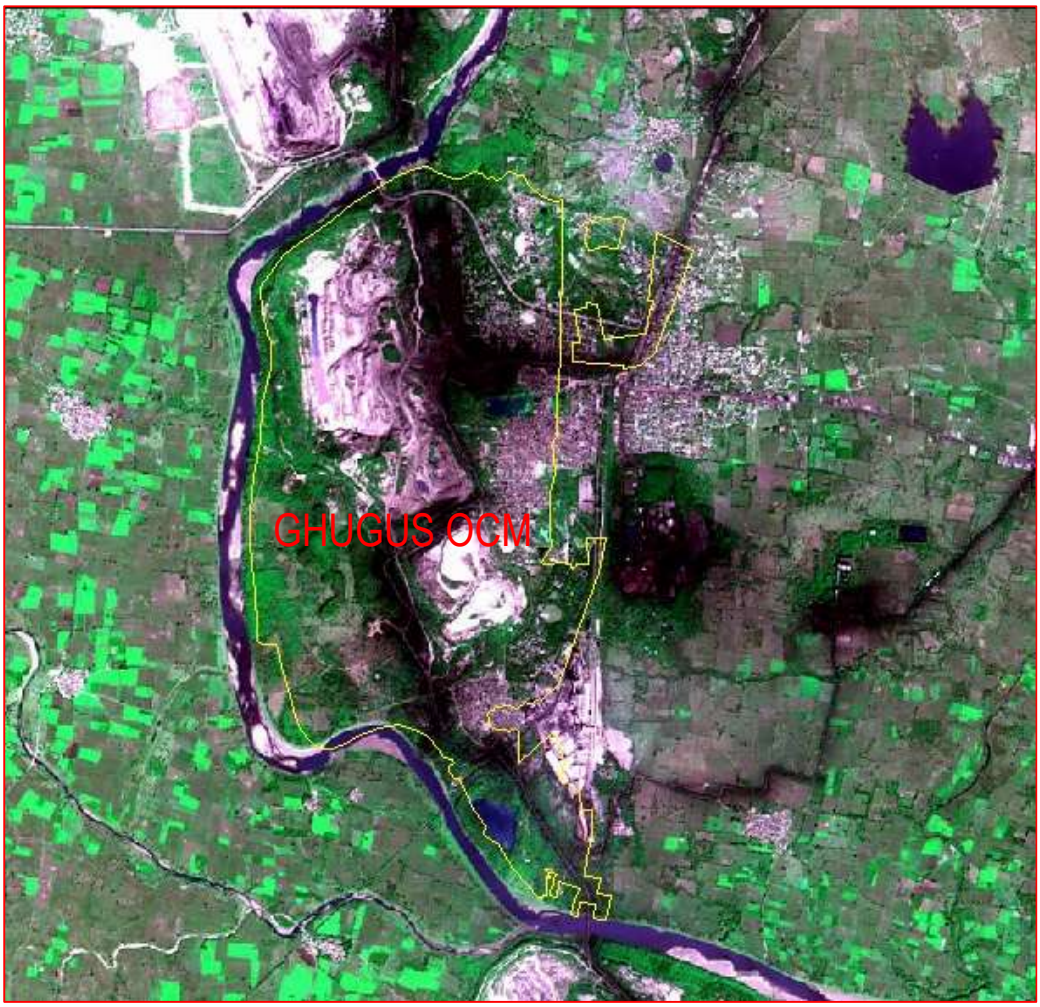
Land Restoration / Reclamation Monitoring of 08 Opencast Coal Mines of Western Coalfields Limited producing less than 5 mcm (Coal+ OB) per annum based on Satellite Data of the Year 2022



Submitted to
WESTERN COALFIELDS LIMITED

March 2023

Land Restoration / Reclamation Monitoring of 08 Opencast Coal Mines of Western Coalfields Limited producing less than 5 mcm (Coal+ OB) per annum based on Satellite Data of the Year 2022

MARCH-2023

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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Executive Summary

1.0 Project

Land restoration/ reclamation monitoring of 08 opencast mine in WCL producing less than 5 million cu.m. (Coal+OB) annually based on satellite data of the year 2022 on regular basis at an interval of three years.

