

**Hon'ble National Green Tribunal (NGT) Principal
Bench, New Delhi order dated 27.01.2020 In the
Matter of O.A.No.117 of 2014
Para 32(f)**

**Shantanu Sharma
Vs.
Union of India & Ors.**

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Joint Committee Report

Submitted in Reference to

**Hon'ble National Green Tribunal (NGT) Principal
Bench, New Delhi order dated 27.01.2020**

In the Matter of

O.A.No.117 of 2014

Shantanu Sharma

Vs.

Union of India & Ors.

Members of the Committee

1. Prof Dr Sudipta Sarkar, Dept of Civil Engineering, IIT Roorkee
2. Sh Sunil Kumar Meena Scientist 'D', CPCB, Regional Directorate, Bhopal

Joint Inspection Report in compliance of Hon'ble NGT Principal Bench order dated 27th January 2020 in O.A. 117/2014 Shantanu Sharma Vs Union of India & Ors.

The Hon'ble National Green Tribunal (NGT) Principal Bench (PB) order dated 27.01.2020 in O.A. No. 117/2014 (Shantanu Sharma Vs Union of India & Ors.), directed under Para 32 (f) as:

“A Committee comprising of CPCB and IIT Roorkee may assess the environmental damage with regard to the breach sites at Vidhyanchal TPP an Essar TPP in Singrauli area and submit its recommendation within three months. CPCB shall be at liberty to engage any other technical expert for this purpose.”

1. A brief on the 02 ash dyke breach incidence happened at M/s Essar Power MP Ltd and M/s NTPC Vindh Nagar, Singrauli during year 2019

i. M/s Essar Power MP Limited, Singrauli, Madhya Pradesh

The ash dyke cell no. 3 (GPS location 23.997408°, 82.415650°) of the industry breached on 07.8.2019. The total area of dyke was 3.34 Ha and 13.5mtrs was the total height of the dyke. The dyke rise upto 10mtrs above the ground level & was under use of slurry disposal during 27.6.2018 to 21.6.2019. As documented, 190000T ash was disposed in this cell. The slope of the dyke was in east side; from here the decanted water is pumped to cell no. 4 with the help of pump as and when required. Looking into the rainfall data from 1.8.2019 to 7.8.2019 (the day when dyke breached); it was revealed that heavy rainfall was observed during 4th August to 7th August 2019 viz. 4.3mm minimum to 29.9mm maximum. Due to increased volume of water at slopping beach during the heavy rainfall the phreatic line (line of seepage) may get disturbed that resulted in rising of phreatic line and

reduced the stability of the slope. That resulted in breach of bund in about 100m length towards east direction. The flow of ash was towards Karsualal & Karsuaraja village. Based on the effective bund area of Cell no. 3 as 2.7Ha and breached out average slurry upto 3m depth of 1.2 T/m³ density; the calculated quantity of slurry breached out was about 97200 Tons (Say 1 Lac Ton).

The lateral spread of the ash before meeting Jaria Naala/river was about 1.8KM with 140-390m (Average 260m) width & in average 1ft height. Nearly about 50 Ha area got affected by the spread of ash slurry. The villagers were utilizing this area for crop cultivation. The Kharif crop was damaged due to this breach incidence. Based on the field survey & aerial videography it was revealed that the slurry has travelled a long path & reached upto Mayer river confluence after flowing through Jaria to Garra river. The slurry travelled about 11 kms in Jaria to Garra river to Mayer river confluence point. The detailed report is enclosed as **Annexure-I**.

ii. **M/s NTPC Vindhychal, Singraulli, Madhya Pradesh**

The industrial unit has 06 ash dykes in total i.e. V1, V2, V3A, V3B, V4A & V4B at Shahpur & Baliyari area. The ash dyke breach incident happened on 6.10.2019 at ash dyke no. V-1 in North-West direction (GPS location 24.063501°, 82.685355°). The area of starter dyke was 474 acres whereas on the exhaust of 4th raising the operating area is 227 acres. The buttressing work was in progress. One line of slurry disposal was in operation on the day of incident. To recirculate the ash water unit has established 03 AWRS systems; out of which AWRS 1 & 2 are of 1000M³/hr capacity whereas the AWRS-03 is of 1500M³/hr capacity. Heavy rains were reported since last

two months in every part of the Madhya Pradesh. Similarly, Singrauli district also had heavy rains during August to 5th Oct 2019. The rainfall data of 20th September to 5th October 2019 revealed that Vindhnagar area had heavy rainfall from minimum 10mm to maximum 68 mm. The water pool so created due to the excavation of $1.55 \text{ m}^3/\text{m}^2$ in affected area i.e. 3.75Ha stored rainwater & slurry water of approx. $58,125\text{m}^3$ say 50000m^3 (density of ash $1.2 \text{ T}/\text{m}^3$). This water pool's hydrological pressure may be the reason of the ash dyke breach. The dyke breached out in about 100mtrs length & pulled of the decanting well along with the slurry water.

After the day of incident AWRS 1 & 2 were out of service as the ash slurry flown through the AWRS building with such a pressure that it broke down the double layer boundary walls & filled up in the working area of the AWRS premises. The ash slurry flow has also dislodged the ash slurry carrying pipeline of the NTPC Shaktinagar plant. That resulted in non-operation of AWRS systems of NTPC Shaktinagar too. The decanting water of NTPC, Shaktinagar ash dyke no. S1 & S2 was directly being discharged in Rihand reservoir. The breached out area so calculated was about 3.75 Hectares with 250mtrs wide & 150mtrs in length dimension. The quantum of ash breached was approx. 225000 Tons (considering ash density $1.2\text{T}/\text{m}^3$). The slurry spread over 33Ha area from the ash dyke V1 to decanting pond and AWRS 1 & 2 surrounding area. Spread over an area of 12 Ha in North-West through garland drain after the broke down the walls of AWRS system. The decanting pond's one side embankment also got breached out in a length of 50-60mtrs & slurry spread over an area of 8Ha towards Rihand reservoir & Surya Drain. However, no large quantity of ash found mixing in reservoir & right bank of Surya drain. In total 53Ha (33 +12+ 8) area came under the

verse of ash slurry. About 1 Lac Ton ash settled in decanting pond. That resulted in 125000Tons of ash spread with average dept of 1ft other than the ash retained in decanting pond.

The ash slurry spread in the plant premises & didn't affect villages like Gehalgarh due to higher elevation. The village Juari was also not affected as it was on the left bank of Surya Drain. No agricultural land got affected on the spread of the ash slurry. The detailed report is enclosed as **Annexure-II**.

2. Assessment of the environmental damage

The environmental damage assessment due to the ash breach incidence at M/s Essar Power MP Ltd & M/s NTPC Vindhagar, Singrauli was assessed for green house gas (GHG) emission & water pollution, based on the available information with MPPCB & industrial units. The Ambient Air Quality monitoring conducted by ABC Techno Labs India Pvt Ltd, a NABET accredited laboratory during the ash collection period shown no exceedance of PM₁₀ from the prescribed NAAQMS, 2009 (Copy of the analysis report is enclosed as **Annexure-III**). Also both the incidence happened during rainy season and the work of ash collection was almost completed before summer season; thus, the air pollution was not considered as major damage contributor.

The assessment of crop damage was not taken up by this committee, as in compliance of the Hon'ble National Green Tribunal (NGT) Principal Bench (PB) order dated 27.01.2020 in O.A. No. 117/2014 (Shantanu Sharma Vs Union of India & Ors.) a separate committee is constituted under Para 32 (g) as:

“The Committee comprising of Collector, CPCB and Member Secretary of MP State Pollution Control Board may assess the damage with regard to the

breach sites at Vidhyanchal TPP and Essar TPP in Singrauli area to the crop and agricultural productivity and ensure effective restoration/remediation of affective sites within three months”.

2 (1) Environmental Damage Assessment: M/s Essar Power MP Ltd

i. Estimation of GHG Emission and Related Cost

GHG emission is expected from the clean-up operation for the ash using JCB, excavator, Vibro-roller, tractor, and other mechanical and diesel generator devices (for work at night). The ash can be taken as loose soil. According to Devi and Palaniappan [Devi, L.P. and Palaniappan, S. “A Study on Energy use for excavation and transportation of soil during building construction”, *J Cleaner Production*, (2017), 164, pp 543-556], the fuel requirement for excavation and disposal up to a distance of 50m for loose soil is 0.28 Litres/m³. Here the average disposal distance was more than 1.5 km. As per the information provided by industrial unit, tractor-trailers were used for carrying the ash. The fuel requirement of tractor-trailers is 37.4 Litres /100 km and volume capacity is approximately 2.8 cubic meters (100 cubic feet). Hence, the fuel requirement is 0.13 L/km/m³. For 1.5 km extra hauling distance the fuel requirement will be 0.196 L/m³. Hence, the total fuel requirement for cleaning up operation is estimated to be 0.476 L/m³.

- Amount of ash cleaned up = 1.8 km X 260 m X 0.3 m = 140,400 m³
- Fuel requirement = 140,400 m³ X 0.476 = 66, 830.4 L ~ 66830L (Diesel)
- Add 10% extra to take care of ancillary fuel requirement such as DG sets, etc. = 6683 L

- Total Fuel requirement = 73513 L
- Density of Diesel = 0.85 kg/L
- Total weight of diesel used = 62486 kg
- Specific CO₂ emission for diesel = 3.15 kg CO₂/ kg of diesel (*Based on Framework for Environmental Damage Cost Assessment, NEERI document, 2019, Table 3*)
- Total CO₂ emission = 196,832 kg CO₂ = 200 T of CO₂ (approximately)
- Considering the social cost of carbon emission at a moderate impact scenario in 2019 = Rs. 3556 (*Based on Framework for Environmental Damage Cost Assessment, NEERI document, 2019 – Page 13*)
- So, The total cost for GHG emission as on 2019 = 200T X Rs 3556/ T = Rs. 711,200 (**Rs 0.0711 crore**)

ii. Water pollution and damaged cost

In the absence of river/drain water flow related data in preliminary report of MPPCB, it is opined to adopt value transfer method in place of the discharge based method to evaluate the economic value of water pollution.

As per the field survey & aerial videography done by MPPCB after the incidence, it was revealed that the slurry has travelled a long path & reached upto Mayer river confluence after flowing through Jaria to Garra River. The slurry travelled about 11 kms in Jaria to Garra River to Mayer river confluence point.

- Considering the total length of ash discharge in water body as 11 kms with an average width of 55mtrs and 0.6mtrs depth of water.
- The total quantum of water get polluted due to ash slurry: $11000 \times 55 \times 0.6 = 363000\text{m}^3$

- Based on the heavy metal analysis report of MPPCB, Jabalpur dated 14.8.2019 of the water samples collected on 9.8.2019 after the incidence. (Copy of the analysis report is enclosed as **Annexure-IV**). The Copper heavy metal was found in exceedance.

S.No.	Location of river/drain water sample	Copper in mg/l
1.	Garra river near Raila village	1.145
2.	Garra river near Rampa village before meeting Mayer river	2.810
3.	Garra river 100m before meeting Mayer river	3.868
4.	Mayer river 100m after meeting Garra river	8.187
5.	Mayer river 100m before meeting Garra river	0.551

Considering the sampling location ‘Mayer River 100m before meeting Garra River’ (Cu – 0.551mg/l) as baseline as it was in upstream and least affected due to ash slurry. The base line value subtracted from the average value of other sampling locations viz. 1 to 4 to calculate the concentration of copper in water bodies due to ash breach.

- Base line value : 0.551mg/l
- Average value : 4.0025 mg/l
- Concentration of Copper in water body : $(4.0025-0.551)=3.4515$ mg/l
- A team of CPCB, MPPCB & District Administration Singraulli inspected the breach site and nearby area on 27.9.2019 to verify the compliance of the direction issued by MPPCB u/s 33A of Water (P & CP) Act 1974 Copy of the direction is enclosed as **Annexure-V**. It was reported that *“On the day of inspection i.e. 27.9.2019, team has not observed any traces of fly ash along the flowing water from Jaria drain to Mayer river confluence”*. In compliance verification of Direction no. 2 *‘Remove the fly ash lying in the fields and deposited in and along the flowing water*

bodies, so that it does not reach Rihand reservoir and cause its siltation.’
Copy of the report is enclosed as **Annexure-VI**.

Total no. of days taken to remove the ash slurry containing Copper in exceedance: days from 7.8.2019 (day of incidence) to 27.9.2019 (day on which compliance was recorded) = 51days

- Total quantity of Copper in water bodies = $363000\text{m}^3 \times 3.4515 \text{ mg/l} = 1252.89 \text{ kgs}$ (Say 1253kgs)
- Total days of non-compliance of direction or damage continued = 51days
- Environmental damage cost associated with heavy metal for Copper = 5 € per Kg emission to water (*Based on Framework for Environmental Damage Cost Assessment, NEERI document, 2019, Table 12 and report of Extern E, 1995 Copy of the same is enclosed as Annexure-VII.*)
- Total environmental damage cost associated with Copper = $1253\text{kgs} \times 5\text{€} = 6265\text{€}$ (as on 1995)
 - 1 € = Rs. 44.93 in 1995
 - Inflation rate = 7% (Average)
 - Daily cost of pollution = $6265 \times 44.93 \times (1.07)^{24} = \text{Rs } 1427802.5/\text{daily}$
- Total days of non-compliance of direction or damage continued = 51days
 - Total cost of pollution for 51 days = $1427802.5 \times 51 = \text{Rs. } 72817927.5$ (Say Rs. 72817928) or Rs 7.28 Crore

Total cost of water pollution as on 2019 = **Rs. 7.28 Crore**

2 (2) Environmental Damage Assessment: M/s NTPC Vindh Nagar

i. Estimation of GHG Emission and Related Cost

As per the information provided by industrial unit, dumpers were used for carrying the ash. The copy of the present status provided by M/s

NTPC is enclosed as **Annexure-VIII**.

- Amount of ash collected till August 2020 = 1.75 Lacs Ton
- Total kilometres travelled by dumpers = 71006 KMs
- Average mileage of dumper = 2.5km/litres
- Total fuel (Diesel) consumed = 28402.4 Litres say 28403 Litres
- Add 10% extra to take care of ancillary fuel requirement such as DG sets, etc. = 2840 L
- Total Fuel requirement = 31243 Litres
- Density of Diesel = 0.85 kg/L
- Total weight of diesel used = 26557 kg
- Specific CO₂ emission for diesel = 3.15 kg CO₂/ kg of diesel (*Based on Framework for Environmental Damage Cost Assessment, NEERI document, 2019, Table 3*)
- Total CO₂ emission = 83655 kg CO₂ = 83.65 T of CO₂ (approximately)
- As per the preliminary report enclosed as Annexure-II; the estimated total ash breached was 225000 T and till date industrial unit has only collected 175000 L Ton only. Still 50000T ash is to be collected. As per above calculation 23.9 T CO₂ will emit on collecting 50000T of the ash.
- So total CO₂ emission = 83.64 + 23.9 = 107.55 say 108 T of CO₂
- Considering the social cost of carbon emission at a moderate impact scenario in 2019 = Rs. 3556 (*Based on Framework for Environmental Damage Cost Assessment, NEERI document, 2019 – Page 13*)
- So, The total cost for GHG emission as on 2019 = 108T X Rs 3556/ T = Rs. 384048/- (**Rs 0.0384 crore**)

ii. Water pollution and damaged cost

As reported in the preliminary report of MPPCB (Annexure-II); the direct ash slurry discharge into Rihand reservoir was observed from the spillway of the Overflow lagoon. Secondly, the NTPC Vindhnagar decanting pond was also found breached and water was flown towards the reservoir. Thirdly, the Ash Water Recirculation System (AWRS) 1 & 2 of 1000M³/hr capacity each of NTPC, Vindhnagar and the AWRS of NTPC Shaktinagar of 4000 M³/hr capacity was out of operation after the breach incidence. Only AWRS no. 3 & 4 of 1500 M³/hr capacity each of NTPC, Vindhnagar were in operation. In the absence of adequate AWRS the decanted water of slurry pond V3A & V3B of NTPC Vindhnagar and S1 & S2 dyke of NTPC Shaktinagar was flown in the overflow lagoon (OFL) through spillway.

a. Basic information for quantifying the discharge from OFL

- Total volume of OFL = 6.05 Lacs M³
- The filled up volume of OFL on the day of incidence = 4.79Lac M³
- The empty volume of the OFL = 1.26 Lacs M³
- The average discharge of ash water in OFL from S1 & S2 of NTPC Shaktinagar due to breach till restoration of the AWRS return pipeline i.e. 25.10.2019 was = 70080 m³/day against 2000MW capacity (Copy of the information submitted by NTPC Shaktinagar is enclosed as **Annexure-IX**).
- As reported by NTPC, Vindhnagar; Stage 1 & 2 was being operated on part load for many days till the ash discharge locations were streamlined. As per the information submitted by M/s NTPC Vindhnagar, the average power production during October- Nov 2019 was 4000MW. All the AWRS got restored on 2.12.2019. As per the information furnished by industrial unit, 17469 m³/day was the discharge of ash containing water in Reservoir through the spillway of Overflow Lagoon till the day of

AWRS restoration i.e. 1.12.2019. The copy of the information provided by M/s NTPC regarding discharge quantity is enclosed as **Annexure-VIII**.

- So the total daily discharge from OFL was = $70080 + 17469 = 87549\text{M}^3$

b. Basic information for quantifying the discharge from breached decanting pond of NTPC Vindhychal

- Total area of decanting pond = 89479 M^2 with effective depth of 1.5mtrs
- Total accumulated water in pond = $1,34,218\text{ M}^3$
- Quantum of ash settled in decanting pond after the incidence 1 Lac Ton (This ash replaced about 1Lac M^3 ash containing water from the pond and flown towards reservoir and peripheral drain of AWRS of NTPC, Vindhnagar)
- The quantum of ash water flown towards reservoir = 1 Lac M^3 .

c. Industrial unit wise discharge and total no, of days for which discharge took place

Industrial Unit	Discharge happened from	Discharged quantity in M^3	Start date of discharge	Date on which discharge stopped (Restoration of AWRS & pipeline)	Total no. of days
NTPC Vindhnagar	OFL of S1 & S2 dyke	17469M^3	7.10.2019	1.12.2019	56
	Decanting pond	100000M^3	6.10.2019	7.10.2019	01
NTPC Shaktinagar	OFL of S1 & S2 dyke	70080M^3	7.10.2019	24.10.2019	18

d. The monitoring report w.r.t. Suspended Solids

The effluent samples collected on 7.10.2019 by MPPCB, Singraulli and analyzed for general parameters. The values of Suspended Solids

were in exceedance of the general discharge standards of 100mg/l. The details are as tabulated below: Copy of the analysis report is enclosed as **Annexure-X**.

S.NO.	Sampling Location	Suspended Solids in mg/l
1.	Water sample from S2 dyke NTPC Shaktinagar going directly to Rihand reservoir	3237
2.	Water sample from breached overflow, lagoon near AWRS towards north going to Rihand reservoir	3227

e. The quantum of suspended solids in Kilogram

The quantum of suspended solids discharged during breach incidence to restoration of the AWRS pipeline w.r.t. the general discharge standard of 100mg/l.

Industrial Unit	Discharge happened from	Discharged quantity in M ³	Suspended Solids in mg/l above general discharge standard of 100mg/l	Total no. of days	Quantum of Suspended Solid in Kgs
NTPC Vindhnagar	OFL of S1 & S2 dyke	17469M ³	3137 = (3237-100)	56	3068814
	Decanting pond	100000M ³	3127 = (3227-100)	01	312700
NTPC Shaktinagar	OFL of S1 & S2 dyke	70080M ³	3137 = (3237-100)	18	3957137

Total quantum of Suspended Solids in Kgs = 7338651 kgs

f. Assessment of damage cost due to discharge of excess Suspended Solids w.r.t. the general discharge standard

Control cost method to rejuvenate the contaminated water bodies covers overall total damage associated with respect to fisheries, recreational sites, environmental property etc. In general control cost

methodology refers to the cost incurred in operating conventional treatment technologies to rejuvenate the surface water body. (*Based on Framework for Environmental Damage Cost Assessment, NEERI document, 2019 page no. 27 Table 11*). The shadow prices of water pollution for Indian industries by estimated by Murty and Kumar, 2004 is used. The Suspended Solid value of Rs. 51427.9 per ton for year 2004 was taken w.r.t. Miscellaneous industry, as Thermal power plant was not reported by Murty and Kumar, 2004.

- The damage cost for suspended solid = 51427.9 per ton (2004)
- Average inflation rate = 7%
- Cost of the damage as on 2019 = Rs. 1041278080 (**Rs. 104.13 Crore**)

3. Damage assessment for M/s Essar Power MP Ltd & M/s NTPC Vindhnagar

The committee has assessed the environmental damage based on the available monitoring reports, field reports and literature. The brief on damage cost is as tabulated below:

Industrial Unit	GHG emission damage cost in Crore Rs,	Water pollution/environmental property/other damage cost in Crore Rs.	Total In Crore Rs.
M/s Essar Power MP Ltd	0.0711	7.28	7.3511
M/s NTPC Vindhnagar	0.0384	104.13	104.1684

4. Limitations

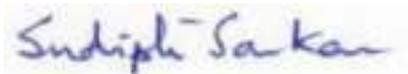
- i. The above assessment is just preliminary for a guidance purpose. As per the information, NEERI has been professionally engaged by the both the industrial units to perform a detailed assessment. Further

discussion/vetting on such report may be initiated when the same is made available to the committee.

- ii. In absence of long term site specific studies in Indian context; one time monitoring, sampling is not adequate to assess the damage cost.

5. Recommendations:

- i. Industrial units have engaged professional institute NEERI, Nagpur to assess the damage; the institute needs to assess the site specific long term direct or indirect impact on the flora fauna, human health and consumptive cost.
- ii. Industrial units need to comply for 100% fly ash utilization to avoid such incidence in future.
- iii. To install monitoring stations on the affected sites, to continuously monitor the movement of plume underground or the leaching of toxic heavy metals from the sediment.
- iv. Industrial units need to take care for the health of workers employed for spill clean-up working.



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**Investigation & Environmental Damage Assessment report w.r.t. the
breaching of M/s Essar Power MP Ltd, Singrauli
ash dyke no. 3 on 7.8.2019**

In compliance of the Madhya Pradesh Pollution Control Board (MPPCB), Bhopal officer order no. 2274 dated 08.08.2019, a team of the following officials of MPPCB & CPCB, RD, Bhopal was constituted to investigate the reason of ash dyke breach & assess the environmental damage (Copy of the office order is enclosed as **Annexure-1**):

1. Shri Manoj Kumar Mandral, SE, MPPCB, Bhopal
2. Shri Sunil Kumar Meena, Sc-D, CPCB, RD, Bhopal – Nominated as rep. of RD, Bhopal
3. Shri K L Chaudhary, Regional Officer, MPPCB, Singrauli
4. Dr Harish Wankhade, Scientist, MPPCB, Bhopal

The team firstly met Shri K V S Chaudhary, Collector Singrauli on 9.8.2019 & briefed the line of action of the team w.r.t. the field survey, sampling of Ground water, surface water & damage assessment. Considering the heavy rain (20.5mm in Hr on 6.8.19) in the Singrauli, day before the ash dyke breached at M/s Essar Power MP Ltd, it was requested to issue a direction to Public Works Department & Water Resource Department to carry out the stability analysis of all the Ash dykes of Thermal Power Plants situated in Singrauli area. In line of this Collector, Singrauli has issued letter 266/CST/F2/2019 on 8.8.2019 to Dept of PWD & WRD for the assessment of stability & safety of ash dykes. Copy of the letter is enclosed as **Annexure-2**. It was informed by Collector Shri Chaudhary that losses of crop and agricultural land shall be assessed by revenue department.

Team has visited the site (breached ash dyke) & had discussion with the plant officials. Shri M K Sharma, Chief Operation Officer of Essar informed that a F.I.R. was filed by Shri Umesh Yadav, Security Officer at Police Station, Maada on 08.08.2019 against unknown involved in ash dyke breaching. Copy of the F.I.R is enclosed as **Annexure-3**. Considering the above, local police may initiate action against the unknown for sabotage action. It was also informed that the ash is spread in the land which is allotted to the industry only; but after getting compensation of the land the local villagers are still living & doing agricultural activities on that land. The statement may be verified by Revenue department. An advisory was issued to M/s Essar by RO, MPPCB,

Singrauli on 10.8.2019 to expedite the dyke repairing work with the help of local administration & clean-up the spread ash from the agricultural fields. Copy of the letter is enclosed as **Annexure-4**.

M/s Essar Power MP Ltd, commissioned its Unit#1 & 2 of 600MW each on 29.4.13 & 7.10.2018 respectively. Industry has stopped its production since 8.8.2019 after the dyke breach incident. Industry has adopted High Concentration Slurry Disposal method (water to slurry ratio 35:65) to dispose the ash (bottom & fly ash) other than use in cement plants, brick making dyke raising & filling low-lying area. Details of ash cell area & year-wise rising, height is as below and enclosed as **Annexure-5**:

Cell no.	Area (in Hectare)	Year-wise bund height (in mtrs)								Total Height (in mtrs)	Status
		2012	2013	2014	2015	2016	2017	2018	2019		
1	1.79	-3.5	5	-	-	-	-	-	-	8.5	Abandoned
2A+2B	5.65	-	-3.5	4	3	3	-	-	-	13.5	Soil covered
3	3.34	-	-	-1	-2.5	4	2	2	2	13.5	Use during 27.6.2018 to 21.6.2019
4A+4B	23.97	-	-	-	-	-3.5	5	-	-	8.5	In Use

Field observations

1. The Cell no. 3 of 3.34 hect. area was found breached from East side. The bund breached in about 100m length. The flow of ash is towards Karsualal & Karsuaraja village. The elevation profile shows that from dyke to village elevation is 340 mt. to 324 mt. (about 16meters) with depression of 2-4mtrs. Considering the effective bund area of Cell no. 3 as 2.7ha and breached out average slurry height upto 3mtrs of 1.2 Ton/m³ density of ash (as reported in Ash handling system document) the quantity of slurry breached out is about **97200 Tons (say 1 Lac Ton)**. Design of the ash dyke along with ash handling system document is enclosed as **Annexure-6**.
2. The affected area lies in following geo-graphical locations

Latitude Longitudes:

- i) 23.998170, 82.415844
- ii) 23.996902, 82.415649
- iii) 23.993257, 82.43356
- iv) 23.99165, 82.431338.

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3. The lateral spread of the ash before meeting Jaria Naala/river is about 1.8km with 140-390m (average 260m) width & in average 1.0 ft. height. Nearly about 50 hectares area got affected by the spread of ash slurry.
4. The aerial photography & video-graphy revealed that the slurry has travelled a long path & reached upto Mayar river confluence after flowing through Jaria to Garra river. The slurry travelled 11kms in Jaria to Garra River to Mayar river confluence point. Google map of the same are enclosed as **Annexure-7**.
5. Team has collected total 09 samples of Ground water & surface water to analyse the water quality deterioration majorly w.r.t. the heavy metals. The details of the sampling location are enclosed as **Annexure-8**. Analysis work is under progress.

Probable reason of Ash dyke breach

The cell no. 3 (3.34ha area) rise upto 10mtrs above the ground level & was under use of slurry disposal during 27.6.2018 to 21.6.2019. As documented, 190000T ash was disposed in this cell. The slope of dyke is in east side; from here the decanted water is pumped to Cell no. 4 with the help of pump as and when required. Looking into the rainfall date from 1.8.2019 to 7.8.2019 (day when dyke breached); it was revealed that heavy rainfall was observed during 4th August to 7th August 2019. The rainfall data is tabulated as below; details are enclosed as **Annexure-9**.

Date	Time	Rainfall in mm
4.8.2019	8PM	29.9mm
6.8.2019	6am	10.4mm
	7pm	20.5mm
	9pm	15.2mm
7.8.2019	1pm	8.3mm
	5pm	7.3mm
	7pm	4.3mm
	8pm	6.3mm

The team is in the opinion that due to increased volume of water at sloping beach during the heavy rainfall the phreatic line (line of seepage) may get disturbed that resulted in rising of phreatic line and reduced the stability of the slope. This may be cross-verified by the expert institutes recognized at national level.

[Handwritten signatures and initials]

Probable damage to the environment:

1. About 50 hect. agricultural land area is found to be affected due to thick deposition of ash.
2. The water sources falls under affected area i.e. 50ha may damage. As reported by villager, a pond & few wells are in the path of affected area. However, same was not verified due to un-availability of approach. Same shall be verified through PHED department.
3. The surface water quality of Jaria River, Garra River & Mayar River may be affected seriously due to the spillage of the ash slurry. Samples were drawn from these surface water bodies, analysis is under progress; however a detailed damage assessment can be carried out with the help of recognized institutes having expertise in the field.
4. Ambient air quality of the area would also be affected due to air blown fly ash during summer.

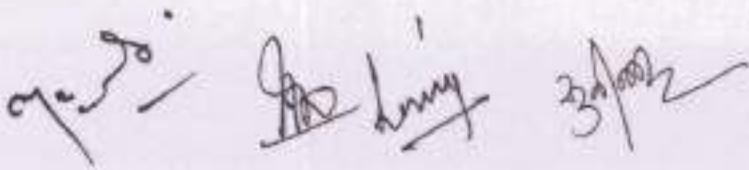
Action taken by the industry after the incident

1. Industry has stopped its operation from 08.08.2019.
2. Industry has deputed JCBs machineries to re-build the breach bund to avoid further spillage of the slurry.
3. With the help of district administration, action regarding the cleaning of the surface of the affected area with the help of labours & tractor. However, agitation of local residents is going on for the instant compensation of the losses. As informed by District Administration that industry has asked deposit Rs. 50 lacs as interim relief to local farmers against crop and others losses.
4. Cleaning of the ash from river Jaria & Garra River was also taken up; however same was also not started due to the protest of the villagers.
5. Industry is taking technical advices from the expert to clean the slurry quickly and effectively.

Recommendation

1. In continuation of the advisory issued to industry by MPPCB on 10.8.2019, ***closure direction may be issued under section 33 A of Water (P&CP), 1974 giving reasonable opportunity of hearing.***

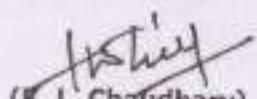
Page 4 of 5



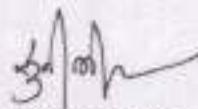
2. Industry may be asked to deposit **10 Crore** to MPPCB towards an interim environmental compensation, pending assessment of actual compensation and further action w.r.t. Aryavart Foundation Vs. M/s Vapi Green Enviro Ltd. & Ors. Hon'ble NGT O.A. 95/2018 order dated 11.1.2019.
3. Industry shall submit time bound action plan for remediation and restoration of the fields, rivers and nallas and other affected areas due to spreading of fly ash.
4. Industry shall depute reputed organization/agency for the assessment of damage caused to environment due to breaching of ash dyke.



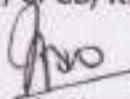
(Manoj Kumar Mandrai)
SE, MPPCB, Bhopal



(K. L. Chaudhary)
RO, MPPCB, Singrauli



(Sunil Kumar Meena)
Sc-D, CPCB, RD Bhopal



(Dr Harish Wankhade)
Scientist, MPPCB, Bhopal



मध्यप्रदेश प्रदूषण नियंत्रण बोर्ड

पर्यावरण परिषद, ई-5, अरेरा कालोनी, भोपाल-462016

☎ (0755) 2464428, 2466191 Fax: 0755 - 2463742 e-mail: it.mppcb@rediffmail.com

क्रमांक /तक/मुप्रनिबो/2019,

भोपाल, दिनांक

// कार्यालय आदेश //

मेसर्स एस्सार पॉवर एम्.पी. लिमिटेड, सिंगरौली के एश पांड से राखड बहने की घटना की सूचना कलेक्टर सिंगरौली तथा क्षेत्रीय अधिकारी, म.प्र. प्रदूषण नियंत्रण बोर्ड, सिंगरौली से प्राप्त हुई है। तदनुसार घटना स्थल का निरीक्षण कर घटना के कारणों तथा उससे हुए पर्यावरणीय दुष्प्रभाव के आंकलन हेतु निम्न अधिकारियों का दल गठित किया जाता है :-

1. श्री मनोज कुमार मंडराई, अधीक्षण यंत्री, म.प्र. प्रदूषण नियंत्रण बोर्ड, भोपाल
2. क्षेत्रीय निदेशालय, केन्द्रीय प्रदूषण नियंत्रण बोर्ड, भोपाल के प्रतिनिधि
3. क्षेत्रीय अधिकारी, क्षेत्रीय कार्यालय, म.प्र. प्रदूषण नियंत्रण बोर्ड, सिंगरौली
4. डॉ. हरीश वानखडे, वैज्ञानिक, म.प्र. प्रदूषण नियंत्रण बोर्ड, भोपाल

उपरोक्त दल घटना स्थल का तत्काल निरीक्षण/मॉनिटरिंग कार्य कर अपना प्रतिवेदन एवं अनुशंसाएँ आदेश प्रसारित होने के 07 दिवस में प्रस्तुत करेगा।

(आर.एस. कोरी)
सदस्य सचिव

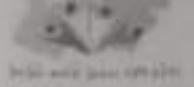
पृ.क्रमांक 2274 /तक/मुप्रनिबो/2019,

भोपाल, दिनांक 8-8-19

प्रतिलिपि :-

1. कलेक्टर, कार्यालय कलेक्टर, जिला सिंगरौली (म.प्र.) की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु।
2. सर्व संबंधित श्री डा. पी.के. बेहरा - R.D. CPCB - BHOPAL की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु।
3. क्षेत्रीय अधिकारी, क्षेत्रीय कार्यालय, म.प्र. प्रदूषण नियंत्रण बोर्ड, सिंगरौली की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु।

(आर.एस. कोरी)
सदस्य सचिव



कार्यालय कलेक्टर एवं जिला मजिस्ट्रेट, जिला सिंगरौली (M0प्र0)

क्रमांक 266 / सीएसटी / एफ.2 / 2019

सिंगरौली दिनांक 8 अगस्त 2019

प्रति

1. कार्यपालन यंत्री
लोक निर्माण विभाग (म./स.)
2. कार्यपालन यंत्री
जल संसाधन विभाग
जिला सिंगरौली (M0प्र0)

विषय:-सिंगरौली जिला स्थित कम्पनियों के ऐश डाइको स्थिरता तथा सुरक्षा के संबंध में जाँच कर रिपोर्ट प्रस्तुत करने बाबत ।

दिनांक 7.8.2019 को एस्सार पावर एम.पी. लिमिटेड बंधीरा जिला सिंगरौली का ऐश डाइक अचानक फूट जाने के कारण आसपास के पूरे इलाके में राख मिश्रित पानी का भराव हुआ है । इससे पूरे क्षेत्र में फसल, परिसम्पत्तियों तथा पर्यावरण की क्षति हुई है । उक्त प्रकार की घटना की पुनरावृत्ति को रोकने के लिए जिले में स्थित समस्त कम्पनियों के ऐश डाइको की मजबूती सुरक्षा व स्थिरता की जाँच कराने का निर्णय लिया गया है । अतः आपको निर्देशित किया जाता है कि सिंगरौली जिला स्थित शासन पावर लिमिटेड, हिण्डालको इण्डस्ट्रीज बरगवा, एन.टी.पी.सी. विन्ध्यनगर, जे.पी. पावर लिमिटेड निगरी, एस्सार पावर बंधीरा के समस्त ऐश डाइक की मजबूती, स्थिरता तथा सुरक्षा के संबंध में विस्तृत जाँच कर अपने स्पष्ट अभिमत के साथ कम्पनीवार पृथक पृथक संयुक्त जाँच प्रतिवेदन एक सप्ताह के अंदर प्रस्तुत करना सुनिश्चित करें ।

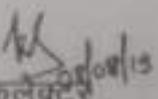

(के.व्ही.एस. चौधरी)
कलेक्टर
जिला, सिंगरौली

पू. क्रमांक 267 / सीएसटी / एफ.2 / 2019

सिंगरौली दिनांक 8 अगस्त 2019

प्रतिलिपि:-

1. कमिश्नर, रीवा संभाग रीवा की ओर सादर सूचनार्थ ।
2. उपखण्ड अधिकारी सिंगरौली/माडा/देवसर/चितरगी जिला सिंगरौली ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु ।
3. कार्यपालन निदेशक, एन.टी.पी.सी. विन्ध्यनगर जिला सिंगरौली की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु ।
4. मुख्य कार्यपालन अधिकारी, शासन पावर लिमिटेड/हिण्डालको इण्डस्ट्रीज बरगवा/जे.पी. पावर लिमिटेड निगरी/एस्सार पावर लिमिटेड बंधीरा की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु ।


कलेक्टर
जिला, सिंगरौली

क्रमांक / ९ / २०१९ / क्षेत्रीय / प्रनिबो / २०१९

सिंगरौली दिनांक १०/०८/२०१९

प्रति,

अधिष्ठाता,

म० एस्सार पावर एम० पी० लिमिटेड

बन्धौरा जिला सिंगरौली (म०प्र०)

विषय:- राखड बाँध के क्षतिग्रस्त होने से समीपस्थ क्षेत्रों में राख बहने के सम्बन्ध में।

उपरोक्त विषयांतर्गत लेख है कि दिनांक ०७ एवं ०८ अगस्त २०१९ की रात्रि के दौरान उद्योग परिसर में स्थित राखड बाँध क्रमांक ३ के टूटने से समीपस्थ क्षेत्रों में नदी, नाले, गाँव एवं खेतों में पानी के साथ राख फैलने से समीपस्थ क्षेत्र प्रभावित हुए हैं।

घटना की सूचना प्राप्त होने पर म० प्र० प्रदूषण नियंत्रण बोर्ड मुख्यालय भोपाल, केन्द्रीय प्रदूषण नियंत्रण बोर्ड के क्षेत्रीय निदेशक कार्यालय भोपाल एवं क्षेत्रीय कार्यालय म०प्र० प्रदूषण नियंत्रण बोर्ड, सिंगरौली के अधिकारियों द्वारा राखड बाँध एवं समीपस्थ प्रभावित क्षेत्रों का संयुक्त दल द्वारा निरीक्षण किया गया। निरीक्षण दौरान पाया गया कि राखड बाँध के टूटने से समीपस्थ ग्रामों के खेतों, नदी, नालों एवं भूमि पर राख का भराव/जमाव पाया गया एवं गरी नदी के माध्यम से मयार नदी होते हुए रिहन्द रिजर्वायर में राख बहने की स्थिति पाई गई।

अतः आपको सूचित किया जाता है कि तत्काल प्रभाव से निम्नानुसार बिन्दुओं पर तत्काल कार्यवाही सुनिश्चित करें:-

- वर्तमान में चूँकि वर्षाकाल जारी है, अतः क्षतिग्रस्त राखड बाँध के टूटे भाग को तत्काल सुधार कार्य प्रारम्भ कर एवं भविष्य में इस प्रकार की घटना की पुनरावृत्ति न हो, इस बावत ठोस कदम उठाये जाये।
- उद्योग परिसर में स्थित अन्य राखड बाँधों की जाँच कर सुनिश्चित करें कि राखड बाँध टूटने/क्षतिग्रस्त होने की स्थिति उत्पन्न न हो।
- जिन नदी/नालों में राख बहने की घटना हुई है उन पर अस्थाई बाँध बनाकर राख बहने से रोका जावे।
- जिस कृषि भूमि पर/नदी/नाले में राख का भराव हुआ है, ऐसे स्थानों पर तत्काल राख हटाने की कार्यवाही प्रारम्भ की जावे।

निरंतर...2

5. उपरोक्त बिन्दुओं पर स्थानीय प्रशासन के द्वारा समन्वय स्थापित कर शीघ्र कार्यवाही प्रारम्भ करे।

[Signature]
10/8/19
(कें० एल० चौधरी)
क्षेत्रीय अधिकारी

क्रमांक / 52 / क्षे.का. / प्रनिबो / 2019

सिंगरीली दिनांक 10/08/2019

प्रतिलिपि:-

1. कलेक्टर, कलेक्टर कार्यालय जिला सिंगरीली की ओर सूचनार्थ एवं आवश्यक कार्यवाही हेतु अर्पित।
2. सदस्य सचिव म0प्र0 प्रदूषण नियंत्रण बोर्ड, भोपाल की ओर सूचनार्थ एवं लेख है कि उपरोक्त घटना के परिपेक्ष में उद्योग को तत्काल प्रभाव से उपरोक्तानुसार कार्यवाही सुनिश्चित करना एवं विधि-संगत कार्यवाही किया जाना प्रस्तावित है।

[Signature]

[Signature]
15/8/19
(कें० एल० चौधरी)
क्षेत्रीय अधिकारी

Received
[Signature]
10/8/19
7:30 Hr.



