmental prices are in most cases also equal to the value to be given to the external costs of pollution and other environmental interventions. This value is equal to the 'Pigovian tax' required to internalize external impacts (Pigou, 1952). Other things being equal, internalization of external costs, so they can be included in policy deliberations, leads to greater economic welfare.

10 In the 2010 Shadow Prices Handbook this was referred to as the shadow price. Formally speaking, the shadow price is the value of a controlling factor (the 'Lagrange factor') at the optimum, which means it is the infinitely small change in the objective function due to an infinitely small change in the controlling factor. 'Shadow price' is thus the proper name for 'abatement cost'. For the damage cost function, though, this is a derived shadow price for the limited availability of environmental quality due to policy. To avoid getting embroiled in a semantic debate, in this study we use the more neutral term 'environmental price'.

2.2.4 Environmental prices as weighting step in characterization

Today over 10,000 pollutants are known that can cause environmental damage and for a long time environmental scientists have been looking for a way to condense the vast amount of data often yielded in environmental analyses into a single indicator. This compression of data can be achieved in two ways: via characterization and weighting.

Characterization is a process in which an index, known as a characterization factor, is used to express how much a standard amount of a given substance contributes to a particular environmental impact. The higher the characterization factor, the greater the contribution. The gas methane has a higher characterization factor for the environmental impact 'climate change' than carbon dioxide, for example. This means a kilo of methane causes more global warming than a kilo of carbon dioxide.

Using characterization factors, emissions can be grouped into a series of aggregated environmental themes like climate change, acidification and human toxicity, referred to as 'midpoints' (cf. Section 2.3.3). These impacts on the various environmental themes cannot then be mutually weighted, however. All a researcher can conclude is that a given recycling policy will impact positively on climate, say, but negatively on eutrophication.
The question is then: Is the policy good or bad for the environment? In other words: Which environmental theme is more important? To answer this question the various environmental impacts can be individually weighted, allowing a 'single score' to be calculated as a final result. This score indicates whether the net result of the LCA signifies environmental gains or losses.

Weighting is thus a process in which midpoint scores are combined to yield a single, uniform indicator. For weighting environmental impacts at midpoint level, various methods have been proposed in the literature, including methods based on 'distance to target' (VROM, 1993), expert panels (Huppes, et al., 2007) and impacts on endpoints (Goedkoop, et al., 2013). In this context, environmental prices can be seen as a further method for mutually weighting environmental themes and combining environmental impacts into a single, uniform indicator. This indicator then provides information on whether a particular measure, purely from an environmental perspective, is to be recommended because it leads to greater 'welfare'.

This means environmental prices can also be used to weight environmental impacts. They express the relative value of emissions (etc.) relative to one another and relative to other goods circulating in society. When valuing emissions, in the context of SCBA for instance, one is generally looking at the value of emissions compared with other financial figures. When it comes to the weighting of emissions, though, we are concerned primarily with how emissions compare to one another. These weighting factors can then be regarded as the socio-economic weight to be attributed to the various environmental impacts.

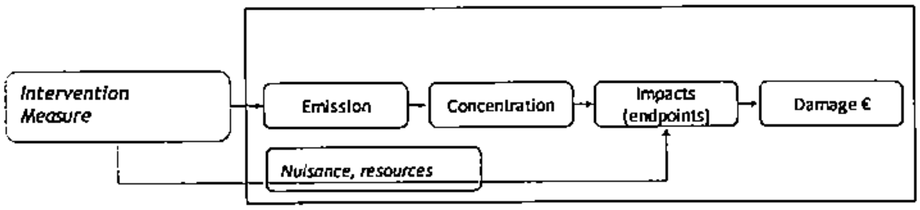
The environmental prices developed in this Handbook are derived from damage costs and are consistent with standard practice in welfare economics. However, there are also other approaches using monetization, such as the Environmental Priority Strategies (EPS) method developed in Sweden (Steen, 1999).[11]

2.3 Valuation framework in this Handbook

2.3.1 Overall framework

The overall framework adopted in this Environmental Prices Handbook is schematically summarized in Figure 4.

Figure 4 Relationships relevant in this Handbook



A given activity leads to a certain intervention in the environment. That intervention, or policy measure, results in a change in emissions, nuisance or resource extraction. In the case of emissions, these are transported via air, soil or water to other areas, where they are added to existing emission concentrations. This concentration then leads to changes in 'endpoints' relevant to human welfare. These changes can be monetarily valued by quantifying the amount of damage caused at the endpoints. The entire chain from emissions, nuisance and resources through to damage in monetary terms is the subject of this Environmental Prices Handbook. The effectiveness of interventions or policy measures is beyond the scope of the Handbook.

2.3.2 Relevant endpoints

In this Environmental Prices Handbook we distinguish five endpoints:

1. Human health (morbidity, i.e. sickness and disease, and premature mortality).
2. Ecosystem services (including agriculture).
3. Buildings and materials (man-made capital).
4. Resource availability.
5. Wellbeing (aesthetic and ethical values).

The issues captured in this fivefold categorization are broader than found in the literature. ReCiPe, for example, distinguishes three endpoints: human health, ecosystem services and resource scarcity (Goedkoop, et al., 2013). The chosen endpoints are described in detail in Chapter 5.

[11] The systematics of the EPS method come close to the concept of 'unpaid cost', with the researcher deriving values for willingness-to-pay via a hierarchy of 'principles'. There is no discounting of future impacts. Particularly for resource depletion, the method establishes a relatively high value, based on 'restoration costs'.

2.3.3 Relevant midpoints

Midpoint categories capture the impact of emissions on aggregated environmental themes. In the various handbooks used by environmental scientists and practitioners there is variation in the number and scope of the midpoints employed. In this Handbook we closely follow the categories used in ReCiPe (Goedkoop, et al., 2013), distinguishing the following eleven midpoints:

1. Ozone depletion.
2. Climate change.
3. Particulate matter formation.
4. Photochemical oxidant formation.
5. Acidification.
6. Eutrophication.
7. Human toxicity.
8. Ecotoxicity.
9. Ionizing radiation.
10. Nuisance (noise and visual nuisance).
11. Extraction (land use).

These midpoints are described in detail in Chapter 5 and are largely in line with what is cited in the literature for midpoint characterization (see (Guinée, et al., 2002); (Goedkoop, et al., 2013); (JRC, 2012). Compared with ReCiPe (Goedkoop, et al., 2013) this means we have added one midpoint: nuisance (in particular, noise nuisance), and combined several ReCiPe midpoints, as with our treatment of ecotoxicity, eutrophication and land use. In contrast to ReCiPe, impacts on the availability of mineral resources, water and fossil fuels are not included as separate midpoints in this Handbook, but valued only at endpoint level (see Chapter 5).

In the systematics adopted in this Handbook, a number of midpoints also cited in the literature (Guinée, et al., 2002) have not been included. These relate primarily to interventions on the interface between nature and the environment:

- erosion of farmland soils;
- salinization of farmland soils;
- light pollution;
- stench;
- visual impact ('horizon pollution');
- spread of invasieve species.

These all impact primarily on the endpoints 'ecosystems' and 'wellbeing'. In many cases there is no directly observable relationship between emissions and these midpoints. In addition, no EU28-average can generally be calculated for these kinds of envirohmental impact, which are often project-specific. Nor are they usually included in LCA calculations. For these reasons they have not been taken as midpoints in this Handbook. Methods and studies concerning valuation of these impacts are described in relation to the endpoint 'nuisance' (see Section 5.7).

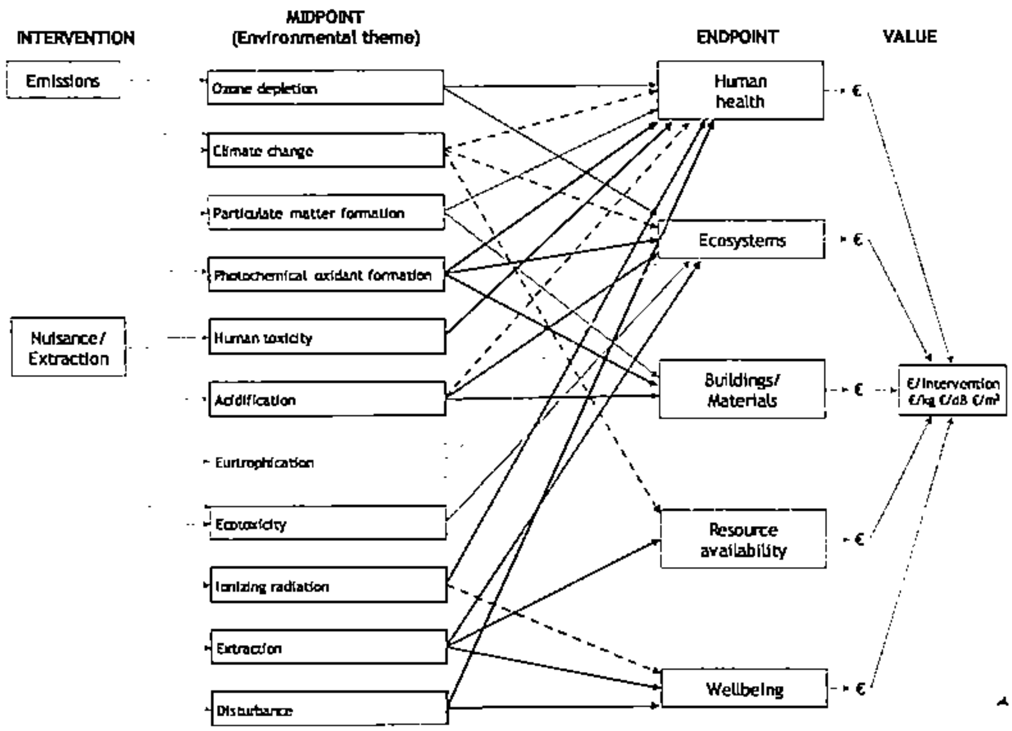
2.3.4 Relations between pollutant, midpoint and endpoint level

At the core of this Environmental Prices Handbook are two steps:

1. Establishing the relationships between environmentally hazardous substances (emissions) or causes of 'disturbance' (noise, land-use change) and their impacts on midpoints and endpoints.
2. Valuing these endpoints and translation back to damage per intervention.

The overall framework is shown in Figure 5, setting out all the relationships between emissions, midpoints and endpoints and their valuation that are of relevance for this Handbook.[12]

Figure 5 Relationships between intervention, midpoints, endpoints and valuation in this Handbook



Note: Dashed lines represent relationships examined and (partly) quantified for this Handbook, dotted lines those that were not directly quantified because a different approach was used for impact quantification. 'Depletion' includes land use, among other things, and 'nuisance' noise nuisance. For further details see Chapter 6.

The endpoint level is that at which there are no longer any 'feedback' effects. This level thus forms the basis for valuation. For the five endpoints, in Chapter 5 we examine people's willingness-to-pay for improvement in the form of pollution abatement. Via the midpoints these values can then be calculated back to a value for reducing the emissions themselves, or avoiding an environmental intervention (as with noise or land-use changes).

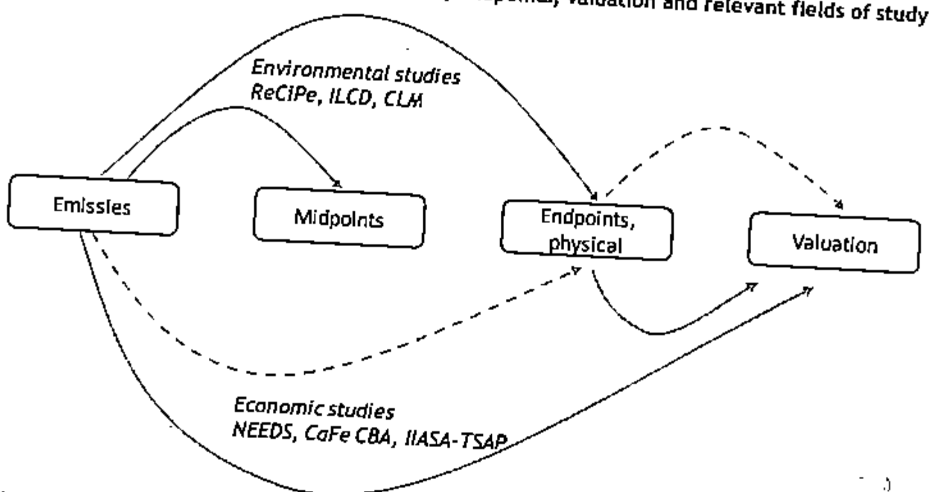
12 This is not to say that all these relationships have indeed been quantitatively determined.

There is currently no single methodology or study that brings all these elements together in a consistent environmental and welfare-economic framework. The 2010 Shadow Prices Handbook endeavoured to do so by combining two kinds of studies:

1. Environmental studies like ReCiPe (Goedkoop, et al., 2013) in which physico-chemical models supplemented by impact studies are used to establish relationships between pollutants and midpoints, on the one hand, and midpoints and endpoints, on the other. Environmental studies typically use both characterization models which define impacts of pollutants relative to each others with impact pathway models that describe the relationship between emissions, via dispersion and concentration, towards impacts.
2. Economic valuation studies like NEEDS (2008a) and Holland (2014), in which dispersion models, concentration-response functions and valuation tools are used to establish a relationship between a pollutant level (emissions) and a monetary value per endpoint level. Economic modelling thus typically combines impact pathway models with economic valuation techniques.

Each type of study models part of this chain of relationships, as shown schematically in Figure 6.

Figure 6 Relationships between emissions, midpoints, endpoints, valuation and relevant fields of study



Note: Dashed lines indicate that these steps are used in the studies, but only infrequently.

What one thus sees is that, on the one hand, there are environmental studies like ReCiPe (Goedkoop, et al., 2013) that establish the primary relationships between emissions, midpoints and endpoints. This information is used in LCA software packages like SimaPro. Environmental studies focus very strongly on describing as precisely as possible the physico-chemical impacts of emissions and how they relate to endpoints. Many economic studies, on the other hand, are concerned with putting a price on pollution, as holds for the major European research programmes NEEDS (NEEDS, 2008a), CAFE-CBA (AEA, 2005) and IIASA-TSAP (IIASA, 2014); (Holland, 2014), the results of which are used in European cost-benefit analyses. These kinds of studies are concerned above all with establishing as accurately as possible a relationship between emissions and valuation according to the premises of neoclassical welfare economics.

Both kinds of studies thus chart a relationship between emissions and endpoints, but with different accents in terms of premises and details. The great advantage of ReCiPe, for example, is its attempt at consistency between midpoint and endpoint impacts (Goedkoop, et al., 2009); (Goedkoop, et al., 2013). ReCiPe, funded partly by the Dutch government, is indeed the first major project guaranteeing, to a certain extent at least, such consistency.

The drawback of ReCiPe for monetary valuation, however, is that the relationship between emissions and endpoints is reported solely as an average global value (or, if global data are lacking, a European average). In addition, impacts are not time-discounted, which means ReCiPe cannot be used to derive values consistent with the premises of welfare theory.

Economic studies, on the other hand, also establish a relationship between emissions and their impacts, but do so in a way that paints with a broad brush in environmental terms. In addition, economic studies have as their main weakness that the relationship between emissions and endpoint damage is established for a mere 20 or so environmental pollutants. For the thousands of other environmentally hazardous substances these studies provide no useful information at all.

2.3.5 Combining modelling approaches

The Environmental Prices methodology employed in this Handbook combines characterization models, impact pathway analyses and valuation methods to arrive at a consistent estimate of the welfare costs associated with emissions at the pollutant, midpoint and endpoint levels. *The key feature of the Environmental Prices methodology thus lies in its harmonization of the premises of the three research methods.*

The manner in which this has been achieved can best be explained with reference to the scheme shown in Figure 7. As can be seen, characterization models as well as the impact pathway approach both establish a relationship between emissions and endpoint impacts. Characterization models like ReCiPe distinguish the endpoints resources, ecosystems and health.[13] Impact pathway approaches like NEEDS distinguish the endpoints ecosystems, health, buildings and nuisance.[14] The impact pathway approach establishes no explicit relationship for resources, while characterization models fail to do so for buildings or nuisance. For two endpoints, there is overlap between the two approaches: ecosystems and human health. For this Handbook it was therefore necessary to balance the two approaches or decide which was preferable.

By combining and harmonizing the environmental and economic models, we obtain a uniform framework in which emissions (etc.) can be valued, with the following advantages:

- A final step is added to environmental characterization: monetization. By clearly defining this monetization as impacts on welfare, a uniform framework is created in which all environmental impacts can be systematically weighed up against one another.

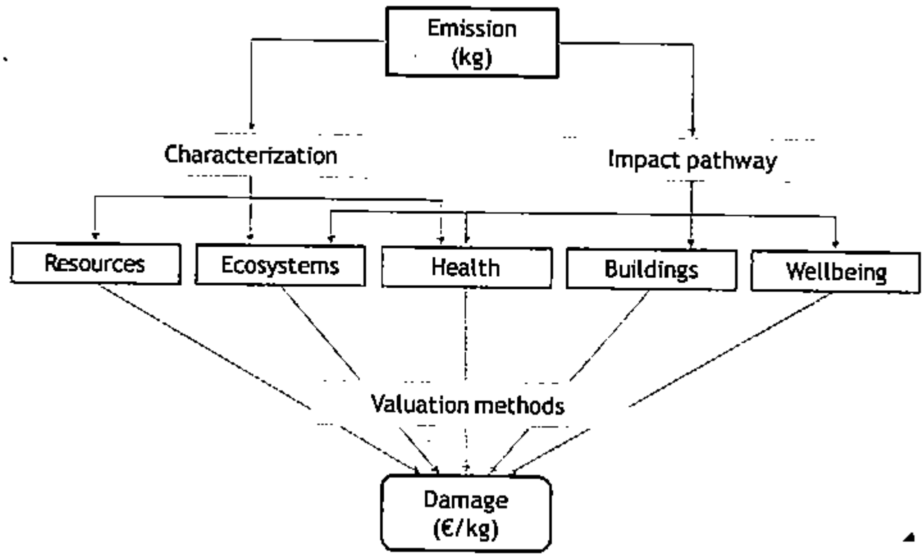
---

[13] Throughout this discussion we base ourselves on ReCiPe (Goedkoop, et al., 2013). While drawing up the present Handbook a new ReCiPe version was published, in January 2017. This was not taken on board in determining our environmental prices, because this was too late into our study.

[14] Nuisance has generally received relatively litte attention, however. The impact pathway approach also treats climate problems as midpoints that generate impacts on the endpoints health and ecosystems.

- Through due use of characterization factors, economic valuation of an individual pollutant can be extended to valuation for all pollutants with a similar environmental endpoint impact. This means the number of pollutants to which an economic value can be assigned is expanded enormously.
- By working with the economic valuation studies that contain data on individual countries, environmental characterization can be land-specific.

Figure 7 Characterization models, impact pathway analyses and valuation methods as a basis for the Environmental Prices Handbook



It is sometimes queried whether it would not be better to proceed directly to valuation at endpoint level, rather than expressing damage costs in kilogram emissions. However, pollution impacts need to be considered from a multi-emission/multi-impact perspective, since the various pollutants contribute to different environmental problems (the 'environmental themes'), which in turn have distinct impacts on the various receptor groups (humans, ecosystems, etc.). Thus, SO_2 contributes both to acidification, impacting ecosystems, and to formation of secondary aerosols, impacting human health. This means there can be no simple one-to-one translation from emissions to impacts but that models must be used.

In Section 4.2 we look in more detail at how the various modelling approaches have been harmonized in this Environmental Prices Handbook. In Chapter 5 an extensive review is provided of the valuation methods adopted.

2.4 Perspectives and use

2.4.1 Lower, upper and central values

This Handbook presents environmental prices at pollutant level (SO_2 and NO_x emissions, for example), midpoint level (environmental themes like climate change and acidification) and endpoint level (indicators for human health and ecosystems).

At pollutant level the prices are expressed as a lower, central and upper value. This approach has been adopted so the reported prices reflect the uncertainties inherent in assigning a value to pollution. The upper and lower values are mainly for use in social cost-benefit analyses (SCBA), to calculate the impacts of (government) policy, for example. The General SCBA Guidelines in the Netherlands (CPB; PBL, 2013), emphasize that uncertainties may no longer be 'concealed' in discount rates or sensitivity analyses, but must be explicitly treated as a core element of the SCBA. To duly account for the uncertainties and gaps in our knowledge when valuing the welfare impacts of emissions (etc.) the Guidelines therefore recommend working with ranges. This means that in this Handbook we have developed an **upper and lower value** for use in SCBAs. These upper and lower bounds have been set at the level of endpoint valuation and work back, via the web of relationships between pollutants and endpoints, to upper and lower values at the pollutant level. We recommend using such values in Social Cost-Benefit Analysis.

For other users, **central values** are reported and recommended. The central value has been elaborated differently for each endpoint and represents the best possible estimate given the uncertainties in endpoint value (cf. Chapter 5). For companies using our environmental prices for detailing business cases or environmental annual reports, it is recommended to use these central values. Corporate financial annual reports do not generally give ranges or upper or lower bounds, and use of our central values is thus in line with standard practice.

For use as weighting factors in LCAs, two values have been developed: a value based on external costs that is consistent with the points of departure of this study, and a value for use as a weighting factor that is entirely in line with the hierarchist perspective in ReCiPe. For an explanation of these perspectives, see Annex A. We recommend using the 'external cost weighting factor' is the results are to be used in external cost calculations, e.g. in SCBA.
We recommend using the 'financial weighting factor' if the approach is to compare the results of various midpoints in the LCA with a consistent indicator according to the ReCiPe hierarchist's perspective.

2.4.2 Objections to the use of environmental prices

The environmental prices presented here are average values for pollution from an average emission source at an average location in Europe (EU28).
These prices can consequently only be taken as approximate averages and should not be used in concrete situations. In such cases it is recommended to perform a dedicated study to establish potential pollutant and other impacts.

Economic valuation of impacts on nature, the environment and human health may also elicit moral objections, with some holding that it is undesirable, inappropriate or morally reprehensible to put a price tag on health or nature. Economic valuation does not justice, they say, to 'intrinsic values' like the mere existence of plant and animal species, or moral values like caring about one's neighbours. This is is no way the case, though. Economic valuation merely facilitates and rationalizes choices between alternative ways of allocating scarce resources (time, money). Money spent on Alternative A cannot be spent on Alternative B. When weighing up these choices it is perfectly feasible to recognise and duly allow for intrinsic or moral values. Even the most dedicated environmental warrior must ultimately decide how much they are willing to spend on environmental aims and how much on their lunch. When deciding what fraction of our money to spend on development cooperation, we do not deny the intrinsic value of those living in the developing world. Economists look at how much people are willing to pay for various goods and objectives and use this information to deduce the economic value of those goods. People may obviously disagree with other people's preferences and (moral) values and thus with their willingness-to-pay, but all economists are doing is observing and noting what is ocurring in society at large.

Environmental prices can only be used to derive marginal values. They cannot be used to calculate the total value of the Earth's biodiversity, say (cf. (Constanza, et al., 1997)). At the margin, decisions are taken that affect nature, the environment and human health. Environmental prices can be used to include these impacts in decision-making, but not to justify or legitimize pollution. Illegal pollution must always be tackled according to the law of the land.

When it comes to valung human health, there are sometimes misconceptions. In putting a value on health it may seem as if judgment is being made on the value to be assigned to a human life, which some people deem immoral. From an ethical perspective, however, there is no moral obligation to save a life at any cost (at the expense of one's own life, for example).
More importantly, though, economic valuation makes no pronouncement on an individual human life, but on so-called *statistical* lives. In the policy decisions in which economic valuation is employed, we are concerned with marginal changes in the risks to which people are exposed. If a certain risk is reduced from fifteen in a million to fourteen in a million for a population of one million, for example, one statistical life is saved. Economists simply note that such comparative assessments of risks and potential gains are made all the time in everyday life, such as when deciding whether or not to get into a car or plane, or pursue a certain lifestyle with its associated risks of premature death. So although no price tag can be put on life itself, when it comes to safety in the sense of statistical risk reduction, it can be. For this reason, in economic terms a problem arises in deciding which risks are aceptable and which are not. With environmental prices, this weighing up of choices is rendered explicit, for use in tandem with other decision-making procedures.

Some critics object to economic valuation on the grounds that by putting the emphasis on the goods owned by individuals, it is only self-interest that is factored in. They hold that issues like environmental protection should be evaluated based on the 'public interest', i.e. with reference to what is best for society as a whole (cf. Mouter & Chorus, 2016). Whether this public interest is the same as the sum of all individual self-interests is still an unanswered, controversial question in political philosophy. We can only stress that environmental prices based on willingness-to-pay that can be used for cost-benefit analyses are no substitute for the political process; all they do is provide information on people's preferences, i.e. how much people are willing to pay for a given change in environmental quality. It is then up to politicians whether and to what extent they opt to deviate.

3 Use of environmental prices

3.1 Introduction

In practice, environmental prices can support decision-making in two ways:
- When analysing the social impacts of investment decisions, environmental impacts can be included along with financial data because they can be assigned a monetary value using environmental prices. A case in point is Social Cost-Benefit Analysis (SCBA), where environmental prices are used primarily for **valuation**, providing a means of comparing environmental impacts with financial items to arrive at integral consideration of all the impacts associated with an (investment) decision. In principle, **valuation** of environmental impacts using environmental prices occurs in every SCBA in which external impacts are also monetized and by companies in calculating social business cases.
- In environmental analyses like Life Cycle Assessment (LCA), Environmental Impact Assessment (EIA) and benchmarking, environmental prices can be used to weight the various environmental impacts identified. The main aim here is environmental **weighting**, as a means of comparing the contribution of different environmental themes. **Weighting** of environmental impacts is sometimes carried out as a final step in LCAs in order to express the results in a 'single-score indicator'. In line with the methodology employed in this Handbook, the welfare impacts of emissions are monetized within a standard welfare-economics framework. The EPS system (Environmental Priority Strategies in product design; (Steen, 1999)) also involves monetary weighting, but using premises based more on monetization of a hierarchy of principles than on welfare economics. Financial valuation is often applied as a weighting method in various LCAs and in concrete calculation tools like the Environmental Barometer (for small and medium-sized enterprises, SME), DuboCalc (used in the construction industry in the Netherlands) and GreenCalc (for comparing the environmental profile of buildings).

In this chapter we present the environmental prices developed for this Handbook and discuss their use in more detail. First of all, in Section 3.2 we report the environmental prices for a series of common air, soil and water pollutants. We then go on to explain the use of environmental prices with reference to three groups of users:
1. Companies calculating their environmental impact (Section 3.3).
2. Practitioners carrying out a Social Cost-Benefit Analysis (Section 3.4).
3. Practitioners weighting LCA environmental impacts to arrive at a single-score indicator (Section 3.5).

For each user group this chapter provides concrete guidelines on how the environmental prices can be applied and what specific issues are likely to be encountered in that particular setting. In doing so, we list prices for a handful of pollutants only. The full list is provided in Annex C. Further information and an online tool for calculating the environmental prices of over 2,500 pollutants (only Dutch values) is available at: www.cedelft.eu/en/environmental-prices.

3.2 Environmental prices: a brief synopsis

This section reports environmental prices for several commmon pollutants. The majority are expressed in €/kg pollutant, in 2015 prices. The two exceptions are noise and ionizing radiation, expressed respectively in € per decibel and € per kiloBequerel (measuring the intensity of emitted radiation).

As stated earlier, the environmental prices reported in this chapter are average values for the EU28. The damage costs of environmental pollution (etc.) can vary widely according to local circumstances (particularly population density) and the nature of the emission (from industrial stacks versus vehicle tailpipes, for example). Environmental prices make no allowance for these differences.[15] For this reason, these environmental prices cannot simply be applied to specific cases of local pollution, for pollution in other countries or for pollution by non-average emission sources. In Chapter 6 these issues are considered in more detail, as well as the background to the calculations (neither of which issues are discussed in the present chapter).

3.2.1 Environmental prices for emissions to the atmosphere

Table 5 reports the values for the most frequently encountered atmospheric emissions in €/kg emission.

Table 5 Environmental prices for key atmospheric emissions (€$_{2015}$ per kg emission)

Pollutant		Environmental price (€/kg emission)			Relevant midpoints[1]							Endpoints[1]		
		Lower	Central	Upper	PM formation	Smog formation	Acidification	Climate change	Ozone layer	Human toxicity	Ecotox./ Eutrophication	Human health	Ecosystem services	Materials/ Buildings
Carbon dioxide[2]	CO_2	€ 0.022	€ 0.057	€ 0.094				x				nc	nc	nc
Chlorofluorocarbons[2]	CFC11	€ 130	€ 306	€ 504				x	x	x	x	x	x	
Fine particulates, 2.5 µ or less	$PM_{2.5}$	€ 27.7	€ 38.7	€ 59.5	x			nc				x		x
Coarse particulates, 10 µ or less	PM_{10}	€ 19	€ 26.6	€ 41	x			nc				x		x
Nitrogen oxides	NO_x	€ 9.97	€ 14.8	€ 22.1	x	x	x	nc			x	x	x	x
Sulphur dioxide	SO_2	€ 8.3	€ 11.5	€ 17.9	x	x	x	nc				x	x	x
Ammonia	NH_3	€ 10	€ 17.5	€ 25.2	x		x				x	x	x	
Volatile organic compounds	NMVOC	€ 0.84	€ 1.15	€ 1.84		x						x	x	X
Carbon monoxide	CO	€ 0.0383	€ 0.0526	€ 0.0918		x						x		
Methane[2]	CH_4	€ 0.673	€ 1.74	€ 2.91		x		x				nc	nc	nc
Cadmium	Cd	€ 371	€ 589	€ 869						x	x	x	x	
Arsenic	As	€ 586	€ 862	€ 963						x	x	x	x	
Lead	Pb	€ 3631	€ 5367	€ 5761						x	x	x	x	
Mercury	Hg	€ 24680	€ 34490	€ 52920						x	x	x	x	
Formaldehyde	CH_2O	€ 9	€ 12.3	€ 19		x				x	x	x	x	

1 An x indicates the pollutant has been characterized on the midpoint or endpoint; nc = not calculated, climate emissions being priced using abatement costs rather than damage costs.

2 The value reported for greenhouse gases includes VAT and increases at 3.5% per annum from the 2015 baseline. These values can therefore only be be used for 2015 emissions. For valuation in later years, see Section 6.3.

15 With the exception of $PM_{2.5}$; see Section 6.4.

These environmental prices are average prices for the EU28.
For particulate matter the specific emission site is crucially important.
In Sections 6.4.9 and 6.4.10, PM damage costs in specific industry and traffic settings are considered in more detail.

3.2.2 Environmental prices for emissions to water

For emissions to water, prices were calculated for the 'prioritary pollutants' for which targets are laid down in the European Water Framework Directive, supplemented by total nitrogen,total phosphorus and phosphate, key factors in eutrophication. Table 6 reports the lower, central and upper values.[16]

Table 6 Environmental prices for emissions to water of prioritary and eutrophying pollutants (€$_{2015}$ per kg 2015 emission)

Pollutant	Environmental price (€/kg emission)			Relevant midpoints		
	Lower	Central	Upper	Eutrophic.	Human tox.	Ecotox.
1,2-Dichloorpropane	€ 8.48	€ 11.6	€ 17.9		x	x
Atrazine	€ 1.69	€ 10.1	€ 11.7		x	x
Aldrin	€ 762	€ 1048	€ 1616		x	x
Benzene	€ 0.0264	€ 0.0381	€ 0.0578		x	x
Beryllium	€ 3.84	€ 25	€ 29.7		x	x
Captan	€ 0.0109	€ 0.0779	€ 0.0886		x	x
DDT	€ 22	€ 33.3	€ 49.8		x	x
Dichloromethane	€ 0.09	€ 0.225	€ 0.296		x	x
Dichlorvos	€ 0.826	€ 1.13	€ 1.75		x	x
Dicofol	€ 115	€ 159	€ 245		x	x
Ethylbenzene	€ 0.00266	€ 0.0102	€ 0.0124		x	x
Hexachlorobenzene	€ 0.25	€ 1.86	€ 2.11		x	x
Naphthtalene	€ 0.0825	€ 0.614	€ 0.696		x	x
Pentachlorophenol	€ 189	€ 260	€ 401		x	x
Phosphate (PO_4)	€ 0.0876	€ 0.159	€ 0.226	x		
Tetrachloroethylene	€ 1.14	€ 8.47	€ 9.6		x	x
Total nitrogen (N)	€ 3.11	€ 3.11	€ 3.11	x		
Total phosphorus (P)	€ 3.45	€ 4.75	€ 7.32	x		
Trichloromethane (chloroform)	€ 1.44	€ 1.98	€ 3.06		x	x
Trifluralin	€ 6.04	€ 9.01	€ 13.5		x	x
Zinc	€ 0.0838	€ 0.795	€ 1.68		x	x

3.2.3 Environmental prices for emissions to the soil

Emissions to the soil can occur via waste dumping or leakage or eutrophication, potentially impacting ecosystems and/or human health. Table 7 reports the environmental prices of several key pollutants with respect to soil pollution. The impacts they may have on IQ have not be quantified. For heavy metals there is a substantial difference between the upper and lower value. This is explained further in Section 6.8 and is, amongst others, due to scientific uncertainty about dispersion of these pollutants in the food chain (via uptake by crops and animals) and the resultant impacts on human health. The lower value is based on far more conservative assumptions than the upper value.

16 No environmental price could be established for di(2-ethylhexyl)phthalate (DEHP), as ReCiPe provides no characterization factor.

Table 7 Environmental prices for key emissions to the soil (€2015 per kg emission)

Pollutant	Lower	Central	Upper
Cadmium	€ 11.2	€ 1151	€ 3533
Arsenic*	€ 10	€ 37.7	€ 95.3
Lead*	€ 0.0497	€ 8.01	€ 24.6
Mercury*	€ 400	€ 816	€ 1673
Nickel	€ 0.0157	€ 0.206	€ 0.546
Formaldehyde	€ 0.699	€ 0.956	€ 1.48
P-fertilizer	€ 0.0132	€ 0.0987	€ 0.112
N-fertilizer	€ 0.227	€ 0.227	€ 0.227

- These values do not include loss of IQ associated with soil pollution.

3.2.4 Environmental prices for other impacts

Environmental prices have also been derived for noise nuisance and land use. Those for noise nuisance indicate the external costs of both health damage and noise-related nuisance. Those for land use are the external costs of the biodiversity loss associated with the land use.

For road-traffic noise the environmental prices reported in Table 8 can be used; these increase with rising noise levels. The decibel units are explained in Section 6.11.3.

Table 8 Environmental prices for road-traffic noise nuisance (€2015 per dB (Lden) per person per year)

Noise nuisance	Lower	Central	Upoer
50-54 dB(A)	18	22	27
55-59 dB(A)	36	42	50
60-64 dB(A)	38	45	56
65-69 dB(A)	69	83	101
70-74 dB(A)	73	87	108
75-79 dB(A)	77	92	116
>= 80 dB(A)	78	95	120

Rail-traffic noise nuisance is generally valued lower, air-traffic noise higher. Precise values for these two variants, including a breakdown into damage costs for nuisance and health, are reported in Section 6.11.

Environmental prices for land use are shown in Table 9. These are the annually recurring costs to be attributed to use of an average m² of land in the EU28.

Table 9 External costs of land use (€2015/m² per year)

	Lower	Central	Upper
EU28	€ 0.025	€ 0.085	€ 0.685

External cost estimates for several specific types of land are reported in Section 6.12.

3.3 Use of environmental prices by companies

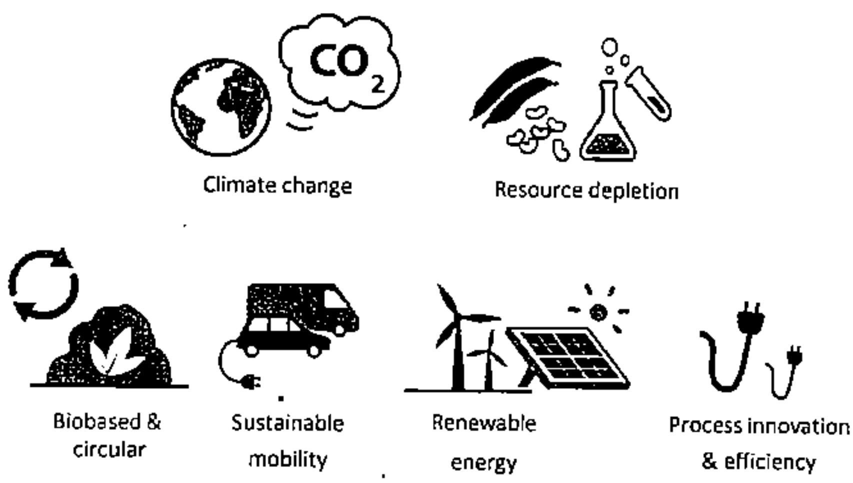
3.3.1 Why environmental prices?

For companies, sustainability is a key constraint on production. Developments and challenges in the realm of sustainability are coming thicker and faster all the time. One of the challenges is suitable integration of the whirlwind of developments in research, technology and policy into everyday business operations (Figure 8).

A growing number of companies now view sustainability not merely as a constraint but as an opportunity to be grasped. By saving on energy and raw materials and by recycling they can add economic value to their production processes while at the same time contributing to a sustainable world. They are appreciating that innovation is not only possible in the production phase but up and down the entire supply chain. In all of this, financial value (price) plays a key role. Prices provide information on the value society assigns to products, but also on the costs of getting the product onto the market.

Some products are unpriced, but still of value to society. The environment is a case in point. There is a risk of gains and losses to society being inadequately reflected in product prices, while at the same time it is hard for sustainability issues to be weighed against financial. This is where environmental prices offer a solution, for they reflect the price society is prepared to pay to avoid pollution or to produce more sustainably. Environmental prices mean a price is put on the impacts of pollution on human beings, plants and animals: the financial value people would assign to a clean environment if it were on sale in a shop like other goods.

Figure 8 Challenges and potential solutions for companies in relation to sustainability



3.3.2 User applications of environmental prices

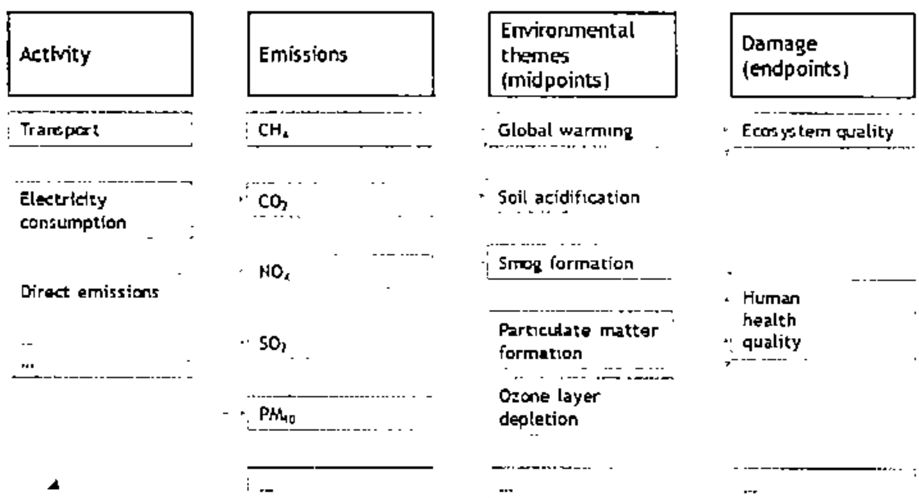
Environmental prices can be used by companies in the context of Corporate Social Responsibility (CSR) to quantify progress on certain sustainability issues, viz. those associated with the environment and the health and wellbeing of human beings and living nature.

Environmental prices can be used in the following situations, for example:
- to improve insight into where in a company's value chain the greatest environmental gains can be made;
- to calculate the sustainability gains achievable via improved procurement policies;
- to assess how additional energy use for recycling compares with reduced primary resource consumption;
- to crunch the numbers on the environmental impacts of alternative investments, equivalent to doing calculations on a social business case;
- to calculate a uniform environmental score for use in an environmental annual report.

3.3.3 How do environmental prices work?

Business activities like transportation, gas and power consumption and material and feedstock production lead to emissions of toxic and otherwise damaging substances. These pollutants have different environmental impacts. Some contribute to global warming, others to soil eutrophication, yet others to ozone layer depletion, while some are toxic to humans or animals. Sometimes an emission of a particular pollutant has several different environmental impacts. Sulphur dioxide, for instance, causes particulate matter formation, photochemical smog and soil acidification. Figure 9 shows a typical example of an industrial activity with a range of environmental impacts causing ultimate damage to human health and ecosystems.

Figure 9 Relationship between industrial activities, emissions and the environment



Note: This figure is merely an illustrative example and is not intended to provide a full picture of environmental cause-effect relationships.

Environmental prices put a price on the chain from emissions to ultimate damage. They are of no use for translating a particular industrial activity into emissions, however. For this purpose there are dedicated tools available, such as the SME Environmental Barometer developed by the Stimular Foundation. Companies can of course also carry out their own analysis. Frameworks available for this purpose include existing reporting obligations to local or national authorities, emissions registration under the EU Emissions Trading Scheme (EU ETS) and reporting to the European Pollutant Release and Transfer Register (E-PRTR).

3.3.4 Concrete use of environmental prices

If quantitative emissions are known, environmental prices can be used to calculate the environmental damage of the company activity concerned or the environmental benefits of an envisaged investment. To do so, the physical emissions (in kg pollutant) are multiplied by the relevant environmental prices (in €/kg pollutant) to express the aggregate resultant impacts in Euros.
This price figure stands for the sum total of the environmental impacts of the pollutant concerned. In the case of SO_2 emissions, for example, it accounts for soil acidification, smog formation and particulate matter formation. In this way all the environmental impacts resulting from the company's various activities can be expressed in monetary terms.

For use by companies, we recommend taking the central values of the environmental prices reported in this Handbook. Table 10 lists these for a (small) selection of emissions covered by the E-PRTR.

Table 10 Central values for emissions to air and water of common E-PRTR pollutants (€/kg emission)

Air compartment	€/kg	Water compartment	
Coarse particulates (PM_{10})	€ 26.6	Aldrin	€ 1048
Nitrogen oxides	€ 14.8	Arsenic	€ 231
Sulphur dioxide	€ 11.5	Atrazine	€ 10.1
Ammonia	€ 17.5	DDT	€ 33.3
Volatile organic compounds (NMVOC)	€ 1.15	Dichloromethane	€ 1.13
Methane	€ 1.74	Hexachlorobenzene	€ 260
Cadmium	€ 589	Mercury	€ 1116
Arsenic	€ 862	Naphthalene	€ 0.159
Lead	€ 5,367	Pentachlorophenol	€ 8.47
Mercury	€ 34,490	Trichloromethane	€ 1.98
Toluene	€ 2.1	Zinc	€ 0.795

Environmental prices for other emissions can be found in the tables in Section 3.2 and Annex D or retrieved from the online tool available at www.cedelft.eu/en/environmental-prices. We reiterate that companies should always take the central value.

In the case of greenhouse gas emissions, companies must make their own choices on what perspective to adopt. There are two possibilities:
- proceed from current policy;
- proceed from policy required to achieve the 2°C Paris target.

If the company opts to calculate the costs of greenhouse gas emissions based on current policy targets, the central value should be taken. Continuing with current policy, i.e. linearly rising emissions cuts under the EU ETS and a continuation of policies favouring renewables, will in all likelihood lead to the planet warming by 2.5-3.5°C by the end of the present century (the High Scenario in the WLO calculations: (Aalbers, et al., 2016).

If, alternatively, the company is keen to participate in efforts towards achieving the 2°C target, the high value of CO_2 prices should be taken.
This results in emission reductions equivalent to the required reductions under a 2°C target. for that scenario must be taken.
In both scenarios the CO_2 prices increase linearly over time by 3.5% per annum (excluding inflation) relative to 2015 values, as shown in Table 11.

Table 11 CO_2 prices (excl. VAT) associated with two policy targets for various years (€/tCO_2, 2015 constant prices)

	2015	2020	2030	2040	2050
Current policy	€ 48	€ 57	€ 80	€ 113	€ 160
2°C policy	€ 80	€ 95	€ 130	€ 180	€ 260

For companies undecided as to which prices to use, we would recommend taking those for the 2°C target, since these correspond best with the premises of Corporate Social Responsibility. If the CO_2 prices are used together with other environmental prices, 18% VAT should be added[17]

3.4 Use of environmental prices in SCBA

3.4.1 General framework

Social Cost-Benefit Analysis (SCBA) is a decision-support tool that can be used to clarify the considerations at work in government policy elaboration.
Most policy alternatives have a range of impacts, and by expressing as many of these as possible in monetary terms, they can be compared, providing valuable information on the pros and cons of each alternative (CPB; PBL, 2013).

In 2013 General Guidelines for SCBA were published in the Netherlands (CPB; PBL, 2013), prescribing how such analyses are to be carried out. These Guidelines were subsequently elaborated in more detail for individual policy domains (in so-called *Werkwijzers*). In 2017 CE Delft drew up SCBA Guidelines for the Environment (CE Delft, 2017). The guidelines, indices and recommendations in this document can be used in environmental policy-making as well as in other policy areas with major environmental implicatiions or impacts.

3.4.2 User applications in SCBA

SCBA can be performed for a wide variety of purposes, including the following:
- Concrete government investments, such as motorway construction or introduction of separated household waste collection. In this case there are (government) investment costs and social benefits in the form of reduced pollution, which SCBA allows to be compared.
- Environmental policy instruments, such as a waste charge or renewable energy subsidy. In this case the government is setting a framework for compelling or 'nudging' industries and consumers to invest or change their behaviour. In such cases, besides policy costs there are above all private costs to industries and/or consumers and social benefits through reduced pollution.
- Exploration of policy options, such as whether air-quality standards need to be tightened or recycling targets increased from the perspective of social welfare. In this case SCBA supports the problem analysis and explores whether additional environmental policy is desirable in welfare terms.

[17] This is an indicative figure. In the Netherlands, SEO (2016b) has calculated this in more detail for the Netherlands and the value in the Netherlands is equal to 18%. We did not perform a similar calculation at the level of the EU28.

3.4.3 How are environmental prices used in SCBA?

In SCBA environmental impacts are quantified whenever possible as volume changes in pollutant emissions to soil, air and water.[18] Emissions are dispersed through the environment, leading ultimately to impacts on endpoints: human health (morbidity and mortality), ecosystem services, buildings and materials, resource availability and nuisance. Environmental prices establish a link between emissions and endpoint impacts and assign a value to those impacts.

Environmental prices can thus be used in a SCBA and are recommended in situations in which it is unknown where exactly the environmental impacts occur, or if such impacts are only a minor, secondary issue in the SCBA. If the SCBA is concerned with a measure or policy with markedlly regional or local impacts, use of environmental prices is not to be recommended. Environmental impact assessment using a method like the impact pathway approach is then recommended. Also, if substantial funds are available for the SCBA and major environmental impacts are anticipated it is recommended to carry out a dedicated environmental impact assessment to explicitly model and estimate the relationships between emissions and impacts on all endpoints. In doing so, the endpoint impact values reported in Chapter 5 of this Handbook can be used.

The recomendation in the SCBA Guidelines for the Environment referenced above (CE Delft, 2017) is to value environmental impacts as far as possible, but to explicitly identify the uncertainties surrounding the monetary values by working with upper and lower values.

The environmental prices presented here have been constructed to implicitly include VAT and other indirect taxes. This is because most of these prices are based on willingness-to-pay studies, where consumers base their preferences on relative prices of other products including taxes. When it comes to climate change this is different: here prices are based on the costs of policy measures calculated exclusive of VAT. However, it is not entirely clear what VAT rates should be added to the CO_2 prices to make them comparable with the other prices.[19] We therefore propose that 'climate prices' be used in SCBAs with 18% VAT added (see footnote 17) until further research has shown what net impact VAT has on these prices.

An overview of the main prices to be used in SCBA can be found in Section 3.2 above.

---

18 SCBA also includes nuisance impacts (noise nuisance, visual nuisance), which while not quantified as emissions can still be valued using environmental prices.

19 No pronouncement can be made, however, as to whether these 'climate prices' including VAT would be higher or lower than those reported in Section 3.3. On the one hand they may be higher, because the technology costs of the measures do include VAT, but on the other they may be lower, if savings on revenues are raised by VAT (including the VAT on the energy tax). In the framework of this Handbook it cannot therefore be stated a priori which effect will dominate and to what extent.

3.5 Use of environmental prices as midpoint weighting factors in LCA

3.5.1 General framework

Environmental prices can also be used for weighting environmental impacts in Life Cycle Assessment and allied applications. These prices signify the relative value of emissions compared with one another and with other goods circulating in the marketplace. When emissions are valued in exercises like SCBA, their value is usually considered relative to other financial parameters.
When weighting emissions in LCA, though, the primary interest is mutual comparison among emissions. These weighting factors can then be regarded as the socio-economic weight attributed to the various environmental impacts.

Weighting factors depend on the characterization method adopted, and the factors developed in this Handbook were developed on the basis of the characterization adopted in ReCiPe.[20] To a certain extent these factors can also be adopted in other characterization methods, such as CML2 (Guinée, et al., 2002) or the PEF methodology ILCD (JRC, 2012).One problem, though, is that on a number of environmental themes these methods base their weighting on different pollutants than the ones considered here. Simple conversion is often unfeasible, because the midpoint environmental prices developed here were calculated in conjunction with characterization. The main elements of our method for calculating weighting factors are described in Section 4.2 (and in more detail in Annex C).

Another key issue to consider when applying the numers to other countries and regions is that the weighting factors in this Handbook are a weighted average of the relative damage caused in the EU28 by the various pollutants with respect to the midpoint concerned. The relative damage is calculated as the emissions multiplied by the endpoint impacts. So the present numbers are valid for the emissions in the EU28 for 2015 as these emissions have been used in calculating the weights of each individual pollutant. Therefore, for other countries and other characterization methods, different weighting factors thus hold.[21]

3.5.2 Environmental prices as weighting factors

The environmental prices that can be used as weighting factors in Life Cycle Assessment are reported in the third column of Table 12. These factors are based on the environmental prices calculated in this project by CE Delft and are specifically suited for use in LCAs according to the ReCiPe methodology under the hierarchist perspective, the one most commonly adopted in LCAs (cf. Annex A).

If the purpose of the LCA is to obtain estimates of external costs, however, the weighting factors must be taken from the external cost set in the last column. Apart from ozone layer depletion, acidification and land use, these are

[20] The environmental prices for use by companies and in SCBAs are based on 3% annual discounting of future developments and the individualist perspective for environmental characterization. While this is in line with standard economic discounting practice, in LCAs the hierarchist perspective is generally used. To guarantee consistent use of environmental prices in LCAs, we have also calculated a central value according to hierarchist principles, which we propose using for LCA weighting. This value is reported solely as an environmental price at midpoint level and can be used with the weighting factors.

[21] In principle it should also be possible to develop weighting factors for impacts at endpoint level using the monetary values presented in Chapter 5, by elaborating values for the ReCiPe endpoints DALY and PDFs. To do so would in all likelihood involve specific conversion steps that are beyond the scope of this Handbook. One aspect requiring special consideration would be the different discounting procedures adopted in ReCiPe and here.

identical to the values used as weighting factors. As explained in Annex A, in calculating external costs we opted for a mix between the individualist and hierarchist perspective, as this is is most in line with the premises of economic damage estimation.

Table 12 **Environmental prices per impact category, for use in LCA**

Impact category	Unit	Environmental price as weighting factor	Environmental price as external cost
Climate change	€/kg CO_2-eq.	€ 0.057	€ 0.057
Ozone layer depletion	€/kg CFC-eq.	€ 123	€ 30.4
Human toxicity	€/kg 1,4 DB-eq.	€ 0.0894	€ 0.0991
Photochemical oxidant formation	€/kg NMVOC-eq.	€ 1.15	€ 1.15
Particulate matter formation	€/kg PM_{10}-eq.	€ 39.2	€ 39.2
Ionizing radiation	€/kg kBq U_{235}-eq.	€ 0.0461	€ 0.0461
Acidification	€/kg SO_2-eq.	€ 7.48	€ 4.97
Freshwater eutrophication	€/kg P-eq.	€ 1.86	€ 1.86
Marine eutrophication	€/kg N	€ 3.11	€ 3.11
Terrestrial ecotoxicity	€/kg 1,4 DB-eq.	€ 8.69	€ 8.69
Freshwater ecotoxicity	€/kg 1,4 DB-eq.	€ 0.0361	€ 0.0361
Marine ecotoxicity	€/kg 1,4 DB-eq.	€ 0.00739	€ 0.00739
Land use	€/m^2a	€ 0.126	€ 0.0845

3.5.3 How are environmental prices used in a LCA?

These weighting factors can be used in Life Cycle Asssessment of products or raw-material supply chains. For this purpose, the environmental prices must be multiplied by the outcomes of the LCA at midpoint level. As stated above: if the purpose of using environmental prices is weighting, we recommend the 'weighting factor' set. If the purpose is the calculation of external costs, we recommend the 'external cost' set. The 'weighting factor' set is entirely based on the Hierarchistic Perspective from ReCiPe whereas the 'external cost' is based on a combination of hierarchist and individualistic perspectives as stated in Annex A.

In Table 13, we provide an example of a (fictional) woven and dyed textile product weighing 200 grams and made of 60% cotton/40% polyester. As can be seen, the environmental price of this product sums to a total of € 0.51, with the environmental impacts PM formation and climate change contributing most.

Table 13 Example: individual impact scores in LCA and weighted environmental score using environmental prices

Impactcategorie	LCA score for 200-g garment, woven and dyed, 60% cottton/40% polyester A	Unit x	Environmental price per environmental impact/ indicator B	Unit =	Result
Climate change	2.44	kg CO_2-eq.	€ 0.0566	€/kg CO_2-eq.	€ 0.14
Ozone depletion	1.78E-07	kg CFC-11-eq.	€ 30.4	€/kg CFC-eq.	€ 0.00
Acidification	0.010	kg SO_2-eq.	€ 4.97	€/kg SO_2-eq.	€ 0.05
Freshwater eutrophication	2.99E-04	kg P-eq.	€ 1.86	€/kg P-eq.	€ 0.00
Marine eutrophication	3.37E-04	kg N-eq.	€ 3.11	€/kg N	€ 0.00
Human toxicity	0.13	kg 1,4 DB-eq.	€ 0.0991	€/kg 1,4 DB-eq.	€ 0.01
Photochemical oxidant formation	0.0047	kg NMVOC	€ 1.15	€/kg NMVOC-eq.	€ 0.01
Particulate matter formation	0.0032	kg PM_{10}-eq.	€ 39.2	€/kg PM_{10}-eq.	€ 0.13
Terrestrial ecotoxicity	4.27E-04	kg 1,4 DB-eq.	€ 8.69	€/kg 1,4 DB-eq.	€ 0.00
Freshwater ecotoxicity	8.97E-04	kg 1,4 DB-eq.	€ 0.0361	€/kg 1,4 DB-eq.	€ 0.00
Marine ecotoxicity	1.96E-03	kg 1,4 DB-eq.	€ 0.00739	€/kg 1,4 DB-eq.	€ 0.00
Ionizing radiation	0.22	kBq U_{235}-eq.	€ 0.0461	€/kg kBq U_{235}-eq.	€ 0.01
Land use	1.8	m^2a	€ 0.0845	€/m^2	€ 0.15
Total weighted LCA score using environmental pricing:					€ 0.50

PART 2: METHODOLOGICAL PART

4 Calculating environmental prices

4.1 Introduction

This chapter discusses how the environmental prices in this Handbook were calculated. First, in Section 4.2 we set out the general methodology, which is based on harmonizing the premises of existing valuation methods, impact pathway analyses and characterization models. We then explain the changes made to the methodology followed in the 2010 Shadow Prices Handbook. This is done in Section 4.3 for the main elements of valuation, in Section 4.4 for the characterization models and in Section 4.5 for the impact pathway approach. Section 4.6, finally, discusses the the use of the environmental prices in the present Handbook now and in the future.

This chapter focuses on the main methodological changes. The precise considerations and literature underpinning these changes are discussed in further detail in Chapters 5 and 6. (In the annexes of the original Dutch language edition there is more comprehensive treatment)

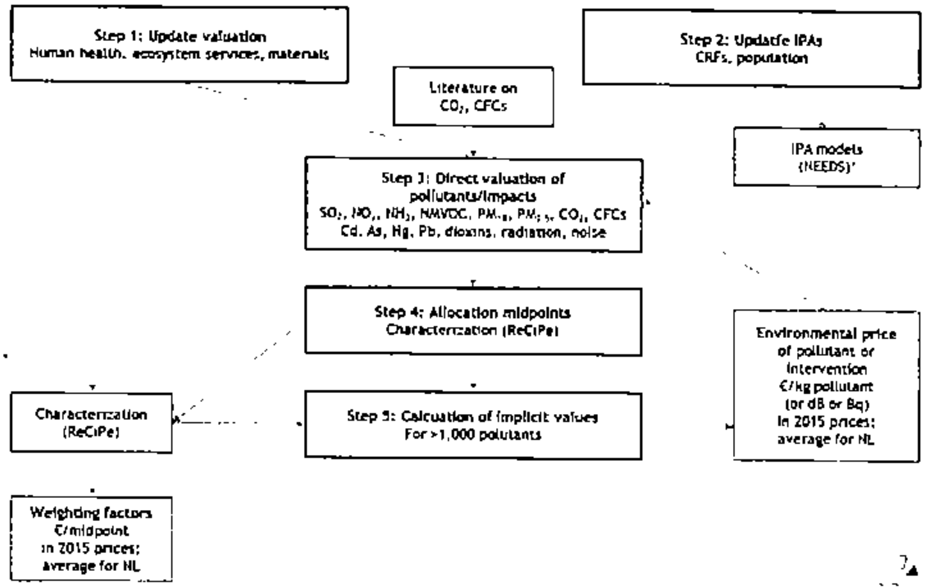
4.2 General methodology

As explained In Section 2.3, the environmental prices presented in this Handbook have been derived by combining three kinds of models/methods:

1. Characterization models defining physico-chemical relationships between interventions like emissions and midpoint impacts (midpoint characterization) and between midpoint impacts and endpoints (endpoint characterization).
2. Impact pathway models describing the relationships between emissions and endpoint impacts, mapping environmental dispersal of emissions and the impacts of the resultant concentrations on humans, animals, plants and buildings/materials.
3. Valuation techniques establishing a financial relationship between endpoint impacts and the changes in economic welfarde resulting from altered availability of the endpoint.

Just as in the Shadow Prices Handbook (CE Delft, 2010) the methodology employed in the present Environmental Prices Handbook combines work in all three fields of research. The process adopted to update the former prices is shown schematically in Figure 10.

Figure 10 **The Environmental Prices Handbook methodology**



Five steps can be distinguished.

In the first step, for each of the five endpoints adopted here monetary values were established that are in accordance with recent international literature and the premises laid down in the General SCBA Guidelines (CPB; PBL, 2013)) and the recommendations of the Discount Rate Working Group. This yielded values for human health, biodiversity, agricultural crops and material restoration costs, all in 2015 prices. These values are broadly discussed in Section 4.3, with a more detailed examination in Chapter 5.

Next, in Step 2, the impact pathway analyses (IPAs) were updated. These specify the relationship between emissions in the EU28 and impacts on endpoints and are built around concentration-response functions (CRFs). These adjustments are broadly discussed in Section 4.5 and in more detail in Chapter 5.

In Step 3 the updated values and IPAs, combined with the results of literature analyses on CO_2 and CFCs, were used for direct valuation of fifteen pollutants or pollutant groups. These values constitute the environmental prices presented for these substances in this Handbook.

Step 4 then consists of allocating these fifteen pollutants or pollutant groups across the various midpoints. Most of these pollutants (the exception being PM) have impacts on multiple environmental themes. The manner of allocation is the same as used in the 2010 Shadow Prices Handbook and is briefly described in the present Annex C.

Next, in Step 5, the damage cost of the various pollutants on each environmental theme was weighted using 2015 EU28 emissions (converted to ReCiPe equivalency factors) to arrive at a weighted average value for damage at the midpoint level. This allows the damage due to all the pollutants characterized in ReCiPe to be calculated and a weighted average midpoint damage factor to be derived. An implicit environmental price is thus calculated for all the pollutants characterized in ReCiPe with respect to the endpoints adopted here.

The main elements of the methodology are shown Figure 10. In Chapters 5 and 6 more detailed descriptions are provided on how the various choices involved in the respective steps were made. Below, we look in more detail at how the valuation methods, characterization and IPAs were adapted compared with the 2010 Shadow Prices Handbook.

4.3 Methodology update: valuation

First of all, the extent to which the valuation principles adopted in the Shadow Prices Handbook needed adjusting was assessed in general terms. As this is reported at length in Chapter 5, here this issue is considered only briefly.

In general, three changes have been introduced:
1. All prices have been brought in line with the recommendations of the Discount Rate Working Group, viz. to no longer apply a positive income elasticity for valuation of health (cf. Section 5.3). For ecosystems a relative price rise of 1% per annum was adopted.
2. All prices have been adjusted to 2015 prices.
3. All prices are presented as an upper and lower value and have been adjusted to incorporate the latest findings reported in the literature.

The main changes in the valuation system are summarized in Table 14.
In Chapter 5 the choices made are explained in more detail and the values for pollutant impacts on materials and buildings, wellbeing and resource availability are also discussed.

Table 14 **Changes to the valuation system**

	2010 Shadow Prices Handbook	This Handbook
Price level	2008 prices	2015 prices
Income elasticity	0.85%	0%. Prices also not adjusted to income elasticity between 2005 and 2015.
Value for human health	VOL = € 40,000 chronic in 2000 prices, € 55,0000 in 2008 prices	For mortality a range from € 50,000 to € 110,000 (2015 prices), for morbidity from € 50,000 to € 100,000.
Value for ecosystems	€ 0.55/PDF/m²/yr based on average European values from (Kuik, et al., 2008)	A range from € 0.025/PDF/m²/yr to € 0.685/PDF/m²/yr (2015 prices) based restoration costs (low) and the median and average European values from (Kuik, et al., 2008)

4.4 Methodology update: characterization

4.4.1 2010 Shadow Prices Handbook

In the previous Handbook, characterization was based on ReCiPe (November 2009 version), adopting the hierarchist perspective. In this respect no changes have been made here, except for the midpoint 'particulate matter formation', where ReCiPe was not used to derive the contributions of the various pollutants, with these being estimated directly using the NEEDS impact pathway approach. The relative contributions of $PM_{2.5}$ and PM_{10} was estimated using our own calculations.

4.4.2 New developments

Since the previous Handbook there have been developments in how emissions are characterized with respect to impacts and the associated indicators. On the one hand, ReCiPe was updated in 2012 and 2013. On the other, the ILCD (International Life Cycle Data) method has been developed by the European Commission's Joint Research Centre (JRC, 2012).This method is now widely applied in Western Europe and has been used to develop the Product Environmental Footprint and Organization Environment Footprint (PEF/OEF) frameworks, among other things.

In calculating environmental impacts and environmental damage these 'umbrella' analysis methods all make frequent use of the same underlying methods. Climate impacts, for example, are calculated using the method developed by the Intergovernmental Panel on Climate Change (IPCC). Nevertheless, the ReCiPe and ILCD methods each adopt a slghtly different approach for human toxicity and land use, for example. In ReCiPe, environmental impacts can be characterized with respect to endpoint damage to human and ecosystem health within a consistent framework. This is not currently feasible in the ILCD approach, though there are plans for further characterization to endpoint damage in the future. In Annex A more information is provided on the differences between ReCiPe and ILCD.

4.4.3 Choices made in this Handbook

In this new Handbook it was opted to again perform characterization on the basis of ReCiPe, for the following three reasons:

1. ReCiPe has multiple characterization methods, depending in part on the perspective adopted (individualist, hierarchist, etc.), but none of these methods is entirely compatible with the impact pathway approach. The individualist perspective in ReCiPe does, however, show some similarity with the discounting adopted in NEEDS.[22]
2. ReCiPe works with harmonized characterization from midpoint to endpoint. This is a major advantange compared with ILCD, where endpoint characterization in particular is still in an early stage of development.
3. ReCiPe is regularly maintained and updated.

In this Handbook, characterization is based on the ReCiPe characterization factors (Version 1.12, April 2016). In contrast to the 2010 Shadow Prices Handbook, the individualist perspective has now been adopted throughout, apart from a few environmental themes discussed in more detail in Chapter 6.

[22] NEEDS works with a 50-year horizon and a 3% discount rate. In the ReCiPe individualist perspective, on certain themes impacts only count for the first 20 years post-emission. If a given value is discounted at 3% p.a. over a 30-year period, this gives approximately the same result as a 20-year horizon with no discounting. A cut-off point therefore works similarly to using a discount rate. Because of the net price increase of 1% p.a. (see Section 5.3.6), for land-use changes it was opted to adopt the ReCiPe hierarchist perspective for characterization.

4.5 Methodology update: impact pathway approach

4.5.1 2010 Shadow Prices Handbook

Traditionally, two approaches have been adopted for expressing emissions in monetary terms: NEEDS and CAFE-CBA. Both proceeded from the impact pathway approach (IPA), in which emissions are related via atmospheric transport and dose-effect relationships to endpoint impacts, which are then assigned a monetary value. NEEDS and CAFE-CBA essentially consist of four interlinked models/databases:

1. Emission databases (and/or projections).
2. Dispersion models converting emissions to concentrations, using a combination of meteorological and atmospheric-chemistry models.
3. Concentration Response Functies (CRFs) converting concentrations to physical endpoint impacts on health, ecosystem services, buildings, etc.
4. Monetary valuation of these physical impacts.

In the 2010 Shadow Prices Handbook the two methods are described in more detail. The handbook Shadow Prices uses then subsequently the NEEDS impact pathway approach.

4.5.2 New developments in the literature

Since 2009 there has been no further development of NEEDS. CAFE-CBA, however, has been further elaborated by, amongst others, Holland (2014); IIASA (2014) and used in policy estimation for European agreements on transboundary air pollution.

In the framework of the present project it was examined whether it would be possible to link up with CAFE-CBA models to value the damage costs of air-pollutant emissions. This proved difficult, as the reporting method is not very transparent and the authors have not made the underlying models and assumptions publically available. For air pollution it only proved feasible to calculate an EU-average value (see the Dutch Annex C).

It is also striking is that recent shadow price manuals for Ireland, Belgium and Germany (under development) are still based on the NEEDS methodology owing to its far greater transparency. This methodology has the added advantage of allowing a certain amount of adjustment, since the underlying spreadsheets and modelling runs were made available to us for the purposes of this project.

In this Handbook it was therefore opted to base environmental prices on NEEDS, adjusting the estimates wherever possible to the 2015 context.

4.5.3 Choices made in this Handbook

It was thus opted to use.the NEEDS model, with the following three adjustments being made:

1. The emissions in 2015 in the EU28 were far lower than in 2005, leading to changes in atmospheric chemistry. The NEEDS results therefore had to be adjusted to the lower background concentrations.
2. In 2015 the European population had grown and was, on average, older compared with 2005. The NEEDS results therefore had to be adjusted to current population size and composition.
3. In 2015 more research results had become available on air-pollution impacts with, in particular, (WHO, 2013); 2014) publishing new recommendations on how these impacts should be included in calculations.

Hereafter we explain how exactly these adjustments were made.

Lower background concentrations

Parts of the NEEDS model, such as the dispersion and atmospheric-chemistry models, could not be explicitly unpacked by us. However, because there are numerous NEEDS modelling runs available for estimating emission reduction scenarios, the underlying model structure can to a certain extent be derived. It was opted to proceed from the 2010 and 2020 emission scenarios in the NEEDS Excel tool (as used in the Ecosense dispersion model). Actual 2015 EU28-emissions were then scaled to the difference between the 2010 and 2020 values. These results were put to and discussed with atmospheric-chemistry experts and explanations for a rise or fall in damage costs per kg pollutant elaborated. In this way an adjustment was made for the lower background pollutant levels in 2015 and their influence on damage estimates.

