BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH

NEW DELHI

ORIGINAL APPLICATION No. 164 OF 2018

<u>IN THE MATTER OF:</u>

ASHWANI KUMAR DUBEY .....APPLICANT

VERSUS

UNION OF INDIA & ORS. ...RESPONDENTS

INDEX

Northern Coalfields Ltd. / Respondent No. 37

Through

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New Delhi-110001
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Filed on:22**/01/2026**
Place: New Delhi

BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH NEW DELHI

ORIGINAL APPLICATION No. 164 OF 2018
(Earlier O.A No. 276/2013)

IN THE MATTER OF:

ASHWANI KUMAR DUBEY .....APPLICANT

VERSUS

UNION OF INDIA & ORS. ...RESPONDENTS

AFFIDAVIT ON BEHALF OF RESPONDENT NO.37 NORTHERN COALFIELDS LTD.

I, Rakesh Kumar, aged about 58 years, S/o Late. K.M.P Keshari, Office at Northern Coalfields Ltd. (Headquarter), Dist- Singrauli, Madhya Pradesh, Presently at New Delhi do hereby solemnly affirm and declare as under: -

1. That I am working as General Manager (Environment), Northern Coalfields Limited, as such in my official capacity, I am well conversant with the facts and circumstances of the Present Case and also Competent to swear this Present Affidavit.

2. That this Hon'ble Tribunal vide its order dated 19.12.2025 directed the Respondent No. 37/Northern Coalfields Ltd to file an affidavit placing on record the issues involved and the scope of the pending Civil Appeal No.4251-4252/2019 pending before the Hon'ble Supreme Court.

3. That this Hon'ble Tribunal vide its order dated 25.08.2014 constituted a Core Committee and 4 sub-committees, essentially for monitoring the

NOTARY PUBLIC GOVT. OF INDIA Sangita Mishra Advocate Delhi Date of Expiry 31-01-2030 hazards of Industrial Development in the Singrauli area. The Core Committee of which the Pollution Control Boards of State of UP & MP and other agencies are part of, submitted its report which was accepted by the Hon'ble Tribunal vide order dated 06.12.2017.

4. That the Core Committee was directed to conduct a fresh inspection. Two supervisory committees were constituted for implementation of recommendations of Core Committee report and submit monthly report to the core committee, and core committee was to submit report to the Tribunal every 3 months. The Core Committee submitted its report before the Tribunal on 03.04.2018, giving its recommendations on various issues including its recommendations for transportation of Coal by Railway Wagons and conveyor system and the precautions to be taken; and that no transportation of Coal by Road is to be done; and that 25 % of fly ash generated by TPP be used for back filing of abandoned mines of NCL.

5. This Hon'ble Tribunal, to comply with the said recommendations, constituted an oversight committee headed by Hon'ble Justice Rajesh Kumar, Retd. Judge Allahabad High Court and other members as detailed in Para 11of the order dated 28.08.2018 of this Hon'ble Tribunal.

"xxxxx

(i) Thermal Power Plants

a)

b)

c)

d)

e)

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f) Transportation of coal in open trucks is continued unabated thereby defying the very purpose of installation of the Pipe Conveyor System. Further, the residents in the concerned area complained about severe noise pollution caused by the prevailing coal transportation system. Necessary compliance should be carried out to reduce the noise pollution to the level required by the concerned SPCB with immediate effect. In case of dire necessity of transportation of fly ash and bottom ash, CPCB Guidelines for Loading/Unloading and Transportation of Flyash (December 2013), made for this purpose should be strictly followed. CCTV cameras are to be installed at strategic locations to monitor such transports by the concerned SPCBs. NCL, Gorbi Block B mine shall complete its railway track at the earliest and stop road transportation of coal up to Morba Railway siding. Similarly, Jayant mine shall either transport coal upto Morba railway siding by conveyor system or make arrangements to load the entire coal in railway wagons from the mine itself and stop the road transportation of coal.

xxxxx

(iii) M/s Northern Coalfields Ltd (NCL)

a) As per the provisions of the Notification of 2009, 25°/o percent of flyash should ,along with Over Burden (OB) generated in the mines of NCL, be used for back filling the abandoned mine. NCL must sign an MOU with NTPC and make available the abandoned Gorbi Mine for this purpose without further delay. NCL is required to obtain the necessary permission from the concerned DGMS in this regard. Further, the external dump and exhausted pits should be scientifically reclaimed using suitable biological and

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engineering measures as well as by mixing fly ash as per fly ash notification. Since human habitation has been seen to exist in the close proximity of the OB dump, NCL must take all possible initiatives for slope stabilization thereby preventing any possibility of accidents of sliding OB causing damage to property and life.

b) The norm of ash content equal to or below 34 percent is not strictly complied with by the NCL and ash content is going as high as 40 percent and beyond .Coal beneficiation is ,therefore, be initiated to obtain coal having less than 34% ash.

c) Also, the coal mines shall ensure that transportation of coal shall only be either by railway wagons or by the dedicated conveyor system. No transportation of coal shall be permitted by road to any of the industries in the Singrauli area, as recommended earlier also. The railway wagon loading area requires better material management as severe dust pollution is found in the area"

NO TRANSPORTATION OF COAL BY ROAD

6. That the Northern Coalfields Ltd filed an Application u/s 14 r/w Section 18 of the NGT Act for various reliefs viz permit NCL for transportation of the limited quantity of coal by road between Gorbi Block-B to Morwa Railway siding spur II for one year or till the completion of laying of the railway tracks of approx. 6 K.M by the railways; permit NCL for transportation of coal for three years from Jayant to Morwa siding spur I or till incremental CHP of 15 MTPA is commissioned at Jayant Project which will facilitate loading of railway wagons for transportation of coal

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and permit transportation of coal to the E-auction purchasers & TPS from various mines of NCL.

7. That the O.A No. 123 of 2019 was listed for hearing on 24.01.2019 before this Hon'ble Tribunal wherein the Hon'ble Tribunal was of the view that the same is not maintainable under Section 14 of the NGT Act, 2010 which can be invoked by a victim of pollution; and moreover transportation of coal in the area in question will be hazardous to environment and accordingly dismissed the application.

8. That the NCL filed Civil Appeal No. 4251-4252 of 2019 titled as "*Northern Coalfields Ltd Vs Ashwani Kumar Dubey*" under section 22 of the NGT Act, 2010 impugning the order dated 28.08.2018 and also the order dated 24.01.2019 of this Tribunal before the Hon'ble Supreme Court. A copy of the Civil Appeal No. 4251-4252 of 2019 filed before the Hon'ble Supreme Court is annexed herewith and marked as **ANNEXURE R-1**.

9. That the Hon'ble Supreme Court vide its order dated 22.04.2019 while issuing notice in the matter granted status quo, as of today in the meantime. A copy of the order dated 22.04.2019 passed by the Hon'ble Supreme Court in Civil Appeal No. 4251-4252 of 2019 is annexed herewith and marked as **ANNEXURE R-2**.

10. That there are three major coal consumers namely Hindalco Industries Ltd, Lanco Anpara Power Ltd, Prayagraj Power Generation Company, to whom coal is dispatched through trucks by the Northern coalfields Ltd. However, the coal dispatched through trucks to the aforesaid consumers is 6.48 % out of total dispatched coal i.e 7.54 MT, out of total 116.43 MT

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dispatched coal by NCL during Financial Year 2023-24. A Copy of the response filed by NCL by way of affidavit in terms of order dated 20.02.2020 passed by the Hon'ble Supreme Court in C.A Nos. 4251-52/2019 is annexed herewith and marked as **ANNEXURE R-3**.

11. That the Hon'ble Supreme Court vide its order dated 14.05.2024 admitted all appeals, interim orders were directed to be continued and hearing was expedited. A copy of the order dated 14.05.2024 passed by the Hon'ble Supreme Court in Civil Appeal No. 4251-4252 of 2019 is annexed herewith and marked as **ANNEXURE R-4**.

MIXING OF FLY ASH WITH OVERBURDEN DUMPS

12. That as per Fly Ash Notification dated 3rd November, 2009, issued by MoEF&CC, Government of India, it is mandated to use fly ash in different sectors with the objective of its gainful utilization. This Notification states that:

i. No person or agency shall within 50 kms (by road) from coal or lignite based thermal power plants, undertake or approve stowing of mines without using at least 25% of fly ash on weight to weight basis, of the total stowing material used and this shall be done under the guidance of the Director General of Mines Safety (DGMS), and

ii. No person or agency shall within 50 kms (by road) from coal or lignite based thermal power plants, undertake or approve without using at least 25% of fly ash on volume to volume basis of the total material used for external dump of overburden and the same percentage in upper benches of

NOTARY PUBLIC GOVT. OF INDIA Regn. No. Date of Expiry 31-01-2030 back filling of opencast mines and this shall be done under the guidance of the Director General of Mines Safety (DGMS).

13. Thereafter, the Ministry of Environment, Forest and Climate Change vide its notification dated 31.12.2021, issued directions for restricting the excavation of top soil for manufacturing of bricks and promoting the utilisation of fly ash in the manufacturing of building materials and in construction activity within a specified radius of three hundred kilometres from the coal or lignite based thermal power plants.

A. Responsibilities of thermal power plants to dispose fly ash and bottom ash.—

(1) Every coal or lignite based thermal power plant (including captive or co-generating stations or both) shall be primarily responsible to ensure 100 per cent utilisation of ash (fly ash, and bottom ash) generated by it in an eco-friendly manner as given in sub-paragraph (2);

(2) The ash generated from coal or lignite based thermal power plants shall be utilised only for the following eco-friendly purposes, namely:-

(i) Fly ash based products viz. bricks, blocks, tiles, fibre cement sheets, pipes, boards, panels;

(ii) Cement manufacturing, ready mix concrete;

(iii) Construction of road and fly over embankment, Ash and Geo-polymer based construction material;

(iv) Construction of dam;

(v) Filling up of low lying area;

(vi) Filling of mine voids;

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(vii) Manufacturing of sintered or cold bonded ash aggregate;

(viii) Agriculture in a controlled manner based on soil testing;

(ix) Construction of shoreline protection structures in coastal districts;

(x) Export of ash to other countries;

(xi) Any other eco-friendly purpose as notified from time to time.

14. Therefore, scientific assessment of fly ash from selected locations is/was required to be carried out and analyzed for any possibility of its disposal in the mine by mixing with overburden materials in appropriate proportions considering the environmental, safety and other statutory conditions. Based on the above discussion the following objectives have been taken for the project study –"*Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of NCL along with its viability and safety aspect of man and machinery*" by IIT-BHU.

1. Geotechnical Study of Overburden dump form mine
2. Geotechnical study of Fly ash sample collected from power plants
3. Geotechnical investigation of mix overburden and fly ash
4. Fly ash characterization study
5. Leaching study
6. Slope stability of mix overburden and fly ash
7. Traffic study for fly ash dumping (Route and Mode of Fly ash Transportation).

15. The Department of Mining Engineering, Indian Institute of Technology (Banaras Hindu University) was assigned the job vide work order No. NCL/SGRL/R&D/2021/90, dated 10.07.2021. The IIT BHU submitted its report in February, 2022 recommending that it is technically not feasible to dump the 25% fly ash in Mine dump in Khadia OCP due to geo mining

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31-01-20

conditions, high stripping ratio, and huge rate of OB removal and instability of dump during rainy season in present condition. A copy of Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of NCL along with its viability and safety aspect of man and machinery submitted by IIT-BHU in February, 2022 is annexed herewith and marked as **ANNEXURE R-5**.

16. Thereafter, the Northern Coalfields Limited (NCL), a subsidiary of Coal India Limited (CIL) has requested CSIR-CIMFR, Dhanbad to study the feasibility of mixing of fly ash and OB in active dumps of Nigahi Opencast Project. The scope of the project included:-

i. Feasibility study of mine for dumping oberburden mixed with pond ash (dry and wet/slury) in the running mine dumps.
ii. Study the properties of different proportion of mix design (overburden and pond ash) in both dry and slurry form with pond ash from all neighbouring thermal power plants.
iii. Study of physicochemical properties of pond ash of all the neighbouring thermal power plants.
iv. Carrying out the field study of OB fly ash mixing in running mine.

17. That the CSIR-CIMFR team visited the Nigahi Mines multiple times for collecting relevant information, conducting field study. After study the report has been submitted and the final recommendations are as :-

"RECOMMENDATIONS

The integration of pond ash with OB in running mine dumps at Nigahi OCP is not recommended under current conditions. The logistical, geo-

technical, environmental, and operational challenges outweighs the potential benefits. Alternatives such as utilizing pond ash in construction or cement manufacturing or filing voids of non-working/exhausted mines, should be explored."

A copy of Feasibility study for dumping overburden mixed with pond ash in the running Nigahi mines of NCL submitted by CSIR-CIMFR, Dhanbad in June, 2025 is annexed herewith and marked as **ANNEXURE R-6**.

18. That the NCL has signed MoU dated 03.01.2019 with NTPC for back filing fly ash from NTPC Vindhyachal Super Thermal Power Station in Gorbi Open Cast abandoned mine (PIT-1) of NCL. A copy of MOU dated 03.01.2019 with NTPC- Vindhyachal Super Thermal Power Plant is annexed herewith and marked as **ANNEXURE R-7**.

19. That the NCL has signed MoU dated 15.07.2023 with UPRVUNL-Anpara Thermal Power Plant for back filing fly ash from Anpara Thermal Project in Gorbi Open Cast abandoned mine (PIT-3) of NCL. A copy of MOU dated 15.07.2023 with UPRVUNL- Anpara Thermal Power Plant is annexed herewith and marked as **ANNEXURE R-8**.

20. Similarly the NCL has signed MoU dated 06.06.2024 with NTPC-VSTPS for back filing fly ash from Vinhyachal Super Thermal Power Station in Gorbi Open Cast abandoned mine (PIT-2) of NCL. A copy of MOU dated 06.06.2024 with NTPC- Vinhyachal Super Thermal Power Station is annexed herewith and marked as **ANNEXURE R-9**.

21. That I say that the Annexure A-1 to A-9 annexed along with the present Affidavit are true copy of its respective original.

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Advocate
Delhi
Regn. No.
Date of Exp.
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22.I say that averments of facts stated herein above are true to my knowledge, no part of it is false and has been derived from the official records and nothing material has been concealed therein.

Rakesh Kumar

DEPONENT

VERIFICATION

I, above named deponent mentioned above do hereby most solemnly affirm and verify that what is stated in the above affidavit is true to my knowledge and I believe the same to be true as per the official records of Northern Coalfield Ltd.

21 JAN 2026

Verified at New Delhi on this day of January, 2026.

Rakesh Kumar

DEPONENT

I identify the deponent who has signed/T.I in my presence

Mr./Ms ....Self.... Adv./Self

ID No. ....

NOTARY PUBLIC
Sangita Mishra
Advocate
Delhi
Regn. No. 16967
Date of Expiry
31-01-2030
GOVT. OF INDIA

ATTESTED

Mrs. Sangita Mishra
Advocate Delhi
Regn. No. 16967
Govt. of India
Mob. No. 9990312780

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Sr. No. 307 PAGE 24
Dated 21-1-26 Reg. No. 5

ANNEXURE R-1

IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

CIVIL APPEAL NOS. OF 2019

D No:

(APPEALS UNDER SECTION 22 OF THE NATIONAL GREEN TRIBUNAL ACT, 2010 AGAINST THE JUDGMENT AND FINAL ORDER DT.28.08.2018 PASSED BY THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH NEW DELHI IN O.A. NO. 164 OF 2018 (EARLIER O.A. NO. 276 OF 2013) AND ALSO CHALLENGING THE JUDGMENT AND FINAL ORDER DT.24.01.2019 PASSED BY THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI IN ORIGINAL APPLICATION NO.123/2019).

IN THE MATTER OF :

Northern Coalfields Ltd. ...Appellant

Versus

Ashwani Kumar Dubey & Ors. ...Respondents

WITH

I.A NOS.______ OF 2019
APPLICATION FOR CONDONATION OF DELAY IN FILING THE CIVIL APPEAL

AND

I.A NOS.______ OF 2019
APPLICATION FOR DIRECTIONS

AND

I.A NOS.______ OF 2019
APPLICATION FOR EXEMPTION FROM FILING THE CERTIFIED COPIES OF THE IMPUGNED ORDERS DT.28.08.2018 AND DT.24.01.2019

(PAPER BOOK)

(KINDLY SEE INSIDE FOR INDEX)

ARS ASSOCIATES : ADVOCATES FOR THE APPELLANT

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IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

CIVIL APPEAL NOS. OF 2019

IN THE MATTER OF :

Northern Coalfields Ltd. ...Appellant

Versus

Ashwani Kumar Dubey & Ors. ...Respondents

OFFICE REPORT ON LIMITATION

1. The Civil Appeal is within time.

2. The Petition is barred by time and there is delay of ....days in filing the same against Final order dt.28.08.2018 and petition for Condonation of .... days delay has been filed.

3. The Petition is barred by time and there is delay of ....days in filing the same against Final order dt.24.01.2019 and petition for Condonation of .... days delay has been filed.

4. There is delay of days in refiling the petition and petition for Condonation of days delay in refiling has been filed.

(BRANCH OFFICER)

NEW DELHI
DATED:07.02.2019

A1

PROFORMA FOR FIRST LISTING

SECTION – XVII

The case pertains to (Please tick/check the correct box):

- [ ] Central Act : NGT Act, 2010
- [ ] Section: U/s 14 of the Act.
- [ ] Central Rule : (Title) ______NA______
- [ ] Rule No(s) ______NA______
- [ ] State Act : ______NA______
- [ ] Section : ______NA______
- [ ] State Rule ______NA______
- [ ] Rule No(s): ______NA______
- [ ] Impugned Interim Order : (Date) : ______NA______
- [ ] Impugned Final Order/Decree: (Date) : 28.08.2018 & 24.01.2019
- [ ] High Court: (Name) :. ______NA______
- [ ] Name of Judges : (i) Hon'ble Mr. Justice Adarsh Kumar Goel, Chairperson, Hon'ble Mr. Justice Jawad Rahim, Judicial Member, Hon'ble Mr. Justice S.P. Wangdi, Judicial Member & Hon'ble Dr. Nagin Nanda, Expert Member.

  (ii) Hon'ble Mr. Justice Adarsh Kumar Goel, Chairperson, Hon'ble Mr. Justice S.P. Wangdi, Judicial Member, Hon'ble Mr. Justice K. Ramakrishnan, Judicial Member & Hon'ble Dr. Nagin Nanda, Expert Member.
- [ ] Tribunal/Authority : National Green Tribunal, Principle Bench, New Delhi

1. Nature of matter : Civil (Yes)

2. (a) Petitioner/appellant No.1: Northern Coalfields Ltd.
   (b) e-mail ID : anipr@sachthey.com
   (c) Mobile phone number: 9810018070

3. (a) Respondent No. 1 : Ashwani Kumar Dubey & Ors.
   (b) e-mail ID : ______NA______
   (c) Mobile phone number : ______NA______

4. (a) Main category classification: 1500
   (b) Sub classification: 1503 Tribunals

5. Not to be listed before : ______NA______

6. 6(a) Decided cases with citation: No Decided case.

   6(b). Similar/Pending matter : Not a Similar Pending Matter.

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7. **Criminal Matters:** -No -

(a) Whether accused/convict has surrendered: NA

(b) FIR No. –**NA**-

(c) Police Station : -**NA**-

(d) Sentence Awarded: **NA**

(e) Period of sentence undergone including period of Detention/Custody Undergone: NA

8. **Land Acquisition Matters:**

(i) Date of Section 4 notification :- -**NA**-

(ii) Date of Section 6 notification : -**NA**-

9. **Tax Matters :** State the tax effect :_____NA_____

10. Special Category (first petitioner/appellant only): ......NA.......

Senior citizen > 65 years SC/ST Woman/child Disabled Legal Aid case In custody

11. Vehicle Number (in case of Motor Accident Claim matters): ____NA____

Date: 07.02.2019

AOR for Appellant(s)

(Name) ___(ARS ASSOCIATES)
Registration No. 2578
Mail: anipr@sachthey.com
9810018070

B

SYNOPSIS AND LIST OF DATES

That the Applicant, Northern Coalfields Ltd., ('NCL' for short) is a Government of India Co. within the meaning of Section 617 of the Companies Act, 1956 and one of Subsidiary Co's of Coal India Limited,having its Regd. Office at Singrauli, P.O. Singrauli, Distt. Sidhi, Madhya Pradesh. The Applicant Coal Co. is carrying on the business of sale and distribution of Coal among others to Thermal Power Stations in and outside the State of Madhya Pradesh.

New coal distribution policy was brought into force by office memorandum dated 18.10.2007 by Government of India, Ministry of Coal. The scheme prescribed for the 10% of annual production of coal was initially to be offered under e-auction scheme which is now increased to 20% by Ministry of Coal vide letter dt.03.01.2017 of the Ministry of Coal to meet the requirement of small consumers. The said scheme replaced the earlier linkage system by Fuel Supply Agreement (FSA).

That O.A No. 164 of 2018 (Ashwani Kumar Dubey Vs. UOI)& O.A No. 276 Of 2013 (Ashwini Kumar Dubey vs.UOI&Ors.) was filed raising certain grievances, including pollution in District, Singrauli, in the State of Madhya Pradesh and District Sonbhdra, in the State of Uttar Pradesh on account of Thermal Power Plants (TPP) in the said Districts.

C

Further grievance was raised that the Industries are discharging mercury beyond the prescribed norms.

The fly ash stored by TPP creates high pollution; and there is pollution also during the process of transportation of coal by trucks to Thermal Power/E-auctionconsumers.

That all the coal mined by NCL is mostly dispatched to core sector consumer, viz. Thermal power plant and steel industries. The percentage of coal mined and sent to core sector is approx 85-90% (depending upon the requirement of Government Power station) and the balance is available for e-auction to small industries.

The TPP's to which the coal is supplied is as under:

Singrauli Super Thermal Power Station (SSTPS), Rihand Super Thermal Power Station (RhSTPS), Vindhyachal Thermal Power Station (VSTPS) of NTPC, Aravali TPS, ATPS, Hindalco Mahan, PMRG Hisar, NTPC Dadri, Surathgarh, Adani Power, Jhajjar, Kota (KTPS), Obra (OTPS), Lalitpur power, NTPC Mauda etc.

It is stated that with regard to use of 25% fly ash from TPP for back filling of abandoned mines, NCL raised the issue with the Director General of Mines Safety on 19.10.2015 for guidance.

The Director General of Mines Safety Varanasi region in response vide its letter dated 12.11.2015, recommended an in-

D

depth study in this behalf by scientific agencies having expertise.

It was further recorded that back filling of exhausted open cast pits can be done hydraulically by deployment of Heavy Earth Moving Machineries/ dumping by dumpers/tipper trucks.

It was requested to look into the issue.

This Hon'ble Tribunal on 25.08.2014 constituted a Core Committee and 4 sub-committees, essentially for monitoring the hazards of Industrial Development in the Singrauli area.

The Core Committee of which the Pollution Control Boards of state of UP & MP and other agencies are part of, submitted its report which was accepted by the Hon'ble Tribunal vide order 06.12.2017.

The Core Committee was directed to conduct a fresh inspection. Two supervisory committees were constituted for implementation of recommendations of Core Committee report and submit monthly report to the core committee; and core committee was to submit report to the Tribunal every 3 months. Further directions were issued to ensure that every village is provided with a RO plant, the cost of which was to be borne by the industries. Directions among others were also given to fix online air and water monitoring systems.

Core committee submitted its report before the Tribunal on 03.04.2018, giving its recommendation on various issues

E

including its recommendations for transportation of Coal by Railway wagons and conveyor system and the precautions to be taken; and that no transportation of Coal by Road is to be done; and that 25 % of fly ash generated by TPP be used for back filing of abandoned mines of NCL.

The Hon'ble Tribunal, to comply with the said recommendations, constituted an oversight committee headed by Hon'ble Justice Rajesh Kumar, Retd. Judge Allahabad High Court and other members as detailed in Para 11 of the order dt.28.08.2018 of the Hon'ble Tribunal.

In pursuance to the aforesaid order dt.28.08.2018, the Oversight Committee held meeting on 25.10.2018, wherein para 4 was with reference to the Appellant NCL;
and in sub para (A) recorded that NCL has taken a decision to declare "Gorbi Mine" as abandoned mine. It was further recorded that NCL has taken up the issue with the NTPC Vindhyachal for back filling the mine with Fly Ash.
It is relevant to state that in this regard the MOU has been entered into between NCL and NTPC on 03.01.2019.
In para B of the minutes dt.25.10.2018 it was recorded that transportation of coal from Gorbi Block –B to Morwa Railway siding (distance of 6 km approx.) was by road; it was because of non availability of railway track; NCL has taken up the issue with the Railways; and for laying of railway tracks the NCL

F

management shall complete the construction of railway line within a year.

In para D, it was recorded that NGT has completely prohibited road transportation of coal from Jayant Mines to Morwa railway siding and NCL shall transport coal by conveyor system or by railway wagons.

In this behalf it is stated by NCL that major quantity of coal mined is transported through rail; and a miniscule quantity is transported by road.

For transportation of all mined coal by NCL by rail at least 3 years is required for development of infrastructure.

It is stated that NCL's Coal production during 2016-2017 was 84.10 MT; during 2017-2018 coal production was 93.03 Mt. and provisional target for 2018-19 is about 100 MT.

It is submitted that, an Automatic Mobile Dust sweeping machines have been deployed in the year 2016 for sweeping of the dust along the coal transportation roads to control & prevent duct pollution.

It is stated that the oversight committee held further meeting on 23.11.2018 as under.

(i) With regard to fly ash disposal in Gorbi abandoned mine, various detailed discussions were held between NCL and NTPC and a draft has been prepared. It is stated that the

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final MOU has been signed on 3rd January, 2019 valid and operative for a period of 10 years.

(ii) Necessary precautions regarding environment and safety are incorporated in the MoU.

(iii) In paras of the minutes, with reference to transportation of coal by road, NCL had informed that certain private enterprise who purchased coal through e-auction, coal is transported through road. The oversight committee stated that

> *"Prima facie the contention of NCL appears to have substance. Let NGT may clarify issue in this regard. NCL is directed to seek necessary clarification from NGT."*

With regard to Transportation of coal by road to LANCO power plant it was recorded that transport by rail will come into operation by end of December 2018. This was confirmed by District Magistrate, Sonebhadra.

The Applicant states that Action taken report (ATR)/ compliance status for the issues deliberated in the minutes of the meeting of Oversight committee under the chairmanship of Hon'ble Justice (Retd.) Sri Rajesh Kumar, Allahabad High Court.

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Incremental CHP of 15 MTPA is to be commissioned at Jayant Project in addition to the existing 10 MTPA CHP capacity.

Tendering process for incremental CHP (15 MTPA) is in progress for and it may take approximately 3 years for its commissioning.

Transportation of coal from Jayant Mines to Morwa siding is continued. However a proposal of construction of separate road for coal transportation is in the process for which the application to MOEF for clearance of forest land involving (7.448 Ha) has been submitted.

The difference measures for control of pollution arising due to coal transportation through road (Jayant to Morwa siding a distance of 3 km) are as follows:-

a) Jet spraying of water through fixed sprinklers at siding.
b) Retaining wall/wind breaking wall (200m (L) X 3m (H)) has been constructed at siding. Its height will be further increased by 3.2m with galvanized sheets all along above the retaining wall for which work is in progress.
c) Furthermore wind breaking curtain of 450m length with height of 6m (of which bottom 3.1m will be constructed of galvanized sheets and above 3m height

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green mat will be fixed) is proposed for construction at Morwa siding for which tender is in process.

d) Plantation between the railway track & spur-1 siding has been done.

e) RCC road from main road junction/kanta more, up to siding has been constructed.

f) Continuous water sprinkling by mobile water tankers on roads and siding.

g) Cleaning of coal transport road by manual sweeping.

h) Coal transporting trucks are covered by tarpaulin sheets.

i) Road from Jayant to Morwa siding is of sufficient width & black topped/pitched.

j) Green belt has been developed all along the road from Jayant to Kanta More.

Transportation of coal from Block B to Spurr II siding is done by M/s BPL-BIPL(JV)

M/s BPL-BIPL JOINT VENTURE

The details of dispatch from Jayant mine to Morwa siding are as follows:-

Year	2017-18	2018-19 (up to Nov.)	% change
Dispatch	5.89 MT.	2.267 MT	
Average per month	0.49 MT Per month	0.283 MT per month	42.24% decrease from last year

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The details of customers are as follows:-

(i) Coal is dispatched to Thermal power Projects/station like- Shaktinagar Super Thermal Power Station, Rihand Super Thermal Power Station, Vindhyachal Super Thermal Power Station through MGR silo/CHP.

(ii) Other consumers & thermal power stations like – Aravali, ATPS, Kota Hindalso Mahan, PMRG Hisar, Surathgarh, Jhajjar, NTPC Dadri, Adani power etc. receive the coal from Jayant mine through Morwa siding.

With regard to Transportation of coal by road to LANCO power plant it was recorded that transport by rail will come into operation by end of December 2018. This was confirmed by District Magistrate, Sonebhadra.

It was further discussed that HINDALCO Industry (Renusagar Power Division, Sonebhadra) purchases coal through e-auction beyond their linkage allotment and such coal is transported through conveyor belt/road.

It was further recorded that HINDALCO in case of purchases from other mines, where there are nofacilities for transportation through conveyor belt, the rail siding at Krishnasheela mining project is required. HINDALCO stated that they can lay pipe

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conveyor belt structureupto NCL which includes NCL land of 2.68 acres.

It was recorded that NCL may approach the NGT & to produce the papers in this regard to the Oversight Committee.

The total quantity of coal mined in NCL in the current year from 01.04.2018 to 30.11.2018 is 65.63 MT against targeted qty of 64.05 MT and how much is dispatched on allotment basis by rail and how much quantity is offered for E-auction sale by road, Mode wise details of dispatch are as follows :-

Dispatch (Through MGR)	30.19 Mill.Tonnes
Dispatch (Through Rail)	22.62 Mill. Tonnes
Dispatch (Through belt pipe conveyor)	2.04 Mill Tonnes
Dispatch (Through Road)	11.35Mill. Tonnes
Total Dispatch :	66.20 Mill. Tonnes

(Out of which total coal dispatched under e-auction was 6.39 MT).

That the Appellant filed an Application u/s 14 r/w Section 18 of the NGT Act for various reliefs viz. permit NCL for transportation of the limited quantity of coal by road between Gorbi Block-B to Morwa Railway siding spur II for one year or till the completion of laying of the railway tracks of approx 6 K.M. by the railways;

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permit NCL for transportation of coal for three years from Jayant to Morwa siding spur I or till incremental CHP of 15 MTPA is commissioned at Jayant Project which will facilitate loading of railway wagons for transportation of coal; and

permit transportation of coal to the E-auction purchasers & TPS from various mines of NCL.

The Original Application No. 123 of 2019 was listed for hearing on 24.01.2019 before the National Green Tribunal, Principal Bench, New Delhi, when the Hon'ble Tribunal was of the view that the same is not maintainable under Section 14 of the National Green Tribunal Act, 2010, which can be invoked by a victim of pollution; and moreover transportation of coal in the area in question will be hazardous to environment and accordingly dismissed the application.

The Hon'ble Court observed that it would be appropriate that the Appellant/NCL challenge the said order dt.28.08.2018 before this Hon'ble Court.

Hence, the present Appeal under Section 22 of the National Green Tribunal Act, 2010 impugning the order dt.28.08.2018 and also the order dt.24.01.2019 before the Hon'ble Court.

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LIST OF DATES

That the Applicant, Northern Coalfields Ltd., ('NCL' for short) is a Government of India Co. within the meaning of Section 617 of the Companies Act, 1956 and one of Subsidiary Co's of Coal India Limited,having its Regd. Office at Singrauli, P.O. Singrauli, Distt. Sidhi, Madhya Pradesh.

The Applicant Coal Co. is carrying on the business of sale and distribution of Coal among others to Thermal Power Stations in and outside the State of Madhya Pradesh.

18.10.2007 New coal distribution policy was brought into force by office memorandum dated 18.10.2007 by Government of India, Ministry of Coal. The scheme prescribed for the 10% of annual production of coal was initially to be offered under e-auction scheme which is now increased to 20% by Ministry of Coal vide letter dt.03.01.2017 of the Ministry of Coal to meet the requirement of small consumers. The said scheme replaced the earlier linkage system by Fuel Supply Agreement (FSA).

That O.A No. 164 of 2018 (Ashwani Kumar

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Dubey Vs. UOI)& O.A No. 276 Of 2013 (Ashwini Kumar Dubey vs.UOI&Ors.) was filed raising certain grievances, including pollution in District, Singrauli, in the State of Madhya Pradesh and District Sonbhdra, in the State of Uttar Pradesh.

1. In the said Applications that there are Thermal Power Plants (TPP), in the said districts and on account of further activities there is pollution effecting the environment. Further the industries are discharging mercury beyond the prescribed norms thus affecting the nervous system causing disorder and other ailments to the people that no safe guards are being adopted.

Further, the fly ash stored by TPP creates high pollution; and there is pollution also during the process of transportation of coal by truck by the coal companies to consumers.

19.10.2015	That with regard to use of 25% fly ash from TPP for back filling of abandoned mines, NCL raised the issue with the Director General of Mines Safety for guidance.

12.11.2015	The Director General of Mines Safety Varanasi region in response recommended an in-depth study in this behalf by scientific agencies having expertise. It was further recorded that back filling of exhausted open cast pits can be done hydraulically by deployment of Heavy Earth Moving Machineries/ dumping by dumpers/ tipper trucks. It was requested to look into the issue.
2016	Automatic mobile dust sweeping machines have been deployed for sweeping of the dust along the coal transportation roads to control & prevent dust pollution.
06.12.2017	The Hon'ble NGT passed orders for constitution of the core committee for monitoring of potential Hazards of Industrial Development in Singrauli area.
03.04.2018	Core committee submitted its report before the Tribunal on 03/04/2018, giving its recommendation on various issues including its recommendations for transportation of Coalby Railway wagons and conveyor system

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and the precautions to be taken; that no transportation of Coal by Road is to be done; and that 25 % of fly ash generated by TPP be used for back filing of abandoned mines of NCL.

28.08.2018 (Impugned Order) This Hon'ble Tribunal finally took up the matter on 28.08.2018 and having perused the records of the case including the report submitted by the core committee on 03.04.2018, the Hon'ble Tribunal after hearing the parties passed orders, wherein final recommendations of the core committee has been set out in Para 9 of the order of the Hon'ble Tribunal and disposed of the original application..

This Hon'ble Tribunal, to comply with the said recommendations, constituted an oversight committee headed by Hon'ble Justice Rajesh Kumar, Retd. Judge Allahabad High Court and other members as detailed in Para 11 of the order dt.28.08.2018 of this Hon'ble Tribunal.

That all the coal mined by NCL is mostly dispatched to core sector consumer, viz Thermal power plant and steel industries. The percentage of coal mined and sent to core sector is approx 85-90% (depending upon the requirement of Government Power station) and the balance is available for e-auction.

The TPP's are as under:

Singrauli Super Thermal Power Station (SSTPS), Rihand Super Thermal Power Station (RhSTPS), Vindhyachal Thermal Power Station (VSTPS) of NTPC, Aravali TPS, ATPS, Hindalco Mahan, PMRG Hisar, NTPC Dadri, Surathgarh, Adani Power, Jhajjar, Kota (KTPS), Obra (OTPS), Lalitpur power, NTPC Mauda etc.

25.10.2018 In pursuance to the aforesaid order, the oversight committee held meeting for implementation of various recommendations.

In para D, it was recorded that NGT has completely prohibited road transportation of coal from Jayant Mines to Morwa railway siding and NCL shall transport coal by conveyor system or by railway wagons.

In this behalf it is stated by NCL that major quantity of coal mined is transported through rail; and a miniscule quantity is transported by

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road.

For transportation of all mined coal by NCL by rail at least 3 years is required for development of infrastructure.

NCL's Coal production during 2016-2017 was 84.10 MT; during 2017-2018 coal production was 93.03 Mt. and provisional target for 2018-19 is about 100 MT.

31.10.2018 That NCL carries out major plantation work every year (Total Plantation upto 2018-19 is 2.37 crore plants, approx), which works out to be more than 1408 plants per employee of NCL. Further NCL has taken afforestation in and around the mined out area and same has been reported by remote sensing satellite data study. The plantation of trees, shrubs and grass has been done profusely on crowns of dumps, ring bunds, dykes, recess, slopes, etc. to ensure thick biological growth.

It is further stated that all the 10 mines of NCL are operating after taking due environmental clearances (EC) from MoEF and Air & Water Consent from State Pollution Control Boards of

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U.P. & M.P. EC is issued after preparation of environmental management plan, getting terms of reference, public hearing, etc. Certified compliance report of EC conditions are issued by the Regional Offices of MoEF at Lucknow and Bhopal. Air and Water consents are issued after verification to the compliance of all Environmental Laws by State Pollution Control Board of UP & MP.

That Environmental Clearances (EC) of each of the mines are available at the site of MoEF and NCL.

An Automatic Mobile Dust sweeping machines have been deployed in the year 2016 for sweeping of the dust along the coal transportation roads to control & prevent duct pollution.

That the Eco- restoration works with 03 tier plantations has been done through Forest Research Institute (FRI) Dehradun for 02 sites of 5.0 Ha, each at Nigahi&Krishanshila Projects. This is one of the endeavours for improving the quality of afforestaion, create rich bio-diversity and improve greenery in the

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areas.

23.11.2018	That the oversight committee held further meeting with regard to fly ash disposal in Gorbi abandoned mine, various detailed discussions were held between NCL and NTPC and a MoU is signed with regard to the same on 03.01.2019, which shall remain valid for a period of 10 years. Necessary precautions regarding environment and safety are incorporated in the MoU.
	In paras of minutes, with reference to transportation of coal by road, NCL had informed that certain private enterprise who purchased coal through e-auction, coal is transported through road, the oversight committee stated that *"Prima facie the contention of NCL appears to have substance. Let NGT may clarify issue in this regard. NCL is directed to seek necessary clarification from NGT."* The committee desired NCL to provide details of quantities of coal supplied to HINDALCO through road as such transportation is subjected to penalty.

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With regard to Transportation of coal by road to LANCO power plant it was recorded that transport by rail will come into operation by end of December 2018. This was confirmed by District Magistrate, Sonebhadra.

In this behalf it is stated that an additional Coal Handing Plant (CHP) of 06 MTY capacity has already been constructed at Khadia Project, NCL and its linkage with M/s Lanco through Merry-Go-Round (MGR) system is currently under load trial stage with effect from 16.12.2018. The schedule period of load trial as per contract is 14 days. As per contract provisions, each equipment and system has to be tested for rated capacity. In case of any deficiencies, the period of load trial may be extended as per need till final parameters are achieved. After load trial run, performance guarantee test has to be done for which scheduled minimum period is one month.

It was further discussed that HINDALCO Industry (Renusagar Power Division, Sonebhadra) purchases coal through e-auction beyond their linkage allotment and such coal is

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	transported through conveyor belt/road.
19.01.2019	The Applicant filed the Original Application No. 129 of 2019 before the Hon'ble National Green Tribunal, Principal Branch, New Delhi for permitting the NCL for transportation of the limited quantity of coal by road, between Gorbi Block-B to Morwa Railway siding spur II, for one year or till the completion of laying of the Railway Tracks of approx 6 km by the Railways. The NCL for transportation of coal for three years from Jayant to Morwa siding spur I or till incremental CHP of 15 MTPA is commissioned at Jayant Project which will facilitate loading of Railway wagons for transportation of coal. The transportation of coal to the E-auction purchasers & TPS from various mines of NCL for which NCL undertakes to ensure the pollution control measures as stated in box (5) above are strictly followed and complied.
24.01.2019 (Impugned Order)	The impugned order of the Hon'ble National Green Tribunal where by the Court held that,"...*we find that the application is not*

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maintainable before this Tribunal Under Section 14 of the National Green Tribunal Act, 2010 which can be invoked by a victim of pollution. Moreover, transportation of coal in the area in question will be hazardous to environment.

The application is accordingly disposed of."

07.02.2019 Hence the present Civil Appeal filed against the Order dt.28.08.2018 and Order dt.24.01.2019.

BEFORE THE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

Original Application No. 164/2018

(Earlier O.A. No. 276/2013)

And

Execution Application No. 22/2018

In

(Original Application No. 276/2013)

In the matters of :-

Ashwani Kumar Dubey Vs. Union of India & Ors.

And

Ashwani Kumar Dubey Vs. Union of India &Ors.

CORAM : HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON

HON'BLE DR. JUSTICE JAWAD RAHIM, JUDICIAL MEMBER

HON'BLE MR. JUSTICE S.P. WANGDI, JUDICIAL MEMBER

HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Present: Applicant : Mr. Ashwani Kr. Dubey, applicant in person

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Respondents: Ms. Deep Shikha Bharti, Adv. for State of UP

Mr. V.K. Shukla and Ms. Vijay Laxmi, Advs. for State of MP

Mr. Mahesh Agarwal and Mr. Nishant Rao, Advs.

Mr. Mukul Singh, Adv. for MoEF

Mr. Daleep Dhyani, Adv. for UPPCB

Mr. Rajkumar, Adv. for CPCB

Mr. Syed Shahid Hussain Rizvi, Zeeshan Rizvi, Advs.

Mr. Yogesh K. Chandna, Adv.

Mr. Rajat Jariwal and Mr.Ayush Jain, Advs. for R-17

Mr. Anip Sachthey, Ms. Anjali Chauhan and Ms. Ria Sachthey, Advs. for R-36

Mr. Rajul Shrivastav, Adv for MPPCB

Mr. Vivek Singh and Mr. Swastik Dalai, Advs.

Mr. Pawan Upadhyay, Mr. Abhishek Awasthi and Mr. Digaj Pathak, Advs. for R-22& 23

Mr. Nitin Mishra and Mitali Gupta, Advs.

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Dr. Ashwani Bhardwaj, Adv.

Mr. Bharat Sanpal, Ms. Isha Gupta,

Ms. Babita Kushwar, Advs.

Date and Remarks	Orders of the Tribunal

Item Nos. 06 &07

August 28, 2018

R

1. The original application was filed with the grievance against pollution caused in District Singrauli in the State of Madhya Pradesh and District Sonebhadra in the State of Uttar Pradesh.

2. Case of the applicant is that there are thermal power plants in the said Districts and on account of their activities, acute pollution is caused resulting in continued 2 Item Nos. 06 & 07 August 28, 2018 R destruction of environment. The industries are discharging mercury beyond prescribed norms affecting the nervous system causing disorders and other ailments to inhabitants. The said areas are critically polluted as per the 'Comprehensive Environmental Polluted Index Report'. There are studies that fly ash stored

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by the industries creates high pollution. High pollution is also caused in the process of transportation of coal by the trucks from the coal companies. No required safeguards are being adopted.

3. This Tribunal vide the order dated 25.08.2014 constituted a Core Committee and four Sub-Committees. The Core Committee for monitoring the hazards of industrial development in Singrauli area comprising of:

   a. The representatives from Central Pollution Control Board, Madhya Pradesh Pollution Control Board, Uttar Pradesh Pollution Control Board.

   b. Director of Indian Agricultural Research Institute.

   c. Director of Indian Council of Forestry Research and Education.

   d. Director of National Institute of Hydrology.

   e. Director of Indian Institute of Toxicology Research.

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f. Dr. I. M Mishra, Chemical Engineering, Department, IIT Roorkee.

g. Dr. Vinod Tare, Professor Environmental Engineering, IIT Kanpur

h. Dr. T. Chakrabarti, Visvesvaraya National Institute of Technology, Nagpur.

i. Porf. Kanchan Chopra, Institute of Economic 3 Item Nos. 06 & 07 August 28, 2018 R Growth.

j. Nominee of Director, All India Institute of Medical Sciences.

k. Nominee of Director, National Institute of Occupational Health, Ahmedabad.

l. Joint Director, EIA Division, Ministry of Environment and Forests.

4. A Sub-Committee was constituted to assess the potential impact of pollution on water resources as follows:

a. Representative of the Central Ground Water Authority having experience in Water Quality.

b. Representative of the Ministry of Water Resources having experience in Water Quality.

c. Representative of State Irrigation Department having experience in Water Quality.

d. Representative of National Institute of Hydrology from Water Quality Laboratory.

5. A Sub-Committee for assessing impact on land resources was also constituted as follows:

a. Representative of Indian Institute of Toxicology Research, Lucknow.

b. Representative of Central Pollution Control Board, Madhya Pradesh State Pollution Control Board and Uttar Pradesh State Pollution Control Board not below the rank of Regional Officer.

c. An Expert of Soil Science from Indian Institute of Soil Science, Bhopal.

d. An Expert on Forest Soil from Indian Council of 4 Item Nos. 06 & 07 August 28, 2018 R Forestry Research and Education, Dehradun.

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6. A Sub-Committee to assess impact on air quality was as follows:

   a) Representative of the Central Pollution Control Board,

   b) Representative of the Madhya Pradesh Pollution Control Board

   c) Representative of the Uttar Pradesh Pollution Control Board

   d) An expert on Air Quality from National Environmental Engineering Research Institute, Nagpur. e) An expert on Air Quality from IIT, Kanpur.

7. A Sub-Committee to assess impact on health was as follows:

   a) Committee to have at least one Doctor each from Uttar Pradesh and Madhya Pradesh apart from one Social Scientist from each of the state and involve Panchayati Raj Institutions for collection of primary data.

8. The Committee submitted its report which was accepted by the Tribunal vide order dated

06.12.2017. The Core Committee was directed to conduct a fresh inspection. Two Supervisory Committees were constituted for implementation of recommendations of the Core Committee Report. Composition of said Committees was as follows:

i) Secretary Environment of the respective States

ii) Member Secretary of the Pollution Control Board of the concerned States

iii) District Magistrate of the concerned district who 5 Item Nos. 06 & 07 August 28, 2018 R shall be conveners of the meeting.

iv) Zila Panchyat Adyayksh of the District in which the village falls inspection of which is being conducted by the Team.

v) Nominee of the Mayor in the case of Urban areas.

vi) Senior Officer from the Coal Mine Department of the States.

9. The Supervisory Committees were required to submit monthly reports to the Core Committee and Core Committee was to submit reports to this

Tribunal every three months. Direction was also issued to ensure that every village is provided with a RO plant and if necessary two or more plants so that every resident can get potable water for drinking. The cost was to be borne by the industries. Direction was also issued to fix on-line air monitoring systems as well as water quality monitoring systems. Land was to be provided by the Government or the Gram Panchayat and the cost of installation or maintenance was to be borne by the industries. The stone crushers working without permission were directed to be closed down. They were permitted to operate and they were required to install RO system as per above directions.

Accordingly, a report of February 2018 has been filed before this Tribunal on 03.04.2018. The report has been signed by Dr. Tapan Chakrabarti, Chairman of Core Committee & former Director, NEERI, Nagpur, Mr. A. Sudhakar, Member Secretary, CPCB, Prof. I.M. Mishra, Prof. I. M. Mishra, Chemical Eng. Dept., ISM, Dhanbad, Dr. Rajesh Singh, Scientist C, NIH, Roorkee, Shri T U Khan, Chief Env. Officer, UPPCB, Lucknow, Dr.

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Khajanchilal, Principal Scientist, IARI, New Delhi, Dr. Veeramgami, Scientist - B, NIOH, Ahmedabad, Mr. 6 Item Nos. 06 & 07 August 28, 2018 R Hemant Sharma, Chief Engineer MPPCB, Bhopal, Dr. Vishavjit Kumar, Scientist D, ICFRE Dehradun. Its recommendations are as follows:

"Final Recommendations

Compliance requirement identified during the Inspection carried out in pursuance of the Order of the NGT dated December 6, 2017.

The Core Committee carried out a fresh investigation in the Singrauli area on January 8 and 9, 2018 as directed by the NGT, New Delhi (vide order dated December 6,2017).The compliance necessary further are documented as under:

(i) Thermal Power Plants

a) All the AWRS and ESPs installed by the thermal power plants should be made functional on continuous basis. The stacks of the power plants and the ambient air monitoring stations need to be linked with CPCB/SPCB network.

b) Necessary renovation of the ash dykes needs to be carried out in order to prevent ash slurry going to Rihand Reservoir.

c) District Administration/State Government is required to declare an area in the 300 km radius of the power plants as a utilization zone where fly ash/bottom ash derived bricks/blocks and building products are made mandatory to be used in the buildings and other construction activities. It is gathered that there are few brick making units which are mixing soil with fly ash to make bricks. It shall be ensured that at least 25% of flyash shall be mixed in making clay bricks within 100 Km radius of thermal power plants, otherwise it will be in contravention to the Fly ash Notification 2009 issued by the MoEF&CC, New Delhi. The .making of bricks from soil or mixed soil is to be banned forthwith.

d) All Thermal Power Plants in Sonebhadra and Singrauli Districts must be supplied with coal containing ash less than 34°/o on quarterly average basis as stipulated vide Notification No. GSR 02 (E) dated January 02,2014.

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e) Shaktinagar Super Thermal Power Plant of NTPC Ltd. must repair their damaged pipeline and stop discharge of sewage into Ballia Nallah with immediate effect.

f) Transportation of coal in open trucks is continued unabated thereby defying the very purpose of installation of the Pipe Conveyor System. Further, the residents in the concerned area complained about severe noise pollution caused by the prevailing coal transportation 7 Item Nos. 06 & 07 August 28, 2018 R system. Necessary compliance should be carried out to reduce the noise pollution to the level required by the concerned SPCB with immediate effect. In case of dire necessity of transportation of fly ash and bottom ash, CPCB Guidelines for Loading/Unloading and Transportation of Flyash (December 2013), made for this purpose should be strictly followed. CCTV cameras are to be installed at strategic locations to monitor such transports by the concerned SPCBs. NCL, Gorbi Block B mine shall complete its railway track at the earliest and stop road transportation of coal up to Morba Railway siding. Similarly, Jayant mine shall either transport coal upto Morba railway siding by conveyor system or make arrangements to load the entire coal in railway wagons from the mine itself and stop the road transportation of coal.

(ii) Aluminum Smelter: M/s Hindalco Industries, Renukoot

a) Industry shall achieve emission limit of 50 mg/Nm3 for particulate matter in respect of all Baking furnaces. The emission from boilers shall be reduced to the level of 50 mg/Nm3 from the existing norms of 150 mg/Nm3by December 31, 2019 retrofitting of exiting ESPs and also meet emission limit of 502 & NOx notified for industrial boilers.

b) Industry shall ensure that no red mud is leached out to ground water during monsoon and post monsoon period. Piezometers/monitoring wells should be installed in and around the red mud disposal sites in consultation with the CGWB/concerned SGWB. Regular monitoring of the leachate should be carried out as per the sampling and analysis plan as proposed by the concerned SPCB. Besides, industry shall facilitate utilization of Red Mud in nearby cement industries, including those located in MP. The industry shall also explore the possibility of extraction of titanium and other heavy metals from the Red Mud.

c) The Core Committee was informed that the industry has taken a zero waste water discharge initiative though no such action plan could be obtained. This action plan must be made ready within a month's time and submitted to UPPCB for necessary approval

(iii) M/s Aditya Birla Chemicals, Renukoot

a) Industry shall ensure proper operation of effluent treatment plant so as to ensure the compliance of the effluent discharge standard. The industry shall also ensure that no untreated/partially treated effluent finds its way in to the Nallah leading to the Rihand Reservoir. The channel leading to Rihand Reservoir has to be intercepted, diverted and treated within the 8 Item Nos. 06 & 07 August 28, 2018 R industry. The nallah presently passing through the factory should be isolated so that the industry cannot discharge

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any treated/partially/treated/untreated effluent which is being done now.

b) There is also an urgent need for the preparation of an action plan by the industry to shift the mercury bearing brine sludge and the muck contaminated with chlorinated chemicals from the factory premises to the TSDF in consultation with the UP State Pollution Control Board. It may be stated here that storage of hazardous mercury bearing brine sludge and the muck contaminated with chlorinated chemicals inside the premises is not permitted by the prevailing Hazardous Waste Management Rules,2016and, therefore, to be shifted to a suitable TSDF immediately.

(iii) M/s Northern Coalfields Limited (NCL)

a) As per the provisions of the Notification of 2009, 25°/o percent of flyash should ,along with Over Burden (OB) generated in the mines of NCL, be used for back filling the abandoned mine. NCL must sign an MOU with NTPC and make available the abandoned Gorbi Mine for this purpose without further delay. NCL is required to obtain the necessary permission from the concerned DGMS in this regard. Further, the external dump and exhausted pits should be scientifically reclaimed using suitable biological and engineering measures as well as by mixing fly ash as per fly ash notification. Since human habitation has been seen to exist in the close proximity of the OB dump, NCL must take all possible initiatives for slope stabilization thereby preventing any possibility of accidents of sliding OB causing damage to property and life.

b) The norm of ash content equal to or below 34 percent is not strictly complied with by the NCL and ash content is going as high as 40 percent and beyond .Coal beneficiation is ,therefore, be initiated to obtain coal having less than 34% ash.

c) Also, the coal mines shall ensure that transportation of coal shall only be either by railway wagons or by the dedicated conveyor system. No transportation of coal shall be permitted by road to any of the industries in the Singrauli area, as recommended earlier also. The railway wagon loading area requires better material

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management as severe dust pollution is found in the area.

(V) Stone crushers

a) All stone crushers in Singrauli are have not taken adequate pollution control measures as the level of air pollution in the vicinity of stone crushers is high and causes a health hazards. Most of the crushers are located very near to habited area or very near to the roads/ 9 Item Nos. 06 & 07 August 28, 2018 R highways. Allsuch stone crushers which are not suitably located as well as which do not have adequate pollution control systems should be immediately closed. Relocation of stone crushers may also be explored.

(VI) Pollution Control Boards and MoEF& CC

a) The regional carrying capacity of the entire Singrauli region is to be assessed before allowing any expansion scheme with respect to the existing industries. This assessment is the prerequisite for such consideration in future.

b) The concerned SPCBs must ensure that all the major stacks from all the industries are being

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continuously monitored and these are linked with the CPCB/SPCB network. Effluent discharges from the industries are monitored once a month.

c) The existing network of monitoring system for AAQ monitoring in both the districts of UP & MP need to strengthened and expanded to get representative air quality status of Singrauli area. Industries in the area should install at least three continuous ambient air quality monitoring stations forthwith on "Polluter Pays Principle" at such locations as may be decided by CPCB in consultation with the respective SPCBs. The data generated should be transferred to SPCBs, CPCB and MoEF& CC on continuing basis.

d) It is also essential that at least three continuous monitoring systems for mercury (Hg) monitoring in the ambient air should be installed (covering both the Districts of UP & MP) forthwith at suitable locations in the Singrauli area by the industries on "Polluter Pays Principle". CPCB in consultation with the SPCBs shall guide the industries regarding the location of the monitoring stations. Besides mercury in and surface and ground water should also be monitored manually once in a three months.

(VII) District Administration of respective States

a) The Awdi-Shaktinagar Marg and Singrauli-Awdi – Dibulgunj Margare extensively used for heavy traffic and for clandestine coal transport leading to dust pollution. Further, the dense population which are residing along these roadsides are severely affected by dust pollution. As has been mentioned, coal transportation by open truck is to be banned forthwith. CCTV cameras are to be installed at strategic location to record any violation in this regard.

b) To improve the prevailing situation, these roads are required to have 4/6lanes and the pavements should be furnished with inter locking bricks of suitable quality to arrest air entrainment of dust.

c) Since there is no strategy for disposal of the RO reject in an environmentally friendly manner, prevailing practice of dumping of RO reject shall affect nearby land as well as water resources with long term consequences leading to 10 Item Nos. 06

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& 07 August 28, 2018 R irreversible ecological damage. Therefore no further installation of RO plants in affected villages is recommended. Instead water supply should now be practiced using water tankers as an interim measure. Piped water supply from Rihand reservoir will be a longterm solution for drinking water supply to fluoride and mercury affected villages.

d) In the past Rihand reservoir was polluted by the major industries in the area such as thermal power plants, coal mines, M/s Aditya Birla Chemicals, Renukoot and M/s Hindalco Industries, Renukoot. Since this reservoir isthe only drinking water source in the area, the reservoir needs restoration and protection. A comprehensive study needs to be undertaken to assess the reservoir's water and sediment quality and to delineate water and sediment remediation and restoration measures on Polluter Pays Principle. All the streams and nullahs joining the reservoir need to be intercepted and diverted to save the reservoir from further pollution. CSIR NEERI, Nagpur and/or CSIR-IITR, Lucknow may be entrusted with this study for which both these organizations have the requisite expertise.

e) As the patients with clinical manifestations suggestive of fluorosis were also noted to have severe malnutrition, mineral and nutrient supplements for these areas should be ensured by the District Administration. Further, patients with clinical manifestations suggestive of fluorosis must be monitored for their health through a scientific plan of periodic checkup as recommended by KGMU, AIIMS, Bhopal and IMS, BHU. Dental as well as bone fluorosis can be improved, if detected in the early stage. It is also essential to establish a Standard Toxicological Testing and Analysis Laboratory in the region. The earlier recommendation of establishment of Training Centers to train Health care workers including Doctors in KGMU, Lucknow and AIIMS, Bhopal for identifying the sources of diseases due to fluoride/mercury emission/discharge and treating the affected patients must now be do neat an early date.

f) There is a number of health related issues like silicosis, fluorosis, and the impact of mercury on the people in the area, which need to be examined in detail. The District Administration is urgently required to identify long term project needs with proper funding and adequate manpower under "Polluter Pays Principle" for estimating the magnitude of health related problem with special reference to silicosis, fluorosis, and the impact of mercury on the people in the area.

g) The District Administration of both the States are required to hold monthly meetings of all the stakeholders of Singrauli area, prepare minutes signed by the Stake holders and place it before the Supervisory Committee constituted by NGT in its 11 Item Nos. 06 & 07 August 28, 2018 R order dated December 6, 2017."

10. The above report was filed before this Tribunal on 03.04.2018. No objection appears to have been filed by any party in spite of sufficient opportunity being available. Learned counsel for respondent no. 17 states that Aditya Birla Chemicals Limited has filed objection to the effect that it cannot divert the

drain in terms of the recommendations. If drain is required to be diverted to prevent pollution, the same must be done unless an alternative is suggested. Thus, we do not find any merit in the objection and the same is rejected. All the recommendations as quoted above are accepted. If any of the industries fails to comply with the recommendations, the same may have to be shut down. The application is accordingly disposed of.

11. To comply with the above directions, we consider it appropriate to constitute an oversight Committee as follows:

a) Justice Rajesh Kumar, Allahabad High Court and former Chairman of Debt Recovery Appellate Tribunal - Chairman.

b) Representative of Central Pollution Control Board - Member.

c) A representative each from the Madhya Pradesh Pollution Control Board and Uttar Pradesh Pollution Control Board – Members.

d) District Magistrates of Districts Sonebhadra and Singrauli - Members. 12 Item Nos. 06 & 07 August 28, 2018 R

12. The Committee will take the following steps:

- Take stock of all actions taken so far.
- Prepare time bound action plan to deal with the problem and ensure its implementation.

13. The Committee may requisition services of such technical experts as may be necessary and may also carry out visits to sites whenever necessary. They will be entitled to all logistic support for performing these functions which shall be provided under the directions of the Chief Secretary, Madhya Pradesh and Chief Secretary, Uttar Pradesh.

14. The Monitoring Committee may also set up website for receiving and giving information on subject.

15. The Monitoring Committee may also involve educational institutions for awareness and feedback about results.

16. All authorities concerned in the States of Madhya Pradesh and Uttar Pradesh shall cooperate and

coordinate with the Monitoring Committee. The Committee can seek such technical assistance as may be required from any relevant authority.

17. The Chief Secretary, Madhya Pradesh and Chief Secretary, Uttar Pradesh to provide all facilities to said Committee to perform its functions. The Committee may send its periodical reports to the Tribunal by E-mail.

18. The Committee may assume its charge within two weeks from today. The Committee may prepare Action 13 Item Nos. 06 & 07 August 28, 2018 R Plan which shall have targets of ensuring compliance. It may meet at such intervals as considered appropriate but twice in every month and fix targets for compliance.

19. The Committee will be free to take up all incidental issues. The Committee will be free to seek any further directions from this Tribunal by E-mail.

20. The Chief Secretary of the State of Madhya Pradesh may determine remuneration of the Chairman in consultation with him and the Chief Secretaries of Madhya Pradesh and Uttar Pradesh will also

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provide all logistic support including security of needed for their proper functioning.

21. The District Magistrates of Districts Sonebhadra and Singrauli will be the co-coordinators for their respective Districts. The Committee may furnish a report of the action taken to this Tribunal after three months.

22. The Committee will be entitled to take the help of the technical experts in execution of this order. The Committee may frame its action plan for implementation within one month from today and implementation may be completed within six months as far as possible. The timelines may be laid down. A copy of the action plan may be sent to this Tribunal. Thereafter, reports may be sent at least once in two months. The Committee may also assess the damage to the environment as well as to the individuals as already suggested in the Report.

The application is disposed of.

A copy of this order be sent to the concerned

authorities by e-mail and by post.

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The applicant may also send a complete set of papers to the members of the Committee.

The Committee may send a report of the action taken to this Tribunal by e-Mail at filing.ngt@gmail.com.

The report may be placed for consideration on 15th February, 2019.

.................., CP
(Adarsh Kumar Goel)

.............., JM
(Dr. Jawad Rahim)

..................., JM
(S.P. Wangdi)

................, EM
(Dr.Nagin Nanda)

28.08.2018

//True Copy//

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Item No.13 Court No.1

BEFORE THE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

Original Application No. 123 / 2019

(I.A. No. 55 / 2019)

Northern Coalfields Ltd. ...Applicant(s)

Versus

Ashwini Kumar Dubey & Ors. ...Respondent(s)

Date of Hearing : 24.01.2019

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON

HON'BLE MR. JUSTICE S.P. WANGDI, JUDICIAL MEMBER

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER

HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

For Applicant(s): Mr. Anip Sachthey, Advocate

ORDER

We have heard the learned counsel for the applicant and perused the application.

We find that the application is not maintainable before this Tribunal under Section 14 of the National Green Tribunal Act, 2010 which can be invoked by a victim of pollution. Moreover, transportation of coal in the area in question will be hazardous to environment.

The application is accordingly disposed of.

Adarsh Kumar Goel, CP

S.P. Wangdi, JM

K. Ramakrishnan, JM

Dr. Nagin Nanda, EM

January 24, 2019
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//TRUE COPY//

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IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

CIVIL APPEAL NOs. OF 2019

(UNDER SECTION 22 OF THE NATIONAL GREEN TRIBUNAL ACT, 2010)

BETWEEN	POSITION OF PARTIES	
	In the National Green Tribunal, Principal Bench, New Delhi	In this Court

I. CIVIL APPEAL NO. OF 2019

(Against the Judgment and Final Order dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013)

IN THE MATTER OF :

Northern Coalfields Ltd. Through Chairman-cum-Managing Director, P.O. Singrauli Colliery Distt. Singrauli, Madhya Pradesh, Pin Code-486 889	Resp. No.36	Appellant

-AND-

1. Ashwani Kumar Dubey R/o-264A, Pocket-C, Mayur Vihar, Phase-II, New Delhi-110092.	Applicant	Contesting Resp. No.1
2. Union of India Ministry of Environment and Forests, Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi-110 003. Through its Chairman/ Secretary	Resp. No.1	Contesting Resp. No.2

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3.	Central Pollution Control Board Parivesh Bhawan CBD-Cum Office Complex, East Arjun Nagar, Delhi-110 032 Through its Chairman	Resp. No.2	Contesting Resp. No.3
4.	State of Madhya Pradesh Department of Environment E-5, Arera Colony, Paryavaran Parisar, Bhopal-462 016, Madhya Pradesh Through its Principal Secretary (Environment)	Resp. No.3	Contesting Resp. No.4
5.	Madhya Pradesh Pollution Control Board, E-5, Arera Colony, Paryavaran Parisar, Bhopal-462 016, Madhya Pradesh Through its Chairman/ Secretary.	Resp. No.4	Contesting Resp. No.5
6.	Madhya Pradesh Forest Department, Satpura Bhawan, Bhopal 462016, Madhya Pradesh Through its Principal Chief Conservator.	Resp. No.5	Contesting Resp. No.6
7.	State of Uttar Pradesh, Room No.601, Bapu Bhawan, Secretariat, Vidhan Sabha Marg, Lucknow-226 001, Uttar Pradesh Through its Principal Secretary.	Resp. No.6	Contesting Resp. No.7
8.	Uttar Pradesh Pollution Control Board PICUP Bhawan, III Floor, Vibhuti Khand, Gomti Nagar, Lucknow-226 001, Uttar Pradesh Through its Principal Secretary.	Resp. No.7	Contesting Resp. No.8

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9.	District Collector Singrauli Collectorate Compound, Waidhan-486886 District-Singrauli, Madhya Pradesh.	Resp. No.8	Contesting Resp. No.9
10.	District Collector Sonebhadra Collectorate Compound, Robertsganj, District-Sonebhadra-231216. Uttar Pradesh.	Resp.No.9	Contesting Resp. No.10
11.	Vindhyachal Super Thermal Power Station P.O-Vindhya Nagar, District- Singrauli, Madhya Pradesh-486885 Through its General Manager.	Resp. No.10	Performa Resp. No.11
12.	Rihand Super Thermal Power Station, P.O. – Rihand Nagar, District-Sonebhadra, Uttar Pradesh-231223 Through its General Manager.	Resp. No.11	Performa Resp. No.12
13.	Singrauli Super Thermal Power Station, P.O. – Shaktinagar, District-Sonebhadra, Uttar Pradesh-231222 Through its General Manager.	Resp. No.12	Performa Resp. No.13
14.	Essar Power Limited 27th KM, Surat, Hazira Road-394 270, Gujarat Through its CEO **ALSO AT:-** M.P. Essar Power Limited Village-Bandhaura, (Waidhan), District-Singrauli, Madhya Pradesh-486886 Through its CEO	Resp. No.13	Performa Resp. No.14

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15.	Hindalco Industries Limited Century Bhawan, 3rd Floor, Annie Besant Road, Worli, Mumbai-400 025, Maharashtra Through its CEO **ALSO AT:-** Hindalco Industries Limited Bargawan, District Singrauli, Madhya Pradesh-486886 Through its CEO.	Resp. No.14	Performa Resp. No.15
16.	Hindalco Industries Power Division Renusagra P.O.- Renusagra- 231 218 District- Sonebhadra, Uttar Pradesh Through its CEO.	Resp. No.15	Performa Resp. No.16
17.	Sasan Ultra Mega power Limited Waidhan-486 886, District-Singrauli, Madhya Pradesh. Through its CEO.	Resp. No.16	Performa Resp. No.17
18.	Kanoria Chemicals and Industries Power Division, District-Renukoot Uttar Pradesh-231217 Through its CEO.	Resp. No.17	Performa Resp. No.18
19.	Obra Thermal Power Station U.P. Rajya Vidyut Utpadan Nigam Ltd. P.O.-Obra, District Sonebhadra, Uttar Pradesh-231219 Through its General Manager	Resp. No.18	Performa Resp. No.19
20.	Anpara Thermal Power Station U.P. Rajya Vidyut Utpadan Nigam Ltd. P.O.-Anpara, District-Mirzapur - 231 225 Uttar Pradesh-231219 Through its General Manager.	Resp. No.19	Performa Resp. No.20

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21.	Hindalco Industries Limited Renukoot Plant Renukoot Road, Renukoot-231 217, Uttar Pradesh Through its General Manager.	Resp. No.20	Performa Resp. No.21
22.	Hi-Tech Carbon Renukoot Plant, Murdhawa Industrial Area, P.O. Renukoot, District-Sonebhadra-231 217 Uttar Pradesh Through its CEO.	Resp. No.21	Performa Resp. No.22
23.	Dalla Cement Factory P.O. Dalla, District Sonebhadra-231 207 Uttar Pradesh Through its CEO.	Resp. No.22	Performa Resp. No.23
24.	Orient Micro Abrasives Limited Renukoot Village-Labhari, Vikas Nagar, P.O.- Bairpanpipri, Shakti Nagar Road, Renukoot-231 217, Uttar Pradesh Through its CEO.	Resp. No.23	Performa Resp. No.24
25.	Trimula Industries Limited House No.45, Ward No.5, Main Road, Singrauli-486892, Madhya Pradesh Through its Managing Director.	Resp. No.24	Performa Resp. No.25
26.	Lanco Anpara Power Limited Gate No.03, Anpara, P.O.- Anpara, District-Sonebhadra, Uttar Pradesh-231225 Through its CEO.	Resp. No.25	Performa Resp. No.26
27.	Jaypee Nigrie Power Plant (Jaypee Power Venture Ltd.) Village Nigrie, Tehsil Deosar District-Singrauli, Madhya Pradesh-486884 Through its CEO.	Resp. No.26	Performa Resp. No.27

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28.	Ideal Industrial Explosives Ltd., Plot No.8, M.P.A.K.V.N Industrial Area, Waidhan, District-Singrauli, Madhya Pradesh-486886 Through its CEO.	Resp. No.27	Performa Resp. No.28
29.	Indian Oil Corporation, Explosive Division P.O.-Jayant, District-Singrauli, Madhya Pradesh-486889 Through its CEO.	Resp. No.28	Performa Resp. No.29
30.	Nav Bharat Explosives Company Limited Plot No.24 & 26, Udyogdeep Industrial Area, Waidhan, District-Singrauli, Madhya Pradesh-486886 Through its CEO.	Resp. No.29	Performa Resp. No.30
31.	Indian Explosives Limited Explosive Division, P.O.-Jayant, District-Singrauli, Madhya Pradesh-486890 Through its CEO.	Resp. No.30	Performa Resp. No.31
32.	Gulf Oil Corp.-IDL Division, Bulk Explosive Plant, P.O.-Jayant, District-Singrauli, Madhya Pradesh-486890 Through its CEO.	Resp. No.31	Performa Resp. No.32
33.	Rewa Gases Private Limited Industrial Estate Waidhan, District-Singrauli, Madhya Pradesh-486886 Through its CEO.	Resp. No.32	Performa Resp. No.33
34.	Railway Board, Ministry of Railways, Government of India, Rail Bhawan, New Delhi – 110 001. Through its Advisor/Executive Director-1 (Land & Amenities)	Resp. No.33	Performa Resp. No.34

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35.	Head Quarters, East Central Railways, Hajipur, District Vaishali (Bihar) - 844118 Through its General Manager/Principal Chief Engineer.	Resp. No.34	Performa Resp. No.35
36.	Dhanbad Division, East Central Railway, District Dhanbad, Jharkhand - 826001 Through its Divisional Railway Manager/ Sr. Divisional Engineer (Co-ordination)	Resp. No.35	Performa Resp. No.36
37.	Moher and Moher Amlohri Extension Coal Blocks Through its CEO P.O. Amlohri District-Singrauli Madhya Pradesh-486 887.	Resp. No.37	Performa Resp. No.37

AND IN THE MATTER OF :

II. CIVIL APPEAL NO. OF 2019

(Against the Judgment and Final Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi in Original Application No.123/2019)

Northern Coalfields Ltd. Through Chairman-cum-Managing Director, P.O. Singrauli Colliery Distt. Singrauli, Madhya Pradesh, Pin Code-486 889	Applicant	Appellant

- AND -

1.	Ashwani Kumar Dubey R/o-264A, Pocket-C, Mayur Vihar, Phase-II, New Delhi-110092.	Resp. No.1	Contesting Resp. No.1

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2.	Union of India Ministry of Environment and Forests, Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi-110 003. Through its Chairman/ Secretary	Resp. No.2	Contesting Resp. No.2
3.	Central Pollution Control Board Parivesh Bhawan CBD-Cum Office Complex, East Arjun Nagar, Delhi-110 032 Through its Chairman	Resp. No.3	Contesting Resp. No.3
4.	State of Madhya Pradesh Department of Environment E-5, Arera Colony, Paryavaran Parisar, Bhopal-462 016, Madhya Pradesh Through its Principal Secretary (Environment)	Resp. No.4	Contesting Resp. No.4
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11.	Vindhyachal Super Thermal Power Station P.O-Vindhya Nagar, District-Singrauli, Madhya Pradesh-486885 Through its General Manager.	Resp. No.11	Performa Resp. No.11
12.	Rihand Super Thermal Power Station, P.O. – Rihand Nagar, District-Sonebhadra, Uttar Pradesh-231223 Through its General Manager.	Resp. No.12	Performa Resp. No.12
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14.	Essar Power Limited 27th KM, Surat, Hazira Road-394 270, Gujarat Through its CEO	Resp. No.14	Performa Resp. No.14

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ALSO AT:-

M.P. Essar Power Limited
Village-Bandhaura,
(Waidhan),
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17.	Sasan Ultra Mega power Limited Waidhan-486 886, District-Singrauli, Madhya Pradesh. Through its CEO.	Resp. No.17	Performa Resp. No.17
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20.	Anpara Thermal Power Station U.P. Rajya Vidyut Utpadan Nigam Ltd. P.O.-Anpara, District-Mirzapur - 231 225 Uttar Pradesh-231219 Through its General Manager.	Resp. No.20	Performa Resp. No.20
21.	Hindalco Industries Limited Renukoot Plant Renukoot Road, Renukoot-231 217, Uttar Pradesh Through its General Manager.	Resp. No.21	Performa Resp. No.21
22.	Hi-Tech Carbon Renukoot Plant, Murdhawa Industrial Area, P.O. Renukoot, District-Sonebhadra-231 217 Uttar Pradesh Through its CEO.	Resp. No.22	Performa Resp. No.22
23.	Dalla Cement Factory P.O. Dalla, District Sonebhadra-231 207 Uttar Pradesh Through its CEO.	Resp. No.23	Performa Resp. No.23
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26.	Lanco Anpara Power Limited Gate No.03, Anpara, P.O.- Anpara, District-Sonebhadra, Uttar Pradesh-231225 Through its CEO.	Resp. No.26	Performa Resp. No.26

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27.	Jaypee Nigrie Power Plant (Jaypee Power Venture Ltd.) Village Nigrie, Tehsil Deosar District-Singrauli, Madhya Pradesh-486884 Through its CEO.	Resp. No.27	Performa Resp. No.27
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30.	Nav Bharat Explosives Company Limited Plot No.24 & 26, Udyogdeep Industrial Area, Waidhan, District-Singrauli, Madhya Pradesh-486886 Through its CEO.	Resp. No.30	Performa Resp. No.30
31.	Indian Explosives Limited Explosive Division, P.O.-Jayant, District-Singrauli, Madhya Pradesh-486890 Through its CEO.	Resp. No.31	Performa Resp. No.31
32.	Gulf Oil Corp.-IDL Division, Bulk Explosive Plant, P.O.-Jayant, District-Singrauli, Madhya Pradesh-486890 Through its CEO.	Resp. No.32	Performa Resp. No.32
33.	Rewa Gases Private Limited Industrial Estate Waidhan, District-Singrauli, Madhya Pradesh-486886 Through its CEO.	Resp. No.33	Performa Resp. No.33

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35.	Head Quarters, East Central Railways, Hajipur, District Vaishali (Bihar) - 844118 Through its General Manager/Principal Chief Engineer.	Resp. No.35	Performa Resp. No.35
36.	Dhanbad Division, East Central Railway, District Dhanbad, Jharkhand - 826001 Through its Divisional Railway Manager/ Sr. Divisional Engineer (Co-ordination)	Resp. No.36	Performa Resp. No.36
37.	Moher and Moher Amlohri Extension Coal Blocks Through its CEO P.O. Amlohri District-Singrauli Madhya Pradesh-486 887.	Resp. No.37	Performa Resp. No.37

To,

The Hon'ble Chief Justice of India
And His Companion Justices of the
Hon'ble Supreme Court of India.

The humble Petition of the Appellant, abovenamed :

MOST RESPECTFULLY SHEWETH :

1. The Appellant is filing the present Civil Appeals challenging the Judgment and Final Order

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dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench in Original Application No. 164 of 2018 (earlier Original Application No. 276 of 2013) and also challenging the Judgment and Final Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi in Original Application No.123/2019, whereby the Hon'ble Court disposed of the Original Application No164 of 2018 (earlier Original Application No. 276 of 2013) filed by the Respondent No.1 herein above and disposed of the Original Application No.123/2019 filed by the appellant hereinabove herein above.

2. That the Appellant/NCL is filing the present Appeal under Section 22 of the NGT Act, 2010 raising the following Questions of Law for determination of this Hon'ble Court:

3. **QUESTIONS OF LAW :**

I. Whether or not in the facts and circumstances of the case, the Appellant/NCL producer of coal, which is supplied to Thermal Power Plants be permitted transportation of coal by road between Gorbi Block B to Morwa Railway siding spur II for the period of one year or till the completion of laying of the railway tracks of approximately 6 k.m. by the railways?

II. Whether or not in the facts and circumstances of the case, the Hon'ble NGT was correct in prohibiting/imposing a complete ban of transportation of coal by road which in any case is to small consumers who participated in E-auction sales, since they can be no transportation of coal through railway wagons to the said consumers.

The transportation of coal by road will be in a controlled manner as indicated by the Oversight Committee to avoid any pollution in the surrounding areas?

III. Whether or not the order dt.24.01.2019 passed by the Hon'ble NGT is dismissing the O.A. No. 164 of 2018 as not maintainable is correct?

IV. That in the Minutes of Meeting held on 23.11.2018 with regard to the transportation of coal by road by certain private enterprises who purchased coal through E-auction, the Oversight Committee duly convinced to the contention of NCL appears to have substance and permitted NCL to seek necessary clarification from NGT in this regard.

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V. Till the incremental CHP of 15 MTPA is to be commissioned at Jayant Project in addition to the existing 10 MTPA CHP capacity which when commissioned after 3 years will facilitate loading of Railway wagons for transportation of coal.

VI. That till the incremental CHP of 15 MTPA is commissioned at Jayant Project NCL will have no option but to continue the transportation of coal by road from Jayant Mines to Morwa siding Spur I.

It is relevant to mention here that the estimated cost of the incremental CHP of 15 MTPA is Rs.832.00 Crores as per the project report prepared by CMPDIL.

VII. The transportation of the limited quantity of coal by road from Gorbi Block – B to Morwa siding Spur II will continue for one year or till the completion of laying of the railway tracks for 6 k.m. by the railways.

VIII. That the issue with regard to the back filling of upper benches of exhausted open cast pits, the issue of backfilling of abandoned mines with 25% of fly ash generated has been referred to DGMS, who has (Annexure 'A-2') recommended an in-depth study in this behalf by scientific agencies having expertise.

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The NCL has made abandoned Gorbi Mine available for the purpose.

IX. It is stated that as per the figures submitted by the Applicant, the production of coal in NCL for 6 months from 01.4.2018 to 30.11.2018 is 65.63 M.T. against targeted quantity of 64.05 M.T.

Out of which 30.19 Million Tonnes is dispatched through MGR;

26.62 Million Tonnes is dispatched through Rail;

2.04 Million Tonnes is dispatched through Belt Pipe Conveyor;

balance of 11.35 Million Tonnes is dispatched through Road.

Out of which 6.39 Million Tonnes is dispatched to e-auction consumers.

X. There are various Thermal Power Projects consumers who are receiving coal from Jayant Mine through Morwa siding for which the under construction incremental CHP is under way and therefore coal is transported by road which will be done in a controlled manner as indicated by the Oversight Committee to avoid any pollution.

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FACTS OF THE CASE:

4. That the Applicant, Northern Coalfields Ltd., ('NCL' for short) is a Government of India Co. within the meaning of Section 617 of the Companies Act, 1956 and one of Subsidiary Co's of Coal India Limited, having its Regd. Office at Singrauli, P.O. Singrauli, Distt. Sidhi, Madhya Pradesh.

   The Applicant Coal Co. is carrying on the business of sale and distribution of Coal among others to Thermal Power Stations in and outside the State of Madhya Pradesh.

5. That on 18.10.2007, New coal distribution policy was brought into force by office memorandum dated 18.10.2007 by Government of India, Ministry of Coal. The scheme prescribed for the 10% of annual production of coal was initially to be offered under e-auction scheme which is now increased to 20% by Ministry of Coal vide letter dt.03.01.2017 of the Ministry of Coal to meet the requirement of small consumers. The said scheme replaced the earlier linkage system by Fuel Supply Agreement (FSA).

6. That O.A No. 164 of 2018 (Ashwani Kumar Dubey Vs. UOI)& O.A No. 276 Of 2013 (Ashwini Kumar Dubey vs.

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UOI & Ors.) was filed raising certain grievances, including pollution in District, Singrauli, in the State of Madhya Pradesh and District Sonbhdra, in the State of Uttar Pradesh.

1. In the said Applications that there are Thermal Power Plants (TPP), in the said districts and on account of further activities there is pollution effecting the environment. Further the industries are discharging mercury beyond the prescribed norms thus affecting the nervous system causing disorder and other ailments to the people that no safe guards are being adopted.

Further, the fly ash stored by TPP creates high pollution; and there is pollution also during the process of transportation of coal by truck by the coal companies to consumers.

7. That on 19.10.2015 with regard to use of 25% fly ash from TPP for back filling of abandoned mines, NCL raised the issue with the Director General of Mines Safety for guidance.

A copy of the letter dt.19.10.2015 by Northern Coalfields Ltd. to the Director of Mines Safety, Varanasi Region, Varanasi is annexed hereto and marked as **Annexure "A-1" (Pg. No.** 67)

8. That on 12.11.2015, the Director General of Mines Safety Varanasi region in response recommended an in-depth study in this behalf by scientific agencies having expertise.

   It was further recorded that back filling of exhausted open cast pits can be done hydraulically by deployment of Heavy Earth Moving Machineries/ dumping by dumpers/ tipper trucks. It was requested to look into the issue.

   A copy of the letter dt.12.11.2015 is annexed hereto and marked as **Annexure "A-2" (Pg. No.** 68-71)

9. In the year 2016, automatic mobile dust sweeping machines have been deployed for sweeping of the dust along the coal transportation roads to control & prevent dust pollution.

   A copy of the Photograph of the Automatic Mobile Dust sweeping machine is annexed hereto and marked as **Annexure "A-3" (Pg. No.** 72)

10. That on 06.12.2017, the Hon'ble NGT passed orders for constitution of the core committee for monitoring

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of potential Hazards of Industrial Development in Singrauli area.

11. That on 03.04.2018, Core committee submitted its report before the Tribunal on 03.04.2018, giving its recommendation on various issues including its recommendations for transportation of Coal by Railway wagons and conveyor system and the precautions to be taken; that no transportation of Coal by Road is to be done; and that 25 % of fly ash generated by TPP be used for back filing of abandoned mines of NCL.

12. That on 28.08.2018, the Hon'ble Tribunal finally took up the matter and having perused the records of the case including the report submitted by the Core Committee on 03.04.2018, the Hon'ble Tribunal after hearing the parties passed orders, wherein final recommendations of the Core Committee has been set out in para 9 of the order of the Hon'ble Tribunal.

The Hon'ble Tribunal to comply with the said recommendations, constituted an Oversight Committee headed by Hon'ble Justice Rajesh Kumar, Retd. Judge Allahabad High Court and other members as detailed in para 11 of the order dt.28.08.2018 of this Hon'ble Tribunal.

13. That all the coal mined by NCL is mostly dispatched to core sector consumer, viz Thermal power plant and steel industries. The percentage of coal mined and sent to core sector is approx 85-90% (depending upon the requirement of Government Power station) and the balance is available for e-auction to small industries.

14. The TPP's to which the coal is supplied is as under: Singrauli Super Thermal Power Station (SSTPS), Rihand Super Thermal Power Station (RhSTPS), Vindhyachal Thermal Power Station (VSTPS) of NTPC, Aravali TPS, ATPS, Hindalco Mahan, PMRG Hisar, NTPC Dadri, Surathgarh, Adani Power, Jhajjar, Kota (KTPS), Obra (OTPS), Lalitpur power, NTPC Mauda etc.

15. In pursuance to the aforesaid order, the Oversight Committee held meeting on 25.10.2018 for implementation of various recommendations.

In para D, it was recorded that NGT has completely prohibited road transportation of coal from Jayant Mines to Morwa railway siding and NCL shall transport coal by conveyor system or by railway wagons.

In this behalf it is stated by NCL that major quantity of coal mined is transported through rail; and a miniscule quantity is transported by road.

For transportation of all mined coal by NCL by rail at least 3 years is required for development of infrastructure.

A copy of the Minutes of meeting by the Chairman of the Oversight Committee dt.25.10.2018 is annexed hereto and marked as **Annexure "A-4"(Pg. No.** 73-88)

16. That NCL's Coal production during 2016-2017 was 84.10 MT; during 2017-2018 coal production was 93.03 Mt. and provisional target for 2018-19 is about 100 MT.

17. That on 31.10.2018, NCL carries out major plantation work every year (Total Plantation upto 2018-19 is 2.37 crore plants, approx), which works out to be more than 1408 plants per employee of NCL. Further NCL has taken afforestation in and around the mined out area and same has been reported by remote sensing satellite data study. The plantation of trees, shrubs and grass has been done profusely on crowns of

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dumps, ring bunds, dykes, recess, slopes, etc. to ensure thick biological growth.

A copy of the Chart of Total Plantation by the Appellant since inception to 31.10.2018 is annexed hereto and marked as **Annexure "A-5" (Pg. No.** 89)

18. It is further stated that all the 10 mines of NCL are operating after taking due environmental clearances (EC) from MoEF and Air & Water Consent from State Pollution Control Boards of U.P. & M.P. EC is issued after preparation of environmental management plan, getting terms of reference, public hearing, etc. Certified compliance report of EC conditions are issued by the Regional Offices of MoEF at Lucknow and Bhopal. Air and Water consents are issued after verification to the compliance of all Environmental Laws by State Pollution Control Board of UP & MP.

That Environmental Clearances (EC) of each of the mines are available at the site of MoEF and NCL.

19. That the Eco-restoration works with 03 tier plantations has been done through Forest Research Institute (FRI) Dehradun for 02 sites of 5.0 Ha, each at Nigahi&Krishanshila Projects. This is one of the endeavours for improving the quality of afforestaion,

create rich bio-diversity and improve greenery in the areas.

20. That on 23.11.2018, the oversight committee held further meeting.

With regard to fly ash disposal in Gorbi abandoned mine, various detailed discussions were held between NCL and NTPC and a MoU is signed with regard to the same on 03.01.2019, which shall remain valid for a period of 10 years.

Necessary precautions regarding environment and safety are incorporated in the MoU.

In paras of minutes, with reference to transportation of coal by road, NCL had informed that certain private enterprise who purchased coal through e-auction, coal is transported through road, the oversight committee stated that

> *"Prima facie the contention of NCL appears to have substance. Let NGT may clarify issue in this regard. NCL is directed to seek necessary clarification from NGT."*

The committee desired NCL to provide details of quantities of coal supplied to HINDALCO through road as such transportation is subjected to penalty.

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A copy of the Minutes of Meeting of the Oversight Committee under the Chairmanship of the Hon'ble Justice (Retd.) Shri Rajes Kumar, Allahabad High Court dt.23.11.2018 is annexed hereto and marked as **Annexure "A-6" (Pg. No.** 90-103)

21. With regard to Transportation of coal by road to LANCO power plant it was recorded that transport by rail will come into operation by end of December 2018. This was confirmed by District Magistrate, Sonebhadra.

22. In this behalf it is stated that an additional Coal Handing Plant (CHP) of 06 MTY capacity has already been constructed at Khadia Project, NCL and its linkage with M/s Lanco through Merry-Go-Round (MGR) system is currently under load trial stage with effect from 16.12.2018. The schedule period of load trial as per contract is 14 days. As per contract provisions, each equipment and system has to be tested for rated capacity. In case of any deficiencies, the period of load trial may be extended as per need till final parameters are achieved. After load trial run, performance guarantee test has to be done for which scheduled minimum period is one month.

23. It was further discussed that HINDALCO Industry (Renusagar Power Division, Sonebhadra) purchases coal through e-auction beyond their linkage allotment and such coal is transported through conveyor belt/road.

24. That on 03.01.2019, MOU between the Appellant/NCL and NTPC for back filling ash from NTPC Vindhyachal Super Thermal Power Station in Gorbi Open Cast abandoned/closed mines of NCL, Singrauli for the necessary precautions regarding environment and safety are incorporated in the MOU.

A copy of the MOU dt.03.01.2019 between the Appellant/NCL and NTPC is annexed hereto and marked as **Annexure "A-7" (Pg. No.** 104 – 122)

25. That on 19.01.2019, the Applicant filed the Original Application No. 123 of 2019 before the Hon'ble National Green Tribunal, Principal Branch, New Delhi for permitting the NCL for transportation of the limited quantity of coal by road, between Gorbi Block-B to Morwa Railway siding spur II, for one year or till the completion of laying of the Railway Tracks of approx 6 km by the Railways.

The NCL for transportation of coal for three years from Jayant to Morwa siding spur I or till incremental CHP of 15 MTPA is commissioned at Jayant Project which will facilitate loading of Railway wagons for transportation of coal.

The transportation of coal to the E-auction purchasers & TPS from various mines of NCL for which NCL undertakes to ensure the pollution control measures as stated in box (5) above are strictly followed and complied.

26. That the impugned order dt.24.01.2019 passed by the Hon'ble National Green Tribunal whereby the Tribunal held that-

> "...*we find that the application is not maintainable before this Tribunal Under Section 14 of the National Green Tribunal Act,2010 which can be invoked by a victim of pollution. Moreover, transportation of coal in the area in question will be hazardous to environment.*
>
> *The application is accordingly disposed of.*"

27. The Appellant/Northern Coalfields Limited in the facts and circumstances of the case is challenging the Judgment and Final Order dt.28.08.2018 passed by the Hon'ble NGT, Principal Bench in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013) and also challenging the Judgment and Final Order

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dt.24.01.2019 passed by the Hon'ble NGT, Principal Bench, New Delhi in Original Application No.123/2019 is filing the present Civil Appeal before this Hon'ble Court interalia on the following:

GROUNDS:

A. That in the facts and circumstances of the case, the Appellant/NCL producer of coal, which is supplied to Thermal Power Plants be permitted transportation of coal by road between Gorbi Block B to Morwa Railway siding spur II for the period of one year or till the completion of laying of the railway tracks of approximately 6 k.m. by the railways.

B. That in the facts and circumstances of the case, the Hon'ble NGT was correct in prohibiting/imposing a complete ban of transportation of coal by road which in any case is to small consumers who participated in E-auction sales, since they can be no transportation of coal through railway wagons to the said consumers. The transportation of coal by road will be in a controlled manner as indicated by the Oversight Committee to avoid any pollution in the surrounding areas.

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C. That the order dt.24.01.2019 passed by the Hon'ble NGT is dismissing the O.A. No. 164 of 2018 as not maintainable.

D. That in the Minutes of Meeting held on 23.11.2018 with regard to the transportation of coal by road by certain private enterprises who purchased coal through E-auction, the Oversight Committee duly convinced to the contention of NCL appears to have substance and permitted NCL to seek necessary clarification from NGT in this regard.

E. Till the incremental CHP of 15 MTPA is to be commissioned at Jayant Project in addition to the existing 10 MTPA CHP capacity which when commissioned after 3 years will facilitate loading of Railway wagons for transportation of coal.

F. That till the incremental CHP of 15 MTPA is commissioned at Jayant Project NCL will have no option but to continue the transportation of coal by road from Jayant Mines to Morwa siding Spur I.

It is relevant to mention here that the estimated cost of the incremental CHP of 15 MTPA is Rs.832.00 Crores as per the project report prepared by CMPDIL.

G. The transportation of the limited quantity of coal by road from Gorbi Block – B to Morwa siding Spur II will continue for one year or till the completion of laying of the railway tracks for 6 k.m. by the railways.

H. That the issue with regard to the back filling of upper benches of exhausted open cast pits, the issue of backfilling of abandoned mines with 25% of fly ash generated has been referred to DGMS, who has (Annexure 'A-2') recommended an in-depth study in this behalf by scientific agencies having expertise.

The NCL has made abandoned Gorbi Mine available for the purpose.

I. It is stated that as per the figures submitted by the Applicant, the production of coal in NCL for 6 months from 01.4.2018 to 30.11.2018 is 65.63 M.T. against targeted quantity of 64.05 M.T.

Out of which 30.19 Million Tonnes is dispatched through MGR;

26.62 Million Tonnes is dispatched through Rail;

2.04 Million Tonnes is dispatched through Belt Pipe Conveyor;

balance of 11.35 Million Tonnes is dispatched through Road.

Out of which 6.39 Million Tonnes is dispatched to e-auction consumers.

J. There are various Thermal Power Projects consumers who are receiving coal from Jayant Mine through Morwa siding for which the under construction incremental CHP is under way and therefore coal is transported by road which will be done in a controlled manner as indicated by the Oversight Committee to avoid any pollution.

The Appellant craves leave to add to, alter or amend all or any of the aforesaid grounds at the time of hearing of the Civil Appeal.

28. The Appellant/NCL has not filed any other Appeals challenging the Impugned Judgment and Final Order dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013) and also Impugned Judgment and Final Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi in Original Application No.123/2019.

29. That the Annexures "A-1" to "A-7" are true copies of their respective originals.

In view of the above, the Appellant/NCL most respectfully prays that this Hon'ble Court may be pleased to:

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PRAYER

(a) Admit and allow the present Appeal against the Judgment and Final Order dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013)

(b) Admit and allow the present Appeal against the Judgment and Final Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi in Original Application No.123/2019.

(c) pass such other order further order/s which this Hon'ble Court deems fit and proper in the facts and circumstances of this case.

AND FOR THIS ACT OF KINDNESS THE APPELLANT AS IN DUTY BOUND SHALL EVER PRAY.

