एनटीपीसीलिमिटेड
(भारत सरकार का उद्यम)

NTPC LIMITED
(A Govt. of India Enterprise)

तालचेरथर्मल / Talcher Thermal

Ref. : TTPS/EMG/C-9/

Date: 06.10.2021

To

Additional Principal Chief Conservator of Forests (C),
Ministry of Environment, Forest and Climate Change,
Regional Office (EZ),A/3, Chandersekharpur,
Bhubaneswar – 751023
Tel. No. 0674- 2301213, 2302432
Fax No.0674- 2302432
Email: roez.bsr-mef@nic.in

Sub: Submission of Half yearly Compliance Report of Environmental Clearance for Talcher Thermal Power Project Stage-III (2 x 660 MW).

Dear Sir,

Please find enclosed herewith Half yearly Compliance Status of Environmental Clearance Conditions given vide MoEF&CC letter no. J-13012/31/2009-IA.II(T) dated. 12.09.2018 regarding Talcher Thermal Power Project Stage-III (2 x 660 MW) near Talcher Town, Tehsil TalcherSadar, Angul District, Odisha, for Compliance period April 2021 to September 2021.

Thanking you,

Yours faithfully,

(A K Kamilla)
AGM (TS/C&M/EMG)
NTPC/TTPS

Encl : As above.

CC:

1- **Central Pollution Control Board,**
Kasba New Market, Sector E, East Kolkata Twp, Kolkata, West Bengal -700107
2- **The Member Secretary, SPCB, Odisha, ParibeshBhawan,**
A/118, Nilakantha Nagar, Unit- VIII,Bhubaneswar -751 012

TALCHER THERMAL POWER PROJECT, STAGE-III (2X660 MW) NEAR TALCHER TOWN, TEHSIL TALCHER SADAR, ANGUL DISTRICT, ODISHA

HALF-YEARLY COMPLIANCE STATUS OF ENVIRONMENTAL CLEARANCE CONDITIONS

EC Ref. No. No. J-13012/31/2009-IA.II(T) Dated: 12.9.2018

S.No.	EC Conditions	Status as on 30.09.2021
A	SPECIFIC CONDITIONS	
(i)	Ash ponds near Village Jhadiamba (133.848 acres) and Village Santhapada (156.538 acres)· shall not be taken up as the ash is proposedto dispose it in the abandoned mine voids	Ash Dyke Construction works have been short closed and hence condition has been complied. Ash will be disposed in abandoned mine voids.
(ii)	The Ash content and Sulphur contents in the Coal shall not exceed 34% and 0.55%, respectively. In case of change in coal characteristics', a fresh reference is to be made to Ministry for reviewing the incremental impact, if any and adequacy of the conditions	The said stipulation will be complied during operation phase of the project.
(iii)	The capital CSR/ CER budget shall be in line with Ministry's OM dated 1.5.2018 or Rs.19.5 crores whichever is higher. The amount shall be implemented during project construction in the surrounding villages.	The said stipulation will be complied during construction phase of the project.
(iv)	As the coal source is determined, the details regarding characteristics of coal along with transport mode shall be submitted to Ministry. Coal transportation shall be done by rail only. In any event, coal shall not be transported by road.	The said stipulation will be complied during construction phase of the project.
(v)	The ash which is sent to South Balanda mines shall be mixed with 8% lime before disposing into the mines	TCLP and Leachate analysis was carried out in the Environmental Laboratory of CMPDI utilizing fly ash and pond ash and mine water of quarry no. 8. The pH was determined for de-ionised water and mine sump water as well as for mixture of water and fly ash slurry prepared for leaching analysis in 1:5 ash suspension ratio. The results show that pH of slurry immediately falls to a level ranging between 4.4 to

S.No.	EC Conditions	Status as on 30.09.2021
		5.0. However values increases slowly as the time passes. Finally pH raises to above 6.5 to as high as 7.2 within 24 Hrs. This behaviour of PFA is mainly due to presence of alumina in fly ash. Alumina has 56% basic constituents and 44% acidic constituents. As the acidic constituents are generally more soluble in water, pH of the sample falls immediately after mixing with water. As time passes, basic constituents neutralize acidic fraction and pH of the sample gradually increases and equilibrium is achieved. Small amount of alkali present in the fly ash also neutralizes the acidic fraction of alumina. The final pH value of the samples is the value observed, when the equilibrium is achieved. Data presented confirms the above behavior. There is little variation in equilibrium pH for the slurry prepared using 10% to 30% fly ash. Since the mine water of Quarry- 7, Jagannath OCP is not acidic in nature, based on data available pH neutralization not required. The test results reveals that leachate parameters are well within the permissible limits and there is no likely impact on the ground water regime due to fly ash disposal in this

S.No.	EC Conditions	Status as on 30.09.2021
		quarry. Leaching Study at Quarry no. 4 & 7 of abandoned Jagannath Mine Void is enclosed as **Annexure-I.**
(vi)	The new emission standards notified vide Ministry's S.O.3305(E) dated 7.12.2015 shall be achieved for existing units as per the extended timelines given by CPCB. Further, the proposed units shall achieve new emissions standards from the date of commissioning of the plant.	Operations of existing units have been discontinued w.e.f 31.03.2021. Further, the proposed units shall achieve new emissions standards from the date of commissioning of the plant.
(vii)	Considering the proposed project is located in the Talcher Critically Polluted Area, the stack height of 275 m shall be erected to achieve maximum dispersion	The said stipulation will be complied during construction phase of the project.
(viii)	The ash pond near Village Santhapada shall not be used as it is near to Brahmani River and high chances of breaching and contaminating the water body.	Ash Dyke Construction works have been short closed and hence condition has been complied.Ash will be disposed in abandoned mine voids.
(ix)	As per the Revised Tariff Policy notified by Ministry of Power vide dated 28.01.2016, project proponent shall explore the use of treated sewage water from the Sewage Treatment Plant of Municipality/ local bodies/ similar organization located within 50 km radius of the proposed power project to minimize the water drawl from River Brahmani/other surface water bodies	The said stipulation will be complied during operation phase of the project.
(x)	Compliance of EC conditions, E(P) Act, 1986, Rules and MoEF&CC(WS) Notifications issued time to time shall be achieved by a qualified environment officer to be nominated by the Project Head of the Company who shall be responsible for implementation and necessary compliance	An Environment Management Group (EMG) headed by AGM (EMG) is already functional at the Talcher Thermal Power Station. AGM (EMG) will be responsible for implementing and monitoring the stipulations. EMG willhave sufficient trained manpower for environmental monitoring and other environmental related activities to ensure compliance with statutory requirements. It will interact regularly with the

S.No.	EC Conditions	Status as on 30.09.2021
		State Pollution Control Board.
(xi)	Thermal Power Plant shall achieve specific water consumption, zero liquid discharge and emission standards as per MoEF&CC Notification S.O. 3305(E) dated 7.12.2015 or subsequent notifications issued time to time.	Talcher The said stipulation will be considered during design of the project.
(xii)	MoEF&CCNotification G.S.R 02(E) dated 2.1.2014 regarding use of raw or blended or beneficiated or washed coal with ash content not exceeding 34% shall be complied with, as applicable.	The said stipulation will be complied during operation phase of the project.
(xiii)	MoEF&CC Notifications on flyash utilization S.O. 763(E) dated 14.09.1999, S.O. 979(E) dated 27.08.2003, S.O. 2804(E) dated 3.11.2009, S.O. 254(E) dated 25.01.2016 and subsequent amendments issue time to time shall be complied with	All MoEF&CC Notifications on flyash utilization will be complied during operation phase of the project.
(xiv)	Construction and inert waste generated during phasing out of existing plants shall be disposed as per Construction and Demolition Waste Management Rules, 2016	Operations of existing units have been discontinued w.e.f 31.03.2021. If the demolition of existing units is completed before the construction of stage-III Units, the same will be complied.
(xv)	Vision document specifying prospective plan for the site shall be formulated and submitted to the Regional Office of the Ministry within six months	TalcherTPS has already submitted a project vision document to the Regional Office of MOEF&CC at Bhubaneswar.
(xvi)	Harnessing solar power within the premises of the plant particularly at available roof tops shall be carried out and status of implementation including actual generation of solar power shall be submitted along with half yearly monitoring report	Solar power is being harnessed from some roof tops. Besides this, scheme for harnessing solar power from roof tops within the premises of the upcoming plant will be implemented.
(xvii)	Online continuous monitoring system for stack emission, ambient air and effluent shall be installed	Online continuous monitoring system for stack emission, ambient air and effluent are already operating for the existing station. For the

S.No.	EC Conditions	Status as on 30.09.2021
		expansion project the same will be utilized for new/ expansion units.
(xviii)	High Efficiency Electrostatic Precipitators (ESPs) shall be installed to ensure that particulate emission does not exceed 30 mg/Nm3 or as would be notified by the Ministry, whichever is stringent. Adequate dust extraction system such as cyclones/bag filters and water spray system in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided along with an environment friendly sludge disposal system.	The High Efficiency Electrostatic Precipitators (ESP) will be designed in order to comply with the direction. Besides, dust extraction systems and suitable water spray systems are included in the design of the plant to suppress/avoid dust emissions from the coal and ash handling areas.
(xix)	Adequate dust extraction system such as cyclones/ bag filters and water spray system in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.	Adequate no. of dust suppression and dust extraction systems will be provided in coal handling area including coal stock yard area, ash handling area and other vulnerable dusty area for control of fugitive dust emissions.
(xx)	Monitoring of surface water quantity and quality shall also be regularly conducted and records maintained. The monitored data shall be submitted to the Ministry regularly. Further, monitoring points shall be located between the plant and drainage in the direction of flow of ground water and records maintained. Monitoring for heavy metals in ground water shall also be undertaken and results/findings submitted along with half yearly monitoring report	Monitoring of Surface and ground water quality will be carried out regularly as per Stipulations and half yearly reports will be submitted to Regional office of MoEF&CC at Bhubaneswar during the operation phase of the project. Heavy metal monitoring in ground water shall be undertaken and results will be submitted along with half yearly monitoring report.
(xxi)	A well designed rain water harvesting system shall be put in place within six months, which shall comprise of rain water collection from the built up and open area in the plant premises and detailed record kept of the quantity of water harvested every year	Rain water harvesting system will be put in place after operation of plant and records shall be maintained.

S.No.	EC Conditions	Status as on 30.09.2021
	and its use	
(xxii)	No water bodies including natural drainage system in the area shall be disturbed due to activities associated with the setting up/operation of the power plant	The said stipulation will be complied both during the construction as well as operation phase of the project.
(xxiii)	Additional soil for leveling of the proposed site shall be generated within the sites (to the extent possible) so that natural drainage system of the area is protected and improved.	All additional soil levelling of the project site will be done from within the sites only with all necessary precautions to protect natural drainage system of the area.
(xxiv)	Fly ash shall be collected in dry form and storage facility (silos) shall be provided. Mercury and other heavy metals (As, Hg, Cr, Pb etc.) shall be monitored in the bottom ash. No ash shall be disposed off in low lying area.	An ash management & disposal scheme will be implemented consisting of dry ash extraction system (DAES) for dry collection of fly ash with storage facility (silos), supply of ash to entrepreneurs for utilization and promoting ash utilization to maximum extent and safe disposal of unused ash in slurry form to the abandoned mine void area. The plant shall also have ash water re-circulation system for bringing back decanted water from abandoned mine voids for reuse inside plant for ash slurry making. Periodic monitoring for mercury & heavy metals in the bottom ash will be done during the operation phase of the project.
(xxv)	No mine void filling will be undertaken as an option for ash utilization Talcher without adequate lining of mine with suitable media such that no leachate shall take place at any point of time. In case, the option of mine	CMPDIL, Ranchi has conductedLeaching Study at Quarry no. 4& 7 of abandoned Jagannath Mine Void and

S.No.	EC Conditions	Status as on 30.09.2021
	void filling is to be adopted, prior detailed study of soil characteristics of the mine area shall be undertaken from an institute of repute and adequate clay lining shall be ascertained by the State Pollution Control Board and implementation done in close co-ordination with the State Pollution Control Board	concluded thatlining of mine voids is notrequired. The said report isenclosed as **Annexure - I.**
(xxvi)	Fugitive emission of fly ash (dry or wet) shall be controlled such that no agricultural or non-agricultural land is affected. Damage to any land shall be mitigated and suitable compensation provided in consultation with the local Panchayat.	Fugitive emission of fly ash & dust will be controlled with the aid of suitable pollution control devices such as dust extraction system and dust suppression system, etc. Extensive plantation will be undertaken in all available spaces including coal handling, ash handling areas etc. selectively with Air Pollution Tolerant (APTI) plant species.
(xxvii)	Green Belt consisting of three tiers of plantations of native species all around plant and at least 50 m width shall be raised. Wherever 50 m width is not feasible a 20 m width shall be raised and adequate justification shall be submitted to the Ministry. Tree density shall not be less than 2500 per ha with survival rate not less than 80 %.	More than 4,18,000 trees of different species were already planted by Talcher project in and around its existing area. Plantation would be developed in the available and feasible areas of Main plant, cooling towers, new admin building, around stock pile of the coal and other material, road sides, internal roads. Extensive afforestation will be undertaken at all available spaces in and around project, after construction is complete.
(xxviii)	The project proponent shall formulate a well laid Corporate Environment Policy and identify and designate responsible officers at all levels of its hierarchy for ensuring adherence to the policy and compliance With the conditions stipulated in this	Corporate Environment Policy is already existing and the same will be adhered to so as to comply with the conditions stipulated in this clearance letter and other applicable

S.No.	EC Conditions	Status as on 30.09.2021
	clearance letter and other applicable environmental laws and regulations.	environmental laws and regulations. Enclosed **Annexure - II.**
(xxix)	CER schemes identified based on need based assessment shall be implemented in consultation with the village Panchayat and the District Administration starting from the development of project itself. As part of CER prior identification of local employable youth and eventual employment in the project after imparting relevant training shall be also undertaken. Company shall provide separate budget for community development activities and income generating programmes	After start of construction of project, CER schemes shall be identified based on Need Based Assessment Survey in consultation with the village Panchayat and the District Administration. NTPC will identify local employable youth and eventual employment in the project through contractors after imparting relevant training shall be also provided. Separate budget has been earmarked for implementing CER-CD activities for the project and shall be utilized in accordance with the said stipulations. NTPC is already providing solar lights & toilets in villages, providing education in schools inside TTPS premises to children from villages in the periphery & organized medical camp for local population.
(xxx)	CER activities will be carried out as per OM No. 22-65/2017-IA.II dated 01.05.2018 or as proposed by the PP in reference to Public Hearing or as earmarked in the EIA/EMP report along with the detailed scheduled of implementation with appropriate budgeting	The said stipulation will be complied during construction phase of the project.
(xxxi)	For proper and periodic monitoring of CSR activities, a CSR committee or a Social Audit committee or a suitable credible external agency shall be appointed. CSR activities shall also be evaluated by an independent external agency. This evaluation shall be both concurrent and final.	In-built mechanism will be adopted for the monitoring CSR schemes through any Government institute or agency of repute in the region.

S.No.	EC Conditions	Status as on 30.09.2021
B	**GENERAL CONDITIONS**	
(i)	The treated effluents conforming to the prescribed standards only shall be re-circulated and reused within the plant. Arrangements shall be made that effluents and storm water do not get mixed	The concept of Zero Liquid Discharge (ZLD) shall be adopted through reuse of plant effluents. An independent plant effluent drainage system will be constructed to ensure that plant effluents do not mix with storm water drainage.
(ii)	A sewage treatment plant shall be provided (as applicable) and the treated sewage shall be used for raising greenbelt/plantation	All domestic sewage emanating from plant and township will be treated in a sewage treatment plant. The treated sewage conforming to prescribed standards shall be utilized for plantation & raising greenbelt to the extent possible.
(iii)	Storage facilities for auxiliary liquid fuel such as LDO/ HFO/LSHS shall be made in the plant area in consultation with Department of Explosives, Nagpur. Sulphur content in the liquid fuel will not exceed 0.5%. Disaster Management Plan shall be prepared to meet any eventuality in case of an accident taking place due to storage of oil	Storage facilities for auxiliary liquid fuel LDO/HFO are designed conforming to the safety standards and where risk is minimal. A detailed Disaster Management Plan & Risk assessment including fire and explosion issues will be prepared and finalized in consultation with Department of Explosives, Nagpur and regular mock drills shall be conducted as per plan in order to address any eventuality in case of an accident.
(iv)	First Aid and sanitation arrangements shall be made for the drivers andother contract workers during construction phase	All arrangements related to first aid, health & safety and sanitation for workers/drivers during construction phase of the project have been kept under the scope of EPC contractor. However, NTPC will ensure effective compliance of the said stipulations.
(v)	Noise levels emanating from turbines shall be so controlled such that the noise in the	Design specification for the

S.No.	EC Conditions	Status as on 30.09.2021
	work zone shall be limited to 85 dB(A) from source. For people working in the high noise area, requisite personal protective equipment like earplugs/ear muffs etc. shall be provided. Workers engaged in noisy areas such as turbine area, air compressors etc shall be periodically examined to maintain audiometric record and for treatment for any hearing loss including shifting to non-noisy/less noisy areas.	equipments has been made to comply with the stipulation. Personal protective equipment has been arranged through contractors during construction phase. Periodic examination of workers during operation phase shall be done as stipulated. The workers of generator hall and other high noise area will be provided with appropriate ear protection devices.
(vi)	Regular monitoring of ambient air ground level concentration of S02, NOx, PM2.s & PM10 and Hg shall be carried out in the impact zone and records maintained. If at any stage these levels are found to exceed the prescribed limits, necessary control measures shall be provided immediately. The location of the monitoring stations and frequency of monitoring shall be decided in consultation with SPCB. Periodic reports shall be submitted to the Regional Office of this Ministry. The data shall also be put on the website of the company.	In existing units, Regular Monitoring of Ambient air quality is being carried out through Continuous Ambient Air Quality Monitoring System and internal as well as through third party monitoring are being done and reports are being submitted to SPCB. For upcoming units also similar scheme will be followed.
(vii)	Utilization of 100% Fly Ash generated shall be made from 4th year of operation. Status of implementation shall be reported to the Regional Office of the Ministry from time to time	Ash Utilization shall be implemented in compliance to fly ash gazette notification by MOEF&CC dt 14.09.1999 and its subsequent amendments and status of ash utilization plan implementation shall be intimated to the RO of Ministry, of MoEF&CC at Bhubaneswar after operation of project.
(viii)	Provision shall be made for the housing of construction labour (as applicable) within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care,	A labour colony with necessary infrastructure facilities such as housing, sanitation, mobile toilet, fuel, medical facilities, safety, drinking water supply, etc. will be provided for