Diferent population composition

The NEEDS modelling results are rooted in a grid-based distribution of the population and an assumed population in 2010. It is not entirely clear which information was used for the estimation in 2010 and 2020. From the description of the EcoSense model we decided to assume that the forecasts from SEDAC were adequate reflecting the actual growth in population so that no additional update would be required. However, we also checked the composition of population against the values that were included in the NEEDS calculation (e.g. Table 2 in the NEEDS deliverable n° 1.1 - RS 3a) and concluded that the actual composition of European population was slightly different, so that we decided to update this with actual population data from Eurostat.[23] Using these data, a further estimate was made of the impacts of this on the CRF functions used in NEEDS (see Annex B). For the estimation of impacts outside the NEEDS model (e.g. heavy metals and radiation) we assumed a population growth of 4% between 2005 and 2015 based on Eurostat statistics.

New findings on air-pollution health impacts

Understanding of air-pollution health impacts has also improved in recent years (WHO, 2013), 2014), which means not all the CRFs adopted in NEEDS (2008a) are still valid. In the present study all these CRFs were individually checked and discussions held on whether they still reflect the latest scientific understanding. On this basis the CRFs for NMVOC and NO_x were adjusted upwards. In Section 6.5 (and in Annex B) this issue is discussed in more detail.

To assess whether the results obtained after these adjustments approximated recent IPA modelling results, as reported in IIASA (2014), in Annex C of the Dutch edition we carried out a rough conversion of our premises for the EU27 and compared these with the recent results in Holland (2014). The calculation in that annex showed that our method yields values lying within the uncertainty margins of the recent studies. It can therefore be concluded that our proposed adjustments probably give a realistic picture of air-pollution impacts in 2015.

[23] One should notice that this assumption differs from the Dutch handbook where we had taken the assumption that the population growth was also not included in the modelling results for 2010/2020 for classical air pollutants.

4.6 Use of environmental prices

4.6.1 Use of midpoint environmental prices and extension to over 2,500 pollutants

Following the procedure described in Section 4.2, and the adjustments made according to the Sections 4.3 to 4.5, the environmental price per midpoint was determined. Table 15 provides a synopsis.

Table 15 Environmental prices for midpoints, based on individualist characterization perspective (€$_{2015}$ per kg, unless otherwise specified)

Midpoint	Unit	Lower	Central	Upper
Climate change	€/kg CO_2-eq.	€ 0.0218	€ 0.0566	€ 0.0944
Ozone depletion	€/kg CFC-eq.	€ 22.1	€ 30.4	€ 45.7
Human toxicity	€/kg 1,4 DB-eq.	€ 0.0725	€ 0.0991	€ 0.153
Smog formation	€/kg NMVOC-eq.	€ 0.84	€ 1.15	€ 1.84
Particulate matter formation	€/kg PM_{10}-eq.	€ 28	€ 39.2	€ 60.4
Ionizing radiation	€/kg kBq U235-eq.	€ 0.0297	€ 0.0461	€ 0.0598
Acidification	€/kg SO_2-eq.	€ 0.526	€ 4.97	€ 5.66
Freshwater eutrophication	€/kg P-eq.	€ 0.25	€ 1.86	€ 2.11
Marine eutrophication	€/kg N	€ 3.11	€ 3.11	€ 3.11
Land use	€/m² a	€ 0.0255	€ 0.0845	€ 0.685
Terrestrial ecotoxicity	€/kg 1,4 DB-eq.	€ 1.17	€ 8.69	€ 9.85
Freshwater ecotoxicity	€/kg 1,4 DB-eq.	€ 0.00485	€ 0.0361	€ 0.0409
Marine ecotoxicity	€/kg 1,4 DB-eq.	€ 0.000992	€ 0.00739	€ 0.00837

Using these environmental prices for each midpoint, as a final step an extensive list of implicit environmental prices can be drawn up. This is done by using the environmental ratio between pollutants contributing to the same environmental theme as determined in ReCiPe. Annex D lists the main values for air, water and soil pollution with over 250 substances.
The values for over 2,500 pollutants are provided online at:
www.cedelft.eu/en/environmental-prices

These values can be used under the following assumptions:
- there is a linear relationship between the pollutant's contribution to the midpoint and the associated damage;
- as ReCiPe characterization is based on European averages, use in individual countries assumes that the impact of the pollutant in relation to its midpoint environmental price is the same as in Europe.

The correctness of these assumptions has not been further examined, as this was beyond the scope of the present study.

It may be noted that Table 15 can also be used for weighting environmental impacts in LCA, but as the hierarchist perspective (see Annex A) is generally adopted in LCA, different weighting factors are proposed for this purpose (see Section 3.5).

4.6.2 Use of these prices for valuing future emissions

The environmental prices reported here are valid for emissions in 2015 and it may be queried whether they change over time. After all, such prices may be used for valuing future emissions, particularly in SCBAs. So can environmental prices calculated as average prices for average EU28 emissions in 2015 also be used for valuing emissions in 2030, say?

For environmental prices relating to climate change Aalbers et al. (2016) suggests how these can be convered to annual figures. This boils down to a 3.5% price increase per annum, starting from the 2015 values (which are calculated back from the 2050 values). In this way the value of greenhouse gas emissions can be calculated for each year in the future (see also Section 6.3).

For the prices of other emissions there is no similar rule of thumb. In general, though, we advise considering the 2015 environmental prices as remaining the same for future emissions. This is based on the following considerations:
- For human health, valuation has been assumed constant in time, in line with the recommendations of the Discount Rate Working Group, which have been adopted as standard Dutch government policy.
- For the impacts of emissions on ecosystems, a 1% annual price increase can be assumed.This would lead to higher environmental prices, particularly for pollutants with severe impacts on ecosystem services. It should be noted, though, that for pollutants with combined impacts on human health and ecosystem services (e.g. SO_2, NO_x, NH_3) impacts on the former are valued far higher than on the latter.
- Paradoxically, to some extent air-pollution impacts of NO_x and SO_2 are aggrevated with declining emissions. This is due to the formation of secondary aerosols, especially in places with excessively high levels of nitrogen compounds in the atmosphere (cf. Section 6.5).
- The impact of certain pollutants may decline if emissions fall below a certain threshold. It should be noted, though, that the existence of such thresholds is by no means always assumed in the toxicological and epidemiological literature and has in most cases not been assumed in calculating the impacts in Chapter 5.

In summary, there is some indication that environmental prices may increase over time, but not to any substantial degree. As a conservative approach, it has therefore been assumed that the prices remain constant.

4.6.3 Use in the future and 'expiry date'

The environmental prices calculated here can be used some way into the future. If an SCBA is carried out in 2020, for example, our environmental prices can be adjusted to 2020 price levels by correcting for inflation between 2015 and 2020, preferably using the consumer price index for this purpose. Following the recommendations of the Discount Rate Working Group, no adjustment need be made for income.

Adjusting for inflation is a non-fundamental adjustment because it involves no changes to the basic system used for calculating the environmental prices.

Fundamental adjustments are, in contrast, necessary if changes are made to the systematic variables underlying the calculations of damage costs. This may be the case if a new method is used for valuing a human life or ecosystem sevices, for example. Adjustments may also be required if the WHO publishes new findings on the potential damage of certain pollutants, say. In this area, particularly, new research is being published all the time. Rejecting a threshold for the chronic impacts of NO_2 pollution may lead to NO_x damage costs rising by around 30-50%, depending on the WHO's overall health impact assessment. New insights into environmental dispersion may also mean the environmental prices need to be updated, and the same holds if characterization factors are adjusted.

At a later date it will therefore need to be reviewed whether the environmental prices reported here still reflect the latest scientific understanding.

5 Valuation of endpoint impacts

5.1 Introduction

This chapter discusses the values of endpoint impacts used for constructing the environmental prices reported here. These values are based on a literature study. First, in Section 5.2, we provide a general review of valuation methods. We then go into more detail on valuation of the various specific endpoints:
- human health (Section 5.3);
- ecosystem services (Section 5.4);
- buildings and materials (Section 5.5);
- resource availability (Section 5.6);
- wellbeing (Section 5.7).

In each section the choices made in the earlier Shadow Prices Handbook are justified and an explanation given of the changes deemed necessary in the present Environmental Prices Handbook. For each endpoint, values are then calculated for use in valuing emissions and midpoints.

5.2 General methodology

5.2.1 General

In the damage-cost approach an attempt is made to estimate the 'demand function' for environmental quality. This function hinges on how much people are prepared to pay for environmental quality: how much of their income they are willing to sacrifice for an additional unit of environmental quality.
This is referred to as the willingness-to-pay (WTP). An alternative option is to consider how much people are prepared to pay to accept environmental damage: their willingness-to-accept (WTA). The concepts of WTP and WTA are thus both defined in terms of individual preference.

Estimation of WTP can be approached in various ways, falling into two basic categories:
- revealed preferences, emerging from the choices people actually make;
- stated preferences, derived from questionnaires that measure people's WTP for maintaining or improving environmental quality.

For many environmental issues it is hard to establish WTP via questionnaires because most people have no real understanding of what environmental quality means for their lives. Questionnaires with questions like 'How much would you be willing to pay for a 1 kt reduction in SO_2 emissions?' will not yield meaningful results, "1 kt SO_2 emissions" being too abstract a notion. Questions therefore need to be carefully construed so respondents can pronounce on concrete issues they can personally relate to. This means WTP is estimated mainly at the endpoint level, in terms of concrete environmental impacts on human health, ecosystem damage, damage to crops, fisheries and biodiversity and so on.

In this Environmental Prices Handbook four methods have been used to estimate the willingess-to-pay for damage avoidance (on the five endpoints):
a. Damage valuation via revealed preferences.
b. Damage valuation via stated preferences.
c. Damage valuation based on restoration costs.
d. Damage valuation based on abatement costs.

In economic valuation studies there is generally held to be a 'ladder' among these methods, with direct damage valuation the most preferred method and valuation based on abatement costs the least preferred. There may be exceptions to this general rule, though. Thus, in the case of climate change the damage – referred to as the 'social cost of carbon' – is so uncertain that the abatement-cost method may sometimes provide a better price indication.

In some cases none of the above valuation methods are truly satisfactory. A different method may then be explored: damage valuation based on modelling loss of income (i.e. Gross Domestic Product). In this Handbook this approach to valuation is explored for resource depletion, among other endpoints (see Section 5.6). Below, the four main methods are discussed and it is explained which method has been adopted for which environmental theme.

5.2.2 Valuation based on revealed preferences

With methods based on revealed preferences, observed market behaviour in an existing, complementary market is used to indirectly derive the willingness-to-pay in a non-existent market. In the Netherlands this is usually done by analysing house prices (hedonic pricing).[24] By comparing house prices at locations exposed to noise nuisance, say, with prices in quieter locations an implicit value for the damage due to noise nuisance can be derived, provided due correction is made for other impacts.

Revealed-preference studies generally use econometric methods, as in the valuation of noise nuisance in the Netherlands, for example (see e.g. (Theebe, 2004)).[25] The great advantage of this method is that it proceeds from people's actual choices (in complementary markets) in light of their budgetary constraints. A drawback, though, is that it can be hard, in econometric terms, to sufficiently isolate the influence of one explanatory variable. Particularly if this variable correlates with missing variables, the method can lead to over- or underestimates.[26] In addition, the method is sensitive to missing-variable bias. If a spoiled view and noise nuisance go hand in hand, for example, the valuation of noise nuisance may be an overestimate if the welfare loss due to the spoiled view is not properly corrected for. The results also need to be duly validated.

Another, more fundamental problem is that revealed-preference methods can lead to erroneous damage estimates if people are inadequately informed about the damage resulting from environmental pollution and other interventions. Experience shows that people are indeed insufficiently aware of certain kinds of health impacts, as in the case of noise, for which there is now growing

[24] An alternative is valuation based on travel times, whereby it is assessed how far people are prepared to travel to spend leisure time in scenic countryside, for example.

[25] See also Section 6.11.

[26] A negative correlation leads to underestimation, a positive correlation to overestimation.

evidence that it causes not only nuisance but also health damage. This kind of damage is not always fully included when people put a value on nuisance.[27]

In this Environmental Prices Handbook, noise nuisance is valued partly on the basis of stated preferences. In addition, the value assigned to air-pollution damage to buildings has also been partly determined using revealed preferences for building clean-up.

5.2.3 Valuation based on stated preferences

Willingness-to-pay can also be derived on the basis of stated preferences obtained via questionnaires, interviews or other methods. The most popular method is the Contingent Valuation Method (CVM), in which respondents are asked directly in a questionnaire what they are willing to pay for a given good, described precisely in the research scenario. Based on consumers' response to how they would react in a hypothetical situation in which supply of the good in question varies, an implicit value for that good is derived. If respondents are honest, well-informed and rational, stated-preference research is in principle the most reliable source of information on people's preferences for environmental quality (Arrow, 1993); (Hoevenagel, 1994). However, this theoretical, ideal situation does not usually hold in practice (as discussed below). Well-known problems include an absence of budgetary constraints, leading to people reporting a higher value than they would in reality be prepared to pay. In addition, the results are very sensitive to how the study is precisely designed and participants' perceptions of how the results will be used (cf. Section 5.2.7). People may also give answers felt to be socially desirable or strategically beneficial.

In the Contingent Valuation Method (CVM) respondents are, for example, asked to report their WTP for health or conservation of certain ecosystems threatened by development. Another option is to ask for respondents' willingness-to-accept (WTA) the loss of that ecosystem, although the WTA approach is considered to yield less credible results (as discussed in the following text box). One variant of the CVM method is the Discrete Choice Experiment (DCE) method, in which respondents are given a number of alternatives and asked to choose the most attractive. The WTP for certain attributes (mortality risk, for example) is then revelaed by econometric analysis.

Box 1 Difference between WTP and WTA in the CVM method

One criticism of the Contingent Valuation Method is that the value obtained depends very much on whether the WTP or WTA is asked for. According to standard economic theory the WTP and WTA should be equal, but empirical and experimental studies have shown that people on average put a more than seven times higher value on a sum to be paid than on a sum to be received (Horowitz & McConell, 2002). At the same time, this need not necessarily be a drawback of the stated-preferences method and a difference between WTP and WTA may indeed emerge from people's preferences, as postulated in Kahneman's Prospect Theory (Kahneman & Tversky, 1979). This is due in part to people attaching more value to material assets and being risk-averse. Research by Kahneman et al. (1990), for example, has shown that the price people ask (WTA) for an article they have just received is higher than the price they would be willing to pay for it (WTP). One reason for this is the 'endowment impact', as described by (Thaler, 1980), which states that people attach more value to a good they

27 This is also due partly to the fact that the costs of health damage are not borne entirely by the home-owner.

already possess than to one they might possibly acquire in the future. In SCBA this would mean there is an implicit preference for the 'status quo'.

In this Handbook health impacts are based mainly on studies using stated preferences. In Section 5.3 this is discussed in more detail.

5.2.4 Valuation based on (potential) restoration costs

A third method for valuing the impacts of environmental pollution is by estimating the (potential) restoration costs, i.e. what it would cost to undo the pollution damage. In the literature (NEEDS, 2008c) it is generally recognized that this is a less accurate measure of damage, for two reasons:

1. Valuation using restoration costs may potentially be based on overestimation, because it is not always economically optimal to restore all damage. In Chapter 2 we saw that the 'optimum' pollution level always exceeds zero. A certain amount of environmental damage is therefore socially optimal. In adopting the restoration-cost approach it is assumed the optimum pollution level is zero.
2. Valuation using restoration costs may lead to underestimation, because not all damage is amenable to 'restoration'.

The objection of overestimation can be parried by not taking the hypothetical restoration costs as the point of departure, but actual monetary outlay by, for example, home-owners. In that case, the restoration costs are used to derive a revealed-preference value. In all probability this will then lead to an underestimate, because not all home-owners will opt to repair the damage. For these reasons the restoration-cost method is less accurate than the revealed-preference and stated-preference methods.

In this Handbook valuation using restoration costs has been used for the impacts of air pollution on buildings and materials and to a certain degree also for assigning a value to ecosystem services. This is not to say that we hold the repair-cost approach to be superior to the revealed-preference and stated-preference methods, merely that there is currently too little research available on these issues for valuation using the latter two methods.

5.2.5 Valuation based on abatement costs

The final valuation method is based on abatement costs, also known as prevention costs. Much environmental policy is associated with quantitative targets (20% emissions reduction relative to 2010, say) and this method proceeds from the marginal cost of securing such targets. The abatement-cost method is based, more specifically, on the costliest abatement measure.

In the 2010 Handbook, abatement costs were recommended for environmental policy for which targets have already been set; this was in line with the former 'OEI Guidelines' used for valuing the impacts of infrastructure projects. These guidelines were superseded in 2013 by the General SCBA Guidelines, which means all midpoint environmental themes have now been valued using damage costs. The only exception is climate change, for which the Discount Rate Working Group has recommended using the abatement-cost method, based on the elaboration of climate policy in the WLO scenarios (see Text Box 2).
In addition, the General SCBA Guidelines also leave open the option of using the abatement-cost methodology if there is no other way to value damage. In this Handbook this proves to be the case for the impacts of nitrogen on marine ecotoxicity. So this too can be valued, we have here used the abatement-cost method, using the existing Dutch water-pollution charge as a

proxy for the willingness-to-pay for damage avoidance (above all, excessive algal growth) resulting from discharge of nitrogen compounds. Here the charge reflects the marginal costs of achieving the policy target (reduced ecotoxicity).

If the abatement-cost method is used, it is important to take 'efficient' or 'least-cost' prices: the minimum price of securing a given policy target. If we assume a fully-informed and economically-rational acting government, policy targets will be designed such that an 'optimum' pollution level is attained. To achieve this pollution level, in welfare economics a 'Pigouvian charge' is introduced on the polluting activity that internalises the external impacts at least cost. What a Pigouvian charge embodies, in other words, is efficient application of policy to optimise economic welfare.

5.2.6 Synopsis of methods used

To summarize, in this Environmental Prices Handbook endpoints have been valued using the methods shown in Table 16.

Table 16 Methods used in this handbook to value endpoints and climate change (through literature)

Endpoint	Methods
Human health, mortality	Stated preferences, range also checked via revealed preferences
Human health, morbidity	Stated preferences, revealed preferences
Ecosystem services	Stated preferences, restoration costs
Buildings and materials	Restoration costs
Resources	Damage costs, abatement costs, modelling
Climate change	Abatement costs
Wellbeing (Nuisance)	Revealed preferences, CRF modelling

5.2.7 Limitations to valuation of environmental quality

Ascribing a value to environmental quality has several serious limitations. Although this issue has spawned thousands of publications over the last two decades, there are still major uncertainties about the reliability of the valuation methods employed. This is due primarily to the fact that values for environmental quality derived in a research setting are hard to verify against people's actual preferences (cf. (Carson, 2000); (Bateman, et al., 2002)). A key factor here is the pronounced in-built bias of each research method. The principal limitations are as follows:

- Completeness: There appear to be no methods that can represent the full spectrum of human appreciation of environmental quality. In particular, optional and intrinsic values are poorly covered in valuation studies.
- Knowledge and information bias: Most people are poorly informed about how environmental pollution relates to human health, to name one example. In revealed-preference methods this results in pollution impacts being undervalued. In CVM studies it is well known that if people are given prior information on air-pollution impacts, they value these far higher.
- Study bias: CVM methods, in particular, yield widely ranging results, depending on how the study is designed. Carson et al. (1997) have shown that the sequence in which questions are asked has a key influence on valuation, a fact that has also been empirically proven (Payne, et al., 2000). While this is well understood by economists, it is often ignored when values are assigned in SCBA (cf. the discussion in Chapter 6). It may be added that this criticism is now generally recognized by researchers and in recent years more and more valuation studies are being designed as

Discrete Choice Experiments, with the sequence of questions also being varied so due corrections can be made (cf. the discussion above).

In this Environmental Prices Handbook we make no pretence of our monetary values being either complete or infallible. We stress, rather, the major uncertainties that are inevitably attached to human valuation of environmental goods. One way we do so is by citing all values as numerical ranges. In Annex C of this handbook we analyse the uncertainties associated with the various methods used. There is no denying, though, that the values presented here are not the outcome of an exact science.
The only way to avoid the scientific uncertainties surrounding environmental prices is to not value environmental goods at all. Although such a course may at first seem to solve the problem of scientific uncertainty, it stands in stark contradiction to the fact that each and every day consumers, industries and governments make decisions involving *implicit* weighting of financial data and impacts that cannot be expressed in financial terms. While numerical environmental prices may not really change this state of affairs, at least they mean these decisions can now be made more explicit. To our mind, this seems to be the main benefit of using environmental prices.

5.3 Valuation of human health

Human health impacts are broken down into morbidity, i.e. illness, and mortality, i.e. premature death, with a distinction made between acute and chronic mortality. Three kinds of pollution-related health impacts can consequently be distinguished:
1. Chronic mortality, expressed as a reduction in life expectancy. Epidemiological studies have shown that people in polluted areas have shorter lives than those in cleaner areas, a relationship that also holds at lower air-pollutant concentrations (OECD, 2012). The main causes of death are cardiovascular and pulmonary disease.
2. Acute mortality, expressed as an increased risk of death. Certain kinds of pollution, including smog, have also been correlated with acute heart failure. This means an increase in the risk of premature death.
3. Morbidity, expressed as an increased incidence of illness at the population level, or 'disease burden'. Environmental pollution leads to an increased incidence of asthma and pulmonary disorders. In addition, there are numerous other health problems associated with pollution, including allergies, eczema and so on. Reduced IQ development due to lead pollution, among other causes, is another element of the morbidity impact.

Following earlier attempts in transport and health care, in the 1970s the health impacts of environmental pollution were also monetarily valued.
In most of the studies published to date, health damage emerges as the single largest cost item in the overall costs of environmental pollution.

5.3.1 Midpoint-to-endpoint relationships

The following midpoints have an impact on the endpoint 'human health':
- particulate matter formation;
- photochemical oxidant formation;
- ionizing radiation;
- human toxicity;
- nuisance (noise nuisance);
- ozone depletion;
- acidification*;

– climate change*.

With the exception of acidification and climate change, all these impacts have been included in the present study. In the case of acidification, the only direct health impacts are probably very minor.[28] The indirect health impacts of acidifying emissions associated with formation of secondary aerosols and ozone have been included under particulate matter formation and photochemical oxidant formation, respectively. In this Handbook the impacts of climate change have been determined on the basis of abatement costs. This means the health impacts of climate change are not treated separately, but integrally included (as a proxy) in the valuation of climate change policy.

5.3.2 Measuring health impacts

Health impacts are usually expressed using a physical indicator expressing the number of life years (mortality) or certain quality of life (morbidity) 'lost'. The most commonly indicators used are: YOLL, DALY and QALY.[29] Table 17 provides a brief explanation of each indicator.

Table 17 Indicators for human health impacts

Indicator	Meaning	Explanation	Used for environmental impacts in:
YOLL	Years of Lost Life	Number of years of life lost due to premature mortality	NEEDS, IIASA-TSAP, CAFE-CBA
DALY	Disability-Adjusted Life Years	Number of years of life lost due to impaired health	ReCiPe
QALY	Quality-Adjusted Life Years	Number of years of perfect health	Certain individual studies (e.g. Hubbell, 2006)

With these indicators, mortality is expressed in 'number of life years lost'. Morbidity (illness) is normally also expressed in these indicators using a conversion table in which illness and disability are expressed as partial mortality, as in Hubbell (2006) for the QALY framework, for example. Generally speaking, morbidity is more usually expressed in QALYs rather than DALYs or YOLL. Studies employing YOLL, such as NEEDS (2008a), often use the QALY framework for valuing the relative disease burden.[30]

YOLL, DALY and QALY essentially each measure a different aspect of health impacts. All the main European studies on the social costs of air pollution have adopted YOLL for premature mortality, with morbidity valued separately using the QALY framework. The reasoning is that the YOLL framework is more congruent with the actual action of environmental pollution, which tends to shorten life span, particularly through respiratory and cardiovascular disease towards the end of a person's life. YOLL then most accurately reflects mortality impacts. DALY and particularly QALY are used more in the realm of health care. Annex B in the Dutch language version provides detailed information on each of these indicators and how they relate to each other.

---

28 Apart from NO_2, but the impact of this pollutant has been added to the chronic impacts of photochemical smog formation; see Section 6.5.

29 YOLL is sometimes also expressed in LYL (Life Years Lost).

30 Here the assumption is made that 1 additional YOLL equals the loss of 1 QALY. For more information see Annex B in the Dutch language version.

5.3.3 Valuation of health impacts

All three indicators in Table 17 are quantified in 'years'. For use in SCBA, in the CSR context or for final weighting in LCAs they therefore need to be assigned a monetary value. The valuation methods most often used for this purpose are the VSL (Value of a Statistical Life) and VOLY (Value Of a Life Year) frameworks. The former is often used in the context of transport policy, but also in health-care and environmental settings. OECD (2012) has carried out a meta-analysis of valuation using VSL. The results show that the median value of VSL for valuing the health impacts of pollution is around € 2.5 million. In NEEDS (2008c) it is rightly stated that, in the air-pollution context at any rate, mortality valuation via VOLY is better than via VSL, for the following reasons:

1. Air pollution can rarely be identified as the primary cause of an individual death, only as a contributing factor.
2. VSL makes no allowance for the fact that the loss of life expectancy through death is far less for mortality associated with air pollution (around six months) than for typical accidents (30-40 years), the figure on which the VSL calculations are based. In other words, the main mortality impact of air pollution occurs later in life, while accidents are more likely to occur at an earlier stage.

For this reason, in the NEEDS project VOLY is used for valuing the mortality impacts of air pollution. This Value Of a Life Year is the value assigned to a life year on the basis of estimated life expectancy. It can be calculated using stated or revealed preferences.

In the NEEDS project, VOLY was valued using the Contingent Valuation Method by asking people for their willingness-to-pay for a three or six month longer life span as a result of improved air quality. One innovative feature of NEEDS was that people were asked explicitly how they value small changes in life expectancy. As a result, a lower value for VOLY was found than in other projects in which people were asked (in Discrete Choice Experiments) about their risk of dying prematurely. As argued in NEEDS (2007a), an analysis based on changes in life expectancy yields a better estimate than one based on changes in mortality risk, because in epidemiological studies the impacts of air pollution manifest themselves as reduced life expectancy.[31]

In NEEDS, VOLY was based more specifically on a 2006 WTP research study in which people were asked, in face-to-face interviews and payment-card experiments, how they valued a few extra months at the end of their life.[32] Based on the empirical results, augmented by literature reviews, the NEEDS team arrived at an average VOLY for the EU25 (plus Switzerland) of € 40,000. This figure is for chronic mortality, i.e. shortening of life expectancy. For the risk of acute mortality the team deemed the results of earlier studies on mortality risk valid, and for acute mortality a VOLY of € 60,000 was thus adopted. In addition, on the basis of an earlier WTP study a QALY-based valuation was used for various kinds of morbidity such as respiratory problems, cancer, lost working hours due to illness and costs of hospital visits.

---

31 This is in line with the evidence of health risks due to PM_{10}, which shorten life span and thus also life expectancy. These impacts have been primarily proven in epidemiological rather than toxicological studies.

32 This method thus combines asking people for their valuation with a simple experiment. By using payment cards, this method is considered more reliable than simply requesting willingness-to-pay, because the physical action of payment makes people more aware of the fact they must pay.

There have been numerous studies showing a strong correlation between the value people give to mortality risk or reduced life expectancy and their financial income. In NEEDS (2006) it was opted to primarily adopt a European perspective and calculate pan-European averages, but differentiating between new member states in Central and Eastern Europe and 'old' states. The central value for the new member states was calculated as € 33,000, with the value for the EU15 plus Switzerland slightly higher: € 41,000 (NEEDS, 2008c).[33]

5.3.4 Methodology in the 2010 Handbook

In the 2010 Shadow Prices Handbook damage to human health was valued using the values reported in NEEDS. In line with the above, an EU25-average VOLY of € 40,000 per annum was therefore taken for chronic mortality. For acute mortality due to smog-related heart failure a higher VOLY was adopted in NEEDS, viz. € 60,000 per annum.[34] The value for morbidity (e.g. hospital costs) was also taken from NEEDS.

In the 2010 Manual these values were thus adopted, but adjusted to 2008 prices and real income, and assuming, in accordance with NEEDS (2008c), that the NEEDS valuation was based on income (and price) levels for the year 2000 (for further discussion, see below). In line with NEEDS, we there applied a positive income elasticity of 0.85, yielding a VOLY of € 55,021.[35] This value was used for all the environmental themes, with the exception of ozone layer depletion, where a direct valuation was based on the ReCiPe characterization, which reports human-health impacts for this theme in DALYs. Based on a VOLY of € 40,000 we calculated a DALY in which, after extensive deliberations, we opted conservatively for taking 1 VOLY as equal to 1 DALY (though there are indications (as discussed in Annex B of the original Dutch version of this Handbook and in the Shadow Prices Handbook (CE Delft, 2010) that a DALY should be assigned a higher value than a VOLY.

5.3.5 New research for this Handbook

For the present Handbook, additional research on valuation of human health was carried out with respect to four issues:
- the implications for VOLY valuation of the recommendations of the Discount Rate Working Group;
- the implications for VOLY valuation of the QALY-value adopted in the new SCBA Guidelines for the Social Domain (SEO, 2016a);
- new insights and interpretations based on NEEDS (2008c);
- new literature and studies on VOLY valuation and deliberations on whether in the light of this literature and more recent insights the VOLY used in the 2010 Handbook is to be deemed too low or too high.

---

33 In the spreadsheet accompanying the EcoSense webmodel, the results were however calculated with the pan-European average of € 40,000/VOLY.

34 The higher value for acute mortality can be justified because in NEEDS people were asked for the influence on their life expectancy, which generally yielded lower values. People are prepared to pay more when they are asked about the risk of mortality. Acute heart failure can obviously be seen as a mortality risk.

35 Furthermore, in NEEDS another assumption was made: that premature mortality of babies implies a two times higher VSL than for adults, based on several studies in the literature. In NEEDS adults have an implicit VSL of € 1.5 million, children € 3 million. According to Rabl et al. (2014) this is also justifiable, parents being acutely sensitive to their childen's health. It should be added, though, that in the totality of impacts this effect is very small, with Rabl et al. (2014, p. 502) stating that for PM_{10} child mortality accounts for no more than 3.4% of total damage, while for $PM_{2.5}$ the damage is negigible. A different assumption on this point would therefore not make any great difference in environmental prices.

Below, we look more closely at these four aspects.

5.3.6 Implications of the Discount Rate Working Group

In line with the recommendations of the Discount Rate Working Group, health benefits may no longer be boosted using a positive income elasticity, because the higher willingness-to-pay for health is cancelled out (over time) by increased 'supply' of health.

We interpret this to mean that technological advances make it ever less expensive to stay healthy, with the overall health of the population improving as a result. According to the standard economic theory of declining marginal utility value, it can then be stated that the value of an additional unit of health is continually falling as a result of declining environmental pollution.[36] In economic terms, this statement is accurate. The relationship between baseline health level and the value to be assigned to health is also evidenced in empirical studies. Istamto et al. (2014), for example, found that the WTP for a reduction in air pollution is negatively correlated with the baseline health level measured by the RAND-36 questionnaire: the healthier one is, the lower the value accorded to measures to curb air pollution.[37]

In this Handbook we have adopted the recommendations of the Discount Rate Working Group, applying no positive income elasticity to VOLY valuation. This means the NEEDS valuation from 2005 has only been increased to correct for inflation and no longer by a factor for income growth. In doing so we thus assume that people in 2015 are prepared to spend a lower fraction of their income on pollution prevention than in 2005 because their health situation has improved.

5.3.7 New interpretation of NEEDS

In the 2010 Shadow Prices Handbook it was stated, in line with NEEDS (2008a), that the prices and incomes adopted in NEEDS were based on the situation in the year 2000. In that Manual the correctness of this assumption was not further examined. In work on the present study, however, it was concluded that this is perhaps erroneous. The VOLY valuation study was based on questionnaires conducted in 2005 and 2006, and respondents therefore answered their questions using 2005 prices and incomes, implying that mortality impacts were likewise expressed in 2005 prices. In the final NEEDS report (NEEDS, 2008a) all impacts are cited in 2000 prices, though. The reason for this course of action is not clearly explained.

The year adopted for expressing prices is important, because precisely between the year 2000 and 2005 there was rapid monetary deflation, i.e. inflation, due to introduction of the Euro. This makes it plausible that respondents in the WTP study conducted after introduction of the Euro worked mentally with different prices than those in WTP studies prior to the Euro.

The value assigned to lost work-days due to sick leave can also be queried. The figure of € 295/day (in 2000 prices) adopted in NEEDS (2008a) is far higher than had previously been used. If this effect is combined with the total number of hours worked (and the result inflation-adjusted), one arrives at a

[36] Here we note that the Working Group does not adopt the argument of declining marginal utility, merely that the costs of health maintenance become cheaper over time.

[37] Other things remaining equal, one would therefore also expect a lower VOLY as the air becomes cleaner. In NEEDS (2008c) this was not taken into account, as a single, constant VOLY-value was used in all the various scenarios, regardless of the baseline pollution level.

figure in excess of EU28 GDP. Why this higher value was adopted is again not entirely clear. In our opinion it is correcter (and simpler) to base valuation on the reward for labour as a production factor (salaries and social security payments) as cited in the National Accounts. Such an approach would yield a value of about € 114/day in 2015 prices.

5.3.8 Implications of QALY-value in SCBA Guidelines

The SCBA Guidelines for the Social Domain (SEO, 2016a) adopt a value of € 50,000-100,000 for a QALY. This QALY-value, from the realm of curative health care, cannot simply be transferred to VOLY.[38] In the first place, QALY takes health benefits as its metric, while VOLY considers impacts on life expectancy. VOLY is thus more in line with *preventive* than *curative* health care. In the appendices of SEO (2016a) it is discussed whether a QALY for preventive health care should be lower than for curative health care. Although there are studies positing that this is indeed the case, SEO (2016b) argued that there are no theoretical grounds for such a move. They therefore recommend that this not be valued separately. The implication is then also that there is no reason to value environmental pollution differently from health-care interventions.

Secondly, valuation using VOLYs is concerned primarily with involuntary risks, valuation using QALYs with voluntary interventions. Willingess-to-pay for avoiding involuntary risks is generally higher, implying higher valuation with VOLYs than with QALYs.

In Annex B of the Dutch language version, we look at a discussion that goes into whether a VOLY-to-QALY conversion factor might be found. Our best guess for such a factor is based on a ratio of 1.087 between DALY and QALY (so that 1 DALY = 1,087 QALY) and a ratio of 1 between DALY and VOLY. The higher value of a VOLY compared with a QALY is due primarily to the value assigned to avoiding premature death being higher than that for avoiding sickness, so that a QALY of zero (no utility value for state of health) per annum does not equal 1 YOLL (no longer alive due to death). Based on age weights and relative disease burden, conversion is then feasible. In Annex B of the Dutch version it is argued that a conversion factor of 1.087 is the best possible estimate at present.

This means the QALY values prescribed in the SCBA Guidelines for the Social Domain result in a value of € 54,350-108,700 per annum for a VOLY. This range is precisely in the middle of the range reported by Desaigues et al. (2011) for the stated preference method used in NEEDS, where, converted to 2015 prices, lower and upper values of € 33,500 and 134,000 are adopted.[39]

5.3.9 New literature and debate on the VOLY-value

Finally, we investigated whether new literature provided any grounds for adopting a higher or lower VOLY than in the 2010 Shadow Prices Handbook.

Since 2011 there have been several studies on the costs and benefits of clean-air policy in the EU (see for example Holland, 2014; IIASA, 2014) and these studies have worked with a far higher VOLY: € 58,000 median and € 135,000 average.
It should be noted, though, that these values are based on the inflation-

[38] The QALY is obviously inverse to the VOLY; see later in this chapter.

[39] In this calculation, income elasticity has been taken as zero. In 2000 prices the lower and upper values are € 25,000 and 100,000.

corected values calculated in the NewExt (2004) study, which are in turn based on mortality risk. As argued above, the value to be assigned to air pollution is better represented by quantifying the impact on life expectancy. For this reason, we do not necessaily see this as a better valuation in scientific terms. What we do observe is that the central value of NEEDS (2007a) is no longer used in a number of important European cost-benefit analyses and has been rejected in the European Commission's 2009 Impact Assessment Guidelines (EC, 2009a); (EC, 2009b), which recommend standard usage of a range of € 50,000-100,000 for a VOLY if pollution-related health damage is being quantified in such assessments.

Chanel & Luchini (2014) posit that the VOLY values adopted in NEEDS lead to underestimation of the true value of prolonged life expectancy. In their WTP study on the benefits of emissions reduction in France they write that the WTP for air-pollution prevention leads to an underestimate if only impacts on one's own life are taken on board. Many people want cleaner air not only for themselves but above all also for the ones they love. When they include this fact, they arrive at a far higher VOLY of € 140,000, in France, for avoiding premature death due to the impacts of air pollution. This is similar to the criticism of Mouters & Chorus (2016) that stated-preference studies yield an underestimate if only the impacts on one's own life expectancy are included.

In addition, Bijlenga et al. (2011) bring forward that WTP studies using questionnaires, as with NEEDS, generally arrive at a lower value for a VOLY than Discrete Choice Experiments in which stated preferences are established for multiple aspects at the same time. However, they also state that there are no theoretical grounds for arguing which of the methods is better. Istamto et al. (2014), on the other hand, arrive at a 3-5 times lower value for air-pollution health impacts than NEEDS (Desaigues, et al., 2011), reporting that this is due to their using a web-based survey compared with the face-to-face interviews plus payment-card experiments used in NEEDS, which they state are known to yield higher values. In our opinion the survey method used by Istamto et al. (2014) is indeed less comprehensive than the NEEDS study and cannot therefore simply be adopted without further ado as a basis for revising VOLY values.

Besides new empirical studies, other research has also been published, in particular several meta-analyses and comparisons of results from the environmental and other domains (such as transport) associated with health impacts. OECD (2012) is a meta-analysis of the values assigned to human health based on the VSL (Value of a Statisical Life) metric. This study concludes that the median VSL used in the environmental domain is approximately € 2.4 million.[40] Based on an average VSL-to-VOLY ratio of between 20 and 40 for pollution (as argued in Annex B of the Dutch language version), this means a VOLY should be valued at between € 60,000 and 120,000. OECD (2012) analyses the differences in values obtained using the VOLY and VSL metrics and reports that use of VSL in combination with QALY generally leads to pollution being valued higher than when VOLY is used, with this due to the fact that VOLY underestimates the price of morbidity (illness). Only if a high value of € 130,000 is adopted for a VOLY is the value assigned to morbidity in line with studies using VSL, according to OECD (2012). Based on the OECD study, the French government has recommended adopting a figure of € 115,000 (in 2010 prices) for a VOLY in cost-benefit analyses (Quinet, 2013).

[40] According to OECD (2012), the VSL used in the environmental context is half that used for victims of traffic accidents. One reason for this, they state, is the fact that in WTP studies people assign a lower value to 'public good'-type issues such as the environment.

Finally, research also shows that, apart from income, education level also influences people's valuation of health. The more educated they are, the higher people value a VOLY (see e.g. OECD (2012) for a general discussion and Istamto et al. (2014)). Because the average education level in Europe is increasing over time, one would anticipate a higher value being assigned to a VOLY.

5.3.10 Choices in this Handbook

As the basic point of departure in this Handbook we have here taken the VOLY-value given in the NEEDS project for the EU15: € 41,000, in 2005 prices. Converting this to 2015 prices gives a figure of € 48,000, slightly less than the lower value of the QALY, expressed in VOLY (see above), from the SCBA Guidelines for the Social Domain (SEO, 2016a), which would give a VOLY of € 55,000 (argumentation for which is provided in Annex B of the Dutch language version). The EU study on the costs and benefits of clean-air policy works with a VOLY of € 58,000 (Holland, 2014) ; (IIASA, 2014). It would seem plausible, therefore, that the true lower value of a VOLY is somewhere around € 50,000 (in 2015 prices). There is indeed evidence that this is only a lower bound.
The values reported in the latest studies are generally higher. Assuming the same range adopted in SEO (2016b), we arrive at an upper VOLY-value of € 110,000, which is similar to the value of € 115,000 recommended by the French government. This value is slightly below the upper bound adopted in the EU studies (Holland, 2014); (IIASA, 2014). It is therefore well feasible that there is a ceiling for the value of a VOLY that lies somewhere between € 110,000 and 120,000.

Based on these consideraions, we have opted to take € 50,000 as the lower bound of a VOLY and € 110,000 as the upper bound.

The VOLY is the most important metric for valuing the health impacts of environmental pollution because pollution has a greater impact on mortality than on morbidity. For morbidity calculations we proceeded from a QALY as formulated in the social domain with a lower value of € 50,000 and an upper value of € 100,000. At the lower bound a VOLY thus equals a QALY. For the upper bound, though, we distinguish between € 100,000 for a QALY and € 110,000 for a VOLY.

These upper and lower values for human health are recommended for use in SCBAs. Industries and environmental scientists generally make less use of ranges, preferring a central value instead. Because the VOLY in all probability does not have a normal distribution, we have opted to take a central value of € 70,000 for both a VOLY and a QALY.

In this Handbook we have also chosen to no longer adopt a separate value for acute mortality. This is because acute mortality due to pollution generally affects senior citizens. There are indications that an extra life-year at the end of one's life is valued less than an extra year of life expectancy earlier on. This is why people approaching the end of their life indeed put a lower value on an additional life-year than the average population. It is not unusual to take the step of valuing acute mortality due to elevated ground-level ozone no differently from chronic mortality; in the Ecosense-model, too, there is assumed to be no difference between chronic and acute mortality (NEEDS, 2008b). In this Handbook, this is the approach that has been adopted.

For infant mortality we followed the approach of NEEDS (2008a), using a VSL twice as high as that for adults. This results in a VSL of € 3 million (in 2005 prices) for the lower bound of health impacts. For loss of working hours we based ourselves on the National Accounts, dividing the sum total of rewards to labour as a production factor (salaries and social security payments) by the aggregate number of hours worked. In 2015 prices the reward for the production factor labour works out at € 175 per day (incl. VAT).

5.4 Valuation of ecosystem services and biodiversity

Ecosystems, i.e. assemblages of organisms in a particular environment, contribute in a multitude of ways to human prosperity. Known as 'ecosystem services', this contribution consists of all the various products and services supplied by the natural world and benefiting our lives. Emissions and land use (changes) can affect the functioning of ecosystems and thus the availability of the services they provide.

Besides ecosystem services, biodiversity, i.e. the diversity of plant and animal species, is also important in its own right. On the one hand, human society considers it of value to pass on this 'rich tapestry' to future generations. On the other, biodiversity is of critical importance for the quality and very survival of nature, because it supports fundamental processes like soil formation and the hydrological cycle, which in turn supply humans with all manner of (ecosystem) services.

This section explains how damage costs due to environmental pollution have been valued for the theme of ecosystem services.

5.4.1 Categorization of ecosystem services

Ecosystem services are defined and categorized acording to the various services and benefit they provide to humanity. CICES (EEA, 2011)[41] distinguishes three classes of service:

- provisioning services (e.g. food from agricultural crops, biomass as fuel, fisheries, forestries, freshwater);
- cultural services (e.g. recreation, aesthetic value of the environment, spiritual values);
- regulation and maintenance services (e.g. climate regulation, soil formation, biological pest control, water purification).

In the Netherlands and the EU there has been copious research on categorizing and quantifying ecosystem services, but relatively little on how these services are affected by emissions, with the exception of carbon emissions, which in this Handbook are treated via abatement costs, however (cf. Section 6.3).[42] For cultural and regulation services there are virtually no useful studies on how these are impacted.

For the provisioning services of ecosystems, in contrast, there is a certain amount of research available, particularly for agricultural crops. NEEDS (2007a), for example, quantifies the impacts of sulphur dioxide and

---

41 The Common International Classification of Ecosystem Services (CICES) system.

42 See for example (Wheeler & Braun, 2013). In this Handbook, climate impacts are treated using abatement costs, with valuation based on the marginal costs of achieving policy targets. This means it is no longer necessary to determine and value the impacts of carbon emissions at endpoint level.

ozone levels on crop yields. The relationships between calcium and acidification and between nitrogen emissions and nutrient requirements have also been studied. By multiplying changes in crop yields by market prices for the crop in question, damage costs can be quantified (see also Annex B). In addition, for certain environmental themes like ozone depletion a relationship has also been established between the emissions causing the environmental problem and the ensuing damage to agricultural crops and forestry (see e.g. (Hayashi, et al., 2006)). However, we know of no research that has systematically quantified the impact of emissions on *all* provisioning services. In addition, impacts on fisheries, for example, are often quantified via the concept of biodiversity (see below).

5.4.2 Biodiversity and its relationship with ecosystem services

Biodiversity can be definied as the variety, number and quality of species, populations and ecosystems, which, apart from their functional significance, also engender ethical and moral considerations. Biodiversity loss leads to loss of ecosystem functions (intrinsic and extrinsic) and loss of ecosystem resilence. People attach value, furthermore, to maintaining the world's rich diversity of natural species and conserving them for future generations.

There is therefore debate as to whether biodiversity should be considered an independent ecosystem service or an indirect contributor to the creation of other ecosystem services. The latter stance appears to be gaining ground (Kuik, et al., 2007). Science for Environment Policy (2015) concludes on the basis of the available literature that, even after 20 years of research, the exact relationship between biodiversity and ecosystem services is still not entirely clear.

Nonetheless, several broad conclusions can be drawn:
- Although biodiversity clearly plays a fundamental role in ecosystem functioning, its exact relationship to ecosystem services cannot be adequately quantified.
- The relationship between biodiversity and the various ecosystem functions is non-linear. Generally speaking, regulation functions benefit from greater biodiversity. Provisioning functions like agriculture and forestry have, on average, the highest yields at relatively low biodiversity, though. In the case of cultural functions, the relationship differs according to the function. In general terms, cultural functions benefit from greater biodiversity, though this does not hold for recreational functions at very high biodiversity levels.
- Regulation and maintenance functions are important in the sense that biodiversity is a precondition for maintaining ecosystem servives. In the longer term, high biodiversity is a precondition for maintaining provisioning functions, for example.
- In all of this there is synergy as well as trade-off among ecosystem services, particularly between provisioning services like crop production and regulation and maintenance services.

Despite the relative paucity of studies on the impacts of emissions on biodiversity, NEEDS (NEEDS, 2008c) and ReCiPe (Goedkoop, et al., 2013) made an attempt at quantification. In ReCiPe it was assumed that species diversity is an adequate proxy for ecosystem functioning and the relationship between emissions and species extinction was quantified. NEEDS, for its part, stated that biodiversity loss leads to loss of ecosystem functions and a deterioration of ecosystem resilience. This is in line with Science for Environment Policy (2015).

There is a certain justification in taking biodiversity as a proxy for the intrinsic and extrinsic value of ecosystems (i.e. nature), given the pivotal role of biodiversity in the quality of ecosystem services. At the same time, though, there may be a negative correlation between biodiversity and agricultural yields, with this arguing for subtracting a figure for crop losses from the value adopted for biodiversity loss. This is the solution adopted in this Handbook, with the welfare impacts of damage to ecosystem services being quantified as biodiversity losses minus crop losses (including forestry and livestock fodder crops, but excluding livestock farming itself and fisheries).

5.4.3 Midpoint-to-endpoint relationships

The following midpoints have an impact on the endpoint 'ecosystems':
- eutrophication;
- acidification;
- smog formation;
- ecotoxicity;
- ozone depletion;
- land use;
- Ionizing radiation*;
- climate change*.

In this Handbook all these impacts have been monetized except for ionizing radiation and climate change. For ionizing radiation no good method could be found for quantifying the impacts of radionuclides on species diversity.
As mentioned above, in this Handbook climate change has been approached via the abatement-cost method, so that no additional distinction can be made between health and ecosystem impacts (cf. Section 6.3. In the case of acidification, ozone depletion and smog formation, impacts on both crop yields and biodiversity have been taken on board in calculating environmental prices. For the other themes, only the impacts on biodiversity have been included here, under the implicit assumption that impacts on crop yields cannot be considered external impacts.[43]

5.4.4 Methodology in the 2010 Handbook

In the 2010 Shadow Prices Handbook the endpoint *damage to ecosystems* was valued only in terms of impacts on biodiversity, with impacts on crop yields quantified on the endpoint 'damage to buildings and materials' and agricultural crops thus considered as 'materials'. There, ecotoxicity impacts were not monetized at all.

In the 2010 Handbook the impacts of emissions on biodiversity were based on NEEDS (2007) for the themes acidification and smog formation, on Hayashi (2006) for ozone depletion and on ReCiPe (Goedkoop, et al., 2009) for the other environmental themes. In line with ReCiPe, biodiversity loss was expressed using a specific indicator: PDF/m^2/yr, where PDF stands for Potentially Disappeared Fraction (of species). This indicator expresses annual species loss in a given area and was used by Goedkoop and Spriensma (PRé, 2000) as one of the first as a metric for biodiversity loss. In ReCiPe (Goedkoop, et al., 2013) a certain reference number of species was established for the various types of land use. If there is land-use change from a type with lower species diversity, biodiversity declines, allowing a 'delta-PDF' to be calculated.

[43] Land use changes may affect crop market prices, for example. We here assume, however, that this is a induced economic effect that is not incorporated in land prices. Land use changes consequently have no external effect.

This delta-PDF approach was also applied in NEEDS (Ott, et al., 2005) for determining the ecosystem impacts of acidification and eutrophication. Complementing this approach, the 2010 Handbook followed (Hayashi, et al., 2006) for direct valuation of crop damage due to ozone-layer depletion.

Box 2 **PDF as a measure of biodiversity**

PDF is an indicator of ecosystem damage that expresses the risk of species extinction as a result of emissions, land-use changes and other deleterious factors. The current assemblage of plant and animal species under a certain land-use regime (Si) is compared with a reference regime (Sref) to give the relative species richness, the inverse of which is PDF:
PDF = 1-Si/Sref
For emissions, PDF : 1 - POO (Probability of Occurance). PDF, the Potentially Damaged Fraction, is the fraction of species that is most probably absent owing to unfavouraable environmental conditions due to acidification, eutrophication and other such factors. A PDF of 0.2 PDF/m^2/year, for example, means a loss of 20% of the species on 1 m^2 of land for 1 year.

In NEEDS (2007a) and the Shadow Prices Handbook, *valuation* of biodiversity impacts was based on Kuik et al. (2008), who carried out a meta-study on the willingness-to-pay for biodiversity found in WTP studies. The meta-study took in international studies that valued various aspects of biodiversity (forest conservation, preservation of ecosystem values, tourism). The value is a proxy for welfare. Kuik et al. (2008) arrive at a value of €$_{2004}$ 0.47 per PDF/m^2/yr. This is an average value for average damage in Europe.

In the 2010 Handbook, damage to agricultural crops was valued in combination with the endpoint 'damage to buildings and materials'. The valuation of crop damage was based on NEEDS. The impacts of SO_2 and ozone were modelled using concentration-response functions. Changes in crop yields due to elevated SO_2 concentrations were calculated for wheat, barley, potatoes, sugarbeet and oats. For ground-level ozone the relative change in yields of rice, tobacco, sugarbeet, potatoes, sunflowers and wheat was calculated. Monetary valuation of crops was based on price per tonne, quantified as an unweighted average of the prices of the above crops.

5.4.5 New developments: valuation and impact quantification

A number of initiatives are underway to value both biodiversity and ecosystem services, such as TEEB and the 'Natural Capital' programme set up by the Dutch Ministry of Economic Affairs. These initiatives aim to quantify the value of biodiversity and ecosystem services to society, so they can be properly accounted for in policy decisions and projects. For the forthcoming SCBA Guidelines for Nature (cf. Section 5.4.8) it is being examined to what extent these initiatives are succeeding in providing a workable handle for quantifying the welfare losses resulting from interventions impacting biodiversity.

TEEB

TEEB (The Economics of Ecosystems and Biodiversity) is a global initiative to put a robust figure on the value of nature. Under this umbrella a variety of studies have been published in recent years that value ecosystem services like timber harvesting, fisheries, recreation and so on. Additional research has also been carried out on valuation of nature as 'natural capital' in the Dutch government programme 'Natural Capital Netherlands' (PBL, 2015). Under this programme the Ministry of Economic Affairs has commissioned research on the economic and social value of nature in the Netherlands.[44] These studies have, to our knowledge, yielded no basis for establishing a relationship between emissions and a physical indicator of ecosystems.

European initiatives

In the framework of the European Biodiversity Strategy a considerable amount of work has been done on developing biodiversity indicators and inventorying and categorizing ecosystem services. Studies include MAES (Mapping and Assessment or Ecosystem Services) and SEBI (Streamlining European Biodiversity Indicators). These types of initiatives are yielding a huge amount of data that may be relevant in the future for updating current indicators (species numbers). These projects are concerned more with assessing the current status of biodiversity in the EU, however, and once again provide no basis for linking emissions to biodiversity and ecosystem services. The results are therefore of no direct use for developing environmental prices.

5.4.6 New insights: characterization

Pollutant characterizion reflects the relationship of one pollutant relative to another in terms of ecosystem impacts. Besides ReCiPe, the International Reference Life Cycle Data System (ILCD) Handbook has been developed by the Institute for Environment and Sustainability at the EU Joint Research Centre (JRC). ILCD is an analysis of best practices dating from 2009 and has been used to elaborate the Product Environmental Footprint (PEF) and Organization Environmental Footprint (OEF). The ILCD method measures changes in land use in terms of kg C-deficit, the degree to which the soil contains and retains carbon. The method makes no allowance for species diversity, nor does it link impacts to biodiversity, so does not enable midpoint-to-endpoint translation. ILCD is therefore less suitable for assigning a value to land use. In other repects the method is in line with ReCiPe.

For ozone layer depletion and freshwater and marine eutrophication, the PROSUITE project[45] recommends the ReCiPe approach (Ecofys, 2014). This project itself uses PDFs for valuing the endpoint 'natural environment' using the ReCiPe characterization factors.

One limitation of using characterization factors as a basis for valuation, as in the PROSUITE project, is that these factors represent typical, European-average relationships for the relative damage of pollutants.

5.4.7 New insights: PDF valuation

In the 2010 Shadow Prices Handbook the value adopted for biodiversity was the average value of an EDP[46] per m^2 per annum of €$_{2004}$ 0.4706, based on Kuik et al. (2008). This value is the average value from a meta-analysis encompassing a number of European countries. The median value in this study is €$_{2004}$ 0.0604, a factor 8 lower. This implies that the overall distribution of values comprises relatively many high values (Kuik, et al., 2008). In a study on

[44] Of the seven studies four have now been completed. One example is a report on the Dutch overseas territory Bonaire in which all ecosystem functions have been valued to yield a 'Total Economic Value' using various methods, including surveys, WTP and avoided damage costs (IVM, 2013).

[45] PROspective SUstainability assessment of TEchnologies, a large-scale EU FP 7 project (2009-2013) aimed at developing methods to determine the lifecycle social, economic and environmental impacts of technologies.

[46] Ecosystem Damage Potential, which is a slightly different measure, but (Kuik, et al., 2008) state that for all practical applications EDP and PDF can be considered identical.

the external costs of energy production, Ecofys (2014) takes Kuik's median value rather than the average. Generally speaking, in meta-analyses more value is attached to the median than to the average. An earlier study by NEEDS (2006) arrived at a minimum PDF-value of € 0.45/€ 0.49 per PDF/m². This means an annual cost of around € 0.017 per PDF/m²/yr using a 3% discount rate and a lifetime of 50 years.[47] NEEDS (2006) use the restoration-cost appr.The Éclaire project (Holland, 2014); (IIASA, 2014) investigated the economic value of air pollution impacts on ecosystem services, with biodiversity valued using WTP (as with Kuik), restoration costs (as with NEEDS) and revealed preferences (costs of legislation). This project indicates that WTP-based values are conceptually the most robust, but that data availability may be a problem. In that case, use can be made of restoration costs. Restoration costs can also be used to validate WTP-values. Holland (2014); IIASA (2014) report that restoration costs represent a minimum value for biodiversity, because even after recovery genetic information may still be lost, for example. Rabl (1999) raises the value of NEEDS (2006) by a factor 2 to capture the true damage. Brink and Grinsven (2011) work with a range, multiplying the value of NEEDS (2006) by an (arbitrary) factor 5 to obtain an upper bound and taking the value of NEEDS (2006) as a lower bound.
This approach was also adopted by Grinsven et al. (2013). Holland (2014); IIASA (2014), state that restoration costs represent the best possible estimate.

5.4.8 Choices in this Handbook

Dose-effect relationships

In this Handbook, relationships between emissions and impacts on PDF have been calculated in the same way as in the 2010 Shadow Prices Handbook.
For NO_x, SO_2 and NH_3 these were determined on the basis of NEEDS (2008a). For ozone depletion we based ourselves on Hayashi et al. (2006) and for other midpoints (eutrophication, ecotoxicity) on ReCiPe. More detail on midpoint valuation is provided in Chapter 6.

Valuation

As an upper value we use the European-average estimate reported in Kuik et al. (2008). This yields an estimated average value of € 0.47/PDF/m²/yr for the EU28 in 2004 prices. As the central value we use the median value calculated by Kuik et al.(2008). This value is equal to € 0.06/PDF/m²/yr in 2004 prices. The lower value will be based on the restoration costs by Ott and equal € 0.017/PDF/m²/yr.

In addition, we have adjusted our values as follows:
- Translation to 2015 prices.
- Annual inflation has been taken as 1%, in line with the recommendations of the Discount Rate Working Group for 'irreplaceable' nature. PBL (2018) has investigated which nature counts as such and to what extent this should then be incorporated in SCBAs using a lower inflation figure and concludes that SCBA would best be performed assuming an annual increase in the real price of impacts on nature of 1%.[48]

---

47 In the Shadow Prices Handbook it was reported that the average value of NEEDS (2006) was € 0.45, which is an EU-average. In NEEDS (2006) it is stated that minimum restoration costs in Germany are € 0.49/PDF/m². The figure of € 0.45 is a conversion from the German price level (using purchasing power parities) to an average European price level.

48 Irreversibility does not play a big role according to PBL as: " it appears that on the basis of historical data a relative price increase of 1% is defensible for a large share of ecosystem services, even though they are all substitutable to some degree". This is primarily because

As in the 2010 Shadow Prices Handbook, no positive income elasticity has been assumed for biodiversity. If deemed necessary, this assumption can be discussed under the umbrella of the SCBA Guidelines for Nature that are currently being drawn up.

From the above, the values reported in Table 18 emerge.

Table 18 Valuation of PDF/m²/yr (€)

	€2004	€2015*
Upper value	€ 0.471	€ 0.649
Central value	€ 0.060	€ 0.083
Lower value	€ 0.017	€ 0.024

* 2015 prices including 1% annual real price increase.

The upper and lower values provide upper and lower bounds for valuing the impacts of emissions on biodiversity and can be used in SCBAs. The central value is the recommended value for use by industry and has also been used for arriving at a characterization factor.

Addition of crop damage

Damage to agricultural crops has been added to the valuation of ecosystems. For the valuation itself the same method was employed as in the 2010 Handbook, adjusting prices to present-day levels in the markets concerned.

New prices have been based on average European producer prices for the EU28 as reported by FAO (see Table 19). Prices in USD_{2014} were converted to EUR_{2014} using the average 2014 exchange rate and then converted to EUR_{2015} using the general Harmonized Index of Consumer Prices (HICP). These prices were then weighted by consumption of the crop concerned to determine the average price rise between 2000 and 2015. Finally, 18% VAT was added.

Table 19 Average EU producer crop prices (€/t crop yield, excl. VAT)

	2000 Prices	Source	2015 Prices	Source
Sunflower	273	FAOSTAT € (2001)	335	FAOSTAT (€2015)
Wheat	137	IFS € (2003)	179	FAOSTAT (€2015)
Potato	113	FAOSTAT € (2001)	214	FAOSTAT (€2015)
Rice	200	IFS € (2003)	305	FAOSTAT (€2015)
Rye	99	FAOSTAT € (2001)	142	FAOSTAT (€2015)
Oats	132	FAOSTAT € (2001)	145	FAOSTAT (€2015)
Tobacco	2,895	IFS € (2003)	3,508	FAOSTAT (€2015)
Barley	93	IFS € (2003)	153	FAOSTAT (€2015)
Sugarbeet	64	FAO € (2002)	34	FAOSTAT (€2015)

nature grows slower than consumption and thus becomes more scarce over time: however the substitutability of nature implies that the income elasticity is not equal to 1.

5.5 Valuation of buildings and materials

5.5.1 Description of endpoint

Pollution can affect the quality of man-made capital goods, leading to higher maintenance costs. Acidification, for example, leads to accelerated erosion of calcareous building materials (gypsum, cement and concrete)[49], iron and steel (reinforced concrete) and zinc gutters (VMM, 2013a). This shortens the useful life of these materials and means additional maintenance costs, as well as potentially causing permanent damage to historic buildings, monuments and suchlike (Watt et al., 2009). Another example is particulate matter soiling windows and causing visual damage to buildings, and thus giving rise to welfare losses. Because of the catalytic action of the soot particles, this pollution also accelerates the erosion of building surfaces.

Aacidification and ozone pollution (photochemical oxidant formation) also corrode rubber and paint, again pushing up maintenance costs. Discharges of toxic and corrosive materials also impact surface waters and sewers, burdening operators of water-treatment and sewage plants with extra costs.

Damage to buildings, materials and machinery is usually modest compared with impacts on other endpoints and has been given relatively little attention by researchers. Although these costs are cited in several comparative valuation studies, it is as a 'memorandum item' (see for example (AEA, 2005)). In the 2010 Shadow Prices Handbook the damage costs of these pollutants were partially monetized, but combined with damage to agricultural crops. Because crop damage is now included with damage to ecosystem services, in this Handbook we sought to make a dedicated estimate of air-pollution damage to buildings and materials, which indeed proved feasible.
For emissions to water this was not the case, though.

5.5.2 Midpoint-to-endpoint relationships

Damage to buildings and materials is caused primarily by air and water pollution on the following midpoints:

- acidification;
- particulate matter formation;
- photochemical oxidant formation.

The other midpoints have no direct impacts on this endpoint.

5.5.3 Methodology in the 2010 Handbook

In the Shadow Prices Handbook these impacts were taken together with impacts on agricultural crops, in line with NEEDS. Only the impacts of acidifying emissions were quantified, with no damage costs included for photochemical oxidant or PM formation. For SO_2, which impacts mainly on buildings (and scarcely crops), a damage figure of € 0.43 per kilogram was taken, for example, based on NEEDS. This is approximately 3% of the total damage of SO_2 on all endpoints (including health and biodiversity). The values in the 2010 Handbook were discounted at 3% p.a. and expressed in 2008 prices. In line with treatment in Watkiss, et al. (2006), damage to buildings was not scaled up with a positive income elasticity, there being no empirical basis for such a step. This issue was examined by Rabl (1999), who in France found no correlation between damage costs and income.

[49] Cement and concrete react with atmospheric carbon dioxide to form calcium carbonate, which is then washed out by acidifying emissions. This calcium carbonate and atmospheric NO_x also react with cement to form calcium nitrate, which is rapidly flushed out.

5.5.4 New findings

A number of case studies have been published in which air-pollution impacts on a specific object or region have been calculated and monetized (see for example (Watt, et al., 2009). Since completion of the NEEDS project, however, no new estimate has been published of damages per kg emission. In an estimate of external costs in Switzerland (Ecoplan and INFRAS, 2014) air-pollution damage to buildings due to traffic was estimated to be about 20% of damage to human health. This is far more than the contribution estimated in NEEDS, which came to a maximum of 2% relative to health damage for the EU27. This can be explained partly by the fact that traffic emissions occur at a lower level, making them more damaging to buildings than emissions at *average* height. Another reason is that in NEEDS only one kind of damage was monetized: acidification impacts on normal, 'utilitarian' buildings.

For this Handbook we have therefore sought to calculate a more comprehensive estimate of external costs, particularly for the upper value. Watkiss, et al. (2006) distinguishes four cost categories associated with this form of damage:

1. Damage due to acid corrosion of metals, paint and stone in utilitarian buildings.
2. Damage due to acid corrosion of calcareous building stone in historic buildings.
3. Damage to paint and rubber due to ground-level ozone.
4. Damage to buildings due to particulate pollution.

In addition, damage due to reduced visibility is sometimes also distinguished (Watkiss, et al., 2001). Although there are a number of American studies allocating such costs to PM_{10} (notably in cities located in valleys), this is not frequently encountered in Europe and is very location specific. Therefore there has been no attempt to quantify this impact here. Cost estimates in the literature (Rabl., 1999); (Holland, et al., 1998); (Bal, et al., 2002); (Watkiss, et al., 2006); (VMM, 2013b) for damage per unit emission are generally based on additional expenditure on building maintenance. While PM pollution is eminently suitable as an issue for CVM studies on the visual 'nuisance' of soot-soiled buildings, in practice such studies are few and far between (cf. (Rabl., 1999)). Using restoration costs is a less accurate measure, because, as also argued in Chapter 2:

1. For impacts on buildings, valuation on the basis of restoration costs may potentially lead to overestimation, as it is not always economically optimal to repair all damage (see also Chapter 2).
2. If valuation based on restoration costs proceeds from real-world expenditure on building repair by property-owners, this objection is removed, as we then have a 'revealed preference'. This is the route adopted by Rabl (1999), among others. For rented buidings this leads to an underestimate, though, as scarcity and regulations mean this market segment is not entirely efficient. Here, the party renting a soot-soiled building may suffer a loss of welfare but see the landlord unwilling to clean it as he can still rent it for the set price. Without providing any supporting evidence, Rabl (1999) states that expenditure on restoration costs amounts to approximately half the total loss of welfare.
3. Finally, not all damage can be restored: besides the damage there is thus also potentially loss of value in monuments and other objects of cultural heritage. According to VMM (2013b), case studies show that aesthetic

impacts on such objects are of the same order of magnitude as restoration costs.[50]

An extra complication is mentioned in Watkiss, et al. (2006) and VMM (2013b), where the point is raised that in determining damage to specific cultural heritage national averages may not simply be taken. This is because the various types of traditional materials used in such objects vary very widely when it comes to air-pollution impacts. Limestone is far more sensitive to damage by acid deposition than brick, for example. This means a study on one particular region or country cannot just be applied to another. For this reason, Watkiss, et al. (2006) proposes not quantifying this impact. At the same time, though, the impacts of acid emissions on concrete, brick and cement are far more uniform, making rough estimates of damage to these materials feasible.

5.5.5 Choices in this Handbook

For this Handbook we have worked with a range: the low/central estimate includes the damages that are certain, the high estimate those that are uncertain, too. Because for the impacts on buildings and materials we found more evidence for the low estimate being correct, in this Handbook we have also taken this as a central value.