EPMPL/LA/537/10

दिनांक :- 11.08.2019

Essar Power M.P Limited
Village: Bandhara,
Post Karsudal,
Tehsil Madia,
Dist. - Singrauli,
Waidhan - 486 686
Madhya Pradesh,
India

प्रति,

श्रीमान् कलेक्टर महोदय,
जिला-सिंगरौली (म0प्र0)Corporate Identity Number
U40100DL2005PLC201961T +91 75090 61540 / 89669 02954
www.essar.com

विषय :- ऐश डाइक से निकले हुए राखड को साफ करने के लिए लगाये गये मजदूरों को ग्राम कर्सुआलाल के लोगों द्वारा कार्य को बाधित करने के सम्बन्ध में।

महोदय,

विषयांकित के सम्बन्ध में निवेदन है कि दिनांक 07 जुलाई 2019 की रात्रि में ऐश डाइक का एक हिस्सा टूट जाने के कारण उसकी राख ग्राम कर्सुआलाल की भूमि तक चला गया है। ऐश डाइक के टूटे हुए हिस्से के मरम्मत हेतु दिनांक 08.08.2019 से ही कम्पनी द्वारा मशीनरी लगाया गया किन्तु ग्राम कर्सुआलाल के व्यक्तियों के द्वारा किये जा रहे मरम्मत कार्य को नहीं करने दिया गया। दिनांक 10.08.2019 को क्षेत्रीय अधिकारी म0प्र0 प्रदूषण बोर्ड सिंगरौली द्वारा ऐश डाइक तथा ग्राम कर्सुआलाल की भूमि का निरीक्षण करने के बाद कम्पनी को एक एडवाजिरी दिया गया है कि ग्राम कर्सुआलाल के भूमि पर जो राखड चला गया है उसको तत्काल वहा से उटाकर कम्पनी के ऐश डाइक में डाल दिया जाये। वारिश होने के उपरान्त यह राख पानी के साथ बहकर नदी नालों में जा सकती है। जिसको बचाने के लिये कम्पनी प्रबन्धन पूर्ण रूप से तत्पर है।

जिला प्रशासन एवं क्षेत्रीय अधिकारी म0प्र0 प्रदूषण बोर्ड सिंगरौली द्वारा दिये गये निर्देशों के तहत कम्पनी के द्वारा आज दिनांक 11.08.2019 को सुबह 9 बजे से कार्य प्रारम्भ करने के लिए 250 मजदूर, 10 टेक्टर, 2 पोकलैण्ड को ग्राम कर्सुआलाल में राखड को साफ करने के लिये लगाया गया था, जिसे उसी ग्राम के सरपंच संतोष कुमार जायसवाल, बृजेश उपाध्याय, चन्द्रकेश जायसवाल एवं अन्य 15 व्यक्तियों के द्वारा काम रोक दिया गया। दोपहर में माननीय उपखण्ड अधिकारी महोदय माडा द्वारा उपरोक्त व्यक्तियों से बात-चीत किया गया तथा उनको समझाइस दी गई कि काम को करने दिया जाय, किन्तु उपरोक्त व्यक्तियों के द्वारा काम शुरू नहीं करने दिया गया। जिससे कम्पनी का काफी नुकसान हुआ है। वारिश होने पर उक्त राख आस-पास के नदी-नालों में जा सकती है, जिसको रोकने के लिए ही क्षेत्रीय अधिकारी म0प्र0 प्रदूषण नियंत्रण बोर्ड सिंगरौली द्वारा राखड को तुरन्त हटाने का निर्देश दिया गया है। उक्त व्यक्तियों के द्वारा पूर्व में भी कई बार अपने निजी फायदे के लिये कम्पनी का विरोध किया गया है।

अतः श्रीमान् से निवेदन है कि उपरोक्त व्यक्तियों के विरुद्ध नियमानुसार कार्यवाही करने की कृपा करे तथा इस कार्य को सुचारु रूप से करने हेतु आवश्यक पुलिस बल उपलब्ध कराने की भी कृपा करे, जिससे ग्राम कर्सुआलाल के भूमि पर फैले हुए राखड को हटाया जा सके।

वास्ते एस्सार पावर एम0पी0 लिमिटेड

प्राधिकृत अधिकारी

- प्रतिलिपि:-
1. श्रीमान् मेम्बर सिक्रेटरी म0प्र0 प्रदूषण कन्ट्रोल बोर्ड भोपाल की ओर सूचनार्थ।
 2. श्रीमान् पुलिस अधीक्षक महोदय जिला सिंगरौली की ओर सूचनार्थ।
 3. श्रीमान् उपखण्ड अधिकारी महोदय माडा जिला सिंगरौली की ओर सूचनार्थ।
 4. श्रीमान् क्षेत्रीय अधिकारी म0प्र0 प्रदूषण नियंत्रण बोर्ड जिला सिंगरौली की ओर सूचनार्थ।

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Immediate Rectification work requirement in Ash dyke area

S. No.	Activity planned	Remark
1	Cell -3 Rectification and Strengthening	
	Ash breached around the bund area will be cleaned with the deployment of adequate number of excavators and labors before being proceeded for bund strengthening. Expert opinion is expected by 13 Aug 2019 for actual strengthening procedures.	Work is frequently stopped by villagers regarding payment compensation. Administration help is sought to expedite the work
2	Bund making around water body	
	Planning to create a bund before the water body with the sand bags to prevent any seepage of ash slurry to the water body in case of any rain. Resource deployment - Labors and JCB	Facing severe resistance from the villagers and the work could not be started even after adequate resources deployed at site, which was primarily due to regular disturbance being created by locals.
3	Collection & cleaning of spread Ash in land area	
	Ash spread around the land area is planned to be cleaned manually with the adequate deployment of tractors, JCB and labors. Further it is planned to deploy grader/Dozer.	Resources deployed waiting for administrative support/ Police protection for job to progress because of local disturbances.
4	Cell - 4 Rectification and Strengthening	
	Expert opinion will be strictly followed for any further rectification and strengthening and adequate resources are already lined up.	Planned to be started from 15 Aug 2019
5	Rebuilding of Boundary wall	
	Damaged portion of boundary wall will be repaired	
6	Cell - 2 Rectification and Strengthening	
	Expert opinion will be strictly followed for any further rectification and strengthening and adequate resources are already lined up.	Planned to be started from 15 Aug 2019

Ash Pond

Cell No.	Year-on-Year Bund Height (in Mtrs)								Total Height
	2012	2013	2014	2015	2016	2017	2018	2019	
1	-3.5	5	-	-	-	-	-	-	8.5
2A+2B	-	-3.5	4	3	3	-	-	-	13.5
3	-	-	-1	-2.5	4	2	2	2	13.5
4A+4B	-	-	-	-	-3.5	5	-	-	8.5

CELL-3 DETAILS & CAPACITY UTILIZATION							
Area in Ha	Effective Bund Area in Ha	Start up	Closed	Filled Height above ground level	Ash accumulation in MT (earlier)	Revised Filled Height (after Cell-3 breach)	Ash accumulation at present
3.34	2.7	27/06/2018	21/06/2019	8	190000	5	120000

APPENDIX – 2**ASH HANDLING SYSTEM**

1.0	SYSTEM CAPACITY CALCULATIONS	WORST COAL (Indian coal)
1.1	Calorific value	: 3300 k cal/kg
1.2	MCR worst coal consumption per unit	: 446 TPH
1.3	Percentage of ash in coal	: 43%
1.4	Percentage of bottom ash	: 20%
1.5	Percentage of fly ash	: 90%
1.6	No. of hours of operation of bottom ash handling system in a shift of 8 hours	: Continuous
1.7	No. of hours of operation of fly ash handling system in a shift of 8 hours	: 6.0 Hrs.
1.8	Total quantity of ash generated per unit (Item No. 1.2 x Item No. 1.3)	: 191.78 TPH say 192 TPH
1.9	Quantity of bottom ash generated per unit (Item No. 1.8 x Item No. 1.4)	: 38.4 TPH say 40 TPH
1.10	Quantity of fly ash generated per unit (Item No.1.8 x Item No.1.5)	: 172.6 TPH say 175 TPH
1.11	Bottom ash handling system capacity required (Item No. 1.9 x 1)	: 40 TPH
1.12	Number of bed ash silos for both the steam generators	two (2)
1.13	Capacity of each bed ash silo based on 36 hours storage capacity for one (1) unit or 18 hours storage for both units considering two (2) silos (item 1.11 x 36 ÷ item 1.12 of appendix - I)	720 T

- 1.14 Bottom ash handling and disposal : 60 TPH
system capacity selected for slurry disposal
- 1.15 Bottom ash handling and disposal : 120 TPH
system capacity selected for dry disposal
- 1.16 Operating time for bottom ash : 6 Hrs
evacuation and disposal system
(Ash generated in 18 hrs) (Item No 1.13 / Item No. 1.15)
- 1.17 Fly ash handling system capacity : $175 \times 8/6 = 233.33\text{TPH}$ say 235 PTH
required to evacuate ash generated in eight hours (Item No. 1.10 x 8 / Item No.1.7)
- 1.18 Fly ash handling system capacity :
selected
 - a) Under emergency : ← 235 TPH →
 - b) Under normal operating : 175 TPH
conditions
- 1.19 No. of fly ash silos for each unit Four (4)
- 1.20 Capacity of each fly ash silo based 700 Tonnes say 720 Tonnes
on 16 hours storage capacity for each unit and considering four (4) silos (item 1.10 x 16 x 1 ÷ item 1.19)
- 1.21 Capacity of fly ash disposal : ← 120 TPH →
equipment at each silo outlet selected for slurry disposal
- 1.22 Fly ash unloading capacity for each ← 240TPH →
unit (considering unloading from two silos simultaneously)
- 1.23 Ash slurry disposal system capacity ← 300 TPH →
selected for each unit (considering disposal from two fly ash silo and one bottom ash silo simultaneously)
- 1.24 Considering ash to water ratio of ← 380 cu. m / Hr. →
65:35 by weight (for mixture of bottom ash and fly ash) required capacity of ash slurry pumps (Item No. 1.23 x 35 + Item .No. 1.23)
65 1.38
- 1.25 Selected capacity of slurry pumps : ← 380 cu. m / Hr. →

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1.26 Water required by HCSD pump for disposal of ash. (Item No. 1.23 x 35/ 65) : ← 165 cu. m / Hr. →

1.27 Number of series of ash slurry pumps each of capacity 380 cu.m / Hr proposed to be installed for each unit : ← 3 series →
(2 W + 1 S)

2.0 **ASH DISPOSAL AREA
CALCULATIONS (CONSIDERING
HCSD SYSTEM)**

2.1 No. of hours of operation in a year with a annual PLF of 0.7 : $24 \times 365 \times 0.8 = 7008$ Hrs

2.2 Ash fill height considered : 15.0 m

2.3 Density of ash considered for ash disposal area calculations : 1.2 tonne/ cu.m

2.4 Total quantity of ash generated by both the units per annum (Item No. 1.8 x Item No. 2.1 x 2) : $192 \times 7008 \times 2 = 2,69,10,72$ tonnes

2.5 Total quantity of ash required to be disposed per annum : 2,69,10,72 tonnes

2.6 Volume of ash required to be disposed per annum : $2,69,10,72 / 1.2 = 2242560$ cum

2.7 Considering that ultimate ash fill height of 15m is achieved in phases, the total storage area required for ash disposal per annum : $2242560 / 15 = 149504$ sqm

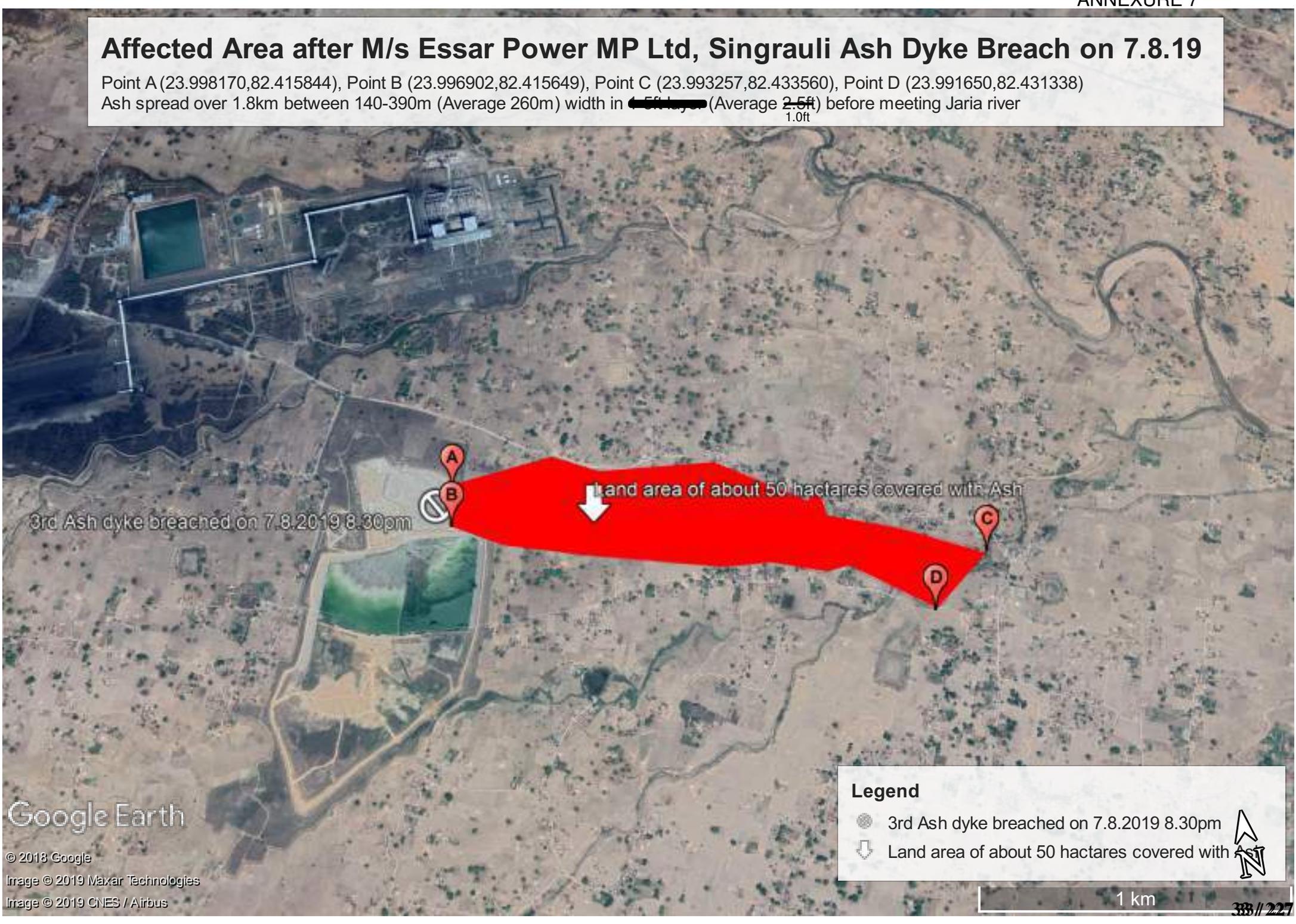
2.8 Considering 5 years of storage, area required : $149504 \times 5 = 747520$ sqm

2.9 Hence area required 74.752 hectare

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R0

Affected Area after M/s Essar Power MP Ltd, Singrauli Ash Dyke Breach on 7.8.19

Point A (23.998170,82.415844), Point B (23.996902,82.415649), Point C (23.993257,82.433560), Point D (23.991650,82.431338)
Ash spread over 1.8km between 140-390m (Average 260m) width in ~~1.5ft~~ (Average 2.5ft) before meeting Jaria river



3rd Ash dyke breached on 7.8.2019 8.30pm

Land area of about 50 hectares covered with Ash

Legend

- 3rd Ash dyke breached on 7.8.2019 8.30pm
- Land area of about 50 hectares covered with Ash

Google Earth

© 2018 Google
Image © 2019 Maxar Technologies
Image © 2019 CNES / Airbus

Path of Ash flow after Ash Dyke Breach on 7.8.19

Ash covered a length of 1.8km before meeting Jaria Naala/rivulet
Ash flow about 11Kms in Jaria & Garra river before conflencing the Mayar river



Legend

- 3 Garra river before conf. To Mayar river
- 2 Garra river, Karsuaaraja
- 1 Jaria river, Karsuaalal
- 4 Mayar river before rihand reservoir at Bijpur Rd

क्षेत्रीय कार्यालय
म0 प्र0 प्रदूषण नियंत्रण बोर्ड
भकुआर, नौगढ़ जिला सिंगरौली (म0प्र0)

एकत्रित जल नमूनों का विवरण

क्र0	सम्पल के नाम और स्थान	सम्पल का विवरण	भौगोलिक स्थिति	संग्रहण दिनांक	जरीकेन कोड क्रमांक	विशलेषित किये जाने वाले पैरा मीटर
01	कर्सुआलाल नियर रोड ब्रिज	नियर वाटर	अक्षांश- 23.993653 देशांश- 82.433808	09.08.2019	01	<p>ऑरोनिक, निकिल, कैडमियम, लीड, मर्क्युरी, जिंक, कॉपर, आयरन एवं अन्य उपलब्ध धातुओं के परीक्षण हेतु।</p> <p>(जल नमूनों को निरीक्षण हेतु रक्षित किया गया)</p>
02	मयार रिवर वाटर, रिहन्द डैम में जाते हुए काचन नदी से मिलने के बाद	रिवर वाटर	अक्षांश- 24.033751 देशांश- 82.624370	09.08.2019	02	
03	गरा नदी रैला गाँव के पास	रिवर वाटर	अक्षांश- 23.995728 देशांश- 82.453367	09.08.2019	03	
04	ओपेन जल वाटर घाम कर्सुआलाल रामदीन दुबे के घर के समीप	ओपेन वॉल	अक्षांश- 23.998665 देशांश- 82.419582	09.08.2019	04	
05	गरा नदी घाम रम्पा नियर रोड ब्रिज मयार नदी के मिलने के पूर्व	रिवर वाटर	अक्षांश- 23.988564 देशांश- 82.499031	09.08.2019	05	
06	गरा नदी 100 मी0 दूर मयार नदी के मिलने के पूर्व	रिवर वाटर	अक्षांश- 23.991962 देशांश- 82.508204	10.08.2019	06	
07	मयार रिवर 100 मी0 दूर गरा नदी के मिलने के पूर्व	रिवर वाटर	अक्षांश- 23.989639 देशांश- 82.511013	10.08.2019	07	
08	मयार रिवर 100 मी0 दूर गरा नदी के मिलने के बाद	रिवर वाटर	अक्षांश- 23.992785 देशांश- 82.512367	10.08.2019	08	
09	हेण्डपम्प वाटर आगनवाडी नियर गरा रेवर	हेण्डपम्प वाटर	अक्षांश- 23.994185 देशांश- 82.508888	10.08.2019	09	

Annexure 9

ESSAR POWER										
	Bar Press ure (mm- Hg)	Voltage (V)	Solar Rad (wat/m2)	RH (%)	Temperat ure (°C)	Rainfall (mm)	Wind Dir (Deg)	Wind Gust (km/h)	Wind Speed (km/h)	Dew Point (°C)
	mm-Hg	V	wat/m2	%	°C	mm	Deg	km/h	km/h	°C
Date and Time	BAR	VLT	SRD	HMD	TMP	RNF	WND	WNG	WNS	DEW
8/1/2019 0:00	725.7		0	83.3	26.2	0	255	0	0	23.2
8/1/2019 1:00	725.6		0	80.7	26.1	0	255	0	0	22.6
8/1/2019 2:00	725.5		0	76.3	25.9	0	255	0	0	21.5
8/1/2019 3:00	725		0	77.4	25.9	0	255	0	0	21.7
8/1/2019 4:00	724.9		0	81.3	25.6	0	255	0	0	22.2
8/1/2019 5:00	724.9		0	83.1	25.5	0	255	0	0	22.5
8/1/2019 6:00	725.1	2	2	83.8	25.7	0	255	0	0	22.8
8/1/2019 7:00	725.7	32	32	83.7	25.8	0	255	0	0	22.9
8/1/2019 8:00	726.2	104	104	76.7	26.3	0	255	0	0	22
8/1/2019 9:00	726.7	230	230	67.5	27.3	0	64	0	0	20.9
8/1/2019 11:00	727	571	571	54.4	29.9	0	40	0	0	19.8
8/1/2019 12:00	726.7	600	600	52.1	30.2	0	351	0	0	19.4
8/1/2019 13:00	726.5	764	764	47.6	31.1	0	59	0	0	18.7
8/1/2019 14:00	725.7	369	369	52.3	30.8	0	142	0	0	20
8/1/2019 15:00	725.3	200	200	51.8	30.3	0	248	0	0	19.4
8/1/2019 16:00	724.8	92	92	58.6	28.7	0	249	0	0	19.9
8/1/2019 17:00	724.3	65	65	59.7	27.9	0	220	0	0	19.5
8/1/2019 18:00	724.1	58	58	58.9	27.8	0	183	0	0	19.2
8/1/2019 19:00	724.3	8	8	62.4	27.3	0	254	0	0	19.6
8/1/2019 20:00	724.6	0	0	68	26.8	0	255	0	0	20.5
8/1/2019 21:00	725.2	0	0	68.7	26.6	0	255	0	0	20.5
8/1/2019 22:00	725.6	0	0	69.2	26.8	0	255	0	0	20.8
8/1/2019 23:00	726.7	0	0	72.9	26.7	0	254	0	0	21.5
8/2/2019 0:00	725.7	0	0	75	26.4	0	254	0	0	21.7
8/2/2019 1:00	725.4	0	0	77	26.2	0	254	0	0	21.9
8/2/2019 2:00	725	0	0	78.8	26.2	0	254	0	0	22.3
8/2/2019 3:00	724.5	0	0	80.7	26.2	0	254	0	0	22.7
8/2/2019 4:00	724.3	0	0	82.4	26.2	0	254	0	0	23
8/2/2019 5:00	724.3	0	0	83.8	26.2	0.2	254	0	0	23.3
8/2/2019 6:00	724.3	2	2	84.3	26.2	0	254	0	0	23.4
8/2/2019 7:00	724.8	52	52	83.3	26.4	0	254	0	0	23.4
8/2/2019 8:00	725.4	68	68	76.6	27.1	0	254	0	0	22.7
8/2/2019 9:00	725.9	172	172	67.2	27.7	0	254	0	0	21.3
8/2/2019 11:00	726.2	581	581	51.3	30.2	0	29	0	0	19.1
8/2/2019 12:00	726	624	624	45.6	31.1	0	62	0	0	18
8/2/2019 13:00	725.7	684	684	40.5	32.1	0	40	0	0	17
8/2/2019 14:00	724.9	704	704	38.8	32.6	0	36	0	0	16.7
8/2/2019 15:00	724.3	594	594	37.8	32.8	0	90	0	0	16.5
8/2/2019 16:00	723.8	248	248	37	32.8	0	67	0	0	16.2
8/2/2019 17:00	723.6	171	171	51.3	32.3	0	151	0	0	21.1
8/2/2019 18:00	722.9	19	19	68.2	27	0.7	262	0	0	20.8
8/2/2019 19:00	723.5	6	6	73.1	26.8	0	262	0	0	21.7
8/2/2019 20:00	724.1	0	0	72.5	27.1	0	262	0	0	21.8
8/2/2019 21:00	724.7	0	0	73.9	27.1	0	262	0	0	22.2
8/2/2019 22:00	725.3	0	0	74.3	26.9	0	261	0	0	22
8/2/2019 23:00	725.6	0	0	75.9	26.9	0	261	0	0	22.4
8/3/2019 0:00	725.3	0	0	80.7	26.8	0	261	0	0	23.1
8/3/2019 1:00	724.8	0	0	83.4	26.3	0	261	0	0	23.3
8/3/2019 2:00	724.1	0	0	85	26	0	261	0	0	23.3
8/3/2019 3:00	723.8	0	0	87.2	25.9	0	179	0	0	23.8
8/3/2019 4:00	723.7	0	0	87.8	25.9	0	179	0	0	23.7
8/3/2019 5:00	723.8	0	0	88	25.7	0	189	0	0	23.6
8/3/2019 6:00	724	6	6	87.8	25.6	0	189	0	0	23.4
8/3/2019 7:00	724.9	64	64	84.6	26.3	0	189	0	0	23.5
8/3/2019 8:00	725.3	152	152	71.6	27.5	0	184	0	0	22
8/3/2019 9:00	725.1	251	251	50.8	29.1	0	142	0	0	19.8
8/3/2019 11:00	727	765	765	42.2	33.4	0	160	0	0	16.8
8/3/2019 12:00	726.4	811	811	38	33.3	0	86	0	0	16.7
8/3/2019 13:00	725.7	701	701	37	33.4	0	49	0	0	16.4
8/3/2019 14:00	725.4		701	34.4	34.4	0		0	0	

8/3/2019 15:00	725	671	34	34.5	0	43	0	0	15.3
8/3/2019 16:00	724.2	235	36.4	33.7	0	139	0	0	16.7
8/3/2019 17:00	723.1	84	63.9	29.8	0.5	240	0	0	22.4
8/3/2019 18:00	723	26	79.9	27.5	5.8	26	0	0	23.8
8/3/2019 19:00	723.2	1	81.4	26.7	0	280	0	0	23.3
8/3/2019 20:00	723.8	0	81.8	26.9	0	151	0	0	23.6
8/3/2019 21:00	724.3	0	82.6	26.9	0	151	0	0	23.7
8/3/2019 22:00	724.9	0	85	27	0	152	0	0	24.3
8/3/2019 23:00	725.3	0	89.5	26.8	0	170	0	0	20.9
8/4/2019 0:00	725.4	0	83.4	27.3	0	162	0	0	19.9
8/4/2019 1:00	725.2	0	82.4	27.4	0	341	0	0	19.7
8/4/2019 2:00	724.9	0	84.3	27.3	0	256	0	0	20.1
8/4/2019 3:00	724.6	0	85.4	27.2	0	252	0	0	20.3
8/4/2019 4:00	724.3	0	86.2	27	0	165	0	0	20.3
8/4/2019 5:00	724.4	0	85.4	27.1	0	248	0	0	20.2
8/4/2019 6:00	724.9	4	87.7	27	0	248	0	0	20.7
8/4/2019 7:00	725.1	42	89.1	27.2	0	248	0	0	21.2
8/4/2019 8:00	725.6	160	89.5	28.3	0	144	0	0	19.8
8/4/2019 9:00	725.8	245	85.5	29.9	0	186	0	0	20.2
8/4/2019 10:00	726.2	195	45.8	31.1	0	252	0	0	18.1
8/4/2019 11:00	726.6	484	40	33.3	0	255	0	0	17.9
8/4/2019 12:00	726.1	721	35	33.8	0	168	0	0	16.2
8/4/2019 13:00	725.1	493	41.5	33.9	0	180	0	0	19
8/4/2019 14:00	724.4	342	44.1	33.3	0	286	0	0	19.5
8/4/2019 15:00	723.7	258	47.3	31.4	0	261	0	0	18.9
8/4/2019 16:00	723.4	153	47.6	31.3	0	271	0	0	18.9
8/4/2019 17:00	723	32	53.1	30.3	0	249	0	0	19.8
8/4/2019 18:00	723.1	0	71.2	28.6	0.5	180	0	0	23
8/4/2019 19:00	723.3	0	87.5	26.2	29.9	163	0	0	24
8/4/2019 20:00	723.9	0	86.5	25.8	4.8	189	0	0	23.4
8/4/2019 21:00	724.5	0	82.2	25.8	5.3	158	0	0	22.6
8/4/2019 22:00	724.2	0	80.5	25.4	0.2	252	0	0	21.9
8/5/2019 0:00	724.1	0	82.2	25.6	0	252	0	0	22.4
8/5/2019 1:00	723.7	0	80.4	25.8	0	255	0	0	22.2
8/5/2019 2:00	723.7	0	81.4	26.2	0	255	0	0	22.8
8/5/2019 3:00	723.4	0	80.8	26.4	0	255	0	0	22.9
8/5/2019 4:00	723.1	0	75.9	26.7	0	264	0	0	22.2
8/5/2019 5:00	723	0	75.5	26.7	0	268	0	0	22.1
8/5/2019 6:00	723.5	3	78.1	26.6	0	268	0	0	22.5
8/5/2019 7:00	724.1	24	79.8	26.8	0	268	0	0	23.1
8/5/2019 8:00	724.6	67	68.4	27.4	0	262	0	0	21.2
8/5/2019 9:00	725.3	99	67.1	28.1	0	271	0	0	21.6
8/5/2019 10:00	725.7	39	71.6	28.3	0	266	0	0	22.8
8/5/2019 11:00	725.1	29	74.9	27.8	0	138	0	0	23
8/5/2019 12:00	724.4	159	70.1	28.2	0	84	0	0	22.4
8/5/2019 13:00	724.3	335	61.5	29.3	0	114	0	0	21.3
8/5/2019 14:00	724.6	587	43.5	31.8	0	249	0	0	17.9
8/5/2019 15:00	724.6	230	44.4	32.7	0	240	0	0	19
8/5/2019 16:00	723.5	175	44.5	32.6	0	249	0	0	19
8/5/2019 17:00	722.9	89	50.7	31.2	0	262	0	0	19.9
8/5/2019 18:00	722.4	9	61.9	29.8	0	262	0	0	21.9
8/5/2019 19:00	722.4	0	72.1	28.6	0	262	0	0	23.2
8/5/2019 20:00	722.9	0	75.7	28.2	0	262	0	0	23.6
8/5/2019 21:00	723.7	0	79.9	27.7	0	262	0	0	24
8/5/2019 22:00	723.9	0	80.8	27.4	0	262	0	0	23.9
8/5/2019 23:00	724	0	81.1	27.3	0	262	0	0	23.8
8/6/2019 0:00	723.5	0	76.2	27.6	0	262	0	0	23.1
8/6/2019 1:00	723.3	0	73.7	27.8	0	269	0	0	22.8
8/6/2019 2:00	722.8	0	74.1	27.8	0	271	0	0	22.9
8/6/2019 3:00	722.7	0	79.4	27.3	0	271	0	0	23.5
8/6/2019 4:00	722.5	0	79.9	27.3	0.5	268	0	0	23.6
8/6/2019 5:00	722.7	0	84.3	25.2	10.4	275	0	0	22.4
8/6/2019 6:00	722.8	1	85.2	24.6	4	273	0	0	22.2
8/6/2019 7:00	723.1	21	86.6	25	6.3	251	0	0	22.6
8/6/2019 8:00	723.8	33	85.5	25.4	0.7	247	0	0	22.8
8/6/2019 9:00	724.4	125	49.1	30.7	0	77	0	0	18.9
8/6/2019 10:00	725.3	694							

8/6/2019 12:00	726.2									
8/6/2019 13:00	724.3		577	48	31.9	0.2				
8/6/2019 14:00	723.3		281	50.9	31.6	0	281	1	0	18.9
8/6/2019 15:00	722.9		228	49.5	31.4	0	300	0	0	20.5
8/6/2019 16:00	721.9		447	42.4	33.2	0	141	0	0	19.7
8/6/2019 17:00	721.4		235	48.6	32.5	0	265	0	0	18.7
8/6/2019 18:00	721.5		113	57.4	31.2	0	35	0	0	20.4
8/6/2019 19:00	720		49	59.9	28.8	0	290	0	0	21.9
8/6/2019 20:00	718.3		0	84.1	26.3	20.5	251	0	0	20.4
8/6/2019 21:00	718.7		0	68.1	25.9	0	247	0	0	23.4
8/6/2019 22:00	719.6		0	69.7	25.9	15.2	245	0	0	23.8
8/6/2019 23:00	719.6		0	92	24.9	1.7	296	0	0	24.1
8/7/2019 0:00	719.5		0	92	24.6	0.5	282	0	0	23.5
8/7/2019 1:00	720.4		0	92.8	24.5	0	128	0	0	23.2
8/7/2019 2:00	720.8		0	93.7	24.4	0	127	0	0	23.2
8/7/2019 3:00	720.4		0	94.5	24.4	0	141	0	0	23.3
8/7/2019 4:00	720.1		0	95	24.4	0.2	141	0	0	23.4
8/7/2019 5:00	720.6		0	95.4	24.2	0	141	0	0	23.4
8/7/2019 6:00	720.9		0	96.1	24.5	0	152	0	0	23.8
8/7/2019 7:00	721.4		1	96.6	24.4	0	152	0	0	23.8
8/7/2019 8:00	722.4		28	97.3	24.8	0	199	0	0	24.3
8/7/2019 9:00	723.8		172	97.5	25.7	0	146	0	0	25.3
8/7/2019 10:00	723.8		241	65.7	27.6	0	269	0	0	20.9
8/7/2019 11:00	723.8		565	52.6	29.7	0	279	0	0	19.1
8/7/2019 12:00	723.1		227	54	30.1	0	350	0	0	19.9
8/7/2019 13:00	722		67	74.8	28.1	8.3	358	0	0	20.3
8/7/2019 14:00	721.3		104	81.8	26.2	1.5	347	0	0	22.9
8/7/2019 15:00	720.8		166	74.2	27.3	0	345	0	0	22.4
8/7/2019 16:00	720.4		187	66.2	28.7	0	337	0	0	19.2
8/7/2019 17:00	719.8		105	70.9	29.1	7.3	307	0	0	23.4
8/7/2019 18:00	719.4		30	80.4	26.4	0.7	228	0	0	22.8
8/7/2019 19:00	719.7		1	84.4	26.4	4.3	83	0	0	23.6
8/7/2019 20:00	720.3		0	88.6	25.8	6.3	94	0	0	23.8
8/7/2019 21:00	720.8		0	91.3	25.5	0	149	0	0	24
8/7/2019 22:00	720.8		0	92	25.6	0	149	0	0	24.2
8/7/2019 23:00	720.7		0	92.6	25.7	0	149	0	0	24.4
8/8/2019 0:00	720.4		0	93.1	25.7	0	149	0	0	24.5
8/8/2019 1:00	719.8		0	93.5	25.8	0	149	0	0	24.7
8/8/2019 2:00	719.4		0	93.8	25.7	0.2	326	0	0	24.6
8/8/2019 3:00	719.1		0	92.5	25.7	0	0	0	0	24.4
8/8/2019 4:00	719		0	92.3	25.7	0	0	0	0	24.3
8/8/2019 5:00	719		0	89.4	25.8	0	9	0	0	23.9
8/8/2019 6:00	719.2		6	85.1	25.8	0.7	19	0	0	23.3
8/8/2019 7:00	719.7		50	78.3	26.1	0	49	0	0	22.1
8/8/2019 8:00	720		73	68.5	26.6	0	48	0	0	20.5
8/8/2019 9:00	720.3		87	66	26.8	0	43	0	0	20.1
8/8/2019 10:00	720		95	74.3	26.1	0.7	57	0	0	21.3
8/8/2019 11:00	720		93	69.1	26.8	0	80	0	0	20.8
8/8/2019 12:00	720.1		98	68	27.2	0	14	0	0	30.9
8/8/2019 13:00	719.6		68	74.3	26.7	0.2	46	0	0	21.8
8/8/2019 14:00	719		61	77.3	26.4	0	35	0	0	22.2
8/8/2019 15:00	718.6		81	74.3	26.9	1	131	0	0	22
8/8/2019 16:00	718.5		122	71.8	27	1.2	74	0	0	21.6
8/8/2019 17:00	718.5		63	65.6	27.2	0	67	0	0	20.3
8/8/2019 18:00	718.9		3	66.4	26.9	0	94	0	0	30.2
8/8/2019 19:00	719.5		0	67.9	26.4	0	81	0	0	20.1
8/8/2019 20:00	720.3		0	71.9	26.2	0	83	0	0	20.8
8/8/2019 21:00	721		0	72.1	26	0	83	0	0	20.7
8/8/2019 22:00	721.7		0	69.7	25.9	0	63	0	0	20.1
8/8/2019 23:00	722.1		0	68.9	25.9	0	74	0	0	19.9
8/9/2019 0:00	722.1		0	68.4	25.8	0	55	0	0	19.7
8/9/2019 1:00	721.8		0	68.5	25.8	0	59	0	0	19.7
8/9/2019 2:00	721.7		0	71.1	25.7	0	31	0	0	19.7
8/9/2019 3:00	721.8		0	69.1	25.6	0	59	0	0	20.2
8/9/2019 4:00	722.2		0	69	124.8	0	70	0	0	19.8
8/9/2019 5:00	805.2	0.249	0	70.5	29.4	0	70	0	0	23.6
8/9/2019 6:00	730.2	2.749	12	67.5	25.7	0	121	0	0	15.4
8/9/2019 7:00	723.5		75	67.5	25.7	0	73	0	0	

8/9/2019 8:00	724.1		94	66.1	25.8	0	90	0	0	19.1
8/9/2019 9:00	724.9		264	58.1	26.8	0	104	0	0	18
8/9/2019 11:00	725.6		225	55.3	27.8	0	145	0	0	18.1
8/9/2019 12:00	725.9		321	49.4	28.7	0	87	0	0	17.1
8/9/2019 13:00	726.1		403	49	29.3	0	77	0	0	17.5
8/9/2019 14:00	725.9		683	44.3	29.9	0	139	0	0	16.5
8/9/2019 15:00	725.4		558	46.4	30.4	0	91	0	0	17.7
8/9/2019 16:00	725		230	43.6	30.2	0	138	0	0	16.5
8/9/2019 17:00	724.7		148	44.1	30.3	0	110	0	0	16.7
8/9/2019 18:00	724.6		134	44.8	29.6	0	156	0	0	16.4
8/9/2019 19:00	724.7		11	51.2	28.3	0	107	0	0	17.3
8/9/2019 20:00	725.2		0	52.2	27.7	0	163	0	0	17.1
8/9/2019 21:00	725.9		0	56.2	27.6	0	196	0	0	18.2
8/9/2019 22:00	726.5		0	56.3	27.1	0	153	0	0	17.8
8/9/2019 23:00	726.8		0	61	26.8	0	153	0	0	18.8
8/10/2019 0:00	726.4		0	68.9	25.8	0	155	0	0	19.8
8/10/2019 1:00	726.6		0	68.2	25.9	0	166	0	0	19.7
8/10/2019 2:00	726.2		0	75	25.4	0	166	0	0	20.7
8/10/2019 3:00	726		0	79.2	25.2	0	166	0	0	21.4
8/10/2019 4:00	725.6		0	81.2	25.1	0	166	0	0	21.7
8/10/2019 5:00	725.7		0	80.9	25.1	0	166	0	0	21.6
8/10/2019 6:00	725.9		6	82.3	25.1	0	166	0	0	21.9
8/10/2019 7:00	726.6		57	76.4	25.7	0	163	0	0	21.3
8/10/2019 8:00	727.6		160	54.8	27.7	0	220	0	0	17.9
8/10/2019 9:00	728.6		450	41.4	30.4	0	262	0	0	15.8
8/10/2019 11:00	728.6		517	38.5	32.2	0	275	0	0	16.3
8/10/2019 12:00	728.8		668	32.5	33.1	0	255	0	0	14.4
8/10/2019 13:00	728.3		553	32.4	33.6	0	276	0	0	14.8
8/10/2019 14:00	727.8		675	31.6	34.5	0	265	0	0	15.2
8/10/2019 15:00	727.2		494	32.4	34.3	0	272	0	0	15.4
8/10/2019 16:00	726.5		242	36.1	33.8	0	134	0	0	16.7

Inspection Report of M/s NTPC, Vindh nagar thermal Power plant w.r.to the Ash dyke breach incident happened on 6.10.2019 (5-6pm)

A detailed inspection of the site i.e. breached ash dyke of NTPC, Vindh nagar was carried out on 9.10.2019 by Sh Sunil Kumar Meena, Sc-D, CPCB , RD Bhopal along with Sh S D Valmiki, EE, Regional Office, MPPCB, Singrauli w.r.to the assessment of the spread area of the ash, contamination of the surface water bodies etc.

On the day of inspection, out of total 13 units; unit number 06 was out of service & the total production load was about 3625MW. The discharge of slurry was on ash dyke no. V3A, V3B & V4A. Unit has 06 ash dykes in total i.e. V1, V2, V3A, V3B, V4A & V4B at Shahpur & Baliyari area. **Details of the dykes are as tabulated below:**

Ash dyke	Area (Starter Dyke)	Raising in service	Operating area (Acre)	Current raising in service since
V-1	474	4 th raising exhausted, <i>Buttressing in progress</i>	227 (after <i>Buttressing</i>)	<i>Not applicable</i>
V-2	600	4 th raising in progress	308 (after 4 th raising)	Not applicable
V-3A	315	3 rd raising in service	218 (after 3 rd raising)	05.10.2019
V-3B	172	2 nd raising in service	126	28.02.2018
V-4A	184	Starter dyke in service	184	31.03.2016
V-4B	165	1 st raising in progress	148 (after 1 st raising)	Not applicable

The ash dyke breach incident happen at ash dyke no. **V-1** in North-West direction. This dyke is in operation since 1987. The area of starter dyke was 474 acres whereas on the exhaust of 4th raising the operating area is 227 acres. The buttressing was in progress. One line of slurry disposal was in operation on the day of incident. To recirculate the ash water unit has established 03 AWRS systems; out of which AWRS 1 & 2 are of 1000M3/hr capacity whereas the AWRS - 03 is of 1500m3/hr capacity. After the day of incident AWRS 1 & 2 are out of service as the ash slurry flown through the AWRS building with such a pressure that it broke down the double layer boundary walls & filled up in the working area of the AWRS premises. Currently AWRS-

03 is in operation. The ash slurry flow has also dislodged the ash slurry carrying pipeline of the NTPC Shaktinagar plant. That resulted in non-operation of AWRS systems of NTPC Shaktinagar. The decanting water of NTPC, Shaktinagar ash dyke N. S1 & S2 is directly being discharged in Rihand reservoir.

Probable reason of the ash dyke (V1) breach

Heavy rains are reported since last two months in every part of the Madhya Pradesh. Similarly, Singraulli district also had heavy rains during August to 5th Oct 2019. Similar kind of ash dyke breaching incident occurred in the month of August 2019 at M/s Essar MP Power limited, Singraulli due to the heavy rain & poor decanting system. The rainfall data of 20th Sept to 5th Oct 2019 revealed that Vindhnagar area had heavy rainfall on the following days:

S.NO.	Day	Rainfall in mm
1.	20.9.2019	10.5
2.	23.09.2019	68
3.	24.09.2019	31.5
4.	25.9.2019	16
5.	26.6.2019	10
6.	27.9.2019	45.2
7.	28.9.2019	50.8
8.	29.9.2019	10
9.	30.9.2019	36.6
10.	1.10.2019	10.5
11.	3.10.2019	19
12.	4.10.2019	10.7
13.	5.10.2019	21

As reported, 4th raising of the V1 ash dyke got exhausted & buttressing work was on going as per the approved design & drawing. Total **14,20,000 M³** quantity of ash got excavated from the 918442 m2 area of the dyke i.e. **1.55 m³/m²** and used in buttressing from V-1 dyke; that in result created voids of different dept & size. As per the field survey; the measurement of the breached out area was done using the Google Earth Pro software. The breached out area so calculated was about **3.75 Hectares** with 250mtrs wide & 150mtrs in length dimension. Taking the average depth of ash breach as 05mtrs as it varied from 9mtrs to 3mtrs throughout the calculated area; the

quantum of ash breached is approx. **225000 Tons** (considering ash density 1.2T/m³). The water pool so created due to the excavation of 1.55 m³/m² in affected area i.e. 3.75Ha stored rainwater & slurry water of approx. 58,125m³ say **50000m³** (density of ash 1.2 T/m³). This water pool's hydrological pressure may be the reason of the ash dyke breach. The dyke breached out in about 100mtrs length & pulled of the decanting well along with the slurry water.

Assessment of the Ash slurry spread over

The team carried out the field survey to understand & assess the spread of ash slurry. With the help of Geo-graphical co-ordinates, elevation data & field survey information; spread area of the slurry was mapped on Google earth Pro software (**Annexure-1**). The slurry spread over **33Ha** area form the ash dyke V1 to decanting pond & AWRS 1 & 2 surrounding area. That dislodged the AWRS pipeline of NTPC Vindhagar & Shaktinagar. The slurry flown in the decanting pond filled up with the decanted water & created a heavy water pressure & broke down the walls of AWRS system & flown through a garland drain and spread over a area of **12 Ha** in North-West. The decanting pond's one side embankment also got breached out in a length of 50-60mtrs & slurry spread over an area of **8Ha** towards Rihand reservoir & Surya Drain. Presently, no large quantity of ash met reservoir & right bank of Surya drain. **In total 53Ha** area came under the verse of ash slurry. Considering the area where ash dumped in as 80000m² & depth of slurry as 1mtr in decanting pond about 1 lac Ton ash retained in the decanting pond. That resulted in **125000Tons** of ash spread over the 45Ha area with average dept of 1ft other than the ash retained in decanting pond.

The ash slurry spread in the plant premises & didn't affect villages like Gehalgarh due to higher elevation. The village Juari was also not affected as it is on the left bank of Surya Drain. No agricultural land got affected on the spread of the ash slurry. Water samples were collected from 04 locations as AWRS garland drain, Rihand reservoir, fall out of S1 dyke decanted water into Rihand reservoir & Juari village. The analysis of the water sample for the heavy metals shall be carried out at MPPCB, Jabalpur.



Measures taken on the day of incident and thereafter by the Unit

1. Total ash slurry in discharge in V-1 dyke was immediately stopped.
2. Power supply to the entire Shahpur ash dyke area was cut-off immediately in-line of the safety.
3. Flooded area was evacuated of all working personnel and complete area was searched immediately following the breach to ensure that no man/animal was trapped inside the affected area. It was informed by plant official Shri Munish Jain, AGM that no casualty/death of man/animal was reported.
4. Breach portion of V-1 dyke was plugged within 30 hours and restoration work was in progress
5. Breach portion of overflow lagoon was plugged within 12 hours and restoration work was in progress
6. Cleaning work in surrounding area of V-1 started at 7:00 AM on 7th Oct'19 and it was in progress. A separate contract has been awarded for cleaning of the entire ash and to put back the same in V-1 ash dyke.
7. AWRS-I cleaning work was in progress
8. Ash spill from overflow lagoon following breach in boundary in the North West side is being collected by deploying equipments from 10th Oct'19.

Recommendations

1. M/s NTPC Shaktinagar to repair the AWRS dislodged pipeline within 07days & to stop discharge of decant water of S1 & S2 dyke immediately by pumping in M/s NTPC Vindhagar AWRS 03 system immediately.
2. M/s NTPC Vindhagar shall collect back the spread over ash from 53Ha area with minimal fugitive emission & dispose it in operating dyke. Unit shall submit the time bound action plan in this regard.
3. M/s NTPC Vindhagar to stop the probable mixing of slurry in Rihand reservoir & Surya drain near decanting pond with no further delay.
4. M/s NTPC Vindhagar may be asked to deposit **01 Crore** to CPCB or MPPCB towards an interim environmental compensation w.r.to Aryavart Foundation Vs M/s Vapi Green Enviro Ltd & Ors. Hon'ble NGT O.A. 95/2018 order dated 11.1.2019.



5. To engage national importance institute like IIT/NEERI/NIT & others to carry out the assessment of the ash dyke stability to further avoid such incident to occur.