S.No.	EC Conditions	Status as on 30.09.2021
	creche etc. The housing may be in the form of temporary structures to be removed after the completion of the project	construction labour through EPC contractor. NTPC will ensure effective compliance of the said stipulation by contractors.
(ix)	The project proponent shall advertise in at least two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned within seven days from the date of this clearance letter, informing that the project has been accorded environmental clearance and copies of clearance letter are available with the Delhi Pollution Control Committee and may also be seen at the Website of MoEF&CC at http://envfor.nic.in.	The information of Environment Clearance was widely circulated in the region in two newspapers, i.e. in English Newspaper -The New Indian Express, and in vernacular language newspaper, i.e. in Sambad, on 19.09.2018.
(x)	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, ZilaParisad I Municipal Corporation, urban local Body and the Local NGO, if any, from whom suggestions/representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent	Copy of Clearance letter has been submitted to Panchayat, ZilaParishad and NGO. The Environmental Clearance was also uploaded in NTPC website.
(xi)	The proponent shall upload the status of compliance of the stipulated environmental clearance conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MOEF, the respective Zonal Office of CPCB and the SPCB. The criteria pollutant levels namely; SPM, RSPM (PM2.s & PM10) , S02, NOx (ambient levels as well as stack emissions) shall be displayed at a convenient location near the main gate of the company in the public domain	The HYC status of the stipulated Environmental Clearance conditions has been uploaded on the NTPC website of the company. The display of ambient air quality in terms of PM10, PM2.5, SO2 and NOx already displayed near main gate of company and in the public domain and same shall be continued during theoperational phase of the project.
(xii)	The environment statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the	The environment statement for each financial year ending 31st March in Form - V will be

S.No.	EC Conditions	Status as on 30.09.2021
	project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of (environmental clearance conditions and shall also be sent to the respective Regional Offices of the Ministry by e-mail	submitted once the plant becomes operational by NTPC to the Odisha State Pollution Control Board and will be upload on NTPC website.
(xiii)	The project proponent shall submit six monthly reports on the status of the implementation of the stipulated environmental safeguards to MoEF&CC, its Regional Office, Central Pollution Control Board and State Pollution Control Board. The project proponent shall upload the status of compliance of the environmental clearance conditions on their website and update the same periodically and simultaneously send the same by e-mail to the Regional Office, MoEF&CC.	Six monthly EC compliance report for the period April 2021 to September 2021 is submitted herewith.
(xiv)	The progress of the project shall be submitted to CEA on six monthly basis.	Shall be complied.
(xv)	Regional Office of the MoEF&CC will monitor the implementation of the stipulated conditions. A complete set of documents including Environmental Impact Assessment Report and Environment Management Plan along with the additional information submitted from time to time shall be forwarded to the Regional Office for their use during monitoring. Project proponent will up-load the compliance status in their website and up-date the same from time to time at least six monthly basis. Criteria pollutants levels including NOx (from stack & ambient air) shall be displayed at the main gate of the power plant.	Shall be complied.
(xvi)	Separate funds shall be allocated for implementation of environmental protection measures along with item-wise break-up. These cost shall be included as part of the project cost. The funds earmarked , for the environment protection measures shall not be diverted for other purposes and	Separate funds for Environment Protection measures already given in Feasibility Report. Financial Provision stipulated towards Env. Protection

S.No.	EC Conditions	Status as on 30.09.2021
	year-wise expenditure should be reported to the Ministry	measure will not be diverted for any other purpose. Construction of project has not started yet.
(xvi i)	The project authorities shall inform the Regional Office as well as the Ministry regarding the date of financial closure and fmal approval of the project by the concerned authorities and the dates of start of land development work and commissioning of plant	Will be complied.
(xvi ii)	Full cooperation shall be extended to the Scientists/Officers from the Ministry j Regional Office of the Ministry I CPCB/ SPCB who would be monitoring the compliance of environmental status	Full cooperation shall be extended to the Scientists / officers from the Ministry / Regional Office of the Ministry / CPCB / SPCB during monitoring of the project.
C	An as built or as completed report on EMP to be submitted stating the scope/extent of work envisaged in the EIA along with estimated cost vis-à-vis the actual completed works and cost incurred. A certificate/completion certificate accordingly, shall have to be submitted before commissioning of the TPP.	Shall be complied before commissioning of plant.
33.	The ministry reserves the right to revoke the clearance if conditions stipulated are not implemented to the satisfaction. The Ministry may also impose additional environmental conditions or modify the existing ones, if necessary.	Noted.
34.	The environmental clearance accorded shall be valid for a period of 7 years from the date of issue of this letter to start operations by the power plant.	Noted.
35.	Concealing factual data or submission of false / fabricated data and failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and	Noted.

S.No.	EC Conditions	Status as on 30.09.2021
	attract action under the provisions of Environmental (Protection) Act, 1986.	
36.	In case of any deviation or alteration in the project proposed including coal transportation system from those submitted to this Ministry for clearance, a fresh reference should be made to the Ministry to assess the adequacy of the conditions (s) imposed and to add additional environmental protection measures required, if any.	Noted.
37.	The above stipulations would be enforced among others under the water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environmental (Protection) Act, 1986 and rules there under, Hazardous Wastes (Management, Handling & Transboundary Movement) Rules, 2008 and its amendments, the Public. Liability Insurance Act, 1991 and its amendments.	Noted.
38.	Any appeal against this environmental clearance shall lie with the National Green Tribunal, if preferred, within 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	Noted.

Fly Ash Disposal into Quarry No. 4 & 7 of Jagannath Mine, MCL from Talcher Thermal Power Station, NTPC

cmpdi
A Mini Ratna Company

Central Mine Planning & Design Institute Limited

Gondwana Place, Kanke Road, Ranchi – 834 031

Job No. 091019045

Contents

List of tables

List of figures

List of plates

Annexed Plates:

Plate I: Location of Jagannath Mines

Plate II: Quarry layout of mine pit

Plate III: Contour plans of the study area

Plate IV: Spot Level Plan

Plate V: Drainage Map of Jagannath OCP in 5km buffer zone radius

Plate VI: Water sampling and piezometer location plan

Plate VII: Land Use/Cover Mapping of Core and Buffer Zones

CHAPTER-I
INTRODUCTION

1.0 Background

NTPC – Talcher Thermal Power Station (TTPS) supplies power to Odisha state and is located in Talcher town, Angul District of Odisha and has a net commissioned capacity of 460 MW (Stage I – 4x60 MW and Stage II – 2x110 MW). The source of coal is from Jagannath mines of Mahanadi Coalfields Limited (MCL).

Figure 1.1: NTPC – TTPS Plant Site

The coal requirement for 460 MW plant capacity is estimated at 3.5 MTPA and the corresponding fly ash generation is estimated at 1.1 MTPA. Currently, NTPC – TTPS has an in-house ash brick plant and the produced ash bricks are utilized for construction activities. However, majority of the fly ash generated (approximately 97%) is being disposed through backfilling in mine voids.

NTPC – TTPS holds EC issued by MoEF&CC vide letter no.: *J-11015/276/2011-IA.II (M) dated 19th Apr, 2017* for disposal of fly ash into abandoned mine voids of South Balanda OCP (Quarry No. 2, 3A & 3B), MCL. This EC is valid for 5 years from date of issue. It is also understood from the EC, that the balance available void in South Balanda Mines is estimated at 3.85 million cubic meters, which will be able to cater to the discharge of fly ash from TTPS till 2021.

However, according to NTPC, the 460 MW TTPS project is estimated to continue operations till 2022/2023. Considering the same, as well as the nearing exhaustion of South Balanda mine voids, NTPC – TTPS now intends to utilize quarry no. 4 & 7 of

Jagannath OCP, MCL for disposal of fly ash – these quarries are located at a distance of about 14 km from TTPS project site.

For the same, an allocation order has been issued by MCL dated 14.11.2009. Quarry No. 4 has been leased out by MCL to two parties: NTPC – TTPS (6.43 million cu.m) as well as Bhushan Steel (17.00 million cu.m). Whereas, Quarry No. 7 (3.96 million cu.m) has been leased out solely to NTPC – TTPS. The copy of the allocation order is included herewith as Annexure – I. The location map (Google Earth) showing the Jagannath Mine voids (Quarry #4 & #7) as well as NTPC – TTPS is shown below.

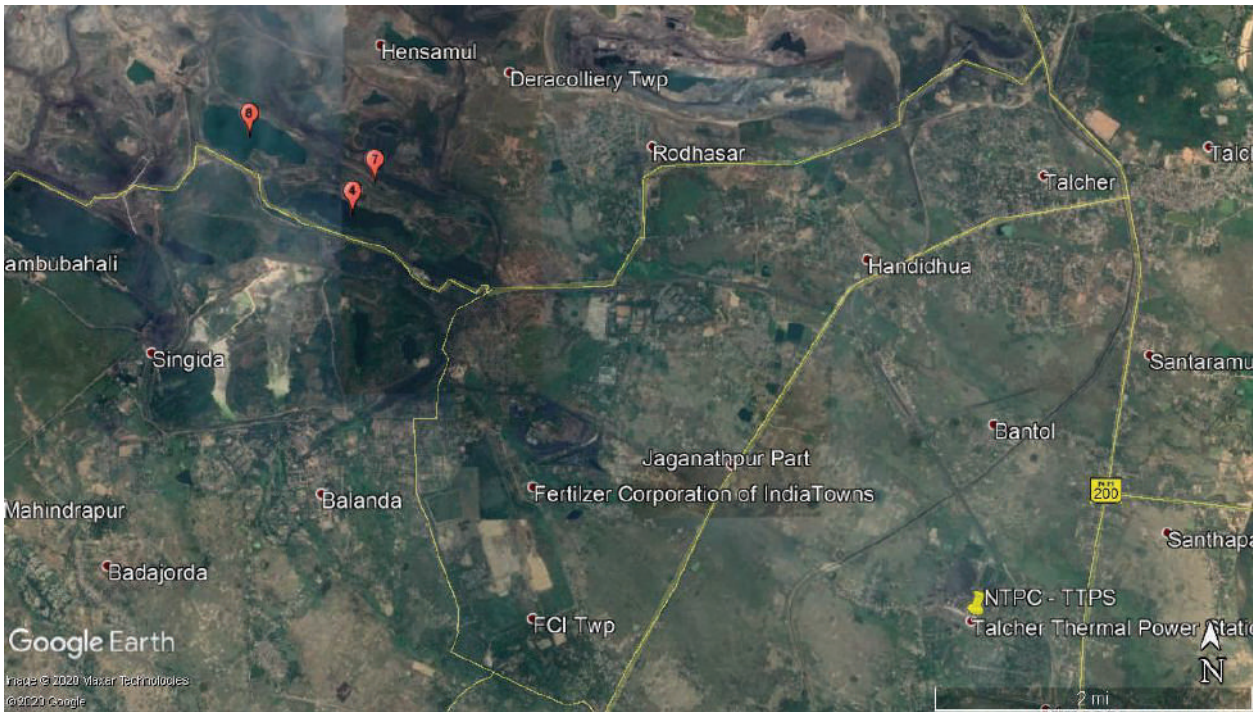


Figure 1.2: Google Earth Location of NTPC – TTPS and Quarry #4 & #7 of Jagannath Mine, MCL

NTPC – TTPS had approached MoEF&CC for amendment in the earlier EC dated 19th Apr, 2017 issued to them for inclusion of provision of disposal of fly ash into Quarry No. 4 & 7 of Jagannath Mines, MCL. In line with the same, MoEF&CC has considered the proposal in its 23rd EAC Meeting held in Nov'18 and based on the EAC recommendations, Terms of Reference was issued vide letter no.: J-11015/276/2011-IA.II(M) dated 15.02.2019. As a part of the ToR conditions, leaching study was required to be carried out w.r.t dumping of fly ash.

Thereafter, CPCB had issued "Guidelines for disposal / utilization of fly ash for reclamation of low lying areas and in stowing of abandoned mines / quarries" in March, 2019.

Further, vide O.M. dated 28th Aug, 2019, the conditions in prevailing ECs of Thermal Power Plants and Coal Mines relating to prohibition on unrestricted use of fly ash in abandoned mines / low lying areas / soil conditioner in agriculture were modified to allow for fly ash disposal in line with the conditions stipulated in the said O.M.

In line with the same, the proposal for amendment in EC dated 19th Apr, 2017 was closed by MoEF&CC with the following remarks:

Quote

The fly ash disposal in mines may be commenced by following the guidelines specified vide O.M. dated 28th Aug, 2019. However, the various studies already commissioned as per ToR shall be completed and the findings are to be submitted to the Ministry and its Regional Office for monitoring the activities. Based on the findings of the study reports, the Ministry reserves the right to specify additional conditions, if any which have bearing on disposal of flyash in the interest of protection of environment.

Unquote

In line with the same, the job for preparation of study report for fly ash disposal into quarry no. 4 & 7 of Jagannath Mine of MCL was awarded to CMPDI by NTPC - TTPS. This report on **Mine Water Characterization & Leachate Analysis** has been prepared as a part of this job.

As a part of preparation of this report, site visits were done at NTPC – TTPS plant and Quarry No. 4 & 7 of Jagannath Mines, MCL. Fly ash samples were collected by officials of NTPC – TTPS and supplied to CMPDI for the study. Mine water samples were collected from Quarry No. 4 of Jagannath Mines, MCL by CMPDI team. Sample preparation and analysis were carried out at the Environment Lab of CMPDI.

CHAPTER-II
LEACHABILITY STUDY

2.0 Mine Water Characterization & TCLP

The mine water characterization & TCLP exercise had been undertaken for the fly ash sample obtained from NTPC - TTPS, Talcher, along with samples of mine water collected from Jagannath Mines, MCL.

2.1 Sampling of Mine Water

Exhausted mine void nos. 4 and 7 of Jagannath mine are located in the Jagannath geological block of Mahanadi Coalfields. Jagannath Block lies between latitude 20° 56' 00" & 20° 57' 31" N and longitudes 85°08'39" & 85°10'02" E.

Quarry No. 4 has been leased out by MCL to two parties: NTPC – TTPS (6.43 million cu.m) as well as Bhushan Steel (17.00 million cu.m). Whereas Quarry No. 7 (3.96 million cu.m) is leased out solely to NTPC – TTPS. **Quarry No. 4 is partly filled with water, however Quarry No. 7 is mostly dry. The location of both quarries has been shown on Google Earth as Image P3.** Quarry #4 was previously being used for fly ash dumping by M/s Bhushan Steel in line with the lease approved by MCL. At the time of site visit, it was observed that fly ash dumping was not being done. Since Quarry #7 was dry, mine water samples were collected from Quarry No. 4 of Jagannath mines (20°56'47.88"N, 85° 9'4.26"E).

The location map (Google Earth image) of Quarry #4 & #7 are shown under Figure 2.1. The photographs of the quarries are shown hereunder (Figure 2.2 – Figure 2.7).

Figure 2.1: Google Earth Location of Quarry #4 & #7 of Jagannath Mine, MCL

Figure 2.2 – Photograph 1 of Quarry #4, Jagannath Mines, MCL

Figure 2.3 – Photograph 2 of Quarry #4, Jagannath Mines, MCL

Figure 2.4 – Photograph 1 of Ash Dumping point previously used by M/s Bhushan Steel at Quarry #4, Jagannath Mines, MCL

Figure 2.5 – Photograph 2 of Ash Dumping point previously used by M/s Bhushan Steel at Quarry #4, Jagannath Mines, MCL

Figure 2.6 – Photograph 1 of Quarry #7, Jagannath Mines, MCL

Figure 2.7 – Photograph 2 of Quarry #7, Jagannath Mines, MCL

2.2 Fly Ash Sampling

The fly ash samples collected from various stages of the ESP fields and bottom ash were mixed and a consolidated sample (quantity approx. 50 kg) was supplied by NTPC – Talcher Thermal Power Station (TTPS).

2.3 Reduction of Gross Sample

The collected fly ash sample was subjected to coning and quartering. The entire quantity of gross sample obtained was mixed well and reduced in stages by coning and quartering till a quantity of approx. 5 kg was obtained. This was then used as the laboratory sample.

2.3.1 Methodology: Coning & Quartering

Fly ash was heaped into the shape of a cone by pouring one scoop full of the material after another at the apex of the cone till the entire sample was coned. The material was allowed to slide down the sides of the cone only under the influence of gravity. The cone was flattened evenly so that it formed a low circular pile. The pile was cut into four quarters along two diameters, which intersected at right angles. One pair of opposite quarters was retained and the other quarters rejected. This was repeated till the size of the retained sample was reduced to approximately 5 kg.

2.4 Leachate Preparation from Fly Ash Sample

The Toxicity Characteristic Leaching Procedure (TCLP) is generally useful for classifying waste material for disposal options. TCLP is a soil / fly ash / pond ash sample extraction method for chemical analysis employed as an analytical method to simulate leaching through a landfill. This procedure utilizes prescribed standard extraction fluids.

However, in case of fly ash disposal into mine voids, the Mine Water Leaching Procedure (MWLP) is a beneficial tool for evaluation of results. This Mine Water Leaching Procedure (MWLP) differs from TCLP in two ways[1].

Firstly, TCLP uses standard synthetic extraction fluids, titrated to various pH ranges with acetic acid, whereas MWLP uses water from the intended application site (i.e. mine water from the abandoned voids). MWLP is expected to provide a more accurate simulation of field conditions than TCLP and accounts for chemical interactions between ions released from the Coal Combustion Byproducts (CCB) and those in the mine water. While MWLP is meant to simulate the likely chemical products resulting from exposure of a given CCB

[1]*Report on Fly Ash Characterization of Talcher Super Thermal Power Station, Kaniha by CMPDI (July, 2014)*

to a particular mine water, in its current configuration, it does not simulate reducing conditions. Additionally, MWLP simulates many years of weathering in a short period.

In this study, samples have been prepared using the standard extraction fluids prescribed in TCLP as well as mine water sample collected from the voids of Quarry # 4, Jagannath Mines, MCL.

Quarry # 7, Jagannath Mine, MCL did not have any water sump, hence the mine water-fly ash interaction studies (TCLP) was carried out for Quarry # 4, Jagannath Mines, MCL. Representative of TTPS, NTPC was accordingly informed of the same.

2.4.1 Methodology

Extraction Fluids in TCLP:

a) Extraction Fluid #1: Add 5.7 mL glacial CH3CH2OOH to 500 mL of reagent water, add 64.3 mL of 1N NaOH, and dilute to a volume of 1 liter. When correctly prepared, the pH of this fluid is 4.93 $\pm$ 0.05.
b) Extraction Fluid #2: Dilute 5.7 mL glacial CH3CH2OOH with reagent water (See Section 5.2) to a volume of 1 liter. When correctly prepared, the pH of this fluid is 2.88 $\pm$ 0.05.

Choice of Extraction Fluid:

About 5 grams of sample (fly ash) is taken in a 500 mL beaker or Erlenmeyer Flask. To this, 96.5 mL of reagent water is added, covered with a watch glass and stirred vigorously for 5 mins. The pH of the solution is then recorded.

- If pH < 5.0, then Extraction Fluid #1 is used.
- If the pH > 5.0, add 3.5 mL 1N HCl, slurry briefly, cover with a watch glass, heat to 50°C, and hold at 50°C for 10 minutes. Let the solution cool to room temperature and record the pH. If the pH < 5.0, use extraction fluid #1. If the pH is > 5.0, use Extraction Fluid #2.

Apart from the TCLP extracts, the leaching procedure has also been carried out with the water samples collected from the quarry as well.