The following four cost categories have been adopted here:

1. **Corrosion due to acidification.** As in the 2010 Shadow Prices Handbook, the corrosive impacts of acidifying emissions on metals, building stone and paint are based on NEEDS (2008a). NEEDS itself derives its prices from maintenance costs per square metre for a number of different materials. These prices have not been adjusted to the slightly higher density of buildings in 2015 compared with 2000, because we assume this has been offset by use of less corrosion-sensitive materials in buildings (including renovations).
2. **Particulate pollution.** The impacts of particulate pollution are based on Defra (2016), who in turn derive their calculations from Rabl (1999), who analysed expenditure on restoration of pollution-soiled buildings in fifteen French cities. Applying a regression analysis, Rabl estimated damage costs, defined a CRF-function and calculated damage costs as € 0.21/kg PM_{13} in 1998 prices. This value has been taken as the basis for EU restoration costs, correcting for population density and inflation and the fact that Rabl took PM_{13} rather than PM_{10}. This results in an estimate of € 0.3 for 1 kg PM_{10} in the EU28.[51] It should be noted, though, that this value holds only for primary particles, because this is the fraction containing soot. For secondary particulates, eventual damage has been set at zero.[52] Given a ratio of 1/2 for $PM_{2.5}/PM_{10}$, this means the value for $PM_{2.5}$ is € 0.15/kg $PM_{2.5}$.
3. **Corrosion impacts on cultural heritage.** In line with the British and Belgian handbooks, impacts on cultural heritage have not been valued using a central value, as the uncertainties are too great. VMM (2013b) states that these are about the same as the restoration costs under category (1). For Paris, Rabl (1999) calculates these to be 62% of the

[50] Since no references are given for the case studies, this statement is hard to verify.

[51] The damage function in Rabl (1999) is: {E*4.14 FF/(person·year·mg/m³) x 1.05 x D} /K, where E = emission in kg/jaar, FF = French Franc, D = population density in 10^{-4} capita/m² and K = deposition velocity, set at 0.01 m/s. Assuming a linear CRF-function, this yields a damage estimate of 31.7 mg/s for France.

[52] As acidifying pollutants like SO_2, NO_x and NH_3 also have an impact on PM_{10}, the impact of these emissions has been deducted from the total damage costs of PM_{10}.

combined restoration costs under (2) and (3). This is in line with the approach adopted in VMM (2013b). We have therefore taken this as the upper damage value.

4. **Impacts on paint and plastics.** For the costs of damage to paint and plastics due to ozone, we adopted the values reported in Watkiss, et al. (2006), who state that paint damage is unlikely have any major impact as average ozone concentrations are generally too low. According to Watkiss, et al., evidence of such impacts dervies mainly from US studies carried out in the late '60s. For damage to rubber materials empirical evidence does exist, though.
   For the UK a central value of £ 85 million/yr has been estimated, with a range from £ 35 million to 189 million (1997 data). If this is compared with total 1997 UK emissions — 2,032 kt — this is a modest sum.[53] Since then there has been a further decline in the use of natural rubber, moreover, which has been largely superseded by synthetic materials. Given these facts, we opted for a central value of zero on this impact. For the upper value we took the CRF-function from the literature underpinning Watkiss, et al. (2006), giving a damage figure of € 0.1/kg NMVOC.

It can still be queried to what extent (2) overlaps with (1) and (4), since the study used for (2) is based on outlay on restoration costs and as the other emissions also generate restoration costs there may potentially be double-counting. Rabl (1999) carried out a regression analyses to assess whether expenditure on restoration costs correlates with atmospheric SO_2 levels, too, and found this variable to be insignificant. His conclusion was therefore that restoration costs in France were due primarily to particulate pollution rather than acidification. He nonetheless hesitates to make an unequivocal call on the issue. VMM (2013b), too, states that including both categories may potentially lead to double-counting, given one-off decisions on repair and the fact that the associated costs cannot be allocated linearly to acidification or PM formation. In light of these uncertainties, we have opted to exclude Rabi's data from the central, low estimate, on the assumption that these costs do not come on top of costs in the other categories. In the high estimate, though, these costs have been included.

5.5.6 Values adopted in this Handbook

Table 20 reports the values for emissions in Euro per kg in 2015 prices for emissions in 2016.

Table 20 Values of emissions with impacts on buildings and materials (€$_{2015}$ per kg emission)

Midpoint	Indicator used	Lower value (= central value)	Upper value
Particulate matter formation	kg PM_{10}-eq.	0	€ 0.8
Acidification	kg SO_2-eq.	€ 0.6	€ 1.2
Photochemical oxidant formation	Kg NMVOC-eq.	€ 0	€ 0.1

Based on the literature used, we recommend taking these values as constant, even if emissions decrease in the future, because most background studies assumed a linear relationship between emissions and damage with respect to this endpoint and, given the empirical evidence, this also seems most plausible.

53 Under the two simplest assumptions of a linear relationship between emission, concentration and damage and no international transport of ozone-forming pollutants, the damage would thus be about 5 €ct per kg NMVOC.

5.6 Valuation of resource availability

Security-of-supply of mineral resources is generally seen as being of major value to society. Over 50 years ago Barnett and Morse (1963) already reported that this issue had been garnering the interest of US politicians and researchers since the late 19th century. Since then that interest has certainly not declined, as evidenced by innumerable reports, from the Club of Rome's 'Limits to Growth' (Meadows, et al., 1972), through to contemporary EC policy documents on 'sustainable use of natural resources' (EC, 2005); (EEA, 2005), 'critical materials' (EC, 2011) and the 'circular economy' (EC, 2014a).
In these and similar policy publications the importance of mineral resources — particularly resources dubbed 'crucial', 'critical' or 'priority' — is generally introduced by noting their pivotal importance for our prosperity, followed by a statement that most of our resources are currently imported from abroad. In recent years reference is then geneally made to China, which today is pursuing an expansive investment policy, mainly in poor African countries, with a view to securing resource stocks. In EU member states, policies of this kind are largely lacking (see e.g. HCSS et al., 2011).

However this may be, the question of relevance here is whether, besides resource extraction, resource *consumption* also has an external impact which might be taken on board in a SCBA or which, for an industry, might be included in calculating its own social value. The idea is then that by reducing resource consumption (including water and energy) aggregate savings accrue to society that exceed the price of the unconsumed resources. But is this the case? Can an economic perspective be developed in which resource consumption induces external costs?

It should be noted that in LCA studies this issue is not deemed relevant. Depletion of abiotic resources has long been included in LCAs as a relevant endpoint of environment interventions (PRé, 2000). What we are concerned with here, though, is the risk of leaving future generations without resources. Given the importance of the 'precautionary principe' and 'stewardship' in the LCA perspective, there is logic in putting a value on this forgotten item.
In ReCiPe (Goedkoop, et al., 2013) impacts on this endpoint are quantified under the assumption that current consumption will eventually lead to higher extraction costs. For a tonne of iron ore, to take an example, this leads to additional costs that are roughly equal to the price of the ore itself. From an economic perspective these extra costs can be regarded as pecuniary externalities.[54]

5.6.1 Methodology in the 2010 Handbook

In the 2010 Shadow Prices Handbook the position was adopted that resource scarcity need not, *in itself*, induce external costs. From a traditional economic perspective resource depletion is not deemed a real or technical externality, merely a financial one.[55] If resource extraction and resource price are in accordance with Hotelling's rule, then the social value of avoiding depletion of non-renewable resources is, by definition, included in the resource price.

[54] The reason for including abiotic resources here is the importance of this theme for recycling issues, which are under the gambit of environment ministeries.

[55] Financial externalities are determined by prices and in the context of the General SCBA Guidelines (CPB; PBL, 2013) are definied as indirect impacts with no effect on welfare. If person A buys a lot of cheese, for example, the cheese price rises, which is bad for person B who also wants cheese. This is part and parcel of an efficient market, though, and is not therefore seen as an externality affecting welfare. Financial externalities do not affect market efficiency, but do influence welfare distribution.

Only if it can be convincingly argued that markets are not operating efficiently can an external cost be assigned to resource consumption — if parties are operating with erroneous information, say, or if heavily polluting extraction generates external costs that are not included in prices (CE Delft, 2010).

In the 2010 Handbook the issue was also raised that in the literature there appears to be excessive focus on the importance of resources for human wellbeing. If revenues from resource extraction are invested in activities that generate more welfare than the resources themselves, even suboptimal extraction boosts welfare. In addition, besides a pronounced cyclical component, long-term price trends of most resources tend to fall, in real terms (Simon, 1981). Innovations with respect to extraction, use and/or recycling reduce demand and increase supply, which means cyclical price rises virtually always causes prices to fall in the longer term (Bruyn, 2000).
A decrease in price is a sign of declining, not growing scarcity.

5.6.2 New research for this Handbook

As part of the research for this Handbook, it was reappraised whether or not resource scarcity gives rise to external impacts with implications for welfare. To that end, the following four issues were examined more closely:

1. Is the assumption valid that resource markets operate efficiently, in an intertemporal sense? This was elaborated by quantifying the social cost of rent-seeking behaviour using Hotelling's rule.
2. Does security of supply come with external costs? This was examined by considering actual expenditure on maintaining strategic oil reserves.
3. Do environmental impacts in the extraction phase have external costs not passed on in resource prices? These costs can be quantified using LCA methods.
4. Can a WTP-value be derived from the 'precautionary principle' or the notion of 'stewardship'? This leads to a recommendation for further study, as consumers cannot simply be assumed to translate moral values into a 'willingness-to-pay'.

Our research on these issues is described at length in an annex of the Dutch version of this Handbook. It emerges from the discussion there that, while it is certainly possible to estimate external costs for these impacts, the resultant figures are very uncertain.

5.6.3 Choices in this Handbook

As our research in the Annex G of the Dutch version of this handbook shows, it proves difficult to put a robust value on resource scarcity. In this Handbook we therefore recommend that further research be conducted on this important issue. Hotelling's rule does not provide a solid enough basis for calculating an interim value, as unambiguous empirical data on which to base such calculations is lacking. In addition, Hotelling's extraction model provides a very simplified picture of reality.

A lower bound would appear to be given by the economic damage associated with resource price volatility. The abatement-cost and damage-cost approaches both yield very low values, with additional costs amounting to less than 1% of the resource's market value.

The upper bound is more uncertain. For setting an absolute upper value, consideration might be given to adopting the method used in ReCiPe. It seems probable, though, that the upper bound is very much lower than the value reported there. Without additonal study, no precise conclusions can be drawn.

5.7 Valuation of wellbeing

Environmental interventions can also cause nuisance by affecting people's general wellbeing, by disturbing their peace and quiet, spoiling valued views, affecting the smell of the countryside, or degrading other aesthetic or spiritual values. In many cases there is no directly observable relationship between emissions and this endpoint. Nor, indeed, is this type of nuisance often included in LCA calculations. For these reasons these issues cannot be quantified as a unique endpoint in this Handbook, but are instead grouped together under the theme 'wellbeing'.

Here, two categories of nuisance are valued:
- noise nuisance;
- visual nuisance.

5.7.1 Noise nuisance

Ambient noise is a major environmental problem that has a variety of deleterious impacts on human wellbeing and health, as well as on nature. As traffic noise is far and away the main source, most studies concerned with valuing noise nuisance have focused on the transport sector (Navrud, 2002). Studies on the valuation of noise from other sources like industry and neighbours are scarce, though several studies have investigated the noise nuisance of wind turbines (see below).

There is growing evidence that noise can have a range of adverse effects on human health, with WHO (2011) distinguishing the following: cardiovascular disease, disturbed sleep patterns, reduced cognitive performance and various hearing problems. In addition, noise can therefore also lead to productivity losses. All these impacts have already been included under the theme 'human health', however.

Even if noise does not cause health impacts or productivity losses, though, it can still be experienced as irritating or annoying, when one is enjoying a summer's day in the garden, for instance. This is the kind of nuisance that is captured in the endpoint 'wellbeing'.

In addition, noise also has impacts on ecosystem services, by disturbing quiet areas, for instance, thus reducing the recreational value of parks and nature and possibly even impacting the ecosystems themselves. There has been very little research on these last two impacts, however, and they are not generally included in analyses.

In this section we consider how nuisance is to be valued. First, we briefly discuss the three methods generally used for this purpose, going on to examine the environmental prices they yield. Finally, we present our own conclusions on valuing noise nuisance with respect to wellbeing.

Valuation methods

Three basic methodologies can be distinguished for valuing nuisance due to ambient noise:
- **Stated preference (SP) methods**, in which people are asked, via surveys or experiments, to state their WTP for noise reduction. This method leads directly to a WTP per dB per person (or household). SP methods have the advantage of allowing the researcher to control for all external factors and thus isolate the value of noise nuisance. One challenge, though, is to define 'nuisance' in such a way that the respondent understands it in the

same way as the researcher. In addition, respondents may answer questions strategically.

- **Revealed preference (RP) methods**, in which the value assigned to noise nuisance is derived from actually observed market impacts. By far the most frequently used RP method for valuing the impacts of noise is hedonic pricing, deriving the WTP for noise reduction from variation in house prices. The great advantage of RP methods is that valuation is based on people's actual behaviour (Andersson, et al., 2013). On the other hand, though, it is difficult to isolate the impact of noise on house prices (methodologically, confounding variables, etc.).
- **Environmental Burden of Disease (EBD)**: in recent years there have been several studies valuing noise nuisance using DALYs (Bruitparif; ORS Ile-de-France; WHO, 2011); (Defra, 2014); (WHO, 2011). In the broad definition of health adopted by the WHO (*"a state of complete physical, mental and social well-being and not merely the abscence of disease or infirmity"*, WHO, 2011) nuisance can be deemed a health impact and can therefore be expressed in DALYs. The advantage of this method is that the risk of double-counting with certain other health impacts (e.g. disturbed sleep) can be avoided, since the number of DALYs can be determined for each 'health endpoint' individually. The greatest drawback of this method is the major uncertainty surrounding the 'disability weight factor' to be adopted. Because nuisance is a less clear-cut health effect, it is hard for experts to assign an appropritate factor. In addition, there is as yet little literature on this issue. The range of values proposed by WHO (WHO, 2011) for the disability weight factor is consequently fairly broad: 0.01 to 0.12, with 0.02 as a central value.

In the literature there is no clear agreement as to which of the three methods is preferable (Andersson, et al., 2013). Here, we therefore take a closer look at the literature on all three methods.[56]

Results of SP studies

In the 2010 Shadow Prices Handbook the damage costs from HEATCO (HEATCO, 2006) were recommended for valuing noise. In that study a review of (six) SP studies published by Navrud (Navrud, 2002) was adopted as the basis for valuation of noise nuisance. The latter study arrives at a range from € 2 to 32 per dB per household per annum (in 2001 prices). Based on this result, the EU Working Group on Health and Socio-Economic Aspects (2003) recommended using a shadow price for noise nuisance of € 25 per dB per household. This value was adopted by HEATCO and converted to national values. Corrected for inflation and average household size, for the Netherlands this gives a (constant) value of € 16 per dB per person per annum for road and rail noise and € 25 for aviation noise (in 2015 prices). The higher price for aviation noise reflects the fact that people experience aircraft noise as 'worse' than road-traffic noise (see e.g. (Miedema & Oudshoorn, 2001)). For rail traffic, HEATCO (2006) applied a 'rail bonus' of 5 dB (a threshold of 55 dB rather than 50 dB), because rail noise is experienced as less of a nuisance than road-traffic noise.

Since HEATCO, 2006/Navrud, 2002, one extenstive meta-analysis of SP studies in this field has been published, by Bristow et al. (2015). For higher noise levels, in particular, this new study reports higher values than HEATCO (2006). In contrast to HEATCO (2006), which uses a constant value per

56 A more elaborated treatment of this can be found in Annex F of the Dutch version of this handbook.

dB, Bristow et al. (2015) work with a value for noise nuisance that rises with noise levels. This rising value is in line with the valuation applied in other European countries (see Table 21; the decibel units are explained in Section 6.11.3).

Table 21 Results of SP studies (€2015 per person per dB(L_{den}))[a]

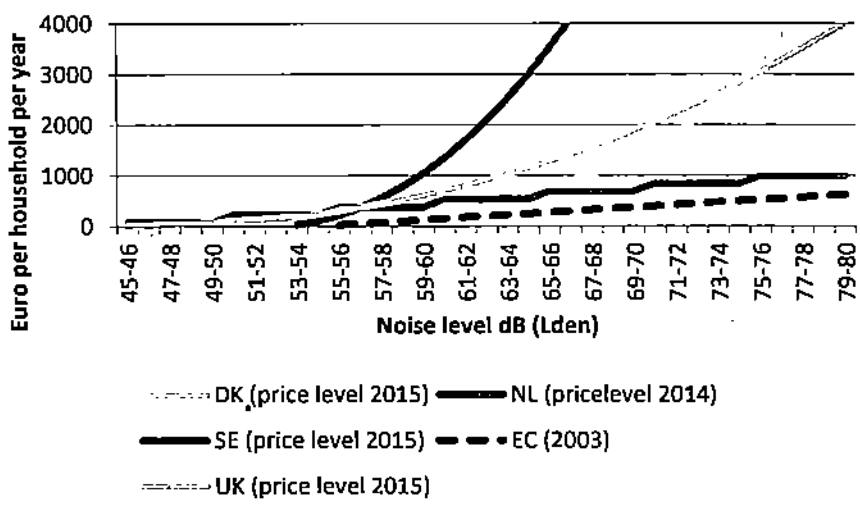
	< 55 dB	55 - 64 dB	> 65 dB
Road traffic			
HEATCO (2006)/Navrud (2002)[c]	16	16	16
Bristow et al. (2015)[b] *Value NL*	22 (18-25)	43 (36-50)	82 (69-95)
Bristow et al. (2015) *Value EU28*	17 (14-20)	34 (28-39)	64 (54-75)
Rail traffic			
HEATCO (2006)/Navrud (2002)[c]	0	16	16
Aviation			
HEATCO (2006)/Navrud (2002)[c]	25	25	25
Bristow et al. (2015) *Value NL*	52 (43-60)	103 (86-119)	196 (164-227)
Bristow et al. (2015) *Value EU28*	40 (34-47)	80 (68-93)	153 (129-178)

a In converting household values to values per person an average EU household size of 2.3 persons was assumed for 2015 (EU SILC survey).

b The range in environmental prices presented by Bristow et al. (2015) depends on how consumer surplus is measured: the lower bound is based on WTP-values for a loss (higher noise level), the upper bound on WTA-values for a gain (lower noise level). The central value is the average of the two.

c The value for the Netherlands is taken here as reference value

Figure 11 Valuation of nuisance due to road-traffic noise as a function of noise levels in various EU countries (€ per household per annum)



Source: CEDR, Technical report 2017-03. State of the art in managing road traffic noise: cost-benefit analysis and cost-effectiveness analysis, January 2017.

As in HEATCO (2006); Bristow et al. (2015) assign a significantly higher value to aircraft noise than to road-traffic noise. In contrast to the acoustic literature, however, no evidence is found for a lower value for rail noise relative to road-traffic noise.

Results of RP studies

Table 22 provides a synopsis of the values assigned to noise nuisance in various studies based on hedonic pricing. The results are reported here in terms of a Noise Sensitivity Depreciation Index (NSDI), which gives the average percentage decline in house prices for a 1 dB increase in noise. An NSDI of 0.55 therefore means that house prices fall on average by 0.55% for every decibel increase in noise.

Table 22 Results of hedonic pricing studies

Study	Noise Sensitivity Depreciation Index (NSDI)
Road traffic	
Dekkers & Van der Straaten (2008)	0.16
Theebe (2004)	0.0-0.5
Udo et al. (2006)	1.7 (1.1-1.9)
Anderson et al. (2010; 2013)	1.15-2.19
Bateman et al. (2001)	0.55 (0.08-2.22)
Day et al. (2007)	0.18-0.55
Navrud (2002)	0.08-2.22
Nelson (2008)	0,4-0,6
SAEFL (2003)	0.6-1.2
Nellthrop et al. (2007)	0.20-1.07
Rail traffic	
Dekkers & Van der Straaten (2008)	0.67
Theebe (2004)	0.0-0.5
Udo et al. (2006)	1.7 (1.1-1.9)
Anderson et al. (2010; 2013)	0.08-1.03
Day et al. (2007)	0.67
Aviation	
Dekkers & Van der Straaten (2008)	0.77
Lijesen et al. (2010)	0.8
Theebe (2004)	0.0-0.5
Getzner & Zak (2012)	0.85 (0.5-1.3)
Nelson (2008)	0.7-0.9

The NSDI varies from 0.08 to 2.22[57], with both Bateman (Bateman, et al., 2002) and Navrud (2002) reporting that the average NSDI is probably towards the lower end of this range (0.55). This is in line with the latest studies. There is also no evidence that the studies on the Netherlands (Dekkers & Van der Straaten, 2008); (Lijesen, et al., 2010); (Theebe, 2004); (Udo, et al., 2006) yield significantly higher or lower values than the international studies.

For a comparison with the values derived from the SP studies, we took an illustrative test case to determine the value (per person). This yielded an NSDI of 0.55. Based on an average house price of € 230,000, an average household of 2.2 persons, a 5% p.a. discount rate and a 10-year discount period, this NSDI corresponds with a WTP of approximately € 75 per person per dB per annum. This value is in relatively close agreement with the values reported by Bristow et al. for higher noise levels.

57 The relatively large differences in estimated NSDI can be (partly) explained by methodological differences among the studies (e.g. the functional form employed), the various methods used for controlling for confounding variables (e.g. air quality), or differences in preferences among those in the cohorts investigated (Blanco & Flindell, 2011).

Many of the RP studies cited in Table 22 assume a linear relationship between noise level and NSDI. There is a paucity of literature on the possibility of this being non-linear (Blanco & Flindell, 2011). Two Dutch studies (Udo, et al., 2006); (Theebe, 2004) have done so explicitly, however, and both conclude that the value increases with rising noise levels. Theebe (2004) only finds this effect at noise levels over 65 dB(A), while Udo et al. (2006) observe it over the entire range.

Finally, the results shown in Table 23 also support the acoustic literature (e.g. (Miedema & Oudshoorn, 2001)) in which people experience aircraft noise as 'worse' than road-traffic noise.

On the comparison between road-traffic and railway noise there is less agreement. The results of Andersson et al. (2010; 2013) indicate people put a higher price on the former, which is in line with the acoustic literature. Day et al. (2007) and Dekkers and Van der Straaten (2008), in contrast, report higher NSDI-values for rail than road, with Day et al. positing that this might be explained by the small number of observations for rail, rendering the results for this category less reliable.

Results of EBD studies
In recent years a number of studies have been carried out that seek to put a price on noise nuisance by estimating how many DALYs correspond with the noise nuisance experienced (e.g. (Bruitparif; ORS Ile-de-France; WHO, 2011); (Defra, 2014)). In doing so, these studies base themselves on the WHO recommendations (WHO, 2011). We converted the results of Defra (2014) to EU28 values; see Table 23.

Table 23 Results of EBD studies (€$_{2015}$ per person per dB (L_{den}))

	< 55 dB	55-64 dB	> 65 dB
Road traffic	10	17	34
Rail traffic	5	12	32
Aviation	18	32	47

Comparison of these results shows that the Defra (2014) values are considerably lower than those of Bristow et al. (2015) as reported in Table 21. This is due (partly) to the EBD method adopting a conservative approach in which only the most serious kinds of nuisance ('highly annoyed') are included. WHO (2011) provides no disability weight factor that can be applied to cases with less nuisance, moreover, making it impossible to correct the estimates on this point.

Like Bristow et al. (2015) and some of the RP studies, Defra (2014) states that the value to be assigned to noise nuisance increases with noise levels. Also, the differences found in the value of noise from the various types of transport are in line with the acoustic literature.

Conclusion
Based on the above analysis, for the EU28 we recommend using the environmental prices found by Bristow et al. (2015). Compared with the prices recommended in the 2010 Shadow Prices Handbook (which were based on HEATCO, 2006), these values have the great advantage of increasing with rising noise levels. This means these values are more in line with both the

latest literature and the valuation indices used in other European countries (Denmark, UK, Sweden). Moreover, using SP rather than RP results has the benefit of these being easy to use in a wide range of research and policy settings, as they are already expressed in € per dB per person. Finally, compared with the EBD results, the SP results of Bristow et al. (2015) have the advantage of including a greater fraction of the nuisance and are also based on more reliable methods.

No values for rail-traffic noise are reported by Bristow et al. (2015). However, in line with the acoustic literature (and some of the valuation literature), we recommend basing these values on those for road-traffic noise, but applying a 5 dB 'rail bonus'.

As a threshold we propose taking 50 dB(A), in line with the recommendations in the 2010 Handbook. Although it is known that lower noise levels also cause nuisance (WHO, 2011); (EEA, 2010) it is insufficiently clear to what extent the valuation studies yield reliable indices for lower noise levels, too.

Table 24 provides a synopsis of the recommended values for noise nuisance.

Table 24 Recommended values for noise nuisance ($€_{2015}$ per dB (L_{den}) per person per annum)

	< 55 dB	55 - 59	60- 64 dB	65-69 dB	≥ 70
Road traffic	18	37	37	70	70
Rail traffic	0	18	37	37	70
Aviation	44	88	88	167	167

These values are added to those for health impacts (see above) to arrive at an integral value for noise nuisance. In Section 6.11 more information on valuation of noise is presented.

5.7.2 Visual nuisance

Visual nuisance, too, can impact welfare. This may the case when a new development reduces local environment quality, by directly blocking a view, for example, or by changing the nature of the landscape and making the view less attractive. Factors affecting the degree to which visual nuisance is experienced are the height, shape and size of the object deemed a nuisance, its proximity to homes and its disharmony with landscape morphology.
In addition, the amount of visual nuisance depends on how well the new development is consciously blended into its surroundings.

Visual nuisance may lead to a decline in the value of the area concerned, making it less attractive to live or be there. As visual nuisance is always highly context-specific, it is impossible to draw up generally valid valuation guidelines. In the Dutch edition of this Handbook a specific study is cited (VU, 2014) that uses revealed preferences to establish the drop in house prices near wind farms. As wind farms also cause noise nuisance, though, a universally valid indicator for visual nuisance still remains unfeasible.

This category of nuisance is consequently not included in the environmental prices in this Handbook.

6 Valuation of midpoint impacts

6.1 Introduction and general methodology

This chapter discusses how environmental prices have been set at midpoint level, i.e. for each of the individual environmental themes. In this Handbook eleven midpoints are distinguished:
1. Ozone depletion.
2. Climate change.
3. Particulate matter formation.
4. Photochemical oxidant formation.
5. Ionizing radiation.
6. Human toxicity.
7. Ecotoxicity.
8. Acidification.
9. Eutrophication (freshwater and marine).
10. Nuisance (noise).
11. Extraction (land use).

These midpoints are described in Sections 6.2 to 6.12, along with the methods used to arrive at the estimated impacts and the values assigned to them. First, though, in Section 6.1.1 we briefly review which midpoints have been taken to relate to which endpoints.

6.1.1 Midpoint-to-endpoint relationships

There is a vast web of potential relationships between the eleven midpoints and five endpoints distinguished in this Handbook. Table 25 summarizes which of them are covered here. For a schematic picture, see Figure 5 in Section 2.3.4.

Table 25 Relationships between midpoints and endpoints covered in this Handbook

Endpoint / Midpoint	Human health	Ecosystems	Buildings & materials	Resource availability	Wellbeing
Ozone depletion	YES	partly			
Climate change	diff	diff	diff	diff	diff
Particulate matter formation	YES		YES		
Photochemical oxidant formation	YES	partly	partly		
Ionizing radiation	YES				
Acidification	diff	YES	YES		
Human toxicity	YES				
Ecotoxicity		YES			
Eutrophication		partly			
Nuisance (noise)	YES				partly
Extraction (land use)		partly		diff	partly

Explanation: YES (green): impact included virtually entirely and monetized accordingly.
partly (orange): impact partly monetized.
x (red): characterization from midpoint to endpoint, but result not incorporated here.
diff: impact determined differently. For climate change (blue) abatement costs were used, while for acidification (yellow) impacts were allocated under the headings of particulate matter formation and smog formation. For extraction (violet), no definitive method was found for the impact on resource availability.
An empty cell means the theme was not characterized with respect to the endpoint or that impacts are negligible.

An empty cell means there is no midpoint-to-endpoint characterization in our methodology. An 'x' in a cell means that while such characterization is in principle feasible, no estimate is provided in this Handbook. Many of these impacts are still being explored by researchers, while others are so location- specific that no universally valid averages can be given for the EU28. 'YES' means midpoint-to-endpoint characterization is relevant and that a quantitative average for the EU28 is included in this Handbook, while 'partly' indicates only some of the impacts have been quantified.

6.2 Ozone depletion

6.2.1 Description of midpoint

The ozone layer is a layer of the atmosphere about 15 to 30 km up in the stratosphere that is relatively rich in ozone (O_3). It filters out much of the incoming solar ultraviolet radiation (UV), which is hazardous to life on Earth. In the 1980s the thickness of the ozone layer was found to be declining, reducing the effectiveness of this shield. Variations in the thickness of the ozone layer are in part a natural phenomenon, caused among other things by volcano eruptions, but are also due to human activity, most specifically emissions of chlorine- and bromine-containing chemicals. These compounds react with stratospheric ozone, reducing its effectiveness as a UV-filter.

While ozone-layer depletion is a global environmental problem, the impacts are not the same everywhere, as the layer's thickness depends very much on latitude. At the equator it is thinner and less subject to variation. This is the source region for production of stratospheric ozone and here emissions have the least impact on ozone levels. In polar regions, in contrast, the layer is thickest but also most subject to fluctuation and depletion through the action of chemicals. This is because the ozone is not produced here, but accumulates after transport from the equator. If transport remains constant while depletion intensifies, a deficit arises, observed as a 'hole' in the ozone layer.

Global emissions of ozone-depleting substances (ODS) peaked in the mid-90s and have been slowly declining since (Fraser, et al., 2015). Despite successful international agreements, ODS are still used in a range of applications and are released as emissions (e.g. through leakage). Because of the time lag between emissions and resultant ozone levels, on average 15 years (VMM, 2013e), it is only recently that the thickness of the ozone layer has begin to recover. With continued decline in ODS emissions, recovery should eventually proceed more effectively than at present.

6.2.2 Sources

Stratospheric ozone is broken down by chlorine, bromine and nitrogen compounds, with CFCs, halons, HCFCs and methyl bromide constituting the main human sources. These chemicals, which have been in production since the early 20th century, are used principally as coolants in refrigerators and air-conditioning systems, as chemical 'dry cleaning' agents, in aerosol cans, as fire retardants, in foam manufacture and for soil defumigation (methyl bromide). Global production of ODS has declined substantially since the mid-'90s thanks to measures implemented under the Montreal Protocol.

Besides chlorine and bromine compounds there are also other pollutants that can impact the ozone layer, such as nitrogen compounds. The main nitrogen compound reaching the stratosphere is nitrous oxide, or laughing gas (N_2O). Although most of this comes from natural sources, there is also a sizeable anthropogenic component, particularly from agriculture.

6.2.3 Impacts

Ozone depletion impacts humans, plants and animals. UV-radiation can damage DNA and proteins in the skin and eyes, and over time cause skin cancer and cataracts. It also affects the physiological functioning of wild plants and agricultural crops and can cause radiation damage (VMM, 2013e).[58] Ozone depletion thus negatively affects both human and ecosystem health.

Most ozone-depleting substances are also greenhouse gases, thus contributing to climate change. These impacts are characterized under the endpoint 'climate change', however, and are included there in this Handbook. In addition, there are impacts on photochemical oxidant formation, with a decrease in stratospheric ozone sometimes leading to an increase in ground-level ozone. This impact is not included in ReCiPe and has consequently not been taken on board in the present Handbook, either.

6.2.4 Midpoint indicator unit

Substances with an impact on the theme 'ozone depletion' were characterized according to ReCiPe (Goedkoop et al., 2009, 2013). In ReCiPe impacts on this midpoint are expressed in kg CFC-11-equivalents. CFC-11, a chlorinated fluorocarbon formerly used mainly as a refrigerant, has the highest ozone-depleting protential (ODP) of any compound in this family.[59] It is defined as having an ODP of 1.

6.2.5 Valuation in this Handbook

Valuing the impact of ODS was not an issue covered by the NEEDS project. Our estimates of human health impacts are therefore based on the ReCiPe methodology (Goedkoop, et al., 2013). There, the impact of a change in UV-B-radiation on human health is calculated using the AMOUR model. The resultant damage factor is expressed in DALYs per unit change in the Effective Equivalent of Stratospheric Chlorine (EESC), with this figure then converted to a characterization factor in DALYs/CFC-11-eq. for each class of ODS. This is the same approach as adopted in the 2010 Shadow Prices Handbook.

For human health impacts, a monetary value was obtained using a standard value for a DALY, under the assumption that 1 DALY = 1 VOLY.

For impacts on ecosystem services, only endpoint damage to agricultural crops was included. For a selected series of crops this damage was multiplied by the estimated production cost, based on Hayashi et al. (2006). This is identical to the approach adopted in the 2010 Handbook.

Table 26 reports the average midpoint characterization factors adopted for the EU28 on this theme. As can seen, there is a substantial difference between valuation according to the individualist perspective and the hierarchist perspective. This is primarily because there is no discounting of longer-term impacts in the latter case, while in the hierarchist perspective other health impacts besides skin cancer are also included, such as cataract. These impacts are more uncertain and are consequently ignored in the individualist perspective.

---

[58] In the Antarctic seas, for example, excessive UV exposure is damaging phytoplankton, affecting both growth and DNA. Phytoplankton form the basis of the marine food chain.

[59] CFC-11 is also an important greenhouse gas.

Table 26 Average damage costs for ozone depletion for an average EU28 emission source in 2015 (€2015 per kg emission)

Pollutant	Perspective	Lower	Central	Upper
CFC-11	Individualist	22.1	30.4	45.7
CFC-11	Hierarchist	NA	123	NA

6.3 Climate change

6.3.1 Description of midpoint

Climate change refers to anthropogenic changes to the Earth's climate (temperature, weather). The climate is currrently changing as a result of rising atmospheric concentrations of greenhouse gases, which let through incoming solar radiation but prevent escape of the infrared radiation reflected from the Earth's surface. This phenomenon, the greenhouse effect, is causing global temperatures to rise. The principal greenhouse gases (GHG) are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), but there are many others, including ozone-depleting chemicals like HCFCs (see above).

Rising atmospheric GHG levels and the resultant rise in global temperatures are already having major effects on ecosystems and weather patterns. If current emission levels remain unchecked, average global temperatures are set to increase to 6°C above preindustrial levels. This will have extremely grave and partly unpredictable impacts on weather systems, sea levels and the environments on which plants, animals and humans depend. Other likely consequences will include increased flooding, droughts and the spread of diseases like malaria.

6.3.2 Sources

The single largest source of GHG emissions is fossil fuel combustion. Fossil fuels are used intensively in every economic sector and over the past century their consumption has spiralled. This generates huge emissions of CO_2, as well as nitrous oxide, which has a far greater Global Warming Potential (GWP) molecule-for-molecule. GHG emissions also arise in agriculture and in landfills, where it is methane and nitrous oxide that are released. Some industries are also characterized by high GHG emissions, such as cement and aluminium production. And then there are refrigerants and aerosol gases that also end up the atmosphere, during production and usage and as waste; this holds for both traditional CFCs and their newer replacements. All these GHG emissions lead to increased atmospheric levels of the gaes in question and consequently to global temperature rise.

Besides the cited GHG emissions there are also other pollutants that play a role in global warming. Black carbon (soot) in the atmosphere, for example, affects the amount of sunlight the Earth can reflect. The dark colour of soot means it absorbs more sunlight, leading to further temperature rise. This is particularly relevant when the particles are deposited on snow-covered surfaces, as it is precisely here that so much of the sunlight reaching the Earth is reflected back into space. There are also emissions with a cooling effect, including sulphur dioxide (SO_2). This has both a direct and an indirect cooling effect, the former due to SO_2 aerosols reflecting sunlight, the latter due to atmospheric SO_2 contributing to cloud formation and thus having a cooling effect (Fuglestvedt, et al., 2010). Aircraft emissions contribute, too, in terms of both cooling and warming (CE Delft, 2014).

6.3.3 Impacts

Without effective climate policy, temperatures are projected to rise to 6°C above prehistoric levels by the end of this century (IPCC, 2007). This kind of extreme climate change will have a major and in many respects irreversible impact on ecosystems, on human health and on the very fabric of our socio-economic systems. The impacts will not be distributed equally around the world, but will be far graver in developing nations, which moreover have less capacity to adapt (GHF, 2009).

The impacts have been described frequently and at length in the various IPCC reports and elsewhere:
- Sea-level rise will lead to major losses of farmland, particularly in river deltas, where the vast majority of the world's population lives. This will in all likelihood lead to major migrations and disrupt societies around the world. It may also lead to additional loss of farmland and wetlands.
- Direct effects on human health stem from reduced cold stress in the winter months and higher temperatures in the summer. Up to a point these impacts will cancel one another out. Additional impacts include an increased risk of exposure to certain parasitic diseases like malaria that are currently restricted mainly to the tropics.
- There will be considerable shifts in global food production, with a loss of agricultural potential in warmer countries being only partly compensated by increased potential in colder regions. These changes are expected to be rapid and may therefore lead to major socio-economic problems in terms of adaptation, with famines and mass migration increasingly common.
- There will be impacts on water supplies, with shortages aggravated in certain regions, not only through drought but also through further salinization of ecosystems. In other regions, in contrast, there will be more water available than has historically been the case.
- Impacts on ecosystems and biodiversity are the most complex and difficult to assess. Potential impacts include an increased risk of extinction of vulnerable species, altered distribution patterns and catastrophic damage to isolated ecosystems like coral reefs.
- Extreme weather events like heat waves, droughts, storms and tornadoes do not depend linearly on temperature rise and the damage they can potentially cause is very hard to estimate. There may also be catastrophic impacts like the loss of the West Antarctic or Greenland ice sheets, methane escape from melting tundra and the sea-bed, instability or collapse of the Amazon rainforest, tipping-over of ocean currents and disruption of the Indian monsoon. All these impacts are very hard to estimate, but their consequences would be enormous.

6.3.4 Mispoint indicator unit

ReCiPe characterizes the various greenhouse gases using their Global Warming Potential (GWP), based on IPCC (2007), with the GWP of CO_2 set at 1.

6.3.5 Environmental prices using the damage-cost method

In welfare economics the preferred method for valuing external costs is to base them on damage estimates (cf. Chapter 2). Ever since the emergence of anthropogenic climate change, economists have been working hard to estimate the damage it is likely to cause. By summing the various forms of damage, discounting them over time and relating them to CO_2 and other emissions, an attempt has been made to determine the Social Cost of Carbon (SCC). This SCC can be interpreted as the net present value of the future costs and benefits associated with emission of one additional so-called CO_2-equivalent.

The SCC is usually calculated using climate economic models in which assumptions about impacts are combined with assumptions on global income trends and distribution. A meta-analysis of 211 studies on the SCC has been carried out by Tol (2008), who showed that the spread in results is enormous: from less than € 1/tCO_2 to over € 500/tCO_2.[60] Taking a 3% annual discount rate, he arrives at an average figure of around € 5/tCO_2 and argues on this basis that the damage estimates reported in the influential Stern report (Stern, 2006) are outliers. He also states there is a less than 1% chance of the average damage estimate exceeding € 20/tCO_2.

Van den Bergh and Botzen (2015) consider such pronouncements premature, however, as the SCC literature is characterized by a very high degree of uncertainty. They cite four main sources of uncertainty in estimating the damage costs of climate change:
- A number of key cost categories are either ignored or only partially included: these include biodiversity losses, potential impacts on economic growth trends, political instability, violent conflicts and migration. The main reason for these omissions is a lack of reliable methodologies to estimate their magnitude.
- Uncertainties regarding impacts: there are major uncertainties about the full extent of the problematique and its impacts on the Earth's climate, sea-level rise and extreme weather events. In particular, potentially extreme events like a weakening or collapse of the Gulf Stream, complete melting of the Greenland and West Antarctic ice sheets, or changes in climate subsystems like the El Niño Southern Oscillation are frequently omitted from the analyses, or insufficiently accounted for.
- Uncertainties as well as widespread debate on the social discount rate to be adopted when calculating the damage costs of climate change.
- Insufficient allowance for people's aversion to losses and risk: people are generally risk-averse and prefer not to suffer loss. In most studies, however, this is scarcely allowed for, if at all.

Given these uncertanties, Van den Bergh and Botzen (2015) conclude that using a damage-cost method to calculate a shadow price for CO_2 will by definition yield highly uncertain results. A beter alternative in their view would be to decide on a safe atmospheric concentration of CO_2 and then perform a cost-effectiveness analysis of policies to achieve it. This boils down to the abatement cost approach.

Taking on board the criticisms of Van den Bergh and Botzen (2015), Bijgaart et al. (2016) consider whether it might be feasible to simplify damage estimates, by examining the most crucial parameters. In their study they present a formula said to combine core insights from economic and climate models. As its input, this formula takes the estimated damage resulting from a given temperature rise, the climate sensitivity (the temperature rise due to a doubling of atmospheric CO_2), gross global income, discount rate, the decay of atmospheric CO_2 and the rate at which the Earth's surface temperature adjusts. Using this simplified formula they carried out Monte Carlo calculations and then determined the extent to which uncertainties in parameters translate into uncertainties with respect to the SCC.[61] On this basis Bijgaart et al. (2016) conclude that the average damage costs of CO_2 are € 43.9/tCO_2 (prices 2010), with a median value of € 20.2/tCO_2. New in their analysis is that they show the

[60] For current CO_2 emissions, with impacts discounted at 3% per annum.

[61] Based on the available literature, an estimate was made of the probability distribution of climate sensitivity, projected damage factor and discount rate.

distribution of estimates is not only skewed, but also has a very long tail. They estimate there is a 10% probability of the SCC exceeding € 100/tCO_2, a considerably higher figure than concluded in the earlier work of Tol (2008). What Bijgaart et al. (2016) in fact do is underscore the conclusion of Van den Bergh and Botzen (2015) that there is a major spread in results, because the underlying calculations require decisions to be made about important parameters (e.g. discount rates) for which an objective scientific ruling is lacking.

6.3.6 Environmental prices using the abatement-cost method

The 2010 Shadow Prices Handbook took as a rule that the abatement-cost method was to be given preference for pollutants on which international agreements had been reached. In this method (cf. Chapter 2) valuation is based on the marginal costs of securing the relevant policy target. To this end a so-called Pigouvian charge is taken that is precisely enough to achieve the target and is given by the cost of the most expensive measure that needs to be taken as part of the most cost-effective policy package for securing the target.

In the 2010 Handbook, valuation was based on the then-valid target of a 20% reduction in carbon emissions in 2020 compared with 1990. For CO_2 emissions a price of € 25/tCO_2 was taken for impacts up to the year 2020, followed by an incremental annual price rise to € 85/tCO_2 in 2050. This increase was based on a meta-analysis that also considered shadow costs.

Today, the EU has agreed to a far more ambitious target of 40% emissions reduction in 2030.[62] Although there are not yet any binding targets for post-2030, European leaders have voiced an ambition to reduce the EU's carbon emissions by 80-95% relative to 1990 as part of efforts by the group of developed nations to reduce their aggregate emissions by a similar amount.[63] In addition, on 5 October, 2016 the European Parliament ratified the Paris climate agreement, under which countries are obliged to do all they can to reduce greenhouse gas emissions to such an extent that average planetary temperature rise remains far below 2°C, with 1.5°C the current objective. At the moment, global distribution of the now vastly shrunken 'emissions space' is not yet entirely clear, but for the EU the total reduction by the year 2050 is anticipated to be closer to 95% than to 80% (PBL, 2016).

In this Handbook we propose adopting two alternative abatement-cost methods for carbon emissions, based on:
1. The current policy path, using the existing targets for 2020 and 2030 and extrapolating these to 2050.
2. The 2°C policy path, using the targets for 2050 to interpolate targets for earlier years such that an efficient price trajectory is achieved.

This is essentially the same approach as adopted in the Dutch WLO scenarios (see Text Box 4), where for climate policy, besides the Low and High scenarios, a 2°C scenario was explored based on trends in carbon prices if the global community seriously pursues drastic emissions cuts. Below we explain how environmental prices have been calculated in the two approaches. Since efforts to control climate change will intensify over time, with least-cost measures soon exhausted, the price tag on greenhouse gas reduction will rise year on year.

62 See for example (COM 2014/15 final).

63 See for example (COM/2011/0112).

Environmental prices for the current policy path

The Netherlands Bureau for Economic Policy Analysis (CPB) and the Netherlands Environmental Assessment Agency (PBL) have calculated the costs of securing various climate targets within the framework of the WLO scenarios published at the end of 2015 (CPB; PBL, 2015a). Around the same time the Dutch Cabinet adopted the recommendations of the Discount Rate Working Group, which specify that CO_2 emissions are to be valued using the price trends calculated by CPB and PBL in the two WLO scenarios: Low and High (see Text Box 3). In the High scenario the policy challenge is in line with the policy for 2030 adopted by the EU in 2014 (and currently elaborated in a range of concrete policy measures like the EU ETS. In the Low scenario the target is weaker than current policy ambitions, under the assumption that around 2025 it is realised that international climate policy is not working, leading to a further weakening of such policy (CPB ; PBL, 2015c).

Box 3 The WLO scenarios

At the end of 2015 PBL and CPB published their 'WLO scenarios' setting out future trends, with their associated uncertainties, for both the Dutch and the global economy (CPB; PBL, 2015a). Two scenarios were elaborated: Low and High.

In the Low scenario there is limited further globalization, resulting in lower economic growth of around 1% per annum and slower population growth. In this scenario, climate and energy policy is based as far as possible on standing arrangements, with policy targets that have already been elaborated in concrete measures and policies.

In the High scenario globalization continues apace. There is greater (international) confidence in the future than in the Low scenario, creating greater willingness to cooperate and conclude agreements. Through trade agreements there is further market integration and continued growth of migration. There is also a greater willingness to conclude international agreements on issues like climate. The High scenario combines relatively high population growth with high economic growth of around 2% per annum. In policy terms, the High scenario is based not only on standing climate and energy policy through to 2030, but also on proposed policy (such as the EU's intention to reduce CO_2 emissions by 40% in 2030 relative to 1990).

In addition to these two scenarios, a specific sensitivity scenario on carbon prices has been developed in case the world decides to pursue the efforts related to the 2-degrees target.

The WLO scenarios are based on CO_2 price trends derived from the EU ETS. These cannot simply be adopted in an SCBA, because the EU ETS is not an economy-wide instrument. In a background document CPB and PBL therefore explain how the WLO scenarios can be employed to calculate a price path that can be used in SCBAs and does offer an economy-wide perspective (Aalbers, et al., 2016). To do so they proceed from the High scenario for the year 2050 and extend the ETS to *all* sectors of the economy.[64] The High scenario thus essentially has an economy-wide CO_2 price, with marginal costs amounting to € 160/tCO_2 in 2050.

64 In their exploration of the 2°C target this is already the case in 2030.

In the Low scenario, too, the 2050 CO_2 price can be considered economy-wide, because in rounded terms the prices for securing the reduction targets in Low are virtually the same as the ETS prices.[65] In both the High and the Low scenarios, then, the 2050 prices are the marginal costs of achieving the set targets for the economy as a whole. On this basis an *efficient* price path can be calculated for the intervening years with the aid of Hotelling's rule, with the CO_2 emissions space being understood as a kind of 'stock' and the prices in 2050 being discounted using the relevant discount rate.[66] For the two scenarios this yields the price paths for efficient CO_2 pricing shown in Table 27.

Table 27 **Efficient CO_2 prices in the WLO scenarios (€/t_{2015} CO_2, constant prices, excl. VAT)**

WLO scenario	2015	2030	2050	GHG emissions reduction in 2030/2050 rel. to 1990
Low	12	20	40	-25%/-45%
High	48	80	160	-40%/-65%

These prices can be interpreted as the marginal social costs of securing the reduction percentages in the WLO scenarios in 2050.

Up to a point, similar prices have also been calculated in other studies (though by different methods). The European Commission's Impact Assessment of the 2030 targets (EC, 2014b), for example, states that in a 40% reduction scenario EU ETS prices may rise to € 40-53 t/CO_2, under an assumption of minimum additional policy on energy efficiency and renewable energy in 2030. In the period up to 2050 prices will range from € 85 to € 264, depending on the emissions cuts that need to be achieved under the EU ETS.

In the PRIMES Reference scenario it is calculated that a standstill of the 2020 targets (as in WLO Low), with only the ETS sectors securing the agreed 1.74% annual reduction, will lead to an EU ETS carbon price of € 35 in 2030. The PRIMES Reference scenario also calculated that if annual ETS reductions up to 2020 are extrapolated to 2050, this will give an EU ETS price of around € 90/tCO_2 and economy-wide carbon emissions cuts of about 48%.

Environmental prices for the two-degree path

If politicians decide to put their shoulders behind the policies required to secure the 2°C target, carbon prices will rise substantially. In that case WLO projects prices rising to € 200 or even € 1,000/tCO_2 in 2050. Using these figures, efficient prices can be calculated for the intervening years; in 2030 they will already have to be between € 100 and € 500.

These figures may seem high, but they are backed up by other studies. In a meta-analysis of the costs of the greenhouse gas abatement required for long-term stabilization of atmospheric levels, Kuik et al. (2009) show that

---

65 According to Aalbers et al. (2016), in the Low scenario the economy-wide efficient CO_2 price in 2050 equals the EU ETS price (after rounding), because the ETS abatement-cost curve is virtually flat over a large range, which means the overall reduction target in Low can be achieved through additional measures at more or less the same marginal cost.

66 Because the ETS prices are European prices, Aalbers et al. (2016) adopt a slightly higher discount rate in Hotelling's rule, resulting in 3.5% annual increase in the carbon price. In justifying this higher discount rate, the authors point to the slightly higher growth rates in Eastern and Southern Europe compared with North-West Europe and the Netherlands, implying a higher discount rate for the EU as a whole than for the Netherlands. The discount rate can also be considered as a price rise.

these costs may in fact rise far more sharply yet. From their meta-analysis of 62 studies they estimated abatement costs as a function of targets (ranging from 450 to 650 ppm CO_2-eq.). For a long-term target of 450 ppm CO_2-eq. (giving a temperature rise of approx. 2°C) they report abatement costs of € 129/tCO_2, with a range of € 69-241. For 2050 their central estimate is € 225/tCO_2, with a range of € 128-396. These values are in constant 2005 Euros.

To correct for inflation, these figures must be increased by 17% to obtain 2015 prices. This gives a central value of € 263/tCO_2, with a range of € 150-463. The central (median) value is thus closer to the lower bound for the 2°C target in the WLO scenarios than to the upper bound.

6.3.7 Valuation in this Handbook

In this Handbook valuation of the impacts of climate change is based on a combination of damage and abatement cost. For the *lower* value we use the median value in Bijgaart et al. Translated into 2015 Euros, this is equivalent to € 21.6. For the central value we use the abatement costs of the current policy plans resulting in a 40% reduction in 2030 and assuming a linear reduction path up to 65% reduction in 2050. For the upper limit we use the abatement costs of the 2-degree scenario as obtained in the meta-analysis of Kuik et al., 2009. In line with Aalbers et al., 2016, the 2050 value from Kuik et al. (2009) has been discounted by 3.5% p.a. to arrive at efficient prices for 2015. To all the abatement costs we have added 18% VAT.

Table 28 shows the CO_2 prices for 2015, 2030 and 2050 proposed in this Handbook.

Table 28 Environmental prices for the theme climate change (€/t CO_2 emission, incl. VAT)

	2015	2030	2050
Lower	22	37	73
Central	57	95	190
Upper	94	160	315

The impacts of other greenhouse gases can be calculated by means of characterization factors. The IPCC publishes such factors for the various gases, expressed in CO_2-equivalents, updating them at regular intervals. The most recent update is the Fifth Assessment Report from 2014. In determining the environmental prices we have based ourselves on the latest IPCC data. As an illustration: for fossil methane IPCC has a characterization factor of 30.5 kg CO_2-eq. for a 100-year time horizon: a basic figure of 28 kg CO_2-eq. plus 2.5 kg CO_2-eq. as a correction factor because methane degrades partly to CO_2.[67] We have here worked with a 100-year horizon because the policy targets agreed to under the auspices of the IPCC are also based on this perspective.

As the basis for calculating the midpoint price we propose taking the central value associated with current policy for the year 2015, viz. € 57/tCO_2-eq.

[67] ReCiPe (v.1.12) currently still uses a somewhat older characterization factor of 25 kg CO_2-eq.; nor are so-called feedback impacts included. There is still debate, though, on what values can be derived for other GHG from an efficient CO_2 reduction path (cf. (PBL, 2016)). In the future these prices may therefore be adjusted to ensure the overall GHG emission cuts required can be achieved at least cost.

6.4 Particulate matter formation

6.4.1 Description of midpoint

Airborne particulate matter (PM) is a mixture of particles (liquid or solid) of varying size and composition. A gas containing suspended PM is known as an aerosol. PM can be categorized in various ways, the most important being:

- By origin (anthropogenic or natural). Anthropogenic emissions are caused by human activity and include soot and smoke formed in combustion, while natural (biogenic) emissions arise through natural processes like sea salt being blown onto coasts.
- By source (primary or secondary). Primary particles are emitted directly into the atmosphere by a wide range of sources. Secondary particles are formed in the atmosphere in chemical reactions involving gaseous compounds like ammonia (NH_3), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and organic chemicals.[68]
- By size/diameter, usually with a breakdown into PM_{10}, $PM_{2.5}$ and PM_1, standing for particles with a diameter less 10, 2.5 and 1 μm, respectively. The smaller particles are more damaging.
- By chemical composition (PM comes in hundreds of forms). Although there are indications that PM toxicity depends not only on diameter but also on composition, there is as yet insufficient solid evidence except in the case of black carbon, which appears more hazardous than other forms (cf. Chapter 5).

6.4.2 Sources

Anthropogenic particulates are emitted from many different sources, the main being combustion processes, which give rise to fine soot particles as well as gases. The PM from combustion reactions generally belongs to the finest categories. PM also arises in certain mechanical processes, such as the milling of grain. The material blown up in these proceses usually belongs to the coarser fractions. Particles deposited on the ground are transferred back to the atmosphere by the wind or by human activity. Examples of such sources include open-air storage of sand or other bulk goods, and dirt and tyre particles blown up from roads and verges. There are also natural sources of wind-blown coarse PM, such as wind erosion of soils and atmospheric dispersion of sea-salt.

6.4.3 Impacts

Airborne particulates impact on human health and damage buildings and monuments.They also cause visual nuisance in the form of haze.

Health impacts

Of all the environmental pollutants to which humans are exposed, it is primary and secondary particulates that cause the greatest health damage, because they transport a wide range of toxic substances directly into the air passages and lungs. Depending on the particle size, they lodge in the nose, throat and mouth cavity or in the lungs and alveoli. The smaller particles penetrate deepest into the lungs, where they can cause both immediate and later damage.

---

[68] These gases are less volatile and are consequently blown downwind, where they generate aerosols by forming new particles (nucleation) or by coalescing with already existing particles (coagulation).

According to the World Health Organization (WHO, 2005), the $PM_{2.5}$ fraction of airborne particulates poses a greater health risk than the PM_{10} fraction. The $PM_{2.5}$ fraction is also more directly related to anthopogenic particulate emissions than PM_{10} and thus more amenable to policy action (RIVM, 2015).

Pope et al. (2004) have found evidence for three possible pathophysiological mechanisms for explaining the impacts van $PM_{2.5}$ on mortality and morbidity:
1. $PM_{2.5}$ aggravatess the severity of COPD (chronic obstructive pulmonary disease) and asthma.[69]
2. $PM_{2.5}$ causes inflammatory reactions and intensifies arteriosclerosis, which can lead to coronary heart disease.
3. $PM_{2.5}$ leads to reduced heart rhythm variability and an elevated risk of heart arrhythmia and mortality (via cardiac arrest).

In addition, toxicological studies show that particulates can also cause genetic damage as well as allergic and inflammatory reactions (VMM, 2013b).

It has been shown in a number of studies (see (VMM, 2013b)) that reduced PM levels lead to a decline in premature mortality. There are several indications that PM toxicity is influenced by both the size and chemical composition of the particles. The ultrafine size of some PM increases its toxicity and explains (in part) the health impacts (see (VMM, 2013b)). There is also evidence that certain heavy metals and black carbon have additional toxic impacts.

Although it is also often held that primary particulates are more damaging than secondary particulates, the WHO (2013) holds there are no scientific grounds for such a distinction. They therefore recommend that the two categories should be considerd equally harmful: in calculating the damage cost, we have followed this recommendation.

Impacts on buildings
Airborne particulates cause visually observable damage to buildings and monuments. Soot soils both streets and buildings, which means they have to be cleaned more often.

6.4.4 Midpoint indicator unit
ReCiPe expresses impacts on this theme in kg PM_{10}-equivalents. ReCiPe (Goedkoop, et al., 2013) has no separate characterization for the relationship between PM_{10} and $PM_{2.5}$.

6.4.5 Treatment in the 2010 Handbook
In the 2010 Handbook the theme of PM formation was modelled entirely using the NEEDS Exceltool. To obtain the weighting factor, the relative damage of each component of PM_{10} was weighted using the 2006 EU28 emission. On this basis a weighted weighting factor for use in LCAs was developed. The ReCiPe characterization was not employed in the 2010 Handbook. Based on the relative emissions of $PM_{2.5}$ and PM_{10} in the EU28 a characterization factor was developed expressing the relative damage of PM_{10} compared with $PM_{2.5}$. For the theme of PM formation the only impacts covered were those on human health.

69 Although this was not strictly proven in the study, this is probably due to COPD patients usually being diagnosed with pneumonia or flu at the time of death.

6.4.6 Update: characterization factors

The ReCiPe midpoint indicator is expressed in kg PM_{10}-equivalent. The list of pollutants contributing to the PM_{10} formation is relatively short: besides PM_{10}, the variants of NO_x and SO_x as well as NH_3, a precursor for secondary aerosol formation. To a very limited extent, NMVOC also feeds in to PM_{10} formation; in ReCiPe this was valued at zero, though. More recent epidemiological studies (cf. WHO, 2013, 2014) have identified chronic health impacts for NMVOC too, however, besides the familiar acute impacts (see Section 6.5). The IIASA-TSAP project (IIASA, 2014) (WHO, 2013)[70] consequently adopted a positive value for NMVOC, equivalent to a characterization factor of 0.09 relative to PM_{10}. Forparticulates we have opted to follow ReCiPe, however, and include the impact of NMVOC under photochemical oxidant formation (see Section 6.5).

It should be noted that ReCiPe works with PM_{10} and not $PM_{2.5}$. One problem when using this indicator is therefore that it is not so much PM_{10} as $PM_{2.5}$ that poses human health risks. Health damage from particles larger than $PM_{2.5}$ is minor and in all likelihood negligible (Mcdonnell, et al., 2000). It is therefore important to know how much $PM_{2.5}$ there is in 1 kg of PM_{10}. In the 2010 Shadow Prices Handbook (CE Delft, 2010) this was determined on the basis of the share of $PM_{2.5}$ emissions in PM_{10} emissions. The EU28 data on emissions show that 66.5% of PM_{10} emissions are in fact also $PM_{2.5}$. Based on these recent emission data a characterization factor of 1.5 seems appropriate.[71]

Because the coarse fraction of PM (the share of PM_{10} with a diameter greater than $PM_{2.5}$) in NEEDS also has a modest impact on human health, we have opted to take the *health damage* of $PM_{2.5}$ relative to PM_{10} as our basis for characterization. This leads to a characterization factor of 1.46 for $PM_{2.5}$ for 1 kg PM_{10}-equivalent.

6.4.7 Discussion: adjustment of valuation for black carbon?

Several recent WHO studies report new scientific findings on black carbon, also known as black smoke. A WHO literature study shows that it has health impacts that are in many cases greater than those due to PM_{10} (by a factor 6-14), but the same within the interquartile range[72].

As a rough approximation, airborne particulates can be taken to comprise three chemical categories:

- carbon: mainly primary anthropogenic PM, which can have health impacts;
- organic: mainly secondary PM deriving from hydrocarbons;
- inorganic: mainly primary natural and secondary sources, making up a large fraction of total PM emissions.

Particle size and chemical composition are related. Smaller particles like $PM_{0.1}$ consists mainly of black carbon. In principle, in this Handbook we have valued health impacts in relation to $PM_{2.5}$ levels rather than PM_{10} levels. On average, using the characterization factors described above, $PM_{2.5}$ causes twice as much damage as PM_{10}. According to WHO (2014) there is no unambiguous evidence that black carbon has a greater impact than $PM_{2.5}$, but at the same time they state that in some cases it may serve as a useful additional indicator.
There must then be information available on the fraction of black carbon in PM and on emissions of black carbon, however. Because such data are not systematically collected as EU28-averages, in this Handbook we propose

70 The reference is to the IIASA-TSAP Clean Air Europe project.

71 1.5 = 1/0.665.

72 Interquartile range is used as a measure of data variability. If the data is divided into four quartiles, the interquartile range is the central 50% of the data.

making no separate adjustment for this issue (but these can be calculated upon request).

6.4.8 Valuation in this Handbook

For the impacts of particulate matter formation on endpoints we adjusted the impacts of $PM_{2.5}$, NO_X, NH_3 and SO_2 from the NEEDS project (2008a) using the updates cited in Section 6.4.6. In addition, the following corrections were implemented:

- lower emissions and consequently lower background concentrations;
- change in age cohorts (see Annex B);
- inflation;
- addition of restoration costs for soiled buildings in the upper price, as per Section 5.5.

For the endpoint 'health', NO_x and to a lesser extent also SO_2 contribute not only to PM formation but also to photochemical smog formation. Here we have allocated acute impacts entirely to the latter theme and chronic impacts besides those of NO_2 (for which see Section 6.5.7) entirely to the former. Table 29 reports the average values for the EU28 for the pollutants of relevance for this midpoint.

Table 29 **Average damage costs for PM formation for an average EU28 emission source in 2015 (€$_{2015}$ per kg emission)**

Pollutant	Lower	Central	Upper
PM_{10}	€ 19	€ 26.6	€ 41
$PM_{2.5}$	€ 27.7	€ 38.7	€ 59.5
SO_2	€ 7.63	€ 10.7	€ 16.4
NO_x	€ 8.69	€ 12.2	€ 18.6
NMVOC*	€ 0	€ 0	€ 0
NH_3	€ 9.43	€ 13.2	€ 20.2
MPF** (kgPM_{10}-eq)	n.c.	€ 39.2	n.c.

* Values for the chronic impacts of photochemical smog formation; cf. Section 6.5.

** MPF = midpoint characterization factor; the prices cover not only damage to human health but also damage to buildings.

Apart from the upper values for PM_{10} and $PM_{2.5}$, all these environmental prices are determined entirely by human-health impacts. Besides these pollutants, there are no others that have impacts on this midpoint. For this reason the ReCiPe characterization factors are of no further relevance here.

The damage costs per unit emission for secondary aerosols tend to be higher if emissions go lower, especially for SO_2 and NO_x. These higher costs are also due to the specific atmospheric reactions involved. NH_3, NO_x and SO_2 all react to form particulates, but in the case of NO_x the relationship is linear, while for NH_3 it is quadratic. Therefore, the reduction of NH_3 is key in determining the relative harmfulness of SO_2 and NO_x. Lower emissions of NO_x and SO_2, if unaccompanied by a more than equal decline in NH_3 emissions, lead to higher damage costs per kg emission for these pollutants.

Based on the same systematics and characterization according to the hierarchist perspective (see Annex A), a midpoint environmental price of € 39.2/kg PM_{10} has been taken as the characterization factor for PM_{10}-equivalent.

6.4.9 Specific values for $PM_{2.5}$ emissions

The values cited above are averages for an average EU28 emission. As a substantial share of PM emissions are traffic-related and emissions height is a particularly important factor in PM distribution and impacts, these average values are not always applicable when the specific emission source is known. Especially for power stations and industry, the height of stacks is a major factor determining further emissions dispersion and dilution resulting in less damage. For traffic it is the other way around where emissions at ambient levels cause more damage than the average values.

For transport we have used the information from Heatco (2006) that provides YOLL estimates for transportrelated impacts of emissions of $PM_{2.5}$. The relative risk of $PM_{2.5}$ emissions is in Heatco the same as applied in our study for mortality (which explains over 70% of the damage costs of $PM_{2.5}$), while the impacts on morbidity are only slightly different. We have used this information and applied the VOLY to the YOLL estimates.

As HEATCO differentiates between the emissions from a metropole region (e.g. cities with >0.5 million of inhabitants) and emissions outside built areas, we use this differentiation as well. In order to obtain an estimate for small and medium sized cities, we took the relationship between metropole emissions and small and mediumsized cities from a previous version from the IMPACT handbook (CE Delft, 2008). This learns that the impacts on small- and mediumsized cities are about 1/3 of the impact of the metropole cities.

Based on the NEEDS modelling runs we can now make a conversion for emissions from stacks over 100 metres high.[73] This is typically the case for coal-fired power stations and refineries. Table 30 summarizes the damage costs to be used in such cases. As can be seen, damage costs are almost 50% lower if emissions are from a stack over 100 metres high.

Table 30 Average damage costs for PM formation for an average EU28 emission from a >100 m stack in 2015 (€$_{2015}$ per kg emission)

Polutant	Lower	Central	Upper
PM_{10}	€ 9.67	€ 13.5	€ 20.9
$PM_{2.5}$	€ 12.7	€ 17.8	€ 27.4
SO_2	€ 3.51	€ 4.92	€ 7.53
NO_x	€ 4	€ 5.6	€ 8.58
NMVOC*	€ 0	€ 0	€ 0
NH_3	€ 4.34	€ 6.08	€ 9.31

* Values for the chronic impacts of photochemical smog formation; cf. Section 6.5.

6.4.10 Specific values for traffic

With traffic, too, a specific emission source is involved with a different damage factor than the average for the EU28 as a whole.
There are two reasons that traffic emissions are more harmful:
1. They occur close to the ground, so the PM is more readily inhaled.
2. They occur mainly in densely populated areas. The damage per unit emission will be greater in built-up areas, as more people are exposed there.

[73] In the 2010 Handbook this conversion could not be properly performed, as too little information was available on the NEEDS modelling runs.

In the 2010 Shadow Prices Handbook we were unable to properly differentiate according to emission height and population density. In the annexes of that Handbook we referred to the HEATCO study (HEATCO, 2006), where such values were calculated. That study worked with modelling runs using the EcoSense dispersion model to calculate the health damage due to traffic and power-station emissions. One of the findings was that 1 kg $PM_{2.5}$ emitted by traffic in an urban area in the Netherlands is over 25 times more damaging than 1 kg emitted from a power station. A study by CE Delft and Vrije Universiteit (2012) made calculations using the values reported in HEATCO (2006), yielding values 1.3 to 7 times higher than the central values in the table in Section 6.4.7.

In Europe, valuation of $PM_{2.5}$ emissions from transport is dealt with in the various IMPACT handbooks. In an on-going update, executed by CE Delft and INFRAS (CE Delft, INFRAS, *forthcoming*), EU28 values for transport emissions have been calculated in line with the points of departure (e.g. valuation and updated CRFs) from this handbook. This has been done by observing ratios in the NEEDS model between damage costs of EU28 compared to the national averages, and by observing ratios in the literature between the various sources of exhaust emissions. This yields insights in the likely damage costs per country for transport emissions.

For transport we have used the information from Heatco (2006) that provides YOLL (Years of Life Lost) estimates for transportrelated impacts of emissions of $PM_{2.5}$. The relative risk of $PM_{2.5}$ emissions is in Heatco the same as applied in our study for mortality (which explains over 70% of the damage costs of $PM_{2.5}$), while the impacts on morbidity are only slightly different. We have used this information and applied the present VOLY of € 70,000 (see Chapter 5) to the YOLL estimates from Heatco.

As HEATCO differentiates between the emissions from a metropole region (e.g. cities with >0.5 million of inhabitants) and emissions outside built areas, we use this differentiation as well. In order to obtain an estimate for small and medium sized cities, we took the relationship between metropole emissions and small and mediumsized cities from a previous version from the IMPACT handbook (CE Delft, 2008). This learns that the impacts on small- and mediumsized cities are about 1/3 of the impact of the metropole cities.