2.0 Objective

Objective of the land restoration / reclamation monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest in the leasehold area of the projects. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3.0 Salient Findings

- Out of total 11 opencast projects producing less than 5 Millon cu.m (Coal+OB) annually of WCL viz Yekona-I & II, New Majri UG to OC, Pauni-II (Expn) OC, Gokul OC, Singhori OC, Bhanegaon OC, MKD-II OC, New sethia OC, Ghugus OC, Pimpalgaon OC and Datla OC mine taken for land reclamation monitoring during the Year 2019-20: Yekona-I & II, New Majri UG to OC and Pauni-II (Expn) OC were included under category of those OC mines which are producing more than 5 Millon cu.m (Coal+OB) together anually and report pertaing to status of land reclamation of these projects is being submitted separately since year 2021 along with other OC mines of similar category.

- Out of the total mine leasehold area of 3461.72 Hectare of the 08 OC projects Viz. Bhanegaon OC, Singhori OC, MKD-II OC, New Sethia OC, Ghugus OC, Pimpalgaon OC and Datla OC and Gokul OC mine taken up for land reclamation monitoring during year-2022-23; total excavated area is 964.19 Ha (27.85%). Out of this excavated area, 103.38 Ha area (10.72%) has been planted on backfill, 462.47 Ha area (47.96%) is under backfilling and balance 398.34 Ha area (41.32%) is under active mining. It is evident from the analysis that 565.85 Ha (58.69%) area of the above OC projects has already been reclaimed (biologically and technically) and balance 398.34 Ha (41.32%) area is under active mining. Project wise details are given in Table-1 & Bar chart (Fig-1).

- On comparing the status of land reclamation for 08 no. of opencast projects in WCL carried out in the year 2022-23 with respect to previous cycle study done in the year 2019-20 in these projects of WCL, it is evident from the analysis that area under land reclamation has increased from 511.10 hectares (Yr. 2019) to 565.85 hectares (Yr. 2022) which includes both plantation on backfill (Biological Reclamation) and area under backfilling (Technical Reclamation).

- It has been observed that area under plantation on backfill (Biological Reclamation) has increased from 88.96 Ha (10.70%) in the Yr. 2019 to 103.38 Ha (10.72%) in the year 2022 whereas area under technical reclamation (area under backfilling) has increased from 422.14 Ha (50.77%) in the year 2019 to 462.47 Ha (47.96%) in the Year 2022. This increase of 14.42 Ha in area of plantation on backfill and 40.33 Ha area under backfilling is the result of the sincere efforts made by Western Coalfields Ltd towards total land reclamation in all OC mines.

- Overall, the area under green cover has gone up from 649.91 Ha in the year 2019 to 736.35 Ha in the year 2022 which shows the sincere effort made by WCL towards environmental protection in their OC projects.

- Total area under reclamation in WCL has gone up from 511.10 Hectares (61.47%) in the year 2019 to 565.85 Hectares (58.69%) in the year 2022.

Table:1
Project wise Land Reclamation Status in OC mine in Western Coalfields Limited
(< 5 Million cu.m (Coal+ OB) together) based on Satellite data of the year 2022

(Area in Ha)