DRAWN & FILED BY:

(ARS ASSOCIATES)
Advocates for the Appellant

DRAWN ON : 31.01.2019
DATED : 07.02.2019
PLACE : NEW DELHI

IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

CIVIL APPEAL NOS. OF 2019

IN THE MATTER OF :

Northern Coalfields Ltd. ...Appellant

Versus

Ashwani Kumar Dubey & Ors. ...Respondents

CERTIFICATE

Certified that the Civil Appeal is confined only to the pleadings before the Court whose order is challenged and the other documents relied upon in those proceedings. No additional facts, documents or grounds has been taken therein or relied upon in the civil appeal. It is further certified that the copies of the documents/annexures attached to the Civil Appeal are necessary to answer the question of law raised in the petition or to make out grounds urged in the Civil Appeal for consideration of this Hon'ble Court. This certificate is given on the basis of the instructions given by the Appellant /person authorized by the Appellant whose affidavit is filed in support of the Civil Appeal.

FILED BY:

(ARS ASSOCIATES)
Advocates for the Appellant

Dated: 07.02.2019
Place : New Delhi.

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IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

CIVIL APPEAL NO. OF 2019

IN THE MATTER OF :

Northern Coalfields Limited. ... Appellant

Versus

Ashwani Kumar Dubey & Ors. ... Respondents

AFFIDAVIT

I, D. Srivastava, General Manager (Environment), Northern Coalfields Limited, P.O. Singrauli, District Singrauli - 486889, Madhya Pradesh, at present at New Delhi, do hereby solemnly affirm and state as under:

1. That I am the General Manager (Environment) of the Appellant Company and am well acquainted with the facts of the present case and competent to affirm this affidavit on behalf of the Appellant.

2. It is stated that I have read the contents of the accompanying Civil Appeal page Nos. 30 to 65 and para 1 to 29 and Synopsis and List of Dates page No. B to W & Applications and say that the facts stated therein are true to the best of my knowledge & belief as per the record of the case and the submissions made therein are based on legal advise received by me through my counsel and believed to be correct.

3. That the Annexures in Civil Appeal are true copies of their respective originals.

DEPONENT

VERIFICATION :

I, the abovenamed deponent do hereby verify that the contents of the above affidavit are true to the best of my knowledge as based on records; nothing is false and nothing material has been concealed therefrom.

Verified by me on this 31st day of January, 2019 at New Delhi.

DEPONENT

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IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

I.A. NOS. OF 2019

IN

CIVIL APPEAL NOS. OF 2019

IN THE MATTER OF :

Northern Coalfields Ltd. ...Appellant

Versus

Ashwani Kumar Dubey & Ors. ...Respondents

APPLICATION FOR EXEMPTION FROM FILING THE CERTIFIED COPIES OF IMPUGNED ORDERS DT.28.08.2018 AND DT.24.01.2019.

To,

The Hon'ble Chief Justice of India
and His Companion Justices of the
Hon'ble Supreme Court of India.

The humble application of the above-named Appellant most respectfully;

SHEWETH:

1. The Appellant above-named respectfully submit this petition seeking Civil Appeal against the Judgment and Final Order dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench

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New Delhi in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013 and also challenging the Judgment and Final Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi in Original Application No.123/2019.

2. The Appellant state that the facts giving rise to this application are stated in the Civil Appeal and the same are not being repeated herein for the sake of brevity.

The Appellant craves leave to refer to the same and treat the same as part and parcel of this application.

3. The Appellant state that the Certified Copy of Impugned Order dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013 has been applied and same be filed alongwith OA No.123 of 2019 of the Impugned Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principle Bench, New Delhi in Original Application No.123/2019 has been applied on 03.02.2019 and the same has not received by the

Appellant therefore, Appellant filing the Civil Appeal with ordinary copies of the Impugned Orders.

4. This application is made bonafide and in the interest of justice.

In the premises the Appellant most humbly prays your Lordships to:

PRAYER

(a) Exempt the Appellant from filing the Certified Copy of the Judgment and Final Order dt.28.08.2018 passed by the Hon'ble National Green Tribunal, Principal Bench New Delhi in O.A. No. 164 of 2018 (earlier O.A. No. 276 of 2013).

(b) Exempt the Appellant from filing the Certified Copy of the Judgment and Final Order dt.24.01.2019 passed by the Hon'ble National Green Tribunal, Principal Bench, New Delhi in Original Application No.123/2019.

(c) pass such other order or orders as this Hon'ble Court deems fit and proper.

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AND FOR THIS ACT OF KINDNESS THE APPELLANT AS IN DUTY BOUND SHALL EVER PRAY.

DRAWN & FILED BY:

(ARS ASSOCIATES)
Advocates for the Appellant

FILED ON : 07.02.2019
PLACE : NEW DELHI

IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

I.A. NO. 91935 OF 2019

IN

CIVIL APPEAL NOs. 4251 – 52 OF 2019

IN THE MATTER OF:

Northern Coalfields Limited. ...Appellant

Versus

Ashwani Kumar Dubey & Ors. ...Respondents

APPLICATION FOR STAY

To,

The Hon'ble Chief Justice of India

And his Companion Justices of the

Hon'ble Supreme Court of India.

The humble Petition of the Appellant, abovenamed;

MOST RESPECTFULLY SHEWETH :

1. The Appellant/NCL has filed the present Civil Appeals under Section 22 of the National Green Tribunal (NGT) Act, 2010 against the Judgment and Final Order dt.28.08.2018 passed by the Hon'ble NGT, Principal Bench, New Delhi in O.A. No. 164 of 2018 (earlier O.A.

No. 276 of 2013) and also against Judgment and Final Order dt.24.01.2019 passed by the Hon'ble NGT, Principal Bench, New Delhi in Original Application No.123/2019.

NGT in its order dt.28.08.2018 had recorded that the transportation of coal shall only be either by Railway Wagons or by the dedicated conveyer system and no transportation of coal shall be permitted by road.

2. That on 22.04.2019 this Hon'ble Court after hearing the submissions made was pleased to pass the following order:

> *"Delay condoned.*
>
> *Issue notice.*
>
> *Status quo, as of today, shall be maintained, in the meantime."*

A copy of the order dt.22.04.2019 passed by this Hon'ble Court is annexed hereto and marked as **Annexure "A-1" (Pg. No.** 21 **).**

3. The Oversight Committee constituted by the NGT by its order dt.28.08.2018 under the Chairmanship of Hon'ble Justice (Retired) Shri Rajesh Kumar, Allahabad High Court held a Meeting on 25.10.2018 which among

others was represented by the Appellant/NCL and detailed submissions were made.

4. The Oversight Committee in its Minutes dt.25.10.2018 (Annexure A-4 at Pgs. 73-88 of the Appeal) had recorded the submissions of Shri Pandey, Dir. (Tech.), NCL that the NCL Board has taken a decision to declare Gorbi Mine as an abandoned mine. That NCL had taken up the issue with the NTPC – Vindhyachal for back filling the mine with fly ash and MOU was entered with the NCL and NTPC, which was finally signed by the parties on 03.01.2019. (A copy of the MOU dt.03.01.2019 is annexed at Pgs. 104 to 122 of the Appeal Paper Book).

It was further submitted by Shri Pandey that the major quantity of coal was transported through Rail and the small quantity of coal was transported by road and for complete transportation of coal either by Conveyer System or by Railway at least two and half years will be required for development of necessary infrastructure.

The Minutes also recorded the submission that NCL had already approached the Hon'ble NGT for modification of the Order.

5. Thereafter the issue was again raised in the meeting of the Oversight Committee dt.23.11.2018, (Annexure A-6 at Pgs. 90-103 of the Appeal Paper Book) and in the Minutes in para 2 recorded the submission of NCL that the private enterprises are purchasing the coal from NCL by e-auction and there is no prohibition to sell and transport their coal through road to the Traders other than Industries.

The Oversight Committee observed that the contention of NCL appears to have substance and NGT may clarify theissue and NCL is directed to seek necessary clarification from NGT.

6. NCL sought clarification from NGT vide O.A. No. 164 of 2018, and the NGT by order dt.24.01.2019 held that the said application is not maintainable. The said order is also impugned before this Hon'ble Court (along with order dt.28.08.2018).

7. It was the case of the Appellant/NCL before this Hon'ble Court that for permitting transportation of the limited quantity of coal by road from Gorbi Block – B to Morwa Railway siding spur II and continue the transportation of coal for one year or till the completion

of laying of the Railway Tracks of approx. 6 k.m. by the railways; and

for permitting NCL transportation of coal for three years from Jayant to Morwa siding spur I or till the incremental CHP of 15 MTPA is commissioned at Jayant Project which was facilitate loading of railway wagons for transportation of coal; and

pointing out that transportation of coal to the e-auction purchasers and TPS from various mines of NCL is undertaken after ensuring the implementation of the pollution control measures.

The following facts were further stated as under:

"It is stated that as per the figures submitted by the Applicant, the production of coal in NCL for 6 months from 01.4.2018 to 30.11.2018 is 65.63 M.T. against targeted quantity of 64.05 M.T.

Out of which 30.19 Million Tonnes is dispatched through MGR;

26.62 Million Tonnes is dispatched through Rail;

2.04 Million Tonnes is dispatched through Belt Pipe Conveyor;

balance of 11.35 Million Tonnes is dispatched through Road.

Out of which 6.39 Million Tonnes is dispatched to e-auction consumers."

8. It is relevant to state that the existing position is that with process of laying of railways tracks of approx. 6 k.m. from Gorbi Block – B to Morwa Railway siding spur II has already begun to be completed in the time period as indicated above.

9. The existing position with regard to the construction of incremental CHP of 15 MTPA, at Jayant Project is that the work of tendering is completed and on issue of work order the construction will start shortly.

10. It was submitted to this Hon'ble Court that the transportation of coal by road is carried on by NCL and this Hon'ble Court after hearing the arguments on behalf of the Appellant by order dt.22.04.2019 while issuing notice granted 'status quo' on the submissions made that the said transportation of coal for the reasons stated above is to be continued to be done by road. The Hon'ble Court considering the importance of issue of transport and supply of coal by road passed the order of status quo, whereby NCL was to continue transportation of coal by road.

11. That all the coal mined by NCL is mostly dispatched to core sector consumer, viz Thermal power plant and steel industries. The percentage of coal mined and sent to core sector is approx 85-90% (depending upon the requirement of Government Power station) and the balance is available for e-auction.

The TPP's to which the coal is supplied by NCL are as under:

Singrauli Super Thermal Power Station (SSTPS),

Rihand Super Thermal Power Station (RhSTPS),

Vindhyachal Thermal Power Station (VSTPS) of NTPC,

Aravali TPS, ATPS,

Hindalco Mahan, PMRG Hisar,

NTPC Dadri, Surathgarh,

Adani Power, Jhajjar, Kota (KTPS),

Obra (OTPS),

Lalitpur power, NTPC Mauda etc.

12. Constraints of movement of coal through rail mode from Northern Coalfields Ltd. (NCL).

NCL is supplying coal to different power houses situated at the pit head as well as at distant locations. The pit head power houses are having dedicated coal movement logistics like MGR (Merry Go Round) and

BPC (Belt Pipe Conveyor). Majority of the coal to these pit head power houses are transported through eco-friendly dedicated system. A small portion of coal requirement is also sourced by road mode by the pit head power houses like Lanco Anpara Power Ltd. and captive power plant of Hindalco Industries Ltd. due insufficient dedicated infrastructure commensurate with their requirement.

Modewise overall despatches during the last three years.

Qnty. in mill. tonnes						
Year		Rail	MGR	BPC	Road	Total
2016-17	Quantity	30.51	39.01	2.96	10.71	83.19
	%age of total desp.	37%	47%	4%	13%	100%
2017-18	Quantity	33.56	45.32	3.16	14.27	96.31
	%age of total desp.	35%	47%	3%	15%	100%
2018-19	Quantity	33.42	47.14	3.32	17.09	100.97
	%age of total desp.	33%	47%	3%	17%	100%

That because of insufficient rail infrastructure for movement of required number of rakes by the railways, the coal requirement for the Power Houses could not be met fully by NCL. Therefore, the annual coal requirement of various Power Houses of Rajasthan, Haryana, Madhya Pradesh and Uttar Pradesh are also partially met by NCL through road transportation.

It is stated that the majority of the projects/mines of NCL are located around Shaktinagar Area. The Rail movement to distant consumers from NCL are made through Shaktinagar – Karela Road Section and Karela Road – Katni Section.

Presently, there is only single railway line operation which handles both passenger and goods rail movement through these sections resulting in heavy congestion of rakes in these sections.

For enabling movement of maximum possible rakes through the existing infrastructure, railways have started four nos. of Goods Sheds in an around Singrauli Area for facilitating coal movement through RCR (Road cum Rail) mode. Through this arrangement coal produced from projects located around Shaktinagar Area is transported by road mode to these Goods Sheds located around Singrauli for onward movement through rail mode to the power houses. This arrangement will cut down the additional rake movement from Shaktinagar to Singrauli section thereby enable increased evacuation of coal from NCL area within the existing rail infrastructure. Due to this constraint off-late distant power houses are compelled to move coal through RCR mode even though this involves additional cost and inconvenience so that within the constraint they can move more coal for meeting their requirement.

The coal requirement and the coal production in NCL is increasing year to year and railways are unable to place required number of rakes a/c these power houses for coal evacuation from NCL due to lack of doubling and electrification in these two rail sections.

13. That the transportation of coal by road from Gorbi Block – B to Morwa Railway siding spur II to be done by road till laying of the railway tracks up to Block B CHP/SILO gets completed.

Coal transportation by road is to be continued for regular/continuous supply to various Thermal Power Stations namely - Kota TPS, Suratgarh TPS, Obra TPS, Hisar TPS, Aravali Power, Sri Singhaji TPP(MPPGCL), Jhajjar Power, Prayagraj TPS, Kawai TPS. Besides this, also to captive units of National Aluminium Co. Ltd. (A PSU).

The transportation of coal by road from Jayant to Morwa siding spur I is also necessary for regular/continued supply of coal to various Thermal Power Stations namely Kota TPS, Suratgarh TPS, Obra TPS, Hisar TPS, Aravali Power, Sri Singhaji TPP (MPPGCL), Jhajjar Power, Prayagraj TPS, Kawai TPS till the incremental CHP of 15 MTPA of Jayant is commissioned.

14. The Oversight Committee thereafter held Meeting on 07.06.2019 and the issue of transportation of coal was taken up and in the Minutes recorded in para 3 the Oversight Committee was of the view that the order of status quo passed by the Hon'ble Supreme Court does not give right to NCL to transport coal by road.

Further, the Oversight Committee was of the view that the order dt.28.08.2018 of NGT completely prohibited NCL from transporting coal by road and the said order of the NGT has not been challenged by the NCL within a reasonable time and has continued till passing of the order by the Hon'ble Supreme Court considering that no stage of Hon'ble NHT or the Oversight Committee has allowed any time to the NCL to transport coal by road.

The Committee further was of the view that when the order of status quo was passed by the Hon'ble Supreme Court, the order of the NGT dt.28.08.2018 was in operation which has prohibited the NCL to transport coal by road in as much as order of NGT dt.28.08.2018 has not been stayed by the Hon'ble Supreme Court.

It is stated that the Oversight Committee had deliberately sought to misread the order of status quo passed by this Hon'ble Court. The Oversight Committee gave directions to the D.M., Sonbhadra and Singrauli, U.P. and M.P. to comply with the directions of Hon'ble NGT strictly and direct all concerned authorities to stop, check and seize the vehicle loaded with coal.

It was further recorded in the Minutes of meeting of Oversight Committee that in case if NCL is found transporting coal by road effecting environment they shall be subject to heavy penalty.

A copy of the Minutes of Meeting of Oversight Committee dt.07.06.2019 is annexed hereto and marked as **Annexure "A-2" (Pg. Nos 22 - 30).**

15. It is stated that the reasons given in the interpretation of the order of status quo passed by the Hon'ble Supreme Court in relation to the order of the NGT dt.28.08.2018, the Appellant/NCL was continue to transport of coal by road in the above three situations.

It is submitted that the reasons given in interpreting the order of status quo by the Oversight Committee is wholly misconceived in so far as it the records that the order of NGT dt.28.08.2018 completely prohibits NCL transportation of coal by road has not been challenged by NCL within a reasonable time and has continued till passing of the order by the Hon'ble Supreme Court.

The said reasoning by the NGT is wholly untenable. The transportation of coal by road in the above stated three situations was brought out and the Hon'ble Supreme Court on 22.04.2019 granted 'status quo' namely road transportation of coal to be continued by NCL.

16. Hence, the present Application before this Hon'ble Court for issuing urgent and immediate directions/ orders to stay the directions issued by the Oversight Committee to the D.M., Sonbhadra and Singrauli, U.P. and M.P. or else the transportation of coal by the

Appellant/NCL to the Power Sector consumers will be gravely affected creating a breakdown of generation of electricity and its supply to nation.

17. The NCL has taken steps to control and prevent dust pollution by deploying automatic mobile dust sweeping machines since 2016. (para 9 of the Appeal and photograph of the machine is annexed as Annexure "A-3" at Pg. 72 of the Appeal).

18. It is stated that the Core Committee appointed by the NGT had in its report recorded measures for control and prevent of dust pollution in case of transportation of coal by road. The said pollution control measures suggested are being followed by NCL as under:

	What are the steps being taken to control pollution for transportation by road?	The difference measures for control of pollution arising due to coal transportation through road (Jayant to Morwa siding a distance of 3 km) are as follows:- a) Jet spraying of water through fixed sprinklers at siding. b) Retaining wall/wind breaking

		wall {200m (L) X 3m (H)} has been constructed at siding. Its height will be further increased by 3.2m with galvanized sheets all along above the retaining wall for which work is in progress. c) Furthermore wind breaking curtain of 450m length with height of 6m (of which bottom 3.1m will be constructed of galvanized sheets and above 3m height green mat will be fixed) is proposed for construction at Morwa siding for which tender is in process. d) Plantation between the railway track & spur-1 siding has been done. e) RCC road from main road junction/kanta more, up to siding has been constructed. f) Continuous water sprinkling

		by mobile water tankers on roads and siding. g) Cleaning of coal transport road by manual sweeping. h) Coal transporting trucks are covered by tarpaulin sheets. i) Road from Jayant to Morwa siding is of sufficient width & black topped/pitched. j) Green belt has been developed all along the road from Jayant to Kanta More.

19. In the facts and circumstances of the above, this Hon'ble Court may be pleased to pass orders staying the directions of the Oversight Committee directing the D.M., Sonbhadra and Singrauli, U.P. and M.P. to comply with the directions of Hon'ble NGT strictly and direct all concerned authorities to stop, check and seize the vehicle loaded with coal.

Unless and until this Hon'ble Court passes an orders as submitted above or else the Appellant/NCL will suffer as it surely effect the transportation/supply of coal to various Core Sectors and Power Stations.

20. This application is made bonafide and in the interest of justice.

In the premises, the Appellant/NCL most respectfully pray your Lordships be pleased to:

PRAYER

(a) stay the directions of the Oversight Committee directing the D.M., Sonbhadra and Singrauli, U.P. and M.P. to comply with the directions of Hon'ble NGT strictly and direct all concerned authorities to stop, check and seize the vehicle loaded with coal.

(b) ad interim ex-parte order in terms of prayer (a) and confirm the same after hearing the parties; and

(c) that road transportation of coal to various Power Stations/other Consumers be continued by NCL as has been submitted/indicated in para 12 herein above.

(d) pass such other order or orders as this Hon'ble Court deems fit and proper in the facts and circumstances of the case.

AND FOR THIS ACT OF KINDNESS THE APPELLANT AS IN DUTY BOUND SHALL EVER PRAY.

DRAWN & FILED BY:

ARS ASSOCIATES)
Advocates for the Appellant

Place : New Delhi
Dated: 27.06.2019

IN THE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

I.A. NO. 91935 OF 2019

IN

CIVIL APPEAL NOs. 4251 – 52 OF 2019

IN THE MATTER OF:

Northern Coalfields Limited. ...Appellant

Versus

Ashwani Kumar Dubey & Ors. ...Respondents

AFFIDAVIT

I, G.P. Singh, Sr. Manager (Legal) I/c, Northern Coalfields Limited, P.O. Singrauli, District Singrauli - 486889, Madhya Pradesh, at present at New Delhi, do hereby solemnly affirm and state as under:

1. That I am the Sr. Manager (Legal) I/c of the Appellant Company and am well acquainted with the facts of the present case and competent to affirm this affidavit on behalf of the Appellant.

2. It is stated that I have read a copy of the Application for Stay and say that the facts stated therein are true to the best of my knowledge & belief as per the record of the case and the submissions made therein are based on legal advise received by me through my counsel and believed to be correct.

3. That the Annexures are true copies of their respective originals.

DEPONENT

VERIFICATION:

I, the abovenamed deponent do hereby verify that the contents of the above affidavit are true to the best of my knowledge and belief as based on records of the case and nothing is false and nothing material has been concealed therefrom.

Identified by Anjali Chauhan Advocate

Verified by me on this 25th day of June, 2019 at New Delhi.

DEPONENT

ITEM NO.11 COURT NO.5 SECTION XVII

S U P R E M E C O U R T O F I N D I A
RECORD OF PROCEEDINGS

CIVIL APPEAL Diary No. 5032/2019

(Arising out of impugned final judgment and order dated 24-01-2019 in OA No. 123/2019 and 28-08-2018 in OA No. 164/2018 passed by the National Green Tribunal)

NORTHERN COALFIELDS LTD **Petitioner(s)**

VERSUS

ASHWANI KUMAR DUBEY & ORS. **Respondent(s)**

(With IA No.41772/2019-CONDONATION OF DELAY IN FILING and IA No.41777/2019-EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT and IA No.41773/2019-APPROPRIATE ORDERS/DIRECTIONS)

Date : 22-04-2019 This matter was called on for hearing today.

CORAM :
HON'BLE MR. JUSTICE ROHINTON FALI NARIMAN
HON'BLE MR. JUSTICE SANJAY KISHAN KAUL

For Petitioner(s)
Mr. Tushar Mehta, SG.
Mr. Anip Sachthey, Sr. Adv.
Mr. Ankur Gupta, Adv.
Ms. Anjali Chauhan, Adv.
Ms. Ria Sachthey, Adv.
M/s ARS Associates, AOR

For Respondent(s)
Mr. Ashwani Kumar Dubey, Caveator-in-person.

UPON hearing the counsel the Court made the following
O R D E R

Delay condoned.

Issue notice.

***Status quo*, as of today, shall be maintained, in the meantime.**

(NIDHI AHUJA) **(RENU DIWAN)**
COURT MASTER (SH) **ASSISTANT REGISTRAR**

ANNEXURE R-3

THE HON'BLE SUPREME COURT OF INDIA

CIVIL APPELLATE JURISDICTION

N.R. No. 28/6/2024
Date 22/02/24
Place Waidhan

CIVIL APPEAL NOS. 4251-52 OF 2019

IN THE MATTER OF:

NORTHERN COALFIELDS LTD. ...APPELLANT

NOTARY JAGAT LAL SHAH Advocate Distt. H.Q. Singrauli M.P. 45/99/16 Singrauli 2018/05-10-2018 GOVT. OF MADHYA PRADESH

VERSUS

ASHWANI KUMAR DUBEY & ORS. ...RESPONDENTS

RESPONSE BY WAY OF AFFIDAVIT ON BEHALF OF THE APPELLANT AS PER ORDER DT.20.02.2020

I, Sanjeev Kumar, General Manager (Environment & Forest), Northern Coalfields Limited, P.O. Singrauli, District Singrauli – 486889, Madhya Pradesh, do hereby solemnly affirm and state as under:

1. That I am the General Manager (Environment & Forest) of the Appellant Company and am well acquainted with the facts of the present case based on the official records and competent to affirm this affidavit on behalf of the Appellant.

NOTARY NOTARIAL JAGAT LAL SHAH Advocate Distt. H.Q. Singrauli M.P. 45/99/16 Singrauli 2018/05-10-2018 GOVT. OF MADHYA PRADESH

NOTARIAL Stamp Rs. 10.00 Affixed

22-02-24

JAGATLAL SHAH
Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

2. This Hon'ble Court vide order dated 08.11.2019 in I.A. No. 169299 of 2019 and I.A. No. 167874 of 2019 duly filed by the Hindalco Industries Ltd. and other stakeholders in Civil Appeal No. 4251-4252 of 2019, Northern Coalfields Ltd v. Ashwani Kumar Dubey & Ors. directed the oversight committee to give a date of hearing to all stakeholders and other interested parties with regard to the ultimate decision given on 09.09.2019. This Hon'ble Court further directed that oversight committee that after the hearing the oversight committee submit a report to this Hon'ble Court in a sealed cover within 8 weeks from the date of hearing. The relevant portion of the order dated 08.11.2019 may be read as under

> *"It is alleged in the application for directions by Hindalco Industries Limited and Dalla Cement Factory that the oversight Committee, before passing the impugned direction on 09.09.2019, did not have any occasion to hear Hindalco or any other stakeholders. We direct the Oversight Committee to give a date of hearing within the next four weeks so that the applicants as well as all other stakeholders interested may be heard with*

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JAGATLAL SHAH
Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

regard to the ultimate direction given on 09.09.2019. The Committee may thereafter submit a report to us in a sealed cover within a period of eight weeks from the date of hearing stating what in its view would be the correct approach to the matter"

3. Pursuant to the above-stated order, the Oversight Committee has called upon Hindalco Industries Limited, Dalla Cement Factory and other stakeholders including Northern Coalfields Ltd. with the request to attend the meeting on 25.11.2019 at Circuit House, Prayagraj to put their cases. Accordingly, the meeting convened on 25.11.2019 at Circuit house, Prayagraj. The submissions of the Northern Coalfields Ltd. from the minutes of the meeting dated 25.11.2019 reads as under

"Representative of NCL states that NCL has no problem if the purchaser may come with the vehicle with the arrangement of closure of coal with the iron sheet. However, he submitted that they may have to face some problem in loading of the coal with the present arrangement which require little bit change".

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Waidhan, Distt.-Singrauli (M.P.)

4. It is stated that after the meeting dated 25.11.2019, a meeting of the Oversight Committee was also held on 17.12.2019 at Adm. Bldg., ED Conference Hall, NTPC-Vindhyachal, wherein the representatives of Hindalco Industries Limited, Dalla Cement Factory and other stakeholders were present. It is submitted that the Oversight Committee has wrongly recorded Para 5, 6, 7, 8 and 9 of the alleged submissions of the Northern Coalfields Limited in the afore-mentioned meeting, which are reproduced below;

> *(5)Amidst the meeting dated 17.12.2019, Mr. S.C. Gupta, Staff Officer provided one pen drive and exhibited a video wherein by mechanical process the truck was fully covered by sheet. The video has been displayed before all the stakeholders. He suggested that sheet can be put in the form of rolling shutter or a metallic sheet which can be conveniently rolled.*
>
> *(6)Shri Gupta submitted that in case if metal sheet is put over the coal, it 100% overrules the possibility of the overloading, at any stage, pilferage, spillage and theft and it is in the*

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Waidhan, Distt.-Singrauli (M.P.)

interest of the purchaser and the transporter also.

(7)He submitted that at the end of the NCL there is no overloading. Overloading only takes place after the departure from the NCL site. in transit, by transporter by transferring coal of one vehicle in two/ three vehicles filled with coal to save cost of transportation.

(8)He also admitted that undoubtedly in case of coverage by polythene or cloth etc., foolproof 100% coverage is not possible and it will lead to pilferage, spillage and overloading, which, of course, on the fall of some coal on the road after it is being crushed by the following truck, becomes powder may lead to air pollution.

(9)He submitted that coverage of vehicle by iron sheet/metal sheet may be possible by little modification in the vehicle.

5. That the submissions were wrongly recorded by the Oversight Committee in the meeting 17.12.2019 and therefore, same needs to be replied by the deponent. The reply to the above-recorded submissions are produced herein below for perusal

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Waidhan, Distt.-Singrauli (M.P.)

A. *As regards the submissions recorded in Para No. 5 of the minutes of meeting dated 17.12.2019, it is submitted that submissions made therein have been wrongly recorded by the oversight committee. It has been wrong recorded that the Representative of the NCL suggested to cover the trucks carrying and transporting coal by the metal sheets. On the contrary, it was suggested that the trucks be covered by tarpaulin and not by metal sheet and the Representative of the NCL even provided the pen drive during the aforesaid meeting in this regard.*

B. *As regards the submissions recorded in Para No. 6 of the minutes of meeting dated 17.12.2019, it is submitted that submissions made therein have been wrongly recorded by the oversight committee that the Representative of the NCL submitted that in case if metal sheet is put over the coal, it 100% overrules the possibility of the overloading. On the contrary, the Representative of the NCL has only displayed the model of covering the trucks by tarpaulin and not by metal sheet.*

C. *As regards submissions recorded in Para No. 7 of the minutes of meeting dated 17.12.2019, it is submitted that the issue of overloading of coal in the trucks were discussed and the Representatives of the NCL informed that there is no overloading in*

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Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

trucks while loading/ transporting the coal as it is completely prohibited in NCL.

D. As regards submissions recorded in Para No. 8 & 9 of the minutes of meeting dated 17.12.2019, it is wrongly recorded by the oversight committee that the coverage of vehicle by iron sheet/ metal sheet may be possible by little modification in the vehicle. On the contrary, the Representative of the NCL never suggested the trucks to be covered by metal sheet.

6. That in pursuance of the order dated 08.11.2019 passed by this Hon'ble Court in I.A. No. 1629299 of 2019 and I.A. No. 167874 of 2019 in Civil Appeal Nos 4251-4252 of 2019, the report dated 04.10.2020 duly submitted by Mr. Justice Rajes Kumar, chairman of the Oversight Committee, Mr. S.K. Gupta, Regional Director, Central Pollution Board, Mr. S.D. Valmik, Regional Officer, M.P. Pollution Control Board and Mr. Radhey Shyam, Regional Officer, U.P. Pollution Control Board, before this Hon'ble Court.

7. That vide order 20.02.2020, this Hon'ble Court permitted the parties to file their response by way of affidavits with respect to the report dated 04.01.2020

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Waidhan, Distt.-Singrauli (M.P.)

filed by Justice Rajesh Kumar, Chairman of the Oversight Committee, Mr. S.K. Gupta, Regional Director, Central Pollution Board, Mr. S.D. Valmik, Regional Officer, M.P. Pollution Control Board and Mr. Radhey Shyam, Regional Officer, U.P. Pollution Control Board.

8. It is relevant to state here that the report dated 04.01.2020 duly submitted by the Oversight Committee to this Hon'ble Court, has also reflected the alleged submissions of the Northern Coalfields Limited in the meeting convened on 17.12.2019. That in order to avoid the multiplicity and prolixity, the submissions made by the deponent in Para 5 of the present response by way of affidavit may be read as part and parcel of the present para.

9. That apart from the above-stated, it is relevant to submit that there are three major coal consumers namely Hindalco Industries Limited, Lanco Anpara Power Ltd., Prayagraj Power Generation Company, to whom coal is dispatched through trucks by the Appellant. However, the coal dispatched through

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Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

trucks to the aforesaid consumers is 6.48% out of total dispatched coal i.e., 7.54 MT, out of the total 116.43 MT dispatched coal by the Appellant during Financial Year 2023-24 (up to 31.01.2024).

A copy of the dispatch details from M&S department, NCL is annexed herewith and marked as **ANNEXURE A-1**.From Page No.

10. It is further stated that the dumpers/tippers deployed for coal transportation are being properly covered with tarpaulin sheets up to half dala with tarpaulin in order to avoid coal spillage.

The photographs showing the dumpers/tippers covered with tarpaulin is annexed herewith and marked as **ANNEXURE A-2**. From Page No.

11. It is stated that water sprinkling on coal transportation roads and railway sidings is being done regularly through mobile and fixed water sprinklers to suppress dust.

The photographs is annexed herewith and marked as **ANNEXURE A-3**. From Page No.

12-02-24

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Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

12. It is pertinent to mention here that 14 truck mounted road sweeping machines, 20 truck mounted dust suppression system with mist guns and 44 fixed type fog cannons are in operation on a regular basis.

    The photographs is annexed herewith and marked as **ANNEXURE A-4.** From Page No.

13. It is stated that nine CAAQMS have been installed in NCL with connectivity to server of Central Pollution Control Board and Madhya Pradesh Pollution Control Board for online monitoring of ambient air quality and data is regularly submitted on the server.

14. It is submitted that every year plantation is being done on overburden dumps, plain areas roadsides, etc., in coal mines of the Appellant and outside areas. In the Financial Year 2023-24, total 10.66 lakhs plants have been planted in NCL projects and outside areas. So far total 2.73 crores plants have been planted in NCL mining areas and outside areas.

    The photographs are annexed herewith and marked as **ANNEXURE A-5.** From Page No.

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JAGATLAL SHAH
Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

15. It is submitted that Wind breaking wall has been constructed as SPUR-1 and SPUR-2 railway sidings to control coal dust transmission.

The photographs are annexed herewith and marked as **ANNEXURE A-6.** From Page No.

16. It is submitted that as per report of CEPI Scores for the year 2018 of the CPCB, CEPI Score of Singrauli region (Uttar Pradesh & Madhya Pradesh) is 62.59 which has come down from 81.73 in 2009, which can be attributed to the various control measures taken in mining projects of NCL. That as per CEPI Score, Singrauli Region is now in severely Polluted Area (SPA) category, whereas the same was critically Polluted Area (CPA) in 2009.

The copy of the CPCB Report December, 2009 is annexed herewith and marked as **ANNEXURE A-7**. From Page No.

17. I state that the affidavit to the present Civil Appeal has been drafted by my counsel as per my instructions, statement of facts stated therein are derived from the

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JAGATLAL SHAH
Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

N.R. No. 98/6/24
Date 22/02/24
Place [illegible]

records and information and I state them to be true and correct.

18. I state that the Annexures are true copy of their respective originals.

19. I undertake those facts stated hereinabove are true to the best of my knowledge, information, belief and nothing has been concealed therefrom.

DEPONENT

VERIFICATION:

Verified at Singrauli (M.P.) on this 22nd day of February, 2024 that the contents of my above affidavit are true and correct to my knowledge based on the records maintained by the Appellant. Nothing is false and no material facts have been concealed therefrom.

DEPONENT

Sig. of Deponent Executant

Filed by:

(ARS ASSOCIATE)
ADVOCATE FOR THE APPELLANT

NOTARY
JAGAT LAL SHAH
Advocate
Distt. H.Q. Singrauli M.P.
45/06/18 Singrauli
2018/05-10-2018
GOVT. OF MADHYA PRADESH

IDENTIFIED BY

22.02.2024

22-02-24

JAGATLAL SHAH
Advocate & Notry
Waidhan, Distt.-Singrauli (M.P.)

ANNEXURE R-4

ITEM NO.43 COURT NO.15 SECTION XVII

S U P R E M E C O U R T O F I N D I A
RECORD OF PROCEEDINGS

Civil Appeal Nos. 4251-4252/2019

NORTHERN COALFIELDS LTD Appellant(s)

VERSUS

ASHWANI KUMAR DUBEY & ORS. Respondent(s)

(IA No. 169299/2019 - APPROPRIATE ORDERS/DIRECTIONS
IA No. 167874/2019 - APPROPRIATE ORDERS/DIRECTIONS
IA No. 41777/2019 - EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT)

WITH
C.A. No. 5324-5325/2019 (XVII)
(IA No. 170529/2019 - CLARIFICATION/DIRECTION
IA No. 79727/2019 - CLARIFICATION/DIRECTION)

C.A. No. 9035/2019 (XVII)
(IA No. 182314/2019 - EX-PARTE STAY
IA No. 180163/2019 - EX-PARTE STAY
IA No. 180164/2019 - EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT
IA No. 180165/2019 - EXEMPTION FROM FILING O.T.
IA No. 182315/2019 - PERMISSION TO FILE ADDITIONAL DOCUMENTS/FACTS/ANNEXURES)

C.A. No. 9339/2019 (XVII)
(IA No. 186439/2019 - EX-PARTE STAY
IA No. 186442/2019 - EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT
IA No. 186443/2019 - EXEMPTION FROM FILING O.T.
IA No. 186446/2019 - PERMISSION TO FILE ADDITIONAL DOCUMENTS/FACTS/ANNEXURES)

C.A. No. 3402/2020 (XVII)

C.A. No. 3329/2020 (XVII)
(IA No. 90390/2020 - ADDITION / DELETION / MODIFICATION PARTIES
IA No. 99023/2020 - EXEMPTION FROM FILING AFFIDAVIT
IA No. 90389/2020 - EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT
IA No. 99024/2020 - EXEMPTION FROM FILING O.T.
IA No. 99022/2020 - PERMISSION TO FILE ADDITIONAL DOCUMENTS/FACTS/ANNEXURES
IA No. 90388/2020 - STAY APPLICATION)

C.A. No. 2983/2020 (XVII)
(IA No. 74503/2020 - EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT
IA No. 74504/2020 - EXEMPTION FROM FILING O.T.
IA No. 74502/2020 - PERMISSION TO FILE ADDITIONAL DOCUMENTS/FACTS/ANNEXURES
IA No. 74501/2020 - STAY APPLICATION)

C.A. No. 3191/2020 (XVII)

Date : 14-05-2024 These matters were called on for hearing today.

CORAM :
HON'BLE MR. JUSTICE PAMIDIGHANTAM SRI NARASIMHA
HON'BLE MR. JUSTICE ARAVIND KUMAR

For Appellant(s) Mr. Ashutosh Kumar Sharma, AOR

Mr. Gaurav Dudeja, Adv.
Mr. Akarsh Garg, Adv.
Mr. Archit Upadhayay, AOR
Mr. Dhruval Singh, Adv.
Mr. Akash Mishra, Adv.

M/S. Ars Associates, AOR
Mr. Ilesh Shukla, Adv.
Mr. Chetanya Singh, Adv.
Ms. Ria Sachthey, Adv.
Mr. Chetan Sharma, Adv.
Mr. Samarth Tyagi, Adv.
Mr. Sarthak Sharma, Adv.
Mr. Manav Jain, Adv.

Mr. Tushar Mehta, Solicitor General
Mr. Sudhanshu Prakash, AOR
Ms. Anisha Agarwal, Adv.

Mr. Talha Abdul Rahman, AOR
Mr. M. Shaz Khan, Adv.
Mr. Adnan Yousuf, Adv.

For Respondent(s) Caveator-in-person, AOR

Mr. Ashok Kumar Sharma, Sr. Adv.
Mr. Kshitij Mudgal, AOR
Ms. Anshul Rajora, Adv.

Mr. Ashutosh Kumar Sharma, AOR

Mr. Tahir Ashraf Siddiqui, AOR

Ms. Mrinal Gopal Elker, AOR

Mr. Avneesh Arputham, AOR
Mr. Ankit Sharma, Adv.
Mr. Nimish Gupta, Adv.

M/S. Arputham Aruna And Co, AOR
Mr. Avneesh Arputham, Adv.
Mr. Ankit Sharma, Adv.
Mr. Nimish Gupta, Adv.

Mr. Arjun Garg, AOR

Mr. Saurabh Mishra, A.A.G.
Mr. Pashupathi Nath Razdan, AOR
Mr. Mirza Kayesh Begg, Adv.
Ms. Maitreyee Jagat Joshi, Adv.
Mr. Astik Gupta, Adv.
Ms. Akanksha Tomar, Adv.
Mr. Argha Roy, Adv.
Mr. Ojaswini Gupta, Adv.
Ms. Ruby, Adv.

Mr. Saurabh Mishra, A.A.G.
Mr. Sunny Choudhary, AOR
Ms. Mrigna Shekhar, Adv.

Mr. Ashwarya Sinha, AOR
Ms. Priyanka Sinha, Adv.
Mr. Aditya Malhotra, Adv.
Ms. Surbi Kumari, Adv.
Ms. Surbhi Kumari, Adv.
Mr. Govind Rishi, Adv.

Mr. Raghav Sharma, Adv.
Mr. Jaskirat Pal Singh, Adv.
Mr. Jakirat Pal Singh, Adv.
Mr. Pranjal Pal Singh, Adv.
Mr. Pranjal Pandey, Adv.
Mr. Salvador Santosh Rebello, AOR

Mr. Pradeep Misra, AOR
Mr. Daleep Dhyani, Adv.
Mr. Suraj Singh, Adv.
Mr. Manoj Kumar Sharma, Adv.
Mr. Bhuwan Chandra, Adv.

Mr. Sudhanshu Prakash, AOR
Ms. Anisha Agarwal, Adv.
Mr. Anisha Agarwal, Adv.

M/S. Ars Associates, AOR
Ms. Ria Sachthey, Adv.
Mr. Ilesh Shukla, Adv.
Mr. Chetanya Singh, Adv.
Mr. Chetan Sharma, Adv.

Mr. Mahesh Agarwal, Adv.
Mr. Anshuman Srivastava, Adv.
Mr. Nishant Rao, Adv.
Mr. E. C. Agrawala, AOR

Mr. Ashish Prasad, Adv.
Ms. Mukta Dutta, Adv.
Mr. Pruthvi Dhinoja, Adv.
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UPON hearing the counsel the Court made the following

O R D E R

1. Let the appeals be admitted.

2. All interim orders to continue.

3. Hearing expedited.

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SENIOR PERSONAL ASSISTANT

(NIDHI WASON)
COURT MASTER (NSH)

Technical Report of a Scientific Study on

"Evaluation of the Effectiveness of Measures Taken By Khadia Project to Control the Air and Water Pollution from the East Dump and Pollution Control/Mitigational Measures to Minimize Pollution Load"

Prof. Aarif Jamal

Prof. Rajesh Rai **Dr. Amrendra Kumar**

Department of Mining Engineering

Indian Institute of Technology (BHU), Varanasi

Final Report

On

"EVALUATION OF THE EFFECTIVENESS OF MEASURES TAKEN BY KHADIA PROJECT TO CONTROL THE AIR AND WATER POLLUTION FROM THE EAST DUMP AND POLLUTION CONTROL/MITIGATIONAL MEASURES TO MINIMIZE POLLUTION LOAD"

Submitted To
NORTHERN COALFIELDS LIMITED
KHADIA AREA
SHAKTINAGAR, SINGRAULI-231222
UTTAR PRADESH

by

06. 2. 2025

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Title of Consultancy Project

Evaluation of the Effectiveness of Measures Taken by Khadia Project to Control Air and Water Pollution from East Dump and Pollution Control/Mitigation Measures to Minimize Pollution Load

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We express our sincere gratitude to the Staff Officer (Mining), Khadia OCP, for entrusting the Department of Mining Engineering, IIT (BHU), Varanasi with the consultancy project titled "*Evaluation of the Effectiveness of Measures Taken by Khadia Project to Control Air and Water Pollution from East Dump and Pollution Control/Mitigation Measures to Minimize Pollution Load*".

We would like to extend our appreciation to Mr. Kamran Mehdi and Dr. Vikas Pandey, who served as Project Technical Officers, for their crucial efforts in preparing this report.

We also acknowledge the valuable contributions of the research personnel involved in the project, including Pawan Kumar Patel, Praveen Kumar, Dinesh Kumar Rai, and Pervez Akhtar, who worked as Project Assistants, and Rishi Raj and Anand Kumar, who contributed as Project Helpers. Their dedication to fieldwork, data collection, and analysis was instrumental in completing the study.

We are especially grateful to the Khadia OCP for their continuous support, including facilitating field visits, providing necessary documents, and assisting with logistics. Their provision of accommodation and transportation for fieldwork significantly contributed to the smooth execution of this study.

We sincerely appreciate all individuals and organizations involved in making this project a success.

06.2.2025

Prof. Aarif Jamal

Preface

Environmental sustainability in opencast mining operations remains a critical challenge, especially in regions where mining activities are conducted in close proximity to human settlements. Recognizing the concerns associated with overburden dumping at the Khadia Project, Northern Coal Limited (NCL), the Hon'ble National Green Tribunal (NGT), in the case of Mukesh Singh v. State of Uttar Pradesh (O.A. No. 580/2022), mandated an investigation into the environmental impact of the East overburden dump site near Nawatola Basti, Sonbhadra, Uttar Pradesh. The findings of the Joint Committee emphasized that relocating the dump material was not feasible and instead recommended a third-party study to assess the effectiveness of the existing pollution control measures and propose further improvements.

In response to this recommendation, the Staff Officer (Mining), Khadia OCP, commissioned a consultancy project to the Department of Mining Engineering, IIT (BHU), Varanasi to evaluate the air and water pollution control measures at the East dump and suggest mitigation strategies to minimize its environmental impact.

Over a four-month period, the study involved extensive monitoring of both air and water quality. Air quality assessments indicated that the daily particulate matter concentrations ($PM_{2.5}$ and PM_{10}) exceeded permissible limits. The air was characterized as moderately polluted, and heavy metal analyses revealed that the finer particulate matter contained higher levels of toxic metals—primarily Fe and Cr, followed by Ni, Zn, Mn, Pb, Cu, Cd, and As. Meteorological observations noted predominantly calm wind conditions, which tended to allow pollutants to remain concentrated near their sources. In parallel, water quality investigations showed that both surface and groundwater samples met the prescribed physicochemical and heavy metal standards, with overall water quality being rated as good.

This report is organized into eight chapters that comprehensively cover the project. The initial chapters introduce the study area and outline the work order and methodology used for air and water quality assessments. Subsequent sections detail the existing pollution control measures at the Khadia Project and the impact of the East dump on environmental quality. The latter part of the report evaluates their effectiveness of the control measures and is followed by a summary, conclusions, and recommendations for enhancing pollution control measures.

06. 2. 2025

Prof. Aarif Jamal

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Chapter 1: Introduction

1.1 Background:

The Khadia Opencast Project (OCP) is one of the operational mines in the Moher sub-basin of the Singrauli Coalfield (SCF). Socio-economically, the SCF region is known as Urjanchal, meaning the 'Land of Energy'. Since the discovery of coal in Singrauli in 1840, the region's development has predominantly centred on the exploitation of this mineral resource (Singh, 2020). Mining of coal at present is confined in the north-eastern part of the Singrauli coalfield. The Singrauli region hosts more than 10% of the total installed thermal capacity of the country. The existing Khadia OCM has a coal production rate of 14 MTPA. In 2022, the Ministry of Environment, Forest and Climate Change (MoEF&CC) granted environmental clearance to increase the production capacity to 15 MTPA. The EC was revalidated by MoEF&CC on 7/02/2024. It is estimated that the total extractable reserve is 296.85 Mt and as of 2022 around 152.31 Mt has been mined.

1.2 Location and Accessibility:

The Khadia OCP is covered under Toposheet no. 63-L/12, between Latitude 24°06'50.68" to 24°08'59.22" N and Longitude 82°41'20.91" to 82°44'27.55 E. It is partly located in the Sonbhadra District of Uttar Pradesh and partly in the Singrauli District of Madhya Pradesh. **Figure 1** shows the location map of the Khadia OCP. The total mine lease area of the Khadia Project is 1640 ha. The nearest major city is Singrauli. It is connected by a metalled road to NCL headquarters in Singrauli, as well as to the Shaktinagar-Varanasi Highway and the Rewa Highway. The nearest railway station is Shaktinagar on the Eastern Railway line and the nearest airport is the Lal Bahadur Shastri Airport, Babatpur. The northern boundary of the project is bordered by MP Forest Land, the western side by the Dudhichua Project, and the eastern side by the Krishnashila Project. On the southern side, there are National Thermal Power Corporation's Shaktinagar and Vindhyanagar superthermal power stations.

1.3 Topography:

The topography of the region has been altered significantly since the commencement of mining in 1984. Presently, the Khadia block emerges prominently as a plateau rising above the southern plains. This plateau is characterized by a steep escarpment on its southern face, ascending from a base elevation of 290 m to a summit of 425 m. The plateau's surface is generally gently undulating, except for a single hill in its northeast corner, which reaches an altitude of 489 m. The overall elevation of the plateau ranges between 420 and 440 m.

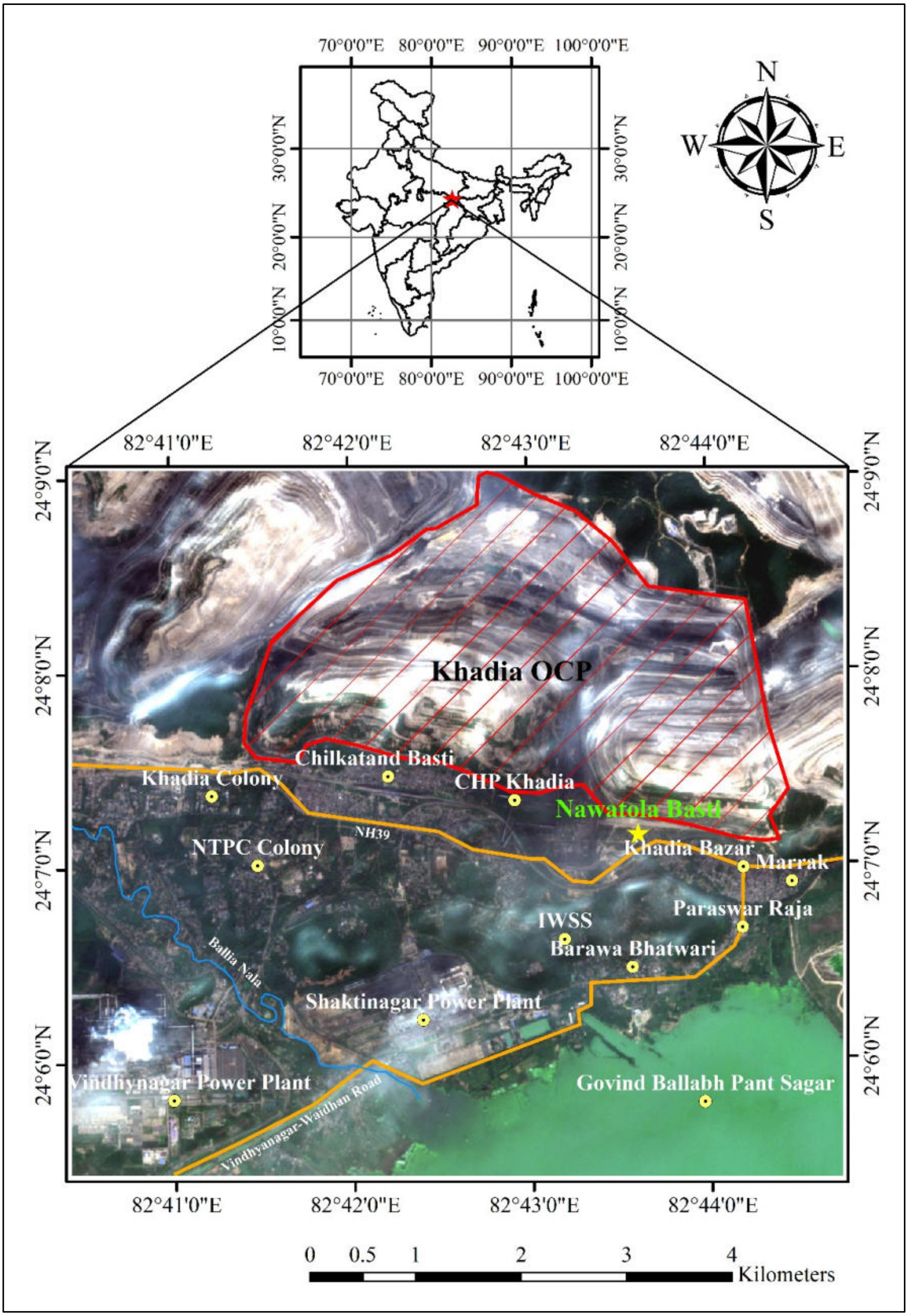


Figure 1: Location Map showing the Khadia OCP and Nawatola Basti based on Sentinel-2 Level-2A imagery acquired on 25 October 2024 from Copernicus Browser

1.4 Climate:

The general climate of the Singrauli region is semi-arid. Winter begins in late November and lasts until early March, followed by summer from March to mid-June, with May being the hottest month. The southwest monsoon sets in by mid-June and continues until the end of September. The post-monsoon season, marked by retreating monsoon conditions, occurs during October and November. The region receives an average annual rainfall of 1132.7 mm, with about 89% occurring between June and September, with July being the wettest month (338.2 mm). The remaining 11% of rainfall occurs from October to May. Humidity is lowest in April, at around 35%, while the southwest monsoon brings peak humidity levels, reaching 85% in August due to heavy rains. In October, humidity decreases with rising temperatures and the retreat of the monsoon. The region's daily mean annual relative humidity is 66%. The predominant wind direction is from the North-East quadrant. The daily annual mean wind velocity of the region is 3.6 km/hr.

1.5 Land Use:

The total leasehold area of the project is 1640 ha which includes 844 ha of forest land, 347 ha of government land and 449 ha of tenancy land. A pie chart shown in **Figure 2** illustrates the distribution of land use in percentages within the mine's leasehold area.

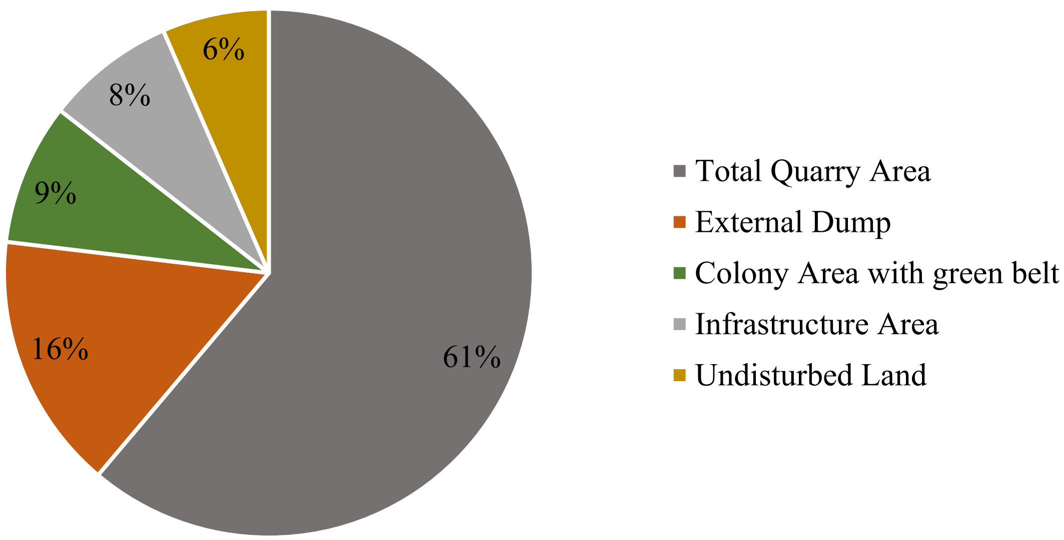


Figure 2: Land Use in the Mine's Leasehold Area

1.6 Drainage:

The drainage system of the Khadia OCM is governed by the Senduri and Hadwaria Nallahs, located in the morphologically distinct southern section of the Moher Basin. These nallahs serve as tributaries to the Ballia Nallah, which eventually discharges into the Govind Ballabh Pant (GBP) Reservoir. Chatka Nala and Tippa Jharia Nala are natural drainage features found on the northern dip side of the project.

The catchment area of the mine is divided into three sections: East Section S1, West Section S2 and West Section S3 covering a total area of 6.39 km^2. To manage water inflow, the mine relies on a combination of sump storage and pumping. Presently, the total existing sump capacity across all three sections is insufficient. A total sump capacity of 9,14,500 m^3 has been proposed to address the shortfall. Additionally, the drainage plan includes standby pumps to ensure operational flexibility.

1.7 Geology:

1.7.1 Regional Geology:

The Singrauli Coalfield, the northernmost part of the Central Indian Coalfields, consists of two distinct techno-sedimentary domains: the Main Basin in the western part, covering an area of 1890 km^2, and the Moher Sub-basin in the northeastern part, spanning 312 km^2. These basins are separated by a NW-SE trending high basement. Among the two, the Moher Sub-basin is the most promising region, and currently, coal mining activities are concentrated in this area. Khadia OCP is situated in the southeastern part of the Moher sub-basin. The general stratigraphic sequence of Singrauli Coalfield (as per GSI, 1977) is shown in **Table 1**.

Table 1: General Stratigraphic Succession of the Singrauli Coalfield

Age	Group	Formation	Lithology	Thickness (m)
Cretaceous		Intrusive	Dolerite dykes and sills	Not estimated
Upper Triassic	Upper Gondwana	Mahadeva	Coarse-grained, ferruginous sandstone with bands of shale, clay and conglomerate.	Not estimated
Lower Triassic	Lower Gondwana	Panchet	White, greenish-white and pink micaceous, medium to coarse-grained sandstone with red beds, greenish-brown silty shales and conglomerates.	Not estimated

Upper Permian		Raniganj	Fine-grained sandstone and shales with coal seams including 134 m Jhingurdah seam.	215-403
Middle Permian		Barren Measures	Very coarse-grained to ferruginous sandstone, green clay and shales	125-300
Lower Permian		Baraker	Medium to coarse-grained sandstones, shale, clay and coal seams.	325-600
Upper Carboniferous		Talchir	Tillites, sandstone, siltstones, needle shales	75-130
--------------------Unconformity-----------------------				
Precambrian	Phyllites, quartzites, schists and gneisses			

1.7.2 Geology of the Khadia Mine:

The Khadia coal mine features multiple coal seams with varying thicknesses and depths. The Purewa Top seam, with a thickness of 7–10.35 m, lies at a depth of 35.35–76.20 m, followed by a parting of 30.34–43.70 m. Below this, the Purewa Bottom seam, 7.10–13.39 m thick, occurs at a depth of 74–139.50 m, separated from the Turra seam by a parting of 52.40–64.28 m. The Turra seam, 18.41–22.93 m thick, lies at a depth of 13.40–209.27 m. The seam gradient ranges between 2° and 4°, with an average stripping ratio of 4.61 m^3/t. The strike exhibits a gradual transition from an NW-SE orientation to an NE-SW direction, curving in the eastern part of Khadia and shifting to an N-S trend in the Bina and Kakri blocks. The area is devoid of any faults; however, two prominent sets of vertical joints (NE-SW and NW-SE) and one less prominent set of joints (E-W) have been observed. Mining operations are conducted at working depths of 158–280 m (EMP-Khadia, CMPDI, 2023). Other seams viz., Kota and Khadia have not been extensively explored due to their thin, discontinuous, and inter-banded nature. These seams belong to the Baraker Formation of the Gondwana Supergroup. The average grade of coal is G-8 (4900-5200 KCal/Kg).

The total overburden as per the project report is 1255.72 Mm^3. By 2023, about 660.05 Mm^3 of overburden had been removed. The East dump, operational since 2002, covers 100.84 ha of external dumping area and 105.6 ha for internal dumping. By 2022, 109.88 Mm^3 of overburden had been deposited in the external section, while 100.36 Mm^3 had been placed in the internal section. The average monthly dumping rate at the East dump is around 2 Mm^3. The height of each dump deck is restricted to 30 meters with individual slopes maintained at 37°. The overall slope of the East dump is approximately 22°. The maximum RL of the East dump is 501.5 m from the MSL which shall be finalized at RL of 530m from MSL as per approved project report.

1.8 Environmental Challenges of Opencast Coal Mining:

The environmental impact of opencast coal mining is shaped by various factors, with the scale and severity of these impacts being influenced by local site conditions. The environmental effects during the operation of an opencast mine typically involve visual disruption to the landscape, air pollution, surface runoff, flooding, noise pollution, vibrations from blasting, water contamination, and coal transportation impacts. Many of these issues are more influenced by factors such as the surrounding rock geology, mining methods, climate, hydrology, reclamation techniques, and the presence or absence of regulations and their enforcement, rather than the petrography or geochemistry of the coal or the disturbed strata (Suarez-Ruiz & Crelling, 2008). A study conducted in 2020 observed significant land-use/land-cover changes in the Singrauli region between 2000 to 2016, with a fourfold rise in overburden, threefold in dumping yards, 2.5 times in urban areas, and a twofold increase in mining areas (Bhardwaj et al., 2020). In the same region, between 1976 to 2015, it was observed that the total area of dense forest decreased by 2.34 times, while the open forest area decreased by 1.79 times (Ahmad and Goparaju, 2017).

In cognizance of the repercussions of OCMs and the allegations raised regarding the dumping of overburden by the Khadia Project of the Northern Coal Limited (NCL), the honourable National Green Tribunal in *Mukesh Singh v. State Of Uttar Pradesh*; O. A. No. 580/2022 constituted a Joint Committee in 2022 to investigate and provide recommendations. The case pertains to Nawatola Basti (shown in **Figure 1**), located in Khadia, Dudhi Tehsil, Sonbhadra, Uttar Pradesh. According to the district administration, about 134 houses are located within 100 meters of the East dump site. This Basti has an aerial extent of 584.85 ha with a population of 1,190 as per the Census of India, 2011.

The committee observed that relocating the vast volume of material at the East dump site was not feasible. However, it emphasized the need for alternative solutions to safeguard the local population and mitigate environmental harm. Among its recommendations, the committee proposed conducting a third-party study through a reputable organization to assess the effectiveness of existing pollution control measures and suggest improvements for enhanced environmental management. Consequently, a consultancy project was awarded to the Department of Mining Engineering, IIT BHU by the Staff Officer (Mining), Khadia OCP to evaluate the effectiveness of pollution control measures at the East dump and provide recommendations for improvement.

Chapter 2: Work Order Assigned

The work order focuses on addressing environmental concerns associated with the East dump of the Khadia Project. The assigned tasks include:

1. *Collection of air and water samples at appropriate locations.*
2. *Evaluation of the effectiveness of measures taken by the Khadia project to control the air and water pollution from the east dump.*
3. *To suggest augmentation of Air & Water Pollution Control / Mitigating measures to be adopted with an aim to zero negative impact on nearby habitation.*
4. *Preparation and Submission of report*

The objectives outlined in the work order for addressing environmental concerns related to the East dump of the Khadia Project represent a crucial step toward sustainable mining practices. The project establishes a robust scientific basis for evaluating the current state of pollution levels and understanding the extent of their impact on the surrounding environment. The evaluation of existing pollution control measures identifies potential gaps or inefficiencies in the current systems. Further, the directive to suggest improvements to air and water pollution mitigation strategies emphasizes compliance with regulatory standards and a commitment to minimizing adverse effects on nearby communities.

Chapter 3: Background and Methodology

The following methodology has been designed to align with the project's objectives, providing a thorough evaluation of current pollution control measures. It also aims to recommend improvements to air and water pollution controls, with the ultimate goal of minimizing negative impacts on nearby communities. Given that the case pertains to Nawatola Basti, much attention was directed toward this area. This focused approach allows for a granular understanding of the specific challenges faced by the people in Nawatola Basti.

3.1 Air Pollution Study

Opencast mining poses a substantial threat to air quality compared to underground mining due to its extensive surface operations. The primary emissions associated with coal mining include particulate matter (PM), sulphur dioxide (SO_2), oxides of nitrogen (NO_X), and heavy metals (Jamal et al., 1992; Pandey et al., 2014). The main sources of air pollution in coal mining regions stem from activities such as drilling, blasting, overburden loading and unloading, coal handling and transportation, haul roads, stockpiles, exposed overburden dumps, coal handling plants, open pit faces, coal yards, and ore yards (Dhar et al., 1991). The generation of fugitive dust mainly occurs due to two physical processes: the pulverization and abrasion of surface materials through mechanical forces applied by equipment such as wheels and blades, and the entrainment of dust particles by turbulent air currents, particularly from wind erosion of exposed surfaces (USEPA, 2006).

These pollution sources are broadly categorized into two types: point sources and nonpoint (or fugitive) sources. Point sources refer to stationary facilities emitting pollutants from specific, identifiable locations. In contrast, nonpoint sources release pollutants over a broad area, resulting in diffuse emissions that are more challenging to manage due to their dispersed nature and lack of containment. The pollutants released by these sources degrade air quality, adversely affecting the health of local communities and surrounding ecosystems (Chaudhary & Gajghate, 2000; Nanda & Tiwary, 2001). Health studies in these regions report high incidences of Upper Respiratory Infection (URIs), gastric, dermatitis and eye cases. Children and the elderly are particularly vulnerable, as their respiratory systems are either still developing or already weakened. Moreover, air pollution from opencast mining also impacts the local flora and fauna. Dust deposition on plant leaves inhibits photosynthesis and stunts growth, while heavy metals in the air and soil can bioaccumulate in the food chain, threatening wildlife. Furthermore, pollutants such as NO_X and SO_2 contribute to acid rain, which alters soil pH and damages aquatic ecosystems.

3.1.1 Air Sampling

One of the primary objectives of this study was to evaluate the impact of the East Dump on ambient air quality. The study focuses on assessing air quality parameters, including SPM, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, and trace elements (As, Cr, Cu, Hg, Mn, Ni, Pb, Zn) bound to particulate matter. To ensure accurate and representative data collection, a network of air quality monitoring stations was strategically established. The locations of the selected air quality monitoring stations used for data collection are presented in **Table 2**.

Table 2: Details of Air Quality Monitoring Sites in and around Khadia OCP

S.No.	Code	Station Location	Latitude	Longitude
1	NB P1	House	24.119630	82.725617
2	NB P2	House	24.118986	82.728631
3	NB P3	House	24.118820	82.727236
4	NB P4	House	24.119069	82.726533
5	NB P5	House	24.119167	82.726111
6	NB P6	House	24.119472	82.723375
7	WW P1	Proposed Wharf Wall Site	24.120045	82.725632
8	WW P2	Proposed Wharf Wall Site	24.120063	82.725607
9	KC P1	Khadia Guest House	24.122112	82.688355

Sampling at the selected monitoring stations was conducted from October 2024 to January 2025 as per the standards laid in CPCB, 2011. The observed values are compared to the 24-hour National Ambient Air Quality Standards (NAAQS), 2009. Additionally, PM concentrations in-and-around the study area were monitored using a handheld Aerosol Monitor. Sampling at Khadia Colony was done to provide insights into the regional air pollution context, beyond the East dump.

Figure 3 shows an overview of various air monitoring sites. Meteorological observations viz., temperature, relative humidity, wind direction and wind speed were made simultaneously along with air quality sampling. Detailed information about the instruments used for air monitoring is provided in **Table 3**.

For heavy metal analysis, the filter paper collected for $PM_{2.5}$ & PM_{10} was sent for Inductively coupled plasma-optical emission spectroscopy (ICP-OES) at Birbal Sahni Institute of Paleosciences (BSIP), Lucknow.

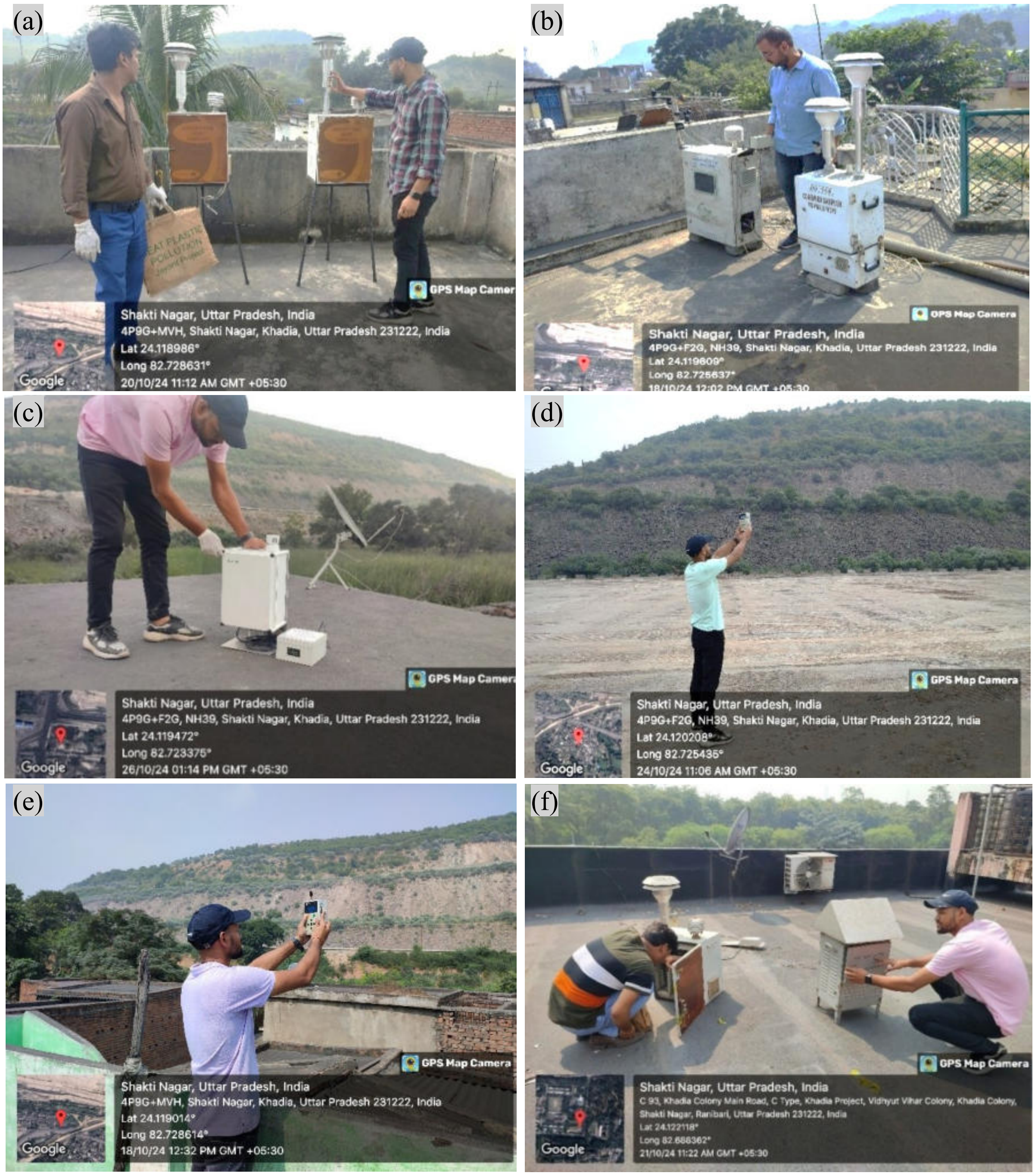


Figure 3: Overview of Various Air Monitoring Sites. (a-c) Instruments installed on the roof of houses in Nawatola Basti. (d) Handheld Aerosol Monitoring on the Wharf Wall in front of the East Dump. (e) Handheld Aerosol Monitoring on the roof of a house in Nawatola Basti. (f) Instruments being installed on the roof of the Khadia Guest House.

3.1.2 Monitoring of TSP in ambient air:

The TSP concentration was measured using a high-volume sampler operating at a flow rate of 1 m^3/min. Glass fibre filter paper (EPM 2000), measuring 8 x 10 inches, was used for sampling.

Table 3: Air Quality Monitoring Instruments used in the Study

S.No.	Instrument Used	Pollutant Measured	Quantity	Method of Analysis	Detection Limit	Figure
1	Respirable Dual Sampler (APM 460 NL)	$PM_{2.5}$ & PM_{10}	1	Gravimetric method (CPCB 2012)	10 µg/m^3 to 1000 µg/m^3	
2	Ambient Fine Dust Sampler (IPM – FDS)		4	Gravimetric method (CPCB 2012)	5 µg/m^3 to 1000 µg/m^3	
3	High Volume Sampler (APM 43-411)	SPM	1	Gravimetric method (CPCB 2012)	10 µg/m^3 to 1000 µg/m^3	
4	Handheld Aerosol Monitor (AEROCET 531S)	PM_{10}, $PM_{2.5}$ & SPM	1	Optical Light Scattering Method	< 1000 µg/m^3	
5	Portable Laser Aerosol Spectrometer (AQ Guard Smart 1100)	$PM_{2.5}$ & PM_{10}	1	Optical Light Scattering Method	< 10^6 µg/m^3	
		SO_2, NO_2 & CO		Electro-chemical Method	100 to 750 µg/m^3, 40 to 340 µg/m^3, 5000 to 20000 µg/m^3	
6	Ambient Air Quality Monitoring System	$PM_{2.5}$ & PM_{10}	1	Optical Light Scattering Method	< 500 µg/m^3, < 1000 µg/m^3	
		SO_2, NO_2 & CO		Electro-chemical Method	< 20 ppm, < 200 ppm, < 1000 ppm	

Before sampling, the filters were equilibrated in silica gel desiccators for 24 hours and weighed using a pre-calibrated microbalance. To account for potential contamination during transport and analysis, a field blank was generated for each sample collected during the study. Subsequently, TSP concentrations were calculated using the following formula (CPCB, 2012):

$$W_{TSP}(\mu g) = (w_f - w_i)g \times 10^6 \mu g$$

Here, W_{TSP} = total mass of the total suspended particulate matter collected (µg), w_f = Final mass of the conditioned EPM2000 filter after sample collection (mg), w_i = Initial mass of the conditioned filter before sample collection (mg), 10^3 = unit conversion factor for mg to µg. After the calculation of the total mass of TSP, the calculation of the total volume of air sampled is as follows:

$$V_{TSP} = Q_{avg} \times t \times 10^{-3} m^3$$

Here, V_{SPM} = Total volume of air sampled for TSP sampling, Q_{avg} = Average flow rate over the entire duration of the sampling period (1 min^{-1}), t = duration of the sampling period (min.), 10^3 = unit conversion for litres (L) into m^3. The concentration of SPM in the air is:

$$TSP = {W_{TSP}}/{V_{TSP}}$$

Here, TSP = mass concentration of SPM (µg/m^3), W_{TSP} = Total mass of the TSP collected (µg), V_{TSP} = Total volume of air sampled for TSP sampling. These particulates usually range from approximately l-100 µm.

3.1.3 Monitoring of $PM_{2.5}$ and PM_{10} in ambient air:

The monitoring of $PM_{2.5}$ & PM_{10} was performed using a Respirable Dust Sampler operating at a flow rate of 1 m^3/hr. Polytetrafluoroethylene (PTFE) membrane filters with diameters of 47 mm and 46.2 mm were used for collecting PM_{10} and $PM_{2.5}$, respectively. The filter papers were weighed using a MYA 5.3Y microbalance, which has a resolution of 10^{-6} g.

The air sampler includes an omnidirectional air inlet designed to maintain circular symmetry, ensuring uniform air entry regardless of wind direction, while preventing the ingress of rain, insects, and large particles. The inlet system leads directly to an impactor stage, which removes particles larger than 10 µm. For $PM_{2.5}$, an additional impactor operates based on the specific tube length, maintaining the system's flow rate at 1 m^3/hr (equivalent to 16.7 LPM).

To minimize sampling errors caused by the tendency of smaller particles to bounce off the impaction surface, a 37 mm diameter GF/A paper coated with silicone oil was employed. Subsequently, SPM concentrations were calculated using the following formula (CPCB, 2012):

$$W_{2\cdot 5/10(ug)} = (w_f - w_i)g \times 10^6 \mu g$$

Here, $W_{2\cdot5/10}$ = total mass of $PM_{2.5/10}$ collected (µg), w_f = Final mass of the conditioned filter after sample collection (mg), w_i = Initial mass of the conditioned filter before sample collection (mg), 10^3 = unit conversion factor for mg to µg.

After the calculation of the total mass of $PM_{2.5/10}$, the calculation of the total volume of air sampled is as follows:

$$V_{2\cdot5/10} = Q_{avg} \times t \times 10^{-3} m^3$$

Here, $V_{2\cdot5/10}$ = Total volume of air sampled for $PM_{2.5/10}$ sampling, Q_{avg} = Average flow rate over the entire duration of the sampling period (LPM), t = duration of the sampling period (min.), 10^3 = unit conversion for L into m^3.

The concentration of $PM_{2.5/10}$ in the air is –

$$PM_{2.5/10} = {W_{2.5/10}}/{V_{2.5/10}}$$

Here, $PM_{2.5/10}$ = Mass concentration of $PM_{2.5/10}$ (µg/m^3), $W_{2.5/10}$ = Total mass of the $PM_{2.5/10}$ collected (µg), $V_{2.5/10}$ = Total volume of air sampled for $PM_{2.5/10}$ sampling.

3.1.4 Estimating the National Air Quality Index (NAQI)

The National Air Quality Index (CPCB, 2015) is a comprehensive tool designed to monitor and communicate air quality in India. It provides a simple, user-friendly framework that translates complex air pollution data into an easily understandable format for the general public. It is based on maximum operating function. The maximum value of the sub-index is considered an index value. Sub-indices of pollutants are calculated by the linear interpolation between the breakpoint concentration values of pollutants as tabulated in **Table 4** and calculated by using the following equations.

$$I_p = \frac{(I_{HI} - I_{LO})}{B_{HI} - B_{LO}} (C_P - B_{LO}) + I_{LO}$$

$$NAQI = max \ (I_P)$$

Where, p = n number of pollutants: 1, 2… n, B_{HI} = Breakpoint concentration value more than or equal to the given concentration value, B_{LO} = Breakpoint concentration value smaller than or equal to the given concentration value, I_{HI} = AQI value corresponding to B_{HI}, I_{LO} = AQI value corresponding to B_{LO}.

AQI categories along with their corresponding health impacts on humans are shown in **Table 5**. It provides a detailed understanding about the implications of each AQI category on the public health.

Table 4: NAQI Categories and Corresponding Breakpoint Concentration of Pollutants

AQI Category	Good	Satisfactory	Moderately Polluted	Poor	Very poor	Severe
AQI Value	0 – 50	51 – 100	101 – 200	201 – 300	301 – 400	401 – 500
PM_{10}	0 – 50	51 – 100	101 – 250	251 – 350	351 – 430	430+
$PM_{2.5}$	0 – 30	31 – 60	61 – 90	91 – 120	121 – 250	250+
NO_2	0 – 40	41 – 80	81 – 180	181 – 280	281 – 400	400+
SO_2	0 – 40	41 – 80	81 – 380	381 – 800	801 – 1600	1600+
CO *	0 – 1	1.1 – 2	2.1 – 10	10 – 17	18 – 34	34+
O_3	0 – 50	51 – 100	101 – 168	169 – 208	209 – 748	748+ **

* All pollutant concentrations are in μg/m^3 except CO in mg/m^3.
24 h average value for PM_{10}, $PM_{2.5}$, SO_2, NO_2, and 8 h average value for CO and O_3.
** Hourly values instead of 8h average

Table 5: AQI Categories and Associated Health Impacts

AQI Category	Associated Health Impacts
Good	Minimal Impact
Satisfactory	May cause minor breathing discomfort to sensitive people
Moderately Polluted	May cause breathing discomfort to people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very Poor	May cause respiratory illness in people on prolonged exposure. The effect may be more pronounced in people with lung and heart diseases
Severe	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

3.2 Water Pollution Study

Opencast and underground coal mining, along with associated auxiliary activities, significantly influence hydrology and water quality (Zeng et al., 2018). The extent of these impacts on the local water regime depends on factors such as mine structure, groundwater recharge rates, and the aquifer properties of surrounding formations. These effects vary over time and across different mining stages.

Mining activities can contaminate surface waters, reduce aquifer potential, lower water levels near the mine, and disrupt groundwater flow. Contamination of groundwater often results from mine water infiltration, which is facilitated by leaching, increased permeability due to aquifer excavation, and fractures caused by blasting activities (Younger et al., 2002). Pollutants can penetrate groundwater to depths of up to 50 meters, as noted by Negrel et al. (2007). Contaminated mine water can travel over 10 km from its source, affecting soils and water bodies in adjacent areas (Naicker et al., 2003).

Overburden and other mining waste frequently contain toxic elements that may accumulate in water bodies, posing long-term risks to groundwater. The permeability of the overburdened topsoil influences its ability to allow the movement of leachate contaminants into the regional groundwater (Alao et al., 2023). Low resistivity in the overburden suggests the presence of sandy or loose soils that are more permeable and allow easier infiltration.

During the rainy season, runoff from mine-adjacent areas often carries a high load of suspended solids into nearby surface waters. This influx of suspended solids can disrupt the natural flow of rivers and streams, harm aquatic habitats, and reduce water quality, posing challenges for downstream water use. Blasting activities further exacerbate hydrogeological disturbances near the mine face, creating wider fractures and joints. These disturbances increase secondary porosity and establish highly permeable zones around the mine, compounding the risks to both groundwater flow and quality.

3.2.1 Sample Collection

Thirteen sampling locations were identified based on a preliminary field survey to assess the overall impact of the East Dump on surface and groundwater resources (see **Table 6**). Out of the total, 7 samples were collected from surface water sources, including siltation ponds and drain outlets from the East Dump.

The remaining 6 samples were obtained from groundwater sources, such as hand pumps and wells. Water from these sources is used by the community for both domestic and agricultural purposes. **Figure 4** provides an overview of various water sampling sites that were chosen in this study.

Table 6: Details of Water Quality Monitoring around Khadia OCP

S.No.	Sample Code	Sampling Location	Latitude	Longitude
1	SW 1	Nala beneath Wharf Wall	24.119574	82.728426
2	SW 2	Settling Pond	24.118990	82.735195
3	SW 3	Settling Pond	24.119032	82.736082
4	SW 4	Settling Pond	24.119674	82.727133
5	SW 5	Settling Pond	24.118738	82.738984
6	SW 6	Settling Pond	24.118316	82.739229
7	SW 7	Settling Pond	24.117376	82.739464
8	GW 1	Handpump	24.118967	82.728674
9	GW 2	Handpump	24.119685	82.725551
10	GW 3	Handpump	24.119069	82.726533
11	GW 4	Well	24.119245	82.726812
12	GW 5	Well	24.119163	82.723128
13	GW 6	Well	24.119385	82.725516

3.2.2 Sample Preparation for Heavy Metal and Ion Analysis

Sample collection, preservation, and analysis were conducted following standard methods outlined by the American Public Health Association (APHA, 2005). From each location, two sets of samples were collected in 1000 ml narrow-mouth, prewashed polyethylene bottles. Before fieldwork, these bottles were thoroughly cleaned in the laboratory using dilute hydrochloric acid, followed by rinsing twice with double-distilled water. At each sampling site, the bottles were rinsed again with the water to be sampled before collection. Once filled, the bottles were immediately sealed and labelled with a sample code and the name of the sampling site to ensure proper identification for future analysis.

All water samples were transported to the laboratory and stored at 4°C to prevent chemical alterations. One set was filtered through a nylon syringe filter and acidified to pH < 2 using HNO_3 for trace metal (As, Cd, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Zn) analysis, while the other set was preserved for ion analysis (Na^+, K^+, Mg^{2+}, Ca^{2+}), following the standard methods outlined by APHA (2005). Representative samples were sent to BSIP, Lucknow for identification of heavy metal and cation analysis.

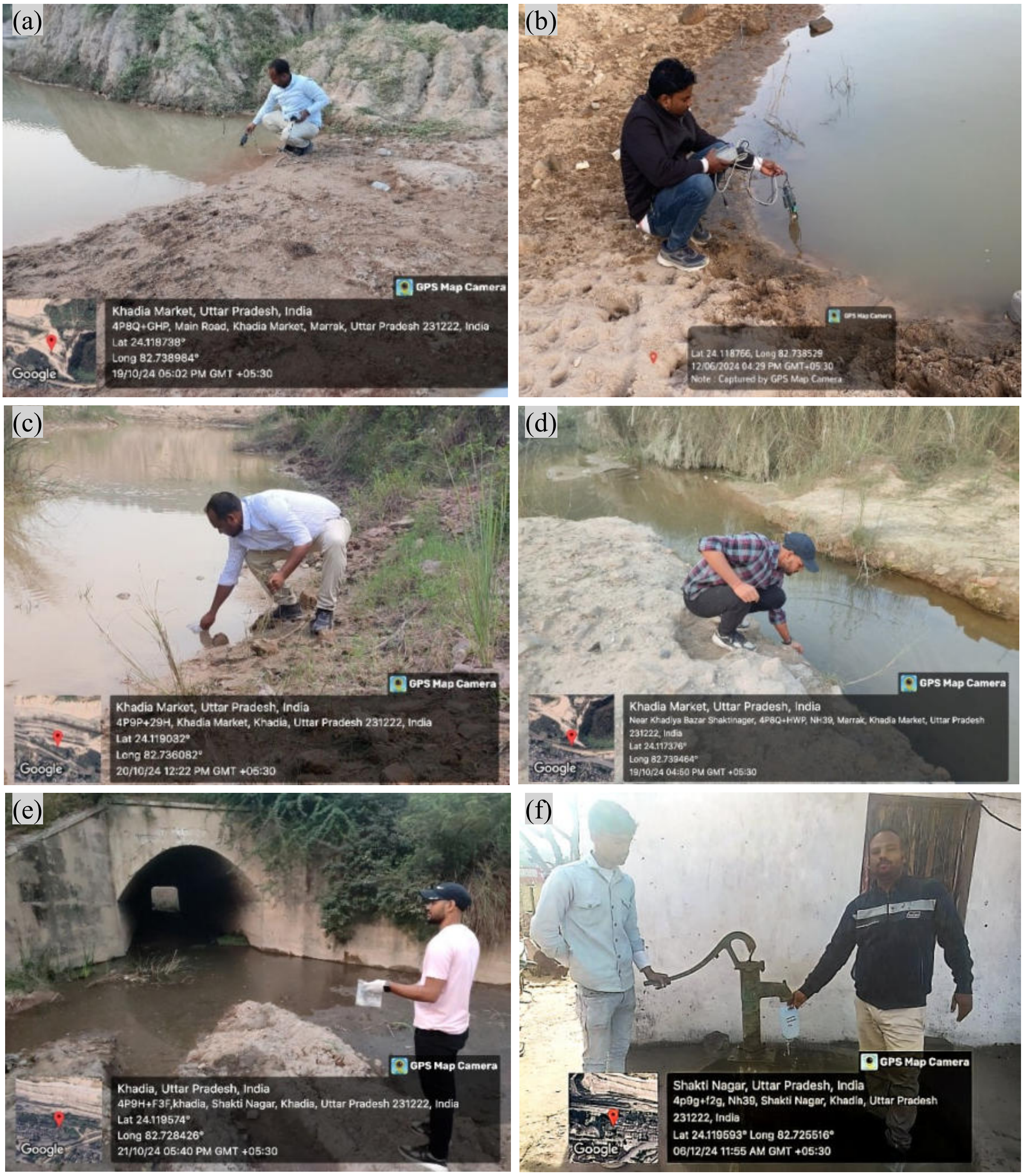


Figure 4: Overview of various Water Sampling Sites. (a-d) Water Sampling and Monitoring at various Siltation Ponds near the East Dump. (e) Sampling of Nala water from the RCC Catch Drain at the East Dump. (f) Sampling of Hand Pump water near the East Dump

3.2.3 Estimating the Water Quality Index

The Water Quality Index (WQI) is calculated using the Canadian Council of Ministers of the Environment Index method. The formulation of the CCME WQI is described in the Canadian Water Quality Index 1.0 –Technical Report (CCME 2001). The WQI provides a convenient means of summarizing complex water quality data and intends to provide a tool for simplifying the reporting of water quality data. The index produces a number between 0 (worst water quality) and 100 (best water quality). These numbers are divided into 5 descriptive categories as shown in **Table 7**.

Table 7: CCME WQI and its respective Values and Description of Water Quality

Category	WQI Value	Description of Water Quality
Excellent	95-100	Protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels
Good	80-94	Protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels
Fair	65-79	Usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
Marginal	45-64	Frequently threatened or impaired; conditions often depart from natural or desirable levels.
Poor	0-44	Almost always threatened or impaired; conditions usually depart from natural or desirable levels.

Essentially, the model consists of three measures of variance from selected water quality objectives (Scope, Frequency, and Amplitude). The "Scope (F1)" represents the extent of water quality guideline non-compliance over the period of interest. The "Frequency (F2)" represents the percentage of individual tests that do not meet objectives. The "Amplitude (F3)" represents the amount by which failed tests do not meet their objectives. These three factors combine to produce a value between 0 and 100 that represents the overall water quality.

Factor 1: F1 (Scope) – The Scope assesses the extent of water quality guideline non-compliance over the period of interest, which means the number of parameters whose objective limits are not met. It has been adopted directly from the British Columbia Water Quality Index:

$$F_1 = \frac{(Number\ of\ Failed\ Variables)}{(Total\ number\ of\ Variables)} \times 100$$

Factor 2: F2 (frequency)- The frequency (i.e., how many occasions the tested or observed value was off the acceptable limits) with which the objectives are not met, which represents the percentage of individual tests that do not meet the objectives ("failed tests"):

$$F_2 = \frac{(Number\ of\ failed\ tests)}{(Total\ number\ of\ tests)} \times 100$$

Factor 3: F3 (amplitude)- The amount by which the objectives are not met (amplitude) represents the amount by which the failed test values do not meet their objectives, and is calculated in three steps. The number of times by which an individual concentration is greater than (or less than, when the objective is a minimum) the objective is termed an "excursion" and is expressed as follows. When the test value must not exceed the objective:

$$Excursion_i = \left(\frac{Failed\ test\ value_i}{Objective_j}\right) - 1$$

For the cases in which the test value must not fall below the objective:

$$Excursion_i = \left(\frac{Objective_j}{Failed\ test\ value_i}\right) - 1$$

The collective amount, by which the individual tests are out of compliance, is calculated by summing the excursions of individual tests from their objectives and then dividing the sum by the total number of tests. This variable, referred to as the normalized sum of excursions (nse) is calculated as:

$$nse = \frac{\sum_{i=1}^{n} excursion_i}{Number\ of\ tests}$$

F3 is then calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a value between 0 and 100.

$$F_3 = \left(\frac{nse}{0.01nse + 0.01}\right)$$

The CCME WQI is finally calculated as:

$$CCME\ WQI = 100 - \left(\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}\right)$$

3.2.4 Evaluation of the Leaching Properties of the East Dump

In the present study, leaching experiments were conducted to simulate the interaction between water and overburden material as it percolates through the dump and potentially infiltrates groundwater. By conducting laboratory-scale leaching experiments, it is possible to gain insights into the chemical processes occurring within the dump and their potential effects on groundwater and surface water quality. Since replicating the exact composition of rainwater in a laboratory setting is challenging, tap water with known properties was used for consistency. The experimental setup was designed to replicate mine site conditions on a laboratory scale.

Two distinct experimental setups were employed to analyse the leaching behaviour of overburden material from different sections of the dump. These sections were selected from the top, middle, and bottom of the dump to represent variations in material age and composition as shown in **Figure 5.** The top section consisted primarily of freshly dumped material, while the middle and toe sections contained progressively older material.

Figure 5: Collection of samples from the East Overburden Dump for Leachate and Runoff Analysis. (a-b) Collection of Overburden material from the top of the dump (c) Collection of Overburden material from the middle of the dump (d) Collection of Overburden material from the toe of the dump.

The leaching model was fabricated using three acrylic boxes (**Figure 6**). The top box, 19 cm × 19 cm × 19 cm, served as a water reservoir with a perforated base to regulate a controlled dripping rate of 2 L/min. The middle box, measuring 19 cm × 19 cm × 60 cm, held the overburden material and had a perforated base to allow water to percolate through the material.

The bottom box collected the leachate, with dimensions of 19 cm × 19 cm × 19 cm. A sample-to-water volume ratio of 1:5 was adopted in these experiments. This was chosen to avoid the requirement of excessive sample and water volumes, which could be challenging in lab setup.

The study consisted of two experiments to investigate leachate characteristics. In the first experiment, a combined sample was created by adding materials from the bottom, middle, and top of the dump in that order, providing a cumulative representation of the entire dump's leachate. **Figure 6a** shows this setup. In the second experiment, individual samples were collected from the top, middle, and bottom sections to assess section-specific variations in leachate composition, as shown in **Figure 6b**.

Figure 6: Leaching Experiments. (a) Combined Leachate Analysis. (b) Section-specific Leachate Analysis.

The leachate was collected for analysis at 10-minute intervals up to the 160-minute mark. The collected leachate at different time instances was analysed for their physio-chemical properties using a Waterproof Portable Meter. Additionally, the rate of infiltration was also monitored during the process.

Chapter 4: Existing Control Measures Adopted for Air and Water Pollution

4.1 Existing control measures adopted for Air Pollution

To effectively manage air quality, multiple measures have been implemented to control dust emissions and airborne particles. Mobile water sprinklers are deployed on haul roads, while most coal is transported via MGR (rail transport), significantly reducing dust emissions. A dust extraction system is operational in Phase-1 of the Coal Handling Plant (CHP), with fixed sprinklers installed around the coal yard and automatic water sprinklers deployed at the receiving pit of the CHP. Drilling equipment is fitted with dust extractors, and service roads are metaled, with approach roads to the mines blacktopped to minimize dust generation. Vehicles transporting coal are covered with tarpaulin and are not overloaded, while wetting of run-of-mine (ROM) coal is done before crushing in the CHP. The CHP operates within an enclosed system to contain emissions.

Routine maintenance and periodic overhauling of heavy earth-moving machinery (HEMM) is done to ensure efficient operations. Water Bound Macadam (WBM) haul roads are constructed to prevent fugitive dust emissions. Additional dust control measures include the deployment of fog cannons, both mobile and fixed, with a fixed fog cannon deployed specifically at the coal yard. Truck-mounted mist spray machines and road sweepers are utilized to maintain road cleanliness and minimize dust. Two surface miners have been deployed to reduce dust emission during drilling and blasting activities. A wheel washing facility is under development and will be commissioned by February 2025. A Rapid Loading System of 04 MTPA is under construction to increase the rail transportation of coal and which will further improve the air quality of the area

Vegetative covers have been established on non-active overburden dumps, with approximately 39.81 hectares planted as of 2022-23. The plantation data for the Khadia OCP includes trees such as *Acacia auriculiformis*, Shisham (*Dalbergia sissoo*), Neem (*Azadirachta indica*), Mango (*Magnifera* indica), Ber (*Zizyphus mauritiana*), Bamboo, Guava etc.

A Continuous Ambient Air Quality Monitoring Station has been established (Lat: 24.122295, Long: 82.684508) to monitor particulate matter levels in ambient air, with real-time data fed to the CPCB. Air quality is continuously monitored at four stations in the core and buffer zones, tracking pollutants such as SPM, RPM, SO_2, NO_X, and heavy metals, with monitoring handled by CMPDI. An overview of the adopted measures for air pollution is shown in **Figure 7**.