Based on the literature reviewed during the course of this study, it was understood that the pH of fly ash may be highly acidic or highly basic when initially mixed with water. However, with passage of time, the pH range may narrow considering the geochemical buffering reactions[2]. Hence, instead of choosing single Extraction Fluid, the TCLP was carried out using both Extraction Fluids. A Millipore Rotary Agitator Y 1320 RAHW was

[2] *Roy, W.R., Berger, P.M., 2011, Geochemical Controls of Coal Fly Ash Leachate pH. Coal Combustion and Gasification Products 3, 63-66, doi: 10.4177/CCGP-D-11-00013.1*

used for preparation of leachates. The leachate preparation using mine water is referred to as Mine Water Leaching Procedure (MWLP) intending to represent the conditions when the ash is placed in the abandoned quarry.

Each 100 gm of Fly Ash Sample + 1000 mL Water Sample (Extraction Fluids and Mine Water from each pit) was agitated end on end rotation for 18 hrs at 30 rpm in TCLP equipment. (Millipore Rotary Agitator Y 1320 RAHW). Samples were filtered with 1.0 µm glass fiber filter. The samples were then analyzed through ICP (Inductively Coupled Plasma Spectrophotometer), iCAP 6300 Duo, Thermo Fisher Make.

The pH of fly ash is as given in Table 2.1:

Table 2.1: pH of fly ash

Sl.No	Sample Name	pH Value
1.	Fly Ash TTPS	5.47

The details of samples prepared for the TCLP and MWLP are tabulated below:

Table 2.2: Details of leachate samples prepared:

Sr. No.:	Sample ID	Leaching Sample Description	pH of Extraction Fluid / Mine Water	Remarks, if any
1.	EF-1	Fly Ash in Extraction Fluid 1	4.93 ± 0.05	As per TCLP
2.	EF-2	Fly Ash in Extraction Fluid 2	2.88 ± 0.05	As per TCLP
3.	MP-1	Fly Ash in Mine Water from Jagannath Quarry #4	6.57	Using MWLP

2.4.2 Results

The results of the leachate analysis are given in the Table 2.3 hereunder.

Table 2.3: TCLP, Analysis Results – TTPS, NTPC

Parameters	Analysis Result				Drinking Water Standards IS 10500:2012 (Rev. 2015)		MoEF&CC Sch VI Class 'a' General Standards for Inland Surface Discharge
	Mine Water (Quarry 4)	Leachate (Buffer-1) (Fly Ash + Buffer-1)	Leachate (Buffer-2) (Fly Ash + Buffer-2)	Leachate Quarry 4 (Fly Ash + Quarry 4)	**Acceptable Limit**	**Permissible Limit**	
Arsenic (As)	<0.005	0.015	0.024	<0.005	0.01	No relaxation	0.2
Barium (Ba)	0.038	0.182	0.330	0.052	0.7	No relaxation	*Not specified*
Boron (B)	0.829	0.098	0.153	0.911	0.5	1.0	*Not specified*
Cadmium (Cd)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.003	No relaxation	2
Chromium (Cr)	0.848	1.021	1.046	0.935	0.05	No relaxation	2
Cobalt (Co)	<0.007	<0.007	<0.007	<0.007	*Not specified*	*Not specified*	*Not specified*
Copper (Cu)	<0.006	0.026	0.069	0.036	0.05	1.5	3
Iron (Fe)	0.017	0.008	0.463	<0.007	1	No relaxation	3
Lead (Pb)	0.034	0.007	0.031	<0.005	0.01	No relaxation	0.1
Manganese (Mn)	0.005	0.132	0.213	0.062	0.1	0.3	2
Mercury (Hg)	<0.0002	<0.0002	<0.0002	<0.0002	0.001	No relaxation	0.01
Nickel (Ni)	<0.015	<0.015	<0.015	<0.015	0.02	No relaxation	3
Potassium (K)	7.461	4.328	0.791	5.012	*Not specified*	*Not specified*	*Not specified*
Sodium (Na)	46.000	-	38.470	34.580	*Not specified*	*Not specified*	*Not specified*
Selenium (Se)	<0.0040	0.217	0.282	0.128	0.01	No relaxation	0.05
Vanadium (V)	<0.0080	0.009	0.066	0.012	*Not specified*	*Not specified*	0.2
Zinc (Zn)	0.003	0.210	0.194	0.133	5	15	5

Note: All values are in mg/L | N.S.: Not Specified

2.4.3 Conclusion

Based on the results from the leaching procedures, we can summarize the following conclusions:

i. The concentration of Chromium and Lead in mine water of quarry no.4 was more than the limits prescribed by MoEF&CC – Schedule VI, Class 'a' standards (for Inland Surface Waters). Rest of the parameters were within the prescribed limits.

ii. When compared with the prescribed limits of MoEF&CC – Schedule VI, Class 'a' standards (for Inland Surface Waters) the concentration of
   - Selenium was found to be more than the prescribed standard of 0.05 mg/l in all three samples i.e. both the extraction fluids, Buffer-1, Buffer-2 (based on TCLP) and leachate sample with mine water of quarry 4(MWLP) .
   - All other metals in both the extraction fluids, Buffer-1, Buffer-2 (based on TCLP) and leachate sample with mine water of quarry 4 (MWLP) were found to be within the prescribed limits.

iii. When compared to Drinking water standards IS:10500:2012 (revision 2015), the following metals were found to be more than the prescribed standards –
   - Arsenic in both the extraction fluids, Buffer-1, Buffer-2 (based on TCLP),
   - Chromium in all three leachate samples, i.e. both the extraction fluids, Buffer-1, Buffer-2 (based on TCLP) and leachate sample with mine water of quarry 4(MWLP) .
   - Lead in in Extraction Fluid, Buffer-2 (based on TCLP)
   - Selenium in all three leachate samples, i.e. both the extraction fluids, Buffer-1, Buffer-2 (based on TCLP) and leachate sample with mine water of quarry 4(MWLP) .

CHAPTER-III
LAND USE PLAN

3.0 General

Land is one of the most important natural resource on which all human activities are based. Therefore, knowledge on different type of lands as well as its spatial distribution in the form of map and statistical data is vital for its geospatial planning and management for optimal use of the land resources. In mining industry, the need for information on land use/ cover pattern has gained importance due to the all-round concern on environmental impact of mining. The information on land use/ cover inventory that includes type, spatial distribution, aerial extent, location, rate and pattern of change of each category is of paramount importance for assessing the impact of coal mining on land use/ cover.

Remote sensing data with its various spectral and spatial resolutions, offers comprehensive and accurate information for mapping and monitoring of land use/cover over a period of time. By analyzing the data of different cut-off dates, impact of coal mining on land use / cover is determined.

3.1 Data Analysis

IRS-1D-R2 (L4FX) Satellite data of the year 2020 was processed using ERDAS Imagine Image Processing s/w in order to interpret the various land use / cover classes present in the core and buffer zone of study area. The analysis was carried out for both the core zone covering an area of 5.54 Km^2 as well as for 10 kms. Buffer zone around the core zone, which covers an area of 460.60 Km^2.

The area of each class was calculated and analysed using ERDAS Imagine Digital Image Processing s/w. Analysis of land use / cover pattern in core and buffer zone was carried out and details of the analysis is shown in table below:

Table 3.1: Area Statistics for Core and Buffer Zone (within 10 kms radius)

Classes		Core Zone		Buffer Zone	
Level-I	**Level-II**	**Area (Sq. km.)**	**% Area**	**Area (Sq. km.)**	**% Area**
Forest Land	Dense Forest	0.00	0.00	45.87	9.96
	Open Forest	0.06	1.08	38.41	8.34
	Total Forest Land	**0.06**	**1.08**	**84.28**	**18.30**
	Scrubs	0.25	4.51	89.41	19.41
Plantation Area	Social Forestry	0.15	2.71	14.95	3.25
	Plantation on OB	0.00	0.00	1.29	0.28
	Plantation on backfill	1.84	33.21	6.02	1.31
	Total Plantation Area	**1.99**	**35.92**	**22.26**	**4.83**
	Total Vegetation	**2.30**	**41.52**	**195.95**	**42.54**
Agriculture Land	Crop land	0.07	1.26	49.81	10.81
	Fallow land	0.55	9.93	116.60	25.31
	Total agriculture land	**0.62**	**11.19**	**166.41**	**36.13**
Waste land	Waste land	0.48	8.66	34.12	7.41
	Sand body	0.00	0.00	5.52	1.20
	Fly ash pond	0.11	1.99	2.94	0.64
	Total waste land	**0.59**	**10.65**	**42.58**	**9.24**
Mining area	Coal quarry	0.30	5.42	6.01	1.30
	Advance quarry site	0.04	0.72	0.59	0.13
	Barren OB dump	0.00	0.00	1.84	0.40
	Back filled area	0.74	13.36	12.40	2.69
	Coal dump	0.09	1.62	1.40	0.30
	Water filled quarry	0.67	12.09	2.59	0.56
	Total mining area	**1.80**	**32.49**	**24.83**	**5.39**
Settlement	Urban settlement	0.00	0.00	7.32	1.59
	Rural settlement	0.04	0.72	7.87	1.71
	Industrial settlement	0.13	2.35	3.51	0.76
	Total settlement area	0.17	3.07	18.70	4.06
Water body	River/pond	0.06	1.08	12.13	2.63
	Total area	**5.54**	**100.00**	**460.60**	**100.00**

CHAPTER-IV
CONTOUR SURVEY

4.0 Contour Survey of the Area

The fly ash filling is proposed in quarry No. 4 and Quarry No. 7 of the Jagannath Mine. The location of Jagannath Mine is shown in Plate-I. The quarry layout of mine pit is shown in Plate-II. The contour survey of the adjoining area was carried out by CMPDI and the contour plan of the study area is shown in Plate-III. The spot level plan is shown in Plate-IV.

4.1 Location

Based on the contour survey of the area, it is evident that for quarry no. 4, the south eastern side of the quarry is at higher elevation (106-112 m). Therefore, it is proposed that pipeline for fly ash slurry from TTPS will have inlet on this side. The north-western side of the quarry is at relatively lower elevation (92-96 m) and therefore the collection, treatment and reuse facilities should be planned at this side. This is shown in the Plate-V attached.

Similarly, for quarry no. 7, the south-eastern side of the quarry is at higher elevation (110-112 m) and therefore the inlet of the pipeline is suggested at this part of the quarry. The north-western side of the quarry is relatively at lower level (108-110 m) and therefore collection, treatment and reuse facilities should be planned at this side. This is shown in the plate attached (Plate-V).

4.2 Drainage Pattern and Construction of Embankment

The drainage pattern of the area is shown in Plate-VI and Plate-VII. The drainage pattern shown that Brahmani River is the main drainage of the area with draining towards south-east. The drainage pattern of the area exhibits the drainage away from the quarry site. However, necessary precautions need to be taken to avoid ingress of water into mine voids to facilitate fly ash dumping.

There are three points observed around the mine pit that have lower elevation and likely to get affected because of fly ash dumping in the mine voids. The location of these sites are shown in the plate attached. *These areas need to be protected by construction of embankment.* This will also help in raising the level of fly ash dumping in the voids thus creating additional capacity of the mine void. The design of the embankment will depend upon the ultimate RL proposed for fly ash dumping in the mine voids.

CHAPTER-V
SCIENTIFIC & ENGINEERING SOLUTIONS

5.1 Hydro-geological Setting & Interaction with Aquifers

The area in and around Jagannath OCP is extensively used for coal mining, which has created large voids in the area. The geology of the area is disturbed due to mining activity. Both underground and opencast mines have created micro basin like mine voids invisibly and visibly in the landscape of the area. Creation of mine voids by mining disturbs the equilibrium condition of the aquifer system in the area, which usually results in groundwater seepage in the mine voids. The underground mine voids fill with groundwater strata seepage whereas open cast mines fill with groundwater strata seepage and direct precipitation in the mine pit. Thus in the study area, ground water occurs under both unconfined and confined conditions. The weathered mantle, recent alluvium and laterites act as unconfined aquifer or phreatic aquifer

Based on hydrogeological studies and geological exploration work carried out in the vicinity of the Jagannath OCP, the following conclusions are drawn:.

1. Talcher coalfield depicts a northwesterly plunging synclinal structure. The strike of strata in southern part of the coalfield is E-W with a dip of 3° to 8° towards north. As a result of this, the coal deposition is at deeper levels at northern part as compared to the southern part of the coal field.
2. The study area falls under the influence of Bangaru Jhor (in north) and Nandira Jhor (in south) pre-dominantly, which are the tributary of Brahmani river which control the overall drainage pattern of the coalfield.
3. There are a few localized ground water troughs and mounds and the watershed boundaries in general coincide with the ground water divides in the area.
4. Regional Aquifer Disposition in and around 5 Km radius of Jagannath OCP aquifers as identified in the ascending order from the data of sub surface geological and ground water exploration studies of the past is as follows:

Table 5.1: Details of aquifers found in Talcher coalfield

Name of the aquifer	Formations	Range of thicknes s in m.	Confining beds
Phreatic aquifer	Detrital mantle, river alluvium soils,	10 to 20	--
Upper Barakar aquifer	Barakar sandstones	5 to 40	Coal seam IX & shales.
Middle Barakar aquifer	Barakar sandstones	5 to 30	Coal seam VI & Shales.
Lower Barakar aquifer	Barakar sandstones	10 to 50	Coal seam III & Shales
Basal aquifer	Basal Barakar conglomerates and sandstones. Karharbari sandstones.	60 to 120	Coal seam II & Shales.
Karharbari aquifer	Karharbari sandstone	> 30	Coal seam I & Shales.

Source: Hydrology of Talcher Coalfield, Orissa, India, CMPDI, Ranchi, 1988

5. The stratified sedimentary deposit contains coal seams, shale and sandstone in multi layers. Coal seams and shale act as a confining bed. Ground water occurs in the porous colluvial material and weathered mantle as well as in the joints, fissures and fractures. These are at shallow depths in the partly weathered rocks and deep seated fresh rocks. Though shale, coal, mud stones etc. act as confining horizon but the very nature of these confining horizon permits considerable vertical flow. As these confining horizons have very poor hydraulic conductivity in horizontal directions, these horizons also act as barrier boundaries when they get juxtaposed with water bearing horizon because of geological disturbance. Formations are also found to be geologically disturbed by faulting, jointing and fracturing produces secondary porosity. This secondary porosity when it is saturated with ground water forms good aquifer.

6. On the basis of geological exploration data in and around 5 km radius of the Jagannath OCP, in the order of superposition, two formations namely Karharbari and Basal Barakar formations are encountered. Two aquifer formations are distinguished namely Karharbari aquifer and Basal Barakar aquifer. Karhar bari aquifer is the lower most aquifer considered in the present study. This aquifer outcrops south of active mining area i.e. south of Talcher, and Nandira Mines and in some areas near South Balanda. Basal aquifer represents the lowermost granular horizons of the area. This aquifer is bounded by Karharbari coal seam-I at the bottom and weathered sandstones and shale at the top. The Basal Barakar and Karharbari aquifers are

dislocated by normal faults which give rise to graben and horst structure. Thus, Structure plays an important role for formation of aquifer in the area.

7. Plate 5.1 shows a cross section of the Jagannath mine void area. Two types of aquifers which have been encountered around quarry no. 8 of Jagannath OCP are mainly phreatic (AQ1) and semi-confined aquifers (AQ2). The details of the aquifers are presented in Table 5.2:

Table 5.2: Details of aquifers present around quarry no. 8

Sl. No.	Aquifer No.	Type of Aquifer	Thickness of aquifer (m)	Average Hydraulic conductivity (m/day)	Lithology	Potentiality of Aquifer
1	AQ1	Phreatic Aquifer	06-11	2.83	Detrital mantle, river alluvium soils etc.	High
2	AQ2	Semi-confined	45-60	0.143	Sandstones and shales	Low

8. The permeability of the aquifers in the study area is influenced by the geological structural disturbance and compactness of the geological strata. Total Annual recharge estimated within 5 km radius buffer zone of Jagannath OCP is 50.35 Mm3.

9. Water level contour maps and flow directional map for pre-monsoon and post-monsoon season in and around Jagannath Mine Voids are presented in Plates 5.1(a) to (c) and Plates 5.2 (a) to (c) respectively. This was developed on the basis of depth of groundwater within 5 km radius in and around the Jagannath OCP was determined from measuring the groundwater levels in the dug well. The monitored dug wells are located in phreatic (unconfined) aquifer in which ground water flow is controlled by gravity.

10. The data shows that in pre-monsoon season maximum depth of water below ground level was 12.95 mbgl in village Ekdal and minimum depth of water below ground level at 2.10 mbgl at village Jagannathpur. Twenty three percent (23%) of dug wells had been observed with very shallow groundwater levels ranging between 0 to 4 mbgl, around sixty four percent (64%) of the dug wells had groundwater levels in the range of 4 to 8 m bgl and only thirteen percent (13%) of the dug wells had deeper groundwater levels between 8 to 13 m bgl. Whereas in post monsoon season, maximum depth of water below ground level was 5.98 m bgl in village Ekdal and minimum depth of water below ground level at 1.21 m bgl in village Deulbera. Seventy seven percent (77%) of dug wells had been observed with very shallow groundwater levels ranging

between 0 to 4 m bgl, and twenty three percent (23%) of the dug wells had groundwater levels between 4 to 8 m bgl.

11. It can be observed from the contours that a predominant groundwater divide is present in middle of the study area trending SW to NE. This divides the whole study area into two halves. In the northern half the ground water is flowing towards north direction and in southern part, the water is moving towards south east direction.

12. Piezometric head (in RL) ranges from 76 to 120 m amsl. The piezometric head contour map depicts a maximum piezometric head in the south eastern part of the study area whereas the minimum piezometric head is seen in north western part. The piezometric surface slopes from south east to North West towards Bangaru Jhor.