Sl.No	Project	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
						Biological Reclamation		Other Plantations											
				Area under Backfilling		Plantation on Excavated / Backfilled Area		Plantation on External Over Burden Dumps		Social Forestry, Avanue Plantation Etc.									
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11(=4+5)	
		2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022	2019	2022
1	Bhanegaon	347.46	347.46	2.45	1.18	0.00	0.00	8.75	16.54	16.11	20.74	31.82	34.86	34.27	36.04	24.86	37.28	2.45	1.18
				7.15%	3.27%	0.00%	0.00%					92.85%	96.73%			7.15%	10.73%	7.15%	3.27%
2	Singhori	425.04	425.04	0.00	0.00	0.00	0.00	0.00	0.00	4.59	7.63	26.82	50.56	26.82	50.56	4.59	7.63	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			1.08%	1.80%	0.00%	0.00%
3	Makardhokra-II	258.23	258.23	44.61	57.75	2.90	0.00	58.76	47.14	2.57	2.57	6.91	0.00	54.42	57.75	64.23	49.71	47.51	57.75
				81.97%	100.00%	5.33%	0.00%					12.70%	0.00%			24.87%	19.25%	87.30%	100.00%
4	New Sethia	144.45	144.45	25.99	30.65	23.58	18.92	6.80	7.01	9.53	10.15	40.81	41.65	90.38	91.22	39.91	36.08	49.57	49.57
				28.76%	33.60%	26.09%	20.74%					45.15%	45.66%			27.63%	24.98%	54.85%	54.34%
5	Ghugus	1020.00	1020.00	267.70	258.74	55.38	73.22	135.00	136.64	84.91	125.20	35.77	26.89	358.85	358.85	275.29	335.06	323.08	331.96
				74.60%	72.10%	15.43%	20.40%					9.97%	7.49%			26.99%	32.85%	90.03%	92.51%
6	Pimpalgaon	451.87	451.87	13.33	13.34	0.00	0.00	136.11	149.76	80.32	79.62	46.25	54.23	59.58	67.57	216.43	229.38	13.33	13.34
				22.37%	19.74%	0.00%	0.00%					77.63%	80.26%			47.90%	50.76%	22.37%	19.74%
7	Datla	57.75	57.75	28.21	25.32	7.10	11.24	0.00	0.00	0.00	0.00	13.21	11.95	48.52	48.51	7.10	11.24	35.31	36.56
				58.14%	52.20%	14.63%	23.17%					27.23%	24.63%			12.29%	19.46%	72.77%	75.37%
8	Gokul	756.92	756.92	39.85	75.49	0.00	0.00	0.00	0.00	17.50	29.97	118.78	178.20	158.63	253.69	17.50	29.97	39.85	75.49
				25.12%	29.76%	0.00%	0.00%					74.88%	70.24%			2.31%	3.96%	25.12%	29.76%
	TOTAL	**3461.72**	**3461.72**	**422.14**	**462.47**	**88.96**	**103.38**	**345.42**	**357.09**	**215.53**	**275.88**	**313.46**	**398.34**	**831.47**	**964.19**	**649.91**	**736.35**	**511.10**	**565.85**
				50.77%	**47.96%**	**10.70%**	**10.72%**					**37.70%**	**41.32%**	**24.02%**	**27.85%**	**18.77%**	**21.27%**	**61.47%**	**58.69%**

(% is calculated with respected to Excavated Area as applicable)

Note : In reference of the above Table-1, different parameters are classified as follows

1.Area under Biological Reclamation includes area under plantation done on backfilled area only.

2.Area under Technical Reclamation includes areas under barren backfill only.

3.Area under Active Mining includes coal quarry, advance quarry & quarry filled with water etc.

4.Social forestry and plantation on external OB dump are not included in biological reclamation and are put under other plantation.

5.% claculated in respect to total excaveted area except for "Total area under plantation" where % has been calculated in terms of leasehold area.