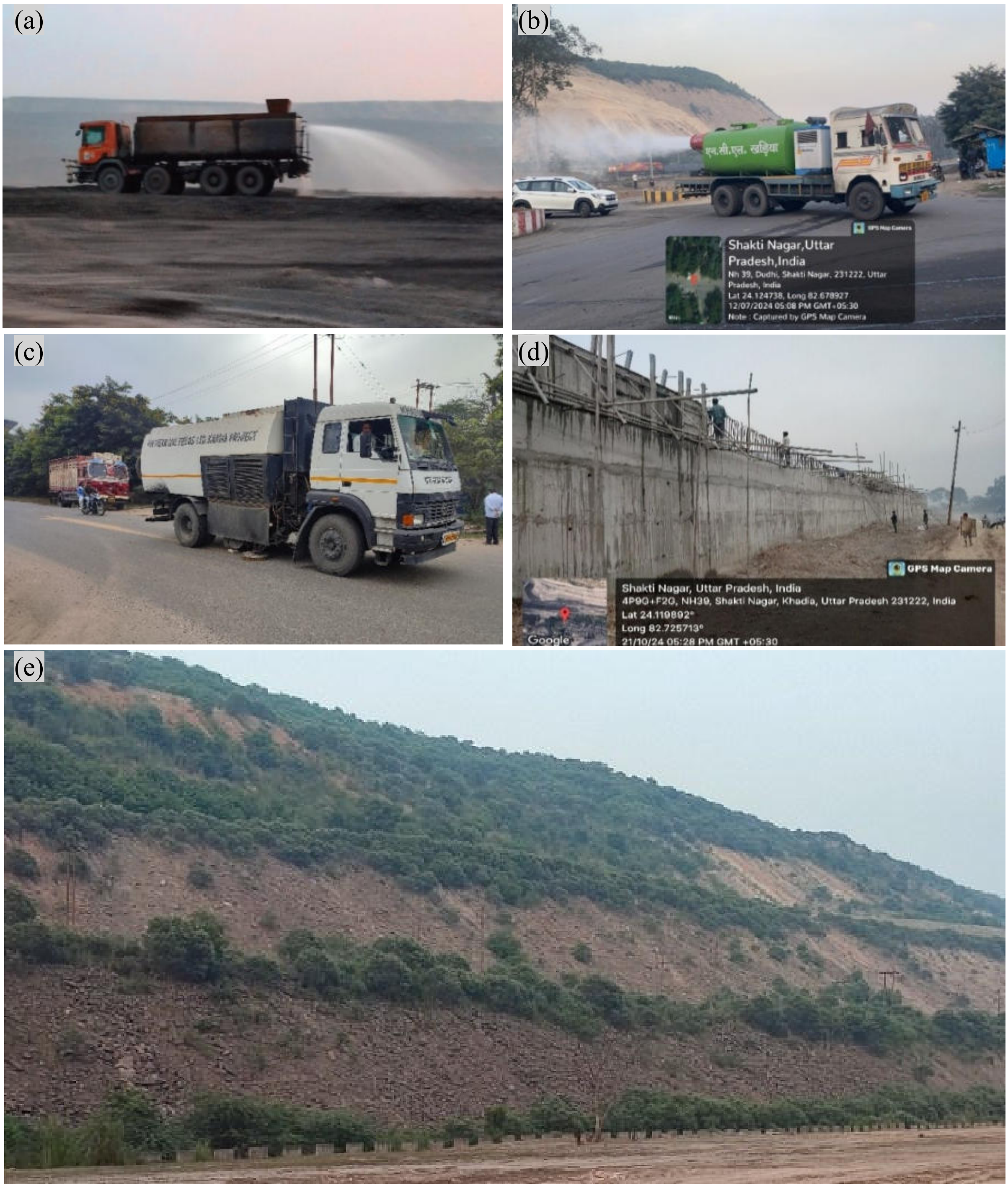


Figure 7: An Overview of different control measures adopted for Air Pollution. (a) Mobile water sprinkling being done on a haul road near the East Dump. (b) Mobile Fog Canon in action on NH 39. (c) Truck-mounted Road Sweeper on NH 39 (d) A Curtain wall in-construction near a proposed Warf Wall to arrest dust. (e) Vegetation planted on the East Overburden Dump facing Nawatola Basti.

4.2 Existing control measures adopted for Water Pollution

In terms of water pollution control, a 4.15 km retaining wall, 3.32 km of catch drains, and 7.8 km of garland drains have been constructed to manage surface runoff effectively. The collected water is treated at a 38.4 MLD Effluent Treatment Plant and reused for watering the mine area, roads, and greenbelt development.

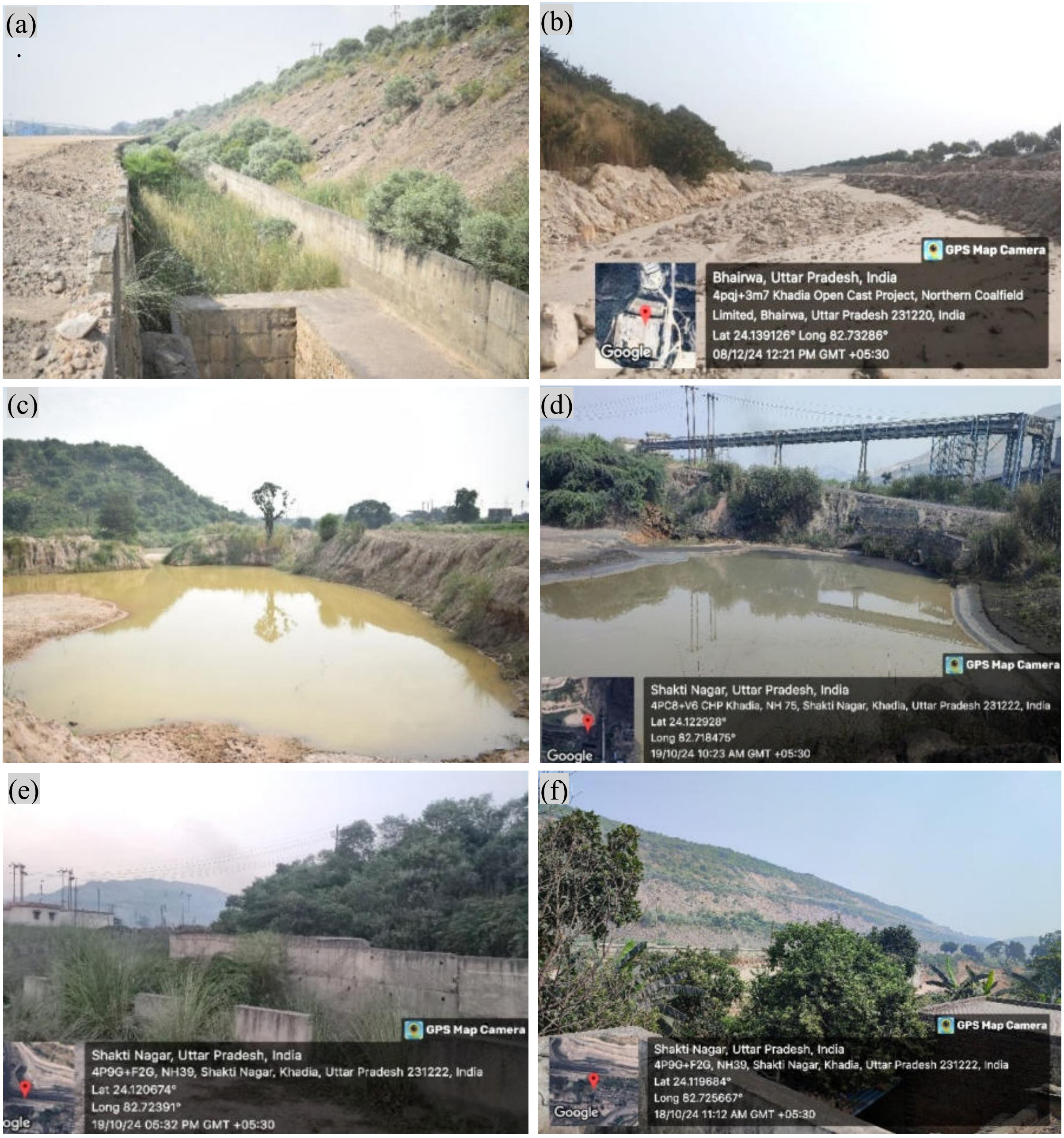


Figure 8: An Overview of different control measures adopted for Water Pollution. (a) RCC Catch Drain along the East Dump. (b) Garland Drain along a dump deck at the East Dump. (c-d) Setling pond near the East Dump. (e) Retaining Wall at the toe of the East Dump. (f) Vegetation along the slope of the East Dump as seen from Nawatola Basti.

Domestic wastewater is treated in a 1.5 MLD Sewage Treatment Plant (STP) and repurposed for horticultural use. Both mine and rainwater are collected in a sump and a large pond for groundwater recharge. Treated sump water is primarily used for mining activities such as dust suppression after allowing silt to settle. Silt-settling ponds have also been constructed to retain sediments and prevent contamination of runoff from dumps, stockyards, and railway sidings. A summary of the adopted water pollution control measures can be found in **Figure 8**.

Chapter 5: Impact of the East Dump on Air and Water Quality of Nawatola Basti

5.1 Air Pollution Study

5.1.1 Meteorological Parameters of the Study Area

The Ambient Air Quality Monitoring System was installed on the rooftop of a house located at coordinates (24.119630, 82.725617) in Nawatola Basti. The site was unobstructed, allowing unrestricted airflow from all directions. Daily measurements were recorded from October 19, 2024, to December 23, 2024, and averaged over a 24-hour UTC period. Monthly meteorological parameter observations are presented in **Tables 8-10**.

Table 8: Meteorological Parameters Observed in October, 2024

Date	Temperature (°C)	Humidity (%)	Wind Direction (deg.)	Wind Speed (m/s)
19-10-2024	29.80	60.80	62.16	0.00
20-10-2024	29.35	62.54	62.02	0.01
21-10-2024	28.87	61.32	63.68	0.00
22-10-2024	29.05	52.59	121.68	0.13
23-10-2024	28.58	55.12	156.72	0.33
24-10-2024	28.20	62.15	157.34	0.74
25-10-2024	26.88	71.15	196.09	0.74
26-10-2024	24.56	81.27	262.71	1.19
29-10-2024	34.43	58.39	40.09	0.14
30-10-2024	33.22	57.58	67.10	0.26
31-10-2024	32.58	48.47	70.14	0.42
Max	34.43	81.27	262.71	1.19
Min	24.56	48.47	40.09	0.00
Mean	29.59	61.03	114.52	0.36
Std. Dvn.	2.86	8.94	-	0.38

Table 9: Meteorological Parameters Observed in November, 2024

Date	Temperature (°C)	Humidity (%)	Wind Direction (deg.)	Wind Speed (m/s)
01-11-2024	31.61	48.98	94.42	0.51
02-11-2024	29.30	43.49	102.21	0.57
12-11-2024	24.84	59.04	50.17	0.00
13-11-2024	27.84	51.16	52.36	0.27
14-11-2024	27.23	44.30	91.14	0.40
15-11-2024	24.77	45.57	62.14	0.24
16-11-2024	25.08	43.84	76.46	0.30
17-11-2024	25.85	42.88	85.98	0.37
18-11-2024	23.89	45.44	76.90	0.14
19-11-2024	23.86	48.58	69.90	0.30

20-11-2024	24.51	48.10	102.89	0.51
21-11-2024	24.25	45.31	77.56	0.36
22-11-2024	22.27	47.91	106.24	0.41
23-11-2024	23.39	47.24	99.61	0.42
24-11-2024	23.25	53.84	69.41	0.19
25-11-2024	23.63	53.38	52.12	0.18
26-11-2024	23.98	44.54	103.93	0.50
27-11-2024	22.85	41.95	91.50	0.44
28-11-2024	22.36	45.41	61.35	0.33
29-11-2024	20.65	53.08	51.60	0.10
30-11-2024	20.88	52.52	70.69	0.13
Max	31.61	59.04	106.24	0.57
Min	20.65	41.95	50.17	0.00
Mean	24.59	47.93	78.50	0.32
Std. Dvn.	2.64	4.45	-	0.15

Table 10: Meteorological Parameters Observed in December, 2024

Date Time	**Temperature (°C)**	**Humidity (%)**	**Wind Direction (deg.)**	**Wind Speed (m/s)**
01-12-2024	23.31	49.03	55.06	0.09
02-12-2024	23.28	50.14	55.12	0.23
03-12-2024	24.19	47.16	66.20	0.26
04-12-2024	24.41	43.16	61.74	0.29
05-12-2024	24.79	40.52	80.53	0.25
06-12-2024	22.95	38.85	137.33	0.58
07-12-2024	24.61	34.96	85.95	0.14
08-12-2024	23.73	42.60	55.33	0.18
09-12-2024	24.96	41.61	121.12	0.21
10-12-2024	23.77	33.73	154.18	0.19
11-12-2024	20.30	42.36	85.17	0.17
12-12-2024	21.10	35.11	111.42	0.27
13-12-2024	19.59	34.62	118.06	0.30
14-12-2024	19.36	32.64	163.95	0.25
15-12-2024	20.03	33.79	110.47	0.27
16-12-2024	19.61	42.80	49.53	0.02
17-12-2024	19.98	45.34	75.98	0.06
18-12-2024	20.96	48.21	69.97	0.07
19-12-2024	20.80	52.83	66.76	0.11
20-12-2024	23.25	50.86	96.09	0.42
21-12-2024	23.64	47.53	134.74	0.60
22-12-2024	23.02	45.05	90.43	0.59
23-12-2024	24.74	46.43	59.19	0.86
24-12-2024	24.10	49.99	50.83	0.33

25-12-2024	24.96	48.70	68.43	0.25
26-12-2024	24.75	49.73	65.02	0.22
27-12-2024	26.90	45.97	60.26	0.55
28-12-2024	22.22	69.27	83.86	0.66
29-12-2024	23.32	67.06	147.12	0.68
30-12-2024	20.37	58.44	225.68	2.17
31-12-2024	19.67	56.19	188.4	1.31
Max	26.90	53.50	163.95	0.60
Min	19.36	32.64	49.53	0.00
Mean	22.25	42.89	91.74	0.24
Std. Dvn.	2.11	9.03	-	0.43

From Tables 7-9, it can be observed that the temperatures range from a high of 34.43°C in late October to a low of 19.36°C in mid-December, reflecting a gradual cooling trend as the months progress. Humidity levels fluctuate significantly, with values as high as 81.27% in October and as low as 32.64% in December, indicating varying moisture levels in the atmosphere. Wind direction shifts widely, with recorded values spanning from 40.09° to 262.71°, suggesting dynamic wind patterns. Wind speeds are generally low, peaking at 1.19 m/s in October and dropping to nearly zero on several occasions, highlighting calm conditions. Overall, the data reveals a transition from warmer, more humid conditions in October to cooler, drier conditions in December, with generally light winds throughout the period.

In order to illustrate wind speed and direction data observed over the study area between October to December, Lakes Environmental Software was used to generate wind rose plots as shown in **Figure 9-11**. The wind rose plot for the October month in **Figure 9** indicates that the prevailing winds primarily blow from the west-northwest (WNW) direction, with a maximum frequency of 3.5%. The plot notes a significant calm wind (below 0.5m/s) percentage of 74.03%, indicating a lack of notable wind movement during much of the observation period. The average wind speed during October was 0.27 m/s, highlighting overall low wind speeds. While relevant to pollution dispersion, weak winds are excluded from wind rose plots as their random and inconsistent directions contribute little to the understanding of prevailing dispersion patterns. In the month of November, see **Figure 10**, the prevailing wind direction started to blow from the southeast (SE) and south-southeast (SSE) directions. A small fraction (2.1%) also blows from the southwest (SW) direction. There is a high percentage of calm conditions, 68.18%, though slightly fewer compared to October (74.03%). The prevailing wind direction shifts in December, now blowing from east (E) and east-northeast (ENE), with a

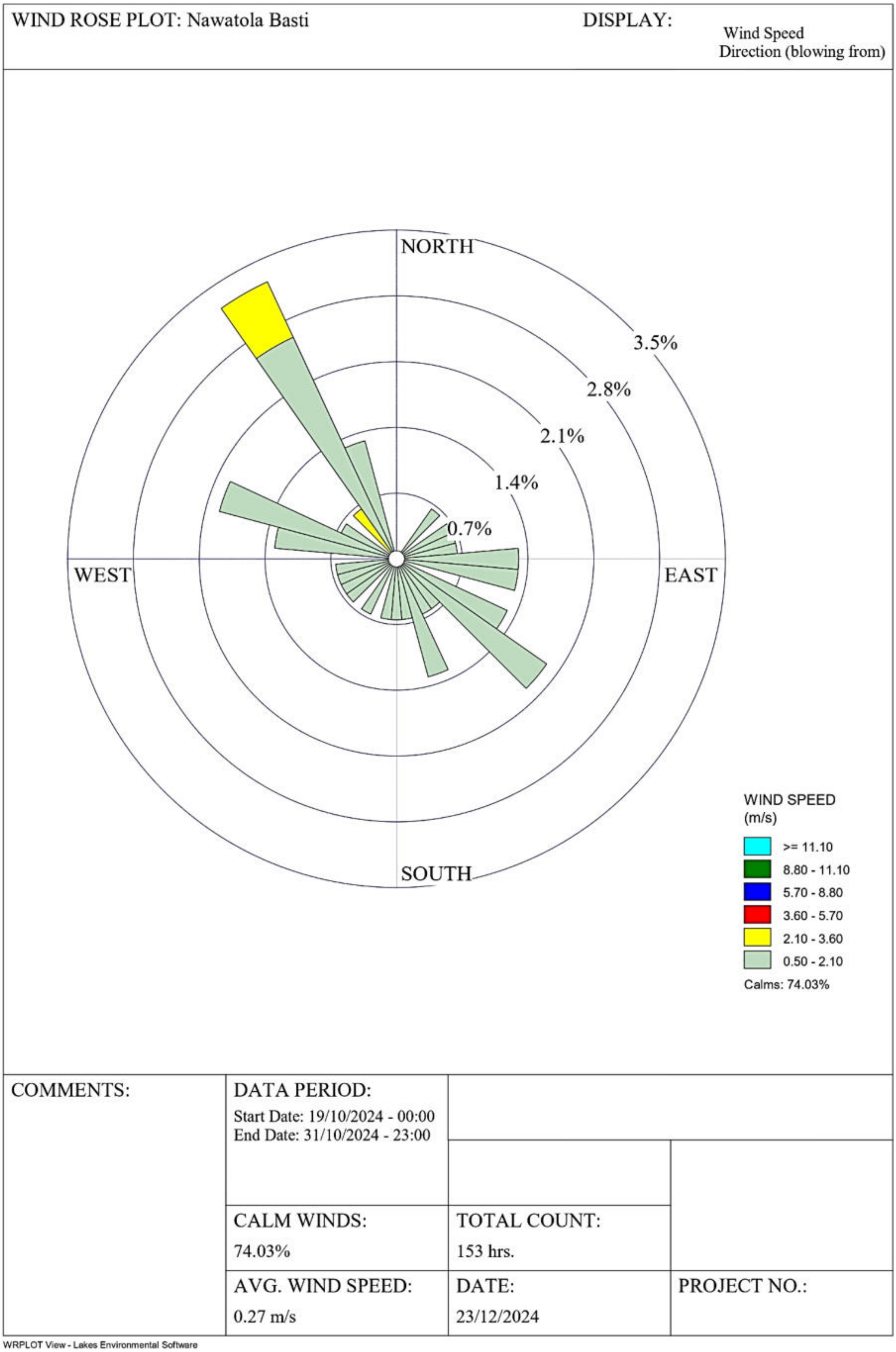
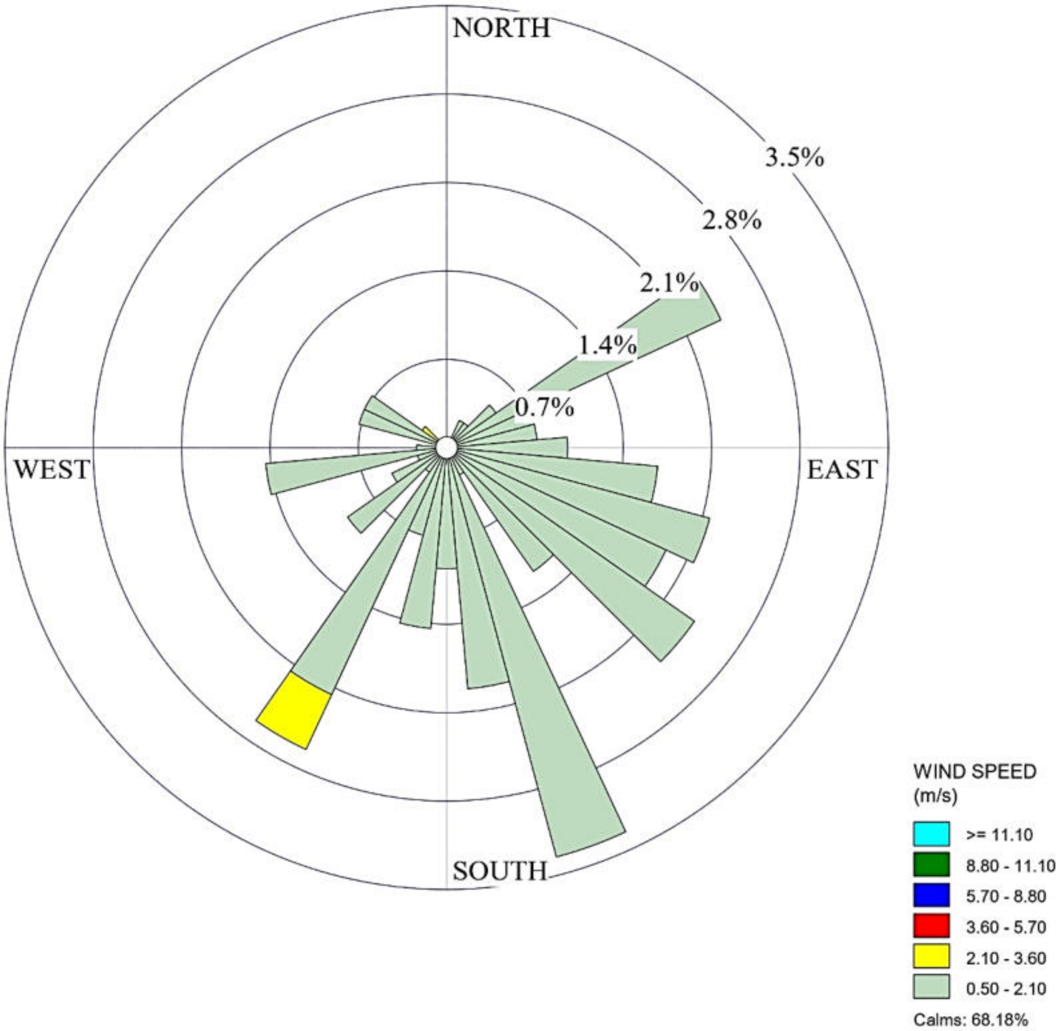


Figure 9: Wind Rose Plot of the Study Area during October, 2024

WIND ROSE PLOT: Nawatola Basti

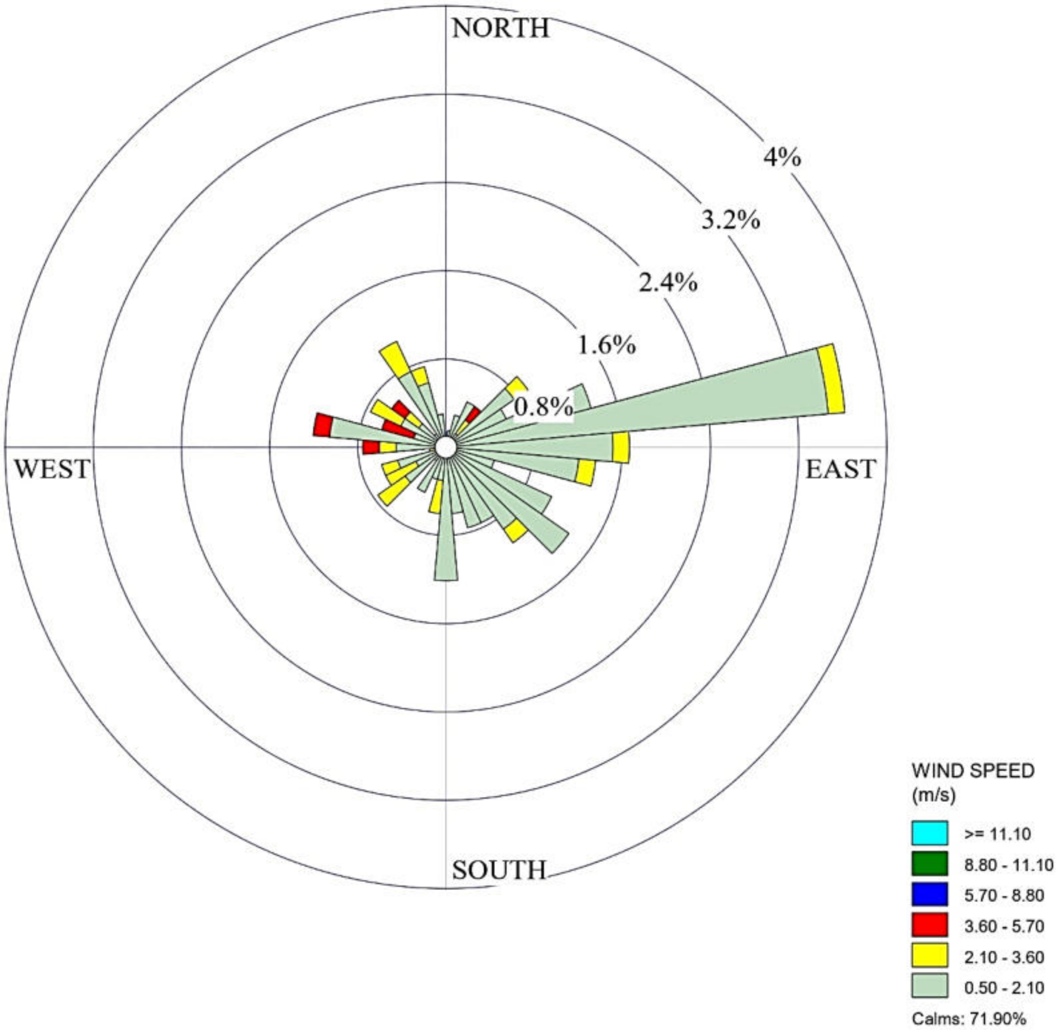
DISPLAY: Wind Speed Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 01/11/2024 - 00:00 End Date: 30/11/2024 - 23:00		
	CALM WINDS: 68.18%	TOTAL COUNT: 417 hrs.	
	AVG. WIND SPEED: 0.31 m/s	DATE: 23/12/2024	PROJECT NO.:

Figure 10: Wind Rose Plot of the Study Area during November, 2024

WIND ROSE PLOT: Nawatola Village	DISPLAY: Wind Speed Direction (blowing from)

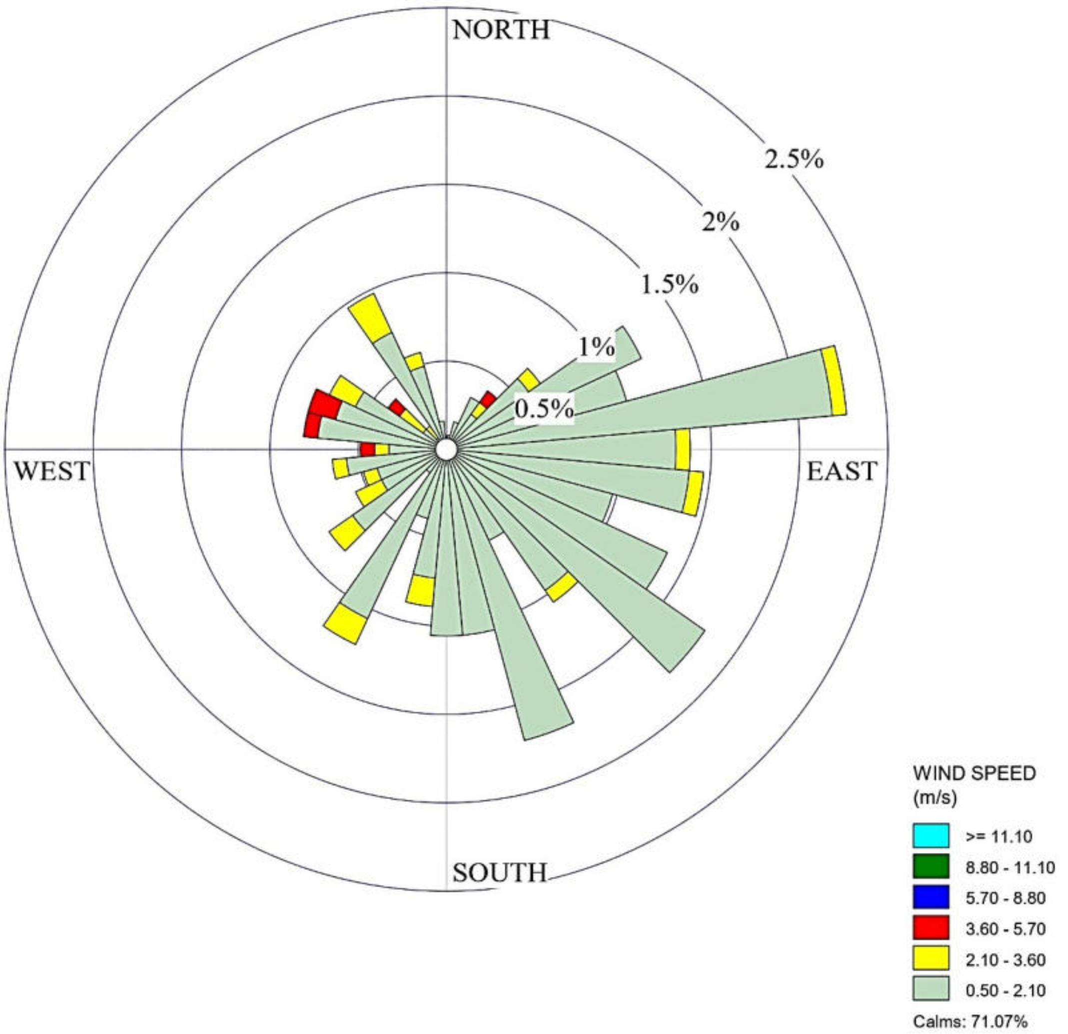


COMMENTS:	DATA PERIOD: Start Date: 01/12/2024 - 00:00 End Date: 31/12/2024 - 23:00		
	CALM WINDS: 71.90%	TOTAL COUNT: 661 hrs.	
	AVG. WIND SPEED: 0.35 m/s	DATE: 18/01/2025	PROJECT NO.:

Figure 11: Wind Rose Plot of the Study Area during December, 2024

WIND ROSE PLOT: Nawatola Basti

DISPLAY: Wind Speed Direction (blowing from)



COMMENTS:	DATA PERIOD: Start Date: 19/10/2024 - 00:00 End Date: 31/12/2024 - 23:00		
	CALM WINDS: 71.07%	TOTAL COUNT: 1233 hrs.	
	AVG. WIND SPEED: 0.33 m/s	DATE: 18/01/2025	PROJECT NO.:

Figure 12: Combined Wind Rose Plot of the Study Area from October to December 2024

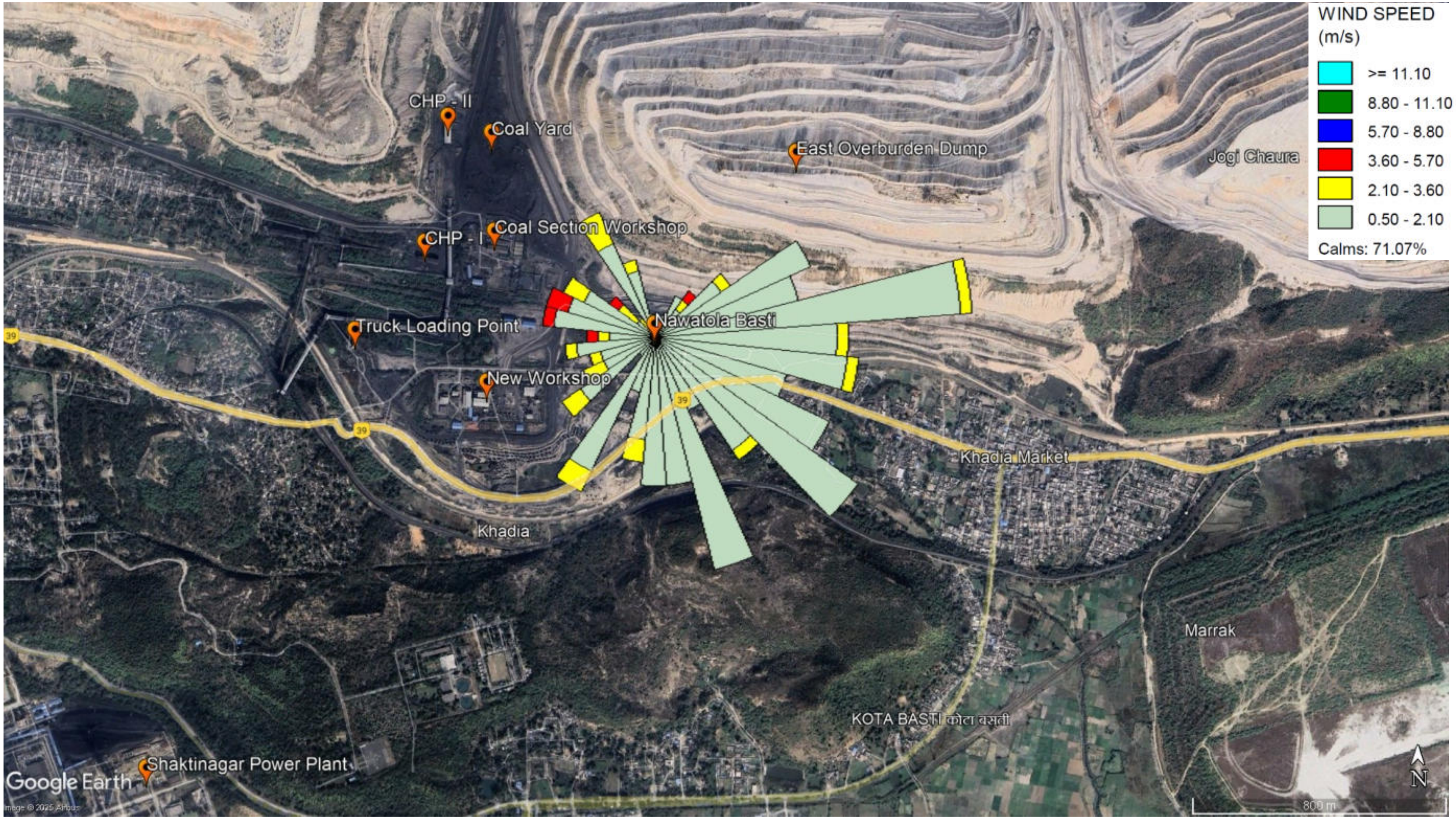


Figure 13: Wind Rose Plot from October to December 2024 on Google Earth Image

maximum frequency of 3%, as shown in **Figure 11**. The percentage of calm winds increased to 71.9%. **Figure 12** represents the wind rose plot from October to December 2024. The calm conditions accounted for 71.07% of the total wind data.

This indicates a predominantly stagnant atmospheric condition which implies that the pollutants released into the atmosphere are likely to remain concentrated near their sources for extended periods. The dominant wind directions are from the East (E), East-Northeast (ENE) and Southeast (SE). Most wind speeds fall within the range of 0.5–2.10 m/s, with a small fraction between 2.10–3.60 m/s. The average wind speed over this period is 0.33 m/s, further emphasizing low wind activity.

To better visualize the prevalent wind dispersion pattern in the geographical context of the study area, the combined wind rose plot (October – December) was exported on the Google Earth Image as shown in **Figure 13**.

5.1.2 Pollutant Concentrations in and around Nawatola Basti

The results for $PM_{2.5}$ and PM_{10} concentrations at NB P1 are presented in **Table 11**, while the corresponding data for NB P2 is detailed in **Table 12**. At NB P1, $PM_{2.5}$ concentrations ranged from 30.61 to 138.53 µg/m^3, while PM_{10} levels varied from 85.21 to 195.06 µg/m^3. The arithmetic means for $PM_{2.5}$ and PM_{10} at NB P1 were 72.19 µg/m^3 and 125.63 µg/m^3. Similarly, at NB P2, $PM_{2.5}$ levels ranged from 45.32 to 123.17 µg/m^3 and PM_{10} concentrations ranged from 85.28 to 188.48 µg/m^3. The arithmetic means for $PM_{2.5}$ and PM_{10} at NB P2 were 69.06 µg/m^3 and 120.33 µg/m^3.

At NB P1, SO_2 and NO_2, ranged from 58.61 to 84.81 and 55.80 to 77.82 µg/m^3 respectively. The mean concentration of SO_2 and NO_2 (77.77 and 65.12 µg/m^3, respectively) were below the permissible limit. The concentration of CO ranged between 0.24 to 1.37 mg/m^3, with the mean concentration also below the permissible limit.

Table 11: Concentration of Air Pollutants at Nawatola Basti (NB P1)

S.No.	Date	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	SO_2 (µg/m^3)	NO_2 (µg/m^3)	CO (mg/m^3)
1	19-10-2024	115.31	135.31	71.52	74.44	0.90
2	20-10-2024	124.21	112.2	71.52	64.62	1.04
3	21-10-2024	103.24	85.21	76.31	74.44	0.94
4	22-10-2024	72.36	107.61	71.52	64.62	1.08
5	23-10-2024	67.36	110.8	71.52	64.62	0.83
6	24-10-2024	84.35	123.9	76.31	74.44	0.81

7	25-10-2024	79.16	132.32	76.31	64.62	0.83
8	26-10-2024	78.33	127.64	84.81	64.62	0.82
9	27-10-2024	77.45	126.28	77.68	66.34	0.83
10	28-10-2024	80.93	152.55	75.08	73.34	0.79
11	29-10-2024	77.45	126.28	77.72	74.44	0.89
12	30-10-2024	78.34	127.64	77.72	74.44	0.72
13	31-10-2024	82.7	132.32	83.92	74.44	0.24
14	01-11-2024	79.33	134.45	77.72	74.44	0.55
15	02-11-2024	75.96	136.55	71.52	74.44	1.04
16	03-11-2024	74.97	136.1	79.89	74.18	1.18
17	04-11-2024	67.45	128.21	70.74	74.64	1.09
18	05-11-2024	74.9	186.41	71.58	75.09	0.80
19	06-11-2024	67.45	128.21	72.43	75.55	1.13
20	07-11-2024	65.35	105.76	73.28	76	1.37
21	08-11-2024	45.25	110.32	74.13	76.45	1.37
22	09-11-2024	40.49	106.64	74.98	76.91	1.37
23	10-11-2024	45.25	110.32	75.83	77.36	1.37
24	11-11-2024	56.77	125.56	76.67	77.82	1.25
25	12-11-2024	53.54	151.12	76.31	64.62	0.84
26	13-11-2024	69.73	153.01	71.52	74.44	0.83
27	14-11-2024	99.88	154.9	76.31	64.62	1.10
28	15-11-2024	86.93	127.45	84.81	64.62	0.85
29	16-11-2024	85.93	128.23	76.31	64.62	0.78
30	17-11-2024	73.97	101.24	76.31	64.62	0.89
31	18-11-2024	94.02	88.48	76.31	64.62	0.94
32	19-11-2024	40.1	146.95	84.81	64.62	1.19
33	20-11-2024	41.41	100.09	84.81	64.62	1.19
34	21-11-2024	82.71	153.23	84.81	64.62	1.19
35	22-11-2024	71.36	126.62	84.81	64.62	1.19
36	23-11-2024	38.09	122.07	84.81	64.62	1.19
37	24-11-2024	96.17	132.53	84.81	64.62	1.19
38	25-11-2024	38.09	195.06	76.31	64.62	1.19
39	26-11-2024	33.61	132.53	76.31	64.62	1.19
40	27-11-2024	75.12	138.27	84.81	64.62	1.19
41	28-11-2024	74.35	137.63	84.81	64.62	1.12
42	29-11-2024	74.72	135.84	58.61	55.8	0.82
43	30-11-2024	74.35	134.67	84.81	55.8	0.78
44	01-12-2024	41.54	125.34	84.81	64.62	0.88
45	02-12-2024	33.07	180.68	76.31	64.62	0.68
46	03-12-2024	69.47	85.43	76.31	64.62	0.46
47	04-12-2024	55.86	105.18	76.31	64.62	0.46
48	05-12-2024	101.9	117.09	76.31	64.62	0.46
49	06-12-2024	31.58	118.91	84.81	64.62	0.46
50	07-12-2024	88.95	147.74	76.31	64.62	0.46
51	08-12-2024	93.92	137.21	84.81	64.62	0.46
52	09-12-2024	88.95	147.74	84.81	64.62	0.46
53	10-12-2024	78.86	166.1	84.81	64.62	0.46
54	11-12-2024	83.74	135.27	84.81	64.62	0.46

55	12-12-2024	78.86	133.27	84.81	55.8	0.46
56	13-12-2024	91.11	98.05	84.81	55.8	0.66
57	14-12-2024	80.29	106.02	84.81	55.8	0.90
58	15-12-2024	138.53	100.78	84.81	55.8	0.87
59	16-12-2024	133.27	134.79	84.81	55.8	0.62
60	17-12-2024	136.23	120.12	76.31	55.8	0.50
61	18-12-2024	75.39	116.69	84.81	55.8	0.50
62	19-12-2024	37.7	136.39	76.31	64.62	0.50
63	20-12-2024	43.55	135.78	76.31	64.62	0.50
64	21-12-2024	78.35	127.55	84.81	64.62	0.50
65	22-12-2024	72.53	120.27	84.81	64.62	0.50
66	23-12-2024	85.05	115.34	76.31	64.62	0.50
67	24-12-2024	94.62	108.05	76.31	64.62	0.63
68	25-12-2024	94.19	115.76	76.31	64.62	0.87
69	26-12-2024	32.1	114.88	76.31	64.62	0.95
70	27-12-2024	30.61	125.94	71.52	64.62	0.87
71	28-12-2024	43.64	124.05	84.81	55.8	0.86
72	29-12-2024	42.64	111.1	84.81	64.62	0.86
73	30-12-2024	81.28	108.2	58.61	55.8	0.86
74	31-12-2024	92.54	108.57	58.61	55.8	0.90
75	01-01-2025	59.8	123.93	74.7	58.51	0.93
76	02-01-2025	56.9	126.47	74.53	58.32	0.89
77	03-01-2025	52.52	113.47	74.35	58.12	0.86
78	04-01-2025	73.97	114.37	74.18	57.92	0.86
79	05-01-2025	46.09	114.03	74	57.72	0.86
80	06-01-2025	72.06	113.5	73.83	57.53	0.86
81	07-01-2025	46.79	105.37	73.65	57.33	0.86
82	08-01-2025	62.83	93.37	73.48	57.13	0.86
Prescribed Standard (NAAQS, 2009)		**0-60**	**0-100**	**0-80**	**0-80**	**0-2**
Minimum Observation		30.61	85.21	58.61	55.80	0.24
Maximum Observation		138.53	195.06	84.81	77.82	1.37
98th Percentile		134.39	182.86	84.81	77.08	1.37
Mean		72.19	125.63	77.77	65.12	0.85
Median		74.81	126.11	76.31	64.62	0.86
Std. Deviation		24.23	20.42	6.17	6.49	0.27

Table 12: Concentration of Air Pollutants at Nawatola Basti (NB P2)

S.No.	Date	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)
1	20-10-2024	74.10	160.23
2	21-10-2024	70.32	167.37
3	22-10-2024	48.45	188.48
4	23-10-2024	59.37	156.21
5	24-10-2024	53.78	139.73
6	25-10-2024	63.61	123.96
7	26-10-2024	54.43	128.39

8	27-10-2024	67.45	107.20
9	28-10-2024	66.88	100.76
10	29-10-2024	68.45	114.99
11	30-10-2024	67.72	104.77
12	31-10-2024	70.28	103.62
13	01-11-2024	72.84	102.50
14	02-11-2024	45.40	102.63
15	03-11-2024	72.84	102.50
16	04-11-2024	72.80	102.19
17	05-11-2024	45.32	146.78
18	06-11-2024	72.80	139.49
19	07-11-2024	54.64	165.63
20	08-11-2024	46.68	160.54
21	09-11-2024	53.10	158.16
22	10-11-2024	46.68	138.51
23	11-11-2024	92.24	145.85
24	12-11-2024	113.27	143.79
25	13-11-2024	120.67	144.61
26	14-11-2024	96.69	145.42
27	15-11-2024	63.35	124.53
28	16-11-2024	55.43	132.98
29	17-11-2024	47.79	130.94
30	18-11-2024	65.49	114.52
31	19-11-2024	74.24	127.41
32	20-11-2024	87.14	134.92
33	21-11-2024	71.29	120.49
34	22-11-2024	55.02	107.29
35	23-11-2024	48.14	107.41
36	24-11-2024	92.50	109.66
37	25-11-2024	123.17	155.69
38	26-11-2024	118.77	149.65
39	27-11-2024	72.53	119.71
40	28-11-2024	69.54	112.36
41	29-11-2024	65.00	109.42
42	30-11-2024	67.96	105.35
43	01-12-2024	45.52	102.79
44	02-12-2024	57.3	123.57
45	03-12-2024	56.39	111.26
46	04-12-2024	55.47	85.21
47	05-12-2024	67.97	102.11
48	06-12-2024	66.61	122.07
49	07-12-2024	64.78	147.3
50	08-12-2024	49.09	147.22
51	09-12-2024	54.21	165.39
52	10-12-2024	66.09	158.94
53	11-12-2024	51.70	124.25
54	12-12-2024	66.09	115.93
55	13-12-2024	64.96	89.73

56	14-12-2024	64.15	88.68
57	15-12-2024	90.45	88.00
58	16-12-2024	102.38	96.62
59	17-12-2024	81.58	94.54
60	18-12-2024	68.14	96.25
61	19-12-2024	63.73	120.76
62	20-12-2024	58.66	118.88
63	21-12-2024	64.39	110.40
64	22-12-2024	61.53	105.38
65	23-12-2024	93.05	93.02
66	24-12-2024	88.97	121.36
67	25-12-2024	86.12	104.69
68	26-12-2024	53.06	108.72
69	27-12-2024	46.43	111.52
70	28-12-2024	55.47	108.72
71	29-12-2024	64.52	111.52
72	30-12-2024	99.04	110.29
73	31-12-2024	110.24	111.68
74	01-01-2025	97.39	99.70
75	02-01-2025	75.72	94.21
76	03-01-2025	66.25	96.78
77	04-01-2025	59.31	99.54
78	05-01-2025	54.62	98.95
79	06-01-2025	58.74	105.67
80	07-01-2025	54.62	108.71
81	08-01-2025	60.29	107.00
82	09-01-2025	69.37	103.19
Prescribed Standard (NAAQS, 2009)		**0-60**	**0-100**
Minimum Observation		45.32	85.21
Maximum Observation		123.17	188.48
98th Percentile		119.49	166.29
Mean		69.06	120.33
Median		65.79	111.60
Std. Deviation		18.46	22.80

In order to observe the instantaneous concentrations of particulate matter ($PM_{2.5}$ & PM_{10}) in and around Nawatola Basti, a handheld aerosol monitor with a sampling period of 1 minute was used. The collected data has been presented in **Table 13**, providing a summary of the observed particulate matter concentrations across different times and locations. It is important to note that these values represent instantaneous measurements, which tend to be higher than longer-term averaged concentrations due to their capture of short-term fluctuations.

The data reveals notable variations in $PM_{2.5}$ & PM_{10} concentrations across different times and locations in Nawatola Basti. However, higher concentrations are generally observed during the late afternoon and evening hours (see **Figure 14f-h**). During field visits, it was observed that many households in Nawatola Basti use coal for cooking (see **Figure 14f-h**). They typically burn the coal in the late evening to prepare it for cooking dinner later in the night. Burning coal earlier allows it to stabilize, reducing smoke and ensuring a consistent heat source for cooking. However, burning coal also produces particulate matter and other harmful gaseous pollutants.

Table 13: Instantaneous Concentrations of $PM_{2.5}$ & PM_{10} in and around Nawatola Basti

S.No.	Latitude	Longitude	Date	Time	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)
1	24.119063	82.728555	18-10-2024	10:47 AM	108	245.8
2	24.119046	82.728553	18-10-2024	12:25 PM	145.4	671.6
3	24.119032	82.728545	18-10-2024	12:27 PM	118.7	610.7
4	24.119031	82.728545	18-10-2024	12:34 PM	107.7	455.2
5	24.119014	82.728614	18-10-2024	12:39 PM	104.4	439.3
6	24.122243	82.688352	18-10-2024	04:59 PM	162.9	903.67
7	24.122243	82.688352	18-10-2024	05:30 PM	348.8	987.97
8	24.118491	82.726891	24-10-2024	10:56 AM	91.7	458.2
9	24.118847	82.727214	24-10-2024	05:53 PM	126	633
10	24.118847	82.727214	24-10-2024	05:55 PM	111.7	313.3
11	24.118463	82.727230	24-10-2024	06:04 PM	154.9	559.4
12	24.119075	82.726527	25-10-2024	11:57 AM	51.9	234.6
13	24.119075	82.726527	25-10-2024	12:00 PM	53.5	262.4
14	24.119075	82.726527	25-10-2024	12:11 PM	54	306.7
15	24.119238	82.725910	26-10-2024	11:11 AM	55.4	275.4
16	24.119228	82.725517	26-10-2024	11:15 AM	51.1	161.9
17	24.119069	82.728547	26-10-2024	11:30 AM	60.2	315.8
18	24.119501	82.723365	26-10-2024	12:16 PM	59.6	279.9
19	24.119501	82.723365	26-10-2024	01:31 PM	215.3	480.5
20	24.119075	82.726527	06-12-2024	10:31 AM	117	512.5
21	24.119075	82.726527	06-12-2024	10:32 AM	112.6	561.2
22	24.119075	82.726527	06-12-2024	10:34 AM	116.1	573.1
23	24.119075	82.726527	06-12-2024	10:36 AM	113.5	490.8
24	24.119075	82.726527	06-12-2024	10:40 AM	109.7	458.2
25	24.119075	82.726527	06-12-2024	10:43 AM	102.6	419.4
26	24.119075	82.726527	06-12-2024	10:46 AM	99.3	409.5
27	24.119075	82.726527	06-12-2024	10:47 AM	96.5	403
28	24.119075	82.726527	06-12-2024	10:49 AM	60.5	261.3
29	24.119075	82.726527	06-12-2024	10:51 AM	63.5	344.1
30	24.119075	82.726527	06-12-2024	04:10 PM	64.1	217.5
31	24.119075	82.726527	06-12-2024	04:12 PM	60.3	528.4
32	24.119075	82.726527	06-12-2024	04:15 PM	55.9	558.9
33	24.119075	82.726527	06-12-2024	04:16 PM	70	1025.6
34	24.119075	82.726527	06-12-2024	04:20 PM	54.6	444
35	24.119075	82.726527	06-12-2024	04:25 PM	79.3	567.2
36	24.119075	82.726527	07-12-2024	11:41 AM	107.5	434.5

37	24.119075	82.726527	07-12-2024	11:44 AM	124.6	550.8
38	24.119075	82.726527	07-12-2024	11:49 AM	127.9	547.3
39	24.119075	82.726527	07-12-2024	11:51 AM	125.4	355
40	24.119075	82.726527	07-12-2024	11:53 AM	126	359.9
41	24.119075	82.726527	07-12-2024	11:55 AM	122.3	387.7
42	24.119075	82.726527	07-12-2024	11:57 AM	122.2	299.1
43	24.119075	82.726527	07-12-2024	12:01 PM	121.8	353.4
44	24.119075	82.726527	07-12-2024	12:03 PM	120.6	350.2

Figure 14: Field Photographs of Nawatola Basti. (a) Nawatola Basti as seen from the Proposed Warf Wall. (b-c) The streets of the Nawatola Basti recently washed to remove dust. (d-e) The East Overburden Dump as seen from the roofs of houses of Nawatola Basti. (f) The view of Shaktinagar from the top of the East Overburden Dump. (f-h) Smoke clouds appearing by the evening hours over Nawatola Basti

5.1.3 Average Concentrations of Pollutants in Winds blowing to Nawatola Basti

The analysis of wind-based average concentrations of air pollutants at Nawatola Basti reveals that the East-Northeast (ENE), East (E), and East-Southeast (ESE) directions dominate wind patterns (see **Table 14**). The high-frequency wind directions are critical in influencing pollutant dispersion and concentration in the area.

Table 14: Wind-Based Average Concentration of Air Pollutants at NB P1

Wind Direction	% Frequency	Avg. $PM_{2.5}$	Avg. PM_{10}	Avg. SO_2	Avg. NO_2	Avg. CO
NE	12.20	71.00	124.74	76.75	64.01	0.89
ENE	30.49	76.79	121.52	77.93	66.55	0.84
E	20.73	67.95	126.05	78.01	66.63	0.79
ESE	21.95	71.30	122.53	78.37	63.94	0.95
SE	3.66	55.61	124.31	81.38	62.52	0.48
SSE	6.10	70.70	123.58	80.45	64.82	0.79
S	1.22	92.54	108.57	58.61	55.80	0.91
SSW	1.22	79.16	132.32	76.31	64.62	0.83
SW	1.22	81.28	108.20	58.61	55.80	0.86
W	1.22	78.33	127.64	84.81	64.62	0.82

Focusing on particulate matter concentrations, the ENE wind direction records 76.79 $\mu g/m^3$ for $PM_{2.5}$ and 121.52 $\mu g/m^3$ for PM_{10}, while the NE shows slightly lower levels of $PM_{2.5}$ at 67.95 $\mu g/m^3$ and a slightly higher PM_{10} concentration of 126.05 $\mu g/m^3$. Although the SSW wind reports the highest $PM_{2.5}$ level at 132.32 μg/m^3, its impact is limited due to its minimal frequency (1.22%). In terms of gaseous pollutants, the SE wind direction shows a slightly higher average concentration of SO_2 at 81.38 μg/m^3. All the other directions have gaseous pollutants under the permissible limit.

5.1.4 Pollutant Concentrations in Khadia Colony

The $PM_{2.5}$ & PM_{10} concentrations at KC P1 varied between 41.31 to 109.01 μg/m^3 and 42.45 to 175 μg/m^3, respectively as can be seen in **Table 15**. The mean concentration observed for $PM_{2.5}$ was 68.69 μg/m^3, while for PM_{10} it was 103.56 μg/m^3. The mean TSP was 371.12 μg/m^3. On comparing the observed averages of $PM_{2.5}$ & PM_{10} between Khadia Colony with that of Nawatola Basti (70.62 μg/m^3 and 122.98 μg/m^3, respectively), it was observed that the pollutant levels at KC P1 were lower than those at Nawatola Basti. This might be because of its farther distance from the core zone of the Khadia project and processing units in particular.

Table 15: Concentration of Air Pollutants at Khadia Colony (KC P1)

S.No.	Date	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)	TSP (μg/m^3)
1	19-10-2024	63.23	99.37	301.89
2	20-10-2024	83.91	115.37	386.72
3	21-10-2024	72.34	87.68	427.37
4	22-10-2024	78.23	114.32	528.56
5	23-10-2024	59.37	175.00	480.43
6	24-10-2024	41.31	134.05	355.07
7	26-10-2024	49.82	113.57	309.16
8	28-10-2024	58.32	93.10	263.24
9	05-11-2024	80.49	123.18	245.99
10	07-11-2024	66.88	105.79	250.89
11	09-11-2024	53.27	88.41	255.79
12	10-11-2024	69.69	89.33	262.49
13	12-11-2024	86.10	90.26	269.19
14	13-11-2024	91.77	91.18	289.34
15	14-11-2024	97.45	92.10	309.48
16	19-11-2024	99.39	72.87	342.53
17	27-11-2024	48.57	53.65	485.74
18	02-12-2024	59.32	45.05	555.92
19	03-12-2024	60.01	79.10	498.57
20	04-12-2024	81.23	113.15	441.22
21	18-12-2024	98.34	153.79	384.70
22	23-12-2024	109.01	164.28	375.05
23	24-12-2024	92.46	148.93	375.25
24	25-12-2024	87.24	133.57	375.45
25	27-12-2024	89.55	121.68	373.51

26	30-12-2024	91.86	109.78	371.58
27	31-12-2024	97.75	99.81	396.40
28	01-01-2025	103.63	89.84	421.23
29	03-01-2025	97.98	66.15	407.40
30	06-01-2025	92.32	42.45	393.58
Prescribed Standard (NAAQS, 2009)		60	100	-
Minimum Observation		41.31	42.45	245.99
Maximum Observation		109.01	175.00	555.92
98th Percentile		105.89	168.78	540.04
Mean		78.69	103.56	371.12
Median		82.57	99.59	375.15
Std. Deviation		18.7936	32.41	85.34

5.1.5 Heavy Metal Concentrations in Air at Nawatola Basti

The heavy metal analysis of air at NB P1 and NB P2, shown in **Table 16**, revealed a similar trend that was observed in particulate matter concentrations at these points which is NB P1 having a higher total ($PM_{2.5} + PM_{10}$) concentration of the heavy metals (THM) (13.46 µg/m^3) than that at NB P2 (11.08 µg/m^3). However, the percentage of heavy metal concentrations (% HM) within the $PM_{2.5}$ & PM_{10} fractions are higher in NB P2 than in NB P1. This discrepancy arises because the overall mass of collected particulate matter on the filter paper was relatively lower at NB P2 as compared to NB P1, leading to a higher proportion of heavy metals.

Table 16: Observed Heavy Metal Concentrations in Air at Nawatola Basti

S.No.	Heavy Metal (µg/m^3)	Date: 23-10-2024					
		NB P1			NB P2		
		$PM_{2.5}$	PM_{10}	$PM_{2.5}$ + PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$ + PM_{10}
1	Cr	0.57	0.48	1.05	0.52	0.51	1.03
2	Mn	0.07	0.23	0.30	0.09	0.23	0.32
3	Fe	2.51	8.41	10.92	2.05	6.28	8.33
4	Ni	0.29	0.23	0.52	0.29	0.25	0.54
5	Cu	0.03	0.05	0.08	0.04	0.04	0.08
6	Zn	0.18	0.13	0.31	0.38	0.14	0.52
7	As	0.004	0.006	0.01	0.005	0.007	0.01
8	Cd	0.002	0.02	0.02	0.002	0.02	0.02
9	Pb	0.05	0.19	0.24	0.04	0.19	0.23
THM		3.71	9.75	13.46	3.42	7.67	11.08
$W_{2.5/10}$ (µg)		1929	6158	8087	226	2827	3053
% HM		0.20	0.16	0.17	1.51	0.27	0.37

Upon observing % HM in $PM_{2.5}$ & PM_{10} at both the monitoring locations, one can observe that higher % HM is in $PM_{2.5}$ than in PM_{10}. This implies that despite PM_{10} contributing a larger mass fraction of total particulate matter, the more toxic and hazardous heavy metals are concentrated in the finer fraction i.e., $PM_{2.5}$. The trend of occurrence of heavy metals in ambient air at NV P1 and NV P2 is as follows: Fe > Cr > Ni > Zn > Mn > Pb > Cu > Cd > As. Among the analyzed metals, iron and chromium are the most abundant heavy metals at both monitoring locations.

The CPCB (NAAQS, 2009) has established standards for Pb, Ni, and As but not for other heavy metals. Among these, only Pb has a 24-hour time-weighted average standard of 1 $\mu g/m^3$, which suggests that the concentration of Pb is below the permissible limit.

5.2 Water Quality Scenario of the Study Area

5.2.1 Physio-chemical parameter analysis of Water Samples

To gain a understanding of water quality in the study area, parameters such as pH, electrical conductivity, total dissolved solids, dissolved oxygen, and temperature were measured in the field using a EUTECH Instrument Portable Water Meter. The properties of the surface waters and groundwater sources are mentioned in **Table 17** and **Table 18**. These observations are compared to the Bureau of Indian Standards (BIS), IS 2296:1992 - Tolerance Limit for Inland Surface Waters, Class – C for surface waters and IS 10500:2012 for groundwater.

Table 17: Physio-chemical Properties and Heavy Metal Analysis of Surface Waters observed near the East Dump

S.No.	Parameter	Sample Code							IS 2296:1992
		SW1	SW2	SW3	SW4	SW5	SW6	SW7	
1	pH	7.28	7.51	7.09	6.78	6.89	6.18	7.01	6.5 to 8.5
2	Temp. (°C)	28.3	29.4	29.92	29.5	29.3	29.7	29.9	NS
3	Cond. (µS)	1.28	267.2	316.5	303	542.5	629.2	684.8	NS
4	TDS (ppm)	762	283.2	208.3	224	271.3	314.6	342.3	≤ 1500
5	DO (mg/l)	6.29	6.18	6.01	6.47	6.06	6.15	6.12	≥ 4
6	TSS (mg/l)	80	60	50	120	80	85	105	NS
7	Na (PPM)	58.02	1.7	3.04	29.53	6.46	8.33	82.85	NS
8	Mg (PPM)	34.37	1.76	1.37	3.4	6.86	6.11	21.68	NS
9	K (PPM)	8.6	3.22	6.35	1.33	2.17	2.31	10.69	NS
10	Ca (PPM)	15.13	2.22	2.12	3.05	5.2	4.96	8.22	NS
11	Cr (PPM)	BQL	BQL	0.01	0.02	0.02	0.01	BQL	≤ 0.05
12	Mn (PPM)	BQL	BQL	0.01	BQL	BQL	BQL	BQL	≤ 0.5

13	Fe (PPM)	0.02	0.04	0.09	0.1	0.08	0.07	0.07	≤ 0.5
14	Ni (PPM)	BQL	BQL	0.01	0.01	BQL	BQL	BQL	NS
15	Cu (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 1.5
16	Zn (PPM)	0.34	0.21	0.52	0.24	0.2	0.26	0.19	≤ 15
17	As (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 0.2
18	Cd (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 0.01
19	Pb (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	BQL	≤ 0.1

NS = Not Specified; BQL = Below Quantifiable Limit

Table 18: Physio-chemical Properties and Heavy Metal Analysis of Groundwater Sources observed in Nawatola Basti near the East Dump

S.No.	Parameter	Sample Code						IS 10500:2012	
		GW1	GW2	GW3	GW4	GW5	GW6	AL	PL
1	pH	7.08	6.85	6.67	6.92	6.78	7.02	6.5 to 8.5	NR
2	Temp. (°C)	27.2	29.2	28.7	27.6	26.3	26.9	NS	NS
3	Cond. (µS)	758	676	692	630	711.5	658	NS	NS
4	TDS (ppm)	618.4	576.6	563	623	695	742	500	2000
5	DO (mg/l)	6.09	5.99	5.82	5.70	5.85	5.78	NS	NS
6	TSS (mg/l)	18	25	34	25	32	28	NS	NS
7	Na (PPM)	149.5	86.62	92.54	102.44	101.33	98.7	NS	NS
8	Mg (PPM)	26.01	15.44	18.45	29.48	28.91	23.46	30	100
9	K (PPM)	2.85	0.88	1.45	0.5	0.39	0.96	NS	NS
10	Ca (PPM)	18.33	9.99	11.24	12.39	11.33	13.25	75	200
11	Cr (PPM)	BQL	0.03	0.01	BQL	BQL	0.04	0.05	NR
12	Mn (PPM)	0.06	0.06	0.08	0.01	BQL	0.09	0.1	0.3
13	Fe (PPM)	BQL	0.17	0.22	BQL	BQL	0.27	0.3	NR
14	Ni (PPM)	BQL	0.02	BQL	BQL	BQL	BQL	0.02	NS
15	Cu (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.05	1.5
16	Zn (PPM)	0.37	0.2	0.57	0.44	0.25	0.62	5	15
17	As (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.01	0.05
18	Cd (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.003	NR
19	Pb (PPM)	BQL	BQL	BQL	BQL	BQL	BQL	0.01	NR

NS = Not Specified; NR = No Relaxation

5.2.2 XRF Analysis of Overburden Samples

The chemical composition of samples from the top, middle and toe were determined by a Handheld XRF analyser (Bruker) and is tabulated in **Table 19**. The sample from the top section at the East dump is characterized by higher alumina (Al_2O_3) content and relatively low iron (Fe) concentrations, indicating the dominance of clayey materials with minimal weathering compared to the lower dumps. In contrast, the sample from the middle section shows an increased presence of iron and calcium, suggesting the accumulation of iron-rich materials, possibly due to the weathering of overlying layers and leaching processes. The toe section, on the other hand, exhibits higher concentrations of silica (SiO_2) and potassium oxide (K_2O), pointing to the concentration of lighter silicate minerals that have been transported and deposited downstream. These variations in chemical content across the sections reflect differences in weathering, leaching, and transport processes within the overburden material.

Table 19: XRF Analysis of East Dump Samples

Element/Oxide	**Percentage of Elements and Oxides from the East Dump**		
	Top Section	**Middle Section**	**Toe Section**
MgO	<LOD	<LOD	<LOD
Al_2O_3	20.68	14.78	15.96
SiO_2	44.67	49.53	55.59
P	<LOD	<LOD	<LOD
S	0.05	<LOD	<LOD
K_2O	1.46	0.79	1.67
Ca	0.05	0.38	0.08
Ti	0.36	0.53	0.47
Cr	0.01	0.02	0.01
Mn	0.01	0.03	0.03
Fe	0.32	2.21	1.51
Co	<LOD	<LOD	<LOD
Ni	0.00	0.01	0.00
Cu	0.00	0.00	0.00
Zn	0.00	0.00	0.00
Ga	0.00	0.00	0.00
As	<LOD	<LOD	0.00
Rb	0.01	0.00	0.01
Sr	0.01	0.00	0.00
Y	0.00	0.00	0.00
Zr	0.02	0.05	0.04
Nb	0.00	0.00	0.00
Pd	<LOD	<LOD	<LOD
Cd	<LOD	<LOD	<LOD
Ba	0.05	0.03	0.05
La	0.01	<LOD	<LOD
Ta	<LOD	<LOD	<LOD
Pb	0.00	0.00	0.00
Th	<LOD	0.00	0.00
U	0.00	<LOD	<LOD

LOD = Limit of Detection

5.2.3 Analysis of Leachate Experiments

Before conducting leachate experiments, the textural analysis of the overburden samples was done based on gravimetric and sedimentation techniques. It was found that while the percentages of gravel and sand was more or less constant across the samples from the top, middle and toe of the East dump, the percentages of silt and clay progressively increased from top to toe, possibly by surface runoff.

Experiment 1: Combined Sample Analysis

To prepare this setup, a sample-to-water volume ratio of 1:5 was adopted. The combined thickness of the top, middle and toe samples was 4 cm. Hence, the volume of the sample was 1444 cm^3. By the ratio, the amount of water was deduced to be 7.22 litres. The experimental observations are tabulated in **Table 20**.

The leaching experiment conducted on the combined overburden material from the East dump provided valuable insights into the behaviour of various parameters over time. The pH of the leachate increased gradually over time, starting from 7.31 and reaching 8.11 the next day, indicating the neutral to slightly alkaline nature of the leachate.

Table 20: Leachate Analysis from Combined Sample

Parameters	**Tap Water**	**Time of Observation (minutes)**					
		10	**20**	**40**	**80**	**160**	**Final***
pH	7.10	7.31	7.64	7.77	8.04	8.22	8.11
Temperature (°C)	25.3	24.6	26.2	26.4	26.1	26.4	27.6
Conductivity (µS)	1045	5223	3345	2004	1394	1147	1084
TDS (ppm)	521	2028	1658	1038	697	573.2	541.1
NaCl (ppm)	514.2	2005	1552	1021	700.2	537.8	536.5
Resistivity (Ω)	968.5	587	608	699.3	775.5	872.4	923.5
D.O (mg/l)	5.71	8.48	7.82	7.81	5.94	5.8	5.74
Water leached (ml)	-	250	450	750	1300	2350	1500

Final*: Cumulative leachate after 24 hours from the start of the experiment

In conductivity, a sharp increase was observed initially (1045 µS in tap water to 5223 µS at 10 minutes), followed by a steady decline, reaching 1084 µS the next day. This trend suggests the rapid leaching of soluble ions initially, which decreased over time as the material became depleted of easily dissolvable salts. Similarly to conductivity, Total Dissolved Solids (TDS) rose significantly at the start (521 ppm to 2028 ppm at 10 minutes) and then declined steadily to 541.1 ppm the next day. This trend confirms the release of soluble solids during the initial stages of leaching.

The concentration of NaCl increased sharply from 514.2 ppm to 2005 ppm at 10 minutes and gradually reduced to 536.5 ppm the next day. This indicates that sodium chloride was a major contributor to the soluble salts in the overburden material. Resistivity increased over time, starting at 587 Ω and reaching 923.5 Ω the next day. This inverse relationship with conductivity highlights the diminishing presence of ions in the leachate as leaching progressed. The Dissolved Oxygen (DO) levels initially increased to 8.48 mg/L at 10 minutes, then decreased steadily, dropping to 5.74 mg/L the next day. This may reflect oxygen consumption due to chemical reactions within the overburden material. The cumulative water leached increased over time, from 250 ml at 10 minutes to 2350 ml at 160 minutes, with an additional 1500 ml the next day.

Experiment 2: Section-specific Leachate Analysis

In this experiment, 4 cm of overburden material from each section i.e., top, middle and toe were placed in three separate middle boxes. The same sample-to-water volume ratio of 1:5 was adopted. Hence, the volume of samples in each box was 1444 cm^3. By the ratio, the amount of water to be used in the experiment was deduced to be 7.22 litres. The experimental observations are tabulated in **Table 21**.

The leaching experiment conducted on the overburden sample from the top reveal significant insights into the behaviour of various parameters over time. Initially, the pH decreased from 7.27 (neutral) to 6.24 (acidic) within the first 10 minutes, indicating the dissolution of acidic compounds. Subsequently, the pH gradually increased to 7.95 (slightly alkaline) by the next day, suggesting the buffering action of minerals and the dilution of acidic compounds as water percolated through the material. Conductivity and TDS followed a similar trend, peaking at 5554 µS and 2781 ppm, respectively, within 10 minutes, highlighting the rapid dissolution of salts and minerals during the initial phase. These values then steadily declined to 1015 µS and 511.9 ppm by the next day, reflecting the exhaustion of easily soluble ions over time. The DO levels decreased, likely due to oxygen consumption during the oxidation of minerals. NaCl concentrations were notably high at the start, peaking at 3151 ppm at 10 minutes and then stabilizing at lower levels, indicating the dominance of soluble salts in early leaching. Resistivity, inversely related to conductivity, was lowest at 132.6 Ω at 10 minutes but increased as the ion concentration decreased.

The leaching experiment on the dump material from the middle section revealed that the pH value rose from 7.81 to 8.15 at 160 minutes, indicating alkaline mineral dissolution, and was

Table 21: Leachate Analysis of Section-Specific Sample

Parameters	Initial (Tap water)	Leachate from the top section						Leachate from the middle section						Leachate from the toe section				
		Time of Observation (minutes)																
		10	20	40	80	160	Final*	10	20	40	80	160	Final*	10	20	40	80	Final*
pH	7.27	6.24	6.96	7.76	7.80	7.82	7.95	7.81	8.03	8.15	8.20	8.15	8.01	7.42	7.53	7.58	7.68	7.54
Temp. (°C)	24.6	23.9	24.1	24.3	24.1	22.6	24.8	23.3	23.1	22.8	22.4	22.6	23.7	21.5	22.1	22.1	22.2	22.4
Conductivity (μS)	990.8	5554	2008	1091	1076	1054	1015	6096	3946	2234	1055	1024	985.8	1670	1125	1069	1049	968.5
TDS (ppm)	495.1	2781	1005	544.3	538.1	527	511.9	3052	1972	1117	526	512	501.9	832.4	562.3	535	525	518.5
NaCl (ppm)	488.2	3151	1952	538.6	535.2	520.5	522.5	3519	2080	1158	521.4	520.5	492.5	852.2	557	529.1	519	512.3
Resistivity (Ω)	918	132.6	498	918.6	933	948.8	953.5	123.2	253.3	447.6	501.2	974.6	996.2	601.5	889.1	934.3	951.7	945
Dissolved Oxygen (mg/l)	7.79	6.58	6.22	6.97	6.88	6.70	6.08	7.99	7.96	7.93	7.82	7.17	6.57	5.77	5.32	5.69	5.76	5.82
Water leached (ml)	-	230	500	1300	1900	2500	250	140	290	480	800	1300	3470	450	850	1800	3300	650

Final*: Cumulative leachate after 24 hours from the start of the experiment stabilized at 8.01 by the next day. Conductivity peaked at 6096 µS in 10 minutes, reflecting rapid salt dissolution, then dropped to 985.8 µS by the next day. Similarly, TDS and NaCl peaked at 3052 ppm and 3519 ppm, respectively, before stabilizing. Resistivity was lowest at 123.2 Ω at 10 minutes and increased to 996.2 Ω as ion concentrations reduced. Dissolved oxygen initially peaked at 7.99 mg/L at 10 minutes but dropped to 6.57 mg/L by the next day, likely due to oxidation reaction.

In the dump sample from the toe section, the leaching analysis revealed that the pH value rose from 7.42 to 7.68 at 80 minutes before stabilizing at 7.54 by the next day, indicating mild alkalinity due to leaching materials. Conductivity peaked at 1670 µS after 10 minutes, reflecting the rapid dissolution of soluble ions, then gradually decreased to 968.5 µS by the next day. Correspondingly, the Total Dissolved Solids (TDS) and NaCl concentrations showed an initial rise to 832.4 ppm and 852.2 ppm, respectively, at 10 minutes, before declining to 518.5 ppm and 512.3 ppm by the next day. Resistivity, inversely proportional to conductivity, showed the lowest value of 601.5 Ω at 10 minutes but increased to 945 Ω as the ion concentrations reduced. Dissolved Oxygen (DO) levels dropped initially from 5.77 mg/L to 5.82 mg/L by the next day, indicating reactive oxygen consumption.

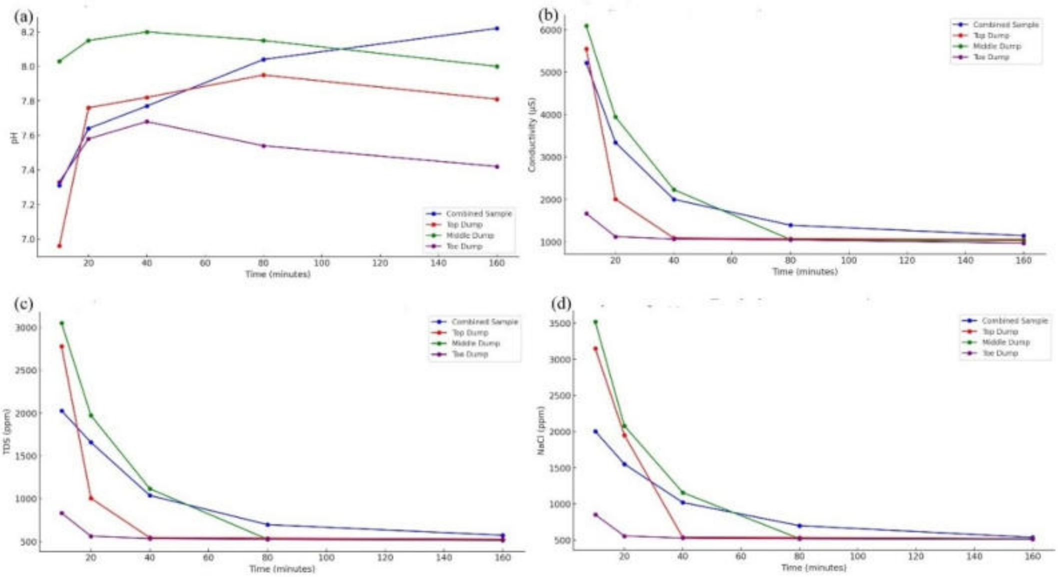


Figure 15: Graphical representation of the Temporal Variation of Physicochemical Properties of Leachates from the Combined and Section-specific samples from East Dump. (a) Variation of Ph with time. (b) Variation of conductivity with time. (c) Variation of TDS with time. (d) Variation of NaCl with time.

The observed data of the leaching experiments are illustrated in **Figure 15**. The pH is lower initially, reflecting the acidic nature of fresh leachate as shown in **Figure 15a**. Over time, pH stabilizes toward neutrality or slight alkalinity, suggesting buffering reactions. The parameters (conductivity, TDS, and NaCl) are high initially, indicating a rapid release of soluble materials due to water interacting with the dump material as shown in **Figure 15b-d**.

Over time, Conductivity, TDS, and NaCl decline steadily, indicating a depletion of easily soluble ions. The middle dump consistently shows the highest conductivity, TDS, and NaCl values, likely due to higher salt content. The toe dump shows the lowest values, possibly due to dilution or less reactive material. Long-term stabilization suggests reduced environmental impact after the initial phase.

Chapter 6: Evaluation of the Effectiveness of Control Measures to Control Air and Water Pollution from the East Dump

6.1 Evaluation of Air Pollution Control Measures

The air pollution study of the Nawatola Basti revealed that, in general, the $PM_{2.5}$ concentrations are 1.1 times higher than the permissible standard of 60 $\mu g/m^3$, while PM_{10} concentrations are 1.22 times higher than the standard of 100 $\mu g/m^3$. From field visits and monitoring of instantaneous concentrations of particulate matter (see **Table 13**), it was observed that higher concentrations are generally prevalent during the late afternoon and evening hours, likely due to coal burning for cooking activities.

Table 22: Summary of Air Quality Parameter ($PM_{2.5}$)

<table>
<tr><th colspan="2" rowspan="2">Category</th><th colspan="6">(%) PM_{2.5} Values</th></tr>
<tr><th colspan="2">At NB P1</th><th colspan="2">At NB P2</th><th colspan="2">At KC P1</th></tr>
<tr><td colspan="2">Below 60</td><td colspan="2">30.49</td><td colspan="2">35.37</td><td colspan="2">36.67</td></tr>
<tr><td>60-100</td><td rowspan="2">Above 60</td><td>60.98</td><td rowspan="2">69.51</td><td>57.32</td><td rowspan="2">64.63</td><td>63.33</td><td rowspan="2">63.33</td></tr>
<tr><td>Above 100</td><td>8.54</td><td>7.32</td><td>0.00</td></tr>
</table>

Table 23: Summary of Air Quality Parameter (PM_{10})

<table>
<tr><th colspan="2" rowspan="2">Category</th><th colspan="6">(%) PM₁₀ Values</th></tr>
<tr><th colspan="2">At NB P1</th><th colspan="2">At NB P2</th><th colspan="2">At KC P1</th></tr>
<tr><td colspan="2">Below 100</td><td colspan="2">6.10</td><td colspan="2">15.85</td><td colspan="2">53.33</td></tr>
<tr><td>100-150</td><td rowspan="2">Above 100</td><td>82.93</td><td rowspan="2">93.90</td><td>71.95</td><td rowspan="2">84.15</td><td>36.67</td><td rowspan="2">46.67</td></tr>
<tr><td>Above 150</td><td>10.98</td><td>12.20</td><td>10.00</td></tr>
</table>

The percentage distribution, shown in **Table 22** and **23**, reveal that at NB P1, 30.49% of $PM_{2.5}$ values are below 60 $\mu g/m^3$, 6.98% lie in the range of 60-100 $\mu g/m^3$, and 8.54% fall above 100 $\mu g/m^3$. For PM_{10}, 6.10% of the values are below 100 $\mu g/m^3$, 82.93% in the range of 100-150 $\mu g/m^3$, and 10.98% above 150 $\mu g/m^3$. At NB P2, 35.37% of the $PM_{2.5}$ values are below 60 $\mu g/m^3$, 57.32% between 60-100 $\mu g/m^3$, and 7.32% above 100 $\mu g/m^3$. For PM_{10}, 15.85% of the values are below 100 $\mu g/m^3$, 71.95% fall within the range of 100-200 $\mu g/m^3$ and 12.20% values are above 150 $\mu g/m^3$ respectively. KC P1 being much farther from the core zone and much vegetated has 36.67% $PM_{2.5}$ values below 60 and 53.33% PM_{10} values below 100.

The NAQI of the study area is calculated based on the maximum value of the sub-index which is calculated for each pollutant by the linear interpolation between the breakpoint concentration values of pollutants. The calculated sub-indices are mentioned in **Table 24**.

Since, $PM_{2.5}$ has the maximum sub-index, 133.84 is considered as the NAQI for Nawatola Basti. This value comes in the “Moderately Polluted” category.

Table 24: Sub-Indices of Air Pollutants at Nawatola Basti for Calculating NAQI

Air Pollutant	I_p
$PM_{2.5}$	133.84
PM_{10}	115.60
SO_2	97.20
NO_2	81.30
CO	29

It is important to note here that these observations only express the prevalent air quality of the region which is subject to a host of sources of all types in all directions. However, in order to solely observe the contribution of the East overburden dump in degrading the air quality of the Nawatola Basti, the wind-based average concentrations of air pollutants, shown in **Table 14**, and the Wind Rose Plot of the entire monitoring period illustrated on a Satellite Image, shown in **Figure 12**, should be taken into account.

The only winds that blow, in a high-frequency, over or close to the East dump towards Nawatola Basti, are the NE winds (12.20%). The dump with a maximum elevation of ~ 200m from the ground appears to guard most of the winds coming from North. The NE winds should bring pollutants from the dump but also from the adjoining coal mines. The average concentration of $PM_{2.5}$ & PM_{10} in the NE winds are 71 $\mu g/m^3$ and 124.74 $\mu g/m^3$ respectively. Regarding gaseous pollutants, all concentrations are below their respective permissible limits.

To calculate the pollution load of $PM_{2.5}$ & PM_{10} from the East dump generated via wind erosion, the following formula is used:

$$Pollution\ Load\ (kg/hr) = Emission\ Factor\ (kg/ha/hr)\ \times Area\ (ha)$$

The emission factor of $PM_{2.5}$ & PM_{10} from the wind erosion from overburden dump as mentioned in the EMP sourced from the United States Environmental Protection Agency (USEPA) is 0.008 and 0.09 kg/ha/hr respectively. The total area of the East Dump, as of 2022, is 206.44 hectares. This figure is derived by combining the internal and external dumping areas, as mentioned in the case report of Mukesh Singh v. State of Uttar Pradesh (O.A. No. 580/2022). By substituting these values into the above formula, the calculated pollution load is 1.65 kg/hr for $PM_{2.5}$ and 18.58 kg/hr for PM_{10}. It is important to note that this is a simplified estimate assuming constant erosion under the conditions embedded in the emission factor as it does not account for wind speed variability, soil moisture, surface roughness etc.

Efforts have been undertaken for the biological reclamation of the East Dump, covering all individual slopes of the dump decks. These areas have been developed despite challenges posed by the erosion of fertile substrates during periods of heavy precipitation. To counteract this, stabilization measures and soil enrichment techniques have been employed to enhance plant survival and growth. Plantations in this area is relatively recent, and its full development is expected to take approximately 2 to 3 years.

The evaluation of the air pollution control measures indicates that while efforts have been made to mitigate the impact of the East overburden dump, challenges remain in effectively addressing particulate matter levels in Nawatola Basti. These findings suggest the need for more comprehensive and adaptive strategies.

6.2 Evaluation of Water Pollution Control Measures

In order to evaluate the effectiveness of water pollution control measures, the physicochemical characterization and heavy metal analysis of surface- and groundwater sources near the East dump was observed. For surface water (see **Table 17**), it was observed that the pH levels across the locations range from 6.18 to 7.51, indicating slightly acidic to neutral conditions, all within the permissible range of 6.5 to 8.5. Conductivity values range significantly, from 1.28 µS (SW1) to 684.8 µS (SW7), reflecting varying levels of ionic content in the water. The TDS concentrations, which indicate dissolved solids in the water, remain below the permissible limit of 1500 ppm, ranging from 208.3 ppm (SW3) to 762 ppm (SW1). Dissolved oxygen (DO), a critical parameter for aquatic life, varies from 6.01 mg/L (SW3) to 6.47 mg/L (SW4), meeting the minimum requirement of 4 mg/L.

For groundwater sources (see **Table 18**), the pH values across the groundwater sources range from 6.67 (GW3) to 7.08 (GW1), falling within the acceptable range of 6.5 to 8.5, indicating neutral to slightly acidic conditions. Total dissolved solids (TDS) concentrations range from 563 ppm (GW3) to 742 ppm (GW6), remaining below the permissible limit of 2000 ppm but exceeding the acceptable limit of 500 ppm, suggesting moderate mineral content.

Concentrations of heavy metals such as chromium (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), cadmium (Cd), and lead (Pb) in both surface- and groundwater sources are either below the permissible limit or below quantifiable limits, indicating minimal heavy metal pollution.

The Water Quality Index (WQI) results for surface water samples SW1 to SW7 and groundwater samples GW1 to GW6 were calculated using the Canadian Council of Ministers of the Environment (CCME) Method as shown in **Table 25**.

Table 25: WQI of Surface water and Groundwater Sources near the East Dump.

Sample	F1	F2	F3	WQI
SW1	10	5.26	36.41	83.99
SW2	10	5.26	35.28	88.61
SW3	10	5.26	33.44	81.62
SW4	10	5.26	38.18	87.01
SW5	10	5.26	33.99	80.32
SW6	20	10.53	22.68	83.85
SW7	10	5.26	34.64	80.42
GW1	9	5.26	19.15	87.39
GW2	9	5.26	13.28	90.22
GW3	9	5.26	11.19	91.14
GW4	9	5.26	19.74	87.09
GW5	9	5.26	28.06	82.70
GW6	9	5.26	32.61	80.22

All surface water samples fall within the “Good” category, with WQI values ranging from 80.32 (SW5) to 88.61 (SW2). Groundwater samples also fall within the “Good” category, with WQI values ranging from 82.70 (GW5) to 91.14 (GW3). The good category implies that the water quality is protected with only a minor degree of threat or impairment.

In addition to estimating the physicochemical characteristics, field visits were made along the foot of the East dump and around the siltation ponds. It was observed that the RCC Catch Drain and Retaining Wall has been constructed along the toe of the dump. However, a small portion towards the east side of the dump is damaged and may be repaired. This has resulted in water spilling over surrounding areas, causing gully erosion and the formation of several unplanned ponds. The embankments of the siltation ponds were vegetated and stabilized.

Chapter 7: Summary and Conclusion

7.1 Summary

This study provides a comprehensive assessment of the effectiveness of measures taken by Khadia Project to control the air and water pollution from the East dump and pollution control/mitigative measures to minimize pollution load. It focuses on air and water pollution in the surrounding settlements, with particular emphasis on Nawatola Basti.

Air pollution control measures include mobile water sprinklers on haul roads, fog cannons, and a dust extraction system in the CHP. Coal is primarily transported via rail to reduce dust emissions, while vehicles carrying coal are covered with tarpaulins. Fixed sprinklers and automatic water sprinklers are installed at the coal yard and CHP receiving pit. Roads are metaled or blacktopped to minimize dust, and drilling equipment is fitted with dust extractors. A Rapid Loading System of 4 MTPA is under construction to increase coal transport via rail and would further improve air quality. A wheel washing facility is also under development and will be commissioned by February 2025. A Continuous Ambient Air Quality Monitoring Station track pollutants like SPM, SO_2, and NO_2, with real-time data sent to CPCB. Vegetative covers have been established on the dump, with approximately 39.81 ha planted as of 2022-23.

Water pollution control measures include a retaining wall, catch drains, and garland drains to manage surface runoff. Water is treated in a 38.4 MLD Effluent Treatment Plant and reused for dust suppression, road watering, and greenbelt development. Domestic wastewater is processed in a 1.5 MLD Sewage Treatment Plant for horticulture. Silt-settling ponds prevent runoff contamination, and mine/rainwater is collected for groundwater recharge and mining activities. Besides this, retaining wall and drains have been provided to avoid siltation.

To evaluate the effectiveness of air pollution mitigation measures from the east dump, continuous monitoring was conducted at multiple locations. Monitoring stations were installed over the rooftops of houses to measure pollutant concentrations ($PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and heavy metals) alongside meteorological parameters.

The air pollution study revealed that the mean $PM_{2.5}$ and PM_{10} concentrations observed in Nawatola Basti were 70.62 µg/m^3 and 122.98 µg/m^3 respectively.

Upon comparing the average concentrations of $PM_{2.5}$ and PM_{10} across the monitoring locations, it was observed that NB P1 and NB P2, located near the core zone of an opencast coal mine, have higher $PM_{2.5}$ and PM_{10} concentrations than KC P1, which is farther and has more vegetation. NB P1 records the highest pollution levels ($PM_{2.5}$: 72.19 µg/m^3, PM_{10}: 125.63

μg/m^3), followed by NB P2 ($PM_{2.5}$: 69.06 μg/m^3, PM_{10}: 120.33 μg/m^3), while KC P1 has lower values ($PM_{2.5}$: 68.69 μg/m^3, PM_{10}: 103.56 μg/m^3).

The heavy metal analysis at NB P1 and NB P2 follows the trend observed in particulate matter concentrations, with NB P1 having a higher total i.e., $PM_{2.5}$- and PM_{10}- bounded heavy metal concentration (THM: 13.46 μg/m^3) than NB P2 (11.08 μg/m^3). However, the percentage of heavy metals (% HM) within $PM_{2.5}$ and PM_{10} is higher at NB P2 due to its lower overall particulate matter mass. Notably, heavy metals are more concentrated in $PM_{2.5}$, indicating that the finer fraction carries more toxic and hazardous metals. The predominant metals at both sites are Fe and Cr, followed by Ni, Zn, Mn, Pb, Cu, Cd, and As. Among monitored metals, only Pb has a 24-hour time-weighted average standard and it remains below the permissible limit.

In order to solely observe the contribution of the East overburden dump in degrading the air quality of the Nawatola Basti, the average concentration of pollutants coming from the winds blowing in a high-frequency, over or close to the dump towards the settlement were observed. The only winds that met these criterions were the NE winds with a percentage frequency of 12.20%. The average concentration of $PM_{2.5}$ & PM_{10} in the NE winds are 71 μg/m^3 and 144.74 μg/m^3 respectively. The gaseous pollutants were below their respective permissible limits. Here, it is important to note that this should be seen with the full geographical context of the area. The NE winds coming from the dump are also blowing over other adjoining coal mines. The possibility of the pollution due to other sources like household coal burning, vehicular movement and thermal power plants in vicinity etc., cannot be ruled out.

The NAQI calculation placed the air quality of Nawatola Basti in the “moderately polluted” category. Upon observing wind speed of the region between October to December, 2024, it was observed that calm conditions i.e., wind speed less than 0.5m/s accounted for 71.07% of the total wind data. This indicates a predominantly stagnant atmospheric condition which implies that the pollutants released into the atmosphere are likely to remain concentrated near their sources for extended periods.

For assessing the impact of east dump in terms of quality of water received by the Nawatola Basti, water samples from various locations were collected and analyzed. The study also evaluated the effectiveness of measures taken by the Khadia mine administration to control surface runoff and erosion from the dump.

The physicochemical characteristics and heavy metal concentrations were found to be below the permissible standards. The TDS concentrations for all groundwater samples were below the permissible limit of 2000 ppm but exceeded the acceptable limit of 500 ppm, indicating that the groundwater contains a moderate amount of dissolved minerals. As per the WQI, surface waters near the East dump fall within the “Good” category implying that the water quality is usually protected but occasionally threatened or impaired. The WQI for groundwater sources also lies in the “Good” category.

Field inspections were made along the toe of the East dump to observe the preventive measures taken to minimize erosion and downstream damages from the surface runoff from the East dump. There it was observed that the RCC Catch Drain and Retaining Wall has been constructed along the toe of the East dump. However, a small portion towards the east side of the dump is damaged and may be repaired. This has resulted in water spilling over surrounding areas, causing gully erosion and the formation of several unplanned ponds. The embankments of the siltation ponds were vegetated and stabilized.

Further, recommendations have been proposed to enhance pollution control measures and further reduce the environmental impact of the East dump.

7.2 Conclusion

The key findings of this study regarding the evaluation of the effectiveness of control measures to control air and water pollution from East dump are summarized as follows:

1. Khadia Opencast Project has taken several steps on overburden dump such as grassing, plantation on finalised overburden dump Area through UP Forest Department, Mobile Water Sprinkling on Haul Road, compaction of the overburden dump through HEMMs etc. in order to control pollution due to East Dump.
2. The NAQI of the region places the air quality of Nawatola Basti in the “moderately polluted” category. The role of pollution sources such as Household Coal Burning, near vicinity to highway and thereby vehicular movement, operational thermal power plants in the vicinity, other than Khadia OCP, cannot be ruled out.
3. Heavy metal analysis revealed that heavy metals are more concentrated in $PM_{2.5}$ than in PM_{10}, indicating that the finer fraction carries more toxic metals. The dominant metals are Fe and Cr, followed by Ni, Zn, Mn, Pb, Cu, Cd, and As.

4. To isolate the East overburden dump's impact on the air quality of the Nawatola Basti, pollutant concentrations were analyzed of high-frequency winds blowing over/near the dump towards the settlement. NE winds, meeting these criterions, showed average concentration of $PM_{2.5}$ & PM_{10} as 71 µg/m^3 and 144.74 µg/m^3 respectively.