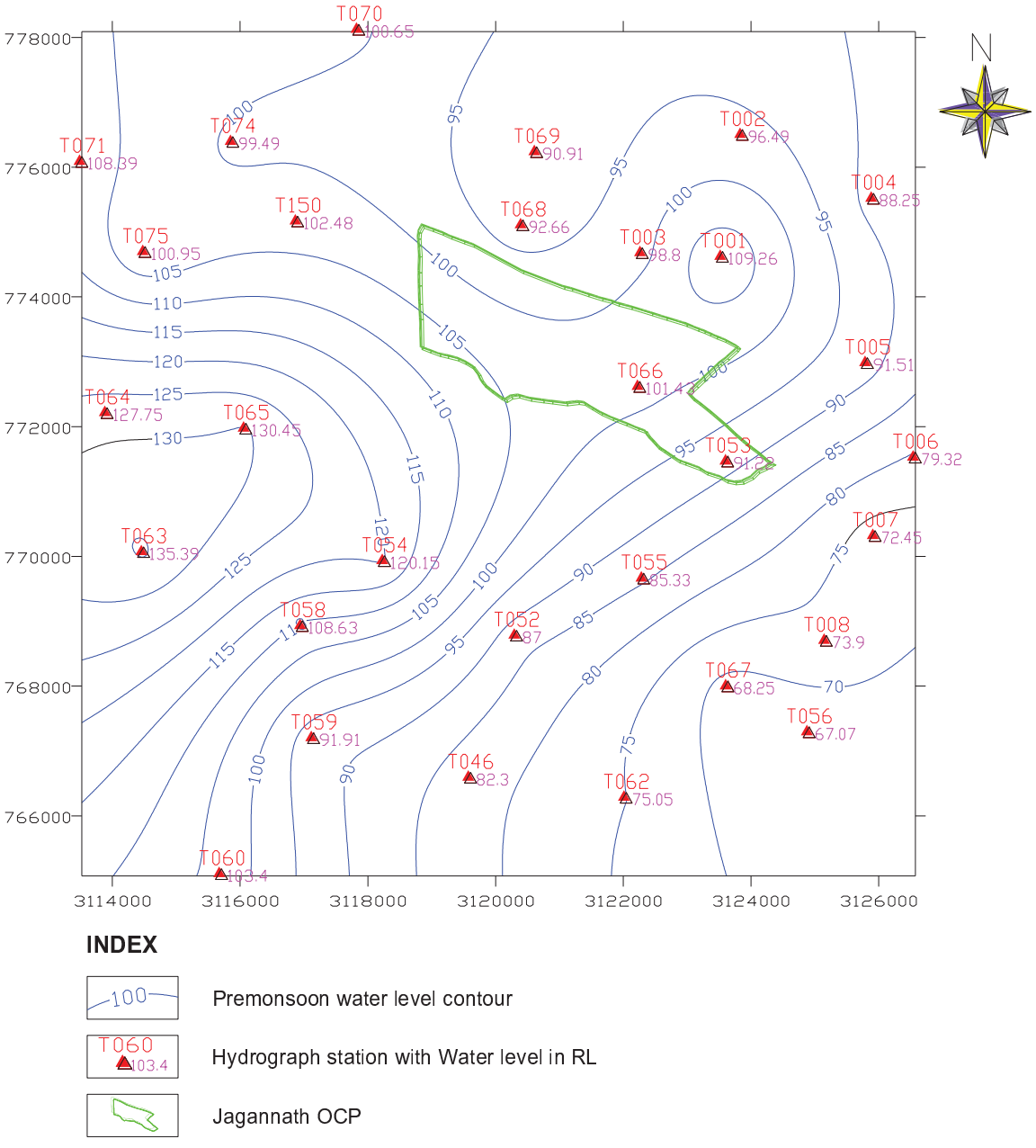


Plate-5.1 (a): Water Level Contour Map of Pre-monsoon Season in and around Jagannath OCP, Talcher Coalfield, Odisha

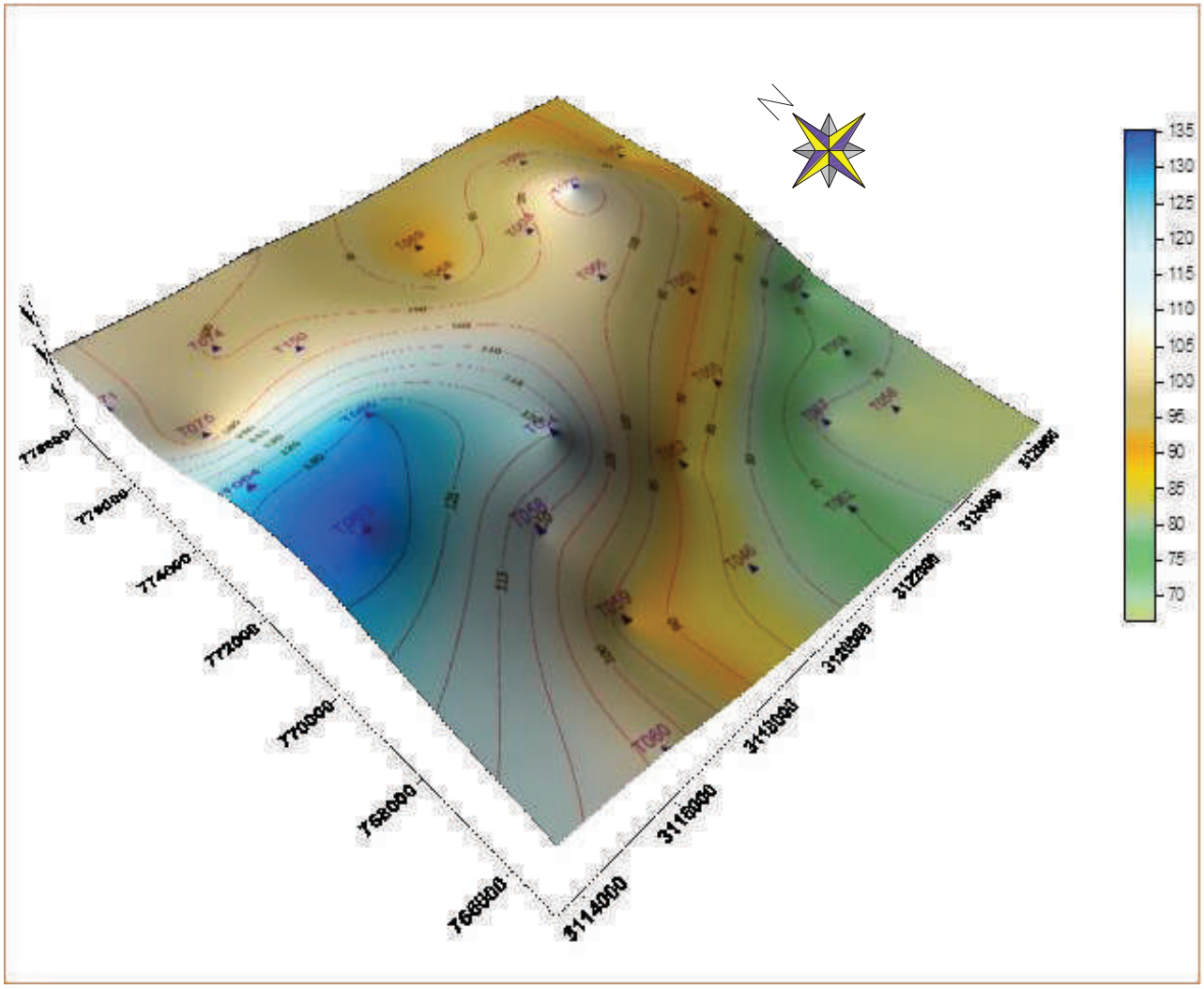


Plate-5.1 (b): Water Level Contour Map (3-D) of Pre-monsoon Season in and around Jagannath OCP, Talcher Coalfield, Odisha

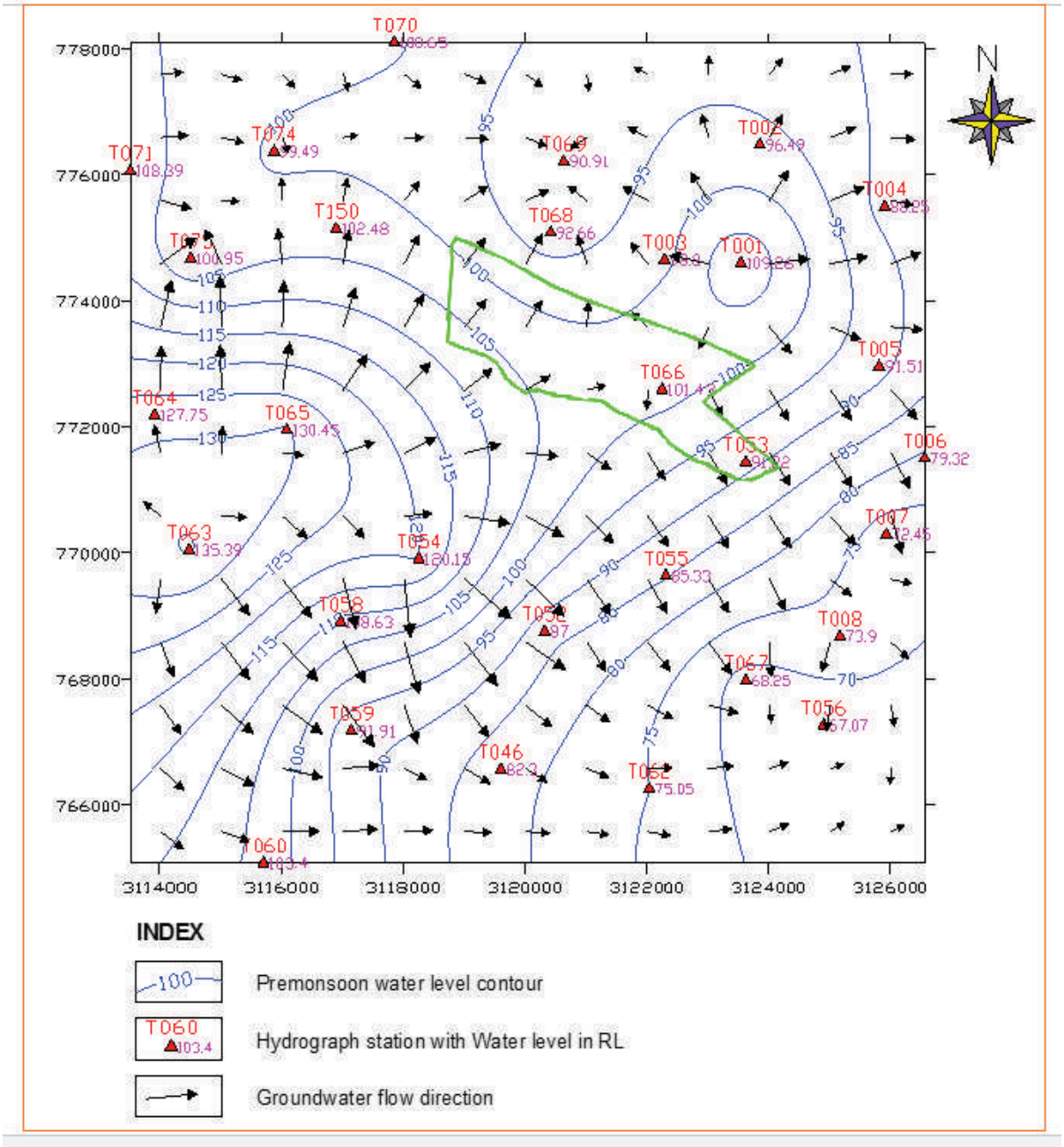


Plate-5.1(c): Ground Water Flow Patternfor Pre-monsoon Season in and around Jagannath OCP, Talcher Coalfield, Odisha

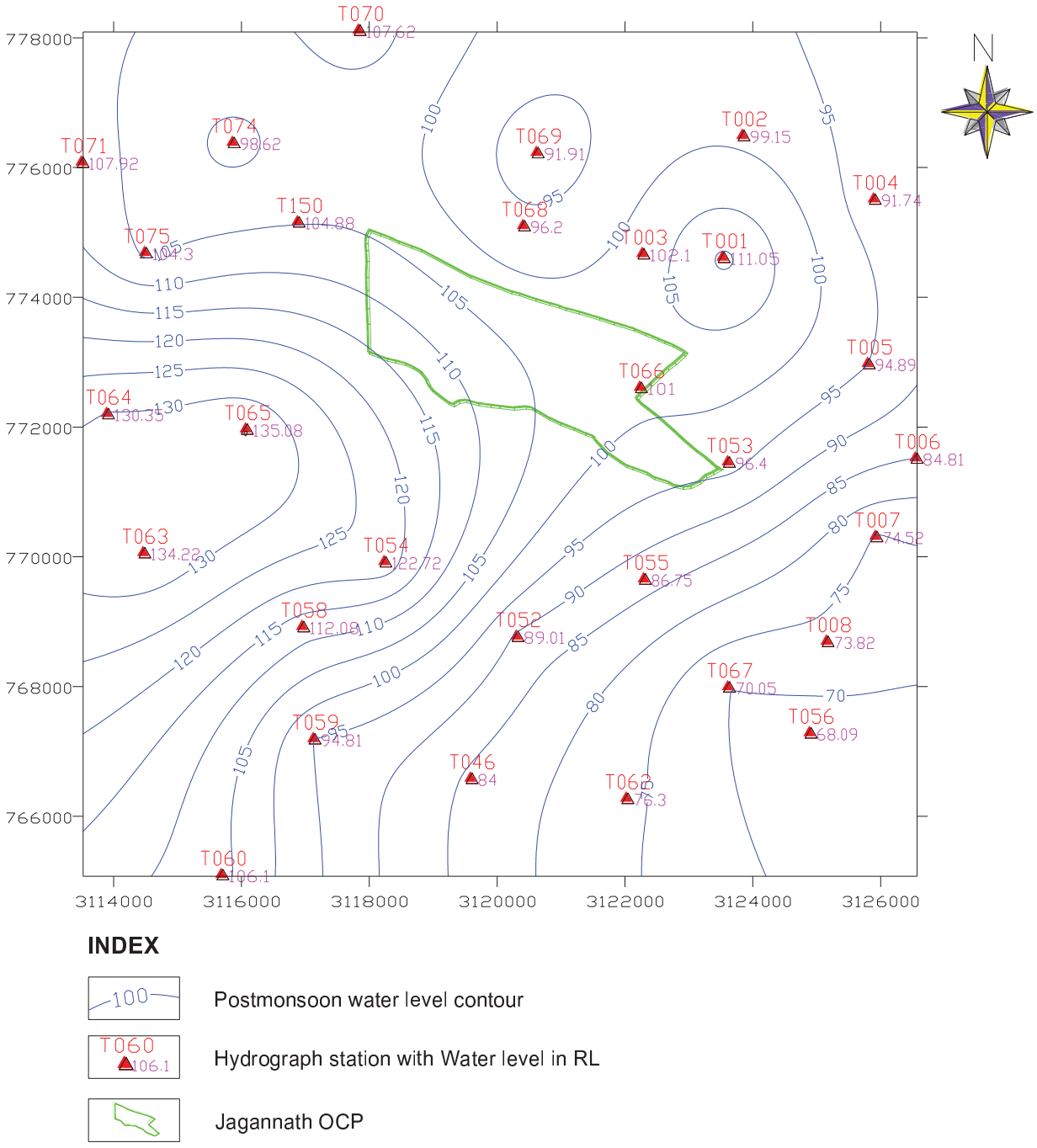


Plate-5.2 (a): Water Level Contour Map of Post-monsoon Season in and around Jagannath OCP, Talcher Coalfield, Odisha

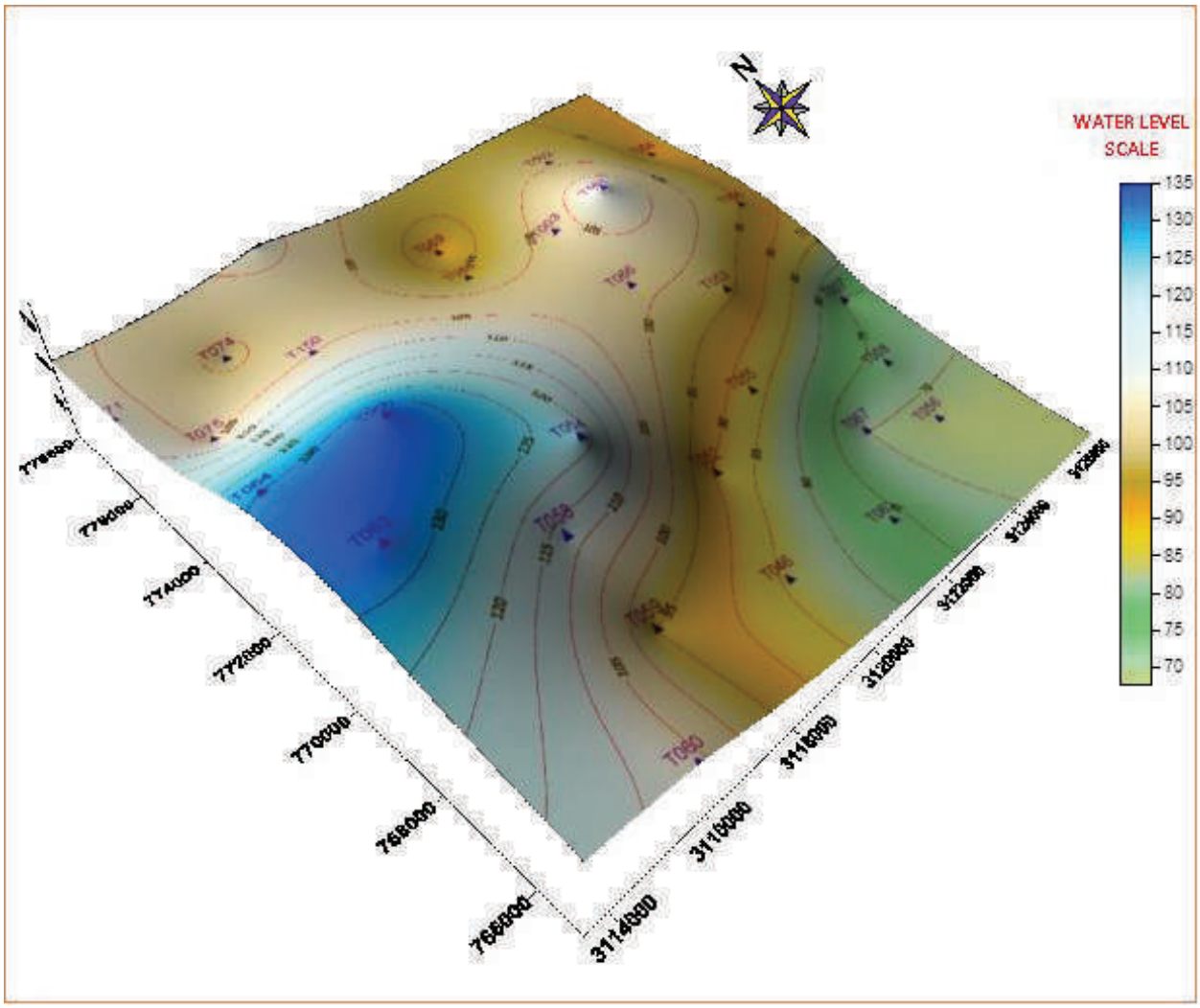


Plate-5.2(b): Water Level Contour Map (3-D) of Post-monsoon Season in and around Jagannath OCP, Talcher Coalfield, Odisha