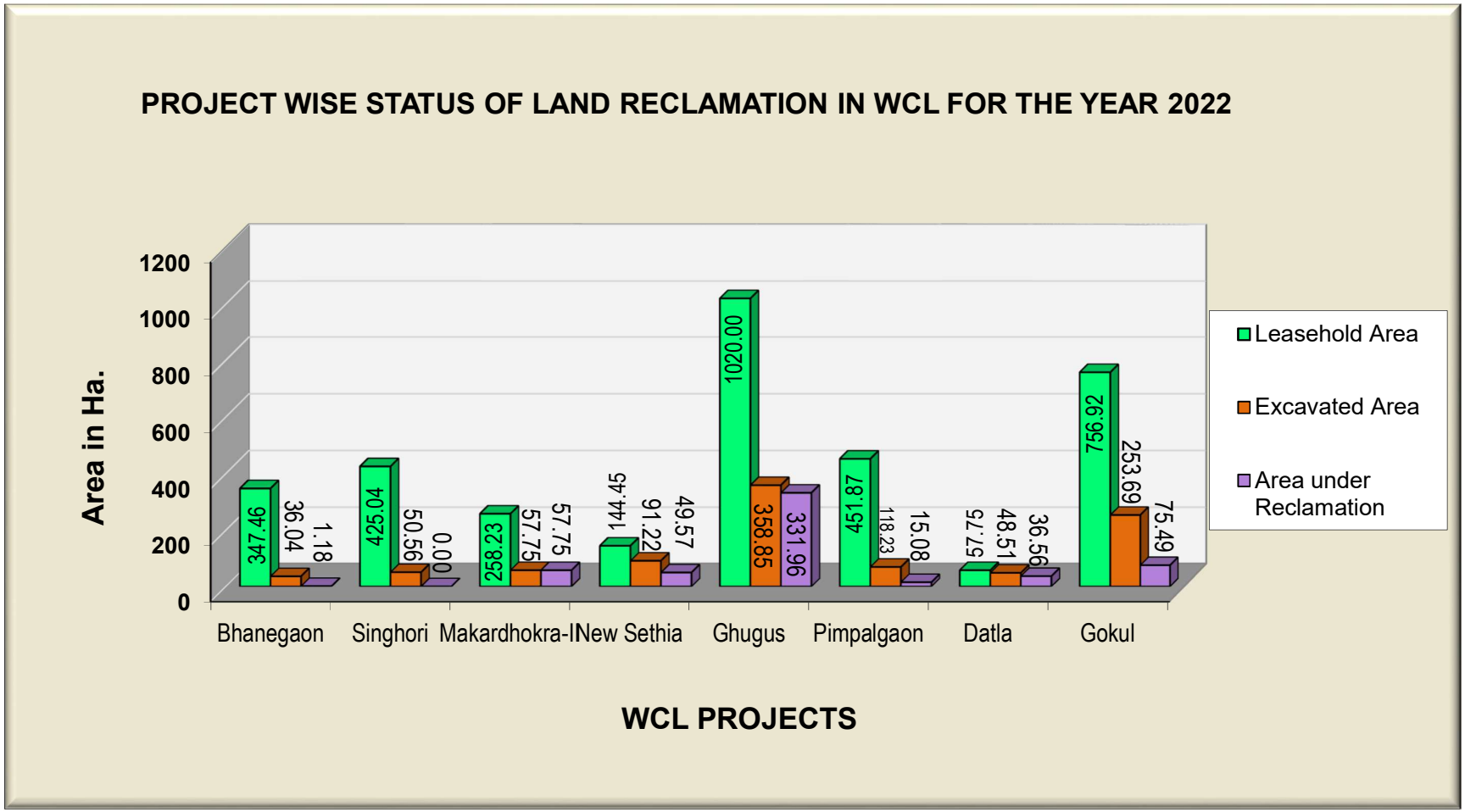


Figure: 1 Land Reclamation status in OC projects producing (less than 5 m.cm (Coal+ OB)) of WCL in the year-2022

1.0 Background

1.1 Land is the most important natural resource which embodies soil, water, flora fauna and total ecosystem. All human activities are based on the land which is the scarcest natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do effect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.12 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation status of all the opencast coal mines having production of less than 5 million m^3 per annum (coal + OB taken together per annum) regularly on annual basis and less than 5 million m^3 per annum (coal + OB taken together per annum) at interval of three years based on remote sensing satellite data, for sustainable development of mining. Further a revised work order vide letter no:CIL/WBP/Env/2017/DP/8477 dated 21.09.2017 from coal india Ltd for the period of 2017-18 to 201-22 for land reclamation monitoring of opencast projects and 19 major coalfields. According to this work order all mines in CIL with output capacity of 5 million cu.m (coal+OB) shall be monitored every year and all mines below this capacity shall be monitored at an interval of three years. The work order was renewed vide letter no. CIL/ ENVT/2022-23/W.O/10899 dated 06.07.2022 for a period of 2 more years from 2022-23 to 2023-24. The result of land reclamation status of all such mines to be put on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detail report to be submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all opencast coal mining projects would also comply the statutory requirements of Ministry of Environment, Forest & Climte Change (MoEF & CC). Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

1.4 Present report is embodying the finding of the study based on satellite data of the Year 2022 carried out for all the OC projects producing less than 5 mcm (Coal+OB) for Western Coalfields Ltd.