This approach yields the following table. It should be noted that these values are to be regarded as 'rough' approximations of the damage costs of transport related emissions. New atmospheric modelling taking into account the height of the exhaust may be required in the future in order to obtain more precise values.

Table 31 **Approximate average damage costs for $PM_{2.5}$ from EU28 traffic emissions, differentiated by emissions location (€$_{2015}$ per kg emission)**

	Lower	Central	Upper
Traffic: highly urbanized areas*	€ 273	€ 381	€ 586
Traffic: medium and small sized cities	€ 88	€ 123	€ 189
Traffic: rural areas	€ 50	€ 70	€ 107

* Cities with over 500,000 inhabitants.

As can be seen, on this basis damage due to traffic $PM_{2.5}$ emissions in urban areas is about 10 times greater than the national averages and about a factor 2 for the rural areas. These differences are bigger than in the Netherlands (CE Delft, 2017b), which is logical since the Netherlands is more densely populated implying that the weight of cities in the national average is higher than elsewhere in Europe.

6.5 Photochemical oxidant formation (smog)

6.5.1 Description of midpoint

Photochemical oxidant formation, otherwise known as photochemical smog or 'summer smog' formation, refers to pollution of the lower atmosphere (troposphere) with compounds like ozone (O_3), peroxyacetylnitrate (PAN), nitrogen dioxide (NO_2) and hydrogen peroxide (H_2O_2) that act as oxidizing agents (VMM, 2013d).

Ozone is the most representative as well as most important component of photochemical smog. It is a strong oxidizing agent and is hazardous to humans, plants and materials. It has an adverse impact on respiratory and cardiac functions, reduces crop yields and erodes certain materials and monuments.

Ozone is not emitted direcly, but is created in the presence of nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC) under the influence of sunlight. Carbon monoxide and methane also play a part in ozone formation.[74] Ozone is itself fairly unstable and reacts constantly with NO to form NO_2 and oxygen. At the same time, NO_2 and oxygen also react to form O_3 and NO. The presence of NMVOC means this equilibrium is being continually upset, however: on balance, more NO is converted to NO_2, leading to rising ozone concentrations.

The relationship between the amount of ozone formed and initial NO_x and NMVOC concentrations is by no means linear (VMM, 2013d). There is a 'worst-case' NO_x-to-NMVOC ratio at which ozone formation is highest (VMM, 2013d). In densely populated areas like Belgium and the Netherlands, where NO_x levels are relatively high, this means the most effective way to lower ozone levels is to reduce NMVOC. In the more thinly populated south and east of Europe it is the other way round. This means that a reduction in NO_x does not always necessarily mean that ozone levels fall. Particularly if NO_x emissions are relatively low, a rise in NO_x emissions may even induce a drop in ozone levels (VMM, 2013d).

6.5.2 Sources

The main source of NO_x emissions are high-temperature combustion processes in vehicle and other engines, heating plant and industrial processes. NMVOC comes from a variety of sources, including fuel combustion and evaporation of industrial solvents, as well as from biogenic sources, in the form of isoprene and terpenes emitted by forests and other vegetation. CH_4 emissions derive primarily from agriculture and landfills, while CO arises through incomplete combustion of fossil fuels.

74 Because of the greater transport distances involved, CO and CH_4 emissions are above all important for background ozone concentrations.

6.5.3 Impacts

Elevated tropspheric ozone levels, and particularly the peak concentrations that then often arise, cause respiratory damage. These 'ozone episodes' are more likely to occur in stagnant weather; particularly on hot, sunny days. Acute health impacts include respiratory disorders and inflammatory reactions in the lungs. During these episodes, anyone — including healthy people — exerting themselves outdoors will suffer from decreased lung capacity and run the risk of inflammation of the respiratory system. The risk is greatest for those already suffering from respiratory disorders. Health effects can be avoided, or at any rate reduced, by refraining from heavy physical activity or remaining indoors.

In epidemiological studies, impacts have generally been quantified above an ozone threshold of 35 ppb or 70 µg/m^3 (known as SOMO35) (NEEDS, 2007c). At higher concentrations there is considered to be a risk of acute mortality during physical exercise. As argued by WHO (2013 and 2014), there also appears to be a chronic health impact above this threshold. This is discussed further in Sections 6.5.5 and 6.5.6.

Besides health impacts, elevated ground-level ozone levels also cause damage to crops, ecosystems and certain materials. Plants take up atmospheric ozone through the stomata (microscopic openings) in their leaves. Within the plant cells, ozone damages cell membranes and causes oxidative stress. The plant responds by producing anti-oxidants (vitamins C and E) and ethylene (a plant hormone). This interrupts normal cell processes, causing crops and other plants to die back or fail to ripen, or lose their foliage early (VMM, 2013d).

The effective ozone dose received by a plant depends on the species and growing conditions. For agricultural crops, Humblot et al. (2013) have demonstrated that yields can be affected very differently depending on the crop, with wheat yields suffering but barley being positively affected.

Certain materials are also sensitive to ozone pollution. Natural rubber cracks more readily in the presence of ozone, and under the influence of ultraviolet radiation and temperature plastics, textile fibres, textile dyes and paints are also degraded.

6.5.4 Midpoint indicator unit

ReCiPe expresses impacts on this theme in kg NMVOC-equivalents.
The characterization factors reported are European averages and thus too coarse for distinguishing the background concentrations important for predicting ambient ozone levels. This is explained further in Section 6.5.8.

6.5.5 Treatment in the 2010 Handbook

In the 2010 Handbook, the impacts of pollutants causing photochemical smog were calculated using the NEEDS models (2008a), with both health impacts and crop damage included. Impacts on materials were not quantified.

6.5.6 Discussion: damage due to ozone

Based on recent toxicological and epidemiological data, the WHO (2013, 2014) is now of the opinion that ozone is more damaging than previously assumed. Besides the health risks in the form of acute mortality and morbidity, the WHO also reports an elevated risk of chronic mortality for the population as a whole. WHO (2013) recommends that this be included when assessing the health impacts of air pollution. Also the typology of impacts from ozone has been changed compared to the NEEDS estimates. A full account of all the relevant changes can be found in Annex B.3.

6.5.7 Update: CRF for damage due to NO_2

A number of recent studies have yielded new information on the health effects of NO_2. When inhaled, nitrogen oxides are converted to nitric acid in the respiratory tract, paralyzing the cilia (hair-like structures) in these passages. This reduces the body's self-cleansing capacity and resistance to bacterial infection, among other knock-on effects (VMM, 2013a). Exposure to NO_2 can have irreversible impacts on pulmonary and respiratory functions, particularly in those already suffering from COPD and similar disorders, and also contribute to cardiovascular disease, leading to premature mortality. The REVIHAAP project (WHO, 2013) reports that since 2004 a growing number of studies have been published identifying short- and long-term correlations between NO_2 and mortality and morbidity that come on top of the impacts of NO_2 on PM formation and of NO_2 on acute mortality due to ozone formation. There is thus a third category that is not associated with particulate matter formation or ozone formation and that has here been added to the theme of acidification.

At the time of the NEEDS project these impacts were not included because the team was unable to identify sufficient studies that properly quantified these epidemiological impacts (NEEDS, 2007b). Today (2016) the situation has changed and the WHO (2013) recommends adopting a higher CRF for NO_2 than was previously used. The HRAPIE experts (WHO, 2013) recommend including the long-term mortality impacts (all-cause and cardiovascular) of NO_2 and advise adopting a linear CRF for NO_2 for all-cause mortality, translating to an RR of 1.055 per 10 $\mu g/m^3$ (WHO, 2013). In this context the WHO (2014) notes that when employing this RR-value in multi-emission studies due care should be taken to avoid double-counting with respect to the impact of NO_2 on PM formation, which they state can be as much as 33%.

To make this double-counting explicit, we examined the contribution of NO_2 to the RR-value for PM formation. For PM, NEEDS (2007b) uses an overall RR for premature mortality of 1.06 per 10 $\mu g/m^3$. The relative contribution of NO_2 to PM formation can be derived from the characterization factors.
For characterizing NO_2 with respect to PM formation, ReCiPe takes a value of 0.22. This means that 22% of the RR increase can be attributed to impacts already been taken into account under the theme of PM-formation, equal to an RR of 1.013 per 10 $\mu g/m^3$.[75] Assuming, in line with WHO (2014), a linear CRF for NO_2-values over the 20 $\mu g/m^3$ threshold, it can be concluded that the *additional* NO_2 RR-value must be 1.042 per 10 $\mu g/m^3$ for pollution in areas above the threshold level. This implies that the chronic health damage attributable to NO_2 should be a factor 3 higher than assumed in NEEDS, based on its contribution to PM formation.

To this factor two additional corrections should be made:
1. The mortality applies only to people older than 30 years.
2. The mortality applies only to population living in areas with an annual mean concentration of pollution above 20 $\mu g/m^3$.

In Annex B.3 more information can be found on the chosen values.

[75] This estimate is feasible because in ReCiPe PM formation is considered only in terms of its impacts on the endpoint 'human health'.

6.5.8 Update: characterization

Characterization factors have been taken from ReCiPe (2013 version) as Western European averages. This characterization does not include the chronic impacts from NO_2 and therefore cannot be used for this particular aspect. Therefore we added the chronic impact of NO_2 only to the emissions of NO_x and not to the other pollutants.

The characterization factor is expressed in the same terms as in ReCiPe: kg NMVOC-equivalents, which is the same as in the 2010 Shadow Prices Handbook.

6.5.9 Valuation in this Handbook

The endpoint impacts of photochemical oxidant formation are based on adjustment of NEEDS, supplemented by a value for NO_2, as described above. Impacts on materials like rubber have been included only in the upper value, as explained in Chapter 5. For NMVOC and NO_x the environmental prices were calculated directly. All the other environmental prices were derived from ReCiPe characterization factors. The resultant prices are shown in Table 32.

Table 32 **Environmental prices for photochemical smog formation for an average EU28 emission source in 2015 (€$_{2015}$ per kg emission)**

Pollutant	Lower	Central	Upper
SO_2*	€ 0.0634	€ 0.0888	€ 0.136
NO_x	€ 0.782	€ 1.1	€ 1.68
NMVOC	€ 0.84	€ 1.15	€ 1.84
CO*	€ 0.0383	€ 0.0526	€ 0.0918
CH_4*	€ 0.00849	€ 0.0116	€ 0.0267
Formaldehyde*	€ 0.737	€ 1.01	€ 1.61

* Determined via valuation of the characterization factor.

Now that the chronic health impacts of NO_x are included, emissions of this pollutant are responsible for the majority of damage on this theme, followed by NMVOC. This also means NO_x health impacts are substantially higher than assumed in earlier studies (see for example Grinsven et al., 2013). On this theme, the environmental prices are due entirely to health impacts, except for the upper value, which also includes damage to buildings and materials.

Using the same methodology, the price for the midpoint characterization factor was also calculated for the hierarchist perspective: € 2.10/kg NMVOC-equivalent.

6.6 Acidification

6.6.1 Description of midpoint

Acidification refers to the collective impacts of airborne pollutants that are converted to sulphuric and nitric acid and deposited on soils and vegetation by means of wet or dry deposition. Unpolluted, natural clouds and rainwater have a pH (acidity) of 5.65 (VMM, 2013a), which means a lower pH is a sign of acidification. Acidifying pollutants have a long atmospheric residence time and can consequently be transported over long distances. This is particularly true of SO_2 and NO_x. This makes acidification a transboundary environmental problem requiring a coordinated international abatement strategy. In the EU the National Emission Ceilings were introduced for this purpose. Although ammonia (NH_3) also contributes to acidification, it soon disappears from the atmosphere, through dry deposition near the emission source or conversion to ammonium salts (VMM, 2013a).

6.6.2 Sources

The main source of potentially acidifying emissions are anthropogenic activities like agriculture (particularly livestock farming, NH_3) and fossil fuel consumption (SO_2, NO_x). There are also natural sources. Vulcano reuptions, for example, are accompanied by major releases of sulphur dioxide.

6.6.3 Impacts

Acidification has impacts on human health, climate change, ecosystems and buildings. In addition, NH_3 can cause stench nuisance.

Damage to human health

Sulphur dioxide acts on the mucus membranes in the mouth, nose and lungs. Its main impact is on respiratory functions (VROM, 2001). This is because when the gas comes into contact with water in the respiratory tract it is converted to sulphuric acid, which causes the air passageways to contract, leading to bronchitis and, if exposure is chronic, even to elevated mortality.
Given today's low concentrations compared with the past, it is unlikely that sulphur dioxide still has any significant health effects (VMM, 2013a).

Although ammonia can in itself affect the respiratory system, this will only be the case at relatively high levels that are only likely to occur in certain working situations, most specifically on intensive livestock holdings (VROM, 2001). As the prices given in this Handbook are for an average concentration, the figures reported here cannot be applied in such situations.

Damage to ecosystems

Soils start to acidify when their acid-buffering capacity is exceeded.
Soil acidification results from both anthropogenic and natural processes. Natural soil acidification can occur when an area receives more rain than it loses. Deposition of anthropogenic SO_2, NO_x and NH_3 can accelerate this process. Soil acidification leads to reduced plant growth and a greater incidence of crop diseases. Earthworms, moulds and other soil organisms can also be negatively impacted, with a variety of knock-on effects. When deep-burrowing earthworms disappear, for example, there is less intermixing of humus and mineral soil and reduced soil aeration (VMM, 2013a). As calcium is leached out from the soil through acidification, reduced availability of this vital element may also impact the health and survival of snails and birds.

Acidification with NH_3 and NO_x also increases soil nutrient levels, which may sometimes have a positive impact on biodiversity. In certain vulnerable ecosystems like heaths, bogs and chalk grasslands, though, such emissions lead to eutrophication and consequently damage (see the following section).

Damage to buildings
Acidifying emissions can lead to accelerated erosion of buildings and monuments, particularly those made of limestone and other calcium-rich stone or concrete.

6.6.4 Midpoint indicator unit
The three pollutants considered to have a capacity to cause acidification are SO_2, NO_2 and NH_3, each with its own 'potential acid equivalent': one mole H+ ions equals one acid-equivalent. In ReCiPe SO_2-equivalents are used as a unit, with acid-equivalents being converted to the amount of acid that can be formed from the SO_2.

6.6.5 Valuation in this Handbook
In this Handbook the environmental prices for acidification are based on the sum of impacts on agricultural crops and biodiversity reported in NEEDS (2008a), adjusted as described in Section 5.4. To this figure was added a price for damage to buildings, as described in Section 5.5. For the reasons set out in Section 6.6.3, no health impacts have been allocated to acidification.

Table 33 reports the environmental prices for the three main pollutants on this theme.

Table 33 Environmental prices for atmospheric emissions contributing to acidification for an average EU28 emission source in 2015 $€_{2015}$/kg emission)

Pollutant	Lower	Central	Upper
SO_2	€ 0.6	€ 0.764	€ 1.4
NO_x	€ 0.496	€ 1.58	€ 1.74
NH_3	€ 0.604	€ 4.35	€ 4.95

6.7 Eutrophication

6.7.1 Description of midpoint
Eutrophication refers to excessive nutrient enrichment of soil, water and air with nitrogen, phosphorus (and to a lesser extent potassium), disturbing ecological processes and natural cycles. It leads to changes in the amount of biomass and in species composition in plant and animal communities at various trophic levels. This increased nutrient availability may be due to external nutrient inputs or to changes in water or mineral balances (internal eutrophication). This increase must always be considered in relation to the 'natural' nutrient situation in the ecosystems concerned.

6.7.2 Sources
In many EU28 countries, agriculture is an important source of eutrophying emissions, due to fertilizer application and livestock manure. Other sources include wastewater discharge, NO_x emissions from combustion processes and dumping of effluent sludge. Eutrophying emissions can thus have an impact on air, water and soil quality.

6.7.3 Impacts

On land, eutrophication is a major threat to natural ecosystems, where interspecies competition is generally governed by limited nitrogen availability. Heaths, unimproved grassland and certain types of woodland are particularly sensitive to nitrogen eutrophication via deposition or water infiltration (VMM, 2013c). Eutrophication of surface waters can lead to algal bloom, which can in turn cause deoxygenation of the water and ultimately fish death.

6.7.4 Midpoint indicator unit

ReCiPe distinguishes eutrophication of freshwaters and marine waters. For the former kg P (phosphorus) is taken as the midpoint indicator unit, for the latter kg N (nitrogen). According to ReCiPe, in regions with a temperate climate like in Europe, P and N are the critical nutrients in freshwaters and marine waters, respectively. This means N-emissions to freshwaters imply no increased eutrophication burden as long as P-emissions are not substantially reduced. Conversely, P-emissions to marine waters will not lead to eutrophication unless N-emissions are substantially reduced.

6.7.5 Treatment in the 2010 Handbook

In the 2010 Handbook only eutrophying emissions to freshwater were quantified, with those to marine waters not valued. For the former category the value reported in Kuik et al. (2008) for PDF/m^2 on land was converted to m^3 water, making due allowance for the difference in species density between land and water. This type of approach can only be adopted under the assumption that a species on land represents as much 'welfare value' as an aquatic species. Although this assumption was queried at the time, there were then no better methods available.

6.7.6 Update: reappraisal of phosphates

In the 2010 Handbook the price of phosphorus was calculated from the monetary value of the ReCiPe characterization factors for the endpoint 'ecosystems'. For this Handbook this issue was re-examined. Now, the price of P has been derived directly from the ReCiPe characterization factors and the value reported in species.yr, with a conversion being made from the number of species to PDF/m^2/yr (see Section 5.4 and the annex on biodiversity valuation in the Dutch Handbook). This is identical to the treatment of ecotoxicity. Use of this method leads to an environmental price for phosphate from animal manure of € 0.16 as lower value, € 0.62 as central value and € 1.22 per kilogram phosphate as upper value.

Because ReCiPe characterization factors are based on *average European values*, the environmental price derived from them possibly leads to an underestimate of specific situation, such as in the Netherlands. Therefore, the abatement costs were also examined for the Dutch handbook. In the Netherlands there is a system of allowances in force for poultry farms designed to keep phosphate emissions within European limits, while a similar system for dairy farms is soon to be introduced (probably on 1 January, 2018). On online trading platforms, poultry allowances are currently leased for about € 2.50/year. Assuming a manure load of 0.5 kg phosphate per poultry unit, this translates to a price of € 5 per kg phosphate. The price of a dairy phosphate allowance, in which there is already some trading, is currently even higher. Here, phosphate allowances were being bought for about € 120/kg phosphate in early 2017. Assuming allowances are bought for 8-10 times the price of leasing them, this would translate to about € 12-15/kg phosphate/year. At the same time, market analysts (Jacobsen, 2016) anticipate that the actual market price may drop by a factor 3-4 once the market has settled down. We therefore judge a price of € 3-5/kg phosphate/year to be probably in line with long-term costs in the livestock sector to meet current standards.

The question is whether these costs can be used if pricing is based on an abatement-cost approach. As an alternative, one can consider the charge levied for effluent emissions to surface waters. In the Netherlands this charge stands at € 37.28 per 'pollution unit', representing annual consumption of 54.8 kg oxygen in the water. For phosphorus, discharge of 20 kg phosphorus amounts to 1 pollution unit. The shadow price of the charge is thus € 1.86 per kg phosphorus for emissions to water. This translates to € 0.61 per kg *phosphate*: precisely the central value calculated for phosphate above.

For these reasons we consider the values found to be in line with what we would expect on the basis of abatement costs. When dealing with measures in agriculture in SCBAs, for example, we nonetheless recommend that impacts on phosphate allowances be quantified, too.

6.7.7 Update: reappraisal of nitrates

To determine the environmental price for nitrogen the first method above could not be used, because ReCiPe provides no endpoint characterization for nitrogenous eutrophication of freshwater. We therefore adopted the abatement-cost method, using the charge paid for discharges to Dutch surface waters: € 37.28 per pollution unit. Adopting the same procedure as for phosphorus (see previous section), the environmental price of 1 kg N can be calculated as € 3.11.[76] This figure, taken here as the estimated environmental price of nitrate emissions to surface waters, is in line with the ReCiPe midpoint characterization factor for 1 kg N-total discharged at a non-specific location. If the nitrogen is discharged directly to sea, the environmental price is 43% higher.

6.7.8 Valuation in this Handbook

Table 34 shows the environmental prices for N and P on the theme of eutrophication.

Table 34 Environmental prices of emissions of eutrophying pollutants to air, water and soil from an average EU28 emission source(€$_{2015}$/kg pollutant), with ReCiPe characterization factors in bold type

Pollutant	Theme	Compartment	Low	Central	High
NO_x	Eutrophication	Air	€ 0.121	€ 0.121	€ 0.121
N-artif. fertizer	Eutrophication	Soil	€ 0.227	€ 0.227	€ 0.227
N-manure	Eutrophication	Soil	€ 0.246	€ 0.246	€ 0.246
P-artif. fertizer	Eutrophication	Soil	€ 0.0132	€ 0.0987	€ 0.112
P-manure	Eutrophication	Soil	€ 0.0125	€ 0.0931	€ 0.106
N-total*	**Eutrophication**	Water, general*	€ 3.11	€ 3.11	€ 3.11
N-total	Eutrophication	Marine waters	€ 4.45	€ 4.45	€ 4.45
P-total*	**Eutrophication**	Water, general*	€ 0.25	€ 1.86	€ 2.11
PO_4	Eutrophication	Water, general*	€ 0.0825	€ 0.614	€ 0.696

* This characterization factor is based on 'water, unspecified' in ReCiPe and can be used if it is not precisely known where the pollution occurs.

[76] The Dutch 'pollution unit' (veO) is defined as Q / 1,000 • (COD + 4.57 • KjN) / 54.8, where Q = stream flow in m^3/a, COD = chemical oxygen demand in mg/l, and KjN = amount of Kjeldahl-nitrogen bound in ammonia or organic matter. The formula thus converts effluent concentrations to kg COD and N-Kjeldahl. The factor 1,000 converts grams to kilos, as COD and N-Kjeldahl concentrations are expressed in mg/l, or gram/m^3. From this formula it follows that 1 kg N = (4.57/54.8) VeO. Multiplying this ratio by the wastewater levy yields a charge of € 3.11 per kg N.

6.8 Human toxicity

6.8.1 Description of midpoint

Human toxicity covers all other pollutants that are potentially hazardous to human health, characterized primarily by their toxicity. The most important of these are heavy metals and chemical products used, among many other applications, as agricultural pesticides and flame retardants in consumer products, for example.

Their toxic impacts fall into five categories:

- acutely poisonous substances;
- substances that can cause cancer (carcionogenicity);
- substances that can cause genetic mutations (mutagenicity);
- substances that can impact reproduction (teratogenicity);
- substances that can irritate and damage skin, eyes or the respiratory tract.

6.8.2 Substances and sources

The main substances with impacts on the theme 'human toxicity' are heavy metals, chlorinated hydrocarbons, pesticides and other biocides and a wide range of specific chemicals used primarily in consumer and other products.

The most important sources of heavy metals are emissions from industrial production plants, from mining and oil refining. These pollutants are discharged in low concentrations in effluents or released as trace elements during combustion, roasting and incineration of fossil fuels, ores and wastes and subsequently dispersed via the atmosphere. In addition, heavy metals are contained in numerous products, including paints, phones, building materials and fertilizers. In the waste phase or via leaching they can then end up in the environment.

In the case of chlorinated hydrocarbons the main pollution source is waste incineration. These compounds are not only inhaled, but can also be ingested in food. Pesticides and other crop protection agents escape to air, soils and water during and after farm application and may remain on edible crops as residue.

6.8.3 Impacts

The toxic impacts of heavy metals have been researched in greatest detail. The most toxic of these are arsenic, cadmium, chromium, copper, mercury, lead, nickel, platinum and zinc. Besides being carcinogens, they can also have specific physiological impacts, including damage to the liver (copper), brain and cognitive learning abilities (lead) and nervous system (mercury).
Heavy metals can impact human health through direct inhalation or ingestion via the food chain following uptake by plants and animals. Heavy metals in the soil can also infiltrate groundwater.

A growing body of data is also available on the toxicity of countless chemicals used in a wide range of consumer products, packaging materials and countless other materials. With many of these chemicals the damage they cause only manifests itself with the passage of time, particularly when it comes to non-acute health impacts like damage to organs, metabolism and reproduction. It was only in the 1970s, for example, that the toxic impacts of dioxins, a particularly hazardous class of chlorinated hydrocarbons, became apparent, following a series of incidents in chemical plants in Seveso and Amsterdam, among other places, where workers came to suffer acute and chronic health problems after exposure to high dioxin concentrations.
Later that decade it was realised that dioxins are also toxic in lower

concentrations and slowly accumulate in the bodies of both humans and animals, being soluble in fatty tissue. Later still it became clear that the class of chlorinated hydrocarbons to which dioxins belong contains many other compounds that are also toxic, including such widely used chemicals as polychlorinated biphenyls (PCBs).

The use of pesticides and other biocides also has human health impacts, which have been unravelled by reseachers in growing detail over the past few decades. They are used to protect farm crops against pests, diseases and weeds, as well as elsewhere.
Numerous consumer products also contain chemicals with potential health impacts, such as bromine-containing flame retardants, softening agents in plastics and additives in products like printing inks. Many of these products at first appeared to pose no health threat to humans, but as more data became available on leaching, intake via food or skin contact and potential for long-term damage, their toxic properties came to the fore.

6.8.4 Midpoint indicator unit

ReCiPe (Goedkoop, et al., 2013) uses kg 1,4-dichlorobenzene as the midpoint indicator unit for human toxicity, the same as for ecotoxicity.
1,4-dichlorobenzene is a chlorinated hydrocarbon that is poorly degradable and therefore accumulates in the environment, posing a hazard above all to aquatic organisms. The chemical is used in such products as mothballs and (formerly) toilet fresheners. Its inhalation can lead to dizziness, fatigue and anemia and, over time, to liver and kidney complaints and it may also be slightly carcinogenic.

In ReCiPe the characterization factor is used to express the relative toxicity of other pollutants. Its value differs substantially, depending on whether the individualist or hierarchist perspective is adopted. In the former case a conservative position is adopted with respect to the burden of proof as to suspected toxicological impacts. Impacts recorded solely in animals are not included, for example, nor heavy-metal dispersal via the soil or uptake in cereals and other food crops. In the hierarchist perspective these impacts are included (see also Annex A).

6.8.5 Treatment in the 2010 Handbook

In the 2010 Handbook toxicity was valued based on the NEEDS damage costs for atmospheric emissions of six metals, formaldehyde and dioxin. Using the ReCiPe characterization factors (hierarchist perspective) these damage costs were converted to a weighted average for 1,4-dichlorobenzene, with weighting according to the relative impact of the metals, formaldehyde and dioxin in the EU28 based on 2006 emissions.

6.8.6 Update: CRF-values

The damage estimates in NEEDS (2008a) and the 2010 Shadow Prices Handbook (CE Delft, 2010) have been reappraised to assess their current validity, principally because the NEEDS values for these toxic chemicals were very low compared with the results of later studies. The damage costs of toxic metals have recently been researched by Rabl, Spadaro and Holland (2014) and by Nedellec and Rabl (2016) as part of the AMESTIS project. The latter study assessed the damage costs of atmospheric emissions of toxic metals by European coal-fired power plants by reviewing the epidemiological literature and concludes that the estimated damage is far higher than the values used in the 2010 Handbook. Comparison with a direct valuation based on DALYs using characterization models like ReCiPe and ILCD also indicates that the values in NEEDS (2008a) are probably too low. Finally, the doctoral study by Frantke

(2012) provides evidence that the damage-cost estimates in the 2010 Handbook for the toxic impacts of pesticides are probably underestimates (see also Annex B).

For the present Handbook we therefore examined several toxicity routes, ultimately opting to disaggregate impacts into two factors:
- impacts on human health (morbidity and premature mortality);
- impacts on IQ.

For the first effect we continued to base the toxicity of dioxins on NEEDS (2008a), but that of atmospheric emissions of the heavy metals arsenic, cadmium, lead and mercury on a combination of four studies (detailed in Annex B), including the model employed in Rabl and Nedellec (2016).[77] Dividing this total damage by the emissions expressed in terms of kg 1,4 dichlorobenzene (converted using the ReCiPe data, Individualist perspective) an estimate was obtained for the emission of 1 kg 1,4 dichlorobenzene. This value was then compared with other estimates, including the estimates for the health damage due to pesticide use reported in Fantke (2012). This showed that our method yields results broadly similar to Fantke's values for the impacts of the herbicide amitrol.

For emissions of arsenic, lead and mercury we furthermore quantified impacts on IQ based on the model of Rabl and Nedellec (2016). In doing so we assigned a value € 17,500 per IQ-point (2015 prices), based on valuation of associated income loss.

6.8.7 Update: characterization factors

In contrast to the 2010 Shadow Prices Handbook, in this Handbook we have in principle consistently used characterization factors based on the Individualist perspective. In the case of human toxicity, however, many of these factors are over 100 times higher in the hierarchist perspective, for two main reasons:
- in the individualist perspective there is a greater burden of proof when it comes to (suspected) human toxic impacts (see Annex A);
- in the individualist perspective environmental dispersal of toxic substances is modelled less comprehensively, with uptake of toxic heavy metals in food crops not included, for example.

For this Handbook we sought to adopt a perspective in line with that adopted for the other themes. To this end we took citations in WHO studies as evidence of toxicological impacts, but, following the Individualist characterization perspective, taking only IARC Categories 1 and 2 as toxicological proof and not Categories 3 and 4 (see Annex A). For uptake via food crops the individualist perspective is incomplete, however, as NEEDS (NEEDS, 2008) and more recently Nedellec and Rabl (2016) show that this is an important route for the health impacts of heavy-metal emissions. For heavy metals we therefore opted to base ourselves on the characterization factors for the hierarchist perspective, corrected for the difference in burden of proof for toxicity.[78]

77 Their model is based on more extensive dispersion routes of toxic substances in food chains than previously quantified. Using a 3% discount rate and the VOLY and QALY values adopted here (see Section 5.3) we calculated the total damage due to emissions of these four metals in the Netherlands in 2015.

78 In doing so, we used substance-specific correction factors based on the model of Nedellec and Rabl (2016).

It was decided to use these higher characterization factors for heavy metals solely in the upper-value estimates. The lower value is thus still based on the individualist perspective. For the central value we took the average of these two characterization factors. For heavy-metal emissions to soil, in particular, this leads to substantial differences between the upper and lower values.

6.8.8 Valuation in this Handbook

Table 35 reports the environmental prices for atmospheric emissions of various toxic substances.

Table 35 **Environmental prices for atmospheric emissions of toxic substances on the midpoint human toxicity for an average EU28 emission source in 2015 (€$_{2015}$/kg pollutant), with ReCiPe characterization factor in bold type**

Pollutant	Lower	Central	Upper
Cadmium	€ 371	€ 589	€ 869
Arsenic	€ 586	€ 862	€ 963
Lead	€ 3631	€ 5367	€ 5761
Mercury	€ 24,680	€ 34,490	€ 52,920
CFC-11*	€ 4.72	€ 6.45	€ 9.97
Nickel*	€ 35.5	€ 85.7	€ 114
Chromium*	€ 0.0782	€ 0.498	€ 0.572
Formaldehyde*	€ 9.05	€ 12.7	€ 19.5
Dioxin	€ 49,450,000	€ 67,650,000	€ 104,500,000
Midpoint: 1,4 DB-equivalent	**€ 0.0725**	**€ 0.0991**	**€ 0.153**

* Environmental price for this emission has been calculated from the applied characterisation factor (see also Section 6.8.7).

It should be emphasized that the environmental prices for human toxicity reported here are more uncertain than for other themes. In studies with a specific focus on toxicity we do not therefore recommend using these prices, but rather a dedicated toxicity analysis. In a future edition of this Handbook a more extensive analysis can hopefully be carried out encompassing the latest research on the dispersion, accumulation and health impacts of toxic substances.

The midpoint price, which can be used as a weighting factor, is € 0.158 for 1 kg 1,4-dichlorobenzene. This price is based on the hierarchist characterization perspective and is lower than the central value in Table 35. This is because the characterization factors from the hierarchist perspective are many times higher than those from the individualist perspective. As the environmental price reported here is the weighted average of results from several studies (see Annex B), its value becomes lower as the characterization factor becomes higher.

6.9 Ecotoxicity

6.9.1 Description of midpoint

Ecotoxicity is the impact of toxic substances not considered elsewhere on non-human organisms in ecosystems, to the extent that non-target organisms are exposed. The main agents involved are agricultural pesticides, which are designed specifically to exterminate organisms deemed to pose a threat to crops and livestock. In addition, though, pesticides are also widely used by households as well as government agencies. Almost 80% of herbicides do not reach their intended target (VMM, 2013g).

A major difference from human toxicity is that in LCA and other such analyses individual organisms are generally ignored entirely when it comes to ecotoxicity (with the exception of certain large mammals like wolves), with consideration given only to the species and population levels (National Research Council, 2014).

6.9.2 Sources and substances

VMM (2013g) distinguishes two kinds of pesticides: crop protection agents and biocides. The first category can be subdivided into insecticides, herbicides, fungicides, bactericides, molluscicides, rodenticides, nematicides (to combat nematode worms) and acariciden (for ticks and mites). These compounds are used mainly by farmers, in allotments and in public spaces.

Biocides are pesticides used in non-agricultural settings, except in applications similar to farm use. On land, examples include hospital disinfectants, wood preservatives and agents used for household pest control. At sea, shipping vessels use anti-fouling agents to avoid hulls becoming overgrown with marine organisms like algae and polyps. These agents can impact shellfish and other non-target organisms. Tributyltin (TBT), the compound that was most frequently used for this purpose, was banned worldwide in 2008, although it is still causing damage to certain European ecosystems (Tornero & Hanke, 2016). Since the TBT ban, copper salts have become the most common alternative. While these are less toxic than TBT, the resultant elevated copper levels in seawater may still pose a risk to marine life (Tornero & Hanke, 2016). These copper-based anti-fouling agents are also often supplemented with biocide 'boosters' like Irgarol (Cybutryne), which is toxic to micro-organisms.

Heavy metals are dispersed through the natural environment as a result of effluent discharges from foundries, fossil-fuel emissions, mining activities and waste incineration (VMM, 2013h). The following metals can have a toxic impact on ecosystems: arsenic (aquatic organisms), cadmium (food chains), chromium (fish), copper (plants), mercury (fish) and lead (aquatic organisms) (VMM, 2013h).

6.9.3 Impacts

Crop protection agents impact on ecosystems through their toxicity to non-target organisms, pollution of surface water, grondwater, aquatic sediments and soils, and bio-accumulation (accumulation in food chains). As pesticide residues often become dispersed throughout the environment, these side-effects occur not only close to the original source but also over far greater distances. The persistence of impacts varies from a few days to several years. The longer a toxic substance remains active, the greater the risk of bio-accumulation. In such cases a low concentration in the aquatic environment may ultimately lead to far higher concentrations in animals further up the food chain. As a result, there may also be knock-on effects on public health (VMM, 2013g) which are treated further under the theme 'human toxicity'.

For non-target invertebrates, exposure to crop protection agents can lead to mortality, a reduced lifespan, changes in growth and fertility rates, changes in sex ratios and a wide range of behavioural changes. The recent decline in populations of honeybees and other pollinating insects may be due in part to pesticides. In vertebrates, certain crop protection agents can lead to hormonal disbalance, as has been observed with reptiles, birds and mammals exposed to organochlorine and organophosphorus pesticides. Pest control may cause mammal mortality, particularly when organochlorine pesticides are involved. These pesticides are also associated with increased mortality and morbidity among marine mammals. Perinatal (just before or after birth) or neonatal (after birth) exposure to pesticides like aldrin, atrazine, chlordane and dieldrin can cause anomalous sexual development in mammals. Bird exposure to pesticides has been extensively studied. In the past, seeds treated with DDT (an organochlorine pesticide) led to the poisoning of millions of birds, with populations of prey animals also being decimated by these kinds of pesticides (VMM, 2013g).

The main impact of the biocide TBT was its effect on the endocrine system of shellfish (Tornero & Hanke, 2016). Copper is an essential trace element for many organisms, but is toxic at high concentrations. It damages the immune system of molluscs and interferes with coral reproduction. The booster biocide Irgarol disturbs photosynthesis and is highly toxic to autotrophic organisms like cyanobacteria and dinoflagelatte symbionts in coral reefs. Heavy metals burden food chains (arsenic, cadmium, chromium, mercury, lead), limit plant growth (copper) and poison aquatic biota (lead) and certain land animals like sheep (copper) (VMM, 2013g).

In our treatment of ecotoxicity all these pollutants have been included. Using ReCiPe data (Goedkoop, et al., 2013) the impacts of over 1,000 chemicals discharged to water or dispersed in soils via waste streams and their ecotoxicity impacts have been included.

6.9.4 Midpoint indicator unit

In ReCiPe (Goedkoop, et al., 2013) the ecotoxicity of a substance is expressed as toxicity relative to 1,4-dicholorobenzene discharged to the marine environment. This is the same indicator as used for human toxicity. 1,4-dichlorobenzene is a poorly degradable chlorinated hydrocarbon that consequently accumulates in the environment, with impacts mainly on aquatic organisms. This explains why the damage for this pollutant, in Euros, on the theme of ecotoxicity is greater than on the theme of human toxicity.

In ReCiPe the characterization factor is used to express the relative toxicity of different pollutants. For some substances this factor differs substantially according to whether the individualist or hierarchist perspective is adopted. This is because the impacts of metals occurring naturally in ocean water are not quantified in the individualist perspective, but are in the hierarchist perspective (Annex A).

No values for the ecotoxicity of pollutants (known as 'Hazard Property 14') have yet been set in the European Union. The European Commission has initiated a project on how this impact is to be quantified.

6.9.5 Update: characterization factors

For the characterization factors on this theme we have based ourselves on the individualist perspective in ReCiPe (Goedkoop, et al., 2013). Similarly to the discussion on human toxicity, in ReCiPe the differences between the individualist and hierarchist perspective derive from the choice of studies used for assessing ecotoxicity and the environmental compartments modelled.

Here, we have opted to work with the studies associated with the individualist perspective, but adopting the hierarchist perspective for a limited number of heavy metals (cobalt, copper, manganese, molybdenum and zinc) for estimating an upper value for marine ecotoxicity. For these pollutants we have taken the average of these two characterization factors as the central value.

6.9.6 Valuation in this Handbook

On this theme, monetary valuation is based on ReCiPe endpoint characterization. As explained in Section 5.3, to this end a relationship was established between the value of biodiversity from the economic literature and the unit of the ReCiPe characterization factor (Goedkoop, et al., 2013). This led to the values reported in Table 36 for ecotoxicity in the various environmerntal compartments, expressed in terms of the compound used for characterization: 1,4-dichlorobenzene (DB).

Table 36 Environmental prices for ecotoxicity for average EU28 emissions in 2015 (€$_{2015}$ per kg pollutant)

Midpoint	Lower	Central	Upper	Unit
Ecotoxicity, terrestrial	€ 1.17	€ 8.69	€ 9.85	€/kg 1,4 DB-eq.
Ecotoxicity, freshwater	€ 0.00485	€ 0.0361	€ 0.0409	€/kg 1,4 DB-eq.
Ecotoxicity, marine	€ 0.000992	€ 0.00739	€ 0.00837	€/kg 1,4 DB-eq.

It should be emphasized that the environmental prices given for ecotoxicity, like those for human toxicity, involve greater uncertainty than those for the other themes. We therefore advise against using them in studies concerned explicitly with ecotoxicity. It is then preferable to perform a dedicated assessment of the impacts of the toxic substances on the particular ecosystems involved and value these using specific values for these particular ecosystems.

6.10 Ionizing radiation

6.10.1 Description of midpoint

The subatomic particles and electromagnetic waves produced by certain materials are sufficiently energetic to eject electrons from other atoms or molecules, a process known as ionization. If living tissue is exposed to ionizing radiation this can cause damage to DNA, leading to apoptosis (cell death) or genetic mutation. Ultimately this may lead to the development of cancer or genetic defects that are passed on to subsequent generations. The ionizing radiation emitted by radionuclides is measured in Becquerels (Bq), expressing the number of radioactive decays per second.

6.10.2 Sources

We are all exposed to natural ionizing radiation. The two main natural sources are cosmic radiation and radioactive minerals occurring naturally in the Earth's crust. One major source of natural exposure is radon, a gas emitted from soils that can build up in crawl spaces in homes and may be responsible for between 100 and 1,200 additional cases of lung cancer per year in the Netherlands, according to the Dutch Health Council (Gezondheidsraad, 2000).

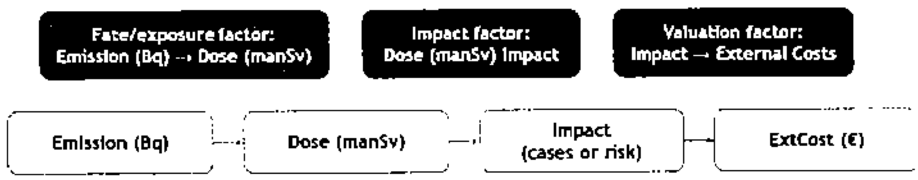
Human activities involving use of radiation (X-ray machines) and radionuclides also expose us to ionizing radiation over and above the natural background. Medical use of radiation is the largest — and growing — anthropogenic source of exposure (UNSCEAR, 2000). In addition, environment pollution with radioactive waste from nuclear power facilities and weapons testing are an important source of exposure worldwide. In some parts of the world, production of fissile material for military ends has left behind vast amounts of radioactive waste. Nuclear power stations, reprocessing plants and other nuclear facilities release radioactive substances to the environment on an everyday basis and produce large volumes of radioactive waste requiring long-term storage. In addition, radioactive materials are emitted in minor amounts from fossil-fuel combustion and the use of certain materials in industry and agriculture.

6.10.3 Impacts

The health impacts of exposure to ionizing radiation manifest themselves as fatal and non-fatal cancers and genetic damage. Human exposure as a result of anthropogenic emissions depends on the medium to which the radionuclide is emitted: surface water or the atmosphere.

6.10.4 Midpoint indicator unit

To calculate the external costs van radionuclide emissions NEEDS (2008a) uses the following simplified model:



NEEDS calculated exposure factors using the method set out by UNSCEAR (1993, 2000), in which a radionuclide emission (in Bq) is converted to a 'radiation dose equivalent' at the population level, expressed in man-Sieverts (manSv). This dose equivalent is obtained by multiplying the amount of absorbed radiation (in J/kg) by a 'quality factor' that depends on the type of radiation involved (e.g. photons vs. alpha particles) and a factor for the exposed part of the body and the duration and intensity of the radiation.

6.10.5 Treatment in the 2010 Handbook

In the 2010 Handbook, characterization and valuation were based on NEEDS (2008a), with impacts valued as the number of DALYs per cancer. This gives the number of lost life years (YOLL) due to premature mortality as a result of cancer, taken as 15.95, in line with NEEDS (2008a). A Cost of Illness (COI) was also added amounting to € 480,000. This yielded a value of € 1.12 million per fatal cancer, with non-fatal cancers only entailing the COI. The external costs per unit emission were calculated by multiplying the disease-specific values by the projected incidence of radiation-induced disease, which depends on the the radiation type.

6.10.6 Valuation in this Handbook

In this new Handbook the NEEDS value of $€_{2000}$/kBq has been recalculated using a characterization factor for Uranium-235 and a correction for inflation (using HCIP) to express prices in $€_{2015}$/kg U235-eq. In addition, a high and a low scenario were created using the high and a low value for VOLY. The upper VOLY-value adopted was € 110,000 and the lower value € 55,000. Allowance was also made for population growth. In NEEDS (2008a) the value for YOLL was reduced from 15.95 to 13, based on Humbert et al. (2012). For non-fatal cancers COI was assigned a lower value of € 420,000 (2015 prices).[79]

[79] In doing so, the decrease in YOLL was translated to a proportional decrease in COI.

In contrast to the 2010 Handbook, characterization is now based on the individualist perspective, to include discounting more explicitly. As there is copious evidence for the carcinogenic properties of ionizing radiation, there is also less difference between the hierarchist and individualist perspectives in ReCiPe (Goedkoop, et al., 2013).

Table 37 reports prices for radionuclides with relatively high radiological impacts.

Table 37 Environmental prices for ionizing radiation for an average EU28 emission source in 2015 (€$_{2015}$ per kBq U235-eq.)

Pollutant	Lower	Central	Upper
Aerosols, radioactive, unspecified	€ 0,00013	€ 0,00020	€ 0,00025
Carbon-14	€ 0,00185	€ 0,00287	€ 0,00373
Cesium-137	€ 0,00184	€ 0,00286	€ 0,00371
Hydrogen-3, Tritium	€ 0,00093	€ 0,00143	€ 0,00186
Iodine-129	€ 0,00075	€ 0,00116	€ 0,00150
Iodine-133	€ 0,00105	€ 0,00162	€ 0,00211
Krypton-85	€ 0,00511	€ 0,00792	€ 0,01029
Radon-222	€ 0,00002	€ 0,00002	€ 0,00003
Thorium-230	€ 0,00222	€ 0,00345	€ 0,00448
Uranium-234	€ 0,00028	€ 0,00043	€ 0,00056
Uranium-235	€ 0,00103	€ 0,00160	€ 0,00208
Uranium-238	€ 0,00288	€ 0,00446	€ 0,00579
Lead-210	€ 0,00222	€ 0,00344	€ 0,00447
Polonium-210	€ 0,00222	€ 0,00344	€ 0,00447
Radium-226	€ 0,00222	€ 0,00344	€ 0,00447

6.11 Noise

6.11.1 Description of midpoint and sources

Ambient noise is a major environmental problem with a range of impacts on people's well-being and health as well as on the natural world. As traffic is the main source, most valuation studies are concerned with this type of noise (EY, 2016; (Navrud, 2002) with only limited research on noise from other sources like building sites, industry, public events and neighbours. Given this lack of data, this Handbook focuses solely on valuation of traffic noise, making a distinction between road, rail and air traffic.

6.11.2 Impacts

Five deleterious impacts of ambient noise can be distinguished (Defra, 2014):

- **Nuisance:** noise can cause people nuisance in many ways, discouraging or preventing them from performing certain activities, for example, and leading to a range of negative emotions like irritation, disappointment, dissatisfaction, a feeling of helplessness or depression (WHO, 2011). It can also lead to stress-related psychological and physical complaints such as fatigue, stress and abdominal pains. In some studies all these impacts are regarded as health impacts (e.g. Defra, 2014; IGCB, 2010)[80], while in others an explicit distinction is made between nuisance and health impacts (e.g.Bristow, et al., 2015; Nelson, 2008).

[80] This is in line with the broad definition of health employed by the WHO: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 2011).

- **Health impacts:** there is a growing body of evidence that noise can impact human health in a variety of ways. WHO (2011) distinguishes the following:
  - *Cardiovascular disease*: ambient noise can contribute to various forms of cardiac disease (including acute heart failure) and elevated blood pressure (hypertension). Noise-related high blood pressure can also lead to strokes and dementia (Harding, et al., 2011). These health impacts have been correlated mainly with traffic noise.
  - *Sleep nuisance*: there is copious scientific evidence for sleep (quality) being adversely affected by ambient noise. Besides the direct impacts (stress responses, time slept, number of nighttime waking episodes) there are also impacts the following day(s) (e.g. fatique, reduced cognitive performance) and long-term impacts (chronic sleep deprivation).
  - *Reduced cognitive performance*: particularly for aircraft noise, there is good evidence that this can affect children's and adolescents' school performance and memory. Exposure to such noise at crucial educational moments may influence children's cognitieve development, with potentially life-long consequences.
  - *Tinnitus*: exposure to especially high noise levels can cause tinnitus or 'phantom noise', a condition in which one hears a hissing, whistling, buzzing or 'beeping' sound in one or both ears in the absence of an external noise source. This impact is scarcely treated in the literature.
  - *Damaged hearing*: there is as yet little scientific evidence for ambient noise causing chronic hearing damage.
- **Productivity loss:** noise can reduce workplace performance for a variety of reasons, including concentration problems, fatigue due to noise-related sleep problems, noise-related learning issues in children and adolescents, leading to a lower education level, and absence from work due to noise-related health complaints (TRL, 2011). These impacts are scarcely treated in the literature. There is, moreover, a risk of some of the above health impacts (like sleep nuisance) being double-counted. These impacts are therefore not included separately here.
- **Nuisance in quiet areas:** Anastasopoulos et al. (2011) have pointed out that ambient noise may reduce people's enjoyment of the benefits of quiet areas like city parks and woods, implying a loss of economic welfare. These costs of ambient noise have barely been researched, however, and have consequently been ignored here.
- **Ecosystem impacts:** there is growing evidence that ambient noise has deleterious impacts on wild animals, by disturbing breeding patterns, for example (Dutilleux, 2012). Here too this is only fledgling research, though, with no reliable monetary values available. Again, these impacts have been ignored here.

Based on the above review we conclude that it is only for the first two categories, nuisance and health impacts, that there is sufficient scientific evidence for deriving cost factors. The economic valuation of these two impacts is therefore discussed in greater detail in the next two sections.

6.11.3 Noise indicators

The unit most commonly used for measuring noise nuisance is the A-weighted decibel dB(A). The decibel is a measure of noise level, and 'A-weighting' is applied to correct for the sensitivity of the human ear to noise pitch.

Besides intensity and pitch, the time and duration of the noise are also important factors, and these are also included in the noise indicator adopted here. There are numerous such indicators, differing in how they account for the influence of the various factors. In this Handbook we use the unit Lden ('den' referring to day, evening, night), the current legal standard for measuring traffic noise in the Netherlands. Lden is calculated by establishing 'equivalent' noise levels in the day (07:00-19:00 h), evening (19:00-23:00 h) and night (23:00-07:00 h), raising evening and night levels by 5 and 10 dB(A), respectively, then calculating the 24-hour average. This indicator thus takes evening and nighttime noise to be more of a nuisance than daytime noise.

6.11.4 Monetary valuation

In this section we present our main conclusions and recommendations with respect to the valuation of noise. In the Dutch Handbook an Annex is included which explains issues in a bit more detail.

Methodology in the 2010 Handbook

In the 2010 Shadow Prices Handbook valuation of traffic noise was based on HEATCO (2006), with a distinction made between road, rail and air traffic, as people experience these three kinds of noise differently. Miedema and Oudshoorn (2001) report how people consider aviation noise to be 'worse' than road-traffic noise, and rail-traffic noise to be less of a nuisance than that of road traffic (the reason why HEATCO (2006) applied a 5 dB 'rail bonus').

In their damage costs for noise, HEATCO (2006) includes only the costs of nuisance and health impacts, in the absence of reliable cost estimates for other deleterious impacts.

New findings

Since the 2010 Handbook there have been several major new findings with respect to noise valuation:

- The marginal costs of noise nuisance (in € per dB) increase with rising noise level: if the level is already high, an extra dB leads to more additional costs than at lower levels. This effect has been demonstrated in a range of studies, including Bristow et al. (2015), Udo et al. (2006), Theebe (2004) and WHO (2011).
- There is evidence of noise nuisance occurring even at noise levels below 50 dB (WHO, 2011). It is unclear, however, whether the results of most valuation studies are also applicable to these lower levels.
- There is new epidemiological literature (WHO, 2011) on the health impacts of noise, including analyses of the risk and magnitude of various forms of cardiovascular disease (including strokes and dementia due to elevated blood pressure).
- There is evidence of health impacts occurring even at noise levels below 70 dB (WHO, 2011; Defra, 2014).
- There is evidence of health impacts increasing with rising noise levels (WHO, 2011; Defra, 2014). In other words, the marginal costs of health impacts rise with noise levels.

Valuation in this Handbook

With respect to the nuisance caused by noise, following an analysis of the available literature (cf. Section 5.6), in this Handbook we have opted to base our prices on the results of Bristow et al. (2015). These results are in turn based on a recent, extensive meta-analysis of stated-preference studies on noise-nuisance valuation. These values are also reasonably in line with the average values of noise nuisance found in revealed-preference studies[81]. In an annex to the Dutch version of this Handbook an illustrative case study is used to calculate that these studies yield an average WTP of € 75 per person per dB per annum. One should notice that in the calculation of noise impacts we have opted for taking an income elasticity of 0.85. Similar to the argumentation on the valuation of nature, we assume here that scilence does not become more available due to technological progress but tends to become more scarce over time. Therefore, a positive income elasticity is assumed, in line with the approach taking in the European Handbook on estimation of external costs (CE Delft and INFRAS, *forthcoming).*

Table 38 **Environmental prices for noise nuisance: central values, with lower and upper values bracketed (€$_{2015}$ per dB (L_{den}) per person per annum)**

Noise level	Nuisance	Health	Total
Road traffic			
50-54 dB(A)	18 (15-21)	4 (3-6)	22 (18-27)
55-59 dB(A)	37 (31-43)	5 (4-7)	42 (36-50)
60-64 dB(A)	37 (31-43)	8 (7-13)	45 (38-56)
65-69 dB(A)	70 (59-81)	13 (10-20)	83 (69-101)
70-74 dB(A)	70 (59-81)	17 (14-27)	87 (73-108)
75-79 dB(A)	70 (59-81)	22 (18-35)	92 (77-116)
>= 80 dB(A)	70 (59-81)	25 (19-39)	95 (78-120)
Rail traffic			
50-54 dB(A)	0	4 (3-6)	4 (3-6)
55-59 dB(A)	18 (15-21)	5 (4-8)	23 (19-29)
60-64 dB(A)	37 (31-43)	9 (7-14)	46 (38-57)
65-69 dB(A)	37 (31-43)	13 (10-20)	50 (41-63)
70-74 dB(A)	70 (59-81)	18 (14-28)	88 (73-109)
75-79 dB(A)	70 (59-81)	23 (18-36)	93 (77-117)
>= 80 dB(A)	70 (59-81)	25 (20-39)	95 (79-120)
Aviation			
50-54 dB(A)	44 (37-51)	7 (6-11)	51 (43-62)
55-59 dB(A)	88 (74-102)	8 (6-13)	96 (80-115)
60-64 dB(A)	88 (74-102)	12 (9-19)	100 (83-121)
65-69 dB(A)	167 (141-194)	16 (13-26)	183 (154-220)
70-74 dB(A)	167 (141-194)	21 (17-33)	188 (158-227)
75-79 dB(A)	167 (141-194)	26 (21-42)	193 (162-236)
>= 80 dB(A)	167 (141-194)	29 (23-45)	196 (164-239)

As Table 38 makes clear, the recommended values for noise nuisance increase with rising noise levels. This is in line with current scientific understanding of this issue, as well as with the values officially prescribed in certain other EU countries (Denmark, UK, Sweden).

For the health impacts of noise we used the results of Defra (2014), translated to the European situation. These results are based directly on recent epidemiological findings published by the WHO (2011). In contrast to the 2010 Shadow Prices Handbook, the new values now also factor in health impacts occurring below 70 dB. The ranges in the health-impact values given reflect the range adopted in this Handbook for valuing DALYs.

81 These are mainly studies using hedonic pricing, with the willingness-to-pay for noise abatement being derived from variation in house prices.

In valuing these health impacts we have ignored the costs of sleep nuisance, to avoid overlap with the costs of noise nuisance itself. Like HEATCO (2006) we assume that people are aware of the sleep-nuisance impacts of noise and that the associated costs are therefore included in the WTP-values for overall nuisance.
As a threshold value for both health and nuisance impacts we recommend adopting 50 dB(A), in line with the recommendations in the 2010 Handbook. Although nuisance is also known to occur at lower noise levels (WHO, 2011; EEA, 2010) it is insufficiently clear to what extent valuation studies also deliver reliable values at these levels, too.

Finally, Table 38 shows that the environmental prices for noise differ according to the type of traffic involved, with the highest prices holding for aircraft noise and the lowest for rail noise. This differentiation is in line with the acoustic literature, which provides a great deal of evidence that people deem aircraft noise 'worse' than road-traffic noise, and rail noise least 'bad'.

6.12 Land use

6.12.1 Description of midpoint and impacts

Large-scale agriculture and residential and industrial development all have impacts on the theme of land use (change). If these impacts harm nature and biodiversity, this means a loss of economic welfare. By examining ecosystem services as a function of land use, a value can be assigned to land use (change).

6.12.2 Treatment in the 2010 Handbook

In 2010 the damage costs of land use were determined using the approach adopted in NEEDS for valuing ecosystems: the Potentially Disappeared Fraction of species (see Section 5.4). Data on the relative species diversity of various kinds of land use were taken from ReCiPe (Goedkoop, et al., 2013), which distinguishes 18 types of land use. These biodiversity figures are averages for Europe. For valuing land use, the average value of the PDF reported in Kuik et al. (2008) was used: € 0.47 per PDF/m^2 (2004 prices). By multiplying the impacts of land-use change on the PDF (the characterization factor, in the hierarchist perspective) by the PDF-value, the external costs associated with each type of land use were calculated. These were weighted for the European situation according to the distribution of land use in Europe from the LUCAS project.

Land use also affects crop revenues, as it pushes up land prices. As this impact probably counts as a pecuniary externality (and thus only a transfer of welfare), this was not included in the 2010 Handbook.

In the 2010 Shadow Prices Handbook the value provided for PDF/m^2 was erroneously set equal to the value for PDF/m^2/year. As a result, land use featured as a very dominant factor in LCA calculations performed using the old Handbook. In practice this led to land use not being adopted as a midpoint when calculating shadow prices.

6.12.3 Valuation in this Handbook

In this Handbook we employ the same method as in the 2010 Handbook, using ReCiPe characterization factors for the hierarchist perspective to derive values for species diversity for each type of land use.[82]

Compared with the 2010 Handbook, valuation has here been adjusted on four points:
- The value per PDF has been adjusted (see Section 5.3.5).
- The value for land use is no longer reported in m^2, but in m^2/year, in line with the units used in LCAs.
- Using the Eurostat LUCAS database, a conversion was carried out to arrive at a value specifically for the EU28. This allowed more land-use categories to be distinguished, so categorization is now more refined than in the 2010 Handbook.
- In setting the price for the midpoint weighting factor (for use in LCAs) it was decided not to base valuation on specific EU28 data, but to use global data based on the ReCiPe endpoint characterization factors for agricultural and urban land occupation. This was done because in LCAs the category 'land use' also covers land use outside the EU28. Biodiversity was therefore calculated in relation to land use at the global level using a simplified model (discussed in an Annex E to the Dutch version). In doing so, specifically EU28 values were used, however.[83]

The PDF-values of impacts of land-use changes remain the same; see (Goedkoop, et al., 2013). Table 39 reports the adjusted values for land use in the EU28.

Table 39 Average values for land use in the EU28 for use as external costs (€$_{2015}$ per m^2 per annum)

	EU28 percentage	Central value	Upper value	Lower value
Intensive crops/weeds	27%	0.106	0.863	0.032
Monoculture broadleaf, mixed forest and woodland	26%	0.050	0.409	0.015
Coniferous forest	14%	0.073	0.591	0.022
Mixed plantations	7%	0.088	0.714	0.027
Extensively-managed grassland	7%	0.055	0.448	0.017
Intensive fertile grassland	15%	0.074	0.597	0.022
Continuous urban	4%	0.112	0.909	0.034
EU28 average	**100%**	**0.084**	**0.685**	**0.025**

Source: Eurostat, own calculations.

On this basis a figure of € 0.084/m^2/yr has been taken as the central value, € 0.025/m^2/yr as the lower value based on restoration costs and € 0.685/m^2/yr as the upper value. The wide range in differences between the lower and upper value reflects the great margin of uncertainty involved in valuing impacts of land use on biodiversity.

82 As the individualist perspective is based solely on temporarily reversible impacts, the hierarchist perspective was deemed to be more in line with the general practice of land use in Europe.

83 To our mind this choice is most in line with the hierarchist perspective adopted in LCAs.

To calculate the midpoint characterization factor we proceeded from the central value and translated this into a implicit value per species.
By multiplying this value by the ReCiPe endpoint factor (for 'Occupation, unknown') in species.yr/m^2 we obtained a value in line with PDF-valuation according to the hierarchist perspective. Table 40 reports the environmental prices for the midpoint characterization factor for global land occupation, valued as if that land use were in the EU28. This value is the same for for Agricultural Land Occupation and Urban Land Occupation (ALO/ULO) — as the characterization factor in ReCiPe in terms of species.yr is similar for these two. The resulting environmental price is equivalent to € 0.126/m^2/yr (rounded) for the hierarchist characterization perspective.

Table 40 **Average environmental prices for land use in the EU28 for use as midpoint characterization factor (€$_{2015}$ per m^2 and per m^2 per annum)**

Midpoint unit	€/m^2*	€/m^2/yr
Agricultural Land Occupation	€ 3.23	€ 0.126
Urban Land Occupation	€ 3.23	€ 0.126

Note: * €/m^2 gives the undiscounted value of land-use change over a 50-year period. This is the value presented in the 2010 Shadow Prices Handbook as land-use factor. For use in LCAs this factor must be converted to an annual figure, however. In line with NEEDS (2006) the monetary value has been discounted at 3% p.a. over 50 years.

One should notice that the environmental prices for the EU28 are higher than earlier reported for the Netherlands because of the different approach that has been taken in the present study.

7 References

Aalbers, R., Renes, G. & Romijn, G., 2016. *WLO-klimaatscenario's en de waardering van CO2-uitstoot in MKBA's*, Den Haag: Centraal Planbureau (CPB) ; Planbureau voor de Leefomgeving (PBL).

AEA, 2005. *Methodology for the Cost-Benefit analysis for CAFE. Vol. 2: Health Impact Assessment*, Didcot: AEA, Technology Environment (AEA).

Allacker, K. & Nocker, K. D., 2012. Approach for Calculating the Environmental External Costs of the Belgian Building Sector. *Journal of Industrial Ecology*, Volume 16, p. 710-721.

Anastasopoulos, C. et al., 2011. *The Economic Value of Quiet Areas, final report*, London: URS/Scott Wilson.

Andersson, H., Jonsson, L. & Ögren, M., 2013. Benefit measures for noise abatement: calculations for road and rail traffic noise. *European Transport Research Review*, 5(3), pp. 135-148.

Andersson, H., Olsson, L. & Ögren, M., 2010. Property Prices and Exposure to Multiple Noise Sources: Hedonic Regression with Road and Railway Noise. *Environmental and Resource Economics*, 45(1), p. 73-89.

Arrow, K. e. a., 1993. Report of the NOAA panel on contingent valuation. *Federal Register 58 (10), 4601-4614.*

Bal, K. et al., 2002. *Bepaling van de milieuschadekosten aan historische gebouwen in Antwerpen door SO2 en roetpollutie*, sl: sn

Barendregt, J., Bonneux, L. & Maas, P. v., 1996. DALYs: the age-weights on balance. *Bulletin of the World Health Organization*, 74(4), pp. 439-443.

Barnett, H. & Morse , C., 1963. *Scarcity and Growth : The Economics of Natural Resource Availability*. 3 (1973) ed. Baltimore: John Hopkins University Press.

Bateman, I., Day, B., Lake, I. & Lovett, A., 2001. *The Effects of Road Traffic on Residential Property Values : A Literature Review and Hedonic Pricing Study*, s.l.: UEA ; ESRC : UCL.

Bateman, I. J. et al., 2002. *Economic Valuation With Stated Preference Techniques: A Manual*. sl:Edward Elgar.

Bellanger, M. et al., 2013. Economic benefits of methylmercury exposure control in Europe: Monetary value of neurotoxicity prevention. *Environmental Health* , Issue Online.

Bergh, J. v. d. & Botzen, W., 2015. Monetary valuation of the social cost of CO2 emissions : A critical survey. *Ecological Economics*, 114(C), pp. 33-46.

Bijlenga, D., Bonsel, G. & Birnie, E., 2011. Eliciting willingness to pay in obstetrics: comparing a direct and an indirect valuation method for complex health outcomes. *Health Economics*, 20(11), pp. 1392-1406.

Blanco, J. & Flindell, L., 2011. Property prices in urban areas affected by road traffic noise. *Applied Acoustics*, Volume 72, pp. 133-141.

Boardman, A., Greenberg, D., Vining, A. & Weimer, D., 2014. *Cost-Benefit Analysis: Concepts and Practice.* 4th red. London: Pearson Education Limited (UK).

Brink, C. & Grinsven, H. v., 2011. Costs and benefits of nitrogen in the environment. In: *The European Nitrogen Assessment : Sources, effects and perspectives.* Cambridge: Cambridge University Press, p. Chapter 22 .

Bristow, A. L., Wardman, M. & Chintakayala, V. P. K., 2015. International meta-analysis of stated preference studies of transportation noise nuisance. *Transportation,* 42(1), pp. 71-100.

Bruitparif; ORS Ile-de-France; WHO, 2011. *Health impact of noise in the Paris agglomeration: quantification of healthy life years lost,* sl: Bruitparif.

Bruyn, S. d., 2000. *Economic growth and the environment : an empirical analysis.* Boston: Kluwer Academic Publishers.

Buck Consultants, 2012. *MKBA Wilhelminakanaal fase 1,5,* Nijmegen: Buck Consultants International.

Carson, R. et al., 1997. Temporal reliability of estimates from contingent valuation. *Land Economics,* 73(2), pp. 151-163.

Carson, R. T., 2000. Contingent Valuation : a User's guide. *Environmental Science & Technology,* 34(8), pp. 1413-1418.

CBS, 2016. *Bevolking per maand; leeftijd, geslacht, herkomst, generatie.* [Online]
Available at:
http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=71090ned&D1=0&D2=0&D3=0-100&D4=0&D5=0&D6=99-107%2c111-120&HDR=T%2cG3%2cG1%2cG2&STB=G4%2cG5&VW=D
[Geopend 9 maart 2017].

CE Delft; INFRAS; Fraunhofer-ISI; University of Gdansk, 2008. *Handbook on the estimation of external costs in the transport sector, Produced within the study Internalisation Measures and Policies for all external cost of Transport (IMPACT) - Deliverable 1,* CE Delft: Delft.

CE Delft, 1997. *Schaduwprijzenprioriteringsmethodiek,* Delft: CE Delft.

CE Delft, 1999. *Efficiënte prijzen voor het wegverkeer, raming van maatschappelijke kosten van het gebruik van verschillende vervoermiddelen,* Delft: CE Delft.

CE Delft, 2002. *Update schaduwprijzen, financiële waardering van milieu-emissies op basis van Nederlandse overheidsdoelen,* Delft: CE Delft.

CE Delft, 2010. *Handboek Schaduwprijzen : Waardering en weging van emissies en milieueffecten,* Delft: CE Delft.

CE Delft, 2011. *Benefito : Description of the Excel tool and user manual,* Delft: CE Delft.

CE Delft, 2014. *Kennisoverzicht luchtvaart en klimaat,* Delft: CE Delft.

CE Delft, 2017. *Guidelines for Environmental SCBAs (only available in Dutch) ,* Delft: CE Delft.

Chanel, O. & Luchini, S., 2014. Monetary values for risk of death from air pollution exposure : A context-dependent scenario with a control for intrafamilial altruism. *Journal of Environment Economics and Policy,* 3(1), pp. 67-91.

Constanza, R. et al., 1997. The value of the world's ecosystem services and natural capital. *Nature,* 387(15 May), pp. 253-260.

CPB ; PBL, 2015c. *Toekomstverkenning Welvaart en Leefomgeving : Cahier Klimaat en energie* , Den Haag: Centraal Planbureau (CPB) en Planbureau voor de Leefomgeving (PBL)..

CPB; PBL, 2013. *Algemene leidraad voor maatschappelijke kosten-batenanalyse,* Den Haag: CPB/PBL.

CPB; PBL, 2015a. *Toekomstverkenning Welvaart en Leefomgeving : Nederland in 2030 en 2050 : Twee referentiescenarios,* Den Haaf: Centraal Planbureau (CPB) ; Planbureau voor de Leefomgeving (PBL).