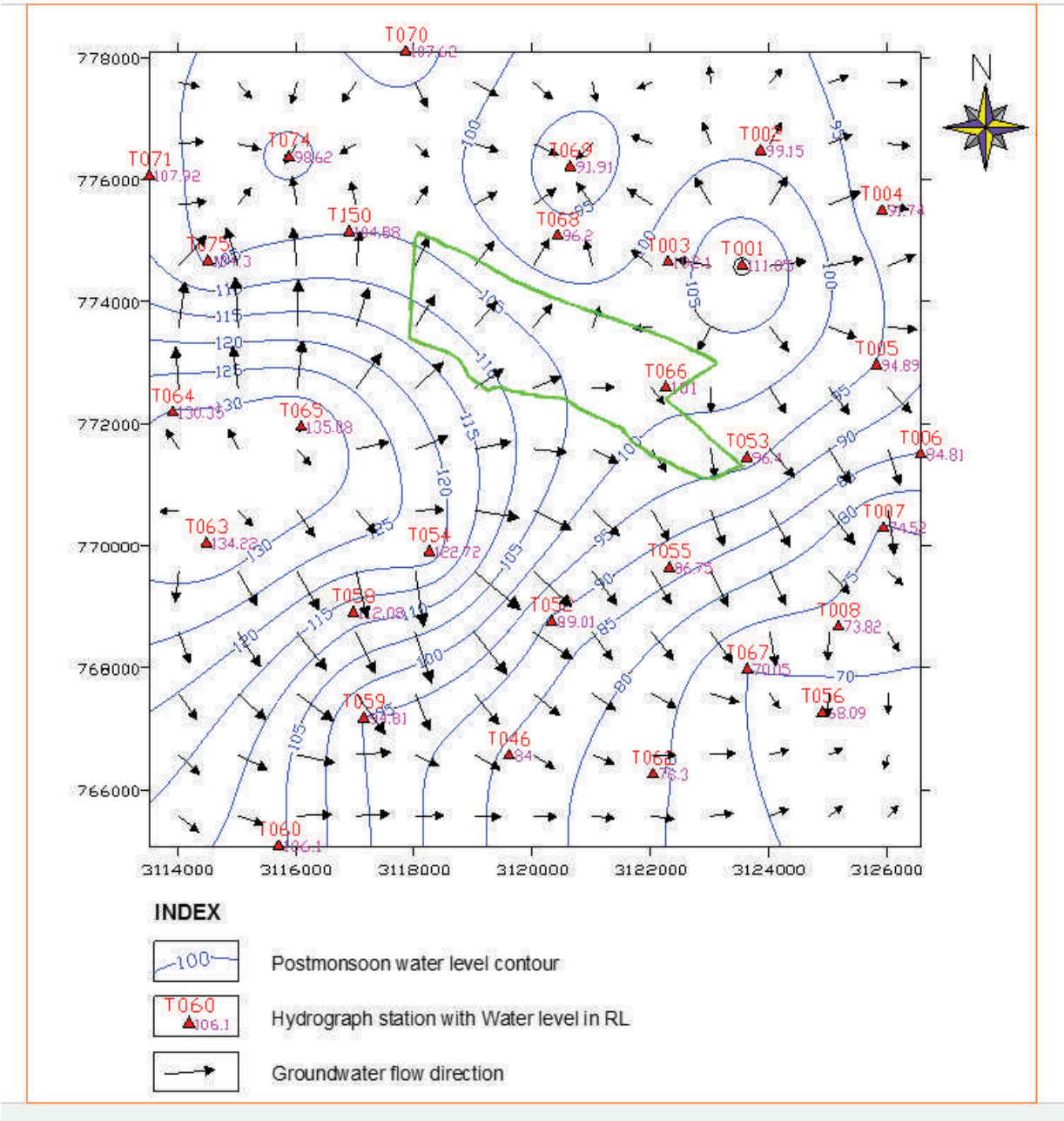


Plate-5.2 (c): Ground Water Flow Patternfor Post-monsoon Season in and around Jagannath OCP, Talcher Coalfield, Odisha

5.2 Alternate Modes of Transport and Disposal of Ash

5.2.1 Ash Transport Systems

This section analyses various modes of transport and disposal of ash and discusses their suitability with respect to Talcher TPP – Jagannath Mine Void combination. At present, the following methods are used in India for transportation of ash:

1. Transport of dry ash through pipeline using pneumatic conveying system – mostly used for transport of ash from ESP to Buffer Hoppers/ Silo, inside the plants/ adjacent cement plants.
2. Transport of dry ash through Dumpers/ Trucks - used by user agencies (cement, aggregate, brick manufacturers etc.)
3. Transport of dry ash through MGR System – recently evolved at few stations for long range transport of ash.
4. Transport of moist ash through Belt Conveyors – used at National Capital Thermal Power Project of NTPC Limited at Dadri, for dry ash disposal
5. Transport of wet ash (lean slurry or high concentration slurry) through pipeline – most widely used method for ash disposal system in India

Due to the presence of Calcium Oxide fly ash has cementing property, which vanishes after mixing with water. Therefore, whenever the transport of ash is intended for its use (like manufacture of cement, RMC, concrete, brick, tile etc.), dry mode of transport is preferred. However, it requires elaborate arrangements and it is costly. Therefore, whenever the ash has to be transported for disposal, wet methods are preferred, which are more convenient and economical. There are further constraints also in adopting the above mentioned systems, such as

1. ***HCSD System*** is not feasible for transport of ash beyond 11 km, as there is no proven HCSD System available. The distance of transportation in present case is 20 kms.
2. ***Transport by Trucks/ Dumpers*** is not feasible as around 170 trucks would be required to run during the day time (8 AM to 8 PM). Use of such large number of trucks and their movement through the villages will lead to issues related to traffic congestion, accidents and air pollution (due to exhausts as well as dust emission).
3. ***Pneumatic Pipe Conveyor:*** The longest distance of pipe conveyor provided in India is 6.8 kms. Hence, it is not considered.
4. ***MGR System:*** This would require laying of additional rail lines, which is a costly proposition considering the capacity of the mine void (17.82 million m3) and its life

(3-4 years). Moreover, the acquisition of land for railway line is higher than in case of slurry disposal.

5. ***Slurry Pumping through pipeline*** is widely used in India for distances up to 20 km. and more, it can be implemented with minimum modification of existing system (minimum cost and time for modification) and can be easily operated.

In view of the above, slurry disposal system through pipeline is proposed for transport of ash from Talcher TPS to Quarry No. 4&7 of Jagannath Mine Voids.

5.2.2 Ash Disposal Systems in India

In India mainly three types of ash disposal is adopted for ash from power plants:

1. Wet Disposal in lean slurry form into ash dyke/ mine voids
2. Wet Disposal in High Concentrated Slurry form into ash dykes
3. Dry Disposal in Ash Mound form

The details of all the above systems are described in the following sections.

5.2.2.1 Wet Disposal in Lean Slurry Form:

This system is widely used in India. The system consists of extraction of fly ash from electrostatic precipitator (ESP), conveying to fly ash silos, slurry mixing tanks and pumping slurry to disposal area using centrifugal pumps. A free flowing lean ash slurry is made with ash and water, which is pumped into storage areas.

Ash disposal lagoons are formed by constructing dykes (embankments) made of earth / ash or using natural depressions such as mine voids and the slurry is discharged into the lagoons from pipelines. Ash particles settle in the lagoons and clear water is decanted above the ash surface. Decanted water is taken out through water escape structures, which is recirculated to plant through an ash water recirculation system (AWRS) for further use in ash disposal system.

A photograph of a typical lean slurry system is shown in Plate-5.3.

Plate-5.3: Lean Slurry Disposal System

Fresh deposits of ash are in the form of marsh. However, over a period of time, specially when overlain by several layers, these deposits gets consolidated into high density layers with no free water. Lean Slurry Ash Disposal system has following advantages:

- Cost effective due to relatively simple system
- No special technology required, centrifugal pumps are used.
- Slurry can be disposed to long distances, if required, booster pups can be used.
- Ash water is recirculated after decantation.

However, at the same time, this system has following disadvantages too:

- Due to high velocity wear and tear of pipes is more
- The dykes are designed as dams and are always filled with slurry, with a risk of breach/ seepage. It needs continuous watch.

5.2.2.2 Wet Disposal in High Concentration Slurry Form:

This system is similar to the lean slurry system, except for the ration of ash and water (concentration of 60% to 75% of ash by weight). Due to high concentration of ash, it is pumped through high pressure piston diaphragm slurry pumps to disposal area and needs seamless steel pipes for conveying slurry. However, flexible pipes are used at disposal area.

High concentration slurry is homogeneous in nature which ensures that no water is released when slurry is discharged in the ash disposal area. Dense, compact deposit is formed with rapid drying. High concentration slurry attains relatively steep slopes at the time of disposal. A photograph of a typical high concentration system is shown in Plate-5.4.

Plate-5.4: High Concentration Slurry Flowing on Slopes which dries out by the time it travels 30-40 m from the source

High Concentration Slurry Disposal (HCSD) system has the following advantages and disadvantages.

Advantages of High Concentration Slurry Disposal (HCSD):

- HCSD reduces water and land requirement, it is ecofriendly, no leachate discharge
- Low water consumption with respect to lean slurry disposal and no release of free water at disposal
- As the slurry travels at slow speed, wear and tear of pipes is less
- High concentration slurry is easy to dig and can be used for various purposes at a later stage
- Low maintenance of ash dyke
- Danger of breaching of dyke is negligible.

Disadvantage of High Concentration Slurry Disposal (HCSD):

- Ash pipes often get chocked due to high concentration slurry
- Seamless steel pipes for conveying HC slurry are required.

- High concentration slurry disposal requires very high pressures and can be transported to a limited distance only.

5.2.2.3 Dry Ash Disposal System:

This system is entirely different from the previous two systems. In the dry ash disposal system, furnace bottom ash (FBA) and pulverized fly ash (PFA) are transported from Hydro bins and Silos respectively to ash mound site on fixed belt conveyors in enclosed gantries. FBA and PFA are conveyed separately. In the ash mound area ash is disposed off by various types of equipment like fixed, extendable, shiftable, slewable and mobile belt conveyors, a crawler mounted boom spreader, a crawler mounted bucket wheel reclaimer and a variety of wheeled and crawler mounted mobile equipment.

At present, it is being used at only one station – National Capital Thermal Power Station at Dadri.

This is first of its kind which uses conveyor belts to dispose off moistened ash in form of ash mound. For surface stabilization and dust suppression at the mound, a number of measures are applied depending upon the nature of surface (flat, finished slope or natural ash dump surface), such as surface compaction & land scaping, sprinkling of water and polymers, spreading of cut grass and vegetation by growing grass, shrubs & trees. As the mound construction proceeds & finished slopes are available, the same are covered with grass & plantation. It is proposed to cover the entire ash mound area by plantation.

Photographs of dry ash disposal system are shown in Plates-5.5 and 5.6.

Plate-5.5: Dry Ash Mound at NCTPS, Dadri (Working Front)

Plate-5.6: Dry Ash Mound at NCTPS, Dadri (After Stabilisation and Plantation)

Dry ash Disposal has several advantages over the above two systems:

- Less land Requirement
- Less water Requirement
- No risk of Ground Water Pollution
- Progressive restoration of ash disposal site as useful land in form of Park

However, it has certain constraints and disadvantages too, such as:

- High maintenance Cost.
- Dependency on weather/climate condition. It has to be discontinued during rains
- Constraints of distance. It is feasible only if disposal area is near to plant

In view of various constraints, the lean phase slurry disposal system through pipe lines is being practices, which offers the following advantages:

- Proven technology
- Better acceptability
- Cheaper indigenous technology
- Lower maintenance and energy requirements
- Adequate mine void capacity for ash disposal available
- No additional requirement of land for ash storage/disposal

5.3 Alternate Modes for Control of Pollution

The present study is planned with an overall objective of assessing various scientific and engineering solutions available for prevention and control of pollution during backfilling of the mines. In this case, one of the prime areas of concern is the long term interaction between the ground water and the ash, as the ash is filled in the mine voids, which sometimes cut through the natural aquifer systems and are filled with water. If contact between ash and water could be avoided, the ash water interaction and the risk of ground water contamination can be eliminated.

5.4 Requirement of Lining of Mine Void Area

In order to establish the requirement of lining in the mine voids or otherwise, it is important to understand the material behaviour of ash in the mine voids after deposition. This was achieved through core drilling carried out at the three mine voids of South Balanda, which have been used for ash disposal for several years by the TTPS. The core samples of ash deposits were collected at 5m interval vertically from each drilling location.

Table-5.3: Location of the drilling and the depth of drilling

Quarry No.	Latitude	Longitude	Total depth of drilling (m)	Ash column encountered upto (m)	No. & Type of Samples Observed (Sequentially, from top)
2	20° 56' 24.0"	85° 08' 28.0"	75	20	5 No. - Dry Ash 11 Nos. - Sand & Clay
3A	20° 56' 13.4"	85° 08' 07.3"	90	50	11 Ns. - Dry Ash 5 Nos. - Sand & Coal
3B	20° 56' 01.3"	85° 08' 07.6"	50	25	3 Nos. - Dry Ash 1 No. - Sludge 2 Nos. - Dry Ash 1 No. - Coal Seam 4 Nos. - Sandstone

Further, in order to establish whether the ash samples have degenerated over a period of time and changed their leaching characteristics/ radioactivity levels, the ash samples from the borehole were subsequently analyzed for TCLP using the standard protocol (ASTM standard D3984), heavy metal content, water extraction test and water elution test. The ash samples were analyzed for parameters namely Na_2O, MgO, SiO_2, Al_2O_3, Fe_2O_3, TiO_2, CaO, K_2O, P_2O_5, SO_3, Cr_2O_3, MnO_2, NiO, CuO, Rb_2O, SrO, Y_2O_3, ZrO_2, Nb_2O_5, BaO, Cl by XRF (Model:PW2403). The samples were also analyzed for radio nuclides namely K40, U238 and Th232 by ICP-MS (Model: Varian 810 MS). The ash samples (3 nos.) from the pond and the power plant were also analyzed for permeability subsequently.

A striking feature of the core samples was that all the ash samples were almost dry without any free pore water and they were not amenable for extraction of pore water.

The results of chemical analysis, metal analysis, TCLP Tests and Leachability Tests indicate that:

- The values are within the normal range.
- The variations in the values observed do not show any definite trend with respect to depth/ age.

- The variations are due to natural cause.
- The ash samples had extremely low permeability (**of the order of 10^{-9} cm/s**) (due to fine size of ash particles) indicating no lateral or vertical movement of water through deposits.

Based on above observations, it may be concluded that the consolidated layers of ash at higher depths are almost free of water pore water to cause any leaching or ground water contamination. This process may be explained through the following mechanism.

A Typical Section of Mine Void Cutting through Various Layers of Geological Strata including Aquifers is shown in Plate-5.7. Sometimes these voids are filled with water – surface run-off and seepage from aquifers. A schematic cross section of a mine void is shown in Plate-5.8. When ash is placed in the mine voids with water, fine particles of ash move along water and clogs the pores of soil/ fine cracks in rocks. This process continues till all the pores/ cracks are blocked and the ash gets consolidated on its own weight. This stage is shown in Plate-5.9.

Plate-5.7: Typical Section of Mine Void showing Geological Strata

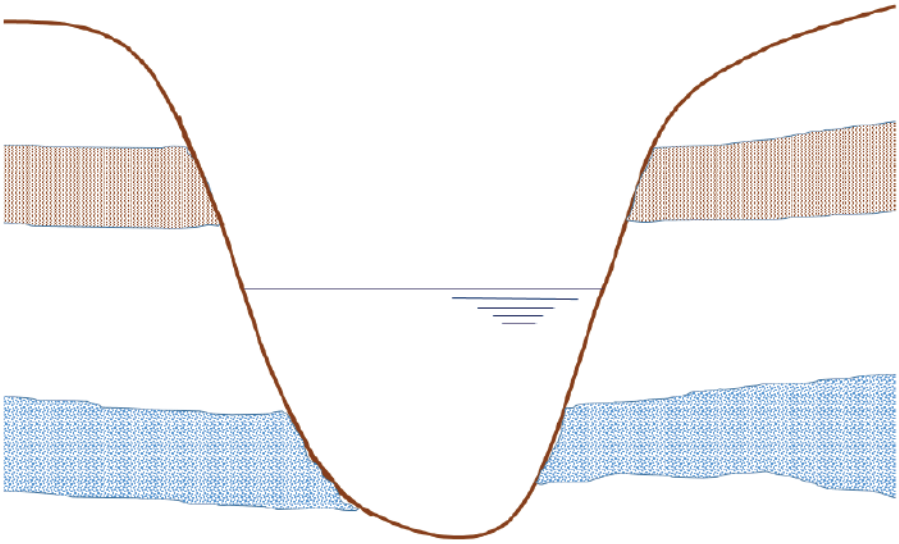


Plate-5.8: A schematic cross section of a mine void

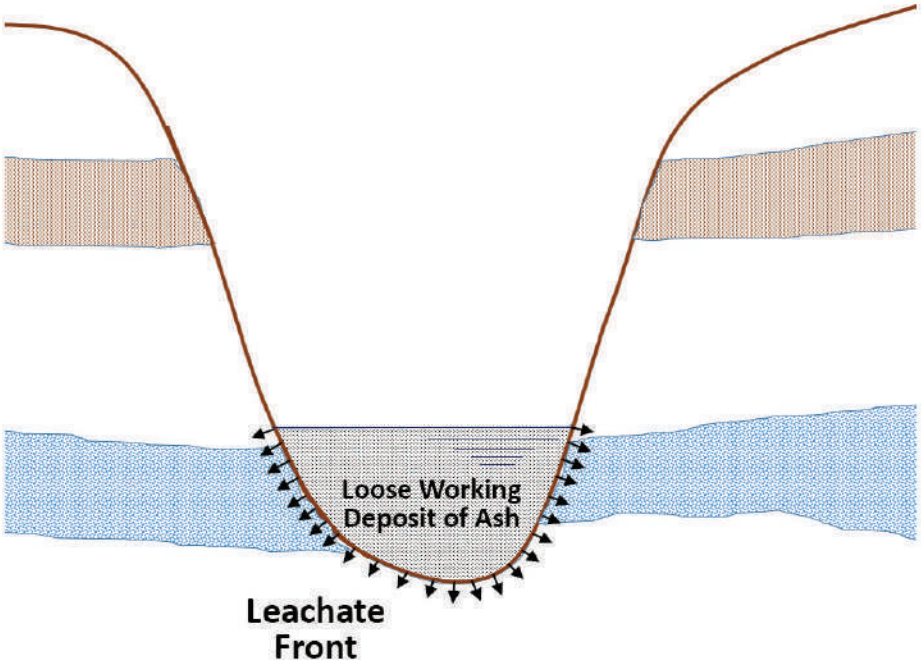


Plate-5.9: Initial phase of ash deposition in the Mine Void

Clogging of the pores/ cracks creates an impermeable interface along the surface of mine void while the consolidated layer itself has very low permeability. This results into an impermeable block at bottom and a loose layer at the top. As the filling progresses, the impermeable block grows upwards. As it takes about 1-1.5 years for a layer to consolidate, the movement of the water/ ash particle during that period may be only few inches in the soil, after which it is sealed, as shown in Plates-5.10 and 5.11.