2.0 Objective

Objective of the land reclamation/restoration monitoring is to assess the area of backfilled, plantation, OB dumps, social forestry, active mining area, settlements and water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3.0 Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in given in figure-2. Following steps are involved in land reclamation /restoration monitoring:

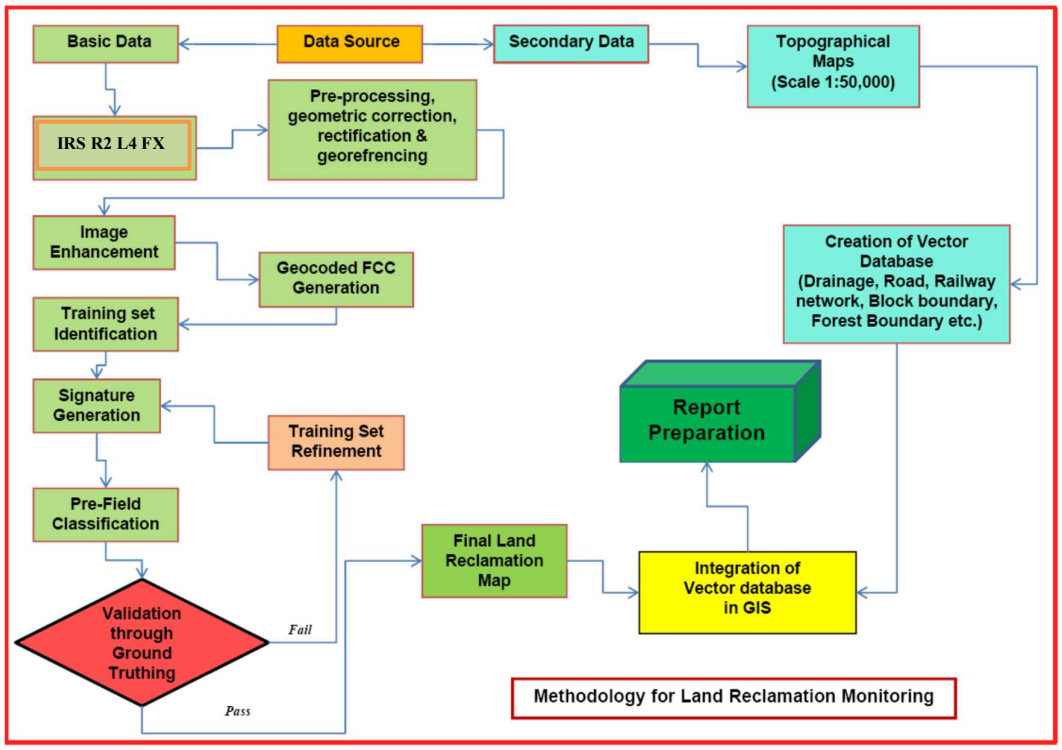


Figure :2 Methodology for Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary area arranged from respective subsidiaries/RIs and topo sheets are procured for creation of vector database.

3.2 Satellite Data Processing: Satellite data are processed using ERDAS IMAGINE version 2014 digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Georeferencing:** Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to satellite receiving station itself. Raw digital images contain geometric distortions, which make them unusable as maps. Therefore, geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible to SoI toposheet.

- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 2014 s/w. and enhance the image quality for interpretation.

- **Training set selection**

  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold of respective mines is determined by using ERDAS IMAGINE v. 2014 software.

- **Overlay of Vector data base**

  Vector data base created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

  Pre-field map is prepared for validation of the classification result

3.3 Ground Truthing:

Selective ground verification of the land use classes are carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation status database is created on GIS platform to identify the temporal changes identified from satellite data of different cut-of dates like year 2016, 2019 and 2022.