CPB; PBL, 2015b. *Toekomstverkenning Welvaart en Leefomgeving : Cahier Demografie,* Den Haag: Planbureau voor de Leefomgeving (PBL).

Dalal, K. & Svanström, L., 2015. Economic Burden of Disability Adjusted Life Years (DALYs) of Injuries. *Health,* Volume 7, pp. 487-494.

Day, B., Bateman, I. & Lake, I., 2007. Beyond implicit prices: recovering theoretically consistent and transferable values for noise avoidance from a hedonic property price model. *Environmental and Resource Economics,* 37(1), p. 211-232.

Defra, 2014. *Environmental noise - Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet,* London: Department for Environment, Food & Rural affairs (Defra).

Dekkers, J. & Van der Straaten, W., 2008. *Monetary Valuation of Aircraft Noise,* Amsterdam: Tinbergen Institute.

Desaigues, B. et al., 2011. Economic valuation of air pollution mortality: A 9-country contingent valuation survey of value of a life year (VOLY). *Ecological Indicators,* Volume 11, pp. 902-910.

Dutilleux, G., 2012. Anthropogenic outdoor sound and wildlife: it's not just bioacousticsl. *Proceedings Acoustics,* pp. 2301-2306.

EC, 2005. *Communication from the Commission to the Council, the European Parliament, the EEESC and the Committee of the Regions - Thematic Strategy on the sustainable use of natural resources {SEC(2005) 1683} {SEC(2005) 1684} /* COM/2005/0670 final,* Brussels: European Commission (EC).

EC, 2009a. *Impact Assessment Guidelines.* [Online]
Available at: http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf
[Accessed 2014].

EC, 2009b. *Part III : Annexes to impact Assessment Guidelines,* Brussels: European Commission (EC).

EC, 2011. *Tackling The Challenges In Commodity Markets And On Raw Materials. Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions, COM/2011/0025 final* , Brussels: European Commission (EC).

EC, 2013. *EU Energy, transport and GHG emissions trends to 2050 : Reference Scenario 2013,* Brussels: European Commission, DG. Energy.

EC, 2014a. *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions : Towards a circular economy: A zero waste programme for Europe. COM(2014) 398 final*, Brussels: European Commission (EC).

EC, 2014b. *Impact Assessment Accompanying the Communication, A policy framework for climate and energy in the period from 2020 up to 2030, XXX draft*, Brussels: European Commisssion (EC).

ECN; SEO, 2013. *Naar een breder afwegings- en reguleringskader voor investeren in interconnectoren: de Maatschappelijke Kosten-Baten Analyse (MKBA)*, Petten: ECN.

Ecofys, 2014. *Subsidies and costs of EU energy : Annex 3*, sl: Ecofys (by order of European Commission).

Ecoplan and INFRAS, 2014. *Externe Effekte des Verkehrs 2010 : Monetarisierung von Umwelt-, Unfall- und Gesundheitseffekten : Schlussbericht* , Bern: Ecoplan.

EEA, 2005. *Sustainable use and management of natural resources*, Copenhagen: European Environment Agency.

EEA, 2010. *Good practice guide on noise exposure and potential health effects*, Copenhagen: European Environment Agency.

EEA, 2011. *An experimental framework for ecosystem capital accounting in Europe*, Copenhagen: European Environment Agency (EEA).

EU Working Group on Health and Socio-economic Aspects, 2003. *Valuation of Noise : Position paper, Brussels* , Brussels: European Union.

ExternE, 2005. *Externalities of Energy, Methodology (ExternE), 2005 update*, Luxembourg: European Commission.

Fantke, P., 2008. *Appendix: Parameterisation of the enviornmental fate and exposure models of WATSON*, Stuttgart: Institute of Energy Economics and Rational Use of Energy.

Fantke, P., 2012. *2012.Health Impact Assessment of Pesticide Use in Europe. Von der Fakultät Energie-, Verfahrens- und Biotechnik der Universität Stuttgart*, Stuttgart: Fakultät Energie-, Verfahrens- und Biotechnik der Universität Stuttgart.

FAOSTAT, 2014. *Productieprijzen gewassen 2014.* [Online]
Available at: http://faostat3.fao.org
[Geopend 4 Oktober 2016].

Fraser, P. J. et al., 2015. *Australian & Global Emissions of Ozone Depleting Substances.* [Online]
Available at:
https://www.environment.gov.au/system/files/resources/1b3c0ae6-e2ec-440a-b147-4d868f0da01f/files/australian-global-emissions-ods-2015.pdf
[Geopend 3 10 2016].

Fuglestvedt, J. et al., 2010. Transport impacts on atmosphere and climate : Metrics. *Atmospheric Environment*, Volume 44, pp. 4648-4677.

Gerlagh, R., Bijgaart, I. v. d. & Liski, M., 2014. *Een eenvoudige formule voor de maatschappelijke kosten van CO2*, s.l.: Tilburg University ; Aalto University.

Getzner, M. & Zak, D., 2012. Health Impacts of Noise Pollution Around Airports: Economic Valuation and Transferability. In: J. Oosthuizen, ed. *Environmental Health - Emerging Issues and Practice.* s.l.:Intech, pp. 247-272.

Gezondheidsraad, 2000. *Radon : Toetsing rapport 'Beir VI'*, Den Haag: Grzondheidsraad.

GHF, 2009. *Human Impact Report : Climate Change - The Anatomy of A Silent Crisis*, Geneva: Global Humanitarian Forum (GHF).

Global Health Data Exchange, 2010. *Global Burden of Disease Study 2010 (GBD 2010) Disability Weights.* [Online]
Available at: http://ghdx.healthdata.org/record/global-burden-disease-study-2010-gbd-2010-disability-weights
[Geopend 2016].

Goedkoop, M. et al., 2009. *ReCiPe 2008, A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level, First edition (version 1.08)*, Den Haag: Ministerie van Volkshuisvesting en Milieubeheer (VROM), Ruimte en Milieu.

Goedkoop, M. et al., 2013. *R. ReCiPe 2008, A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level; First edition (version 1.08) Report I: Characterisation*, Den Haag: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milkieubeheer (VROM).

Grinsven, H. J. et al., 2013. Costs and benefits of nitrogen for Europe and implications for mitigation. *Environmental Science & Technology*, 47(8), p. 3571-3579.

Grinsven, H. J. v., Rabl, A. & Kok, T. M. d., 2010. Estimation of incidence and social cost of colon cancer due to nitrate in drinking water in the EU: a tentative cost-benefit assessment. *Environmental Health*, October(Online).

Guinée, J. et al., 2002. *Handbook on life cycle assessment. Operational guide to the ISO standards..* Dordrecht: Kluwer Academic Publishers.

Hardin, G., 1968. The tragedy of commens. *Science*, 162(3859), pp. 1243-1248.

Harding, A.-H.et al., 2011. *Quantifying the links between environmental noise related hypertension and health effects*, Buxton(UK): Health and safety laboratory.

Hayashi, K., Nakagawa, A., Itsubo, N. & Inaba, A., 2006. Expanded Damage Funcion of Stratosheric Ozone Depletion to Cover Major Endpoint Regarding Life Cycle Impact Assessment. *The International Journal of Life Cycle Assessment*, 11(3), pp. 150-161.

HCCS; TNO; CE Delft, 2011. *Op weg naar een Grondstoffenstrategie ; Quick scan ten behoeve van de Grondstoffennotitie*, Den Haag: Het Den Haag Centrum voor Strategische Studiës (HCSS).

HEATCO, 2006. *Developing Harmonised European Approaches for Transport Costing and Project Assessment (HEATCO). Deliverable D5: Proposal for Harmonised Guidelines*, Stuttgart: IER, University of Stuttgart.

Hoevenagel, R., 1994. *The contingent valuation method : scope and validity*, Amsterdam: Free University.

Hoevenagel, R. & De Bruyn, S., 2008. Nog weinig waardering voor milieuwaardering. In: F. Ooosterhuis, red. *Aan schaarste geen gebrek.* sl:sn, pp. 31-42.

Holland, M., 2014. *Cost-benefit Analysis of Final Policy Scenarios for the EU Clean Air Package Version 2 Corresponding to IIASA TSAP Report 11, Version 1*, sl: EMRC.

Holland, M. et al., 1998. *The effects of ozone on materials*, London: Department of the Environment, Transport and the Regions (DETR).

Horowitz, J. & McConell, K., 2002. A Review of WTA/WTP Studies. *Journal of Environmental Economics and Management*, Volume 44, pp. 426-427.

Hotelling, H., 1931. The Economics of Exhaustible Resources. *The Journal of Political Economy*, 39(2), pp. 137-175.

Hubbell, B., 2006. Implementing QALYs in the Analysis of Air Polution Regulations. *Environmental &Resource Economics*, 34(3), pp. 365-384.

Hubbell, B. J., 2002. *Implementing QALYs in the Analysis of Air Pollution Regulations : QALY Paper for Environmental and Resource Economics , Draft May*, sl: U.S. Environmental Protection Agency (EPA).

Hueting, R., 1980. *New scarcity and economic growth*. English ed. Amsterdam: North-Holland Publishing Company.

Humbeeck, P. v., Nocker, L. D., Panis, L. I. & Torfs, R., 2000. Baten van milieumaatregelen en milieubeleid : begrippen, definities en methoden. In: VMM, red. *MIRA-S 2000 Gevolgen voor de Economie*. Mechelen: Vlaamse Milieumaatschappij (VMM), pp. 1-23.

Humblot, P. et al., 2013. Assessment of ozone impacts on farming systems: A bio-economic modeling approach applied to the widely diverse French case. *Ecological Economics*, Volume 85, pp. .50-58.

Hunt, A. & Arnold, S., 2009. *National and EU-Level Estimates of Energy Supply Externalities*. [Online]
Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1395667
[Geopend 2016].

Huppes, G. et al., 2007. Eco-efficient environmental policy in oil and gas production in The Netherlands. *Ecological Economics*, 61(1), pp. 43-51.

IGCB, 2010. *Noise & Health : Valuing the Human Health Impacts of Environmental Noise Exposure*, sl: The Interdepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)).

IIASA, 2014. *A flexibility mechanism for complying with national emission ceilings for air pollutants. TSAP report #15*, Laxenburg: International Institute for Applied Systems Analysis (IIASA).

IPCC, 2007. Summary for Policymakers. In: S. Solomon, et al. eds. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge ; New York: Cambridge University Press.

IPCC, 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press.

Istamto, T., Houthuijs, D. & Lebret, E., 2014. Multi-country willingness to pay study on road-traffic environmental health effects: are people willing and able to provide a number?. *Environmental Health*, Issue Online.

IVM, 2013. *The total economic value of nature on Bonaire: Exploring the future with an ecological-economic simulation*, Amsterdam: Institute for Environmental Studies (IVM).

Jacobsen, S., 2016. *Fosfaatrecht geen 4.000 tot 5.000 euro waard.* [Online] Available at: http://www.melkvee.nl/nieuws/9984/-fosfaatrecht-geen-4000-tot-5000-euro-waard-
[Geopend 2017].

JRC, 2012. *JRC Reference Report on the International Reference Life Cycle Data System (ILCD) Handbook*, Luxembourg: Publications Office of the European Union.

Kahneman, D. &. T. A., 1979. Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the econometric society*, pp. 263-291.

Kahneman, D., Knetsch, J. L. & Thaler, R. H., 1990. Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy*, 98(6), pp. 1325-1348.

Kloosterhuis, E. & Mulder, M., 2013. *Competition law and environmental protection : the Dutch Agreement on coal-fired power plants, Paper prepared for the 9th annual Competition & Regulation Meeting, ACLE, 12 december.* Amsterdam, sn

KPMG, 2015. *Introducing KPMG Treu Value : a tool to connect corporate and societal value creation.* [Online]
Available at:
https://home.kpmg.com/content/dam/kpmg/ae/pdf/introduction-kpmg-truevalue.pdf
[Accessed 2017].

Krupnick (ed.), A., Ostro, B. & Bull, K., 2004. *Peer review of the methodology of cost-benefit analysis of the Clean Air for Europe programme*, Brussels: European Commission , DG Environment.

Kuik, O. et al., 2008. *Report on the monetary valuation of energy related impacts on land use, D.3.2. CASES Cost Assessment of Sustainable Energy Systems, updated july 2008*, s.l.: s.n.

Kuik, O. et al., 2007. *Cost Assessment of Sustainable Energy Systems (CASES) : D. 3.2 Report on the monetary valuation of energy related impacts on land use changes, acidification, eutrophication visual intrusion and climate change*, Amsterdam: Institute for Environmental Studies (IVM).

Kuik, O., Brander, L. & Tol, R., 2009. Marginal abatement costs of greenhouse gas emissions : A meta-analysis. *Energy Policy*, 37(4), pp. 1395-1403.

Lee, D. et al., 2010. Transport impacts on atmosphere and climate : Aviation. *Atmospheric Environment*, 44(37), pp. 4678-4734.

Lijesen, M. et al., 2010. How much noise reduction at airports?. *Transportation Research Part D: Transport and Environment*, 15(1), pp. 51-59.

Mcdonnell, W. et al., 2000. Relationships of mortality with the fine and coarse fractions of long-term ambient PM10 concentrations in nonsmokers. *Journal of Exposure Analysis and Environmental Epidemiology*, 10(5), pp. 427-436.

Meadows, D. H., Meadows, D. L., Randers, J. & Behrens III, W. W., 1972. *The limits To Growth*, Falls Church (USA): Potomac Associates .

METHODEX, 2007. *Methods and data on environmental and health externalities: harmonising and sharing of operational estimates (Closed Cordis Project)*, Brussels: European Commission (EC).

Miedema, H. & Oudshoorn, C., 2001. Annoyance from transportation noise : relationships with exposure metrics DNL and DENL and their confidence intervals. *Environmental Health perspectives*, 109(4), p. 409-416.

Ministerie van Financiën, 2015. *Rapport Werkgroep Discontovoet 2015*, Den Haag: Ministerie van Financiën.

Mouter, N. & Chorus, C., 2016. Value of Time : a citizen Perspective. *Transportation Research*, 91(Part A: Policy and Practice), pp. 317-329.

Murray, C., 1994. Quantifying the burden of disease: the technical basis for disability-adjusted life years. *Bulletin World Heathe Organization*, 72(3), pp. 429-445.

Murray, C. J. L. et al., 2012. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, 380(December), pp. 2197-2223.

Murray, C., Lopez, A. & Jamison, D., 1994. The global burden of disease in 1990: summary results, sensitivity analysis and future directions. *Bulletin World Health Organization*, 72(3), pp. 495-509.

Navrud, S., 2002. *The state-of-the-art on economic valuation of noise*, Oslo: s.n.

NEEDS, 2006. *Assessment of Biodiversity Losses, NEEDS deliverable D.4.2.-R.S. 1b/WP4, priority 6.1: Sustainable Energy Systems and, more specifically Sub-priority 6.1.3.2.5: Socio-economic tools and concepts for energy stragegy.* [Online]
Available at: http://www.needs-project.org/docs/results/RS1b/RS1b_D4.2.pdf
[Accessed 2017].

NEEDS, 2007a. *Value Transfer Techniques and Expected uncertainties. Deliverable No 2.2-RS 3a. Priority 6.1: Sustainable Energy Systems and more specifically Sub-priority 6.1.3.2.5. etc.....*, Brussels: European Commission.

NEEDS, 2007b. *Final report on casual links between pollutants and health impacts. Deliverable RS 1b D 3.7. : A set of concentration-response functions. (...),Sub-priority 6.1.3.2.5: Socio-economic tools and concepts for energy strategy*, Brussels: European Commission.

NEEDS, 2007c. *Final repprt on the uncertainty of the transfer/generalization of externE results. New Energy Externalities Developments for Sustainability. Deliverable RS 2a D3.2 f.*, Brussels: European Commission.

NEEDS, 2007d. *NEEDS Technical paper no. RS 1b TP 7.4. Description of updated and extended draft tools for the detailed site dependent assessment of external costs*, Brussels: Europpean Commission.

NEEDS, 2008a. *NEEDS deliverable No 1.1.-RS 3a Report on the procedure and data to generate averaged/aggregated data. Priority 6.1 (...) Sub-priority 6.1.3.2.5: Socio-economic tools and cencepts for energy strategy*, Brussels: European Commission.

NEEDS, 2008b. *NEEDS deliverable D 3.2. Final report on the Uncertainty on the Transfer/Generalization og ExternE Results (revised in March 2009).*

Priority 6.1. (...) Sub-prioority 6.1.3.2.5.: Socio-economic tools and concepts for enegrgy strategy, Brussels: European Commission.

NEEDS, 2008c. *NEEDS deliverable 6.7 Final report on the monetary valuation of mortality and morbidity risks from air pollution. Priority 6.1 (...) Sub-priority 6.1.3.2.5.: Socio-economic tools and concepts for energy strategy*, Brussels: European Commission.

Nellthorp, J., Bristow, A. & Day, B., 2007. Introducing willingness-to-pay for noise changes into transport appraisal : an application of benefit transfer. *Transport reviews*, 27(3).

Nelson, J. P., 2008. Hedonic Property Value Studies of Transportation Noise: Aircraft and Road Traffic. In: Barazini, red. *Hedonic Methods in Housing Market Economics*. sl:Springer.

NewExt, 2004. *New Elements for the Assessment of External Costs from Energy Technologies, final report*, Stuttgart: University of Stuttgart.

NS, 2014. *Toelichting bij MVO berekeningen NS Jaarverslag 2013 : Beschrijving scope en berekeningswijze NS energieverbruik, CO2 uitstoot en afval in Nederland* , Utrecht: Nederlandse Spoorwegen (NS).

OECD, 2012. *The value of statistical life : a meta analysis ENV/EPOC/WPNEP(2010)9/FINAL, version 30-Jan-2012*, Paris: OECD.

OECD, 2016. *The Economic Consequences of Outdoor Pollution*, Paris: Organization for Economic Co-operation and Development (OECD).

Opschoor, H., 1974. *Economic Valuation of Environmental Pollution*. Assen: Van Gorcum.

Ott, W., Bauer, M., Iten, R. & Vettori, A., 2005. *Konsequente Umsetzung des Verursacherprinzips*, Bern: Bundesamt für Umwelt, Wald und Landschaft.

Payne, J. W., Schkade, D. A., Desvousges, W. H. & Aultman, C., 2000. Valuation of Multiple Environmental Programs. *Journal of Risk and Uncertainty*, 21(1), pp. 95-115.

PBL, 2012. *Gezondheid in maatschappelijke kosten-batenanalyses van omgevingsbeleid. Achtergrondstudie*, den Haag: Planbureau voor de Leefomgeving (PBL).

PBL, 2015. *Natuurlijk Kapitaal Nederland : natuur & economie verbinden*. [Online]
Available at: http://themasites.pbl.nl/natuurlijk-kapitaal-nederland/
[Accessed 2018].

PBL, 2016. *Wat betekent het Parijsakkoord voor het Nederlandse lange-termijn-klimaatbeleid?*, Den Haag: Planbureau voor de Leefomgeving (PBL).

PBL, 2018. *Relative Price Increase For Nature And Ecosystem Services In Cost-Benefit Analysis*, The Hague: Netherlands Environmental Assessment Agency (PBL).

Pope, C. 3. et al., 2004. Cardiovascular mortality and long-term exposure to particulate air pollution: epidemiological evidence of general pathophysiological pathways of disease. *Circulation*, Volume 109, pp. 71-77.

PRé, 2000. *The Eco-indicator 99 : a damage-oriented method for Life Cycle Impact Assessment, methodology report, second edition*, Amersfoort: PRé Consultants B.V. .

Quinet, E., 2013. *L'évaluation socioéconomique des investissements publics. Tome 1 Rapport Final Rapport de la mission présidée par Émile Quinet*, Paris: Commissariat général à la stratégie et à la prospective.

Rabl., A., 1999. Air pollution and buildings : An estimation of damage costs in France. *Environment Impact Assessment Review*, Volume 19, pp. 361-385.

Rabl, A., 1998. Mortality Risks of Air Pollution : the Role of Exposure-Response Functions. *Journal of Hazardous Materials*, Volume 61, pp. 91-98.

Rabl, A., Spadaro, J. & Holland, M., 2014. *How Much Is Clean Air Worth?: Calculating the Benefits of Pollution Control*, Cambridge: Cambridge University Press.

'Read, J., 1963. The Trail Smelter Dispute. *The Canadian Yearbook of International Law*, Volume 1, pp. 213-229.

Ricardo-AEA; DIW econ; CAU, 2014. *Update of the Handbook on external costs of transport*, London: Ricardo-AEA.

RIVM, 2001. *Composition and Origin of Airborne Particulate Matter in the Netherlands*, Bilthoven: RIVM.

RIVM, 2015. *Grootschalige concentratie - en depositiekaarten Nederland : rapportage 2015*, Bilthoven: RIVM.

SAEFL, 2003. *Monetisation of the health impact due to traffic noise*, Bern: Swiss Agency for the Environment, Forests and Landscape (SAEFL).

Sas, H., Huppes, G., Haan, E. d. & Kuyer, J., 1996. *Weegfactoren voor bedrijfsmilieuplannen NOGEPA = Weighing factors for firms' environmental policy plans in NOGEPA*, Den Haag: NOGEPA.

Sassi, F., 2006. Calculating QALYs, comparing QALY and DALY calculations. *Health Policy and Planning*, 21(5), pp. 402-409.

Science for Environment Policy, 2015. *Ecosystem Services and Biodiversity : In-depth report*, Brussels: European Union.

SEDAC, 2006. *Gridded Population of the World, version 3 (GPWv3).* [Online] Available at: http://sedac.ciesin.columbia.edu/gpw
[Accessed 2017].

SEO, 2016a. *Werkwijzer voor kosten-batenanalyse in het sociale domein, Hoofdrapport*, Amsterdam: SEO Economisch Onderzoek.

SEO, 2016b. *Werkwijzer voor kosten-batenanalyse in het sociale domein, bijlagen*, Amsterdam: SEO Economisch Onderzoek.

Simon, J., 1981. *The Ultimate Resource.* Princeton (NJ): Princeton University Press.

Spadaro, J. V. & Rabl, A., 2007. *Global Health Impacts and Costs due to Mercury Emissions*, Paris: ARMINES/ Ecole des Mines .

Steen, B., 1999. *A systematic approach to environmental priority strategies in product development (EPS) version 2000 : models and data of default method*, Göteborg: Chalmers university of technology.

Stern, N., 2006. *The Economics of Climate Change : The Stern Review*, London: Cabinet Office-HM Treasury, 2006.

Stimular, 2016. *De Milieubarometer: een veelzijdig instrument.* [Online]
Available at: https://www.milieubarometer.nl/productinformatie/
[Geopend 2016].

Thaler, R., 1980. Some empirical evidence on dynamic inconsistency. *Econom. Lett. 8*, pp. 201-207.

Theebe, M. A., 2004. Planes, Trains, and Automobiles: The Impact of Traffic Noise on House Prices. *Journal of Real Estate Finance and Economics*, 28(2/3), pp. 2009-234.

Thompson, M. R., Ellis, J. & Wildavsky, A., 1990. *Cultural Theory*, Boulder: Westview.

TNO, 2014. *Materialen in de Nederlandse Economie : een beoordeling van de kwetsbaarheid, eindrapport*, Delft: TNO.

Tol, R., 2008. *The Social Cost of Carbon: Trends, Outliers and Catastrophes*, Kiel: Kiel Institute for the World Economy.

Tærup, S. L. M., Ortiz, R. A. & Markandya, A., 2011. The Costs of Climate Change: A Study of Cholera in Tanzania. *International Journal Research and Public Health*, 8(12), pp. 4386-4405.

TRL, 2011. *Estimating the productivity impacts of noise*, London: Defra.

True Price, 2017. *The True Price of Diamonds.* [Online]
Available at:
https://www.abnamro.com/en/images/Documents/040_Sustainable_banking/Publications/Report_The_True_Price_of_Diamonds.pdf
[Accessed 2017].

Udo, J., Janssen, L. H. & Kruitwagen, S., 2006. Stilte heeft zijn 'prijs'. *ESB*, Issue 4477, pp. 14-16.

UNSCEAR, 1993. *Sources and effects of ionizing radiation : Report to the General Assembly, with scientific Annexes.* [Online]
Available at: http://www.unscear.org/unscear/en/publications/1993.html
[Accessed 2017].

UNSCEAR, 2000. *UNSCEAR 2000 Report to the General Assembly with scientific annexes, Volume 1: Scources.* [Online]
Available at: http://www.unscear.org/unscear/en/publications/2000_1.html
[Accessed 2017].

VITO, 2012. *Inschatting ziektelast en externe kosten veroorzaakt door verschillende milieufactoren in Vlaanderen*, Mechelen: Vlaamse Milieumaatschappij Milieurapportering (MIRA).

VMM, 2013a. *Milieurapport Vlaanderen MIRA : Themabeschrijving Verzuring*, Mechelen: Vlaamse Milieumaatschappij (VMM).

VMM, 2013b. *Milieurapport Vlaanderen MIRA : Themabeschrijving Zwevend stof*, Mechelen: Vlaamse Milieumaatschappij (VMM).

VMM, 2013c. *Milieurapport Vlaanderen MIRA : Themabeschrijving Vermesting*, Mechelen: Vlaamse Milieumaatschappij (VMM).

VMM, 2013d. *Milieurapport Vlaanderen MIRA : Themabeschrijving Fotochemeische luchtverontreining*, Mechelen: Vlaamse Milieumaatschappij (VMM).

VMM, 2013e. *Milieurapport Vlaanderen, Themabeschrijving Aantasting van de ozonlaag*, Mechelen: Vlaamse Milieumaatschappij (VMM).

VMM, 2013g. *Milieurapport Vlaanderen, Themabeschrijving Pesticiden*, Mechelen: Vlaamse Milieumaatschappij (VMM).

Vogtländer, J. & Bijma, A., 2000. The Virtual Pollution Prevention Costs '99: a single LCA-based indicator for emissions. *The International Journal of Life Cycle Assessment 5(2): 113-124*, 5(2), pp. 113-124.

VROM, 1993. *Environmental policy performance indicators*, The Hague: Ministry VROM.

VU, 2014. *Renewable Energy and Negative Externalities: The effect of Wind Turbines on House Prices*, Amsterdam: Vrije Universiteit (VU).

VVM, 2013h. *Milieurapport Vlaanderen MIRA : Themabeschrijving Verspreiding van zware metalen*, Mechelen: Vlaamse Milieumaatschappij (VMM).

Watkiss, P., Holland, M., Hurley, F. & Pye, S., 2006. *Damage Costs for Air Pollution*, London: Defra.

Watkiss, P. et al., 2001. *Quantification of the non-health effects of air pollution in the UK for. PM10 objective analysis*, London: The Department for Environment, Food and Rural Affairs (Defra).

Watt, J., Tidblad, J., Kucera, V. & Hamilton, R., 2009. *The effects of Air Pollution on Cultural Heritage*. sl:Springer.

Wheeler, T. & Braun, J. v., 2013. Climate change impacts on global food security. *Science*, 341(6145), pp. 508-513.

WHO, 2005. *Air quality guidelines for particulate matter, ozone, niitrogen dioxide and sulfur dioxide : Global update 2005, summery of risk assement*, Geneva: World Health Organization (WHO).

WHO, 2008. *Health statistics and health information systems (bezocht 28 juli 2009)*, Geneva: World Health Organisation (WHO).

WHO, 2011. *Burden of disease from environmental noise : Quantification of healthy life years lost in Europe*, Copenhagen: World Health Organization (WHO).

WHO, 2013. *Health risks of air pollution in Europe - HRAPIE project. Recommendations for concentration-response functions for cost-benefit analysis of particulate matter, ozone and nitrogen dioxide*, Geneva: World Health Organization (WHO).

WHO, 2014. *WHO Expert Meeting: Methods and tools for assessing the health risks of air pollution at local, national and international level, meeting report 12-13 May* , Bonn: WHO.

Annex A Characterization

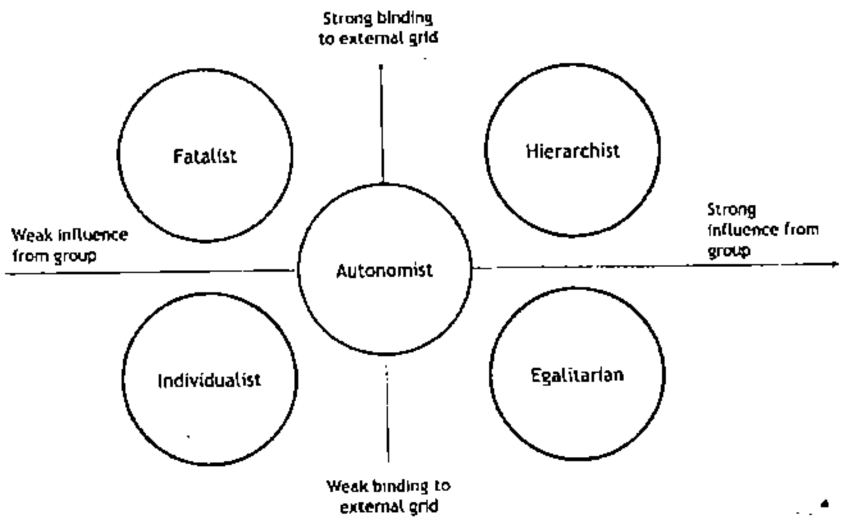
A.1 Introduction

The characterization models used in the ReCiPe project are subject to uncertainty, since the modelled relationships reflect currently incomplete and uncertain knowledge of environmental mechanisms. Just as in Eco-indicator 99, it was therefore decided to group different sources of uncertainty and choices into a limited number of perspectives, according to the 'Cultural Theory' elaborated by Thompson et al. (1990).

A.2 Cultural theory as the basis of characterization perspectives

Thompson et al. distinguish five basic value systems by looking at the strength of the relations people have with their group and the degree to which an individual's life is circumscribed by externally imposed prescriptions (their so-called 'grid'); see Figure 12.

Figure 12 The five basic value systems according to Thompson et al.



The most important characteristics of these five 'archetypes' are:

1. Individualists lack strong links with either their group or their grid. They hold that all environmental limits are provisional and subject to negotiation.
2. Egalitarians have a strong link to the group, but a weak link to their grid. Relations between group members are often ambiguous and conflicts readily occur.
3. Hierarchists have strong links to both group and grid, both controlling others and being controlled by them. This hierarchy creates a high degree of stability in the group.
4. Fatalists have a strong link with the grid, but not with the group. These people act individually and are usually controlled by others.
5. Autonomists are a relatively small group that escapes the manipulative forces of both groups and grids.

The last two archetypes cannot be used in the present context, because fatalists are guided by what others say and autonomists think completely independently.

A.3 The three perspectives

In ReCiPe, characterization of environmental impacts is based on scenarios representing the other three perspectives, which can be summarized as follows:

1. Individualist. In this scenario only proven cause-effect relationships are included and a short-term perspective is adopted. For human-health issues age-weighting is applied. There is technological optimism with regard to human adaptation.
2. Hierarchist. Included in this scenario are facts backed up by scientific and political bodies. The hierarchist attitude is common in the scientific community and among policy-makers.
3. Egalitarian. This scenario uses the precautionary principle and the very long-term perspective.

This Handbook generally follows the ReCiPe hierarchist perspective, though the individualist perspective has sometimes been adopted.

Table 41 indicates how these perspectives have been elaborated in ReCiPe and shows which choices we have made with respect to characterisation in this handbook. Note that for climate change we chose to base the characterisation on the IPCC 2013 values for a 100-year time-frame.

Table 41 The perspectives from ReCiPe and the chosen perspective in this Handbook

Environmental theme	Principals ReCiPe Individualistic Perspective	Principals ReCiPe Hierarchistic Perspective	Choices in this handbook for characterisation
Climate Change	N.A.	N.A.	IPCC (2013).
Ozone Depletion	Only effects of UV on skin cancer are taken into account: basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and cutaneous melanoma (CM).	In addition to effects of UV on skin cancer, also additional effects such as cataract.	Individualistic perspective.
Smog-formation and particulate matter	Using non-discounted impacts for a period of 20 year.	Non-discounted impacts for a period of 100 year.	Individualistic perspective.
Acidification	Using non-discounted impacts for a period of 20 year.	Non-discounted impacts for a period of 100 year.	Individualistic perspective.
Human toxicity	For metals only distribution via air and drinking water, no spreading via soil and uptake food crops. Accumulation in the environment for 100 years. Only strong scientific evidence of carcinogenic effects on humans: no evidence in animal testing. Included studies:IARC-category 1, 2A and 2B.	The distribution of metals in food crops is also taken into account by emissions. Accumulation in the environment permanently. Also included evidence of tests on animals. Studies considered IARC-category 1, 2A and 2B and 3.	At the lower value the individualistic perspective and top value the hierarchical perspective. Central value is the average of the lower and upper value.
Eco-toxicity	No dispersion to oceans of Cobalt, Copper, Manganese, Molybdenum and Zinc.	All substances are included.	As with Human Toxicity.

Environmental theme	Principals ReCiPe Individualistic Perspective	Principals ReCiPe Hierarchistic Perspective	Choices in this handbook for characterisation
Land-use	Only temporary effects on ecosystems, full recovery to natural values in 5-100 years (depending on the type of ecosystem).	More permanent damage to ecosystems, in 100 years not all damage has been restored.	Hierarchistic perspective.

More information on the choices made can be found in Chapter 6.

A.4 Comparison ReCiPe and ILCD with respect to charactisation

IThe ReCiPe method was used in this Handbook on environmental prices. In addition to ReCiPe, other characterization methods exist, such as ILCD and PEF. Here we briefly indicate the differences.

Table 42 summarizes the units used in ReCiPe and ILCD characterization at midpoint level. The PEF methodology is taken directly from the ILCD characterization.

Table 42 Units in the various characterisation methods

Environmental effect	ReCiPe (2013)	ILCD/PEF
Climate change	kg CO_2-eq.	kg CO_2-eq.
Ozone depletion	kg CFC-11-eq.	kg CFC-11-eq.
Acidification	kg SO_2-eq.	mol H+-eq.
Freshwater eutrophication	kg P-eq.	kg P-eq.
Marine eutrophication	kg N-eq.	kg N-eq.
Terrestrial eutrophication		molc N-eq.
Eutrophication		
Human toxicity	kg 1,4 DB-eq.	
Non-cancer effects		CTUh
Cancer effects		CTUh
Photochemical oxidant formation	kg NMVOC	kg NMVOC-eq.
Particulate matter formation	kg PM_{10}-eq.	kg $PM_{2,5}$-eq.
Terrestrial ecotoxicity	kg 1,4 DB-eq.	
Freshwater ecotoxicity	kg 1,4 DB-eq.	CTUe
Marine ecotoxicity	kg 1,4 DB-eq.	
Ionising radiation	kBq U235-eq.	
Human health		kBq U235-eq.
Ecosystems		CTUe
Agricultural land occupation/land use	m^2a	kg-C-deficit
Urban land occupation	m^2a	
Natural land transformation	m^2	
Water depletion	m^3	m^3 water-eq.
Metal depletion	kg Fe-eq.	
Fossil depletion	kg oil-eq.	
Mineral, fossil & ren resource depletion		kg Sb-eq.
Abiotic depletion (fuel & non-fuel)		

At first glance, therefore, it appears that there may be major differences between ReCiPe on the one hand and ILCD on the other. However, a closer study of these differences showed that ReCiPe and ILCD use the same methods and literature on most themes.
For most midpoints the method of characterisation is quite similar between both methods. However, more fundamental differences exists for some midpoints, especially for human toxicity, ecotoxxicity and land use. In the Dutch version of the Handbook Environmental Prices, more information about the differences can be found.

Annex B Impact pathway modelling

B.1 Introduction

The damage calculated on the environmental themes acidification, photochemical smog formation and particulate matter formation were determined directly via an adaptation of the NEEDS modeling from 2008 (NEEDS, 2008a). In this annex we explain which assumptions are behind the original NEEDS project and which adjustments have been made.

B.2 NEEDS project (2008)

Between 1991 and 2008, various large European research projects attempted to estimate the external costs of energy production and other activities. These research projects were called ExternE, CASES, MethodEx and NEEDS.[84] These projects, financed from European research funds, involved more than 50 research teams from more than 20 countries. The NEEDS (New Energy Externalities Developments for Sustainability) project is the most recent research carried out in this context.

To calculate environmental prices, we use an Excel application developed by the University of Stuttgart in the framework of NEEDS/CASES. This Excel application works with input of the ecological-economic model of EcoSense.This Excel tool was subsequently adjusted to more recent information concerning: concentrations response functions, affected population and background concentration of emissions.

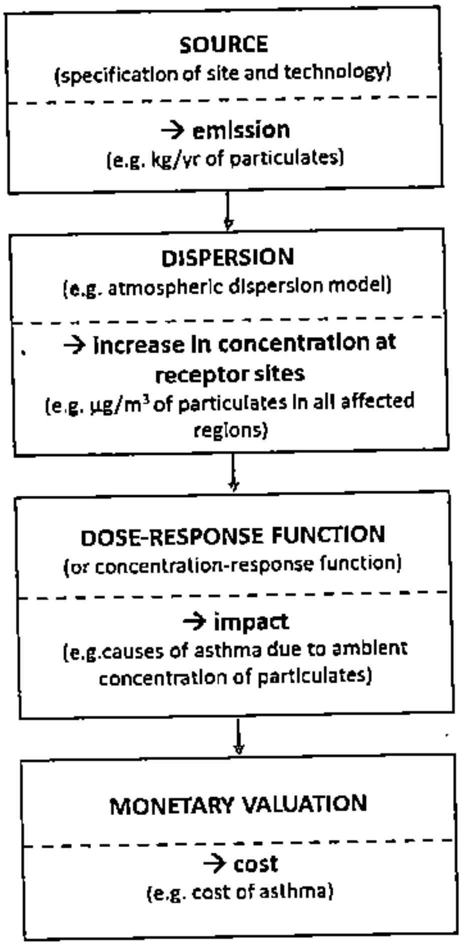
B.2.1 Impact pathway approach

To assess damage costs per unit of specific pollutants in monetary terms, an analysis method has been developed that is known as the Impact Pathway Approach (NEEDS, 2008a; see figure 10).

The Impact Pathway Approach (IPA) has been used in several international research projects initiated by the European Commission, starting with the original ExternE study implemented in mid-1990s. Recent updates to the ExternE series include the NEEDS project. Another EC-funded project using the IPA is CASES. These projects have been designed to develop methodology and provide estimates of the externalities of energy conversion and transportation. The ExternE methodology aims to cover all relevant (i.e. non-negligible) externalities identified through the impact pathway approach (see Figure 13).

84 ExternE (External costs of Energy) is a series of research projects initiated by the European Commission aimed at estimating the socio-environmental damages associated with energy conversion.

Figure 13 Impact pathway approach



The various steps will be described below.

Step 1: Source-Emissions
This step identifies, within a geographical grid, all relevant emission sources. In the EcoSense model used in the final stages of the ExternE project, the emissions were taken from the EMEP (European Monitoring and Evaluation Programme) database with a spatial resolution of approximately 50 x 50 km^2.

Step 2: Dispersion-Receptor sites
This step translates emissions into concentrations at specific, geographically diversified receptor points (sometimes called immissions). For classical air pollutants, dispersion and chemical transformation in Europe have been modeled using the EMEP/MSC-West Eulerian model, which also includes meteorological data. Source-receptor matrices have been derived which allowed a change in concentration or deposition to be attributed to each unit of emission and for each of the EMEP grid cells across Europe. Model runs have been performed for a 15% reduction of each airborne pollutant. Within the model, meteorological conditions are averaged across four representative meteorological years. For emissions in the years 2000-2014, dispersion results reflect the estimated background emissions in 2010. For other future years, the estimated background emissions modeled for 2020 were used. It should be noted that the chemical reactions and interactions are fairly complex.
For example, a reduction of NO_x emissions leaves more background NH_3 for

reaction with background SO_2 than without NO_x reduction. The reaction of additional free NH_3 with SO_2 increases the concentration of sulphates at certain locations (NEEDS, 2008).

Step 3: Dose-response functions and impacts
This step establishes the relationship between pollution concentration and physical impacts at the endpoint level. With the aid of a so-called concentration-response function and with reference to the size of the exposed population, physical impacts have been calculated for each grid cell. Population density data were taken from SEDAC (2006).

Three types of physical impacts are described:
- Mortality: the risk of premature death due to reception of the pollutant. A distinction can be made here between acute mortality (immediate death) and chronic mortality (death occurring after a certain period of exposure to a given pollutant). Acute mortality may be the result of photo-oxidant formation (smog), for example, while chronic mortality is typically associated with emissions of particles (primary and secondary).
  For classical air pollutants, reduced life expectancy (YOLL, years of life lost) was found to be the most important endpoint.
- Morbidity: the risk of developing a disease due to reception of the pollutant. The following effects have been evaluated and factored in to our final calculations: restricted activity days, work loss days, hospital admissions and medication use.
- Potentially disappearing species: a measure of how pollutants impact on ecosystems and biodiversity.

For impacts on materials and productivity changes in environmental services (e.g. fisheries, forests, crop losses), no physical impact is normally given, with estimates being directly transferred in monetary terms.

Step 4: Monetary valuation
The final step is monetary valuation. Impacts on productivity changes are revealed directly via market prices. Impacts on materials are revealed by examining restoration costs. Impacts on human health and ecosystems cannot be directly observed via the market, however. These have therefore been estimated using various methods.

The monetary values recommended in ExternE for YOLL were derived from questionnaires. In the NEEDS project, VOLY was valued directly using CVM (i.e. a stated preferences method), asking people about their WTP for 3 or 6 months' longer life due to air quality improvement. The monetary values for diseases proposed by the economic expert group have been derived on the basis of informal meta-analysis and the most recent robust estimates (ExternE, 2005). Finally, impacts on ecosystems have been estimated using the results of a meta-analysis of studies related to valuation of biodiversity changes by Kuik et al. (2008).

Discussion of Impact Pathway Approach
It should be noted that the full Impact Pathway Approach can be used only for those impacts for which it is possible to determine specific units of environmental impact, such as emission of specific pollutants in kilograms, and dose-response functions related to these units. The best example of an endpoint that can be modelled using the IPA is the impact of pollution on human health. If, according to epidemiological tests, an increased concentration of a specific pollutant leads to a certain increase of the number of cases of a certain disease (and if this disease shortens average human life

expectancy by a given number of years), using medical statistics we can arrive at a number of years lost due to a disease which can be expressed in YOLLs or DALYs and then evaluated in monetary terms. However, devising dose-response models for endpoints like visual aesthetics or recreational value would be very hard. Although we can establish a relationship between the source of damage and a receptor (e.g. the shorter the distance to the source of visual intrusion, the higher the damage in terms of visual disturbance or loss of recreational amenities), we would lack a common unit for valuation.

B.3 Impacts on human health and updates of NEEDS CRFs

Within the NEEDS project, a set of CRFs for PM and ozone and corresponding monetary values have been proposed. These functions are the most important and reliable concentration-response functions used in the ExternE series of projects for valuing the health effects associated with emissions of classical pollutants.

It should be noted that according to the recommendations of the NEEDS project experts, human health impacts have only been defined for particulate matter (primary as well as secondary) and ozone.[85] Impacts due to emissions of SO_2, NO_x and NH_3 are factored in after chemical transformation with reactants leading to an increase of concentration of secondary particulate matter (SIA, secondary inorganic aerosols). In the scientific community there is considerable debate on whether SIA has the same toxicity as primary particles, with no consensus yet emerging. In the NEEDS project it was therefore assumed that the damage due to SIA should be the same as for primary particles.

The general approach to estimating the effects of PM (or ozone) on morbidity uses the relative risk found in epidemiological studies, expressed as a percentage change in endpoint per (10) μg/m³ PM_{10} (or $PM_{2.5}$) and links this with (i) the background level of the health endpoint in the target population, expressed as new cases per year per unit population, (ii) population size and age, and (iii) the relevant pollution increment, expressed in μg/m³. The results are then expressed as extra cases, events or days per year attributed to PM (ExternE, 2005). Within the Ecosense model, uniform breakdown into age groups (Age Group Functions, AGF) and risk groups (Risk Group Functions, RGF) have been assumed for the whole of Europe, based on NEEDS (2007b).

The updates in the Concentration Response functions have been set up by comparing the NEEDS outcome on the Concentration Response functions with the WHO (2013) recommended values and approaches. This is not straightforward as both studies report different units. Whereas the NEEDS study reports CRF functions, expressed in ug/m³, works the WHO with Relative Risks (RR).

Most epidemiological studies report their results in terms of relative risk RR, defined as the ratio of the incidence observed at two different exposure levels. The RR thus can be interpreted as the increase in percentages in the relative risk in the reported impact due to an increase in exposure levels of 10/μg/m³. To quantify damages one needs to translate this RR in terms of an concentration response function, also called exposure response function (Rabl,

[85] These toxic impacts cover the bulk of the toxic impacts associated with these pollutants. However, NO_x also has a toxic effect other than through SIA. In this study this is taken into account in Section 4.6, using equivalence factors.

et al., 2014). For this one needs to know the existing risk on these incidents. So for an RR of 1.046 per $10/\mu g/m^3$ for Working Days Loss due to $PM_{2.5}$ lung diseases, one needs to understand how often the population already is suffering from these diseases. Then the CRF can then be regarded as the product of the baseline and the Delta RR.
Table 42 gives in the green shaded cells which information has been adjusted from the original NEEDS modelling.

Table 43 Overview of concentration response functions particulate matter formation and acute and chronic impacts from ozone. Cells in green imply changes in CRFs compared to the NEEDS approach. Cells in yellow imply changes in population mix

Core Endpoints	pollutant	risk group (RG)	RGF value	Age Group (AG)	AGF value	CRF [1/ug/m3]	unit
			Primary and SIA < 2.5 i.e. Particle < 2,5 um				
Life expectancy reduction - YOLLchronic	PM2.5	all	1	Total	1	6.51E-04	YOLL
netto Restricted activity days (netRADs)	PM2.5	all	1	MIX	1	9.59E-03	days
Work loss days (WLD)	PM2.5	all	1	Working population	0.4131472	2.07E-02	days
Minor restricted activity days (MRAD)	PM2.5	all	1	Adults_18_to_64_years	0.6232606	5.77E-02	days
			Primary and SIA < 10 i.e. Particle < 10 um				
Increased mortality risk (infants)	PM10	infants	0.0019	Total	0.0102755	4.00E-03	cases
New cases of chronic bronchitis	PM10	all	1	Adults_18andAboves	0.812034	4.51E-05	cases
respiratory hospital admissions	PM10	all	1	Total	1	7.03E-06	cases
cardiac hospital admissions	PM10	all	1	Total	1	4.34E-06	cases
medication use/bronchodilator use	PM10	Children with severe astma	0.045	Children_5_to_14	0.1046751	4.76E-03	cases
medication use/bronchodilator use	PM10	asthmatic	0.045	Adults_20andAboves	0.7907585	0.00E+00	cases
lower respiratory symptoms (adult)	PM10	symptom	0.3	Adults	0.812034	0.00E+00	days
lower respiratory symptoms (child)	PM10	all	1	Children_5_to_14	0.1046751	0.00E+00	days
			Ozone (ug/m3) - from SOMO35				
Increased mortality risk	SOMO35	baseline_	0.0099	Total (YOLL = 0,75a/case)	1	1.80E-03	YOLL
respiratory hospital admissions	SOMO35	all	1	Elderly_65andAbove	0.1887735	3.43E-05	cases
MRAD	SOMO35	all	1	Adults_18_to_64_years	0.6232606	1.15E-02	days
medication use/bronchodilator use	SOMO35	asthmatic	0.045	Adults_20andAboves	0.7907585	0.00E+00	cases
LRS excluding cough	SOMO35	all	1	Children_5_to_14	0.1046751	0.00E+00	days
Cough days	SOMO35	all	1	Children_5_to_14	0.1046751	0.00E+00	days
			NO2 above 20 ug/m3 annual mean				
Increased mortality risk	NO2	all	0.28	Adults 30+	0.6690976	4.41E-04	YOLL
Prevalence of bronchitis in asthmatich children	NO2	all	0.045	Children_5_to_19	0.1578638	5.25E-03	cases
Hospital admissions due to respiratory diseases	NO2	all	1	Total	1	1.11E-05	cases

Abbevations: Risk Group, RG: group within the general population with a handicap; RGF value: share of RG within the general population; Age group, AG: groups distinguished by different age cohorts; AG value: share of different age cohorts; CRF: concentration-response function; YOLL: Years of Life Lost; RAD: Restricted Activity Days; SIA: Secondary Inorganic Aerosols; SOMO35: sum of ozone means over 35 ppb; WLD: Work Loss Days; MRAD: Minor Restricted Activity Days; LRS: lower respiratory symptoms.

Source: Ajusted from NEEDS (2008a), based on NEEDS (2007b) with own recalculations of the green cells.

The updates falls apart in two categories:

1. Age groups: here we have used the Eurostat data on the age composition of the EU28 population and these changes have been indicated in yellow in the table.
2. The Concentration Response Functions. These changes have been indicated by the green cells in the table.

Below we will discuss these latter updates for various impact groups and elaborate on how we have adjusted the NEEDS estimates to the WHO (2013) update.

B.3.1 Update of mortalitiy impacts

Mortality impacts occur because of $PM_{2.5}$, ozone pollution (also called SOMO-35,Sum Of Means Over 35 ppb, e.g. the excess of max daily 8-hour averages over 35 ppb which is about 70 μg/m^3).

A. All-cause mortality $PM_{2.5}$

The HRAPIE experts recommended estimation of the impact of long-term (annual average) exposure to $PM_{2.5}$ on all-cause (natural) mortality in adult populations (age 30+ years) for cost-effectiveness analysis (Group A). A linear ERF, with an RR of 1.062 (95% CI = 1.040, 1.083) per 10 μg/m^3, has been recommended — even though some recent evidence has suggested a RR of 1.066. We observe that these RRs are practically similar to the used RR of 1.06 in the NEEDS project. As the Iref is probably nowadays slightly lower due to better health in population due to healthier lifestyles. ***Therefore our conclusion is that this value will not be altered compared to the NEEDS estimates.***

B. All-cause mortality SOMO 35

The NEEDS project only includes acute mortality (e.g. heart attack) with an RR of 1.003 per 10 ug/m^3 compared to the normal change of having an heart attack (which was established as 1% of population). The valuation of acute mortality is 50% higher than for chronic impacts. WHO (2013 and 2014) provide insights that there also chronical components included in ozone pollution. For a population 30 years old or older, the WHO (2013) recommends adopting a relative risk factor (RR) of 1.014 per 10 μg/m^3 in the summer months (April-September) for 8-hours concentration higher than 35 ppb. As explained in Jerrett et al. (2009), this may increase the CRF with a factor 9 compared to the acute impact. This is not only due to the higher RR, but also due to taking a different incidence rate. However, the precise impact is very uncertain. In our model we proposed to use the factor 3.5 as a lower bound and the factor 9 as an upper bound, so that the average factor through which the NEEDS outcomes need to be multiplied is equivalent to a factor 6.
We therefore propose to include the mortality impacts by calculating them as a factor 6 higher compared to NEEDS (2008) and by keeping the incidence rate the same (% of population with a heart attack).

C. Mortality N_2O

The REVIHAAP project (WHO, 2013) reports that since 2004 a growing number of studies have been published identifying short- and long-term correlations between NO_2 and mortality and morbidity that come on top of the impacts of NO_2 on PM formation and of NO_2 on acute mortality due to ozone formation. There is thus a third category that is not associated with particulate matter formation or ozone formation and that has here been added to the theme of acidification. These have not yet been included in the NEEDS project.

At the time of the NEEDS project these impacts were not included because the team was unable to identify sufficient studies that properly quantified these epidemiological impacts (NEEDS, 2007b). Today (2016) the situation has changed and the WHO (2013) recommends adopting a higher CRF for NO_2 than was previously used. The HRAPIE experts (WHO, 2013) recommend including the long-term mortality impacts (all-cause and cardiovascular) of NO_2 and advise adopting a linear CRF for NO_2 for all-cause mortality, translating to an RR of 1.055 per 10 μg/m^3 (WHO, 2013). In this context the WHO (2014) notes that when employing this RR-value in multi-emission studies due care should be taken to avoid double-counting with respect to the impact of NO_2 on PM formation, which they state can be as much as 33%.

To make this double-counting explicit, we examined the contribution of NO_2 to the RR-value for PM formation. For PM, NEEDS (2007b) uses an overall RR for premature mortality of 1.06 per 10 μg/m³. The relative contribution of NO_2 to PM formation can be derived from the characterization factors.
For characterizing NO_2 with respect to PM formation, ReCiPe takes a value of 0.22. This means that 22% of the RR increase can be attributed to impacts already been taken into account under the theme of PM-formation, equal to an RR of 1.013 per 10 μg/m³.[86] Assuming, in line with WHO (2014), a linear CRF for NO_2-values over the 20 μg/m³ threshold, it can be concluded that the *additional* NO_2 RR-value must be 1.042 per 10 μg/m³ for pollution in areas above the threshold level. This implies that the chronic health damage attributable to NO_2 should be a factor 3 higher than assumed in NEEDS, based on its contribution to PM formation.

To this factor two additional corrections should be made:
1. The mortality applies only to people older than 30 years.
2. The mortality applies only to population living in areas with an annual mean concentration of pollution above 20 μg/m³.

B.3.2 Update of morbidity impacts

For the morbidity impacts we have consulted WHO (2014), annex 6, and WHO (2013). Below we will discuss first the morbidity impacts of particulate matter, ozone pollution and NO_2.

Morbidity impacts of $PM_{2.5}$ and PM_{10}

A. Cardiac hospital admissions
The value in Rabl et al. (2016) has been taken. This is taken from Hurley et al. *(2005) and* based on a RR of 1.006 per 10/ug/m³ PM_{10}. Calculated to $PM_{2.5}$ we use the factor 1.6 as in the Handbook Environmental Prices, which implies that this would translate itself to a RR of 1.0096 per 10 ug/m³ $PM_{2.5}$. This in turn is more or less equivalent to the recommended value of 10091 from the WHO. ***Therefore our conclusion is that this value will not be altered compared to the NEEDS estimates.***

B. $PM_{2.5}$ Net restricted activity days
The analysis in WHO (2014) is based on the same sources as NEEDS (2008) and Rabl et al. (2016). We use here the routine in the EcoSense model where the Restricted Activity Days have been netted by substracting the working days loss, the minor restricted activity days and the hospital admissions due to $PM_{2.5}$ pollution from the RR from WHO. We have followed this routine here as well and have used the values from the EcoSense model. ***Therefore our conclusion is that this value will be taken from the EcoSense model.***

C. $PM_{2.5}$: Minor restricted activity days (MRAD)
This category has not been included in WHO (2014) separately but is added to the net restricted activity days. We follow here NEEDS as the valuation of both days differs and our aim is to include this differentiation in our calculations. ***Therefore our conclusion is that this value will be taken from the EcoSense model.***

86 This estimate is feasible because in ReCiPe PM formation is considered only in terms of its impacts on the endpoint 'human health'.

D. $PM_{2.5}$ Working days loss
The approach and data in the NEEDS (2008) project are the same as in WHO (2014, background paper 6)). ***Therefore our conclusion is that this value will not be altered compared to the NEEDS estimates.***

E. Respiratory hospital admissions
The WHO (2014) reports a RR of 1.019 for the whole population on the basis of a meta-analysis. This is slightly lower than the RR that has been used in the NEEDS project, which would be around 1.022 recalculated on the basis of the factor between $PM_{2.5}$ and PM_{10}. Since these values only differ slightly we have decided not to update this estimate. **Therefore our conclusion is to update the NEEDS estimate with the estimate from the WHO (2014).**

F. Medication use and lower respiratory symptoms because of asthma
These categories relate to the costs of medication and disutility for asthmatic people from additional coughing days. The additional medication use is valued at 1 Euro/day and the disutility is valued at 38 Euro/day. has been estimated by recent WHO (2014) update advices to only take impacts on children (age 5-19) into account. They report an RR of 1.028 for children with asthma.
In Europe, on average, 4.5% of the children suffer from asthma. Taking the incidence rate of 17% of the days that they suffer from asthma, the ERF becomes: 0.17*(1.028-1)=0.00476 days. **Our conclusion is to follow here the WHO (2014) approach and only use medication use and lower respiratory symptoms for asthmatic children.** The costs have been based on Ready et al (2004), as quoted in Rabl et al., (2014) where we assumed that every fourth cough day for children leads to an additional visit to the doctor. The medical costs are then calculated as € 11/day.

G. New cases of chronic bronchitis and COPD for adults
WHO (2014) advices to use an RR differentiated between children and adults. The RR for adults is 1.117 and for children 1.08. There is quite some discussion on the basic incidence rate (see e.g. Hurley, 2005), but the WHO proposes to use an incidence rate of 18.6% for children and 0.39% of adults. The NEEDS project used an RR of 1.07 per 10 ug/m^3 and an incidence rate of 0.378%. This implies that the new RR is about 70% higher. We used thus a 70% higher ERF in our modelling. In addition, WHO (2014) advices to use this factor for all population older than 18, whereas NEEDS used this impact only for 27 and older. **Therefore our conclusion is that the NEEDS estimate underestimates the recent WHO Guidelines and we have updated our estimates using a 70% higher estimate.** One should notice that the WHO classifies this information with a 'B' label indicating that these impacts are more uncertain than other impacts. We also have decided not to include potential new cases of chronic bronchitis for children (also labelled as 'B', as the unit in which this indicator is not an endpoint in the NEEDS modelling effort).

Morbidity impacts of ozone (SOMO-35)

A. Hospital admissions
WHO (2014) reports hospital admissions from ozone both for respiratory and cardiac diseases. NEEDS (2008) has only used respiratory diseases. The RR used in NEEDS for respiratory diseases is very similar to the one proposed in WHO (2014). **Therefore our conclusion is to follow WHO and extend this category by inclusing cardiac hospital admissions.**

B. Minor restricted activity days
The background studies and assumed RR is the same for NEEDS (2008) and WHO (2014). **Therefore our conclusion is that this value will not be altered compared to the NEEDS estimates.**

C. Medication use, lower respiratory symptoms and cough days
These impacts have not been included in WHO (2014). **We propose here to follow WHO (2014) and not include these symptoms in the cost calculations.**

Morbidity impacts of NO_2

Morbidity impacts of NO_2 have not been included in the NEEDS project as scientific evidence was not yet overwhelming as to the chronic impacts from NO_2 pollution. WHO (2013) recommends including these in cost-benefit analysis and here we have followed WHO (2013).

A. Prevalence of bronchitis.
Here WHO (2013) was followed.

B. Hospital admissions respiratory problems.
We follow the same routine as in Hurley et al. (2015) where the estimated baseline of hospital admissions related to respiratory problems is 617 per 100.000 inhabitants.

The C-R function and estimated baseline rates can be linked to provide an impact function:
Annual rate of attributable emergency respiratory hospital admissions
= background incidence rate (617/100,000) × change per 10 µg/m^3 NO_2 (1.8%)
= 7.03 (95% CI 3.83, 10.30) per 10 µg/m^3 PM_{10} per 100,000 people (all ages)

A careful review learned us that it is very likely that NEEDS underestimates as well the impacts from NO_2 from morbidity but that it is not possible to include these within the context of the NEEDS modelling because there are no concentrations of NO_2 modelled. Unlike the mortality impacts, the measurement of NO_2 follows a different trajectory than that of $PM_{2.5}$, so we cannot base a factor on these impacts. Therefore these impacts have not been fully covered in our analysis and the estimation of the morbidity impacts of NO_2 may be an underestimation. In total we believe that this is, however, a relatively minor issue as the morbidity impacts are much less important in valuation.

B.4 Impacts on biodiversity

Within ExternE, the environmental impact of air pollution on biodiversity has been estimated for emissions of SO_2, NO_x and NH_3. This impact is associated with acidification and eutrophication of soils. An approach using the measure 'potentially disappeared fraction' (PDF), i.e. biodiversity losses due to acidification and eutrophication, was used (NEEDS, 2008a).

Acidification is caused mainly by emissions of sulphur oxide (SO_x), nitrogen oxides (NO_x) and ammonia (NH_3) and the attendant deposition of acidifying substances like H_2SO_4 as well as a range of sulphates. Eutrophication due to airborne pollutants is due mainly to NO_x and NH_3.

B.4.1 Concentration-response function

For any given land use type, a certain average number of plant species can generally be established. If the soil becomes polluted due to deposition of acifidfying and eutrophying substances, the number of species present and thus biodiversity are reduced. Hence, a delta PDF per deposition can be calculated.

In EcoSense the following information is used to model the loss of biodiversity due to SO_2, NO_x and NH_3 emissions, using the following data:

- Values of PDF per deposition of N and S on natural soils are taken from NEEDS (2006); see Table 44.
- Depositions per 50 x 50 km² grid cell are available from regional dispersion modelling.
- In addition, for each grid cell the share of natural soil is available.
- Finally, a (country-dependent) 'pressure index' is used to account for differences in soil sensitivity.

Table 44 PDF per deposition of N and S on natural soil

Air pollutant	Deposition increase in kg/m² * year on natural soil (10 mol/ha)	Average PDF of natural land	PDF * m² * year per kg deposition
Reference Value (Background Level)	--	0.746429	--
SO_x	6.4 * 10-5	0.74654	1.73
NO_x	4.6 * 10-5	0.746867	9.52
NH_3	1.7 * 10-5	0.74687	25.94

Source: (NEEDS, 2008a).

B.4.2 Impacts on agricultural crops

Within the NEEDS project, the impacts of air pollution on crops have been divided into impact of SO_2, acidification of agricultural soils due to NH_3, SO_2 and NO_x, impact of ozone and effects of nitrogen deposition (NEEDS, 2008a).

Impact of SO_2

The CRF function for SO_2 assumes that yields will increase with SO_2 concentrations from 0 to 6.8 ppb (part per billion on a molecular level) and decline thereafter. The function is used to quantify changes in crop yield for wheat, barley, potato, sugar beet and oats and is defined as:

$$y = 0.74 \cdot [SO_2] - 0.055 \cdot [SO_2]^2 \quad \text{for } 0 < [SO_2] < 13.6 \text{ ppb}$$
$$y = -0.69 \cdot [SO_2] + 9.35 \quad \text{for } [SO_2] > 13.6 \text{ ppb}$$

with y = relative yield change; and
$[SO_2]$ = SO_2 concentration in ppb.

Acidification of agricultural soils

For acidification effects, an upper-bound estimate of the amount of lime required to balance atmospheric acid inputs on agricultural soils across Europe has been estimated. Ideally, the analysis of liming would be restricted to non-calcareous soils, but this refinement has not been introduced given that even the upper-bound estimate of additional liming requirements is small compared with other externalities. The additional lime required is calculated as:

$$dL = 50\ kg/meq \cdot A \cdot dDA$$

with dL = additional lime requirement in kg/year;
A = agricultural area in ha; and
dDA = annual acid deposition in meq/m^2/year.

Impact of ozone

For the assessment of ozone impacts, a linear relationship between yield loss and the AOT 40 value (Accumulated Ozone concentration above a Threshold of 40 ppbV) calculated for the crop growing season (May to June) has been assumed. The relative yield change is then calculated using the following equation together with the sensitivity factors given in Table 45:

$$y = 99.7 - Alpha \cdot AOT40crops$$

with y = relative yield change; and
Alpha = sensitivity factors.

Table 45 Sensitivity factors for different crop species

Crop species	Sensitivity factor
Rice	0.4
Tobacco	0.5
Sugar beet, potato	0.6
Sunflower	1.2
Wheat	1.7

Fertilisation effecs from nitrogen deposition

When it comes to nitrogen there is also a beneficial effect, in the sense that nitrogen is an essential plant nutrient, applied by farmers in large quantities to their crops. Deposition of oxidised nitrogen on agricultural soils is thus beneficial (assuming the dosage of any fertiliser applied by the farmer is not excessive). The reduction in fertiliser requirement is calculated as:

$$dF = 14.0067\ g/mol \cdot A \cdot dDN$$

with dF = reduction in fertiliser requirement in kg/year;
A = agricultural area in km^2; and
dDN = annual nitrogen deposition in meq/m^2/year.

B.4.3 Monetary valuation of crop losses

Crop losses are assessed in monetary terms using the prices of the crops damaged by air pollution. Table 46 summarises the prices per tonne used within the NEEDS project for assessing crop damage due to air pollution.

Table 46 Updated prices of major crops used in this project (€/t)

	Updated price per tonne
Sunflower	335.00
Wheat	179.00
Potato	214.00
Rice	305.00
Rye	142.00
Oats	145.00
Tobacco	3,508.00
Barley	153.00
Sugar beet	34.00

Source: FAOStat. Prices reflect price levels in the Netherlands. No update to EU prices has been undertaken in this project because the Dutch prices for these products are supposed to reflect world market prices.

It should be noted that prices have fluctuated significantly over the last 15 years.

B.5 Impacts of human toxicity

B.5.1 Approach followed in this study

Impacts of human toxicity have been calculated using impacts of airborne heavy metals and dioxins. Within the NEEDS project, damage costs have been established for several toxic pollutants, viz. heavy metals, formaldehyde and dioxins. Country-specific results used in the NEEDS project regarding the inhalation pathway for heavy metals (As, Cd, Cr, Ni, Pb) have been calculated in the ESPREME project (ESPREME, 2007), with country-specific values regarding ingestion being calculated for As, Cd and Pb in the NEEDS project (Fantke, 2008). The Excel tool developed in NEEDS also includes values for mercury, formaldehyde and dioxins based on various studies. These are so-called generic values, expressed directly as 'Euro per tonne'. As these are European averages, they are applicable to all the countries of Europe and any height of release.

The value for Cr-VI is derived from the value for Cr. It is assumed that Cr-VI is the only toxic form of chromium and that this accounts for approx. 20% of environmental chromium. Hence, the monetary value for Cr-VI is around 5 times that for Cr. Consequently, damage costs for either Cr or Cr-VI must be used, and not both.

CRF for inhalation of heavy metals can be found in ESPREME (2007), Spadaro and Rabl (2008) and MethodEx (2006). Country-specific external costs associated with inhalation of heavy metals are included in the EcoSense model.

The concentration response functions for these substances were taken from the literature and valued with a VOLY value of € 40,000 and an IQ point value of € 8,600. This approach was also followed in the Shadow Prices Handbook 2010. Based on a review of the more recent literature, it was decided that:
- on the one hand, the CRF functions from NEEDS (2008a) appear to be an underestimation compared to more recent toxicity information, as shown by the characterization models ReCiPe and ILCD;
- on the other hand, the appreciation for the loss of IQ points seems to be higher in more recent research.

Based on this insight, we have estimated the valuation of human toxicity as an average of four methods:
- The original NEEDS approach that has been followed in the Handbook Shadow Prices (CE Delft, 2010).
- ReCiPe (Goedkoop, et al., 2013) that is a characterization model and relates the midpoint effect to the endpoint effect by means of characterization factors and emission response functions. The indicator for human toxicity is expressed in kg 1,4-DB-eq. The effect on health of the population is shown in DALYs. This can then be valued by means of a monetary value per DALY where we assumed that 1 VOLY is 1 DALY. We calculated here with a VOLY of € 55,000 to assure the comparison with the Handbook Shadow Prices.
- The International Reference Life Cycle Data System (ILCD) method that provides the characterization factors for metals for human toxicity. However, this method does not provide a monetary valuation at the endpoint level, but characterization factors in the unit CTUh/kg. This can then be valued using a DALY factor per CTUh and a monetary valuation per DALY. Also here we calculated the impacts with a DALY of € 55,000.
- A recent study by Nedellec and Rabl (2016) that has provided a spreadsheet model calculating the dispersion and valuation of heavy metals.