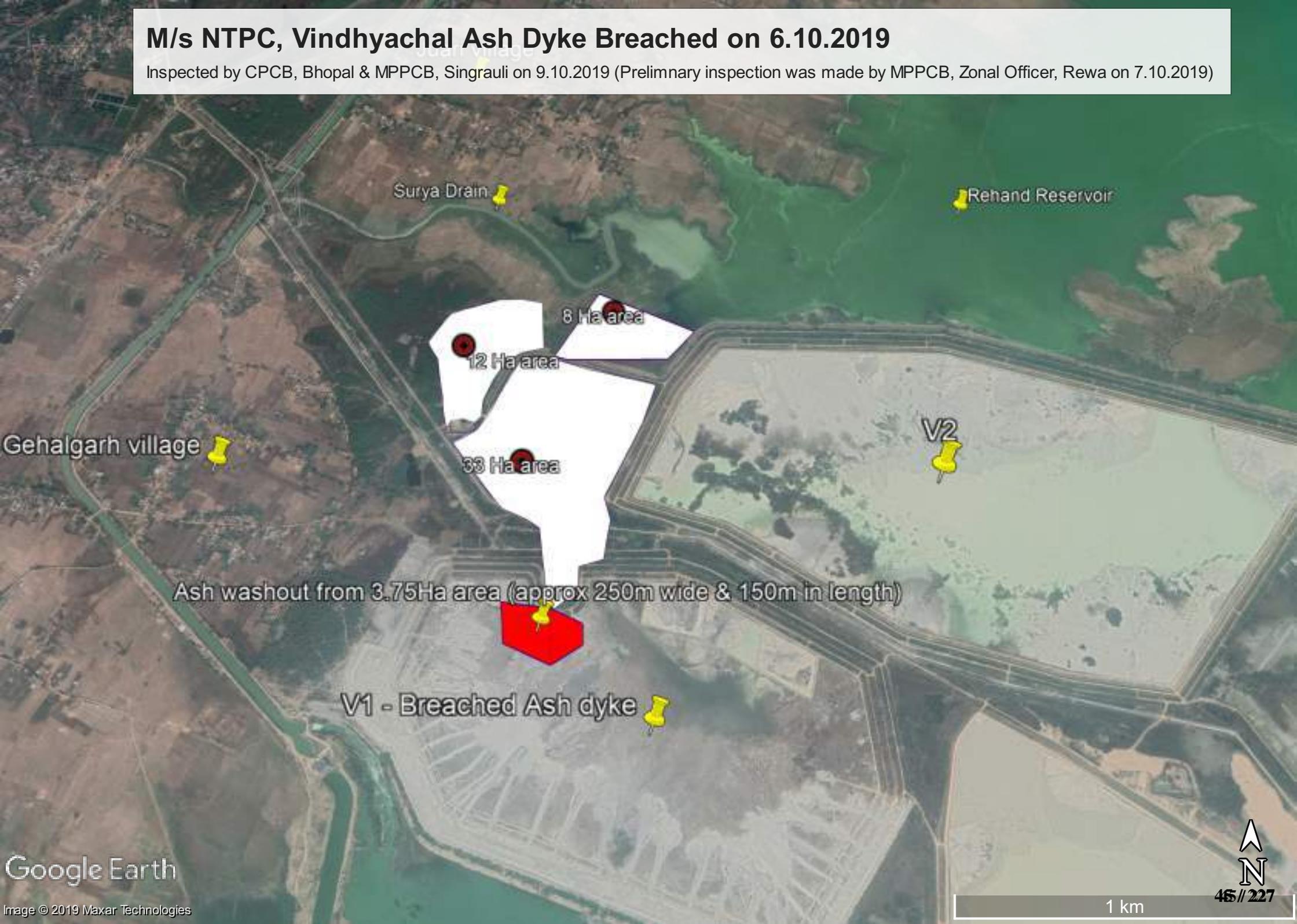
(S D Valmiki)
Executive Engineer
RO, MPPCB, Singrauli



(Sunil Kr Meena)
Scientist 'D'

M/s NTPC, Vindhychal Ash Dyke Breached on 6.10.2019

Inspected by CPCB, Bhopal & MPPCB, Singrauli on 9.10.2019 (Preliminary inspection was made by MPPCB, Zonal Officer, Rewa on 7.10.2019)



**Photographs of the Ash Dyke Breach incident on 6.10.2019 at M/s NTPC
Vindhnagar, Singrauli**

(Photographs taken on 9.10.2019)



Breached out ash



Ash breached in one side of the dyke



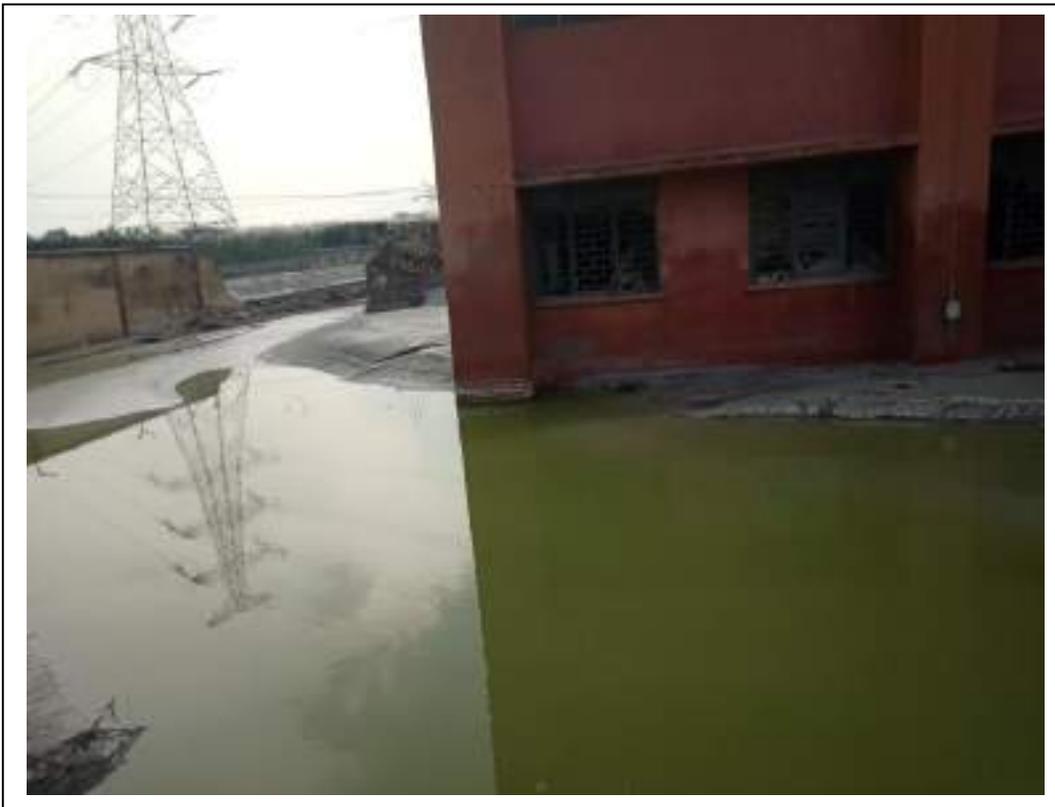
Spread over ash slurry near dyke V1 area



Tractor turns down due to the pressure of flown ash slurry



Broken down boundary wall



Slurry entered in the AWRS 1 & 2 system



Broken down boundary walls



Cleaning of ash in AWRS area is going on



Slurry entered in Decanting pond



Broken down Ash slurry recirculation pipelines



Ash slurry effluent directly discharged in Rihand reservoir from decant pond of S1 & S2 dyke



Breached decanting pond near AWRS 1 & 2 under repair & restoration



Spread over ash slurry towards Rihand reservoir after the breach of decanting pond near AWRS 1 & 2



Ash flowing in the garland drain near AWRS 1 & 2



REGIONAL OFFICE
M.P. POLLUTION CONTROL BOARD
PLOT NO. 455/456, VIJAY NAGAR, JABALPUR (M.P.)

No. 2122 /SS/RO/PCB/2019

Jabalpur, Dated 23/10/19

To,

Lab Incharge,
M.P. Pollution Control Board,
Singrauli (M.P.)

Sub:- Heavy metal reports,

Ref:- Your letter no. 642 dated 10/10/2019.

Please find enclosed herewith the heavy metal reports of water samples of NTPC vindhyannagar ash dyke. For information please.

Encl:- As above.

(Dr. S. K. KHARE)
LAB INCHARGE
M.P. POLLUTION CONTROL BOARD
JABALPUR

To,
Shri Sunil Kumar Meena
S.O., RD Bhopal (M.P.)
CPCB, Bhopal
Heavy metal report regarding NTPC/VSTPP, Vindhyaal
ash dyke breached related.
for RO/MPPCB/Singrauli (M.P.)



REGIONAL OFFICE
M.P. Pollution Control Board
455,456, Vijay Nagar, Jabalpur (M.P.)

WATER SAMPLE HEAVY METAL ANALYSIS REPORT

Date of Collection :- 07/10/2019	Analysis No. 164/1-4	Bill No.	Di.						
Date of Receipt :- 11/10/2019	Sample From: NTPC vindhyannagar ash dyke								
Date of Analysis :- 18/10/2019	Sample collected by :- RO Singrauli staff								
Analysis Done By :- Mrs. Amiya Ekka									
S No	Description of Sample	Unit	Lead (Pb)	Zinc (Zn)	Nickel (Ni)	Copper (Cu)	Iron (Fe)	Arsenic (As)	Mercury (Hg)
1	Ash slurry water from canal near AWRS going to Rihand reservoir	mg/l	ND	ND	ND	ND	1.247	ND	ND
2	Water sample from Rihand reservoir at village Juvari dist. Singrauli	mg/l	ND	ND	ND	ND	1.219	ND	ND
3	Water sample from S-2 to dyke S.S.T.P. NTPC shakrinagar going directly Rihand reservoir	mg/l	ND	ND	ND	ND	1.109	ND	ND
4	Water sample from breached over flow lagoon near AWRS towards north going to Rihand reservoir	mg/l	ND	ND	ND	ND	0.631	ND	ND
GENERAL MARKS:- ND - Not Detected									


Analyst


Lab incharge

Issued to :

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Tehsil: Mada-486886
Distt: Singrauli (MP)



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TEST REPORT

REPORT NUMBER : ABCTL/C/191024/AAQ/0385
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24 HOURS)
DATE OF SAMPLING : 24-10-2019-25-10-2019
REPORT DATE : 05-11-2019

Page 2 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 µm (PM ₁₀), µg/m ³	85.1	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 µm (PM _{2.5}), µg/m ³	50.3	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009

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S. Ravi
S. Ravi
Vice President - Labs

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TEST REPORT

REPORT NUMBER : ABCTL/C/191106/AAQ/0943
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24 HOURS)
DATE OF SAMPLING : 06-11-2019-07-11-2019
REPORT DATE : 28-11-2019

Page 1 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 µm (PM ₁₀), µg/m ³	85.2	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 µm (PM _{2.5}), µg/m ³	44.7	EPA- 40 Appendix L To-Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009

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TEST REPORT

REPORT NUMBER : ABCTL/C/191120/AAQ/0945
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24 HOURS)
DATE OF SAMPLING : 20-11-2019-21-11-2019
REPORT DATE : 28-11-2019

Page 2 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 μm (PM_{10}), $\mu\text{g}/\text{m}^3$	78.6	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 μm ($\text{PM}_{2.5}$), $\mu\text{g}/\text{m}^3$	49.4	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009




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Vice President - Labs

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TEST REPORT

REPORT NUMBER : ABCTL/C/191202/AAQ/1286
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24 HOURS)
DATE OF SAMPLING : 02-12-2019-03-12-2019
REPORT DATE : 06-01-2020

Page 1 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 µm (PM ₁₀), µg/m ³	82.7	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 µm (PM _{2.5}), µg/m ³	47.6	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009

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Vice President - Labs

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TEST REPORT

REPORT NUMBER : ABCTL/C/191210/AAQ/1287
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24HOURS)
DATE OF SAMPLING : 10-12-2019-11-12-2019
REPORT DATE : 06-01-2020

Page 2 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 µm (PM ₁₀), µg/m ³	75.9	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 µm (PM _{2.5}), µg/m ³	42.3	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009

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68/227

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TEST REPORT

REPORT NUMBER : ABCTL/C/191218/AAQ/1288
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24 HOURS)
DATE OF SAMPLING : 18-12-2019-19-12-2019
REPORT DATE : 06-01-2020

Page 2 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 µm (PM ₁₀), µg/m ³	92.7	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 µm (PM _{2.5}), µg/m ³	51.4	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009




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TEST REPORT

REPORT NUMBER : ABCTL/C/200113/AAQ/1963
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24HOURS)
DATE OF SAMPLING : 13-01-2020-14-01-2020
REPORT DATE : 03-02-2020

Page 2 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 µm (PM ₁₀), µg/m ³	79.8	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 µm (PM _{2.5}), µg/m ³	50.5	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.200

.....END OF REPORT.....



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Vice President - Labs

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TEST REPORT

REPORT NUMBER : ABCTL/C/200106/AAQ/1962
SAMPLE DESCRIPTION : AMBIENT AIR QUALITY MONITORING(24HOURS)
DATE OF SAMPLING : 06-01-2020-07-01-2020
REPORT DATE : 03-02-2020

Page 1 of 6

S. No.	Parameters	Downward of New Ash Dyke Cell No 3	Test Method	Limits*
1	Particulate Matter size less than 10 μm (PM_{10}), $\mu\text{g}/\text{m}^3$	81.3	IS 5182 Part-23 : 2006 (Reaff. 2017)	100
2	Particulate Matter size less than 2.5 μm ($\text{PM}_{2.5}$), $\mu\text{g}/\text{m}^3$	49.0	EPA- 40 Appendix L To Part 50	60

*National Ambient Air Quality Standards prescribed by Ministry of Environment, Forest and Climate Change, Government of India, vide Gazette Notification G.S.R. 826(E) dated 18.11.2009



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Vice President - Labs

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REGIONAL OFFICE
M.P. POLLUTION CONTROL BOARD
PLOT NO. 455/456, VIJAY NAGAR, JABALPUR (M.P.)

No. 1387.../ SS/ RO/ PCB/ 2019

Jabalpur, Dated 14/8/19

To,

✓ Lab Incharge,
M.P. Pollution Control Board,
Singrauli (M.P.)

Sub:- Heavy metal reports.

Ref:- Your letter no.489 dated 10/08/2019.

Please find enclosed herewith the heavy metal reports of ash dyke of M/S Essar Power MP Limited, Bandhaura. For information please.

Encl:- As above.

Anil
(Dr. S. K. KHARE)
LAB INCHARGE
M.P.POLLUTION CONTROL BOARD
JABALPUR

for

Handwritten notes:
4/9/19
Anurag
04/09/19
4/9/19
4/9/19



REGIONAL OFFICE
M.P. Pollution Control Board
455,456, Vijay Nagar, Jabalpur (M.P.)

WATER SAMPLE HEAVY METAL ANALYSIS REPORT

Date of Collection :- 09/08/2019	Analysis No: L45/1-9	Bill No.	Dt.
Date of Receipt :- 11/08/2019	Sample From: M/S Essar Power MP Ltd. Bandhaura (MP)		
Date of Analysis :- 13/08/2019	Sample collected by :- Dr Ajay Khare (Scientist) & Dharmendra Arya (Chemist)		
Analysis Done By :- Mrs. Amiya Ekka			

S No	Description of Sample	Unit	Arsenic (As)	Mercury (Hg)	Lead (Pb)	Nickel (Ni)	Zinc (Zn)	Copper (Cu)	Iron (Fe)
1	Karsua lal nala near road bridge	mg / l	ND	ND	ND	ND	ND	ND	ND
2	Mayar river rihand dam after meeting kachan	mg / l	ND	ND	ND	ND	ND	3.930	ND
3	Garra river raila village	mg / l	ND	ND	ND	ND	ND	1.145	ND
4	Openwell karsua lal near Lal Randeem Dubey	mg / l	ND	ND	ND	ND	ND	2.393	0.025
5	Garra river rampa village before meeting mayar river	mg / l	ND	ND	ND	ND	ND	2.810	ND
6	Garra river 100 m before meeting mayar river	mg / l	ND	ND	ND	ND	ND	3.868	ND
7	Mayar river 100 m before meeting garra river	mg / l	ND	ND	ND	ND	ND	0.551	ND
8	Mayar river 100 m after meeting garra river	mg / l	ND	ND	ND	ND	ND	8.187	ND
9	Hand pump water near Garra river	mg / l	ND	ND	ND	ND	ND	4.601	0.231

GENERAL MARKS:- ND – Not Detected

Minimum Detection Limit of Elements in mg/l:- As (0.0001), Hg (0.00047), Pb (0.18), Ni (0.06), Zn (0.006), Cu (0.025), Fe (0.04)

Analyst
Ami
(Amiya Ekka)
(Amiya Ekka)
Junior Scientist
Regional Office
M.P. Pollution Control Board
Jabalpur

Khare
Cabincharge
(Dr. S K Khare)
V. K. BAGHEL
Scientist
M.P. Pollution Control Board
Jabalpur (M.P.)



REGIONAL OFFICE M.P. POLLUTION CONTROL BOARD
Bhakuar Naugadh Disst- Singrauli-486887

Summary of Water Analysis Data of Samples Collected after the Leakage of Ash Dyke of Essar Power Plant

S.No.	Parameter	Collection Point									
		Collection date 09.08.2019				Collection date 10.08.2019					
		1	2	3	4	5	6	7	8	9	Remark
1	Colour	Muddy	Muddy	Muddy	Clear	Muddy	Muddy	Muddy	Muddy	Clear	
2	Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	
3	pH	7.2	7.4	7.8	7.3	7.7	7.5	7.8	7.6	7.3	
4	Conductivity	290	180	280	450	250	290	190	200	430	
5	T.S.	374	305	372	391	347	373	303	304	382	
6	TDS	194	120	188	301	167	195	128	134	288	
7	S.S.	180	185	184	90	180	178	175	170	94	
8	Cloride	20	24	26	30	26	22	25	27	35	

Analyzed by
Phanendra (for Ays)
Chemist

(Signature)
Dr. Ajay Whare
Scientist in Charge
Regional Laboratory
M.P. Pollution Control Board



MADHYA PRADESH POLLUTION CONTROL BOARD

Paryawaran Parisar, E-5, Arera Colony, BHOPAL- 462 016

☎ (0755) 2464428, 2466191 Fax : (0755) 2463742 e-mail: mppcb@rediffmail.com

Whereas; looking to the grave danger to the environment you are required to :-

- Take up the repair works of the broken Ash dyke immediately and in a technically sound manner
- Remove the fly ash lying in the fields and deposited in and along the flowing water bodies, so that it does not reach Rihand reservoir and cause its siltation.
- Depute an organisation of national repute to assess the quantum of environmental damages caused due to the breakage of ash dyke.
- Depute an institute of repute to assess the overall technical quality of construction and the lapses that the industry has made, including engineering and design lapses, which has resulted into the breach of ash dyke and measures to be implemented to avert such incidence in future.
- Deposit with MPPCB a sum of Rs 10 Cr. towards interim environmental compensation, pending the assessment of actual damages.
- Submit a time bound action plan for remediation and restoration of the fields, rivers, nallahs and other affected areas.

In light of the above facts and failure to comply with the above directions within 15 days, in exercise of powers conferred upon under section 33 A of the Water (Prevention & Control of Pollution) Act, 1974 confirmed directions shall be issued to you as follows :-

1. That the industry shall remain closed and not restart the production till further orders.
2. That the concerned authorities shall disconnect water supply and supply of electricity and other facilities available to the industry with immediate effect and;

You are hereby given an opportunity to comply with the points mentioned in para 5 within 15 days from the date of issue of this notice. In



MADHYA PRADESH POLLUTION CONTROL BOARD

Paryawaran Parisar, E-5, Arera Colony, BHOPAL- 462 016

☎ (0755) 2464428, 2466191 Fax : (0755) 2463742 e-mail: it.mppcb@rediffmail.com

case no compliance report is received within stipulated period, the proposed directions shall be confirmed without further communication to the industry.

If the industry fails to comply the directions the interalia action under section 41 of the Water (Prevention & Control of Pollution) Act, 1974 will be initiated against all the persons having control over the unit.

For & On Behalf of M. P. Pollution Control Board

(R. S. KORI)
Member Secretary

Endt. No. 1843 /TS/MPPCB/2019

Date: 14/8/19

Copy to :

1. Collector, District Singrauli
2. Regional Officer, M.P. Pollution Control Board, Singrauli for necessary action.

(R. S. KORI)
Member Secretary



क्षेत्रीय कार्यालय
म.प्र. प्रदूषण नियंत्रण बोर्ड
शकुआर, बौगड, जिला सिंगरौली(म.प्र.)-486887
फोन नं. 9752497772, E-Mail: romppcb.sgri@gmail.com



क्रमांक / 661 क्षेत्र.का./प्रनिबो/2019, सिंगरौली, दिनांक 15/10/2019

प्रति,

सदस्य सचिव,
म.प्र. प्रदूषण नियंत्रण बोर्ड,
भोपाल (म.प्र.)

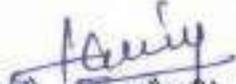
विषय:- जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 की धारा 33 "क" के तहत जारी निर्देश के संबंध में भौतिक सत्यापन रिपोर्ट प्रेषित करने बाबत।

संदर्भ:- मुख्यालय भोपाल का पत्र क्रमांक 2489/तक/सी.ई.-2/प्रनिबो/2019, भोपाल, दिनांक 04.09.2019।

उपरोक्त विषयांतर्गत लेख है कि मे. एस्सार पॉवर एम.पी. लिमिटेड, ग्राम बंधौरा, जिला सिंगरौली (म.प्र.) का राखण बांध क्र. 3, दिनांक 07.08.2019 को breach होने के कारण बोर्ड मुख्यालय भोपाल के पत्र क्र. 1842/TS/MPPCB/2019/भोपाल दिनांक 14.08.2019 के माध्यम से जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 की धारा 33 "क" के तहत निर्देश जारी किये गये थे।

जारी निर्देश के अनुपालन में संयुक्त भौतिक निरीक्षण कार्य दिनांक 27.09.2019 को किया गया था। निरीक्षण प्रतिवेदन संलग्न कर आपकी ओर अवलोकनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित है।

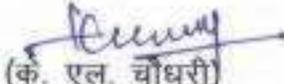
संलग्न:- उपरोक्तानुसार


(कै. एल. चौधरी)
क्षेत्रीय अधिकारी,
सिंगरौली (म.प्र.)

ok

क्रमांक 662 /क्षे.का./प्रनिबो/2019, सिंगरौली, दिनांक 15/10/2019
प्रतिलिपि :-

1. डायरेक्टर (पर्यावरण), यूनिट हेड सिंगरौली क्षेत्र, म.प्र. प्रदूषण नियंत्रण बोर्ड, भोपाल (म.प्र.) की ओर सूचनार्थ।


(कै. एल. चौधरी)
क्षेत्रीय अधिकारी,
सिंगरौली (म.प्र.)

ok

Compliance verification report of M/s Essar Power MP Limited, Singrauli
w.r.to the Notice issued by Madhya Pradesh Pollution Control Board, Bhopal
under Section 33A of Water (Prevention & Control of Pollution) Act 1974
vide Letter no. 1843/TS/MPPCB/2019 on 14.8.2019

An incident of ash dyke breach from cell 3 of M/s Essar Power MP Limited, Singrauli was reported on 7th August 2019; a team of Madhya Pradesh Pollution Control Board, Bhopal & Singrauli along with the Central Pollution Control Board, Regional Directorate, Bhopal carried out detailed investigation & field survey and reported the cause of breach, spread of ash on the agricultural land & water bodies vide their report dated 9th August 2019. Based on the findings & recommendations, a notice was issued by Madhya Pradesh Pollution Control Board, Bhopal under Section 33A of Water (Prevention & Control of Pollution) Act 1974 vide Letter no. 1843/TS/MPPCB/2019 on 14.8.2019. Industry has submitted its compliance report on the directions issued under the above notice on 27.8.2019. To verify the progress made so far by the industry a team of the following officers visited M/s Essar Power Mp Ltd on 27.9.2019 in compliance of the Board's letter no. 2658/TS/MPPCB/2019 dated 27.9.2019.

1. Sh Sunil Kumar Meena, Scientist-D, CPCB, RD, Bhopal
2. Sh K L Choudhary, Regional Officer, MPPCB, Singrauli
3. Ms Divya Singh, Nayab Tehsildar, Mada, Singrauli

The team first had a discussion on the six directions issued by board vide notice dated 14.8.2019 followed by field visit to verify the claims authenticity. Sh M K Sharma, COO of M/s Essar Power MP Ltd was present from the industrial side.

Point-wise compliance verification w.r.to the directions are as below:

Direction No. 1: Take up the repair works of the broken ash dyke immediately and in a technically sound manner.

Compliance status: Industry has claimed that they completed the repair works of the broken ash dyke on 13.8.2019, the claim found correct; as same is evident in photographs taken on 10.8.2019. The JCBs machines were operational to repair the breached out portion. On the day of inspection i.e. 27.9.2019, team observed

that approximately 100mtrs in length, 5mtrs wide, and 8mtrs raised tarpaulin covered repaired wall constructed with the help of sand & ash bags. No spillage of water was observed through this wall. Photographs are enclosed as **Annexure-1a**. To maintain the stability of the wall; a protective wall of Tin sheets also placed before the sand bags. To decant the rainwater from the Cell 3, a floating pump is also placed & water is decanted in Cell 4 which is found in use to discharge the ash slurry.

Industry had communications with IIT Kanpur & IIT Roorkee for further strengthening & stability of the ash dykes on 21.8.2019 Copy of the email communications are enclosed as **Annexure-1b**. Team of IIT Kanpur visited the plant on 14.9.2019. As per the IIT Kanpur's preliminary site survey; it will take about 5-6 months to carry out the study & placing the corrective actions w.r.to the dykes strengthening. Team of IIT Roorkee visited the site on 28.9.2019 for their preliminary survey. As informed, a detailed offer from IIT Kanpur is expected by 20th Oct 19. **However no agency till today 12.10.2019 submitted the detailed offer to carry out the study & corrective actions on strengthening of the dykes.**

Direction No. 2: Remove the fly ash lying in the fields and deposited in and along the flowing water bodies, so that it does not reach Rihand reservoir and cause its siltation.

Compliance status: As reported, about 1 Lac Ton ash slurry spread over an area of 50 Ha in a length of 1.8km, average 260mtrs width & average 1ft depth before meeting Jaria drain. And also traveled 11kms path through Jaria drain/river to Mayar river confluence. On the day of inspection i.e, 27.9.2019, team has not observed any traces of fly ash along the flowing water from Jaria drain to Mayar river confluence. During the field visit of team on 9.8.2019; advisory was issued by RO, MPPCB, Singrauli on 10.8.2019, to immediately carry out the cleaning work of deposited ash in water bodies & put sand bags before the Jaria drain to further stop the flow of ash slurry in water bodies. Industry

deployed local villages for the cleaning work of the same. Photographs taken during visit are enclosed as **Annexure 2a**.

Further, to remove the ash lying on the fields, industry has issued work order EPMPL/SCI/9610009261 dated 26.8.2019 to M/s V2P Engineering Services Private Limited, Noida for cleaning, collection & shifting of spilled ash from ash dyke. Copy of the work order is enclosed as **Annexure 2b**. Till date (27.9.2019), via V2P Engineering services, industry has collected 39739MT soil mixed ash i.e. 39.7% of total quantity of 1 Lac Ton by deploying labors to clean, collect & shift the ash in Cell 3 by sand bags, tractor with trolley & dumpers. Copy of the ash collection details is enclosed as **Annexure 2c**. The work of ash collection was slow-down for 5 days in August 2019 i.e. (19th, 20th, 23rd, 26th, 27th) and 9 days in September 2019 i.e. (2nd, 12th, 17th, 18th, 21st, 23rd, 24th, 25th & 28th) due to heavy rain during these days. As per the field survey, ash has been collected from the length of about 850mtrs. Map provided by industry regarding ash collection work is enclosed as **Annexure-2d**.

Direction No. 3: Depute an organization of national repute to assess the quantum of environmental damages caused due to the breakage of ash dyke.

Compliance status: As informed by representative of the industry Sh Sharma, COO, M/s The Energy and Resources Institute (TERI), New Delhi has shown interest in taking the study of assessing the quantum of environmental damage caused due to the breakage of Ash Dyke & has submitted the proposal on 27.8.19 & the experts from TERI were visiting site on 11th Sept 2019. However, looking into the expertise of National Environmental Engineering Research Institute (NEERI), Mumbai in the field of environmental damage assessment and their previous related studies; industry has started communication with NEERI from 21st Aug 2019. Experts of Institute visited the site on 18th Sept 19. A detailed project proposal was received on 28th Sept 2019 from NEERI. *Finalization of work order towards NEERI*

is under progress. Copy of the Communication with TERI & proposal of NEERI, Nagpur is enclosed as **Annexure 3a & 3b.**

Direction No. 4: Depute an institute of repute to assess the overall technical quality of construction and the lapses that the industry has made, including engineering and design lapses which has resulted into the breach of the Ash Dyke and measures to be implemented to avert such incidence in future.

Compliance status: Industry had communications on 21.8.2019 with IIT Kanpur & IIT Roorkee for the assessment of the quality of ash dykes construction & lapses made in past. Copy of the email communications are enclosed as **Annexure-4a.** Team of IIT Kanpur visited the plant on 14.9.2019. As per the IIT Kanpur's preliminary site survey; it will take about 5-6 months to carry out the study & placing the corrective actions w.r.to the dykes strengthening. Team of IIT Roorkee visited the site on 28.9.2019 for their preliminary survey. As informed, a detailed offer from IIT Kanpur is expected by 20th Oct 19. However no agency till today 12.10.2019 submitted the detailed offer to carry out the study & corrective actions on strengthening of the dykes.

Direction No. 5: Deposit with MPPCB a sum of Rs. 10 Crore towards interim environmental compensation, pending the assessment of actual damages.

Compliance status: Industry has deposited Rs. 50L w.r.to the District Collector, Singrauli on 13.8.2019 as an immediate compensatory amount to compensate farmers & residents for their crop losses, damages to non-movable properties & water bodies losses. As on 24.9.2019, Sub Divisional Office, Maada, Singrauli has issued an amount of Rs. 37,81,950/- (Thirty Seven Lacs Eighty one thousand Nine hundred fifty rupees only) in favor of 247 farmers of Karsualal & Karsuaraja villagers. Copy of the letter no, 760/SDO/Re-1/2019 dated 24.9.2019 is enclosed as **Annexure-5a.**

As informed, industry has submitted bank guarantee of **Rs. 1 Cr** to MPPCB as security deposit towards environmental damage on 21st Aug 2019 against

the sum of Rs. 10 Cr. Industry stated their liquidity constraints, Non Performing Assets classification of the company accounts etc. and seek relief from the total interim environmental damage amount of Rs. 10 Cr.

Regarding this, Competent authority of MPPCB may take the decision.

Direction No. 6: Submit a time bound action plan for remediation and restoration of the fields, rivers, nallahs and other affected areas.

Compliance status: Industry has submitted its time bound action plan for remediation and restoration of the fields, rivers, nallahs and other affected areas on 27.8.2019. However, the previously defined target dates of work completion regarding strengthening of ash dykes, environmental damage assessment were revised considering the delay in final proposals from IIT Kanpur & NEERI Nagpur respectively. Similarly due to the 14 days of heavy rains in August & September 2019 the work related to cleaning, collection & shifting of ash from fields to Cell 3 was also delayed. Till date about 39% ash spread over the fields got collected. IIT Kanpur & NEERI Nagpur will take about 5-6 months time to submit their reports w.r.to strengthening of dykes & corrective measure therefore and environmental damage assessment studies respectively after the allotment of the work order. Time bound action plan submitted by the industry as on 27.9.2019 is enclosed as **Annexure-6**.


(Sunil Kr Meena)
Scientist-D
CPCB, RD, Bhopal


(K L Choudhary)
Regional Officer
MPPCB, Singrauli


(Divya Singh)
Nayab Tehsildar
Mada, Singrauli

Repair work of the broken ash dyke of Essar Power MP Ltd



Photograph clicked on 27.9.2019; breached wall was found repaired in 100 mtrs length with raised height of 8mtrs using sand bags and covered with tarpaulin



Photograph clicked on 27.9.2019; breached wall was found repaired in 100 mtrs length with raised height of 8mtrs using sand bags and covered with tarpaulin & Tin sheet protection

Saran, Jay Shanker- EPMPL-HSE&F- Mahan

From: Sharma, Pankaj- EPMPL- Purchase-Mahan
Sent: Monday, August 26, 2019 6:03 PM
To: AMIT PRASAD
Cc: nrpatra@iitk.ac.in; aprasad@iitk.ac.in; Sharma M K - COO-EPMPL-Waidhan; Sutradhar, S. - EPMPL (Tori); Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; Singh, Lallan - EXT - EPJL - Civil Execution - HAZ; Tomar, Gaurav - EPMPL - Waidhan
Subject: FW: INDIAN INSTITUTE OF TECHNOLOGY
Attachments: Proforma Invoice and letter for site visit.
Importance: High

Dear Sir,

Please find below the UTR details for the payment done against enclosed PI and our communication.
 Please confirm the receipt of same.

Kindly confirm your earliest visit schedule.

Transaction Details	
Account Number	029305004129
Transaction Date	06-26-2019
Transaction Amount	1,35,000.00
Hold Level	Debit
Transaction Description	CMS/009582280224/1800002576

(Note: This is an electronically generated record and does not need any signature.)

Sr. No.	Submission Date	Vendor Code	Name of Vendor	Amount (Doc Curr)	Currency	Hold Amount (TDS)	Amount by Cash / RTGS (Rs.)	Bank Payme vouch No. (K)
1	26.08.2019	168717	INDIAN INSTITUTE OF TECHNOLOGY	147,500	INR	12,500	135,000	

With regards,

Pankaj Sharma

Thanks & Regards,

Pankaj Sharma | Sr. Manager – Purchase | Essar Power M.P. Ltd. |

Essar Power MP Ltd-Mahan Power, Village - Bandhora, Post-Karsualal, Tehsil-Mada, Dist-Singrauli,Waidhan-486886 | Madhya Pradesh | India |

T +91 8959591713 | +91 896 8902954 Ext. : 2117 |

E Pankaj.Sharma2@essarpower.co.in | www.essar.com |



 Please don't print this e-mail unless you really need to.

Disclaimer:

This email is subject to a disclaimer, please click on the following link or cut and paste the link into the address bar of your browser.
< http://www.essar.com/email_disclaimer.html >



Saran, Jay Shanker- EPMPL-HSE&F- Mahan

From: AMIT PRASAD <aprasad@iitk.ac.in>
Sent: Thursday, August 22, 2019 6:28 PM
To: Sharma M K - COO-EPMPL-Waidhan; Sutradhar, S. - EPMPL (Tori); Sharma, Pankaj- EPMPL- Purchase-Mahan; Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; Singh, Lallan - EXT - EPJL - Civil Execution - HAZ
Cc: nrpatra@iitk.ac.in; aprasad@iitk.ac.in
Subject: Proforma Invoice and letter for site visit.
Attachments: Proforma Invoice and letter.pdf; GST_Registration_Certificate_dord_office.pdf; SBI_Bank_Detail_Current.pdf

Dear Sir,
 With reference to your email to Prof. N.R Patra, please find attached proforma invoice regarding site visit "to conduct the study for ash dyke and its strengthening requirements" at Essar Power M.P. Ltd ,600x2 MW coal based power plant at Singrauli District of Madhya Pradesh".
 Please transfer the amount of Rs. 1,47,500/- by tomorrow for the registration at IIT Kanpur. The details of GST and bank details for online transfer has been attached with this mail.

It is proposed to have site visit on August 27th, 2019 . You may book tickets and taxi from IIT Kanpur for our journey on August 26, 2019 (After 5PM).

Thank you

Regards

AMIT PRASAD
 TECHNICAL SUPERINTENDENT
 GEOTECHNICAL ENGINEERING LABORATORY
 CIVIL ENGINEERING
 I.I.T KANPUR
 Phone - +91-9454741722(M),
 0512-259-7724(O)

> ----- Forwarded Message -----

> Subject: Re: FW: Enquiry for Technical Study
 > Date: Thu, 22 Aug 2019 12:28:22 +0530
 > From: Dr. Nihar Ranjan Patra <nrpatra@iitk.ac.in>
 > To: Sharma M K - COO-EPMPL-Waidhan <Manojkumar.Sharma@essarpower.co.in>
 CC: head_ce@iitk.ac.in <head_ce@iitk.ac.in>, Sutradhar, S. - EPMPL (Tori) <Siddhartha.Sutradhar@essarpower.co.in>, Sharma, Pankaj- EPMPL- Purchase-Mahan <Pankaj.Sharma2@essarpower.co.in>, Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP <Surajsingh.Somvanshi@essarpower.co.in>, RajMohan, T - EPOrL - Mum <Rajmohan.T@essarpower.co.in>, Singh, Lallan - EXT - EPJL - Civil Execution - HAZ <Lallan.Singh@acerinox.co.in>, Dr. Nihar Ranjan Patra <nrpatra@iitk.ac.in>, snt@iitk.ac.in
 > Dear Sharma Ji,
 > We will take up this job. Will communicate you soon regarding the site visit.
 > Regards
 > Sincerely
 > Nihar



> ++++++

> Dr. Nihar Ranjan Patra, Professor
 > Office:#316, Faculty Building
 > Department of Civil Engineering
 > IIT Kanpur, India-208016
 > E mail:nrpatra@iitk.ac.in
 > Phone:+91-512-2597623(O),+91-512-2598226(R)
 > Fax:+91-512-2597395
 > ++++++

> On 22-08-2019 12:30, Sharma M K - COO-EPMPL-Waidhan wrote:
 >> *Dear Dr. Nihar Ranjan Patra,*
 >> **
 >> It was nice talking to you over phone. As explained We are operating a
 600x2 MW Coal based power plant at Singrauli District of Madhya Pradesh
 and wanted to conduct the study for our ash dyke and its strengthening
 requirements if any. In this regard the mail was sent yesterday to Dr.
 Sachidananda Tripathi also but since he is out of station the same
 trailing mail I am forwarding to you for necessary take up of job
 accordingly.
 >> Request you to send the offer for the said job so that it may be taken
 up accordingly and the site visit may be arranged at the earliest. Regards,
 >> *MK SHARMA*
 >> Thanks & Regards
 >> M K Sharma | Chief Operating Officer-COO EPMPL | Essar Power M.P.
 Ltd. |
 >> Village Bandhora, Post Karsualal, Tehsil Mada, Dist. -
 >> Singrauli,Waidhan-486886 | Madhya Pradesh | India |
 >> T +91 8959233777 | +91 8966902954 Extn. :- 2005 VoIP 729 2005 | E
 Manojkumar.Sharma@essarpower.co.in | www.essar.com |
 >> P *Please don't print this e-mail unless you really need to.*
 >> -----
 Disclaimer:
 >> This email is subject to a disclaimer, please click on the following
 link or cut and paste the link into the address bar of your browser. <
http://www.essar.com/email_disclaimer.html >
 >> <http://www.essar.com/email_disclaimer.html>
 >> *From:* Sharma M K - COO-EPMPL-Waidhan
 >> *Sent:* 21 August 2019 15:31
 >> *To:* 'head_ce@iitk.ac.in'
 >> *Cc:* Sutradhar, S. - EPMPL (Tori); Sharma, Pankaj- EPMPL-
 >> Purchase-Mahan; Somvanshi, Surajsingh C- EPMPL- Technical Services &
 >> MTP; RajMohan, T - EPOrL - Mum
 >> *Subject:* Enquiry for Technical Study
 >> *Dear Mr Sachidanad Tripathi,*
 >> *HOD Civil , IIT Kanpur.*
 >> **
 >> We are operating a 600x2 MW Coal based power plant at Singrauli
 District of Madhya Pradesh. Both of our units are commissioned however we
 have been operating with very less capacity (approx. 25% only)
 mainly due to less coal availability. A dedicated Ash Bund has been
 constructed on around 87 Ha of acquired land outside plant boundary for
 storage of ash. This Ash is in form of High Concentration Slurry
 Discharge (HCSD) which is having 35% water only.
 >> On 7th Aug 19 some portion of dyke wall of ash bund (which was not in
 use) got partially breached. The rains was also happening that time so due
 to conditions, some ash got spread in surrounding area.
 >> We wanted to conduct a study to assess overall technical quality of
 construction for ash pond by an expert agency along with the reason of dyke
 breach. It should also include the correction and strengthening work
 required for ash pond. Therefore requesting you to provide a



techno-commercial offer for the same.

>> Further please include following with the offer:

>> Methodology of the study

>> Time duration for assessment and submission of reports.

>> Reference list and some samples of similar studies conducted elsewhere.

Please do let us know if anything further required from our end and
arrange for your offer at the earliest.

>> Regards,

>> *MK SHARMA*

--
AMIT PRASAD
TECHNICAL SUPERINTENDENT
GEOTECHNICAL ENGINEERING LABORATORY
CIVIL ENGINEERING
I.I.T KANPUR
Phone - +91-9454741722(M),
0512-259-7724(O)





Indian Institute of Technology Kanpur
Office of Dean Research & Development

Details of ECS/Wire Transfer/Online Fund Transfer **Within India**

A. Details of Account Holder:		
1	Name of the Account holder	Registrar, IIT Kanpur
2	Complete Postal Address	Dean, Research & Development Indian Institute of Technology, Kanpur – 208016 (Uttar Pradesh)
3	Telephone No.	+91-0512-2597385 +91-0512-2597178/7564
4	E-mail Id:	sdr_dord@iitk.ac.in; sachan@iitk.ac.in
B. Bank Account Details :		
1	Bank Name	State Bank of India
2	Branch Name	IIT Kanpur Branch
3	Complete Postal Address	IIT Campus, Kanpur - 208016
4	Telephone No.	+91-0512-2590592
5	Email Id	sbi.01161@sbi.co.in
6	Bank Account Number	10426002126
7	Type of Account	Current Account
8	IFC code (A unique allotted by RBI to all RTGS/NEFT enabled branches in India)	SBIN0001161
9	9 digit MICR code	208002041
	GSTIN	09AAAJI0169A3ZL
	PAN	AAAJI0169A

16/3/16
Joint Registrar (R&D)



Signature & Seal of Bank Manager
State Bank of India, IIT Kanpur



16/3/16



भारतीय स्टेट बैंक
State Bank Of India

(01181) IIT (KANPUR) (PS Code: SBIN001181)
IIT CAMPUS
DIST KANPUR
UTTAR PRADESH 208018

DATE OF DEPOSIT: _____

D	D	M	M	Y	Y	V	V

PAY को या उनके आदेश पर OR ORDER

रुपये RUPEES अदा करें ₹

CANCELLED BEFORE ISSUE

Signature

Account No: MCA 10426002126

NOT ABOVE Rs. 5000000.00

Prefix
1516000002

DY. REGISTRAR (F&A)/REGISTRAR/DY. DIRECTOR INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

MULTI-CITY CHEQUE Payable at Par at All Branches of SBI

Please sign above

⑈ 2786 26 ⑈ 20800 204 ⑈ 000 ⑈ 3 ⑈ 29

Signature



[Handwritten signature]

INCOME TAX PAN SERVICES UNIT

(Managed by National Securities Depository Limited)
3rd Floor, 'A' Wing, Trade World, Kamala Mills Compound, S. B. Marg,
Lower Parel, Mumbai - 400 013.

The Income Tax Department takes pleasure in informing that the PAN allotted to you is:

AAAJI0169A

and the PAN card is enclosed herewith. Further, for filing the return of income, please contact

DCIT /ACIT -I, KANPUR

Quoting of PAN on return of income and challans for payment of taxes is necessary to ensure accurate credit of taxes paid by you and faster processing of return of income. Moreover, quoting PAN on all other communications with the department will help to improve taxpayer services.

You may inform that it is mandatory to quote PAN in several transactions specified under the Income Tax Act, 1961. For further details of such transactions, reference is invited to rule 14B of the Income Tax Rules, 1962 read with section 139A of the Income Tax Act, 1961.

In the unlikely event of more than one PAN being allotted, this fact should be brought to the notice of your Assessing Officer, as possessing or using more than one PAN is against law and may attract penalty of upto Rs. 10,000/-.

Any errors in the data printed on your PAN Card may be brought to the notice of IT PAN Services Unit at the address given above and on the reverse of the PAN Card.

Income Tax Department

REG ID PRC / 00342 / 04022005_01
CNP / 11 / 010970100000705 / 599507
NSDIAN INSTITUTE OF TECHNOLOGY KANPUR
NSDIAN INSTITUTE OF TECHNOLOGY,
BY REGISTRAR OF FINANCE OF, ACCOUNTS,
KALYAN PUR, KANPUR,
UTTAR PRADESH - 208016
TEL NO. - 512 - 2597382



(This being a computer-generated letter, no signatures are required)

भू-प्रीयोगिकी प्रयोगशाला
जानपद अभियान्त्रिकी विभाग
भारतीय प्रीयोगिकी संस्थान
कानपुर-208 016 (उ.प्र.)



Geotechnical Engineering Laboratory
Civil Engineering Department
Indian Institute of Technology
KANPUR-208 016 (U.P.)

दूरभाष / Tel. : +91-512-2597724
फैक्स / Fax : +91-512-2597395
No. CE/GTE/NRP/2019
Dated: 22/08/ 2019

Dr.N.R.Patra
Professor

M/S
Chief Operating Officer-COO EPMPPL
Essar Power M.P. Ltd.
Village Bandhora, Post Karsualal, Tehsil Mada,
Dist. - Singrauli, Waidhan-486886
Madhya Pradesh, India

Kind Attention: Shri. M K Sharma (Chief Operating Officer)

Subject: Consultancy regarding site visit "to conduct the study for ash dyke and its strengthening requirements" at Essar Power M.P. Ltd ,600x2 MW coal based power plant at Singrauli District of Madhya Pradesh".

Ref: Your email dated August 22, 2019, addressed to Prof. N.R Patra, Professor, Civil Engineering, IIT Kanpur and telephonic conversation.

Dear Sir,

With reference to your email cited above and our telephonic conversation, this is to inform you that we would like to take up this project.