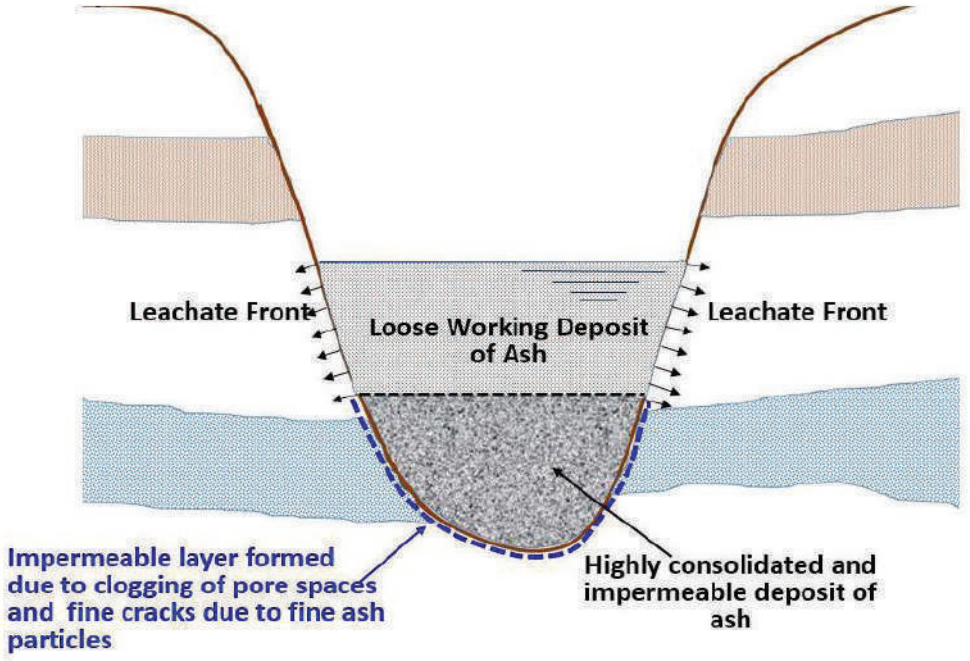


Plate-5.10: Gradual Compaction of the deposited ash

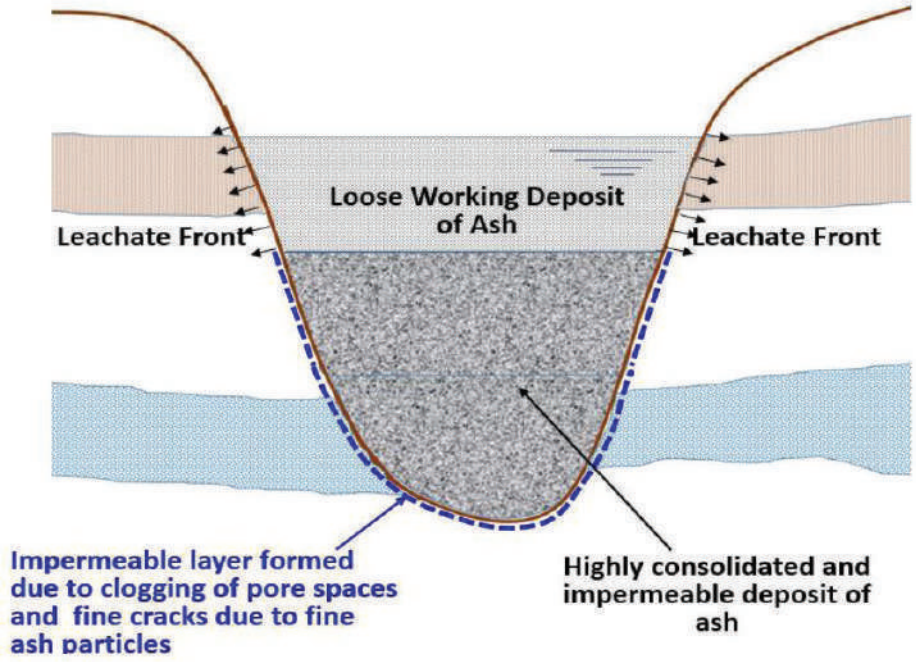


Plate-5.11: Increase in the volume of the consolidated and impermeable deposit of ash

Finally, a typical Section of Mine Void Filled with Ash has two types of layers (Plate-5.12):

- Highly consolidated lower layer and
- Loose upper layer

The consolidated lower layer acts as a solid impermeable mass of ash, which neither has free pore water nor allows any water to pass through it. Therefore, there is no risk of ground water contamination due to ash water or further disposal of ash slurry on top of it. As the mass of consolidated ash itself is impermeable, there is no need for lining of the mine void also.

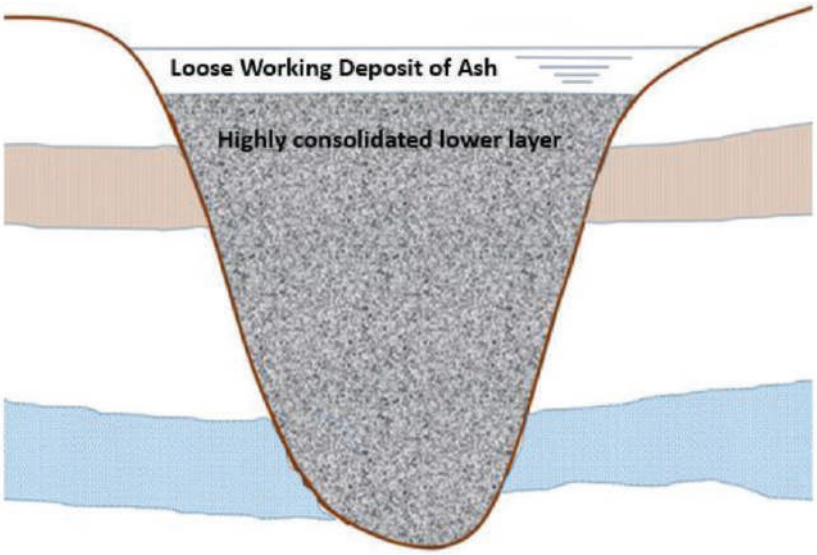


Plate-5.12: Build-up of the highly consolidated ash matrix in the Mine Void

The above hypothesis is supported by observations during core drilling tests inside actual ash deposits in South Balanda Mine Voids, during which it was observed that:

a. Extremely low permeability of ash deposits (10^{-9} cm/s) (due to fine size of ash particles) indicating no lateral or vertical movement of water through deposits
b. Almost dry (moist ash with no free water) core samples at greater depths indicating no vertical/ horizontal percolation

Further, no change in ash characteristics (chemical constituents, leachates and radioactivity) were observed at greater depths, indicating that there are no effects of aging on the ash and leachate characteristics.

In view of the above, it may be concluded that the lining of mine voids is not required.

5.5 Continuity of Aquifer

The fly ash, filled in the quarry will get solidified in due course of time and will act as impermeable medium and will not allow water to percolate from top or on either side of the filled in fly ash body.

Presently there are no aquifers found inside the de-coaled quarry No. 4 & 7 because of the mining activities which created voids and partially filled with water. The mining activities are now over.

5.6 Leachate Potential and Need for Neutralization

TCLP and Leachate analysis was carried out in the Environmental Laboratory of CMPDI utilizing fly ash and pond ash of TSTPS and mine water of quarry no. 8. The pH was determined for de-ionised water and mine sump water as well as for mixture of water and fly ash slurry prepared for leaching analysis in 1:5 ash suspension ratio.

The results show that pH of slurry immediately falls to a level ranging between 4.4 to 5.0. However values increases slowly as the time passes. Finally pH raises to above 6.5 to as high as 7.2 within 24 Hrs. This behavior of PFA is mainly due to presence of alumina in fly ash. Alumina has 56% basic constituents and 44% acidic constituents. As the acidic constituents are generally more soluble in water, pH of the sample falls immediately after mixing with water. As time passes, basic constituents neutralize acidic fraction and pH of the sample gradually increases and equilibrium is achieved.

Small amount of alkali present in the fly ash also neutralizes the acidic fraction of alumina. The final pH value of the samples is the value observed, when the equilibrium is achieved. Data presented confirms the above behavior. There is little variation in equilibrium pH for the slurry prepared using 10% to 30% fly ash.

Since the mine water of Quarry-7, Jagannath OCP is not acidic in nature, based on data available pH neutralization not required. The test results reveals that leachate parameters are well within the permissible limits and there is no likely impact on the ground water regime due to fly ash disposal in this quarry.

5.7 Post-filling Reclamation of Land

After the quarry no. 4 &7 are filled up to the desired height, the same hall be provided with a soil cover and will be vegetated, to make it a part of the overall post-mining land use pattern envisaged in the mine closure plan of the Jagannath OCP. The design of surface contours and land profile will be in consonance with the surrounding features. The vegetation shall be of preferably indigenous species and a three tier plantation approach will be followed for overall eco-restoration of the area. This will also help in checking the surface run-off, prevent the water from percolation and maintaining the aesthetics of the surrounding in general. A conceptual diagram of the reclaimed mine void is presented in Plate-5.13.

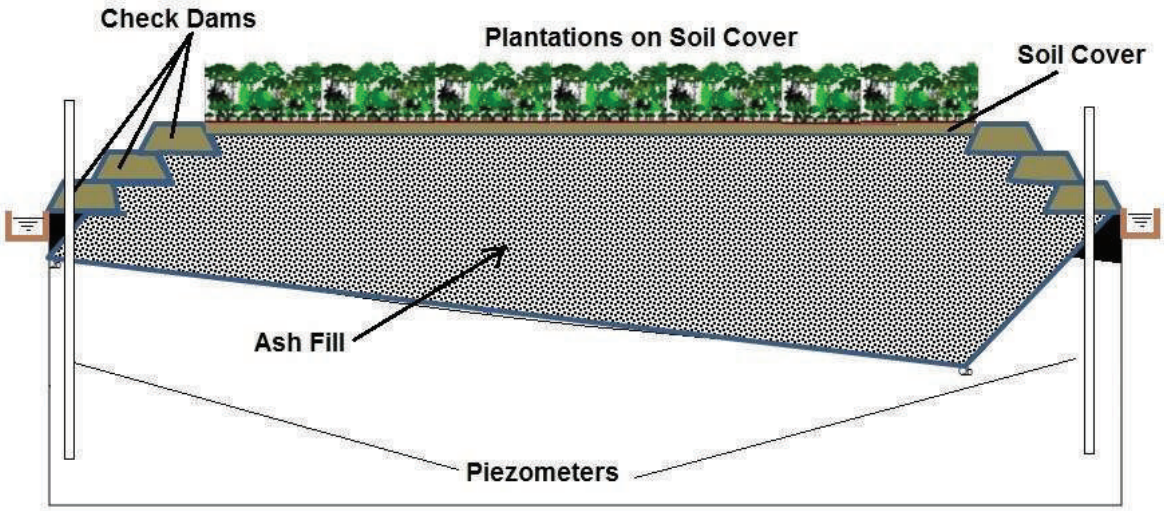


Plate-5.13: Conceptual Plan for Reclamation of Mine Void

(Drawing not to Scale)

During the mine void reclamation, the following measures are proposed to be undertaken:

i. Storm water drains shall be constructed for channelizing the run-off water away from the disposal site.

ii. A 30 cms thick soil cover shall be provided to prevent fugitive emissions and promote vegetation growth.

iii. For vegetation purpose, preference is given to native species and mixed culture. The species will be selected carefully from the following groups for quick reclamation:
   - Nitrogen fixing tree species for fuel wood and timber
   - Forestry type tree species.

- Tree species with dense foliage for shade.
- Native species.

iv. However, fruit bearing and fodder species shall be avoided.

5.8 List of Species Recommended for Plantation

The list of plant species recommended for afforestation on the filled-up ash surface and its surrounding areas are presented in Table-5.4:

Table-5.4: List of Plant Species Recommended for Afforestation on the Filled-up Ash Surface (Source: Guidelines for Developing Greenbelt, CPCB, 2000)

Grasses	Herbaceous Legumes	Trees
Bothriochloa intermedia	*Cajanus cajan*	*Acacia albida*
Bothriochloa pertus	*Crotalaria juncea*	*Acacia auricoliformis*
Brachiaria mutica	*Crotalaria burhia*	*Acacia catechu*
Cenchrus setigerus	*Desmodium triflorum*	*Acacia holosericea*
Chloris gayana	*Medicago sativa*	*Aracia nilotica*
Chryosopogon fulvus	*Phaseolus mungo*	*Acacia senegal*
Cynodon dactylon	*Stylosanthes hamata*	*Albizia amara*
Echinochloa colona		*Albizia lebbeck*
Eragrostis cynosuroides		*Azadirachta indica*
Heteropogon contortus		*Dalbergia sissoo*
Paspalidium geminatum		*Eucalyptus hybrid*
Sacharum bengalense		*Erythrina variegata*
Sehima nervosum		*Gliricidia sepium*
Sporobolus airoides		*Grewia tenax*
Sporobolus coromendelines		*Hardwikhia binata*
		Leucaena latisiliqua
		Pithecellobium dulce
		Zizyphus nummularia

5.9 Soil Additives and Manures

Fly ash is deficient in plant nutrients like nitrogen and sometimes phosphorus and other minerals and contains toxic metals like copper, cadmium, cobalt, chromium, manganese, molybdenum, nickel, lead, zinc and boron. Amendment of ash with nutrients and agents

to arrest toxicants are essential for covering it with plants. Some suitable and inexpensive soil additives are given in Table-5.5 along with their properties. Nutrient contents of some commonly used organic manures are given in Table-5.6.

For growing grasses, this mix need be in the top soil (upto 15 cm) only, while for tree saplings, pits of suitable dimensions (60x60x60 or 90x90x90 cm) are required with similar mixtures. Watering regimes depend upon local climatic conditions, though in initial stages regular watering daily for grass and 2-3 times a week for trees is a must.

Table-5.5: Soil Additives and their Properties (Source: Guidelines for Developing Greenbelt, CPCB, 2000)

Material	**pH**	**Durability**	**C:N Ratio**	**Application to soil (tons per ha)**		
				(a)	(b)	(c)
Hay	5.5	1 season	25.1	2	3	4
Manure	6.6	6-12 months	25.1	15	30	40
Sawdust	3-7	3-5 years	200.1 to 500.1	1	5	10
Leaves (Composted)	6.5	1 season	40.1	3	4	5
Refuse	7.5	1 season	45.1 to 55.1	20	-	-
Compost	8.5					

(a) While seeding (b) For erosion control (c) around already established plants.

Table-5.6: Nutrient contents of some types of organic manures

Manure Type	Nutrient contents %			Organic Matter %
	N	P	K	
Farm Yard Manure	0.62	0.13	0.49	24
Pig slurry	0.21	0.10	0.18	5
Poultry manure	2.30	0.90	0.65	65
Sewage sludge	1.82	0.43	0.46	39
Mushroom compost	2.80	0.20	0.80	65
Domestic refuse	0.50	0.20	0.30	65
Straw	0.48	1.62	0.85	95

(Source: Juwakar et.al 1969 cited in Guidelines for Developing Greenbelt, CPCB, 2000)

5.10 Detailed Plan for Reclamation

A detailed plan for biological reclamation of filled-up mine void area shall be developed towards the completion of the filling up activity, with the help of Forest Department and experts in the area.

5.11 Environmental Monitoring Programme

Regular environmental monitoring is proposed to be undertaken during the period of disposal of ash into mine void as well as after the reclamation of mine void. The detailed monitoring programme is given in Tables-5.7 and 5.8 respectively.

Table-5.7: Proposed Monitoring Programme during Disposal of Ash

Samples	Parameters to be Analysed	Frequency
Ash Samples	Chemical Parameters (%): SiO_2, Al_2O_3, Fe_2O_3, K_2O, TiO_2, CaO, MgO, Na_2O, P_2O_5, SO_3 Trace Elements (mg/kg, using TCLP Test): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn Radio-activity (Bq/kg): ^{238}U, ^{236}Ra, ^{232}Th, ^{228}Ra, ^{230}Pb, ^{40}K, ^{137}Cs	Once a year
Ash Leachate Analysis	Trace Elements (mg/kg, using TCLP Test): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Once a year
Piezometer Water Samples	Chemical Parameters (mg/l, except, pH and EC): pH, EC, TDS, Total Alkalinity, Ca, Mg, Na, K, Cl, SO_4, NO_3, PO_4, Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Monthly
Mine Water Sample	Same as above	Monthly
Ground Water	Same as above	Twice a year - Pre-monsoon and Post-monsoon

Samples	Parameters to be Analysed	Frequency
Surface Water Samples	Same as above	Twice a year - Pre-monsoon and Post-monsoon
Soil Samples	Texture, type, pH & cation exchange capacity. Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	**Once a year**
Survey of Floraand Fauna	• Listing of Flora (herbs, shrubs and trees) and Fauna (soil invertebrates and other animals) based on field observations and review of information available • Analysis of trace elements in plants (herbs, shrubs and trees), the invertebrates • Analysis of trace elements in aquatic fauna from the mine void filled with fly ash	Once in two years

Table-5.8: Proposed Monitoring Programme After Reclamation of Mine Void

Samples	Parameters to be Analysed	Frequency
Piezometer Water Samples	Chemical Parameters (mg/l, except, pH and EC): pH, EC, TDS, Total Alkalinity, Ca, Mg, Na, K, Cl, SO_4, NO_3, PO_4, Trace Elements (mg/l): As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Zn	Twice a year - Pre-monsoon and Post-monsoon
Ground Water Samples	Same as above	Once a year - Pre-monsoon
Surface Water Samples	Same as above	Once a year - Pre-monsoon
Survey of Flora and Fauna	• Listing of Flora (herbs, shrubs and trees) and Fauna (soil invertebrates and other animals) based on field observations and review of	Once in five years

Samples	Parameters to be Analysed	Frequency
	information available • Analysis of trace elements in plants (herbs, shrubs and trees), the invertebrates • Analysis of trace elements in aquatic fauna from the mine void filled with fly ash	

For environmental monitoring, the OM dated 28.08.2019 issued by MoEFCC need to be complied with.

In the event of deterioration of environmental quality, suitable preventive/ corrective action will be undertaken.