Summarizing thess approaches gave the following results:

Table 47 **Valuation of heavy metals according to four characterisation studies using a VOLY/DALY of € 55,000 in €/kg emission to air**

	ILCD-midpoint	ReCiPe-endpoint	Handbook Shadow Prices 2010, EU27	Nedellec en Rabl, 2016
Cd	€ 3,408	€ 1,384	€ 115	€ 61,376
As	€ 1,439	€ 1,972	€ 728	€ 2,229
Ni	€ 37	€ 17	€ 3.16	NA
Pb	€ 694	€ 607	€ 383	€ 8,267

Noot: Na = no value assigned

This shows that the valuations in the Shadow Prices Handbook for the EU27 are considerably lower than the average values in Europe according to ILCD and ReCiPe. Nedellec and Rabl again produce much higher values, in particular for cadmium and lead. The reason for these differences is not entirely clear and is probably related to the more complete uptake of the toxic substances in the food described in detail by Nedellec and Rabl. As a result, the toxic effects are also much greater than if only the inhalation of the substances is examined via the air. But the exact causes of the differences are difficult to trace.

In the Environmental Price Handbook we decided to take an average valuation for the above substances from the table. We have added the appreciation for Dioxin and mercury from NEEDS. Based on these six substances, we have multiplied the emissions on EU28 territory with the average damage according to these four sources and calculated then a weighted sum using the ReCiPe characterisation factors to obtain a weighted valuation for the midpoint characterization factor.

We would like to emphasize that the appreciation for human toxicity is very uncertain and should be subjected to a further investigation in future versions of this Handbook in order to arrive at a more precise calculation.

B.5.2 Toxicity and perspectives in ReCiPe

In ReCiPe (Goedkoop, et al., 2013) deals with toxicity differently in the Individualist worldview than in the Hierarchical world view.
There are two types of differences:
- difference in the distribution of impacts taken into account;
- difference in burden of proof of toxicity.

In the Hierarchic Perspective, there is a broader spread of impacts included, such as damage caused by the uptake of heavy metals in the food chain, which are not included in the Individualistic Perspective. Actually, the bulk of the damage associated with heavy metal pollution to soil seems to be related to the potential spread of emissions to groundwater and the food chain.

This fear is also expressed in the social aversion in living on former, non-cleaned garbage dumps. That is why we opt for basing the impacts of Human Toxicity of heavy metals on the hierarchist perspective.

For the other toxic substances we followed a different routine.
Scientific studies on toxicology of materials are divided into four IARC categories according to the WHO:

Table 48 Classification of substances to toxicity according to WHO

Group	Classificatie WHO
Group 1	Carcinogenic to humans
Group 2A	Probably carcinogenic to humans
Group 2B	Possibly carcinogenic to humans
Group 3	Not classifiable as to its carcinogenicity to humans
Group 4	Probably not carcinogenic to humans

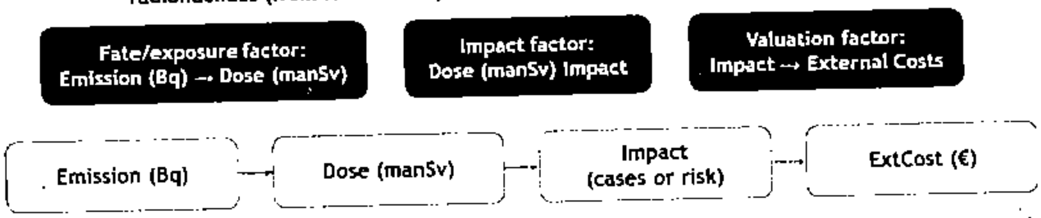
In total, the WHO has categorized nearly 1,000 substances (or groups of substances) in this way. ReCiPe Individualist Perspective takes Category 1 and 2 in consideration, but in Hierarchistic Perspective, Category 3 is added plus other studies and substances that have not been approved by the WHO.

If we compare this with the other themes, where we follow the WHO strictly (both at High and Low, with acidification, smog formation, particulate matter formation and ozone depletion), the Individualistic perspective is most consistent with the general principles of our handbook and with those of the other themes. Therefore we followed here the Individualistic Perspective for all of the toxic substances that are not heavy metals.

B.6 Ionising radiation

The subatomic particles and electromagnetic waves radiating from certain materials carry enough energy to detach electrons from other atoms or molecules, a process called ionisation. When living tissue is exposed to ionising radiation, it may suffer DNA damage, leading to apoptosis or genetic mutation, which may eventually lead to the development of cancers as well as to heriditary defects passed on to subsequent generations. The amount of ionising radiation resulting from radionuclide emissions is measured in Becquerel (Bq), which expresses the number of nucleus decays per second.
In NEEDS (2008a) the following simplified approach has been adopted to calculate the external costs of radionuclide emissions.

Figure 14 Scheme of assessment of exposure, physical impact and external costs due to release of radionuclides (from Needs 2008)



B.6.1 Health-related effects

The fate and exposure factors used in NEEDS have been calculated using the methodology set out in UNSCEAR (1993, 2000), whereby radionuclide emissions (in Bq) are related to the 'equivalent radiation dose' at the population level. This equivalent dose is expressed in man-Sievert (manSV), which is calculated by multiplying the amount of absorbed radiation (in J/kg) by a 'quality factor' that depends on radiation type (e.g. photons vs. alpha particles) and a factor that takes into account the exposed part of the body, the duration and level of irradiation. The resulting combined fate and exposure factors in manSv/PetaBequerel (PBq; 10^{15} Becquerel) are listed Table 49. As can be seen from these data, the human radiation exposure associated with emissions depends on the medium to which the radionuclide was emitted.

Table 49 Endpoint damages to human health caused by radionuclide emissions

Radionuclide	Emitted to	Dose (manSv/PBq)	Fatal cancers (cases/PBq)	Non-fatal cancers (cases/PBq)	Hereditary defects (cases/PBq)
Aerosols, radioactive, unspecified	Air	2,000	100	240	20
Carbon-14	Air	92,270	4,614	11,072	923
Carbon-14	Water	1,000	50	120	10
Cesium-137	Air	7,400	370	888	74
Cesium-137	Water	98	4.90	11.76	0.98
Hydrogen-3, Tritium	Air	4.1	0.21	0.49	0.04
Hydrogen-3, Tritium	Water	0.85	0.04	0,10	0.01
Iodine-129	Air	64,000	3,200	7,680	640
Iodine-131	Air	20,300	1,015	2,436	203
Iodine-131	Water	63,438	3,172	7,613	634
Iodine-133	Air	0	0	0	0
Iodine-133	Water	0	0	0	0
Iodine-135	Air	0	0	0	0
Krypton-85	Air	0.214	0.01	0.03	0.00
Krypton-85	Water	0	0	0	0
Krypton-85m	Air	0	0	0	0
Noble gases, radioactive, unspecified	Air	0.43	0.02	0.05	0.00
Radon-222	Air	2,5	0.13	0.30	0.03
Thorium-230	Air	30,000	1,500	3,600	300
Thorium-230	Water	0	0	0	0
Uranium-234	Air	8,000	400	960	80
Uranium-234	Water	198	9.90	23.75	1.98
Uranium-235	Air	0	0	0	0
Uranium-235	Water	0	0	0	0

Radionuclide	Emitted to	Dose (manSv/PBq)	Fatal cancers (cases/PBq)	Non-fatal cancers (cases/PBq)	Hereditary defects (cases/PBq)
Uranium-238	Air	7,000	350	840	70
Uranium-238	Water	1,963	98	236	20
Strontium-90	Water	4.7	0.24	0.56	0.05
Rubidium-106	Water	3.3	0.17	0.40	0.03
Lead-210	Air	1,000	50	120	10
Polonium-210	Air	1,000	50	120	10
Radium-226	Air	600	30	72	6

Source: CASES, 2008.

The health impacts of radiation absorption may manifest themselves in the form of fatal and non-fatal cancers and hereditary defects. It is estimated that each manSv equivalent radiation dose leads to 0.05 cases of fatal cancers, 0.12 cases of non-fatal cancers and 0.01 cases of hereditary defects (see NEEDS, 2008a). For each of these, the expected number of cases per unit emission are shown in Table 51, columns 3-5, for each of the relevant radionuclides.

The valuation of these impacts was based on the number of DALYs per cancer. For fatal cancers, the resulting YOLL (15.95) was multiplied by a VOLY of € 40,000 and the Cost of Illness (COI; € 481,050) was added, summing to € 1.12 million. For non-fatal cancers, the COI of € 481,050 was used. For hereditary effects, a standard value of statistical life (VSL) was taken, summing to € 1.5 million per case.

The external cost per unit emission was calculated by multiplying the disease-specific valuations by the expected number of diseases. As described in Annex A, in NEEDS an uplift factor is applied to account for the positive income elasticities of demand (1.7% until 2030, 0.85% thereafter), and a discount factor of 3% until 2030 and 2% thereafter. Importantly, the radiation emitted by a certain substance changes over time, depending on its half-life. This should be corrected for in the uplift and discount factors, which in NEEDS was only done for Rn-222, H-3 and C-14 (the most prevalent emissions associated with nuclear fuel cycles). The resulting Net Present Values of emissions in the year 2008 are listed in Table 50.

Table 50 External costs of radionuclide emissions

Radionuclide	Emitted to	€2008/PBq NPV 2008
Aerosols, radioactive, unspecified	Air	3.54E+08
Carbon-14	Air	1.92E+09
Carbon-14	Water	1.29E+07
Cesium-137	Air	1.31E+09
Cesium-137	Water	1.74E+07
Hydrogen-3, Tritium	Air	7.02E+05
Hydrogen-3, Tritium	Water	1.51E+05
Iodine-129	Air	1.13E+10
Iodine-131	Air	3.59E+09
Iodine-131	Water	1.12E+10
Iodine-133	Air	5.17E+05
Iodine-133	Water	0.00E+00
Iodine-135	Air	0.00E+00
Krypton-85	Air	3.79E+04
Krypton-85	Water	0.00E+00
Krypton-85m	Air	0.00E+00
Noble gases, radioactive, unspecified	Air	7.61E+04
Radon-222	Air	1.99E+04
Thorium-230	Air	5.31E+09
Thorium-230	Water	0.00E+00
Uranium-234	Air	1.42E+09
Uranium-234	Water	3.50E+07
Uranium-235	Air	1.16E+09
Uranium-235	Water	1.27E+08
Uranium-238	Air	1.24E+09
Uranium-238	Water	3.48E+08
Strontium-90	Water	8.32E+05
Rubidium-106	Water	5.84E+05
Lead-210	Air	1.77E+08
Polonium-210	Air	1.77E+08
Radium-226	Air	1.06E+08

Source: (NEEDS, 2008a).

B.6.2 Nature- and capital-related effects

Radiation exposure also affects non-human organisms, and has a detrimental effect on social assets (e.g. it may cause malfunctioning in electronic equipment). No monetary valuation of these effects was available from the literature, and the external costs presented here are therefore an underestimate of the true costs.

Annex C Specific themes

C.1 Allocation and development of weighting sets

In translating from monetary valuation to weighting sets, in practice two problems are encountered:

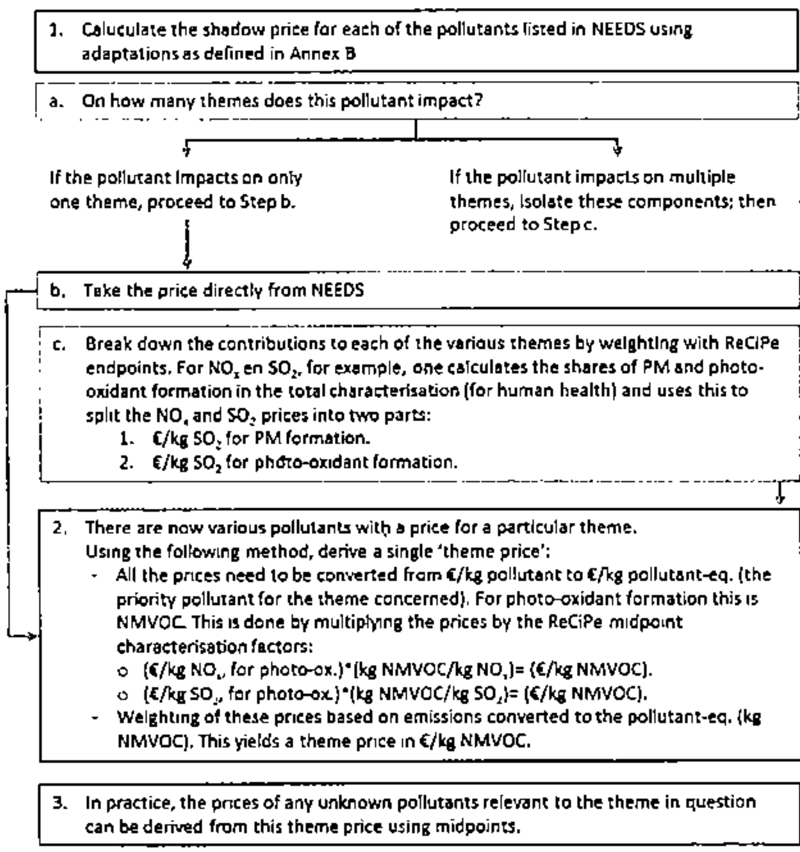
a. Multiple impacts: many pollutants impact simultaneously on several environmental themes, across which their shadow price needs to be allocated.
b. Implicit characterisation: the fact that the damage estimates for multiple pollutants within a given theme already express an implicit characterisation, which may deviate from the midpoint characterisation cited in ReCiPe. How to deal with such differences?

Problem B (implicit characterisation) was resolved by taking a weighted average of the damages occurring in the EU28. To this end we multiplied all the damages calculated in Annex C by the respective emissions occurring in the EU28 and then divided the figure obtained by the emissions expressed in the relevant ReCiPe midpoint characterisation factor.

In resolving Problem A (multiple environmental impacts) use was made of the ReCiPe endpoints. This is because these express, according to ReCiPe, how much each pollutant contributes to a particular endpoint. These were used to allocate the contributions of each pollutant across the midpoints.

The procedure adopted is shown in Figure 15.

Figure 15 **Schematic representation of procedure adopted to calculate economic damage costs**



C.2 Treatment of uncertainty[87]

The methodology for assessing uncertainty of the NEEDS estimates of damage costs is based on lognormal distributions and geometric standard deviations (i.e. multiplicative confidence intervals). This choice is related to the fact that damage cost values according to the Impact Assessment Method used within the NEEDS project are a product of several factors, such as increase in concentration of a given pollutant, slope of the CRF, density of the receptors and a monetary estimate of a given endpoint.

The lognormal distribution of a variable z (here representing damage costs) is obtained by assuming that the logarithm of z has a normal distribution. Invoking the central limit theorem for the product z, one can say that the lognormal distribution is the 'natural' distribution for multiplicative processes, in the same way that the Gaussian distribution is 'natural' for additive processes. Although the lognormal distribution becomes exact only in the limit of infinitely many factors, in practice it can serve as a good approximation even for a few factors, provided the distributions with the largest spread are not too far from lognormal (NEEDS, 2008b).

For many environmental impacts the lognormal model for the result is quite relevant because the impact is a product of factors and the distributions of the individual factors are not too far from lognormality. For most situations of interest here one can assume independence of the distributions (e.g. for atmospheric dispersion, CRFs and monetary values), and thus one finds that the geometric standard deviation σ_{gz} of the product z is given by:

$$[\ln(\sigma_{gz})]^2 = [\ln(\sigma_{gx1})]^2 + [\ln(\sigma_{gx2})]^2 + \ldots + [\ln(\sigma_{gxn})]^2 \qquad (3)$$

For a lognormal distribution, the geometric mean μ_g is equal to the median. If a quantity with a lognormal distribution has a geometric mean μ_g and a geometric standard deviation σ_g, the probability is approximately 68% that the true value will lie within the interval (μ_g/σ_g, $\mu_g\sigma_g$,) and 95% that it will be in the interval (μ_g/σ_g^2, $\mu_g\sigma_g^2$).

Below, we report the approximate confidence intervals for damage values calculated within the NEEDS project in three categories: classical pollutants, GHGs and trace pollutants.

Uncertainty in classical pollutants

Rabl and Spadaro (1999) have examined the uncertainties of each step of the impact pathway analysis for classical pollutants to estimate the uncertainties associated with the various components of the calculation. Table 51 reports their assumptions for the component uncertainties and the results for the damage costs for mortality. Because mortality accounts for over two-thirds of the damage costs of many pollutants, the uncertainty associated with this endpoint can be viewed as a good estimate for that associated with the sum total of impacts.

---

87 This description is based on NEEDS and most of this annex has earlier been published in the Handbook Shadow Prices 2010 (CE Delft, 2010).

Table 51 Uncertainty of damage cost estimates per kg of pollutant for mortality

	Log-normal?	σ_{gi} PM	*ln* $(\sigma_{gi})^2$	σ_{gi} SO_2 via sulphates	*ln* $(\sigma_{gi})^2$	σ_{gi} NO_x via nitrates	*ln* $(\sigma_{gi})^2$
Exposure calculation							
Dispersion	*yes*	1.5	*0.164*	1.7	*0.282*	1.7	*0.282*
Chemical transformation	*yes*	1	*0*	1.2	*0.033*	1.4	*0.113*
Background emissions	*no*	1	*0*	1.05	*0.002*	1.15	*0.02*
Total σ_g for exposure		1.5	*0.16*	1.76	*0.32*	1.9	*0.41*
ERF							
Relative risk	*no*	1.5	*0.164*	1.5	*0.164*	1.5	*0.164*
Toxicity of PM components	*?*	1.5	*0.164*	2	*0.48*	2	*0.48*
YOLL, given relative risk	*no?*	1.3	*0.069*	1.3	*0.069*	1.3	*0.069*
Total σ_g for ERF		1.88	*0.4*	2.33	*0.71*	2.33	*0.71*
Monetary valuation							
Value of YOLL (VOLY)	*yes*	2	*0.48*	2	*0.48*	2	*0.48*
Total σ_g		2.78	*1.04*	3.42	*1.51*	3.55	*1.61*

Source: NEEDS, 2008b.

Table 51 shows sample calculations of geometric standard deviation σ_g. The relative contributions of the σ_{gi} to the total can be seen in the column $\ln(\sigma_{gi})^2$.

NEEDS (2008b) report to three significant figures only, to bring out the differences between these pollutants and the larger uncertainties of the secondary pollutants. But in view of the subjective and rather uncertain assumptions made, the authors believe it is best to simply sum the results by saying that **the geometric standard deviation of these damage costs equals approximately 3**. This means that for classical pollutants, the true values lie, with a 68% probability, within an interval between the central value divided by three and the central value multiplied by three.

Uncertainty of trace pollutants

Using the same assumption about lognormality of damage distribution, NEEDS (2008b) calculate geometric means for the trace pollutants. The results are shown in Table 52.

Table 52 Summary of geometric standard deviations for the damage costs

Pollutant	σ_g
As, Cd, Cr-VI, Hg, Ni, Pb	4
Dioxins	5

This also relates to an observation made in Annex B that the valuation of human toxicity is much more uncertain than substances in other environmental themes.

Uncertainty related to transfer to other regions

NEEDS (2008b) have also examined the uncertainties associated with the transfer of the individual components of the damage costs calculation (emissions, atmospheric modeling, dose-response functions and monetary valuation) to regions other than the EU. The results are expressed in terms of geometric standard deviations and listed in Table 53. To obtain the total uncertainty for a given region, the figures relevant to that region need to be combined with the geometric standard deviations of the damage costs for the EU15.

Table 53 Geometric standard deviations associated with the transfer of components of the damage cost calculation

Component of calculation	σ_g
Transfer of technologies	
CO_2 emissions with CCS	1.3
Other emissions	[a]
Atmospheric modelling	
If no data for effective deposition velocity v_{dep}	1.5
If no data for stack height	2
If no data for local population or no data for wind	3
Background concentrations for sulphate and nitrate formation	1.2
Background concentrations for O_3 formation due to NO_x	2
Background concentrations for O_3 formation due to VOC	1.3
Modelling of ingestion dose	
Toxic metals	2
Exposure-Response Functions	
PM, NO_x, SO_2, toxic metals	2
Monetary values, non-market goods	
WTP for goods other than health	2
WTP for health	
$(GDP/cap)/(GDP/cap)_{ref} = 0.5$	1.3
$(GDP/cap)/(GDP/cap)_{ref} = 0.2$	1.7
$(GDP/cap)/(GDP/cap)_{ref} = 0.1$	2.1

[a] Depends on site.

For example, if the transfer is to a region where no data for the effective deposition velocity v_{dep} are available, where the health system and individual sensitivities are very different from the EU15, and where the PPP-adjusted GDP/capita is 1/5 that of the EU15, the data in Table 54 indicate that the total uncertainty for the damage cost of PM_{10} can be expressed as $\sigma_g = 4.3$, which is much larger than the $\sigma_g = 3$ in the EU15. The calculations are based on Equation 1, earlier in the text.

Table 54 Example of estimation of uncertainty with transfers

Example for PM_{10}	σ_g	$\log(\sigma_g)^2$
In EU15	3	1.21
No v_{dep} data	1.5	0.16
CRF	2	0.48
WTP in region with $(GDP/cap)/(GDP/cap)_{ref} = 0.2$	1.7	0.28
Total	4.3	2.13

As can be seen in the table, the total uncertainty for the damage cost of PM_{10} in the region is $\sigma_g = 4.3$, much greater than the $\sigma_g = 3$ in the EU15. If local population data are lacking, the uncertainty will increase to $\sigma_g = 5$.

NEEDS (2008b) note that many if not most policy applications of ExternE concern choices where the detailed location of the installations is not known in advance; in such cases one needs typical values for a country rather than site-specific results.

The authors conclude that the estimation of uncertainties is difficult and replete with uncertainties of its own; it necessarily involves subjective judgment, and various readers might well come up with different assessments of the component uncertainties. However, the authors of the report believe that unless all the component uncertainties are systematically over- or underestimated, there will be compensation of errors: some may be higher, some lower, but overall, the sum in Equation 1 is not likely to change much.

Annex D List of environmental prices

D.1 Introduction

The following tables list the environmental prices calculated in this Handbook for emissions to air, water and soil. The substances listed are a selection of those considered by to be 'of major concern' under the terms of the Dutch 'Activity Decree', which requires industries and others to avoid emissions of these pollutants to the atmosphere, soil and water, or limit them to the best of their ability. For around 20% of these substances we were able to calculate environmental prices. To this core list we have appended several other common pollutants.

D.2 Emissions to the atmosphere

Table 55 gives the environmental prices for emissions of selected pollutants to the atmosphere, listed in alphabetical order.

Table 55 Environmental prices (damage costs) for average atmospheric emissions in the EU28 (€$_{2015}$/kg emission)

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
1,1'-Biphenyl, 3,3',4,4'-tetrachloro-, PCB-77	032598-13-3	1.96E-03	1.46E-02	1.66E-02
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	057653-85-7	1.59E+00	1.19E+01	1.34E+01
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	040321-76-4	2.43E+02	1.81E+03	2.05E+03
1,3-Dichloro-2-propanol	000096-23-1	6.99E-03	5.21E-02	5.90E-02
1,5,9-Cyclododecatriene	004904-61-4	8.65E-09	6.44E-08	7.30E-08
1-Bromopropane	000106-94-5	1.20E-06	8.92E-06	1.01E-05
2,2-Bis(4-hydroxy-3,5-dibromophenyl)propane	000079-94-7	1.25E-02	9.33E-02	1.06E-01
2,3-Dibromo-1-propanol	000096-13-9	7.40E-06	5.51E-05	6.25E-05
2,3-Dinitrotoluene	000602-01-7	8.11E-03	6.04E-02	6.85E-02
2,4,5,2',5'-Pentachlorobiphenyl	037680-73-2	7.27E-03	5.41E-02	6.14E-02
2,4,6-Tri(tert-butyl)phenol	000732-26-3	9.35E-03	6.96E-02	7.89E-02
2,5-Dinitrotoluene	000619-15-8	1.09E-03	8.11E-03	9.20E-03
2-Butenal	004170-30-3	9.12E-06	6.80E-05	7.70E-05
2-Ethoxyethyl acetate	000111-15-9	7.18E-06	5.35E-05	6.06E-05
2-Methoxyethyl acetate	000110-49-6	1.09E-06	8.11E-06	9.20E-06
3,4-Dinitrotoluene	000610-39-9	1.10E-03	8.23E-03	9.33E-03
3,5-Dinitrotoluene	000618-85-9	5.67E-05	4.22E-04	4.79E-04
4,4'-Methylene di-o-toluidine	000838-88-0	3.53E-01	4.83E-01	7.46E-01
4,4'-Methylenebis-(2-chlorobenzenamine)	000101-14-4	1.08E+00	1.48E+00	2.28E+00
4,4'-Oxybisbenzenamine	000101-80-4	2.00E-01	2.74E-01	4.23E-01
4,4-Thiodianiline	000139-65-1	7.54E-01	1.03E+00	1.59E+00
4-Aminoazobenzene	000060-09-3	2.49E-04	1.85E-03	2.10E-03
Acenaphthene	000083-32-9	6.52E-02	8.92E-02	1.38E-01
Acenaphthene, 5-nitro-	000602-87-9	1.83E+00	2.51E+00	3.88E+00
Acridine	000260-94-6	2.29E-03	1.71E-02	1.94E-02
Acrylamide	000079-06-1	2.82E+01	3.86E+01	5.96E+01
Acrylonitrile	000107-13-1	4.63E+00	6.34E+00	9.79E+00
A-endosulfan	000959-98-8	1.18E+00	8.76E+00	9.93E+00
Aldrin	000309-00-2	2.71E+01	3.71E+01	5.73E+01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Ammonia	007664-41-7	1.00E+01	1.75E+01	2.52E+01
Aniline, p-chloro-	000106-47-8	4.36E-01	6.02E-01	9.27E-01
Anisole, pentachloro-	001825-21-4	1.50E-02	1.12E-01	1.27E-01
Anthracene	000120-12-7	2.61E-02	3.63E-02	5.58E-02
Arsenic	007440-38-2	5.86E+02	8.62E+02	9.63E+02
Azobenzene	000103-33-3	4.28E-03	3.19E-02	3.61E-02
Azocyclotin	041083-11-8	1.12E+01	1.62E+01	2.45E+01
Benomyl	017804-35-2	5.06E-02	7.62E-02	1.14E-01
Benz(a)acridine	000225-11-6	6.50E-03	4.85E-02	5.49E-02
Benz(c)acridine	000225-51-4	7.80E-02	5.81E-01	6.59E-01
Benzene	000071-43-2	4.07E-01	5.58E-01	8.82E-01
Benzene, (epoxyethyl)-	000096-09-3	1.64E-01	2.24E-01	3.46E-01
Benzene, 1,2,3-trichloro-	000087-61-6	1.60E-03	1.19E-02	1.35E-02
Benzene, 1,2,4-trichloro-	000120-82-1	4.71E-01	6.53E-01	1.00E+00
Benzene, 1,3,5-trichloro-	000108-70-3	5.52E-04	4.11E-03	4.66E-03
Benzene, 1-methyl-2-nitro-	000088-72-2	4.36E-05	3.25E-04	3.69E-04
Benzene, 2,4-dichloro-1-(4-nitrophenoxy)-	001836-75-5	1.76E-01	2.60E-01	3.92E-01
Benzene, hexachloro-	000118-74-1	6.56E+01	9.12E+01	1.40E+02
Benzene, pentachloro-	000608-93-5	1.19E+01	1.66E+01	2.55E+01
Benzidine	000092-87-5	6.94E+00	9.50E+00	1.47E+01
Benzidine, 3,3'-dichloro-	000091-94-1	4.39E+00	6.01E+00	9.28E+00
Benzidine, 3,3'-dimethyl-	000119-93-7	4.48E-05	3.34E-04	3.78E-04
Benzo(a)anthracene	000056-55-3	3.51E-06	2.61E-05	2.96E-05
Benzo(a)pyrene	000050-32-8	3.87E+00	5.29E+00	8.18E+00
Benzoic acid, 4-(tert-butyl)-	000098-73-7	1.07E-04	8.00E-04	9.06E-04
Benzotrichloride	000098-07-7	4.60E+01	6.30E+01	9.73E+01
Benzyl chloride	000100-44-7	2.94E-01	4.03E-01	6.22E-01
Beryllium	007440-41-7	2.57E+04	3.34E+04	4.89E+04
beta-Naphthylamine	000091-59-8	1.35E-01	1.84E-01	2.85E-01
Binapacryl	000485-31-4	2.17E-03	1.62E-02	1.83E-02
Biphenyl, 4-amino-	000092-67-1	2.62E+00	3.58E+00	5.53E+00
Bis(chloromethyl)ether	000542-88-1	3.32E+03	4.54E+03	7.02E+03
Bisphenol A	000080-05-7	1.55E-01	2.22E-01	3.38E-01
Brodifacoum	056073-10-0	1.23E-03	9.19E-03	1.04E-02
Butadiene	000106-99-0	1.57E+00	2.16E+00	3.41E+00
Butadiene, hexachloro-	000087-68-3	7.90E-03	5.88E-02	6.67E-02
Butane	000106-97-8	5.00E-01	6.86E-01	1.09E+00
C.I. basic violet 3	000548-62-9	3.95E-02	2.95E-01	3.34E-01
C.I. disperse blue 1	002475-45-8	2.16E-02	2.95E-02	4.56E-02
C.I. solvent yellow 3	000097-56-3	2.33E+00	3.19E+00	4.93E+00
Cadmium	007440-43-9	3.71E+02	5.89E+02	8.69E+02
Carbamic acid, ethyl ester	000051-79-6	7.83E-02	1.07E-01	1.65E-01
Carbendazim	010605-21-7	2.09E-01	4.31E-01	5.93E-01
Carbon dioxide .	000124-38-9	2.18E-02	5.66E-02	9.44E-02
Carbon monoxide	000630-08-0	3.83E-02	5.26E-02	9.18E-02
Chlordane , pur	000057-74-9	6.47E+02	8.86E+02	1.37E+03
Chlorfenvinphos	000470-90-6	6.67E+01	9.20E+01	1.42E+02
Chloromethyl methyl ether	000107-30-2	1.75E+00	2.39E+00	3.69E+00
Chloroprene	000126-99-8	5.05E-01	6.91E-01	1.07E+00
Chromium	007440-47-3	7.82E-02	4.98E-01	5.72E-01
Copper	007440-50-8	5.92E-01	3.88E+00	4.69E+00
Cyclododecane	000294-62-2	3.01E-08	2.24E-07	2.54E-07

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Cyclododecane, hexabromo-	025637-99-4	1.13E-02	8.40E-02	9.52E-02
Cycloheximide	000066-81-9	8.26E-04	6.16E-03	6.98E-03
Cyclopentadiene, hexachloro-	000077-47-4	1.08E+02	1.48E+02	2.28E+02
Cyhexatin	013121-70-5	6.88E+00	9.95E+00	1.51E+01
DDT	000050-29-3	2.91E+01	4.02E+01	6.19E+01
Decabromodiphenyl oxide	001163-19-5	5.94E+01	8.13E+01	1.26E+02
Delta-hexachlorocyclohexane	000319-86-8	8.83E-03	6.58E-02	7.46E-02
Dibenz(a,h)anthracene	000053-70-3	2.01E+02	2.76E+02	4.26E+02
Dibenzofuran, 2,3,7,8-tetrachloro-	051207-31-9	2.78E+02	2.07E+03	2.35E+03
Dibutyl dichloro tin	000683-18-1	1.81E-03	1.35E-02	1.53E-02
Dibutyltin oxide	000818-08-6	7.12E-09	5.31E-08	6.01E-08
Dicofol	000115-32-2	3.29E+01	4.51E+01	6.96E+01
Dieldrin	000060-57-1	3.24E+02	4.46E+02	6.88E+02
Difenacoum	056073-07-5	1.17E-04	8.75E-04	9.91E-04
Di-isobutylphthalate	000084-69-5	4.33E-05	3.22E-04	3.65E-04
Dimethyl formamide	000068-12-2	6.86E-01	9.39E-01	1.45E+00
Dimethylcarbamyl chloride	000079-44-7	1.57E+01	2.15E+01	3.32E+01
Dimethylphenol phosphate (3:1)	025155-23-1	1.37E-04	1.02E-03	1.15E-03
Dinitrogen monoxide	010024-97-2	5.78E+00	1.50E+01	2.50E+01
Dinocap	039300-45-3	2.34E+00	3.29E+00	5.03E+00
Dinoseb	000088-85-7	3.32E+01	4.69E+01	7.18E+01
Dinoterb	001420-07-1	3.68E-01	2.74E+00	3.11E+00
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	001746-01-6	4.95E+07	6.77E+07	1.05E+08
Diuron	000330-54-1	1.43E+00	2.39E+00	3.47E+00
Endosulfan	000115-29-7	4.76E+00	6.56E+00	1.01E+01
Endosulfan (beta)	033213-65-9	1.62E+00	1.21E+01	1.37E+01
Endrin	000072-20-8	5.96E+00	9.52E+00	1.40E+01
Endrocide (endox) (coumatetralyl)	005836-29-3	7.37E-05	5.49E-04	6.22E-04
Epichlorohydrin	000106-89-8	9.28E+00	1.27E+01	1.96E+01
Ethane, 1,2-dibromo-	000106-93-4	1.07E+01	1.46E+01	2.25E+01
Ethane, 1,2-dichloro-	000107-06-2	2.37E+00	3.24E+00	5.01E+00
Ethane, pentachloro-	000076-01-7	6.41E-06	4.78E-05	5.41E-05
Ethanol, 2-ethoxy-	000110-80-5	5.89E-01	8.08E-01	1.28E+00
Ethanol, 2-methoxy-	000109-86-4	6.07E-01	8.32E-01	1.31E+00
Ethene, bromo-	000593-60-2	1.35E+00	1.84E+00	2.85E+00
Ethene, chloro-	000075-01-4	1.12E+00	1.53E+00	2.36E+00
Ethene, trichloro-	000079-01-6	4.74E-01	6.51E-01	1.04E+00
Ethyl O-(p-nitrophenyl) phenylphosphonothionate	002104-64-5	1.82E+02	2.49E+02	3.85E+02
Ethylene oxide	000075-21-8	7.32E-01	1.00E+00	1.55E+00
Ethylene thiourea	000096-45-7	3.51E-01	4.80E-01	7.41E-01
Ethyleneimine	000151-56-4	4.60E+01	6.30E+01	9.73E+01
Fenbutatin oxide	013356-08-6	3.00E+01	4.10E+01	6.34E+01
Fenchlorazole-ethyl	103112-35-2	5.16E-02	3.85E-01	4.36E-01
Fentin acetate	000900-95-8	1.60E+02	2.20E+02	3.39E+02
Fentin chloride	000639-58-7	1.61E+02	2.23E+02	3.42E+02
Fentin hydroxide	000076-87-9	1.52E+02	2.10E+02	3.24E+02
Fluazifop-butyl	069806-50-4	1.43E-03	1.06E-02	1.21E-02
Flucythrinate	070124-77-5	6.58E+00	2.17E+01	2.71E+01
Fluoranthene	000206-44-0	1.39E-01	2.00E-01	3.04E-01
Fluorene	000086-73-7	1.81E-01	2.53E-01	3.88E-01
Flusilazole	085509-19-9	5.86E+00	8.01E+00	1.24E+01
Formaldehyde	000050-00-0	9.00E+00	1.23E+01	1.91E+01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Furan	000110-00-9	2.21E+01	3.02E+01	4.67E+01
Glufosinate ammonium	077182-82-2	2.64E+00	3.62E+00	5.59E+00
Glycidol	000556-52-5	2.46E+00	3.37E+00	5.21E+00
Glycydyltrimethylammonium chloride	003033-77-0	1.43E-07	1.06E-06	1.21E-06
Heptachlor	000076-44-8	6.83E+00	9.34E+00	1.44E+01
Heptachlor epoxide	001024-57-3	7.69E+01	1.06E+02	1.63E+02
Heptachloronorbornene	028680-45-7	7.96E-05	5.93E-04	6.72E-04
Hexachlorocyclohexane	000608-73-1	6.66E+00	9.32E+00	1.43E+01
Hexamethylphosphoramide	000680-31-9	9.93E+01	1.36E+02	2.10E+02
Hydrazine	000302-01-2	1.86E+01	2.55E+01	3.94E+01
Hydrazine, 1,1-dimethyl-	000057-14-7	1.51E-01	2.48E-01	3.62E-01
Hydrazine, 1,2-diphenyl-	000122-66-7	2.08E-05	1.55E-04	1.75E-04
Isobutane	000075-28-5	4.36E-01	5.99E-01	9.53E-01
Isodrin	000465-73-6	1.18E-02	8.80E-02	9.98E-02
Isoprene	000078-79-5	1.56E+00	2.15E+00	3.42E+00
Isoquinoline	000119-65-3	2.44E-04	1.82E-03	2.06E-03
Kepone	000143-50-0	8.17E+01	1.15E+02	1.76E+02
Lead	007439-92-1	3.63E+03	5.37E+03	5.76E+03
Lindane	000058-89-9	3.33E+01	4.61E+01	7.10E+01
Lindane, alpha-	000319-84-6	6.43E+00	8.87E+00	1.37E+01
Lindane, beta-	000319-85-7	3.84E+00	5.26E+00	8.12E+00
Linuron	000330-55-2	1.10E+00	1.56E+00	2.38E+00
Mercury	007439-97-6	2.47E+04	3.45E+04	5.29E+04
Mercury	007439-97-6	2.47E+04	3.45E+04	5.29E+04
Methane	000074-82-8	6.73E-01	1.74E+00	2.90E+00
Methoxychlor	000072-43-5	2.45E-01	3.36E-01	5.19E-01
Methylmercury	022967-92-6	1.20E+03	1.64E+03	2.53E+03
Mirex	002385-85-5	4.98E+03	6.81E+03	1.05E+04
Naphthalene	000091-20-3	5.22E-01	7.14E-01	1.10E+00
Naphthalene, 2-methyl-	000091-57-6	4.48E-01	6.13E-01	9.47E-01
Nickel	007440-02-0	3.55E+01	8.57E+01	1.14E+02
Nitroanisole, o-	000091-23-6	9.50E-01	1.30E+00	2.01E+00
Nitrobenzene	000098-95-3	9.06E+00	1.24E+01	1.91E+01
Nitrogen oxides	011104-93-1	9.97E+00	1.48E+01	2.21E+01
Nitrosoguanidine, N-methyl-N'-nitro-N-	000070-25-7	2.38E+01	3.26E+01	5.04E+01
NMVOC, non-methane volatile organic compounds, unspecified origin		8.40E-01	1.15E+00	1.84E+00
N-Nitrosodiethanolamine	001116-54-7	1.84E+00	2.52E+00	3.89E+00
N-Nitrosodimethylamine	000062-75-9	1.12E+02	1.54E+02	2.37E+02
N-Nitrosodipropylamine	000621-64-7	2.45E+02	3.35E+02	5.18E+02
N-nonylphenol	084852-15-3	3.07E-03	2.29E-02	2.59E-02
Nonylphenol	025154-52-3	7.80E-08	5.81E-07	6.59E-07
O,p'-ddt	000789-02-6	7.32E-02	5.45E-01	6.18E-01
o-Aminoanisole	000090-04-0	5.41E-06	4.03E-05	4.56E-05
o-Toluidine	000095-53-4	7.99E-12	5.95E-11	6.75E-11
o-Toluidine, 4-chloro-, hydrochloride	003165-93-3	3.54E-01	4.85E-01	7.49E-01
Oxirane, (phenoxymethyl)-	000122-60-1	1.46E-01	2.00E-01	3.09E-01
P-(1,1,3,3-tetramethylbutyl)phenol	000140-66-9	1.40E-03	1.05E-02	1.18E-02
Particulates, < 10 um		1.90E+01	2.66E+01	4.10E+01
Particulates, < 2.5 um		2.77E+01	3.87E+01	5.95E+01
p-Cresidine	000120-71-8	1.67E-02	2.28E-02	3.52E-02
Pentabromodiphenyl ether	032534-81-9	6.05E+01	8.28E+01	1.28E+02

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Phenanthrene	000085-01-8	1.09E-04	8.15E-04	9.23E-04
Phenanthridine	000229-87-8	1.27E-03	9.44E-03	1.07E-02
Phenol, pentachloro-	000087-86-5	3.18E+00	4.35E+00	6.73E+00
Phenolphthalein	000077-09-8	2.72E-02	3.72E-02	5.74E-02
Phenyl hydrazine	000100-63-0	1.82E-05	1.36E-04	1.54E-04
Phenylmercuric acetate	000062-38-4	5.14E+02	7.06E+02	1.09E+03
Phosphate, tris(2-chloroethyl)-	000115-96-8	1.16E-05	8.67E-05	9.83E-05
Phthalate, butyl-benzyl-	000085-68-7	8.65E-02	1.20E-01	1.85E-01
Phthalate, dibutyl-	000084-74-2	7.38E-02	1.10E-01	1.65E-01
Phthalate, dihexyl-	000084-75-3	3.71E-04	2.76E-03	3.13E-03
Phthalate, dioctyl-	000117-81-7	4.51E+00	6.17E+00	9.53E+00
P-nonylphenol	000104-40-5	1.58E-04	1.18E-03	1.34E-03
Polychlorinated biphenyls	001336-36-3	1.48E-03	1.10E-02	1.25E-02
Propane sultone	001120-71-4	3.79E+00	5.19E+00	8.01E+00
Propane, 1,2,3-trichloro-	000096-18-4	1.37E+01	1.88E+01	2.90E+01
Propane, 1,2-dibromo-3-chloro-	000096-12-8	7.83E+01	1.07E+02	1.65E+02
Propane, 1,2-dichloro-	000078-87-5	1.93E+01	2.64E+01	4.07E+01
Propane, 2-nitro-	000079-46-9	5.94E-01	8.13E-01	1.26E+00
Propiolactone	000057-57-8	8.48E+00	1.16E+01	1.79E+01
Propylene oxide	000075-56-9	3.07E+00	4.20E+00	6.49E+00
P-tert-amylphenol	000080-46-6	1.51E-04	1.13E-03	1.28E-03
Pyrene	000129-00-0	2.44E-01	3.35E-01	5.17E-01
Quinoline	000091-22-5	2.92E-04	2.17E-03	2.46E-03
Safrole	000094-59-7	8.12E-03	1.11E-02	1.72E-02
Sulfallate	000095-06-7	1.12E-01	1.53E-01	2.36E-01
Sulfur dioxide	007446-09-5	8.30E+00	1.15E+01	1.79E+01
Sulfur hexafluoride	002551-62-4	5.12E+02	1.33E+03	2.22E+03
Sulfuric acid, dimethyl ester	000077-78-1	3.26E-07	2.43E-06	2.75E-06
Tetrabutyltin	001461-25-2	1.18E-08	8.79E-08	9.96E-08
Tetraethyl lead	000078-00-2	1.14E+04	1.56E+04	2.40E+04
Tetrahydrofurfuryl alcohol	000097-99-4	3.84E-08	2.86E-07	3.24E-07
Tetramethyl lead	000075-74-1	6.13E-07	4.57E-06	5.18E-06
Tetrasul	002227-13-6	5.41E-05	4.03E-04	4.56E-04
Thioacetamide	000062-55-5	5.91E-01	8.09E-01	1.25E+00
Toluene, 2,4-diamine	000095-80-7	1.15E+00	1.57E+00	2.42E+00
Toluene, 2,4-dinitro-	000121-14-2	1.07E+01	1.46E+01	2.25E+01
Toluene, 2,6-dinitro-	000606-20-2	1.09E+02	1.50E+02	2.31E+02
Toxaphene	008001-35-2	2.37E+00	3.84E+00	5.63E+00
Tributylstannane	000688-73-3	1.06E-06	7.92E-06	8.97E-06
Tributyltin oxide	000056-35-9	3.18E+01	5.99E+01	8.43E+01
Trichlorobenzenes	012002-48-1	1.24E-04	9.21E-04	1.04E-03
Triflumizole	068694-11-1	1.69E-02	1.26E-01	1.43E-01
Trifluralin	001582-09-8	2.57E-01	3.52E-01	5.44E-01
Vinclozolin	050471-44-8	2.44E+00	3.35E+00	5.16E+00
Warfarin	000081-81-2	2.54E+01	3.48E+01	5.38E+01
Zinc	007440-66-6	1.05E+00	6.66E+00	1.78E+01

D.3 Emissions to water

Table 56 gives the environmental prices for emissions of selected pollutants to water, listed in alphabetical order.

Table 56 Environmental prices (damage costs) for average emissions to water in the EU28 (€$_{2015}$/kg emission)

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
1,1'-Biphenyl, 3,3',4,4'-tetrachloro-, PCB-77	032598-13-3	3.28E-04	2.45E-03	2.77E-03
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	057653-85-7	9.65E-02	7.19E-01	8.15E-01
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	040321-76-4	4.27E+01	3.18E+02	3.61E+02
1,3-Dichloro-2-propanol	000096-23-1	9.75E-02	7.26E-01	8.23E-01
1,5,9-Cyclododecatriene	004904-61-4	3.13E-05	2.33E-04	2.64E-04
1-Bromopropane	000106-94-5	2.23E-06	1.66E-05	1.88E-05
2,2-Bis(4-hydroxy-3,5-dibromophenyl)propane	000079-94-7	5.65E-02	4.21E-01	4.77E-01
2,3-Dibromo-1-propanol	000096-13-9	2.44E-06	1.82E-05	2.06E-05
2,3-Dinitrotoluene	000602-01-7	1.25E-01	9.30E-01	1.05E+00
2,4,5,2',5'-Pentachlorobiphenyl	037680-73-2	2.96E-03	2.20E-02	2.50E-02
2,4,6-Tri(tert-butyl)phenol	000732-26-3	6.76E-03	5.03E-02	5.71E-02
2,5-Dinitrotoluene	000619-15-8	3.40E-04	2.53E-03	2.87E-03
2-Butenal	004170-30-3	1.46E-03	1.08E-02	1.23E-02
2-Ethoxyethyl acetate	000111-15-9	3.61E-04	2.69E-03	3.05E-03
2-Methoxyethyl acetate	000110-49-6	1.89E-07	1.41E-06	1.60E-06
3,4-Dinitrotoluene	000610-39-9	4.48E-04	3.34E-03	3.78E-03
3,5-Dinitrotoluene	000618-85-9	1.71E-05	1.27E-04	1.44E-04
4,4'-Methylene di-o-toluidine	000838-88-0	2.61E+00	3.57E+00	5.51E+00
4,4'-Methylenebis-(2-chlorobenzenamine)	000101-14-4	9.93E+00	1.36E+01	2.10E+01
4,4'-Oxybisbenzenamine	000101-80-4	1.68E-01	2.30E-01	3.55E-01
4,4-Thiodianiline	000139-65-1	7.10E-01	9.71E-01	1.50E+00
4-Aminoazobenzene	000060-09-3	4.62E-04	3.44E-03	3.90E-03
Acenaphthene	000083-32-9	1.79E-02	9.61E-02	1.12E-01
Acenaphthene, 5-nitro-	000602-87-9	2.77E+00	3.79E+00	5.85E+00
Acridine	000260-94-6	1.35E-01	1.01E+00	1.14E+00
Acrylamide	000079-06-1	3.52E-01	4.83E-01	7.46E-01
Acrylonitrile	000107-13-1	3.84E-01	5.36E-01	8.23E-01
A-endosulfan	000959-98-8	3.02E+01	2.25E+02	2.55E+02
Aldrin	000309-00-2	7.62E+02	1.05E+03	1.62E+03
Aniline, p-chloro-	000106-47-8	1.01E-01	2.37E-01	3.16E-01
Anisole, pentachloro-	001825-21-4	1.51E-02	1.13E-01	1.28E-01
Anthracene	000120-12-7	1.93E-02	1.42E-01	1.62E-01
Azobenzene	000103-33-3	1.05E-01	7.80E-01	8.84E-01
Azocyclotin	041083-11-8	8.82E+01	1.50E+02	2.17E+02
Benomyl	017804-35-2	4.24E-02	2.86E-01	3.27E-01
Benz(a)acridine	000225-11-6	1.41E-02	1.05E-01	1.19E-01
Benz(c)acridine	000225-51-4	1.69E-01	1.26E+00	1.43E+00
Benzene	000071-43-2	2.64E-02	3.81E-02	5.78E-02
Benzene, (epoxyethyl)-	000096-09-3	3.81E-03	5.21E-03	8.04E-03
Benzene, 1,2,3-trichloro-	000087-61-6	2.92E-02	2.18E-01	2.47E-01
Benzene, 1,2,4-trichloro-	000120-82-1	3.50E-01	5.91E-01	8.57E-01
Benzene, 1,3,5-trichloro-	000108-70-3	6.30E-04	4.70E-03	5.32E-03
Benzene, 1-methyl-2-nitro-	000088-72-2	1.05E-03	7.83E-03	8.88E-03
Benzene, 2,4-dichloro-1-(4-nitrophenoxy)-	001836-75-5	5.38E-01	1.34E+00	1.77E+00

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Benzene, hexachloro-	000118-74-1	1.89E+02	2.60E+02	4.01E+02
Benzene, pentachloro-	000608-93-5	2.44E+01	3.40E+01	5.23E+01
Benzidine	000092-87-5	6.18E-01	8.46E-01	1.31E+00
Benzidine, 3,3'-dichloro-	000091-94-1	1.67E+01	2.29E+01	3.53E+01
Benzidine, 3,3'-dimethyl-	000119-93-7	4.24E-04	3.16E-03	3.58E-03
Benzo(a)anthracene	000056-55-3	1.90E-06	1.42E-05	1.60E-05
Benzo(a)pyrene	000050-32-8	1.32E-01	2.80E-01	3.82E-01
Benzoic acid, 4-(tert-butyl)-	000098-73-7	4.62E-05	3.44E-04	3.90E-04
Benzotrichloride	000098-07-7	3.33E-03	4.56E-03	7.05E-03
Benzyl chloride	000100-44-7	3.88E-02	8.06E-02	1.11E-01
Beryllium	007440-41-7	3.84E+00	2.50E+01	2.97E+01
beta-Naphthylamine	000091-59-8	2.36E-01	3.23E-01	4.99E-01
Binapacryl	000485-31-4	1.93E-01	1.44E+00	1.63E+00
Biphenyl, 4-amino-	000092-67-1	1.58E+00	2.16E+00	3.34E+00
Bis(chloromethyl)ether	000542-88-1	6.62E+02	9.05E+02	1.40E+03
Bisphenol A	000080-05-7	1.86E-01	7.17E-01	8.75E-01
Brodifacoum	056073-10-0	2.92E-03	2.17E-02	2.46E-02
Butadiene	000106-99-0	1.45E-02	1.98E-02	3.06E-02
Butadiene, hexachloro-	000087-68-3	6.40E-02	4.77E-01	5.41E-01
C.I. basic violet 3	000548-62-9	4.19E-02	3.12E-01	3.54E-01
C.I. disperse blue 1	002475-45-8	7.39E-02	1.01E-01	1.56E-01
C.I. solvent yellow 3	000097-56-3	2.85E+01	3.90E+01	6.02E+01
Cadmium	007440-43-9	2.44E+00	3.54E+00	5.04E+00
Carbamic acid, ethyl ester	000051-79-6	3.99E-03	5.46E-03	8.44E-03
Carbendazim	010605-21-7	4.36E-01	2.63E+00	3.04E+00
Chlordane , pur	000057-74-9	2.43E+02	3.34E+02	5.15E+02
Chlorfenvinphos	000470-90-6	1.46E+02	2.10E+02	3.19E+02
Chloromethyl methyl ether	000107-30-2	9.49E-05	1.30E-04	2.01E-04
Chloroprene	000126-99-8	8.63E-02	1.18E-01	1.82E-01
Copper	007440-50-8	7.54E-01	5.80E+00	6.83E+00
Cyclododecane	000294-62-2	3.18E-06	2.37E-05	2.69E-05
Cyclododecane, hexabromo-	025637-99-4	1.54E-03	1.15E-02	1.30E-02
Cycloheximide	000066-81-9	3.66E-04	2.73E-03	3.09E-03
Cyclopentadiene, hexachloro-	000077-47-4	4.41E-02	6.07E-02	9.36E-02
Cyhexatin	013121-70-5	8.67E+01	1.39E+02	2.05E+02
DDT	000050-29-3	2.20E+01	3.33E+01	4.98E+01
Decabromodiphenyl oxide	001163-19-5	1.05E-04	1.44E-04	2.22E-04
Delta-hexachlorocyclohexane	000319-86-8	2.00E-01	1.49E+00	1.69E+00
Dibenz(a,h)anthracene	000053-70-3	9.28E+01	1.27E+02	1.96E+02
Dibenzofuran, 2,3,7,8-tetrachloro-	051207-31-9	1.79E+02	1.33E+03	1.51E+03
Dibutyl dichloro tin	000683-18-1	5.92E-01	4.41E+00	5.00E+00
Dibutyltin oxide	000818-08-6	2.33E-05	1.74E-04	1.97E-04
Dicofol	000115-32-2	1.15E+02	1.59E+02	2.45E+02
Dieldrin	000060-57-1	2.57E+03	3.55E+03	5.47E+03
Difenacoum	056073-07-5	1.03E-04	7.71E-04	8.74E-04
Di-isobutylphthalate	000084-69-5	3.57E-05	2.66E-04	3.01E-04
Dimethyl formamide	000068-12-2	4.29E-02	5.87E-02	9.07E-02
Dimethylcarbamyl chloride	000079-44-7	2.89E+00	3.96E+00	6.11E+00
Dimethylphenol phosphate (3:1)	025155-23-1	1.08E-05	8.06E-05	9.13E-05
Dinocap	039300-45-3	3.66E+01	5.71E+01	8.47E+01
Dinoseb	000088-85-7	8.93E+00	2.07E+01	2.77E+01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Dinoterb	001420-07-1	5.29E+00	3.94E+01	4.46E+01
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	001746-01-6	2.25E+06	3.07E+06	4.75E+06
Diuron	000330-54-1	1.64E+00	6.54E+00	7.94E+00
Endosulfan	000115-29-7	6.09E+00	2.56E+01	3.09E+01
Endosulfan (beta)	033213-65-9	2.78E+01	2.07E+02	2.35E+02
Endrin	000072-20-8	3.94E+02	7.54E+02	1.06E+03
Endrocide (endox) (coumatetralyl)	005836-29-3	1.96E-03	1.46E-02	1.66E-02
Epichlorohydrin	000106-89-8	8.21E-01	1.14E+00	1.75E+00
Ethane, 1,2-dibromo-	000106-93-4	4.63E+00	6.36E+00	9.81E+00
Ethane, 1,2-dichloro-	000107-06-2	1.24E+00	1.70E+00	2.62E+00
Ethane, pentachloro-	000076-01-7	1.53E-03	1.14E-02	1.29E-02
Ethanol, 2-ethoxy-	000110-80-5	5.14E-03	7.03E-03	1.09E-02
Ethanol, 2-methoxy-	000109-86-4	1.12E-02	1.53E-02	2.36E-02
Ethene, bromo-	000593-60-2	1.49E-01	2.04E-01	3.16E-01
Ethene, chloro-	000075-01-4	3.38E-01	4.63E-01	7.15E-01
Ethene, trichloro-	000079-01-6	4.71E-03	1.10E-02	1.47E-02
Ethyl O-(p-nitrophenyl) phenylphosphonothionate	002104-64-5	2.38E+03	3.26E+03	5.04E+03
Ethylene oxide	000075-21-8	1.35E-01	1.86E-01	2.87E-01
Ethylene thiourea	000096-45-7	2.23E-01	3.07E-01	4.73E-01
Ethyleneimine	000151-56-4	1.01E+01	1.39E+01	2.14E+01
Fenbutatin oxide	013356-08-6	2.15E-06	1.38E-05	1.59E-05
Fenchlorazole-ethyl	103112-35-2	1.10E+00	8.20E+00	9.30E+00
Fentin acetate	000900-95-8	9.31E+01	1.65E+02	2.36E+02
Fentin chloride	000639-58-7	7.88E+01	1.60E+02	2.21E+02
Fentin hydroxide	000076-87-9	9.40E+01	1.71E+02	2.43E+02
Fluazifop-butyl	069806-50-4	8.36E-02	6.23E-01	7.06E-01
Flucythrinate	070124-77-5	1.13E+02	4.80E+02	5.77E+02
Fluoranthene	000206-44-0	8.51E-01	4.69E+00	5.47E+00
Fluorene	000086-73-7	1.25E-01	3.84E-01	4.85E-01
Flusilazole	085509-19-9	7.39E+00	1.01E+01	1.56E+01
Formaldehyde	000050-00-0	3.87E-01	5.36E-01	8.25E-01
Furan	000110-00-9	1.11E+00	1.52E+00	2.34E+00
Glufosinate ammonium	077182-82-2	8.95E-02	1.73E-01	2.42E-01
Glycidol	000556-52-5	1.12E-01	1.53E-01	2.36E-01
Glycydyltrimethylammonium chloride	003033-77-0	1.02E-07	7.60E-07	8.61E-07
Heptachlor	000076-44-8	1.43E+02	1.98E+02	3.04E+02
Heptachlor epoxide	001024-57-3	5.90E+02	8.40E+02	1.28E+03
Heptachloronorbornene	028680-45-7	5.97E-03	4.45E-02	5.04E-02
Hexachlorocyclohexane	000608-73-1	1.13E+01	2.01E+01	2.87E+01
Hexamethylphosphoramide	000680-31-9	3.80E+01	5.20E+01	8.03E+01
Hydrazine	000302-01-2	9.84E-01	1.87E+00	2.62E+00
Hydrazine, 1,1-dimethyl-	000057-14-7	4.60E-02	2.21E-01	2.62E-01
Hydrazine, 1,2-diphenyl-	000122-66-7	8.11E-05	6.04E-04	6.85E-04
Isodrin	000465-73-6	5.52E-02	4.11E-01	4.66E-01
Isoprene	000078-79-5	4.39E-03	7.71E-03	1.11E-02
Isoquinoline	000119-65-3	8.05E-03	6.00E-02	6.80E-02
Kepone	000143-50-0	6.76E+02	9.70E+02	1.48E+03
Lead	007439-92-1	4.46E-01	3.25E+00	9.06E+00
Lindane	000058-89-9	7.71E+01	1.25E+02	1.83E+02
Lindane, alpha-	000319-84-6	7.95E+00	1.25E+01	1.84E+01
Lindane, beta-	000319-85-7	6.70E+00	9.18E+00	1.42E+01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Linuron	000330-55-2	6.80E+00	1.76E+01	2.30E+01
Mercury	007439-97-6	3.66E+01	1.12E+03	3.36E+03
Mercury	007439-97-6	3.66E+01	1.12E+03	3.36E+03
Methoxychlor	000072-43-5	1.25E-01	7.19E-01	8.34E-01
Methylmercury	022967-92-6	5.92E+00	8.10E+00	1.25E+01
Mirex	002385-85-5	2.87E+03	3.93E+03	6.07E+03
Naphthalene	000091-20-3	8.76E-02	1.59E-01	2.26E-01
Naphthalene, 2-methyl-	000091-57-6	1.49E-01	3.57E-01	4.74E-01
Nickel	007440-02-0	7.73E-01	5.57E+00	6.82E+00
Nitroanisole, o-	000091-23-6	1.34E-01	1.94E-01	2.94E-01
Nitrobenzene	000098-95-3	1.32E+00	1.83E+00	2.81E+00
Nitrosoguanidine, N-methyl-N'-nitro-N-	000070-25-7	1.83E+00	2.50E+00	3.86E+00
N-Nitrosodiethanolamine	001116-54-7	1.39E-01	1.90E-01	2.94E-01
N-Nitrosodimethylamine	000062-75-9	5.44E+00	7.44E+00	1.15E+01
N-Nitrosodipropylamine	000621-64-7	5.15E+01	7.05E+01	1.09E+02
N-nonylphenol	084852-15-3	7.59E-01	5.65E+00	6.41E+00
Nonylphenol	025154-52-3	1.32E-01	9.83E-01	1.11E+00
O,p'-ddt	000789-02-6	1.72E-02	1.28E-01	1.45E-01
o-Aminoanisole	000090-04-0	5.64E-05	4.20E-04	4.76E-04
o-Toluidine	000095-53-4	3.90E-04	2.91E-03	3.30E-03
o-Toluidine, 4-chloro-, hydrochloride	003165-93-3	1.53E-01	2.09E-01	3.23E-01
Oxirane, (phenoxymethyl)-	000122-60-1	4.02E-02	5.51E-02	8.51E-02
P-(1,1,3,3-tetramethylbutyl)phenol	000140-66-9	3.83E-01	2.85E+00	3.23E+00
p-Cresidine	000120-71-8	1.71E-02	2.34E-02	3.61E-02
Pentabromodiphenyl ether	032534-81-9	1.91E+01	2.61E+01	4.03E+01
Phenanthrene	000085-01-8	2.22E-02	1.65E-01	1.87E-01
Phenanthridine	000229-87-8	8.03E-04	5.98E-03	6.78E-03
Phenol, pentachloro-	000087-86-5	1.79E-01	3.47E-01	4.85E-01
Phenolphthalein	000077-09-8	9.42E-03	1.29E-02	1.99E-02
Phenyl hydrazine	000100-63-0	2.80E-05	2.08E-04	2.36E-04
Phenylmercuric acetate	000062-38-4	2.12E+01	3.95E+01	5.57E+01
Phosphate, tris(2-chloroethyl)-	000115-96-8	8.10E-04	6.03E-03	6.84E-03
Phthalate, butyl-benzyl-	000085-68-7	1.88E-02	1.32E-01	1.51E-01
Phthalate, dibutyl-	000084-74-2	7.11E-02	4.47E-01	5.15E-01
Tetramethyldiaminobenzophenone	000090-94-8	0.00E+00	0.00E+00	0.00E+00
Phthalate, dihexyl-	000084-75-3	4.39E-04	3.27E-03	3.71E-03
Phthalate, dioctyl-	000117-81-7	4.63E-01	6.43E-01	9.88E-01
P-nonylphenol	000104-40-5	8.23E-02	6.13E-01	6.95E-01
Polychlorinated biphenyls	001336-36-3	1.00E-03	7.48E-03	8.48E-03
Propane sultone	001120-71-4	4.12E-01	5.64E-01	8.72E-01
Propane, 1,2,3-trichloro-	000096-18-4	5.85E+00	8.03E+00	1.24E+01
Propane, 1,2-dibromo-3-chloro-	000096-12-8	2.55E+01	3.49E+01	5.39E+01
Propane, 1,2-dichloro-	000078-87-5	8.48E+00	1.16E+01	1.79E+01
Propane, 2-nitro-	000079-46-9	1.46E-01	2.00E-01	3.09E-01
Propiolactone	000057-57-8	3.40E-01	4.65E-01	7.18E-01
Propylene oxide	000075-56-9	3.32E-01	4.54E-01	7.02E-01
P-tert-amylphenol	000080-46-6	4.16E-04	3.10E-03	3.52E-03
Pyrene	000129-00-0	9.24E-02	6.13E-01	7.01E-01
Quinoline	000091-22-5	2.26E-03	1.69E-02	1.91E-02
Safrole	000094-59-7	2.44E-02	3.34E-02	5.16E-02
Sulfallate	000095-06-7	2.89E-01	3.96E-01	6.11E-01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Sulfuric acid, dimethyl ester	000077-78-1	1.26E-09	9.38E-09	1.06E-08
Tetrabutyltin	001461-25-2	6.83E-04	5.09E-03	5.77E-03
Tetraethyl lead	000078-00-2	1.09E+04	1.50E+04	2.31E+04
Tetrahydrofurfuryl alcohol	000097-99-4	1.19E-08	8.86E-08	1.00E-07
Tetramethyl lead	000075-74-1	5.88E-02	4.38E-01	4.96E-01
Tetrasul	002227-13-6	1.95E-05	1.46E-04	1.65E-04
Thioacetamide	000062-55-5	3.99E-02	5.46E-02	8.44E-02
Toluene, 2,4-diamine	000095-80-7	5.86E-01	8.01E-01	1.24E+00
Toluene, 2,4-dinitro-	000121-14-2	4.17E-02	6.89E-02	1.01E-01
Toluene, 2,6-dinitro-	000606-20-2	1.95E-01	2.68E-01	4.13E-01
Toxaphene	008001-35-2	3.75E+00	2.01E+01	2.35E+01
Tributylstannane	000688-73-3	1.49E+00	1.11E+01	1.26E+01
Tributyltin oxide	000056-35-9	6.78E+01	3.53E+02	4.14E+02
Trichlorobenzenes	012002-48-1	1.38E-04	1.03E-03	1.17E-03
Triflumizole	068694-11-1	1.28E-01	9.52E-01	1.08E+00
Trifluralin	001582-09-8	6.04E+00	9.01E+00	1.35E+01
Vinclozolin	050471-44-8	1.15E+00	1.71E+00	2.58E+00
Warfarin	000081-81-2	1.60E+01	2.19E+01	3.39E+01
Zinc	007440-66-6	8.38E-02	7.95E-01	1.68E+00

D.4 Emissions to the soil

Table 57 gives the environmental prices for emissions of selected pollutants to the soil, listed in alphabetical order.