For this work, it is proposed to have a site visit at Essar Power M.P. Ltd which is a 600x2 MW coal based power plant at Singrauli District of Madhya Pradesh. The detailed proposal including cost of consultancy work "to conduct the study for ash dyke and its strengthening requirements" will be decided after the site visit by the IITK team. However, you are requested to arrange to and fro travel, boarding, lodging and fooding arrangement for IITK personnel visiting the site.

The proforma bill for the site visit fee amounting to Rs.1, 47, 500/- has been attached for your perusal. The advance payment for the site visit may be drawn by crossed DD/cheque/online transfer in favour of "The Registrar, IIT Kanpur" and mailed directly to the undersigned.

On hearing from you, the proposed date of site visit will be confirmed.

Thanking you,

Sincerely,

(N.R.PATRA)

Encl: as above.

Location : Room 101-105, Western Lab. Extension Building

भू-प्रीयोगिकी प्रयोगशाला
जानपद अभियान्त्रिकी विभाग
भारतीय प्रीयोगिकी संस्थान
कानपुर-208 016 (उ.प्र.)



Geotechnical Engineering Laboratory
Civil Engineering Department
Indian Institute of Technology
KANPUR-208 016 (U.P.)

दूरभाष / Tel. : +91-512-2597724

फैक्स / Fax : +91-512-2597395

PROFORMA INVOICE OF CONSULTANCY & TESTING CHARGES

Dr.N.R Patra
Professor
Dean R& D IITK GSTIN:09AAAJI0169A3ZL

No.:CE/GTE/NRP/2019

Dated: 22/08/2019

Sponsoring Org:
Chief Operating Officer-COO EPMPL
Essar Power M.P. Ltd.
Village Bandhora, Post Karsualal, Tehsil Mada,
Dist. - Singrauli, Waidhan-486886
Madhya Pradesh, India

Kind Attention: Shri. M K Sharma (Chief Operating Officer)

Ref.: Your email dated August 22, 2019, addressed to Prof. N.R Patra, Professor, Civil Engineering, IIT Kanpur and telephonic conversation.

S.No.	Particulars	Amount(INR)
1	Consultancy charges for the site visit "to conduct the study for ash dyke and its strengthening requirements" at Essar Power M.P. Ltd ,600x2 MW coal based power plant at Singrauli District of Madhya Pradesh".	100,000.00
	Subtotal	100,000.00
	Add Institute overheads 25 %	25,000.00
	Total	125,000.00
	CGST@ 9 %	11,250.00
	SGST@ 9 %	11,250.00
	Grand Total	147,500.00

Rs. One lakhs Fourty Seven Thousand Five Hundred Only.

N.R. Patra
(N.R. PATRA)

*Note: To and fro travel, boarding, lodging and fooding arrangement for IITK personnel visiting the site will be arrange by your side.

P.S.: Above amount may please be paid by crossed DD/Cheque/online transfer drawn in favour of "The Registrar, IIT Kanpur" and mailed directly to the undersigned

20

Location : Room 101-105, Western Lab. Extension Building

[Signature]



(Amended)

Government of India
Form GST REG-06
[See Rule 10(1)]

Registration Certificate

Registration Number :09AAAJI0169A3ZL

1.	Legal Name	INDIAN INSTITUTE OF TECHNOLOGY KANPUR			
2.	Trade Name, if any	DEAN OF RESEARCH AND DEVELOPMENT- IIT KANPUR			
3.	Constitution of Business	Statutory Body			
4.	Address of Principal Place of Business	RESEARCH AND DEVELOPMENT OFFICE, ACCOUNTS-2, IIT KANPUR, KANPUR, Kanpur Nagar, Uttar Pradesh, 208016			
5.	Date of Liability	01/07/2017			
6.	Date of Validity	From	03/08/2017	To	NA
7.	Type of Registration	Regular			
8.	Particulars of Approving Authority				
<i>Signature</i>					
Name					
Designation					
Office					
Date of issue of Certificate		03/11/2017			
Note: The registration certificate is required to be prominently displayed at all places of Business/Office(s) in the State.					

This is a system generated digitally signed Registration Certificate issued based on the deemed approval of the application for registration

Power Club- EPMPL- Mahan

Φρονι: Hari Prasad Hotnoor Suryan <suryafce@litr.ac.in>
 Σεντ: 29 August 2019 18:53
 Το: Sharma M K - COO-EPMPL-Waidhan; harisurya1@yahoo.com
 Χχ: Sulradhar, S. - EPMPL (Tori); Sharma, Pankaj- EPMPL- Purchase-Mahan; Somwanshi, Surajsingh
 C- EPMPL- Technical Services & MTP; RajMohan, T - EPOrL - Mum
 Σοβρεχτ: Re: Draft Enquiry for Technical Study
 Αττάχημεντα: SINGRAULI_PROPOSAL.pdf

Sri. M K Sharma

Dt. 29th Aug. 2019

Chief Operating Officer COO EPMPL
 Essar Power M.P. Ltd.
 Village Bandhora, Post Karsualal, Tehsil Mada,
 Dist. – Singrauli, Waidhan-486886
 Madhya Pradesh India

Dear Sir,

Kindly find attached the IIT Roorkee proposal for the site vsiit.

with regards,

K S Hari Prasad

On 08/21/19 03:27 PM, Sharma M K - COO-EPMPL-Waidhan <Manojkumar.Sharma@essarpower.co.in> wrote:

Dear Mr KS Hari Prasad,

IIT Roorkee

This has reference to our telecom on Study to be carried at our site.

We are operating a 600x2 MW Coal based power plant at Singrauli District of Madhya Pradesh. Both of our units are commissioned however we have been operating with very less capacity (approx. 25% only) mainly due to less coal availability. A dedicated Ash Bund has been constructed on around 87 Ha of acquired land outside plant boundary for storage of ash. This Ash is in form of High Concentration Slurry Discharge (HCSD) which is having 35% water only.



On 7th Aug 19 some portion of dyke wall of ash bund (which was not in use) got partially breached. The rains was also happening that time so due to conditions, some ash got spread in surrounding area.

We wanted to conduct a study to assess overall technical quality of construction for ash pond by an expert agency along with the reason of dyke breach. It should also include the correction and strengthening work required for ash pond. Therefore requesting you to provide a techno-commercial offer for the same.

Further please include following with the offer:

1. Methodology of the study
2. Time duration for assessment and submission of reports.
3. Reference list and some samples of similar studies conducted elsewhere.

Please do let us know if anything further required from our end and arrange for your offer at the earliest.

Regards,

MK SHARMA

Thanks & Regards

M K Sharma | Chief Operating Officer-COO EPMP | Essar Power M.P. Ltd. |
Village Bandhora, Post Karsualal, Tehsil Mada, Dist. - Singrauli, Waidhan-486886 | Madhya Pradesh | India |
T +91 8959233777 | +91 8986902954 Extn. :- 2005 VoIP 729 2005 |
E Manojkumar.Sharma@essarpower.co.in | www.essar.com |

 **Please don't print this e-mail unless you really need to.**

Disclaimer:

This email is subject to a disclaimer, please click on the following link or cut and paste the link into the address bar of your browser.
<http://www.essar.com/email_disclaimer.html>



Removal of Ash from fields, water bodies by Essar Power MP Ltd







Photographs clicked on 09.08.2019



Photographs clicked on 27.09.2019



Photographs clicked on 09.08.2019



Photographs clicked on 27.09.2019





Photographs clicked on 09.08.2019



Photographs clicked on 27.09.2019

Essar Power M. P. Limited Essar Power M. P. Limited Village: Bandhora, Karsualal Tehsil - Waidhan-486886 Madhya Pradesh, India. Ph : 7509061540/8986902954 Fax : CIN : U40100DL2005PLC201961		VAT/IST NO : 23637305853 CST NO : 23637305853 ECC NO : NIL S.TAX REG NO : AA@CE6086CST031 RANGE : WAIDHAN PAN NO : AASCE6086C GST NO : 23AABCE6086C1ZZ		 WORK ORDER WO NO: EPMP/SCI/9610009261 DATE : 26.08.2019	
CONTRACTOR'S NAME & ADDRESS CODE 166403 Company V2P ENGINEERING SERVICES PRIVATE LIMITED BC-118/124, FIRST FLOOR, , MATRIX TOWER,B-4 SECTOR 132 NOIDA Noida-201301 Uttar Pradesh,India. Ph. :91-987-1611146 Fax : E-mail :v2pespl@gmail.com GST Number: 09AAFCV5143F1ZA			With reference to your quotation and discussion we had with you, we are pleased to place this Work Order on you. Please quote this Work Order No on all correspondences and invoices. Our General Terms and Conditions of Contract attached forms part of the contract.		
			Contact for this WO : Mr. Pankaj Sharma Tel. : 91-9959591713 Fax. : 91- Email : Pankaj.Sharma2@Essarpower.Co.In		
Your Person Responsible : Mr. Sanjeev Singh Email : v2pespl@gmail.com,			Telephone : 9871611146		
With reference to our letter of intent (LOI) ref: LOI/Aug-19/1004 dated 19.08.2019 & on the basis of or further discussions held, we are pleased to issue this work order for cleaning, collection & shifting of spilled ash from ash dyke at Kherahi.					
SR Ref no. - 9410014521					
SR.NO.	SERV. NO	QTY	UNIT	RATE/UNIT (INR)	AMOUNT (INR)
	SCOPE OF WORK				
00010	SPREAD ASH COLLECTION & SHIFTING	1	Activ.unit	35,000,000.00	35,000,000.00
	HSN/SAC ID:				
			GST		6,300,000.00
			Net value includ	35,000,000.00 /1AU	41,300,000.00
Applicable Taxes & Duties : Integrated GST: 18%					
The item contains the following services:					
10	500000102	1	Perf units	35,000,000.00	35,000,000.00
MISC SERVICES FOR CIVIL DEPT					
Scope of Work:					
Job contract for full cleaning & restoration of spilled ash from Ash dyke. Certification from affected village panchayats before release of final payment. Liaising with local & administrative bodies. Ash cleaning and collection shall be done through tractor trolley. Equipment support shall be provided by Essar. Diesel required for running of equipments shall be provided by Essar Power MP Ltd.					
.....contd. Page 1 of 9					

Sanjeev

[Signature]

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8966902954

Fax :

CIN : U40100DL2005PLC201961

VAT/ST NO : 23637305853

CST NO : 23637305853

ECC NO : NL

S.TAX REG NO : AABCE6086CST001

RANGE : WAIDHAN

PAN NO : AABCE6086C

GST NO: 23AABCE6086C1ZZ

ESSAR
WORK ORDER

WO NO: EPMP/SCI/96100 09261

DATE : 26.08.2019

CONTRACTOR'S NAME : V2P ENGINEERING SERVICES PRIVATE LIMITED

SR.NO.	SERV. NO	QTY	UNIT	RATE/UNIT (INR)	AMOUNT (INR)
SCOPE OF WORK					

Please provide services to: (00010 to 00010)

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan, Singrauli

3100-Central Store

Total net value incl. tax INR

41,300,000.00

Rupee forty-one million three hundred thousand Only

Delivery date: 31.12.2019

Price basis : AOS At our Site(Services only) Kherahi

Payment terms : As Per Details given in PO; Curr. INR

Pricing types

A.O.S - Kherahi,

THE PRICES ARE INCLUSIVE OF ALL TAXES, DUTIES AND LEVIES IF ANY.
ALL STATUTORY LEVIES IN FORCE SHALL BE DEDUCTED FROM YOUR BILLS.

Terms of delivery

Work shall be done as per instructions of the EPMP/ Job execution incharge.

This work order shall be valid till 31st Dec 2019.

Terms of payment

Advance of Rs. 50.00 lacs shall be paid along with order & balance payment shall be done on pro rata basis after 15 day's period subject to verification & certification of the invoices by the Job Execution Incharge.

TDS and other taxes shall be deducted from your bills as per the IT rule of the Govt. of India.

.....contd. Page 2 of 5

*Handwritten signature**Handwritten signature*

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8968902954

Fax :

CIN : U40100DL2005PLC201961

VAT/ST NO : 23637305853

CST NO : 23637305853

ECC NO : NIL

S.TAX REG NO : AABCE6086CST001

RANGE : WAIDHAN

PAN NO : AABCE6086C

GST NO: 23AABCE6086C1Z2

ESSAR
WORK ORDER

WO NO: EPMP/SCU/9610009261

DATE : 26.08.2019

CONTRACTOR'S NAME : V2P ENGINEERING SERVICES PRIVATE LIMITED

Payment shall be done as per actual no. of days of work done at site.

Vendor memo (special)

Police Clearance Certification

"The contractor shall apply for and obtain Police Clearance Certificate(hereinafter referred to PCC) of his employees from the respective police station before being deployed at Essar premises. If for any reason, Contractor does not obtain PCC of his employees before deploying them at the Essar Premises despite his best and genuine efforts, the Contractor undertakes to obtain and submit the PCC of such employees within 15 days from the date of deploying them at Essar Premises. The period of 15 days may be extended for further period of 15 days at the sole discretion of Essar.

The contractor undertakes and confirm that he shall verify the antecedents of employees before deploying them at Essar Premises and shall certify in writing to the effect that the employee was never involved in any criminal activities and no case/ proceedings before police and or in any court is pending against him.

Failure to furnish the PCC and certificate of antecedents of his employees shall be treated as material breach of agreement by the vendor which shall empower the Essar to terminate the contract and also empower the Essar to forfeit vendor's security deposit. If the certificate issued by vendor is found to be forged, Vendor shall be held liable criminally.

The contractor shall at all times during the agreement and thereafter, indemnify and keep indemnified the Essar, its officers, employees and representatives, from all or any claims, losses, demands, damages, etc., which the Essar, its officers, employees and representatives may or are likely to suffer by reason of acts, defaults, deeds, things, omissions and commissions committed by the vendor and or its employees, while performing the conditions of this agreement".

VAT/CST/Service Tax

IGST @ 18% is included in the final order value.

You shall ensure deposition of the same to the taxation dept.

Insurance

Composite insurance shall be in scope of vendor.

Inspection

Thorough inspection of the work will be carried out by the Job execution Incharge.

Vendor must comply with the health & safety norms as laid down by the EPMP HSE team while working. Violation of the same shall attract huge penalties on the part of the vendor.

PO Terms & Conditions

----contd. Page 3 of 3

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8966902954

Fax :

CIN : U40100DL2005PLC201961

VAT/LST NO : 23637305853

CST NO : 23637305853

ECC NO : NIL

S.TAX REG NO : AABCE6086C5T001

RANGE : WAIDHAN

PAN NO : AABCE6086C

GST NO: 23AABCE6086C1Z2

ESSAR
WORK ORDER

WO NO: EPMP/SCI/9610009261

DATE : 25.08.2019

CONTRACTOR'S NAME : V2P ENGINEERING SERVICES PRIVATE LI MITED

The invoice should also state Buyer/ Customer as following address:BUYER/CUSTOMER

Essar Power M.P.Ltd.

Village: Bandhora, Post Karsualal,

Tehsil Mada,

Dist- Singrauli, M.P.

Pin 486 886

All correspondence including Commercial Invoices, Despatch Documents, etc.to be couriered to following address.

Essar Power M.P.Ltd,

Village: Bandhora, Post Karsualal,

Tehsil Mada,

Dist- Singrauli, M.P.

Pin 486 886

Contact Person From Essar :

Mr. Lallan Singh (Incharge - Civil Dept.)

Mob. No.:- 9304212566

E & OE.

For Essar Power MP Limited


Authorized Signatory.

.....contd. Page 4 of 8



Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualai

Tehsil - Waidhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8966902954

Fax :

CIN : U40100DL2005PLC201961

VAT/LST NO : 23637305853

CST NO : 23837305853

ECC NO : NIL

S. TAX REG NO : AABCE6088CST001

RANGE : WAIDHAN

PAN NO : AABCE6085C

GST NO: 23AABCE6085C12Z

ESSAR
WORK ORDER

WO NO: EPMP/SCI/9610009261

DATE : 26.08.2019

GENERAL TERMS & CONDITION FOR WORK ORDER

1. Agreement:

V2P ENGINEERING SERVICES PRIVATE LI acceptance of the work order in writing/e-mail shall constitute contract between Vendor and Essar Power MP Limited. If there is no acceptance/ comments (if any) received from Vendor within 7 (seven) days from the date of this order, it shall be considered that the scope/ various terms and conditions indicated in the order is acceptable to the Vendor.

2. Measurement of Work:

Work shall be supervised, inspected and measured as directed by Engineer-in-charge (hereafter referred as EIC) to be appointed by the Company and entered in the measurement book for the Scope of Work with signature of either Vendor & EIC or their representative as token of acceptance. Payment shall be made as per actual quantity executed. For all labour intensive jobs, it is mandatory to maintain and submit daily report of workmen attendance duly verified by EIC.

3. Taxes and Duties:

Unless otherwise specified, all taxes, duties, levies, charges etc. that may be applicable to this contract is included in the contract price. Service / Sales Tax, as applicable, must be indicated in the bills separately. This will be paid only if supported by documentary proof of payment. The bills shall be prepared & raised along with following information:

- Tax Credit documents should be submitted in original. The document should be serially numbered either with numbering machine, or pre-printed stationery or computer printed with date.
- The document should contain the name, address, PAN and service tax registration number (if applicable) of the service provider.
- The document should contain description of service provided, value of taxable service provided, the amount of service tax payable and education cess thereon.
- As regards to Indian Income Tax, Surcharge on Income Tax, Withholding Tax or any Corporate Tax, the Company shall not bear any tax liabilities whatsoever. The Vendor shall be liable and responsible for payment of all such taxes, if attracted under the provisions of law. The Company shall, however, deduct applicable taxes at source like TDS under Income Tax Rules and Work Contract Tax under State VAT Act as per applicable law from time to time from bills / payments to be made from the Vendor and will issue the TDS Certificate for the same to the Vendor.

4. Submission and Payment of Bill:

- The invoice/ RA bills for the Scope of Work should be submitted within 2 weeks of completion of job to EIC in triplicate for verification on monthly basis or as specified complete in all respect and acceptable.
- The invoice must be supplemented with the work measurement sheet and workmen attendance sheet duly attested by EIC.
- In case, the job is associated with the supply of materials, the invoice must be supplemented with the material challan duly stamped with Gate Entry number, Packing list, Tax invoice, Quality assurance & test certificates.
- The workmen payment sheet and PF challan, if applicable, must be submitted with invoice after verification and attestation by HR & Administration in-charge. If applicable and specified explicitly in the work order, PF and Insurance shall be reimbursed at actual on producing documentary evidence.
- The Company will release the payment after all deductions as per specified conditions and statutory rules within 30 days after receipt of the invoice.

5. Statutory and Labour Regulations:

- Vendor and his workmen shall abide by all statutory rules and regulations, including but not limited to Contract Labour Act, Workmen's Compensation Act, Minimum Wages Act, Employee Insurance Act, Group Personal Accident Insurance, Provident Fund Act, and any other laws, rules and regulations etc. that may be applicable to this type of work, including any licenses like labour license etc. that may be required to be obtained by the Vendors.
- Vendor shall comply & maintain all statutory records, registers and displays as required under various labour laws. Any deviation or fine levied by the Govt. authorities while their inspection will be recovered with penalty from Vendor's running bills or security deposit.

6. Safety, Health & Environment:

- Vendor and his workmen shall abide by all Safety, Health and Environment rules and regulations of the Company. Any violation of the safety rule shall be viewed seriously and Vendor shall be penalized as per the Company's rule.
- Vendor's workmen shall have to obtain Gate pass before commencement of work, which shall be issued only after getting safety training & guidelines from Company's HSE in-charge and ensuring medical fitness from Company's medical officer.
- All safety equipment as per statutory requirements like helmets, safety shoes, safety belts and any other specific safety equipment required for the work will have to be provided by the Vendor to his manpower. All use of PPE at site as are used as per below standards:

- Safety helmet : Approved by BIS-IS:2925:1984
- Safety shoe : Approved by BIS-IS: 15298(Part2):2002
- Safety belt : Approved by BIS-IS:3521:1999
- Safety earmuff : Approved BY BIS-IS:6229:1980
- Safety earplug : Approved by BIS-IS: IS:6229:1980

.....contd. Page 3 of 9

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8966902954

Fax :

CIN : U40100DL2005PLC201961

VAT/LST NO : 23637305853

CST NO : 23637305853

ECC NO : NL

S.TAX REG NO : AABCE6086CST001

RANGE : WAIDHAN

PAN NO : AABCE6086C

GST NO: 23AABCE6086C1Z2

ESSAR
WORK ORDER

WO NO: EPMP/SCI/9610009261

DATE : 26.08.2019

d) Vendor shall have to ensure minimization of pollution at source through environment friendly processes, techniques.

e) Before starting the work, Vendor shall submit detailed work program, milestone of different activities, safety & quality plan and any other relevant documents required for the work to the EIC for his approval, after which work shall be started as per the approved program.

7. Discipline:

The Vendor and his workmen shall have to follow Company's standard Code of Conduct and the law of the land where the services are required to be performed. It shall be Vendor's responsibility to maintain and keep the deployed manpower in specified area only. If the Vendor or his workmen is found violating the same or participating in unlawful activities or influencing Company staff by any offerings or other inducements, the contract shall stand terminated with immediate effect.

8. Offloading & Subletting of Job:

In case, it is observed during the tenure of contract that the Vendor is not capable or is not in a position to complete the job, the Company reserves the right to offload the same from alternate source at the cost and risk of the Vendor. Sub-letting of job is not allowed unless otherwise approved by the Company.

9. Indemnity:

Vendor shall keep the Company indemnified from all liabilities resulting out of this contract and act of Vendor workman, including but not limited to taxes & duties, damages, penalties, fines, punitive measures, accidental damage charges, lawyer fees etc. of whatever nature due to non-compliance by Vendor in his scope of the applicable statutory laws, rules, notifications etc.

10. Force Majeure:

In case force majeure is established and one party informs the other promptly of such occurrences, no increase in price and / or any claim shall be made by the Vendor. In case of very prolonged force majeure condition the parties shall mutually discuss and agree to the future course of action.

11. Deduction and penalties:

- The Company shall be entitled to recover from Vendor's bills all cost damages, expenses which may have to incur or become liable to incur as a result of Vendor's negligence or any other action that may originate such cost, charges, expenses etc.
- In case Vendor's bill amount is not sufficient to cover such recovery amount the balance shall be deducted from any sum which may become due to Vendor at any time thereafter under this or any other contract Vendor may have with us. Should this sum also not be sufficient to cover the full amount recoverable, then we reserve our right to recover the same as remedies available under the law.
- If there is any delay in completion of work on the part of the Vendor and there is any statutory increase in duties / taxes / levies during the period of delay, in such cases the differential shall be on account of the Vendor. In case of failure to execute the work within due date, the work order awarded may be automatically cancelled without any reference to Vendor and the security deposit, if any, shall be forfeited.
- Any intentional delay or delay due to improper mobilization of man and material for executing the work by Vendor or any unprofessional attitude of Vendor causing delay, penalty @ 1% of the contract value for each week of delay shall be imposed subject to a maximum of 10% of the contract value.
- In case of delay in completion of work due to reasons attributable to Vendor, Vendor is liable to pay the liquidated damages @ 1% of the total order value above for each completed week of delay or part thereof subjected to a maximum of 10% the total order value.
- In case of non-performance / continuous poor performances, the contract shall be terminated and the work shall be done by alternate source at Vendor's cost and risk. If the price of contract for the balance work shall be higher, the additional amount shall be recovered from Vendor's security deposit, if any, or any dues of this contract or any other contract that the Vendor may have taken in the Company.
- The Vendor shall be solely responsible for any loss or damage to the Company property during the currency of this package due to negligence, fraud etc. on the part of their personal and will be liable to make the damages in good condition. In case of any Company material is lost or damaged during execution of work due to Vendor negligence or wrong workmanship, the cost of the same as per prevailing market rate plus departmental expenses shall be recovered from Vendor bills.
- Repeated occurrences of penalties may lead to stern actions including termination of contract and getting the job done from alternate source at the risk and cost of Vendor.
- For any accident due to the negligence of the Vendor/ Vendor's deployed agencies/workers or sub-Vendors, following penalties shall be levied.
 - For fatal accident - Rs. 5,00,000/-
 - For reportable accident (Permanent disability) - Rs. 1,00,000/-

12. Assignment:

This contract shall be binding on and ensure to the benefit of the Company and Vendor and to their respective heirs, executors, administrators, successors and assigns, but neither the Company nor the Vendor shall assign this PO or any portion thereof, or any benefit or money accruing to it there under, without the written consent of the other party. However, it is clarified that the Company shall assign this P.O. to any of its Group Company(ies) without written consent of the Vendor.

.....contd. Page 5 of 9

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8966902954

Fax :

CIN : U40100DL2005PLC201961

VAT/ST NO : 23637305853

CST NO : 23637305853

ECC NO : NIL

S.TAX REG NO : AABCE6086CST001

RANGE : WAIDHAN

PAN NO : AABCE6086C

GST NO: 23AADCE6086C122

ESSAR⁺

WORK ORDER

WO NO: EPMP/SCU/9610009261

DATE : 26.08.2019

13. Termination of the contract:

For reasons not covered elsewhere in this contract document, if the Contract is to be terminated, 7 (seven) days notice shall be given by the Company. In such an eventuality, the security deposit, if any, and outstanding payments, if any, may also be forfeited at sole discretion of the Company. However, if the Vendor desires to quit the Contract, Vendor shall give at least 1 (one) month's notice.

14. Dispute Settlement:

i. Arbitration, if arises, shall be resolved in accordance to the Indian Arbitration & Conciliation Act, 1996 as amended from time to time.
ii. This agreement being executed at Mahan & the parties agreed that any dispute or differences arising out of this agreement would be subject to the jurisdiction of only Mahan court.

STATUTORY COMPLIANCE ANNEXURE

The statutory and legal conditions shall be applicable to all labour intensive jobs and the Vendor shall have to strictly comply with all the clauses mentioned hereby:

1. Labour Act:

Vendor shall abide by all provision of contract labour (R&A) act 1970 and other applicable labour laws and rules made there under from time to time.

2. Labour License:

Before commencement of work, Vendor shall submit labour license (if applicable) from competent authority to the Company's HR & Administration officer through EIC.

3. Gate Pass:

Before commencement of work, Vendor has to arrange gate pass for his workmen from Company's HR & Administration officer as per ESSAR's standard norms.

4. PF registration:

Before commencement of work, Vendor shall submit the Provident Fund Registration No. and ensure to recover provident fund amount from wages of all workmen and deposit to the Provident fund authorities and submit a copy of the same by 20th of every month to the Company's HR & Administration officer through EIC. In case Vendor fails to produce documentary evidence of PF recovery and deposition, the Company will arrange to deposit the same to the Provident fund authorities and the amount along with overheads @30% will be recovered from the Vendor's bill.

5. Workmen Insurance:

Before commencement of work, Vendor shall obtain insurance policies under Group Personal Accident Policy & Workmen's Compensation Policy covering employment accidental benefit upto Rs. 4.00 lacs through each policy (total Rs. 8.00 lacs) and furnish the copy of it to the Company's HR & Administration officer through EIC. In case of non-submission of Policies before start of work, 5 % (Five percent) of the Monthly Bill values shall be retained by ESSAR until the Vendor presents the copy of Policy document.

6. Wage Payment:

Payment to Vendor's workmen shall be disbursed on or before seventh day of the wage period in presence of the Company's HR & Administration officer & EIC or their duly authorized representative who shall certify on the payment sheet/register for fulfillment of provision of law. In case of failure to make payment to the workmen within 07(seven) days after wage period, the Company will arrange for labour payment and the amount along with overheads @30% will be recovered from the Vendor's bill.

7. Bonus & Retrenchment:

Vendor shall have to pay its workmen the bonus as per applicable act. Moreover, retrenchment benefits to workmen under Inter State Migrant act if being retrenched shall be paid by Vendor.

8. Records, Register and Display Notices:

Vendor must maintain statutory registers and records as applicable under various labor laws. Vendor must display notices in front of his office in Hindi & English as required under various labour laws.

9. Statutory Reimbursement:

Any payment against statutory obligations, if applicable and specified explicitly under ESSAR's scope, such as PF, insurance etc. shall be reimbursed at actual by the Company on producing documentary evidence by the Vendor.

10. Labour Strike:

In case of labour strikes, Vendor shall arrange fresh workmen and perform the contract without any discontinuation. If there is discontinuation of work, the contract shall be terminated immediately and Vendor will be debarred to participate in any future bid in the Company for next 05(five) years.

11. Code of Conduct:

The Vendor shall have to follow the Company's standard Code of Conduct. If the Vendor is found violating the same or influencing the Company staff by any offerings or other inducements, the contract shall stand terminated with immediate effect.

12. Work Permit:

Work on any equipment or in any area should be started only after ensuring valid permit. Before starting the work, Vendor shall submit detailed work program, milestone of different activities, safety & quality plan and any other relevant documents required for the work to the EIC for his approval, after which work shall be started as per the approved program.

13. Tools & Tackles:

Vendor will have to produce fitness test certificate of all lifting tools and tackles being used by him from any outside competent person.

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waldhan-486886

Madhya Pradesh, India.

Ph : 7509061540/8968902954

Fax :

CIN : U40100DL2005PLC201961

VAT/LST NO : 23637305853

CST NO : 23637305853

ECC NO : NIL

S.TAX REG NO : AABCE6086CST001

RANGE : WADHAN

PAN NO : AABCE6086C

GST NO: 23AABCE6086C1Z2

ESSAR
WORK ORDER

WO NO: EPMP/SCI/9610009261

DATE : 26.08.2019

14. Vehicle:

All the vehicles (except use by specific person) to be deployed by contractor shall be fit for use in all respect. The Vehicle must be commercially registered with the local transport authority and must carry all statutory documents all the time. Vehicle must have comprehensive insurance policy and the driver must have valid driving license.

15. Lighting:

Lighting at work site will be Vendor's responsibility for which power supply of 220V will be provided by the Company free of cost. Only 24V supply will be permitted for lighting in confined spaces. Vendor has to ensure availability of 220V/24V transformers and bulbs for the purpose.

16. Health Safety & Environment Policy:

Vendor and his workmen shall abide by Health Safety & Environment rules and regulations of the Company. Any violation of these rules shall be viewed seriously and Vendor shall be penalized as per Company's rule.

17. Labour Health & Hygiene:

Vendor shall have to ensure periodical cleaning and disposal of waste from workers residential colonies. Vendor must ensure the hygiene, potable drinking water and regular house keeping in his workers colony. Non compliance of the same would be viewed seriously by the company and suitable action would be initiated to ensure proper living conditions. During summer this area becomes very hot and prone to the cases of dehydration. Vendor must ensure the provision of ORS drink to all the workers during summer.

.....contd. Page 8 of 9

Essar Power M. P. Limited

Essar Power M. P. Limited

Village: Bandhora, Karsualal

Tehsil - Waidhan-485886

Madhya Pradesh, India.

Ph : 7509061540/8966902954

Fax :

CIN : U40100DL2005PLC201981

VAT/ST NO : 23037305853

CST NO : 23537305853

ECC NO - NE

S.TAX REG NO : AA8CE6086CST001

RANGE : WAIDHAN

PAN NO : AA8CE6086C

GST NO: 23AA8CE6086C1ZZ

ESSAR
WORK ORDER

WO NO: EPMP/SCI/9610009261

DATE : 26.08.2019

ANNEXURE : CONTRACTUAL CLAUSES - LOW RISK THIRD PARTIES:

1. V2P ENGINEERING SERVICES PRIVATE LI is and shall remain in compliance with all relevant laws applicable to the services [he/she/it] shall perform under this Agreement including all relevant anti-corruption laws.

2. V2P ENGINEERING SERVICES PRIVATE LI shall not, and nor shall any of its officers, employees, shareholders, representatives or agents ("Associated Parties") directly or indirectly, either in private business dealings or in dealings with the public sector, offer, give or agree to offer or give (either itself or in agreement with others) any payment, gift or other advantage (whether or not by using any payments under the Agreement) with respect to any matters which are the subject of this Agreement which (i) would violate any anti-corruption laws or regulations applicable to V2P ENGINEERING SERVICES PRIVATE LI or [Company], (ii) is intended to or does influence any person to act or reward any person for acting in breach of an expectation of good faith, impartiality or trust, or which it would otherwise be improper for the recipient to accept, (iii) is made to or for a Public Official with the intention of influencing such a person and obtaining or retaining an advantage in the conduct of business, or (iv) which a reasonable person would otherwise consider to be unethical, illegal or improper.

3. Without prejudice to clause [Termination], in the event company Reasonably suspects there to have been a breach of clauses [Anti Corruption clauses] of this agreement, [company may terminate the Agreement immediately upon giving notice in writing to the V2P ENGINEERING SERVICES PRIVATE LI



S.No.	Particulars	Quantity (MT)
1	Total Ash spillage from Cell-3	70000
2	Anticipated quantity of soil mixed with ash	30000
3	Total quantity to be collected	100000

4	Ash collection details	Quantity	Quantity per trip (MT)	Total Quantity (MT)
a	Ash collection from manual filled bags	23325	0.02	467
b	Ash collection from Tractors with trolley	12241	2	24482
c	Ash collection from Dumpers	2465	6	14790
	<i>Total Ash Collection (MT)</i>			39739
5	% Completion			39.7%

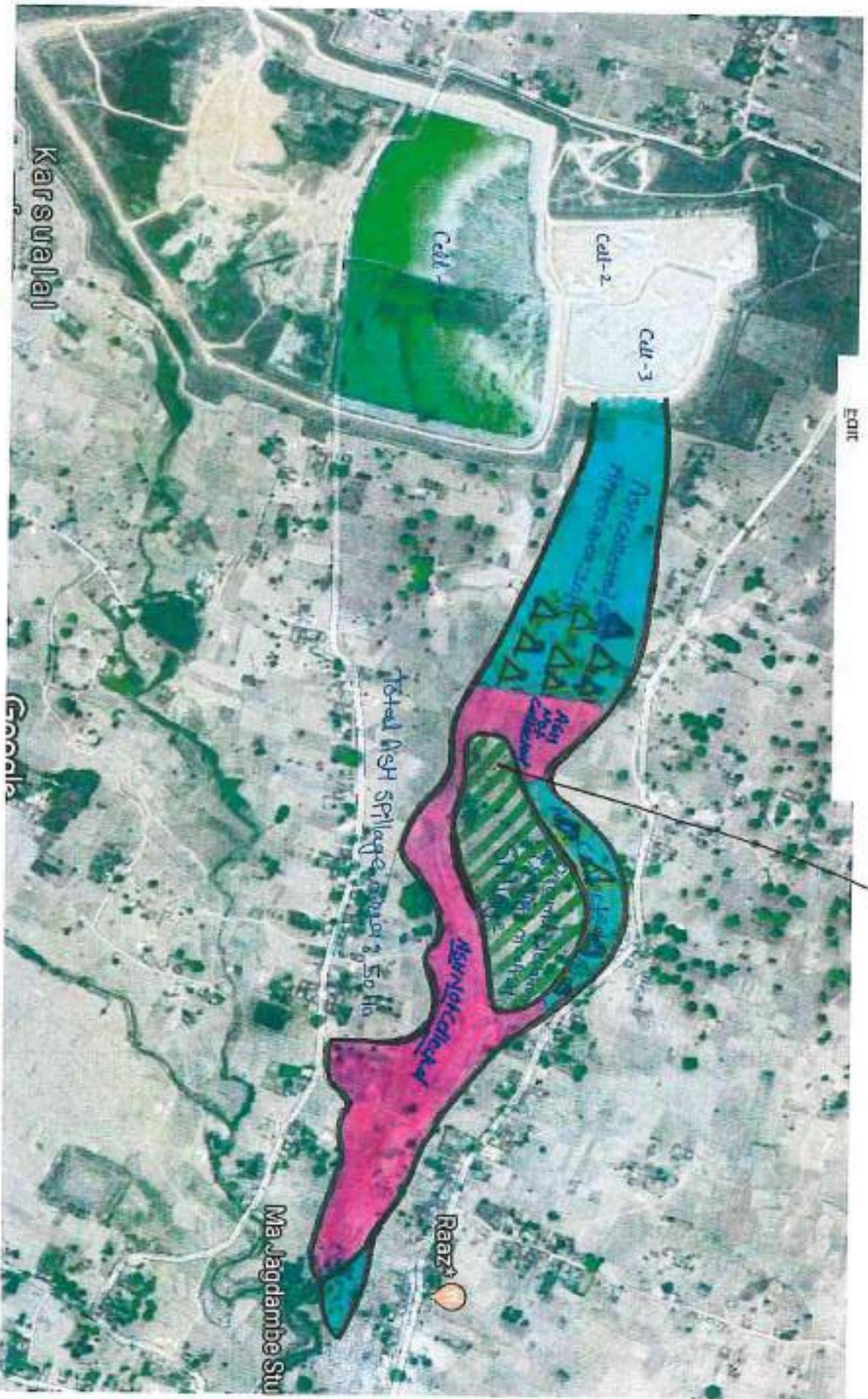
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Rainfall data August & Sept 2019

RAINFALL DATA FOR MONTH OF AUG-19																			
Date & Time	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	Total Rainfall (mm)	Avg Rainfall (mm)
00:00	0	0	0	0	9.9	0	0	0	0	0	0	0.2	14.4	0	0	0	0	24.5	1.4
01:00	0	0	0	0	7.8	0	0	0	0	0	0	0.2	0	0	0	0	0	8	0.5
02:00	0	0	0	0	0.7	0	0.5	0	0	0.2	0	0.7	0	0	0	0	0	2.1	0.1
03:00	0	0	0	0	0.7	0.2	0	0	0	0.2	0	0.5	0	0	0	0	0	1.6	0.1
04:00	0	0	0	0	1.7	0	0	0	0	0	0	0	0	0	0	0	0	1.7	0.1
05:00	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	1	0.1
06:00	0	0	0	0	0.2	4	0	0	0	0	0	0	0	0	0	0	0	4.2	0.2
07:00	0	0	0.2	0	1.5	4.5	0	0	0	0.2	0	0	0	0	0	0	0	6.4	0.4
08:00	0	0	0	0	1.2	0.5	0	0	0	0	0	0	0	0	0	0	0	1.7	0.1
09:00	0	0	0	0	2.7	0	0	0	0	0	0	0	0	0	0	0	0	2.7	0.2
10:00	0	0	0	0	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0.4	0.0
11:00	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0.2	0.0
12:00	0	0	0	0	1.2	2	0	0	0	0	0	0	0	0	0	0	0	3.2	0.2
13:00	0	0	0	0.7	5.5	13.9	0	0	2.7	0	0	2	0.2	0	0	0	0	25	1.5
14:00	0	0	0	0	0.7	6.8	0	0	5.8	0	0	0	0	0	0	0	0	14.3	0.8
15:00	0	0	0	0	0	0	0.7	0	3.3	0	0	0	0	0	0	0	0	4	0.2
16:00	0	0	0	0	0	0	0	0.2	0	0	0	0	0	0	0	0	0	0.2	0.0
17:00	0	0	0	0	0	0	0	0.2	0.2	0	0	0	0	0	0	0	0	0.4	0.0
18:00	0	0	0	0.2	15.2	0	0	0	0	0	0	0	0	0	0	0	0	15.4	0.9
19:00	0	0	0	0.7	1.5	0	0	0.2	0	0	0	0	2.7	0	0	0	0	5.1	0.3
20:00	0	0	0	0.7	0.2	0	0	0.5	0	0	0	0	12.4	0	0	0	0	13.8	0.8
21:00	0	0.7	0	0	0	0	0	0.5	0	0	0	0	0.7	0	0	0	0	1.9	0.1
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
23:00	0	0	0	0	0	0	0	0	0	0	0.5	8.8	0	0	0	0	0	9.3	0.5
Total rainfall (mm)	0	0.7	0.2	2.3	51.4	32.8	1.2	1.6	13	0.6	0.5	12.4	30.4	0	0	0	0	147.1	8.7

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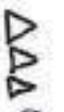
Page 1 of 2



Ash Collected



Ash not Collected



Collected ash Heap

[Handwritten signature]

Power Club- EPMPL- Mahan

Φρονι: h.bherwani@neeri.res.in on behalf of Hemant Bherwani <h.bherwani@neeri.res.in>
 Σεντ: 28 September 2019 11:02
 Το: Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; Sharma M K - COO-EPMPL-
 Waidhan
 Χχ: RajMohan, T - EPOrL - Mum; Saran, Jay Shanker- EPMPL-HSE&F- Mahan
 Συβρεχτ: Re: FW: RFQ_Environmental Study
 Αποχρηματο: Proposal for Environmental Damage Cost Assessment.pdf

Dear Mr. Sharma,

Please find attached our proposal for your kind perusal. Apologies for the delay, was travelling heavily during past few days.

Please feel free to get back to me in case you have any queries.

Kind regards
Hemant

On 09/24/19 10:13 AM, "Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP"
<Surajsingh.Somvanshi@essarpower.co.in> wrote:

Dear Mr Hemant

Thanks for considering our request and taking out time from your pre occupied schedule to visit our site on 18th Sep.

We had nice and informative interaction during the visit and few soil and ground water samples were taken by you from the vicinity for testing, you may share preliminary assessment of the same.

Further please share the way forward including visit schedule and tentative timelines for final reports on the scope discussed.

Thanks and Regards

Suraj Singh

Thanks & Regards

Surajsingh Somvanshi | Dy. General Manager | Essar Power M.P. Ltd. |
 Essar Power MP Ltd-Mahan Power, Village - Bandhora, Post-Karsualal, Tehsil-Mada, Dist-Singrauli,Waidhan-486886 | Madhya
 Pradesh | India |
 T +91 9626905318 | +7 29 2211 | +91 89889 02954 Ext. : 2393 |
 E Surajsingh.Somvanshi@essarpower.co.in | www.essar.com |

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From: Sharma M K - COO-EPMPL-Waidhan

Sent: 16 September 2019 16:47

To: Singh, Rajesh - EPMPL - HR, IR & Admin (MUM)

Cc: Sutradhar, S. - EPMPL (Tori); Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; Shetty, Naveen - EPHL - MUM; RajMohan, T - EPOrL - Mum

Subject: FW: RFQ_Environmental Study

Dear Rajesh,

Please arrange for the tickets and other related things as per trailing mail.

Regards,

MK SHARMA

Thanks & Regards

M K Sharma | Chief Operating Officer-COO EPMPL | Essar Power M.P. Ltd. |

Village Bandhora, Post Karsualal, Tehsil Mada, Dist. - Singrauli, Waidhan-486886 | Madhya Pradesh | India |

T +91 8959233777 | +91 8966902954 Extn. :- 2005 VoIP 729 2005 |

E Manojkumar.Sharma@essarpower.co.in | www.essar.com |

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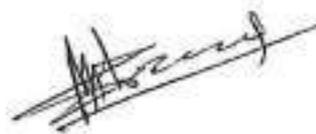
From: h.bherwani@neeri.res.in [<mailto:h.bherwani@neeri.res.in>]

Sent: 16 September 2019 16:38

To: Sharma M K - COO-EPMPL-Waidhan

Cc: director@neeri.res.in; Sharma, Pankaj- EPMPL- Purchase-Mahan; Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; RajMohan, T - EPOrL - Mum; Sutradhar, S. - EPMPL (Tori); Shetty, Naveen - EPHL - MUM; lakshmikanthar@neeri.res.in

Subject: RE: RFQ_Environmental Study



Dear Mr. Sharma,

Yes, the dates are confirmed. Please see that the flights are as suggested in my email because they are convenient to us and give us sufficient time at site.

Kind regards

Hemant

From: Sharma M K - COO-EPMPL-Waidhan <Manojkumar.Sharma@essarpower.co.in>

Sent: 16 September 2019 16:05

To: h.bherwani@neeri.res.in

Cc: director@neeri.res.in; Sharma, Pankaj- EPMPL- Purchase-Mahan <Pankaj.Sharma2@essarpower.co.in>;

Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP <Surajsingh.Somvanshi@essarpower.co.in>;

RajMohan, T - EPOrL - Mum <Rajmohan.T@essarpower.co.in>; Sutradhar, S. - EPMPL (Tori)

<Siddhartha.Sutradhar@essarpower.co.in>; Shetty, Naveen - EPHL - MUM

<Naveen.Shetty1@essarpower.co.in>

Subject: RE: RFQ_Environmental Study

Dear Mr. Hemant Bherwani,

We are ok with the dates suggested by you.

We will be arranging for tickets as mentioned below after your confirmation please.