   Here, it is important to note that this should be seen with the full geographical context of the area. The NE winds coming from the dump are also blowing over other adjoining mines.
5. Wind speed analysis during the study duration showed predominantly calm conditions (<0.5m/s). This stagnant atmospheric condition suggests that pollutants released are likely to remain concentrated near their sources for extended periods.
6. The ongoing works such as Wheel Washing Facility and Construction of Rapid Loading System (04 MTPA) will further improve the air quality of the area.
7. In water pollution study, it was found that the water samples were compliant with permissible standards for physicochemical characteristics and heavy metal concentrations.
8. The water quality of surface waters and groundwaters is placed in the "good" category according to WQI. The good category implies that the water quality is protected with only a minor degree of threat or impairment.
9. The RCC Catch drain and retaining wall have been constructed along the toe of the East dump. However, at the eastern side of the dump, it was observed that a small portion was damaged and requires restoration.

Chapter 8: Recommendations

An environmental protection plan involves designing and implementing a series of preventive and suppressive measures aimed at addressing specific pollutants. These measures are guided by considerations such as the cost of controlling pollution, the societal damage caused by the pollutant, and the feasibility of mitigation strategies. As stricter measures are implemented, the cost of pollution control often rises due to the need for advanced technologies and operational adjustments. Conversely, insufficient control results in significant damages, including adverse health impacts, ecosystem degradation, and economic losses. The key challenge is to identify an equilibrium where the combined costs of control measures and societal damages are minimized. This balance ensures that resources are allocated efficiently, achieving meaningful reductions in harm without imposing excessive financial strain.

8.1 Suggestive control measures for Air pollution

Planting vegetation is one of the most effective and sustainable methods to mitigate air pollution, as plants act as natural air filters by trapping dust particles and absorbing harmful gases. However, the steep slopes of dump decks, often inclined at angles up to 37°, present challenges for vegetation establishment. Fertile substrates applied to these slopes are prone to being washed away by water erosion during precipitation, leaving significant bare areas that contribute to air pollution.

Hydroseeding offers a practical and efficient solution to this problem. By using a mixture of grass seeds, trees, and shrubs combined with mineral fertilizers and nutrient-rich substrates (mulch), hydroseeding accelerates vegetation growth on steep slopes. This approach helps stabilize the substrate, reduces bare areas susceptible to wind erosion, and promotes long-term ecological restoration.

Antonik et al. (2022) recommend including seeds from four plant groups in the hydraulic mixture for slope reclamation: herbaceous grasses, herbaceous legumes, deciduous trees, and shrubs. These plants collectively create a green cover and contribute to the development of humus, enhancing soil fertility and stability. Additionally, Skousen and Clinger (1993) highlighted the benefits of incorporating sewage sludge into the hydroseeding mixture. The sludge is rich in essential nutrients such as phosphorus, nitrogen, and potassium, which further support plant growth. A common challenge in biologically reclaiming dump slopes is plant mortality due to drought, especially during hot months. To address this, the same machinery used for hydroseeding can be repurposed for irrigation and maintenance, ensuring adequate care for vegetation and improving the success rate of reclamation efforts.

Strategic tree planting in concentric patterns around pollution sources and perpendicular to prevailing winds enhances their capacity to trap airborne dust and harmful gases. Incorporating a mix of open and dense planting patterns, along with trees of varying heights, will create a layered canopy that optimizes pollution control by targeting different levels of airborne particles (Ghose and Majee, 2001).

In addition to vegetative measures, controlling dust during transportation and unloading of overburden material is equally important. Enforcing strict speed limits for haul trucks can significantly reduce dust uplift from unpaved roads. Furthermore, regular maintenance of haul trucks is crucial to ensure they are in good condition to minimize exhaust emissions.

8.2 Suggestive control measures for Water pollution

During the field visit, it was observed that a small section of the RCC drain towards the eastern side of the dump was damaged. To mitigate this, the catch drain should be repaired to fully connect with the siltation pond, ensuring proper water flow and minimizing the risk of flooding and erosion during heavy rainfall. Additionally, the catch drain was found to be obstructed by eroded material from the East dump. These obstructions can lead to water retention and spillage. Regular inspections of the drain, particularly before the monsoon season, should be conducted to clear any blockages and address damages.

Retaining walls are critical for stabilizing overburden dumps and controlling runoff. It is recommended to ensure proper maintenance of the retaining wall along the toe of the East dump to provide additional structural support and reduce sediment movement.

ANNEXURE R-6

सीएसआईआर–केंद्रीय खनन एवं ईंधन अनुसंधान संस्थान, धनबाद

CSIR-CENTRAL INSTITUTE OF MINING AND FUEL RESEARCH, DHANBAD

वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद (Council of Scientific & Industrial Research)

एनसीएल की चालू निगाही खदान में तालाब की राख के साथ मिश्रित ओवरबर्डन को डंप करने के लिए व्यवहार्यता अध्ययन

FEASIBILITY STUDY FOR DUMPING OVERBURDEN MIXED WITH POND ASH IN THE RUNNING NIGAHI MINES OF NCL

प्रायोजक /Sponsor: Northern Coalfields Limited

दिसंबर / June 2025

FINALIZED REPORT

परियोजना प्रस्तावकों के हस्ताक्षर / Signature of Project Proponents

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1. BACKGROUND

India's electricity industry has undergone a significant transformation that has altered its prospects. India's need for power is still being driven by sustained economic expansion. The ambitious 'Power for All' initiative has been introduced by the Union government. The programme calls for quickening the expansion of power capacity. According to the Central Electricity Authority data as of May 2023, India has a total installed capacity of 417,448 MW for electricity generation. Out of this total, coal-based thermal power plants (TPPs) account for 205,235 MW, which represents 49.01% of the overall installed capacity.

Indian coal is known for its high ash content and relatively low calorific value. The ash content of Indian coal typically ranges from 30% to 45%. Consequently, coal-based thermal power plants (TPPs) in India generate a significant amount of fly ash compared to TPPs in other countries when producing the same amount of energy. The disposal of this substantial quantity of fly ash poses a challenge as its utilization is relatively low.

Due to the limited utilization of fly ash, a large portion of it is disposed of in ash ponds. This results in the need for a significant land area dedicated to ash disposal, often amounting to about one-third of the space required to construct a TPP. Unfortunately, this disposal approach leads to permanent land degradation and deterioration.

The inefficient use of fly ash not only results in environmental concerns but also contributes to the wastage of a valuable resource that could otherwise be utilized for various beneficial applications. It is important to explore and promote strategies for increased utilization of fly ash to minimize the need for large ash disposal areas and mitigate the environmental impacts associated with coal-based TPPs in India.

India holds the position of being the second-largest coal producer globally. The production of fly ash increased from 85 million metric tons (Mt) in 2000–2001 to 185 Mt in 2014–15 and to 270 Mt in 2021-22. This fly ash in year 2021-22 was produced by burning approximately 759 Mt of coal, with an average ash content of 35.68%. The Installed capacity of TPPs during this period was about 213,620 MW (CEA report, 2021-22). To achieve an economic growth rate of 8% to 9%, India's coal demand is projected to 2000 Mt by 2030-31. Based on estimates, a thermal power plant with a capacity of 1000 MW generates approximately 1.6 Mt to 1.8 Mt of fly ash per year, depending on the ash content of 29% or 40% respectively (Chattopadhyay 2015). With the expected increase in coal production in the upcoming years, the generation of fly ash could reach nearly 600 Mt by 2030 (Krishnan 2013).

Percentage utilization of the ash has increased over the years however the quantity of the unused fly ash is increasing every year because of the increased generation. According to Pandey et al. (2011), India had around 1500 MT (or 65000 hectares) of fly ash that has not been used. With the current pattern of use, the worry over land degradation is escalating. In order to secure greater fly ash usage, more efforts are needed. The fly ash utilization statistics for year 2021-22 is presented in Figure 1.

In India, the management and utilization of fly ash is regulated by the MoEFCC and the Central Pollution Control Board (CPCB). The MoEFCC and CPCB have issued several guidelines and notifications over the years to promote the proper disposal, utilization, and safe handling of fly ash. These guidelines aim to minimize the environmental impact of fly ash and encourage its use in various applications, such as in the construction industry for manufacturing cement, bricks, and other building materials.

However, the practice of disposing of fly ash by mixing it in overburden (OB) dumps in coal mines has not yet gained momentum, even though approximately one-third of the thermal power plants in India are near opencast coal mines (Figure 2). By taking advantage of the strategic placement of thermal power plants and the abundance of fly ash in the vicinity of coal mines, it is possible to economically dispose of fly ash by blending it with OB dumps and utilizing the mixture for constructing haul roads in opencast coal mines.

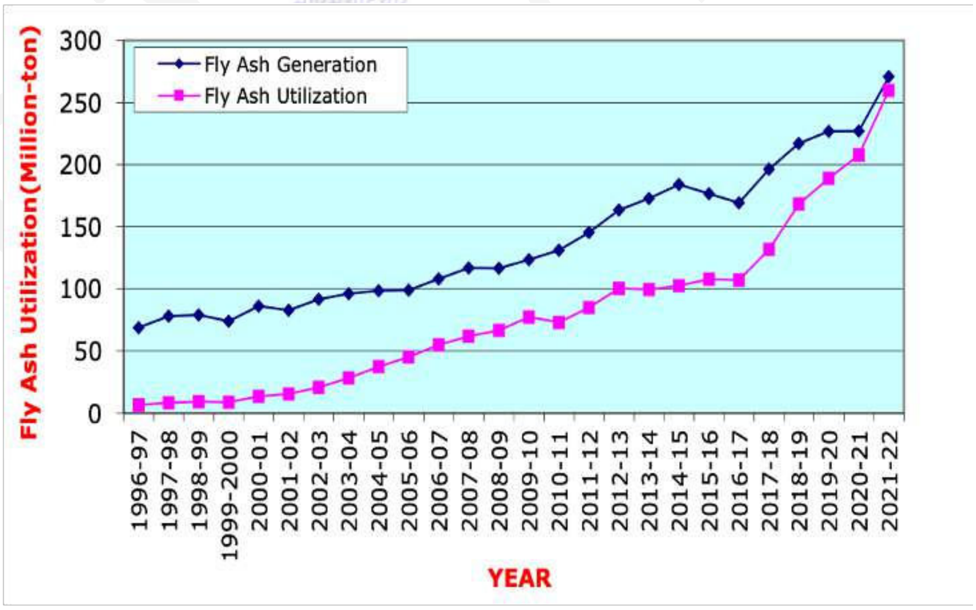


Figure 1: Progressive fly ash generation and its utilization for the period from 1996-97 to 2021-22 (CEA, 2021-22)

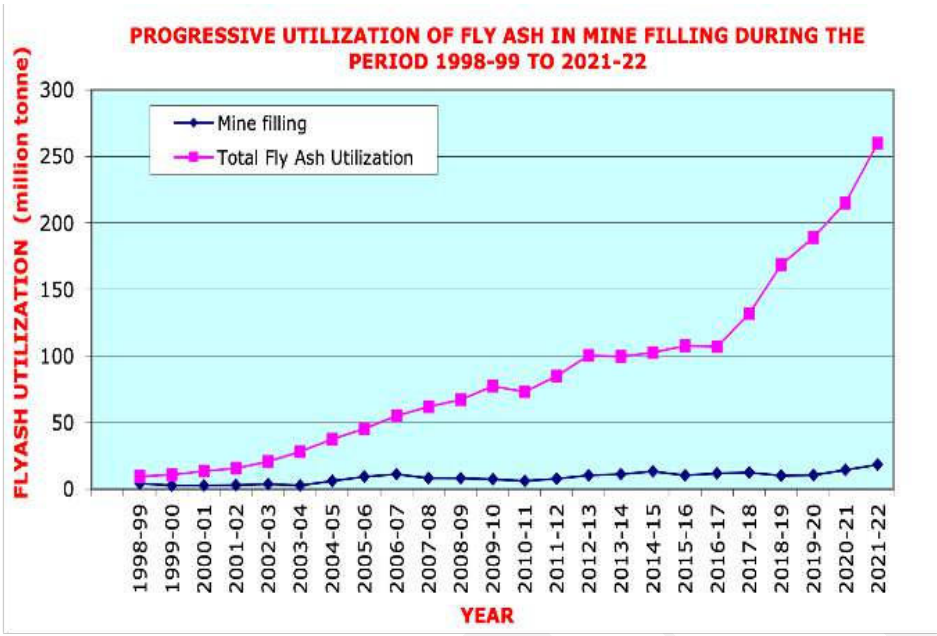


Figure 2: The progressive utilization of fly ash in the mines for the period from 1998-99 to 2021-22 (CEA, 2021-22)

As per the Gazette Notification issued by the Ministry of Environment, Forest and Climate Change (MoEF&CC) on December 31, 2021, thermal power plants have been made responsible for the proper disposal of both fly ash and bottom ash. The notification outlines the following key points:

- It is the primary responsibility of every coal or lignite based thermal power plant, including captive or co-generating stations, to ensure the 100% utilization of ash (fly ash and bottom ash) generated by them in an environmentally friendly manner.
- The ash generated from these thermal power plants should only be used for eco-friendly purposes, which include:
    - Manufacturing fly ash-based products such as bricks, blocks, tiles, cement sheets, pipes, boards, panels.
    - Utilization in cement manufacturing and ready-mix concrete.
    - Construction of roads, flyovers, embankments, and construction materials using ash and geo-polymer.
    - Dam construction.
    - Filling up low-lying areas.
    - Filling mine voids or mixing of ash with external Overburden dumps.
    - Manufacturing sintered or cold bonded ash aggregate.
    - Controlled agricultural use based on soil testing.

- Construction of shoreline protection structures in coastal districts.
- Export of ash to other countries.
- Any other eco-friendly purpose notified from time to time.

o To ensure effective utilization of ash, the notification requires all government, semi-government, and private agencies located within 300 km of lignite or coal based thermal power plants to mandatorily utilize ash in the activities.

In line with this, Northern Coalfield Limited (NCL), a subsidiary of Coal India Limited (CIL), has requested CSIR-CIMFR, Dhanbad to study the feasibility of mixing of fly ash and OB in active dumps of Nigahi Opencast Project (Ref. No. NCL/SGRL/R&D/2022-23/261). The scope of the project includes:

1. Feasibility study of mine for dumping overburden mixed with pond ash (dry and wet/slurry) in the running mine dumps.
2. Study the properties of different proportion of mix design (overburden and pond ash) in both dry and slurry form with pond ash from all neighboring thermal power plants.
3. Study of physicochemical properties of pond ash of all the neighboring thermal power plants.
4. Carrying out the field study of OB fly ash mixing in running mine.

Field study is being conducted to assess the feasibility of dumping ash with overburden. In this regard, the CSIR-CIMFR team has visited the Nigahi Mines multiple times for collecting relevant information, conducting field study.

2. LITERATIRE REVIEW

Coal ash, also known as coal combustion residuals (CCR), is the residue produced from burning coal in power plants to generate electricity. It is composed of inorganic materials that are left behind after the combustion process. Coal ash typically consists of two main types: fly ash and bottom ash.

Fly ash is the fine, powdery material that is carried away with the flue gases during coal combustion. It is collected by electrostatic precipitators or other air pollution control devices. Fly ash is primarily made up of small, spherical particles and contains a range of inorganic compounds such as silica, alumina, iron oxide, and calcium oxide.

Bottom ash is the coarser, heavier material that settles at the bottom of the combustion chamber. It is typically collected in the ash hoppers of power plants. Bottom ash consists of larger, irregularly shaped particles and contains a higher concentration of unburned carbon and heavy metals compared to fly ash.

2.1 Pond ash

Pond ash is a type of coal ash that is specifically derived from the bottom ash or fly ash collected in ash ponds or lagoons. Ash ponds are large containment areas where coal ash is stored after it is produced by coal-fired power plants. Over time, the ash settles and accumulates in these ponds, and the water content in the ash gradually evaporates, resulting in the formation of pond ash. Pond ash consists of fine particles that have undergone some degree of dewatering and drying in the ash pond. It typically has a higher moisture content compared to dry ash, but it can still be beneficially used in various applications. Pond ash shares similar chemical and physical properties with fly ash and bottom ash, including high levels of silica, alumina, iron oxide, and other mineral components.

2.2 Fly ash

There are two classes of fly ash according to ASTM C 618: Class F fly ash and Class C fly ash. Class F fly ash is typically produced from the burning of anthracite or bituminous coal and possesses pozzolanic properties. Class C fly ash is usually derived from the burning of lignite or sub-bituminous coal and has both pozzolanic and self-cementing properties.

2.3 Soil-fly ash interaction

The addition of fly ash to soil can lead to improvements in its engineering properties. These improvements can be attributed to two main types of reactions: short-term reactions involving cation exchange and flocculation-agglomeration, and long-term reactions involving pozzolanic activity.

In the *short term*, when fly ash is introduced to clay soil, it initiates cation exchange at the surfaces of the clay particles. The lime (CaO) present in fly ash reacts rapidly with water, releasing calcium ions (Ca^{2+}) and hydroxide ions (OH^-) into the soil-fly ash system.

$$CaO + H_2O = Ca(OH)_2$$

$$Ca(OH)_2 = Ca^{2+} + 2(OH)^-$$

When fly ash is added to clay soil, one of the short-term reactions that occur is the replacement of monovalent cations (such as Li^+, Na^+, H^+, K^+) with divalent calcium ions (Ca^{2+})

on the surfaces of the clay particles. This substitution of cations leads to an increase in the valence (charge) around the clay particles. As the valence increases, the formation of hydrous double layers, which are layers of water molecules associated with the clay particles, is reduced. This alteration in the electrical charge density around the clay particles promotes the formation of flocs. Flocculation refers to the process in which individual clay particles come together to form larger aggregates or flocs. The formation of flocs and agglomerates occurs within the first few hours after the addition of fly ash to the soil. This process is beneficial because it significantly reduces the swelling behavior of the soil. Swelling refers to the increase in volume or expansion of the soil due to the absorption of water. By promoting the formation of flocs, fly ash helps to stabilize the soil structure and decrease its propensity to swell. Overall, the cation exchange, increase in valence, and subsequent flocculation induced by fly ash contribute to the reduction in soil swelling and improve its engineering properties, making it more suitable for various geotechnical applications.

In *long term*, the pozzolanic activity of fly ash primarily occurs through the reactions between the reactive silica present in the fly ash and free lime. These reactions result in the formation of calcium-silica-hydrates (CSH), which have cementitious properties and contribute to the improvement of the soil.

$$Ca^{2+} + 2(OH)^{-} + SiO_2 \text{ (Fly Ash Silica)} \longrightarrow CSH$$

The pozzolanic reaction is a slow process and can take several years to complete. During this reaction, the reactive silica in the fly ash reacts with moisture and free lime, forming the cementitious CSH compounds. The presence of moisture and free lime is essential for the pozzolanic activity to occur. The fineness of the fly ash, which is related to its surface area, also affects its pozzolanic reactivity. Finer fly ash particles provide a larger surface area for the reaction to take place, increasing the potential for pozzolanic reactions. Other factors that influence the pozzolanic reactivity of fly ash include its carbon content, hydrogen ion concentration, and iron content. Lower carbon content, lower hydrogen ion concentration, and lower iron content generally promote higher pozzolanic reactivity. The self-hardening of fly ash, which refers to its ability to harden and gain strength over time, is also influenced by factors such as density, temperature, and age of the ash. These factors can affect the rate and extent of pozzolanic reactions and the overall performance of fly ash in improving the soil properties. Overall, the amount of reactive silica, presence of moisture and free lime, fineness of the fly ash, carbon content, hydrogen ion concentration, iron content, and self-hardening characteristics are all important factors that determine the pozzolanic reactivity of fly ash and its effectiveness in enhancing the soil.

2.4 Geo-technical properties of fly ash

a) Physical properties

Fly ash is composed of fine powdery particles that are mainly spherical in shape, and they can be either solid or hollow. Most fly ash particles have a glassy (amorphous) structure. The carbonaceous material present in fly ash consists of angular particles. The lime reactivity of fly ash is an important parameter that determines its suitability for various applications. Finer fly ash particles tend to exhibit higher lime reactivity. In Indian fly ash samples, the lime reactivity typically ranges from 27 kg/cm^2 to 89 kg/cm^2 (Karandikar et al., 1999). Over time, the strength of fly ash generally improves due to pozzolanic reactions. The pozzolanic reactivity of fly ash is influenced by factors such as fineness, silica and alumina content, loss on ignition (LOI), and alkali content.

b) Specific gravity

The specific gravity of Indian fly ash generally falls within the range of 1.46 to 2.66 (Pandian et al., 1998). The relatively low specific gravity of fly ash contributes to its low unit weight compared to soil. This characteristic is advantageous when using fly ash as a backfill material for retaining walls, as it reduces the pressure exerted on the retaining structure and foundation. Other applications that benefit from the low unit weight of fly ash include embankments, especially in areas with weak foundation soils, and the reclamation of low-lying areas. The specific gravity of fly ash is influenced by various factors, including particle gradation, shape, and chemical composition (Gray and Lin, 1972). The presence of a significant number of hollow cenospheres, which trap air and cannot be removed, contributes to the low specific gravity. Additionally, variations in the chemical composition, particularly the iron content, can influence the specific gravity of fly ash (Pandian et al., 1998).

c) Grain size distribution

Fly ash is primarily composed of silt-sized particles that are non-plastic. Approximately 60% to 90% of the particles in fly ash are finer than 0.075 mm (No. 200 sieve). The grain size distribution of fly ash is generally poorly graded, with a coefficient of curvature ranging between 0.61 and 3.70. The coefficient of uniformity falls within the range of 1.59 to 14.0 (Pandian, 2004).

d) Liquid limit

The liquid limit of fly ash refers to the water content at which it exhibits a certain degree of liquidity. For fly ash, the liquid limit water content typically ranges from 26% to 51% (Pandian et al., 1995; Pandian, 2004). It's important to note that the liquid limit values observed in fly ash are influenced by its fabric and carbon content rather than its plasticity characteristics.

e) Compaction behavior

The compaction process improves the engineering properties of fly ash. The compacted unit weight of fly ash is influenced by various factors such as the amount and method of energy application, grain size distribution, plasticity characteristics, and moisture content during compaction (Pandian, 2004). The relationship between dry density and moisture content for fly ash exhibits less variation compared to well-graded soils with similar median grain size (Moulton, 1978; Sridharan et al., 2001). This reduced sensitivity of fly ash to moisture content is mainly attributed to its higher air void content. In soils, the air void content typically ranges from 1% to 5% at maximum dry density, while for fly ash, it ranges from 5% to 15% (Moulton, 1978). The increased void content in fly ash helps limit the buildup of pore pressures during compaction, allowing for compaction over a wider range of water content (Toth et al., 1988; Sridharan et al., 2001). Gray and Lin (1972) have reported on the engineering properties of compacted fly ash and have suggested that properly compacted and stabilised fly ash possesses the necessary properties for use in load-bearing fills or highway sub-bases. Leonard and Bailey (1982) conducted tests on compacted coal ash fill using standard and static cone penetration tests and found it suitable for use as a foundation material for a new precipitator in a power generating station.

Indian fly ash exhibits a maximum dry density ranging from 8.9 kN/m^3 to 13.8 kN/m^3 and an optimum moisture content ranging from 17.9% to 62.3% (Sridharan et al., 2001; Sridharan and Prakash, 2007b). Fly ash has a lower maximum dry density and higher optimum moisture content compared to soils with organic content, which can be attributed to the presence of cenospheres and plerospheres (Pandian et al., 1998). Fly ash from different sources can exhibit significant variations in optimum moisture content and maximum dry density due to factors such as specific gravity, iron content, and carbon content (Singh, 1996; Krishna, 2001).

Sridharan et al. (2001) and Pandian and Mir (2002) reported that the compaction curves of fly ash resemble those of cohesionless soils, and changes in water content do not significantly affect the dry unit weight.

f) Strength behavior

The strength of fly ash is an important engineering property for its various geotechnical applications. Freshly compacted fly ash samples primarily derive their shear strength from internal friction, although some apparent cohesion has been observed in bituminous (pozzolanic) fly ash. The shear strength of fly ash is influenced by its density and moisture content, with maximum shear strength typically occurring at the optimum moisture content. Leonards and Bailey (1982) reported that fine ash exhibits higher unconfined compressive strength values compared to coarser ash specimens. The presence of free lime in fly ash contributes to self-hardening and age hardening, as indicated by Yudbir and Honjo (1991) and Digioia and Nuzzo (1972) respectively. Singh (1996) studied the unconfined compressive strength of fly ash and its correlation with free lime content. Shear strength tests performed by Singh and Panda (1996) on freshly compacted fly ash specimens at various water contents concluded that most of the shear strength is due to internal friction. Indraratna et al. (1991) compared the cohesion intercept and angle of shearing resistance of saturated and unsaturated fly ash specimens, reporting complete loss of cohesion in fully saturated conditions with no change in the angle of shearing resistance. Martin et al. (1990) emphasized that fly ash in a moist but unsaturated condition may exhibit apparent cohesion due to the tensile stress of retained capillary water, but long-term stability cannot rely on this apparent cohesion. Therefore, the strength property associated with the angle of shearing resistance is considered more important. Various studies have conducted consolidated drained or undrained tests with pore water pressure measurements, reporting mean values of the angle of shearing resistance ranging from 29° to 40°, with an average of 34°.

g) California Bearing Ratio (CBR)

Fly ash finds significant application as a sub-base material in pavement construction. Toth et al. (1988) reported CBR values ranging from 6.8% to 13.5% for soaked conditions, and 10.8% to 15.4% for unsoaked conditions. Poran and Ali (1989) suggested that fly ash mixed with 5%

to 10% lime and cement is suitable as a base and subbase material in road construction. Indraratna et al. (1991) investigated the engineering behavior of low carbon, pozzolanic fly ash and found that CBR values in soaked conditions are lower than those in unsoaked conditions. Properly compacted and cured fly ash samples were reported to exhibit excellent CBR values. Sridharan et al. (1996) reported the use of fly ash as an additive to improve the CBR of soils, particularly black cotton soils. Pandian et al. (2001) also documented the beneficial use of fly ash in enhancing the CBR of soils. However, it is important to note that the usage of additives has an optimum level beyond which the CBR value decreases.

h) Hydraulic conductivity

Well-compacted fly ash exhibits hydraulic conductivity ranging from 10^{-4} cm/s to 10^{-6} cm/s, which is comparable to the hydraulic conductivity of silty sand to silty clay soils (Porbha et al., 2000). The hydraulic conductivity of fly ash is influenced by the degree of compaction, grain size distribution, and internal pore structure (Porbaha et al., 2000; Sridharan and Prakash, 2007a). Due to the spherical shape of fly ash particles and their dense packing during compaction, fly ash exhibits relatively low hydraulic conductivity, minimizing water seepage through fly ash embankments.

i) Chemical characteristics

The chemical properties of fly ash are greatly influenced by the chemical content of the burned coal, the air pollution control strategy at the power plant, and the storage and handling techniques. Most fly ash samples consist of SiO2 (38-63%), Al2O3 (27-44%), Fe2O3 (3.3-6.4%), as well as unburnt carbon and small amounts of calcium, magnesium, alkalies, and sulphates. Fly ash from lignite, however, may contain a significant amount of CaO, ranging from 0 to 9% (Pandian, 2004; Mir and Sridharan, 2013).

j) Mineralogical characteristics

The mineralogical composition of fly ash is dependent on the coal formation, deposition, and combustion conditions, which can be determined through X-Ray diffraction (XRD) analysis. Low calcium fly ash (CaO < 5%) is characterised by major crystalline constituents such as quartz and mullite (Pandian, 2004; Sridharan and Prakash, 2007a).

2.5 Bottom ash

The bottom ash can be of different types:

- Dry Bottom Ash: This is the most common type of bottom ash produced in coal-fired power plants. It is collected from the bottom of the boiler in a dry state. Dry bottom ash typically has a coarse, granular texture.
- Wet Bottom Ash: In some power plants, the bottom ash is discharged in a wet state along with water. This is known as wet bottom ash. It is often mixed with water in submerged or quenching systems to cool down the ash before disposal.
- Clinker Ash: Clinker ash is a type of bottom ash that has been subjected to higher temperatures during the combustion process. It is typically denser and harder compared to regular bottom ash. Clinker ash may contain fused particles and has a more irregular shape.
- Ponded or Settled Ash: In certain cases, bottom ash is sluiced or transported as a slurry to ponds or settling basins for temporary storage and dewatering. The ash settles at the bottom of these ponds, and over time, the water is drained or evaporated, leaving behind a consolidated mass of settled ash.
- Ash Aggregate: Bottom ash can also be processed to produce aggregate material for various construction applications. This involves crushing, screening, and grading the bottom ash to produce a desired particle size distribution and quality. The resulting ash aggregate can be used as a replacement for natural aggregates in applications such as road construction, concrete production, and embankment construction.

2.6 Geotechnical properties of Bottom ash

a) Particle Shape and Texture

Bottom ash particles are typically greyish black in color and have a variety of shapes, including spherical, irregular, and porous. The surface of the particles is rough, and some particles may have complicated shapes and surface textures. The presence of spherical particles is more common in cases of pulverized coal combustion, where the ash melts and forms spherical shapes due to high temperature and pressure. Some particles may be angular in shape and can degrade easily under compaction (Mandal and Sinha, 2014).

b) Particle Size

The particle size of bottom ash ranges from fine gravel to fine sand, typically between 10 to 0.75 mm. The ash particles exhibit interlocking characteristics, and the material is lighter, and more brittle compared to natural sand. The particle size distribution of bottom ash can vary, but it is generally well-graded, although variations may occur within the same power plant (Mandal and Sinha, 2014).

c) Specific Gravity

The specific gravity of bottom ash varies widely depending on its chemical composition. Typical values range from 1.60 to 2.39. The specific gravity is influenced by factors such as iron content and grain size. Higher iron content tends to increase the bulk density of bottom ash. Bottom ash with low specific gravity tends to have a porous texture and can degrade under loading (Mandal and Sinha, 2014).

d) Bulk Density

The bulk density of bottom ash varies between 630 to 776 kg/m^3 for different types of bottom ash. The presence of hollow spherical particles contributes to the lower bulk density values. However, in cases where bottom ash has irregular-shaped particles without spherical hollow structures, the bulk density can be higher than 1,100 kg/m^3 (Mandal and Sinha, 2014).

2.7 Literature review on effect of mixing ash with soil/ overburden material

Fly ash, though having limited inherent cementitious properties, undergoes chemical reactions upon exposure to moisture, producing cementitious compounds that enhance the strength and compressibility characteristics of soils. The presence of free lime and inert particles in fly ash makes it particularly suitable for stabilizing expansive soils, as noted by Indraratna et al. (1991). Extensive research has confirmed that incorporating fly ash into soil improves several geotechnical properties, including Atterberg limits, compressive strength, durability, hydration, permeability, and compaction characteristics (Lees et al., 1982; Bell, 1996; Cokca, 2001; Pandian et al., 2002; Prabakar et al., 2004; Kim et al., 2005; Arora and Aydilek, 2005; Mackiewicz and Ferguson, 2005; Sharma et al., 2006; Eskioglou and Oikonomou, 2008; Yoon et al., 2009; Geliga and Ismail, 2010; Brooks et al., 2011; Santos et al., 2011; Lopes et al., 2012; Mir and Shridharan, 2013).

Cokca (2001) demonstrated that adding 20% fly ash to expansive soil decreased the plasticity index, activity, and swelling potential, with curing time and stabilizer content significantly influencing results. Prabakar et al. (2004) reported improvements in shear strength, California Bearing Ratio (CBR), and reduced swelling potential in soils mixed with fly ash, recommending its use in road bases and backfilling. Phani and Sharma (2004) observed that 20% fly ash addition reduced the free swell index (FSI) by 50% and decreased hydraulic conductivity due to increased maximum dry unit weight. Similarly, Kim et al. (2005) found fly ash and bottom ash mixtures suitable for highway embankments, provided proper design and construction measures were followed. Arora and Aydilek (2005) highlighted that curing period, compactive energy, cement content, and water content influenced the strength of fly ash mixtures, although lime treatment alone was insufficient for highway base design.

Mackiewicz and Ferguson (2005) suggested that 12%-15% fly ash content was typically required for stabilization applications. Eskioglou and Oikonomou (2008) noted diminishing strength gains beyond 10% fly ash content in sand-gravel mixtures. Yoon et al. (2009) observed the successful stabilization of a demonstration embankment constructed with fly ash and bottom ash mixtures, which stabilized within five months. Lopes et al. (2012) identified that coal ash additions immediately increased the resilient modulus of pavement bases. Mir and Shridharan (2013) found that high- and low-calcium fly ash improved black cotton soil properties, determining optimal percentages for both types.

Tannant and Kumar (2000) showed that mixing fly ash, kiln dust, and mine spoil improved compressive strength and elastic modulus, making the composite suitable for coal mine haul road bases. Behra and Mishra (2012) found that lime-stabilized fly ash-OB mixtures enhanced CBR values under unsoaked conditions, although soaked conditions reduced strength. Mallick and Mishra (2013) demonstrated that a composite of 62% fly ash and 8% clinker provided sufficient strength for mine haul road subbases. Singh (2011) determined that OB dump slopes incorporating 30% fly ash remained stable under dry conditions, but stability was critical under wet conditions.

Jayanthu et al. (2012) analyzed OB dumps incorporating 25% fly ash, finding both alternate layering and mixed configurations stable for heights up to 120 m. Pradhan et al. (2014) confirmed the stability of a 60 m slope with OB mixed with 20% fly ash. Gupta and Paul (2016) reported that shear strength increased with fly ash additions of 10%-20% by weight, but higher percentages yielded diminishing returns. Dewangan et al. (2015) and Dewangan et al. (2016a, 2016b) conducted studies revealing that fly ash improved cohesion and optimized slope stability for dump angles of 24°-28°, though higher contents reduced the friction angle.

Rajak et al. (2021) found that adding 10% fly ash increased CBR values by 21.38% and 16.31% under unsoaked and soaked conditions, respectively, while 20% fly ash maximized compressive strength and cohesion. Optimal dump heights of 55 m and 50 m were recommended for slope angles of 35° and 37°, respectively. These findings underscore fly ash's suitability for enhancing geotechnical performance and stabilizing OB dumps when used appropriately with overburden materials.

3. DETAILS OF THE STUDY AREA

The Singrauli Coalfield consists of two distinct sedimentary regions spanning approximately 2,202 square kilometers. The main basin, located in the western part, covers about 1,890 square kilometers, while the north-eastern region, known as the Moher Sub-Basin, encompasses an area of 312 square kilo meters.

Coal extracted from various Northern Coalfields Limited (NCL) mines supports electricity generation totalling approximately 10,515 MW across power plants operated by the National Thermal Power Corporation (NTPC), Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd (UPRVUNL), and the Renu Power Division of Hindalco Industries. The availability of Govind Ballabh Pant Sagar, a reliable water resource, makes this region highly suitable for establishing thermal power plants, contributing significantly to both regional and national energy security.

The planned power generation capacity from these plants is around 13,295 MW, and NCL has committed to meeting the increased coal demand required for this expansion. Additionally, NCL supplies coal to power plants operated by Rajasthan Rajya Vidyut Utpadan Nigam Ltd, Delhi Vidyut Board (DVB), and the Haryana State Electricity Board.

3.1 About the mine: Nigahi OCP

The Nigahi Opencast Project (OCP) is situated in the Moher Sub-Basin of the Singrauli Coalfield. It is mapped on Toposheet No. 63-L/12 of the Survey of India and is geographically located between latitudes 24°07’30” to 24°10’58” N and longitudes 82°36’24” to 82°39’28” E.

The Nigahi block features a hilly plateau with elevations ranging from 400 to 450 meters above mean sea level, with some peaks exceeding 500 meters. The western portion of the plateau is characterized by a steep escarpment facing south, intersected by drains and small streams (nallas) flowing along its slopes. At the base, the plateau transitions into a plain with elevations around 300 meters.

The current production capacity of Nigahi OCP stands at 25 Mtpa. This recent expansion to 25 Mtpa involves internal dumping of a significant quantity of OB expected to be generated in the coming years. The production enhancement is achieved by extending the existing operations on the dip side, incorporating the remaining portions of the Nigahi Block, including major parts of the Nigahi North Extension Block, Nigahi Dip Extension Block, and small sections of the Block-B Extension Block and Bijul Block.

Several thermal power plants are situated near the NCL mines, as shown in Figure 3. To meet the growing demand for coal supply, which necessitates increased OB removal, the excavation at Nigahi OCP is carried out through a combination of departmental operations and partial OB outsourcing, as outlined in the approved mine plan for 25 Mtpa. This includes the production of 15 Mtpa of coal by departmental methods, with an additional 10 Mtpa of incremental coal extracted using surface miners. The corresponding incremental OB removal is handled through outsourcing to ensure efficient operations.

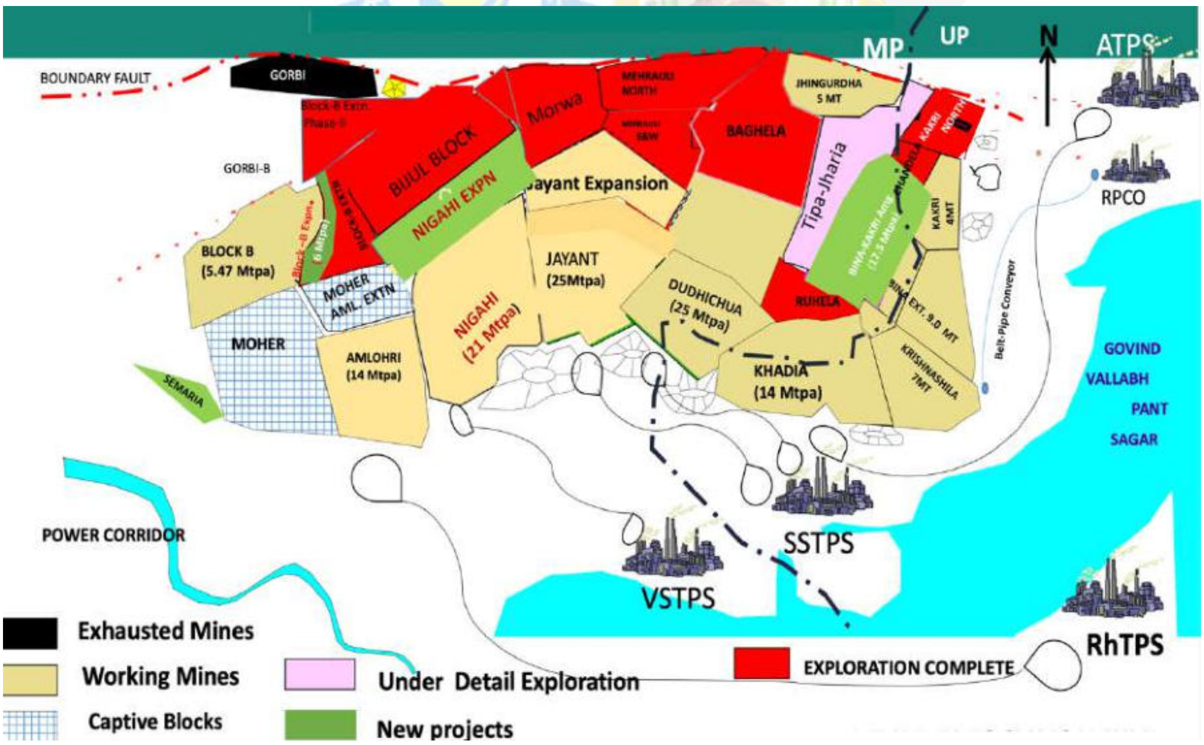


Figure 3: Location plan of NCL mines and surrounding Thermal Power Plants (Ref: Ground water monitoring report of Niaghi OCP)

The mine operates in two sections—Western and Eastern—connected by a central haul road situated on the floor of the Purewa seam and the backfilled area. Two additional haul roads run along the extreme sides of the lease area. The Western section is further divided into two sub-sections, serviced by a mid-entry haul road located on the floor of the Turra seam. In the Eastern section, the Turra seam is accessed via a haul road situated on the seam's eastern flank.

The Nigahi OCP is connected to the Vindhyachal Super Thermal Power Station (STPS), which has a current generation capacity of 4,760 MW. Following its expansion to 25 MTPA, Nigahi OCP is supplying coal to Vindhyachal STPS. Moreover, it will function as a Basket Linkage mine to help meet the overall coal demand of Northern Coalfields Limited (NCL).

3.2 Location and connectivity of the mine

The Nigahi OCP is in the Singrauli district of Madhya Pradesh and is part of the Moher Sub-Basin within the Singrauli Coalfield (See Figure 4). It lies approximately 20 km south of Singrauli Railway Station on the Chopan-Katni branch line.

The project has excellent connectivity, being linked to the company headquarters in Singrauli (20 km away) via an all-weather road. It is also connected to Shaktinagar, located 10 km away, through a metalled road. Additionally, the project is accessible from major cities via all-weather roads, with the Renukut-Waidhan road passing near the project colony.

The nearest town, Waidhan, which serves as the district headquarters of Singrauli, is situated about 8 km to the south. Other key locations include Renukut (60 km to the east), Varanasi (215 km to the north), and Rewa (190 km to the west).

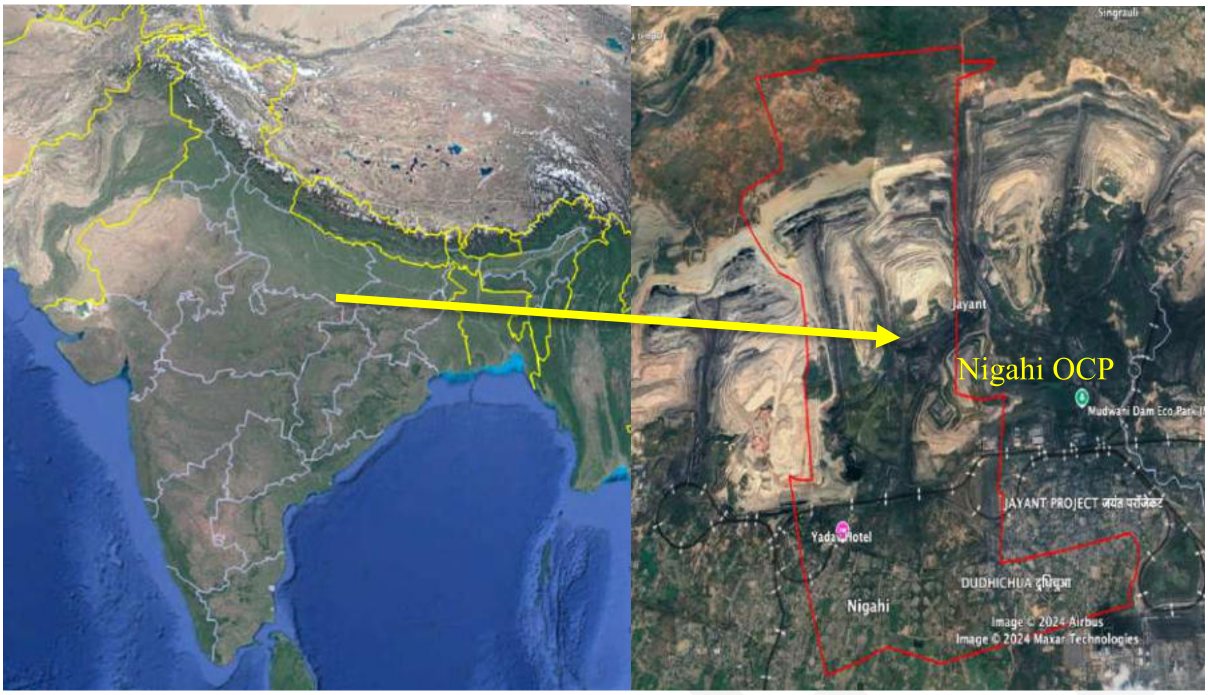


Figure 4: Location of Nigahi OCP

3.3 Climate

The area experiences a tropical climate characterized by intense summers. During May and June, temperatures can soar as high as 48°C. Winters are comparatively mild, with temperatures ranging from 4°C to 21°C between November and February.

The predominant wind direction is from the northwest, with average monthly wind speeds ranging between 2.5 and 4.5 km/h.

The region receives an average annual rainfall of approximately 1200 mm over the past 20 years, with 88% of the precipitation occurring during the monsoon season from June to September.

3.4 Physiography

The Nigahi Block is situated between the Jayant Project to the east and the Amlohri Project to the west. It is characterized by a hilly plateau with elevations ranging from 400 to 450 meters above mean sea level, with some relief features rising above 500 meters.

In the western part of the block, where the Turra Seam outcrops, as well as in the central and eastern areas south of the outcrop, the plateau is marked by steep escarpments facing south. These escarpments are traversed by seasonal drains and nallas. At the base, the plateau transitions into a plain with elevations of around 300 meters.

The outcrop of the Purewa Bottom Seam is located on the face of a smaller escarpment, which also faces south. The general elevation of the plateau varies between 405 and 455 meters.

The drainage system is primarily seasonal, with small nallas controlling water flow. In most of the opencast mine area, the flow is directed southward, while in the northern part of the minefield, it flows northward.

3.5 Land Use

The vegetation on the top of the plateau is rather scanty and represented mainly by shrubs. The slope of the escarpment facing the south is thickly forested. Cultivation is limited in patches on the plateau. The total land requirement for Nigahi OCP for 25 Mtpa coal production is 3582.723 Ha. Out of 3582.723 Ha, 1510.011 Ha is forest land, and 2072.712 Ha is non-forest land. Out of the non-forest land, 355.829Ha is government land, and 1716.883 Ha is tenancy land.

4. GEOLOGY AND METHOD OF WORKING

4.1 Reginal Geology

The Singrauli Coalfield, located at the northernmost edge of the Central Indian Coalfields, consists of two distinct techno-sedimentary domains. The western part, covering an area of 1,890 square kilometers, is known as the Main Basin, while the northeastern part, spanning 312 square kilometers, is referred to as the Moher Sub-Basin. These two basins are separated by a high basement trending northwest-southeast. The Moher Sub-Basin is considered the most promising area for coal mining, and currently, mining operations in the Singrauli Coalfield are focused within this region. The Nigahi OCP is in the southern-central part of the Moher Sub-Basin. The general stratigraphic sequence of Singrauli Coalfield (as per GSI,1977) is presented in Table 1.

Table 1: General Stratigraphic Succession, Singrauli Coalfields

Age	Group	Formation	Lithology	Thickness(m)
Cretaceous		Intrusive	Dolerite dykes and sills	Not estimated
Upper Triassic	Upper Gondwana	Mahadeva	Coarse grained, ferruginous sandstone	Not Estimated

			with bands of shale, clay and conglomerate	
Lower Triassic	Lower Gondwana	Panchet	White, greenish white and pink micaceous, medium to coarse grained sandstone with red bed, greenish brown silty shales and conglomerates	Not estimated
Upper Permian		Raniganj	Fine grained sandstones and shales with coal seams.	215-403
Middle Permian		Barren Measures	Very coarse grained ferruginous sandstones, green clay and shales.	125-300
Lower Permain		Barakar	Medium to coarse grained sandstones, shales, and coal seams	325-600
Upper Carboniferous		Talchir	Tillites, sandstones, siltstones, shales, clays and coal seams	75-130
-----------------------------------Unconformity--------------------------------				
Precambrian	Phyllites, quartzites, schists and gneisses			

The general strike of the beds in the Singrauli Coalfield is predominantly east-west, except in Block-B to the west and the Bina and Kakri blocks to the east, where the strike is nearly north-south. The beds exhibit a corresponding centripetal dip, with the dip generally ranging from 2 to 3 degrees. However, in the eastern part of the basin, steeper dips of around 8° to 10° have been observed.

4.2 Geology of the block

The entire block area is primarily composed of sediments from the Barakar Formation, with a thin layer of soil and alluvium in certain areas. The stratigraphic sequence of rocks within the Barakar Formation, based on drill hole data, is provided in Table 2.

Table 2: Stratigraphic sequence of rocks within the Barakar Formation

Lithology	Thickness Range (m)		Remarks
	From	To	
Sand and Sub soil	0.00	95.00	In the North-western part of the area the Purewa Top and Bottom seams are merged to form Purewa merged seam in the depth range of 74.3-228 m from surface.
Sandstone with 2 to 3 clay bands and 1 to 2 thin impersistent carbonaceous horizon.	0.82	91.85	--
Coal Seam : Purewa Top	0.93	10.15	Avg. Thickness: 6.22
Sandstone within shale bands	1.29	29.35	--
Coal Seam : Purewa Bottom	9.2	14.46	Avg. Thickness: 23.85
Coal Seam : Purewa Merged	15.5	28.3	Avg Thickness: 23.85
Sandstone within carb shale	55.3	77.8	--
Coal Seam : Turra	4.4	22.5	Avg. thickness 18.11

The Barakar sequence primarily consists of fine to coarse-grained, light grey, feldspathic sandstone, shale, clay, and coal seams. Kaolinized feldspar typically serves as the cementing material. Within the upper horizon of the Barakar formation, there are two to three clay beds, while shale bands are commonly interbedded with coal and form most of the dirt bands within the seams. Thin shale bands have also been observed within the sandstone at certain locations.

The major lithofacies of the Barakar formation, including the coal seams, belong to the arenaceous facies, which vary in grain size but are predominantly composed of coarse-grained sandstone. The argillaceous facies constitute about 5% of the total rock column in a vertical section. The sandstones are typically feldspathic, sometimes kaolinized, and rarely micaceous. The coal horizon is composed of coal, shaly coal, and carbonaceous shales.

4.3 Geological Structure

The sandstone exposures and topography do not provide much insight into the geological structure of the area. Therefore, the entire structural framework has been determined based on subsurface data collected from Nigahi and the adjoining blocks.

The block is located in the south-central part of the crescent-shaped Moher Sub-Basin. Consistent with the regional structure, the beds generally exhibit an ENE-WSW trend with a northerly dip. The dip is typically around 2° to 3°. Faults have been postulated in the northeastern region of the area.

4.4 Description of Coal seams

a) Turra Seam

The Turra seam is the most significant and lowest workable coal horizon in the area, occurring between 55.3 m and 77.8 m below the Purewa Bottom/merged seam. The depth of the seam ranges from a minimum of 134.4 m to a maximum of 313.4 m. The full thickness of the Turra seam, including all dirt bands, varies from 4.4 m to 22.5 m, with the effective thickness also ranging from 4.4 m to 22.5 m.

The immediate roof and floor of the Turra seam are typically composed of fine to coarse-grained sandstone, sandy shale, carbonaceous shale, and alternating bands of shale and sandstone. Compared to the younger seams, the Turra seam is less inter-banded. The dirt bands are generally less than 1 m thick, though some boreholes have encountered dirt bands of 1 m or more, with the maximum thickness reaching 1.2 m. These dirt bands are typically composed of carbonaceous shale, with shale occurring in a few instances. The coal present in this seam is of low rank, high volatile, non-coking and bituminous type.

b) Purewa Bottom Seam

The Purewa Bottom seam represents the middle workable coal horizon in the area, with its depth of occurrence ranging from 67.7 m to 138.6 m. In the northwestern part of the block, the seam merges with the Purewa Top seam. The full thickness of the Purewa Bottom seam, including all dirt bands, varies between 9.2 m and 14.46 m. The parting thickness between the Purewa Bottom seam and the Turra seam ranges from 55.3 m to 61.78 m.

The roof of the seam is typically composed of medium to coarse-grained sandstone, occasionally interbedded with shale or clay bands. The immediate floor is generally made up of fine to coarse-grained sandstone and, in some areas, grey shale. The seam is highly interbanded in nature. These bands are generally represented by carbonaceous and grey shales. The coal of Purewa Bottom seam is low rank, high volatile, non-coking, bituminous type.

c) Purewa Top seam

The Purewa Top seam is the uppermost workable coal horizon in the area, occurring at depths ranging from 35 m to 111.85 m. Its full thickness, including all dirt bands, varies from 0.93 m to 10.15 m.

The roof of the seam is generally composed of medium to coarse-grained sandstone, with occasional shale or clay bands. The immediate floor typically consists of fine to coarse-grained sandstone, with grey shale present in some areas. The seam has an inter-banded nature, with dirt bands primarily composed of carbonaceous and grey shale. Dirt bands thicker than 1 m are rare. The coal of Purewa Top seam is of low rank, high volatile, non-coking, bituminous type.

d) Purewa Merged seam

In the northwestern part of the area, the Purewa Top and Purewa Bottom seams merge to form the thick Purewa Merged seam. The parting between this merged seam and the underlying Turra seam ranges from 55.3 m to 77.8 m. The seam occurs at depths between 74.3 m and 228 m. The thickness of the Purewa Merged seam, including all dirt bands, ranges from 15.5 m to 28.3 m, while its effective thickness typically varies between 11.95 m and 26.75 m.

The roof and floor of the seam are generally composed of medium to coarse-grained sandstone. However, in some instances, the roof also consists of carbonaceous sandy shale or alternating bands of shale and sandstone. The seam has an inter-banded nature, with dirt bands represented by carbonaceous shale, carbonaceous sandy shale, and shale. The coal of Purewa Merged seam is of low rank, high volatile, non-coking, bituminous type.

4.5 Coal production plan and average stripping ratio

The estimation of mineable coal reserves and overburden volumes was conducted in the EPR of Nigahi OCP based on the existing mine working plan as of March 31, 2020. The total mineable reserve was estimated at 473.34 Mt, with a total OB volume of 2,213.39 Mm^3. The Year wise coal production plan and average stripping ratio is presented in Table 3.

Table 3: Year wise coal production plan and average stripping ratio

Year	Year	Coal (Mt)	OB (Mm^3)	SR (m^3/t)
2023-24	Yr-1	25.00	133.12	5.32
2024-25	Yr-2	25.00	135.00	5.40
2025-26	Yr-3	25.00	135.00	5.40
2026-27	Yr-4	25.00	135.00	5.40
2027-28	Yr-5	25.00	135.00	5.40
2028-29	Yr-6	25.00	135.00	5.40
2029-30	Yr-7	25.00	135.00	5.40
2030-31	Yr-8	25.00	135.00	5.40
2031-32	Yr-9	25.00	135.00	5.40
2032-33	Yr-10	25.00	128.00	5.12
2033-34	Yr-11	25.00	122.99	4.92
2034-35	Yr-12	25.00	120.76	4.83
2035-36	Yr-13	25.00	106.03	4.24
2036-37	Yr-14	25.00	104.48	4.18
2037-38	Yr-15	20.00	80.26	4.01
2038-39	Yr-16	18.00	60.75	3.38
2039-40	Yr-17	14.00	45.00	3.21
2040-41	Yr-18	7.10	15.00	2.11
	Total	**409.10**	**1996.39**	**4.88**

Based on the mineable coal reserve and rated capacity of 25 Mtpa of the mine, the balance life of Nigahi expansion project has been estimated as 21 years from 01.04.2020. Total project life as on 31.03.2020 is presented in Table 4.

Table 4: Total project life as on 31.03.2020

S. No.	Particulars	Project Year	Value
1	Quarry Life		
	Period of build-up of production from 15 to 25 Mtpa	Yr-1 to Yr-4	(4 years)
	Period of production level at 25 Mtpa	Yr-5 to Yr-17	(13 Years)
	Period of tapering down production	Yr-18 to Yr-21	(4 Years)
	Total production/quarry	Yr-1 to Yr-21	(21 Years)
2	Total project duration	Yr-1 to Yr-21	(21 Years)

4.6 Method of working

Turra, Purewa Bottom, Purewa Top and Purewa Merged seams are being excavated by opencast mining. Table 5 presents the geological and mining characteristics of the mining block. The quarry parameters are presented in Table 6.

Table 5: Geological and mining characteristics

S. No.	Particulars	Unit	Value	
1.	Thickness of Coal Seam (Full Seam thickness zone)			
	Seam		Stratigraphic Thickness	Effective Thickness
	Turra Seam	m	4.4- 22.5 (18.11)	4.4-22.5 (18.04)
	Purewa Bottom Seam	m	9.2-14.46 (11.79)	8.92-13.11 (10.91)
	Purewa Top Seam	m	0.93-10.15 (6.22)	0.93-10.15 (5.74)
	Purewa Merged Seam	m	15.5-28.3 (23.85)	11.95-26.75 (21.85)
2.	Thickness of OB and Partings			
	OB above Purewa Top	m	45-225	
	Parting between Purewa Bottom and Purewa Top Seam	m	1.29-29.35	

	Parting between Turra & Purewa Bottom Seams	m	-
	Parting between Turra & Purewa Merged Seams	m	55.3-77.8
3.	Seam Gradient	Deg.	2-3
4.	Volume Density of Coal (with dirt bands upto 1m thick)		
	Turra Seam	t/m^3	1.48
	Purewa Bottom Seam	t/m^3	1.64
	Purewa Top Seam	t/m^3	1.61
	Purewa Merged Seam	t/m^3	1.65
5.	Volume Density of OB rocks	t/m^3	2.00
6.	Excavation Category		
	Coal	Cat-III- 90% Cat-IV-10%	
	Overburden	Cat-III-90% Cat-IV-10%	

Table 6: Nigahi OCP- Quarry parameters

S. No	Particulars	Unit	Western	Eastern	Total
1.	Average Strike length of quarry along Turra seam floor	km	1.5	1.7	3.2
2.	Average Strike length of quarry along surface	km	1.8	2.1	3.9
3.	Average Dip-Rise Width of the quarry on Turra Seam floor from existing face	km	2.90	3.15	3.15
4.	Average Dip-Rise Width of the quarry on the surface from existing face	km	3.30	3.50	3.50
5.	Existing depth as on 31.03.2020	M	235	175	235

6.	Maximum depth of the quarry from the surface	M	320	295	320
7.	Quarry Surface Area (Expansion) from existing face	Sq. km	7.62	5.97	13.59
8.	Total quarry Surface Area (Existing and Expansion)	Sq. km	21.46		21.46

The minefield is divided into two operational sections: the Western Section and the Eastern Section, connected by a central haul road that runs along the floor level of the Purewa seam and the backfilled area, facilitating access and transportation. The Western Section is further subdivided into two sub-sections, each accessed by a mid-entry haul road located on the floor of the Turra seam. In contrast, the Eastern Section has a haul road on the eastern flank at the seam's floor level for accessing the Turra seam. The elements of mining system is presented in Figure 5.

a) Equipment Deployment and Current Operations

- **Dragline Deployment:**
  - Two 24m³/88mR draglines operate in the Eastern Section for OB removal above the Turra seam.
  - One 20m³/83mR dragline operates in each sub-section of the Western Section.
- **Shovel-Dumper Combination:**
  - The remaining OB above dragline sitting levels is excavated using shovel-dumper systems and transported via the central, eastern, and western haul roads.
  - Coal extraction from the Turra and Purewa seams is carried out by 10m³ electric rope shovels paired with 100 T dumpers and transported to Coal Handling Plant (CHP) receiving pits via multiple haul roads.
- **Coal Extraction:**
  - Purewa seams (Bottom, Top, and Merged) are being worked in two sub-benches, depending on seam thickness, using 10m³ electric rope shovels, 10-12m³ hydraulic shovels, and 100 T dumpers.
  - Surface miners are used in the Purewa seams with coal loading and transport outsourced.
- **Overburden (OB) Removal:**

- OB removal is managed by draglines and $20m^3$ electric rope shovels paired with 190-210 T rear dumpers.
- OB in advance benches are excavated in inclined layers parallel to the seam floor, eliminating the need for cutting new horizons and simplifying water drainage to sumps.

b) Mining System Design

- **Bench Design:**
  - **Main OB Bench:** Heights of 28-30m, with dragline cut widths of 80m.
  - **Shovel OB Benches:** Heights of 15-18m and cut widths of 20m.
  - **Coal Benches:** Working bench widths are 45m, non-working bench widths are 25m, and the cut width is 20m.
  - **Slope Parameters:** Bench slopes are 70° for OB and 80° for coal, with an overall running slope of 15°-18°.
- **Dump Design:**
  - OB dump benches formed by the shovel-dumper system have heights of 30m and slopes of 37°.
  - Berm widths between adjacent benches is 40m, with an overall dump slope of 28°.

c) Parameters for Flexibility

- Persistent coal bands thicker than 1m are mined separately using $10\text{-}12m^3$ front-end loaders.
- Bench widths include allowances for traffic, power supply arrangements, and safety berms, ensuring operational flexibility.

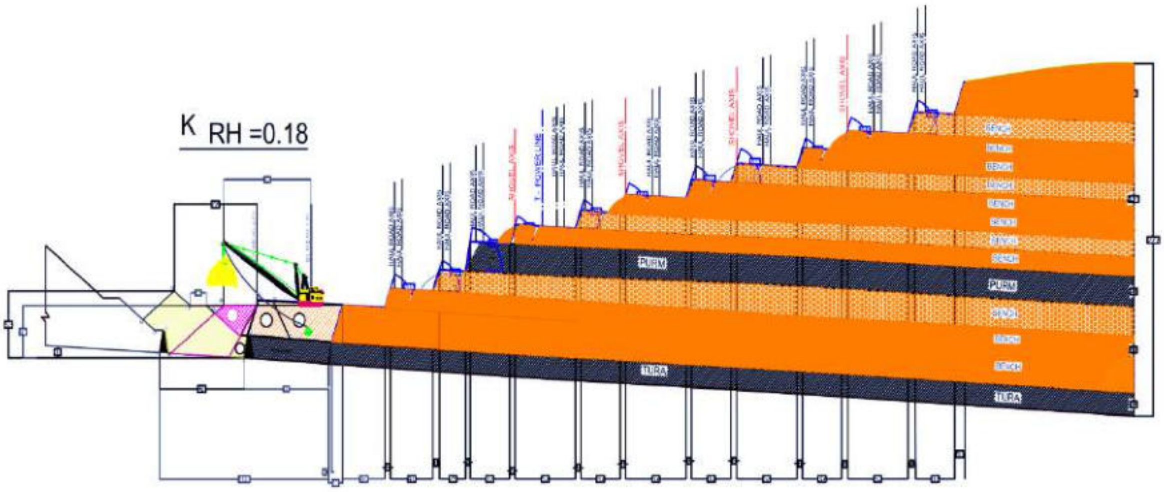


Figure 5: Elements of mining system (Ref: EPR for Nigahi OCP)

5. HYDROGEOLOGY

5.1 Topography

Nigahi OCP lies in between existing Jayant OCP on the east and Amlohri OCP in the west. It stands out as a hilly plateau with elevations as high as 583 m. The project is situated in hilly rugged and undulating topography sloping gently towards south and east, with general elevation variation from 141 to 583 m. In the western part of the block, the plateau is pronounced by steep escarpment facing the south. Drains and nalas traverse the slope of escarpment. The base of the plateau extends as a plain with elevations around 300 m.

5.2 Geomorphology and Drainage

The study area contains different types of water bodies such as reservoirs and nalas in varying sizes. The core and buffer zone of 10 Km is traversed by numerous seasonal nalas flowing from north to south and south to north drain through this area and meet the master drain the Rihand dam (Govind Ballabh Pant Sagar) which is located south of this area. The drainage map is shown in Figure 6.

The local drainage is mainly radial in nature. Kachan Nala, Bijul Nala, Motwani Nala, Balia Nala, drains this area. Kachan nala drains the Nigahi OCP area in south and Bijul Nala drains the northern part of the OCP in north.

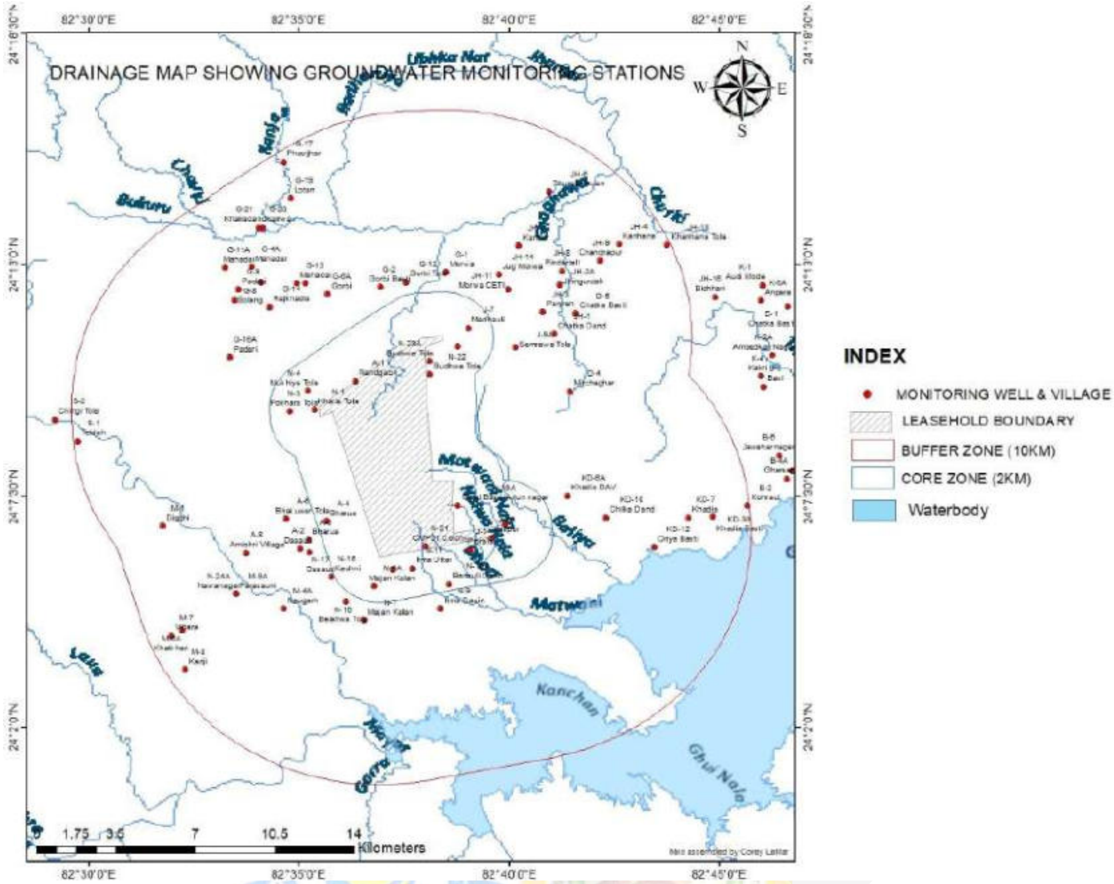


Figure 6: Drainage Map of Nigahi Project

5.3 Aquifer Characteristics

Below the soil cover of the study area hick Barakar formations have been developed. The soil thickness varies from 0m to 9 m. The formation comprising mainly of alluvium, weathered sandstone and sandstone within shale (thickness 30.50 m -167.40 m) lying above top most working coal seam- Purewa (Top) behaves as unconfined aquifer. Whereas, lower formations consisting of compact sandstone with secondary porosity behave as semiconfined to confined aquifer.

The sandstone aquifer present between Purewa Top and Purewa Bottom seam has a thickness range of 1m to 29.35 m. The sandstone aquifer present between Purewa

Bottom seam and Turra seam have a thickness range of 52.10 to 69.60m. In the unconfined aquifer groundwater moves laterally through the inter-granular pore spaces in the sandstone. Whereas in lower aquifers the groundwater movement is restricted mainly through joints and fractures (i.e. secondary porosity) developed. With the presence of intercalated shale and carbonaceous shale beds and reduction in permeability with depth, the lower aquifers are poor in potential. The deeper aquifers are divided into multi aquifer system due to the presence of clay, shale beds and persistent impervious thick Coal seams (i.e. Purewa and Turra seam). The deeper aquifers behave as unconfined aquifers at the outcrop region.

The aquifer units present above the working coal seams are the major sources for inflow into present and the proposed mine workings. With the presence of shale and compaction, the seepage from Mine floor may be considered as negligible. The aquifer parameters for the unconfined aquifers as reported by CMPDIL is given below:

Transmissivity (T):	82 m^2/d
Permeability (k):	1.0 m/d (For Unconfined Aquifer)

5.4 Climate and rainfall

The climate of the area is tropical with severe summer. The temperature in summer goes as high as 48°C in May June. The summer is very hot and dusty. In winter the temperature varies from 4°C to 21°C (November-February).Climate of the area is tropical with three distinct seasons. The minimum &maximum temperature recorded is 40°C and 48^0C respectively. Predominant wind direction is north-west. The month – wise rainfall data for the last 15 years is given in the Table 7.

Table 7: Rainfall data at the mine area

Measure in - mm. **Figure in -mm**

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
2010	0.50	12.97	0.00	0.00	25.45	42.82	546.42	320.65	251.24	80.08	0.00	6.00	**1286.13**
2011	11.30	12.64	0.00	17.95	28.31	397.68	242.89	517.94	576.14	53.24	0.00	0.00	**1858.09**
2012	54.53	0.00	0.00	0.00	0.00	75.31	524.92	423.18	188.98	0.00	37.91	7.98	**1312.81**
2013	0.00	119.91	49.26	6.97	29.92	108.58	432.77	267.65	159.59	213.91	0.00	0.00	**1388.56**
2014	53.21	71.62	41.89	0.00	0.00	150.73	290.89	237.41	187.46	65.15	0.00	11.80	**1110.16**
2015	19.76	7.34	66.94	35.91	13.97	50.39	342.73	239.14	70.49	63.52	0.00	5.51	**915.70**
2016	15.30	0.00	23.61	0.00	33.25	23.94	563.74	663.06	613.71	87.84	0.00	0.00	**2024.45**
2017	15.44	4.60	0.00	0.00	11.28	130.09	466.56	166.00	167.50	68.00	0.00	0.00	**1029.47**
2018	0.00	20.00	0.00	9.00	39.00	65.50	346.00	415.00	47.50	6.00	0.00	8.00	**956.00**
2019	10.00	21.00	40.00	14.00	16.00	66.00	307.50	439.50	339.00	63.00	0.00	48.00	**1364.00**
2020	20.00	31.00	51.00	25.00	58.00	463.00	140.00	399.00	235.00	154.00	18.00	8.00	**1602.00**
2021	0.00	0.00	0.00	0.00	230.00	641.00	494.00	513.00	289.00	6.00	0.00	0.00	**2173.00**
2022	24.00	25.00	0.00	0.00	31.00	146.00	159.00	494.00	182.00	205.00	0.00	0.00	**1266.00**
2023	0	0	43	22	147	152	164	306	443	203	20	57	**1557.00**
2024	25	57	43	12	34	133	308	1210	399	0	0		**2221.00**

The average monthly wind velocity varies from 25 to 4.5 km/hr. The rainy season is generally from June to October. From the rainfall data it can be seen that the average rainfall per year in the last fifteen year is about 1470.958 mm. Out of the total average rain fall per year, about 90 % of rainfall occurs during the monsoon period and remaining 10% during non – monsoon period.

5.5 Water accumulation at the Mine Pit

The main sources of water in the mine pit are rainwater and ground water seepage. As per the study report of CMPDIL, the average rainwater accumulation in the pit comes to about 847 m^3//day. The mine seepage as predicted by the Modelling studies carried out by CMPDIL per year is given in the Table 8.

Table 8: Predicted Mine Seepage during Monsoon and Non-monsoon seasons

Calander Year	Season	Outflow into the mine (m^3/day)	Annual weighted Avg. (m^3/day)
2022-23	Monsoon Season	2952	2946
	Non-Monsoon Season	2943	
2023-24	Monsoon Season	2940	2936
	Non-Monsoon Season	2934	
2024-25	Monsoon Season	3227	3223
	Non-Monsoon Season	3221	
2025-26	Monsoon Season	3514	3509
	Non-Monsoon Season	3507	
2026 -27	Monsoon Season	3800	3795
	Non-Monsoon Season	3792	
2027 -28	Monsoon Season	4104	4099
	Non-Monsoon Season	4096	

The cumulative water accumulation as per the above study comes to 3,783 m^3 in the year 2024. Water (rain or seepage) have an adverse effect on the bench stability (OB and working faces) of dumps as it causes reduction in shear strength (lowers the cohesion and friction angle), erosion, liquefaction caused due to increase in pore water pressure. Hence, it is critical to consider the hydrogeology of the region while planning the mine dumps.

5.6 Ground water flow and depth of water level

CMPDI has established a network of 34 monitoring stations (dug wells) spread over the core and buffer zone (10 km radius) to collect the representative groundwater levels in the study area for monitoring GW level in pre-monsoon and post-monsoon period for last few years as shown in the Table 9, and Figure 7.

Table 9: Location of monitoring station and GW level during pre and post monsoon

Well No.	Elevation (m)	Latitude (Deg.)	Longitude (Deg.)	Pre monsoon(m)	Post-monsoon (m)	Fluctuation (m)
CORE ZONE (2KM)						
A-1	299.79	24.170556	82.605833	4.9	2.4	2.5
A-4	311.81	24.115	82.594167	7.1	4.35	2.75
J-3	294.33	24.113924	82.664996	5.6	3.1	2.5
J-1	293.35	24.103622	82.651339	8.45	2.55	5.9
J-2A	274	24.108287	82.659653	6.5	2.25	4.25
J-14A	384	24.190278	82.649444	4.6	3.6	1
J-15A	301	24.121111	82.646389	3.8	2.65	1.15
N-1	487.94	24.159201	82.589589	13.85	11.45	2.4
N-3	488.45	24.15855	82.579874	10.5	9	1.5
N-4	484.34	24.166617	82.586948	21.57	20.67	0.9
N-6A	293.73	24.089236	82.613083	10.6	4.65	5.95
N-10A	287.75	24.090112	82.642774	12	2.5	9.5
N-11	297.07	24.096166	82.628291	6	1.7	4.3
N-13	300.37	24.09587	82.620466	2.9	1.9	1
N-14A	393.6	24.184444	82.646389	9.55	8.9	0.65
N-21	305.2	24.105002	82.633539	3.35	1.95	1.4
N-22	417.07	24.173151	82.635131	15.4	14.65	0.75
N-23A	414.37	24.178333	82.635	15.45	11.85	3.6
A-1	299.79	24.170556	82.605833	4.9	2.4	2.5
A-4	311.81	24.115	82.594167	7.1	4.35	2.75
J-3	294.33	24.113924	82.664996	5.6	3.1	2.5
BUFFER ZONE (10KM)						
A-2	302.25	24.104167	82.583889	7.7	6.4	1.3
A-3	305	24.1075	82.587222	5.4	1.85	3.55
A-6	312.33	24.115833	82.578056	6	5.3	0.7
A-7	305.88	24.110833	82.579444	11.7	5.8	5.9
A-8	296.91	24.102476	82.562372	3.8	2.35	1.45
M-1	305	24.113048	82.529237	7.2	4.65	2.55
M-4A	286	24.080296	82.577243	7.05	3.85	3.2
M-6A	307	24.071689	82.537015	4.2	1.5	2.7
M-8	308	24.05624	82.538368	3.8	2.35	1.45
S-1	326	24.146729	82.495591	3.6	2.35	1.25
D-3A	369.98	24.198889	82.688611	7.05	4.9	2.15
D-4	383.37	24.166494	82.69093	11.2	7.8	3.4

D-5	370.42	24.197222	82.693056	12.2	10.8	1.4
G-1	357.75	24.213611	82.641667	3.5	1.65	1.85
G-2	381.86	24.207778	82.615556	6.8	4.5	2.3
G-4A	380	24.215833	82.564444	5.35	3.3	2.05
G-6A	380	24.205	82.594722	2.45	0.7	1.75
G-7	386.47	24.209829	82.568325	6.8	2.35	4.45
G-8	385.15	24.202473	82.557612	8.2	5.8	2.4
G-9	384.21	24.206832	82.559214	6.6	6.1	0.5
G-10	385.55	24.224875	82.543569	10.85	7.4	3.45
G-11A	380	24.215556	82.553889	7.5	5.6	1.9
G-13	388.58	24.209278	82.585917	5	3.95	1.05
G-14	388.71	24.19991	82.571673	4.5	3.55	0.95
G-16A	379.52	24.179861	82.555875	3.3	1.3	2
G-17	391	24.2575	82.577222	11.1	8.5	2.6
G-19	383.9	24.24309	82.58	14.7	13.5	1.2
G-21	370.9	24.231389	82.5675	8.2	4.4	3.8
J-9A	386.5	24.184167	82.669167	9.1	6.65	2.45
JH-2A	357	24.208804	82.686752	7.1	3.55	3.55
JH-3	368.6	24.197941	82.679996	3.7	3.05	0.65
JH-4	367.22	24.224727	82.710323	4.4	2.65	1.75
JH-6	360.49	24.245469	82.682494	10.9	6.15	4.75
JH-7	341.89	24.224165	82.67049	15.65	11.8	3.85
JH-8	366.94	24.214189	82.687839	4.45	1.05	3.4
JH-9	357.66	24.218225	82.702957	5.6	2.3	3.3
JH-11	378.79	24.206857	82.666352	8.9	7.8	1.1
JH-14	366.03	24.212753	82.66263	8.9	7.15	1.75
JH-15	366.74	24.203137	82.680915	5.5	2.4	3.1
JH-18	365.53	24.224495	82.729161	7.55	3.8	3.75
KD-10	290.97	24.116349	82.704962	3.2	2.65	0.55
B-2	272.97	24.121124	82.76107	5.75	2.45	3.3
KD-7	273.3	24.116326	82.737836	1.2	0.2	1
N-7	286.54	24.075648	82.609248	6.65	3.95	2.7
N-9	285.53	24.08028	82.639514	4.3	3.7	0.6
N-16	293.06	24.093034	82.596165	13.05	7.1	5.95
N-17	302.08	24.102778	82.5875	10.35	5.85	4.5
N-20A	307.59	24.099722	82.633333	8.25	3.55	4.7
N-24A	306.59	24.086111	82.558333	7.2	4.65	2.55

From the table above it can be seen that the maximum and the minimum depth of water table in the core zone of the mine during pre – monsoon period was found to 21.57m (at well no – N4) and 2.9m (at well no – N13) respectively and the average depth of water table was

8.56 m. Similarly, it can be seen that the maximum and the minimum depth of water table in the core zone of the mine during post – monsoon period was found to be 20.67m (at well no – N4) and 1.7m (at well no – N11) respectively and the average depth of water table was 5.71 m. The average elevation of the mine bottom is about 270 to 205m above mean sea level and that of water table is 370m

It is well known that hydrogeology influences dump stability. Water saturation has an adverse effect on stability as it reduces shear strength of the dump material by reducing the cohesion and friction between particles and due to which majority of the dump failure is mostly reported during rainy season. Upward thrust of water caused due to capillary action of accumulated water at the base of dump has also an adverse on dump stability. It is determined by the product of unit weight of water. In addition to that, seepage of water exerts dragging force on the dump materials. Seepage pressure acts on the base of slice below the phreatic line and in the direction of flow. Thus, it is important to incorporate the effect of water saturation due to rainwater and the pore water pressure within the material below the phreatic surface while carrying out stability analysis of dumps. Keeping the above fact in mind, the average depth of water level of **8m** is considered while doing stability analysis of dumps

Figure 7: Location of monitoring wells in the core and buffer zone of the mine

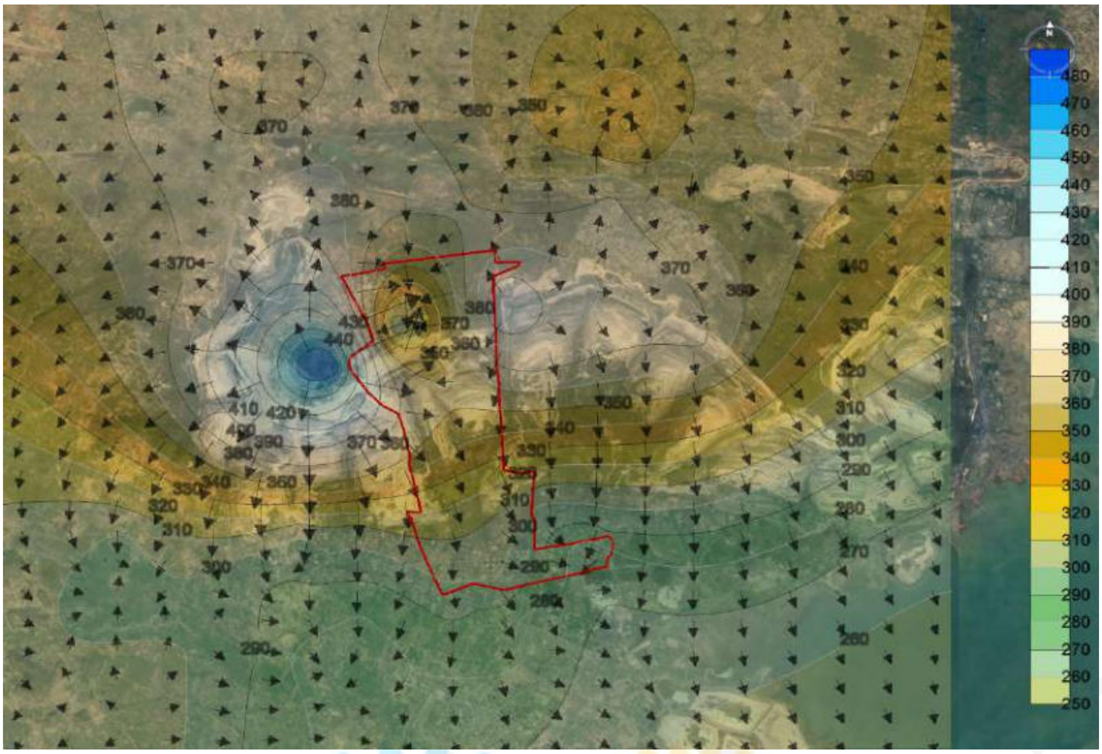


Figure 8: Pre-monsoon ground water flow direction

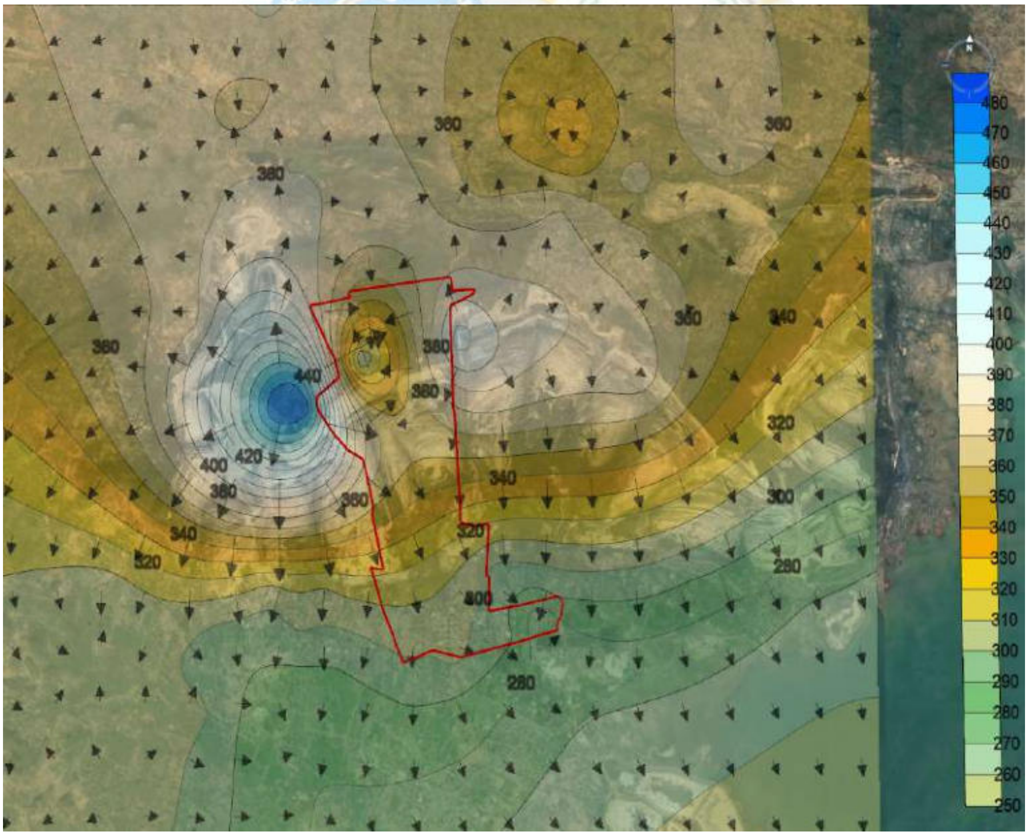


Figure 9: Post-monsoon ground water flow direction

The plot of ground water flow direction during pre and post monsoon season indicates that the flow converges towards the dip of the seam at the north portion of the mine lease area. On the south of the lease area, the flow of ground water is in southward direction as shown in the Figure 8 and 9.

6. SAMPLE COLLECTION

6.1 Overburden Samples

The overburden and inter burden samples were collected from different operating benches of Nigahi OCP. Ten to fifteen Kgs of overburden samples were collected in empty cement bags. During two visits made at site, five bags of OB samples were collected from the mine and while sampling, care was taken to collect representative sample from different locations. One batch of inter-burden samples was collected from in between Turra and Purewa bottom seam and another batch of overburden sample was collected above Purewa seam i.e., for both dragline and shovel-dumper faces. The coordinates of sampling points are given in Table 10. The sample collection locations at Nigahi OCP are shown in Figure 10.

Table 10: Coordinates of OB samples collected from Nigahi OCP

Date	**Sample-1**		**Sample-2**		**Sample-3**	
	Latitude	**Longitude**	**Latitude**	**Longitude**	**Latitude**	**Longitude**
19.12.22	24° 9'34.38"N	82°37'39.36"E	24° 9'57.00"N	82°37'44.94"E	24° 9'57.48"N	82°36'58.56"E
28.02.23	24° 9'53.34"N	82°36'53.52"E	24°9'38.10"N	82°36'52.86"E	No samples were taken	

Figure 10:: Location of sample collection site at Nigahi OCP

6.2 Ash Samples

On 19th December, 2022, the pond ash samples were collected from Vindhyachal Super Thermal Power Plant and on 28th February, 2023, the pond ash samples were collected from Shakti Nagar Thermal Power Plant. While collecting the samples, care was taken to draw it across the layer of deposit by digging a ditch of 2 to 3 feet deep and scraping it across the depth. The samples were collected in empty cement bags and were sealed with thread. The representatives' samples were then prepared by coning and quartering in the laboratory for the analysis. The coordinates and pictures of location from where pond ash samples of Vindhyachal and Shakti Nagar Thermal Power was collected is given in Table11 and Figure 11 and Figure 12 respectively.

Table 11: Coordinates of Pond ash samples collected

Date/ Location	Sample-1		Sample-2		Sample-3	
	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
19.12.22 Vindhyachal	24° 3'43.32"N	82°41'11.40"E	24° 3'43.13"N	82°41'11.14"E	24° 3'42.81"N	82°41'10.70"E

28.02.23 Shakti Nagar	Latitude: 24° 3'33.07"N; Longitude: 82°41'54.73"E

Figure 11: Pond ash sampling location at Vindhyachal Thermal Power Plant

Figure 12: Pond ash sampling location at Shakti Nagar Thermal Power Plant

7. LABORATORY STUDIES

7.1 Physical Characteristics

The physical characteristics of ash vary with the quality/rank of coal used, degree of pulverization, furnace temperature, its chemical composition etc. Likewise, the physical characteristics of overburden are principally affected by the geology of the area, mining method, topography of the area etc. Storage, transportation, re-handling and reclaiming of pond ash and overburden material at opencast mine have been found to be greatly influenced by physical characteristics viz., specific gravity, bulk density, porosity, angle of repose, permeability, compressibility, granulometric distribution and other geotechnical parameters.

(a) **Specific gravity** of fill material is determined in the laboratory by a standard procedure as per B S- 733.

Sp. Gr. of Solid particles

Vindhyachal Pond Ash (VPA) = 2.07

Shaktinagar Pond Ash (SPA) = 2.16

Overburden = 2.54

(b) Bulk density is measured as follows:

- A known weight of the sample is taken in a measuring cylinder of 2000ml capacity.
- The volume occupied by the material in a loose state is noted down; then
- The cylinder is tapped gently over a soft cushion till a constant height is achieved.
- The volume occupied by the tapped material is noted down.

$$\text{Bulk density} = \frac{\text{Weight of the sample}}{\text{Volume occupied}} \text{ in T/m}^3 \text{ or gm/cc}$$

Bulk Density (T/m^3 or gm/cc)

Vindhyachal PA : 1.01

Shaktinagar PA : 0.94

OB : 1.77

Bulk densities of different percentage mix of Vindhyachal Pond ash in overburden material were determined in the laboratory and the results are given in the Table 12.

Table 12: Bulk density of different mix composition of overburden and ash

OB/ Pond Ash	Bulk Density (T/m^3)
100/0	1.77
80/20	1.565
70/30	1.512
60/40	1.407
0/100	1.01

It is seen that with increasing the percentage of pond ash in mix with overburden, bulk density of admixture decreases. For predicting long term phenomenon, the linear regression model is fitted to the data and corresponding coefficient of determination (R^2) is estimated. The results show that the variation in bulk density with different percentage of pond ash can be well explained through the fitting of linear regression model.

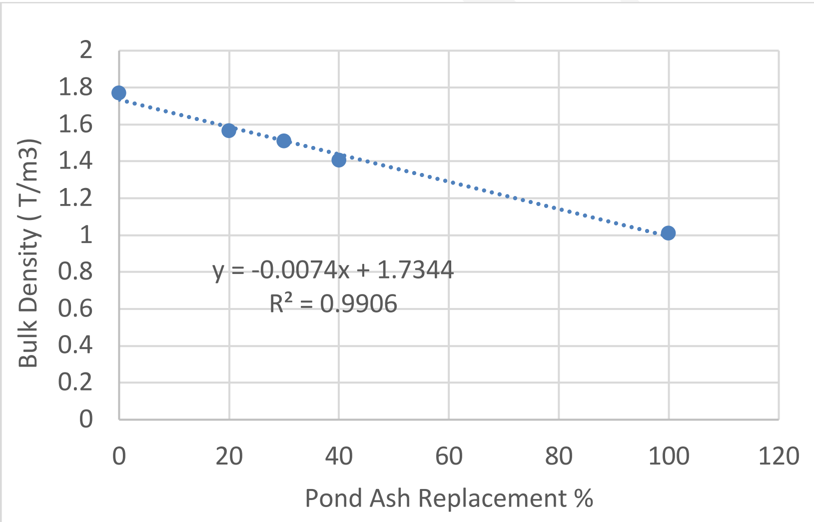


Figure 13: Variation in bulk density of the ash- OB admixture with the increase in ash %

(c) Grain Size Distribution

Grain size distribution controls the percolation and settlement properties of back fill, it's porosity, compressibility and in case of pozzolan, it's pozzolanic activities. Depending upon the quantity of the fill material, degree of size reduction (depending on the method of removing the overburden and its fragmentation) there could be great variability in the fractional size analysis of opencast backfill material. The higher the fines content, lower is the percolation or infiltration rate. Grain size also affects void ratio, compressibility and ultimately the bearing capacity of the fill. The lower the void ratio, higher is the strength.

Assuming other parameters to be same, different grain sizes during and following backfilling, one can analyze particle sizes to predict how a fill composed of a given material may be expected to behave. A fill with well-graded particles will offer more resistance to displacement and settlement than one with uniformly graded particles. Poorly graded material has more uniform distribution with a disproportionately high amount of overburden/ash within a narrow size range

The grading of a fill material is determines by the coefficient of uniformity (Cu). The shape of the grain size distribution curve called coefficient of curvature (Cc) were determined by using the following relation:

$$Cu = D_{60}/D_{10}; \quad \text{and}$$

$$Cc = (D_{30})^2 / (D_{10} * D_{60})$$

Where;

D_{30} =30% finer size

D_{10} =10% finer size

D_{60} =60%finer size

A well graded soil is generally considered to have a coefficient of uniformity (Cu) of 4 – 6 and coefficient of curvature (C_c) of 1 – 3. Cu value of less than 4 is considered to be uniformly graded. A flat size distribution curve indicates a material which is well graded, where the size fraction is relatively evenly represented

Particle size distribution means the range of sizes of particles in a soil or ash particles and percentage of particles which occur within a range. This can be done either by sieve analysis by using mechanical sieve shaker or by using lazer based particle size analyzer, former being preferred for coarse grained material like overburden and bottom ash and later for fine grained soils such as fly ash, mill tailings and dust sample. In many cases combination of both is required. In this experiment, both the use of mechanical sieve shaker and lazer based particle size were used. The photographic view of the sieves in sieve shaker with sieves and the laser-based Malvern "MASTERSIZER – 3000" is shown in the Figure 14.

In the laboratory, the grain size analysis was done using the following procedure:

1. The raw material is well mixed and by coning & quartering a representative sample is taken.
2. A known weight of the representative sample is taken and sieved with sieves of sizes given in the subsequent table was carried out

Figure 14: Electrically operated sieve shaker and Lazer based MASTERSIZER – 3000

The grain size distribution of the Pond ash sample of shaktinagar and vindhyanagar was carried out by "Mastersizer -3000". This instrument works on the principle of wet dispersion method. It is based on laser diffraction technique.