References:

The following resources have been referred to during the making of this report:

1. Fly Ash Notification issued by MoEF&CC dated 14.09.1999 and subsequent amendments
2. EPA Method 1311 for Toxicity Characteristic Leaching Procedure
3. Roy, W.R., Berger, P.M., 2011, Geochemical Controls of Coal Fly Ash Leachate pH. *Coal Combustion and Gasification Products* 3, 63-66, doi: 10.4177/CCGP-D-11-00013.1
4. Task Report IV as a part of Report on 'Hydro-Geological Investigations & EIA Studies for filling NTPC Singrauli Ash in Abandoned Gorbi Mines' by CMPDI (Job No.: 091002203)
5. Report on Fly Ash Characterization of Talcher Super Thermal Power Station, Kaniha by CMPDI (July, 2014)

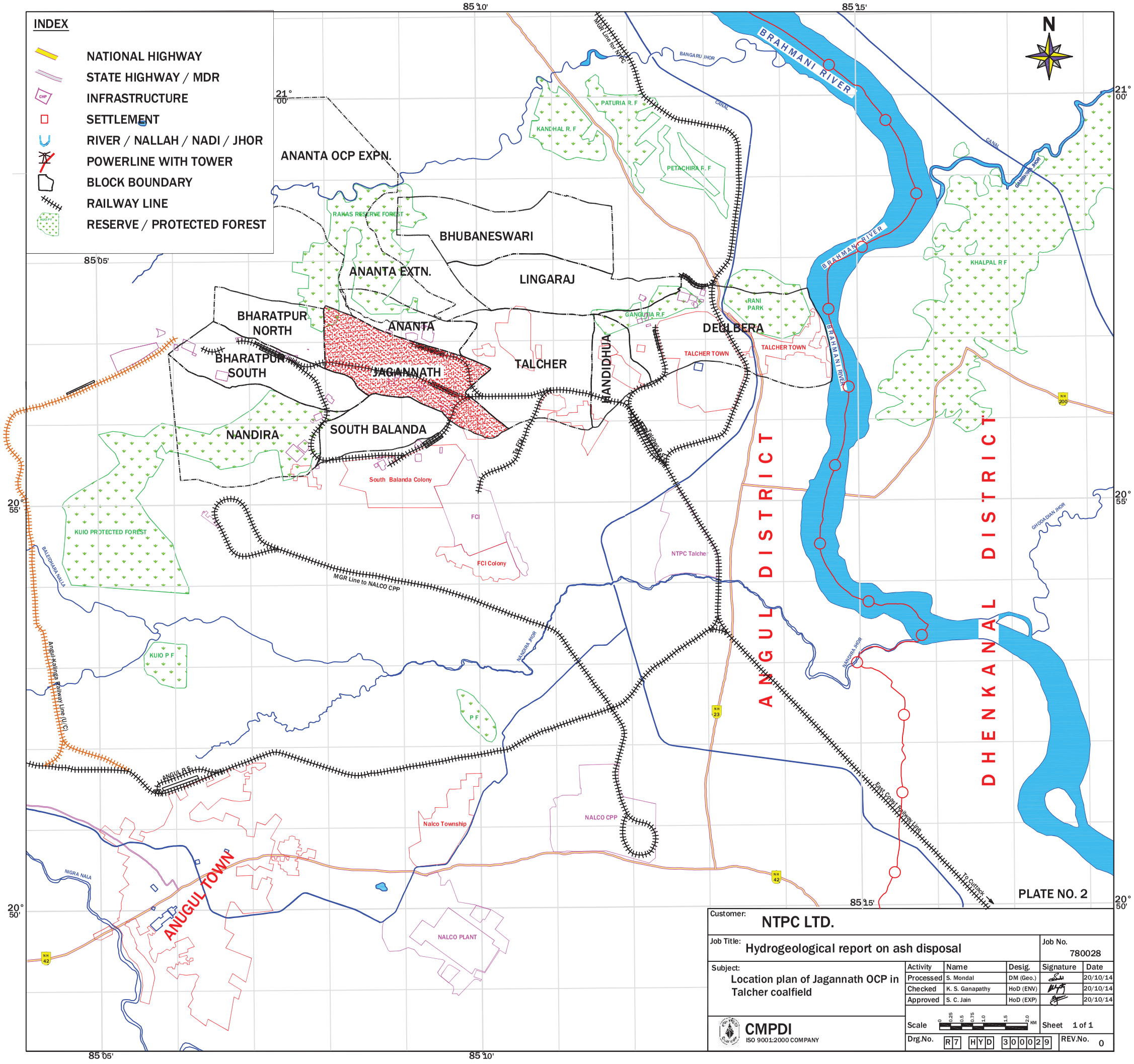
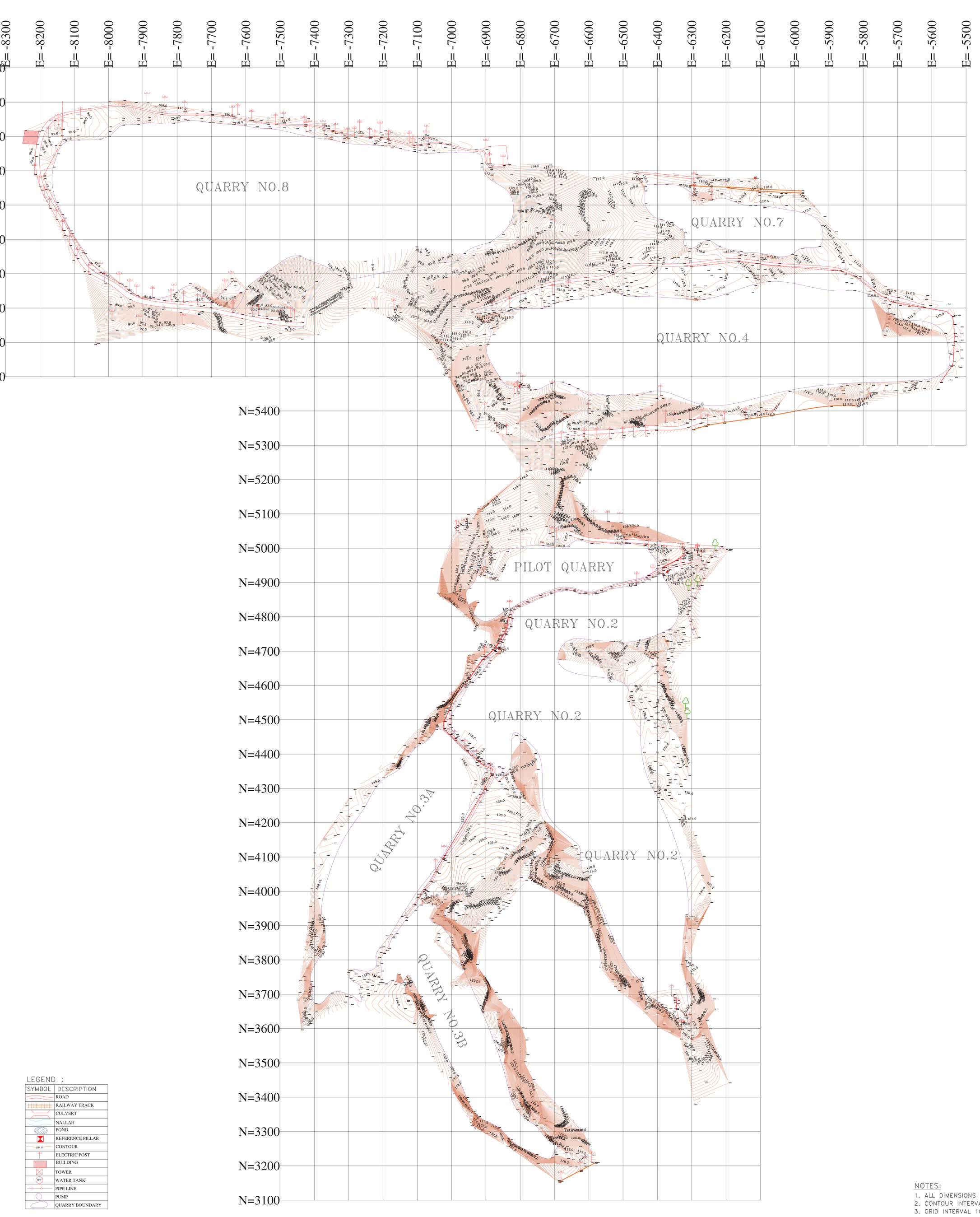


PLATE NO. 2

Customer: NTPC LTD.				
Job Title: Hydrogeological report on ash disposal				Job No. 780028
Subject: Location plan of Jagannath OCP in Talcher coalfield	Activity	Name	Desig.	Signature / Date
	Processed	S. Mondal	DM (Geo.)	20/10/14
	Checked	K. S. Ganapathy	HoD (ENV)	20/10/14
	Approved	S. C. Jain	HoD (EXP)	20/10/14
CMPDI ISO 9001:2000 COMPANY	Scale 0 0.25 0.5 0.75 1.0 1.5 2.0 KM			Sheet 1 of 1
	Drg.No. R7 HYD 300029			REV.No. 0

Reference: As per Master Plan Talcher Coalfield 2009



LEGEND :

SYMBOL	DESCRIPTION
	ROAD
	RAILWAY TRACK
	CULVERT
	NALLAH
	POND
	REFERENCE PILLAR
104.0	CONTOUR
	ELECTRIC POST
	BUILDING
	TOWER
WT	WATER TANK
	PIPE LINE
	PUMP
	QUARRY BOUNDARY

NOTES:

1. ALL DIMENSIONS ARE IN METRE.
2. CONTOUR INTERVAL 0.5M.
3. GRID INTERVAL 100M.
4. ALL CO-ORDINATES ARE IN RESPECT TO REF. PILLAR -1.
   VALUE:- NORTH: 4993.995M; EAST:-6193.243M.
5. ALL RL'S ARE IN RESPECT TO BENCH MARK LOCATED NEAR JAGANNATH MINES.
   VALUE:-125.869M, SUPPLIED BY NTPC.

NO.	DATE	REVISIONS	DRN	CHKD	APPD.

CLIENT : NTPC LIMITED
TALCHER THERMAL POWER STATION

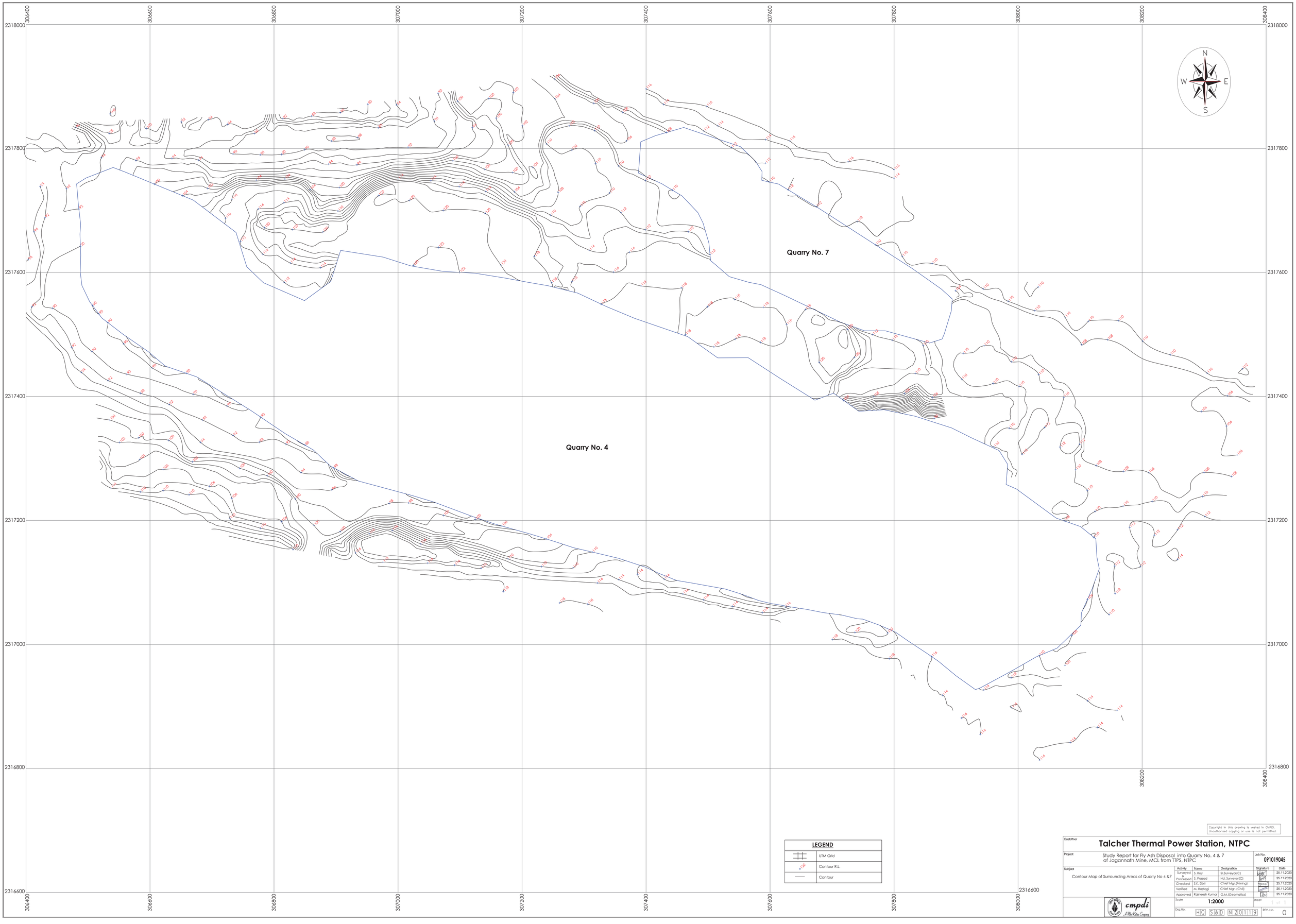
SURVEYED BY : C & C CONSULTING FIRM
18A PARK STREET (STEPHEN COURT)
6G, 6th. FLOOR KOLKATA 700 071

TITLE : TOPOGRAPHICAL SURVEY PLAN OF MINES AREA

DRG. NO. CCCF/NTPC/TS/10/2035

SHEET NO.	REV.
1	0

DRAWN BY	CHECKED BY	DATE	APPROVED BY	SCALE
SD	SC	20.04.2010		1:4000



LEGEND	
	UTM Grid
x120	Contour R.L.
	Contour

Customer: **Talcher Thermal Power Station, NTPC**

Project: Study Report for Fly Ash Disposal into Quarry No. 4 & 7 of Jagannath Mine, MCL from TTPS, NTPC

Job No. 091019045

Subject: Contour Map of Surrounding Areas of Quarry No 4 &7

Activity	Name	Designation	Signature	Date
Surveyed & Processed	S. Roy	Sr.Surveyor(C)		25.11.2020
	S. Prasad	Hd. Surveyor(C)		25.11.2020
Checked	S.K. Dixit	Chief Mgr.(Mining)		25.11.2020
Verified	M. Rastogi	Chief Mgr. (Civil)		25.11.2020
Approved	Rajneesh Kumar	G.M.(Geomatics)		25.11.2020

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Scale: 1:2000

Sheet: 1 of 1

Drg.No. HQ S&D N20119

REV. No. 0

304400 306600 306800 307000 307200 307400 307600 307800 308000 308200 308400

2318000 2317800 2317600 2317400 2317200 2317000 2316800 2316600

N

W E

S

Quarry No. 7

Quarry No. 4

LEGEND

	UTM Grid
XYZ 1.40	Spot R.L.
	Alignment of Pipeline

Customer: **Talcher Thermal Power Station, NTPC**

Project: Study Report for Fly Ash Disposal into Quarry No. 4 & 7 of Jagannath Mine, MCL from TTPS, NTPC

Job No. 0910190045

Subject: Spot Levels of Surrounding Areas of Quarry No. 4 &7

Activity	Name	Designation	Signature	Date
Surveyed & Processed	S. Roy	Sr.Surveyor(C)		25.11.2020
	S. Prasad	Hd. Surveyor(C)		25.11.2020
Checked	S.K. Dixit	Chief Mgr.(Mining)		25.11.2020
Verified	M. Kostagi	Chief Mgr. (Civil)		25.11.2020
Approved	Rajneesh Kumar	G.M.(Geomatics)		25.11.2020

Scale: 1:2000

Sheet: 1 of 1

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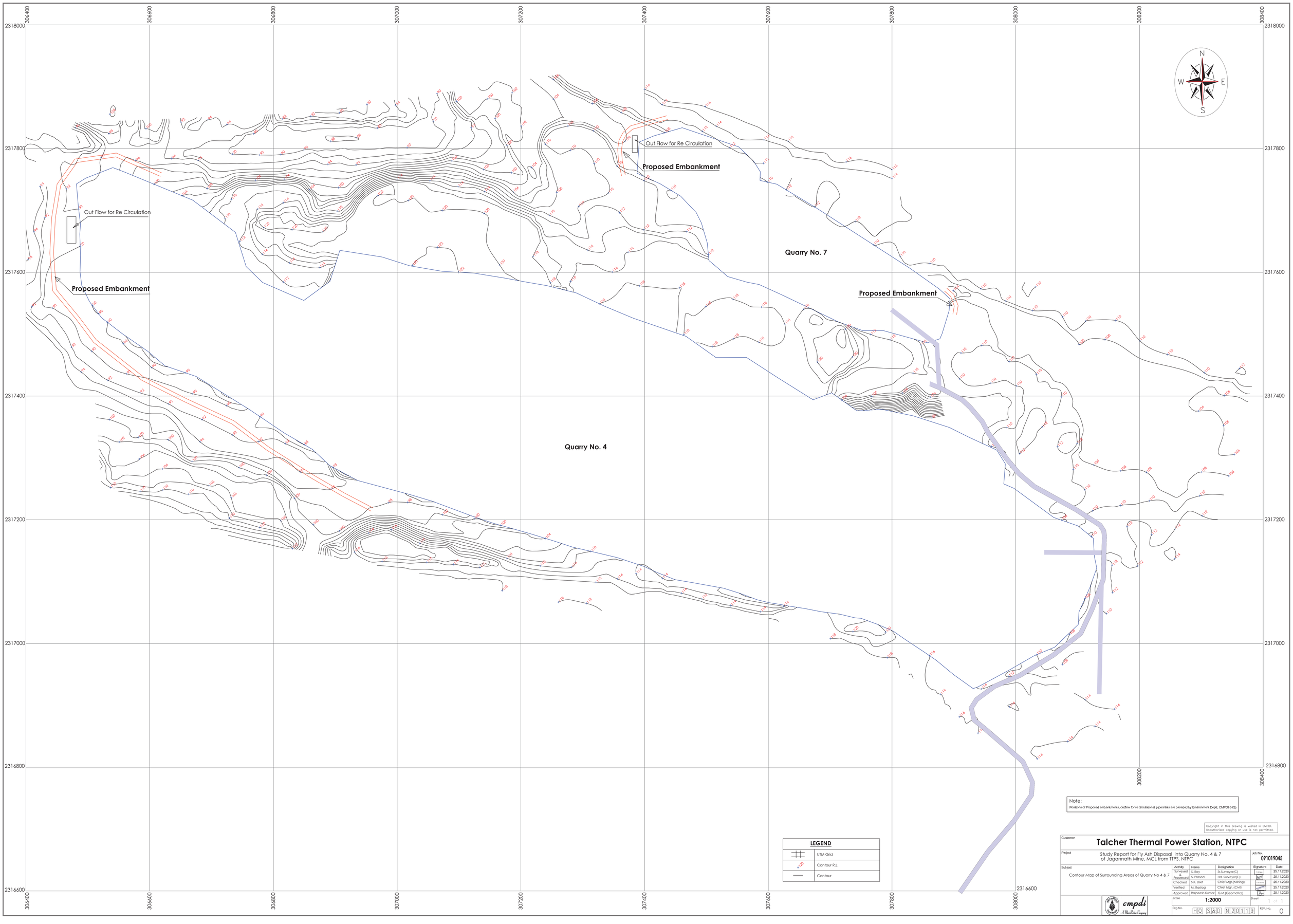
Org.No.: HQ S&D N20118

REV. No.: 0



Note:
Positions of Proposed embankmenets, outflow for re circulation & pipe inlets are provided by Environment Deptt, CMPDI (HQ)

LEGEND

	UTM Grid
x 120	Contour R.L.
	Contour

Customer: **Talcher Thermal Power Station, NTPC**

Project: Study Report for Fly Ash Disposal into Quarry No. 4 & 7 of Jagannath Mine, MCL from TTPS, NTPC — Job No. 091019045

Subject: Contour Map of Surrounding Areas of Quarry No 4 & 7

Activity	Name	Designation	Signature	Date
Surveyed & Processed	S. Roy	Sr.Surveyor(C)		25.11.2020
	S. Prasad	Hd. Surveyor(C)		25.11.2020
Checked	S.K. Dixit	Chief Mgr.(Mining)		25.11.2020
Verified	M. Rastogi	Chief Mgr. (Civil)		25.11.2020
Approved	Rajneesh Kumar	G.M.(Geomatics)		25.11.2020

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Scale: 1:2000 — Sheet: 1 of 1