Regards,

MK SHARMA

Thanks & Regards

M K Sharma | Chief Operating Officer-COO EPMPL | Essar Power M.P. Ltd. |

Village Bandhora, Post Karsualal, Tehsil Mada, Dist. - Singrauli, Waidhan-486888 | Madhya Pradesh | India |

T +91 8959233777 | +91 8966902954 Extn. :- 2005 VoIP 729 2005 |

E Manojkumar.Sharma@essarpower.co.in | www.essar.com |



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< http://www.essar.com/email_disclaimer.html >

From: h.bherwani@neeri.res.in [<mailto:h.bherwani@neeri.res.in>]

Sent: 16 September 2019 12:55

To: Sharma M K - COO-EPMPL-Waidhan

Cc: director@neeri.res.in; 'Lakshmikanthan P'; Sharma, Pankaj- EPMPL- Purchase-Mahan

Subject: RE: RFQ_Environmental Study

Dear Mr. M K Sharma,

As discussed, me and my colleague Dr. Lakshmikanthan, would like to visit your facility and contaminated site before finalising the proposal. Following dates and flights are suggested for your kind perusal and necessary action.

1. Nagpur to Varanasi dated 18th September 2019

2. Varanasi to Nagpur dated 20th September 2019

Request your to kindly arrange the flight tickets, travel from Varanasi to your plant along with return and accommodation for both of us.

Please feel free to get back to us for any queries.

Kind regards



Hemant

Hemant Bherwani / हेमंतभेरवानी,
Scientist / वैज्ञानिक,

Director's Research Cell / निदेशक अनुसंधान केंद्र

Centre of Strategic Urban Management / सामरिक शहरी प्रबंधन केंद्र,

CSIR-National Environmental Engineering Research Institute,

सीएसआईआर-राष्ट्रीयपर्यावरणअभियांत्रिकीअनुसंधानसंस्थान,

Nehru Marg, Nagpur - 440 020 [Maharashtra] India

नेहरूमार्ग, नागपुर - 440 020 [महाराष्ट्र] भारत

Mobile /संमणध्वनि+91-9096-049-515.

From: Sharma, Pankaj- EPMPPL- Purchase-Mahan <Pankaj.Sharma2@essarpower.co.in>

Sent: 11 September 2019 10:52

To: h.bherwani@neeri.res.in

Cc: director@neeri.res.in; Sharma M K - COO-EPMPPL-Waidhan <Manojkumar.Sharma@essarpower.co.in>;

Sharma, Pankaj- EPMPPL- Purchase-Mahan <Pankaj.Sharma2@essarpower.co.in>

Subject: FW: RFQ_Environmental Study

Dear Sir,

As discussed today, we are looking forward for your confirmation towards initial visit at site at earliest.

Request you to please confirm tentative dates, so that logistics may be arranged.

As confirmed by you, please also send your preliminary offer by today EOD.

With regards,



Pankaj Sharma

Thanks & Regards,

PankajSharma | Sr. Manager – Purchase | Essar Power M.P. Ltd. |

Essar Power MP Ltd-Mahan Power, Village - Bandhora, Post-Karsualal, Tehsil-Mada, Dist-Singrauli,Waidhan-486886 | Madhya Pradesh | India |

T +91 8959591713 | +91 896 6902954 Ext. : 2117 |

E Pankaj.Sharma2@essarpower.co.in | www.essar.com |

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From: Somvanshi, Surajsingh C- EPMPPL- Technical Services & MTP

Sent: Tuesday, September 3, 2019 9:59 AM

To: h.bherwani@neeri.res.in

Cc: director@neeri.res.in; Sharma M K - COO-EPMPPL-Waidhan; Sharma, Pankaj- EPMPPL- Purchase-Mahan

Subject: FW: RFQ_Environmental Study

Dear Sir,

Refer trailing email communication for offering a techno commercial quote for the environmental study

As desired please find attached fly ash test reports and Longitude Latitude of the affected area as required

23.998170, 82.415844

23.996902, 82.415649

23.993257, 82.43456

23.99165, 82.431338

Requesting for your best offer in this regards at the earliest.



Regards

Suraj Singh

Thanks & Regards

Suraj Singh Somvanshi | Dy. General Manager | Essar Power M.P. Ltd. |

Essar Power MP Ltd-Mahan Power, Village - Bandhora, Post-Karsualal, Tehsil-Mada, Dist-Singrauli, Waidhan-486886 | Madhya Pradesh | India |

T +91 9926905318 | +7 29 2211 | +91 89869 02954 Ext. : 2393 |

E Suraj Singh Somvanshi@essarpower.co.in | www.essar.com |

 Please don't print this e-mail unless you really need to.

Disclaimer:

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< http://www.essar.com/email_disclaimer.html >

From: Sharma, Pankaj- EPMPL- Purchase-Mahan

Sent: 29 August 2019 13:09

To: h.bherwani@neeri.res.in

Cc: director@neeri.res.in; Sharma M K - COO-EPMPL-Waidhan; Somvanshi, Suraj Singh C- EPMPL- Technical Services & MTP

Subject: FW: RFQ Environmental Study

Dear Sir,

We are waiting for your best offer for below matter.

If you have any query, you may please revert via email.

With regards,

Pankaj Sharma

Thanks & Regards,

Pankaj Sharma | Sr. Manager – Purchase | Essar Power M.P. Ltd. |



Essar Power MP Ltd-Mahan Power, Village - Bandhora, Post-Karsualal, Tehsil-Mada, Dist-Singrauli,Waidhan-486886 | Madhya Pradesh | India |
 T +91 8959591713 | +91 896 6902954 Ext. : 2117 |
 E Pankaj.Sharma2@essarpower.co.in | www.essar.com |

✉ Please don't print this e-mail unless you really need to.

Disclaimer:

This email is subject to a disclaimer, please click on the following link or cut and paste the link into the address bar of your browser.
http://www.essar.com/email_disclaimer.html

From: Sharma, Pankaj- EPMPL- Purchase-Mahan
Sent: Monday, August 26, 2019 9:29 AM
To: 'director@neeri.res.in'
Subject: FW: RFQ_Environmental Study

Dear Sir,

Gentle reminder... we are waiting for your best offer for below matter.

With regards,

Pankaj Sharma

From: Sharma, Pankaj- EPMPL- Purchase-Mahan
Sent: Wednesday, August 21, 2019 3:12 PM
To: 'director@neeri.res.in'
Subject: RFQ_Environmental Study

Dear Sir,

This has reference to our telecom on Environmental Impact Study to be carried at our site.

We are operating a 600x2 MW Coal based power plant at Singrauli District of Madhya Pradesh. Both of our units are commissioned however we have been operating with very less capacity (approx. 25% only) mainly due to less coal availability. A dedicated Ash Bund has been constructed on around 87 Ha of acquired land outside plant boundary for storage of ash. This Ash is in form of High Concentration Slurry Discharge (HCSD) which is having 35% water only.



On 7th Aug 19 some portion of dyke wall of ash bund (which was not in use) got partially breached. The rains was also happening that time so due to conditions, some ash got spread in surrounding area outside the boundary of ash dyke majority of which is also the land acquired by company only.

We wanted to conduct a study of the quantum of environmental damage caused due to the ash in nearby area by expert agency.

Hence requesting to provide a techno-commercial offer for the same

Further please include following with the offer:

1. Methodology of the study
2. Time duration for assessment and submission of reports.
3. Reference list and some samples of similar studies conducted elsewhere.

Please do let us know if anything further required from our end and arrange for your offer at the earliest

With regards,

Pankaj Sharma



Saran, Jay Shanker- EP MPL-HSE&F- Mahan

From: Shivang Agarwal <shivang.agarwal@teri.res.in>
Sent: Monday, September 2, 2019 6:34 PM
To: Somvanshi, Suraj Singh C- EP MPL- Technical Services & MTP
Cc: R Suresh; Ved Prakash Sharma
Subject: RE: Preliminary visit estimate cost

Dear Mr. Suraj,
 Due to some work emergency, I wont be available till 10th September'19, so kindly see if its possible to book ticket for 11th or anytime after 11th September'19.

Regards,

Shivang Agarwal

.....
 Project Associate
 Centre for Environmental Studies
 The Energy and Resources Institute
 Mob- +91-8800554457

From: Ved Prakash Sharma <vpsharma@teri.res.in>
Sent: Thursday, August 29, 2019 4:59:29 PM
To: scsomvanshi@essar.com <scsomvanshi@essar.com>
Cc: R Suresh <sureshr@teri.res.in>; Shivang Agarwal <shivang.agarwal@teri.res.in>
Subject: Preliminary visit estimate cost

Dear Mr. Suraj,
 Further to our telecom on preliminary visit of TERI team to Essar premises for proposed study; this is to inform that we are two persons who have planned to visit next week. As you need official formalities for this approval; please arrange Air tickets Delhi to Varanasi and back along with vehicle pick up and drop from Varanasi to Singrauli. Accordingly, lodging and boarding would have to be arranged for 2-3 days as per our schedule. We intend to start our visit on Monday and return by Wednesday. Details of persons who would visit your plant are as under:

Mr. Ved Prakash Sharma	49Yrs	Manager
Mr. Shivang Agarwal	23yrs	Project associate

Looking forward your response.

Best regards

Ved Prakash Sharma

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1


Environmental Damage Cost Assessment due to Spillage of Ash at Essar Mahan Power Ltd., Waidhan, Madhya Pradesh



Submitted to

ESSAR Power M.P. Ltd., Waidhan, Madhya Pradesh



CSIR- National Environmental Engineering Research Institute (NEERI)

September, 2019

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1.0 Introduction

Essar Power Ltd is one of India's largest private sector power producers with over 20 years of experience in this field. It owns power plants not only in India but in Canada as well and has a total planned generation capacity of about 5,000 MW, of which about 4000 MW is operational. Of the total operational capacity, about 2,800 MW is coal-based, while 1,000 MW is gas-based. In India, the operational plants are at Mahan in MP, Hazira and Salaya in Gujarat, and Paradip in Odisha, while in Canada, there is one operational plant in Algoma. A 1,200 MW coal-based power plant at Tori in Jharkhand state is under development.

Essar Mahan Power (MP) plant has stable operation since 2012 when the unit 1 was commissioned. Unit 2 with the same capacity of 600MW was commissioned in 2017. Essar Power Ltd built the plant, which is located in Madhya Pradesh's Singrauli district, at a cost of more than Rs 8,000 crore. It requires approximately 5.5 million tonnes of domestic coal per year to generate full load. Currently the plant operates at about 25% to 30% of its capacity due to limited coal supply.

Being a thermal power plant, lot of ash is produced which is stored in ash ponds. The ash pond of thermal power plant consists of ash in the form of High Concentration Slurry Disposal (HCSD). Coal ash typically contains heavy metals including arsenic, lead, mercury, cadmium, chromium and selenium, as well as aluminum, antimony, barium, beryllium, boron, chlorine, cobalt, manganese, molybdenum, nickel, thallium, vanadium, and zinc. Many of these elements are highly toxic to human and other life. Spillage of coal ash can also cause the pollution of waterways, drinking water, air and soil.

Fly ash spillage was reported on 7th of August from Essar's coal thermal power plant due to the breaching of dyke wall. In order to do valuation of environmental damage cost for the above-mentioned impacts, exact impact caused due to the spillage needs to be analyzed. The detailing with respect to quantification of environmental damage of ash spillage is given in subsequent sections. CSIR-NEERI team conducted an initial survey and sample collection on 18th to 20th of September 2019 based on which the proposal is prepared. The location of the spillage and company area is shown in the figure 1 below:



Figure 1 : Location of Ash Pond near Power Plant

2.0 Scope of the Study

The main objective is to study the environmental damage cost incurred due spillage of coal ash at Essar power area located at Waidhan, Madhya Pradesh.

The study is divided into two parts:

Part 1. Demarcation of the contaminated site and analysis of suitable samples for contamination

Part 2. Environmental damage cost assessment due to spillage of ash

3.0 Stages of the Study:

- **Delineation of Study Area:** Area of source of contamination shall be analyzed in detail in order to ascertain the number of samples required to understand the impact of ash

contamination. Remote sensing tools and ArcGIS will be used to create digital elevation model and drainage map of the region to understand the possible flow of contaminants.

- **Finalization of Parameters and Sampling:** Radial boundaries shall be marked based on drainage patterns of the region to finalize the number of samples. Soil and water samples shall be collected based on requirement.
- **Laboratory Assessment:** The soil and water samples shall be analyzed along with virgin ash samples to understand the contamination. Heavy metals leaching would be analyzed in soil samples, if any. Physico-chemical parameters along with heavy metals shall be analyzed in the water samples. Baseline analysis shall also be done with multiple samples.
- **Multiple Sampling:** The restoration process of spilled ash is ongoing on the site. Hence multiple sampling including and pre and post remediation shall be done in order to understand the change in concentration of contamination
- **Damage Assessment:** Based on assessment of samples, available literature and methodologies for damage cost assessment shall be used to determine the monetary damages.
- **Remediation:** Based on assessments, remedial action plan shall be suggested for the contaminated area.

4.0 Valuation Methodology

1. **Soil pollution:** Spillage of ash on nearby land area of pond may cause deposition of layers of ash on soil. To evaluate the impact on the affected land, soil monitoring shall be carried out in and around the site of spillage. Heavy metal analysis, fertility loss may also be considered to estimate the monetary damage due to soil pollution. The damage cost due to contaminated soil shall be estimated using benefits transfer/avoided cost methodology.

2. Ground and surface water pollution:

Due to the occurrence of heavy rainfall after and at the time of incident leachate generated from the ash slurry is directly subjected to the open land, which has a tendency to percolate and reach the nearby water bodies. The harmful metal concentrations in leachate can cause considerable impacts on human health and agriculture in addition to the aquatic life. Water quality testing of nearby ground and surface water sources will be carried out to analyze the level of pollution. The concentration value, breaching the standards, will be determined and resulting environmental damage will be estimated using control cost methodology linking all the environmental values/indices. Where costs are quantified on the basis of the cost of one pollutant coupled with linked environmental values. Both environmental and health effects are covered by the study.

3. Miscellaneous impacts: If in the detailed site study other miscellaneous impacts such as vegetation, life loss etc. are identified, corresponding monetary value associated with the impact shall be quantified using market price method or shadow pricing method.

4.0 Total Study Duration: 06 (Six) Months from the receipt of first instalment.

- First Report on Initial Sampling: Two Months
- Final Report on Second Sampling: Three Months
- Final report based on Comments: One Month

5.0 Total Budget for the Study: Rupees 21.2 Lakhs + GST (Twenty-One Lakh Twenty Thousand +GST) Budget breakup is given as follows along with its justification

Sl. No	Breakup Description	Cost (Rs in Lakhs)
1	Manpower	5.0
2	Travel	4.0
3	Chemical & Consumables	6.2
4	Contingency	2.5

5	Institute Fee (20%)	3.5
6	Total	21.2
7	GST	As applicable

1. Manpower: Permanent and temporary manpower will be required to do a site survey, collect and analyze samples, conduct the economic survey, conduct modeling (if required), carry out a questionnaire survey and damage cost assessment exercise.
2. Travel: Travel from Nagpur will be required to carry out preliminary studies and survey.
3. Chemicals & Consumables: For the purpose of sampling and heavy metal analysis, chemicals and consumables will be needed.
4. Contingency: Towards miscellaneous and unforeseen expenses.
5. Institute Fees: Includes overheads, utilities and consultancy charges.

6.0 Payment Terms:

1. 50% advance with the award of the project
2. 30% post submission of the draft project report
3. 20% on submission of the final report.

7.0 Support from Essar Team

- Provide any past record of soil, fly ash and groundwater quality
- Provide groundwater table details
- Provide details of bore wells, open wells, dig wells, hand pumps for sampling in the defined study area
- Provide details about area which got contaminated.

Further, the following assistance to visiting CSIR-NEERI staff may be provided

- Accommodation for NEERI staff during the visit

- Local transport facility
- A senior technical staff for data collection and coordination

8.0 About CSIR-NEERI

CSIR-NEERI is the premier research institute dealing in environmental science and engineering in India. The institute comprises research departments dealing with various components of environment. The role of the institute is to provide scientific and technical information and services to the various authorities and industries and promote planning, policy and management strategy for the regional environmental efforts in India as well as overseas. More than 300 scientific and technical staff members make CSIR-NEERI a highly qualified partner contributing analytical facilities and extensive knowledge on various aspects of environment.

Among the various environmental domains, the institute is dealing with the research and development of better and scientific water and wastewater management practices, for more than four decades. The primary focus of the water and wastewater management has been shifting over the years from treatment to reuse, and recycle in recent years. The Institute has expertise and research capabilities in following domains of the Sewage and MSW management.

- Sewage treatment plants design, construction and commissioning
- Integrated hydrogeological and modelling studies for water resources management including storm water management and groundwater recharge
- Industrial wastewater management plan
- Chemo-de-fluoridation household units
- Solar energy based electrolytic de-fluoridation plants
- Wise water management system for Ashrams (residential schools) and households
- Constructed Wetlands Technology for sewage treatment
- Comprehensive Municipal Solid Waste Management (MSWM)
- Environmental Impact Assessment (EIA)
- Assessment of groundwater and soil quality

- Strategic Urban Environmental Management

9.0 Some Examples of Studies related to Economic Evaluation:

1. Ecosystem Services Valuation of Mangroves of Andamans vis-vis impacts of climate change
2. Damage cost assessment due to additional pollution caused by Volkswagen vehicles



3. Damage cost assessment due to breach of discharge standards by Vapi CETP for river Daman-Ganga

GREEN WATCHDOG'S WRATH

NGT's DIRECTIONS

- Form a five-member committee to assess damage and cost of environment remediation in Vapi. Ensure CETP and industrial units are held accountable.
- GPCB should consider exercising its statutory powers of prosecution.
- CPCB and GPCB should undertake surveillance of CETPs and submit reports to the NGT every three months.
- CPCB to conduct performance audits of all state pollution control boards (SPCB) and pollution control committees (PCC) within six months by constituting expert inspection teams.
- Three-member committee of CPCB, NEERI and MoEF to review functioning of CETPs in the country and suggest modifications.



ON CPCB

- GPCB has not taken stringent action that can deter pollution norm violations. Simply issuing notices has not brought about the desired results.
- An inspection team with GPCB, CPCB and Vapi CETP representatives on January 3 found frequent violations of inlet and outlet norms in Vapi.
- The Vapi CETP operator and industrial units have failed to comply with environmental norms.
- There is a large-scale failure in the functioning of CETPs in the country.
- State pollution control boards (SPCBs) are unable to appoint qualified, impartial and politically neutral persons of high standing to crucial regulatory posts.

	Large units	Medium units	Small units	Vapi CETP
FINES IMPOSED	₹1 crore each	₹50 lakh each	₹25 lakh each	₹10 crore

- Apart from above, NEERI has been asked to conduct environmental damage cost assessment for Bhandwari dumpsite by CPCB and another dumpsite in Port Blair by Andamans and Nicobar Pollution Protection Committee.

Saran, Jay Shanker- EPMPL-HSE&F- Mahan

From: Sharma, Pankaj- EPMPL- Purchase-Mahan
Sent: Monday, August 26, 2019 6:03 PM
To: AMIT PRASAD
Cc: nrpatra@iitk.ac.in; aprasad@iitk.ac.in; Sharma M K - COO-EPMPL-Waidhan; Sutradhar, S. - EPMPL (Tori); Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; Singh, Lallan - EXT - EPJL - Civil Execution - HAZ; Tomar, Gaurav - EPMPL - Waidhan
Subject: FW: INDIAN INSTITUTE OF TECHNOLOGY
Attachments: Proforma Invoice and letter for site visit
Importance: High

Dear Sir,

Please find below the UTR details for the payment done against enclosed PI and our communication.
 Please confirm the receipt of same.

Kindly confirm your earliest visit schedule.



Sr. No.	Submission Date	Vendor Code	Name of Vendor	Amount (Doc Curr)	Currency	Hold Amount (TDS)	Amount by Cash / RTGS (Rs.)	Bank Payme vouch No. (K)
1	26.08.2019	168717	INDIAN INSTITUTE OF TECHNOLOGY	147,500	INR	12,500	135,000	

With regards,

Pankaj Sharma

Thanks & Regards,

Pankaj Sharma | Sr. Manager – Purchase | Essar Power M.P. Ltd. |

Essar Power MP Ltd-Mahan Power, Village - Bandhora, Post-Karsualal, Tehsil-Mada, Dist-Singrauli,Waidhan-486886 | Madhya Pradesh | India |

T +91 8959591713 | +91 896 8902954 Ext. : 2117 |

E Pankaj.Sharma2@essarpower.co.in | www.essar.com |

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< http://www.essar.com/email_disclaimer.html >



Saran, Jay Shanker- EPMPL-HSE&F- Mahan

From: AMIT PRASAD <aprasad@iitk.ac.in>
Sent: Thursday, August 22, 2019 6:28 PM
To: Sharma M K - COO-EPMPL-Waidhan; Sutradhar, S. - EPMPL (Tori); Sharma, Pankaj- EPMPL- Purchase-Mahan; Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP; Singh, Lallan - EXT - EPJL - Civil Execution - HAZ
Cc: nrpatra@iitk.ac.in; aprasad@iitk.ac.in
Subject: Proforma Invoice and letter for site visit.
Attachments: Proforma Invoice and letter.pdf; GST_Registration_Certificate_dord_office.pdf; SBI_Bank_Detail_Current.pdf

Dear Sir,
 With reference to your email to Prof. N.R Patra, please find attached proforma invoice regarding site visit "to conduct the study for ash dyke and its strengthening requirements" at Essar Power M.P. Ltd ,600x2 MW coal based power plant at Singrauli District of Madhya Pradesh".
 Please transfer the amount of Rs. 1,47,500/- by tomorrow for the registration at IIT Kanpur. The details of GST and bank details for online transfer has been attached with this mail.

It is proposed to have site visit on August 27th, 2019 . You may book tickets and taxi from IIT Kanpur for our journey on August 26, 2019 (After 5PM).

Thank you

Regards
 --
 AMIT PRASAD
 TECHNICAL SUPERINTENDENT
 GEOTECHNICAL ENGINEERING LABORATORY
 CIVIL ENGINEERING
 I.I.T KANPUR
 Phone - +91-9454741722(M),
 0512-259-7724(O)

> ----- Forwarded Message -----
 > Subject: Re: FW: Enquiry for Technical Study
 > Date: Thu, 22 Aug 2019 12:28:22 +0530
 > From: Dr. Nihar Ranjan Patra <nrpatra@iitk.ac.in>
 > To: Sharma M K - COO-EPMPL-Waidhan <Manojkumar.Sharma@essarpower.co.in>
 CC: head_ce@iitk.ac.in <head_ce@iitk.ac.in>, Sutradhar, S. - EPMPL (Tori) <Siddhartha.Sutradhar@essarpower.co.in>, Sharma, Pankaj- EPMPL- Purchase-Mahan <Pankaj.Sharma2@essarpower.co.in>, Somvanshi, Surajsingh C- EPMPL- Technical Services & MTP <Surajsingh.Somvanshi@essarpower.co.in>, RajMohan, T - EPOrL - Mum <Rajmohan.T@essarpower.co.in>, Singh, Lallan - EXT - EPJL - Civil Execution - HAZ <Lallan.Singh@acerinox.co.in>, Dr. Nihar Ranjan Patra <nrpatra@iitk.ac.in>, snt@iitk.ac.in
 > Dear Sharma Ji,
 > We will take up this job. Will communicate you soon regarding the site visit.
 > Regards
 > Sincerely
 > Nihar



> -----
 > Dr. Nihar Ranjan Patra, Professor
 > Office:#316, Faculty Building
 > Department of Civil Engineering
 > IIT Kanpur, India-208016
 > E mail:nrpatra@iitk.ac.in
 > Phone:+91-512-2597623(O),+91-512-2598226(R)
 > Fax:+91-512-2597395
 > -----
 > On 22-08-2019 12:30, Sharma M K - COO-EPMPL-Waidhan wrote:
 >> *Dear Dr. Nihar Ranjan Patra,*
 >> **
 >> It was nice talking to you over phone. As explained We are operating a
 600x2 MW Coal based power plant at Singrauli District of Madhya Pradesh
 and wanted to conduct the study for our ash dyke and its strengthening
 requirements if any. In this regard the mail was sent yesterday to Dr.
 Sachidananda Tripathi also but since he is out of station the same
 trailing mail I am forwarding to you for necessary take up of job
 accordingly.
 >> Request you to send the offer for the said job so that it may be taken
 up accordingly and the site visit may be arranged at the earliest. Regards,
 >> *MK SHARMA*
 >> Thanks & Regards
 >> M K Sharma | Chief Operating Officer-COO EPMPL | Essar Power M.P.
 Ltd. |
 >> Village Bandhora, Post Karsualal, Tehsil Mada, Dist. -
 >> Singrauli,Waidhan-486886 | Madhya Pradesh | India |
 >> T +91 8959233777 | +91 8966902954 Extn. :- 2005 VoIP 729 2005 | E
 Manojkumar.Sharma@essarpower.co.in | www.essar.com |
 >> P *Please don't print this e-mail unless you really need to.*
 >> -----
 Disclaimer:
 >> This email is subject to a disclaimer, please click on the following
 link or cut and paste the link into the address bar of your browser. <
http://www.essar.com/email_disclaimer.html >
 >> <http://www.essar.com/email_disclaimer.html>
 >> *From:* Sharma M K - COO-EPMPL-Waidhan
 >> *Sent:* 21 August 2019 15:31
 >> *To:* 'head_ce@iitk.ac.in'
 >> *Cc:* Sutradhar, S. - EPMPL (Tori); Sharma, Pankaj- EPMPL-
 >> Purchase-Mahan; Somvanshi, Surajsingh C- EPMPL- Technical Services &
 >> MTP; RajMohan, T - EPOrL - Mum
 >> *Subject:* Enquiry for Technical Study
 >> *Dear Mr Sachidanad Tripathi,*
 >> *HOD Civil , IIT Kanpur.*
 >> **
 >> We are operating a 600x2 MW Coal based power plant at Singrauli
 District of Madhya Pradesh. Both of our units are commissioned however we
 have been operating with very less capacity (approx. 25% only)
 mainly due to less coal availability. A dedicated Ash Bund has been
 constructed on around 87 Ha of acquired land outside plant boundary for
 storage of ash. This Ash is in form of High Concentration Slurry
 Discharge (HCSD) which is having 35% water only.
 >> On 7th Aug 19 some portion of dyke wall of ash bund (which was not in
 use) got partially breached. The rains was also happening that time so due
 to conditions, some ash got spread in surrounding area.
 >> We wanted to conduct a study to assess overall technical quality of
 construction for ash pond by an expert agency along with the reason of dyke
 breach. It should also include the correction and strengthening work
 required for ash pond. Therefore requesting you to provide a



techno-commercial offer for the same.

>> Further please include following with the offer:

>> Methodology of the study

>> Time duration for assessment and submission of reports.

>> Reference list and some samples of similar studies conducted elsewhere.

Please do let us know if anything further required from our end and
arrange for your offer at the earliest.

>> Regards,

>> *MK SHARMA*

--
AMIT PRASAD
TECHNICAL SUPERINTENDENT
GEOTECHNICAL ENGINEERING LABORATORY
CIVIL ENGINEERING
I.I.T KANPUR
Phone - +91-9454741722(M),
0512-259-7724(O)





Indian Institute of Technology Kanpur
Office of Dean Research & Development

Details of ECS/Wire Transfer/Online Fund Transfer **Within India**

A. Details of Account Holder:		
1	Name of the Account holder	Registrar, IIT Kanpur
2	Complete Postal Address	Dean, Research & Development Indian Institute of Technology, Kanpur – 208016 (Uttar Pradesh)
3	Telephone No.	+91-0512-2597385 +91-0512-2597178/7564
4	E-mail Id:	sdr_dord@iitk.ac.in; sachan@iitk.ac.in
B. Bank Account Details :		
1	Bank Name	State Bank of India
2	Branch Name	IIT Kanpur Branch
3	Complete Postal Address	IIT Campus, Kanpur - 208016
4	Telephone No.	+91-0512-2590592
5	Email Id	sbi.01161@sbi.co.in
6	Bank Account Number	10426002126
7	Type of Account	Current Account
8	IFC code (A unique allotted by RBI to all RTGS/NEFT enabled branches in India)	SBIN0001161
9	9 digit MICR code	208002041
	GSTIN	09AAAJI0169A3ZL
	PAN	AAAJI0169A

Subhas
16/3/16
Joint Registrar (R&D)



संयुक्त कुलसचिव (अनुसंधान एवं वि०)
Joint Registrar (R&D)
भारतीय प्रौद्योगिकी संस्थान कानपुर
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Signature & Seal of Bank Manager
State Bank of India, IIT Kanpur



Subhas



भारतीय स्टेट बैंक
State Bank Of India

(01181) IIT (KANPUR) (PS Code: SBIN00116)
IIT CAMPUS
DIST KANPUR
UTTAR PRADESH 208016

DATE OF DEPOSIT: _____

D	D	M	M	Y	Y	V	V

PAY को या उनके आदेश पर OR ORDER

रुपये RUPEES अदा करें ₹

CANCELLED BEFORE ISSUE

Signature

Account No: MCA 10426002126

NOT ABOVE Rs. 5000000.00

Prefix
1516000002

DY. REGISTRAR (F&A)/REGISTRAR/DY. DIRECTOR INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

MULTI-CITY CHEQUE Payable at Par at All Branches of SBI

Please sign above

⑈ 2786 26 ⑈ 20800 204 ⑈ 000 ⑈ 3 ⑈ 29

Signature



[Handwritten signature]

INCOME TAX PAN SERVICES UNIT

(Managed by National Securities Depository Limited)
3rd Floor, 'A' Wing, Trade World, Kamala Mills Compound, S. B. Marg,
Lower Parel, Mumbai - 400 013.

The Income Tax Department takes pleasure in informing that the PAN allotted to you is:

AAAJI0169A

and the PAN card is enclosed herewith. Further, for filing the return of income, please contact

DCIT /ACIT -I, KANPUR

Quoting of PAN on return of income and challans for payment of taxes is necessary to ensure accurate credit of taxes paid by you and faster processing of return of income. Moreover, quoting PAN on all other communications with the department will help to improve taxpayer services.

You may inform that it is mandatory to quote PAN in several transactions specified under the Income Tax Act, 1961. For further details of such transactions, reference is invited to rule 14B of the Income Tax Rules, 1962 read with section 139A of the Income Tax Act, 1961.

In the unlikely event of more than one PAN being allotted, this fact should be brought to the notice of your Assessing Officer, as possessing or using more than one PAN is against law and may attract penalty of upto Rs. 10,000/-.

Any errors in the data printed on your PAN Card may be brought to the notice of IT PAN Services Unit at the address given above and on the reverse of the PAN Card.

Income Tax Department

REG ID PRC / 00342 / 04022005_01
CNP / 11 / 010970100000705 / 599507
NSDI INSTITUTE OF TECHNOLOGY KANPUR
NSDI INSTITUTE OF TECHNOLOGY,
BY REGISTRAR OF FINANCE OF, ACCOUNTS,
KALYAN PUR, KANPUR,
UTTAR PRADESH - 208016
TEL NO. - 512 - 2597382



(This being a computer-generated letter, no signatures are required)

भू-प्रीयोगिकी प्रयोगशाला
जानपद अभियान्त्रिकी विभाग
भारतीय प्रीयोगिकी संस्थान
कानपुर-208 016 (उ.प्र.)



Geotechnical Engineering Laboratory
Civil Engineering Department
Indian Institute of Technology
KANPUR-208 016 (U.P.)

दूरभाष / Tel. : +91-512-2597724
फैक्स / Fax : +91-512-2597395
No. CE/GTE/NRP/2019
Dated: 22/08/ 2019

Dr.N.R.Patra
Professor

M/S
Chief Operating Officer-COO EPMPPL
Essar Power M.P. Ltd.
Village Bandhora, Post Karsualal, Tehsil Mada,
Dist. - Singrauli, Waidhan-486886
Madhya Pradesh, India

Kind Attention: Shri. M K Sharma (Chief Operating Officer)

Subject: Consultancy regarding site visit "to conduct the study for ash dyke and its strengthening requirements" at Essar Power M.P. Ltd ,600x2 MW coal based power plant at Singrauli District of Madhya Pradesh".

Ref: Your email dated August 22, 2019, addressed to Prof. N.R Patra, Professor, Civil Engineering, IIT Kanpur and telephonic conversation.

Dear Sir,

With reference to your email cited above and our telephonic conversation, this is to inform you that we would like to take up this project.

For this work, it is proposed to have a site visit at Essar Power M.P. Ltd which is a 600x2 MW coal based power plant at Singrauli District of Madhya Pradesh. The detailed proposal including cost of consultancy work "to conduct the study for ash dyke and its strengthening requirements" will be decided after the site visit by the IITK team. However, you are requested to arrange to and fro travel, boarding, lodging and fooding arrangement for IITK personnel visiting the site.

The proforma bill for the site visit fee amounting to Rs.1, 47, 500/- has been attached for your perusal. The advance payment for the site visit may be drawn by crossed DD/cheque/online transfer in favour of "The Registrar, IIT Kanpur" and mailed directly to the undersigned.

On hearing from you, the proposed date of site visit will be confirmed.

Thanking you,

Sincerely,

(N.R.PATRA)

Encl: as above.

Location : Room 101-105, Western Lab. Extension Building

भू-प्रीयोगिकी प्रयोगशाला
जानपद अभियांत्रिकी विभाग
भारतीय प्रीयोगिकी संस्थान
कानपुर-208 016 (उ.प्र.)



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फैक्स / Fax : +91-512-2597395

PROFORMA INVOICE OF CONSULTANCY & TESTING CHARGES

Dr.N.R Patra
Professor
Dean R& D IITK GSTIN:09AAAJI0169A3ZL

No.:CE/GTE/NRP/2019

Dated: 22/08/2019

Sponsoring Org:
Chief Operating Officer-COO EPMPL
Essar Power M.P. Ltd.
Village Bandhora, Post Karsualal, Tehsil Mada,
Dist. - Singrauli, Waidhan-486886
Madhya Pradesh, India

Kind Attention: Shri. M K Sharma (Chief Operating Officer)

Ref.: Your email dated August 22, 2019, addressed to Prof. N.R Patra, Professor, Civil Engineering, IIT Kanpur and telephonic conversation.

S.No.	Particulars	Amount(INR)
1	Consultancy charges for the site visit "to conduct the study for ash dyke and its strengthening requirements" at Essar Power M.P. Ltd ,600x2 MW coal based power plant at Singrauli District of Madhya Pradesh".	100,000.00
	Subtotal	100,000.00
	Add Institute overheads 25 %	25,000.00
	Total	125,000.00
	CGST@ 9 %	11,250.00
	SGST@ 9 %	11,250.00
	Grand Total	147,500.00

Rs. One lakhs Fourty Seven Thousand Five Hundred Only.

N.R. Patra
(N.R. PATRA)

*Note: To and fro travel, boarding, lodging and fooding arrangement for IITK personnel visiting the site will be arrange by your side.

P.S.: Above amount may please be paid by crossed DD/Cheque/online transfer drawn in favour of "The Registrar, IIT Kanpur" and mailed directly to the undersigned

20

Location : Room 101-105, Western Lab. Extension Building

[Signature]



(Amended)

Government of India
Form GST REG-06
[See Rule 10(1)]

Registration Certificate

Registration Number :09AAAJI0169A3ZL

1.	Legal Name	INDIAN INSTITUTE OF TECHNOLOGY KANPUR			
2.	Trade Name, if any	DEAN OF RESEARCH AND DEVELOPMENT- IIT KANPUR			
3.	Constitution of Business	Statutory Body			
4.	Address of Principal Place of Business	RESEARCH AND DEVELOPMENT OFFICE, ACCOUNTS-2, IIT KANPUR, KANPUR, Kanpur Nagar, Uttar Pradesh, 208016			
5.	Date of Liability	01/07/2017			
6.	Date of Validity	From	03/08/2017	To	NA
7.	Type of Registration	Regular			
8.	Particulars of Approving Authority				
<i>Signature</i>					
Name					
Designation					
Office					
Date of issue of Certificate		03/11/2017			
Note: The registration certificate is required to be prominently displayed at all places of Business/Office(s) in the State.					

This is a system generated digitally signed Registration Certificate issued based on the deemed approval of the application for registration

Power Club- EPMPL- Mahan

Φρον: Hari Prasad Hotnoor Suryan <suryafce@litr.ac.in>
 Σεντ: 29 August 2019 18:53
 Το: Sharma M K - COO-EPMPL-Waidhan; harisurya1@yahoo.com
 Χχ: Sulradhar, S. - EPMPL (Tori); Sharma, Pankaj- EPMPL- Purchase-Mahan; Somwanshi, Surajsingh
 C- EPMPL- Technical Services & MTP; RajMohan, T - EPOrL - Mum
 Σοβρεχτ: Re: Draft Enquiry for Technical Study
 Αττάχημεντα: SINGRAULI_PROPOSAL.pdf

Sri. M K Sharma

Dt. 29th Aug. 2019

Chief Operating Officer COO EPMPPL
Essar Power M.P. Ltd.
Village Bandhora, Post Karsualal, Tehsil Mada,
Dist. – Singrauli, Waidhan-486886
Madhya Pradesh India

Dear Sir,

Kindly find attached the IIT Roorkee proposal for the site vsiit.

with regards,

K S Hari Prasad

On 08/21/19 03:27 PM, Sharma M K - COO-EPMPL-Waidhan <Manojkumar.Sharma@essarpower.co.in> wrote:

Dear Mr KS Hari Prasad,

IIT Roorkee

This has reference to our telecom on Study to be carried at our site.

We are operating a 600x2 MW Coal based power plant at Singrauli District of Madhya Pradesh. Both of our units are commissioned however we have been operating with very less capacity (approx. 25% only) mainly due to less coal availability. A dedicated Ash Bund has been constructed on around 87 Ha of acquired land outside plant boundary for storage of ash. This Ash is in form of High Concentration Slurry Discharge (HCSD) which is having 35% water only.



On 7th Aug 19 some portion of dyke wall of ash bund (which was not in use) got partially breached. The rains was also happening that time so due to conditions, some ash got spread in surrounding area.

We wanted to conduct a study to assess overall technical quality of construction for ash pond by an expert agency along with the reason of dyke breach. It should also include the correction and strengthening work required for ash pond. Therefore requesting you to provide a techno-commercial offer for the same.

Further please include following with the offer:

1. Methodology of the study
2. Time duration for assessment and submission of reports.
3. Reference list and some samples of similar studies conducted elsewhere.

Please do let us know if anything further required from our end and arrange for your offer at the earliest.

Regards,

MK SHARMA

Thanks & Regards

M K Sharma | Chief Operating Officer-COO EPMP | Essar Power M.P. Ltd. |
Village Bandhora, Post Karsualal, Tehsil Mada, Dist. - Singrauli, Waidhan-486886 | Madhya Pradesh | India |
T +91 8959233777 | +91 8966902954 Extn. :- 2005 VoIP 729 2005 |
E Manojkumar.Sharma@essarpower.co.in | www.essar.com |

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Disclaimer:

This email is subject to a disclaimer, please click on the following link or cut and paste the link into the address bar of your browser.
<http://www.essar.com/email_disclaimer.html>





कार्यालय उपखण्ड अधिकारी माडा जिला सिंगरौली (म0प्र0)

क्रमांक/ 760/एस.डी.ओ./री-1/2019

माडा दिनांक 24.09.2019

प्रति,

मुख्य कार्यपालन अधिकारी
एस्सार पावर एम0पी0लि0 बन्धौरा
जिला सिंगरौली (म0प्र0)

विषय:- एस्सार पावर प्लाण्ट बन्धौरा के ऐश डेम फूटने से हुई फसल/मकान/कूप/बोर के नुकसानी की क्षतिपूर्ति राशि भुगतान के संबंध मे।

-----00000-----

विषयांकित के संबंध में ऐश डेम फूटने से प्रभावित कृषको को राशि भुगतान इस कार्यालय से किया गया जो निम्नानुसार है :-

क्र	पत्र क्रमांक	दिनांक	कृषक संख्या/ग्राम	राशि	विवरण
1	656/री-1/2019	14.08.2019	06/ कर्सुआलाल	988000.00	मकान क्षति
2	627/री-1/2019	16.08.2019	25/कर्सुआलाल	158000.00	फसल क्षति
3	652/री-1/2019	19.08.2019	93/कर्सुआलाल	822680.00	फसल क्षति
4	658/री-1/2019	20.08.2019	31/कर्सुआलाल	318940.00	फसल क्षति
5	681/री-1/2019	22.08.2019	25/कर्सुआलाल	188420.00	फसल क्षति
6	724/री-1/2019	04.09.2019	36/कर्सुआलाल	213990.00	फसल क्षति
7	725/री-1/2019	04.09.2019	8/कर्सुआराजा	40000.00	फसल क्षति
8	757/री-1/2019	13.09.2019	21/कर्सुआलाल	1038000.00	मकान, कूप, बोर क्षति
9	756/री-1/2019	20.09.2019	2/कर्सुआलाल	13920.00	फसल क्षति
	योग-		247 व्यक्ति	3781950.00	


उपखण्ड अधिकारी
माडा जिला सिंगरौली (म0प्र0)

Action Plan for Ash Dyke Restoration			
Sr No	Activity	Target Completion	Present Status
1	Restoration of one set of Ash Discharge pipeline to Cell-4A. (Prerequisite for plant start-up)	10-Aug-19	Completed on 10 th Aug 18
2	Restoration of damaged Ash Water Recovery pipeline. (Prerequisite for plant start-up)	12-Aug-19	Completed on 14 th Aug 19
3	Repair work of Cell 3 Bund wall east side	13-Aug-19	Completed on 13-Aug-19
5	Preparation of temporary dam near water bodies to arrest further ash spread	15-Aug-19	Completed on 14 th Aug 18
6	Repair of dyke wall between Cell 4A and Cell 3	16-Aug-19	Completed on 18 th Aug 18
7	Ash collection from nallah and dumping in cell 3	25-Aug-19	Completed on 25 th Aug 20
8	Strengthening of Cell-3 bund wall east side (subject to no rainfall)	15-Dec-19	Under Progress
	Cleaning of the area	30-Oct-19	
	Excavation	10-Nov-19	
	Leveling & compaction	15-Nov-19	
	HDPPE laying & concreting in inner slope	30-Nov-19	
	Stone pitching & slope in outer slope	30-Nov-19	
	Protection wall 1.0 Mtr Height	10-Dec-19	
	Drainage around the dyke	15-Dec-19	
9	Strengthening of Cell-4 south side bund wall (subject to no rainfall)	20-Sep-19	Completed
	Immediate strengthening of the intermediate bund	20-Aug-19	Completed
	Height raising by 2 Mtr	15-Sep-19	Completed
	Compaction and capping	20-Sep-19	Completed
10	Collection of spread ash from agricultural land and shifting to Cell-3 (subject to rainfall)	30-Oct-19	Under Progress
11	Environmental damage assessment and implementation of corrective measures	30-Mar-20	Under Progress
	Initial visit and assessment by the agency	19-Sep-19	Completed
	Final offer, Scope finalisation and WO award after initial assessment/visit	28-Sep-19	Completed
	First report on initial sampling	30-Nov-19	Under Progress
	Final report on second sampling	28-Feb-20	Under Progress
	Final assessment and report submission based on comments	30-Mar-20	
12	Assessment of the overall technical quality of existing construction including engineering and design and recommendations for improvement	30-Nov-19	Under Progress
	Initial visit and assessment by the agency	28-Sep-19	
	Final offer, Scope finalisation and WO award after initial assessment/visit	30-Sep-19	
	Report submission	30-Nov-19	



Framework for **ENVIRONMENTAL DAMAGES COST ASSESSMENT** with Examples

Special Report on
Monetising Damages



**Council of Scientific & Industrial Research-
National Environmental Engineering Research Institute
(CSIR-NEERI)**

Disclaimer:

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Mentor and Task Coordinator

Rakesh Kumar, PhD
Director, CSIR-NEERI

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Foreword

Dr. Rakesh Kumar Director, CSIR-NEERI



CSIR-NEERI have completed 60 years of glorious service to society as a leading national research institution and have significantly contributed to the growth of the industries and transforming the lives of the common man. We believe, it is our responsibility to continue to be involved in providing sustainable solutions to the challenging environmental problems and develop robust environmental solutions that target the productive and sustainable use of natural resources. The ongoing era of urbanization in India has seen steep growth in industrial and commercial activities resulting in bringing more complex environmental challenges to the society. Unidirectional nature of the industry focusing on profitability and shareholders benefit has resulted in severe damages to the environment and ecosystem, directly and indirectly contributing to climate change.

In view of the above, it becomes important to preserve the environment and society at large by assessing the assimilative and carrying capacity of the environment and finding better and green solutions to curb pollution. However, the industries and businesses are polluting on a scale which are breaching the set standards. It is becoming essential that we should have a mechanism of accounting for the damages being done to the environment. The necessity to develop a framework that can apply the laws and regulations like “polluter pays principle” and “extended producers responsibility” has become very relevant in today's environment. In order to implement the above principles, regulators are looking forward to a systematic framework that can guide them to evaluate the damages to the environment, in order to recover the cost of restoration and bring in application of constructive ideas for the betterment of the environment. Such frameworks are available at an international level, however, the direct application of those frameworks is limited in the Indian context. This further strengthens the need to develop an India specific framework for evaluation of environmental externalities.