7.2 Nigahi overburden

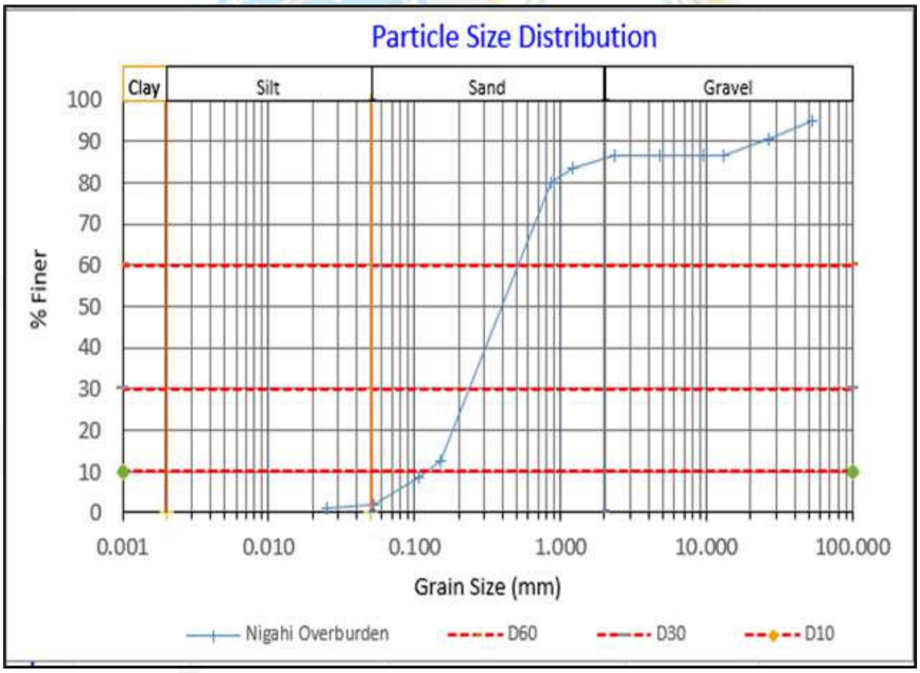


Figure 15: Particle Size Distribution of Nigahi Overburden Material

Sieve Size (mm)	% Passing
53	95.15
50	95.15
37.5	95.15
26.5	90.73
13.2	86.50
12.5	86.50
9.5	86.50
6.7	86.50
4.75	86.50
2.36	86.50
1.2	83.74
0.85	79.83
0.15	12.69
0.106	135.77
0.053	207.12
0.045	30.56
0.038	2.77
0.025	0
PAN	0

Cu (Coefficient of Uniformity) =	3.97
Cu (Coefficient of Curvature) =	0.91

D_{60} =	0.50 mm
D_{30} =	0.24 mm
D_{10} =	0.126 mm

A value of Cu greater than 4 to 6 classifies the soil as well graded. When Cu is less than 4, it is classified as poorly graded or uniformly graded soil. The grain size distribution curve indicate that Nigahi overburden belongs to the category of poorly graded sand with a CBR varying from 10 to 40 ks = 54 - 81 MN/m3, Drained Behavior, k > 1E-5 m/s.

7.3 Vindhyachal Pond Ash

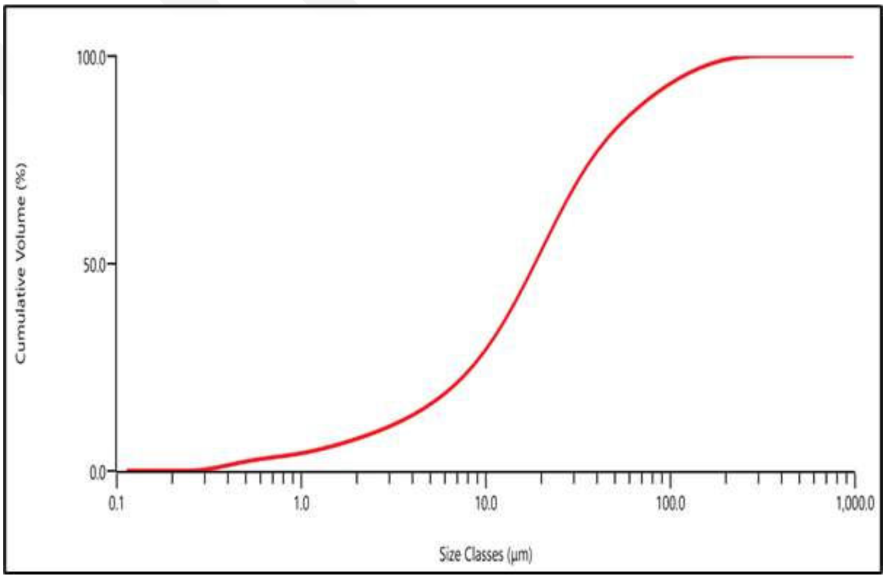


Figure 16: Particle Size Distribution of Vindhyachal Pond Ash

Specific Surface Area 1119 m^2/kg
D [3,2] 5.309 µm
D [4,3] 31.550 µm
Volume Below (25) µm 61.78 %
Volume Below (53) µm 83.38 %

Dv (10) 2.748 µm
Dv (50) 18.446 µm
Dv (90) 78.023 µm
Dv (30) 10.258 µm
Dv (60) 23.838 µm

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.500	2.26	30.000	68.31	600.000	100.00
1.000	4.26	50.000	82.18	800.000	100.00
2.000	7.76	60.000	85.72	900.000	100.00
5.000	16.09	100.000	93.38		
10.000	29.29	150.000	97.42		
20.000	53.17	300.000	99.99		

7.4 Shakti Nagar Pond Ash

Concentration 0.0575 %
Uniformity 0.557
Specific Surface Area 412.4 m^2/kg
D [3,2] 13.724 µm
D [4,3] 172.040 µm
Volume Below (25) µm 9.28 %
Volume Below (53) µm 13.23 %

Dv (10) 31.079 µm
Dv (50) 155.761 µm
Dv (90) 317.593 µm
Dv (30) 108.347 µm
Dv (60) 181.647 µm

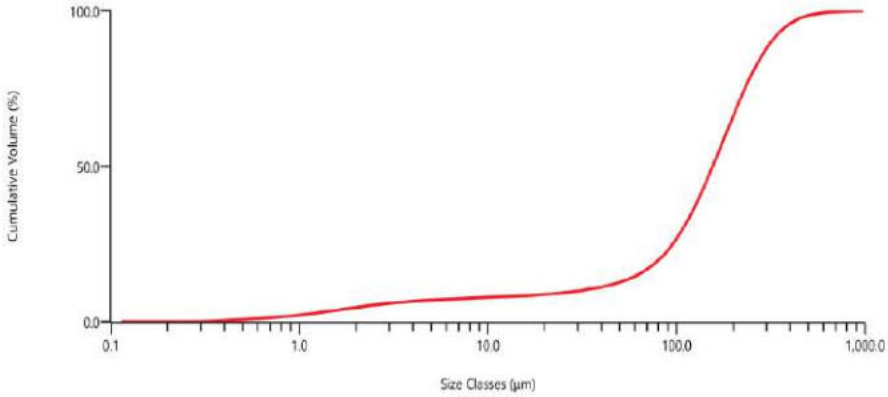


Figure 17: Particle Size Distribution of Shaktinagar Pond Ash

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.500	0.69	30.000	9.87	600.000	99.30
1.000	2.16	50.000	12.71	800.000	99.80
2.000	4.64	60.000	14.58	900.000	99.92
5.000	6.94	100.000	26.67		
10.000	7.79	150.000	47.61		
20.000	8.75	300.000	87.89		

7.5 Grain Size Distribution of Ash – OB admixture

Grain Size distribution (GSD) was carried out when ash was mixed with OB in different proportion to determine the changes in material gradation on adding ash to OB

Vindhyanagar

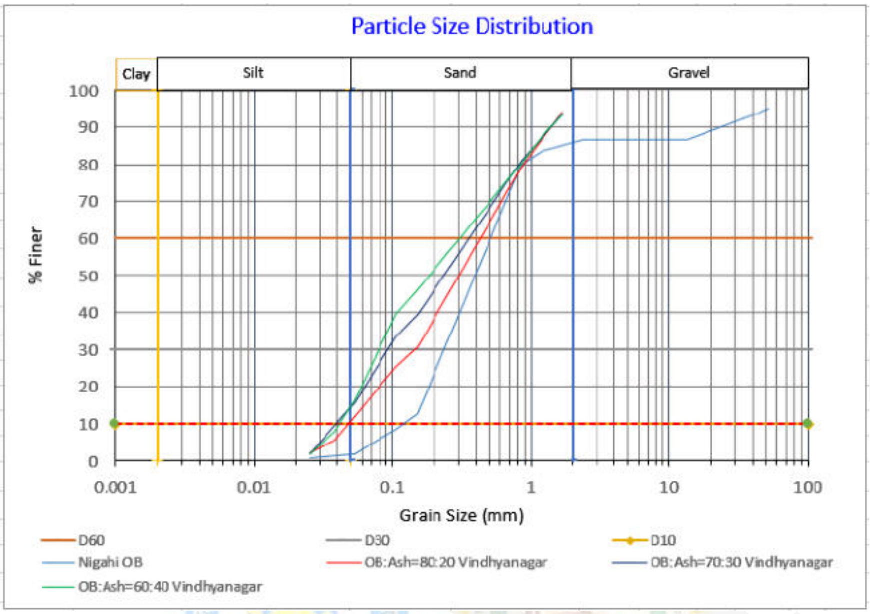


Figure 18: Variation in PSD with the increase in Vindhyachal ash % in OB

OB %	Ash%	Cu	Cc
100	0	4.03	1.01
80	20	8.75	0.97
70	30	11.67	0.77
60	40	10.00	0.71

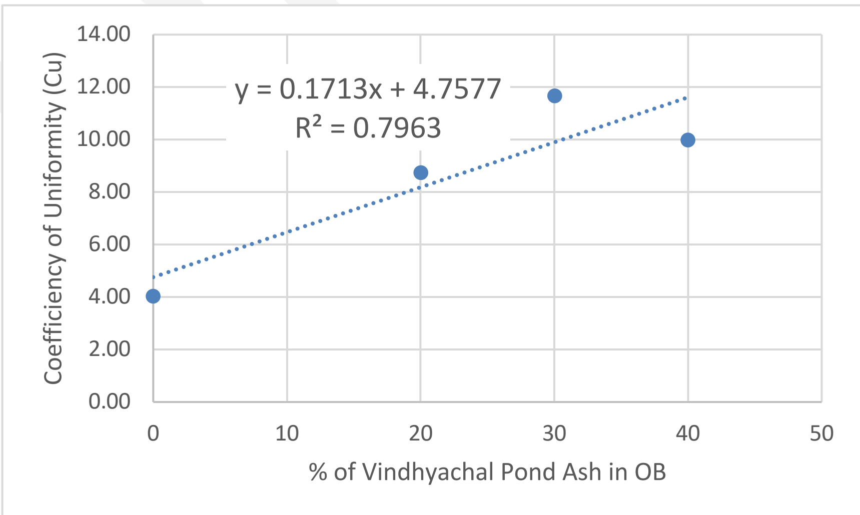


Figure 19: Variation in Cu with increased Vindhyachal ash % in OB

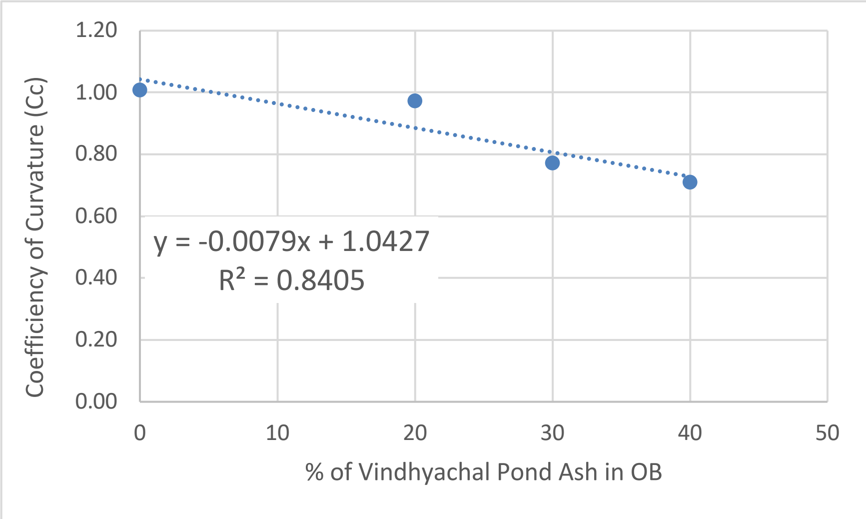


Figure 20: Variation in Cc with increased Vindhyachal ash % in OB

From the grain size distribution curve, it was found out that the coefficient of uniformity and coefficient of curvature for Vindhyachal ash increases and decreases respectively with the increase in ash % in OB. Therefore, it can be concluded increase in ash percentage in OB increases the overall grading of the mix as Cu increased from 4.03 to 10.

Shaktinagar

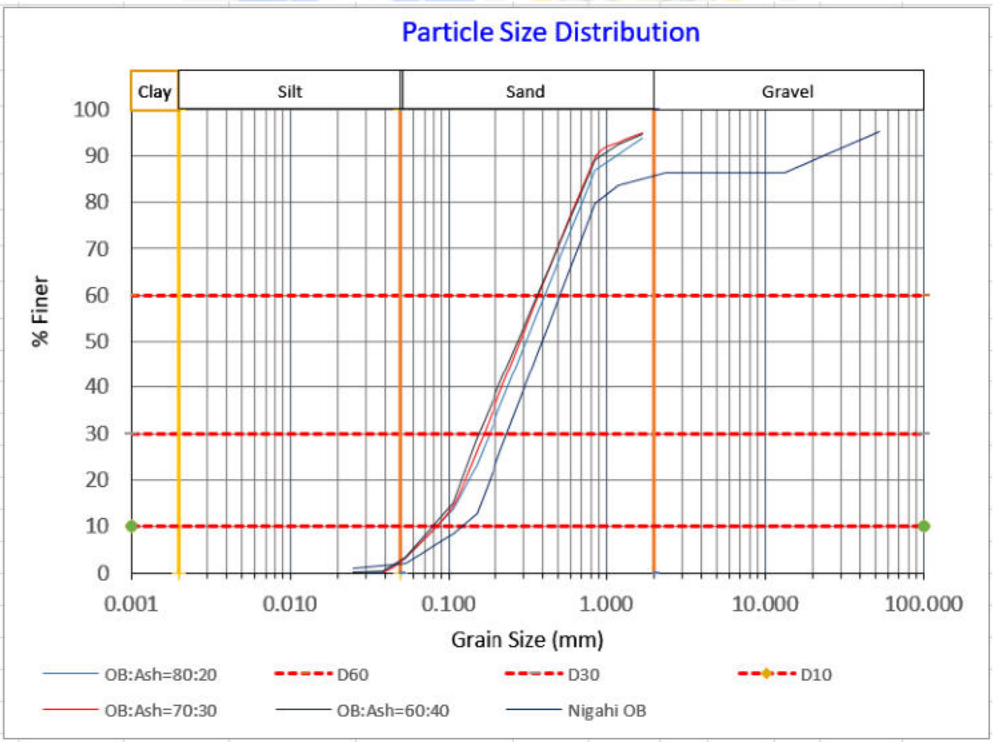


Figure 21: Variation in GSD with the increase in Shaktinagar ash % in OB

OB	Ash	Cu	Cc
100	0	4.03	1.01
80	20	4.71	0.97
70	30	4.72	0.92
60	40	4.92	0.86

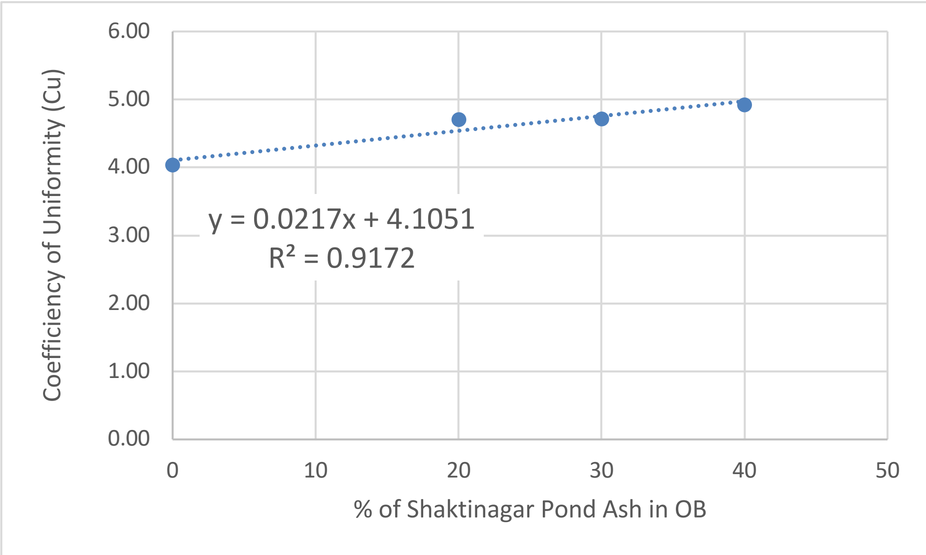


Figure 22: Variation in Cu with increased Shaktinagar ash % in OB

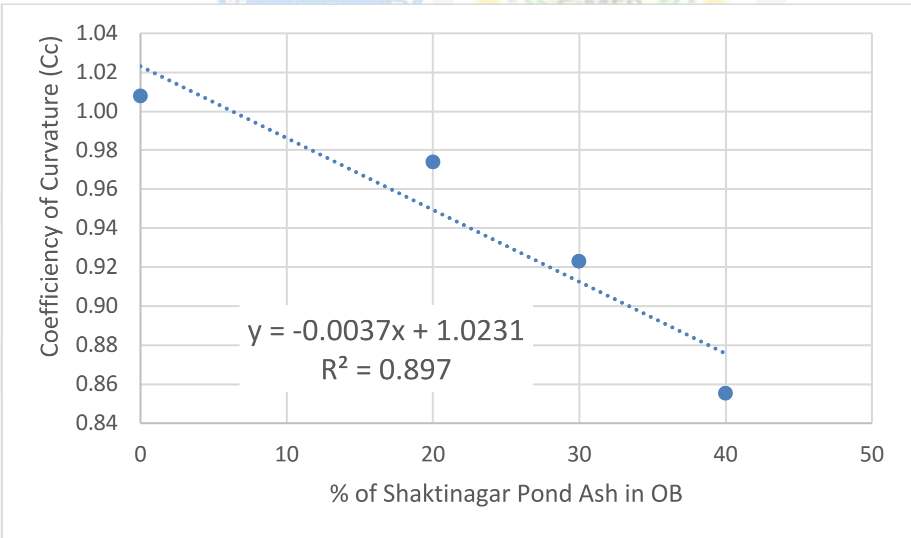


Figure 23: Variation in Cc with increased Shaktinagar ash % in OB

From the grain size distribution curve, it was found out that the coefficient of uniformity and coefficient of curvature for Shaktinagar ash increases and decreases slightly respectively with the increase in ash % in OB. Therefore, it can be concluded increase in ash percentage in OB increases the overall grading of the mix as Cu increased from 4.03 to 4.92.

(d) Permeability and Angle of Repose

Permeability test

Permeability refers to the ability of a porous material to allow a liquid to pass through its pores. Since the pores are connected with each other, the flow of a liquid takes place through the pores if there is difference in head at the two ends of the sample. The ability of the in situ fill to dissipate pore pressure is affected by its permeability characteristics which in turn are affected by the percentage of fine particles in the fill. Water (rain and ground water) present in the pore spaces of loose unconsolidated porous overburden dumps as well as in fissures, joints and fault planes of rock slopes plays an important role to define the stability of overburden/rock slopes. Water present in such pore and fissures increases the dead weight of the slope causing the tangential component of stress to increase and it also decreases the shear strength of the backfilled mass (cohesion between particles reduce), this leads to its instability. Water also influences the angle of repose of unconsolidated dumps. Slightly wet unconsolidated materials exhibit a very high angle of repose because surface tension between the water and the solid grains tends to hold the grains in place. When the material becomes saturated with water, the angle of repose is reduced to very small values. This situation is dangerous and is likely for an accident to happen, an application of cyclic loading may cause the whole mass to liquefy (caused due to drastic and sudden reduction is shear stress holding the particles together) and the material tends to flow like a fluid. Ground water can wash away the mineral cements or pozzolans that hold grains together. Water entering the soil can dissolve this cement and thus reduce the cohesion between the mineral grains. The position of water table also plays an important role in dump stability, water table tends to rise during wet seasons when more water infiltrates into the system, and falls during dry seasons when less water infiltrates.

Movements of leached out water from fill mass, containing heavy metals and trace elements, to the surrounding water bodies as well as soil depends on the water permeability characteristics of the fill material. This phenomenon in case of ash depends upon its grain size, porosity, level of densification and cohesion property. In general, ash due to its fineness and pozzolanic nature shows very low infiltration rate and high cohesion property, due to this, an ash filled mass acts as a barrier against the movements of the leachates. Keeping the above facts in mind permeability test on different admixture of overburden and pond ash was carried out in the laboratory using constant head permeameter apparatus.

Constant Head Test

Predictions of the drainage behaviors of a given fill materials are made on the basis of laboratory tests using a standard constant head permeameter. A constant head permeameter, as shown in Figure 24, consists of a glass tube, open at the top and a hole close to the top on the side. Three fourth of the tube is filled with the fill material in a slurry state and gently tapped over a soft cushion till a constant length "L" (cm) is attained. The tube is vertically clamped and water is allowed to pour through rubber tubing connected to the mains at a slow rate at the top so that a constant head 'H' (cm) is maintained over the fill material. The excess water is allowed to overflow from the top through rubber tubing connected to the hole in the tube close to the top. A measuring cylinder is placed in the bottom of the permeameter to collect the percolated water 'Q' (cm^3) through the time 't' (hours). The area of percolation 'A' (cm^2) is noted by measuring the diameter of the bottom screen. The permeability 'K' (cm/hr) is calculated using the well-known Darcy's equation:

$$K = QL/AHt \text{ (cm/hr)}$$

The result of percolation test showed that for all mixes of Pond Ash and Overburden is given in the Table 13.

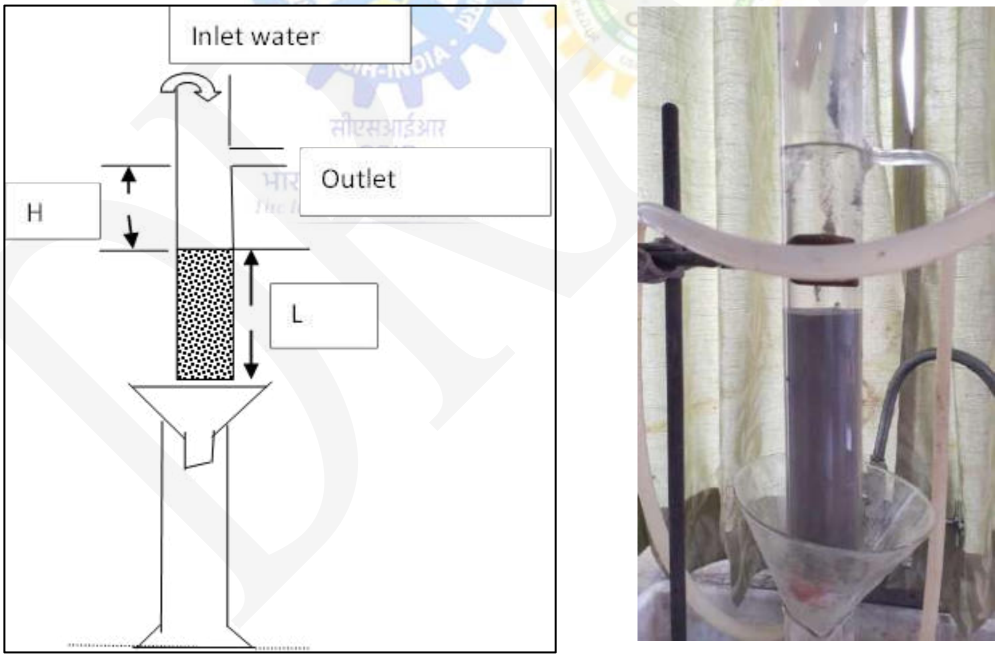


Figure 24: Constant Head Permeameter

Table 13: Permeability of different mix composition of Vindhyachal PA and OB

Pond Ash (%)	**Permeability k (cm/ hr)**
0 (100% OB)	25.57
5	18.204
30	7.237
40	5.705
50	4.386

The permeability of water is the OB was found to reduce from 25.57 cm/hr to 9.18 cm/hr when ash is added to it. This may be attributed to the fact that the test was carried out under saturation condition with constant head of water over it, this facilitated the finer ash particles to seep in the voids of larger OB particles thereby filling up the voids and reducing the permeability.

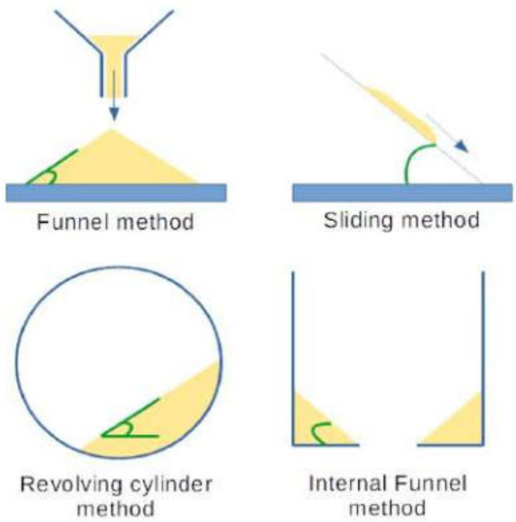
Angle of Repose

The Angle of Repose (AR) has been made use of in many branches of scientific research to show the solids flow homes. The angle of the repose is a characteristic that belongs to inter particle resistance or friction to the movement amongst the particles.

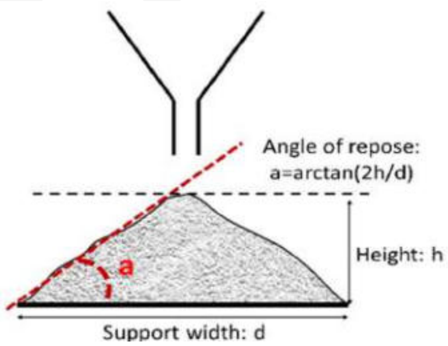
The angle of repose refers to the maximum angle at which a granular material, such as sand, soil, or grains, can rest without sliding or flowing downslope. It is the steepest angle relative to the horizontal plane that a pile of loose material can maintain without collapsing or cascading. At this angle, the gravitational force acting on the material is balanced by the frictional forces between the particles, preventing further movement. One of the most commonly used definitions of the angle of repose is the steepest slope of the unconfined material, measured from the horizontal plane on which the material can be heaped without collapsing. In soil mechanics, Karl Terzaghi defined the angle of repose as a special internal friction angle that is acquired under extreme (loosest state) conditions. Additionally, it may be defined as the angle of maximum slope inclination at which the soil is barely stable. Geotechnically, the primary application of the angle of repose is in the determination of slope stability and design of retaining structures.

Method of Determine the Angle of Repose

Although there are different methods and guidelines available in the literature, the methods are neither standardized nor consistent.



The method adopted to determine angle of repose at the laboratory is called the fixed funnel method. In the fixed funnel method, the granular materials are poured from a funnel at a certain height onto a selected base with known roughness properties. The funnel is either fixed or raised slowly while the conical shape of the material heap is forming to minimize the effect of the falling particles. The pouring of the material is stopped when the heap reaches a predetermined height or width. Then, the angle of repose is measured by the inverse tangent (arctan) rule at which the average radius of the formed conical shape and the maximum height of the heaped material are measured, and then the angle of repose is determined as the arctan of the maximum height to average radius ratio. This test is the most frequently used for different sizes



7.6 Factors Influencing Angle of Repose

The angle of repose is influenced by various factors, including the size, shape, and cohesion of the particles, as well as the moisture content of the material. Cohesive and saturated materials tend to have a lower angle of repose, as they exhibit greater internal friction between particles. In contrast, dry and coarse materials generally have higher angles of repose.

The angle of repose of an ash and overburden mixture can vary depending on several factors, including the characteristics of the ash and overburden materials, their particle sizes, shapes, and moisture content, as well as the mixing ratio of the two components.

Generally, the angle of repose of a mixture tends to be influenced by the individual angles of repose of the components and their relative proportions. If the mixture contains fine ash particles and coarser overburden materials, the angle of repose may be closer to the angle of repose of the overburden component due to the larger particles dominating the overall behavior. Similarly, if the mixture has a higher proportion of ash, its angle of repose may be closer to the angle of repose of ash.

The effect of adding ash to overburden material on its angle of repose can vary depending on several factors, including the characteristics of the ash and overburden materials, their particle sizes, shapes, moisture content, and the mixing ratio of the two components. Here are some general considerations:

1. Particle Size and Shape: If the ash and overburden materials have similar particle sizes and shapes, the addition of ash may not significantly alter the angle of repose. However, if the ash particles are finer compared to the overburden particles, it can affect the overall packing and interlocking behavior, potentially resulting in changes to the angle of repose. Ash being finer enters the voids of larger size overburden material and acts as a filler material increasing the overall bonding and increased angle of repose

2. Cohesion and Friction: Ash particles generally have lower cohesion compared to many overburden materials. Overburden may consist of various materials, including soil, rock, clay, sand, or gravel. The cohesion of overburden can vary depending on its composition and the geological processes that have acted upon, As the percentage of ash increases, the overall cohesion of the mixture may decrease, potentially resulting in a lower angle of repose.

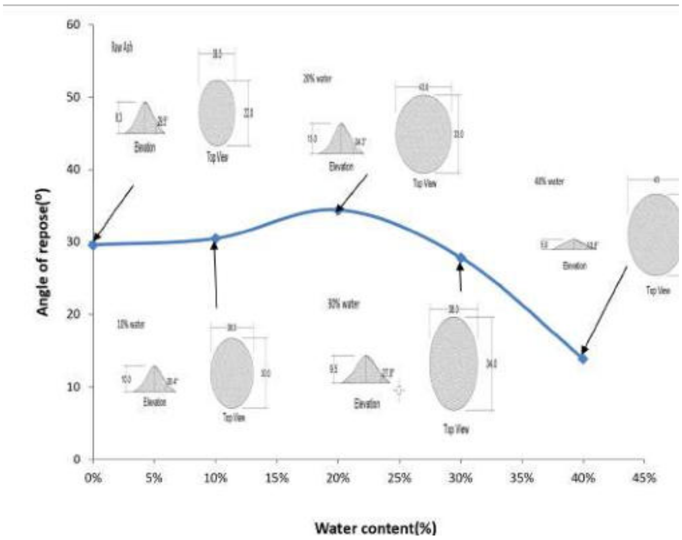
Table 14: Angle of repose of different mix composition of pond ash and overburden

Sl No.	**Composition**	**Vindhyachal**	**Shaktinagar**
		Average Angle of Repose (degree)	
1	100 % OB	37	37

2	80% OB + 20 FA	39	38
3	70% OB + 30% FA	42	40
4	60% OB + 40% FA	44	41
5	50% OB + 50 % FA	46	43

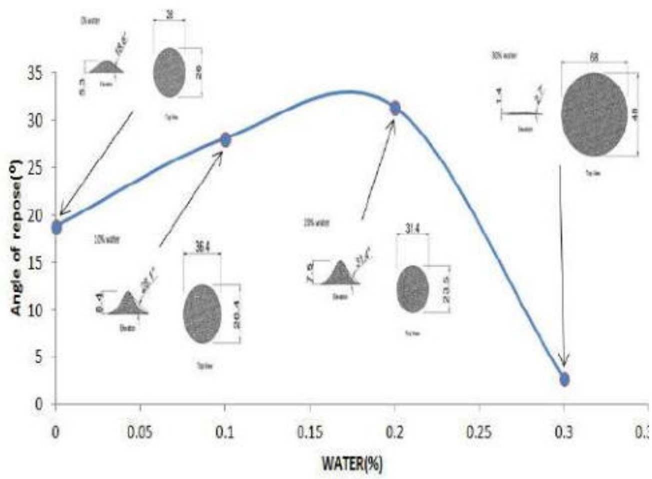
Ash with water (0% OB)

Water content(%)	Angle of repose(⁰)
0%	29.57
10%	30.46
20%	34.38
30%	27.82
40%	13.87



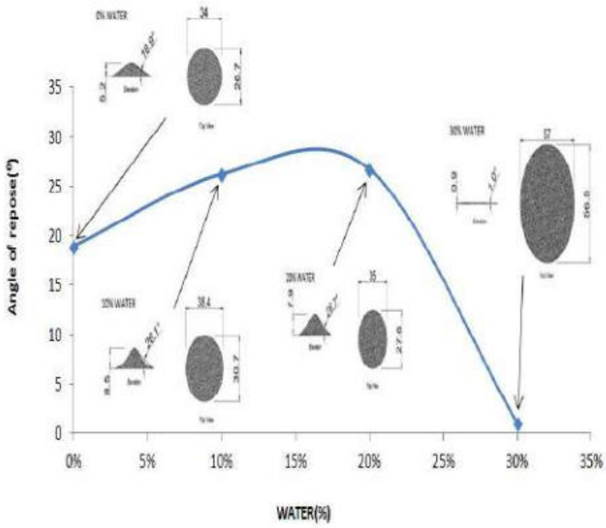
OB with water (0% Ash)

Water content(%)	Angle of repose(⁰)
0%	18.87
10%	28.14
20%	31.46
30%	2.76



OB: Ash with water (70:30)

WATER(%)	Angle of repose(⁰)
0%	18.91
10%	26.19
20%	26.71
30%	1.009



Laboratory studies were conducted to determine the changes in angle of repose of ash, OB and ash-OB admixture (30:70) when water was added to it. From the test results following conclusion could be drawn:

1. When water was added to coal ash, the angle of repose initially increased from 29.57 degrees to 34.38 degrees, but when the water % in the ash increased beyond 20, drastic reduction in angle of repose of ash was observed
2. When water was added to OB material which is mainly crushed sand stone, the angle of repose initially increased from 18.87 degrees to 31.46 degrees, but when the water % in the ash increased beyond 20, drastic reduction in angle of repose of OB was observed.
3. When water was added to OB and Ash admixture in the ratio 70:30, the angle of repose initially increased from 18.91 degrees to 26.71 degrees, but when the water % in the mix increased beyond 20, drastic reduction in angle of repose of the mix was observed. When the mix was saturated with 30% water, the angle of repose reduced to around 1 (one) degree

Laboratory studies to determine the angle of repose of the fill material indicates that when the mix or ash or OB is undersaturated, cohesion exists between particles and the angle increases. But, when the water percentage in the backfill, material is increased beyond a certain limit, cohesion between the particles decreases and the pore water pressure increases resulting in decrease in shear strength of the fill material. Hence, it is advised to encapsulate the ash – OB mix backfilled material with a layer of OB so that it is not exposed to direct rainfall, further, it is also advised to install proper drainage system (gully, toe and peripheral drains , water garlands etc.) to prevent water movement along the crest edge of the dump

Figure 25: Angle of Repose of Nigahi Overburden

The change in angle of repose of OB was found out to be negligible (almost 2 degrees increase) when OB was mixed with 25% pond ash

7.7 Compressibility Characteristics

Compressibility study was carried out as CSIR-CIMFR geotechnical laboratory with the help of (Universal Testing Machine) UTM and a cylindrical container with a lid arrangement. The result of compressibility test on Vindhyachal pond ash, OB and its admixture is shown in Table 15.

Table 15: Percentage Compressibility of overburden, ash and its admixture

Pressure	Compressibility (%)		
(kg/cm^2)	**OB**	**Pond Ash**	**OB: PA = 75: 25**
0	0.00	0.00	0.00
5	3.38	1.97	3.02
10	4.66	3.94	4.64
15	6.72	5.63	6.33
20	8.01	6.20	7.21
25	8.77	6.76	7.94
30	9.45	7.89	8.73
35	10.12	8.73	9.96
40	10.76	9.58	10.54
45	11.65	10.42	10.98
50	12.44	10.70	11.65
55	13.09	10.99	12.64
60	13.55	10.99	12.98
65	14.01	12.39	13.34
70	14.14	12.39	13.78
75	14.87	12.39	13.98
80	14.96	12.39	14.12
85	15.21	12.39	14.34
90	15.45	12.68	14.52

Compressibility broadly describes the overall tendency to soil to compress under applied stress**.** The compressibility of OB material mainly composed of sandstone and clay material was found out to be maximum followed by pond ash. The compressibility of OB:PA mix in the ratio of 75:25 was found to decrease when compared to compressibility of OB along, this may be attributed to the filling of interstitial voids in the OB matrix by finer PA particles forming a compact mass resisting the applied external stress.

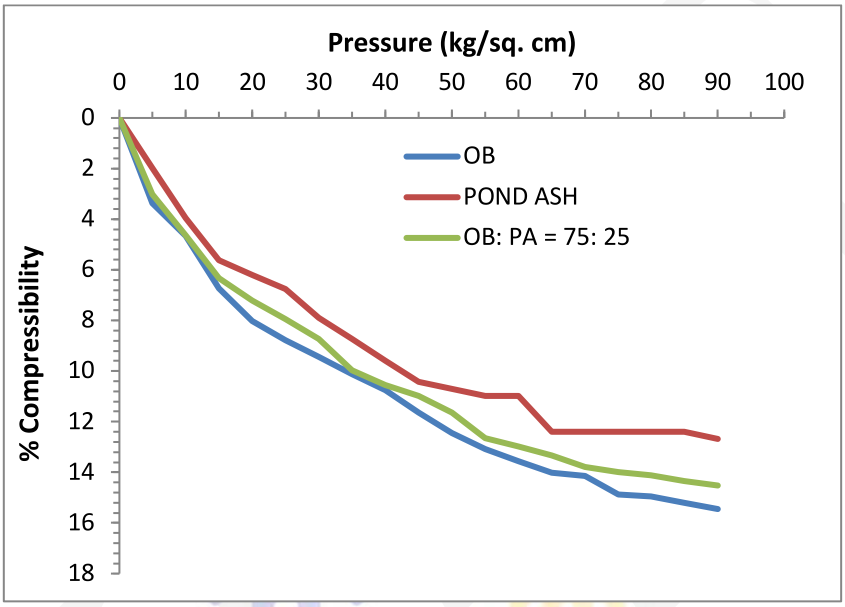


Figure 26: Compressibility of pond ash -OB mix

7.8 Geotechnical Studies

7.8.1 Liquid Limit Test

OBJECTIVE

From liquid limit test, the compression index may be estimated, which is used in settlement analysis. If the natural moisture content of soil is higher than liquid limit, the soil can be considered as soft and if the moisture content is lesser than liquid limit, the soil is brittle and stiffer. The value of liquid limit is used in classification of the soil and it gives an idea about plasticity of the soil

The liquid limit is the moisture content at which the groove formed by a standard tool into the sample of soil taken in the standard cup, closes for 12 mm on being given 25 blows in a standard manner. At this limit, the soil possesses low shear strength

Grooving Tool

Conforming to IS: 9259-1979.

Figure 27: Mechanical Liquid Limit Device (Conforming to IS: 9259-1979)

Ref: IS 2720(Part 5):1985 Methods of test for soils: Determination of Liquid and Plastic limit (second revision).

VINDHYACHAL ASH – OB MIX

OBSERVATION

1. Details of the sample- 100 % OB

Parameters	Observation N0.1	Observation N0.2	Observation N0.3
Container Number	1	2	3
Weight of Container	32.4 gm	31.9 gm	31.6 gm
Weight of container + Wet soil	83.9 gm	73.2 gm	77.9 gm
Weight of container + dry soil	76.6 gm	67.5 gm	71.8 gm
Weight of water	7.3 gm	5.7 gm	6.1 gm
Weight of dry soil	44.2 gm	35.6 gm	40.2 gm
Moisture content (%)	16.52	16.12	15.174
No. of blows	20	22	30

CALCULATION

A flow curve shall be plotted on a semi logarithmic graph representing water content on the arithmetical scale and the number of drops on the logarithmic scale. The flow curve is a straight line drawn as nearly as possible through the four or more plotted points. The moisture content corresponding to 25 drops as read from the curve shall be rounded off to the nearest whole number and reported as the liquid limit of the soil.

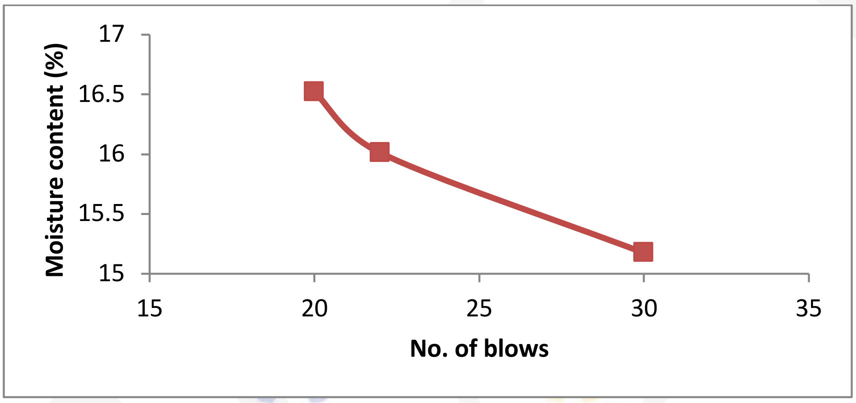
Flow index, If = (W1-W2)/ $\log_{10}$ (N2/N1)

Were,

If = Flow Index

W1 = Moisture content in percentage corresponding to N1 drops and

W2 = Moisture content in percentage corresponding to N2 drops

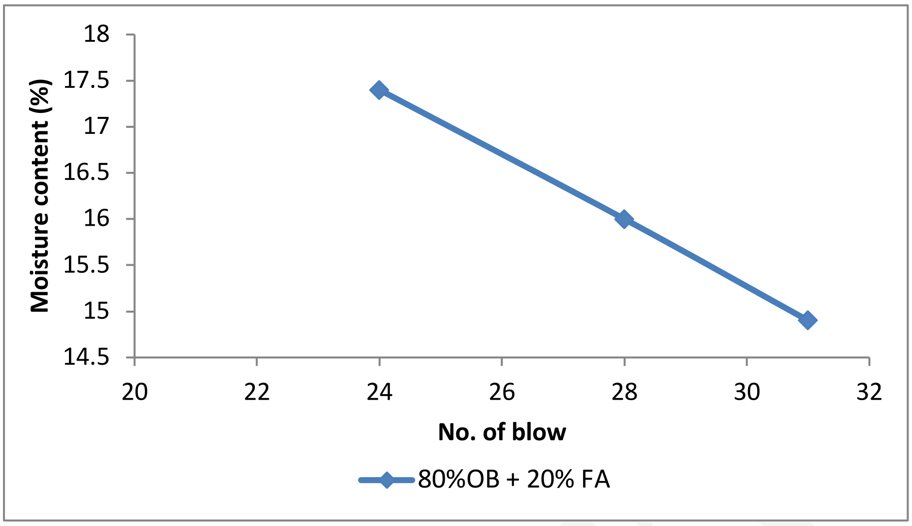


The moisture content corresponding 25 number of blows is **15.7 % for OB**

Similarly,

2. Details of sample- 20% Pond Ash + 80% OB

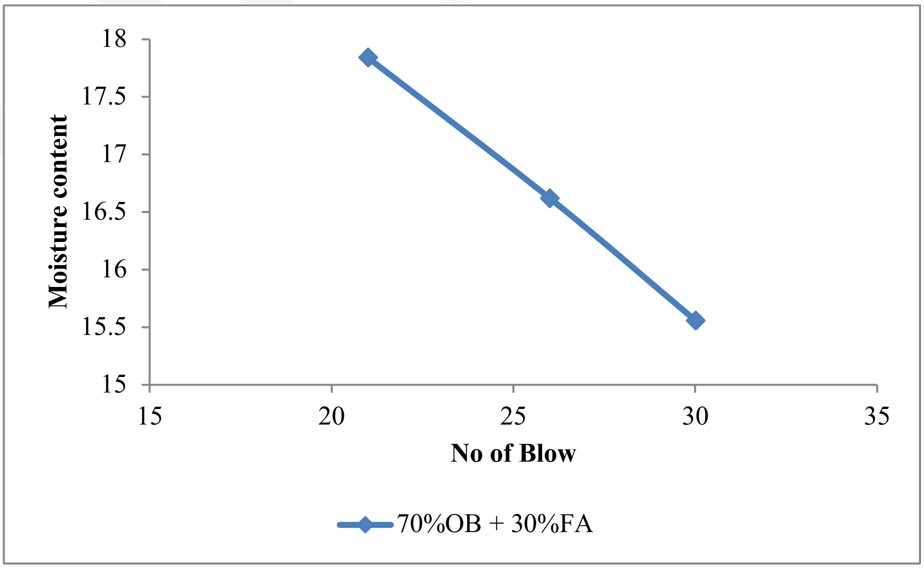
Parameters	Observation N0.1	Observation N0.2	Observation N0.3
Container Number	1	2	3
Weight of Container	31.5 gm	31.4 gm	31 gm
Weight of container + Wet soil	82.9 gm	63.5 gm	63.4 gm
Weight of container + dry soil	75.3 gm	59.1 gm	59.2 gm
Weight of water	7.6 gm	4.4 gm	4.2 gm
Weight of dry soil	43.8 gm	27.7 gm	28.2 gm
Moisture content (%)	17.4	15.9	14.9
No. of blows	24	28	31



The moisture content corresponding 25 number of blows is **17.05 %**

3. Details of sample- 30% Pond Ash + 70% OB

Parameters	Observation N0.1	Observation N0.2	Observation N0.3
Container Number	1	2	3
Weight of Container	48.5 gm	49.9 gm	43 gm
Weight of container + Wet soil	102 gm	94.8 gm	93.5 gm
Weight of container + dry soil	93.9 gm	88.4 gm	86.7 gm
Weight of water	8.1 gm	6.4 gm	6.8 gm
Weight of dry soil	45.4 gm	38.5 gm	43.7 gm
Moisture content (%)	17.84	16.62	15.56
No. of blows	21	26	30

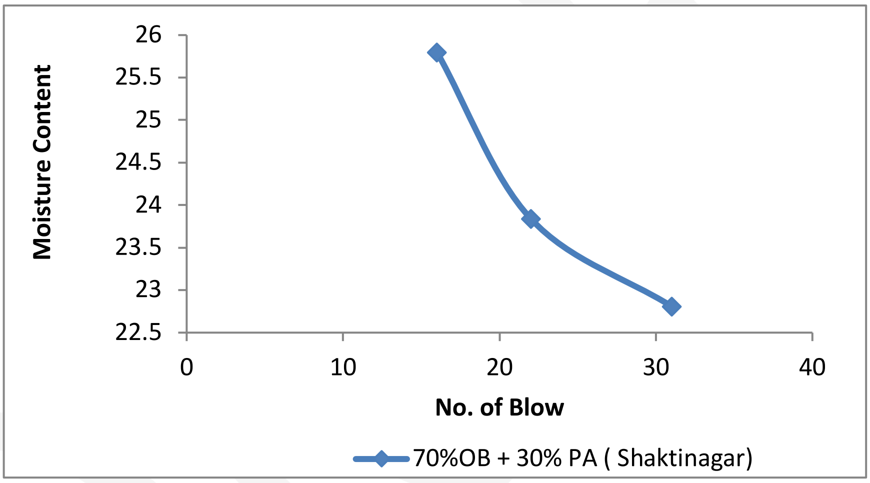


The moisture content corresponding 25 number of blows is **16.86 %**

SHAKTINAGAR ASH – OB MIX

1. **80% OB + 20% PA (Shaktinagar)**

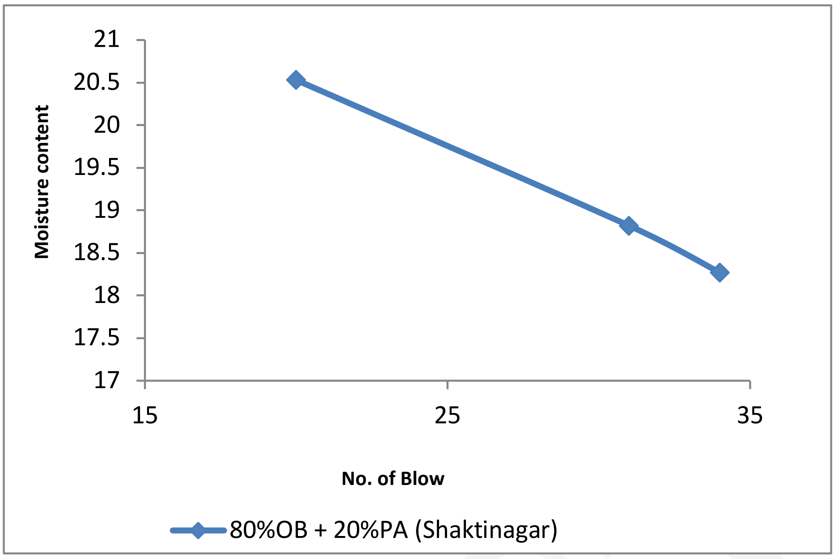
2. Parameters	Observation N0.1	Observation N0.2	Observation N0.3
Container Number	1	2	3
Weight of Container	31.6 gm	49.9 gm	31.5 gm
Weight of container + Wet soil	78.9 gm	100.8 gm	70.8 gm
Weight of container + dry soil	69.2 gm	91 gm	63.5 gm
Weight of water	9.7 gm	9.8 gm	7.3 gm
Weight of dry soil	37.6 gm	41.1 gm	32 gm
Moisture content (%)	25.8	23.84	22.81
No. of blows	16	22	31



The Liquid Limit corresponding 25 number of blows is **22.86 %**

3. **70% OB + 30% PA (Shaktinagar)**

Parameters	Observation N0.1	Observation N0.2	Observation N0.3
Container Number	1	2	3
Weight of Container	32.4 gm	31.9 gm	31.8 gm
Weight of container + Wet soil	72.9 gm	74.2 gm	64.8 gm
Weight of container + dry soil	66 gm	67.5 gm	59.7 gm
Weight of water	6.9 gm	6.7 gm	5.1 gm
Weight of dry soil	33.6 gm	35.6 gm	27.9 gm
Moisture content (%)	20.53	18.82	18.27
No. of blows	20	30	34



The Liquid Limit corresponding 25 number of blows is **19.75 %**

Summary

Variation of Liquid Limit of the mix with increase in PA % in OB

Ash in Overburden (%)	**LIQUID LIMIT**	
	Vindhyachal PA	Shaktinagar PA
0	15.7	15.7
20	17.05	22.86
30	16.86	19.75

From the laboratory studies on Liquid Limit of OB and Ash – OB admixture, it was found that with the increase in ash % in the OB the Liquid Limit increases when the ash % in OB increased to 20 % beyond that, the liquid limit decreases for both Vindhyachal and Shaktinagar Pond Ash% in OB.

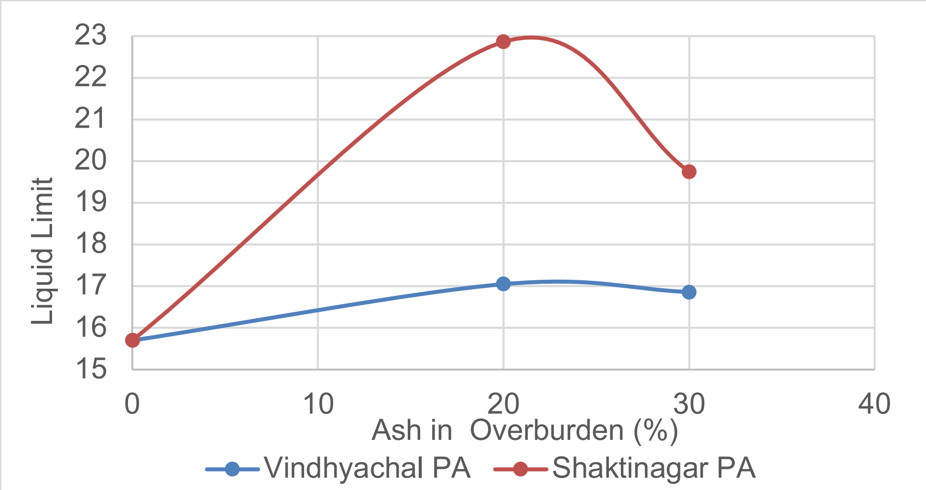


Figure 28: Variation in Liquid Limit with the increase ash content in OB

7.8.2 STANDARD PROCTOR TEST

Standard Proctor Test is carried out to study or understand the soil's compaction characteristics with variable moisture content. The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density.

Reference: - **IS 2720-PART VII-1980) Reaffirmed-2011**

Procedure

1. A 5-kg sample of air dried soil passing the 20 mm IS test sieve shall be taken. The sample shall be mixed thoroughly with a suitable amount of water depending on the soil type.
2. Weight the proctor mould without collar. Fix the collar and base plate. Place the soil in the Proctor mould and compact it in 3 layers giving 25 blows per layer with the 2.6 kg rammer falling through. The blows shall be distributed uniformly over the surface of each layer.
3. Remove the collar; trim the compacted soil even with the top of mould using a straight edge and weight
4. Divide the weight of the compacted specimen by 1000 cc and record the result as the bulk density.
5. Remove the sample from mould and slice vertically through and obtain a small sample for water content.
6. Thoroughly break up the remainder of the material until it will pass a no.4 sieve as judged by the eye. Add water in sufficient amounts to increase the moisture content of

the soil sample by one or two percentage points and repeat the above procedure for each increment of water added. Continue this series of determination until there is either a decrease or no change in the wet unit weight of the compacted soil.

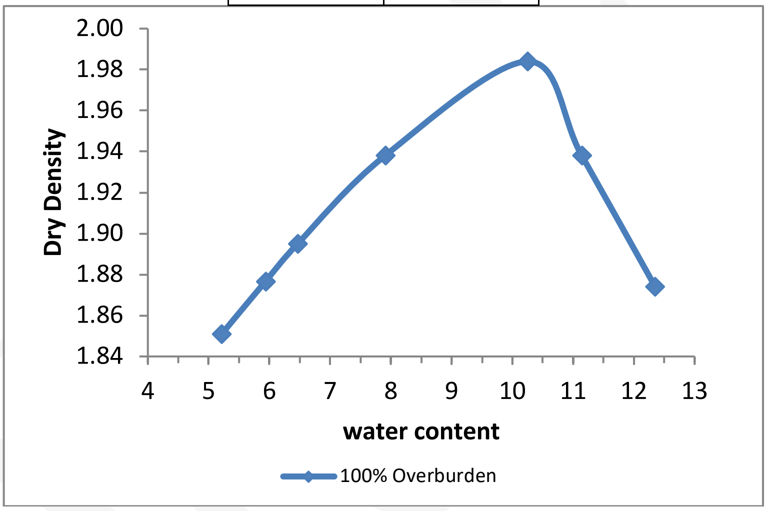
VINDHYACHAL ASH – OB MIX

Data and observation

1. <u>100% Overburden</u>

Dry Density (gm/cc)	1.85	1.88	1.89	1.94	1.98	1.94	1.87
Moisture Content (%)	5.21	5.94	6.46	7.91	10.25	11.14	12.35

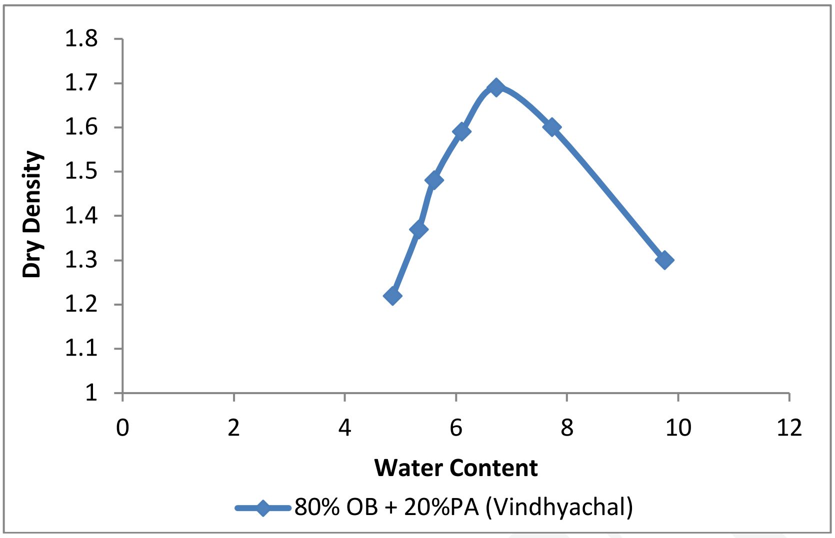
OMC	MDD
10.25	1.98



2. <u>80% Overburden + 20%PA (Vindhyachal)</u>

Dry Density (gm/cc)	1.22	1.37	1.48	1.59	1.69	1.6	1.3
Moisture Content (%)	4.86	5.33	5.6	6.1	6.72	7.72	9.75

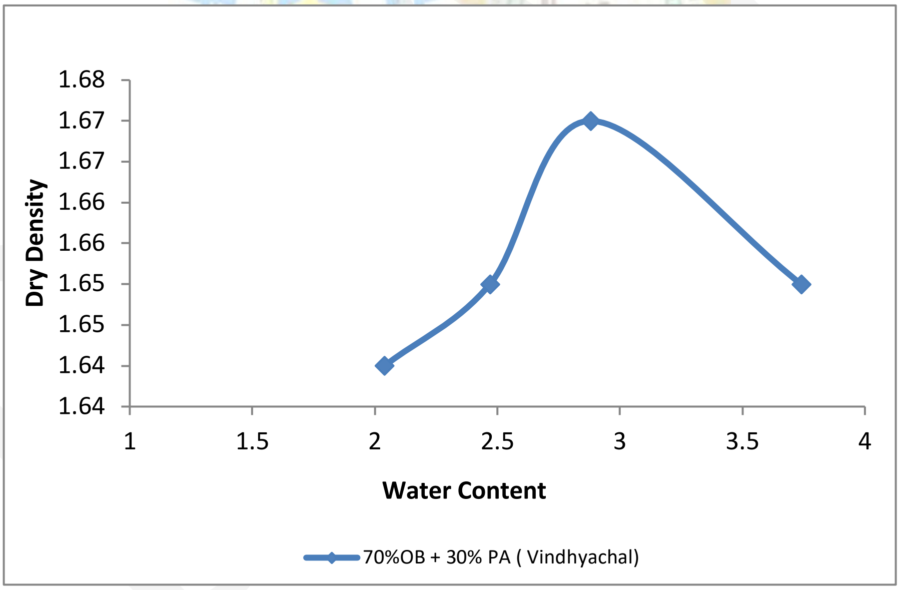
OMC	MDD
6.72	1.69



3. 70% Overburden + 30%PA (Vindhyachal)

Dry Density (gm/cc)	1.636	1.647	1.666	1.648
Moisture Content (%)	2.04	2.47	2.88	3.74

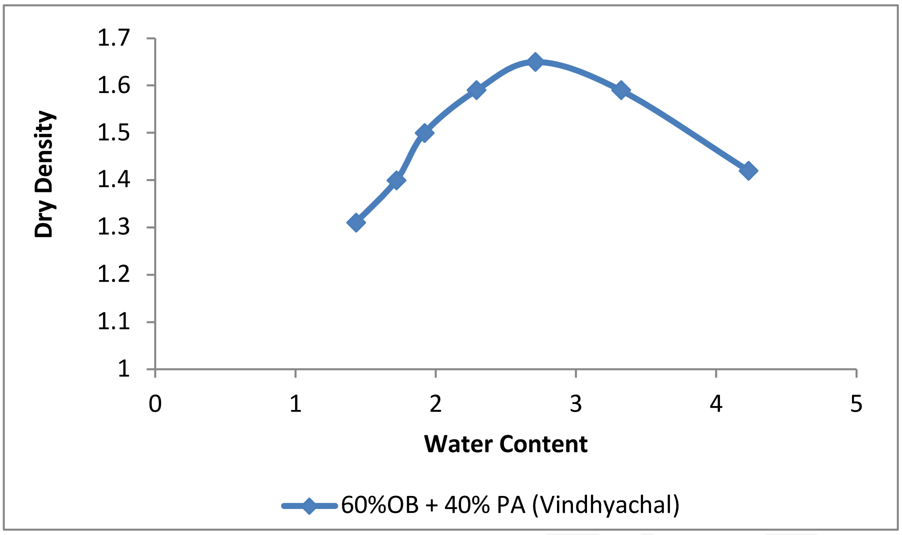
OMC	MDD
2.88	1.666



4. 60% Overburden + 40%PA (Vindhyachal)

Dry Density (gm/cc)	1.31	1.4	1.5	1.59	1.65	1.59	1.42
Moisture Content (%)	1.43	1.72	1.92	2.29	2.71	3.32	4.23

OMC	MDD
2.71	1.65



Summary

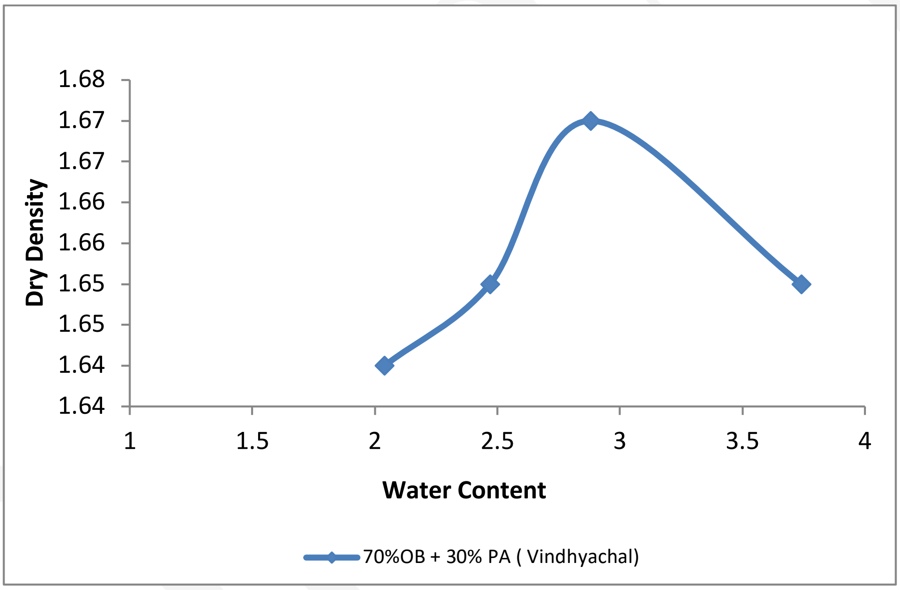


Table 16: Variation in OMC and MDD with change in Vindhyachal PA % in OB

Ash %	OMC	MDD
0	10.25	1.98
20	6.72	1.69
30	2.88	1.666
40	2.71	1.65

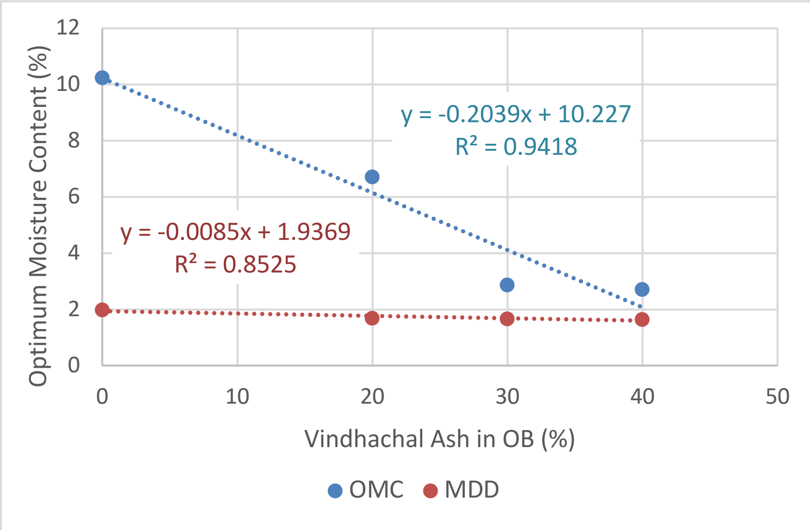


Figure 29: Variation of OMC and MDD with the increase in Vindhyachal ash % in OB

From the test results it is seen that with the increase in Vindhyachal ash % in OB the Optimum Moisture Content decreases and same is the case for Maximum Dry Density

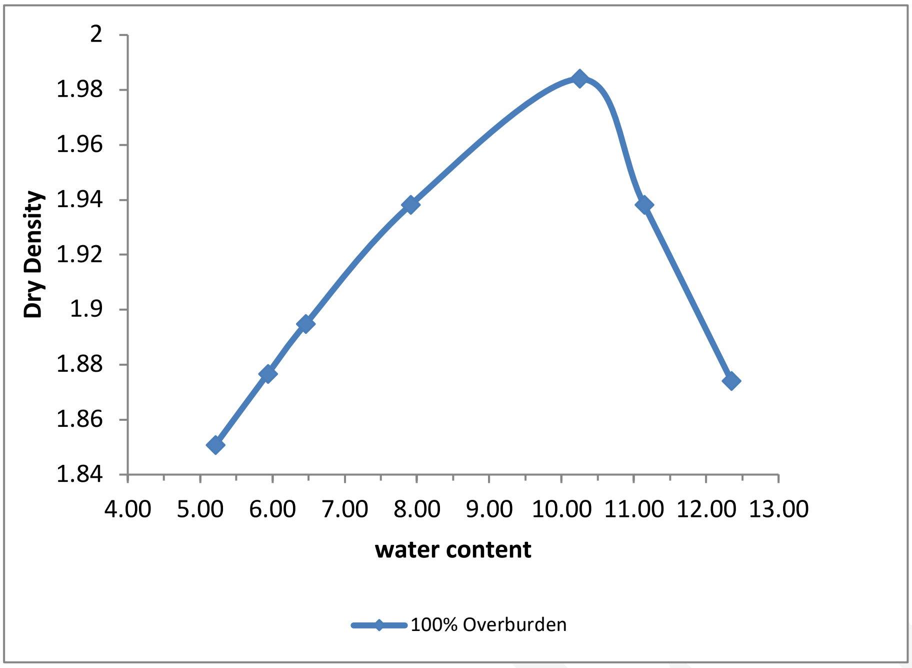
SHAKTINAGAR ASH – OB MIX

Data and observation

1. <u>100% Overburden</u>

Dry Density (gm/cc)	1.85	1.88	1.89	1.94	1.98	1.94	1.87
Moisture Content (%)	5.21	5.94	6.46	7.91	10.25	11.14	12.35

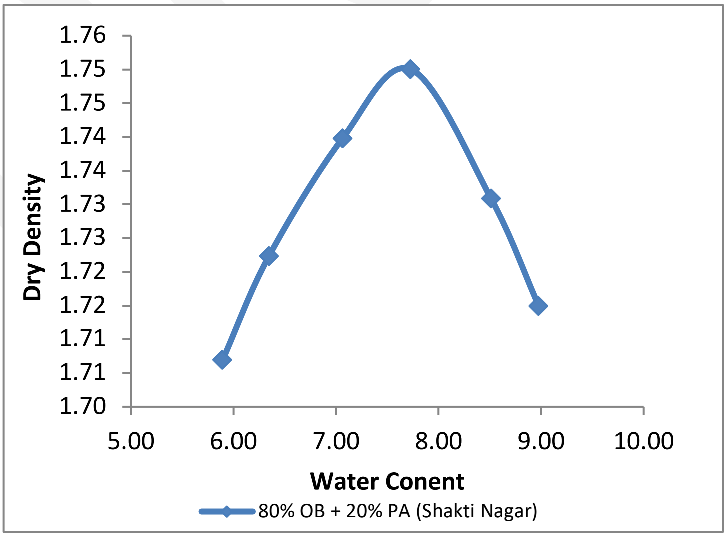
OMC	MDD
10.25	1.98



2. 80% Sandstone + 20% FA (SN)

Dry Density (gm/cc)	1.71	1.72	1.74	1.75	1.73	1.71
Moisture Content (%)	5.89	6.35	7.06	7.73	8.51	8.98

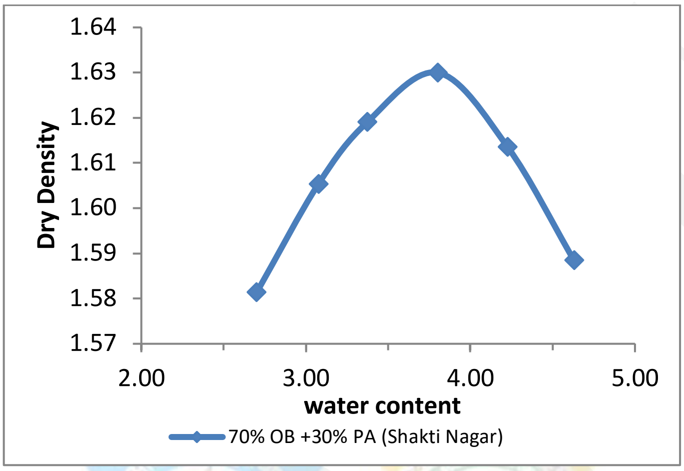
OMC	MDD
7.73	1.75



3. 70% Overburden + 30% Fly Ash

Dry Density (gm/cc)	1.58	1.61	1.62	1.63	1.61	1.59
Moisture Content (%)	2.70	3.08	3.37	3.80	4.23	4.63

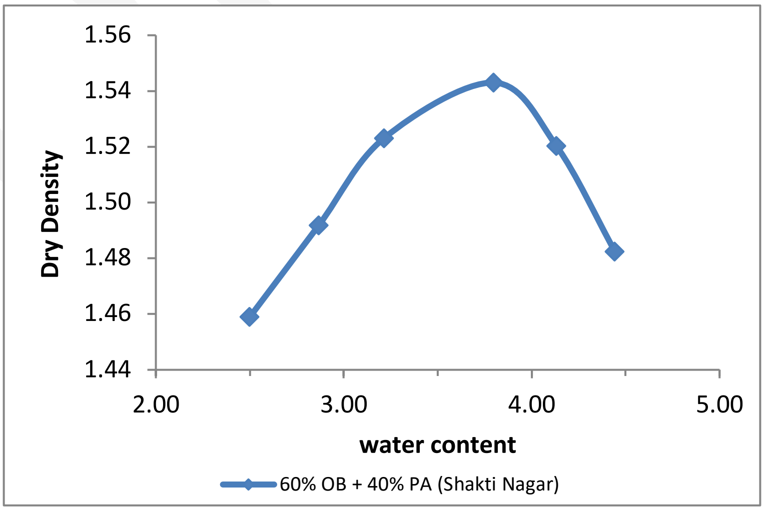
OMC	MDD
3.80	1.63



<u>60% Overburden + 40% Fly Ash</u>

Dry Density (gm/cc)	1.46	1.49	1.52	1.54	1.52	1.48
Moisture Content (%)	2.50	2.87	3.22	3.80	4.13	4.44

OMC	MDD
3.80	1.54



Summary

Table 17: Variation in OMC and MDD with change in Shaktinagar PA % in OB

Ash %	OMC	MDD
0	10.25	1.98
20	7.73	1.75
30	3.8	1.63
40	3.72	1.54

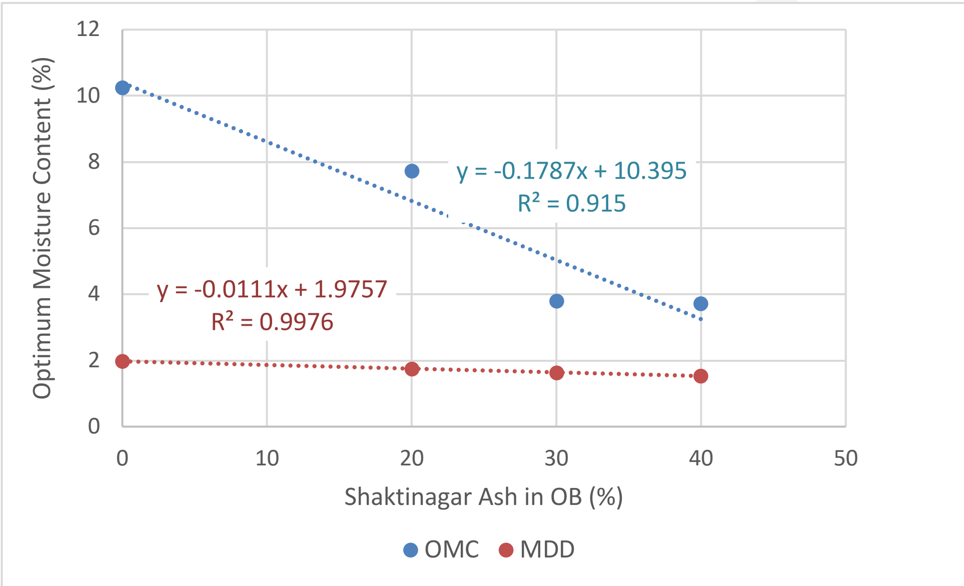


Figure 30: Variation of OMC and MDD with the increase in Shaktinagar ash % in OB

From the test results it is seen that with the percentage increase of Shakti Nagar ash in OB, the Optimum Moisture Content and Maximum Dry Density follows the same trend as it was observed in Vindhyanagar ash i.e. their value decreases with the increase in ash percentage in OB

DIRECT SHEAR TEST

Shear strength of a dump soil may be defined as the maximum resistance to shear displacement caused by shear. Shear strength in a soil is derived from the surface frictional resistance along the sliding plane interlocking between individual rock grains and cohesion in sliding surface of soil model. The shear strength of soil is given by Mohr-Coulomb expression:

$$S = C + S_n \tan(ø)$$

Where S=Shear Strength

Sn =Normal Strength in failure plane

C =unit cohesion

ø =Angle of internal friction

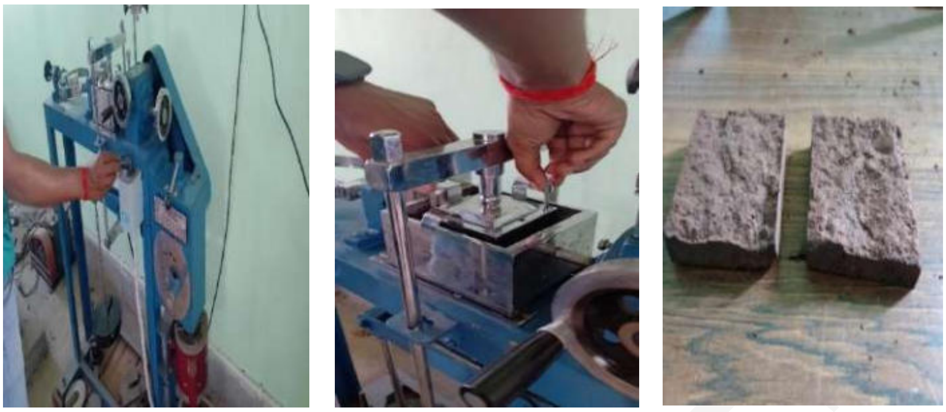
Direct shear test was carried out as per IS2720 (P-XIII) by using a direct shear apparatus. The Test apparatus consists of shear box with its accessories, loading frame, proving ring, dial gauges, sample trimmer, balance, weights, grid plates and spatula as shown in the figure below.

In a test of soil, there are two basic stages. First nominal load is applied to specimen and then failure is induced by applying a shear stress. The graph is plotted between the shear strength and normal stress

Figure 31: Direct shear test apparatus

On the basis of direct shear test, values of cohesion and angle of internal friction were determined in the laboratory by preparing molds of different mixes of ash and overburden saturated at their optimum moisture content. For carrying out the shear test of OB samples, the large size samples collected from the site were crushed into smaller fraction so that it can fit into the shear box. The oldest form of shear test upon soil is the direct shear test, first used by Coulomb. The sample is held in a box that is split across its middle; the bottom portion of the box is usually fixed against lateral movement. A confining normal force, N, is applied, and then a tangential shear force, T, is applied to cause relative displacement between the two parts of the box. The magnitude of the shear force is recorded as a function of the shear displacement, and usually, the change in thickness of the sample is also recorded

Based on direct shear test, values of cohesion and angle of internal friction were determined in the laboratory for different mixes of ash and overburden. For carrying out the shear test of OB samples, the large size samples collected from the site were crushed into smaller fraction so that it can fit into the shear box. The result of direct shear test is given the Table 19.



(c) Mould being tested and sheared

Figure 32: (a), (b), (c): Direct Shear test of Ash and Overburden Waste

Table 18: Shear Strength of Nigahi OB and Pond Ash sample

Sl.No	Sample Mix	C (KPa/ Kg/cm^2)	Ø (degree)
1	Overburden (OB)	43/0.44	32
2	Vindhyachal Pond ash	24/ 0.245	29
3	Shaktinagar Pond ash	30/0.306	25

Table 19 : Shear Strength of Nigahi OB and Vindhyachal PA sample

Sl.No	Sample Mix	C (KPa/ Kg/cm^2)	Ø (degree)
1	100% OB	43/0.44	32
2	80% OB + 20% PA	110/1.122	29
3	70% OB + 30% PA	93/0.948	28
4	60% OB + 40% PA	72/0.734	28

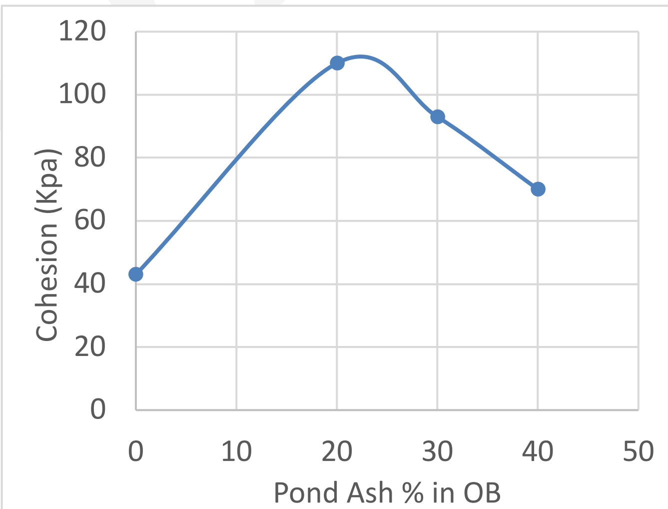


Figure 33: Variation in Cohesion with the increase in Vindhyachal Ash % in OB

The results of Direct Shear Test indicates that the cohesion of the Ash – OB mix increases with the increase in Vindhyachal ash percentage and the maximum cohesion of 110 KPa was achieved with 20 % PA , subsequently , the cohesion value decreased with the increase in PA percentage as shown in the Figure 33.

Geotechnical studies have also been carried out at Geotechnical Laboratory, Civil Engineering Department MNNIT, Allahabad. The study was carried out to determine the strength parameters of materials making the OB Dump and Highwall benches of Nigahi OCP. The summary of the test results are given in the Table 21.

Table 20: Shear strength properties of material collected from Nigahi OCP *

Sl. No	Material	Unit Weight KN/m^3	Cohesion KN/m^2	Angle of internal friction.
1	Grey color Silty Sand	26.4	25.0	50.52
2	Gravel size coal pieces	23.8	29.0	29.64
3	Boulder Size coal (Purewa Bottom Seam)	23.7	140.0	26.50
4	Light grey color silty sand	25.6	23.8	38.30
5	Poorly grade sand with gravel (Turra Material)	26.6	217.0	37.00
6	**Interburden between Turra and Purewa Seam**	25.8	25.0	49.37
7	Crushable boulder with cable (Top Layer Material)	26.4	190.0	21.05
8	Boulder Size coal block (Purewa Top Seam)	17.4	280.0	28.0
9	Grey poorly graded sand	27.10	21.0	44.92
10	**Turra Floor**	**25.6**	**300**	**27**
11	Turra Coal	23.8	129	29.6

* Source – Report on Scientific study on Nigahi OCP, Slope Stability Cell, CMPDIL,

The shear strength properties determined in the laboratory and collected from the literature survey were used as input in determining the stability of in pit dumps. The material key used for slope stability analysis is shown in the Table 22.

Table 21: Material key with colour coding for stability analysis

Sl. No	Material	Unit Weight KN/m^3	Cohesion KPa	Ø (degree)	Colour
1	Turra Floor	25.6	300	27	
2	70% OB + 30% PA	14.71	93	28	
3	100% Overburden	17.36	43	32	
5	Interburden between Turra and Purewa Seam	25.8	25.0	49.37	

6.3 CHEMICAL PROPERTIES

6.3.1 XRF Analysis

The chemical composition (element oxides) of the pond ash and fly ash samples were determined by X-Ray Fluorescence (XRF) Technique using Rigaku, ZSX Primus (Tokyo, Japan) instrument, which is a wavelength dispersive X-ray fluorescence spectrometer. as shown in Figure 34. The results of chemical compositions of Fly ash, samples obtained by the XRF study are presented in Table 23. The chemical compositions of the samples were determined with an accuracy of 95%.

The chemical compositions of the samples were determined with an accuracy of 95%. Chemically, both pond ash from Vindhyachal and Shaktinagar pond ash can be considered as siliceous fuel ash since the sum of silica (SiO_2), alumina (AI_2O_3) and iron oxide (Fe_2O_3) is greater than 70% by mass in accordance with IS 3812 (Part 1) :2003. Alternatively, these can be categorized as Class F fly ash as per ASTM C-618 as the percentage of CaO was found to be less than 10 %.

Table 22: XRF chemical compositions of samples by mass (%)

Oxides	Vindhyachal Ash	Shaktinagar Ash
SiO_2	60.18	53.82
Al_2O_3	22.02	24.32
Fe_2O_3	6.24	8.89
CaO	4.98	6.23
MgO	2.1	2.5
TiO_2	1.22	1.22
K_2O	1.8	1.25
Na_2O	0.58	0.46

P_2O_5	0.48	0.52
SO_3	0.58	0.38
V_2O_5	0.03	0.04
MnO	0.07	0.08
BaO	0.3	0.2
PbO	0.04	0.02

Figure 34: ZSX Primus (Rigaku) X-Ray fluorescence spectrometer (XRF)

6.3.2 XRD Analysis

The mineral phases present in the pond ash samples from Vindhyachal and Shaktinagar Thermal Power Plant were recognized by the X-Ray Diffraction (XRD) technique. The various mineral phases associated with the pond ash samples were determined from their diffractograms. The XRD patterns of the samples were determined by a Rigaku Ultima-IVX ray diffractometer (Tokyo, Japan) operated at 40 kV and 20 mA utilizing Cu Kα radiation (λ=1.542 Å). The detector is scanned over a scattering angle (2θ) range from 10° to 80°, with a 0.0001° step size and a dwell time of 2 s per step.

Figure 35: XRD Equipment Rigaku Ultima-IV X ray diffractometer at CSIR-CIMFR

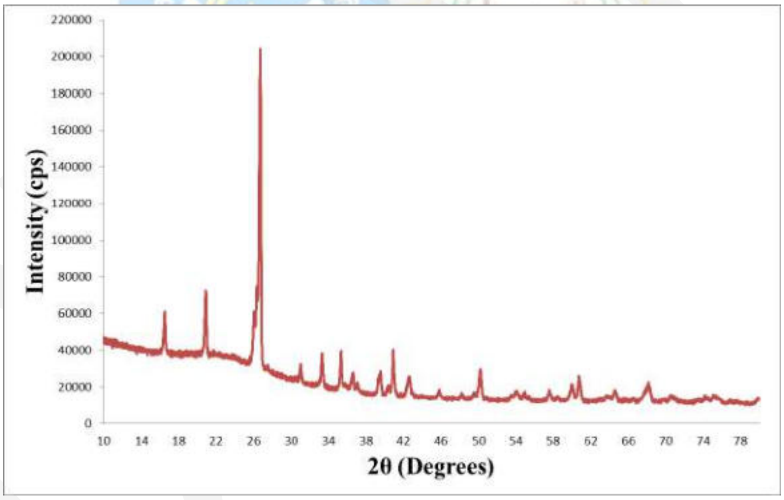


Figure 36: XRD pattern of Vindhyachal pond ash sample

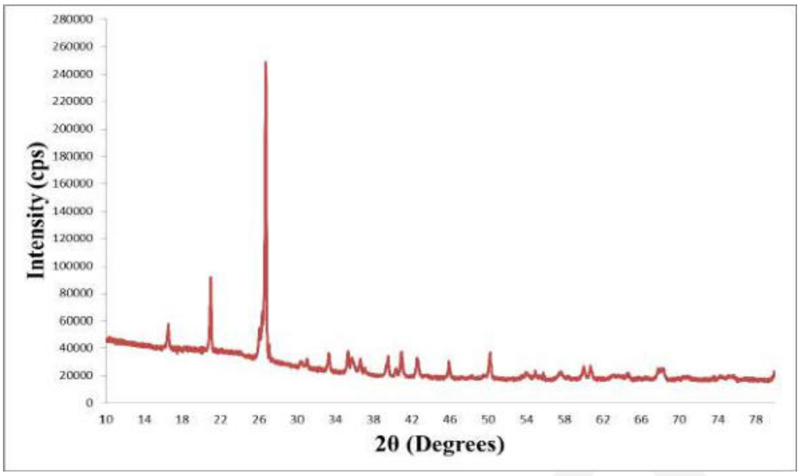


Figure 37: XRD pattern of Shaktinagar pond ash sample.

The XRD patterns pond ash samples are shown in Figure 36 and 37, respectively. From the diffraction patterns of pond ash and fly ash, the crystalline phases were identified by comparing the peak positions and intensities with those in the JCPDS (Joint Committee on Powder Diffraction Standards) data files and labelled above the respective peaks. The major common mineral phases found in the pond ash sample are quartz (SiO_2), mullite ($Al_6Si_2O_{13}$), rutile (TiO_2), hematite (Fe_2O_3). Similarlry, quartz (SiO_2), mullite ($Al_6Si_2O_{13}$), rutile (TiO_2), magnetite (Fe_3O_4).

The pollution potential of any ash fill would mainly depend upon its chemical and leaching properties. The distribution of each element within the fly ash structure is different, however; the smaller the particle size, the higher is the trace elements content due to the increase in the surface/weight ratio. As evident from the elemental composition of ash, oxides of Si, Al, Fe and Ca account for nearly 90% of the composition of fly ash. The alkaline content depends on the concentration of the basic oxides (CaO & MgO) and the number of acidic substances such as SO_2, SO_3, and P_2O_5 which are also present in the coal fly ash. Literature survey suggest that Most coal contains 238U and 232Th as well as their decay products and 40K. The total levels of individual radionuclides typically are not great and generally occur about the same as in other rocks near to the coal mine and it varies according to region and geology. Enhanced radionuclide concentration in coal tends to be associated with the presence of other heavy metals and high sulphur content. During combustion, the radionuclides are retained and concentrated in the fly ash and bottom ash, with a greater concentration to be found in the fly ash. The concentration of ^{238}U and ^{232}Th in fly ash may be ten times greater than that of the burnt coal, while other radionuclides such as ^{210}Pb and ^{40}K can concentrate to an even greater degree in the fly ash.

Fly ash possesses heavy metals and traces elements like Mn, B, As, Mo, Fe, Al, Si, etc. These trace elements and heavy metals can bioaccumulate and enter the food chain creating toxic effects in living organisms and human health. Because of its toxicity with respect to heavy metals, radionuclides, trace elements, and organic pollutants which are of environmental concern it may pose deleterious effects on human beings, groundwater, soil, vegetation, birds, animals, and nearby water bodies (BHU Report, Jan 2022)

6.3.3 SEM-EDS

Scanning Electron Microscopy (SEM) study was conducted to understand the morphology and elemental composition of Nigahi overburden sample, Shaktinagar ash sample and Vindhyachal ash sample. SEM analysis was carried out with SEM instrument (ZEISS) MERLIN VP COMPACT and for Energy dispersive X-ray spectroscopy (EDS) analysis TEAM™ EDS System with Apollo X Silicon Drift Detector (SDD) was used. SEM, uses a focused electron beam to scan the surface of a sample, generates a variety of signals. The three most common modes of operation in SEM analysis are back scattered electron imaging (BSE), secondary electron imaging (SEI), and EDS. In this study, EDS were used to characterize ash samples.

Being non-conducting in nature, all the samples were coated with gold using Quorum gold coater. The elemental compositions of the samples were determined by the energy dispersive X-ray spectroscopy (EDS) technique The elemental analysis was performed both in a ‘‘spot mode’’ as well as “area mode” in which the beam is localized on a single spot or area manually chosen within the field of view on the SEM micrograph. The mean values of the elements obtained at different points during the EDS analysis were considered as the elemental composition of each sample.

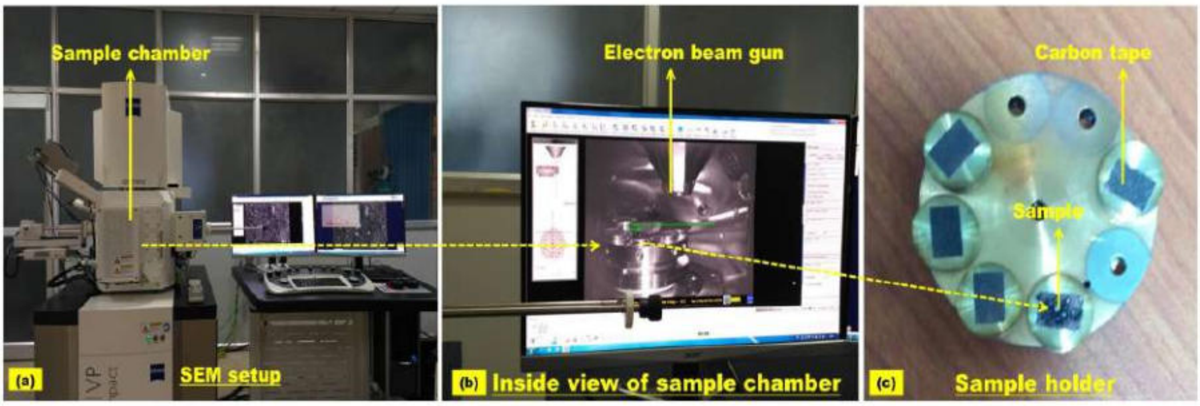


Figure 38: Scanning electron microscopy instrument: (a) SEM setup, (b) Inside view of the sample chamber, and (c) Sample holder with carbon tape

a) Elemental composition

Figure 39 shows the EDS spectra and Table 24 shows the elemental composition of Nigahi overburden sample. The results show that the Nigahi overburden sample mainly consists of O, Si, Al, C, K and very minute weight percentage of S, Ca and P.

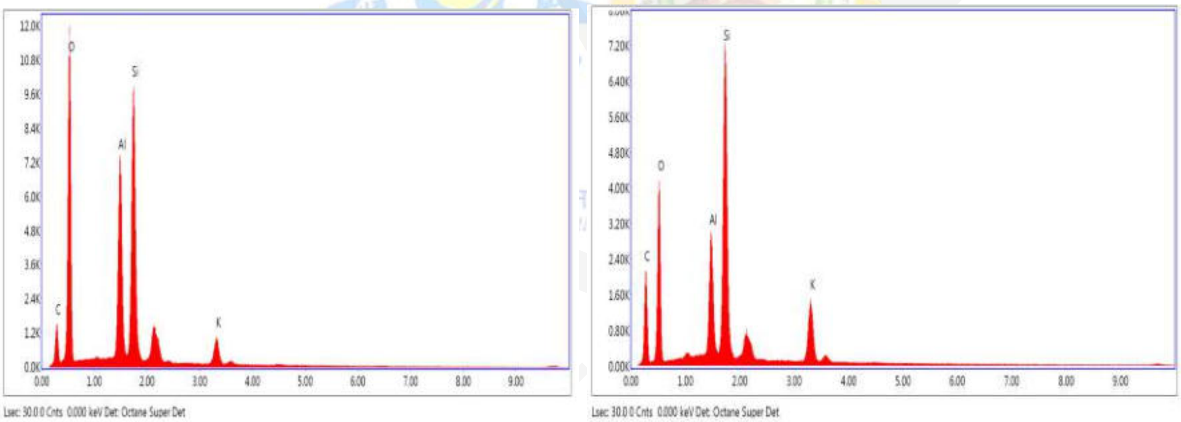


Figure 39: EDS spectra of Nigahi Overburden sample

Table 23: SEM-EDS elemental composition of Nigahi Overburden Sample

Element	**Weight%**
C	13.856
O	45.12
Al	14.28
Si	20.856
S	0.57
Ca	0.401
K	4.364
P	0.553

Similarly, Figure 40 and Table 25 shows the SEM-EDS results for the ash sample of Shaktinagar Thermal Power Station. It can be seen that the ash sample mostly contains O, Al, Si, and Fe with very little weight percentage of K.

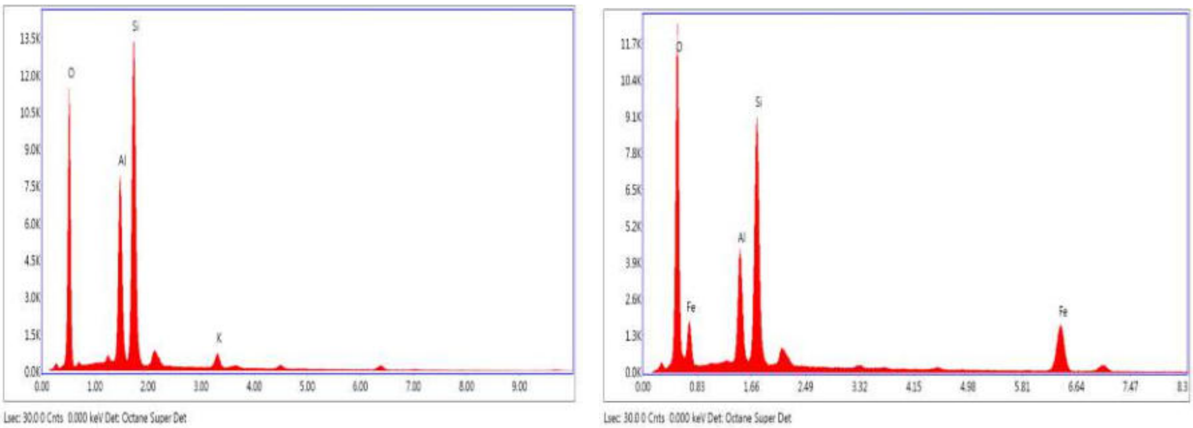


Figure 40: EDS spectra of Shaktinagar Ash sample

Table 24: SEM-EDS elemental composition of Shaktinagar Ash sample

Element	**Weight%**
O	37.276
Al	10.504
Si	28.07967
Fe	23.36367
K	0.777

In a similar way, Figure 41 and Table 26 demonstrates that the ash sample of Vindhyachal Thermal Power Plant primarily contains O, Al, Si, Fe and little percentage of C, Ti and K.