4.0 Land Reclamation Status in Western Coalfields Ltd.

4.1 Following eight opencast projects producing less than 5 million cubic m. (Coal + OB together) of Western Coalfields Ltd. have been taken up for land reclamation monitoring during the year 2022-23:

- Bhanegaon
- Singhori
- Makardhokra-II
- New Sethia
- Ghugus
- Pimpalgaon
- Datla
- Gokul

4.2 Area statistics of different land use classes present in the mine leasehold of the above projects for the year 2022 are shown in the Table - 2. Land use maps derived from satellite data are shown in Plate 1– 8. Status of land reclamation monitoring for the above mentioned 08 opencast projects were also prepared for the year 2016, 2019. Year wise changes in the different land use classes based on satellite data of the year 2016, 2019 and 2022 are depicted in Bar Charts in Fig. 3 – 10

4.3 Study reveals that out of total mine leasehold area of 3461.72 Ha of 08 OC projects in WCL Viz. Bhanegaon, Singhori, Makardhokra-II, New Sethia, Ghugus, Pimpalgaon, Datla and Gokul OC considered for monitoring during year 2022-23; total excavated area is 964.19 Ha (27.85%), out of which 103.38 Ha (10.72%) area has been revegetated (Biologically reclaimed) and 462.47 Ha (47.96%) area is under backfilling (Technically reclaimed) and balance 398.34 Hectare (41.32%) area is under active mining. It is evident from analysis that 565.85 Hectare (58.69%) area of above OC projects is under total reclamation in WCL. Project wise details are given in Table-1.

4.4 It is evident from the analysis that area under land reclamation has increased from 511.10 Ha (Yr. 2019) to 565.85 Ha (Yr. 2022) which includes both plantation on backfill (Biological Reclamation) and area under backfilling (Technical Reclamation). This

increase of 54.75 Ha area under total reclamation for eight opencast mines of WCL in the period of three years is due to increase in area under Technical reclamation and Biological Reclamation to the tune of 40.33 Ha and 14.42 Ha respectively. Project wise status of Land reclamation for eight OC mines is shown in bar chart (Figure-1).

4.5 There has been overall increase in area under Technical reclamation (area under backfilling) in all projects of WCL except in Bhanegaon, Ghugus and Datla OC. In Bhanegaon OC, area under technical reclamation has decreased from 2.45 Ha (Yr. 2019) to 1.18 Ha (Yr. 2022). This decrease of 1.27 Ha area under backfilling during year 2022 as compared to the year 2019 is due to rehandling of backfill whereas decrease of 8.96 Ha and 2.89 Ha area under backfilling in Ghugus OC and Datla OC are due to more backfilling area occupied with plantation on backfill area.

4.6 After analyzing the satellite data of year 2019 vs. 2022, it is evident that total area under plantation (Green Cover) carried out on backfilled area, OB dumps as well as area under social forestry in all the mines of WCL has increased from 649.91 Ha area (Yr. 2019) to 736.35 Hectare area (Yr. 2022). This increase of 86.44 Hectare area under total plantation (Green Cover) during three years is due to more plantation has been carried out on backfill, OB dump and under social forestry within leasehold area of the mines.

4.7 MKD-II OC mine has been closed and backfilling process is in progress, hence active mining is zero whereas area under backfilling (Technical Reclamation) has increased from 44.61 Hectare in the year 2019 to 57.75 Hectare in the year 2022.

4.8 In Datla OC mine area under backfilling (Technical Reclamation) has decreased from 28.21 Ha in the year 2019 to 25.32 Ha in the year 2022. This decrease of 2.89 Ha in area under backfilling is due to more plantation carried out in backfill area resulting which area of plantation on backfill (Biological Reclamation) has increased from 7.10 Ha in the year 2019 to 11.24 Ha in the year 2022.