Drg.No. HQ S&D N20119 — REV. No. 0

85°05'
85°10'
85°15'
21°00'
20°55'
NSW03
N
JAGANNATH OCP
BANGARU JHOR
BRAHMANI RIVER
BRAHMANI R
CANAL
GAMBHIRA JHOR
BRAHMANI RIVER
BRAHMANI RIVER
ANGUL DISTRICT
DHENKANAL DISTRICT
BALIDHARA NALA
NANDIRA JHOR
NANDIRA JHOR
NIGIRA NALA
NH 200
NH 23
NH 42

INDEX

- River/ Nallah/ Jhor/ Pond
- National Highway
- 5 Km Buffer Zone Boundary
- State/District Boundary
- Mine Leasehold Boundary
- Flow direction

PLATE NO. 3

Customer: **NTPC LTD.**

Job Title: Hydrogeological report on ash disposal

Job No. 780028

Subject: Drainage Map of Jagannath OCP in 5 km buffer zone radius

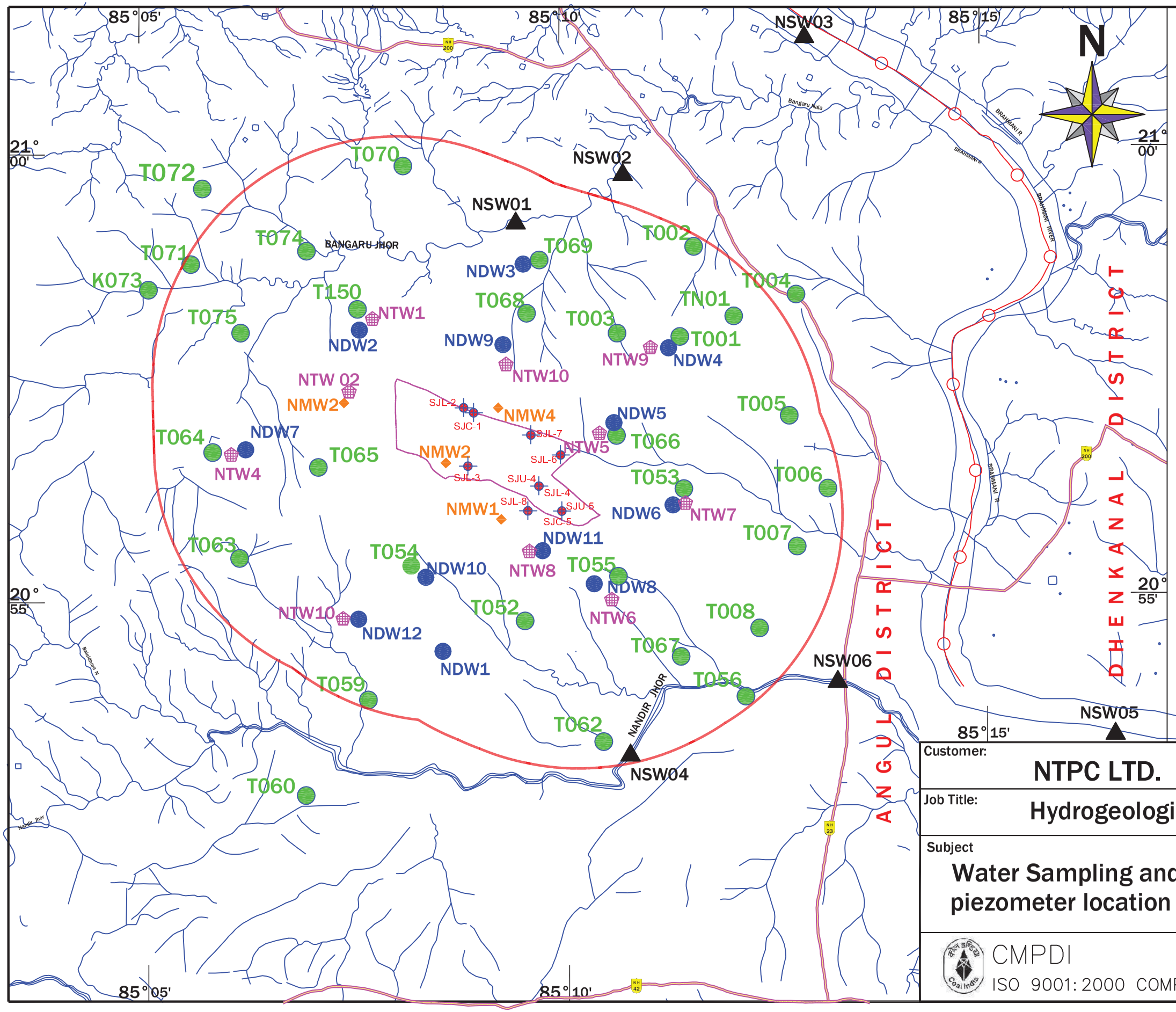
Activity	Name	Desig.	Signature	Date
Processed	S. Mondal	DM (Geo)		20/10/14
Checked	K.S.Ganapathy	HoD (Env.)		20/10/14
Approved	S. C. Jain	HOD (Exp.)		20/10/14

Scale: 0 500 1000 1500 2000 3000 4000

Sheet 1 of 1

CMPDI
ISO 9001:2000 COMPANY

Drg.No. R7 HYD 300030 REV.No. 0



INDEX

- River/ Nallah/ Jhor/ Pond
- SJL-7 — Piezometer location point
- T005 — Hydrograph station
- NSW06 — Surface water sampling location
- NTW7 — Tube well water sampling location
- NMW2 — Mine water sampling location
- NDW2 — Dug well water sampling location
- 5 Km Buffer Zone Boundary
- State/District Boundary
- Jagannath Mine Leasehold Boundary
- National Highway

PLATE NO. 6

Customer: **NTPC LTD.**

Job Title: **Hydrogeological report on ash disposal**

Job No. 780028

Subject: **Water Sampling and piezometer location plan**

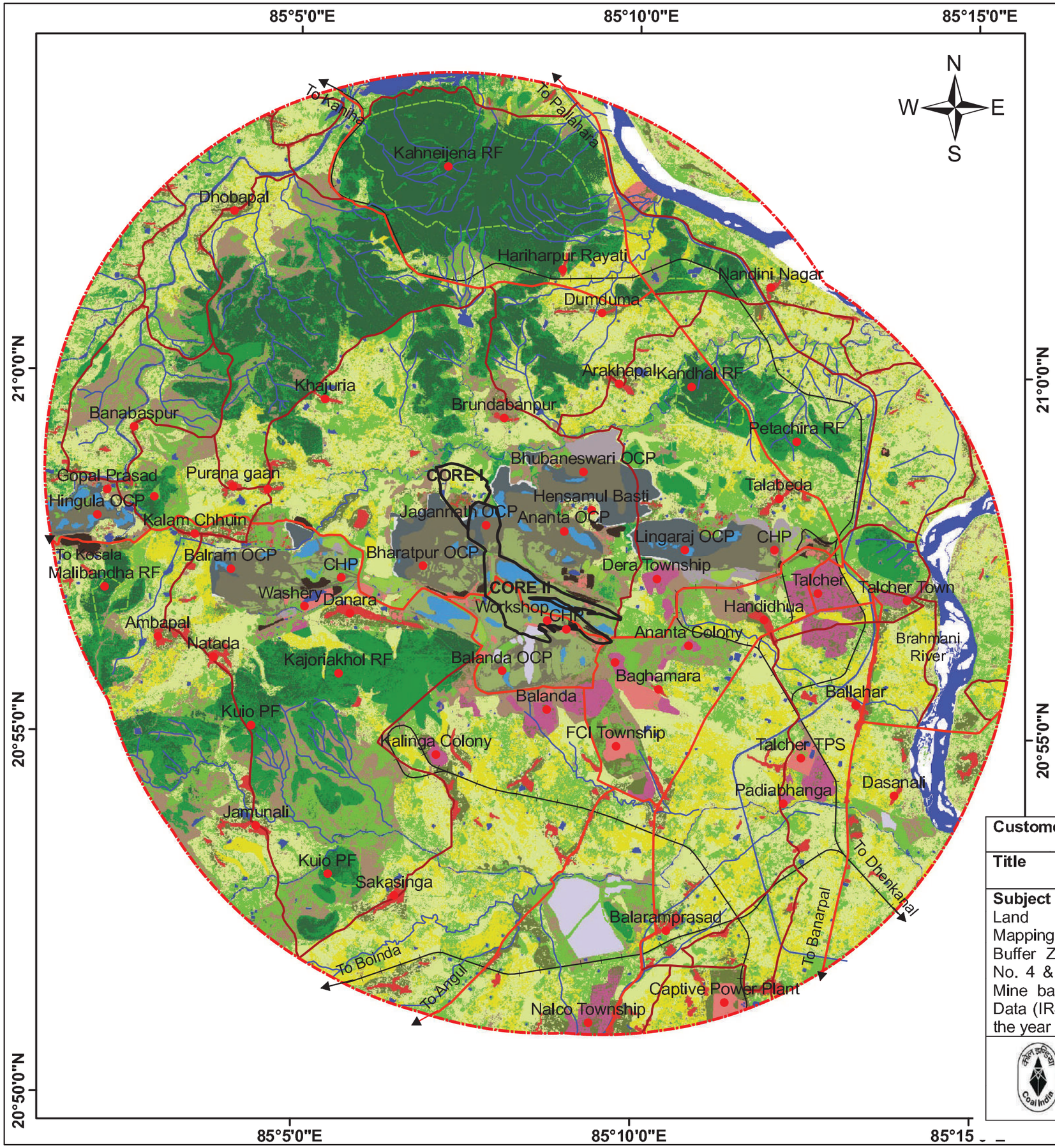
Activity	Name	Desig.	Signature	Date
Processed	S. Mondal	DM (Geo)		20/10/14
Checked	K.S.Ganapathy	HoD (Env.)		20/10/14
Approved	S. C. Jain	HOD (Exp.)		20/10/14

Scale: 0 500 1000 1500 2000 3000 4000

Sheet 1 of 1

CMPDI
ISO 9001:2000 COMPANY

Drg.No. R7 HYD 300033 REV.No. 0



Area Statistics - Quarry No. 4 & 7 of Jagannath Mine (2019)

Classes		Color	Core I+II		Buffer Zone	
Level-I	Level-II		Area (Km^2)	% of Total	Area (Km^2)	% of Total
Forest Land	Dense Forest		0.00	0.00	45.87	9.96
	Open Forest		0.06	1.08	38.41	8.34
	Total Forest Land		**0.06**	**1.08**	**84.28**	**18.30**
	Scrubs		**0.25**	**4.51**	**89.41**	**19.41**
Plantation Area	Social Forestry		0.15	2.71	14.95	3.25
	Plantation on OB		0.00	0.00	1.29	0.28
	Plantation on Backfill		1.84	33.21	6.02	1.31
	Total Plantation Area		**1.99**	**35.92**	**22.26**	**4.83**
	Total Vegetation		**2.30**	**41.52**	**195.95**	**42.54**
Agriculture Land	Crop land		0.07	1.26	49.81	10.81
	Fallow Land		0.55	9.93	116.60	25.31
	Total Agriculture Land		**0.62**	**11.19**	**166.41**	**36.13**
Waste Land	Waste Land		0.48	8.66	34.12	7.41
	Sand Body		0.00	0.00	5.52	1.20
	Fly Ash Pond		0.11	1.99	2.94	0.64
	Total Waste Land		**0.59**	**10.65**	**42.58**	**9.24**
Mining Area	Coal Quarry		0.30	5.42	6.01	1.30
	Advance Quarry Site		0.04	0.72	0.59	0.13
	Barren OB Dump		0.00	0.00	1.84	0.40
	Back Filled Area		0.74	13.36	12.40	2.69
	Coal Dump		0.09	1.62	1.40	0.30
	Water Filled Quarry		0.67	12.09	2.59	0.56
	Total Mining Area		**1.80**	**32.49**	**24.83**	**5.39**
Settlements	Urban Settlements		0.00	0.00	7.32	1.59
	Rural Settlements		0.04	0.72	7.87	1.71
	Industrial Settlements		0.13	2.35	3.51	0.76
	Total Settlement Area		**0.17**	**3.07**	**18.70**	**4.06**
Water Body	**River/ Ponds**		**0.06**	**1.08**	**12.13**	**2.63**
	Total Area		**5.54**	**100.00**	**460.60**	**100.00**

INDEX

- Buffer Zone
- Core Zone
- Railway Line
- Settlements
- Main Road
- Other Road
- Nala/River

Customer	National Thermal Power Corporation				
Title	Land Use/Cover Mapping of Core and Buffer Zones				**Job No.** 091019045
Subject Land Use/ Cover Mapping of Core and Buffer Zones of Quarry No. 4 & 7 of Jagannath Mine based on Satellite Data (IRS-R2/LISS-IV) of the year 2019.	**Activity**	**Name**	**Designation**	**Sign**	**Date**
	Prepared	A. Biswas	Mgr.(Geology)	ABiswas	
	Checked	T. Mondal	CM(RSC)	Tmondal	
	Approved	R. Kumar	GM(Geomatics)		
cmpdi A Mini Ratna Company	**Scale** 0 1 2 4 6 Km				**Sheet 1**
	Drg No. HQ REM A3 19 01				**REVNo** 0

Environment Policy-2021

I. Purpose:

NTPC being country's largest power generator, with its presence across the energy value chain, recognizes that protection of environment is essential for sustainable business.

In the context of Environment Policy, the definition of environment covers all the domains of environment - Physical, Chemical, Biological and Socio- economic aspect.

NTPC hereby adopts Environment Policy-2021, superseding its earlier policy document of 2017.

The intent of this policy is to meet environmental expectations and provide actionable guidance, as NTPC strives to foster a culture of excellence and challenges itself for continual improvement.

This document contains:

II. Policy Statement:

"To provide cleaner energy by committing to highest possible levels of performance in environmental compliance, practices and stewardship."

III. Applicability:

This policy shall apply to all establishments of NTPC and each employee shall be made a partner in implementing the policy.

IV. Principles:

This policy is based on the following principles:

1. Consideration of Environmental factors right from the stage of planning, design and operation of project/station to ensure that mandatory principles of conservation and sustainability are adhered to.

2. Adopting the best possible Environment management practices and state-of the-art technology to minimize impact of business on Environment.

3. NTPC's commitment as a responsible corporate citizen is demonstrated by striving to achieve and setting benchmarks not limited to statutory compliance.

4. Innovation by carrying out Research & Developmental activities, coupled with enablers leading to continual improvement.

5. Accepting accountability for all operations and expeditiously respond to any aberration.

6. Continuous monitoring and sharing of environmental indicators with stakeholders.

7. Develop each employee as environmental steward by improving his awareness levels while soliciting his commitment.

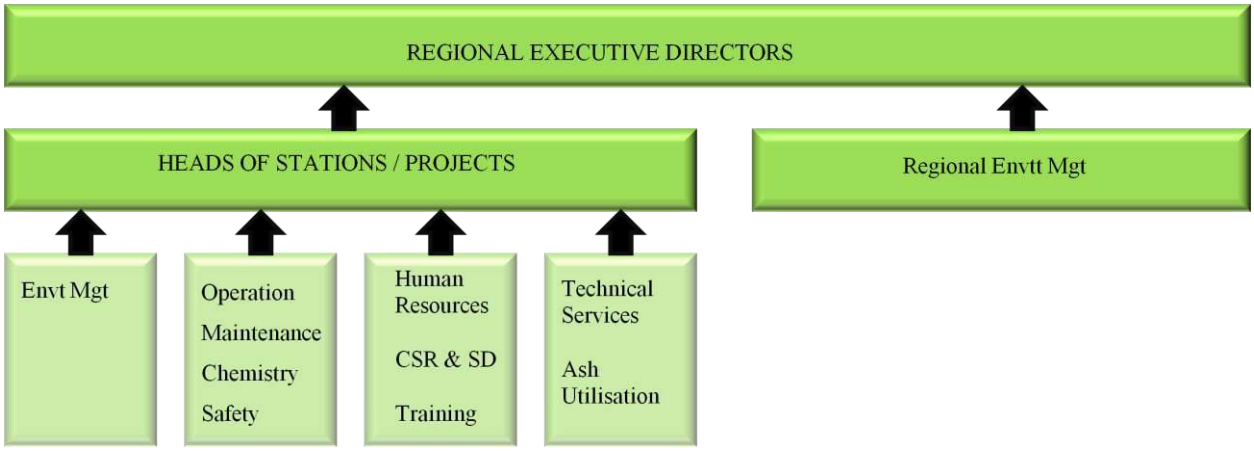
V. Institutional Framework:

Three tier structure for environmental systems implementation:

1. Corporate Level Functions - Engineering, planning and monitoring

2. Regional Level Functions – Compliance monitoring, Facilitators to stations and Coordination between Stations & Corporate.

3. Stations: Functions - Execution and reporting



Note: These charts do not reflect the organizational structure/reporting arrangement, but serve to identify responsible departments within NTPC.

VI. Policy:

NTPC shall achieve these objectives by:

1. Stewardship:

NTPC shall:

a. Adopt a pro-active approach, place environmental aspects as one of the prime consideration in decision-making process.

b. Identify and manage environmental impacts due to business activities, by adopting possible latest environment management technologies and practices.

c. Act to manage risks, as identified by Risk Management Committee (RMC)*.

d. Evaluate performance of Environment protection equipment, program and practices, with respect to legal provisions and prepare action plans for concerned functional groups.

e. Ensure efficient and optimal use of resources such as land, water, fuel, construction materials, oils, and chemicals etc, especially the non-renewables.

f. Spearhead waste management by 3Rs principles (reducing, re-using, and recycling) and safe disposal.

g. Adopt more environment friendly and energy-efficient inputs.

h. Provide innovative technological solutions to environment related issues.

i. Benchmark parameters to establish and adopt best practices.

j. Take up environmentally befitting projects in areas of climate change, renewable energy, conservation and responsible consumption of natural resources under Sustainable Development initiatives.

k. Adopt principles of green procurement by incorporating appropriate provisions in contracts and procurements.

l. To formulate and adopt separate Policies for Ash, Rehabilitation & Resettlement, Community Development – Corporate Social Responsibility and Sustainable Development.

m. Creation of carbon sink by adding green cover in and around NTPC Stations.

*RMC comprises of members from senior functionaries of management as per provisions of Companies Act 2016.

2. **Compliance and Assurance:**

a. NTPC shall continue to comply with all relevant environmental regulations, standards and other codes of practice, by operating and maintaining the assets within the boundary of permits, consents, and licenses.

b. Risk Management Committee, shall establish system for reporting environment related parameters, deviations and constraints to Management. Environmental risks perceived shall be reviewed through risk management mechanism for appropriate action.

c. Concerned group shall oversee compliance assurance of operating stations through reviews and appraisals.

d. Requirement stipulated in all obtained clearances shall be complied with, including in new establishments and expansions.

3. Stakeholder Engagement:

NTPC shall continue to identify all stakeholders and engage with them at appropriate levels, to exchange views on environmental concerns and mitigation measures thereof.

4. Capacity Building:

a. NTPC shall ensure all employees are made environmentally aware, to enable them to integrate its principles into their activities and decisions by conducting the suitable trainings/skill development programmes.

b. Environment Management Group shall come up with focused requirements (including skill training and culture building), clearly bringing out the desired objectives, audience and responsibility.

VII. Review:

This policy shall be reviewed at opportune time, but not later than once in three years.