The current report on “Framework for Environmental Damages Cost Assessment with Examples: Special Report on Monetizing Damages” will act as a baseline tool, providing a platform to assess damages done to the environment in monetary terms. The current edition is expected to significantly contribute to policymaking, environmental regulations, and implementation; guiding various National and State level expert committees constituted by Ministries and Regulatory agencies.

Rising to the challenge faced by the Indian environmental scientific community, CSIR-NEERI has emerged as a front runner in developing a need-based baseline framework that will continue to evolve over time adding more domains of environmental damages whilst addressing complex relationships between different environmental processes. The current work has the potential to strengthen local, regional and national capabilities to address urban and industrial pollution and implement pollution prevention and waste minimization programs.

I hope that with the support of the Government of India, State Government, CSIR, Industries, CPCB, SPCBs, judiciary, valued Stakeholders and our society, the Institute will rise in defining the path to address similar emerging environmental challenges. The focus of the Institute has always been to develop end to end environmental solutions and keep the focus of CSIR NEERI as a place for “Society has driven Solution through the use of Science and Engineering. This is a small step towards understanding the concept of damage assessment and its use as policy tools.

Dr Rakesh Kumar
Director, CSIR-NEERI

P R E F A C E

Businesses and industries are dependent on nature for the supply of resources; be it water, air metals, fuel, etc. Our growing population and demand-supply gap are putting pressure on the businesses and industries to perform better and better every day. Moreover, the stock of raw materials is decreasing. With this trend, the world we live in is changing rapidly. One of the most important components of our world is the environment in which we humans and bio-diversity thrive upon. Pressing human activities, fueled by increasing demand, are detrimental to our environment. The business as usual scenario disregards the fact that our environment has a finite assimilative capacity for pollutants. Once the limit is breached, all kinds of problems including, but not limited to, the decline in human health, extinction of species, losses of aquatic systems, climate change and so on will stand in our face with limited solutions at our bay.

The current project, as covered in the book, tries to develop a framework through which businesses and industries can be transformed for a better environment. The framework described in the report helps in estimating the cost of environmental damages caused due to any activity once it breaches particular standards set by a regulatory authority.

The purpose behind making this framework is to make governments, industries, businesses, societies and people in general, understand the magnitude of impact generated by breach of environmental standards. Further, the magnitude of impact is calculated in monetary terms, a common language, understood by all stakeholders. The framework has become a need of the hour since people are failing to realize the impact of actions being taken at any level by any developmental activity.

The framework will also help regulators to understand the magnitude of an impact once the environmental limits are broken. The value of damages can be recovered from the polluter and can be used constructive activities for the betterment of the environment. Moreover, it is clear that how businesses operate in the future will need to be transformed. Expectations of governments, societies, customers, and suppliers are already changing. There is a growing recognition that the good/right kind of growth is also possible and that businesses need to consider stakeholders into perspective beyond the old school shareholder perspective. The current framework also helps businesses to understand the impact of their actions and help them channelize their energy into doing inclusive growth.

While there is a wide range of literature available on the evaluation of environmental externalities using various economic theories and models, the application in the Indian context is still evolving. The current framework has tried to adapt the values and literature available globally for their application in the Indian context. Currently, there are four parameters, namely Greenhouse Gases (GHGs) emissions, air pollution, water pollution, and solid waste, which are looked upon in detail and framework for the calculation of these externalities is given with some examples. This framework should help in developing a basic understanding of the topic and should help in conducting initial assessments related to the evaluation of environmental damages cost. The framework will form a stepping stone and can be improved to include other factors like biodiversity loss, land use, land cover change, and freshwater loss.

I am thankful to Director, CSIR-NEERI, Dr. Rakesh Kumar, for continuously guiding me through the whole process of understanding the field and keeping me motivated to face the challenges and hurdles which came my way during developing this area. I am thankful to Dr. Nitin Labhsetwar, Chief Scientist and Head ERMD, for his constant encouragement. I am also thankful to my colleague Er. Ankit Gupta, who has helped me develop this field. I am grateful to all my colleagues in the Director's Research Cell, especially Dr. Atya Kapley, Head DRC, for constant support. Last but not least, I express my gratitude to my team of project fellows without whom, the project would have never reached the current scale.

Hemant Bherwani
Scientist, CSIR-NEERI

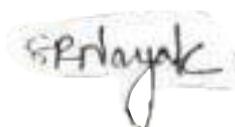


Dr. Shailash Nayak

Chairman, Research Council,
CSIR-NEERI & Director, NIAS



CSIR-NEERI has been on the forefront in developing technologies for managing air pollution, solid and hazardous waste, wastewater treatment, as well as environmental impact assessment. The recent thrust on "sustainability" has focused attention on developing the end-to-end solutions. I have always believed that valuation of environmental damages is becoming a need of the hour and has evolved in supporting regulatory bodies to recover the cost of restoration for the polluted environment. Incorporating cost assessment of damages in policy making practices can make a positive contribution to the environmental, socio-economic sustainability of the community. CSIR-NEERI has come a long way since its inception and has been contributing towards providing solutions to various scientific challenges. I wish CSIR-NEERI success in its endeavour to meet environmental grand challenges. I congratulate CSIR-NEERI team for their excellent initiative on developing a basic framework on environmental damages cost assessment with examples.



Dr. Shailash Nayak

Chairman, Research Council,
CSIR-NEERI & Director, NIAS

A U T H O R ' S P R O F I L E



Dr. Rakesh Kumar (born in 1964) obtained M.Tech. in Environmental Science and Engineering from IIT-Bombay and Ph.D. in Environmental Engineering from RTM, Nagpur University. Before assuming the charge as Director, CSIR-National Environmental Engineering Research Institute (CSIR-NEERI) in May 2016, he has served as Chief Scientist and Head of CSIR-NEERI's Mumbai Zonal Centre. He has a vast experience in all fields of environmental science and engineering, especially air pollution control and management, urban air quality monitoring, emission inventory and modeling, environmental impact assessment, environmental audit,

climate change, and health. He has received 9 awards for his outstanding contribution to Environmental Science & Engineering, among which the notable ones are Commonwealth Commission Award, UK in 1994; "Environmental Leadership Award" by US Asia Environmental Partnership and US-AID for the year 2005. He has been given VASVIK award, 2012 for his exemplary work for sustainable technology "Phytorid". He has been also awarded the "Hiyoshi Think of Ecology Award" in September 2015. He has also served as "Adjunct Professor" at Centre for Environmental Science and Engineering, IIT-Bombay.

Dr. Kumar has over 10 patents including 2 international patents and published more than 100 papers in national and international journals.



Hemant Bherwani obtained B. Tech (Chemical Engineering) from LIT, Nagpur University and M.Tech (Environmental Science and Engineering) from IIT Bombay. He started his carrier with Thermax as Graduate Engineering Trainee and handled Waste Heat Recovery Boilers. Post-M.Tech., he joined as an associate in GIST Advisory and worked on environmental, human and social capital externalities and ecosystem services. He later joined Yes Bank as Assistant Vice President to develop a framework for evaluation of environmental risk in the bank's portfolio. Presently, he is working as a Scientist in Director's Research Cell, CSIR -

National Environmental Engineering Research Institute (NEERI), Nagpur. His areas of expertise include environmental Externalities Evaluation, Ecosystem Services Valuation, GIS and Remote Sensing, Air Pollution and Wastewater Treatment. He has more than 8 years of experience in varied fields of environment. He has published 7 papers in peer-reviewed journals, 15 in national and international conferences and has 1 patent. He has also transferred the technology of In- Situ drain treatment called RENEU.



Ankit Gupta obtained B. Tech (Mechanical & Energy Engineering) from VIT University and M.Tech (Environmental System Modelling & Optimization) from Academy of Scientific and Innovative Research (AcSIR), New Delhi. Presently, he is working as Scientist in Energy and Resource Management Division, CSIR - National Environmental Engineering Research Institute (NEERI), Nagpur. His areas of expertise include energy System Design, CFD&HT Modelling, Stochastic and Statistical Modelling, Air Pollution Control, Design of Experiments and Optimisation, etc. He has more than 7 years

of experience and has published 10 papers in peer-reviewed journals, national and international conferences, 8 design registrations, 3 patents and transferred the technologies on improved cookstove “Neerdhur” and improved sanitary pad incinerator “GreenDispo”.



Moorthy Nair Obtained B.E. (Mechanical Engineering) from Visvesvaraya Technological University (VTU) and M.Tech (Environmental Engineering) from Manipal University. He started his carrier with a private consultancy handling turnkey wastewater treatment and environmental impact assessment (EIA) projects. He presently is working as a project assistant in Director’s Research Cell, CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur. His areas of expertise include wastewater treatment, environmental impact assessment, air quality modeling, Remote Sensing & GIS, Monetary Assessment of Environmental Damages &

Natural /Synthetic Fibre Composites materials. He has a total of 2.5 years of experience in various domains of environment. He has a total of 6 journal publications and presented 6 in national and international conferences.



Himani Sonwane obtained B.E. (Environmental Engineering) from Kolhapur Institute of Technology, Kolhapur and M.E. (Environmental Engineering) from Sinhgad College of Engineering, Pune University. Post M.E. she started her carrier with a private consultancy as Proposal Engineer and handled STP, ETP, CETP projects involving technologies like UASB, MBBR, RO, UF. Currently, she is working as a Project Assistant in Director’s Research Cell, CSIR -National Environmental Engineering Research Institute (NEERI), Nagpur.

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C H A P T E R 1

Introduction

1 Introduction

India has witnessed massive growth in urbanization and industrialization in the past few decades. While development has been at the forefront, environmental aspects have often suffered the most. Despite generating awareness regarding the need and importance of natural resources, the degradation of natural resources is growing at an alarming rate. Optimizing the use of available natural resources to maintain sustainability and thereby human well-being is the biggest challenge faced by the policymakers today. The economic assessment is one such tool that can scrutinize the potential profit and loss with respect to anticipated impacts on the natural environment due to proposed industrial activities.

Environmental economics is a relatively new field compared to classical economics and generally considers two aspects in detail: one being depletion of natural resources thereby relating to the valuation of services they provide, and other being damage to the environment due to pollution loading.

The pollution-related damages have gained importance in recent times due to the fact that the environment is taking center stage in sustainability-driven agendas throughout the globe. Further, the businesses, in the long term may not be viable as the environmental laws and policies might hit them with stricter and tighter regulations. Another fact is that the resource once depleted may force the industry violator's to look for alternatives and question the viability of business.

The aspect of environmental degradation generally deals with following points:

- What are the causes of environmental problems and degradation?
- How to assess the damages?
- How can we design economic incentives either to reverse the damages and/or to halt/reduce them?

Environmental Impact Assessment (EIA) & Life Cycle Assessment (LCA) are globally employed to understand the impacts generated by any operation used in product manufacturing or process-driven industry. These methods often tell about the footprints related to various steps involved in the process and referred to as midpoint analysis methods. These methods limit themselves to identifying the potential threats/impacts to the environment, due to the execution of approved development projects/activities. Environmental impacts as indicated in **Figure 1** during cradle to grave activities are identified during the product cycle using various impact analysis methods but are seldom quantified in monetary terms. Non-transparency between the emission and its likely impacts have resulted in the exploitation of the environment beyond the assimilative

capacity. This report focuses on mainstreaming the linkage between various pollutant identification methods (LCA, EIA) along with methods to evaluate the impacts on physical, chemical and biological environments using economic methods to quantify the impacts in terms of monetary value. In today's business sector, certain environmental impacts affect society larger than the company's profit value. Identifying such impacts and effects of emissions in monetary terms can bring awareness among the industries to take the resulting impacts into account thereby enabling them to deliver better outcomes favoring environment and human well beings. Further, this monetary evaluation of impacts can help regulators in devising laws based on actual quantified numbers.

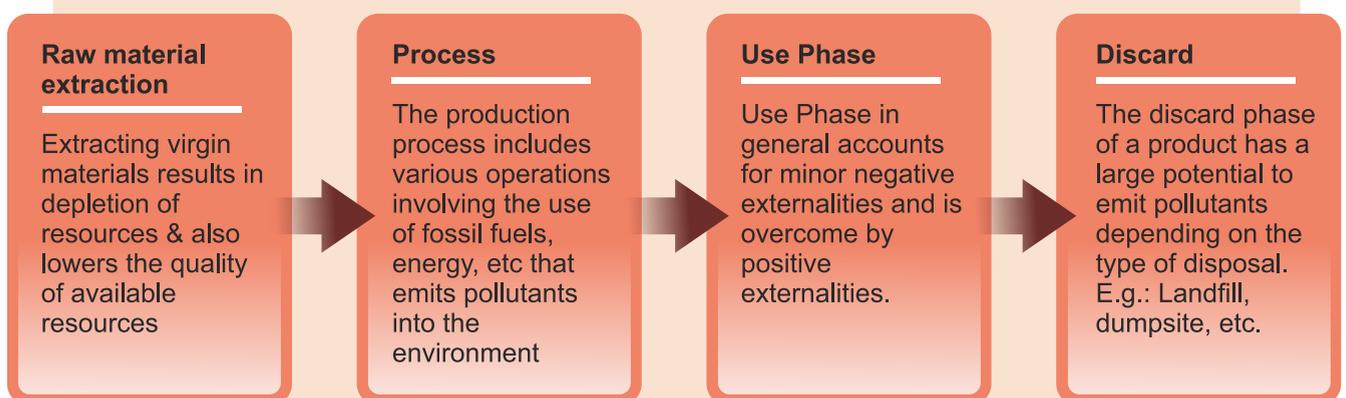


Figure 1. Negative externalities during cradle to grave cycle

Environmental Externatities: How it all started?

Millennium Ecosystem Assessment (MEA) and The Economics of Ecosystem and Biodiversity (TEEB): In the early 2000s, due to the efforts made over the decades, the ecosystem services started getting reflected in the policy arena as well. The Ecosystem Approach as adopted by UNEP-CBD and the Global Biodiversity Assessment are just examples of these. As discussed in the introduction, the MEA framework was one of the most important stepping stones in this regard. The objective of the MEA was to assess the consequences of the change in the ecosystem on human well-being. The multi-scale assessment approach used in MEA which includes component assessment undertaken at multiple spatial scales-global, sub-global, regional, national, basin and local levels, also involved natural and social science perspectives. It was the first assessment carried out with a focus on the impact of ecosystem changes on human well-being.

The MEA findings show that the human actions are depleting earth's natural resources and putting a strain on ecosystem, also assessment result shows that with appropriate actions it is possible to reverse the degradation of many ecosystems through the substantial changes in policy and practices. After the MEA framework in 2007, the biggest landmark in assessing the value of ecosystem services was the formulation of the TEEB project i.e. "The Economics of Ecosystem and Biodiversity" project. TEEB was a global initiative developed with a view to recognizing the value of the ecosystem and its service to help the decision-makers to identify

the wide range of benefits from the ecosystem and demonstrate values in economic terms. TEEB employed 3 core principle approaches namely, recognizing the purpose of the ecosystem, demonstrating the value of ecosystem in terms of costs & benefits and introducing the values in decision making in terms of waste-tax, environmental subsidy, etc. TEEB mainly focuses in comprehending the cost & benefit values accounted from natural ecosystem service such as wetlands, forest, river ecosystem, desert ecosystem, etc.

TEEB focuses on evaluating the hidden values of an ecosystem, cost of biodiversity loss and ecosystem degradation with the help of expertise from ecology, economics, and development to better equip the decision-makers for mainstreaming biodiversity and ecosystem considerations at all levels, including government and private. TEEB, in its first phase, released an interim report setting up the path for detailed assessment of biodiversity and ecosystem in economic terms with the ultimate aim of providing a tool to policymakers and decision-makers by helping them to incorporate the value of nature in their current decisions. TEEB followed 3 tier approach for the valuation: recognizing the value (in the biodiversity and ecosystem); demonstrating value (in economic terms, to improve the visibility, causing defense mechanism) and capturing value (in decision making).

There are different methods as reported by **(Pascual & Muradian, 2010)** used to estimate economic values associated with ecosystem according to TEEB which are as follows

- **Market price method:** Based on the commercial market, products, and benefits of an ecosystem are monetized.
- **Productivity method:** Quantify the financial value of the ecosystem-based on its service on traded goods.
- **Hedonic pricing method:** Quantify the economic value of service provided by an ecosystem based on its direct effect on other marketed goods.
- **Travel cost method:** Estimates economic values of ecosystem based on the amount spent by people to travel the site.
- **Damage cost avoided, Replacement cost and Substitute costs method:** Calculates economic value on the basis of the amount saved by preventing the loss, renewal or substitution of an ecosystem.
- **Contingent valuation method:** Economic value is estimated by directly inquiring among the people about the willingness to spend or accept compensation on particular ecosystem services based on hypothetical condition.
- **Contingent choice method:** Estimates economic values by asking people to market among the set of services in the ecosystem
- **Benefit transfer method:** Estimates the economic value of one location by transferring the study carried out at another location.

ExternE and Stern Review:

ExternE stands for “External cost of Energy”. In the early 90s till 2005 series of projects were carried out under this domain. “Impact-Pathway- Approach” is used for calculating the environmental external cost in the ExternE project series. Earlier damages caused to the environment were not integrated into the pricing system, these left out the cost is termed as externalities or the external cost based on the concept proposed in welfare economics.

Consideration of external cost in the assessment will help to design policy in order to reduce the burden of various economic activities on various socio-economic factors.

Globally, the sensitization around the topic and the impact of current living are known due to the Stern Review on the economics of climate change, a 700-page document released in

2006. The key

points from the report indicate at increased risks of serious and irreversible impacts from climate change associated with business as usual case. Further, the basic elements required for living i.e. food, air, water, and health are threatened by climate change. In 2006, it was estimated that arresting the carbon dioxide concentration to 500-550 ppm will require 1% of the global GDP whereas to arrest to 450 ppm, which is necessary for 2 0C, it may take up to 5 to 20% of the world's GDP.

In India, one of the early attempts of integrating the current accounting practices with the environmental parameters was done by CSIR-NEERI. The study indicates that if environmental degradation is taken into account the net GDP is negative. **Table 1** shows the valuation from the study made by **(Khanna and Ram Babu, 1997)**

Table 1: Integrated Environment and Economics Accounts (1980-90; 1991-95)

Item	Changes during (1980-90) (₹ Crore)	Annual Growth Rate	Change during (1991-95) (₹ Crore)	Annual Growth rate
Economic accounts GDP	+2,02,354	+5.66% (Without accounting for environmental degradation)	+87,721	+4.43% (without accounting for environmental degradation)
Environmental accounts				
• Air Environment Damage to health and ecology due to air pollution	-26,772	-11,308		
• Water Environment Ground water mining - Quantitate decline - Quality degradation surface water - Pollution avoidance cost	-96,900 -24,985 -1,014	-48,877 -13,386 -512		
• Land degradation - Productivity losses due to land degradation - Land rejuvenation cost	-1,38,750 -24,000	-61,768 -10,668		
• Forest Cover Decline Loss of services/ value	-2,704	-1,337		
Total environmental and ecological damage costs	-3,15,125-	1,47,856		
Adjusted growth in GDP (Accounting for Environmental degradation)	-1,12,771	-4.92%	-60,135	-4.74%

Source of data

1. National Accounts Statistics, 1995, central statistical Organization
2. India's National Income Statistics, October, 1996, Centre for Monitoring Indian Economy

Economic assessment in this chapter seeks to value the impact on the well-being of humans from a change in the surrounding environment as a result of emissions and adverse impacts by business/industrial sectors. The driver-based impacts here are classified into four sectors namely Greenhouse Gas (GHGs) Emission, Air Pollution, Water Pollution, and Solid Waste.

Greenhouse gases (GHGs): GHGs emissions due to various anthropogenic activities are significant in resulting in climate change, sea-level rise, glacier melting, global warming, etc. These have adverse effects on the surrounding environment, dwellers comfortability as well as health and economy.

Air pollution: The industrial and transportation sector emits various harmful pollutants such as particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO₂), nitrous oxide (NO_x), etc. that have an adverse effect on human health and natural environment.

Water pollution: Effluent and sewage

generated by the business sector are to be discharged through proper channels so that the pollutant level in final discharge is within safety limit for humans and another surrounding environment. Violation of discharge standards as per the central pollution control board (CPCB) for inland surface water bodies can bring about serious health impacts such as morbidity and mortality due to toxicity developed in water bodies ultimately demising the natural water source and inhabitant aquatic life.

Solid waste: Driver based impacts on human health and environment varies based on the waste disposal technique such as engineered landfill, open burning, informal dumping, recycling, etc.

1.1 Drivers of Impact

Sl. No.	Sectors	Drivers
1	Greenhouse gas (GHGs)	Carbon Dioxide (CO ₂) Methane (CH ₄) Nitrous Oxide (N ₂ O) Particulate Matter (PM) Ozone (O ₃) Water Vapour (H ₂ O) Sulphur Hexafluoride (SF ₆) Hydrofluorocarbons (HFC) Perfluorinated Compounds (PFC)
2	Air pollution	Carbon Monoxide (CO) Sulphur Dioxide (SO ₂) Nitrogen Oxides (NO _x) Other Toxic Pollutants (Organic, Inorganic and Heavy Metals)
3	Water pollution	Nutrient Pollutants (Nitrogen(N) & Phosphorous(P)) Pathogens (E-Coliforms) Emission of Air Pollutants
4	Solid waste	Leachate Release Greenhouse Gas Emissions (GHGs)

Monetary valuation is done based on the drivers in every stipulated four sectors that damage human health and the surrounding environment. The assessment uses empirical equations and a set of scientific/proved assumptions. Sector-wise damage cost assessment will be considered as a strong indicator of inevitable risk if suitable mitigation measures and policy structures remain abandoned.

1.2 Economic Evaluation of Environmental Impacts

Evaluation is generally carried out in 3 steps as showed in **Figure 2**.

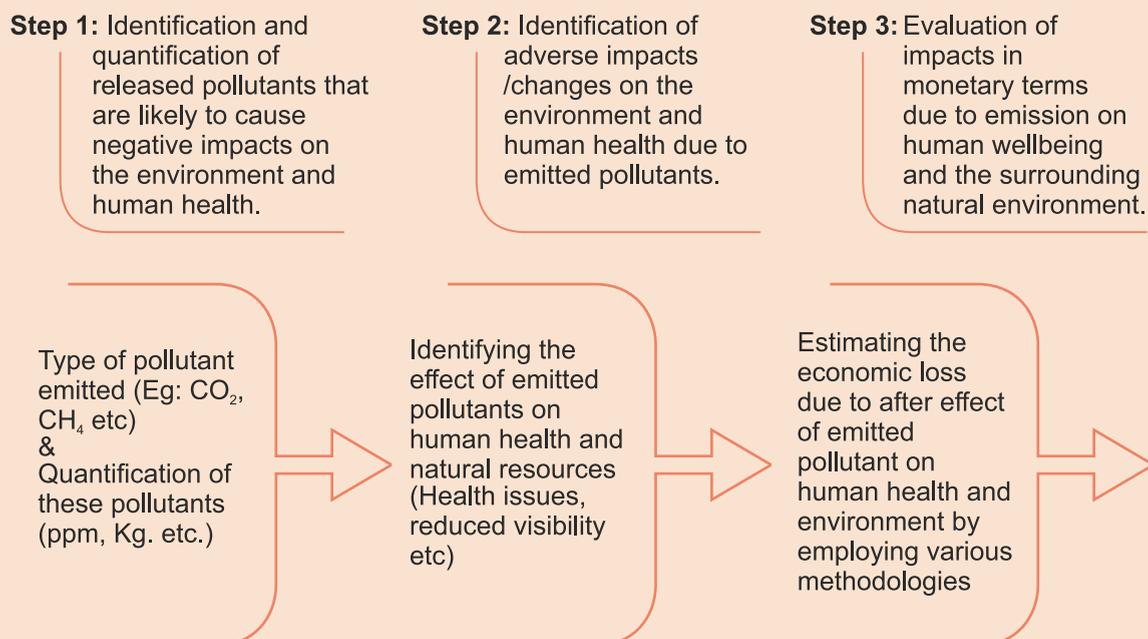


Figure 2. Indicative pathway towards environmental damages cost assessment

As can be seen from above, a lot of research has been done on the methodologies for environmental externalities assessment. Further, it is clear that it would be of great help to policymakers and regulators if the midpoint analysis conducted by life cycle assessment (LCA) and environmental impact assessment (EIA) are taken a step ahead and externalities are evaluated along with midpoint. The aim of this framework document is to help researchers and policymakers to carry out basic assessment

based on the available database and methodologies. Based on the drivers of environmental impacts, the detailed methodology to evaluate monetary damages is outlined in subsequent chapters. With the detailed methodology, illustrative case studies along with calculations are also provided for better understanding. Varied economic methodologies have also been showcased with the illustrative examples.

C H A P T E R **2**

Greenhouse Gases

Greenhouse Gases (GHGs)



The present world is largely facing problems with respect to rising ambient temperature, heatwaves, severe drought, and flood, rising sea level, melting of glaciers, altered precipitation pattern, reduced crop yield, shifting climate patterns, etc. Behind all these environmental outcomes, emissions of GHGs from various sources are the major contributors. Gases like CH₄, CO₂, water vapor, N₂O, HFCs, PFCs, and SF₆, etc. are considered as greenhouse gases as they absorb and emit solar radiation and thus warming the atmospheric surfaces ultimately leading to global warming. India is also one

of the major emitters of greenhouse gases and has a contribution of 6.82% of the global share, in the year 2017 with the amount of emission as 2,467 metric tonnes CO₂ equivalent, thus it is 3rd largest emitter of GHGs after China and United States (**URL 01**). The major portion of GHGs emission comes from energy generation sector (nearly 65%) due to use of fossil fuels, followed by agriculture sector which has contributed nearly 20%, industrial activities nearly 6% and waste disposal nearly 4% and some minor sectors may also contribute to GHGs like biomass burning, etc.

Potential Environmental Impacts due to GHGs Emission

Extreme weather events

The basics of physics pinpoint that GHGs add more energy into the atmospheres and as it warms, higher content of water vapor is held, resulting in decreased cold weather events. Emission of tonnes of GHGs into the atmosphere has resulted in severe heatwave conditions, drought, floods, rising sea levels (there), etc. making it one of the severe most impacts of climate change. However, there still exist uncertainties in attributing individual weather events to climate change. The damages and losses to human-associated with extreme weather events depend upon exposure and relative risk.

Rising mean temperature

Global warming is an unusual rise in the earth's average surface temperature. The mean temperature of the atmosphere is increasing every year and with the present rate of emission of GHGs, an average increase in temperature by 2 deg C in the next two or three decades

(**IPCC, 2018**) is inevitable. GHGs emission rate has been increased artificially by humans over the years mainly by fossil fuel use, deforestation of carbon-absorbing forests, land-use change, and agriculture.

Reduced crop yield

Rise in surface temperature, changing climate pattern, untimely rainfall, and frequent drought has a significant adverse impact on agricultural productivity and nutritional quality of

Rise in surface temperature, changing climate pattern, untimely rainfall, and frequent drought has a significant adverse effect on agricultural productivity and nutritional quality of food. There is climate-smart crop production being adopted intensifying crop yield and addressing climate change in sustainable way. Along with attributable impacts from climate change, agriculture itself contributes to GHG emissions. Studies suggest that organic farming features a reduction in GHGs emissions due to lower chemical inputs, but at the same time, emissions exacerbate due to greater food production while compensating to a lower yield (**smith et al., 2019**). The same study also reported that only way to reduce GHGs emissions is by limiting the farming area.

Loss of bio-diversity

Adverse impacts of climate change make the survival of plants and animals vulnerable. Change in climate patterns affects flora and fauna of an area in various ways as some of the species are very sensitive to climate change. There exists evidence related to threats on species such as physiological effect on green ringtail possum, coral bleaching, salinity issues in Muray darling Basin affecting aquatic biota, Ice melt at polar regions affecting polar habitats, etc.

Impact Drivers

Emission of Green house gases (CO₂, CH₄, Water vapour, N₂O, HFC, PFCs SF6 etc) from different sources like combustion of fossil fuel, agricultural activity, industrial activity, waste disposal sites, biomass burning etc.



Reduced air quality, increased temperature, sea level rise, shifting climate pattern, extreme weather events (flood, drought).

Adverse Impacts on Society

Reduced agricultural productivity, Thermal discomforts, Health impacts etc

2.1 Quantification of GHGs Emission

Quantification is the first step towards any assessment. There exists various monitoring instruments and empirical formulae to determine the GHGs emissions from an activity. The activity here includes transportation, industrial operations, power & energy or any other direct and indirect activities involving substantial amount GHGs emission

2.1.1 Quantification Using Continuous Monitoring System

The CO₂ emission can be monitored using a continuous monitoring system with flow monitoring system to measure the volumetric flue gas rate to determine the total CO₂ emissions. The continuous monitoring system may not favor in quantifying other GHGs such as water vapor, CH₄, HFC, etc. In such cases, empirical formulas can be used to quantify GHGs in terms of CO₂ equivalent.

2.1.2 Quantification Using Fuel Analysis Method

Gases such as CH₄ and N₂O emitted from stacks of industries can be quantified in terms of CO₂ emission. The quantity of emission can be estimated by mathematical calculations based on the type and quantity of fuel used as shown in **Eq (1) (EPA, 2016)**.

$$\text{Emissions of CH}_4 / \text{N}_2\text{O} = QF \times EF$$

Where, QF = Quantity of fuel (Kg)

EF = Emission factor (Values as per appendix –A) (EPA, 2016)

Eq (1)

Emissions of CH₄ and N₂O are calculated using Fuel heat content value based on the type of fuel used as shown in **Eq (2)** (EPA, 2016).

$$\text{Emissions of CH}_4 / \text{N}_2\text{O} = QF \times \text{HHV} \times EF \quad \text{Eq (2)}$$

Where, QF = Quantity of fuel (Kg)

$$\left. \begin{array}{l} \text{HHV} = \text{Fuel heat content} \\ \text{EF} = \text{Emission factor} \end{array} \right\} \text{ (Values as per appendix –A) (EPA, 2016)}$$

The derived emission values for CH₄ and N₂O are converted to CO₂ equivalent emission using global warming potential (GWP) as shown in **Table 2**

Table 2: Global warming potential (GWP) For GHG (IPCC, Fifth Assessment Report) (URL 02)

Greenhouse Gas	GWP
CO ₂	1
CH ₄	28
N ₂ O	265

To mathematically calculate Carbon Dioxide (CO₂) emission from fuel, the carbon content of the fuel must be multiplied with the ratio of molecular weight of CO₂ to the molecular weight of carbon as in **Eq (3)** (URL 03).

$$Q_{\text{CO}_2} = (C_{\text{Fuel}} / E_{\text{Fuel}}) \times (M_{\text{CO}_2} / M_c) \quad \text{Eq (3)}$$

Where,

Q_{CO_2} = specific CO₂ emission [kgCO₂/kWh]

C_{Fuel} = specific carbon content in the fuel [kgC/kgfuel]

E_{Fuel} = specific energy content in the fuel [kWh/kgfuel]

M_{CO_2} = Molecular weight Carbon Dioxide [kg/kmol CO₂]

M_c = Molecular weight Carbon [kg/kmol Carbon]

} Values as shown in **Table 3**

Table 3: Default value of Specific carbon and energy content based on type of fuel utilised (Source: Engineering tool box)

Fuel	Specific carbon content (kgC/kgfuel)	Specific energy content (kWh/kgfuel)	Specific CO ₂ emission (amount of fuel basis), kgCO ₂ / kgfuel
Wood	0.50	4.5	1.83
Subbituminous	0.4	6.8	1.47
Propane	0.82	13.8	2.99
Petroleum Coke	0.89	9.4	3.26
Peat	0.52	4.7	1.91
Methanol Fuel	0.37	5.5	1.37
Methane	0.75	15.4	2.75
LPG	0.82	13.7	3.01
Lignite	0.3	3.9	1.10
Kerosene	0.82	12.0	3.00
Heavy Fuel oil	0.85	11.6	3.11
Gasoline	0.90	12.9	3.30
Ethanol Fuel	0.5	8.3	1.91
Diesel	0.86	12.7	3.15
Coke	0.77	7.2	2.82

Fuel	Specific carbon content (kgC/kgfuel)	Specific energy content (kWh/kgfuel)	Specific CO ₂ emission (amount of fuel basis), kgCO ₂ / kgfuel
Butane	0.83	13.6	3.03
Bituminous	0.65	8.4	2.38
Anthracite	0.92	9.0	3.37

The quantified CO₂ emission (Kg/Kwh) is then multiplied with an energy consumption rate of the boiler (Kwh) and operating time to arrive at total CO₂ emission (Kgs).

2.1.3 Quantification Using Life Cycle Assessment Modelling

Life Cycle Assessment (LCA) is a tool to identify the environmental outcomes during the stages of product life. (from cradle to grave). The model uses various inputs corresponding to raw material, the process involved, material flow, usage, and disposal. The model assesses the final impacts on environment such as acidification, climate change, abiotic resources depletion, ecotoxicity, eutrophication, human toxicity, etc. associated with each of the processes considering various emissions (particulates, gases, GHGs, physio-chemical parameters, heavy metals, etc.) into an ecosystem.

2.2 Monetary Evaluation of Damages due to GHGs Emission

Carbon pricing is the tool used for financial decisions on social and environmental costs of climate change. Carbon pricing attaches value to emission as an initiative to spur low carbon innovation. Moreover, the method has been developed as a common choice in risk management and achieving the industry level target in the reduction of GHGs emissions. The approach in determining the carbon pricing involves internal carbon fees, shadow price, implicit price, hybrid carbon pricing and social cost of carbon.

2.2.1 Internal Carbon Fee Method

The internal carbon fee defined as a cost that a corporate attaches to GHGs emissions in various economic and other activities. This can target the high emitter activities to take a shift towards low emissions by undertaking necessary policy decisions and measures. Unlike regulatory taxes and fee schemes, the pricing remains internal within the organization. The observed price range for companies using an internal carbon fee is from \$5-\$20 per metric ton (URL 04). The internal carbon price developed by Dalmia Bharat cement was \$11 per CO₂ metric ton. However, the methods are indigenously developed and internalized by the organizations and hence transferring the values directly can have ambiguity.

2.2.2 Shadow Price Method

The shadow price is the hypothetical cost assigned by the corporates with respect to emissions to assess the risk associated with different business activities. This helps to stems the higher carbon emission activities and prioritizes on low emission investments and regulations in the business activities. The observed range of shadow price varies from \$2-\$892 per ton (URL 04). Shadow price considered by the ESSAR group at the oil & gas sector was reported to be \$15 per ton of CO₂ and Infosys associated with business consulting, information technology, resource outsourcing used \$11 per ton of CO₂ (Gajjar & Adhia, 2018).

2.2.3 Implicit Price Method

Implicit price defines as the value of emission's impact by analyzing the cost incurred by the organization in curbing the emissions. The abatement measures include the amount spent so as to shift towards renewable energy resources etc. The implicit price expressed in a metric tonne of CO₂ equivalent is determined by comparing the cost of abatement measure with the subsequent reduction in emission.

2.2.4 Hybrid Pricing Method

Some organizations combine the above-mentioned methods to meet GHGs emission reduction goals. Mahindra & Mahindra, a utility and tractor manufacturing sector, use the approach of hedonic pricing combining implicit price for green investment and shadow price at \$10 per metric ton CO₂. This approach aids the organization by advancing towards low-cost abatement measures so as to reduce the greater reduction of emissions in the future.

2.2.5 Social Cost of Carbon (SCC) Method

All the previously mentioned approaches are associated mainly with corporate sectors and corresponding policies/regulations to curb indigenous CO₂ equivalent emissions. No common relation could be derived with respect to previously mentioned methods and CO₂ equivalent emitted irrespective of sectors. The social cost of carbon establishes a general relation between CO₂ equivalent emissions and monetary damage. The SCC method provides a comprehensive estimate of climate change damages and include damages such as changes in net agricultural productivity, human health, property damages from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. However, given current modeling and data limitations, it does not include all important damages. But, it is needless to say that it gives far better estimates than the other methods given above since it actually addresses the problem of social and environmental damages associated with GHG emissions. The method is largely employed by EPA (Environmental Protection Agency) and other federal agencies to study the impact of climate change on the environment (USEPA, 2017). For regulatory impact analysis social cost of CO₂, (2015-2050) as suggested by USEPA is mentioned in **Table (4)** and the damage is estimated using **Eq (4)**.

$$SCC = \text{Quantity of CO}_2 \text{ emitted (tCO}_2\text{)} \times (\text{cost of CO}_2 \text{ per tones)} \times \text{exchange rates} \quad \text{Eq (4)}$$

Table 4: Social carbon cost as per USEPA (USEPA, 2017)

Discount rate and statistic				
Year	5% Average	3% Average	2.5% Average	High impact (95th pact at 3%)
2015	\$11	\$36	\$56	\$105
2020	\$12	\$42	\$62	\$123
2025	\$14	\$46	\$68	\$138
2030	\$16	\$50	\$73	\$152
2035	\$18	\$55	\$78	\$168
2040	\$21	\$60	\$84	\$183
2045	\$23	\$64	\$89	\$197
2050	\$26	\$69	\$95	\$212

Based on above methods, an example is shown so as to how to use the above values and methods to arrive at monetary loss associated with GHGs emissions.

Example:

An industry violating emission norms and emitting methane 5 tonnes per day. The environmental damage cost associated with it can be calculated in the following steps. Carbon equivalent of CH₄ = 5 tonnes CH₄ * 28 (GWP) = 140 tonnes of CO₂

It is recommended to use the SCC approach since it encompasses the actual damages associated with these emissions. Further, unless a high impact value is to be calculated, 3% average discount rates values can be used for emissions. High impact scenario can be used as an upper cap to the damages.

Social carbon cost per tonne for 2019 (using moderate impact scenario) = \$40.8 = ₹3556 (including inflation of 1.23 from 2017 to 2019) (using Social cost of CO₂, 2015-2050, USEPA)

SCC = ₹ 4,97,915 per day

SCC (High Impact) = 119 x 140 x 70.87 x 1.23 = ₹14,52,253 per day.

The above values give a better estimate of the global damages which occur due to GHGs emission in any part of the world. The internal carbon pricing based on other methods would yield a much lower number in the range of 50 thousand rupees to ₹ 1 lakh only. Thus it is important to use a damage based approach rather than relying on values that are devised for internal or corporate to corporate-based trading only. The method of internal carbon pricing is mostly a market-based value and does not include damages portion which is the most important factor in the context of environmental damage cost assessment.

C H A P T E R 3

Air Pollution

Air Pollution



Business activities in most of the sectors result in harmful emission of particulates and gaseous pollutants to air pollution. Pollutants are either emitted directly (primary pollutants) or are formed in the atmosphere due to the reaction of two or more pollutants (secondary pollutants). Most of the primary and

secondary air pollutants create a negative impacts on human health, visibility, agriculture, tourism, and other components of environment. There is a need to understand the level of impact these pollutants generate and monetizing these impacts/damages is one of the ways by which the scale of impact can be communicated.

Impact Pathways for Air Pollution

In order to quantify the impacts in monetary terms, it is essential to understand the mechanism by which the impact happens. The impact pathway reveals, how emitted pollutants lead to different adverse outcomes on human wellbeing and another natural environment. The sources of pollutants and their impacts are discussed in sections given below.

Primary Pollutants

Particulates:

Particulate matter (PM) are generally suspended particles being emitted from automobile & industrial exhaust, agro-residue burning, soil dust, etc. Generally, PM_{10} is considered coarse and $PM_{2.5}$ as fine based on the diameter of the particulates.

Oxides of Nitrogen and Sulphur:

Oxides of Nitrogen (NO_x) & Sulphur (SO_x) are emitted largely due to fossil fuel combustion.

Carbon Monoxide:

Carbon monoxide (CO) is mainly emitted from the vehicular exhaust and industrial stacks

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Secondary Pollutants

Ammonium (NH_4^+):

NH_3 emissions into air are due to nitrogen-based fertilizers. Emitted ammonia reacts with acid pollutant and produce fine ammonium ion (NH_4^+) containing aerosol.

Ozone (O_3):

O_3 is formed due to the combination of volatile organic compounds and Nitrous oxide in the presence of sunlight.

3.1 Adverse Outcomes on Society & Environment

Emission of primary pollutants and formation of secondary pollutants result in poor air quality ultimately leading to some adverse impacts on human and environment as follows:

- 1. Health effects on human:**
Emission of pollutants leads to respiratory diseases such as bronchitis, asthma, allergy, lung disorder, pulmonary diseases, Lung cancer, etc.
- 2. Visibility:**
Navigation during the time of transportation is largely affected due to the formation of smog. PM and O₃ are the major contributors to reduced visibility.
- 3. Impacts on flora:**
Reduced air quality within the atmosphere can retard the growth of trees affecting metabolism at the cellular level. Acid rain can also damage trees and acidifies soil reducing the yield.
- 4. Wear and tear of materials:**
Acidic components formed due to the reaction of pollutants in the atmosphere result in acid rain that has a tendency to corrode the building materials. PM has discoloring properties reducing aesthetic beauty and quality.



Once the impact outcome is known, the impacts can be quantified in monetary terms. To understand the economic cost associated with air pollution, the following steps need to be worked out.

3.2 Quantification of Pollutants

Discrete methods to quantify air pollutants concentration other than EIA and LCA reports are mentioned, as per CPCB guidelines, in **Table 5**.

Table 5: Methods of measurement based on pollutant type (CPCB, 2013)

Sl. No	Pollutant type	Method of measurements
1	Particulate matter	(PM ₁₀ & PM _{2.5}) Gravimetric TEOM Beta Attenuation Air sensors
2	Sulphur dioxide (SO ₂)	Improved West and Gaeke Method Ultraviolet Fluorescence Air sensors
3	Nitrogen dioxide (NO ₂)	Jacob & Hochheiser modified (NaOH-NaAsO ₂) Meth Gas Phase Chemiluminescence Air Sensors

Sl. No	Pollutant type	Method of measurements
4	Ozone (O ₃)	UV Photometric Chemiluminescence Chemical Method Air Sensors
5	Carbon Monoxide	(CO)Non dispersive Infrared (NDIR) Spectroscopy Air sensors
6	Ammonium (NH ₄ ⁺)	Air sensors

In addition to ground measurements, modeling can be used to understand the dispersion of pollutants in ambient air. AERMOD (American meteorological society & environmental protection agency model) dispersion model can be used to determine the change in concentration of air pollutant over the impact zone. The model uses various meteorological factors such as wind speed, direction, cloud cover, temperature, humidity, precipitation, etc. to generate isopleth of various pollutant concentrations such as PM₁₀, PM_{2.5}, SO_x, NO_x, O₃, NH₃, etc. based on hourly averages.

Secondary pollutants such as O₃, NH₃ isopleth may be less accurate as the properties of these pollutants are not recorded in the AERMOD database. In such cases, CALPUFF (California Puff) dispersion modeling can also be preferred. Both AERMOD and CALPUFF do not hold well for modeling vehicular emission, in such cases CALINE (California Line) model is preferred.

Other than pollutant concentrations, meteorological conditions of the location are to be recorded by setting up a met station for a minimum duration of 3 months as per CPCB standards. If not, the Indian Meteorological Department recognized met stations data can be taken for model simulation.

3.3 Valuation of Air Pollution Damages

The above outcomes can be used to calculate the monetary impacts of air pollution, which is a driver of the impact. There are various approaches like the cost of illness, value of statistical life, opportunity cost, shadow cost, that can be used for determining the monetary damage value. The various dimensions to the calculation and related results are given in the subsequent sections.

3.3.1 Health Impacts (Mortality & Morbidity) Valuation

Value of statistical life and Cost of illness method

Pollutants such as PM₁₀, NO_x, SO_x result in various health damages such as respiratory diseases, chronic obstructive pulmonary diseases (COPD), cardiovascular diseases and total mortality. The determined pollutant concentration will be compared with National Ambient Air Quality Standard (NAAQS, 2019) and subsequent damage cost will be evaluated for breached concentration using formulas **Eq (5) – Eq (9)**. Health risk assessment is calculated using factors such as NAAQS standard on pollutant concentration as in **Table 6**, relative risk and baseline incidence as shown in **Table 7**. Relative risk is the probability that a person is likely to develop diseases via exposing to that of a person developing the same diseases without the exposure towards air pollutants (**Rothman et al., 2008**). The valuation is carried out for both morbidity and mortality using value for statistical life (VSL) and cost of illness (COI) method respectively. VSL is used for mortality cases, which can be calculated on the basis of baseline incidences and relative risk of a particular disease. COI includes the total cost incurred such as medicinal cost, travel cost, hospital admission and lost day (**Maji et al., 2017**).