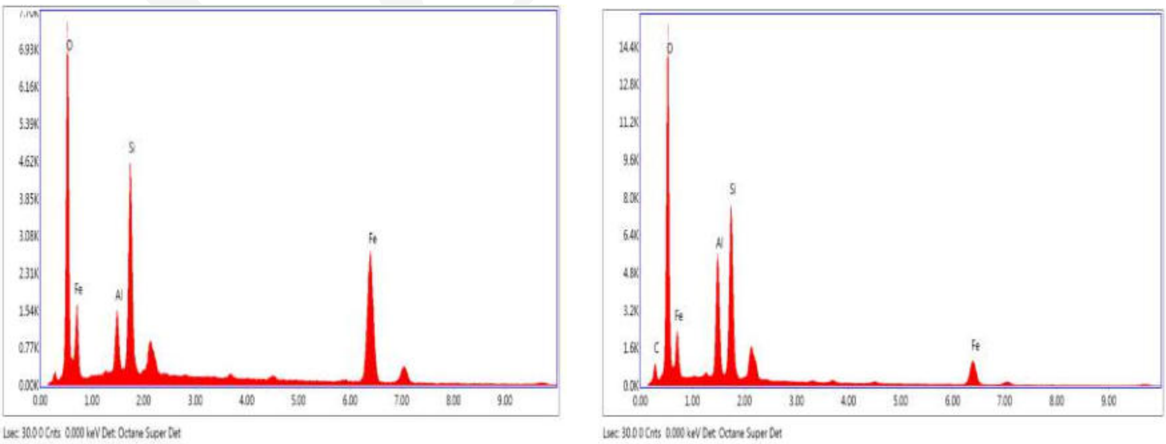


Figure 41: EDS spectra of Vindhyachal Ash sample

Table 25: SEM-EDS elemental composition of Vindhyachal Ash sample

Element	**Weight%**
O K	33.735
AlK	17.155
SiK	24.56
K K	1.143
C K	3.118
FeK	18.452
TiK	1.837

b) Particle morphology

The morphology of pond ash and fly ash were determined by scanning electron microscopy (SEM) [Model: ZEISS-MERLIN VP COMPACT]. From the SEM image analysis it is observed that the OB sample contains rough, irregular and subrounded particles (Figure 42)

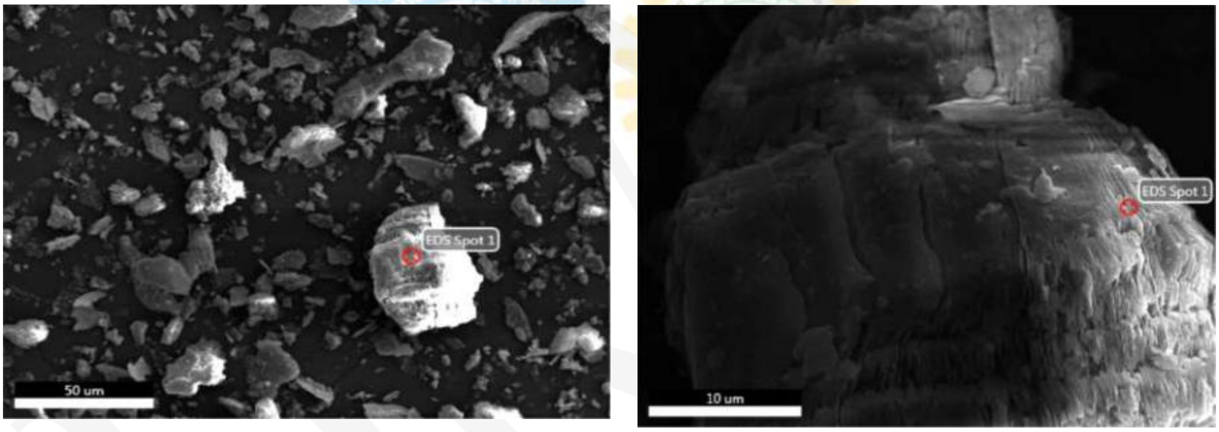


Figure 42: SEM image of Nigahi OB sample

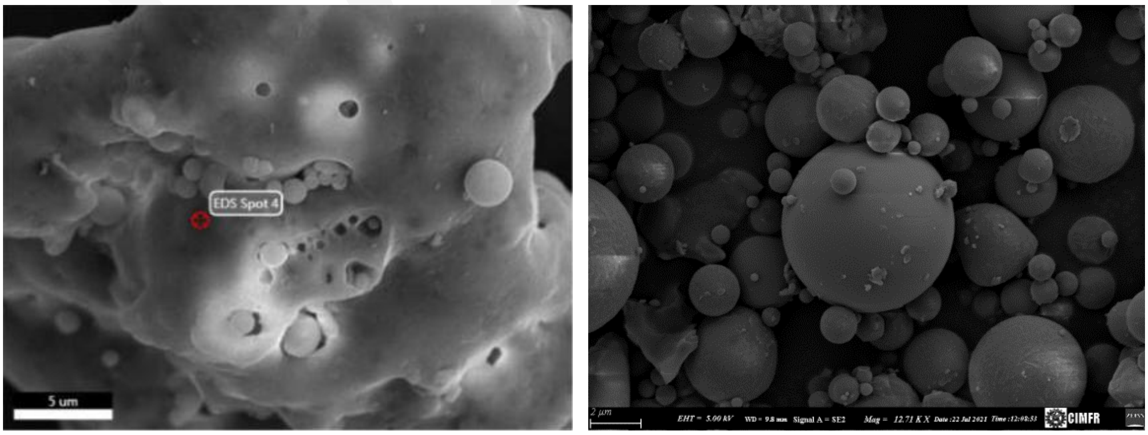


Figure 43: SEM image of Shaktinagar and Vindhyachal Pond Ash Sample

From the SEM image analysis of Vindhyachal and Shaktinagar Pond Ash sample, it is observed that pond ash sample consist of few amount of fly ash in addition to bottom ash. The spherical shaped particles identified in pond ash can be considered as fly ash. In general majority of pond ash samples consists of lump of irregular shaped particles, which are mainly bottom ash. Further, the SEM image of fly ash samples clearly show spherical shaped particles, which are called as cenosphere.

8. FIELD STUDY- PART I

8.1 Pilot scale study of ash–ob filling

One of the important objectives envisaged in the sope of work of the study was to carry out a field trial of ash – overburden filling at Nigahi OCP by making a pilot scale dump of 15m height and monitor its behavior both during pre and monsoon period. Accordingly, a site for making a pilot scale dump was selected by CIMFR team as shown in the Figure 44 below.

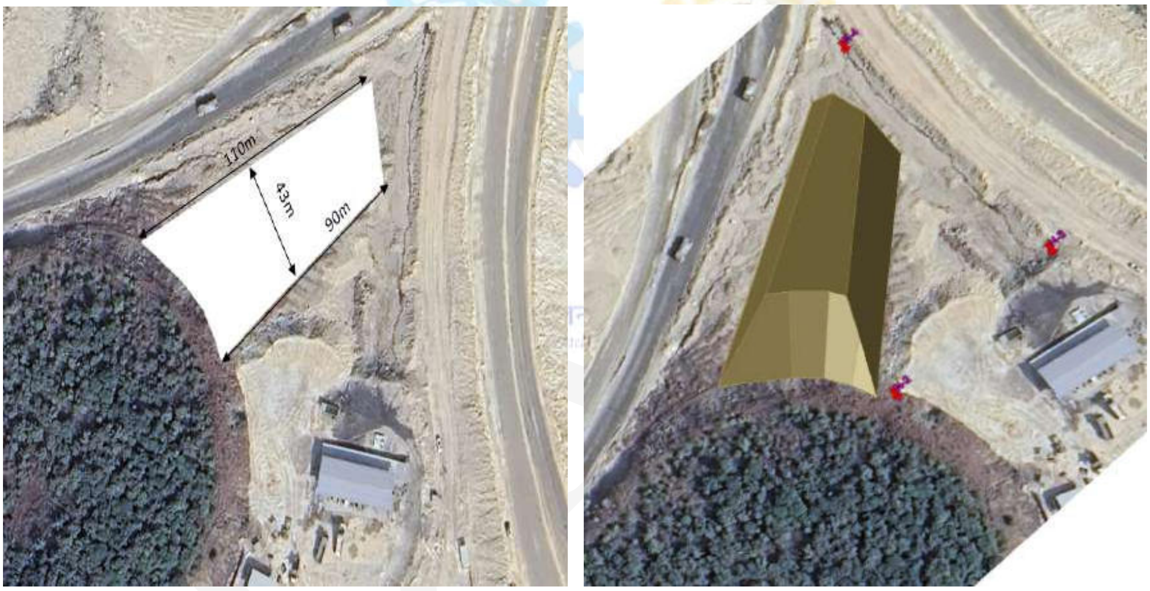


Figure 44: Site for pilot scale study of ash–OB filling near P. C. Patel camp

Base Area of the proposed site = 4100m^2
Perimeter of the base area = 293m

Site Selection

After discussion with the mine management regarding the site for pilot scale dump location and its accessibility for ash and OB transportation without hindering the usual mine traffic, it was decided to change the location of pilot scale dump. The new site for the pilot scale study as suggested by the mine management is given in the n with the mine management, it was eventually decided to shift the site as shown in the Figure 45.

The height of the pilot scale dump was fixed at 15m and with a dump slope angle same as that of angle of repose of the OB material viz. 37^0. The available area for making the dump was measured at the site. The measured dimensions are as follows

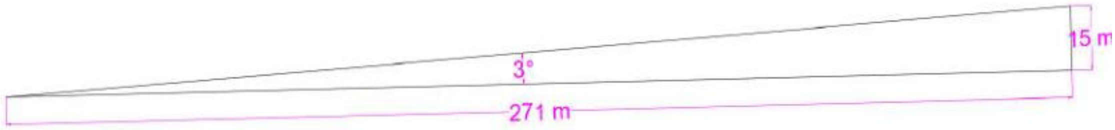
Dimension of the proposed area for pilot scale study

- ✓ W1 = 21.5 m, W2 = 31.8 m and W3 = 30.9 m , Average width of the area = 28.06 m
- ✓ Length = 133 m (approx.)
- ✓ Perimeter of the Area = 338 m
- ✓ Area of the place = 4143 m^2

View of the extreme tipping end View of the dump on the north side View of the approach road

Figure 45 : View of the site for making the pilot scale ash – OB mix dump

The approach ramp to the pilot scale dump is to be inclined at 3^0 and the width of the ramp is proposed to be 12m so the two dumpers can move adjacent to each other while moving over the ramp.



At 3-degree ramp angle the length of approach ramp from the pilot dump area comes to about 271m. It is proposed to widen the dumping area to at least 60m so that enough turning radius is available for the dumpers. As can be seen from the above Figure the site was levelled and cleaned prior to the formation of the pilot dump.

As it is well known, ash being lighter than OB material have the tendency of getting washed off when in contact with water (rain or ground water). Hence it was decided to encapsulate the Ash – OB admixture in the pilot dump with a layer of overburden (5m thick) all along the periphery in such a way that ash – OB mix is not exposed to any source of water. CIMFR team visited the site on 14/06/2023 for site inspection along with the mine management, it was decided to extend the width of the dump to 49m (average) and length to 170m and also to mark the position of the berm at the pilot dumping site so that it would be easier for the dumper operator to dump the overburden at right places along the periphery of the dump for the formation of 11.6m bund along the slope and top to the dump as shown in the Figure below.

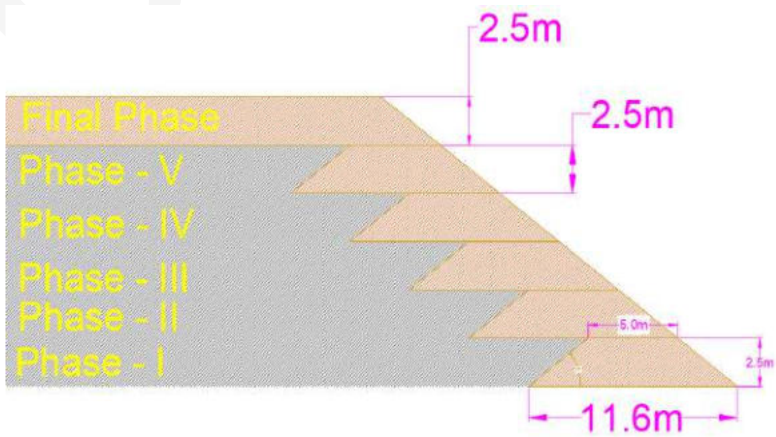
Figure 46: Proposed berm of OB material along the periphery of ash – OB pilot dump

A join survey was conducted by NTPC officials and Nigahi Mine management along with CIMFR officials to finalize the route for ash transportation from Vindhyanagar Thermal power plan ash pond to the pilot scale dump site. The methodology of dumping ash – OB admixture for preparing the pilot scale dump is elaborated in the subsequent section.

Dumping methodology at pilot scale bench

- The pilot scale field study is planned for ash – OB dump of 15m height and dimensions a mentioned earlier, a bund of OB not less than 11.6m width and 2.5m high shall be formed all along the periphery of the proposed dumping area as shown in the Figure below with the help of JCB/Poclain. The bund should have width of 5m at the top and the angle of bund is 37 degree on both sides.

- The area thus formed by the bund in phases is filled randomly with pond ash and overburden is phases of each 2.5m height eighter at one go or in two stages of 1.3m and 1.2m. Experimental deck of 15m high is filled in 5 phases as shown in the subsequent figure. The Phase I, II, III, IV and V is filled with pond ash – OB admixture randomly in the ratio of 1:3 (for every one truck of pond ash dumped 3 trucks of OB is required to be dumped). After the completion of the Ist Phase, bund of same dimension as mentioned earlier is formed on the previous placed bund so that a slope angle of 37^0 is maintained as shown in the figure below. In the final phase, only OB of 2.5m height will be filled as shown in the figure below. so that ash -OB admixture is completely encapsulated by overburden material of at least 2.5m thick along the sides and deck slope.



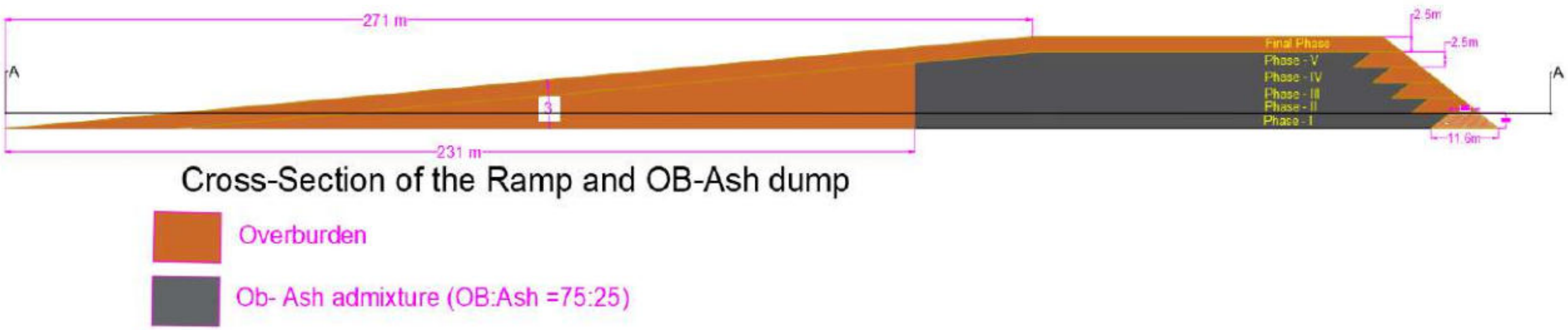


Figure 47:Profile of the proposed pilot scale dump

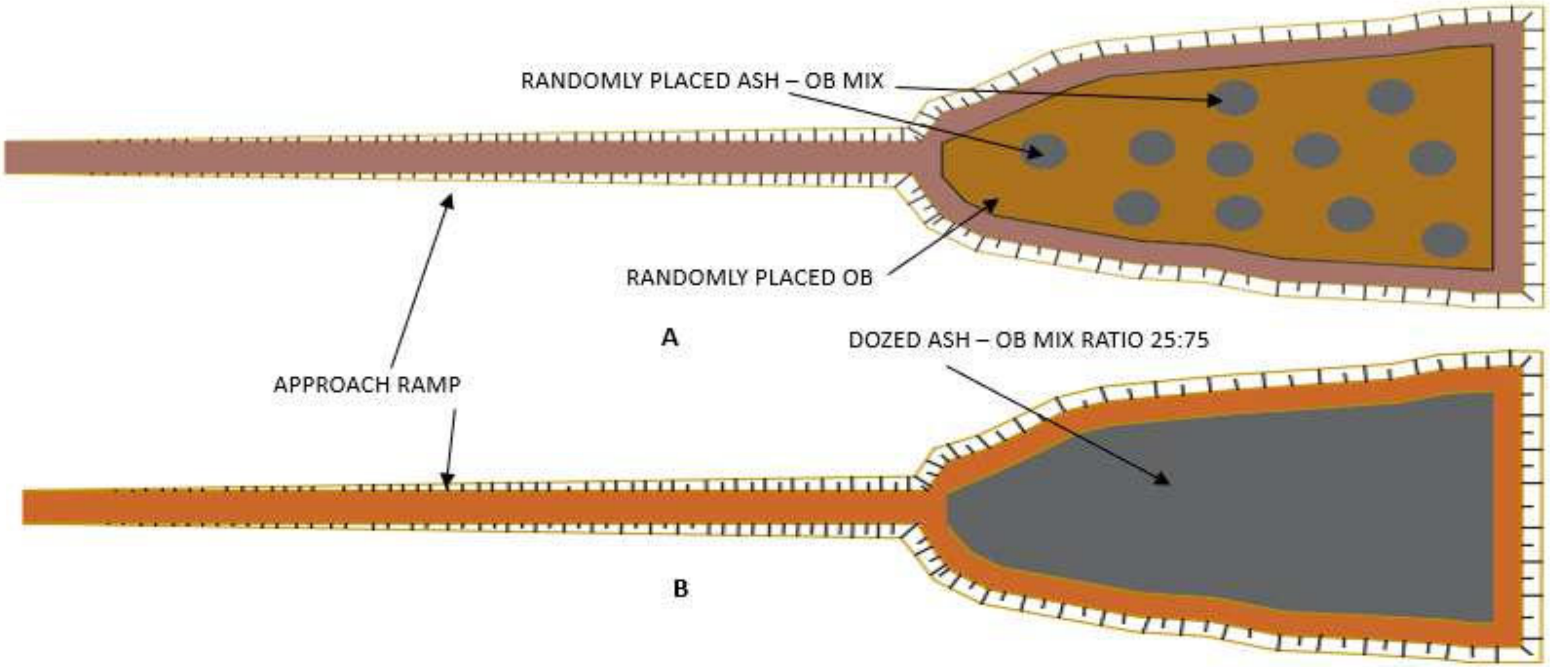


Figure 48 : Randomly Placed Ash dumps surrounded by OB material in 25:75 Ratio, B – Dozed Ash – OB mix inside the OB Bund

During dumping, the voids between the ash dumps will be filled with overburden material by trucks to maintain a ratio of 1:3 (ash: OB). After the completion of the 1st phase, dozing, compaction and levelling is required to be done (by dozers) to mix the ash and overburden as thoroughly as possible.

- During formation of bunds, care should be taken to maintain its dimension and compaction with the help of JCB/Poclain/Dozer.
- For the formation of pilot scale dump of 15m height, a ramp will be formed with a gradient of 3^0. It is proposed to keep the width of ramp to 7m and length of ramp to reach a height of 15m (deck height) comes to about 176m as show in the Figure 47 and 48.
- Adequate precaution against rain fall shall be taken by formation of gully drains along the slope of the dump and formation of toe walls and peripheral drains during the trials
- Surface runoff and supernatant water, in any case shall not be let into the surrounding areas by providing adequate drains around the toe of the proposed pilot scale bench mine.

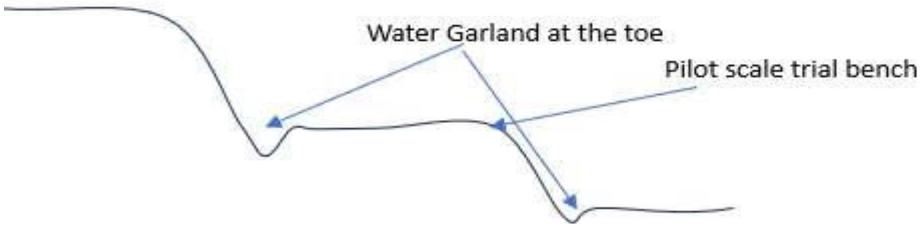
Monitoring carried out at Site

The monitoring work and the field study which was carried out at the pilot scale ash – OB dump during pre and post monsoon season are given below:

1. 3D scanning of the pilot dump using laser scanner of the entire experimental dump

Entire top portion of the dump   Entire Slope of the dump

2. Formation of garland drains along the periphery of the dumps



The garland drain should be dipping from the elevated entrance of the trial site

3. Behavior of dump under the influence of monsoon rain/ water
   - Development of cracks on the slope surface of the dump
   - Erosion of soil and exposure of ash – OB mix
   - Behavior of exposed ash – OB mix under rains
4. Overall dump stability with respect to sliding of slope, sinkholes, or other structural failures
5. Drainage pattern of water over the dumps
6. Effect of water on the vehicular movement over the dump

The Field work which was carried out during the initial visit of CIMFR team before monsoon, i.e. June, 2023 included data collection regarding traffic density and type, identification of travel route for ash and OB transportation from the ash pond of Vindhyanagar Thermal Power Station, marking of lead distance from different running faces and OB removal sites the in pit dumping face, ash pond to the experimental site and the formation of bund along the periphery of the dump as shown in the Figure 49 and Figure 50. Monsoon hit Nigahi on 23rd June, 2023 with intermittent showers and preparation of the pilot scale dump was stopped

Figure 49: Bund Formation with OB material (June, 2023)

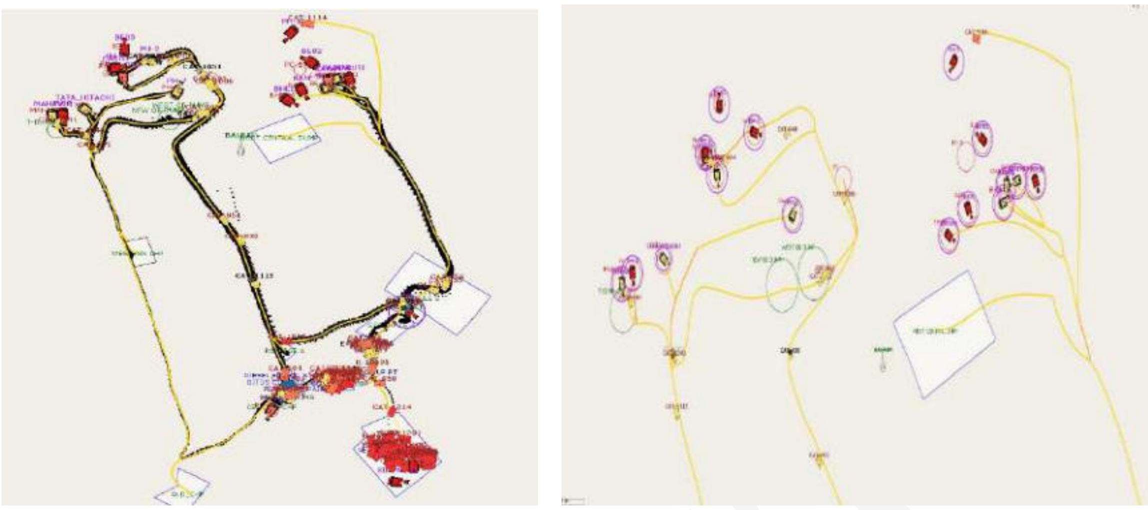


Figure 50: Traffic Route of Tippers/Dumpers for OB dumping

The pilot scale dumping of ash – OB mix commenced once again in the month of October 2023 (after monsoon) and the entire dump formation was completed in the month of April 2024.

8.2 Summary of quantum of material used for dump formation

Final Quantity of Material which was used for the formation of the dump is given below

Data considered for quantum of material required is given below

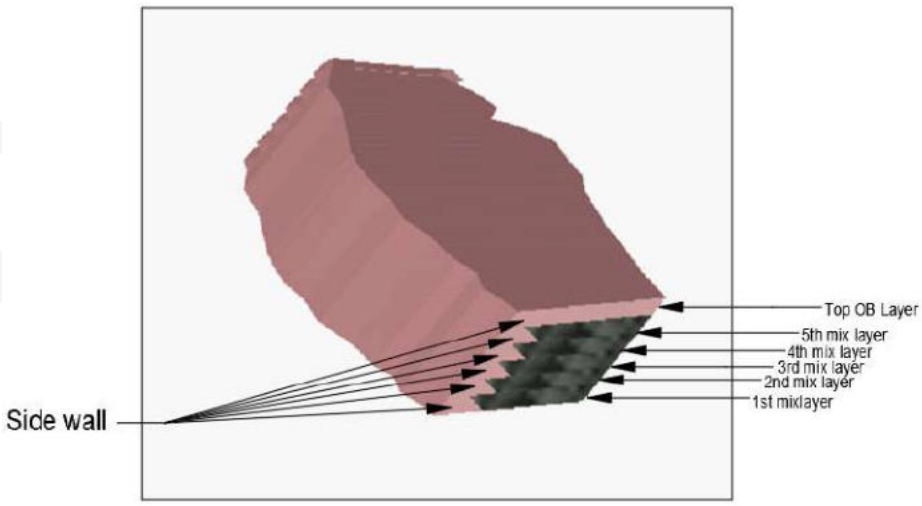


Figure 51: Isometric view of the section of the pilot scale dump

- ✓ Bulk Density of Vindhyanagar Pond Ash = 1.01 T/m^3
- ✓ Bulk Density of Nigahi OB material = 1.77 T/m^3
- ✓ Tipper capacity for OB transportation, 19 m^3 - 23 m^3 = 20m^3 Avg. value considering fill factor

Therefore, Capacity of OB tipper in tons = 20 x 1.77 = 35.4 ton

- ✓ Dumper capacity for ash transportation 28 m^3 - 33 m^3= 30m^3 Avg. value considering fill factor

Therefore, Capacity of Ash dumpers in tons = 30 x 1.01 = 30.3 ton

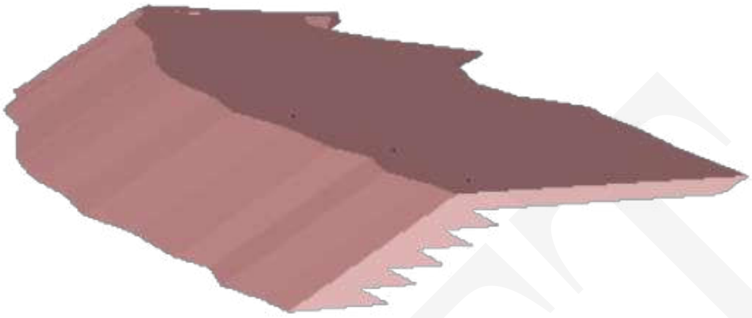


Figure 52: Georeferenced volume of OB material consumed in top layer and side wall

Figure 53: Georeferenced volume of Ash(25%) :OB (75%) mix used in pilot dump

Volume of OB – Ash Admixture in the pilot scale dump = 1743.1

Volume of each tipper of overburden = 20 cubic meter

Mass of overburden in each tipper = 20 x 1.77 = 35.4 ton

Similarly for Ash,

Volume of each tipper = 30 cubic meter

Mass of each tipper =30 x 1.01 = 30.3 ton

- Total number of ash trips dumped on the site = **577 trips**

  Weight of 577 trips of ash = 577 x 30.3 = 17483.1 ton

- The mass of overburden required for it = 17483.1 x 3 = 52449.3 ton

  Number of trips of overburden required = (52449.3)/35.4 = 1481.61 =**1482 trips**

- The volume of each side wall of height 2.5 meters = 6357.86 cubic meter

  Total volume of side walls of all six layers = 6357.86 x 6 = 38147.16 cubic meter

Number of overburden trips required = 38147.16/20 = **1908 trips**

- Volume of top layer except side wall = 27132.51 cubic meter

  Number of overburden trips required = 27132.51/20 = **1357 trips**

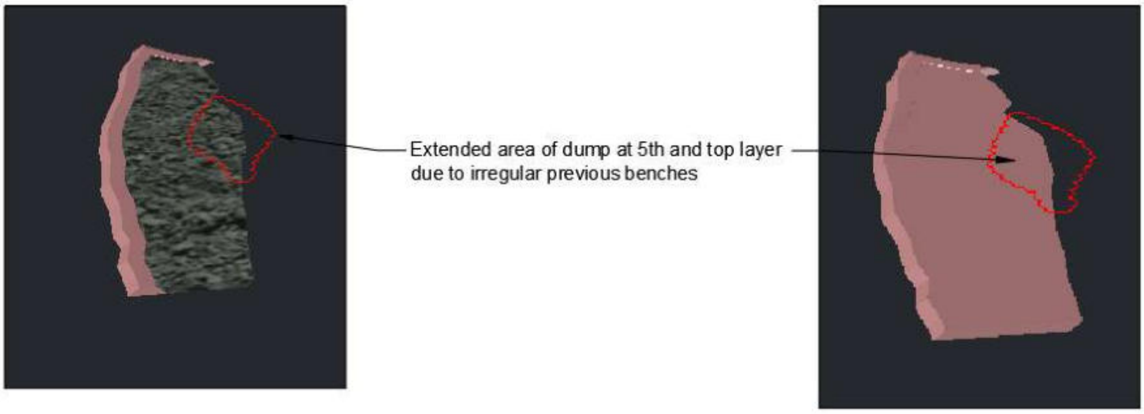


Figure 54: Snapshot of extended area of the fifth and top layer

Total number of overburden trips = 4747 trips

Total number of ash trips dumped on the site = 577 trips

It was found out that the initial computation of the number of OB trips (20 m^3 capacity) and ash trips (30 m^3 capacity) required for making the pilot scale dump was about **4471 and 534** respectively, but while making the dump the number of OB and Ash trips increased to **4747 and 577** respectively. This increase in the quantum of material required in making the dump may be attributed to the fact that the area of fifth layer (Ash – OB mix) and the top layer (OB) of the pilot dump increased due to the slope of the dump present in the north direction as shown in the Figure 54.

The materials required and the materials provided on the site on each day is mentioned in Annexure – I

Throughout the pilot scale during dump formation, strict monitoring by CIMFR official was carried out prevent deviation from the proposed dump design. To enable that following monitoring work and advice/ instruction was given to the mine/contractual personnel involved in the pilot scale dump formation.

a. Ensuring Peripheral bund formation as per the proposed dimension
b. Ensuring proper mixing of ash – OB in the required ratio (Ash: OB = 1:3)

c. Ensuring regular dozing, levelling and consolidation after each cycle of dumping

d. Ensuring formation of garland drains at the toe of the pilot scale dump and the adjacent dump

Water draining along at toe of adjacent bench and pilot scale dump

8.3 Pre – monsoon monitoring study

A team from CSIR – CIMFR visited the experimental dump site in the month June ,2024 for preparing the site for post-monsoon studies and to carry out 3 D laser scanning to the dump for base line data generation prior to monsoon. The preparatory work mainly included two important tasks, the first task was to supervise the formation of garland drains along the high wall and toe of the pilot dump and the second task was to carry out 3D laser scanning of the dump to generate data regarding its position in x, y and z coordinates prior monsoon season.

Figure 55: Arial view of the completed pilot scale dump

Garland drain was dug with the help of JCB along the predefined location as per the instruction of CIMFR officials as shown in the Fig . __ above.

3D laser scanning of the dump was carried out with the help of Nigahi Survey Team equipped with RIEGL terrestrial laser scanners Model No. VZ-4000 as shown in the Figure 56. RIEGL VZ-4000 terrestrial laser scanners are rugged and provide detailed and highly accurate 3D data rapidly and its applications are wide ranging, including Topography, Mining, As-Built Surveying etc. This model has a very long range of 4000 m and uses eye safe laser class 1 for high-speed data acquisition up to 222,000 meas./sec with a wide field of view of 60° x 360°. This instrument has a built-in calibrated digital camera, On-board inclination sensors, Integrated L1 GNSS receiver with antenna, Integrated compass with a built-in SSD drive storage

Figure 56: RIEGL VZ-4000 3D laser scanner

For carrying out the 3D scanning of the pilot scale dump, three scanning stations were identified in consultation with the mine survey team in such a way that the whole of the dump is scanned and the field of scan from each station over-lapped each other. The coordinates of the scanning station are given in the table below and its position is shown in the Figure 57.

Station	Easting (Long.)	Northing (Lat.)	Remarks
A	665427.06 m	2671322.66 m	Edge of the dump slope
B	665755.51 m	2671701.19 m	Elevated position towards pilot dump
C	665427.64 m	2671246.80 m	North of PC Patel Camp

Figure 57: Location of the Scanning Station A, B and C

The pre- monsoon data collected from the scanning station was processed by Nigahi survey team and were converted from Mine Coordinate System to Google Earth Coordinate System and were provided to CIMFR team in CSV (comma separated variable) format.

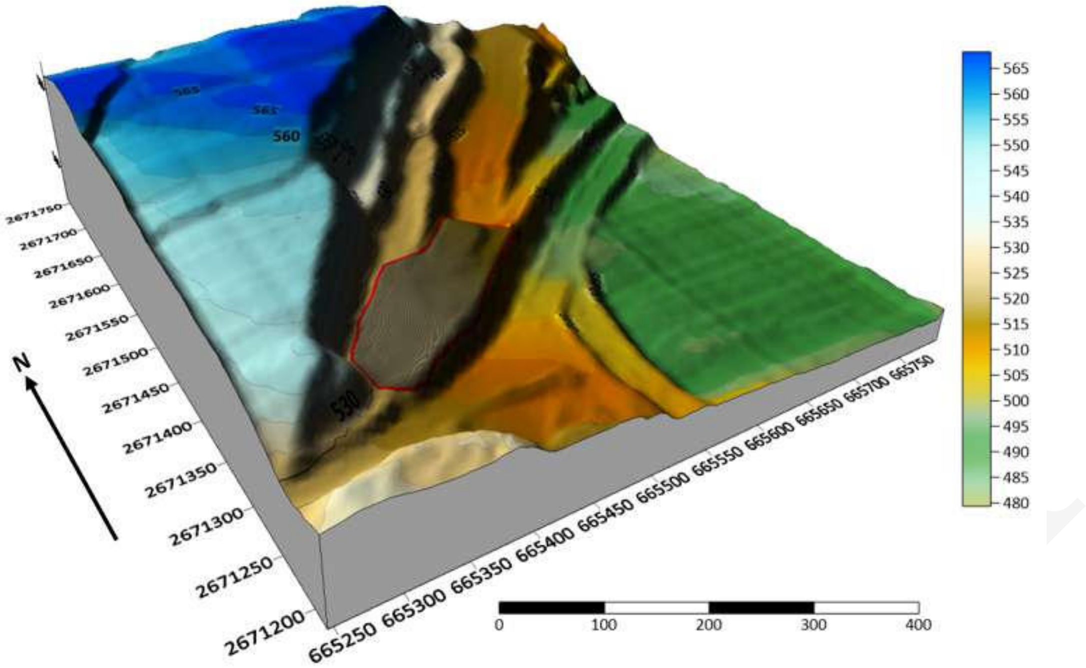
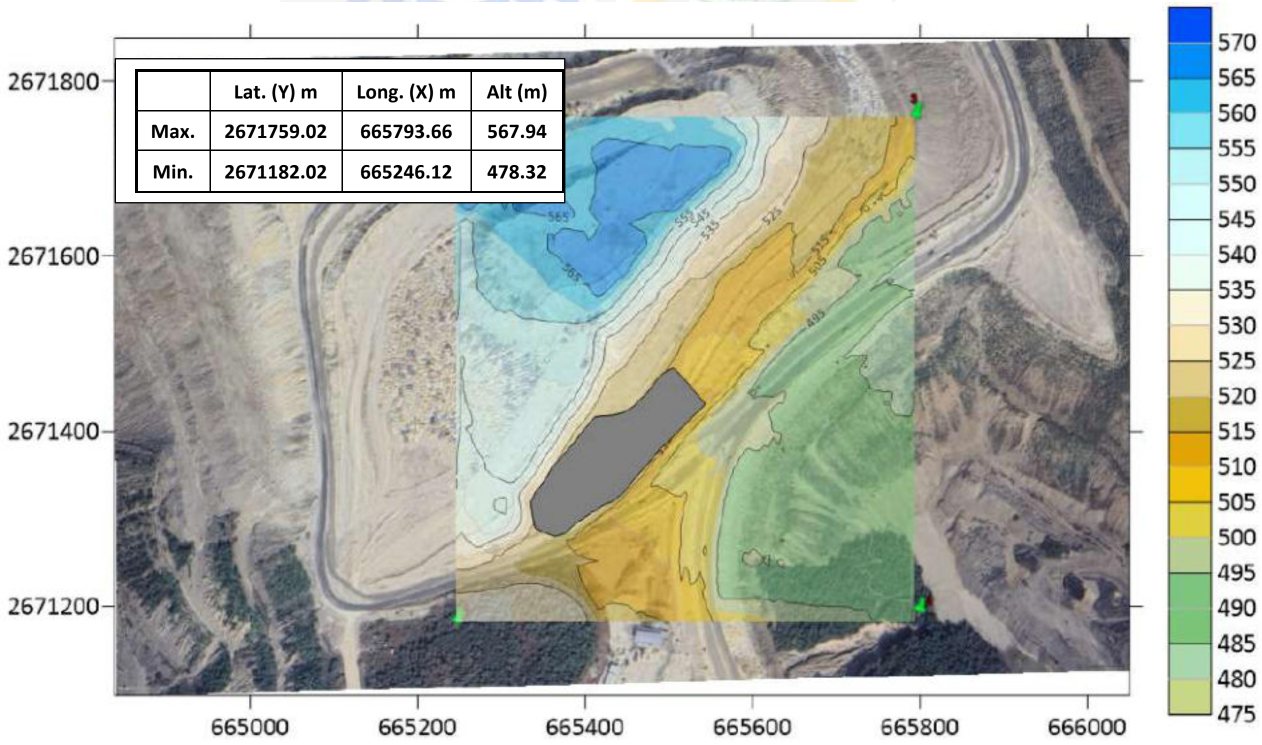


Figure 58: Isometric view of the pilot scale dump (pre – monsoon)



	Lat. (Y) m	Long. (X) m	Alt (m)
Max.	2671759.02	665793.66	567.94
Min.	2671182.02	665246.12	478.32

Figure 59: Contour plot of study area showing the location of pilot scale dump

The plot of csv data obtained from the 3D laser scan were superimposed with the plot of the boundary of the dump as shown in the Figure 60.

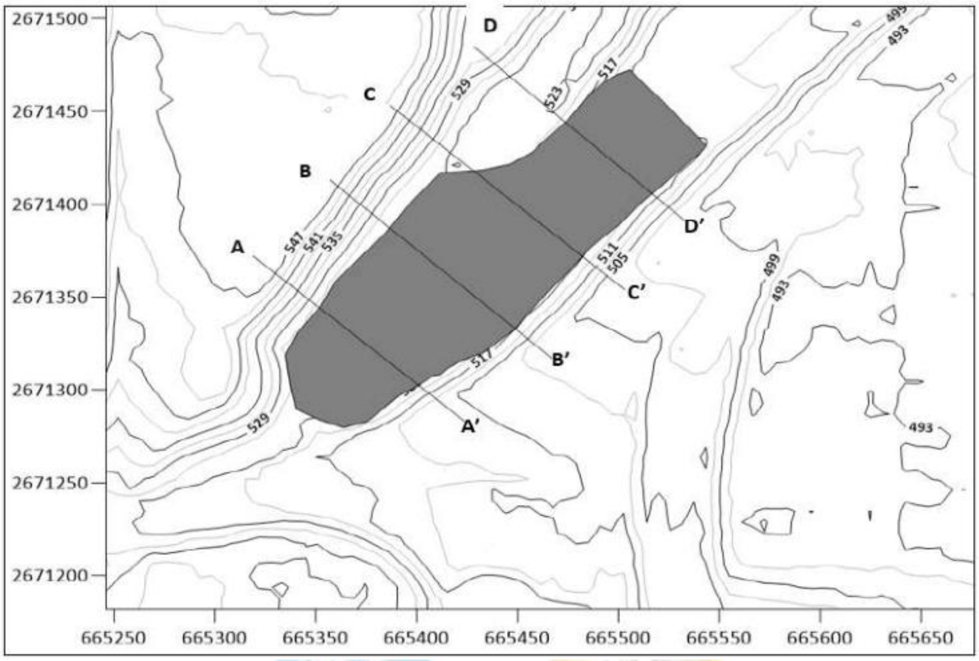
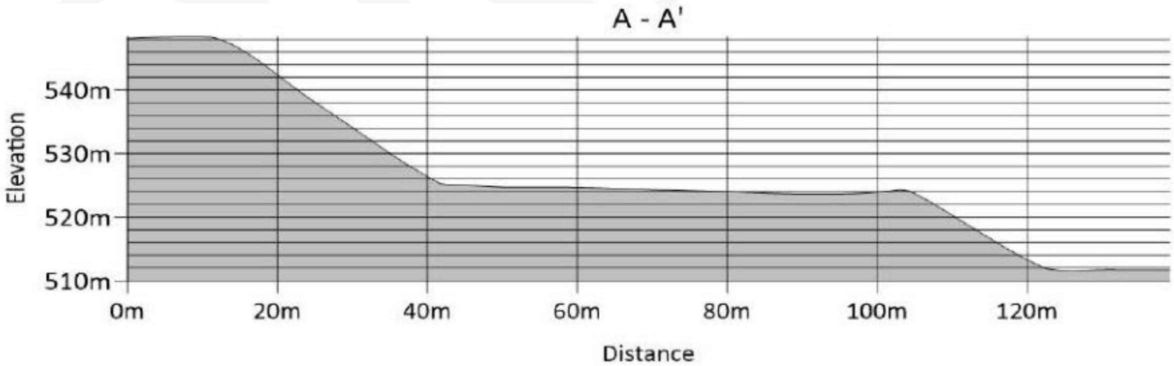


Figure 60: Sections across the dump to evaluate dump movement (Pre-Monsoon)

Table 26 : Coordinates of section made across the pilot scale Ash – OB mix dump

Section	A	A'	B	B'	C	C'	D	D'
X	665319	665425	665357	665467	665387	665503	665428	665533
Y	2671372	2671282	2671413	2671317	2671453	2671354	2671485	2671391



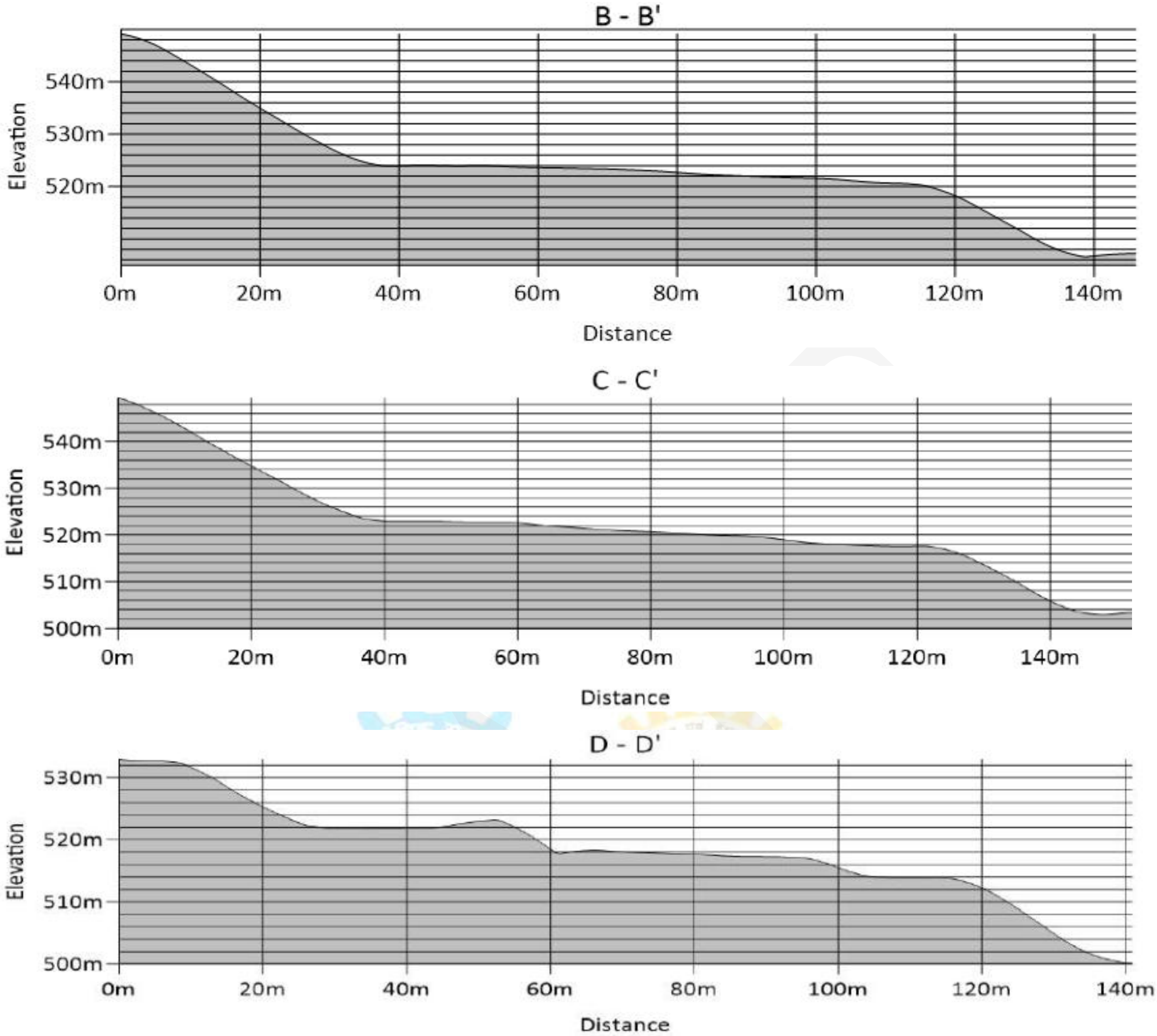


Figure 61: Profile of sections made across the pilot scale dumps (Pre - Monsoon)

Profiles along A-A’, B -B,’ C – C’ and D – D’ was made across the pilot scale dumps along the coordinates as given in the Table 27. A team from CSIR – CIMFR visited the experimental site again in the month of September (during monsoon period)and October (post monsoon period), 2024 to carry out observation and monitoring work.at the dump site during and after monsoon season. Following observation were made :

1. CIMFR team visited the toe of the experimental pilot scale dump to evaluate the dump angle and to see if there is movement along the dump slope (siding) in form of gully erosion, development of cracks, leakage or escape of ash – OB mix encapsulated by the OB material along with rain water, movement of rain water along the garland drain as shown in Fig

West Direction East Direction

Figure 62: Pilot dump slope condition and angle 37^0 (monsoon)

Water garland filled with water Water draining along at toe of adjacent bench

Figure 63: View of pilot dump from the top of the adjacent OB dump (monsoon)

From the examination of the dump slope during monsoon period, following were observed

- There was no slide along the slope of the dump
- The dump slope angle was found to be 37^0
- The rain water was not stagnant and was draining along the natural dip of the haul road
- No noticeable cracks or sink holes was observed at the pilot scale dump

Washed out fine soil after monsoon Generation of cracks due to drying

Condition of water garland at the pilot scale dump top and toe (Post – Monsoon)

Figure 64: Condition of the pilot scale dump slope (post-monsoon)

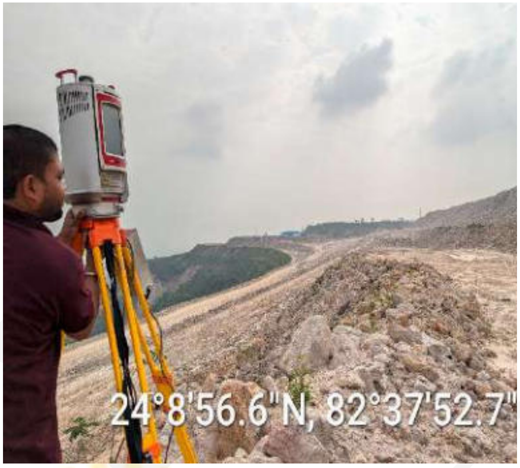
8.4 Post – monsoon monitoring study

From the examination of the pilot scale dump during post monsoon period, following observation were made

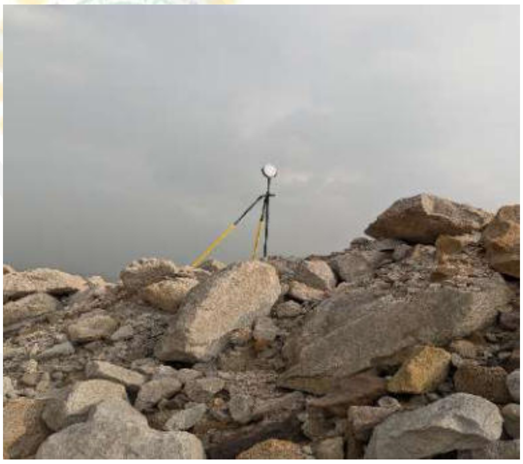
1. Due to rains, the top portion of the dump was observed to be washed out of sand (fine particles) at many places specially at places having dipping dowards the ramp.
2. Surface cracks were observed in some places on the dump top surface, this may be attributed to shrinking effect caused by drying of soil
3. The water garland was found to be intact after monsoon and was filled with fine sand which may have been eroded from the pilot and adjacent dumps. The drainage pattern over the dump was mostly restricted along the water garland and this kept the dump mostly dry during monsoon.
4. Vehicular movement over the pilot scale was not an issue over the washed off dump top as it was mostly devoid of fine clay material
5. No major structural movement (sinkhole, sliding etc.) was observed at the pilot dump, however, minor erosion was observed along the dipping ramp portion of the dump

As was the case during pre-monsoon season, 3D laser scanning of the dump was again carried out from the same established station as shown in the Fig __ below

The data collected from the field was processed at the Nigahi Survey department and the CSV file as well as the recently conducted drone imaginary was provided to CIMFR team. Contour of the area of intrest and corrosponding isometric view of the post monsoon dump was plotted



Station A Station B



Station C

Figure 65: Locaions where 3D Laser Scanner was placed during post-monsoon study

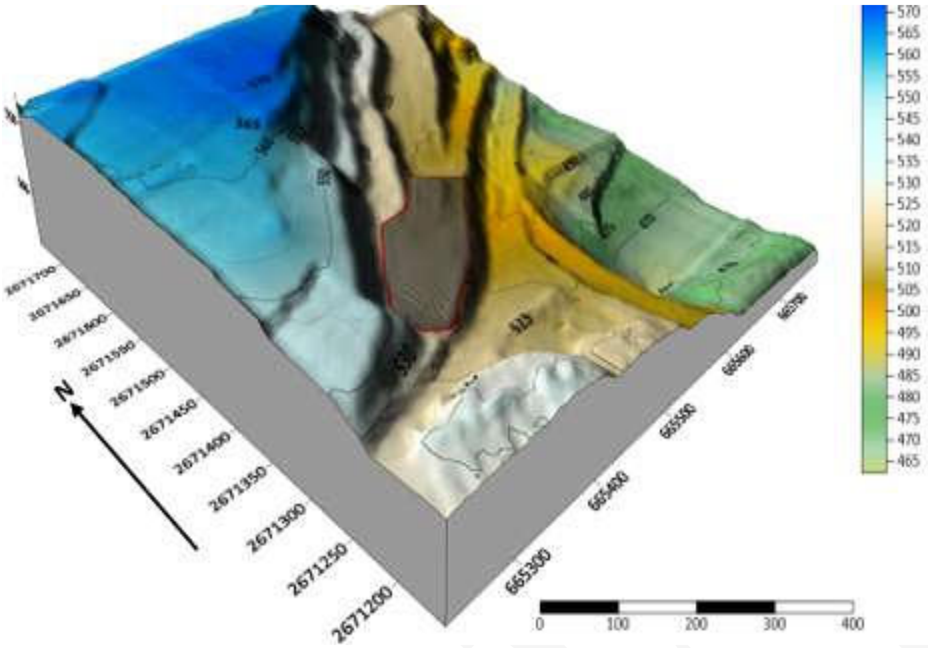


Figure 66: Isometric view of the pilot scale dump (post – monsoon)

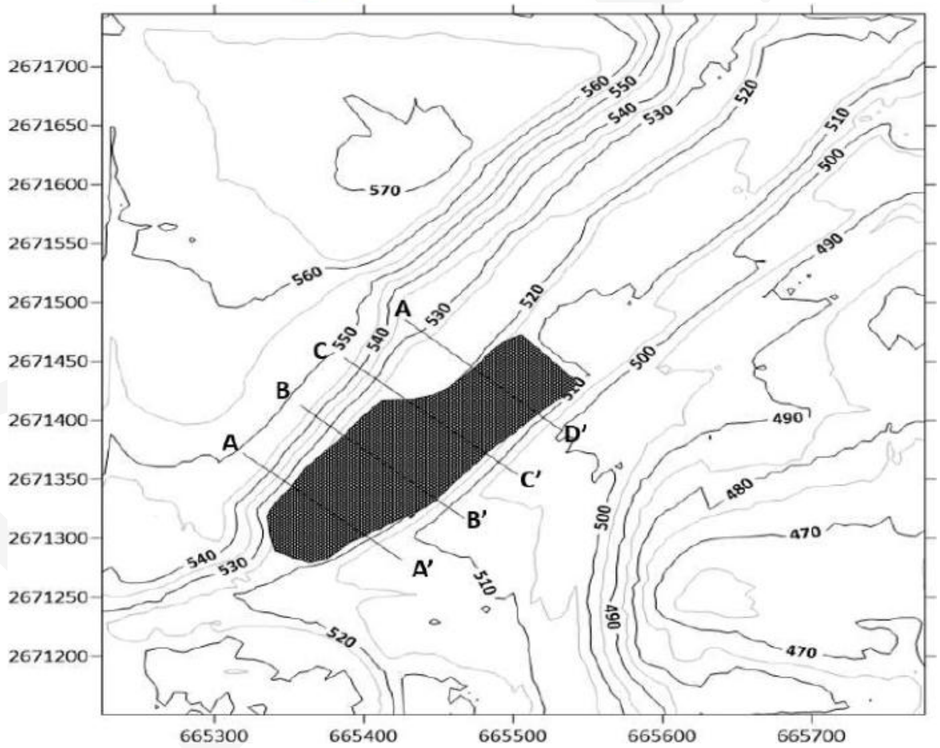


Figure 67: Sections across the dump to evaluate dump movement (post - monsoon)

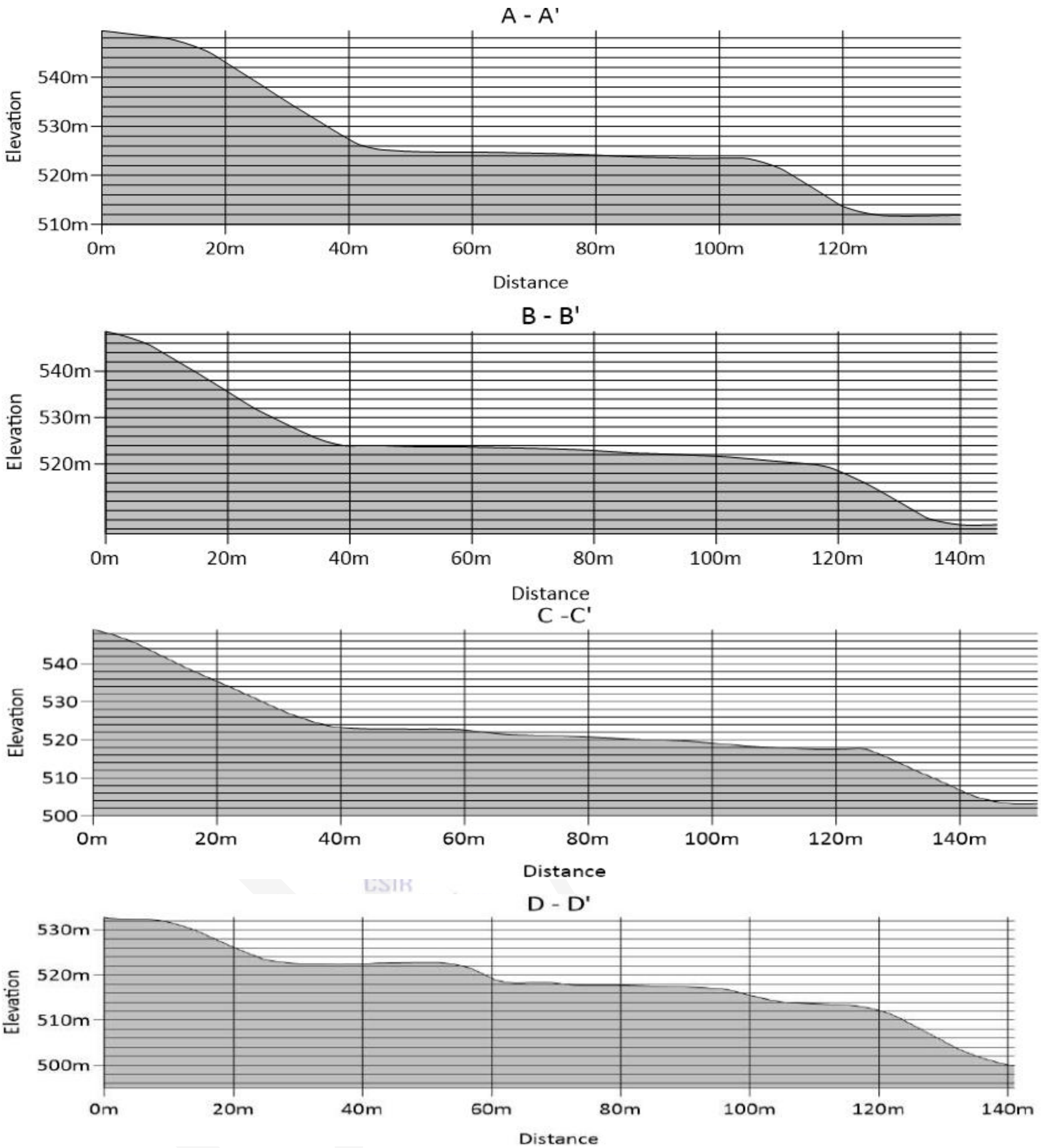


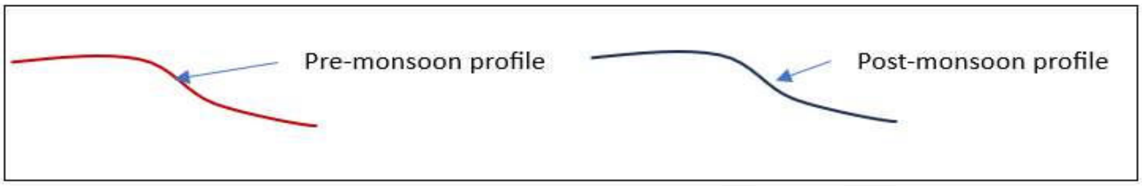
Figure 68: Profile of sections made across the pilot scale dumps (Post - Monsoon)

Post monsoon profiles along A-A’, B - B,’ C – C’ and D – D’ was made across the pilot scale dumps along the same coordinates as given in Table 27 so that the sections coincide with previous made profiles of pre – monsoon period. The profiles along different section of pre and post monsoon period were plotted and superimosed over each other do find the movement of the pilot scale dump along it.

8.5 Evaluation of variations in dump profiles

The change in dump profiles along different identified across sections (A- A' , B – B', C – C' and D – D') of the pilot scale dump post monsoon is summarized in the Section below, The " RED" and " BLUE" colour indicates pre – monsoon and post-monsoon profile

KEY

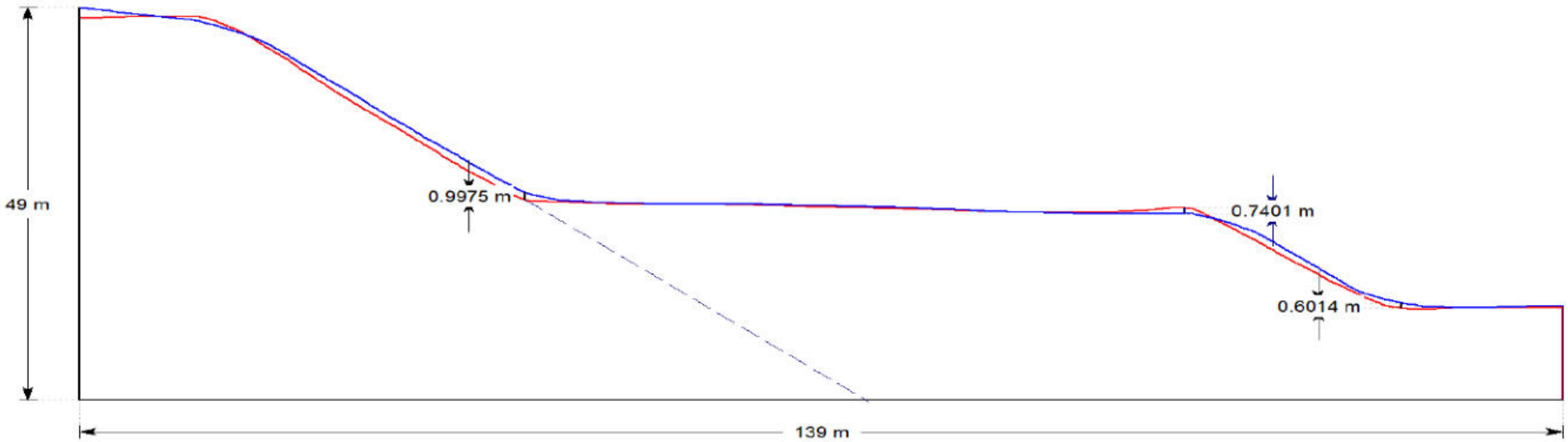


SECTION A – A'

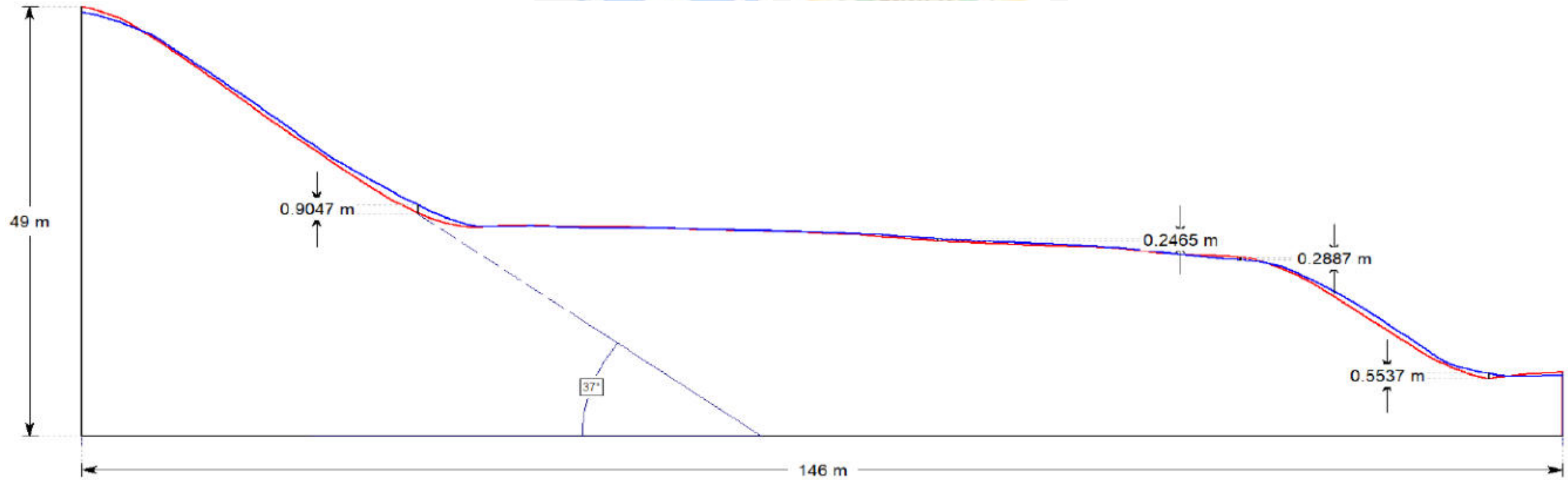
- Vertical upward heave of 997.5mm was observed at the toe of the adjacent dump.
- Vertical downward movement of 740 mm was observed at the crest of the pilot scale dump.
- Vertical heave of 601mm was observed at the toe of the pilot scale dump.

SECTION B – B'

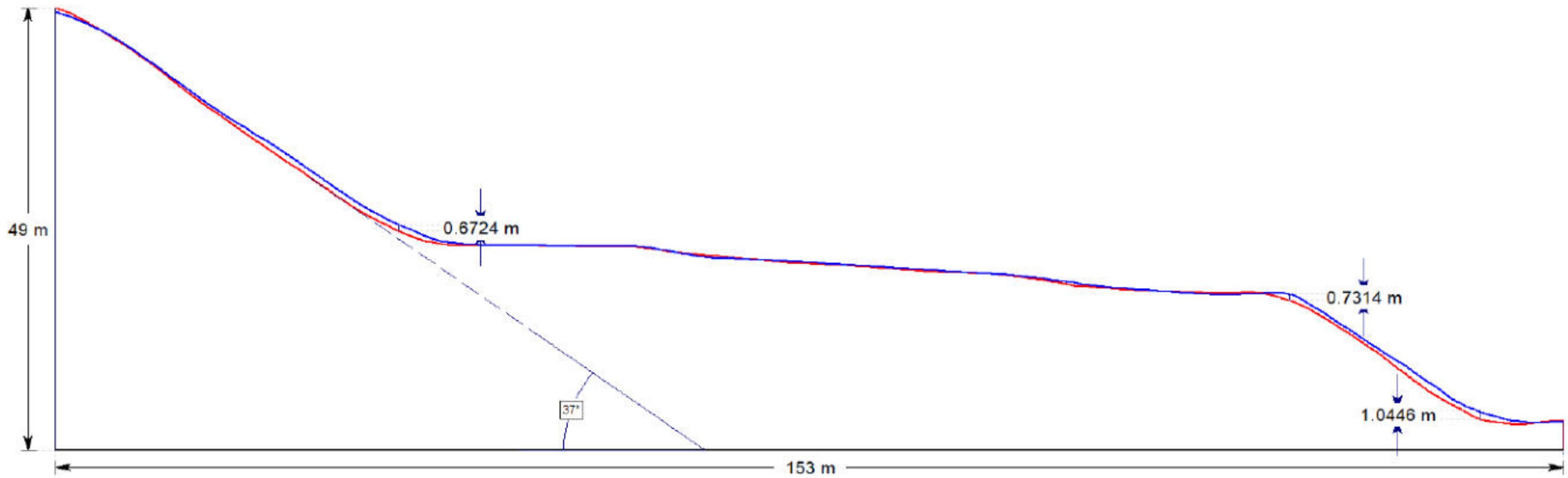
- Vertical upward heave of 904 mm was observed at the toe of the adjacent dump.
- Vertial downward movement of 246 mm was observed at the top of the pilot dump.
- Vertical downward movement of 288 mm was observed at the crest of the pilot scale dump.
- Vertical upward heave of 553 mm was observed at the toe of the pilot scale dump.



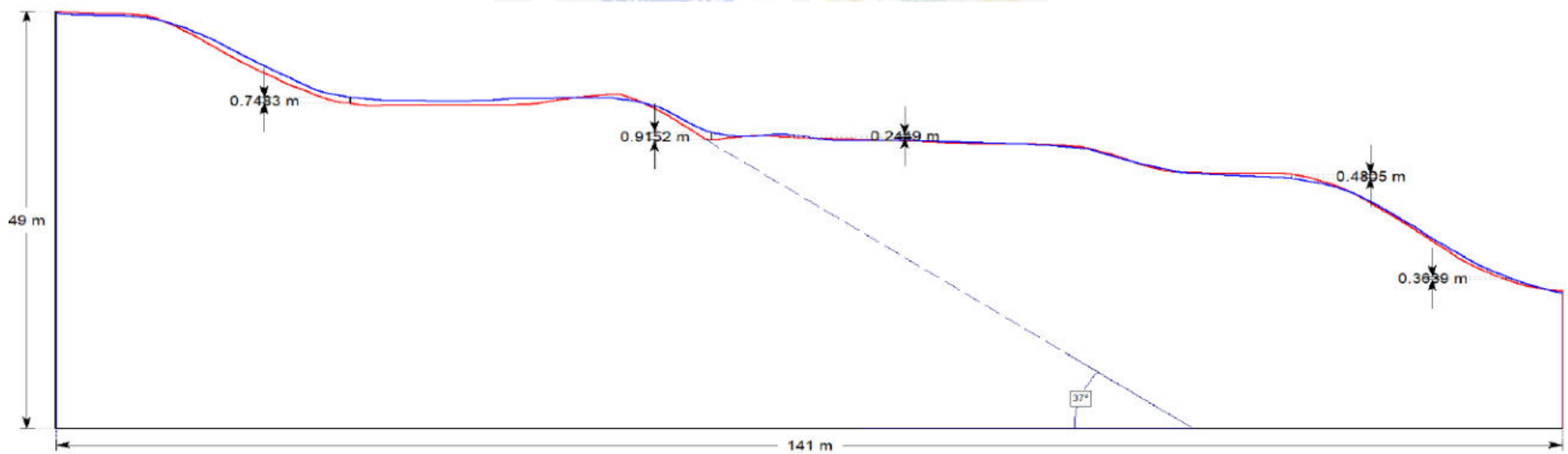
Section along A – A’



Section along B – B’



Section along C – C’



Section along D – D’

SECTION C – C’

- Vertical upward heave of 672 mm was observed at the toe of the adjacent dump
- Vertial upward heave of 731 mm was observed at the at the crest of the pilot scale dump.
- Vertical upward heave of 10446 mm was observed at the toe of the pilot scale dump.

SECTION D – D’

- Vertical upward heave of 743 mm was observed at the toe of the first bench (top) of adjacent dump.
- Vertical upward heave of 915 mm was observed at the toe of the second bench of adjacent dump.
- Vertical downward movement of 244 mm was observed at the top of the pilot dump
- Vertical downward movement of 480 mm was observed at the crest of the pilot dump.
- Vertical downward movement of 360 mm was observed at the slope of the pilot dump near its toe.

In almost all the cross sections taken into account, the top or the flat portion of the pilot scale dump did not encounter much vertical movement and it was restricted to less than 250mm and this can be attributed to washouts of fine sand along with rain water towards the natural dip. The maximum movement along all cross sections was observed at the toe and crest of the adjacent dump and the pilot scale dump, and mostly vertical upward heave was observed. The upward heave of the profile may be attributed to the sliding of material along with rain water along the crest and slope of the original profile.

Considering average movement of about 700mm along the toe and crest of the slope under the influence of one monsoon, the cumulative movement in the long run over numerous monsoon could have adverse effect on the stability of the dumps in the long run. Hence, Keeping the above fact in mind it is not advisable to use ash as a backfill material under current scenario until and unless a long-term evaluation of dump movement is undertaken by scientific agency during different monsoon seasons.

9. FIELD STUDY- PART II

9.1 Study of present overburden dumping strategy at Nigahi OCP

The OB bench, with a height of 28–30 m above the Turra seam, is excavated using draglines, with the material side-cast into the de-coaled area of the previous cut. The remaining OB from the upper benches is managed using a shovel-dumper system and dumped either internally or externally, depending on space availability.

Figure 69 presents typical profile of benches for shovel dumper combination. To mitigate risks of dump slope failure, the mine management maintains an overall slope of 17° towards active operations and around 37° towards the back end. The current highest RL of the dump at Nigahi OCP is 610 mRL with a floor RL of 240 mRL. Proper 30 m × 30 m decks are formed, maintaining the requisite overall slope angle, with no further space for additional lifts or decks due to height constraints. The final stage dump plan, depicted in Figure 70, including shovel-dumper spoil dumps formed in 30 m high benches with a slope of 37.5°, corresponding to the natural repose angle of the OB material. Adjacent benches are separated by 40 m-wide berms, and the overall dump slope is planned at 28°. Topsoil, stored separately, will be used to cover completed OB dumps and slopes, facilitating vegetation growth. Safety measures include creating bumps at dump edges to prevent dumpers from rolling down, while 410/850 HP dozers are deployed for levelling and maintaining dumps.

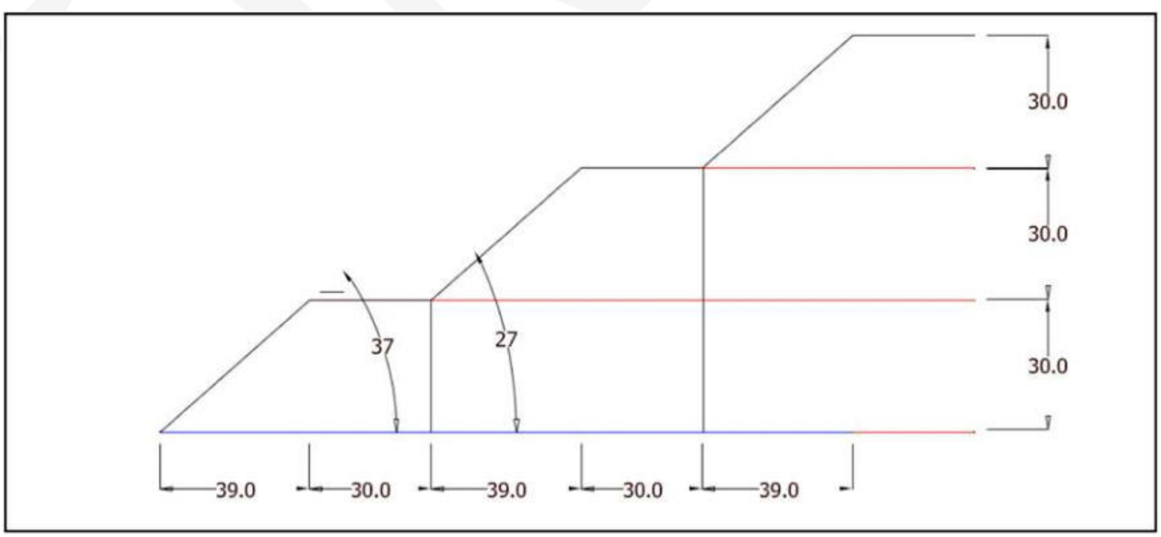


Figure 69: Typical profile of benches for shovel dumper combination

According to the EPR, to achieve an annual production target of 25 Mtpa, the projected final dump volume is 2213.39 Mm³. Of this, 232.02 Mm³ is side-cast directly by draglines, and 14.69 Mm³ facilitated through cast blasting, while the remaining 1966.68 Mm³ is excavated and transported using the shovel-dumper system. Since the initiation of OB removal in 1985–86, a cumulative volume of 954.12 Mm³ has been dumped as of 31 March 2020, both internally in de-coaled areas and externally in non-coal-bearing zones within the leasehold area.

Internal dumps can accommodate a total of 1530.05 Mm³ (Table 28). However, due to storage limitations and the infeasibility of external dumping—restricted by coal-bearing areas to the north and existing infrastructure to the south—the remaining 683.34 Mm³ of waste is planned to be addressed by utilizing voids in adjoining mines after their operations are completed. The calculation of shortfall is detailed in Table 29.

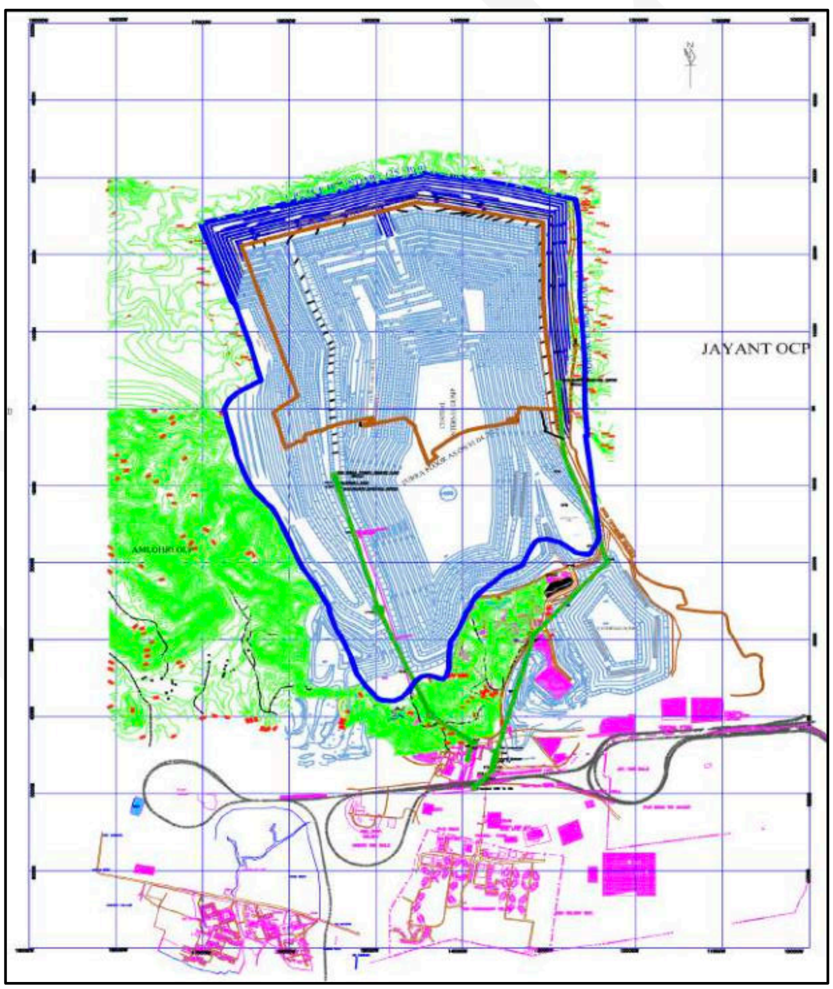


Figure 70: Final Stage dump plan of Nigahi OCP (Ref: Approved mining plan of Nigahi OCP)

Table 27: Calculation of OB to be dumped in central and east section dump and Interim west section dump

	S. No.	RL (m)	OB Volume (Mm^3)
A	**Central + East Section Dump Volume**		
	1.	Dragline Dump	246.71
	2.	215-245	146.36
	3.	245-275	117.23
	4.	275-305	138.86
	5.	305-335	124.01
	6.	335-365	113.46
	7.	365-395	108.9
	8.	395-425	89.6
	9	425-455	68.8
	10	455-485	79.97
	11	485-515	60.83
	12	515-545	43.17
	13	545-575	30.14
	Total (A)		1368.04
B	**Interim West Section Dump Volume**		
	SI. No.	**RL(m)**	**Solid Volume (Mm^3)**
	1	140-170	10.12
	2	170-200	17.75
	3	200-230	23.61
	4	230-260	28.88
	5	260-290	32.32
	6	290-320	15.27
	7	320-350	12.26
	8	350-380	9.32
	9	380-410	6.53
	10	410-450	5.92
	Total (B)		161.99
Total OB that can accommodated in internal dumps(A+B)			**1530.05**

Table 28: Total OB to be removed and shortfall of dumping space

Particular	Total OB to be removed from 2020-21 to 2040-41	Total quantity of OB to be dumped in Internal Dump of Nigahi OCP from 2020-21 to 2040-41 (Mm^3)	Quantity of OB left after internal dumping (Mm^3)
OB (Mm^3)	2213.39	1530.05	**683.34**

9.2 Quantity of ash required

Table 29: Calendar program of excavation since 2023-24 as per the approved mine plan

Year	Coal production (Mt)	Waste By Product		Total Volume for Dumping (Mm^3)
		OB Removal (Mm^3)	Generation of Manufactured Sand (Mm^3) from OB	
2023-24	25.00	133.12	0.16	132.96
2024-25	25.00	135.00	0.31	134.69
2025-26	25.00	135.00	0.62	134.38
2026-27	25.00	135.00	0.62	134.38
2027-28	25.00	135.00	0.62	134.38
2028-29	25.00	135.00	0.62	134.38
2029-30	25.00	135.00	0.62	134.38
2030-31	25.00	135.00	0.62	134.38
2031-32	25.00	135.00	0.62	134.38
2032-33	25.00	128.00	0.62	127.38
2033-34	25.00	122.99	0.62	122.37
2034-35	25.00	120.76	0.62	120.14
2035-36	25.00	106.03	0.62	105.41
2036-37	25.00	104.48	0.62	103.86
2037-38	20.00	80.26	0.62	79.64
2038-39	18.00	60.75	0.62	60.13
2039-40	14.00	45.00	0.62	44.38
2040-41	7.10	15.00	0.62	14.38
Total	**409.10**	**1996.39**	**10.39**	**1986.00**

- Total OB to be removed 2020-2041= 2213.49 Mm^3
- Total OB left for dumping from 2025-2041= 1718.35 Mm^3 (as per mine plan)
- Total OB to be removed by dragline and cast blasting = 246.71 Mm^3
- OB removed by dragline and cast blasting between EPR to 2024-25 = 60.26 Mm^3
- Balance OB to be removed by dragline and cast blasting (2025-26 to 2040-41) = 186.45 Mm^3
- Total OB left for shovel dumper (2025-26 to 2040-41) = 1718.35-186.45 = 1531.90 Mm^3

Table 30: Calculation for quantity of ash required per year at different percentage of OB in Nigahi OCP

Year	OB to be removed by shovel-dumper (Mm^3)	Quantity of ash required (WoW basis) (Mm^3)				
		5% Ash	10% Ash	15% Ash	20% Ash	25% Ash
2025-26	121.99	10.69	21.38	32.07	42.76	53.45
2026-27	121.99	10.69	21.38	32.07	42.76	53.45
2027-28	121.99	10.69	21.38	32.07	42.76	53.45
2028-29	121.99	10.69	21.38	32.07	42.76	53.45
2029-30	121.99	10.69	21.38	32.07	42.76	53.45
2030-31	121.99	10.69	21.38	32.07	42.76	53.45
2031-32	121.99	10.69	21.38	32.07	42.76	53.45
2032-33	114.99	10.08	20.15	30.23	40.30	50.38
2033-34	109.98	9.64	19.27	28.91	38.55	48.18
2034-35	107.75	9.44	18.88	28.32	37.77	47.21
2035-36	93.02	8.15	16.30	24.45	32.60	40.75
2036-37	91.47	8.01	16.03	24.04	32.06	40.07
2037-38	67.25	5.89	11.79	17.68	23.57	29.46
2038-39	47.74	4.18	8.37	12.55	16.73	20.92
2039-40	34.79	3.05	6.10	9.15	12.19	15.24
2040-41	10.98	0.96	1.92	2.89	3.85	4.81
Total	**1531.90**	**134.23**	**268.46**	**402.69**	**536.92**	**671.15**

9.3 Calculation for quantity of shortfall

The incorporation of pond ash into the overburden (OB) mix will increase the total volume requiring disposal within the mine. However, given the existing storage constraints and the infeasibility of external dumping, there is already an excess of 683.34 Mm^3 of waste that cannot be accommodated internally. The addition of ash will further exacerbate this shortfall.

Table 32 provides a detailed calculation of the excess OB volume remaining after internal dumping, along with the estimated timeline for when the storage capacity will be exhausted. To address this issue, it is planned to utilize the voids of adjoining mines for the disposal of the excess OB after their operations are concluded. However, a comprehensive study is necessary to assess the total excess quantity of OB that can be effectively accommodated in these neighbouring mine voids.

When determining the quantity of ash required, the possibility of mixing ash with overburden has been considered only for shovel-dumper dumps, as mixing ash with dragline dumps is not feasible. This constraint limits the application of ash to specific types of dumps.

Table 31: Excess quantity of OB and generated due lack to space in internal dumps

Quantity of OB and Ash (Mm^3)	**Total OB to be dumped from 2025-26 to 2040-41**	**Quantity of OB left after internal dumping (Mm^3)**	**Estimated year after which there will be no space for dumping**
OB with 0% Ash	1718.35	683.34	2034
OB+5% Ash	1852.58	817.67	2033
OB+10% Ash	1986.81	951.90	2032
OB+15% Ash	2121.04	1086.13	2032
OB+20% Ash	2255.27	1220.36	2031
OB+25% Ash	2389.5	1354.59	2031

9.4 Modes of transport of ash

The transport of ash in mines is a critical operation that must be carefully planned based on specific requirements and existing infrastructure. Factors such as transport distance, the nature of the ash (dry or slurry), available infrastructure, cost-effectiveness, and safety considerations play a crucial role in determining the appropriate transport method. The selection process ensures that operations are efficient and environmentally sustainable. Common modes of ash transport in mines include conveyor systems, trucks and dumpers, rail transport, slurry pipelines, pneumatic conveying, and bucket elevators or hoppers.

a) Conveyor Systems

Conveyor belts offer a continuous and efficient means of transporting ash within mines or to external storage or disposal areas. They are particularly useful for medium to long distances where consistent operation is required. However, open conveyor systems may pose dust emission challenges, especially in windy conditions.

b) Trucks and Dumpers

Trucks and dumpers are flexible and widely used for transporting ash, especially over short to medium distances. They are capable of transferring ash from collection points to storage or processing areas within the mine premises. This mode is adaptable to changing mine layouts but can generate dust and lead to wear on haul roads.

c) Rail Transport

For larger mines or mining complexes, rail transport is an economical choice for moving large quantities of ash over long distances. Specialized rail cars or wagons are used to transport ash efficiently to designated areas within the mine or off-site locations. However, rail systems require dedicated infrastructure, such as tracks and terminals, limiting flexibility in dynamic mine environments.

d) Slurry Pipelines

Slurry pipelines transport ash mixed with water under pressure through pipelines. This method is suited for long distances but has notable challenges, including high water consumption and environmental concerns related to ash pond formation at the destination. Studies indicate that fly ash transport as slurry is generally not feasible beyond 15–20% solid concentration by weight due to excessive water requirements and energy consumption (Bunn, 1989; Bunn & Chambers, 1992; Rani & Jain, 2017). Additionally, the financial viability depends on factors such as viscosity, yield stress, and electricity usage for pumping. Examples of slurry pipelines include, a 525-km Minas-Rio pipeline in Brazil (Silva et al., 2009) and in India, NTPC's Talcher Thermal Power Plant uses a slurry pipeline to transport ash to an abandoned mine pit over 9 km (NTPC, 2012).

e) Pneumatic Conveying

Pneumatic conveying uses pressurized air to move ash through pipes. While this method minimizes spillage and environmental contamination, it is energy-intensive due to significant pressure losses, especially at bends. Studies show that pneumatic systems experience high losses and inefficiencies, particularly when conveying dense-phase materials (Tripathi et al., 2015). Consequently, this method is less economical and practical for large-scale or long-distance ash transportation.

f) Closed Pipe Conveyor Systems

Closed pipe conveyors enclose ash within a pipe-like structure on a conveyor belt, preventing spillage and dust emissions. This environmentally friendly system is effective for long distances and undulating terrains but comes with high capital and installation costs. Additionally, it is less adaptable to changing mine layouts where dumping sites are dynamic.

g) Road Transport

Road transport is widely used due to its ability to provide door-to-door service and adaptability to dynamic mine conditions. Trucks are suitable for short to medium distances and can easily access changing dumping locations within mine premises. This method is economical for shorter distances, though it may generate dust and increase road maintenance costs.

Each mode of ash transport has specific advantages and limitations, with the choice depending on the mine's operational and environmental requirements. For long-distance transport from thermal power plants to mine boundaries, rail systems or closed pipe conveyors are preferred for their cost-effectiveness and environmental benefits. Within mine premises, trucks and dumpers are ideal for their flexibility and adaptability to changing mine faces and dumping sites.

To study the feasibility of road transport of ash from ash pond to the dumping site at Nigahi OCP, a survey was done outside the mine premises to find the status of traffic flow. A traffic study was conducted near Balia Nalla (N 24’ 07.381’ & E 82’ 39.984’) to understand the current traffic situations (see Figure 71).

The survey was conducted on four different days between 10 am to 6 pm. The duration was selected considering the peak time when the maximum number of vehicles are on road and the point of survey is the place which has the maximum traffic is seen between NTPC and NCL. The average number of vehicles moving at the junction is presented in Table 33.

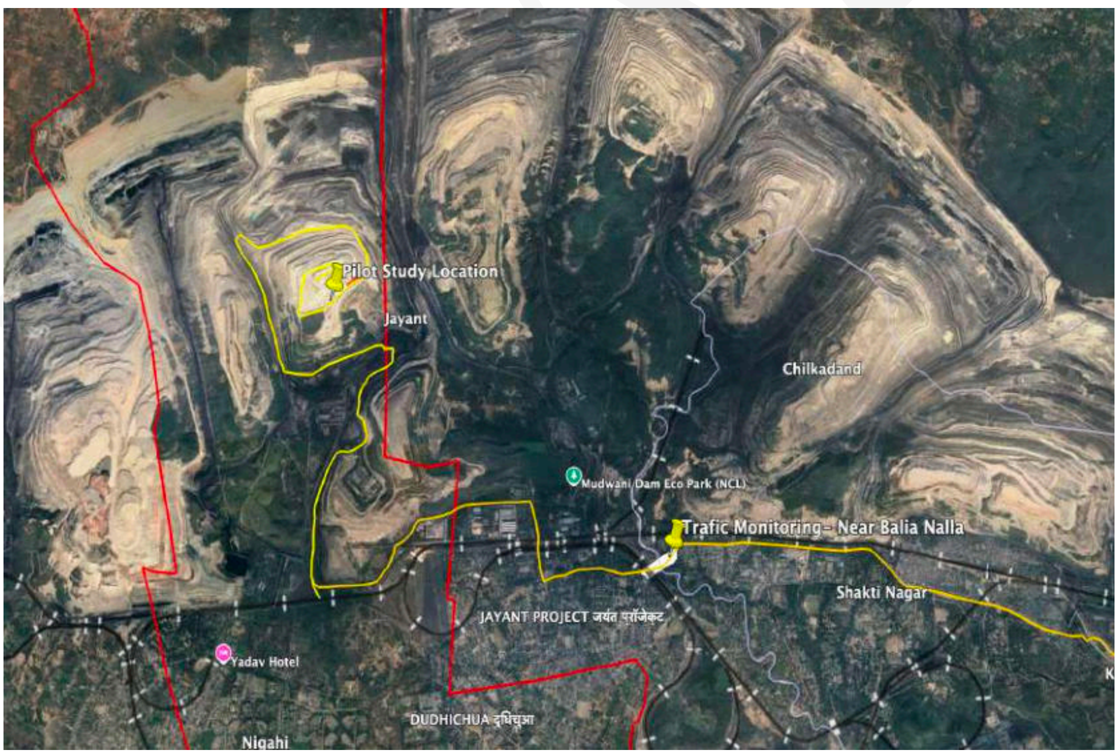


Figure 71: Location of traffic monitoring station near Balia nalla

Table 32: Traffic study at Balia nalla

Time	Traffic volume for Nigahi to NTPC (vehicle /hour)	Traffic density for Nigahi to NTPC (vehicle / km)	Traffic volume for NTPC to Nigahi (vehicle /hour)	Traffic density for NTPC to Nigahi (vehicle / km)
10.00 am to 11 am	334	817	310	758
11:00 am to 12:00 noon	371	921	419	1024
12:00 noon to 1:00 pm	308	753	312	763
1:.00 pm to 2:00 pm	303	756	285	681
3:00 pm to 4:00 pm	308	753	312	763
4:00 pm to 5:00 pm	375	917	381	950
5:00 pm to 6:00 pm	212	518	249	609

The traffic study indicates significant congestion at the site, making road transport alone an unsuitable option for handling large quantities of ash. A combined approach, utilizing both rail and road transport, could offer an effective solution to this issue.

Currently, in the pilot-scale project, only road transport is being utilized. This involves a relatively small number of ash trucks, approximately six hundred, making the system manageable. However, when large-scale ash and overburden mixed dumping operations begin, relying solely on road transport will not be feasible due to increased traffic volumes and logistical challenges.

Adopting a rail-and-road transport system would streamline operations and mitigate traffic-related issues (Figure 72). In this approach, bulk ash can be transported via rail to the mine premises, significantly reducing road traffic. From the rail unloading point, trucks can then transport the ash to the designated dump sites within the mine.