Table 57 Environmental prices (damage costs) for average emissions to soil in the EU28 (€$_{2015}$/kg emission)

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
1,1'-Biphenyl, 3,3',4,4'-tetrachloro-, PCB-77	032598-13-3	4.28E-05	3.19E-04	3.61E-04
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	057653-85-7	2.88E-04	2.15E-03	2.43E-03
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	040321-76-4	2.50E-01	1.86E+00	2.11E+00
1,3-Dichloro-2-propanol	000096-23-1	9.32E-03	6.94E-02	7.87E-02
1,5,9-Cyclododecatriene	004904-61-4	2.46E-08	1.83E-07	2.07E-07
1-Bromopropane	000106-94-5	6.87E-07	5.12E-06	5.80E-06
2,2-Bis(4-hydroxy-3,5-dibromophenyl)propane	000079-94-7	1.97E-05	1.47E-04	1.67E-04
2,3-Dibromo-1-propanol	000096-13-9	3.65E-06	2.72E-05	3.08E-05
2,3-Dinitrotoluene	000602-01-7	9.19E-03	6.85E-02	7.76E-02
2,4,5,2',5'-Pentachlorobiphenyl	037680-73-2	1.20E-03	8.92E-03	1.01E-02
2,4,6-Tri(tert-butyl)phenol	000732-26-3	5.31E-04	3.95E-03	4.48E-03
2,5-Dinitrotoluene	000619-15-8	5.42E-04	4.04E-03	4.58E-03
2-Butenal	004170-30-3	6.63E-05	4.94E-04	5.60E-04
2-Ethoxyethyl acetate	000111-15-9	2.23E-05	1.66E-04	1.88E-04
2-Methoxyethyl acetate	000110-49-6	4.94E-07	3.68E-06	4.17E-06
3,4-Dinitrotoluene	000610-39-9	5.89E-04	4.39E-03	4.98E-03
3,5-Dinitrotoluene	000618-85-9	1.98E-05	1.47E-04	1.67E-04
4,4'-Methylene di-o-toluidine	000838-88-0	3.25E-01	4.44E-01	6.86E-01
4,4'-Methylenebis-(2-chlorobenzenamine)	000101-14-4	5.15E-01	7.05E-01	1.09E+00
4,4'-Oxybisbenzenamine	000101-80-4	1.82E-01	2.49E-01	3.84E-01
4,4-Thiodianiline	000139-65-1	3.04E-01	4.15E-01	6.42E-01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
4-Aminoazobenzene	000060-09-3	1.63E-05	1.21E-04	1.38E-04
Acenaphthene	000083-32-9	2.04E-03	2.92E-03	4.45E-03
Acenaphthene, 5-nitro-	000602-87-9	5.88E-01	8.04E-01	1.24E+00
Acridine	000260-94-6	3.26E-03	2.43E-02	2.75E-02
Acrylamide	000079-06-1	6.52E-02	8.92E-02	1.38E-01
Acrylonitrile	000107-13-1	3.28E-01	4.49E-01	6.93E-01
A-endosulfan	000959-98-8	1.10E+00	8.22E+00	9.32E+00
Aldrin	000309-00-2	1.66E+01	2.28E+01	3.51E+01
Aniline, p-chloro-	000106-47-8	3.00E-02	4.96E-02	7.23E-02
Anisole, pentachloro-	001825-21-4	7.33E-03	5.46E-02	6.19E-02
Anthracene	000120-12-7	3.80E-03	5.73E-03	8.59E-03
Arsenic	007440-38-2	1.00E+01	3.77E+01	9.53E+01
Azobenzene	000103-33-3	2.67E-03	1.99E-02	2.25E-02
Azocyclotin	041083-11-8	6.13E-01	8.85E-01	1.34E+00
Benomyl	017804-35-2	3.80E-04	2.29E-03	2.65E-03
Benz(a)acridine	000225-11-6	6.50E-04	4.84E-03	5.48E-03
Benz(c)acridine	000225-51-4	7.80E-03	5.81E-02	6.59E-02
Benzene	000071-43-2	5.47E-02	7.48E-02	1.16E-01
Benzene, (epoxyethyl)-	000096-09-3	8.34E-03	1.14E-02	1.76E-02
Benzene, 1,2,3-trichloro-	000087-61-6	8.59E-04	6.40E-03	7.25E-03
Benzene, 1,2,4-trichloro-	000120-82-1	1.15E-01	1.62E-01	2.48E-01
Benzene, 1,3,5-trichloro-	000108-70-3	2.82E-04	2.10E-03	2.38E-03
Benzene, 1-methyl-2-nitro-	000088-72-2	6.13E-05	4.57E-04	5.18E-04
Benzene, 2,4-dichloro-1-(4-nitrophenoxy)-	001836-75-5	3.57E-02	5.47E-02	8.16E-02
Benzene, hexachloro-	000118-74-1	1.15E+02	1.58E+02	2.43E+02
Benzene, pentachloro-	000608-93-5	8.21E+00	1.14E+01	1.75E+01
Benzidine	000092-87-5	2.57E-01	3.51E-01	5.42E-01
Benzidine, 3,3'-dichloro-	000091-94-1	1.57E+00	2.15E+00	3.33E+00
Benzidine, 3,3'-dimethyl-	000119-93-7	4.59E-05	3.42E-04	3.87E-04
Benzo(a)anthracene	000056-55-3	1.04E-06	7.77E-06	8.80E-06
Benzo(a)pyrene	000050-32-8	3.17E+01	4.33E+01	6.69E+01
Benzoic acid, 4-(tert-butyl)-	000098-73-7	1.71E-05	1.28E-04	1.45E-04
Benzotrichloride	000098-07-7	1.07E+00	1.47E+00	2.27E+00
Benzyl chloride	000100-44-7	2.30E-02	3.16E-02	4.88E-02
Beryllium	007440-41-7	2.26E+00	7.04E+00	9.84E+00
beta-Naphthylamine	000091-59-8	1.44E-01	1.96E-01	3.03E-01
Binapacryl	000485-31-4	8.68E-04	6.47E-03	7.33E-03
Biphenyl, 4-amino-	000092-67-1	2.02E-01	2.77E-01	4.27E-01
Bis(chloromethyl)ether	000542-88-1	8.92E+02	1.22E+03	1.88E+03
Bisphenol A	000080-05-7	6.02E-03	1.55E-02	2.03E-02
Brodifacoum	056073-10-0	5.24E-07	3.91E-06	4.43E-06
Butadiene	000106-99-0	7.39E-03	1.01E-02	1.56E-02
Butadiene, hexachloro-	000087-68-3	3.96E-03	2.95E-02	3.35E-02
C.I. basic violet 3	000548-62-9	7.58E-03	5.64E-02	6.40E-02
C.I. disperse blue 1	002475-45-8	1.59E-02	2.17E-02	3.35E-02
C.I. solvent yellow 3	000097-56-3	7.97E-01	1.09E+00	1.68E+00
Cadmium	007440-43-9	1.12E+01	1.15E+03	3.53E+03
Carbamic acid, ethyl ester	000051-79-6	1.15E-02	1.58E-02	2.44E-02
Carbendazim	010605-21-7	4.77E-02	2.43E-01	2.86E-01
Chlordane , pur	000057-74-9	2.36E+02	3.23E+02	4.99E+02
Chlorfenvinphos	000470-90-6	2.33E+01	3.24E+01	4.99E+01
Chloromethyl methyl ether	000107-30-2	5.51E-02	7.54E-02	1.16E-01

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Chloroprene	000126-99-8	7.47E-02	1.02E-01	1.58E-01
Chromium	007440-47-3	2.73E-05	4.18E-04	9.97E-04
Copper	007440-50-8	5.94E-03	1.46E-01	3.93E-01
Cyclododecane	000294-62-2	2.12E-08	1.58E-07	1.79E-07
Cyclododecane, hexabromo-	025637-99-4	1.89E-03	1.41E-02	1.60E-02
Cycloheximide	000066-81-9	5.55E-05	4.13E-04	4.68E-04
Cyclopentadiene, hexachloro-	000077-47-4	1.66E+01	2.27E+01	3.51E+01
Cyhexatin	013121-70-5	4.52E-01	6.23E-01	9.59E-01
DDT	000050-29-3	7.10E+00	9.78E+00	1.51E+01
Decabromodiphenyl oxide	001163-19-5	3.58E+01	4.90E+01	7.57E+01
Delta-hexachlorocyclohexane	000319-86-8	2.65E-03	1.97E-02	2.24E-02
Dibenz(a,h)anthracene	000053-70-3	4.82E+00	6.59E+00	1.02E+01
Dibenzofuran, 2,3,7,8-tetrachloro-	051207-31-9	6.47E+01	4.82E+02	5.46E+02
Dibutyl dichloro tin	000683-18-1	1.42E-02	1.06E-01	1.20E-01
Dibutyltin oxide	000818-08-6	6.20E-09	4.62E-08	5.24E-08
Dicofol	000115-32-2	1.03E+00	1.41E+00	2.18E+00
Dieldrin	000060-57-1	1.39E+02	1.92E+02	2.95E+02
Difenacoum	056073-07-5	1.81E-06	1.35E-05	1.53E-05
Di-isobutylphthalate	000084-69-5	2.50E-05	1.86E-04	2.11E-04
Dimethyl formamide	000068-12-2	1.23E-01	1.69E-01	2.60E-01
Dimethylcarbamyl chloride	000079-44-7	6.54E+00	8.94E+00	1.38E+01
Dimethylphenol phosphate (3:1)	025155-23-1	2.53E-09	1.89E-08	2.14E-08
Dinocap	039300-45-3	1.22E-01	1.69E-01	2.60E-01
Dinoseb	000088-85-7	1.07E+01	1.55E+01	2.36E+01
Dinoterb	001420-07-1	7.17E-02	5.35E-01	6.06E-01
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	001746-01-6	3.48E+05	4.76E+05	7.35E+05
Diuron	000330-54-1	1.93E-01	6.09E-01	7.67E-01
Endosulfan	000115-29-7	1.17E-01	1.84E-01	2.72E-01
Endosulfan (beta)	033213-65-9	9.93E-01	7.40E+00	8.38E+00
Endrin	000072-20-8	1.22E+01	2.02E+01	2.95E+01
Endrocide (endox) (coumatetralyl)	005836-29-3	1.47E-05	1.10E-04	1.24E-04
Epichlorohydrin	000106-89-8	7.54E-01	1.03E+00	1.59E+00
Ethane, 1,2-dibromo-	000106-93-4	3.12E+00	4.28E+00	6.60E+00
Ethane, 1,2-dichloro-	000107-06-2	1.16E+00	1.59E+00	2.45E+00
Ethane, pentachloro-	000076-01-7	4.40E-06	3.28E-05	3.72E-05
Ethanol, 2-ethoxy-	000110-80-5	4.34E-03	5.94E-03	9.17E-03
Ethanol, 2-methoxy-	000109-86-4	2.28E-02	3.12E-02	4.82E-02
Ethene, bromo-	000593-60-2	1.38E-01	1.88E-01	2.91E-01
Ethene, chloro-	000075-01-4	2.29E+00	3.13E+00	4.84E+00
Ethene, trichloro-	000079-01-6	8.13E-03	1.12E-02	1.73E-02
Ethyl O-(p-nitrophenyl) phenylphosphonothionate	002104-64-5	2.89E+01	3.96E+01	6.12E+01
Ethylene oxide	000075-21-8	9.71E-02	1.33E-01	2.05E-01
Ethylene thiourea	000096-45-7	5.90E-02	8.09E-02	1.25E-01
Ethyleneimine	000151-56-4	9.21E+00	1.26E+01	1.95E+01
Fenbutatin oxide	013356-08-6	3.24E+01	4.43E+01	6.85E+01
Fenchlorazole-ethyl	103112-35-2	9.99E-03	7.45E-02	8.44E-02
Fentin acetate	000900-95-8	1.26E+00	1.87E+00	2.82E+00
Fentin chloride	000639-58-7	2.45E+01	3.48E+01	5.31E+01
Fentin hydroxide	000076-87-9	7.94E-01	1.25E+00	1.84E+00
Fluazifop-butyl	069806-50-4	4.04E-04	3.01E-03	3.41E-03
Flucythrinate	070124-77-5	2.02E-01	3.89E-01	5.44E-01
Fluoranthene	000206-44-0	1.10E-02	2.63E-02	3.50E-02

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Fluorene	000086-73-7	1.19E-02	2.02E-02	2.93E-02
Flusilazole	085509-19-9	4.33E-01	5.93E-01	9.16E-01
Formaldehyde	000050-00-0	6.99E-01	9.56E-01	1.48E+00
Furan	000110-00-9	3.57E+00	4.88E+00	7.54E+00
Glufosinate ammonium	077182-82-2	3.46E-01	4.81E-01	7.39E-01
Glycidol	000556-52-5	4.43E-01	6.06E-01	9.36E-01
Glycydyltrimethylammonium chloride	003033-77-0	1.57E-08	1.17E-07	1.32E-07
Heptachlor	000076-44-8	4.36E-01	5.96E-01	9.21E-01
Heptachlor epoxide	001024-57-3	6.42E+01	8.82E+01	1.36E+02
Heptachloronorbornene	028680-45-7	8.34E-05	6.21E-04	7.04E-04
Hexachlorocyclohexane	000608-73-1	8.51E-01	1.23E+00	1.86E+00
Hexamethylphosphoramide	000680-31-9	1.68E+02	2.30E+02	3.55E+02
Hydrazine	000302-01-2	2.43E+00	3.36E+00	5.18E+00
Hydrazine, 1,1-dimethyl-	000057-14-7	2.58E-02	5.67E-02	7.68E-02
Hydrazine, 1,2-diphenyl-	000122-66-7	2.40E-06	1.79E-05	2.03E-05
Isodrin	000465-73-6	4.47E-03	3.33E-02	3.78E-02
Isoprene	000078-79-5	2.87E-03	3.93E-03	6.07E-03
Isoquinoline	000119-65-3	4.83E-04	3.60E-03	4.08E-03
Kepone	000143-50-0	1.58E+01	2.18E+01	3.35E+01
Lead	007439-92-1	4.97E-02	8.01E+00	2.46E+01
Lindane	000058-89-9	7.65E+00	1.11E+01	1.69E+01
Lindane, alpha-	000319-84-6	2.63E+00	3.64E+00	5.60E+00
Lindane, beta-	000319-85-7	4.32E-01	5.92E-01	9.14E-01
Linuron	000330-55-2	9.03E-01	1.57E+00	2.26E+00
Mercury	007439-97-6	4.00E+02	8.16E+02	1.67E+03
Mercury	007439-97-6	4.00E+02	8.16E+02	1.67E+03
Methoxychlor	000072-43-5	2.25E-02	3.15E-02	4.83E-02
Methylmercury	022967-92-6	1.17E+02	1.60E+02	2.47E+02
Mirex	002385-85-5	2.11E+03	2.89E+03	4.46E+03
Naphthalene	000091-20-3	2.01E-02	2.77E-02	4.27E-02
Naphthalene, 2-methyl-	000091-57-6	1.46E-02	2.04E-02	3.13E-02
Nickel	007440-02-0	1.57E-02	2.06E-01	5.46E-01
Nitroanisole, o-	000091-23-6	2.43E-01	3.33E-01	5.15E-01
Nitrobenzene	000098-95-3	8.19E-01	1.12E+00	1.73E+00
Nitrosoguanidine, N-methyl-N'-nitro-N-	000070-25-7	7.61E+00	1.04E+01	1.61E+01
N-Nitrosodiethanolamine	001116-54-7	3.24E-01	4.43E-01	6.85E-01
N-Nitrosodimethylamine	000062-75-9	1.70E+01	2.32E+01	3.58E+01
N-Nitrosodipropylamine	000621-64-7	3.94E+01	5.38E+01	8.32E+01
N-nonylphenol	084852-15-3	5.23E-04	3.89E-03	4.41E-03
Nonylphenol	025154-52-3	8.68E-05	6.47E-04	7.33E-04
O,p'-ddt	000789-02-6	1.58E-03	1.17E-02	1.33E-02
o-Aminoanisole	000090-04-0	1.22E-05	9.09E-05	1.03E-04
o-Toluidine	000095-53-4	3.21E-08	2.39E-07	2.71E-07
o-Toluidine, 4-chloro-, hydrochloride	003165-93-3	5.39E-02	7.37E-02	1.14E-01
Oxirane, (phenoxymethyl)-	000122-60-1	3.59E-02	4.91E-02	7.59E-02
P-(1,1,3,3-tetramethylbutyl)phenol	000140-66-9	1.06E-03	7.92E-03	8.98E-03
p-Cresidine	000120-71-8	7.32E-03	1.00E-02	1.55E-02
Pentabromodiphenyl ether	032534-81-9	9.06E+00	1.24E+01	1.91E+01
Phenanthrene	000085-01-8	8.12E-05	6.05E-04	6.85E-04
Phenanthridine	000229-87-8	3.58E-05	2.66E-04	3.02E-04
Phenol, pentachloro-	000087-86-5	3.14E-03	4.48E-03	6.83E-03
Phenolphthalein	000077-09-8	1.39E-03	1.90E-03	2.94E-03

Pollutant	CAS registry number	Lower value €/kg	Central value €/kg	Upper value €/kg
Phenyl hydrazine	000100-63-0	4.13E-06	3.08E-05	3.49E-05
Phenylmercuric acetate	000062-38-4	6.46E+01	8.99E+01	1.38E+02
Phosphate, tris(2-chloroethyl)-	000115-96-8	5.40E-05	4.02E-04	4.56E-04
Phthalate, butyl-benzyl-	000085-68-7	2.39E-03	3.97E-03	5.78E-03
Phthalate, dibutyl-	000084-74-2	6.29E-03	1.26E-02	1.74E-02
Phthalate, dihexyl-	000084-75-3	1.27E-04	9.44E-04	1.07E-03
Phthalate, dioctyl-	000117-81-7	1.21E-01	1.66E-01	2.56E-01
P-nonylphenol	000104-40-5	6.24E-05	4.65E-04	5.27E-04
Polychlorinated biphenyls	001336-36-3	5.64E-04	4.20E-03	4.76E-03
Propane sultone	001120-71-4	1.49E+00	2.03E+00	3.14E+00
Propane, 1,2,3-trichloro-	000096-18-4	8.48E+00	1.16E+01	1.79E+01
Propane, 1,2-dibromo-3-chloro-	000096-12-8	1.31E+01	1.79E+01	2.77E+01
Propane, 1,2-dichloro-	000078-87-5	9.71E+00	1.33E+01	2.05E+01
Propane, 2-nitro-	000079-46-9	1.22E-01	1.67E-01	2.57E-01
Propiolactone	000057-57-8	1.56E+00	2.13E+00	3.29E+00
Propylene oxide	000075-56-9	2.95E-01	4.04E-01	6.23E-01
P-tert-amylphenol	000080-46-6	8.88E-05	6.62E-04	7.50E-04
Pyrene	000129-00-0	9.52E-02	1.32E-01	2.03E-01
Quinoline	000091-22-5	1.79E-04	1.33E-03	1.51E-03
Safrole	000094-59-7	2.14E-03	2.92E-03	4.52E-03
Sulfallate	000095-06-7	3.76E-02	5.16E-02	7.96E-02
Sulfuric acid, dimethyl ester	000077-78-1	1.11E-07	8.29E-07	9.39E-07
Tetrabutyltin	001461-25-2	1.91E-08	1.42E-07	1.61E-07
Tetraethyl lead	000078-00-2	5.37E+02	7.35E+02	1.13E+03
Tetrahydrofurfuryl alcohol	000097-99-4	1.35E-08	1.01E-07	1.14E-07
Tetramethyl lead	000075-74-1	3.68E-05	2.74E-04	3.10E-04
Tetrasul	002227-13-6	3.97E-06	2.96E-05	3.35E-05
Thioacetamide	000062-55-5	9.13E-02	1.25E-01	1.93E-01
Toluene, 2,4-diamine	000095-80-7	4.10E+00	5.61E+00	8.67E+00
Toluene, 2,4-dinitro-	000121-14-2	3.74E+00	5.12E+00	7.91E+00
Toluene, 2,6-dinitro-	000606-20-2	4.24E+01	5.80E+01	8.96E+01
Toxaphene	008001-35-2	5.82E+00	9.08E+00	1.35E+01
Tributylstannane	000688-73-3	8.47E-06	6.31E-05	7.15E-05
Tributyltin oxide	000056-35-9	8.75E-01	2.97E+00	3.69E+00
Trichlorobenzenes	012002-48-1	6.26E-05	4.67E-04	5.29E-04
Triflumizole	068694-11-1	1.91E-02	1.42E-01	1.61E-01
Trifluralin	001582-09-8	5.56E-01	7.63E-01	1.18E+00
Vinclozolin	050471-44-8	1.97E-01	2.77E-01	4.24E-01
Warfarin	000081-81-2	4.31E+00	5.90E+00	9.12E+00
Zinc	000612-82-8	4.33E-02	4.96E+00	1.52E+01

ANNEXURE – XV

If the probability of risk so calculated is in the high-risk zone leading to loss of life, penalty as applicable as per the Government norms will be levied. In the zone of moderate and low risk committee will decide penalty on the study

COST OF COMPLIANCE WITH HEALTH AND SAFETY MANAGEMENT SYSTEM AMONG CONTRACTOR IN CONSTRUCTION INDUSTRY

Conference Paper · April 2014

DOI: 10.13140/2.1.1158.9445

Abdul Rahim Abdul Hamid
Universiti Teknologi Malaysia

Bachan Singh
Universiti Teknologi Malaysia

C11

COST OF COMPLIANCE WITH HEALTH AND SAFETY MANAGEMENT SYSTEM AMONG CONTRACTOR IN CONSTRUCTION INDUSTRY

Abdul Rahim Abdul Hamid[1], Bachan Singh[2] and Ahmad Suhaimi Mohd Salleh[3]

[1, 2, 3] *Department of Structures and Materials, Faculty of Civil Engineering, Universiti Teknologi Malaysia 81310 Johor Bahru, Johor, Malaysia.*

•Corresponding author: *rahimfka@gmail.com*

Abstract: Accidents and injury statistic in construction industry were among the highest compared to the other sector every year. One of the main reasons that contribute to this problem was due to the insufficient amount allocated for occupational health and safety management. The aim of this study was to identify the contractors approach towards safety and health management system compliance by investigating the cost and benefit of that approach. This study was conducted using questionnaire surveys around the District of Johor Bahru, Johor, Malaysia. The respondents were made of supervisor, engineer and project manager that work with main contractor which the project values worth from RM 1 to 25 million. The data were collected using questionnaire forms and frequency analysis was being used to analyze the data gathered. Overall, this study had identified the different approaches taken by contractor in implementing health and safety management system within organization such as recorded work-related accidents but few for ill-health and most of contractors undertook basic elements but very few of them implemented performance measurement. Cost implication was still is the biggest barrier to implement formal OHSMS. Thus, such implementation was legally driven. This study also manages to highlight what are the nature of expenditure and impact of the implementation to the organization. The cost of compliance varies from minimum 0.15% to 1.08% with average of 0.41% from project value. Most respondents perceived benefits outweighed cost compare to those who thought cost outweighed benefits.

Keywords: *Occupational Health and Safety; Management System; Construction; Cost; Benefits.*

1.0 Introduction

Health and safety management system must be supported by an amount of cost to make it efficient in reducing rate of accidents and deaths among the construction workers (Abdul Rahim et al., 2000). The statistic shown that the death rate occurs in the construction sector is among the highest compared to the other industries (Abdul Rahim et al., 2008). This problem was caused by poor handling in health and safety management of contractor due to insufficient amount allocated to meet such compliance (Shaari, 1995; Mohammed, 2002).

The occupational safety and health (OSH) management system(OSHAS 18001, 1999) in the organization has five main elements which follow the internationally accepted Demming cycle of Plan-Do-Check-Act, which is the basic to the "system" approach to management (Michael, 2004). The elements are namely Policy, Organizing, Planning and implementation, Evaluation and Action for improvement as shown in Figure 1(Abdul Rahim et al., 2004).

Policy contains the elements of OSH policy and worker participation. It is the basis of the OSH management system as it set the direction for the organization to follow. Organizing contains the elements of responsibility and accountability, competence and training, documentation and communication. It makes sure that the management structure is in place, as well as the necessary responsibilities allocated for delivering the OSH policy. Planning and implementation contains the elements of initial review, system planning, development and implementation, OSH objectives and hazard prevention. Through the initial review, it shows where the organization stands concerning OSH, and uses this as the baseline to implement the OSH policy. Evaluation contains the elements of performance monitoring and measurement, investigation of work-related injuries, ill-health, diseases and incident, audit and management review (Syed et al., 2000). It shows how the OSH management system functions and identifies any weaknesses that need improvement. It includes the very important of auditing, which should be undertaken for each stage. Person independent of the activity being audited should conduct the audits (Weinstein, 1997). This does not necessarily mean third party auditors. Action for improvement includes the elements of preventive and corrective action and continual improvement. It implements the necessary preventive and corrective actions identified by the evaluation and audits carried out. It also emphasizes the need for continual improvement of OSH performance through the constant development of policies, systems and techniques to prevent and control work-related injuries, ill-health, diseases and incidents (SIRIM, 2005).

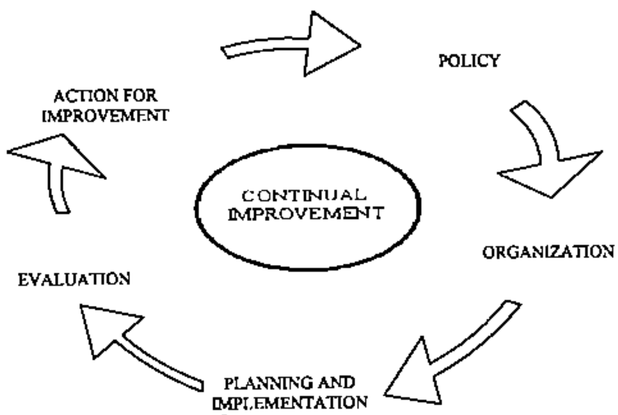


Figure 1: OSH Management System

Meanwhile, the safety laws and regulations such as Occupational Safety and Health Act (OSHA) 1994, Factory and Machinery Act (FMA) 1967 and Building Operation and Work of Engineering Construction (BOWEC) 1986 were reviewed in order to list the aspect that need to be included in the cost evaluation. There are eight items being considered.

1. Worker's Insurances
2. Safety inspection

3. Safety meeting
4. Safety training
5. Payment to safety officer /consultant
6. Safety tool
7. Personal protective equipment
8. Supporting equipment for administration, management and documentation.

2.0 Objective of Study

The aim of this study was to investigate cost of compliance with health and safety management among contractors. Two objectives had been set up as below:

1. To identify the approach taking by contractor in implementing aspects of health and safety management system within their organization
2. To investigate cost and benefits of the compliance to the OSH Management System.

This study was conducted in District of Johor Bahru and Skudai, Johor. The respondents consist of supervisor, engineer and project manager working within contractor organization which the project value ranging from RM 1 million and above in the building construction sector only.

3.0 Methodology of Study

This study employed questionnaire survey that follow these steps:

1. Initial planning
2. Questionnaire preparation
3. Choosing respondents
4. Distributing and collecting questionnaire form
5. Analyze the data
6. Conclusion

When the objectives and scope of the study was determined from the literature review, a set of questionnaire was developed based on what has been discussed before. This questionnaire contains four sections A, B, C and D. Section A captured the background of the respondent. Section B was about approach towards health and safety management. Section C was about nature of expenditure and the benefit of the compliance whilst section D gathered the rate provided by contractor in compliance with health and safety management system.

The questionnaire forms were distributed by hand (20 set) and by post (30 set). The return only 15 sets by hand and 5 sets by post make the total of 20 set that available to be analyzed. Analysis of the data was done using frequency analysis in the form of percentage. The cost of compliance was stated by percent from total project value.

$$\boxed{\text{Frequency (percent)} = \frac{\text{No. of respondent}}{\text{Total respondents}} \times 100\%}$$

4.0 Results and Discussion

Brief results presented below were based on the analysis of the questions for each section that correspond to the objectives of study.

4.1 Section A: Respondents background

Figure 3 shows make up of respondents, Figure 3 shows 80% of company had been operated more than 5 years, while 20% was less than 5 years old.

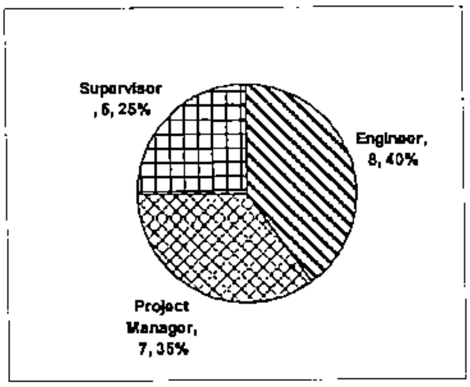


Figure 2: Types of Respondents

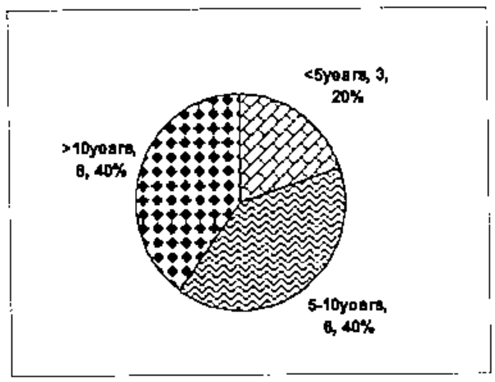


Figure 3: Years Operated

4.2 Section B: Approach toward Health and Safety Management System

Figure 4 shows 85% respondent had formal health and safety management system while 15% said conversely. Figure 5 shows that 85% respondents recorded work related accidents, only 30% recorded ill-health and 15% said neither.

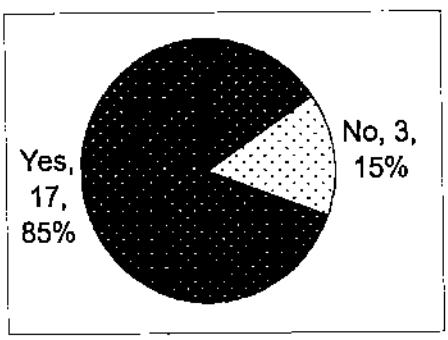


Figure 4: Formal Health and Safety Management System in place.

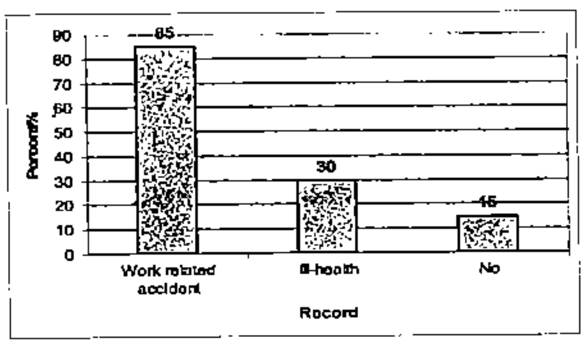


Figure 5: Work Related Accident and/or ill-health record

Figure 6 shows what were included in the contractor health and safety system. Many of them have safety officer (70%), accident reporting system (85%), documented risk assessment (75%), and written policy (85%). But few of them have performance measurement (30%), and performance target (55%).

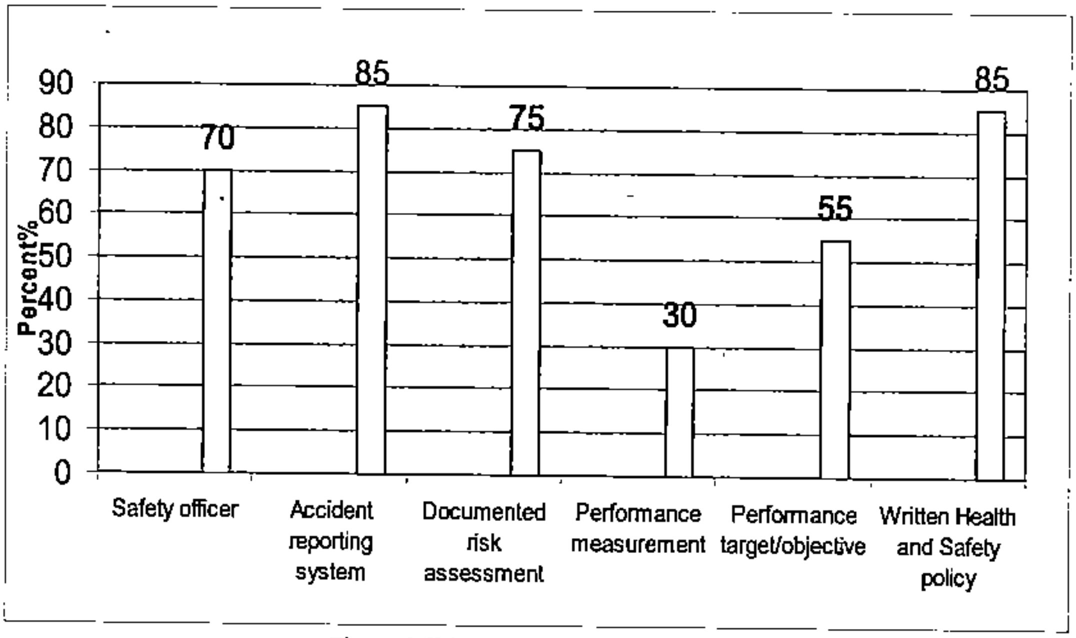


Figure 6: What were included in OSHMS

Figure 7 shows what were the barrier faced to implement OSH system. The result indicated cost implication (90%), not priority (10%), lack of knowledge or information (45%) and time restriction (40%).

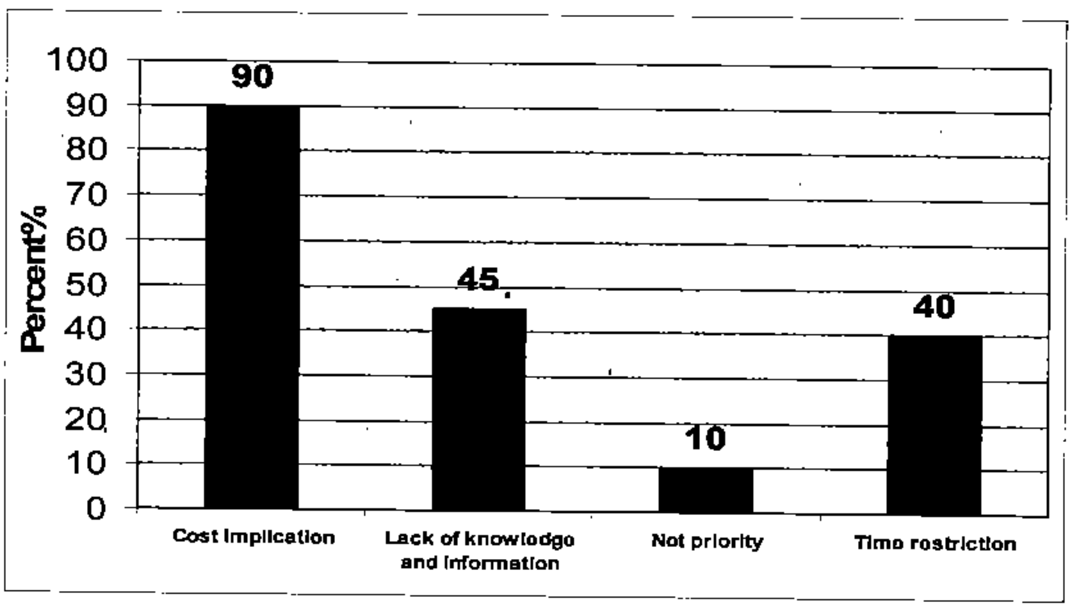


Figure 7: Barriers in Implementing OHSMS

Figure 8 shows factors that motivate the contractor to have OHSMS. Legal obligation (75%), had been visited by DOSH Inspector (70%), Insurance cost and health and safety publicity (65%), Organization reached particular size (15%), and supplier/customer/client pressure (5%).

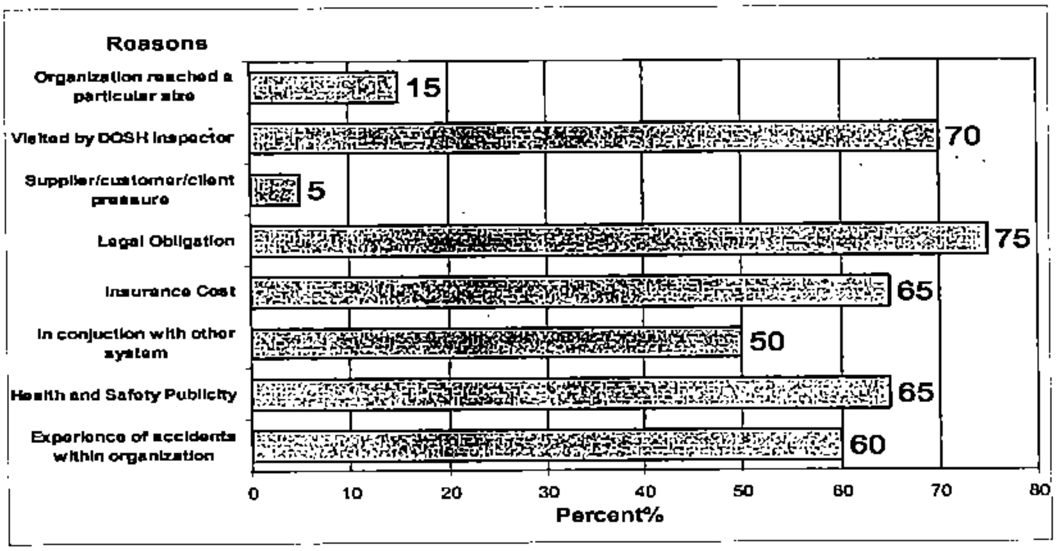


Figure 8: Reason for Developing OHSMS.

Figure 9 shows sources the contractor got health and safety advice from i.e. Safety consultant/officer and DOSH (95%), CIDB (75%), SOCSO (60%), NIOSH (55%), Local Authority (10%), Contractor service center (10%), Internet (15%).

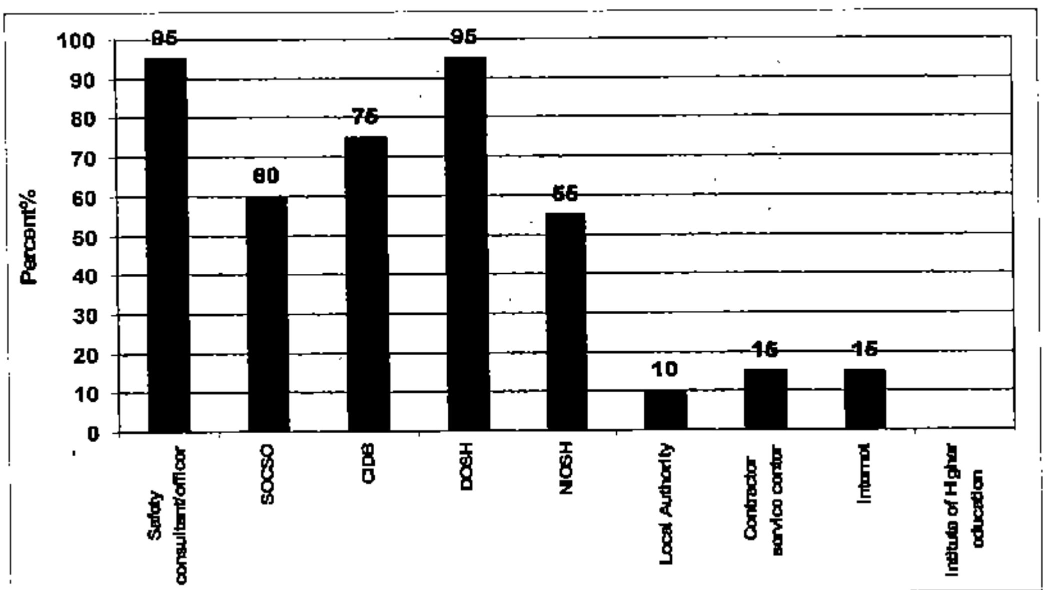


Figure 9: Sources to Get Health and Safety Advice/Information

4.3 Section C: Nature of Expenditure and Benefits of the Compliance

Figure 10 shows main health and safety expenditures among respondents i.e. Workers training and personal protective equipment (90%), safety tool (60%), payment for H&S officer (25%), and safety consultant (35%).

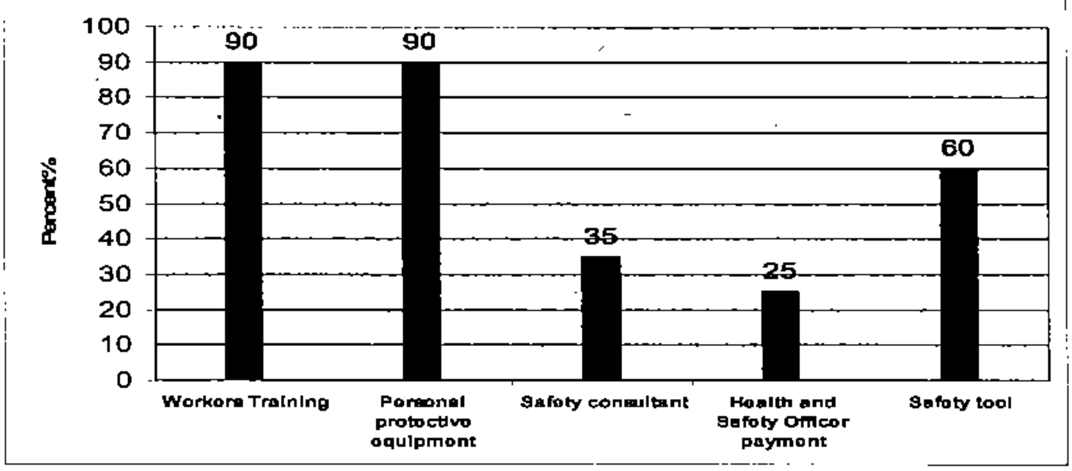


Figure 10: The Main Health and Safety Expenditures.

Table 1 shows the impact of the compliance with OHSMS. The values in each cell represent frequency of respondents choose the impact regarding the aspect. Insurance premiums (60%) and number of staff employed (80%) recorded no effect. In positive side, Performance (80% increase), staff morale (55% increase), sickness absence (70% decrease, 5% increase), time lost through accident (80% decrease, 5% increase). For negative side, Compensation claims (20% increase, 10% decrease), staff turnover (20% increase, 10% decrease).

Table 1: Impact of the Action Taken

Impact (%) / Aspect	Increased	No effect	Decreased	Too early to say	Don't know
Compensation claims	20	25	10	20	25
Insurance Premiums	10	60		15	15
No. of staff Employed	15	80		5	
Performance Of employees	80			10	10
Sickness Absence	5	15	70		10
Staff Morale	55	15		10	20
Staff turnover	20	30	10	25	15
Time lost Trough Accident	5	10	80		5
Quality of work	30	15		15	40

Figure 11 shows the comparison between cost and benefits from respondent's perception on implementation of OHSMS. About 35% felt benefits outweighed the costs and 25%

said conversely. Around 25% felt they were even broken and 15% just don't know or in the state too early to say.

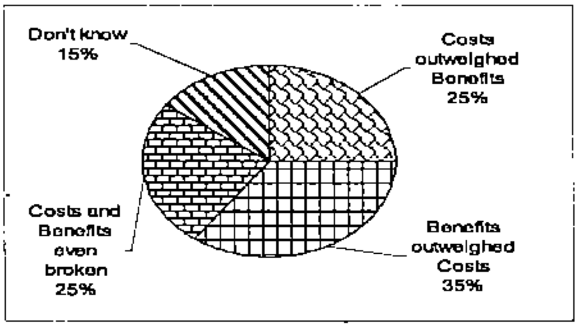


Figure 11: Comparison between the costs and benefits of OHSMS implementation

4.4 Section D: Cost of Compliance with OHSMS

Table 2 shows the cost provide by contractors in compliance with health and safety management system. The cost was calculated and classified from total project value.

Table 2: Cost of compliance

Project Value (million) / Items	RM1 – RM5 (Min – Max), (%) (2 respondents)	RM5 – RM10 (Min – Max), (%) (3 respondents)	RM10 – RM20 (Min – Max), (%) (12 respondents)	>RM20 (Min – Max), (%) (3 respondents)
Workers Insurance	0.022-0.067	0.038-0.094	0.020-0.064	0.030-0.500
Safety Inspection	0.022-0.067	0.020-0.094	0.007-0.027	0.012-0.150
Safety Meeting	0.022-0.067	0.020-0.038	0.006-0.027	0.005-0.012
Workers training	0.067-0.067	0.020-0.038	0.007-0.188	0.000-0.030
Safety officer/ Consultant payment	0.067-0.167	0.060-0.094	0.009-0.188	0.015-0.030
Safety tools	0.022-0.022	0.060-0.375	0.020-0.188	0.015-0.120
Personal protective Equipments	0.022-0.022	0.020-0.375	0.006-0.188	0.030-0.120
Supporting equipments for Administration, Management, and Documentation.	0.022-0.067	0.038-0.094	0.019-0.188	0.015-0.120
Min-Max (Σ %)	0.36-0.46	0.31-1.08	0.15-0.85	0.19-0.74
Average (Σ %)	0.410	0.663	0.342	0.473

Figure 12 shows Estimated Expenditure compared to Actual Expenditures. We can see that actual expenditures were much lower than estimated. The estimated expenditure based on respondent's perception on the right amount of OHS cost need to be spends. The actual expenditure based on their experience.

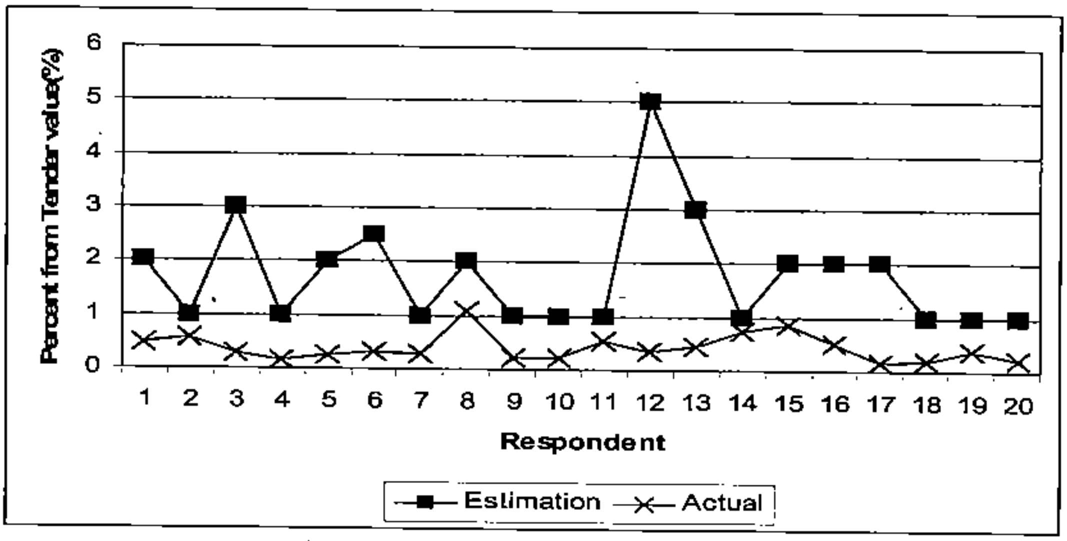


Figure 12: Actual versus estimated expenditures

5.0 Conclusion

Based on the objectives of the study conclusions are as follows:

1. Majority of contractors had Occupational Health and Safety Management System in place but they were taking different approach for some aspects of the implementation.

   (i) Most of the contractor recorded work-related accidents but few for ill-health.

   (ii) Most of contractor included basic elements like accident reporting system, risk assessment, and written health and safety policy but very few of them make performance measurement.

   (iii) Cost implication still the biggest barrier to implement formal OHSMS.

   (iv) Legal obligation became main motivation for contractors to implement OHSMS.

   (v) Government agencies like DOSH, CIDB, SOCSO and NIOSH were the main sources to seek advice about OHS management besides Safety consultant or Safety Officer.

2. The quantum of safety allocation needed in order to comply to requirement and the benefit for this effort are as follows:

   i. The cost of compliance varies from minimum 0.15% to 1.08% with average of 0.41% from project value. Workers training and personal protective equipments are the main expenditure. The actual expenditure based on respondents experience was much lower than the estimated expenditure based on their perceptions on the right amount to spend for OHS cost.

ii. Most the respondents think OHSMS shows positive impact in some aspects such as performance, staff morale, sickness absence, and time lost trough accident while they think conversely in compensation claims and staff turnover. More respondents think benefits outweighed cost compare to those who think cost outweighed benefits.

6.0 REFERENCES

Abdul Rahim Abdul Hamid, Muhd Zaimi Abd Majid and Bachan Singh (2008). Causes of Accident at Construction Sites, published in MJCE Vol 20, No 2, pp 242-259.

Abdul Rahim Abdul Hamid, Bachan Singh, Wan Zulkifli Wan Yusof and ATY King. (2004) The Integration of Safety, Health, Environmental and Quality (SHEQ) Management Systems in Construction: A Review, Jurnal Kejuruteraan Awam 16 (1), 24-37.

Abdul Rahim Abdul Hamid (2000). Cost of Accidents at Construction Sites, paper presented at Civil Engineering Seminar – FKA UTM (Semka 2000), Hotel Grand Continental, Pahang

Mohammed Alias bin Yusof (2002). "Amalan Keselamatan yang Baik di Tapak Bina". Universiti Teknologi Malaysia: Final Year Report.

Michael Findley, Susan Smith, Tyler Kress, Gregory Petty and Kim Enoch (2004). "Safety program elements in construction. Which ones best prevent injuries and control related workers' compensation costs ?" Journal of Policy Analysis Management.England: Butterworth & Co, pp. 651 – 674.

Occupational Safety And Health Management System-Guidelines (2005), MS:1722:2005, Standard Management Department SIRIM Berhad, pp. 5-18.

Occupational Health And Safety Assessement Series (OSHAS 18001:1999) Guidelines, pp. 4-49.

Shaari Mohd (1995). "Pengurusan Keselamatan dan Kesihatan Pekerjaan di Tapak Bina." Selangor D.E: Syarikat Percetakan Ihsan.

Syed M. Ahmed, Peter Tang, Salman Azhar and Irtishad Ahmad (2000). "An Evaluation of Safety Measures in the Hong Kong Construction Industry Based on Total Quality Management Principals." The Associated General Contractors of America, Alexandria.

Weinstein, M.B.,(1997). "Total Quality Safety Management and Auditing." New York: Lewis Publishers.

ANNEXURE – XVI

CPCB Noise rules 2000 & 2010

THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

(The Principal Rules were published in the Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended vide S.O. 1046(E), dated 22.11.2000, S.O. 1088(E), dated 11.10.2002, S.O. 1569 (E), dated 19.09.2006 and S.O. 50 (E) dated 11.01.2010 under the Environment (Protection) Act, 1986.)

Whereas the increasing ambient noise levels in public places from various sources, inter-alia, industrial activity, construction activity, fire crackers, sound producing instruments, generator sets, loud speakers, public address systems, music systems, vehicular horns and other mechanical devices have deleterious effects on human health and the psychological well being of the people; it is considered necessary to regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise;

Whereas a draft of Noise Pollution (Control and Regulation) Rules, 1999 was published under the notification of the Government of India in the Ministry of Environment and Forests vide number S.O. 528 (E), dated the 28th June, 1999 inviting objections and suggestions from all the persons likely to be affected thereby, before the expiry of the period of sixty days from the date on which the copies of the Gazette containing the said notification are made available to the public;

And whereas copies of the said Gazette were made available to the public on the 1st day of July, 1999;

And whereas the objections and suggestions received from the public in respect of the said draft rules have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by clause (ii) of sub-section (2) of section 3, sub-section (1) and clause (b) of sub-section (2) of section 6 and section 25 of the Environment (Protection) Act, 1986 (29 of 1986) read with rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following rules for the regulation and control of noise producing and generating sources, namely:-

The Noise Pollution (Regulation and Control) Rules, 2000

1. Short-title and commencement.-

(1) These rules may be called the 'Noise Pollution (Regulation and Control) Rules, 2000.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. **Definitions-** In these rules, unless the context otherwise requires,-

(a) "Act" means the Environment (Protection) Act, 1986 (29 of 1986);

(b) "area / zone" means all areas which fall in either of the four categories given in the Schedule annexed to these rules;

(c) "authority" means and includes any authority or officer authorized by the Central Government, or as the case may be, the State Government in accordance with the laws in force and includes a District Magistrate, Police Commissioner, or any other officer not below the rank of the Deputy Superintendent of Police designated for the maintenance of the ambient air quality standards in respect of noise under any law for the time being in force;

(d) "court" means a governmental body consisting of one or more judges who sit to adjudicate disputes and administer justice and includes any court of law presided over by a judge, judges or a magistrate and acting as a tribunal in civil, taxation and criminal cases;

(e) "educational institution" means a school, seminary, college, university, professional academies, training institutes or other educational establishment, not necessarily a chartered institution and includes not only buildings, but also all grounds necessary for the accomplishment of the full scope of educational instruction, including those things essential to mental, moral and physical development;

(f) "hospital" means an institution for the reception and care of sick, wounded, infirm or aged persons, and includes government or private hospitals, nursing homes and clinics;

(g) "person" shall include any company or association or body of individuals, whether incorporated or not;

(h) "State Government" in relation to a Union territory means the Administrator thereof appointed under article 239 of the Constitution.

(i) "public place" means any place to which the public have access, whether as of right or not, and includes auditorium, hotels, public waiting rooms, convention centres, public offices, shopping malls, cinema halls, educational institutions, libraries, open grounds and the like which are visited by general public; and

(j) "night time" means the period between 10.00 p.m. and 6.00 a.m.

3. **<u>Ambient air quality standards in respect of noise for different areas/zones.-</u>**

(1) The ambient air quality standards in respect of noise for different areas / zones shall be such as specified in the Schedule annexed to these rules.

(2) The State Government shall categorize the areas into industrial, commercial, residential or silence areas / zones for the purpose of implementation of noise standards for different areas.

(3) The State Government shall take measures for abatement of noise including noise emanating from vehicular movements, blowing of horns, bursting of sound emitting firecrackers, use of loud speakers or public address system and sound producing instruments and ensure that the existing noise levels do not exceed the ambient air quality standards specified under these rules.

(4) All development authorities, local bodies and other concerned authorities while planning developmental activity or carrying out functions relating to town and country planning shall take into consideration all aspects of noise pollution as a parameter of quality of life to avoid noise menace and to achieve the objective of maintaining the ambient air quality standards in respect of noise.

(5) An area comprising not less than 100 metres around hospitals, educational institutions and courts may be declared as silence area / zone for the purpose of these rules.

4. **<u>Responsibility as to enforcement of noise pollution control measures.-</u>**

(1) The noise levels in any area / zone shall not exceed the ambient air quality standards in respect of noise as specified in the Schedule.

(2) The authority shall be responsible for the enforcement of noise pollution control measures and the due compliance of the ambient air quality standards in respect of noise.

(3) The respective State Pollution Control Boards or Pollution Control Committees in consultation with the Central Pollution Control Board shall collect, compile and publish technical and statistical data relating to noise pollution and measures devised for its effective prevention, control and abatement.

5. Restrictions on the use of loud speakers / public address system and sound producing instruments.-

(1) A loud speaker or a public address system shall not be used except after obtaining written permission from the authority.

(2) A loud speaker or a public address system or any sound producing instrument or a musical instrument or a sound amplifier shall not be used at night time except in closed premises for communication within, like auditoria, conference rooms, community halls, banquet halls or during a public emergency.

(3) Notwithstanding any thing contained in sub-rule (2), the State Government may subject to such terms and conditions as are necessary to reduce noise pollution, permit use of loud speakers or public address system and the like during night hours (between 10.00 p.m. to 12.00 midnight) on or during any cultural or religious festive occasion of a limited duration not exceeding fifteen days in all during a calendar year. The concerned State Government shall generally specify in advance, the number and particulars of the days on which such exemption would be operative.

(4) The noise level at the boundary of the public place, where loudspeaker or public address system or any other noise source is being used shall not exceed 10 dB (A) above the ambient noise standards for the area or 75 dB (A) whichever is lower;

(5) The peripheral noise level of a privately owned sound system or a sound producing instrument shall not, at the boundary of the private place, exceed by more than 5 dB (A) the ambient noise standards specified for the area in which it is used.

5A. Restrictions on the use of horns, sound emitting construction equipments and bursting of fire crackers:-

(1) No horn shall be used in silence zones or during night time in residential areas except during a public emergency.

(2) Sound emitting fire crackers shall not be burst in silence zone or during night time.

(3) Sound emitting construction equipments shall not be used or operated during night time in residential areas and silence zones.

6. **Consequences of any violation in silence zone / area.-**

Whoever, in any place covered under the silence zone / area commits any of the following offence, he shall be liable for penalty under the provisions of the Act:-

(i) whoever, plays any music or uses any sound amplifiers,

(ii) whoever, beats a drum or tom-tom or blows a horn either musical or pressure, or trumpet or beats or sounds any instrument, or

(iii) whoever, exhibits any mimetic, musical or other performances of a nature to attract crowds.

(iv) whoever, bursts sound emitting fire crackers; or

(v) whoever, uses a loud speaker or a public address system.

7. **Complaints to be made to the authority.-**

(1) A person may, if the noise level exceeds the ambient noise standards by 10 dB (A) or more given in the corresponding columns against any area / zone or, if there is a violation of any provision of these rules regarding restrictions imposed during night time, make a complaint to the authority.

(2) The authority shall act on the complaint and take action against the violator in accordance with the provisions of these rules and any other law in force.

8 **Power to prohibit etc. continuance of music sound or noise.-**

(1) If the authority is satisfied from the report of an officer incharge of a police station or other information received by him including from the complainant that it is necessary to do so in order to prevent annoyance, disturbance, discomfort or injury or risk of annoyance, disturbance, discomfort or injury to the public or to any person who dwell or occupy property on the vicinity, he may, by a written order issue such directions as he may consider necessary to any person for preventing, prohibiting, controlling or regulating:-

(a) the incidence or continuance in or upon any premises of-

(i) any vocal or instrumental music,

(ii) sounds caused by playing, beating, clashing, blowing or use in any manner whatsoever of any instrument including loudspeakers, public address systems, horn, construction equipment, appliance or apparatus or contrivance which is capable of producing or re-producing sound, or

(iii) sound caused by bursting of sound emitting fire crackers, or,

(b) the carrying on in or upon, any premises of any trade, avocation or operation or process resulting in or attended with noise.

(2) The authority empowered under sub-rule (1) may, either on its own motion, or on the application of any person aggrieved by an order made under sub-rule (1), either rescind, modify or alter any such order:

Provided that before any such application is disposed of, the said authority shall afford to the applicant and to the original complainant, as the case may be, an opportunity of appearing before it either in person or by a person representing him and showing cause against the order and shall, if it rejects any such application either wholly or in part, record its reasons for such rejection.

SCHEDULE

(see rule 3(1) and 4(1))

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:- 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specified period.

ANNEXURE – XVII

IRO Report on Compliance of EC Vide E-File No:ENV/IRO-HYD/MR-40/2022/397 dated: 08.03.2022

भारत सरकार
Government of India
पर्यावरण वन और जलवायु परिवर्तन मंत्रालय
Ministry of Environment, Forests & Climate Change
एकीकृत क्षेत्रीय कार्यालय/**Integrated Regional Office**
Aranya Bhavan, 3rdfloor, Saifabad, Hyderabad-500004, Telangana
E-mail: iro.hyderabad-mefcc@gov.in

E-File No: ENV/IRO-HYD/MR-40/2022/397 **08.03.2022**

To
The Member Secretary,
Ministry of Environment, Forest and Climate Change,
IA Division-I,
Indira Paryavaran Bhavan,
3rd Floor, Vayu Wing,
Jor Bagh Road, New Delhi-110 003.

Sub: Kaleshwaram Project in Karimnagar District of Telangna by I&CAD Department, Government of Telangana-Environmental Clearance (EC)-regarding.
Ref: MoEF&CC, F.No: J-12011/1/2017-IA-I(R) dated 22.12.2017.
MoEF&CC, F.No: L-11011/4/2018-IA.I(R) dated 23.12.2021

Sir,

Your kind attention is invited on the subject and reference cited above wherein MoEF&CC has accorded environmental clearance to Kaleshwaram Project to I&CAD Department, Government of Telangana in in Karimnagar District of Telangana vide MoEF&CC, F.No: J-12011/1/2017-IA-I(R) dated 22.12.2017. Ministry vide letter no. L-11011/4/2018-IA.I(R) dated 23.12.2021 has requested IRO, MoEFCC, Hyderabad to submit latest compliance report of this project. Monitoring report is enclosed herewith for your information and further necessary action.

This issue with the approval of Regional Officer, IRO, MoEF&CC, Hyderabad.

Yours faithfully

(Dr. E. Arockia Lenin)
Scientist C/Deputy Director
(Email: arockia.lenin@gov.in)

Copy to

1. Additional Director, Monitoring Cell, Ministry of Environment Forest and Climate Change. Indira Paryavaran Bhawan, Aliganj, Jorbagh Road, New Delhi-110003
2. Shri. B. Hariram, Engineering in Chief. Kaleshwaram Project, 1st Floor. Jalasoudha Building. Errumanzil, Hyderabad-500082.
3. Guard file.

(Dr. E. Arockia Lenin)
Scientist C/Deputy Director

डॉ. इ. आरोकिया लेनिन/Dr. E. Arockia Lenin
वैज्ञानिक 'सी'/Scientist 'C'
उप निदेशक/Deputy Director
पर्यावरण वन और जलवायु परिवर्तन मंत्रालय
Ministry of Environment Forest & Climate Change
एकीकृत क्षेत्रीय कार्यालय, हैदराबाद-500 004.
Integrated Regional Office, Hyderabad-500 004.

SUMMARY NOTE

Background

MoEF&CC has accorded environmental to Kaleshwaram Project in Karimnagar District of Telangana by I&CAD Department, Government of Telangana vide MoEF&CC, F.No: J-12011/1/2017-IA-I(R) dated 22.12.2017. Ministry letter no. L-11011/4/2018-IA.I(R) dated 23.12.2021 has requested IRO, MoEFCC, Hyderabad to submit latest EC compliance report. Site visit has been carried out by IRO, Hyderabad on 08.02.2022 & 09.02.2022 to verify compliance status of conditions stipulated in the Environment Clearance. Project details and present status are as under.

Kaleshwaram Project envisages construction of a barrage across River Godavari near Medigadda village in Karimnagar District of Telangana for diversion of 180 TMC of water for providing irrigation facility in 7,38,851 ha covering 7 Districts namely Adilabad, Karimnagar, Nizamabad, Warangal, Medak, Nalgonda and Rangareddy Districts. It is also proposed to stabilize the existing command area of 7,62,028 ha of area. The project is also proposing to provide drinking water facility for Hyderabad cities as well as enroute villages. Total land requirement is 37,852 ha, out of which 3168.1315 ha is forest land and 34,684 ha is private land. Total estimated cost of the project as approved by Central Water Commission, New Delhi is about Rs. 80,499.71 Crores.

During site visit, the following areas are visited,

1. Laxmi barrage at Medigadda (Elevation wise lowest structure)
2. Saraswathi barrage-Annaram
3. Parvathi barrage-Sundilla
4. Laxmi Pump house near Medigadda
5. A stone quarry near Nandi Power house
6. Gayathri Pump house & Gravity Canal feeding Gayathri Pump house
7. Sri Ranganayak Sagar reservoir & Underground pump house at Sri Ranganayake Sagar reservoir.
8. Konda Pochhama pump house, gravity canal & tank (Elevation wise highest structure)

Present Status

Medigadda, Annaram and Sundilla barrages are completed in 2019. Kondapocchamma, Rankayanaka, Ananthagiri reservoirs are completed in 2020, and Mallana Sagar reservoir is completed and commissioned in 2022.

Activities proposed under Environment Management: The total allocation of the Environmental Management Plan (EMP) under this project is Rs. 16230.43 Crores, as per the information provided by project authority, an amount of Rs.9082.666 have been incurred towards environmental management under this project (copy enclosed-Annexure-1).

i. **Catchment Area Treatment (CAT):** The Catchment Area Treatment (CAT) Plan of this project has been proposed in the Chapter-9 of Environment Management Plan. CAT of Kaleshwaram project receives precipitation mainly in the form of rainfall. Majority of catchment area falls between and periphery of Godavari and Pranahita rivers (as shown in red colour in Annexure-1). As per EMP, Catchment Area Treatment (CAT) Plan has been proposed in an area of 32.83 sq.km with a total allocated financial grant of Rs. 362.04 crores. Engineering and bio-engineering works like, gabion structures in Sri ranganayaka sagar, flood banks and guide bunds in all three barrages, check dams across local streams have been carried out by PA. Till date, an amount of Rs. 3.02 Crores incurred for plantation, Rs.76.49 Crores for construction of Check dams and Rs.608.87 Crores for River stabilization (Action plan for further plantation development in an area of 412.39 ha from Link I, II, IV & VII are in progress. Director General, Water and Land Management Training and Research Institute (WALAMTARI) has been designated as the nodal officer for the implementation of CAT plan and Shri Kukrety, Retired Additional PCCF has been designated as technical consultant to co-ordinate implementation of CAT Plan.

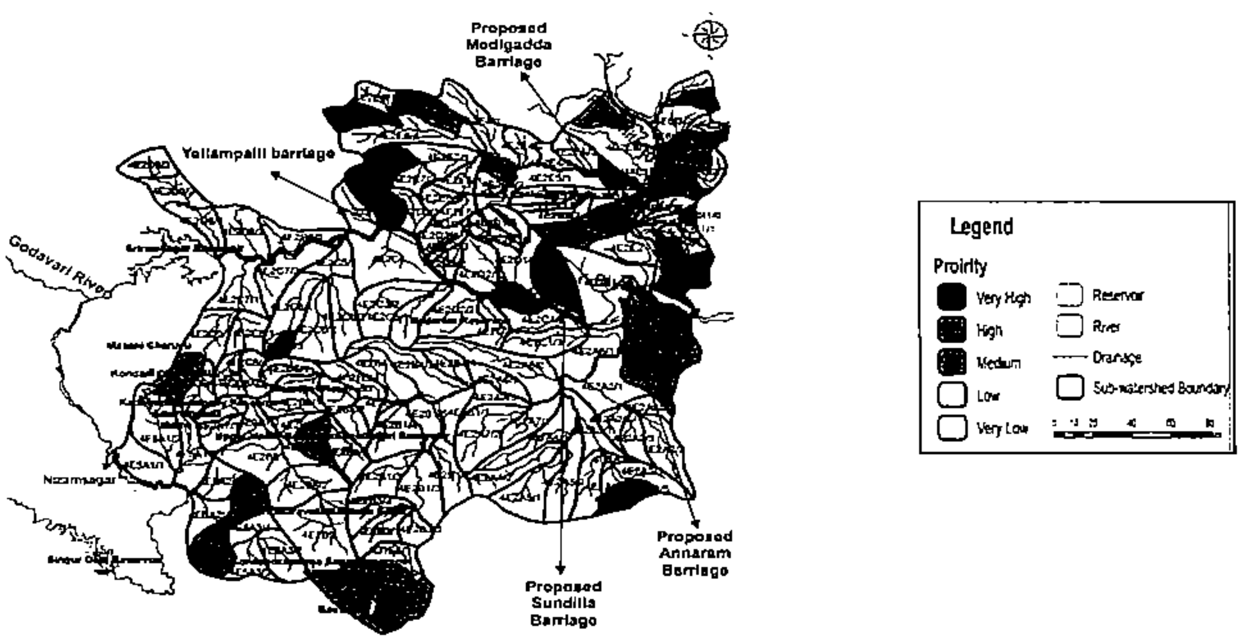


Fig. 1. Thematic representation showing Catchment area of the project

ii. **Command Area Development (CAD):** The proposed Command Area Development (CAD) of this project is 7,38,851ha. The total cost of command area development as per EMP is estimated Rs. 1326.86 Lakhs. The details as follows,

S.No.	Particular	Rs. (in Lakhs)
1	On farm evelopment	1,23,506.00
2	Drainage	8,407.00
3	Conjugative use of ground water	703.00
4	Reclamation of saline soils	70.00
		Rs. 132,686.00

An amount of Rs. 174.31 Crores were incurred for the implementation of distributaries in Link IV till date. Construction of Bund, Field Channel, Irrigation Channel, Drainage Channels under this programme are in progress. As per EMP, the year wise phasing of financial cost for command area development plan have not been fully utilized.

iii. **GB/Plantation:** An amount of Rs.19.21 Crores is allocated to develop green belt in the barrages of the project and reservoirs periphery and canal bank as stipulated. At present, a total of 79,913 saplings with twenty (20) local plant species have been planted in the project area through Telangana state as a part of Haritha Haram programme. Plantation programme all along the approach road to barrage, reservoir periphery and along the canal length are in progress. Further, Palle Prakruti Vanam (small forest) are developed at various locations within the Project area. In addition to that, an amount of Rs.722.30 Crores has been paid to State Forest Department under compensatory afforestation programme. Implementation of compensatory afforestation programme is in progress. The item wise break up are given below

- Rs. 205,33,16,114/- towards NPV,
- Rs.386,78,26,734/ towards CA,
- Rs.77, 52,56,928/- towards SMC works,
- Rs.36,56,895/ towards PCA,
- Rs.4,97,59,034/ towards WL Conservation Plan,
- Rs.29,39,66,074/ towards CAT Plan
- Rs. 6,75,68,700/- for demarcation of the forest land by erecting 4 ft high RCC pillars
- Rs. 10,98,80,664/ towards extraction of tree growth and
- Rs. 18,06,993/- towards enumeration of trees

iv. **Muck Management:** Consolidation and compaction of generated muck are carried out in the muck dumping sites near by Lakshmi barrage, along the gravity canals and in few areas of the barrages in response to the observation made in Joint Committee report. Generated muck has been utilized in construction material for civil works, making service road and inspection paths, embankments, guided bunds, barrage constructions and leveling and filling trenches. Turfing, plantation on muck dumps are carried out in few areas of Meddigadda, Annaram and Sundilla barrages, reservoirs, pump houses. However, compaction, slope, stabilization, retention wall and reclamation with vegetation of muck dumping sites need to be improved in few places of Meddigadda, Annaram and Sundilla barrages, reservoirs, pump houses and along the gravity canals. It is submitted that the overall muck management needs to be improved. PA shall take time bound action to restore/reclaim the muck dump sites. Delaying the management of muck dump sites may attribute to the siltation of the catchment area and thereby increasing the chance of sediment load to the river.

v. **Bio & WLC:** As per the information provided by PA, an amount of Rs.722.30 Crores has been paid to State Forest Department under compensatory afforestation programme. Implementation of compensatory afforestation programme is in progress. An amount of Rs.4,97,59,034/ has been paid to State Forest Department towards WL Conservation Plan. The activities proposed in the chapter 9.4 of EMP for biodiversity, wildlife conservation and management plan is in progress.

vi. **Water, Air, Noise monitoring & Management plan:** Ambient air, water, Noise levels are monitored by EPTRI, Hyderabad, third party NABL accredited laboratory. Ambient noise level monitored at 10 locations. The locations are as follows., 1. Pochampalli, 2. Suraram, 3. Chintharevula, 4. Rachapalli, 5. Sundara shala, 6. Kommera, 7. Gundrathpalli, 8. Gunjapadugu (BN8), 9. Kundaram, 10. Mustyala. As per the report, monitored parameters are within prescribed limits (copy enclosed-Annexure V) and Ambient air quality monitored at ten locations (i.e., 1. Pochampalli, 2. Suraram, 3. Chintharevula, 4. Rachapalli, 5. Sundara shala, 6. Kommera, 7. Gundrathpalli, 8. Gunjapadugu (BN8), 9. Kundaram, 10. Mustyala. Surface water was monitored at six locations (i.e. 1. Laxmi (Medigadda Barrage), 2. Saraswathi (Annaram) Barrage, 3. Parvathi (Sundilla) Barrage, 4. Laxmi pump house, 5. Saraswathi Pump House, 6. Parvathi Pump House). Ground water quality was monitored at four locations. i.e. (1. Bore well-Sundilla, 2. Bore well- Saraswathi Barrage, 3-Bore well-Laxmi barrage camp, 4. Bore well-CRPF Colony, Laxmi Barrage). As per the report, Monitored parameters are within prescribed limits (Copy enclosed-Annexure V).

vii. **Public hearing:** Public hearing was carried out in fifteen districts (1. Commitments made during the public hearing are being fulfilled. Compensation has been paid land outsees as per the Telangana Amendment Act (Act No. 21 of 2017) & Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. As per EMP, Environmental Management Plan are being implemented in phased manner for project implementation and operational phase. Compliance status of public hearing is enclosed (Annexure-VII).

viii. **Local area management plan:** PA has submitted that Water User Associations/ Co-operative shall be formed after ayacut localization. Distributary network system for creation of ayacut under Kaleshwaram Project is in progress PA has submitted that On Farm Development (OFD) works and Water User Associations shall be carried out after ayacut localization.