Table 6: National Ambient Air Quality Standards (NAAQS, 2019)

Parameters	NAAQS standard ($\mu\text{g}/\text{m}^3$)	
	Annual mean	Daily mean
PM ₁₀	60	100
NO ₂	40	80
SO ₂	50	80

Relative risk for exposed category 'c' $R_r(c)$ is calculated using Eq (5). Where C_a is ambient air concentration of pollutant 'K', C_w is NAAQS permissible standard for the pollutant 'K' as shown in Table 6, R_r is relative risk for the pollutant 'K' and the value for the same is shown in Table 7.

$$R_r(c) = 1 + (C_a - C_w) \times (R_r - 1) / 10 \quad \text{Eq (5)}$$

Population attributable risk (PAR) is calculated using Eq (6). Where $\rho(c)$ is proportion of population in 'C' category being exposed to the pollutant.

$$PAR = (\sum [R_r(c) - 1] \times \rho(c)) / (\sum [R_r(c) - 1] \times \rho(c) + 1) \quad \text{Eq (6)}$$

I_e is the rate attributed to exposure in population and is calculated using Eq (7). Where I_w is Baseline incidence per 10^5 population. The values for the same are shown in Table 7.

$$I_e = I_w \times PAR \quad \text{Eq (7)}$$

I_{ne} is the estimated number of cases of mortality/morbidity is calculated using Eq (8). Where N is total population.

$$I_{ne} = I_e \times N \quad \text{Eq (8)}$$

Table 7: Relative risk & baseline incidence corresponding to short term mortality/morbidity

Parameters	Health effect	Relative risk (Rr)	Baseline incidence (I_b)	References
PM ₁₀	Mortality	1.0044	1013	(Balakrishnan et al., 2011; Dholakia et al., 2014)
	Cardiovascular Mortality	1.006	497	(Zhang et al., 2010b; Shang et al., 2013)
	Respiratory Mortality	1.0082	66	(Zhang et al., 2010b; Shang et al., 2013)
	COPD Morbidity	1.005	101.4	(Lai et al., 2013)
	Respiratory Disease	1.0039	1260	(Chen et al., 2010; Lai et al., 2013)
	Cardiovascular Disease	1.0021	436	(Chen et al., 2010; Lai et al., 2013)
NO ₂	Total Mortality	1.0242	543.5	(Huang et al., 2011; Shang et al., 2013)
	Cardio vascular Mortality	1.0206	497	(Huang et al., 2011; Shang et al., 2013)
	Respiratory Mortality	1.0371	48.4	(Huang et al., 2011; Shang et al., 2013)
	COPD Morbidity	1.009	101.4	(Lai et al., 2013)
	Respiratory Disease	1.006	1260	(Chen et al., 2010; Lai et al., 2013)
	Cardiovascular Disease	1.0095	436	(Chen et al., 2010; Lai et al., 2013)

Parameters	Health effect	Relative risk (Rr)	Baseline incidence (I _b)	References
SO ₂	Total Mortality	1.0068	1013	(Wong et al., 2008; Shang et al., 2013)
	Cardiovascular Mortality	1.013	497	(Wong et al., 2008; Shang et al., 2013)
	Respiratory Mortality	1.0106	66	(Wong et al., 2008; Shang et al., 2013)
	COPD Morbidity	1.007	101.4	(Lai et al., 2013)
	Respiratory Disease	1.0014	1260	(Chen et al., 2010; Lai et al., 2013)
	Cardiovascular Disease	1.0079	436	(Chen et al., 2010; Lai et al., 2013)

The latest values of the global burden of disease can also be used to understand the relative risk related to various diseases (**GBD, 2010**). and Total health damage cost calculated by VSL/COI by (**Maji et al., 2017**) is shown in **Table 8**. The values suggested are for the city of Agra which need to be converted for the study area using per capita income for both cities using **Eq (9)**

$$VSL \text{ or } COI_{Study \text{ Region}} = (VSL / COI_{Agra}) \times \left(\frac{(\text{Per capita income Study region})}{(\text{Per capita income agra})} \right) \quad \text{Eq (9)}$$

Table 8: Mortality and Morbidity cost using Value of statistical life (VSL) and Cost of illness (COI) method respectively. (**Maji et al. 2017**)

Health effect	Value (in ₹ as 2010)	Value (in US\$ as 2010)
Mortality	2683680	60000
COPD Morbidity	22824	510
Respiratory Morbidity	58280	130
Cardiovascular Morbidity	11906	266

3.3.2 Monetising Damages due to Poor Visibility

To date, there are hardly any studies in India that calculate the extent of damages due to poor visibility. However, given the gap and importance of the topic, there exists a need to carry out site-specific studies so as to come up with a common methodology to assess country-level damages. Willingness to pay (WTP) method (**Muller & Mendelsohn, 2007**) and direct transfer function method (**PWC, 2015**) are previously used methodologies to assess the damage due to poor visibility. WTP consists of a set of survey questions that determine the dwellers' willingness to pay so as to eradicate the problem of poor visibility due to air pollution. A site specific generic equation using statistical tool correlating willingness amount and other known dependent parameters (population density, average income, extent of pollution area, average rainfall, average temperature & air quality index) affecting visibility needs to be developed as in **Eq (10)**. This can be used as a direct transfer function in determining the monetary loss due to poor visibility which avoids the need for WTP survey every now and then.

$$I_p = \left[\frac{(I_{HI} - I_{LO})}{(B_{HI} - B_{LO})} \right] * (C_p - B_{LO}) + I_{LO} \quad \text{Eq(10)}$$

Where,

B_{HI} = Breakpoint concentration greater or equal to given conc.

B_{LO} = Breakpoint concentration smaller or equal to given conc.

I_{HI} = AQI value corresponding to B_{HI}

I_{LO} = AQI value corresponding to B_{LO}

C_p = pollutant concentration Finally;

AQI = Max (I_p) (where; $P= 1, 2, \dots, n$; n denotes pollutants)

3.3.3 Monetising Damages due to Reduced Agricultural Productivity

No India specific studies are carried out to assess damage on agricultural productivity loss due to air pollution. However there exist, certain studies carried out for foreign countries such as (Muller & Mendelsohn, 2007; PWC, 2015), but when values are transferred directly can create ambiguity as the values are site-specific. However, a similar approach can be followed to develop India's specific framework. Marginal damage cost is the suggested method to quantify the monetary damage due to agricultural productivity loss. The method determines the cost incurred due to release of additional units of pollutants. India, being a victim of rising air pollution, demands an urgent need in developing a country-specific framework to assess each damage individually. Alternatively, benefit transfer can also be employed over the marginal damage cost values along with subsequent uncertainties.

In order to show a case of how the calculations can be carried out, an example is given in detail for the monetization of health impacts of air pollution..

Example:

City 'X' with total population 25 lakhs showed annual mean concentration for various pollutants such as PM₁₀, NO₂ & SO₂ as 110, 35 & 52 ppm respectively. Calculate the total damage cost due to health risk (Mortality & morbidity).

Mortality due to PM₁₀ exposure

Considering that the given population is subjected to short term exposure, relative risk due to exposed pollutant concentration using Eq (5).

$$Rr(c) = 1 + (110 - 60) \times (1.0044 - 1) / 10$$

$$Rr(c) = 1.022$$

Using Eq (6) Population attributable risk (PAR) is calculated as follows

$$PAR = (\sum\{[1.022 - 1]\} \times 1) / (\sum\{[1.022 - 1]\} \times 1 + 1)$$

Where, $\rho(c) = (\text{Number of days of exposure in a year}) / 365$
 $PAR = 0.02153$

Using Eq (7) & (8) the number of cases subject to total mortality due to exposure of pollutant PM₁₀ is estimated

$$ne = 1013 \times 0.02153 \times 25$$

$$ne = 545.3 \text{ cases}$$

Total monetary loss using VSL method is estimated using Eq (9). Here per capita income of Mumbai district was considered for VSL estimation.

$$VSL = 2683680 \times \frac{188739}{68795}$$

VSL = ₹ 7.4 million as of 2010 per case

Damage cost due to mortality as a result of short term exposure of PM₁₀ inflated for the year 2019 is ₹ 13.24 million (by considering inflation rate 1.79)

Similarly, Mortality/Morbidity cost estimated due to short term exposure of pollutants are estimated

Table 9: Mortality/Morbidity cost estimated due to short & long term exposure of pollutants

Pollutant	Health effect	Health damage cost (million, ₹) as of 2019
PM ₁₀	Total Mortality	7184
	Cardiovascular Mortality	4769
	Respiratory Mortality	856
	COPD Morbidity	7
	Respiratory Disease	17
	Cardiovascular Disease	6
SO ₂	Total Mortality	1
	Cardiovascular Mortality	1
	Respiratory Mortality	0.1
	COPD Morbidity	0
	Respiratory Disease	0
	Cardiovascular Disease	0
Total		7216

It is observed that, mentioned annual mean concentration for NO₂ is within the NAAQS 2019 standards, hence health risk assessment due to the pollutant 'NO₂' was not carried out. In the case of total damage cost estimation, only total mortality cost for individual pollutants was considered to avoid double counting. The total damage due to exposure of all the breached pollutant concentration is ₹7216 million as of 2019.

The above example gives an idea related to the calculation of monetary damages of the health impacts of air pollution. For other damages like loss of agricultural productivity, visibility, tourism losses; the approaches are given in the chapter can be used. A detailed survey of on-ground data is required to calculate the actual damage cost of air pollution.

C H A P T E R 4

Water Pollution

Water Pollution



Water pollution is amongst the main problems faced by developing countries. Many economic activities such as production, transportation, consumption in all sectors result in a direct and indirect discharge of a pollutant in water bodies.

Despite the innovation of many water treatment technologies, the problem of water pollution is rising globally. This chapter includes the methodology to assess and identify the cost of water pollution. To assess the damage cost associated with water pollution, it is necessary to identify the characteristics and fate of a pollutant. Also, substance and contextual data such as bio-accumulation factor, does response, wastewater treatment level, geophysical parameters, enforcement of regulations, characteristics of receiving water body,

consumption of water and food product derived from the affected area, etc. are required to put monetary value for damage. A diverse range of pollutants find its way in water bodies through various means showing equally diverse effect on human beings and ecosystems. Quantifying pollutant discharge can be done with the help of various water modeling equations and software. If data regarding direct discharge, drivers associated with the discharges are not available then the application of LCA can be used to get a wholesome idea for quantification of pollutants which is discharged from a source. Gathering data is an important step to evaluate the environmental impact of water pollution. Described methodology considered three types of data (PWC, 2015).

a) Metric Data: This data is related to the discharge of effluent to the water from sources.

- Pollutant source
- Pollutant Type
- Pollutant quantity

b) Substance Data: This data is related to the characteristics of pollutants.

- Physical / Chemical characteristics of pollutant (molecular weight, Partitioning coefficient, degradation rate in water, air, soil, sediment)
- Bio-accumulation factor
- Dose-response to human health
- Impact of pollutant on human health/ecology/receiving water body

c) Contextual Data: This data is related to the context in which pollutant are released

- Wastewater treatment levels
- Enforcement of regulation
- Destination of pollutant
- Characteristics of receiving water body
- Immediate exposure to human
- Geophysical data
- Water consumption from affected water bodies
- Consumption of meat, dairy, fruits, vegetables, grains, fish, and seafood from the affected areas.

4.1 Overview of Impact of Water Pollution

Water pollution caused due to accident or prolonged discharge of pollutants in water bodies leaves an adverse impact on the overall ecosystem. Water pollution has already become a serious problem in India and other part of world. To evaluate the monetary value of water pollution pollutants are categorized in the following classes. There are numerous individual pollutants that can be classified under the following key categories.

Disease-causing agents

Harmful microorganisms such as Escherichia- coli (E- coli) can be released in water by the sewage discharge. Also, industrial discharge from food, leather, and bio-technical industry releases pathogens in water.

Synthetic organic pollutants

These include pesticides, synthetic organic chemicals, and detergents. These pollutants are of bioaccumulative in nature and can become toxic in their subsequent stages in the ecosystem.

Plant nutrients

Nitrogen and phosphorus are essential elements for plants and animal growth. Presence of these nutrients in large quantities causes an algal bloom in water bodies leading to depletion of oxygen from

water bodies

Inorganic chemicals and minerals
These include inorganic salts, mineral aids, finely divided metals and metal

compounds.

Sediments

Sediments include soil, sand and mineral particles washed into the aquatic environment by storms and flood waters. Also, a large deposit of pulverized coal, ash, various industrial solids disposed into rivers and marine waters.

Radioactive substances

Uranium and thorium mining and refining, nuclear power plant, industrial use of radioactive materials can cause radioactive pollution in water bodies.

Oil

Oil spillage from industrial effluents, oil refineries, oil storage tanks, automobile waste oil, and petrochemical plants lead to water pollution.

Thermal discharge

Discharge water used for cooling in power plants and industry causes thermal pollution of water.

4.2 Societal and Environmental Impact

Pollution of water affects adversely the environment. According to reports, the heavy percent of India's surface water resources and groundwater reserves are contaminated by toxic, inorganic, organic, biological pollutants. In 2015, 0.64 million deaths per year are reported due to water pollution in India. In developing countries the industry is responsible for releasing an estimated 300-500 million tonnes of toxic pollutants into the water every year (WWAP, 2012).

Damage to the human health:

Inorganic pollutants, toxic chemicals, heavy metals that are discharged from various industrial sources into the water bodies can affect the health of humans who come in direct contact with it. Prolonged exposure of these toxic chemicals to the human can cause various acute and chronic illness.

Damage to fishery:

Bio-accumulation of heavy metals and other toxic chemicals in fish and other sea products damages the fishery industry. Also, depletion of oxygen in water leads to a decrease in fish yield resulting in economic loss.

Damage to recreational function:

Eutrophication condition of water bodies can

affect the recreational value of it. Toxic bloom, water congestion, unpleasant odor can lead to the loss of the recreational value of water bodies.

Introduction of toxic substances in water bodies causes a decrease in livestock, crop yield. Accumulation of toxic or nutrients in the ecosystem can lead to loss of regulation and supporting services.

Other indirect damages:

Eutrophication of water bodies affect the potential sale value of local property. Also due to the oil spill, there is a reduction in the number of sea creatures which ultimately hampers the seafood industry.

4.3 Monetary Evaluation of Damages due to Water Pollution

There are very few previous studies which are carried out in India to estimate environmental damages due to water pollution. In order to develop a country specific framework, studies carried out by foreign authors can be used. Alternatively, value transfer can also be used over completed studies of different locations along with subsequent uncertainties.

To drive the monetary value of impact associated with water pollution relationship between levels of activity to the degree of physical damage should be developed. The impact pathway describes the link between activities, environmental impact, and resultant outcomes. The detailed pathway is shown in **Figure 3**.

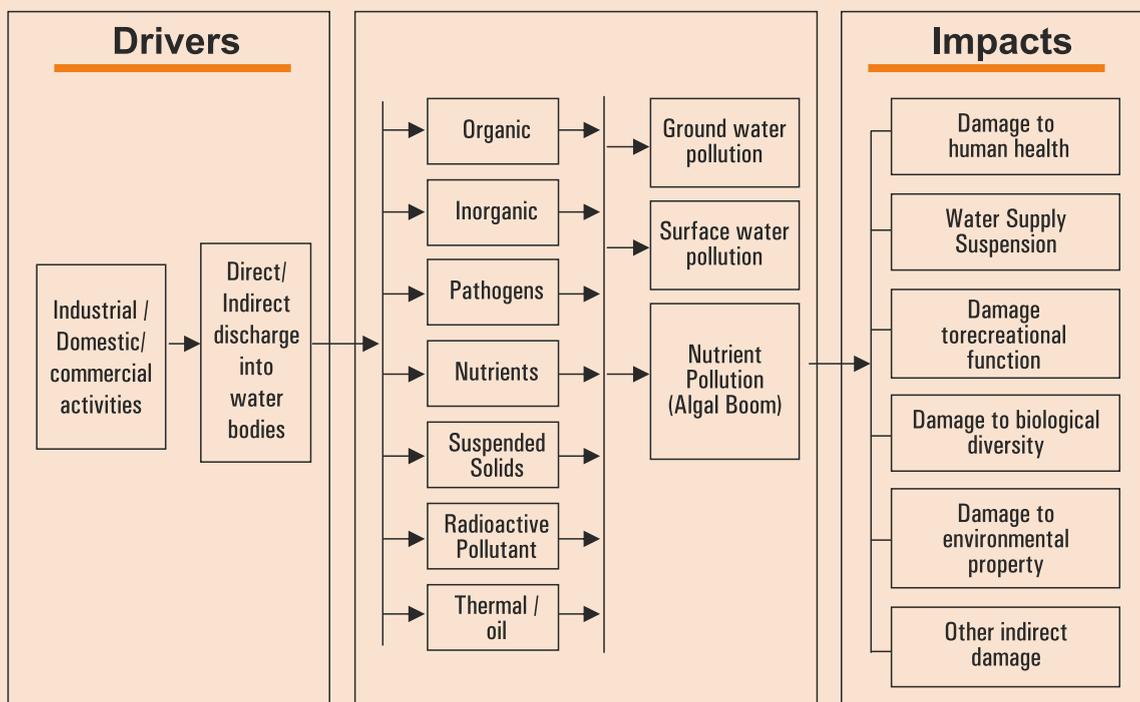


Figure 3: Drivers, outcomes and impacts of water pollution (Adopted from PWC, 2015)

4.3.1 Damage to Human Health

Human health damage refers to both the loss of human lives and health harm due to pollution. The dose-response method based on the type of pollutant present within the human body can be used to estimate the damage cost. Site specific toxicity survey needs to be carried out on health affected humans to analyse the dose-response factor of individual heavy metal contaminants present in water. Total damage incurred due to the presence of pollutants can be determined by the cost of illness or DALY using the **Eq (11)**. Cost of illness refers to total cost (Hospital admission charges) incurred in treatment and Disability-adjusted life year (DALY) refers to total working days lost due to illness.

$$\text{Total Health damage due to pollutant 'K'} = \text{Dose response} \times \text{Discharged Pollutant concentration 'K'} \times \text{Cost of illness / DALY} \quad \text{Eq(11)}$$

For the valuation of damage cost associated with fatality due to water pollution person's potential economic production shall be considered. Also, the cost of one fatality includes the living cost of the dependent. Thus the cost of one fatality depends on age of victim, his income, number of dependents on him. By assuming the life expectancy of healthy human 80 years we can estimate the fatality cost using **Eq (12)**

$$\begin{aligned} \text{Cost of one fatality} &= \text{Victim's own loss in age} + \text{Cost of dependent's living needs} \\ &= [\text{Victim's income} \times (80 - \text{actual age})] + [\text{Income} \times (\text{age of dependent}^*)] \end{aligned} \quad \text{Eq(12)}$$

Age of dependent*:

- a) For dependent above 60 yrs.: 80 – age of dependent above 60 years
- b) For dependent below 18 yrs.: 18 – age of dependent below 18 years

Total cost associated with the damage to human because of water pollution can be calculated by adding cost of fatality and cost of human health as shown in **Eq (13)**

$$\text{Economic loss of damage to human health} = \{(\text{Economic loss of one fatality} \times \text{No. of fatalities}) + \text{Total health damage due to pollutant } k\} \quad \text{Eq (13)}$$

4.3.2 Damage to Fisheries

Surface water pollution directly affects the production of fishes and the population of fishes. To recover the fish yield in water bodies, it is assumed that rejuvenation of the water body for a certain time period is required. To roughly estimate the recovery time of the aquatic product, the total days required for rejuvenation of contaminated water body is assumed. Assuming that before the quantities of aquatic product recover, fishing is forbidden, thus the economic loss of damage to a fishery can be expressed using **Eq (14)**.

$$\text{Total monetary damage on fishes} = \text{Daily gross income from fisheries} \times \text{Total days for rejuvenation} \quad \text{Eq (14)}$$

In case, fishing restricted areas or areas where fishing activity is not prominent, rejuvenation cost related to surface water body treatment which can be also termed and analyze under control cost method can be expressed as total damage cost associated with water pollution of that area.

4.3.3 Damage to Recreational Function

There are many recreational activities associated with surface water quality such as swimming, angling, boating, etc. Water pollution affects the economic function of these recreation activities. To evaluate the cost associated with the recreation, willingness to pay (WTP) survey can be carried out. The survey determines the total amount; people are willing to pay to restore the damaged recreational site. The determined value can be considered as the total monetary value of the damaged recreational site. Alternatively, the control cost method can also be employed as a purpose of restoration. To evaluate the cost associated with the recreational function (**Hong Yao et al., 2016**) suggested formulae as in **Table 10**.

Table 10: Formulae & Nomenclature to estimate damage associated with recreational area

Formulas	Nomenclature
$L_R = L_{SM} + L_{BT} + L_{AG}$	L_R : the loss of damage to recreation L_{SM} : the loss of swimming L_{BT} : the loss of boating L_{AG} : the loss of angling L_{LM} : loss of leisure means
$L_{SM} = P_{SM} \times N_{SM} \times d$	P_{SM} : the price of replacement of swimming per person (₹/cap/ day) N_{SM} : the number of people swimming in the water per day (cap/ day) d : duration of the pollution episode (day)
$L_{BT} = P_{BT} \times N_{BT} \times d$	P_{BT} : the price for replacement for boating (₹/cap/ day) N_{BT} : the number of people boating in water per day d : duration of pollution episode (d)
$L_{AG} = P_{AG} \times N_{AG} \times d$	P_{AG} : the price for angling for boating (₹/cap/ day) N_{AG} : the number of people angling in water per day d : duration of pollution episode (d)

4.3.4 Damage to Environmental Property/Other Damages

Control cost method to rejuvenate the contaminated water bodies covers overall total damage associated with respect to fisheries, recreational sites, environmental property, etc. In general, control cost methodology refers to the cost incurred in operating conventional treatment technologies to rejuvenate the surface water body.

As mentioned previously, there are studies carried out by foreign authors defining the damage cost with respect to each pollutant such as BOD₅, COD, TSS, heavy metals, etc. These values can be transferred to the study location subject to the uncertainties. Needless to say, the ground data would improve the calculations. (Murty and Kumar, 2004) have estimated the shadow prices of water pollution for Indian industries as shown in Table 11.

Table 11: Shadow price of Physio-Chemical pollutants corresponding to individual industries

Industry/ Pollutant	BOD per ton	COD per ton	SS per ton
Leather	45856.6	272568.3	92998.9
Distillery	80141.9	193283.4	115712.9
Chemicals	47999.4	223711.7	56142.2
Sugar	52713.6	239140.1	71999.1
Paper & Pulp Products	79284.8	125141.4	78856.2
Fertilizer	45428.0	239140.1	4714.2
Pharmaceuticals	39856.6	273425.4	88713.2
Petro Chemicals	58285.0	178712.2	53570.8
Miscellaneous	57427.9	254139.9	51427.9
Overall	57427.9	216854.6	71570.6

4.4 Value Transfer Method

The value transfer method was developed to evaluate the economic value of ecosystem services. The application of the value transfer method can be done to evaluate the economic value of water pollution. This method is based on the method of transferring available information from already completed studies in another location or context.

The value transfer method is less costly and less time consuming than other available methods for economic assessment. Without undertaking an original valuation study this method gives the quick result for the assessment. Also, can be used as a screening process to decide whether the original valuation study should be conducted or not. Whereas non data availability, less result accuracy can be the limitation for this method.

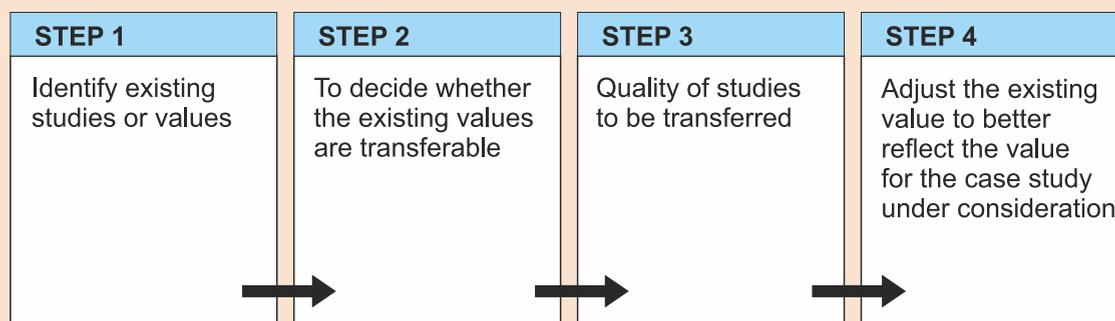


Figure 4: Steps covered in value transfer method

Studies have been carried out by foreign researchers to evaluate damages per kg discharge of heavy metals into the water. Monetary value associated with given heavy metal emission can be directly used in the value transfer method to calculate the damage cost due to the discharge of heavy metal into water bodies above standard limits. The costs associated with individual heavy metal are shown in **Table 12 (Extern E, 1995)**.

Table 12: Environmental damages cost associated with heavy metal above permissible limit.

Pollutant	Cost of per kg emission to water (€, 1995)
Lead (Pb)	178
Cadmium (Cd)	622
Mercury (Hg)	1,022
Dioxins	62,824,889
Antimony (Sb)	121,366
Arsenic (As)	308
Barium (Ba)	31
Beryllium (Be)	44,928
Copper (Cu)	17,479
Nickel (Ni)	12
Selenium (Se)	16,125
Zinc (Zn)	1

4.5 Discharge Based Method

This method focuses on the economic loss incurred due to damage caused by the discharge of a pollutant from point source into water bodies. This method is based on the value transfer method and the actual cost method. Like the value transfer method, a reference study is considered as a baseline study in this method also. While evaluating the cost, the potential damage from the concerned pollutant is considered, accordingly, the assessment should be done. Damage can be calculated for a particular parameter's value breaching standards prescribed by pollution control authorities. The additional discharge, above the prescribed standards, is used for calculations. Following assumptions are used for damage cost assessment:

1. An ideal river ecosystem provides all the ecosystem services as described in the impact pathway.
2. It is the pollution dumped in the river ecosystem which causes the damages and hence it becomes unfit for any use
3. Average pollution loads and discharges are used for calculation and represent the actual conditions
4. The flow of water in the water on an average remains the same for the years of analysis considered.

The zeroth dimensional model is used to calculate the concentration at downstream flow after the discharge of a pollutant in the water body using **Eq (15)**.

$$C_o = \frac{(C_s \times Q_s + C_B \times Q_B)}{(Q_s + Q_B)} \quad \text{Eq (15)}$$

Where,

- C_B - Initial concentration in upper stream (mg/l)
- C_s - concentration of the pollutant in the waste water (mg/l)
- Q_B - Initial flow of upstream (m^3/s)
- Q_s - The effluent discharge of outfall (m^3/s)

Damage cost can be calculated as shown in **Table 13**

Table 13: Damage cost assessment calculation based on Dilution Model

Year	Parameter (eg. COD) exceeded after dilution in river in mg/l	Unit damage cost	Damage cost in rupees	Damage cost considering inflation
n th	x	Y	$x \times y = z$	sum of inflation rate upto n th year

In the above example, based on dilution and value transfer, the extent of damages in monetary terms can be calculated. Another method of Preventive Expenditure can also be used in the above case, in which the treatment cost of water can be taken at actuals as the value of damages.

The above methods and idea give an understanding of the approaches which can be used for the valuation of damages done due to water pollution. A detailed set of data is required to arrive at actual environmental damages hence an on-ground study with primary datasets is always recommended to arrive at better numbers than numbers arrived from shadow pricing or value transfer method.

Example:

Calculate cost of damages due to release of BOD₅ and chromium into surface body with respect to details given using direct value transfer.

Discharge quantity = 1 MLD

Total days of discharge = 365

BOD₃ = 120ppm (Consider 0.033 € /Kg as of 2010 as damage cost)

Chromium = 0.2ppm (Consider 17479 € /Kg as of 1995 as damage cost)

Pollutant type	Permissible limit (ppm)	Discharge concentration	Discharge concentration (Kg)	Damage cost for value transfer (Hernández-Sancho, 2010)	Exchange rate	Inflation	Total damage (Lakhs ₹)
BOD ₃	30	120	90	0.033	60.59	1.69	1
Chromium	0.05	0.2	0.15	17479	23.39	4.81	1076

Hence the total damage incurred due to release of BOD₃ and chromium for the complete 365 days beyond the permissible limit is ₹ 1077 Lakhs.

C H A P T E R 5

Solid Waste

Solid Waste



The amount of solid waste in urban areas has increased significantly due to the increasing population in urban agglomerations and the lure of western lifestyle among people. Despite having country-specific waste management rules to promote sustainable development, the problem still persists. **PIB, 2017** reported a total generation of 62 million tonnes of solid waste for the year 2017 in India, out of which 70% is collected from which 28% is treated and remaining is dumped into landfill. The increase in solid waste generation as a by-product of economic development has caused problems corresponding to efficient collection, segregation, and safe disposal.

A typical solid waste consists of different types of waste including organic waste, plastics, rubber, textile, leather, metals, glass, etc.

Although in the case of solid waste being generated from a particular type of industry, the characteristics of waste may vary. The key to deter adverse environmental impacts due to different types of waste including hazardous and non-hazardous waste is by ensuring adequate segregation at source, processing/treatment to optimize resource recovery and recycle followed by safe disposal of final unutilized residue into scientifically secured landfill sites.

5.1

Environmental Impacts Likely to be Caused due to Solid Waste

Poor management of solid waste has several adverse impacts on the environment via different sources and media. The problem may pertain to any of the stages of waste processing, which needs to be identified and quantified. (*Example: Emission into the air from poorly maintained collection vehicles, odor due to sick disposal methods*). In general, environmental and societal impacts due to impulsive handling of solid waste are classified as follows

GHGs Emissions

Various types of gases like methane (CH_4), carbon dioxide (CO_2) and VOCs (Volatile organic carbon) are generated during the anaerobic degradation inside the landfills. CO_2 is also a part of waste to energy plants (WTE). These gases, when emitted directly into the atmosphere, have a significant effect on climate change which ultimately impacts the lifeline of the ecosystems. The drivers and impacts are the same as mentioned in **Chapter (2)**.

Aesthetic Environment

The most obvious and unrecognized damage caused by the solid waste site is aesthetic. The aesthetics of the vicinity of a solid waste disposal site turns displeasing due to bad odor, visual disturbance, noise, and communicable diseases from rodents, pests resulting in land value depreciation and reduced demand of the area for residential purposes.

Leachate discharge

Leachate generated from landfill sites when discharged directly has the potential to reach groundwater and contaminate the same. Heavy metals (Cr, Mg, As, Cu, etc) present in leachate are carcinogenic as they enter the food chain via direct contact with groundwater. This potential risk can be avoided by providing landfill liners and leachate collection cum treatment systems at landfill sites. Many landfill sites in urban areas are in dearth of the organized leachate management system and hence the groundwater quality in the nearby areas is severely prone to contamination especially during precipitation.

Poor air quality

Emissions of pollutants (particulates & gases) are prominent during the process of unscientific incineration, open burning, informal dumping of construction & demolition (C&D) waste, operation of poor maintained waste utility vehicles/machines and has adverse impacts on human health and other environmental factors. The drivers and impacts are the same as mentioned in **Chapter (3)**.

Impact Drivers

- Leachate release
- Waste management site at vicinity
- Emission of pollutant
- GHG emission

Reduced air quality, soil contamination, surface and groundwater contamination, odor & a visual nuisance, etc

Adverse Impacts on Society and Environment

- Human Health
- Aesthetics Climatic patterns
- Another Ecosystem service

5.2

Quantification of Pollutants Emitted from Solid Waste Site

In this context, solid waste sites are categorized into engineered landfill & open dumpsite. High potential for pollutant emissions is from open dumpsite as it defies the norms of solid waste management. United States Environmental Protection Agency (USEPA) approved tools such as LandGem (**URL 05**) & SWEET (**URL 06**) are generally employed to quantify pollutants emitted during various operations within the solid waste site. The inputs required to run SWEET & LandGem model is as in **Table 14**. In the case of open dumpsite, using SWEET model pollutants such as Particulates, GHGs, SO_x & NO_x are quantified with respect to emission from waste collection vehicles, waste burning, landfill, landfill gas, and waste handling equipment. Whereas LandGem uses first-order decomposition rates to quantify emissions such as CH₄, CO₂, Non-methane organic compound (NMOC) and hazardous air pollutants (HAP) as listed in Title III of the 1990 USEPA Clean Air Act Amendments from the decomposed waste in the landfills. Alternatively, air quality monitoring instruments and pollutant dispersion models can be used to compute the concentrations of emissions as mentioned in **Chapter (3)**.

Table 14: Input data required to run SWEET & LandGEM models

Sr. No.	SWEET model	LandGem model
1	Treatment facilities employed within the dumpsite	Start year of landfill site
2	Start Year of dumpsite Site	Closure year of landfill site
3	Estimated Population during the modelling year	Waste design capacity
4	Average Annual Precipitation (mm/year)	Yearly waste input data
5	Mean Annual Temperature (°C)	Methane generation rate (K) based on field data. Else consider the default value as per the model

Sr. No.	SWEET model	LandGem model
6	Per capita waste generation rate (kg/capita/day)	Potential methane generation capacity (Lo). Default value can be considered in case of absence of field data
7	Annual Average Growth Rate in waste generation (%)	
8	Percentage of waste generated inside the collection Zone (%)	
9	Waste Composition/characterisation	
10	Number of trips of heavy duty diesel vehicles in a year	
11	Kilometre travelled by a typical vehicles inside the landfill site in a year (km)	
12	Hours spent idling for typical heavy duty trucks per year inside the landfill site	
13	Annual disposal : Most recent year data	
14	Type of Sites (Landfill/Dump Site)	
15	Average Waste Depth(m)	
16	Waste Handling Equipment (excavator, Grader, Loader, Bulldozer)	

5.3

Monetary Evaluation of Environmental Damages

This section describes the methodology to calculate environmental damages due to impact drivers showing up at various stages of waste processing. Foreign studies were taken as reference, as there exist no India specific studies on quantifying monetary-based negative externalities due to poorly practiced solid waste handling. Implementing foreign studies directly may have uncertainties associated with emission standards, market value, individuals' awareness regarding the environment, etc. which needs to be considered until an indigenous framework is developed.

5.3.1

Damage Cost due to the Release of Greenhouse Gas (GHGs)

GHG's are inevitable parcels being generated during the degradation of solid waste. This can be a global problem if not managed efficiently. GHG's are most common in the case of open dump sites where poor solid waste management techniques are managed. GHG's emitted in terms of CO₂ equivalent are determined using LandGEM and SWEET model through which monetary damage is estimated as mentioned in **Chapter (2)**.

5.3.2

Damage Cost due to Air Pollution

Monetary damage cost due to pollutant emission is quantified as mentioned in **Chapter (3)**. The quantification of damage to the environment due to NMOC (Non-Methane Organic Compound) and other HAPs (Hazardous Air Pollutants) are not included due to the limitation in the availability of the data. However, to identify the impacts of identical pollutants requires a thorough cohort study. The current trend of the cohort has shifted largely towards identifying adverse health impacts mainly due to particulates matter. Air pollution-related damages can be evaluated as described in **Chapter (3)**.

5.3.3 Damage Cost due to Release of Leachate into Ground

Untreated leachate released into the ground has a tendency to percolate into the nearby ground/surface water bodies and soil surfaces causing contamination. Leachates are inventories source for heavy metals, which when accumulated can have adverse effects on human health and bio-diversity. Damage cost evaluation can be carried out using the avoided cost method. Avoided cost method is the cost incurred in mitigating the potential effects on the environment and humans due to the release of leachate. Avoided cost method evaluation is carried out by considering total daily expenses incurred in treating leachate via various conventional methods and is shown in **Table 15** so as to comply with the discharge standards. The conservative methods are limited to Physio-chemical parameter removal and underperform in case heavy metal removal. Discharging leachate without considering heavy metal removal turns the entire purpose futile. Hence Zero Liquid Discharge (ZLD) treatment system is considered along with each of the conventional treatment methods that aid in heavy metal removal.

Table 15: Daily expense (as of 2019) incurred in treating of liquid waste using various conventional technologies (CPCB, 2013)

Treatment methods Description	ASP	MBBR	SBR	UASB+EA	MBR	WSP
Power Cost per MLD	1538.7	1878.3	1274.0	1039.7	2514.3	185.1
O&M cost per MLD	899.8	737.1	695.6	937.6	0	665.4
Chemical cost per MLD	2003.7	2003.7	1247.6	2381.8	0	2722.1
Manpower cost per MLD	318.3	156.11	95.931	8.3	0	242.2
ZLD cost per MLD	246400	246400	246400	246400	246400	246400
Total daily cost per MLD	255926.1	255955.5	253230	255759.9	251431.2	254034

Where,

ASP – Activated sludge process; **MBBR** – Moving bed biofilm reactor; **SBR** – Sequential batch reactor; **UASB + EA** – Upflow anaerobic sludge blanket + Extended aeration; **MBR** – Membrane bioreactor; **WSP** – Waste stabilization pond; **ZLD** – Zero liquid discharge Alternatively, direct value transfer method as in **Chapter (4)** can be employed in estimating the total damage cost, given that heavy metal, physio-chemical characteristic & leachate generation is known.

5.3.4 Damage Cost Valuation due to Aesthetic Loss

Dwellers residing within the vicinity of the solid waste sites are likely to be exposed to perpetual externalities such as odor, noise, visual nuisances, communicable diseases via pest & rodents, etc. Rather than considering individual damage cost, all the externalities are clubbed together an aesthetic loss. Hedonic pricing method is generally employed to estimate land depreciation value due to visual and odor nuisance as a part of a poorly managed solid waste site within the vicinity. The hedonic method evaluates the economic value of goods with respect to the direct or indirect effect of other marketed goods. **Table 16** shows the land depreciation value due to the presence of a solid waste site. Several studies revealed land depreciation loss of range 0.4% to 17.6% per km up to 5km from the solid waste site, beyond which there is no impact (**Arif & Doumani, 2014**).

Apart from the damages, it is important to understand people's perception of the problem and the same can be studied in term of willingness to pay. The section 5.3.5 gives a brief framework for evaluating willingness to pay of people.

Table 16: Land depreciation value using the hedonic pricing method (Nelson, 1978; Arif & Doumani, 2014)

Solid waste site type	Area (m ²)	Radius 1 (m)	Radius 2 (m)	Losses 1	Losses 2
Landfill	> 0	≤ 30	>31 to < 100	15%	10%
Municipal dump site	≤ 500	+20	>20 to <100	10%	4%
Municipal dump site	≥ 500	+ 200	>200 to <1000	10%	4%

5.3.5 Willingness to pay method

Willingness to pay in the context is the maximum amount an individual can contribute in managing the solid waste scientifically. The monetary estimation is carried out by survey among the dwellers within the vicinity who are victims of poor waste management activities. The survey gives an overall image regarding the waste management awareness, total damages incurred to the environment and humans favoring the need for developing strategies in waste management. A typical questionnaire is shown in **Table 17**.

Table 17: Questionnaire survey to estimate monetary damage using willingness to pay

Sr. No	Questionnaire
1	Name
2	Gender
3	Age
4	Household Size
5	Duration of stay (in years)
6	The distance of house from dumpsite
7	Daily waste generation rate (Kg/day/household)
8	Does the waste collection vehicle daily collect your household waste?
9	Is there any amount paid for waste collector/rag pickers. If yes, mention the amount per Kg waste
10	Mention, If any other type of disposal practice followed (such as open dumping, Insitu- composting, burning)
11	Does dumpsite at your vicinity cause inconvenience?
12	Mention the severe problems that tend to be due to the presence of nearby dumpsite. Mention the expense incurred to overcome the negative externalities
13	Any negative impact observed on air quality? Eg (Dust, odor)
14	Any negative impact observed on water quality? Eg (Change in taste, odor, color, etc)
15	Is there any aesthetic loss caused due to the presence of a landfill. If yes, mention the after effect on land prices
16	Suggestions to improve the nearby dumpsite.
17	In case of implementing improvement to the existing solid waste dumpsite, What amount can be contributed Every month as a purpose of maintenance?

Example:

Municipal dumpsite was reported to be violating environmental standards. The details of dumpsite are as below. Calculate damage cost due to leachate release and disamenity for the complete year 2019.

Total area of dumpsite = 650 m² (radius)

Leachate generation = 300 KLD

Nearby land price = 2000 m² (Reported for the year 2019)

Damage cost due to release of leachate into the ground (₹)

ASP	MBBR	SBR	UASB+EA	MBR	WSP
76777	76786	75969	76727	75429	76210

Damage cost due to aesthetic loss (₹)

Waste site type	Total area	Radius 1	Radius 2	Area 1	Area 2	Loss 1 (Million, ₹)	Loss 2 (Million, ₹)	Total (Million, ₹)
Municipal	650	214	814	143872.38	2081606.73	29	166	195

Total damage cost estimated due to the release of leachate range from ₹ 75,429 – ₹ 76,786 per day i.e., ₹ 27,531,585 – ₹ 28,026,890 per year Total aesthetic loss estimated for the year 2019 = ₹ 195 million.

Hence, Annual damage cost due to release of leachate and aesthetic loss ≈ ₹ 223 million

Improper solid waste management can become a complex problem as it affects the environment from multiple angles including but not limited to GHGs, Air pollution, water pollution, soil pollution, human health, etc. The above approach can be used to evaluate the overall externalities associated with solid waste generation and management. The assessment and monetary evaluation can be further extended to various scenarios in which recycling and reducing the emissions can also be evaluated as cases of Cost Benefit Analysis (CBA). The scenario analysis will guide to which method has the least footprint and provides maximum benefit.

C H A P T E R 6

Case Study

Case Study 1:

Assessment of environmental damage cost due to air and water pollution for Nagpur city.

Nagpur, city located in Maharashtra, has a total projected population of 29.3 lakhs (approx) for the year 2018. Environmental status reports (ESR) for developing cities are prepared with a concern towards environment; analysing the pollution trends, degradation rate and subsequent shift in policy and legislation to improve ecosystem sustainability. Similar report for Nagpur city shows annual concentration of some pollutants (air and Nag river water quality) to be exceeding the permissible limit set by CPCB. The damage cost on both human health and river ecosystem due to higher contribution of air and water pollutant respectively is to be quantified using value of statistical life/cost of illness method for air pollution and direct value transfer method for water pollution.

Annual Emission of various pollutants such as PM₁₀, SO₂, NO₂ into air atmosphere are 105.83 ppm, 17ppm and 50ppm respectively (**ESR-Nagpur, 2019**).

In case of water environment, damage caused to Nag River due to discharge of pollutants beyond the permissible limits is to be estimated. Total volume of river is estimated as 6086 MLD (**MPCB, 2011**) using the various references available for the dimensions of the river. Physio-chemical characteristics of Nag River such as BOD5 and fecal coliform concentration were 112 mg/l and 16×10^5 MPN/100 ml respectively (**ESR-Nagpur, 2019**).

Damage due to air pollution

Assumptions:

- WHO global relative risk for health applied for estimation of burden of disease
- 6% average inflation rate for India

Exceptions:

- Air Pollution impacts on crop damage and infrastructure damage not included
- Only major diseases as per WHO considered for mortality and morbidity

The health damages caused by air pollution in Nagpur city are estimated and given in **Table 18**.

Only PM₁₀ valuation is carried out for 2018 as it was breaching the standard. SO_x and NO_x are within the standards and hence the damages related to them is not valued. Morbidity is valued by using the estimates of cost of treatment and related expenses under the heading of cost of illness and mortality using value of statistical life using **Eq (5-9)**. Disability cost due to unfavourable health condition is also taken into consideration. The valuation is based on per capita income of the individuals in the city.

Table 18: Monetary valuation of air pollution health impacts in Nagpur city (₹ crore)

Pollutant	Mortality/ Morbidity	Mortality Damage	Cost of Illness	Disability Cost	Total Cost	Total Cost per Pollutant
PM ₁₀	Total Mortality	3621			3621	
	Cardiovascular Mortality	1919			1919	
	Respiratory Mortality	380			380	3,622
	Respiratory Disease		0.4	0.5	0.9	
	Cardiovascular Disease		0.15	0.35	0.5	

Damage to river ecosystem

Damage were estimated with respect to CPCB prescribed best designated use 'C' class of water as shown in **Table 19**.