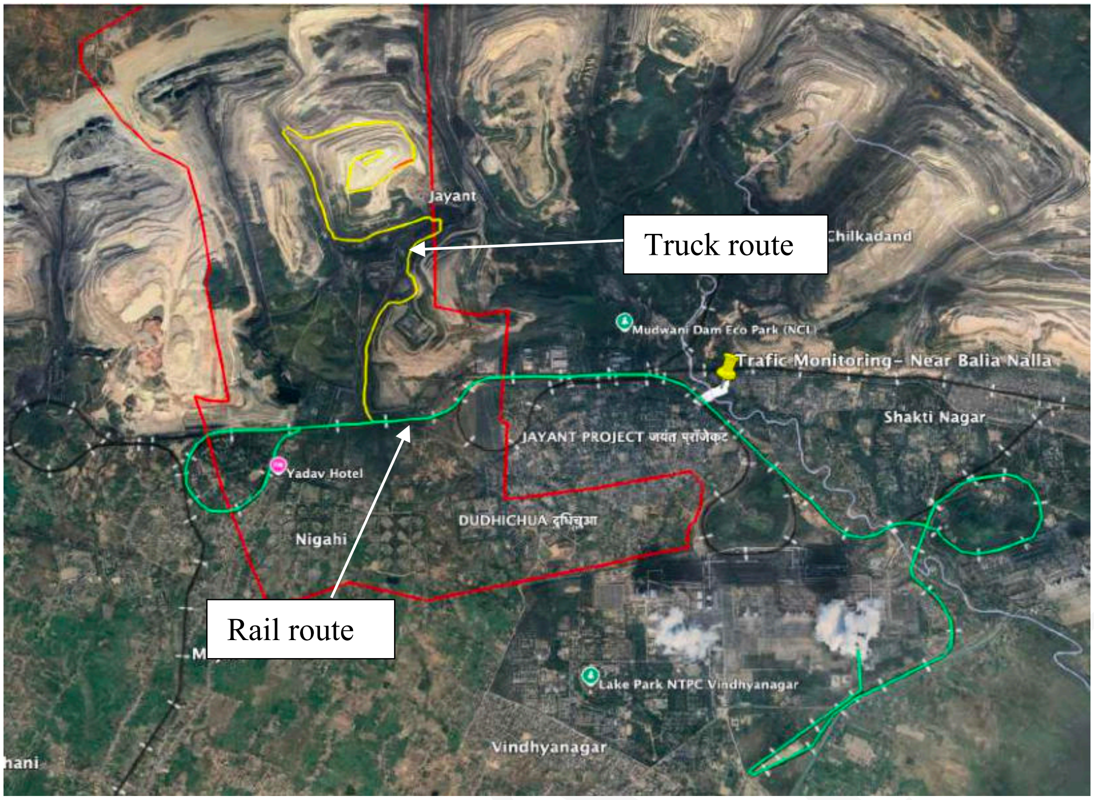


Figure 72: Possible hybrid ash transport route to Nigahi OCP

Implementing a hybrid mode of ash transportation in Nigahi OCP may present several challenges that must be addressed to ensure efficiency, sustainability, and environmental compliance. Infrastructure limitations could pose significant issues, as existing rail terminals may need substantial upgrades. It will require closed wagons to carry pond, arrangements for loading and unloading of pond at ash pond and mine site respectively and requiring a local buffer area in Nigahi OCP for keeping pond ash. Internal roads within the mine will require strengthening or widening to support the additional traffic from heavy-duty trucks transporting ash to dump sites. Additionally, acquiring suitable land for new infrastructure, such as rail terminals or storage facilities, could also be challenging.

The creation of an ash pond near the railway unloading point could pose another significant issue. Ensuring that the ash pond does not adversely impact local water resources or the surrounding environment will demand careful planning and continuous monitoring. Moreover, possibility of delays in obtaining clearances for land acquisition and environmental permissions could significantly impact project timelines as the mine has to achieve its production targets.

Traffic management within the mine premises will also be critical, as increased truck movement may lead to congestion and impact cycle times for overburden and ash transport. Coordinating truck movements with rail arrivals and mine operations could result in scheduling conflicts and operational delays. Environmental concerns such as dust generation, ash spillage during transport, and increased emissions from heightened vehicular activity need specific mitigation with appropriate measures, such as sealed containers, dust suppression systems, and optimized routes etc. Material handling challenges, such as ensuring a proper mix of ash and OB at dumping sites, require precision to prevent disruptions, while integrating ash handling with overburden operations, otherwise it could slow down cycles and reduce overall productivity.

9.4 Traffic study in Nigahi OCP

In mining operations, the efficiency and safety of material transportation, especially OB and coal, depend heavily on the proper evaluation and optimization of haulage routes. Key metrics such as the surveyed route distance, time taken for trips (both towards the dump site and back towards the mining face), and vehicle speed play a crucial role in operational planning, cost reduction, and safety enhancement. The survey focused on identifying possible routes for transportation of ash to the dumping sites. The coordinates of starting and ending points of the transportation routes at the time of the survey are presented in Table 34. Figure 73 presents the routes for OB and coal transport in Nigahi OCP.

Table 33: Coordinates of starting and ending points of transportation routes inside Nigahi OCP

S No.	Routes	Starting point		Ending point	
		Northing	Easting	Northing	Easting
1	Route 1	24.16506944	82.61441944	24.15083889	82.62922500
2	Route 2	24.16155833	82.60346111	24.13618056	82.60592222
3	Route 3	24.16079167	82.62306111	24.15374722	82.62454444
4	Route 4	24.16507778	82.62591389	24.15078889	82.62706111
5	Route 5	24.16769444	82.61756111	24.15078889	82.62706111
6	Route 6	24.16616111	82.62673056	24.15078889	82.62706111
7	Route 7	24.16616111	82.62395278	24.15078889	82.62706111
8	Route 8	24.16114167	82.60054444	24.15284722	82.60592222

9	Route 9	24.16079167	82.62306111	24.15769167	82.62917500
10	Route 10	24.16304722	82.62613333	24.15370556	82.62404444
11	Route 11	24.16038611	82.62814444	24.15746111	82.62561111

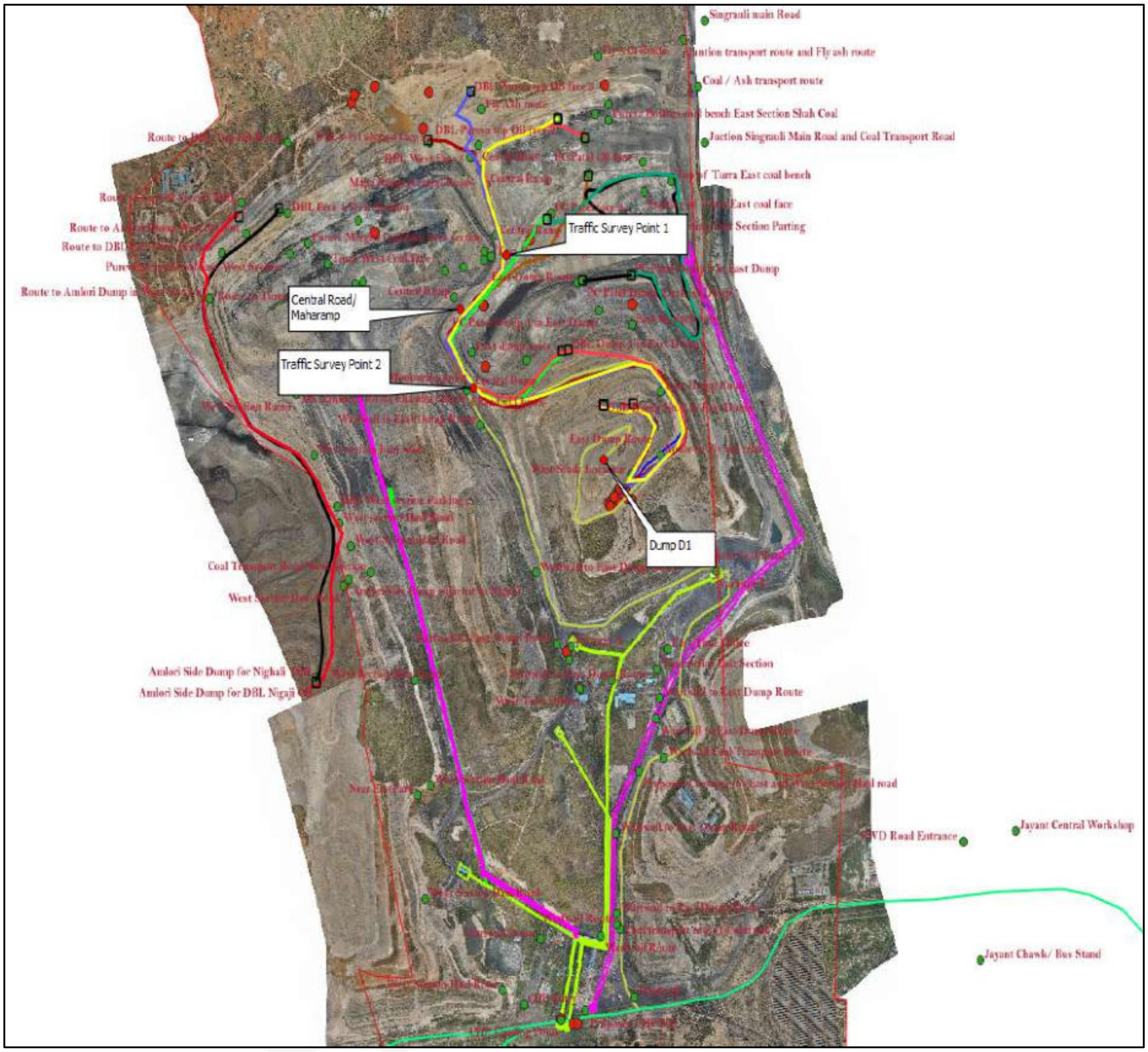


Figure 73: Routes for OB and coal transport in Nigahi OCP

A comprehensive route survey of overburden and coal transport routes was carried out at Nigahi Opencast Project (OCP) to assess the transportation system and traffic movement within the mine. The study involved recording the average time taken by dump trucks traveling towards the dump site and back towards the mining face over a period of five days.

The data collected during this survey was utilized to calculate the average speeds of the dump trucks on each of the identified routes. The analysis focused on understanding the efficiency of the transport system, identifying potential bottlenecks, and providing insights for optimization of haulage operations. Tables 16 and 17 present the detailed calculations for the average time taken and the corresponding average speeds of dump trucks on all 11 identified routes in Nigahi OCP.

Table 34: Average speed calculations towards unloading point

Routes	**Distance (meter)**	**Average time taken (towards dump, in minutes)**	**Speed (km/hr)**
Route 1	5000	20	15.00
Route 2	3480	10	20.88
Route 3	2194	12	10.97
Route 4	6050	10	36.30
Route 5	5428	16	20.36
Route 6	5324	20	15.97
Route 7	5428	20	16.28
Route 8	3497	10	20.98
Route 9	2715	15	10.86
Route 10	2661	10	15.97
Route 11	3021	12	15.11
		Average speed	**18.06 km/hr**

Table 35: Average speed calculations towards loading station

Routes	Distance (meter)	Average time taken (towards face, in minutes)	Speed (km/hr)
Route 1	5000	10	30.00
Route 2	3480	6	34.80
Route 3	2194	8	16.46
Route 4	6050	8	45.38
Route 5	5428	11	29.61
Route 6	5324	12	26.62
Route 7	5428	10	32.57
Route 8	3497	7	29.97
Route 9	2715	10	16.29
Route 10	2661	7	22.81
Route 11	3021	8	22.66
		Average speed	**27.92 km/hr**

The initial traffic survey aimed to assess the traffic status within the mine, focusing on a route with the highest overburden tipper movement. This route, referred to as "Maha-ramp," was chosen as the primary survey location. The survey was conducted at coordinates **N 24.158801, E 82.619024**, where vehicle movement in different lanes was recorded for multiple hours spaning 05 days. A second traffic survey was conducted at a location known as "Chandni Chowk" within NCL Nigahi, situated at coordinates **N 24.151836, E 82.617170** (Figure 74). This survey also involved multiple hour field observation spanned over 05 days to capture vehicle movement patterns at this critical junction.

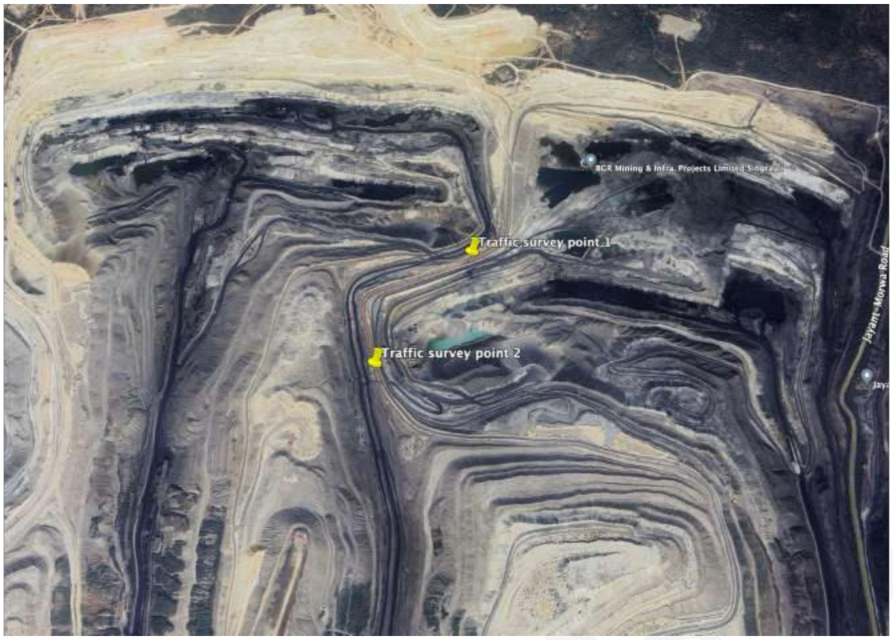


Figure 74: Traffic survey points in Nigahi OCP

The data from these surveys served as a baseline for monitoring changes in traffic dynamics over time, in case of transportation of ash to the mine. Additionally, the survey recorded travel times, loading durations, and unloading durations to calculate the average speed of vehicles in both lanes.

The observations recorded during the traffic survey indicate the number of vehicles passing through a specific point within a defined time interval. Traffic flow is quantified as the number of vehicles traversing a point over a set duration. For ease of interpretation in this study, traffic flow has been calculated in **vehicles per hour**. The minimum spacing between the two vehicles are also calculated to analyze the possibility of adding fly ash trucks maintaining a minimum spacing of 40 m between two dumpers and maximum speed 30km/hr. The results of traffic survey are presented in Table 37. For the sake of simplicity, the values of traffic flow, average no. of vehicle, and average spacing between two consecutive vehicles are rounded off to next numeral. Figure 75 presents some snapshots of loading and unloading stations in Nigahi OCP.

Table 36: Traffic flow and spacing between two consecutive vehicles

Towards face			
Traffic Survey	Average traffic flow (Vehicle/hour)	Average no. of vehicles (vehicles/km)	Average spacing between two consecutive vehicles (m)
Day 1	268	10	104
Day 2	236	8	118
Day 3	248	9	109
Day 4	253	10	105
Day 5	275	11	93
Average	**256**	**9.6**	**105.8**
Towards dump			
Traffic Survey	Average traffic flow (vehicle/hour)	Average no. of vehicles (vehicles/km)	Average spacing between two consecutive vehicles (m)
Day 1	256	14	71
Day 2	246	14	73
Day 3	268	17	59
Day 4	257	15	68
Day 5	297	16	61
Average	**264.8**	**15.2**	**66.4**

Figure 75: Snapshots of loading and unloading stations in Nigahi OCP

9.5 Effect on production due to mixing of pond ash

In this study, a key focus was on mixing and dozing time of ash and OB, as variations in this parameter could directly impact production efficiency. Changes in dozing time can either increase or decrease production losses, making it critical to monitor this factor carefully. To determine the actual time required for a dozer and a hydraulic excavator to efficiently handle overburden and ash, detailed observations were conducted at the pilot study site. Figure 76 presents the snapshots of working of dozer and excavator at the pilot study site.

Key operational parameters for the calculations include an overburden truck capacity of 20 m^3 and an ash truck capacity of 30 m^3. The targeted annual production for Nigahi is 25 Mtpa. The density of overburden is estimated at 1.77 tonnes per cubic meter (t/m^3), while the bulk density of pond ash is 1.01 t/m^3.

Figure 76: Snapshots of working of dozer and excavator at pilot study site

The working of Dozer and excavator including the ash and OB trips were observed during the entire pilot study duration. From the observations recorded, the following times were calculated:

- Time taken by the dozer individually: 2.26 minutes
- Time taken by the hydraulic excavator individually: 2.37 minutes
- Time taken when both the excavator and dozer working together: 1.87 minutes

These results highlight the operational efficiency achieved through the combined efforts of the dozer and excavator. The collaboration between the two significantly reduced the time required to handle the overburden and ash compared to when each operated individually.

Using these time measurements, the effect on production was evaluated. By analyzing the difference in time taken, the potential gains or losses in production efficiency were quantified, in case of mixing ash with OB dumps.

The total number of trips for overburden and ash was considered for dumping at a single site where one dozer and one hydraulic excavator were deployed. Later, the study also explored the effect of increasing the number of sites and machinery on production losses.

a) Key Parameters

- **Base OB Trips**: 256 trips per hour, with an OB volume of 5120 cubic meters (20 cubic meters per trip).
- **Fly Ash Variation**: Fly ash percentage was varied from 5% to 25%, leading to an increase in total trips as more ash was added to the mix.
- **Machinery Setup**: Calculations were performed for one PC and one dozer working together and their impact on handling time and production losses.

b) Production Loss Calculations

The dozing time when the excavator and dozer were working together was calculated. This value was used to estimate the losses in OB volume due to increased ash trips. Table 38 summarizes the calculations.

Table 37: Losses in OB volume due to increased ash trips

Ash percentage	OB trips	OB volume (cubic meter)	Volume of ash required (cubic meter)	No. of ash trips	Total trips	Total HEMM working time (minutes)	Loss in OB (cubic meter)	Loss in OB, %
5%	256	5120	448.63	15	271	63	270	5%
10%	256	5120	897.27	30	286	67	523	10%
15%	256	5120	1345.90	45	301	70	752	15%
20%	256	5120	1794.53	60	316	74	959	19%
25%	256	5120	2243.17	75	331	77	1147	22%

To minimize production losses, the number of sites were increased, and corresponding excavator and dozers were also increased. Each site will have one dozer and one excavator. Production loss percentages for different fly ash compositions were calculated for setups ranging from 1 to 10 sites is presented in Table 39.

Table 38: Production loss due trends with increase in number of sites

Number of sites	Production loss percent				
	for 5% ash	for 10% ash	for 15% ash	for 20% ash	for 25% ash
1	88	89	89	90	90
2	76	78	79	80	81
3	64	66	68	70	71
4	53	55	57	59	61
5	41	44	47	49	51
6	29	33	36	39	42
7	17	21	25	29	32
8	5	10	15	19	22
9	-7	-1	4	9	13
10	-18	-12	-7	-2	3

c) *Observations*

1. **Single Site Operations**: With only one PC and one dozer, losses were high due to increased ash trips and limited handling capacity.
2. **Incremental Sites**: Increasing the number of sites reduced production losses significantly. At 9 or more sites, losses for all ash compositions dropped to acceptable levels.
3. **Optimal Machinery Allocation**: Using 9 or 10 sites with corresponding equipment setups led to negative losses, indicating surplus handling capacity.

The study demonstrated the importance of scaling up the number of sites and machinery to handle increased ash percentages efficiently. Incremental setups reduced production losses and improved material handling. For sustainable and optimized operations, configurations with 8 to 10 sites were found to be the most effective.

9.6 Effect of rain on ash-OB dump

Rain can significantly impact the mixing of OB and pond ash in Nigahi OCP, affecting both operational efficiency and environmental stability. One of the primary concerns is the reduction in the shear strength of the dump material. Pond ash, characterized by its fine particles and low cohesion, becomes highly susceptible to water infiltration during rainfall. This can lead to an increase in moisture content, reducing the stability of OB-ash mixtures and raising the risk of slope failures in mine dumps. The presence of water can also result in uneven settlement and compaction, further compromising dump integrity.

The leaching potential of pond ash during rainfall poses a significant environmental risk. Rainwater flow can carry ash with it, potentially contaminating nearby surface and groundwater resources. This could be of importance particularly in areas where drainage systems are inadequate to handle excess water. Moreover, the fine nature of ash increases the likelihood of surface runoff carrying particulate matter, contributing to sedimentation in surrounding water bodies and degrading water quality.

Rainfall can also disrupt operations by making haul roads slippery and less navigable, especially for heavy vehicles transporting OB and ash. Water accumulation on roads and dumping sites can slow down transportation cycles, increase vehicle maintenance requirements, and raise the likelihood of accidents. Additionally, wet ash is more difficult to handle due to its tendency to form clumps, causing delays in loading, unloading, and dozing operations. Figure 77 presents some Snapshots of ash OB dumping area during monsoon.

Figure 77: Snapshots of ash OB dumping area during monsoon

10. SLOPE STABILITY ANALYSIS

The root cause of slope failure may be attributed to two main reasons, firstly failure cased by natural disturbance and secondly due to manmade disturbances. The natural causes include seismic activities of the earth crust, seepage due to rain, cyclone, and geological disturbances, the manmade disturbance includes blasting, excavation, HEMM induced vibrations. The above-mentioned causes influence the dump stability by changing the geo-physical properties of the dump material. The other factors which influence the dump stability includes

- ✓ Bulk density of dump mass:

Bulk density of dump mass is one of the important parameters in stability calculation. It determines the weight of waste rock / soil mass, and most important factor in determination of factor of safety of slope mass.

- ✓ Strength of interface material

Strength of interface materials is also holding the very important key factors to keep then slope stand safely. Generally, interface materials become slurry due to the crust of coal, soil, and accumulation of rainwater. It badly affects cohesion of soil and frictional coefficient of the pedestal material dump. So, arrangement should be made to prevent formation of slurry.

- ✓ Grain size distribution of the dump material:

It indicates composition of dump material comprising of clay, silt, sand, gravels and boulders and the particle size of dump mass varies from 0.075 mm to more than 1.0m and the percentage composition of dump material. It influences the permeability,
density, range of values of shear strength parameters and other characteristics of the soil materials.

- ✓ Plastic Limits

If there is existence of clay material within the dump, determination of Atterberg limits are necessary to assess the expansive properties of clay material. In case of expansive soil, shear strength properties drastically reduce due to swelling when meeting water. Swelling index is also to be determined in case of expansive soil

- ✓ Hydro-geological parameters–

The effect of Hydrogeology in determining stability of dump is as follows:

a) Shear strength parameters of dump materials gets affected due to water saturation during rainy season. Majority of the dump failure is reported during rainy season & thus the effect of water saturation due to rainwater is to be considered.
b) Upward thrust of water i.e. hydro-static force is created due to accumulated water at the base of dump. It is determined by the product of unit weight of water and volume of submerged overburden dump material falling within the failure mass.

c) Seepage of water exerts dragging force on the dump materials. It depends upon the unit weight of moving water, speed and resistant offered by soil particles. Seepage pressure acts on the base of slice below the phreatic line and in the direction of flow.

✓ Geo-mining parameters

a) Mine floor inclination

It is one of the major influencing parameters controlling stability of internal dump. As the internal dumps are formed above the mine floor, which is the place of natural occurrence of coal seam or layer, all the internal dumps are to be designed as per the gradient of coal seam which is not in the control of the mine operators. Inclination of floor (dip) reduces the effective angle of repose as such shear strength of materials.

b) Blasting affect

Blasting has the adverse effect on the stability of dump. Seismicity of the area is to be considered as per Indian Seismic map.

c) Profile of the dump

The profile of the dump, i.e height, and berm width and slope angle of individual bench are the crucial factors to determine the stability of slope. Usually, it is recommended to keep the angle of individual slope to be less than the angle of repose of material As the height of dump increases, the natural time period of dump mass increases as such amplitude of natural frequency. This increases the momentum of whole mass and become susceptible to the even smaller vibration.

d) Location of dump

Location of dump site also play vital role in the stability of the slope. Site of the dump must be on firm ground and away from the quarry edge to avoid differential settlement, highwall and base failure.

e) Surcharge

Since it is usually assumed that the surcharge is caused by the weight of objects found on the slope body, the vertical component of surcharge having the direction of weight is added to the weight of blocks (slices) and horizontal component give the outward thrust on the slope face

10.1 General Principle for stability analysis

There are many methods for performing stability analysis. These are analytical, numerical, probabilistic and empirical methods. The widely used approach of stability analysis is the limit equilibrium approach, which is based upon the assumption that a slope is under limiting equilibrium condition when the shear strength available to resist sliding is just equal to the shear stress mobilized along the failure surface. The Factor of Safety (FoS) of a slope is defined as:

$$FOS = \frac{\text{Shear strength available to resist sliding}}{\text{Shear stress acting along failure surface}}$$

The shear strength (τ) of the material is characterized by Cohesion, c and Angle of internal friction, Ø, which are, related according to the Mohr - Coulomb failure criteria by the following equation (1)

$$\tau = C + (\sigma - u) \text{ Tan } Ø \qquad (1)$$

Where, $\sigma$is the normal stress & u is the water pressure acting upon the failure surface, (σ - u) thus indicates an effective normal stress across the failure surface. As mentioned earlier, Factor of safety is calculated as the ratio of shear strength to the available shear stress required for equilibrium, integrated through the whole slide. It is assumed to be constant throughout the potentially sliding mass. Due to scatter of test results and the uncertainty of these input parameters, earlier a cut-of FOS value of 1.3 safety factor was selected for Pit & Dump slope stability analysis on the basis of the long-term stability (Hoek and Bray, 1981). **But, in the light of the DGMS (Tech.) Circular No. 3 of 2020 dated 16.01.2020, Factor of Safety shall not be less than that of 1.5 for both Open cast Mine Pits and Dump Slopes.**

10.2 Bishop's Simplified Method

This method considers a circular failure surface along which the slope mass is assumed to slide. The sliding mass is assumed to be divided into number of slices. This method assumes a circular failure surface and that the slide forces are assumed to be horizontal- This analysis satisfies vertical forces and overall moment equilibrium. The parameters that need to be defined for each slice are:

1. The angle 'α'of the base of the slice,
2. The vertical stress on the base of the slice,

3. The uplift water pressure ‘u’

The factor of safety is given by the following equation:

$$F = \frac{\sum X/(1+Y/F)\ F}{\sum Z + Q} \qquad (2)$$

Where,

$X - \{c' + (\gamma h - \gamma_w h_w) \text{ Tan } Ø'\} \Delta x/\text{Cos } a$ (3)

$Y = \text{Tan } \alpha \text{ Tan } Ø$ (4)

$Z = \gamma h \, \Delta x \text{ Sin } \alpha$ ' (5)

$Q = 0.5\gamma_w Z^2 (\alpha / R)$ (6)

c' = effective cohesion, KN/m^2

Ø’ = effective friction angle, degree

γ = unit weight of the slope material, kg/m^3

h = height of slice, m

γ_w = unit weight of water, Kg/m^3

z = depth of water in the tension crack, m

Δx = width of slice, m

HW = height to the phreatic surface, m

R = radius of failure circle, m

The following conditions must be satisfied for each slice:

1. $$\sigma' = \frac{(\gamma h - \gamma_w h_w - c' \text{ Tan } \alpha/F)}{(1 + Y/F)} > 0$$

2. Cos α(1 + Y/F) > 0.2

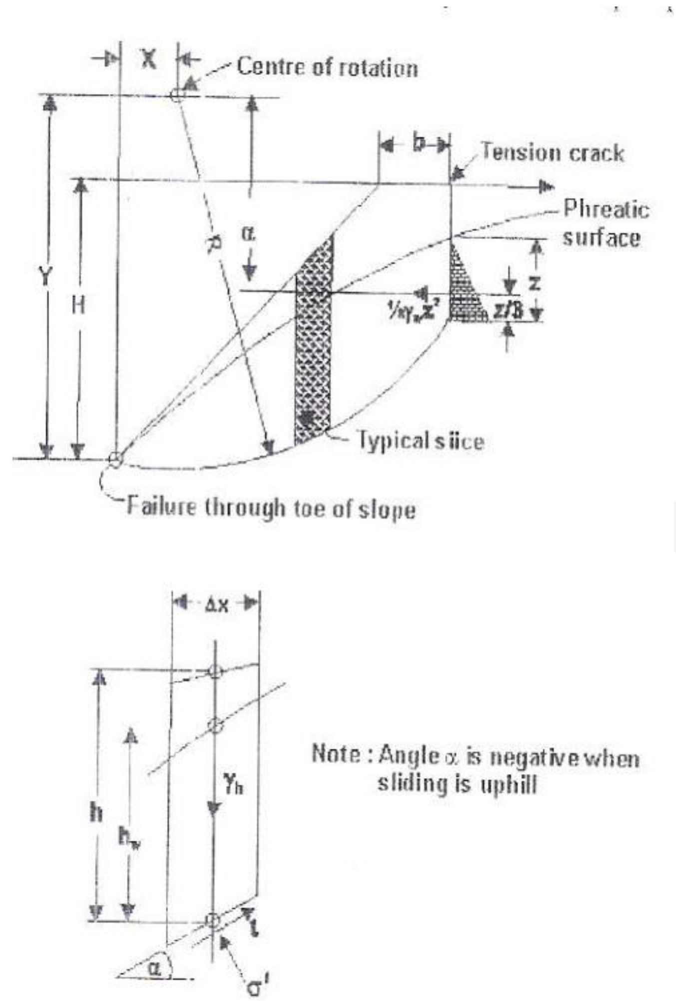


Figure 78: Bishop’s Simplified method of slices for stability analysis

Stability analysis to optimize bench configuration for ash-overburden admixture was carried out using numerical modelling with Slope Stability Analyses Software. This software works on the limit equilibrium principle and can perform analysis using different methods like Bishop's simplified method, Morgenstera - Price method, Janbu’s and Sharma method. These methods are used under different failure conditions. For analysis of stability, the most widely used method is Bishop’s simplified slip circle analysis. Initially, the geometry of the slope to be analysed is created, and the properties of material proposed to be used in bench formation are entered. The Bishop analysis is a method of slices. The method used in the program divides the specified cross section into a large number of slices (approximately 100). Slices are chosen so that all slice have the same width. The entire modelled section is divided into these slices. The results are in the form of grids of factor of safety (FOS) displayed at the corresponding slip circle centre.

The geo-technical parameters of overburden –ash admixture which is proposed to be used as backfill material in overburden dumps were determined in the laboratory. Stability analysis is performed considering realistic ground water conditions. The study of hydro geological situation by available reports and discussions with mine officials revealed that the water table is at an average depth of 8m in the mine area and the same was incorporated in the FoS analysis.

In all the numerical modelling simulation where water table is incorporated in the model, the value of Hu is taken as 1, which indicates that value of pore pressure is maximum or adverse, when Hu is equal to zero it indicates dry condition with zero pore water pressure. Analysis was carried out with most adverse situations or at high pore water conditions so as to obtain a Factor of Safety (FOS) which is conservative. The depth of the water table in the limit equilibrium model was kept at 5m bgl.

The sections of the dumps along which the stability analysis is carried out was provided by the mine management as given in the Figure below. In total six sections were provided to CIMFR, two in the western flank, two in the eastern flank and two in the central section. Out of the six sections, one section B – B' in the western flank, one central section D – D' and one section E – E' was in the eastern flank was chosen for stability analysis. The Input parameters for stability analysis includes plans and cross sections of the mine, material properties (unit weight, cohesion, angle of internal friction,) water table level to determine the pore water pressure.

Two Dump configuration was considered while evaluating the FoS, they are as follows:

Dump Configuration 1

In Dump configuration 1, after each bench of ash – OB mix dump, the top layer of 5m thick OB layer will be placed, and, this sequence will continue till the ultimate dump height is reached. In addition to that, 5m thick OB layer will be dumped all along the periphery of the ash – OB mix dump (along the slope) to encapsulate it

Dump Configuration 2

In dump Dump Configuration 2, the entire dump will be formed with ash – OB mix, a 5m thick OB layer will be placed at the top and periphery (along slope) of the entire dump to encapsulte the ash-OB mix with OB material

SECTIONS ALONG THE WORKING BENCHES (FINAL STAGE DUMP PLAN)

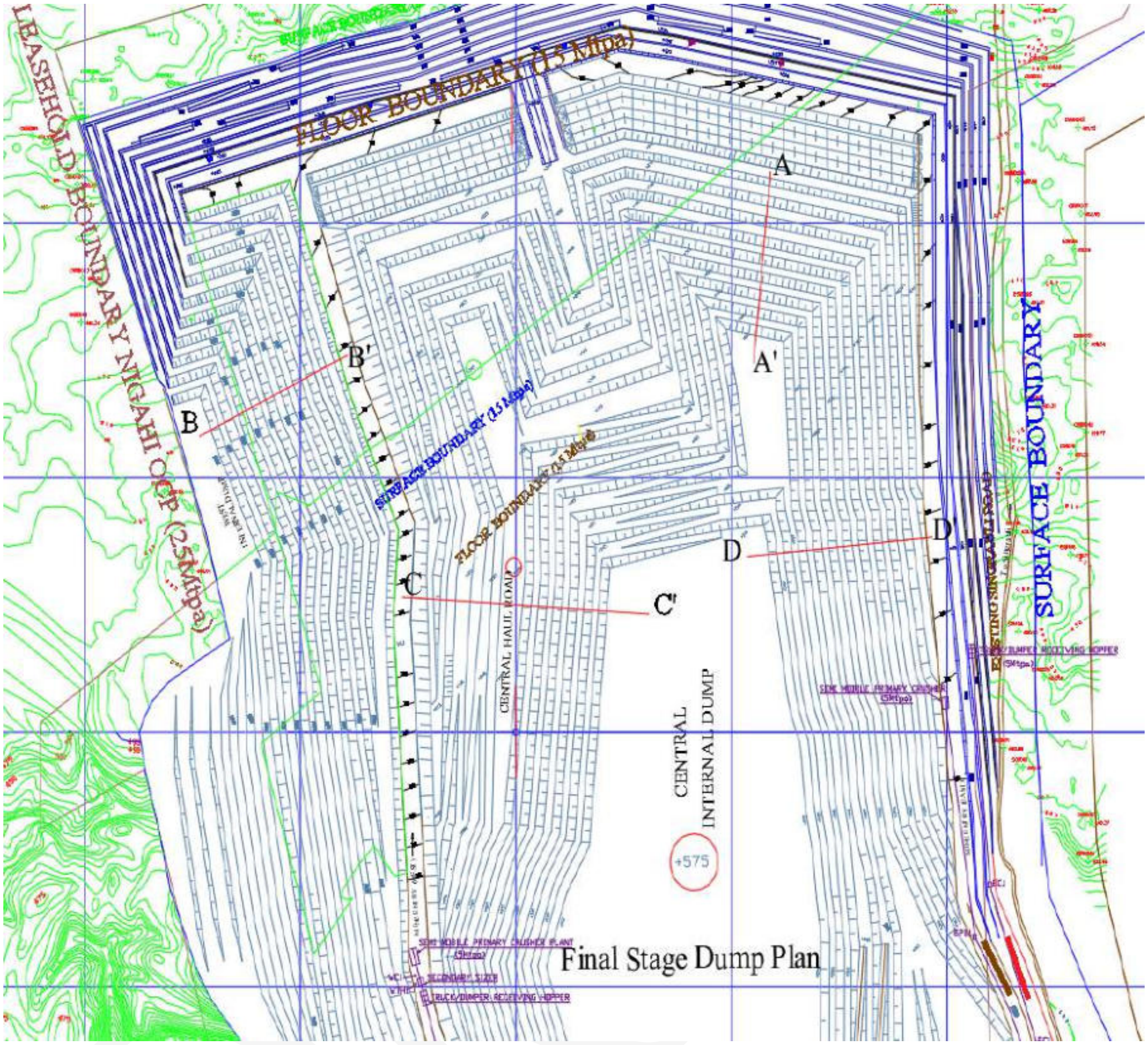
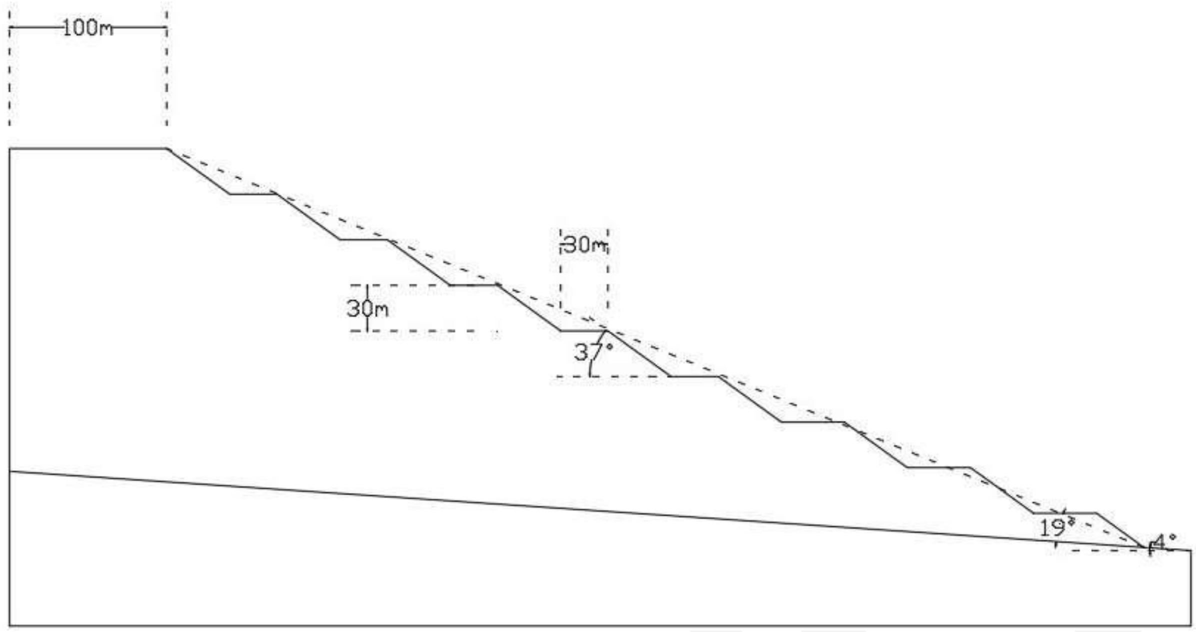
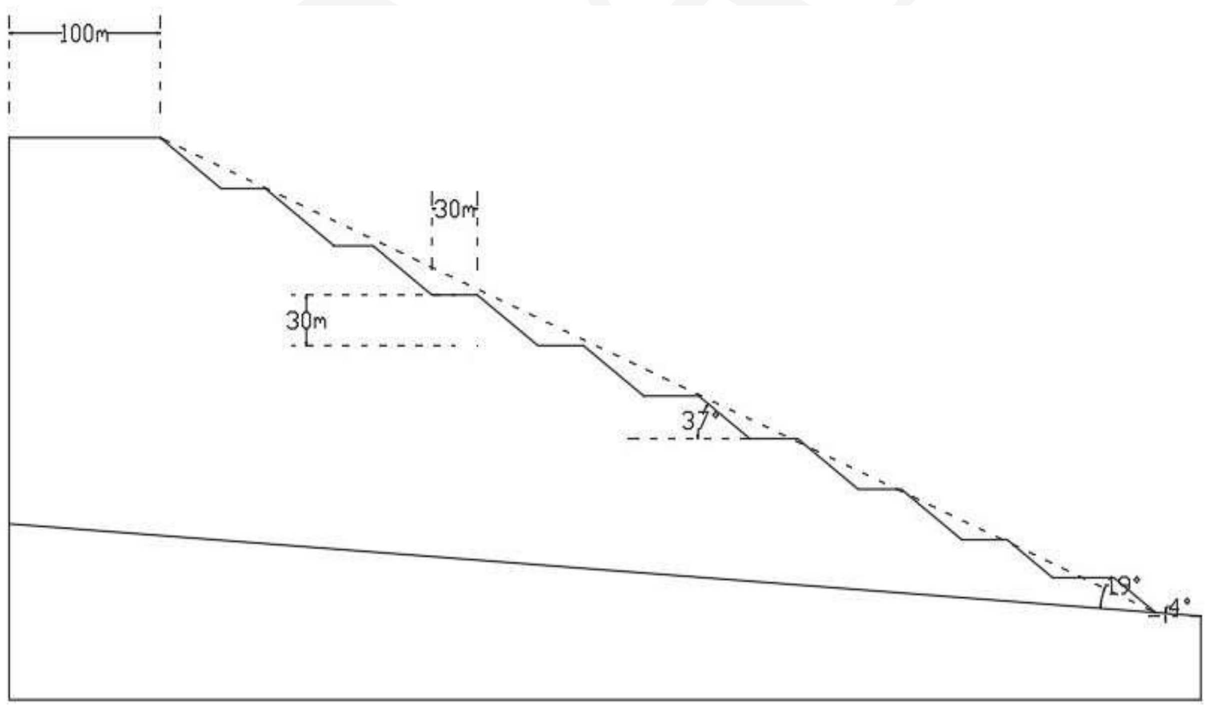


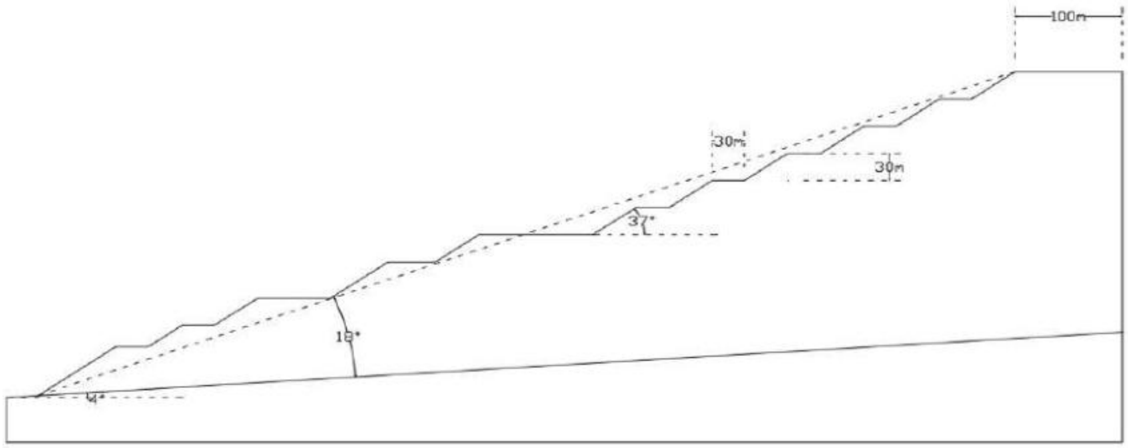
Fig.79: 4 set of cross sections, section A – A', B – B' , C – C' and D – D' considered for stability analysis



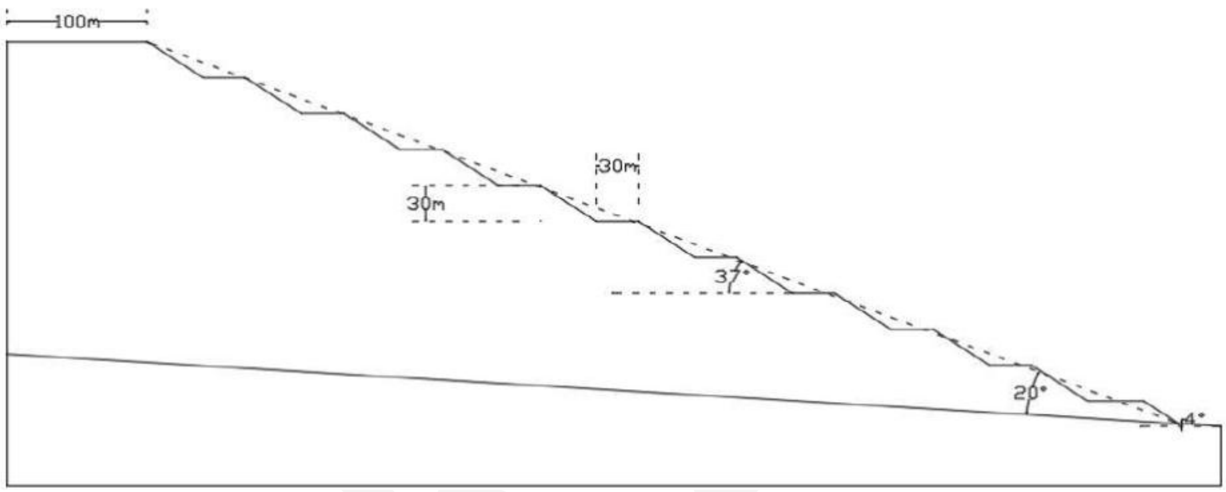
Section A – A’



Section B – B’



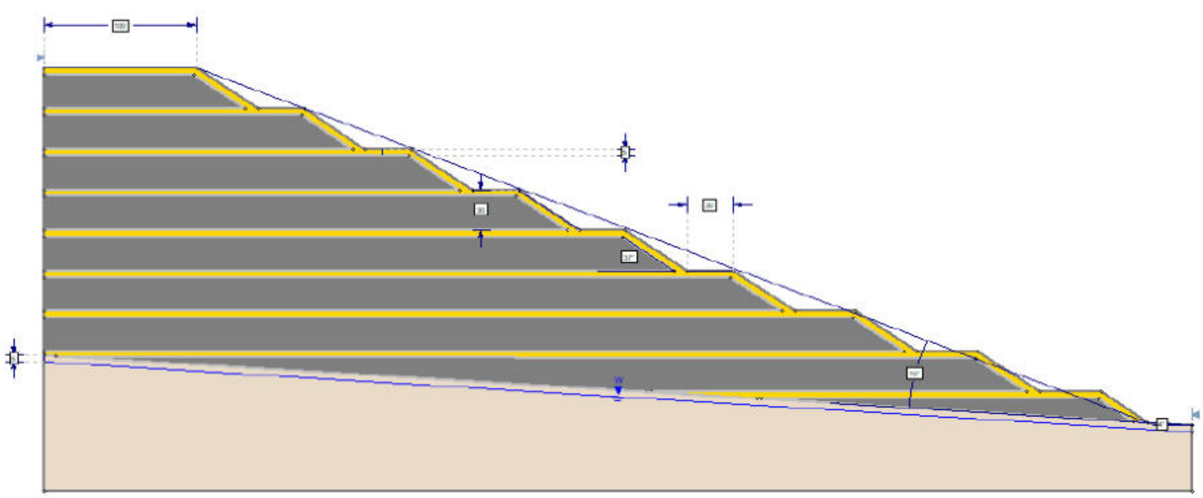
: Section C – C’

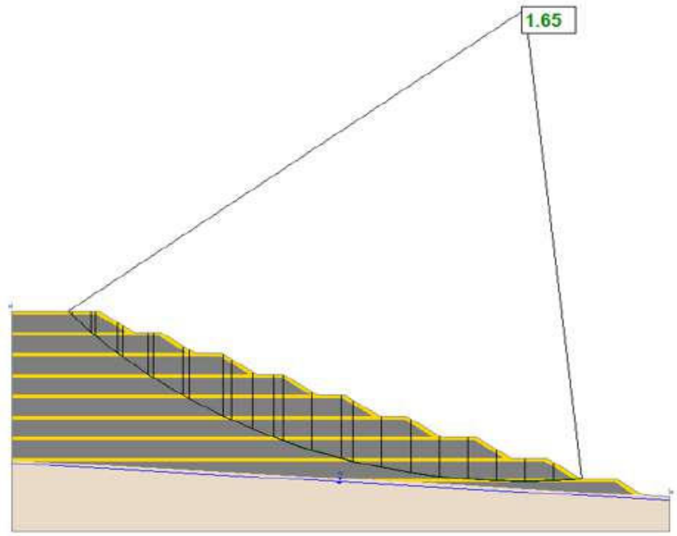


Section D – D’

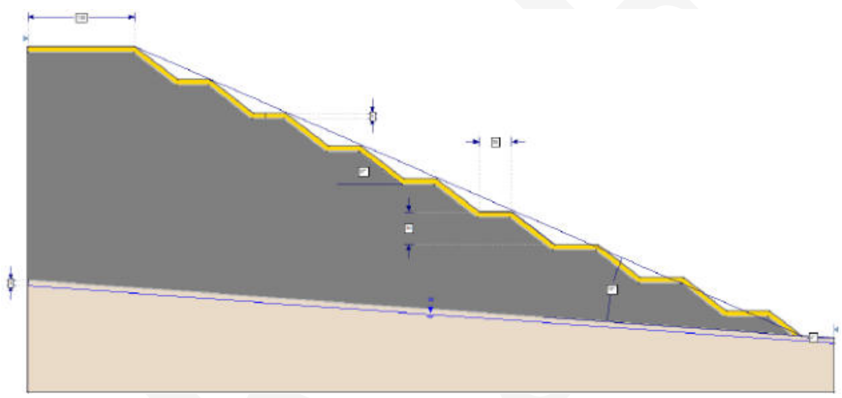
Fig. 80: Dump profile along different sections of final stage mine plan

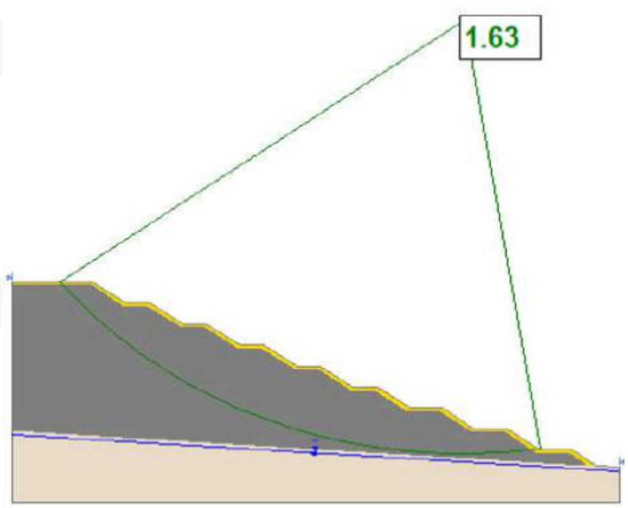
SECTION A – A’





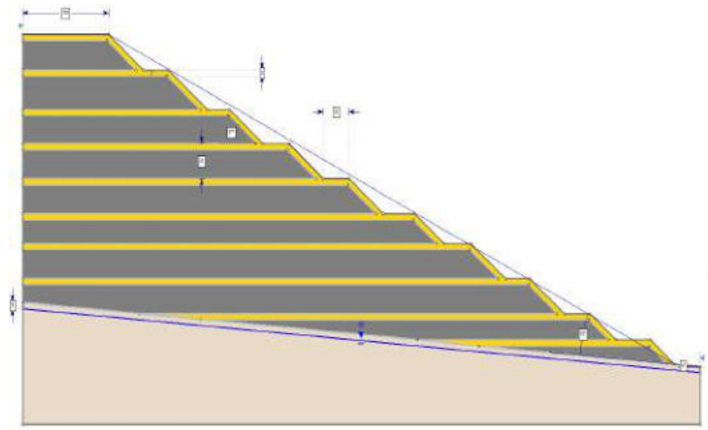
Dump Configuration 1

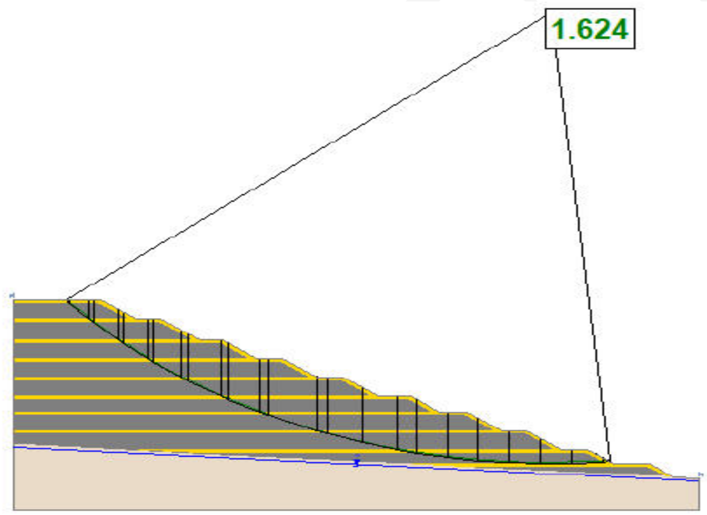




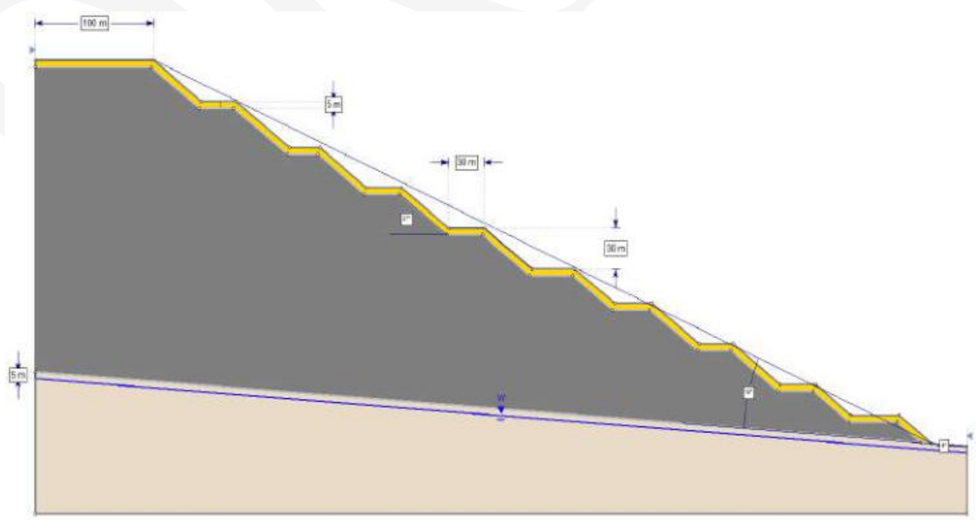
Dump Configuration 2

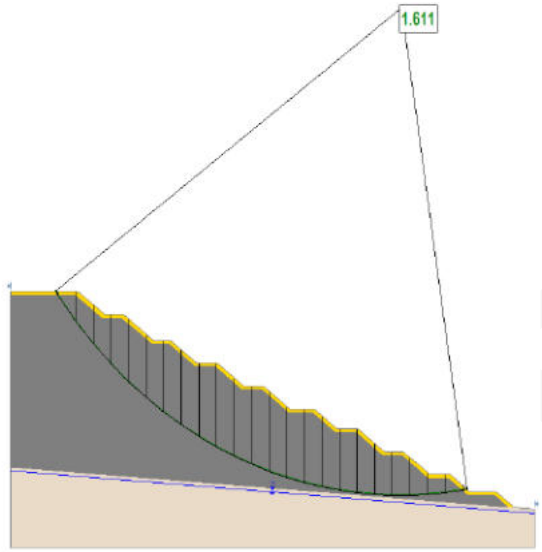
SECTION B – B’





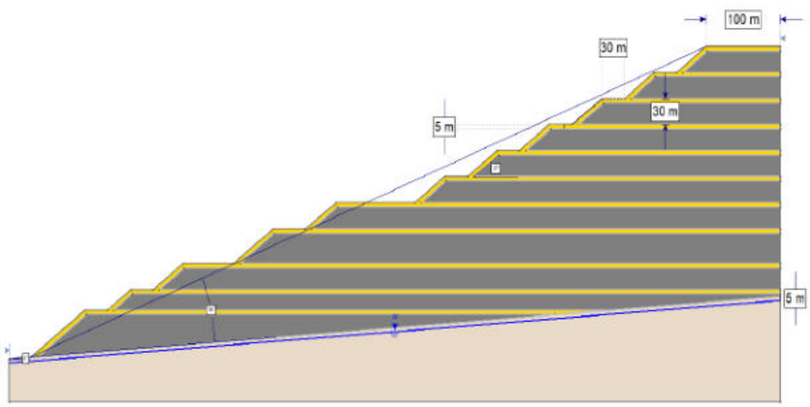
Dump Configuration 1

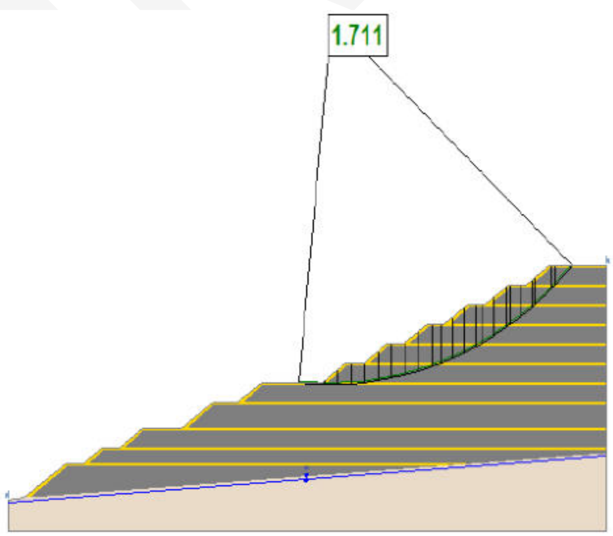




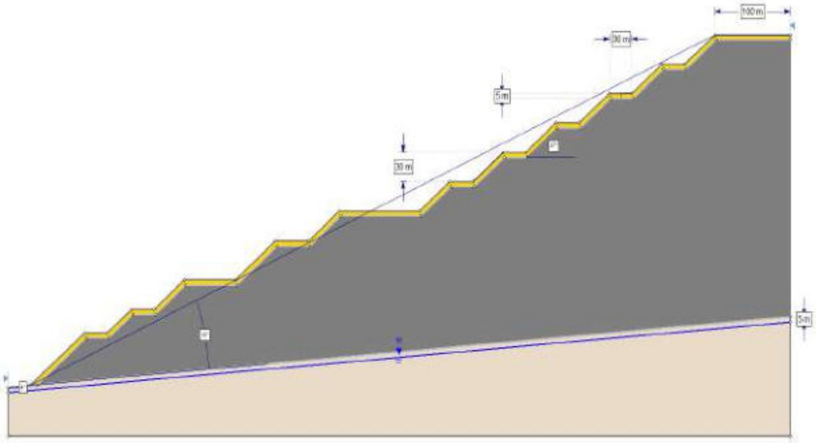
Dump Configuration 2

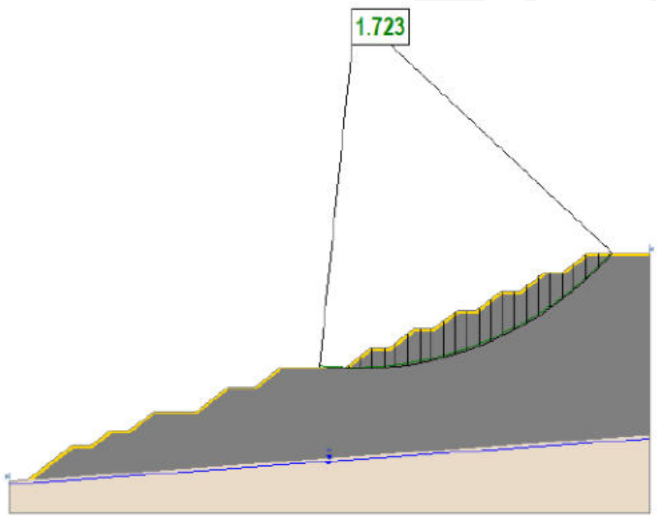
SECTION C – C'





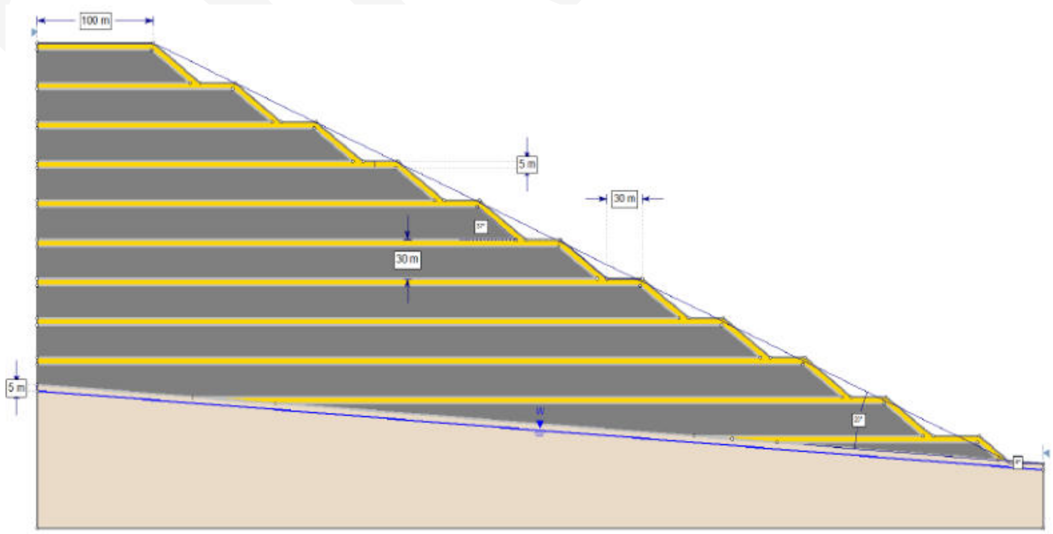
Dump Configuration 1

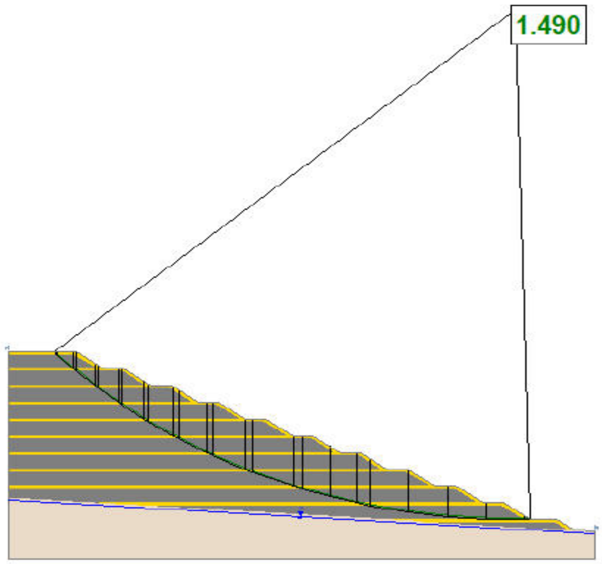




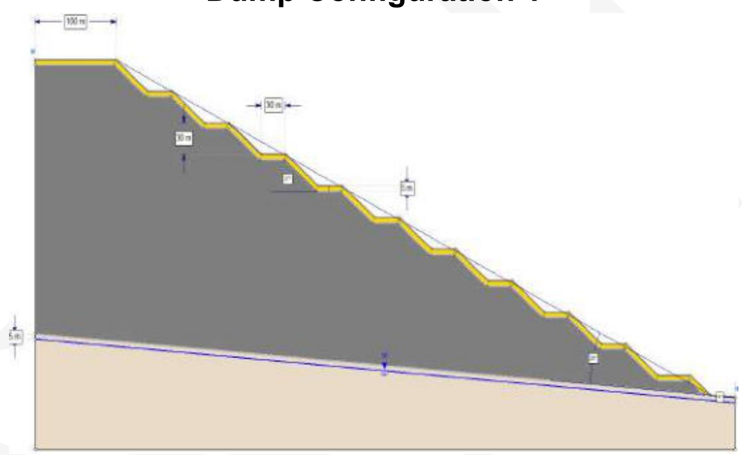
Dump Configuration 2

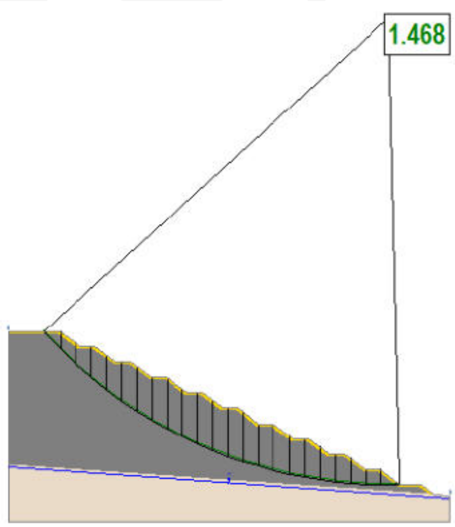
SECTION D – D'





Dump Configuration 1





Dump Configuration 2

Sections Along Pilot Scale Dump

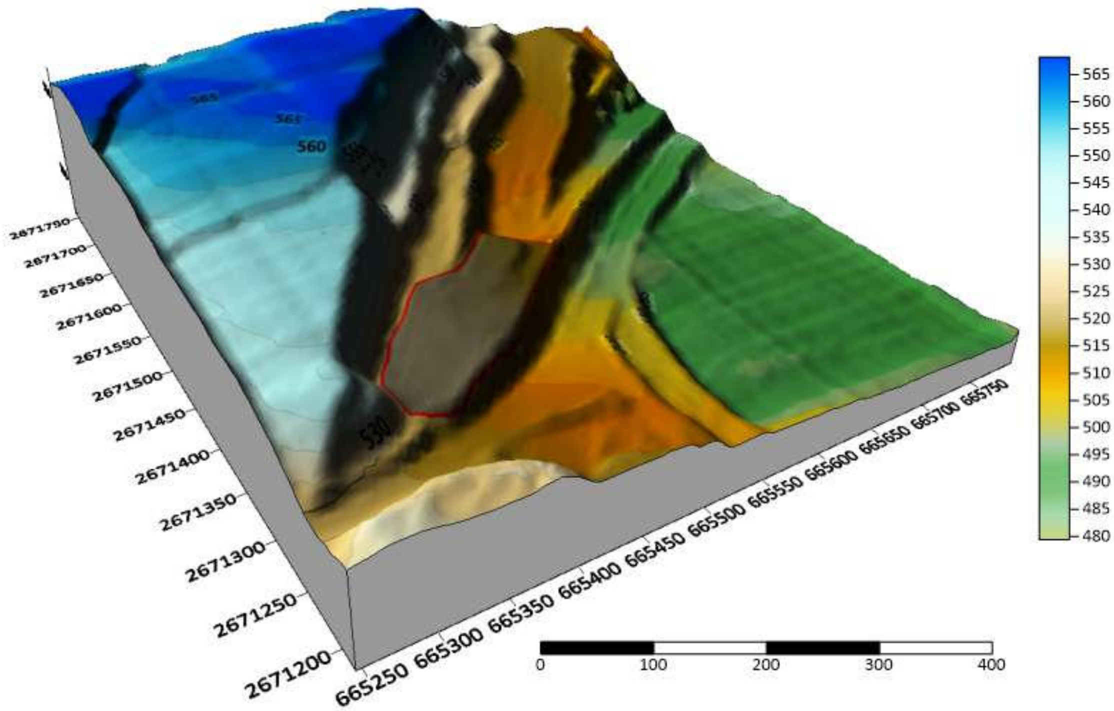


Fig. 81: Isometric view of the pilot scale dump

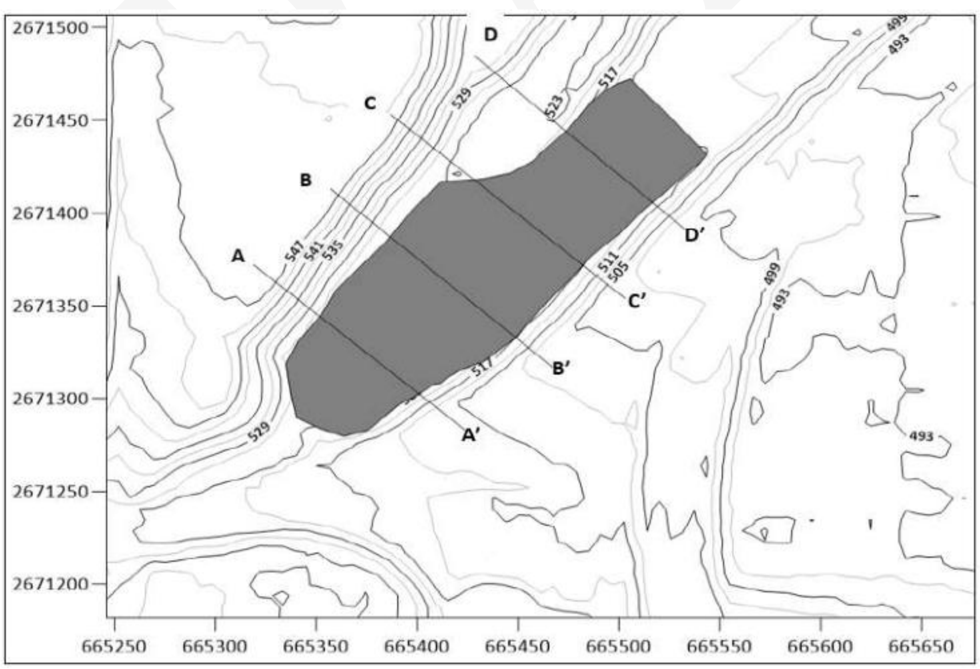
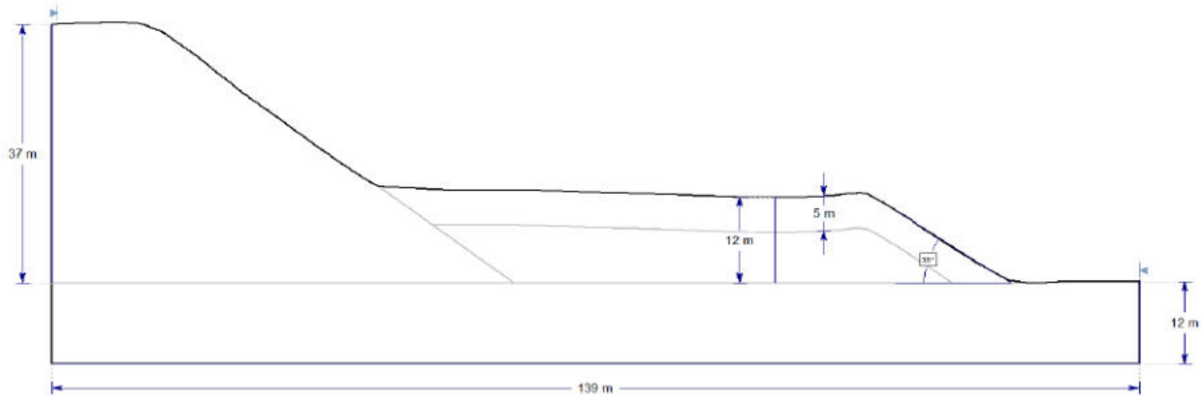


Fig 82: Section across pilot scale dump for displacement measurement

Stability analysis of pilot scale dump was carried out along section A – A' and C – C' using **Dump Configuration 2,** having a 5m thick OB layer at the top and along the periphery of the dump



Section A – A', Dump Configuration 2

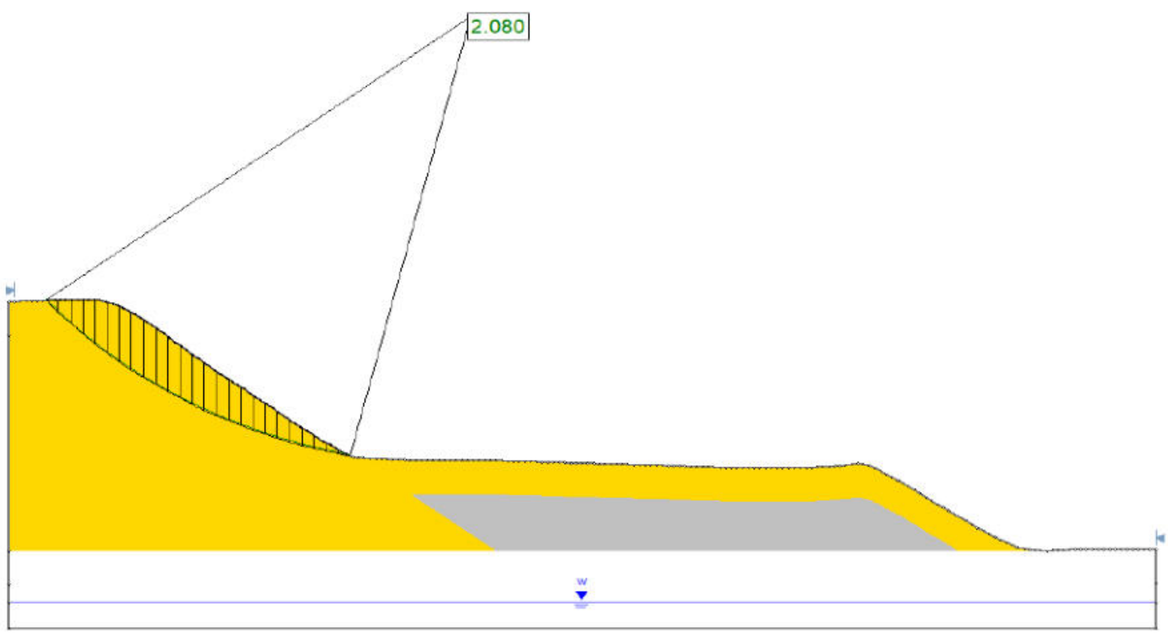
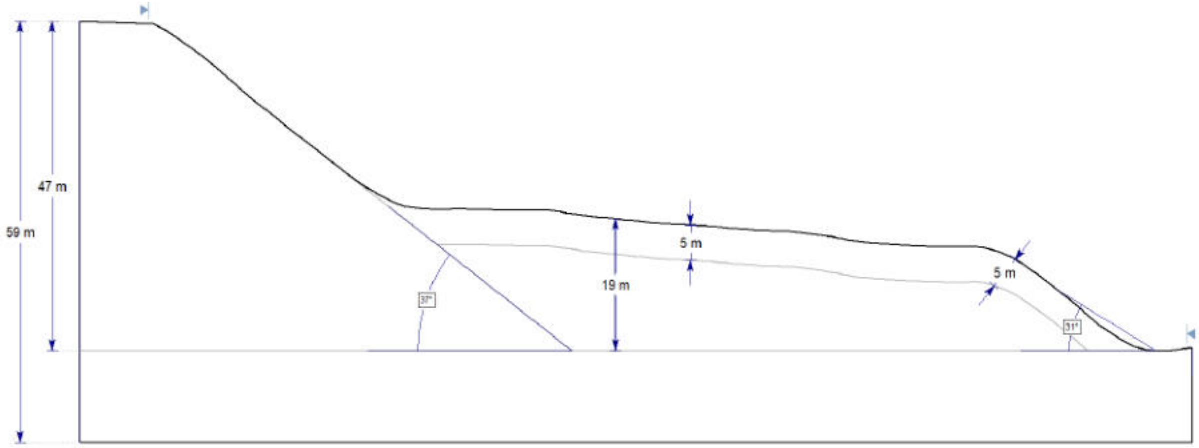


Figure 79: FoS along section A – A' of the pilot scale dump



Section C – C', Dump Configuration 2

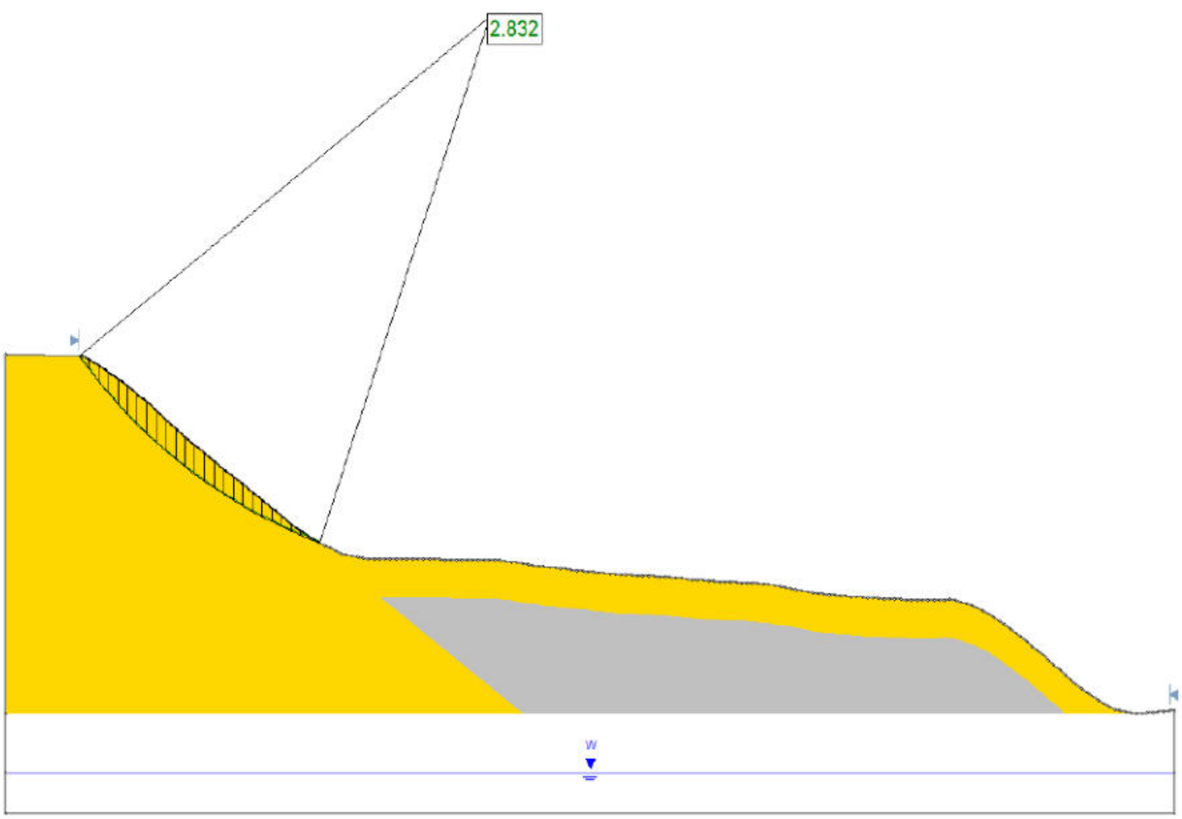


Figure 80: FoS along section C – C' of the pilot scale dump

As mentioned earlier, the limit Equilibrium analysis of dump stability of the existing internal dumps was carried out with dump configuration 1 & 2, similarly, the dump stability analysis for pilot scale dump was carried out with dump configuration 2. In both the case properties of OB:

Ash admixture in the ratio of 70:30 was used. The results of FoS is summarized in Table 39 and Table 40.

Table 39**:** FoS of sections in internal dump using (30:70) Ash-OB mix

Sl.No	Cross Section	Dump Configuration	Method	FoS Value
1	A - A'	1	Bishop	1.650
2		2	Bishop	1.630
3	B - B'	1	Bishop	1.624
4		2	Bishop	1.611
5	C – C'	1	Bishop	1.711
6		2	Bishop	1.723
7	D – D'	1	Bishop	**1.49**
8		2	Bishop	**1.468**

Table 40: FoS of sections in Pilot Dump using (30:70) Ash-OB mix

Sl.No	Cross Section	Dump Configuration	Method	FoS Value
1	A – A'	2	Bishop	2.08
2	C – C'	2	Bishop	2.83

10.3 Evaluation of slope stability analysis results

From the test results on FoS analysis following conclusion can be drawn:

1. The slope angle of internal and pilot scale dump sections along which stability analysis was carried out was found to be less that the 29^0 which is less than the natural angle of repose of both OB material and ash: OB mix material (Ash: OB = 30:70). This resulted in enhanced stability of the dumps which was reflected in the FoS results.
2. The FoS of the internal dump was evaluated considering the final stage dumping plan as per the data provided by the mine management. In total 4 sections of the dump oriented in different directions was taken into account as shown in Fig
3. The FoS of internal dumps along sections A- A', B – B' and C – C' was found to be more than 1.5 whereas the FoS of dump along section D – D' was found to be less than 1.5 and

hence considered un - stable as stipulated in DGMS(Tech.) Circular No. 3 of 2020 dated 16.01.2020

4. The stability of dump may vary when the backfill dump profile changes at different stages of the mine life.

11. FEASIBILITY OF DUMPING ASH IN SLURRY FROM

Feasibility study was carried out to determine dumping of ash is in high concentration paste form in running pit of Nigahi opencast mines. The most feasible location for dumping ash in active mines is that portion of mine which is isolated and on which no backfilling or reclaiming work is planned. Keeping that fact in mind, the most feasible location for forming an embankment to contain ash in high concentration slurry or paste form is the place where in-pit dumps have reached their ultimate planned height, which is free from traffic movement and is at a safe distance from the mine face to prevent propagation of blast vibration to the retaining embankment for ash slurry fill. Laboratory studies was carried out on Vindhyachal Pond Ash to determine mix optimization of ash paste fill, optimum concentration of ash to prepare paste with water, slump and water bleed test of paste mix, flow behavior and rheology of the paste mix. The results of the laboratory studies are given in subsequent sections

Mix optimization for paste filling in running mines

Paste material which is proposed to be backfilled in Nigahi Opencast Mine is mainly composed of three principal components, namely, Pond ash obtained from Vindhyachal thermal power plant and DCPP captive thermal power plant, additive (if required) and water as shown in the Figure 81.

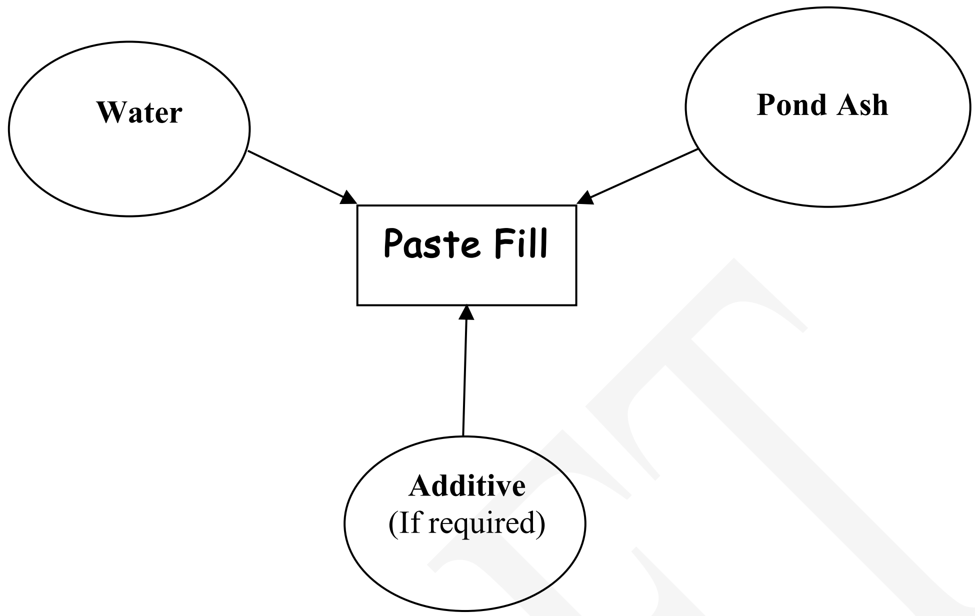


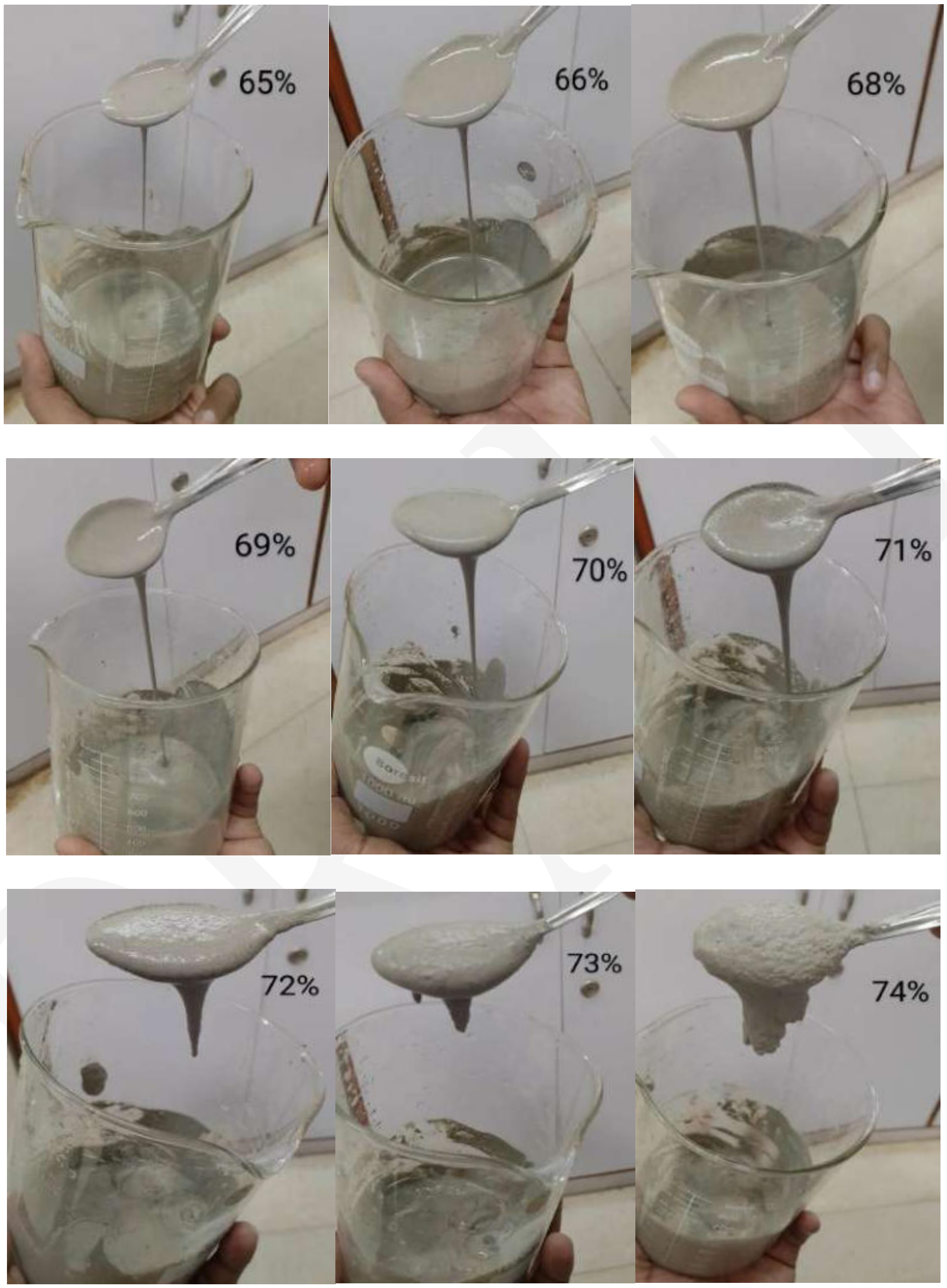
Figure 81: Schematic diagram illustrating different component of paste backfill

Literature survey indicates that additive is added to the paste to improve the workability and flow behavior the ash paste mix. The addition of fourth component (binder) and its concentration is optional, depending on the need for developing short-term and long –term strength. This is governed by the role of paste backfill, weather it is used to provide working platform or just as a means of waste disposal. The extent of water added to the paste mix depends on the consistency of paste required for its pipeline transportation. Theory suggests that the Pond ash paste, when compared to low concentration slurry fill consolidates at a faster rate, the rate of dumping or discharge is high and the water requirement for transportation is also low and hence the water pumping cost.

Determination of Concentration of Ash for Paste Filling

Laboratory studies was carried out to determine the concentraion at which vindhyachal pons ash formed paste. A know quanity (weight) of ash was taken into beaker and know weight of water was added to it to vary its concentration.The results of laboratory studies it shown in the following section:

Vindhyachal pond ash



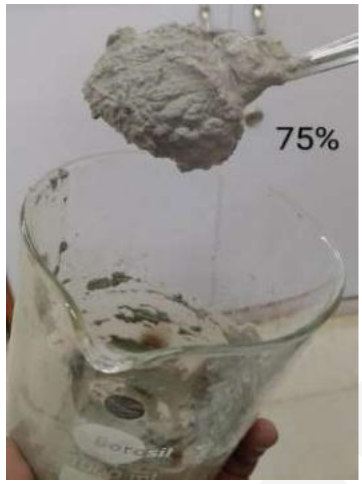


Figure 82: Flow behaviour of pond ash at different concentration

Table 41: Determination of concentration to form paste with Vindhyachal Pond Ash

Sl. No.	Concentration by weight (Cw) %	Remarks
1	65	Medium Concentration slurry, flowable
2	66	Medium Concentration slurry, flowable
3	68	Hight concentration slurry , flowable
4	69	Hight concentration slurry , flowable
5	70	Hight concentration slurry , flowable
6	71	Paste flow
7	72	Paste flow
8	73	Paste flow
9	74	Non Flowable
10	75	Non Flowable

From the result laboratory study, it was found out that maximum concentration at which the paste slurry is flowable is at 73 % Cw beyond this concentration the paste did not flow as shown in the Table 41.

11.1 DRAINAGE BEHAVIOUR

Water bleeding

Water bleeding, usually referred to as concrete bleeding in the concrete industry, is a particular form of segregation due from the materials in the paste fill not being able to adsorb all the water added into the slurry/paste. A well-known segregation phenomenon is so-called “bleeding”. This is a rise of water to the surface of the freshly poured concrete/paste fill due to the difference in density between the mixing water and the concrete/paste denser solid components (aggregates, pond ash, Pond ash, cement and additives). The extra water moves upwards and accumulates at the surface of backfill. Coarser materials release more water through drainage than those of medium and fine material. The bleeding directly causes the shrinkage of filling resulting in consolidation of the fill. The water bleed rate of different concentration of Pond ash paste made with Vindhyachal pond ash was investigated in the laboratory and the results are presented in subsequent section. The slurry was weighed after preparation (as m1), then it was placed stationarity. At the time of 1 hour, the seepage water was taken out rapidly, and the rest of slurry was weighed (as m2). The seepage water bleed rate, a, was calculated according to Equation given as:

$$\alpha = \left[{(m_1 - m_2)}/{m_0} \right] * 100$$

where, m0 is the weight of water used for the preparation of backfill.

The water bleeding out of the paste mixes was observed up to a duration of one hour after it was prepared. The results of the water bleeding tests are shown Table 42.

Table 42: Results of slump cone and water bleeding test of different paste mix

Pond Ash	Paste Mix (Concentration by weight)	Slump (mm)	Density (gm/cc)	Bleeding (%)
Vindhyachal	71% Cw (29% Water)	288	1.43	9.40
	72% Cw (28% Water)	285	1.48	6.49
	73% Cw (27% Water)	277	1.52	3.36

From the slump test, it was served that the slump values decreased with an increase in solid percentage for Vindhyachal pond ash paste (71 wt% to 73wt%). It's worth mentioning that the pulp or paste density (g/cc) reduced with the increase in water content. Reduction in density is a natural phenomenon as the addition of more water makes the paste fill thin.

To determine the sensitivity to water addition, small increments of water was added to the paste sample. After each addition, slump and solid content was determined. This generates a relationship between slump and solids content which is typically used to determine the degree of process control required in order to maintain slump control of the final paste fill. The effect of solid percentage on the slump for different mix scenarios are given in Figure 83. The results show an inverse relationship between the solid content of paste and the slump. This observation supports the consideration for a continuous backfill preparation process rather than a batch type process, the latter being necessary where tight control over the water content is required.

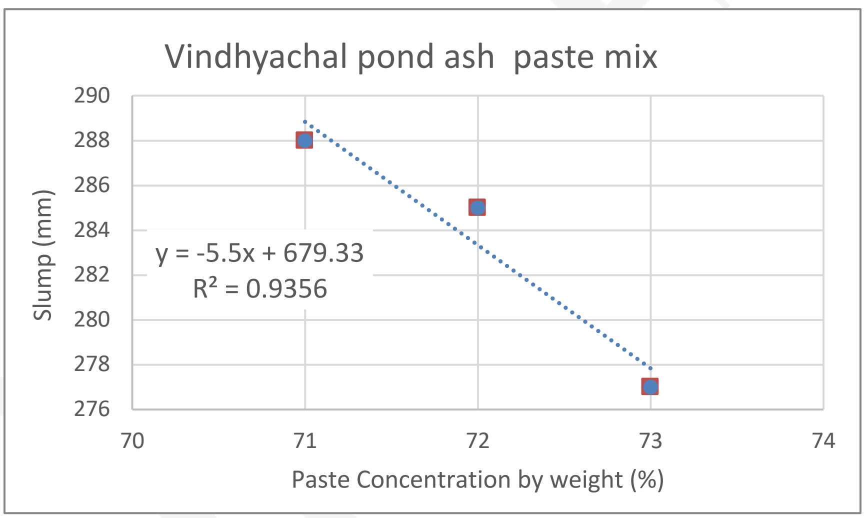


Figure 83: Variation of slump of Vindhyachal pond ash paste with solid percentage.

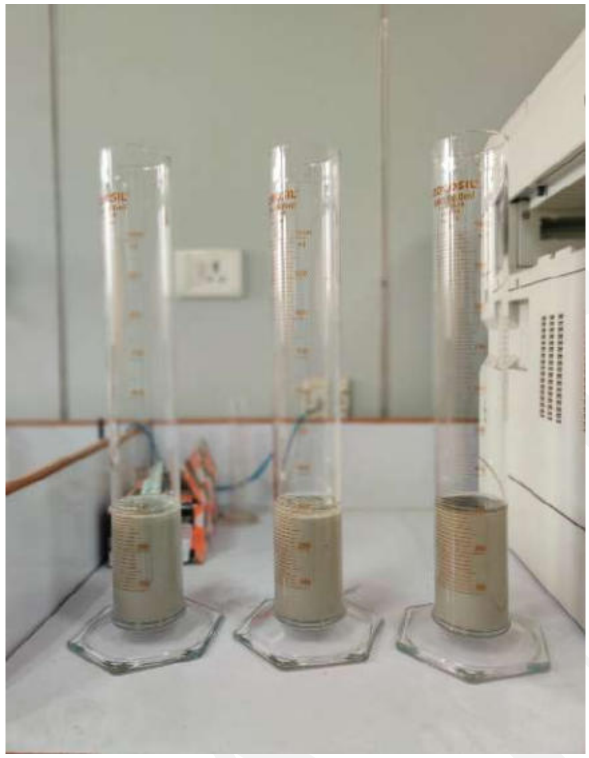


Fig. 17: Bleeding test Vindhyachal pond ash

From the water bleeding test results, it was found out that the water bleeding out of the paste mix decreases with increase in Pond ash percentage. This phenomenon was observed in all mix configuration of paste mix and may be attributed to the fact that increased addition of Pond ash in the mix increases the internal surface area of the mix and this allows more water molecules to adhere to it and the paste matrix. The capacity of a material to attract water molecules toward itself (hydrophilic) mainly depends on its mineralogical composition, its properties and its size (finer particles have more surface area and its capacity to retain water molecules is more).

11.2 FLOW BEHAVIOUR OF PASTE

Rheological Study

To determine the yield stress and viscosity of pond ash paste at different concentration, rheological studies was carried out in CIMFR laboratory using Anton Par Rheometer (MCR 102.