Partial compliances

Part A: Specific Condition no.ii: R&R benefits involved in Gandhamala reservoir have not been paid to the land outsees due to land acquisition issues. No work has been carried out in Gandhamala reservoir.

Condition no vii: Compaction, slope, stabilization and plantation, retention wall in muck dumping sites need to be improved in few places of Meddigadda, Annaram and Sundilla barrages, reservoirs, pump houses and along the gravity canals. PA shall take time bound action to restore/reclaim the muck dump sites. Delaying the management of muck dump sites may attribute to the siltation of the catchment area and thereby increasing the chance of sediment load to the river.

Condition no: xviii: Half yearly compliance reports to IRO, Hyderabad MoEF&CC have not been submitted regularly.

Part B: General Conditions

Condition no.iv: Fugitive dust emissions are observed along the approach road to the pump houses and inside the pump houses. PA shall monitor ambient air quality in those areas and take necessary

Condition no.16: Advertisements were not made in the local newspapers about grant of environmental clearance to Kaleshwaram Project.

Point wise EC compliance status are given in Part II.

Government of India
Ministry of Environment, Forest and Climate Change
MONITORING REPORT
PART-I
DATA SHEET

i.	Project Type: River-valley / Mining / Industry /Thermal / Nuclear / Other (Specify)	River Valley and Hydroelectric Projects
ii.	Name of the Project	Kaleshwaram Project in Karimnagar District of Telangna by I&CAD Department, Government of Telangana-Environmental Clearance (EC
iii.	Clearance Letter (s) / OM No. and date	MoEF&CC, F.No: J-12011/1/2017-IA-I(R) dated 22.12.2017
iv.	Location	
	a. District (s)	Karim Nagar
	b. State (s)	Talangana
	c. Latitude / Longitude	-
v. vi.	Address for correspondence / Address of concerned Project Chief Engineer (with Pin Code & Telephone / Telex / Fax Numbers)	Shri. B. Hariram, Engineering in Chief, Kaleshwaram Project, 1st Floor, Jalasoudha Building, Errumanzil, Hyderabad-500082. (email: encgjl irr" <encgjl.irr@gmail.com)
vii.	Salient features	
	a. Of the Project	Basin: Godavari Barrages: • Medigadda (Laxmi) barrage • Annaram (Saraswathi) barrage • Sundilla (Parvathi) barrage • Reservoir: 17 • Command area districts: Karimnagar, Rajanna Siricilla, Siddipet, Medak, Yadadri - Bhongiri, Nalgonda, Sangareddy, Nizamabad, Jagityal, Kamareddy, Nirmal, Medchal and Peddapalli districts • Total land requirement: 37,852 ha • Land Acquisition: 34684 ha • Gravity canal: 1531 km • Gravity Tunnel: 203 km • Pressure Main: 98 km • Lift (No.s): 20 • Pump houses: 19 • Total power requirement: 4627.24MW • Total Length of the conveyance system: 1832 km • Total cost of the project: Rs. 80,190.46 Crores
	b. Of the Environmental Management Plan	As per EMP

viii.	a. The status of approval for diversion of Forestland for non-forestry use	Forest land: 3168 ha
	b. The Status of clearing felling	
	c. The status of compensatory Afforestation if any	
ix.	The status of clear felling in non-forest areas (such as submergence area of reservoir, Approach roads), if any with quantitative information	
x.	a. Date of commencement (Actual and/or Planned)	2017
xi.	Reasons for the delay if the project is yet to start	-
xii.	Dates of site visits a. The dates on which the Project was monitored by Integrated Regional Office on previous occasions, if any	
xiii.	b. Date of site visit for this monitoring Report	08.02.2022 & 09.02.2022
xiv.	Details of correspondence with project authorities for obtaining action plan / information on status of compliance to safeguards other than the routine letters for logistic support for site visit.	-

PART-II

POINT WISE EC COMPLIANCE STATUS

Sub: Kaleshwaram Project in Karimnagar District of Telangna by I&CAD Department, Government of Telangana-Environmental Clearance (EC)-regarding
Ref: MoEF&CC, F.No: J-12011/1/2017-IA-I(R) dated 22.12.2017

S. No.	EC Conditions	Compliance status
Part-A - Specific conditions		
i.	The Catchment Area Treatment (CAT) Plan as has been proposed in the Chapter-9 of EMP (9.1-CAT Plan; November, 2017) shall be implemented in consultation with the Telangana State Forest Department. The allocated grant of Rs.362.04 Crores for this purpose should be fully utilized and not be diverted for any other purpose. As per plan, the area of CAT is 32.83 Sq.km	**Being Complied** The Catchment Area Treatment (CAT) Plan of this project has been proposed in the Chapter-9 of Environment Management Plan. CAT of Kaleshwaram project receives precipitation mainly in the form of rainfall. Majority of catchment area falls between and periphery of Godavari and Pranahita rivers (as shown in-Fig.1). As per EMP, Catchment Area Treatment (CAT) Plan has been proposed in an area of 32.83 sq.km with a total allocated financial grant of Rs. 362.04 crores. Engineering and bio-engineering works like, gabion structures in Sri ranganayaka sagar, flood banks and guide bunds in all three barrages, check dams across local streams have been carried out by PA. Till date, an amount of Rs. 3.02 Crores incurred for plantation, Rs.76.49 Crores for construction of Check dams and Rs.608.87 Crores for River stabilization (Action plan for further plantation development in an area of 412.39 ha from Link I, II, IV & VII are in progress. Director General, Water and Land Management Training and Research Institute (WALAMTARI) has been designated as the nodal officer for the implementation of CAT plan and Shri Kukrety, Retired Additional PCCF has been designated as

S. No.	EC Conditions	Compliance status
		Technical consultant to co-ordinate implementation of CAT Plan.
ii	The project involves acquisition of 34,684 ha of land. The R&R benefits for the land losing will have to comply with the Right to Fair Compensation and Transparency in land acquisition, Rehabilitation & Resettlement Act, 2013 or any other act which would be beneficial to the project oustees. Adequate publicity of the compensation package should be circulated in the affected villages. All R&R issues shall be completed before commissioning of the project	**Partly complied** The Rehabilitation & Resettlement benefits for the land outsees have been paid in accordance with R&R Act, 2017 of State Government of Telangana which is slightly higher than the Right to Fair Compensation and Transparency in land acquisition, Rehabilitation & Resettlement Act 2013. Till date, an amount of Rs. 6677.61 crores have been incurred towards Land Acquisition and R&R of this Project (Annexure-II & III). R&R benefits involved in Gandhamala reservoir have not been paid to the land outsees due to land acquisition issues. No work has been carried out in Gandhamala reservoir.
iii	Construction work to be carried-out after following due procedure of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 as applicable to the State of Telangana (21/2017) as amended by Act	**Complied** Compensation has been paid to land outsees as per the Telangana Amendment Act (Act No. 21 of 2017) and Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. Facilities of Drinking water, Electricity, Roads, Drainage, Community Hall are provided under this programme. The details of villages, No. of houses shifted, PAFs, PDFs etc. as part of submergence of Anantagiri (Annapurna) reservoir, Sri Komarelli Mallanna Sagar, Kondapochamma Sagar, Gandhamalla and Nrusimha Sagar (Baswapur Reservoir) are enclosed in Annexure II. R&R are not carried out in Gandhamala reservoir as work has not been started yet (Annexure II)

S. No.	EC Conditions	Compliance status
iv.	A Monitoring Committee for R&R shall be constituted which shall include representatives of project affected persons including representative from SC/ST category and a woman beneficiary.	**Complied** Monitoring committee for R&R has been set up as stipulated. An internal committee under the supervision of Engineer-in-Chief (I), Gajwel is monitoring the implementation of Rehabilitation programme.
v.	All commitment made during the public hearing should be fulfilled completely by the project proponent and record maintained, if any	**Being Complied** Public hearing was carried out in fifteen districts (1. Commitments made during the public hearing are being fulfilled. Compensation has been paid land outsees as per the Telangana Amendment Act (Act No. 21 of 2017) & Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. As per EMP, Environmental Management Plan are being implemented in phased manner for project implementation and operational phase. Compliance status of public hearing is enclosed (Annexure-II, III, VII, VIII)
vi.	The Command Area Development (CAD) Plan as proposed in the EIA/EMP report (November, 2017) report shall be strictly implemented	**Being Complied** The proposed Command Area Development (CAD) of this project is 7,38,851ha. The total cost of command area development as per EMP is estimated Rs. 1326.86 Lakhs. The details as follows.

S.No.	Particular	Rs. (in Lakhs)
1	On farm development	1,23,506.00
2	Drainage	8,407.00
3	Conjugative use of ground water	703.00
4	Reclamation of saline soils	70.00
		Rs. 132,686.00

S. No.	EC Conditions	Compliance status
		As submitted by PA, Under Command area development plan, an amount of Rs. 174.31 Crores were incurred for the implementation of distributaries in Link IV till date. Provision of Bund, Field Channel, Irrigation Channel, Drainage Channels under this programme are in progress'. The year wise phasing of financial cost for command area development plan have not been fully utilized as per EMP.
vii.	Consolidation and compaction of the generated muck should be carried-out in the muck dumping sites. As proposed in the muck disposal plan, out of 1480 lakh m^3 muck generated, the entire to be utilized for service road & inspection paths, embankments, land leveling, filling trenches, and construction material for CD works, road etc. and restoration works for canal banks should be strictly adhered. The muck disposal sites shall be reclaimed/ restored with vegetation once capacity is utilized. Allocated amount of Rs.32.79 crores for this purpose should be fully utilized and not be diverted for any other purpose	**Partly complied** Consolidation and compaction of generated muck are carried out in the muck dumping sites near by Lakshmi barrage, along the gravity canals and in few areas of the barrages in response to the observation made in Joint Committee report. Generated muck has been utilized in construction material for civil works, making service road and inspection paths, embankments, guided bunds, barrage constructions and leveling and filling trenches. Plantation on the mucks are carried out in few areas of Meddigadda, Annaram and Sundilla barrages, reservoirs, pump houses. Slope stabilization and plantation are being carried out. However, compaction, slope, stabilization and reclamation with vegetation of muck dumping sites need to be improved in various places of Meddigadda, Annaram and Sundilla barrages, reservoirs, pump houses and along the gravity canals. It is submitted that PA shall take time bound action to restore/reclaim the muck dump sites. Delaying the management of muck dump sites may attribute to the siltation of the catchment area and

S. No.	EC Conditions	Compliance status
		thereby increasing the chance of sediment load to the river.
viii.	The proposed compensatory afforestation programme in 5333.817 ha of degraded forest area with twenty two (22) local plant species identified for the programme shall be undertaken strictly in consultation with State Forest Department. The allocated amount of Rs.722.30 Crores for this purpose should be fully utilized and not to be diverted for any other purpose	**Being Compiled** As per the information provided by PA, an amount of Rs.722.30 Crores has been paid to State Forest Department under compensatory afforestation programme. Implementation of compensatory afforestation programme is in progress. The item wise break up are given below • Rs. 205,33,16,114/- towards NPV, • Rs.386,78,26,734/ towards CA, • Rs.77, 52,56,928/- towards SMC works, • Rs.36,56,895/ towards PCA, • Rs.4,97,59,034/ towards WL Conservation Plan, • Rs.29,39,66,074/ towards CAT Plan • Rs. 6,75,68,700/- for demarcation of the forest land by erecting 4 ft high RCC pillars • Rs. 10,98,80,664/ towards extraction of tree growth and • Rs. 18,06,993/- towards enumeration of trees
ix.	To enhance the environment of project site, greenbelt, as proposed in the EIA/EMP report (November, 2017) shall be developed. The proposed green belt shall be developed in the barrages of the project and reservoirs periphery of 110.20 km and canal bank of 116.334 km of the project proposed with local plant species in consultation with	**Being Compiled** An amount of Rs.19.21 Crores is allocated to develop green belt in the barrages of the project and reservoirs periphery and canal bank as stipulated. At present, a total of 79,913 saplings with twenty (20) local plant species were planted in the project area through Telangana state as a part of Haritha Haram programme. Plantation programme all along the approach road to barrage, reservoir periphery and along the canal length are in progress.

S. No.	EC Conditions	Compliance status
	State Forest Department should be taken-up strictly. The allocated grant of Rs.19.21 Crores should be fully utilized this purpose and not be diverted for any other purpose.	
x.	The Fisheries Development Plan as proposed in the EIA/EMP (November, 2017) for the conservation of fish in river & reservoir shall be implemented completely in consultation State Fisheries Department. A budget of Rs.485 Crores provided for fisheries development plan should be utilized fully for this purpose and not to be diverted for any other purpose	**Agreed to comply** At present, Fisheries department of state government is implementing fisheries development programme in twelve districts falls under this project. An amount of Rs.209.57 crores have been incurred by Fisheries Department for this purpose. The expenditure includes enhancing seed and fish production, harvesting support, marketing support, infrastructure development, capacity building and salary of fisheries management (Copy enclosed). PA is agreed to implement the fisheries development as stipulated apart from the above under this programme in future.
xi.	The proposed Biodiversity Conservation and Management Plan as proposed in the EIA/EMP report (November, 2017) should be implemented in consultation with State Forest Department. The allocated grant of Rs.3.36 Crores should be fully utilized this purpose and not be diverted for any other purpose	**Being complied** As per the information provided by PA, an amount of Rs.722.30 Crores has been paid to State Forest Department under compensatory afforestation programme. Implementation of compensatory afforestation programme is in progress. An amount of Rs.4,97,59,034/ has been paid to State Forest Department towards WL Conservation Plan. The activities proposed in the chapter 9.4 of EMP for biodiversity, wildlife conservation and management plan is in progress.
xii.	Water User Association's (WUAs)/ Co-operative shall be formed and involvement of the whole community	**Agreed to comply** PA has submitted that Water User Associations/ Co-operative shall be formed after ayacut localization.

S. No.	EC Conditions	Compliance status
	for disciplined use of available waters shall be ensured	Distributary network system for creation of ayacut under Kaleshwaram Project is in progress.
xiii.	Conjunctive use of surface water shall be planned to check water logging as well as to increase productivity	**Agreed to comply** PA has agreed that Conjunctive use of surface water in the command area shall be implemented considering crop pattern submitted as per EMP. Further, about 253 Piezometers/ observation wells are provided for monitoring ground water level and quality. An amount of Rs. 3.35 crores are incurred till date. (Annexure IV).
xiv.	The equipment likely to generate high noise levels during the construction period or otherwise shall meet the ambient noise level standards as notified under the Noise Pollution (Regulation and Control) Rules, 2000, as amended in 2010 under the Environment Protection Act (EPA), 1986. Ambient Noise level monitoring shall be conducted on a monthly basis during the period of construction at suitable locations and copy of the test reports to be submitted to Regional Office, MoEF & CC, Chennai on six monthly basis	**Being complied** Ambient Noise level monitored at ten locations through third party NABL recognized laboratory, EPTRI. The locations are as follows., 1. Pochampalli, 2. Suraram, 3. Chintharevula, 4. Rachapalli, 5. Sundara shala, 6. Kommera, 7. Gundrathpalli, 8. Gunjapadugu (BN8), 9. Kundaram, 10. Mustyala. As per the report, monitored parameters are within prescribed limits (copy enclosed-Annexure V)
xv.	The On Farm Development (OFD) works shall be completed and WUAs (Water User Associations) shall be made functional before commencement of irrigation	**Agreed to comply** PA has submitted that On Farm Development (OFD) works and Water User Associations shall be carried out after ayacut localization.

S. No.	EC Conditions	Compliance status
xvi	Occurrence of stagnant pools/ slow moving water channels during construction and operation of the project providing breeding source for vector mosquitoes and other parasites. The river should be properly channelized so that no small pools and puddles are allowed to be formed. Even after taking precautions, due to un-foreseen situations, breeding of mosquito and resultant malaria or mosquito borne diseases can increase. If such a situation arises, it will be the responsibility of project authorities to take all steps i.e. residual insecticidal spray in all the project area and surrounding 3 km area keeping the flight range of mosquitoes in consideration.	**Being complied** Labour camps for the labours are provided within the project site. Domestic effluents are treated in septic tanks followed by soak pits. As submitted by PA, Insecticidal sprays are being used to control the mosquito breeding.
xvii.	Any other clearance from any other organization/ department if required should be obtained	**Complied** All the requisite clearances are obtained from the Competent Authorities (Copy enclosed Annexure VI).
xviii	The submergence area is very large, micro-climatic change conditions in the project area during construction/ post-construction period to be brought-out/ reported at regular intervals.	**Partly complied** Half yearly compliance reports to IRO, Hyderabad MoEF&CC have not been submitted regularly.
xix.	Plans for greenbelt development and reservoir rim treatment have to be	**Being compiled**

S. No.	EC Conditions	Compliance status
	made in consultation with State Forest Department. Preference shall also be given to plant local indigenous species.	Green belt development with native species are developed within the project site and nearby villages (Copy enclosed). Palle Prakruti Vanam are developed at various locations within the Project area. In addition, green belt development are being carried out through Haritha Haram programme of Telangana state. Turfing and revetment/ rip rap works are carried out as a part of reservoir rim treatment. As per information provided by PA, an amount of Rs. 433.28 crores are incurred towards Reservoir Rim treatment.
xx.	Solid waste generated; especially plastic waste should not be disposed of as landfill material. It should be treated with scientific approach and recycled.	**Being Compiled** As per the information provided by PA, plastic wastes generated from the project site are being disposed off to local panchayat/municipality disposal facility.
xxi.	Six monthly compliance reports shall be submitted to Regional Office, MoEF & CC, Chennai until completion of the modernization works.	**Partly complied** Half yearly compliance reports to IRO, Hyderabad MoEF&CC have not been submitted regularly.
Part-B	**- General Conditions**	
i.	Adequate arrangements for providing free fuel like LPG shall be made at the project cost for the labour engaged in the construction work so that indiscriminate felling of trees is prevented.	**Being complied** As per the records submitted by the PA, about 34828 LPG cylinders are provided to the labour/ manpower engaged in the construction work by the concerned agencies within the project cost.
ii.	Medical facilities as well as recreational facilities shall also be provided to the labourers	**Partly complied** As per the records provided by PA, about 548 medical camps were carried till date. An amount of

S. No.	EC Conditions	Compliance status
		Rs. 1.7 Crores were spent on medical checkups of labours. Recreational facilities are not provided to the labours.
iii.	The labourers to be engaged for construction works shall be thoroughly examined by health personnel and adequately treated before issuing them work permit	**Being complied** The labourers engaged in the construction works are examined for health personnel and adequately treated before issuing them work permit.
iv.	Water sprinkling arrangements shall be made to suppress the fugitive emissions and on monthly basis, ambient air quality to be monitored during the period of construction	**Partly complied** Water sprinkling arrangements are made available at the project site. As per the records submitted by PA, about 2790 water tankers are engaged for sprinkling water regularly at the construction sites. Ambient air quality monitored at ten locations through NABL recognized laboratory (i.e., 1. Pochampalli, 2. Suraram, 3. Chintharevula, 4. Rachapalli, 5. Sundara shala, 6. Kommera, 7. Gundrathpalli, 8. Gunjapadugu (BN8), 9. Kundaram, 10. Mustyala. As per the report, monitored parameters are within prescribed limits (copy enclosed-Annexure V). Surface water was monitored at six locations (i.e. 1. Laxmi (Medigadda Barrage), 2. Saraswathi (Annaram) Barrage, 3. Parvathi (Sundilla) Barrage, 4. Laxmi pump house, 5. Saraswathi Pump House, 6. Parvathi Pump House). Ground water quality was monitored at four locations. i.e. (1. Bore well-Sundilla, 2. Bore well-Saraswathi Barrage, 3-Bore well-Laxmi barrage camp, 4. Bore well-CRPF Colony, Laxmi Barrage). As per the report, Monitored parameters are within prescribed limits (Copy enclosed-Annexure IV&V).

S. No.	EC Conditions	Compliance status
		Further, it is submitted that fugitive dust emissions are observed along the approach road to the pump houses and inside the pump houses. PA shall monitor ambient air quality in those areas and take necessary steps to mitigate the particulate emission in consultation with TSPCB and NABL accredited laboratory who is monitoring ambient air quality of this project.
v.	Potable drinking water and proper sanitary facilities shall be provided for the labour force.	**Being complied** Potable drinking water and sanitary facilities are made available to the labours within project site. Septic tanks followed by soak pit are provided for disposal of domestic effluents.
vi.	Restoration of construction area including dumping sites of excavated materials shall be ensured by leveling, filling up of borrow pits, landscaping etc. the area should be properly treated with suitable plantation	**Agreed to comply** Improvement is needed for the management of dumping sites of excavated materials. PA is agreed to implement the levelling, filling of borrow pits and developing greenery with suitable local plant species.
vii.	Environmental parameters shall be monitored and six monthly monitoring reports shall be submitted to the concerned Regional Office of the Ministry, Chennai	**Partly complied** Monitoring of the environmental parameters is being carried out by third party NABL accredited laboratory, EPTRI, Hyderabad. Half yearly compliance reports to IRO, Hyderabad MoEF&CC have not been submitted regularly.
7	The Project Proponent shall provide full cooperation and all required documents / data to the Officials from concerned Regional Office of the Ministry, Chennai who would be	**Agreed to comply with.**

S. No.	EC Conditions	Compliance status
	monitoring the implementation of environmental safeguards	
8	The responsibility of implementation of environmental safeguards and carrying out environmental monitoring rests fully with Irrigation & CAD Department, Government of Telangana	**Agreed to comply with.**
9	Besides the above stated conditions, the Project Proponent shall also implement all environmental safeguards, as proposed in the EIA/EMP report and other reports from time to time. The Regional Office of the Ministry, Chennai shall monitor implementation of EMP at regular intervals	**Agreed to comply with.** Environmental safeguards proposed in the EIA/EMP are being implemented.
10	The Environmental Management Plan (EMP) shall be strictly adhered to and a sum of Rs. 16230.43 Crores, the budgetary provisions for the implementation of EMP, shall be fully utilized and not to be diverted to any other purpose. In case of revision of the project cost or due to price level change, the cost of EMP shall also be updated proportionately	**Agreed to comply with.** Amount of Rs. 16230.43 Crores are allocated in the budgetary provisions for the implementation of EMP. As of now, an amount of Rs.9082.666 Crores incurred for the implementation Environment protection measures (Annexure-1).
11	In case of change in the scope of the project, the same shall be intimated to the Ministry and fresh approval, if	**Agreed to comply with.**

S. No.	EC Conditions	Compliance status
	required, shall be taken from the Ministry	
12	The Ministry reserves the right to add additional safeguard measures subsequently, if found necessary and to take action including revoking of the clearance under the provisions of the Environment (Protection) Act, 1986, to ensure effective implementation of the suggested safeguard measures in the time-bound and satisfactory manner	**Agreed to comply with.**
13	This clearance letter is valid for a period of 10 years from the date of issue of this letter for commencement of construction work of the project	**Being Complied** Construction work of the project for main trunk has already been completed up to Kondapochamma Sagar. Distributaries network are in progress.
14	A copy of the clearance letter shall be marked to concerned Panchayat/Zilla Parishad/Municipal Corporation, Urban Local body and local NGO, if any, from whom any suggestion/representations were received while processing the proposal. The Clearance letter shall also be put on website by the project proponent	**Complied** A copy of the clearance letter is marked to the concerned panchayat/Municipal corporation. A copy of the clearance letter has been made available on the project website (https://www.irrigation.telangana.gov.in/icad/home)
15	State Pollution Control Board / Committee shall display a copy of the clearance letter at the Regional Office, District Industries Centre and	**Complied** A copy of the clearance letter is marked to the concerned panchayat/Municipal corporation.

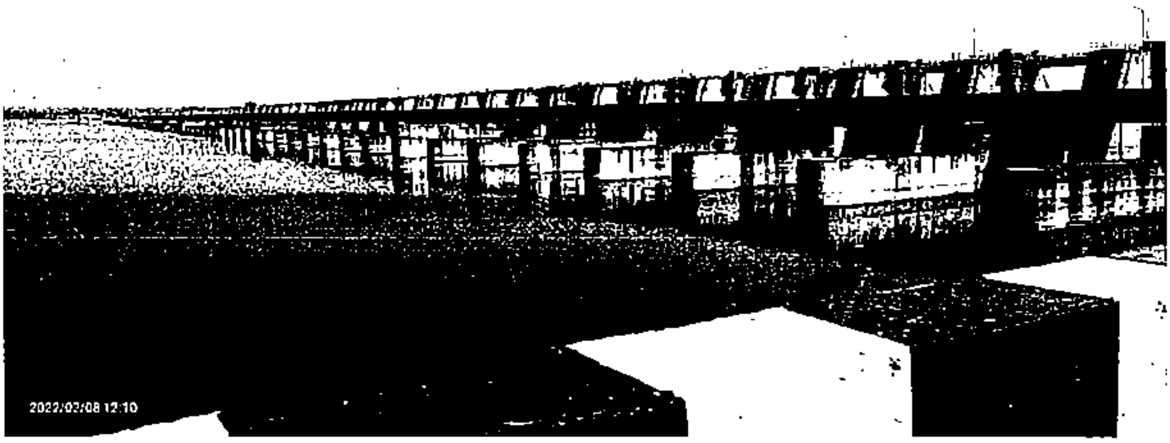
S. No.	EC Conditions	Compliance status
	Collector's / Tehsildar's Office for 30 days	
16	The project proponent should advertise at least in two local newspapers widely circulated in the region around the project, one of which shall be in vernacular language of the locality concerned informing that the project has been accorded environmental clearance and copies of clearance letters are available with the State Pollution Control Board / Committee and may also be seen at Website of the Ministry of Environment, Forest & Climate Change at http://www.moef.nic.in	**Partly Complied** Advertisements were not made in the local newspapers about grant of environmental clearance to Kaleshwaram Project. A copy of the clearance letter has been made available on the project website (https://www.irrigation.telangana.gov.in/icad/home)
17	After 5 years of the commissioning of the Project, a study shall be undertaken regarding impact of the project on the environment and downstream ecology. The study shall be undertaken by an independent agency, decided in consultation with the Ministry	**Agreed to comply with.** Three barrages(Lakshmi, Saraswathi and Parvarthi) were commissioned in 2019. Kondapocchamma Sagar and Mallana Sagar reservoir were commissioned in 2020 and 2022 respectively. PA is agreed to undertake study on the impact of environment and downstream ecology as stipulated.
18	The project proponent shall also submit six monthly reports on the status of compliance of stipulated EC conditions including the results of monthly monitored data (both in hard copies as well as email) to the	**Partly complied** Half yearly compliance reports to IRO, Hyderabad MoEF&CC have not been submitted regularly.

S. No.	EC Conditions	Compliance status
	respective Regional Office of MoEF & CC, Chennai	
19	Any appeal against this environmental clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days from the date of issue, as prescribed under Section-16 of the National Green Tribunal Act, 2010	As submitted by PA, no application is received within 30 days period from the date of issue of clearance.

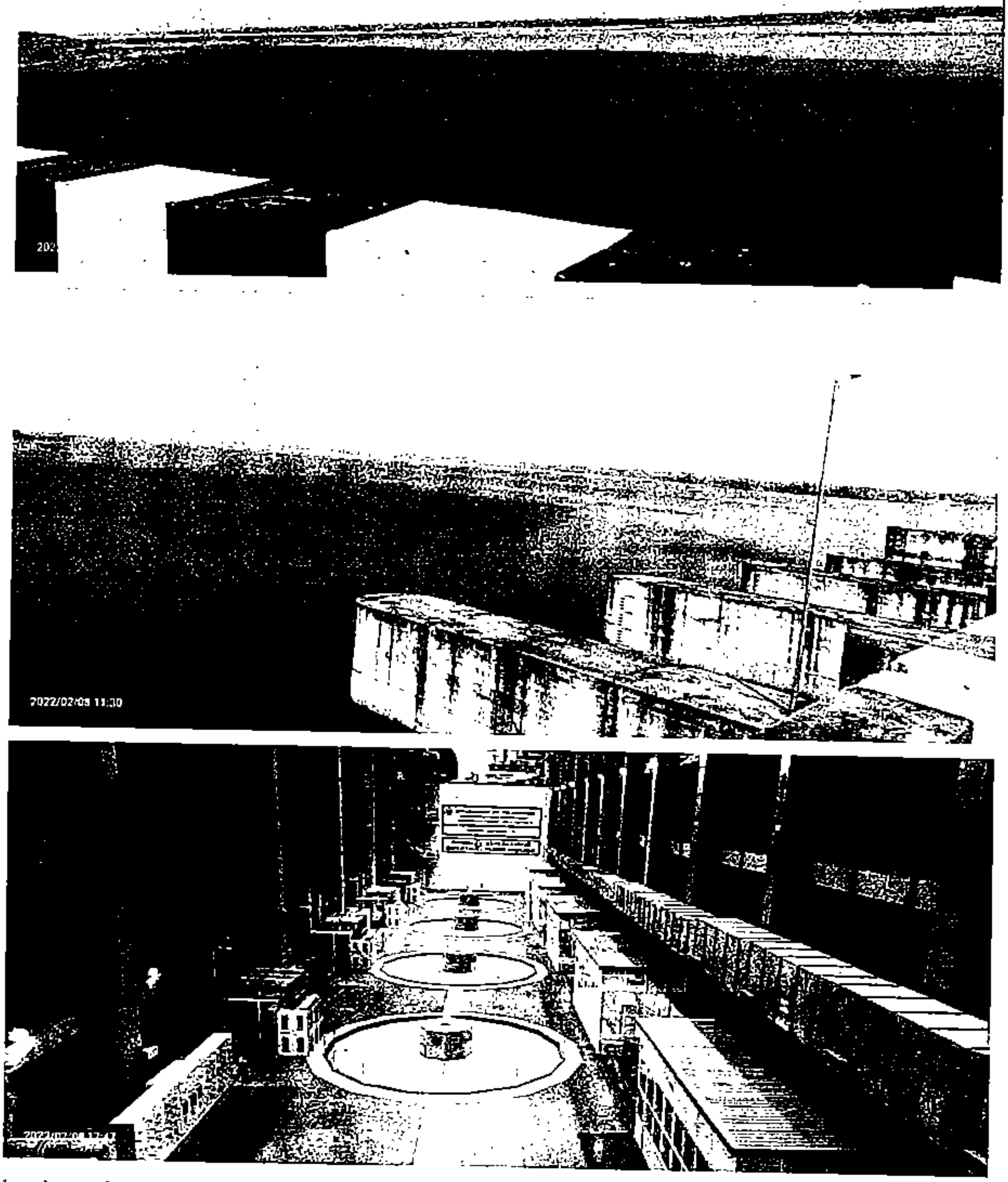
(Dr. E. Arockia Lenin)
Scientist C/Deputy Director

डॉ. इ. आरोकिया लेनिन/Dr. E. Arockia Lenin
वैज्ञानिक 'सी'/Scientist 'C'
उप निदेशक/Deputy Director
पर्यावरण वन और जलवायु परिवर्तन मंत्रालय
Ministry of Environment Forest & Climate Change
एकीकृत क्षेत्रीय कार्यालय, हैदराबाद-500 004.
Integrated Regional Office, Hyderabad-500 004.

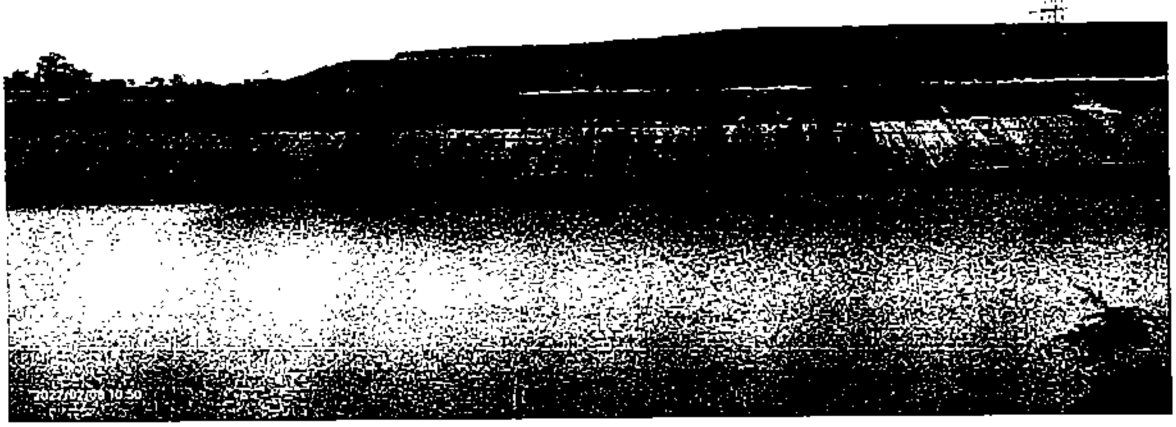
SITE PHOTOGRAPHS



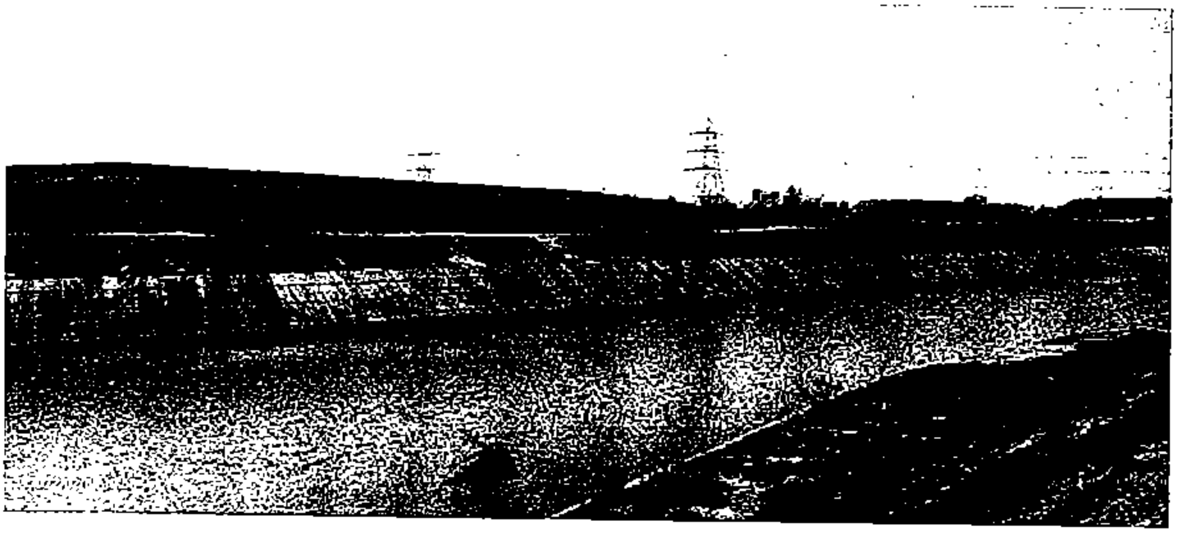
a. Lakshmi barrage, and pump houses.

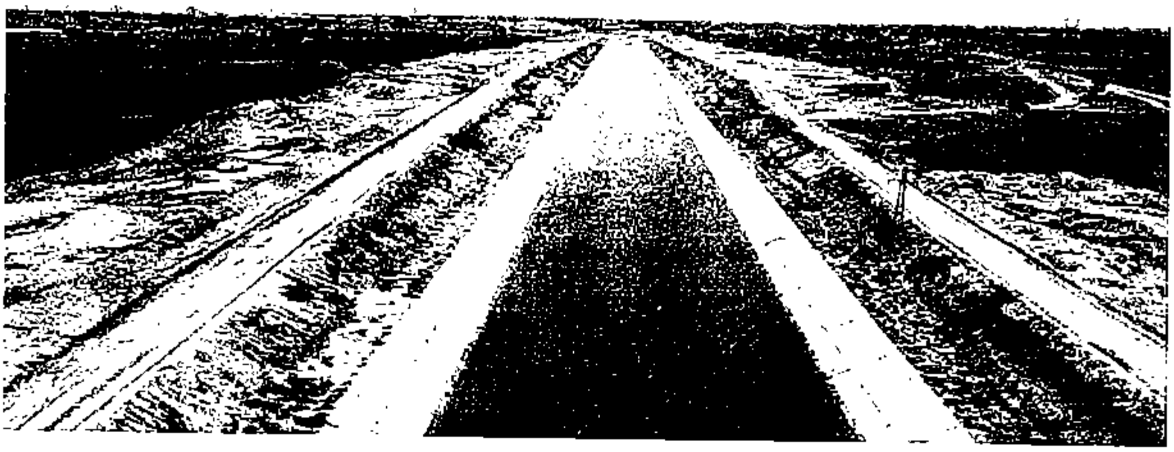


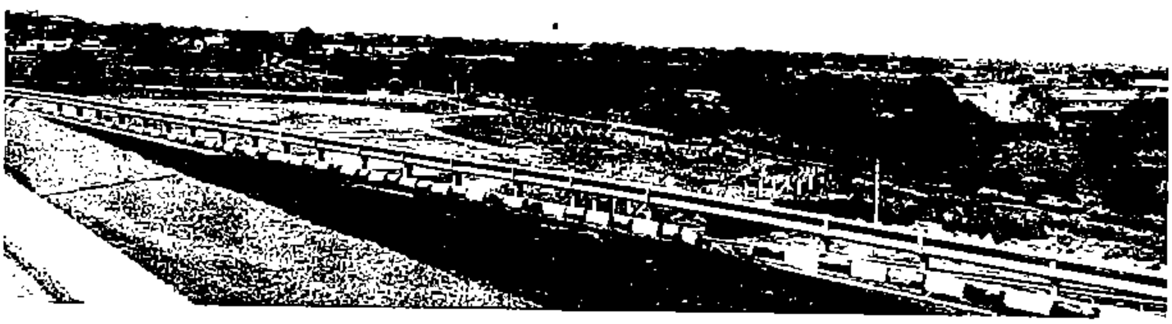
b. view of saraswathi barrage, kayathri pump houses



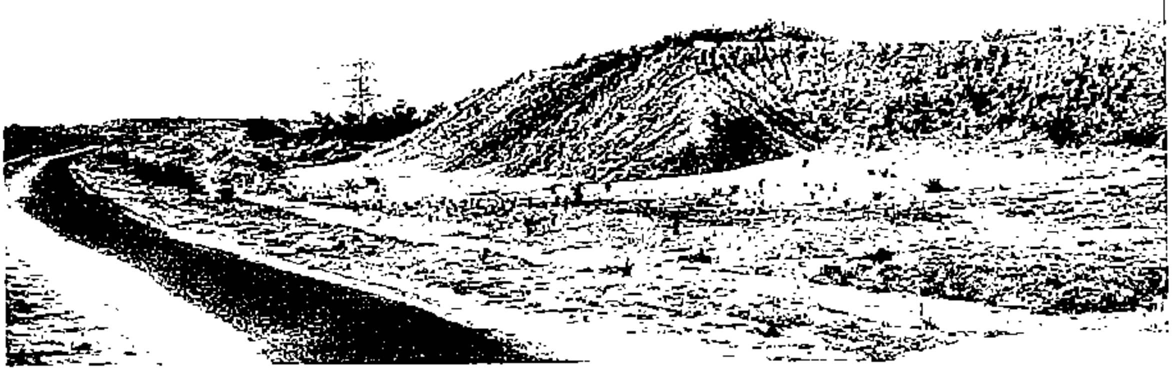
c. plantation, slope stabilisation, turfing carried out in the barrages and gravity canals.





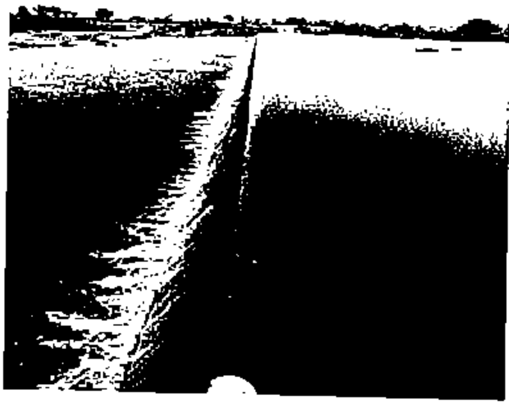


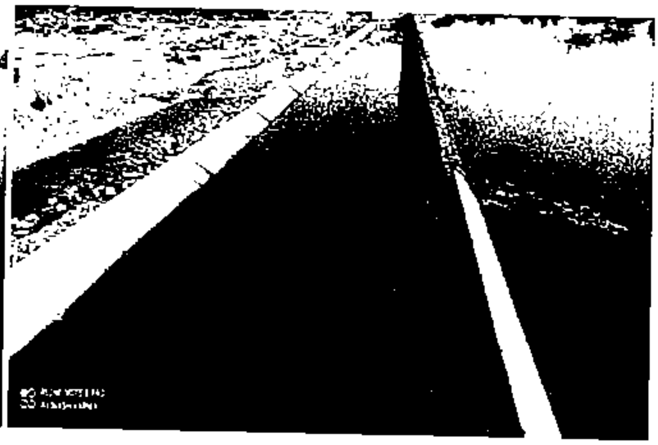
c. Plantation, slope stabilisation, turfing carried out in the barrages, Rankanayaka sagar and gravity canal package 13.



d. Plantation, slope stabilisation, turfing need to be carried out in muck dumps near Lakshmi pumb house

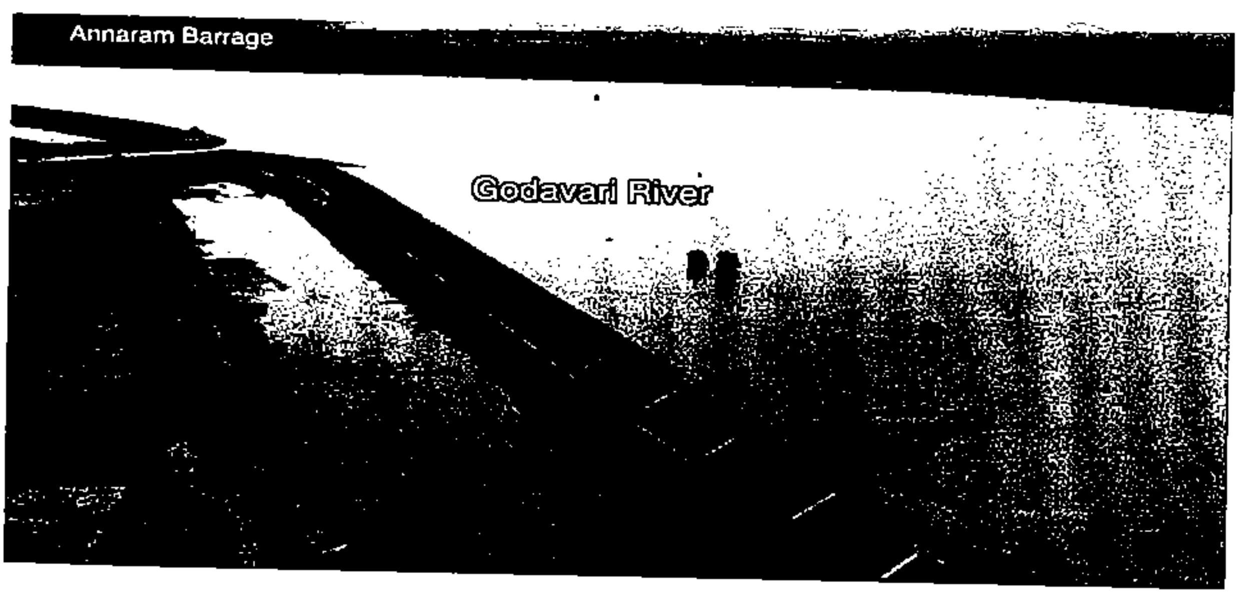
e. Check dam at Medak District



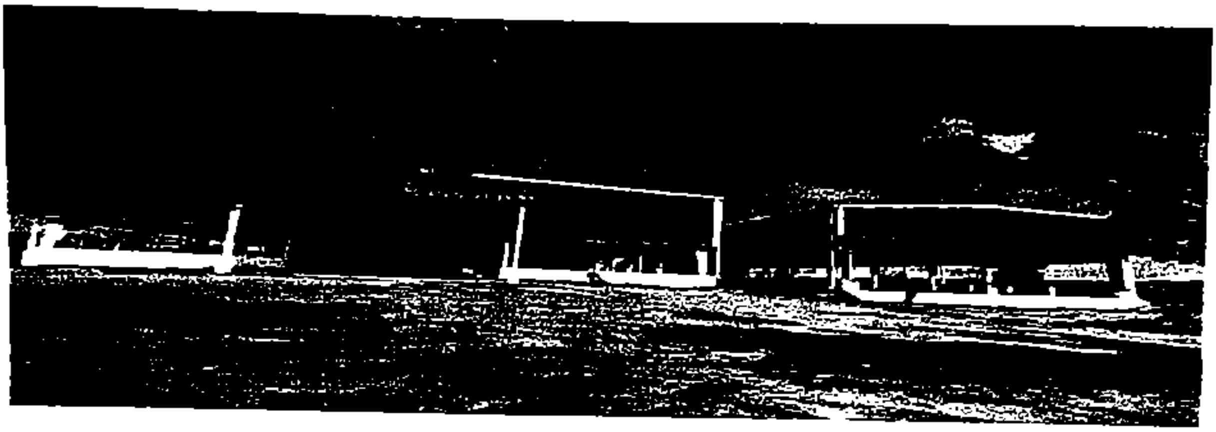


f. Gabbions

g. Photographs of Guide bunds



h. R&R Colony

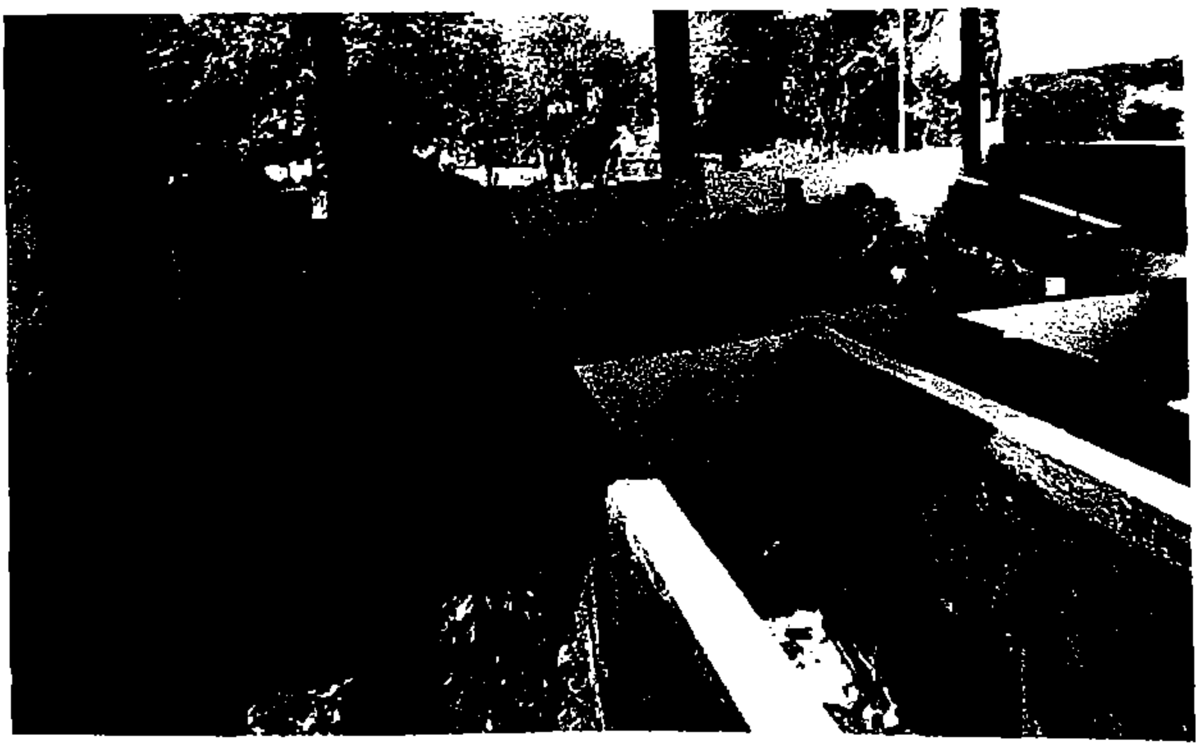


i. Function hall at Chandlapur under CSR activity

j. CC Road Construction at Pedhakodur under CSR activity

k. Street Lighting under CSR activity

l. STP at Chandalapur at Package 11



m. Dumpyard at project site at Venkatapur Package 11

n. Covid Camp at Chandlapur

KALESHWARAM PROJECT PACKAGE-15

For SPML-SEW-AMR (JV)
Authorised Signatory

LPG GAS

Dy. Executive Engineer
Irrigation Sub Division No.
Irrigation Division
Jagadevpur, Siddipet Dist

Executive Engineer I & CAD
Irrigation Division
Jagadevpur, Siddipet Dist

KALESHWARAM PROJECT PACKAGE-15

For SPML-SEW-AMR (JV)
Authorised Signatory

BLOOD DONATION CAMP

Dy. Executive Engineer
Irrigation Sub Division No.
Irrigation Division 8
Jagadevpur, Siddipet Dist

Executive Engineer I & CAD
Irrigation Division
Jagadevpur, Siddipet Dist

Superintending Engineer
Irrigation Circle

o. Health Camps

p. Green belt development at various places of the project

q. Officials accompanied during site visit

ANNEXURE-XVIII

Site Visit Report dated 25th-28th August 2021

Tour Report

A team comprising of the members of a sub-committee visited Kaleswaram Project in Telangana from 25th -28th for ascertaining violations by the PP in going ahead with the project without EC (2008-2017). The list of the names of the members is inter-alia given in Annex-I. During the visit, the committee physically examined various structures of the project and the surroundings as detailed herein. The tour bears the sanction order no: F.no. L-11011/4/2018-IA.I(R) dated 18.8.2021 of MoEF&CC.

Background

Kaleswaram Lift Irrigation Scheme is situated in the state of Telangana and is billed to be the largest such project in the world and is designed to lift upto 2 TMC water of the Godavari water per day by about 530 meters in height. It consumes about 4600 Mw of power for pumping with the largest single pumping unite being of 139 Mw. Spread over a distance of about 500 Km., the project consists of 7 Links with 22 pump houses and 20 reservoirs. The total length of the water conductor system is 1850 meters which comprises of Canals, pipe lines and tunnels. The major components of the project already stand completed, and only some distributary canals and minors etc. are under execution.

The EC for the project was granted in Dec. 2017. However the project had come into scrutiny by the Hon'ble NGT due to alleged environmental violations during the construction of the project as appealed by one Mr. Md. Hayathuddin of Sidipet, Telangana, who inter-alia had charged that the work was started before the grant of EC. In this regard the Hon'ble NGT, asked the MoEF&CC to constitute a seven-member committee to go into various alleged violations and assess the damage caused to the environment, before the issuance of the EC. The said committee was formed by the MoEF & CC. vide no. L-11014/4/2018-IA I(R) dated 20th November 2020. The committee was allowed six months' time for carrying out necessary inspection and studies and submit the report. As such the committee was supposed to submit its report on or before 20th May 2021. The detailed order is attached hereto as Annexure –I. The committee has held 4 meetings thus far, out of which two meetings were also attended by the PP and one was attended by their Environmental consultant namely M/s EPTRI. In these meetings the requirements of various kind of data required for assessing the requisite damage was discussed. The requisitions for various kind of data were given to the PP in the shape of proper formats, through three letters and some of the data was infact received from them. However, still a sizeable data was found missing and accordingly a comprehensive statement showing the balance data requirement was sent to the PP, the information on which is still awaited. A list of the data required is attached herewith as Annex-II.

As may be seen from the order of constitution of the committee, one of the terms of reference of the committee was to visit the site, but the visit could not be held due to the prevailing pandemic conditions (2nd wave) in the country and accordingly, Hon'ble NGT allowed an extension of 3 months from the date of the order, for submission of the report i.e. by 17th Sept. 2021.

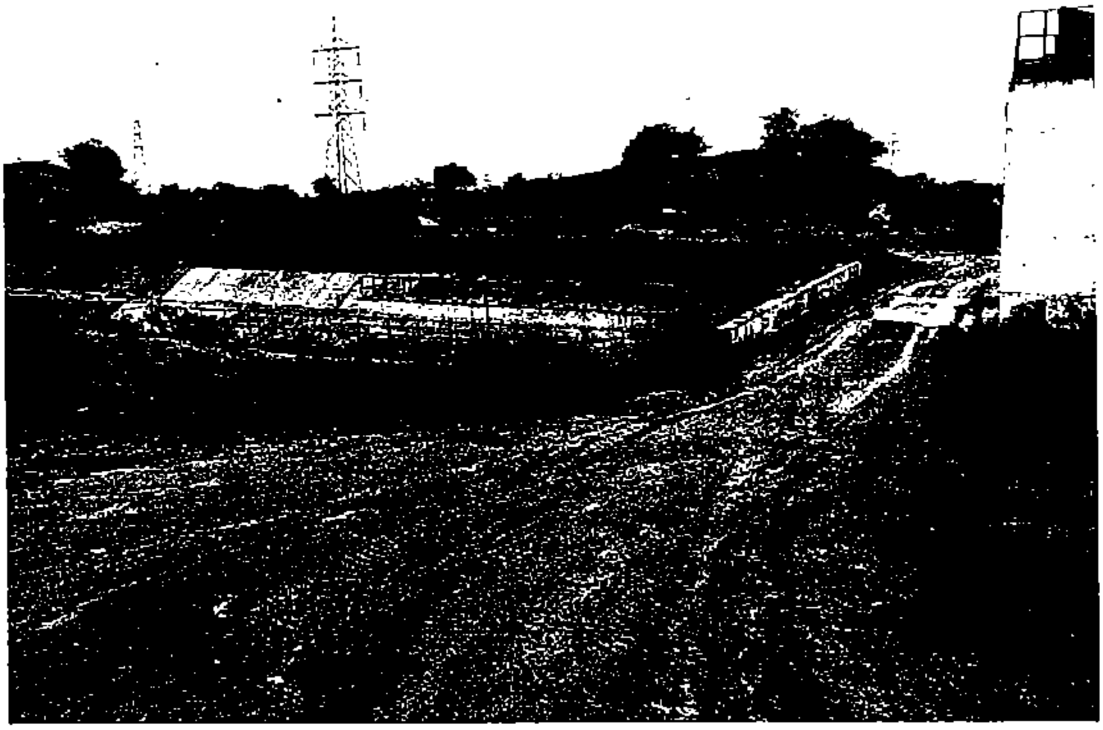
Now, with the amelioration in the Pandemic situation, various travel restrictions have been eased and accordingly the visit of the committee could be held w.e.f. 25th August to 28th August 2021. The detailed itinerary of the visit is appended as Annex-II.

Observations during the visit

During the visit only a few of the components of the project could be seen, namely:

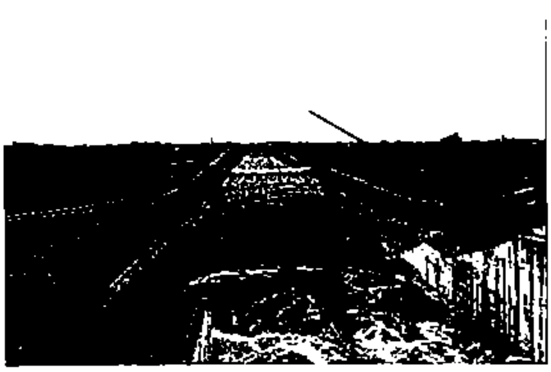
1. Laxmi barrage at Medigadda (Elevation wise lowest structure)
2. 680 Mw Laxmi Pump house near Medigadda
3. A stone quarry near Nandi Power house
4. Gravity Canal feeding Gayathri Pump house
5. Gayathri Pump house
6. Sri Ranganayake Sagar reservoir
7. Underground pump house at Sri Ranganayake Sagar reservoir.
8. Konda Pochhama pump house
9. Konda Pochhama gravity canal
10. Konda Pochhama sagar tank. (Elevation wise at the highest structure)

As on the date of the visit, all the above works were complete and commissioned. On the way to Konda Pochhama pump house, some work was seen under progress on the canal regulator structures.

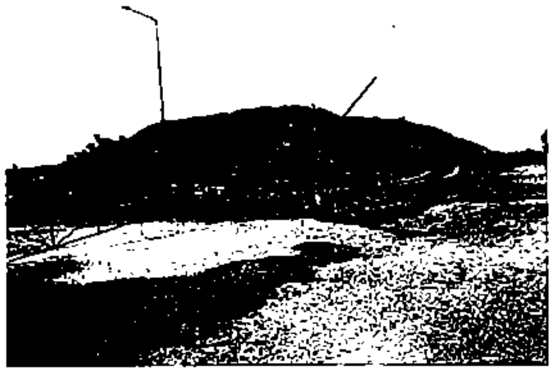


Muck disposal

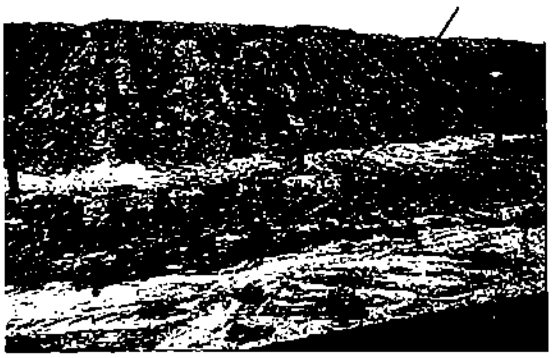
It was observed that the overall muck management was poor. The muck was found dumped haphazardly in the vicinity of component structures. The terracing of the muck was not proper and there was virtually no turfing done to avoid rain cuts and loss of material from the dumps. The slope of the dumps was quite steep and therefore the muck had slid down, sometimes finding its way into the canals. There were no toe walls and drains at the toe of the dumps to maintain their integrity. A few glimpses of the same are given below:



Dumps on the sides of canal



Muck mounds near barrage

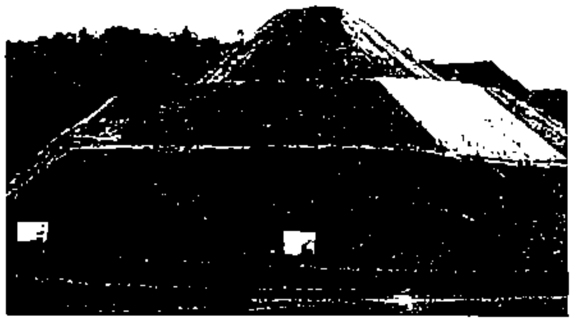


No toe wall and /or drain

Surface degradation

These dumps need to be re-worked, shaped up and protected so that they do not contribute either to the fugitive dust or enter the water courses which could be detrimental for consumption by humans and cattle. Also the places where these dumps are located near the agricultural land, the damage to such agricultural land also needs to be ascertained and quantified as per the extant norms.

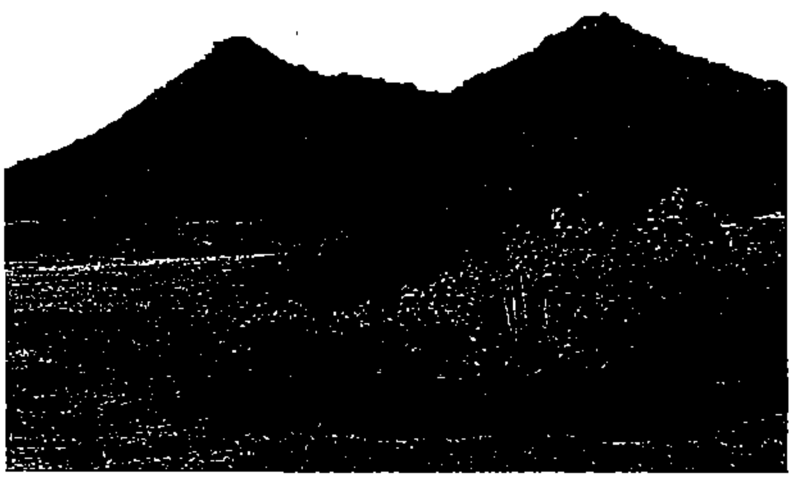
The requisite methodology of muck management consists of disposing off the material in layers with compaction and dressing the same to a stable slope. The slopes are then planted with live sods for turfing to avoid surficial damages due to rain and wind. The dump should be supported at the toe with a toe wall with weep holes which should discharge the accumulated as well as surface water in a toe-drain lined appropriately to maintain its integrity. The dump and the surrounding area is then covered with plantation to merge the same with the surrounding landscape. A sample of what should an ideal dump look like is given below:



Required measures for dump management – retaining walls,drains and turfing

Rehabilitation of Quarries

It was observed that the quarries have been closed after completion of the project work and have been left on as-is-where-is basis with large scarred hills prone to weathering and deterioration over a period of time. In the absence of any protection and drainage arrangements, these quarries are prone to get further loosened and may collapse. A photo of the quarry near Pedapalli as closed is given below:



Quarry left as it is – crusher location in the foreground

Required benches in a quarry – Vegetation is planted on benches

Afforestation and green belt

The PP intimated that the work of afforestation is being done by the state forest department with whom the necessary amount as envisaged in the EMP has been deposited. It was seen that in some locations luxuriant plantation was growing, whereas in yet other areas the plantation is yet to be taken up. Now, defining the extent of these areas for working out the damage that the non-afforestation in time would have been caused to the environment in respect of the air quality is a cumbersome exercise which needs use of computer modelling and analysis thereof. The data of such areas with their locations and co-ordinates for working out the damage is still awaited.

a. A meeting was held by the committee with the PP headed by E-In-Cs of the project on 27.8.2021 and it was brought out that the data as projected is essential for assessing the damage caused to the environment without taking required safeguards as envisaged in the EC. It was recalled that various inputs required for the requisite assessment as intimated earlier during the should be expeditiously submitted. The requirement was reiterated again outlining submission of ADS other than details sought earlier vide Annexures I, II, III & IV. Following points came up for discussion :

b. The PP shall urgently supply the following data :

    i. Distance of coffer dam from each barrage and details of dimensions

ii. List of quarries project wise (Barrage, Pump house, canals, etc) with its EC details, area, excavation of OB & ROM, aggregate with lead details and line diagram of transport route

iii. Status of WLCP submitted to PCCF and its approval

iv. Post project Bi annual monitoring / EC compliance report submission to SEIAA / MoEFCC regional office was not done and same was confirmed by EIA consultant.

c. The PP is yet to establish Environment monitoring cell and same was agreed by PP.

d. In line with the mandate of the committee as ordered by Honourable NGT, the committee may also examine the "effective implementation of EMP earlier submitted by PP based on which EC was granted and compliance of EC conditions".

e. It appeared that many of the activities enumerated in specific and general conditions of EC of Dec 2017 to comply with EMP & EC have not been initiated so far. For example, - Activities proposed under EMP for CAT, CAD, GB/plantation, muck management, Quarry reclamation and restoration, Bio &WLC, Water, Air, Noise monitoring and management plan, local area development plan etc.

f. In view of the above it was suggested to initiate visit from RO of MoEF &CC for submission of latest EC compliance report of all the components of the project

Conclusion:

During the visit, it was observed that muck management has been handled shoddily and the quarries have also not been rehabilitated. The mounds of dumped muck adjacent to the structures like canals, as also the agricultural land is a cause of concern. For assessing the damage incurred as a result of taking up the work without taking adequate safe guards as contained in the EC, a sizeable data is still required to be supplied by the PP as brought out herein above. In this regard it is pertinent to mention that before the visit, a meeting of the committee was held on 31st July, in which besides the PP, their EIA consultant viz. M/s EPTRI was also present. The data requirements were intimated to them in the meeting and later a consolidated proforma requesting for the balance information was sent to the PP, so that the same could be made available during the visit. However, the proforma could not be filled by the PP and at the close of the visit they have requested for 15 days more time for submitting the information.

In view of the above and also considering that the scrutiny of the data, modelling and other analysis based on the above requirement would take at two- three months' time it is proposed that we may request the Hon'ble NGT for allowing 3 more months for the submission of the report. Accordingly, the matter may please be taken up by MoEF &CC with the Hon'ble NGT.

Balraj Joshi
Chairman Expert committee

Member- Secy EAC

Encl: Annex-I

Annex -I

The sub-committee comprises of the following members:

1.	Sh. Balraj Joshi	EX CMD NHPC	Member EAC(RVP)
2.	Dr. K. Gowrappan	Ex Member Violation committee, MoEF& CC	
3.	Dr. Mukesh Sharma	Professor IIT Kanpur	Member EAC(RVP)
4.	Dr. A.K. Malhotra	IFoS (Retd.)	Member EAC(RVP)
5.	Sh. Amrendra K. Singh	Chief Engineer (CWC)	Member EAC(RVP)
6.	Dr. J.A. Johnson	Wild life instt. of India	Member EAC(RVP)
7.	Sh. Y.P. Singh	Scientist – E	Member Secretary - EAC(RVP)

- Dr. K.N Shenoy Member EAC, could not join due to his pre-occupations