Table 19: Best designated use as per CPCB standards

Designated best use	Class of water	criteria
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20C 3mg/l or less

Assessment is carried out on the basis of damage cost value suggested by **(Hernandez-Sancho et al., 2010)** and **(URL 08)** for BOD and Fecal coliform respectively. The values are transferred fro Indian context and are calculated based on **Eq (16)** to predict the annual economic damage cost for the year 2018. Economic damage cost due to excess BOD value suggested by **(Hernandez- Sancho et al., 2010)** was € 0.033 as per year 2010.

$$\text{Economic damage (₹)} = F \times P_c \times D_c \times E_r \times I_f \times 365 \quad \text{Eq (16)}$$

Where,

F =Flowrate (Lt/day)

E_r = Exchange rate (₹)

P_c = Pollutant concentration (Kg/l)

I_f = Inflation (URL 05)

D_c = Economic damage cost (cost / Kg)

Fecal coliforms are reduced basically by disinfection. Chlorination is the most commonly used disinfection method. While chlorine dosing, an important parameter to be taken into consideration is final residual chlorine content. Final residual chlorine suggested by Indian standards for drinking water IS 10500:2012 is <1 mg/l (BIS, 2012). Generally in water treatment plants to retain residual chlorine <1 mg/l, Chlorine not more than 5 mg/l is dosed. The study carried out by **(Pant & Mittal., 2007)** showed that 5 mg/l dosage chlorine reduced fecal coliform content by less than 90%. In this case chlorination method is not efficient as it fails to reduce fecal content of Nag River as per the requirement put forth for class C water type. Ultraviolet treatment is next cost effective and feasible solution and hence is considered in this study for the purpose of disinfection. UV of dosage 40mj/cm² will suffice to reduce the fecal content as per the required standard **(NYSERDA, 2004)**. The cost of UV treatment with dosage 40mj/cm² as suggested by USEPA was \$0.046/100m³ for the year 1996 **(URL 08)**.

Table 20: Environmental damage cost due to pollutant loading in Nag River

Parameters	Pollutant concentration	CPCB standards (MLD)	Breached values of Pollutants	Water quantity	Environmental damage cost (Lakhs, ₹)
Biological oxygen demand (BOD)	112 mg/l	3 mg/l	109 mg/l	6086	9919
Fecal coliform	16 x 10 ⁵ MPN/100ml	5 x 10 ³ MPN/100ml	15.95 x 10 ⁵ MPN/100ml	6086	1612
		Total			1531

Table 20 shows the total economic damage incurred due to pollutant loading (BOD & Fecal Coliform) in Nag River. The value estimated is ₹ 115 crores.

Therefore, the total economic damage cost incurred due to air pollution and pollutant loading in river Nag is **3737 crores**.

Case Study 2:

Assessment of damage cost on Daman-Ganga river due to discharge of excess (breaching the desired standards) pollutant concentration from vapi CETP.

Daman Ganga, also known as river Daman, flows through the state of Maharashtra and Gujarat as well as through the union territories of Diu, Daman, Dadra and Nagar Haveli. The river was major source of water supply for irrigation and other purpose with various biotic and abiotic interactions. A survey conducted on common effluent treatment plant (CETP) at Vapi, which dispenses its treated water into Daman Ganga River found discharging treated water with very high organic and solid content. It was analysed that final treated water had organic and solid content approximately 1.5 and 4.5 times the standards set by the CPCB respectively. This action has disrupted the ecological balance of the river which is evaluated in this case study.

Approach of shadow pricing mechanism is used for damage cost calculation. The shadow price refers to the value of damage which could have been avoided if the treatment would have been done for the pollutant loads. Thus the basis of economic evaluation is avoided cost method. Shadow prices (avoided cost) have been referred from (Hernandez- Sancho et al., 2010). The paper describes the shadow prices for each pollutant individually and are represented in **Table 21**.

In order to estimate the damages done to the river, the CPCB discharge standards have been taken into consideration. The base data for each parameter is taken from the GSPCB data shared with the committee for the last 5 years. The resolution is monthly, hence the calculations are also done on monthly basis. Months in which the discharge limit, are being breached, are considered for analysis and yearly average value for each parameter is taken for calculation.

The estimation of damage cost is done for 2018 values. An average of 6% inflation for each year is considered from the base year of calculation. The damage cost per kg of the load used for the study is given in the **Table 21**.

Table 21: Damage cost for each pollutant in €/kg

Pollutant	Damage in €/Kg (2010)
Nitrogen	16.353
Phosphorous	30.944
Suspended Solids	0.005
Biological Oxygen Demand	0.033
Chemical Oxygen Demand	0.098

The euro figure is converted into Indian Rupees using exchange rate for 2010.

The load calculation and cost for each pollutant load is calculated and given in **Table 22, 23, 24, and 25** respectively for COD, BOD, TSS and Nitrogen.

Table 22: Cost of damages for excess cod discharge in ₹ lakhs (2018)

Year	Discharge in MLD (Million liters per day)	Breaching Standard, value of COD in mg/l (above 250 mg/l)	Load exceeding the standard in Kg	Cost in ₹ Lakhs (2018)
2013	53.65	274	14717	508
2014	53.82	261	14047	485
2015	53.16	148	7872	272
2016	53.01	29	1515	52
2017	51.96	29	1498	52
2018	53.90	28	1527	53

Table 23: Cost of damages for excess bod discharge in ₹ lakhs (2018)

Year	Discharge in MLD	Breaching standard, value of BOD in mg/l (above 30 mg/l)	Load exceeding the standard in Kg	Cost in ₹ Lakhs (2018)
2013	53.65	41.17	2208	26
2014	53.82	22.50	1211	42
2015	53.16	0.00	0	0
2016	53.01	0.00	0	0
2017	51.96	0.83	43	1
2018	53.90	0.67	36	1

Table 24: Cost of damages for excess tss discharge in ₹ lakhs (2018)

Year	Discharge in MLD	Breaching standard, value of TSS in mg/l (above 100 mg/l)	Load exceeding the standard in Kg	Cost in ₹ Lakhs (2018)
2013	53.65	77.83	4175	7
2014	53.82	61.17	3292	6
2015	53.16	0.50	27	0
2016	53.01	1.33	71	0
2017	51.96	0.17	9	0
2018	53.90	0.00	0	0

Table 25: Cost of damages for excess nitrogen discharge in ₹ lakhs (2018)

Year	Discharge in MLD	Breaching standard, value of N in mg/l (above 50 mg/l)	Load exceeding the standard in Kg	Cost in ₹ Lakhs (2018)
2013	53.65	3.3	179	1031
2014	53.82	4.3	233	1344
2015	53.16	0.2	9	51
2016	53.01	0.8	44	255
2017	51.96	4.4	229	1323
2018	53.90	3.8	207	1191

Table 26: Cost of damages for excess nitrogen discharge in ₹ lakhs (2018)

Damage cost in lakhs (expressed in 2018 ₹)					
Year	COD	BOD	TSS	N	Total
2013	5.08	0.26	0.07	10.31	1572
2014	4.85	0.42	0.06	13.44	1877
2015	2.72	0.00	0.00	0.51	323
2016	0.52	0.00	0.00	2.55	307
2017	0.52	0.01	0.00	13.23	1376
2018	0.53	0.01	0.00	11.91	1245
Total in Last 6 Years in ₹ Lakhs					6700
Average damage in each year in ₹ Lakhs					1117

From the above **Table 26**, it is clear that a damage of ₹ 67 Crore has been caused due to excess discharge of pollutants in the river ecosystem in last six years between 2013- 2018. An average of ₹ 1117 Lakhs damage to environment in each year. A linear extrapolation of average damage per year yields a total damage of ₹ 234 Crores due to operation of CETP for 21 years till 2018 since its inception in 1997. The above damage is directly attributable to the CETP discharge and hence this is the damage done by CETP to the Daman - Ganga river ecosystem.

7 Summary and Conclusion

The economic growth of the world started majorly with the industrialization. The raw material required for different industries directly or indirectly comes from the natural resources, the ecosystem and the biodiversity of the ecosystem that human lives in. Bio-diversity refers generally to variability within the living environment. The problem is not the utilization of the natural resources but the indiscriminate and overexploitation of ecosystem or unsustainable use of the very biodiversity that has life-sustaining functions. Often businesses and communities forget that they are part of the ecosystem, such that if the environment is polluted or degraded ultimately humans are going to get affected adversely. Biodiversity loss threatens human economic activity by destroying the resources millions of people rely upon for their own lives and livelihoods. Hence it is our responsibility to maintain and preserve the structure of our current habitats and ecosystems as well as the economic systems and industries which they support.

Today's for profit oriented businesses and communities need to understand that if they do not value environment, ecosystem, and bio-diversity properly, in time they are going to cost them dearly. So much so that companies had to shut down operations because of the non-availability of natural resources in a particular region. But, in order to make business, governments, communities and public in general, understand the true value of nature, it is necessary to demonstrate it and hence the valuation is necessary.

Not only for making communities understand, but also this process of valuation is an excellent tool for policymakers and especially in India where the importance of preserving the environment is increasing rapidly. For example, in 2016, CPCB released guidelines on implementing liabilities for Environmental Damages due to handling and disposal of hazardous wastes. The guidelines suggest that penalties are to impose depending upon the level of hazard which has taken place and if the company itself is taking action or CPCB or SPCB has to intervene first. However, the penalties are decided not on the basis of a particular externalities evaluation methodology which is the need of the hour. Similarly, MoEFCC notification (S.O. 1805 (E); 804(E)) on violation cases in the realty sector, the guidelines are being formulated for penalizing the businesses who have not obtained the environmental clearances beforehand. In such a case, a tool can be developed based on the above methodologies in order to assess the actual damage to the environment and hence determine the value of the penalty.

Environment damage cost assessment (EDCA) has been briefed for major 4 sectors namely air, water, greenhouse gases and solid waste. In general, EDCA does not limits itself within these 4 sectors but can be extended with respect to land use, bio-diversity & other ecosystems. The main purpose of the report is to mainstream the concept of EDCA so as to bring awareness among the policymakers, industrialists, and environmentalists. The concept is not to obstruct any kind of development, but to pay serious attention towards the improvement of degrading environment as a matter of concern towards sustainability.

This report illustrates, the major concepts/methodology required to estimate damage cost for each of the 4 sectors. There exist several studies previously developed for foreign countries. The concept of EDCA, has just begun gaining attention in India, hence a robust framework with methodology has to be developed to estimate country specific damage cost assessment. As the country is largely facing environmental issues due to inadequate management, there is an urgent demand for the need for EDCA. However, due to lack of country specific studies, work carried out by foreign authors are used as references to determine the monetary damages.

EDCA is generally carried out using several methods. Major of the methods are covered in the chapters with an example for each. India/Asia specific study for mortality/morbidity assessment due to air pollution is carried out by several researchers. Other major adverse impacts such as effect on agricultural productivity, poor visibility, etc are considered due to lack of site specific methodology. However, a surrogate idea with respect to foreign studies has been suggested, so that the total damage cost due to air pollution covers the major of the adverse effects.

Untreated sewage discharge is the main cause of water pollution. The situation worsens when effluents and other hazardous materials are dumped into a water body. Commonly employed assessment method for damage cost estimation due to water pollution is direct value transfer which considers the monetary loss due to individual breached pollutants. There is alternative

methodology such as control cost method, a contingent valuation was suggested so as to develop site specific studies for minimizing the uncertainties with respect to the previous concept of direct value transfer.

Greenhouse gases majorly affect the climatic conditions. The report uses the method of social cost of carbon (SCC) to determine the damage cost due to release of CO₂ equivalent gases. SCC employed in the report is as per USEPA estimation. However, country specific SCC estimation is essential to support the final damage cost assessment.

Poor solid waste management techniques can damage all the three mentioned sectors in the previous chapters. The concepts and methodology developed to assess damages for the previous environments (air, Water & GHG) can be used here. In addition to this environment, depreciation of land value is common within the vicinity of the solid waste site which is termed as an aesthetic loss. Previous researchers has evaluated the damage due to aesthetic loss using hedonic pricing and the same is mentioned in the chapter. However, there exists a site specific survey to assess the hedonic pricing method to determine monetary damage.

All the basic concepts needed to estimate the monetary loss, covering major areas of damage is defined in these chapters. Further, if country specific database is developed for the damage related data including dose-response, on-ground impacts, the above-defined methodologies will pave the way for India. Certain drivers of externalities like freshwater depletion and bio-diversity related impacts need a more detailed framework and database of its own. These parameters can be explored simultaneously along with the four major impact drivers explained above.

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About The Report

Extraneous and unreasonable interventions by humans into nature lead to adverse effects on overall environment. Climate change, air pollution, water pollution, biodiversity loss and many more are examples of environmental concerns that are faced by humans today. It is a way, in which, nature is trying to close the loop. Activities beyond a limit should be curtailed and regulators are trying hard to keep environmental problems in check. To combat environmental issues and to lead a sustainable future, it is today's need to evaluate the environmental damages in monetary terms. It will not only help the regulatory body to penalize damage-causing agents but also will help in decision making for better environmental policies.

Through this special report, authors have tried to build a primary framework of methodologies for calculating the monetary value of environmental damages, by considering Indian data and scenario. Proposed methodologies will give a general scheme for carrying out calculations relating to environmental externalities from a point and non- point sources of pollution. Incorporation of various case studies and examples will help readers to understand this report comprehensively.

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क्षेत्रीय कार्यालय

ANNEXURE--VIII

म.प्र. प्रदूषण नियंत्रण बोर्ड

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पत्र क्र. NGT/117/2014/क्षे.का./प्रनिबो/2020,
प्रति,

सिंगरौली, दिनांक 02/9/2020

- 1- अपर महाप्रबंधक (पर्यावरण),
एन.टी.पी.सी. लिमिटेड विंध्यांचल,
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- 2- अपर महाप्रबंधक (पर्यावरण),
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- 3- मुख्य कार्यपालन अधिकारी,
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बंधौरा, सिंगरौली (म.प्र.) ।

by e-mail

विषय : एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) के परिपेक्ष्य में संलग्न अनुसार वांछित जानकारियाँ तत्काल ई-मेल के माध्यम से उपलब्ध कराने बावत।

उपरोक्त विषयांतर्गत एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) के परिपेक्ष्य में संलग्न अनुसार वांछित जानकारियाँ मय हस्ताक्षरित एवं सील सहित दिनांक 03/09/2020 को तत्काल ई-मेल के माध्यम से इस कार्यालय को उपलब्ध कराया जाना सुनिश्चित करें। कृपया ध्यान दें कि जानकारियाँ अति आवश्यक हैं एवं माननीय एन.जी.टी प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) से सम्बंधित हैं।

अतः अनुरोध है कि नियत तिथि तक वांछित जानकारियाँ अनिवार्य रूप से उपलब्ध करने का कष्ट करेंगे।

संलग्न: बिन्दुवार वांछित जानकारियाँ।

(एस.डी.वाल्मीकि)
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पृ.क्र. HGT/117/2014/क्षे.का./प्रनिबो/2020,
प्रतिलिपि :

सिंगरौली, दिनांक 02/9/2020

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4. श्री जे.एस.सरन. (पर्यावरण, हेल्थ एंड सेफ्टी) मे.एस्सार पॉवर एम.पी. लिमिटेड,
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02/9/2020
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V1 Dyke Breach – Additional data submission to NGT Committee for environment damage assessment

S.NO.	REQUIREMENT	STATUS
1.	Expenditure on Studies:	
	-Environment Damage Assessment	Awarded to NEERI, PO. No.4000231379. Value Rs.22.9 lacs, GST 18 %. Total – 27 lacs
	-Ash dyke Technical Evaluation	Awarded to IIT Roorkee vide PO No. 4000229511 Total Value – Rs. 8.9 lacs
	-Other studies: Consultancy for restoration of V-1 ash dyke	Awarded to NIT Rourkela vide PO No. 4000234684 Value Rs. 2.3 lacs
2.	Third Party report on effluent discharge in reservoir	The discharge in Reservoir was essentially AWRS water only that was getting collected in the OFL. AWRS 3 water report of Nov'19 attached as Annexure 1.
3a.	Discharge of Ash Slurry subsequent to breach and its daily quantity	Ash slurry discharge was done in the other available dykes of VSTPS (V3A, V3B, V4A, V4B). Stage 1 & 2 were being operated on part-load for many days till the ash discharge locations were streamlined. Average Daily slurry discharge of Stg 1, 2 is estimated to be 76000 m3 during this period.
3b.	When were the pipelines plugged and AWRS made operational.	Ash slurry discharge from the damaged ash pipelines was stopped immediately and load was reduced till alternate pipelines became available. Damaged Ash pipelines were repaired within two days. SSTPS AWRS status will be given by SSTPS.
3c.	Till how many days the S1 dyke discharge was continued towards reservoir.	To be replied by SSTPS
3d.	Decanted water stored quantity	Decanting pond area of OFL: 89,479 M2, Height of Embankment is 3 Mtrs [(6+0)/2], Free board is 1.5 Mtrs hence ponding depth is 1.5 Mtrs, Total accumulated water in OFL= 1,34,218 Cum



मुनीष जैन
 Munish Jain
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3e.	Dimension of S1 decant pond	To be given by SSTPS.
4a.	Total ash collected	~ 1.75 lac T
4b.	Total Expenditure Incurred in Ash Removal	~ 2.1 Crores (PO Nos. 4000229578, 4000233086, 4000236268, 4000239678, 4000230406, 4000218707, 4000224619, 4000238941)
4c.	Machinery deputed	Poclain/Dumpers/Hyvas/Tractor etc.
4d.	Total km run of dumpers etc	71,006 km
4e.	Average mileage of machinery deployed	2.5 km/l
5a.	Expenditure incurred on dredging the ash from Rihand Reservoir	Contract value Rs. 2 crores. PO no. 4000241902. Work in progress.
5b.	Expenditure incurred on dredging the ash from AWRS OFL	i. Estimated qty deposited in OFL following the breach – 1 lac cum. ii. Estimated expenditure on dredging – 1.2 crores. PO No. 550027304. Work in progress.
5c.	Cost of Other Repairs	i. Repair of OFL of V-1/V-2 ash dyke: PO No. 4000230889 Rs. 47.8 lacs (including GST) ii. Rip rap work in OFL: PO No. 4000231599 Rs. 76.4 lacs (including GST) iii. Repair of breach area of V-1, new decanting well, additional spillway in V-1: PO No. 550027304, Approx cost: 6.0 Crore


 मुनीश जैन
 Munish Jain
 अकाउंट्स एंड ऑडिटिंग (इंजीनियरिंग)
 AGM (EMG/AUD)
 एन.एच.सी. लिमिटेड-विन्ध्यचल
 N.H.C. Limited-Vindhyachal



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पत्र क्र. 144T/117/2014/3/क्षे.का./प्रनिबो/2020,
प्रति,

सिंगरौली, दिनांक 04/9/2020

अपर महाप्रबंधक (पर्यावरण),
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विषय : एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) के परिपेक्ष्य में तत्काल जानकारियां उपलब्ध करने बावत ।

उपरोक्त विषयांतर्गत एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) के परिपेक्ष्य में निम्नानुसार जानकारियां तत्काल ई-मेल के माध्यम से इस कार्यालय को उपलब्ध कराया जाना सुनिश्चित करें ।

अतः अनुरोध हैं कि वांछित जानकारियाँ अनिवार्य रूप आज ही उपलब्ध कराने का कष्ट करेंगे ।

वांछित जानकारियां :

- 1- स्लरी वाटर की मात्रा प्रतिदिन औसतन, मे. सिंगरौली सुपर थर्मल पावर प्लांट शक्ति नगर जिला - सोनभद्र के ओवरफ्लो लैगून में निस्तारित कि गयी ।
- 2- किस दिनांक से किस दिनांक तक सिंगरौली सुपर थर्मल पावर प्लांट शक्ति नगर जिला - सोनभद्र के ओवरफ्लो लैगून में डिस्चार्ज किया गया ।
- 3- आपका AWRS सिस्टम जोकि V1 डाइक के क्षतिग्रस्त होने के कारण राखड़ का बहाव AWRS Boundry Wall को तोड़ते हुए ऐश बहाव के कारण क्षतिग्रस्त हो गया था जिसका सुधार कार्य आपके द्वारा किस दिनांक से प्रारम्भ किया गया एवं AWRS सिस्टम पुनः किस दिनांक से क्रियान्वित किया गया ।

कृपया अनुरोध हैं की उपरोक्त जानकारी अनिवार्य रूप से आज ही उपलब्ध कराने का कष्ट करें, ताकि विषयांकित एन.जी.टी. प्रकरण के परिपेक्ष्य में जानकारी वरिष्ठ कार्यालय को उपलब्ध करायी जा सके ।

o/c (एस.डी.वाल्मीकि)
क्षेत्रीय अधिकारी
सिंगरौली (म.प्र.)
04/9/2020

पृ.क्र. 144T/117/2014/4 /क्षे.का./प्रनिबो/2020,
प्रतिलिपि :

सिंगरौली, दिनांक 04/9/2020

1. कार्यकारी निदेशक, एन.टी.पी.सी. लिमिटेड विंध्यांचल, विन्ध्यनगर,सिंगरौली (म.प्र.)।
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04/9/2020

V1 Dyke Breach – Additional data submission to NGT Committee for environment damage assessment

(Ref: RO, MPPCB (Singrauli) letter no. NGT/117/2014/3 dtd 04/09/20)

S.NO.	QUERY	VSTPS SUBMISSION
1.	क्या बंध की बाह्य परीक्षा अवसर, में निम्नलिखित मुद्दों पर ध्यान देना चाहिए था किना - संकेतक के अवसरों के रूप में निम्नलिखित कि गयी।	<p>i) It is categorically stated that no ash slurry discharge was done by VSTPS in the OFL of SSTPS at any stage.</p> <p>ii) Decanted water from the OFL of VSTPS dykes of V3A, V3B did overflow into the OFL of SSTPS. However, since there is no flowmeter installed at the OFL point, the exact quantity of overflow water is not known.</p>
2.	किस दिनांक से किस दिनांक तक निम्नलिखित मुद्दों पर ध्यान देना चाहिए था किना - संकेतक के अवसरों के रूप में निम्नलिखित कि गयी।	<p>Subsequent to the V1 ash dyke breach on 06/10/19, VSTPS had 4 operational ash lagoons, namely V3A, V3B, V4A and V4B which were catering to the ash slurry discharge of Units of all the 5 stages of the Plant. The ash line discharge from individual stages is not segregated dyke wise. The overflow into the OFL of SSTPS takes place only from the OFL of V3A and V3B. SSTPS OFL basically caters to the decanted water of S1, S2 dykes. However, an overflow of V3A, V3B OFL may not necessarily cause an overflow of SSTPS OFL unless there is an unbalance in the water flowing in to the OFL and the water discharged from the OFL through the AWRS of SSTPS. As long as the OFL of SSTPS is not overflowing, overflow from V3A, V3B OFL is not closely monitored. Hence, there is no record of exactly when the overflow from V3A, V3B OFL started overflowing into the OFL of SSTPS and when it got stopped altogether although it can be assumed that it started on 07/10/19.</p>
3.	क्या AWRS निरस्त जहाँ V1 बंध के क्षतिग्रस्त होने के कारण था किना AWRS Boundary Wall को लगे हुए पुराने बंध के कारण क्षतिग्रस्त हो गया था किना मुद्दों पर ध्यान देना किना दिनांक से काम किना था किना AWRS निरस्त पूरा किना दिनांक से विपरीत किना था।	<p>i) AWRS restoration work was started on 07/10/20.</p> <p>ii) AWRS was taken back in service on 02/12/20.</p>


 मुनीश जैन 04/09/20
 Munish Jain
 ज्येष्ठ महासचिव (पर्यावरण/प्रदूषण)
 AGM (EMG/AUD)
 एनटीपीसी लिमिटेड-विन्ध्यचल
 NTPC Limited-Vindhyachal



Sunil Kumar Meena <biosunil2006@gmail.com>

AWRS overflow calculation

Munish Kumar Jain <mkjain@ntpc.co.in>
To: biosunil2006 <biosunil2006@gmail.com>

6 September 2020 at 10:01

प्रिय महोदय / Dear Sir,

May pls go through the attachment.

सादर धन्यवाद / Thanks and regards .

MUNISH JAIN
AGM (EMG), NTPC-VINDHYACHAL.
Mob. 9415342516

 **AWRS OVERFLOW (OCT-NOV).xls**
30K

M/s NTPC Vindhnagar

Total Ash Generated (Oct'19-Nov'19)	1376380	MT
Dry Ash Utilisation (Oct'19-Nov'19)	12675	MT
Total Ash Disposal to Ash Dyke(Oct'19-Nov'19)	1363705	MT
Total Ash Disposal to Ash Dyke(Oct'19-Nov'19)	1136421	cum
Total Qty of Water used for Ash Disposal to Ash Dyke(Oct'19-Nov'19)	6818525	cum
Total Qty of Water available for recirculation (Oct'19-Nov'19) considering 20% loss in Toe drain and 10% in evaporation	4772968	cum
AWRS Flow Oct-19-Nov-19 (based on pump running hours)	3724825	cum
Overflow Qty	1048143	cum
Overflow Qty	17469	cum/day

AWRS Flow Oct-19-Nov-19 (based on pump running hours)

MONTH	ST-1		ST-2		ST-3		ST-4		ST-5		Total Quantity M3
	p/p Running hours	Quantity in M3									
Oct-19	8	10000	24	16800	100	50000	1293	1228350	744	632400	1937550
Nov-19	0	0	0	0	385	192500	1034.5	982775	720	612000	1787275
Total		10000		16800		242500		2211125		1244400	3724825



क्षेत्रीय कार्यालय

म.प्र. प्रदूषण नियंत्रण बोर्ड

भकुआर, नौगढ, जिला सिंगरौली (म.प्र.)-486887

E-Mail: romppcb.sgrl@gmail.com , Contact No. : 9752497772

ANNEXURE-IX

पत्र क्र. NGT/117/2014/क्षे.का./प्रनिबो/2020,
प्रति,

सिंगरौली, दिनांक 02/9/2020

- 1- अपर महाप्रबंधक (पर्यावरण),
एन.टी.पी.सी. लिमिटेड विंध्यांचल,
विन्ध्यनगर, सिंगरौली (म.प्र.) ।
- 2- अपर महाप्रबंधक (पर्यावरण),
सिंगरौली सुपर थर्मल पावर प्रोजेक्ट,
शक्ति नगर, जिला - सोनभद्र (यू.पी.)
- 3- मुख्य कार्यपालन अधिकारी,
मे.एस्सार पावर एम.पी. लिमिटेड,
बंधौरा, सिंगरौली (म.प्र.) ।

by e-mail

विषय : एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) के परिपेक्ष्य में संलग्न अनुसार वांछित जानकारियाँ तत्काल ई-मेल के माध्यम से उपलब्ध कराने बावत।

उपरोक्त विषयांतर्गत एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) के परिपेक्ष्य में संलग्न अनुसार वांछित जानकारियाँ मय हस्ताक्षरित एवं सील सहित दिनांक 03/09/2020 को तत्काल ई-मेल के माध्यम से इस कार्यालय को उपलब्ध कराया जाना सुनिश्चित करें। कृपया ध्यान दें कि जानकारियाँ अति आवश्यक हैं एवं माननीय एन.जी.टी प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरुद्ध यूनियन ऑफ इंडिया एवं अन्य) से सम्बंधित हैं।

अतः अनुरोध है कि नियत तिथि तक वांछित जानकारियाँ अनिवार्य रूप से उपलब्ध करने का कष्ट करेंगे।

संलग्न: बिन्दुवार वांछित जानकारियाँ।

02/9/2020
(एस.डी.वाल्मीकि)
क्षेत्रीय अधिकारी
सिंगरौली (म.प्र.)

पृ.क्र. NGT/117/2014/क्षे.का./प्रनिबो/2020,
प्रतिलिपि :

सिंगरौली, दिनांक 02/9/2020

1. कार्यकारी निदेशक, एन.टी.पी.सी. लिमिटेड विंध्यांचल, विन्ध्यनगर, सिंगरौली (म.प्र.)।
2. कार्यकारी निदेशक, सिंगरौली सुपर थर्मल पावर प्रोजेक्ट, एन.टी.पी.सी. लिमिटेड शक्ति नगर, जिला - सोनभद्र (यू.पी.) ।



क्षेत्रीय कार्यालय
म.प्र. प्रदूषण नियंत्रण बोर्ड
भकुआर, नौगढ, जिला सिंगरौली (म.प्र.)-486887
E-Mail: romppcb.sgrl@gmail.com , Contact No. : 9752497772

3. श्री सुनील कुमार मीना, Scientist 'D', CPCB, क्षेत्रीय निदेशालय (मध्य)
पर्यावरण परिसर, भोपाल कि ओर कृपया सूचनार्थ ।
4. श्री जे.एस.सरन. (पर्यावरण, हेल्थ एंड सेफ्टी) मे.एस्सार पॉवर एम.पी. लिमिटेड,
बंधौरा, सिंगरौली (म.प्र.) ।

02/9/2020
(एस.डी.वाल्मीकि)
क्षेत्रीय अधिकारी
सिंगरौली (म.प्र.)



एनटीपीसी लिमिटेड

(एनएलसी अंतर्गत में) (Under NLC)

NTPC Limited

(A Govt. of India Enterprise)

सिंगरावली सिंगरावली

031/EMG/2020

Dtd: 03.09.2020

To,

The Regional Officer,

Madhya Pradesh Pollution Control Board,

Bhakuar, Naugarh

Distt. Singrauli (MP). 486887

Sub: Information regarding NGT matter Sl. 117/2014 (Shantanu Sharma Vs UOI & others)

Sir,

Please find attached herewith information as desired, vide your letter ref No. NGT/ 117 / 2014 / RO/PCB/2020 dtd 2.09.2020 in Respect of NTPC- Singrauli Super Thermal Power Station Shaktinagar, Sonbhadra (UP).

Thanking You,

Yours faithfully,

(Sudeep Manna)

AGM(EMG)

SUDEEP MANNA सुदीप मन्ना
AGM(T&O & EMG) अग मन्ना टाओ एमजी (टीएओ-इंजीनियरिंग)
NTPC Singrauli एनटीपीसी, सिंगरावली
Shaktinagar 231222 शक्तिनगर 231222

Encl: as above

NTPC Shaktinagar

Query reply regarding S1 Dyke AWRS pipe line due to Breach of V1 ash dyke of Vindhyachal STPS

Sl.	Query	Reply
1	Expenditure of assessment studies	
	-Environmental damage studies	Not pertaining to NTPC Shaktinagar
	-Ash Dyke Strength	Conducted through IIT Roorkee report submitted cost Rs.400000.00
	- Other study	Nil
	-Compensation (if any)	Nil
2	Any third party testing report of effluent discharged in reservoir	No
3	As due to breach, AWRS line got breached. However plant was operation round the clock	No dyke breach of SSTPS. Breach was occurred at V1 Ash dyke of Vindhyachal STPS.
	- Where you discharged the slurry water its daily quantity?	No dyke breach in NTPC Shaktinagar. Slurry discharge was being done in S1 dyke .
	- When you plugged the pipe line and start operating AWRS?	AWRS pipe line restored on 25.10.2019 and AWRS started on 25.10.2019
	- Till how many days the S1 dyke discharge was continue towards reservoir	No dyke discharge was there to reservoir. However overflow from over flow lagoon water of TSS<100mg/l was discharging for 23 days from spillway
	- What was the decanted water stored quantity in decanted pond on the day of incidence.	4.79 Lac M3 on the day of V1 Dyke incidence
	- Dimension of S1 decant pond that was discharging in reservoir	Over flow lagoon area 121000 m ² x 5 m
4	Total ash collected. Truck machinery deputed & kilometer run in total	Not applicable to NTPC Shaktinagar
5	Expenditure incurred on	
	- Dragging the ash from Rihand reservoir (Rs. Tender doc & quantity of sludge)	Not applicable to NTPC Shaktinagar
	- Cost of repair (Decanting well, wall, re operation of AWRS & others)	Only AWRS pipe line is concerned for which cost of repair of AWRS for putting in to operation Rs. 8.0 lac.

S. Manne 03/9/2020

SUDEEP MANNA
 (S1740 & EMG) Sr. Engineer (Civil)
 NTPC Singrauli
 Shaktinagar 21
 2170000 231222

एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरूद्ध यूनियन ऑफ़ इंडिया एवं अन्य) के परिपेक्ष्य में तत्काल जानकारियां उपलब्ध करने बावत ।

Regional office <romppcb.sgrl@gmail.com>
To: biosunil2006@gmail.com

4 September 2020 at 17:05

----- Forwarded message -----

From: **Sudeep Manna सुदीप मन्ना** <sudeepmanna@ntpc.co.in>

Date: Fri, 4 Sep, 2020, 4:45 pm

Subject: Re: एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरूद्ध यूनियन ऑफ़ इंडिया एवं अन्य) के परिपेक्ष्य में तत्काल जानकारियां उपलब्ध करने बावत ।

To: romppcb sgrl <romppcb.sgrl@gmail.com>

Cc: Deepika Singh Singh <deepikasingh@ntpc.co.in>

Sir,

With reference to your mail dated 4.9.20 please find the detail as below :

1. Per day average discharge from Overflow lagoon of S1&S2 of NTPC Shaktinagar due to breach of V1 ash dyke of NTPC Vindhyachal till restoration of AWRS return pipe line of NTPC Shaktinagar : 70080 M3 per day (2920 M3/Hr)
2. Copy of log book pages for dtd. 6.10.19 / 25.10.19 / 26.10.19 (attached)

SUDEEP MANNA

AGM(AU & EMG)

NTPC SSTPS

MOB NO :8004940460

Respected Sir
Please Find the Attachment.

Regional Officer
MP PCB, Singrauli
Distt. Singrauli-486887

From: **Regional office** <romppcb.sgrl@gmail.com>

Date: Fri, 4 Sep 2020 at 12:22

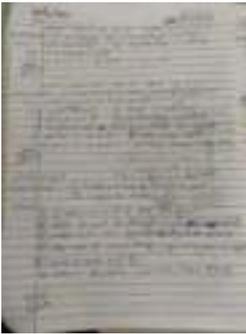
Subject: एन.जी.टी. प्रकरण क्रमांक 117/2014 (शांतनु शर्मा विरूद्ध यूनियन ऑफ़ इंडिया एवं अन्य) के परिपेक्ष्य में तत्काल जानकारियां उपलब्ध करने बावत ।

To: <sudeepmanna@ntpc.co.in>, <biosunil2006@gmail.com>

3 attachments



awrs Log book 3.jpg
162K



awrs lb 2.jpg
118K



awrs lb 1.jpg
129K



**REGIONAL LABORATORY
M.P. POLLUTION CONTROL BOARD**

Bhakuar, Naugarh, Distt. Singrauli 486887 (M.P.)

Contact no 9752497772 / E mail : rl_mppcb_sgrl@gmail.com, cmppcb_sgrl@gmail.com



A-Sample from :- M/S NTPC Vindhyanagar, Ash Dyke Distt-Singrauli(M.P.)

B-Description of sample- Ash Slurry Water of NTPC from canal near AWRS going to Rihand Reservoir

C-Date of collection- 07-10-2019

Sample collected by:- Sampler

D-Date of receive- 07-10-2019

E-Date of analysis- 08-10-2019

No	Characteristics	Unit	Result	No	Characteristics	Unit	Result
1.	Temp	C	32.1	17.	Sulphate (as So ₄)	mg/l	-----
2.	Appearance		Strong turbid	18.	Total Alkalinity (CoCo ₃)	mg/l	-----
3.	Colour		whites	19.	Total Hardness (as CaCo ₃)	mg/l	-----
4.	Odour	Threshold no	Ordorless	20.	Calcium Hardness	mg/l	-----
5.	ph	pH Unit	7.80	21.	Magnesium Hardness	mg/l	-----
6.	Turbidity	Ppm/NTU	-----	22.	Fluoride (as F)	mg/l	-----
7.	Specific conductivity	Ms/cm	-----	23.	Dissolved Oxygen	mg/l	-----
8.	Total solids	mg/l	4512.0	24.	Biochemical Oxygen Demand (3days at 27 C)	mg/l	-----
9.	Dissolved solids	mg/l	1271.0	25.	Chemical Oxygen demand	mg/l	171.0
10.	Suspended solids	mg/l	3241.0	26.	Oil and Grease	mg/l	-----
11.	Ammonica nitrogen	mg/l	-----	27.	Residual Chlorine	mg/l	-----
12.	Nitrate nitrogen	mg/l	-----	28.	Total Coliform	MPN/100ML	-----
13.	Nitrite nitrogen	mg/l	-----	29.	Fecal Coliform	MPN/100ML	-----
14.	Phosphate (as P)	mg/l	-----	30.	Sodium	mg/l	-----
15.	Chloride (as Cl)	mg/l	127.17	31.	Potassium	mg/l	-----
16.	Any other test		-----	32.	Any other test		-----

1. Indicates that value exceed the permissible limits

2. Compared with M.P.P.C.B in Standard.

- Standard prescribed by M.P.P.C.B in gazette notification dated 25.03.1988
- IS-2296-1982 Class- ,A ,B ,C ,D (Tolerance limit for inland surface water subject to pollution.
- IS-10500 [Drinking water specification]


Sampler


Analyst


Laboratory Incharge
Regional Lab. MPPCB, Singrauli (M.P.)



REGIONAL LABORATORY
M.P. POLLUTION CONTROL BOARD
Bhakuar , Naugarh ,Distt. Singrauli 486887 (M.P.)

Contact no 9752497772 / E mail : rl_mppcb_agri@gmail.com, remppcb_agri@gmail.com



A-Sample from :- M/S NTPC Vindhyanagar, Ash Dyke Distt-Singrauli (M.P.)

B-Description of sample- Water Sample from Rihand Reservoir at Village Juari, Distt. Singrauli

C-Date of collection- 07-10-2019

Sample collected by:- Sampler

D-Date of receive- 07-10-2019

E-Date of analysis- 08-10-2019

No	Characteristics	Unit	Result	No	Characteristics	Unit	Result
1.	Temp	C	32.1	17.	Sulphate (as So ₄)	mg/l	-----
2.	Appearance		Sl turbid	18.	Total Alkalinity (CoCo ₃)	mg/l	106.0
3.	Colour		Pale Yellow	19.	Total Hardness (as CaCo ₃)	mg/l	141.0
4.	Odour	Threshold no	Odourless	20.	Calcium Hardness	mg/l	89.0
5.	ph	pH Unit	7.36	21.	Magnesium Hardness	mg/l	52.0
6.	Turbidity	Ppm/NTU	-----	22.	Fluoride (as F)	mg/l	-----
7.	Specific conductivity	Ms/cm	-----	23.	Dissolved Oxygen	mg/l	5.9
8.	Total solids	mg/l	595.00	24.	Biochemical Oxygen Demand (3days at 27 C)	mg/l	-----
9.	Dissolved solids	mg/l	841.00	25.	Chemical Oxygen demand	mg/l	38.2
10.	Suspended solids	mg/l	114.00	26.	Oil and Grease	mg/l	-----
11.	Ammonia nitrogen	mg/l	-----	27.	Residual Chlorine	mg/l	-----
12.	Nitrate nitrogen	mg/l	-----	28.	Total Coliform	MPN/100ML	-----
13.	Nitrite nitrogen	mg/l	-----	29.	Fecal Coliform	MPN/100ML	-----
14.	Phosphate (as P)	mg/l	-----	30.	Sodium	mg/l	-----
15.	Chloride (as Cl)	mg/l	62.43	31.	Potassium	mg/l	-----
16.	Any other test		-----	32.	Any other test		-----

1. Indicates that value exceed the permissible limits

2. Compared with M.P.P.C.B in Standard.

- i. Standard prescribed by M.P.P.C.B in gazette notification dated 25.03.1988
- ii. IS-2296-1982 Class- ,A ,B ,C ,D (Tolerance limit for inland surface water subject to pollution.
- iii. IS-10500 [Drinking water specification]


Sampler


Analyst


Laboratory Incharge
Regional Lab.MPPCB, Singrauli (M.P.)



**REGIONAL LABORATORY
M.P. POLLUTION CONTROL BOARD**

Bhakuar, Naugarh, Distt. Singrauli 486887 (M.P.)
Contact no 9752497772 / E mail : rl.mppcb.sgrl@gmail.com, romppcb.sgrl@gmail.com



A-Sample from :- M/S NTPC Vindhyanagar, Ash Dyke Distt-Singrauli (M.P.)

B-Description of sample- Water Sample from S/2 Duke S.S.T.P. NTPC, Shaktinagar going to directly Rihand Reservoir

C-Date of collection- 07-10-2019

Sample collected by:- Sampler

D-Date of receive- 07-10-2019

E-Date of analysis- 08-10-2019

No	Characteristics	Unit	Result	No	Characteristics	Unit	Result
1.	Temp	C	32.2	17.	Sulphate (as So ₄)	mg/l	----
2.	Appearance		Strong turbid	18.	Total Alkalinity (CoCo ₃)	mg/l	----
3.	Colour		Whites	19.	Total Hardness (as CaCo ₃)	mg/l	----
4.	Odour	Threshold no	Odourless	20.	Calcium Hardness	mg/l	----
5.	ph	pH Unit	7.82	21.	Magnesium Hardness	mg/l	----
6.	Turbidity	Ppm/NTU	----	22.	Fluoride (as F)	mg/l	----
7.	Specific conductivity	Ms/cm	----	23.	Dissolved Oxygen	mg/l	----
8.	Total solids	mg/l	4503.0	24.	Biochemical Oxygen Demand (3days at 27 C)	mg/l	----
9.	Dissolved solids	mg/l	1266.0	25.	Chemical Oxygen demand	mg/l	170.0
10.	Suspended solids	mg/l	3237.0	26.	Oil and Grease	mg/l	----
11.	Ammonia nitrogen	mg/l	----	27.	Residual Chlorine	mg/l	----
12.	Nitrate nitrogen	mg/l	----	28.	Total Coliform	MPN/100ML	----
13.	Nitrite nitrogen	mg/l	----	29.	Fecal Coliform	MPN/100ML	----
14.	Phosphate (as P)	mg/l	----	30.	Sodium	mg/l	----
15.	Chloride (as Cl)	mg/l	125.16	31.	Potassium	mg/l	----
16.	Any other test		----	32.	Any other test		----

1. Indicates that value exceed the permissible limits
2. Compared with M.P.P.C.B in Standard.

- Standard prescribed by M.P.P.C.B in gazette notification dated 25.03.1988
- IS-2296-1982 Class- ,A ,B ,C ,D (Tolerance limit for inland surface water subject to pollution.
- IS-10500 [Drinking water specification]

Sampler

Analyst

Laboratory Incharge
Regional Lab.MPPCB, Singrauli (M.P.)



REGIONAL LABORATORY
M.P. POLLUTION CONTROL BOARD
Bhakuar, Naugarh, Distt. Singrauli 486887 (M.P.)

Contact no 9752497772 / E mail : rlmppcb.sgrl@gmail.com, romppcb_sgrl@gmail.com



A-Sample from :- M/S NTPC Vindhyanagar, Ash Dyke Distt-Singrauli (M.P.)

B-Description of sample- Water Sample from Breached over flow, Lagoon near AWRS,
towards north going to Rihand Reservoir

C-Date of collection- 07-10-2019

Sample collected by:- Sampler

D-Date of receive- 07-10-2019

E-Date of analysis- 08-10-2019

No	Characteristics	Unit	Result	No	Characteristics	Unit	Result
1.	Temp	C	32.1	17.	Sulphate (as So ₄)	mg/l	-----
2.	Appearance		Strong turbid	18.	Total Alkalinity (CoCo ₃)	mg/l	-----
3.	Colour		Whites	19.	Total Hardness (as CaCo ₃)	mg/l	-----
4.	Odour	Threshold no	Odourless	20.	Calcium Hardness	mg/l	-----
5.	ph	pH Unit	7.82	21.	Magnesium Hardness	mg/l	-----
6.	Turbidity	Ppm/NTU	-----	22.	Fluoride (as F)	mg/l	-----
7.	Specific conductivity	Ms/cm	-----	23.	Dissolved Oxygen	mg/l	-----
8.	Total solids	mg/l	4499.0	24.	Biochemical Oxygen Demand (3days at 27 C)	mg/l	-----
9.	Dissolved solids	mg/l	1272.0	25.	Chemical Oxygen demand	mg/l	171.0
10.	Suspended solids	mg/l	3227.0	26.	Oil and Grease	mg/l	-----
11.	Ammonica nitrogen	mg/l	-----	27.	Residual Chlorine	mg/l	-----
12.	Nitrate nitrogen	mg/l	-----	28.	Total Coliform	MPN/100ML	-----
13.	Nitrite nitrogen	mg/l	-----	29.	Fecal Coliform	MPN/100ML	-----
14.	Phosphate (as P)	mg/l	-----	30.	Sodium	mg/l	-----
15.	Chloride (as Cl)	mg/l	125.43	31.	Potassium	mg/l	-----
16.	Any other test		-----	32.	Any other test		-----

1. Indicates that value exceed the permissible limits

2. Compared with M.P.P.C.B in Standard.

- Standard prescribed by M.P.P.C.B in gazette notification dated 25.03.1988
- IS-2296-1982 Class- ,A ,B ,C ,D (Tolerance limit for inland surface water subject to pollution.
- IS-10500 [Drinking water specification]

Sampler

Analyst

Laboratory Incharge
Regional Lab.MPPCB, Singrauli (M.P.)