Yield stress of paste mixes were carried out by shear strain ramp method where the shear rate was ramped from 0 to 600 1/S as shown in the Figure 84.

Figure 84: Anton Par Rheometer (MCR – 102)

Pond ash paste of different concentration (by weight) i.e. Cw was prepared for Vindhyachal pond ash in the laboratory. The paste prepared were analysed for its yield stress behaviour using Bingham Plastic correlation equation. The result of yield stress of Vindhyachal pond ash paste mixes rheological studies is shown in the Table 43.

Table 43: Yield stress of different past mixes - Vindhyachal Pond ash

Mix	**Recipe**	**Yield Stress (Pa)**
Vindhyachal 1	71 cw % Vindhyachal pond ash	13.772
Vindhyachal 2	72 cw % Vindhyachal pond ash	13.998
Vindhyachal 3	73 cw % Vindhyachal pond ash	14.895
Vindhyachal 4	74 cw % Vindhyachal pond ash	14.902

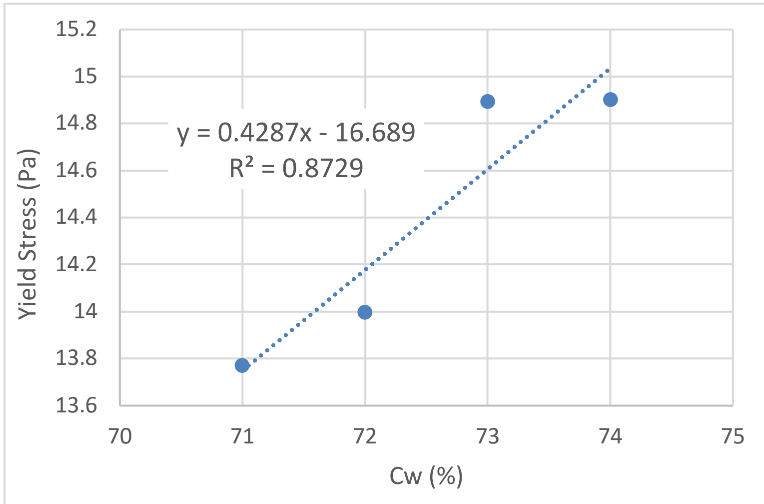


Figure 85: Variation in yield stress of Vindhyachal pond ash paste mix with concentration (by weight)

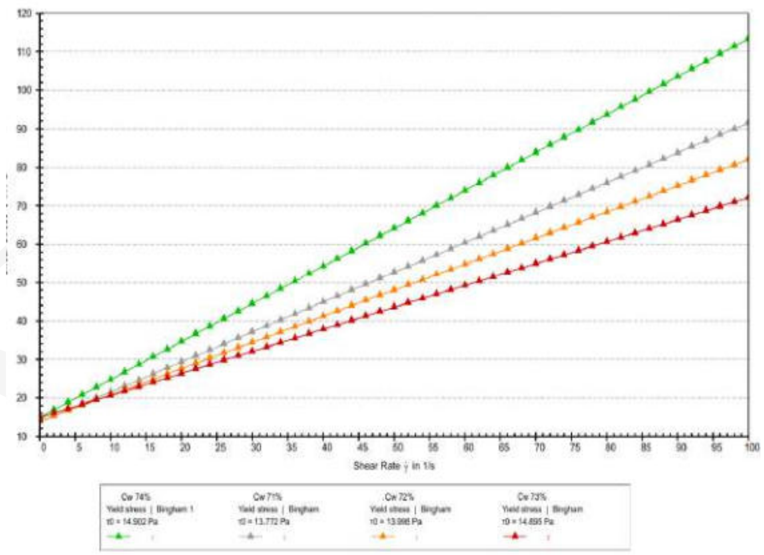


Figure 86: Variation of yield stress with increased concentration for Vindhyachal pond ash paste

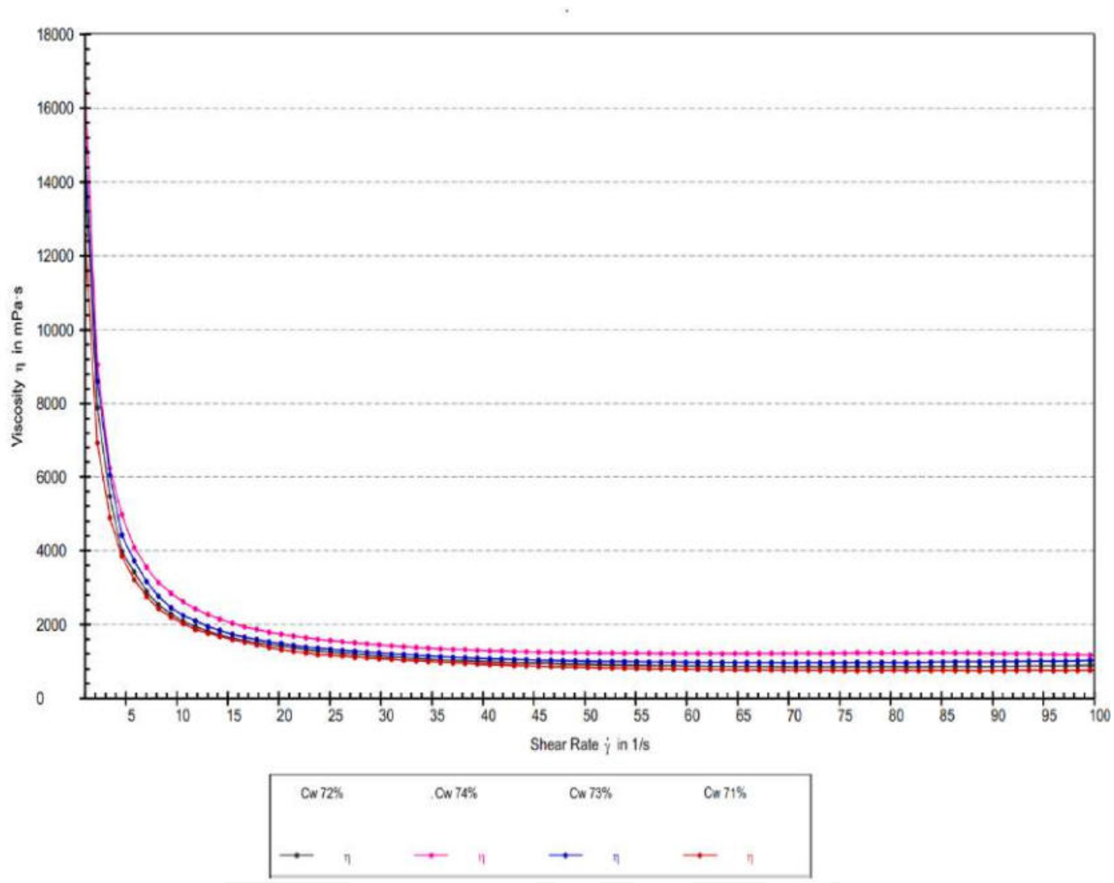


Figure 87: Variation in viscosity with increased concentration for Vindhyachal paste mix

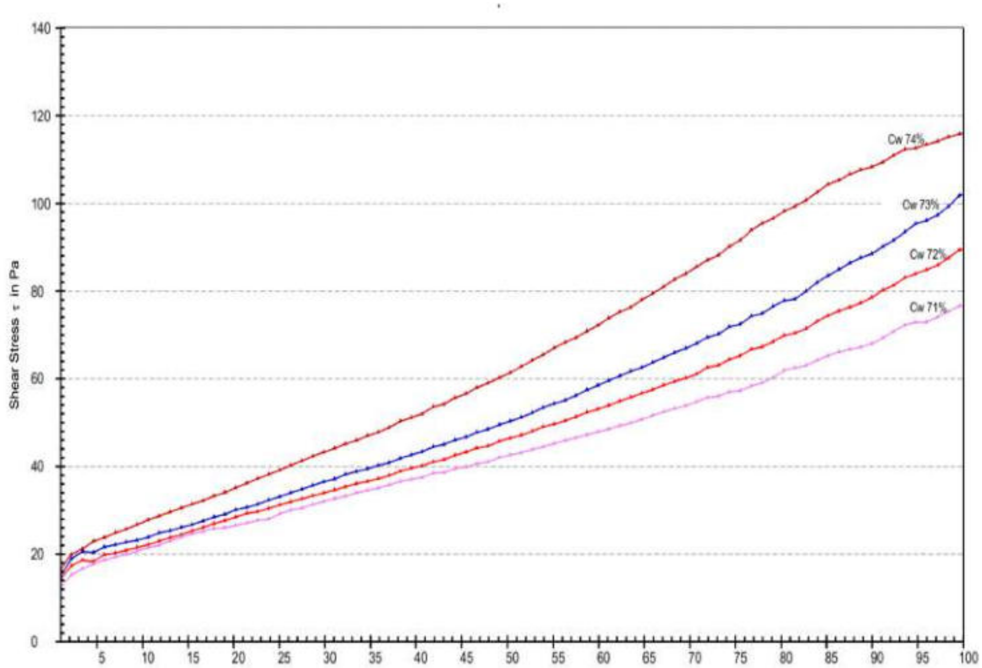


Figure 88: Shear stress Vs shear strain for Vindhyachal pond ash paste of different Cw

11.3 High density slurry disposal system for coal ash

Construction of coal ash storage facility along with overburden is done by three principle methods viz. upstream construction method, downstream construction method and the centre line construction method. Each stage has an increasing or incrementing height of 3-5m. Prior to ash slurry disposal in such artificial embankment, care should be taken to line the inner side and bottom of the embankment with geo-textile or similar material to arrest the flow of ash leachate to the ground or surface water.

Though it is possible to construct ash embankment within the active mine boundary, it has following risks and disadvantages:

a) As per the notification of MoEF&CC dated 31st December, 2021, the responsibility for utilization of fly ash lies on thermal power plants to dispose fly- and bottom ash in low lying areas and mining voids. The excavated mining area for any ongoing mining project/mine cannot be termed as static void as because HEMMs and other machineries ply in these regions and the internal dumps are progressive in nature and always moves towards the active face Furthermore, the internal dumps are progressive in nature and always moves towards the active mine operations with a minimum distance (100 m or more) from the face as laid down in the statute by DGMS. Further, making an retaining embankment with ash slurry inside do not amounts to mixing 25% ash with OB.

b) Construction of embankment is feasible in the operating mine if the mine is divided into several sub – pits separated from each other by internal barrier (OB material). Each such isolated pits within the mine can act as an embankment for retaining the ash slurry or paste. The space created by evacuation of coal cannot be said as mine void because the free area so created is used for filling the waste generated and is a continuous process. The space created by evacuation of coal can be termed as mine void only when the volume of waste is less considering the permitted dump height as permitted by DGMS i.e., only where the stripping ratio is less.

c) Blasting effect – If the embankment is constructed with in the mine boundary, it will be subjected to cycling dynamic loading due to blasting and this will result in enhanced liquefaction potential of the embankment and may cause its failure. The term liquefaction has been used in conjunction with a variety of phenomena that involves soil deformations caused by monotonic, transient, or cyclic loading of saturated soil. The Committee on Soil Dynamics of the Geotechnical Engineering Division, American Society of Civil Engineering (1978) has defined liquefaction as the process of transforming any substance into a liquid. In cohesionless soils, the transformation is from a solid state to a liquefied state because of increased pore pressure and reduced effective stress. According to this definition, the generation of excess porewater pressure is a key feature of liquefaction phenomena. Generally, when saturated soils are subjected to rapid loading under undrained conditions the tendency for contraction causes excess porewater pressures to increase and effective stresses to decrease. In other words, the generation of excess porewater pressure due to static or dynamic loading, might be sufficient to bring the soil to the steady state condition or a condition of zero effective stress leading to deformation. This phenomena will pose a serious threat to operating mine faces if the embankment is constructed on the rise side of the working face.

Keeping the above fact in mind, it is not recommended to opt to dispose ash in a lean or dense phase in active running mine if the mine is not divided into isolated sub pits which are not connected with the active operational portion of the mine.

12.CONCLUSIONS AND RECOMMENDATIONS

The comprehensive study, including extensive laboratory investigation, numerical modelling and field studies conducted at Nigahi Opencast Project, for studying the feasibility, challenges, and implications of dumping pond ash with overburden in running mine dumps. While utilizing pond ash for reclamation and reducing its environmental footprint offers potential benefits, the findings reveal several operational, environmental, and logistical challenges that need to be addressed. The following inferences could be drawn from the study:

1. The study of hydrogeological study report revealed that the maximum and the minimum depth of water table in the core zone of the mine during pre – monsoon period was found to 21.57m and 2.9m respectively and the average depth of water table was 8.56 m. Similarly, it can be seen that the maximum and the minimum depth of water table in the core zone of the mine during post – monsoon period was found to be 20.67m and 1.7m respectively and the average depth of water table was 5.71 m. Keeping the above fact in mind, the average depth of water level of 8m is considered in the core zone of the mine while doing stability analysis of dumps

2. Laboratory study indicates that the specific gravity of mines overburden is 2.54 and pond ash from Vindhyachal and Shakti Nagar Thermal Power Plant is 2.07 and 2.16 respectively. It is also observed that with increasing the percentage of pond ash in mix with overburden, bulk density of admixture decreases. From the grain size distribution curve, it was found that the coefficient of uniformity and coefficient of curvature for Vindhyachal ash increases and decreases respectively with the increase in ash % in OB. Therefore, it can be concluded increase in ash percentage in OB increases the overall grading of the mix as Cu increased from 4.03 to 10. A well graded sample have lesser porosity when compared to uniformly graded sample as the GSD curves are flatter indicating even distribution of particles in different size range.

3. Permeability test carried out in the laboratory indicates that the permeability of OB was found to reduce from 25.57 cm/hr to 9.18 cm/hr when ash is added to it. This may be attributed to the fact that the test was carried out under saturation condition with constant head of water over it, this facilitated the finer ash particles to seep in the voids of larger OB particles thereby filling up the voids and reducing the permeability. From the laboratory studies it was found out that Nigahi OB material has a natural angle of repose of 37^0 and which increases when it was mixed with pond. Reduced permeability increases the water retention property of the fill material, which in turn results in increase in pore water pressure. Water present in such pore and fissures increases the dead weight of the slope causing the tangential component of stress to increase. It also decreases the shear strength of the backfilled mass (cohesion between particles reduce), leading to its instability.

4. Laboratory studies conducted to determine the angle of repose of the fill material indicate that, when the ash-OB mix is in an undersaturated state, cohesion between particles is present, resulting in an increased angle of repose. However, as the water content in the backfilled material exceeds a certain threshold, particle cohesion diminishes while pore water pressure rises, leading to a reduction in the shear strength of the fill. Therefore, it is recommended to encapsulate the ash–OB mix with a layer of OB to protect it from direct rainfall. Additionally, the installation of a proper drainage system—including gullies, toe and peripheral drains, and water garlands—is strongly advised to prevent surface runoff and water infiltration along the dump crest.

5. The compressibility of OB:PA mix in the ratio of 75:25 was found to decrease when compared to compressibility of OB along, this may be attributed to the filling of interstitial voids in the OB matrix by finer PA particles forming a compact mass resisting the applied external stress.

6. Findings of Geotechnical studies suggest with the increase in ash % in the OB, the liquid limit increases when the ash % in OB increased to 20 %, beyond that, the liquid limit decreases for both Vindhyachal and Shaktinagar pond ash. From the proctor compaction test results, it was found out that with the increase in Vindhyachal ash % in OB the optimum moisture content decreases and same is the case for maximum dry density. Shanktinagar pond ash also followed

the same trend as Vindhyachal ash i.e. the value of optimum moisture content and maximum dry density decreases with the increase in ash percentage in OB.

7. The results of direct shear test indicates that the cohesion of the Ash – OB mix increases with the increase in Vindhyachal ash percentage and the maximum cohesion of 110 KPa was achieved with 20 % pond ash , subsequently , the cohesion value decreased with the increase in pond ash percentage.

8. From XRF analysis it was found out that the chemical compositions of both pond ash from Vindhyachal and Shaktinagar can be considered as siliceous fuel ash since the sum of silica (SiO_2), alumina (AI_2O_3) and iron oxide (Fe_2O_3) is greater than 70% by mass in accordance with IS 3812 (Part 1) :2003. Alternatively, these can be categorized as Class F fly ash as per ASTM C-618 as the percentage of CaO was found to be less than 10 %.

9. From the XRD analysis it was found out that the major common mineral phases found in both Vindhyachal and Shaktinagar pond ash sample are quartz (SiO_2), mullite ($Al_6Si_2O_{13}$), rutile (TiO_2), hematite (Fe_2O_3). Similarlry, quartz (SiO_2), mullite ($Al_6Si_2O_{13}$), rutile (TiO_2), magnetite (Fe_3O_4).

10. From the SEM image analysis of Vindhyachal and Shaktinagar Pond Ash sample, it is observed that pond ash sample consist of few amounts of fly ash in addition to bottom ash. The spherical shaped particles identified in pond ash can be considered as fly ash. In general majority of pond ash samples consists of lump of irregular shaped particles, which are mainly bottom ash. Further, the SEM image of fly ash samples clearly show spherical shaped particles, which are called as cenosphere.

11. The field studies encompassed route and traffic surveys, time-motion analyses, and equipment performance evaluations to assess the current transportation and dumping processes. Key observations from the route survey indicated high traffic volumes at critical points like Maha-ramp and Chandni Chowk. The traffic survey identified an average of 256 overburden trips per hour, with significant increases anticipated when ash is added to the mix.

Time-motion studies revealed inefficiencies in dozing and handling operations during mixing of ash with overburden, particularly when higher percentages of ash were incorporated, increasing handling time and production losses.

12. The hybrid transportation system combining rail and road modes was evaluated for its feasibility in ash transportation. Rail transport, though cost-effective for long distances, is constrained by terminal infrastructure and wagon availability. Road transport, while flexible for short distances, faces challenges such as traffic congestion, safety risks, and environmental issues, including dust and spillage. The addition of fly ash trucks to existing traffic flows can lead to congestion, particularly at critical junctions. Overcrowding, coupled with reduced spacing between vehicles, can further exacerbate risks, making it challenging to maintain safe operations. Land acquisition for critical infrastructure, such as ash ponds near railway unloading points, poses additional challenges.

13. The field study on pilot scale dump was mainly carried out to evaluate the influence of monsoon on the dump movement and stability. The movement of the pilot scale dump was evaluated along four sections (A – A’, B – B’, C – C’ and D – D’). The selected dump profiles of the pilot bench during the pre-monsoon period and post-monsoon period were plotted and the difference in elevation was measured by superimposing the profiles. It was found out that in almost all the cross sections taken into account, the top or the flat portion of the pilot scale dump did not encounter much vertical movement and it was restricted to less than 250mm and this can be attributed to washouts of fine sand along with rain water towards the natural dip. The maximum movement along all cross sections was observed at the toe and crest of the adjacent dump and the pilot scale dump, and mostly vertical upward heave was observed. The upward heave of the profile may be attributed to the sliding of material along with rainwater along the crest and slope of the original profile.

Considering average movement of about 700mm along the toe and crest of the slope under the influence of one monsoon, the cumulative movement in the long run over numerous monsoons could have adverse effect on the stability of the dumps in the long run. Hence, keeping the above fact in mind it is not advisable to use ash as a backfill material under current scenario until and unless a long-term evaluation of dump movement is undertaken by scientific agency during the course of numerous monsoon seasons.

14. Numerical modelling considering the limit equilibrium method was adopted to determine the Factor of Safety (FOS). Geo-technical data of ash – OB mix, OB, in-situ rock properties, water table etc. were obtained from the laboratory studies, literature survey. Two dump configuration was considered while carrying out Stability analysis of dumps i.e. Dump Configuration 1 and 2. The FOS obtained were compared with recommended FOS issued by the DGMS (Tech.) Circular No. 3 of 2020 dated 16.01.2020 which suggest FOS shall not be less than 1.50. From the modelling result it was found out that out of four sections considered for stability analysis of the final stage dumping plan of the mine, one section viz. D – D' was found to be unstable as its FOS was found to be less than 1.5. The FOS of the dump is a function of physico-mechanical properties of the dump and the base material, dump geometry (slope angle, bench height and width), base slope, water table position and associated pore water pressure etc.and other factors mentioned in the previous sections. Hence, FOS of a dump is dynamic phenomena and may vary with dump position, orientation etc. The FOS obtained in this study indicates marginal stability of the section considered (FOS was found to be slightly higher that the stipulated value of 1.5) and may vary on the basis of factors mentioned above.

15. Study was also conducted to assess the possibility of dumping ash in high concentration paste form within the running pit of Nigahi Opencast Mine. After evaluating the operational, regulatory, and geotechnical constraints, it was concluded that constructing ash embankments within active mine boundaries entails significant risks. These include potential disruption of progressive mining operations, and increased vulnerability to embankment failure due to blasting-induced liquefaction. Therefore, unless the mine is segmented into isolated, non-operational sub-pits, the disposal of ash in slurry or paste form within active mining areas is not recommended.

16. Field observations also highlighted the geotechnical challenges of overburden-ash mixing. The heterogeneity of overburden material and the fine, low-cohesion properties of ash reduce dump stability, especially under wet conditions. Operationally, rainfall disrupts transportation and dumping activities. Haul roads can become slippery and difficult to navigate, increasing vehicle turnaround times and the risk of accidents. Wet ash tends to clump, complicating loading, unloading, and dozing operations, which further slows production cycles.

17. From the field data, it was evident that higher ash compositions significantly impact operational efficiency. Increased handling times and production losses were recorded, even when equipment such as dozers and hydraulic excavators worked in tandem. Moreover, a significant challenge is the shortage of area for dumping overburden. The total overburden volume to be managed is 2213.39 Mm^3. According to the approved Mining Plan, 1530.05 Mm^3 of overburden is still required to be accommodated internally. However, there is a shortfall of 683.34 Mm^3, which cannot be managed within the existing mine boundaries.

18. This shortage necessitates the dumping of excess overburden in adjoining mines requiring a study pertaining to neighboring mines for availability of space and possible effect on vehicular movement and impact on production. The limitations of space in Nigahi OCP arise due to the lack of external dumping space in coal-bearing northern areas and developed infrastructure, such as colonies and mine railways, on the southern side. The restricted availability of dumping zones emphasizes the critical need for strategic planning, including optimizing internal dumping, utilizing de-coaled voids efficiently, and coordinating with neighboring mines for possibility of post-mining void utilization.

12.1 RECOMMENDATION

The integration of pond ash with OB in running mine dumps at Nigahi OCP is not recommended under current conditions. The logistical, geo-technical, environmental, and operational challenges outweigh the potential benefits. Alternatives, such as utilizing pond ash in construction or cement manufacturing or filling voids of non-working/exhausted mines, should be explored.

13. BIBLIOGRAPHY

1. Arora, S. and Aydilek, A. H. (2005). Class F fly ash amended soils as highway base material. *Journal of Material in Civil Engineering* 17(6), 640-649.
2. Behra, B. and Mishra M. K. (2012). California bearing ratio and Brazilian tensile strength of mine overburden-fly ash-lime mixtures for mine haul road construction, *Journal of Geological and Geotechnical Engineering* 30, pp. 449–459.
3. Bell, F.G. (1996). Lime stabilization of clay minerals and soils. *Engineering Geology* 42, 223–237.
4. Brooks, R., Udoeyo, F. F. and Takkalapell, K. V. (2011). Geotechnical properties of problem soils stabilized with fly ash and limestone dust in Philadelphia. *Journals of Material in Civil Engineering* 23(5), 711-716.
5. Bunn, T. F. (1989, January). Dense phase hydraulic conveying of power station fly ash and bottom ash. In Third International Conference on Bulk Materials, Storage, Handling and Transportation: Preprints of Papers (pp. 250-255). Barton, ACT: Institution of Engineers, Australia.
6. Bunn, T. F., & Chambers, A. J. (1992, January). Experiences with dense phase hydraulic conveying of Vales point fly ash. In 4th International Conference on Bulk Materials, Storage, Handling and Transportation: 7th International Symposium on Freight Pipelines; Preprints of Papers (pp. 175-183). Barton, ACT: Institution of Engineers, Australia.
7. Central Electricity Authority, CEA (2022), Fly ash generation and utilisation report 2021-22. Retrieved on 22.06.2023 fromhttps://cea.nic.in/wp-content/uploads/tcd/2022/08/Fly_ash_Generation_and_utilisation_Report_2021_22-1.pdf
8. Cokca, E. (2001). Uses of class C fly ashes for the stabilization of an expansive soil. *Journal of Geotechnical and Geoenvironmental Engineering* 127(7), 568-573.
9. Dewangan, P. K., Pradhan, M., & Kumar, P. (2020). Geotechnical, environmental and other issues pertaining to fly ash disposal in opencast mine voids. *Journal of Mines, Metals & Fuels*, *68*(1).
10. Dewangan, P. K., Pradhan, M., & Ramtekkar, G. D. (2015). Effect of fragment size, uniformity coefficient and moisture content on compaction and shear strength behavior of coal mine

overburden dump material. *European Journal of Advances in Engineering and Technology*, *2*(12), 1-10.

11. Dewangan, P. K., Pradhan, M., & Ramtekkar, G. D. (2016a). Shear strength behaviour of fly ash mixed coal mine overburden dump material and stability assessment using numerical modelling. *ARPN J Eng Appl Sci*, *11*(1), 615-628.
12. Dewangan, P. K., Pradhan, M., & Ramtekkar, G. D. (2016b). Effect of compaction density and moisture content level on shear strength behaviour of fly ash mixed coal mine overburden dump material. *ARPN J Eng Appl Sci*, *11*(13), 8038-8048.
13. DiGioia, A.M. and Nuzzo, W.L. (1972). Fly ash as structural fill. Journal of Power Division, ASCE 98(1), 283–294.
14. Eskioglou, P. and Oikonomou, N. (2008), Protection of environment using fly ash in road construction. *Global Nest Journal* 10(10), 1-6.
15. Geliga, E. A. and Ismail D. S. A. (2010). Geotechnical properties of fly ash and its application on soft soil stabilization, UNIMAS. *Electronic Journal of Civil Engineering* 1(2), 1-6.
16. Gray, D.H. and Lin, Y.K. (1972). Engineering properties of compacted fly ash. *Journal of Soil Mechanics and Foundations Divisions*, *ASCE* 98(4), 361–380
17. Gupta A. K. and Paul B. (2016). Augmenting the stability of OB dump by using fly ash: A geotechnical approach to sustainably manage OB dump at Jharia Coalfield, India. *Current World Environment* 11(1), 204-211.
18. Hustrulid, W. A., Kuchta, M., & Martin, R. K. (2013). Open pit mine planning and design, two volume set & CD-ROM pack. CRC Press.
19. Indraratna, B., Nautalaya, P., Koo, K. S. and Kuganethira, N. (1991). Engineering behaviour of a low carbon, pozzolanic fly ash and its potential as a construction fill. Canadian Journal of Geotechnical Engineering 28, 542–555.
20. Jayanthu, S., Das, S. K. and Equeenuddin, (2012). Stability of fly ash and overburden material in opencast mines- A case study. *Proceedings of International Conference on Chemical Civil and Environmental Engineering,* Dubai, 24-25 March, 276-278.
21. Karandikar, M. V., Lele, P. G., & Khadilkar, S. A. (1999). Enhancement of reactivity and increased usage of low lime class-F-fly ash-possible avenues. 116-126.

22. Kim, B., Prezzi, M. and Salgado, R. (2005). Geotechnical properties of fly and bottom ash mixtures for use in highway embankments. *Journal of Geotechnical and Geoenvironmental Engineering* 131(7), 914-924.
23. Kim, B., Prezzi, M. and Salgado, R. (2005). Geotechnical properties of fly and bottom ash mixtures for use in highway embankments. *Journal of Geotechnical and Geoenvironmental Engineering* 131(7), 914-924.
24. Krishna, K. C. (2001), CBR behavior of fly ash-soil-cement mixes. Ph.D Thesis, Indian Institute of Science, Bangalore, India.
25. Lees, G. Abdelkader, M. O. and Hamdani, S. K. (1982). Effect of the clay fraction on some mechanical properties of lime–soil mixtures. *J Inst Highw Eng* 11, 3–9
26. Leonard, G. A. and Bailey, B. (1982). Pulverized coal ash as structural fill. *Journal of Soil Mechanics and Foundation Engineering Division,* ASCE108, 517–531.
27. Lopes, L.S.E., Szeliga, L. Casagrande, M.D.T. and Motta, L.M.G. (2012). Applicability of coal ashes to be used as stablized pavements base. *Geo Congress* 55(21), 2562-7759.
28. Mackiewicz, S. M. and Ferguson, E.G. (2005). Stabilization of soil with self-cementing coal ashes. *World of Coal Ash*, Lexington, Kentucky, USA, 11-15 April, 1-7.
29. Mandal, A.K., Sinha, O.P. Review on Current Research Status on Bottom Ash: An Indian Prospective. *Journal of The Institution of Engineers (India): Series A*, *95*, 277–297, (2014). https://doi.org/10.1007/s40030-014-0100-0
30. Martin, J.P., Collins, R.A., Browning, J.S. and Bieh F. J. (1990). Properties and use of fly ashes for embankments. Journal of Energy Engineering 116(2), 71-86.
31. Mir, B. A. and Sridharan, A. (2013). Physical and compaction behavior of clay soil-fly ash mixtures. *Journal of Geotechnical and Geological Engineering* 31(4), 1059-1072.
32. Moulton, K. L. (1978). Technology and utilization of power plant ash in structural fills and embankments. West Virginia University, Morgan Town, 791–806
33. Nayak, P. K., Dash, A., & Dewangan, P. (2020). Design considerations for waste dumps in Indian opencast coal mines-a critical appraisal. In *Proceedings of 2nd International Conference on Opencast Mining Technology & Sustainability* (pp. 19-31).
34. NTPC Kaniha Thermal Power Station. (2012). Feasibility report for ash disposal system at NTPC Kaniha Thermal Power Station Units # 1 to 6 (Phase#1+Phase#2). Retrieved from

https://forestsclearance.nic.in/writereaddata/FormA/Justification/2112912101217PWP71FeasibilityReportAshDisposalSystem.pdf.

35. Pandian N.S., Sridharan, A. and Chittibabu, G., (2001). Shear strength of coal ashes for geotechnical applications. *Proceedings of Indian Geotechnical Conference*. Indore, India, 14-16 December, 466–469.
36. Pandian, N. S. and Mir B. A. (2002). Compaction behavior of fly ash-BC soil mixes. Proceedings of Indian geotechnical conference. N. I. T. Allahabad, 261–264.
37. Pandian, N. S., Rajasekhar, C. and Sridharan, A. (1995). Fly ash lime systems for the retention of lead ions. *Proceedings of Indian Geotechnical Conference,* Bangalore 1, 219-222.
38. Pandian, N. S., Rajasekhar, C., & Sridharan, A. (1998). Studies of the specific gravity of some Indian coal ashes. Journal of Testing and Evaluation, 26(3), 177–186. https://doi.org/10.1520/JTE11990J
39. Pandian, N.S. (2004). Fly ash characterization with reference to geotechnical applications. Journal of the Indian Institute of Science 84, 189-216.
40. Phani, K. B. R. and Sharma, R. S. (2004). Effect of fly ash on engineering properties of expansive soils. *Journal of Geotechnical and Geoenvironmental Engineering* 130(7),764-767.
41. Poran, C. J. and Ali, F. A. (1989). Properties of solid waste incinerator fly ash. Journal of Geotechnical. Engineering, ASCE 115, 1118-1133.
42. Porbaha, A., Pradhan, T. B. S. and Yamane, N. (2000). Time effect on shear strength and permeability of fly ash. *Journal of Energy Engineering* 15, 15-31.
43. Prabakar, J., Dendorkar, N. and Morchhale, R.K. (2004). Influence of fly ash on strength behaviour of typical soils. *Construction and Building Material* 18, 263–267.
44. Pradhan S. P., Vishal V., Singh T. N. and Singh V. K. (2014). Optimisation of dump slope geometry *vis-a-vis* fly ash utilization using numerical simulation. *American Journal of Mining and Metallurgy* 2(1), 1-7.
45. Rajak, T. K., Yadu, L., Chouksey, S. K., & Dewangan, P. K. (2021). Stability analysis of mine overburden dump stabilized with fly ash. *International Journal of Geotechnical Engineering*, *15*(5), 587-597.
46. Rani, R., & Jain, M. K. (2017). Effect of bottom ash at different ratios on hydraulic transportation of fly ash during mine fill. Powder Technology, 315, 309-317.

47. Santos, F., Lin Li., Yadong Li. and Amini, F. (2011). Geotechnical properties of fly ash and soil mixtures for use in highway embankments. *Proceedings of World of Coal Ash Conference*, 11 May, 1-11.
48. Sharma, N. K., Swain, S. K. and Sahoo, U. C. (2006). Stabilization of a clayey soil with fly ash and lime: A micro level investigation. *Journal of Geotechnical and Geological Engineering* 24(2), 1-11.
49. Singh, D. N. (1996). Influence of chemical constituents on fly ash characteristics. Proceedings of Indian Geotechnical Conference. IIT Madras 1, 227 – 230.
50. Singh, S. R. and Panda, A. P. (1996). Utilization of fly ash in geotechnical construction. Proceedings of Indian Geotechnical Conference, Madras 1, 547-550.
51. Singh, T.N. 2011. Assessment of coal mine overburden dump behaviour using numerical modelling. *Proceedings of Rock Mechanics*. Fuenkajorn & Phien-wej (eds), 25-36.
52. Sridharan A. and Prakash K. (2007a). Geotechnical engineering characterization of coal ashes, 1st ed., New Delhi: S.K. Jain for CBS Publishers.
53. Sridharan, A. and Prakash, K. (2007b). Physical properties, geotechnical engineering characterization of coal ashes. New Delhi: CBS Publishers & Distributors.
54. Sridharan, A., Pandian, N. S. and Rajasekhar, C. (1996). Geotechnical characterization of pond ash. Proceedings of Conference on Ash Ponds and Ash Disposal Systems, Indian Institute of Technology, New Delhi, India, 97–110.
55. Sridharan, A., Pandian, N.S. and Srinavas, S. (2001). Compaction behavior of Indian coal ashes. Proceedings of Ground Improvement. Thomas Telford, UK 5, 13–22.
56. Tannant, D. D. and Kumar, V. (2000). Properties of fly ash stabilized haul road construction material. *International Journal of Surface Mining Reclamation and Environment* 14, 121–135.
57. Toth, P. S., Chan, H. T. and Cragg C. B. (1988). Coal ash as a structural fill with special reference to Ontario experience. Canadian Geotechnical Journal 25(4), 694–704.
58. Tripathi, N., Sharma, A., Mallick, S. S., & Wypych, P. W. (2015). Energy loss at bends in the pneumatic conveying of fly ash. Particuology, 21, 65-73.
59. Wyllie, D. C. (2017). Stabilization of rock slopes. In *Rock slope engineering* (pp. 391-442). CRC Press.
60. Wyllie, D. C., & Mah, C. (2004). *Rock slope engineering*. CRC Press.

61. Yoon, S., Balunaini, U., Yildirim, I. Z., Prezzi, M. and Siddiki, N. Z. (2009). Construction of an embankment with a fly and bottom ash mixture: Field performance study. *Journal of Material in Civil Engineering* 21(6), 271-278.
62. Yudhbir and Honjo, Y. (1991). Applications of geotechnical engineering to environmental control. Proceedings of 9th Asian Regional Conference on Soil Mechanics and Foundation Engineering, Bangkok, Thailand, 9-13 December, 2, 431-466.
63. Zevgolis, I. E. (2018). Geotechnical characterization of mining rock waste dumps in central Evia, Greece. *Environmental Earth Sciences*, *77*(16), 566.
64. BHU Report, on "Scientific study of fly ash utilization/dumping/Mixing in the OB of the running/active mines of NCL along with its viability and safety aspect of man and machinery, Jan 2022, 57 – 60.

परियोजना नायक /

Project Leader

Mr. Prashant

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परियोजना नायक /

Project Leader

Dr. Vineeth Balakrishnan,

Senior Scientist

भारतीय गैर न्यायिक

एक सौ रुपये Rs. 100

रु. 100 ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

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मध्य प्रदेश MADHYA PRADESH

AW 121209

MEMORANDUM OF UNDERSTANDING BETWEEN NCL & NTPC FOR BACK FILING FLY-ASH FROM NTPC VINDHYACHAL SUPER THERMAL POWER STATION IN GORBI OPEN CAST ABANDONED/CLOSED MINE OF NORTHERN COALFIELDS LIMITED. SINGRAULI (MP).

The Memorandum of Understanding (MOU in short) is made on the 03rd day of Jan 2019 by and between M/s NTPC Ltd, a wholly owned Govt. of India Undertaking incorporated under the companies Act, 1956 and having its Registered Office at NTPC Bhawan, Core-7, Scope Complex, 7-Institutional Area, Lodhi road, New Delhi-110 003 and having one of its Project namely Vindhyachal Super Thermal Power Station, Vindhyachal, Dist Singrauli, (MP) hereinafter referred to as "NTPC" (which expression shall unless repugnant to the context of meaning there of "NTPC" includes its successors and assigns) on one part.

AND

M/s Northern Coalfields Limited, a Mini Ratna Company, a subsidiary of Coal India Ltd, Kolkata having its registered office at District: Singrauli (MP) (hereinafter referred to as "**NCL**") which expression shall unless repugnant to the context, or meaning there of include its successors and assigns) of the other part.

WHEREAS NTPC Ltd. has amongst other, a Thermal Power Station of known as Vindhyachal Super Thermal Power Station located at Vindhyanagar in Singrauli district of Madhya Pradesh State which is known as NTPC, VSTPS

AND WHEREAS in the operation of the said VSTPS, huge amount of Ash is generated.

AND WHEREAS NTPC, VSTPS has approached NCL for providing Abandoned/closed opencast quarry/mine for filling of the such fly Ash from NTPC,VSTPS on mutually agreed terms and conditions herein after mentioned.

AND WHEREAS MoEF in the notification of 3rd Nov 2009 has recommended the use of fly ash in the back filling of mines.

AND WHEREAS NGT core committee and MPPCB has also been pursuing NTPC VSTPS and NCL to start back filling of abandoned mines with fly ash.

And whereas, as per the MoEF notification of 3rd Nov 2009, the term "fly ash" means and includes all categories or groups of coal or lignite ash generated at the thermal power plant such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash.

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29/12/2018

एन. सी. एल ब्लाक 'बी' गोरबी जिला सिंगरौली (म०प्र०)

वास्ते - एग्रीमेन्ट

Afjal Mohammad
Stamp Vendor
D.J. Court Waidhan

भारतीय गैर न्यायिक

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AND WHEREAS NCL has agreed to provide such part of the closed/ abandoned opencast mine/quarry of its Mines known as Gorbi Mines located in DT: Singrauli, P.O. Gorbi for filling of Ash from said VSTPS of NTPC in fly-ash slurry form or any other method which is technically suitable and for which consent is granted by statutory authorities like MPPCB, MoEF & CC etc.

AND WHEREAS necessary NOCs from Madhya Pradesh Pollution Control Board (MPPCB), Ministry of Environment, Forest & Climate Change (MoEF & CC) have to be obtained by NTPC, VSTPS.

NOW THE MEMORANDUM OF UNDERSTANDING WITNESSES AS FOLLOWS: That in consideration of the mutual agreement and with intent to achieve in above objectives both NTPC and NCL mutually agree as under:-

1. To comply the order of NGT Principal Bench New Delhi , competent authority of NCL has given their kind consent to allow NTPC VSTPS Vindhyanagar for filling of fly ash in one of the void of closed / abandoned Gorbi Mine located in P.O. Gorbi Dist : Singrauli, subject to the fulfilment of the conditions as mentioned in this MOU. The quantity of fly-ash allowed to be filled will be limited to the filling of the void up to the ground level only. The estimated volume of the void filled with acidic water is approximately 14 Million m3 which will be made available for filling with fly-ash. The volume may vary by about 10-15% more than the volume of water in the voids. The exact volume is not available but in no case the fly-ash shall be filled more than ground level of the void.
2. As known, water accumulated in the pits are acidic in nature. NTPC will carry out the treatment / management of acidic water as ascertained and suggested through study undertaken by the expert agency and cost against consultancy fee as well as execution of same shall be borne by NTPC. NCL shall have no financial liability on this Account. The treatment should be as per the requirements of the various environmental and other laws and should be with due permission from the statutory agencies. Water quality monitoring shall be done by NTPC Vindhyachal if required in future too and in case of any deviation from permissible limit & probability of contamination of ground water & soil NTPC shall take all possible treatment measures and shall be reported to NCL and statutory body.
3. NTPC shall have to prepare the safety management plan as per Coal Mines Regulation 1957 and amended in year 2017 by hiring any scientific / expert agencies and comply the same.
4. NTPC shall have to make the drainage system of the outlet / drainage water , its treatment and discharge to prevent impact on surrounding surface / underground water.
5. Based on the studies undertaken by NTPC Talcher, where ash filling in MCL mines is already in progress, NCL & NTPC VSTPS has proposed following studies prior to ash filling in the mines :
   1. Hydrogeology & EIA Study
   2. Flora & Fauna Study
   3. Radiotracer Study

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As specified by NCL/MPPCB/DGMS/MoEF & CC, if any further study is required for successful filling of ash in abandoned Gorbi Mines, it shall be conducted by NTPC Vindhyachal at their own cost.

6. Before the filling operation, NTPC Vindhyachal shall prepare a comprehensive scheme for fly Ash filling containing the methodology including mode of transport in environmentally acceptable manner, acidic water treatment / management, safety and other allied issues. The comprehensive report should also include the EIA and EMP for the fly ash filling which shall be required during the process of permission from MoEF&CC, New Delhi. Scientific/Expert body shall also ensure whether filling of soil over filled up fly ash in the voids up to GL is technically feasible in the report. Scientific body should specifically include this point in the comprehensive scheme to be submitted by NTPC. NTPC shall submit the mentioned scheme and all reports for permission to NCL before starting of the operation.

7. Necessary NOCs / Permissions from Madhya Pradesh Pollution Control Board (MPPCB), Ministry of Environment, Forest & Climate Change (MoEF & CC), permission of District Collector for transportation of fly ash and other statutory bodies have to be obtained by NTPC as per the latest laws applicable, and any further amendment in statutory laws in future too till execution of work.
As per DMS letter, NCL being the owner of Gorbi Mine all the necessary permission from DGMS shall be obtained by NCL on the request of NTPC, VSTPS Vindhyachal. NTPC VSTPS Vindhyachal will be bound to comply all the conditions imposed in the permission letter of DGMS.

8. Mode of Transportation :
Stage-I : A study for transport of fly ash is to be done before transport of fly ash. Till completion of the installation of permanent mode of transport , NTPC shall transport and fill the fly ash either in lean slurry form or any other form which is non-polluting and shall not hamper the normal activities of the mines of NCL. This should be technically feasible for which necessary consent / permission is required from M.P.P.C.B, MoEF &CC, DGMS District Administration or any other statutory body.
Stage-II : After completion of permanent mode of transportation of conduit pipe the transportation of fly ash in slurry form will be started by NTPC. The corridor for laying of pipeline in portion of NCL lease hold area shall be provided by NCL. The safety , security of the structure / corridor / system installed by NTPC will be the responsibility of NTPC.

9. The preparation and maintenance of the dumping pit near the void of the Gorbi mine will be done by NTPC in consultation with officials of NCL.

10. Any damage / leakage of the closed conduit pipe which is being used for transportation of fly ash in slurry condition shall be immediately redressed to avoid any further legal complications.

11. On account of such fly-ash filling in the pits provided by NCL either during transportation from NTPC to Gorbi Mines or during the process of ash filling, if there is any pollution beyond permissible limit or environmental hazards or any violation, NTPC shall be solely liable for any such deviations or violations and will be solely responsible and also rectify by its own means and cost. Further, NTPC

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वास्ते - एग्रीमेन्ट

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एक सौ रुपये Rs. 100

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shall keep NCL, for all times to come, legally unharmed and indemnified in this regard. Any statutory or legal problems arising out of the process of fly-ash filling shall be the responsibility of NTPC.

12. That transportation, storage, filling of fly Ash will be done exclusively by NTPC at their own cost. NCL shall have no financial, civil or criminal liability in this regard or in respect of any other incidental factors, whatsoever. NTPC shall have no claim on the fly Ash dumped inside the NCL mines.
13. Space of NCL leased area will be provided for erection of any type of infrastructure for construction of ETP, Pump house etc in respect of filling of fly ash.
14. Power for running of electrical appliances and lighting of area will be provided from the nearest source of Block-B mines of NCL at the cost of NTPC.
15. NTPC will take all reasonable care in line with EIA report in filling of fly ash to the extent that filling of such ash will in no way affect the quality of ground water seeping through the ash bed.
16. The process of filling of fly-ash to the mentioned pit shall be as per the approval of MPPCB, MoEF & CC and DGMS. Permission from MPPCB, MoEF & CC and district administration (if required) shall be obtained by NTPC before the start of operations. NCL shall obtain the permission of DGMS prior to start of ash filling operations on the request of NTPC.

   NTPC shall ensure for all times to come that there should not be any pollution hazard due to fly- ash filling, either on transportation corridor or at dumped fly-ash site. NTPC shall be solely responsible for any violation. If any violation beyond approved standards laid down by appropriate statutory authorities including MPPCB occurs / reported , NTPC will take necessary action in time to rectify / mitigate.
17. That NCL shall not in any way, be responsible for any accident or injury to the persons engaged or otherwise affected in the process of transportation, storage and filling of fly-ash and NTPC shall keep NCL unharmed and indemnified against any claim on this account.
18. NTPC shall be responsible in the event if any violation of the relevant provision of Mines Act 1952. Environment Protection Act.1986. Air (Prevention and Control) Act, 1981. Water (Prevention and Control) Act.1974 or any other related act arising as a direct or indirect consequence of filling of fly ash.
19. As per the direction of any statutory/regulatory authority Environment impact assessment (EIA) report along with tests in respect of toxicity, leach-ability and combustible content of ash should be prepared by a reputed Government Scientific Agency at the cost of NTPC to the satisfaction of MPPCB and the EIA report along with test details and NOC shall be submitted to NCL. If required, necessary test boreholes for monitoring of ground water quality around the voids shall be done by NTPC.
20. (a) That after filling of the voids with fly ash, the top ash layer will be levelled, compacted and covered with soil of 1m thickness or as mentioned in EIA report / consent order of MPPCB, if required. The conditions may vary as per requirement of statutory agencies. Although the land shall belong to NCL during the process of filling also, NTPC shall be responsible of all liabilities on

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वास्ते - एग्रीमेन्ट

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account of filling and will have to ensure the stability of filled up fly ash during the course of filling and future too. The filled up land shall be returned by NTPC to NCL.

(b) If it is established through study that dumping of overburden over ash filled area of Gorbi Mines is not technically feasible then only NTPC will cover the filled area in dome shape with spreading / filling of 01 meter of soil layer in first stage then layer of 0.3 meter thickness soil all around with 1 meter in centre resulting in convex structure .

(c) Adequate precautionary measures are required to be taken for prevention of leaching of the fly-ash and possibility of mixing with ground water. Necessary studies of experts may be done for ensuring this. After completing the filling, capping with soil and OB is to be done in a manner so that the surface should be convex in nature and garland drains should be provided in the periphery so that the rain water does not enter the packed fly-ash pit.

(d) As instructed / advised by regulatory / statutory bodies for the safety of man & material, fencing at required places shall be done by NTPC at their own cost.

(e) That NTPC will indemnify NCL for any consequential damage or liability. NCL shall owe no responsibility to the persons engaged by NTPC.

21. That NCL reserves the right to suspend this permission at any time with a prior written notice to that effect in the event of any breach of any condition already specified to NTPC, till NTPC addresses the issues suitably.
22. Stage wise progress report of the work will be submitted to Director (T/O) NCL and GM, Block-B quarterly, as per the format mutually finalised between NTPC and NCL from time to time.
23. That the fly-ash shall be filled only at the designated site as identified above and not anywhere else. There should not be any spillage of fly-ash anywhere.
24. If the operation of filling of fly-ash is abandoned by NTPC at any stage keeping the dumped fly-ash bare, NCL shall be within its right to get the bare dump covered by earth of required thickness or as mentioned in EIA report/consent order either on its own or through any contractor/agency at the risk and cost of NTPC.
25. All disputes/differences arising out of this subject between two parties shall at the first instance be resolved amicably, failing which , all unresolved disputes shall be settled through Administrative Mechanism for Resolution of CPSEs Disputes (AMRCD) as mentioned in Department of Public Enterprises, Govt.of India, OM No.4(1)/2013-DPE(GM)/FTS-1835 Dtd.22.05.2018

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एन.सी.एल ब्लाक 'बी' गोरबी जिला -सिंगरौली (म०प्र)

वास्ते एग्रीमेन्ट

26 Any Notice to be given under this MOU shall be in writing and shall be deemed to have been duly and properly served upon the parties here to if delivered against acknowledgement or by Registered A/D post, address to the parties herein at the following address as will be duly notified by the parties from time to time.

NTPC Ltd.,
Vindhyachal Super Thermal Power Station,
Vindhyanagar
Distt- Singrauli, Madhya Pradesh-486885
And

NCL
Northern Coalfields Ltd.,
PO- Singrauli,
Dist- Singrauli
Madhya Pradesh – 486889

27 This MOU shall come into force for all purposes and intents from the date of its signing and shall remain valid and operative for a period of 10 years from the date of signing of MoU . The period of MOU may be extended , under special circumstances and observing all the parameters stipulated in the MOU, on request of NTPC to NCL for mutual agreed period which will not exceed the time of ten (10) years in any case. NCL will reserve all the rights to give permission for extension.

28 This MOU shall be governed by Indian Laws. All the disputes will be settled by Waidhan Court Dist. Singrauli (MP) .

29 The MOU terms can be reviewed on mutual agreement between NTPC and NCL whenever required owing to new conditions.

30 Irrevocable liability on the fly-ash filling matter shall devolve on NTPC. NTPC shall reimburse all expenditure including any legal charges on any matter of fly-ash filling in case of any litigation, orders of Government and orders of regulatory authority. This liability will operate even after termination of the agreement for 4 years and indefinitely thereafter, if any litigation commences within 4 years and continues beyond that till all litigation ceases.

31 During the execution (commencement to actual completion) of the mentioned work GM (Block-B) or his authorized representative will have right to monitor of workings as and when required. NTPC will intimate to GM (Block-B), NCL the name of authorized person on behalf of NTPC to whom Block-B project will interact during the execution of the work. Any instruction / advise given by Block-B project within the scope and objective of MoU will have to be followed by NTPC representative in due diligence.

32. NTPC is allowed to fill fly ash in the abandoned Gorbi mines in a phased manner, transported through road / conduit pipe, and study the impact on the water chemistry of the water inside the mine, ground water on the periphery of the mine and from the wells in the adjoining villages around mines. Primarily NTPC will be allowed to fill fly ash through closed tanker by road till the structure of transportation of fly ash through conduit pipe is completed. Initially 1 million m^3 quantity of fly ash is allowed for filling in pit of Gorbi mine by NTPC. After satisfactory completion/filling of 1 million m^3 fly ash, the quantity can further be enhanced after getting competent approval on request of NTPC.NTPC will take prior permission from all relevant statutory bodies like MoEF &CC , MPPCB , District Administration and any other statutory authorities as applicable etc.

In witness whereof the parties through their authorised representative put their respective signature of the Memorandum of Understanding on the day month and year first above written.

03/01/2019
GM, Block B Area

On behalf of NTPC, VSTPS
(Authorised Signatory)

03.01.2019
A.K.Tewary

On behalf of NCL
(Authorised Signatory)

Witness:

1. MGangle 03/01/2019 M.K. Mangle

2. 03/01 M.K. JAIN

1.

(D. Sivradhan)
GM (Env)

2.

P. R. Dhal
(GM / TTO Cmd)
NCL

7853

Registration and Stamp Department
Madhya Pradesh

Certificate of Stamp Duty

E-Stamp Details

E-Stamp Code	01015013072023010397
Total E-Stamp Amount	500
Govt. Stamp Duty (Rs.)	500 — Municipality Duty (Rs.) 0
Janpad Duty (Rs.)	0 — Upkar Amount (Rs.) 0
Exempted Amount(Rs.)	0
E-Stamp Type	NON-JUDICIAL
Issue Date & Time	13/07/2023 15:06:44
Service Provider or Issuer Details	IMRAN AHAMED SIDDIQUI/SP015040808201900131
SP/SRO/DRO/HO Details	TALKIES ROAD WAIDHAN SINGROLI NAGAR SINGROLI

Deed Details

Deed Type	Agreement or Memorandum of an agreement
Deed Instrument	If not otherwise provided for- Five hundred rupees.
Purpose	AGREEMENT

First Party Details

Organization Name	U.P.R.V.U.N.L
Address	ANPARA THERMAL PROJECT, ANPARA SONBHADRA (U.P) SINGROLI Madhya Pradesh INDIA
Number of Persons	1

Second Party Details

Organization Name	N.C.L BLOCK 'B' GORBI
Address	DISTRICT-SINGRAULI (M.P) SINGROLI Madhya Pradesh INDIA
Number of Persons	1

AGREEMENT

MEMORANDUM OF UNDERSTANDING BETWEEN NCL & UPRVUNL- ATP FOR BACK FILING FLY ASH FROM UPRVUNL- ANPARA THERMAL PROJECT IN GORBI OPEN CAST ABANDONED MINE (PIT-3) OF NORTHERN COALFIELDS LIMITED, SINGRAULI (MP).

The Memorandum of Understanding (MoU in short) is made on the 15th july 2023 by and between M/s Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd., a wholly owned state thermal power utility, Govt. of Uttar Pradesh incorporated under the companies Act, 1956 and having its Registered Office at Shakti Bhawan, 14- Ashok Marg, Lucknow-226001 and having one of its Project namely Anpara Thermal Project (ATP) Anpara, Sonbhadra herein after referred to as "UPRVUNL" (which expression shall unless repugnant to the context of meaning there of "UPRVUNL" includes its successors and assigns) on one part.

AND

M/s Northern Coalfields Limited, a Mini Ratna Company, a subsidiary of Coal India Ltd, Kolkata having its registered office at District Singrauli (MP) (hereinafter referred to as "**NCL**") which expression shall unless repugnant to the context or meaning there of include its successors and assigns) of the other part.

Digitally signed by IMRAN AHAMED SIDDIQUI
Date: 2023.07.13 15:06:55 IST

15.7.23

महाप्रबंधक
ब्लाक'बी' क्षेत्र
नार्दर्न कोलफिल्ड्स लिमिटेड
पो०-गोरबी, जिला-सिंगरौली
मध्य प्रदेश-486892

मुख्य महाप्रबन्धक
अनपरा ताप विद्युत गृह
उ०प्र०रा०वि०उत्पादन निगम लि०
अनपरा, सोनभद्र-231225

01015013072023010397

WHEREAS UPRVUNL has amongst other, a Thermal Power Station of known as Anpara Thermal Project located at Anpara in Sonbhadra district of Uttar Pradesh State which is known as UPRVUNL- ATP.

AND WHERE AS in the operation of the said ATP, huge amount of Ash is generated.

AND WHEREAS UPRVUNL-ATP had approached MoC/NCL for providing Abandoned/closed opencast quarry/mine for filling of the such fly Ash from UPRVUNL- ATP on mutually agreed terms and conditions herein after mentioned. MoC vide MoM dated 04.05.2023, has allocated **Pit-3 of Gorbi** abandoned/disused open cast mine to UPRVUNL-ATP for disposal of ash for back filling of the said mine pit.

AND WHEREAS MoEF&CC in the notification of 3rd Nov 2009 and **31st Dec 2021** has recommended the use of fly ash in the back filling of mines.

And whereas, as per the MoEF&CC notification of 3rd Nov 2009, the term "fly ash" means and includes all categories or groups of coal or lignite ash generated at the thermal power plant such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash.

AND WHEREAS NCL has agreed to provide **Pit-3 of** the abandoned opencast mine of its Mines known as Gorbi Mines located in DT: Singrauli, P.O. Gorbi for filling of Ash from said ATP of UPRVUNL in fly-ash slurry form or any other method which is technically suitable and for which consent is granted by statutory authorities like MPPCB, UPPCB, MoEF & CC etc.

AND WHEREAS necessary NOCs from Madhya Pradesh Pollution Control Board (MPPCB), Uttar Pradesh Pollution Control Board (UPPCB), Forest Department-Singrauli, Ministry of Environment, Forest & Climate Change (MoEF & CC) have to be obtained by UPRVUNL-ATP.

NOW THE MEMORANDUM OF UNDERSTANDING WITNESSES AS FOLLOWS: That in consideration of the mutual agreement and with intent to achieve in above objectives both UPRVUNL- ATP and NCL mutually agree as under: -

1. The competent authority of NCL has given their kind consent to allow UPRVUNL- ATP for filling of fly ash in Pit-3 of abandoned Gorbi Mine located in P.O. Gorbi Distt : Singrauli, subject to the fulfilment of the conditions as mentioned in this MOU. The quantity of flyash allowed to be filled will be limited to the filling of the void up to the ground level only. The estimated volume of the void filled with acidic water is approximately **13 Million m³ (Gorbi Pit-3)** which will be made available for filling with flyash. The volume may vary by about 10-15% more than the volume of water in the voids. The exact volume is not available but in no case the fly-ash shall be filled more than ground level of the void.

2. As known, water accumulated in the Gorbi Pit-3 is acidic in nature. UPRVUNL- ATP will carry out the treatment / management of acidic water as ascertained and suggested through study undertaken by the expert agency and cost against consultancy fee as well as execution of same shall be borne by UPRVUNL-ATP. NCL shall have no financial liability on this Account. The treatment should be as per the requirements of the various environmental and other laws and should be with due permission from the

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statutory agencies. Water quality monitoring, Air Quality Monitoring and soil quality Monitoring of nearby villages of Gorbi Pit-3 shall be done by UPRVUNL-ATP Anpara if required in future too and in case of any deviation from permissible limit & probability of contamination of Air quality, ground water & soil UPRVUNL-ATP shall take all possible treatment measures and shall be reported to NCL and statutory body.

3. UPRVUNL-ATP shall have to prepare the safety management plan as per Coal Mines Regulation 1957 and amended in year 2017 by hiring any scientific/expert agencies at their own cost and be submitted before the designated authority with a copy to NCL (before start of fly ash filling).

4. UPRVUNL-ATP shall have to make the drainage system of the outlet / drainage water, its treatment and discharge to prevent impact on surrounding surface / underground water.

5. Based on the studies undertaken by NTPC Talcher, where ash filling in MCL mines is already in progress, NCL & UPRVUNL-ATP has proposed following studies prior to ash filling in the **Gorbi Pit-3** mines:
   1. Hydrogeology & EIA Study
   2. Flora & Fauna Study
   3. Radiotracer Study

   As specified by NCL/MPPCB/UPPCB/Forest Department/DGMS/MoEF & CC, if any further study is required for successful filling of ash in Pit-3 of abandoned Gorbi Mines, it shall be conducted by UPRVUNL-ATP at their own cost.

6. Before the filling operation, UPRVUNL-ATP shall prepare a comprehensive scheme for fly ash filling containing the methodology including mode of transport in environmentally acceptable manner, acidic water treatment / management, safety and other allied issues. The comprehensive report should also include the EIA and EMP for the fly ash filling which shall be required during the process of permission from MoEF & CC, New Delhi. Scientific/Expert body shall also ensure whether filling of soil over filled up fly ash in the voids up to GL is technically feasible in the report. Scientific body should specifically include this point in the comprehensive scheme to be submitted by UPRVUNL-ATP. UPRVUNL-ATP shall submit the mentioned scheme and all reports for permission to NCL before starting of the operation.

7. Necessary NOCs / Permissions from Madhya Pradesh Pollution Control Board (MPPCB), Uttar Pradesh Pollution Control Board (UPPCB), Ministry of Environment, Forest & Climate Change (MoEF & CC), Permissions/NoCs from Divisional Forest Officer (DFO) Singrauli MP for Forest clearance, permission of District Collector for transportation of fly ash and other statutory bodies have to be obtained by UPRVUNL-ATP as per the latest laws applicable, and any further amendment in statutory laws in future too till execution of work.

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पो०–गोरबी, जिला–सिंगरौली
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As per DMS letter, NCL being the owner of Gorbi Mine all the necessary permission from DGMS shall be obtained by NCL on the request of UPRVUNL-ATP. UPRVUNL-ATP will be bound to comply all the conditions imposed in the permission letter of DGMS.

UPRVUNL-ATP solely responsible for permissions/approvals/NoCs/clearances in any form required from any statute/rules/bye-laws etc.

8. Mode of Transportation:

Stage-I : A study for transport of fly ash is to be done before transport of fly ash. UPRVUNL-ATP shall transport and fill the fly ash either in lean slurry form or any other form which is non-polluting and shall not hamper the normal activities of the mines of NCL. This should be technically feasible for which necessary consent / permission is required from MPPCB, UPPCB, MP Forest Department, MoEF & CC, DGMS District Administration or any other statutory body.

Stage-II : After completion of permanent mode of transportation, transportation of fly ash through conduit pipe or Covered/closed Railway wagon/ Covered rail mode/covered and closed bulker in slurry form will be started by UPRVUNL-ATP. The corridor for laying of pipeline/Railway track and related infrastructure in portion of NCL lease hold area shall be provided by NCL and charges/lease rent for the area which will be borne by UPRVUNL-ATP. The safety, security of the structure / corridor / system installed by UPRVUNL-ATP will be the responsibility of UPRVUNL-ATP.

9. The preparation and maintenance of the dumping pit near the void of the Gorbi mine Pit-3 will be done by UPRVUNL-ATP in consultation with officials of NCL.

10. UPRVUNL-ATP will be solely responsible and also rectify by its own means and cost of any damage/ leakage of the closed conduit pipe/Railway track and related infrastructure/Closed Bulker which is being used for transportation of fly ash in slurry condition shall be immediately redressed to avoid any further legal complications.

(a). UPRVUNL-ATP will be solely responsible for clean-up of site and remedial action of any spillage of ash.

(b). UPRVUNL-ATP will be solely responsible for any penalty / Environmental Compensation imposed by Pollution Control Board or any regulatory authority.

11. On account of such fly-ash filling in the pits provided by NCL either during transportation from UPRVUNL-ATP to Gorbi Mines or during the process of ash filling, if there is any pollution beyond permissible limit or environmental hazards or any violation, UPRVUNL-ATP shall be solely liable for any such deviations or violations and will be solely responsible and also rectify by its own means and cost. Further, UPRVUNL-ATP shall keep NCL, for all times to come, legally unharmed and indemnified in this regard. Any statutory or legal problems arising out of the process of fly-ash filling shall be the responsibility of UPRVUNL-ATP.

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12. That transportation, storage, filling of fly Ash will be done exclusively by UPRVUNL-ATP at their own cost. NCL shall have no financial, civil or criminal liability in this regard or in respect of any other incidental factors, whatsoever. UPRVUN- ATP shall have no claim on the fly ash dumped inside the NCL mines.

13. Space of NCL leased area will be provided for erection of any type of infrastructure for construction of WTP/ETP, Pump house etc in respect of filling of fly ash. Lease rent as per applicable rules shall be payable by UPRVUNL-ATP.

    UPRVUNL-ATP should allow NCL to use the space if required for any other initiatives in that region. After the completion of work/project tenure as proposed by UPRVUNL-ATP, the infrastructure should be handed over to the NCL, if desired by NCL. UPRVUNL-ATP will have to remove the infrastructure at their own cost in case the infrastructures are not required by NCL.

14. Power for running of electrical appliances and lighting of area will be provided from the nearest source of Block-B mines of NCL at the cost of UPRVUNL-ATP.

15. UPRVUNL-ATP will take all reasonable care in line with EIA report in filling of fly ash to the extent that filling of such ash will in no way affect the quality of ground water seeping through the ash bed.

16. The process of filling of fly-ash to the mentioned pit (Gorbi pit-3) shall be as per the approval of MPPCB, UPPCB, MP Forest Department-Singrauli, MoEF & CC and DGMS. Permission from MPPCB, UPPCB, MP Forest Department-Singrauli, MoEF & CC and district administration (if required) shall be obtained by UPRVUNL-ATP before the start of operations. NCL shall obtain the permission of DGMS prior to start of ash filling operations on the request of UPRVUNL-ATP.

    UPRVUNL- ATP shall ensure for all times to come that there should not be any pollution hazard due to fly- ash filling, either on transportation corridor or at dumped fly-ash site. UPRVUNL- ATP shall be solely responsible for any violation. If any violation beyond approved standards laid down by appropriate statutory authorities including UPPCB and MPPCB occurs / reported, UPRVUNL-ATP will take necessary action in time to rectify / mitigate.

17. That NCL shall not in any way, be responsible for any accident or injury to the persons engaged or otherwise affected in the process of transportation, storage and filling of fly-ash and UPRVUNL, ATP shall keep NCL unharmed and indemnified against any claim on this account.

18. UPRVUNL-ATP shall be responsible in the event if any violation of the relevant provision of Mines Act 1952. Environment Protection Act.1986, Air (Prevention and Control of Pollution) Act, 1981, Water (Prevention and Control of Pollution) Act. 1974, **Forest Conservation Act. 1980** or any other related act arising as a direct or indirect consequence of filling of fly ash.

19. As per the direction of any statutory/regulatory authority Environment impact assessment (EIA) report along with tests in respect of toxicity, leachability and combustible content of ash should be prepared by a

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reputed Government Scientific Agency at the cost of UPRVUNL- ATP to the satisfaction of MPPCB, UPPCB and the EIA report along with test details and NOC shall be submitted to NCL. If required, necessary test boreholes for monitoring of ground water quality around the voids shall be done by UPRVUNL-ATP.

20. UPRVUNL-ATP will be bound to comply/follow, Office Memorandum, F.No. 22-13/2019-IA.III, MoEF & CC, dt. 28th August 2019 and the Guidelines prepared by CPCB in March-2019, for disposal/utilisation of fly ash for reclamation of low lying areas and in stowing of abandoned mines/Quarries during disposal of ash in abandoned mines.

(a) The land shall belong to NCL during the process of filling also, UPRVUNL- ATP shall be responsible of all liabilities on account of filling and will have to ensure the stability of filled up fly ash during the course of filling and future too. The filled up land shall be returned by UPRVUNL- ATP to NCL.

(b) If it is established through study that dumping of overburden over ash filled area of Gorbi Mines is not technically feasible then only UPRVUNL-ATP will reclaim /cover the filled area as per MoEF & CC, OM dt. 28th August 2019 and the Guidelines prepared by CPCB in March-2019.

(c) Adequate precautionary measures are required to be taken for prevention of leaching of the fly-ash and possibility of mixing with ground water. Necessary studies of experts may be done for ensuring this. After completing the filling, capping with soil and OB is to be done in a manner so that the surface should be convex in nature and garland drains should be provided in the periphery so that the rain water does not enter the packed fly-ash pit.

(d) As instructed/advised by regulatory/statutory bodies for the safety of man & material, fencing at required places shall be done by UPRVUNL-ATP at their own cost.

(e) That UPRVUNL- ATP will indemnify NCL for any consequential damage or liability. NCL shall owe no responsibility to the persons engaged by UPRVUNL-ATP.

21. That NCL reserves the right to suspend this permission at any time with a prior written notice to that effect in the event of any breach of any condition already specified to UPRVUNL-ATP, till UPRVUNL-ATP addresses the issues suitably.

22. Stage wise progress report of the fly ash filling work along with Environmental Monitoring Report (Air quality, Ground water quality & Soil quality) will be submitted to Director Technical (P&P) NCL, General Manager, Block-B and General Manager Environment NCL-HQ quarterly.

23. That the fly-ash shall be filled only at the designated site as identified above and not anywhere else. There should not be any spillage of fly-ash anywhere.

24. If the operation of filling of fly-ash is abandoned by UPRVUNL-ATP at any stage keeping the dumped fly-ash bare, NCL shall be within its right to get the bare dump covered by earth of required thickness or as mentioned in EIA report/consent order either on its own or through any contractor/agency at the risk and cost of UPRVUNL- ATP.

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25. All disputes/ differences arising out of this subject between two parties shall at the first instance be resolved amicably, failing which, all unresolved disputes shall be settled through Administrative Mechanism for Resolution of CPSEs Disputes (AMRCD) as mentioned in Department of Public Enterprises, Govt. of India, OM No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22.05.2018.

26. Any Notice to be given under this MoU shall be in writing and shall be deemed to have been duly and properly served upon the parties here to if delivered through e-mail or against acknowledgement or by Registered A/D post, address to the parties herein at the following address as will be duly notified by the parties from time to time.

UPRVUNL-ATP
Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd.
Anpara Thermal Project, Anpara
Distt- Sonbhadra, Uttar Pradesh - 231225
And
NCL
Northern Coalfields Ltd.,
PO- Singrauli,
Dist- Singrauli
Madhya Pradesh – 486889

27. This MoU shall come into force for all purposes and intents from the date of its signing and shall remain valid and operative for a period of 10 years from the date of signing of MoU. The period of MoU may be extended, under special circumstances and observing all the parameters stipulated in the MOU, on request of UPRVUNL-ATP to NCL for mutual agreed period which will not exceed the time of ten (10) years in any case. NCL will reserve all the rights to give permission for extension and revise the MoU.

28. This MoU shall be governed by Indian Laws. All the disputes will be settled by Waidhan Court Dist. Singrauli (MP).

29. The MOU terms can be reviewed on mutual agreement between UPRVUNL- ATP and NCL whenever required owing to new conditions.

30. Irrevocable liability on the fly-ash filling matter shall devolve on UPRVUNL-ATP. UPRVUNL- ATP shall reimburse all expenditure including any legal charges on any matter of fly-ash filling in case of any litigation, orders of Government and orders of regulatory authority. This liability will operate even after termination of the agreement and indefinitely thereafter, if any litigation commences thereafter and continues beyond that till all litigation ceases.

31. During the execution (commencement to actual completion) of the mentioned work GM (Block-B) or his authorized representative will have right to monitor of workings as and when required. UPRVUNL- ATP

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will intimate to GM (Block-B), NCL with authorization letter citing the name of authorized person who shall be the in-charge of the site and will be responsible to carry out all activities related to fly ash filling in safe manner following all the terms and conditions of the various permissions accordingly on behalf of UPRVUNL-ATP with whom Block-B project will interact during the execution of the work. Any instruction / advise given by Block-B project within the scope and objective of MoU will have to be followed by UPRVUNL-ATP representative in due diligence.

32. UPRVUNL-ATP is allowed to fill fly ash in the Gorbi Pit-3 abandoned mine in a phased manner, transported through road / conduit pipe/rail, and study the impact on the Air quality, water chemistry of the water inside the mine, ground water on the periphery of the mine and from the wells in the adjoining villages around mines. Initially UPRVUNL-ATP will be allowed to fill fly ash through closed tanker by road till the structure of transportation of fly ash through conduit pipe/Rail infrastructure is completed. Initially 1 million m^3 quantity of fly ash is allowed for filling in Pit-3 of Gorbi mine by UPRVUNL-ATP. After satisfactory completion/filling of 1 million m^3 fly ash, the quantity can further be enhanced after getting competent approval on request of UPRVUNL-ATP. UPRVUNL-ATP will take prior permission from all relevant statutory bodies like MoEF&CC, MPPCB, UPPCB, MP Forest Department Singrauli, District Administration and any other statutory authorities as applicable etc.

33. If UPRVUNL-ATP fails to commence filling of flyash in the area marked to them as per MoU within the maximum period of 5 years the validity of MoU will stand cancelled.

34. UPRVUNL-ATP shall install PTZ Camera at Gorbi Pit-3 along with proper internet connectivity to GM Block-B and NCL HQ for monitoring of fly ash filling operations on priority basis.

In witness whereof the parties through their authorised representative put their respective signature of the Memorandum of Understanding on the day month and year first above written.

s/d	**s/d**
15-07-2023	15.7.23
On behalf of UPRVUNL-ATP	**On behalf of NCL**
Chief General Manager	General Manager (Block B)
Anpara Thermal Project (UPRVUNL)	Northern Coalfields Ltd.
Distt.- Sonbhadara, Uttar Pradesh – 231225	Distt.- Singrauli Madhya Pradesh
(Authorised Signatory)	(Authorised Signatory)
महाप्रबंधक अनपरा तापीय विद्युत गृह उ०प्र०रा०वि०उत्पादन निगम लि० अनपरा, सोनभद्र–231225	महाप्रबंधक ब्लाक 'बी' क्षेत्र नार्दर्न कोलफिल्ड्स लिमिटेड पो०-..., जिला-सिंगरौली मध्य प्रदेश–486892

Witness:

1. 15/07/2023 (R. P. MALL) SE - CMC - I, ATP	1. 15/07/23 Project officer (BLB)
2. 15/07/2023 (R. K. Kuber) E.E C.M.D.-III ATP.	2. 15/7/23 Staff officer (Excvn) BLB

Registration and Stamp Department
Madhya Pradesh

Certificate of Stamp Duty

E-Stamp Details

E-Stamp Code	01015028052024003831
Total E-Stamp Amount	500
Govt. Stamp Duty (Rs.)	500
Municipality Duty (Rs.)	0
Janpad Duty (Rs.)	0
Upkar Amount (Rs.)	0
Exempted Amount(Rs.)	0
E-Stamp Type	NON-JUDICIAL
Issue Date & Time	28/05/2024 12:03:12
Service Provider or Issuer Details	AABHA SHAH/SP01504080820210022O
SP/SRO/DRO/HO Details	VILLAGE- DHOTI POST- WAIDHAN TEHSIL & DISTT- SINGRAULI (M.P.) SINGRAULI (BAIDHAN) SINGROLI

Deed Details

Deed Type	Agreement or Memorandum of an agreement
Deed Instrument	If not otherwise provided for- Five hundred rupees.
Purpose	Memorandum of understanding (MoU) between NCL and NTPC-VSTPS

First Party Details

Organization Name	NTPC-VSTPS
Address	VINDHYANAGAR DISTRICT- SINGROLI Madhya Pradesh INDIA
Number of Persons	1

Second Party Details

Organization Name	Northern Coalfields Limited (NCL)
Address	SINGRAULI DISTRICT- SINGROLI Madhya Pradesh INDIA
Number of Persons	1

Memorandum of understanding (MoU) between NCL and NTPC-VSTPS

Digitally signed by Aabha Shah
Date: 2024.05.28 12:03:18 IST

ई. सत्य फणि कुमार
E. SATYA PHANI KUMAR
कार्यकारी निदेशक
Executive Director
एनटीपीसी लि. विंध्याचल-सिंगरौली (म.प्र.)
NTPC Ltd. Vindhyachal-Singrauli (M.P.)

General Manager
Block-B Area
Northern Coalfields Limited
P.O.-Gorbi, Distt.-Singrauli
(M.P.) 486 892

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MEMORANDUM OF UNDERSTANDING BETWEEN NCL & NTPC-VSTPS FOR BACK FILING FLY-ASH FROM NTPC VINDHYACHAL SUPER THERMAL POWER STATION (VSTPS) IN GORBI OPEN CAST ABANDONED MINE (PIT-2) OF NORTHERN COALFIELDS LIMITED, SINGRAULI (MP).

This Memorandum of Understanding (MoU in short) is made on the 6th june 2024 between M/s NTPC Ltd, a Govt. of India Undertaking incorporated under the companies Act, 1956and having its Registered Office at NTPC Bhawan, Core-7, Scope Complex, 7-Institutional Area, Lodhi road, New Delhi-110 003 and having one of its Project namely Vindhyachal Super Thermal Power Station, Vindhyachal, Dist Singrauli, (MP) hereinafter referred to as "NTPC-VSTPS" (which expression shall unless repugnant to the context of meaning there of "NTPC" includes its successors and assigns) on one part.

AND

M/s Northern Coalfields Limited, a Mini Ratna Company, a subsidiary of Coal India Ltd, Kolkata having its registered office at District: Singrauli (MP) (hereinafter referred to as "**NCL**") which expression shall unless repugnant to the context, or meaning there of include its successors and assigns) of the other part.

WHEREAS NTPC Ltd. has amongst other, a Thermal Power Station of known as Vindhyachal Super Thermal Power Station located at Vindhyanagar in Singrauli district of Madhya Pradesh State which is known as NTPC-VSTPS.

AND WHEREAS in the operation of the said VSTPS, huge amount of Ash is generated.

AND WHEREAS NTPC-VSTPS had approached MoC/NCL for providing Abandoned/closed opencast quarry/mine for filling of such fly Ash from NTPC-VSTPS on mutually agreed terms and conditions herein after mentioned. MoC vide MoM dated 04.05.2023, has allocated Pit-2 of Gorbi abandoned/disused open cast mine to NTPC-VSTPS for disposal of ash for back filling of the said mine pit.

AND WHEREAS MoEF in the notification of 3rd Nov 2009 and 31st Dec 2021 has recommended the use of fly ash in the back filling of mines.

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And whereas, as per the MoEF&CC notification of 3rd Nov 2009, the term "fly ash" means and includes all categories or groups of coal or lignite ash generated at the thermal power plant such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash.

AND WHEREAS NCL has agreed to provide **Pit-2** of the abandoned opencast mine of its Mines known as Gorbi Mines located in DT: Singrauli, P.O. Gorbi for filling of Ash from said VSTPS of NTPC in fly-ash slurry form or any other method which is technically suitable and for which consent is granted by statutory authorities like MPPCB, MoEF & CC etc.

AND WHEREAS necessary NOCs from Madhya Pradesh Pollution Control Board (MPPCB), Forest Department-Singrauli , Ministry of Environment, Forest & Climate Change (MoEF&CC) have to be obtained by NTPC- VSTPS.

NOW THE MEMORANDUM OF UNDERSTANDING WITNESSES AS FOLLOWS: That in consideration of the mutual agreement and with intent to achieve in above objectives both NTPC-VSTPS and NCL mutually agree as under:-

1. The competent authority of NCL has given their kind consent to allow NTPC-VSTPS for filling of fly ash in **Pit-2** of abandoned Gorbi Mine located in P.O. Gorbi Dist : Singrauli, subject to the fulfilment of the conditions as mentioned in this MoU. The quantity of fly-ash allowed to be filled will be limited to the filling of the void up to the ground level only. The estimated volume of the void filled with acidic water is approximately **4 Million m^3 (Gorbi Pit-2)** which will be made available for filling with fly-ash. The volume may vary by about 10-15% more than the volume of water in the voids. The exact volume is not available but in no case the fly-ash shall be filled more than ground level of the void.

2. As known, water accumulated in the **Gorbi Pit-2** is acidic in nature. NTPC will carry out the treatment / management of acidic water as ascertained and suggested through study undertaken by the expert agency and cost against consultancy fee as well as execution of same shall be borne by NTPC-VSTPS. NCL shall have no financial liability on this account. The treatment should be as per the requirements of the various environmental and other laws and should be with due permission from the statutory agencies. Water quality monitoring, Air

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Quality Monitoring and soil quality Monitoring of nearby villages of Gorbi Pit-2 shall be done by NTPC Vindhyachal if required in future too and in case of any deviation from permissible limit & probability of contamination of Air quality, ground water & soil, NTPC-VSTPS shall take all possible treatment measures and shall be reported to NCL and statutory body.

3. NTPC shall have to prepare and submit (before start of fly ash filling) the safety management plan as per Coal Mines Regulation 2017 by hiring any scientific / expert agencies at their own cost and be submitted before the designated authority with a copy to NCL (before start of fly ash filling).

4. NTPC shall have to make the drainage system of the outlet / drainage water, its treatment and discharge to prevent impact on surrounding surface / underground water.

5. Based on the studies undertaken by NTPC -Talcher, where ash filling in MCL mines is already in progress, NCL & NTPC - VSTPS has proposed the following studies prior to ash filling in the **Gorbi pit-2** mines :
   1. Hydrogeology & EIA Study
   2. Flora & Fauna Study
   3. Radiotracer Study

   As specified by NCL/MPPCB/Forest Department/DGMS/MoEF & CC, if any further study is required for successful filling of ash in Pit-2 of abandoned Gorbi Mines, it shall be conducted by NTPC Vindhyachal at their own cost.

6. Before the filling operation, NTPC-VSTPS Vindhyachal shall prepare a comprehensive scheme for fly Ash filling containing the methodology including mode of transport in environmentally acceptable manner, acidic water treatment / management, safety and other allied issues. The comprehensive report should also include the EIA and EMP for the fly ash filling which shall be required during the process of permission from MoEF&CC, New Delhi. Scientific/Expert body shall also ensure whether filling of soil over filled up fly ash in the voids up to GL is technically feasible in the report. Scientific body should specifically include this point in the comprehensive scheme to be submitted by NTPC-VSTPS. NTPC-VSTPS shall

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submit the mentioned scheme and all reports for permission to NCL before starting of the operation.

7. Necessary NOCs / Permissions from Madhya Pradesh Pollution Control Board (MPPCB), Ministry of Environment, Forest & Climate Change (MoEF & CC), Permissions/NoCs from Divisional Forest Officer (DFO) Singrauli, MP for Forest clearance, permission of District Collector for transportation of fly ash and other statutory bodies have to be obtained by NTPC-VSTPS as per the latest laws applicable, and any further amendment in statutory laws in future too till execution of work.

As per DMS letter, NCL being the owner of Gorbi Mine all the necessary permission from DGMS shall be obtained by NCL on the request of NTPC-VSTPS. NTPC- VSTPS will be bound to comply all the conditions imposed in the permission letter of DGMS.

NTPC-VSTPS will be solely responsible for permissions/approvals/NoCs/clearances in any form required by any statute/rules/bye-laws etc.

8. Mode of Transportation :

Stage-I : A study for transport of fly ash is to be done before transport of fly ash. Till completion of the installation of permanent mode of transport, NTPC shall transport and fill the fly ash either in lean slurry form or any other form which is non-polluting and shall not hamper the normal activities of the mines of NCL. This should be technically feasible for which necessary consent / permission is required from M.P.P.C.B, **MP Forest Department,** MoEF &CC, DGMS, District Administration or any other statutory body.

Stage-II : After completion of permanent mode of transportation, transportation of fly ash through conduit pipe or Covered/closed Railway wagon/ Covered rail mode/covered and closed bulker in slurry form will be started by NTPC-VSTPS. The corridor for lying of pipeline/Railway track and related infrastructure in portion of NCL lease hold area shall be provided by NCL and charges/lease rent for the area which will be borne by NTPC-VSTPS. The safety, security of the structure / corridor / system installed by NTPC will be the responsibility of NTPC-VSTPS.

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9. The preparation and maintenance of the dumping pit near the void of the **Gorbi mine Pit-2** will be done by NTPC-VSTPS in consultation with officials of NCL.

10. NTPC-VSTPS will be solely responsible and also rectify by its own means and cost of any damage / leakage of the closed conduit pipe/Railway track and related infrastructure/Closed Bulker which is being used for transportation of fly ash in slurry condition shall be immediately redressed to avoid any further legal complications.

    (a). NTPC-VSTPS will be solely responsible for clean-up of site and remedial action of any spillage of ash.

    (b). NTPC-VSTPS will be solely responsible for any penalty / Environmental Compensation imposed by Pollution Control Board or any regulatory authority.

11. On account of such fly-ash filling in the pits provided by NCL either during transportation from NTPC-VSTPS to Gorbi Mines or during the process of ash filling, if there is any pollution beyond permissible limit or environmental hazards or any violation, NTPC-VSTPS shall be solely liable for any such deviations or violations and will be solely responsible and also rectify by its own means and cost. Further, NTPC shall keep NCL, for all times to come, legally unharmed and indemnified in this regard. Any statutory or legal problems arising out of the process of fly-ash filling shall be the responsibility of NTPC-VSTPS.

12. That transportation, storage, filling of fly Ash will be done exclusively by NTPC-VSTPS at their own cost. NCL shall have no financial, civil or criminal liability in this regard or in respect of any other incidental factors, whatsoever. NTPC-VSTPS shall have no claim on the fly Ash dumped inside the NCL mines.

13. Space of NCL leased area will be provided for erection of any type of infrastructure for construction of WTP/ETP, Pump house etc in respect of filling of fly ash. Lease rent as per standard parameters & applicable rules as decided by NCL shall be payable by NTPC-VSTPS.

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NTPC-VSTPS should allow NCL to use the space if required for any other initiatives in that region.

After the completion of work/project tenure as proposed by NTPC-VSTPS, the infrastructure should be handed over to the NCL, if desired by NCL. NTPC-VSTPS will have to remove the infrastructure at their own cost, in case the infrastructures are not required by NCL.

14. Power for running of electrical appliances and lighting of area will be provided from the nearest source of Block-B mines of NCL at the cost of NTPC-VSTPS.

15. NTPC-VSTPS will take all reasonable care in line with EIA report in filling of fly ash to the extent that filling of such ash will in no way affect the quality of ground water seeping through the ash bed.

16. The process of filling of fly-ash to the mentioned pit (Gorbi pit-2) shall be as per the approval of MPPCB, MP Forest Department-Singrauli, MoEF & CC and DGMS. Permission from MPPCB, Forest Department-Singrauli, MoEF & CC and district administration (if required) shall be obtained by NTPC-VSTPS before the start of operations. NCL shall obtain the permission of DGMS prior to start of ash filling operations on the request of NTPC-VSTPS.

NTPC-VSTPS shall ensure for all times to come that there should not be any pollution hazard due to fly- ash filling, either on transportation corridor or at dumped fly-ash site. NTPC-VSTPS shall be solely responsible for any violation. If any violation beyond approved standards laid down by appropriate statutory authorities including MPPCB occurs / reported, NTPC-VSTPS will take necessary action in time to rectify / mitigate.

17. That NCL shall not in any way, be responsible for any accident or injury to the persons engaged or otherwise affected in the process of transportation, storage and filling of fly-ash and NTPC-VSTPS shall keep NCL unharmed and indemnified against any claim on this account.

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18. NTPC- VSTPS shall be responsible in the event if any violation of the relevant provision of Mines Act 1952. Environment Protection Act.1986. Air (Prevention and Control) Act, 1981. Water (Prevention and Control) Act.1974, Forest Conservation Act, 1980 or any other related act arising as a direct or indirect consequence of filling of fly ash.

19. As per the direction of any statutory/regulatory authority Environment impact assessment (EIA) report along with tests in respect of toxicity, leach-ability and combustible content of ash should be prepared by a reputed Government Scientific Agency at the cost of NTPC-VSTPS to the satisfaction of MPPCB and the EIA report along with test details and NOC shall be submitted to NCL. If required, necessary test boreholes for monitoring of ground water quality around the voids shall be done by NTPC-VSTPS.

20. NTPC-VSTPS will be bound to comply/follow, Office Memorandum, F.No. 22-13/2019-IA.III, MoEF&CC, dt. 28th August, 2019 and the Guidelines prepared by CPCB in March-2019, for disposal/utilisation of fly ash for reclamation of low lying areas and in stowing of abandoned mines/Quarries during disposal of ash in abandoned mines.

(a) The land shall belong to NCL during the process of filling also, NTPC-VSTPS shall be responsible of all liabilities on account of filling and will have to ensure the stability of filled up fly ash during the course of filling and future too. The filled up land shall be returned by NTPC-VSTPS to NCL.

(b) If it is established through study that dumping of overburden over ash filled area of Gorbi Mines is not technically feasible then only NTPC-VSTPS will reclaim /cover the filled area as per MoEF&CC, OM dt. 28th August, 2019 and the Guidelines prepared by CPCB in March-2019.

(c) Adequate precautionary measures are required to be taken for prevention of leaching of the fly-ash and possibility of mixing with ground water. Necessary studies of experts may be done for ensuring this. After completing the filling, capping with soil and OB is to be done in a manner so that the surface should be convex in nature and garland drains should be provided in the periphery so that the rain water does not enter the packed fly-ash pit.

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(d) As instructed/advised by regulatory/statutory bodies for the safety of man & material, fencing at required places shall be done by NTPC-VSTPS at their own cost.

(e) That NTPC -VSTPS will indemnify NCL for any consequential damage or liability. NCL shall owe no responsibility to the persons engaged by NTPC-VSTPS.

21. That NCL reserves the right to suspend this permission at any time with a prior written notice to that effect in the event of any breach of any condition already specified to NTPC-VSTPS, till NTPC-VSTPS addresses the issues suitably.

22. Stage wise progress report of the fly ash filling work along with Environmental Monitoring Report (Air quality, Ground water quality & Soil quality) will be submitted to Director Technical (P&P) NCL, General Manager, Block-B and General Manager Environment NCL-HQ quarterly.

23. That the fly-ash shall be filled only at the designated site as identified above and not anywhere else. There should not be any spillage of fly-ash anywhere.

24. If the operation of filling of fly-ash is abandoned by NTPC-VSTPS at any stage keeping the dumped fly-ash bare, NCL shall be within its right to get the bare dump covered by earth of required thickness or as mentioned in EIA report/consent order either on its own or through any contractor/agency at the risk and cost of NTPC-VSTPS.

25. All disputes/ differences arising out of this subject between two parties shall at the first instance be resolved amicably, failing which, all unresolved disputes shall be settled through Administrative Mechanism for Resolution of CPSEs Disputes (AMRCD) as mentioned in Department of Public Enterprises, Govt. of India, as per Office Memorandum No. 05/0003/2019-FTS-10937, dated 14.12.2022 and its further guidelines, modifications and amendments on the subject issued from time to time.

26. Any Notice to be given under this MoU shall be in writing and shall be deemed to have been duly and properly served upon the parties here to if delivered through e-mail or against

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acknowledgement or by Registered A/D post, address to the parties herein at the following address as will be duly notified by the parties from time to time.

NTPC-VSTPS Ltd.,
Vindhyachal Super Thermal Power Station,
Vindhyanagar
Distt- Singrauli, Madhya Pradesh-486885
e-mail - hopvindhyachal@ntpc.co.in

And

NCL
Northern Coalfields Ltd.,
PO- Singrauli,
Dist- Singrauli
Madhya Pradesh – 486889
e-mail- dtpp.ncl@coalindia.in , gmnclbb@gmail.com, gmenv.ncl@coalindia.in

27. This MoU shall come into force for all purposes and intents from the date of its signing and shall remain valid and operative for a period of 10 years from the date of signing of MoU. The period of MoU may be extended, under any circumstances and observing all the parameters stipulated in the MOU, on request of NTPC-VSTPS to NCL for mutual agreed period which will not exceed ten (10) years in any case. NCL will reserve all the rights to give permission for extension and revise the MoU.

28. This MoU shall be governed by Indian Laws. All the disputes will be settled by Waidhan Court Dist. Singrauli (MP) subject to clause 25 of this MoU).

29. The MoU terms can be reviewed on mutual agreement between NTPC-VSTPS and NCL whenever required owing to new conditions.

30. Irrevocable liability on the fly-ash filling matter shall devolve on NTPC-VSTPS. NTPC-VSTPS shall reimburse all expenditure including any legal charges on any matter of fly-ash filling in case of any litigation, orders of Government and orders of regulatory authority. This liability

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will operate even after termination of the agreement and indefinitely thereafter, if any litigation commences thereafter and continues beyond that till all litigation ceases.

31. During the execution (Commencement to actual completion) of the mentioned work GM (Block-B) or his authorized representative will have right to monitor of workings as and when required. NTPC will intimate to GM (Block-B), NCL with authorization letter citing the name of authorized person who shall be the in-charge of the site and will be responsible to carry out all activities related to fly ash filling in safe manner following all the terms and conditions of the various permissions accordingly on behalf of NTPC- VSTPS with whom Block-B project will interact during the execution of the work. Any instruction / advise given by Block-B project within the scope and objective of MoU will have to be followed by NTPC-VSTPS representative in due diligence.

32. NTPC-VSTPS is allowed to fill fly ash in the **Gorbi Pit-2** of abandoned Gorbi mine in a phased manner, transported through road / conduit pipe/**rail**, and study the impact on the **Air quality**, water chemistry of the water inside the mine, ground water on the periphery of the mine and from the wells in the adjoining villages around mines. Initially NTPC-VSTPS will be allowed to fill fly ash through closed tanker by road till the structure of transportation of fly ash through conduit pipe/**Rail infrastructure** is completed. Initially 1 million m^3 quantity of fly ash is allowed for filling in pit of Gorbi mine by NTPC-VSTPS. After satisfactory completion/filling of 1 million m^3 fly ash, the quantity can further be enhanced after getting competent approval on request of NTPC-VSTPS. NTPC-VSTPS will take prior permission from all relevant statutory bodies like MoEF &CC, MPPCB, Forest Department-Singrauli, District Administration and any other statutory authorities as applicable etc.

33. If NTPC-VSTPS fails to commence filling of flyash in the area marked to them as per MoU within the maximum period of 5 years the validity of MoU will stand cancelled.

34. NTPC-VSTPS shall install PTZ Camera at Gorbi Pit-2 along with proper internet connectivity to GM Block-B and NCL HQ for monitoring of fly ash filling operations on priority basis.

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In witness whereof the parties through their authorised representative put their respective signature in the Memorandum of Understanding on the day month and year first above written.

s/d

On behalf of NTPC-VSTPS
Vindhyachal Super Thermal Power Station,
Vindhyanagar,
Distt- Singrauli,
Madhya Pradesh-486889

E S Phani Kumar

(Authorised Signatory)

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NTPC Ltd. Vindhyachal-Singrauli (M.P.)

Witness:

1. SANTOSH KUMAR SINGH
SR. MANAGER (AUD)
E.NO. - 043033

2. Satpathy
ASHUTOSH SATPATHY.
GM (M & ADM).
E. NO. 005626

s/d

On behalf of NCL
General Manager (Block B)
Northern Coalfields Ltd.,
Distt- Singrauli M.P.- 486885

(Authorised Signatory)

General Manager
Block-B Area
Northern Coalfields Limited
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1. RAMESH KUMAR MISHRA
Sr. MANAGER (E&M)
90216367

2. Vinod Kumar Sinha
Chief Manager (M)
EIS NO - 90142662