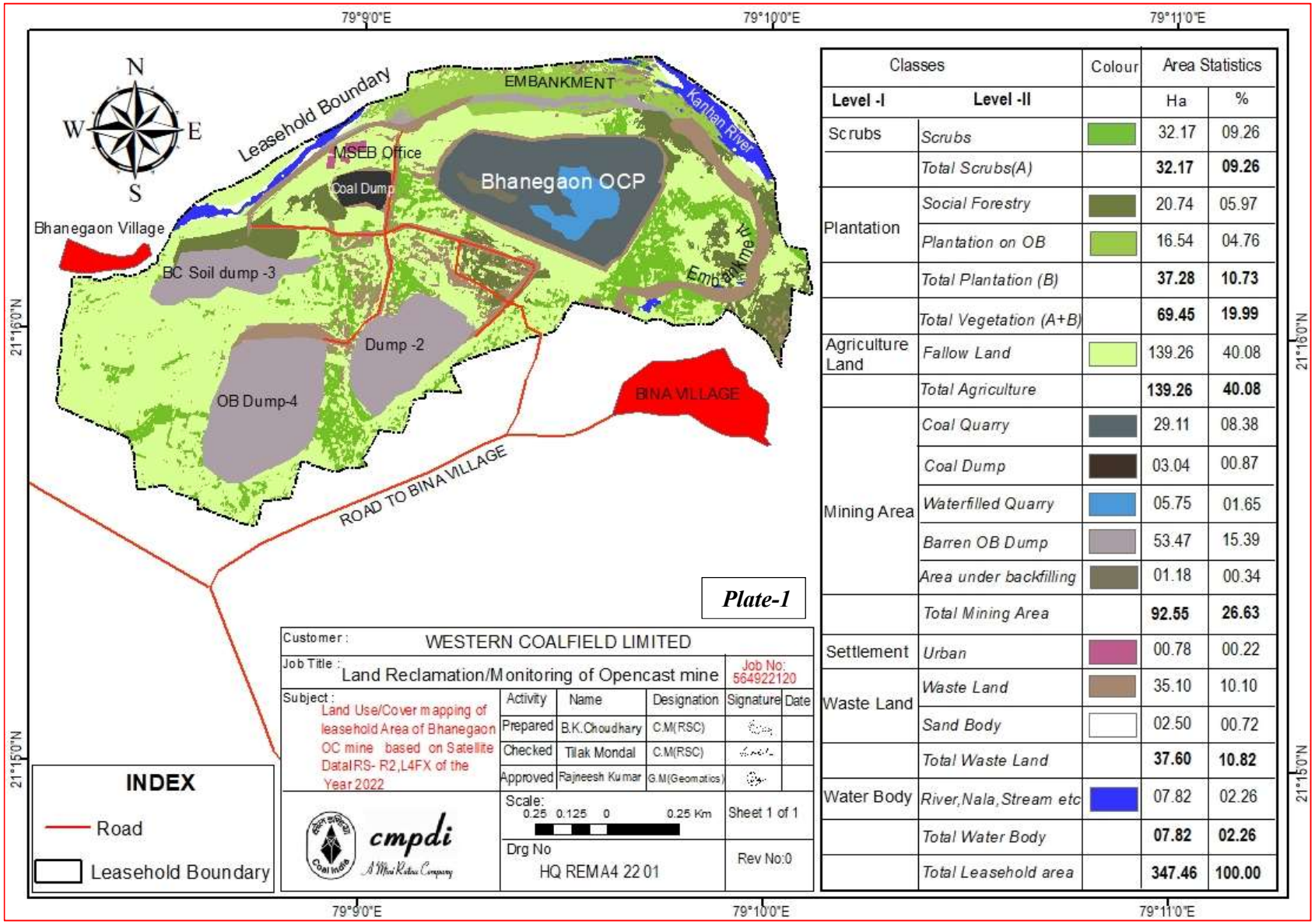
4.9 Out of 08 projects of WCL, maximum land reclamation has been carried out in MKD-II OC projects (100%) followed by Ghugus (92.51%), Datla OC (75.37%), New sethia (54.34%) and Gokul (29.76%) respectively.

TABLE 2

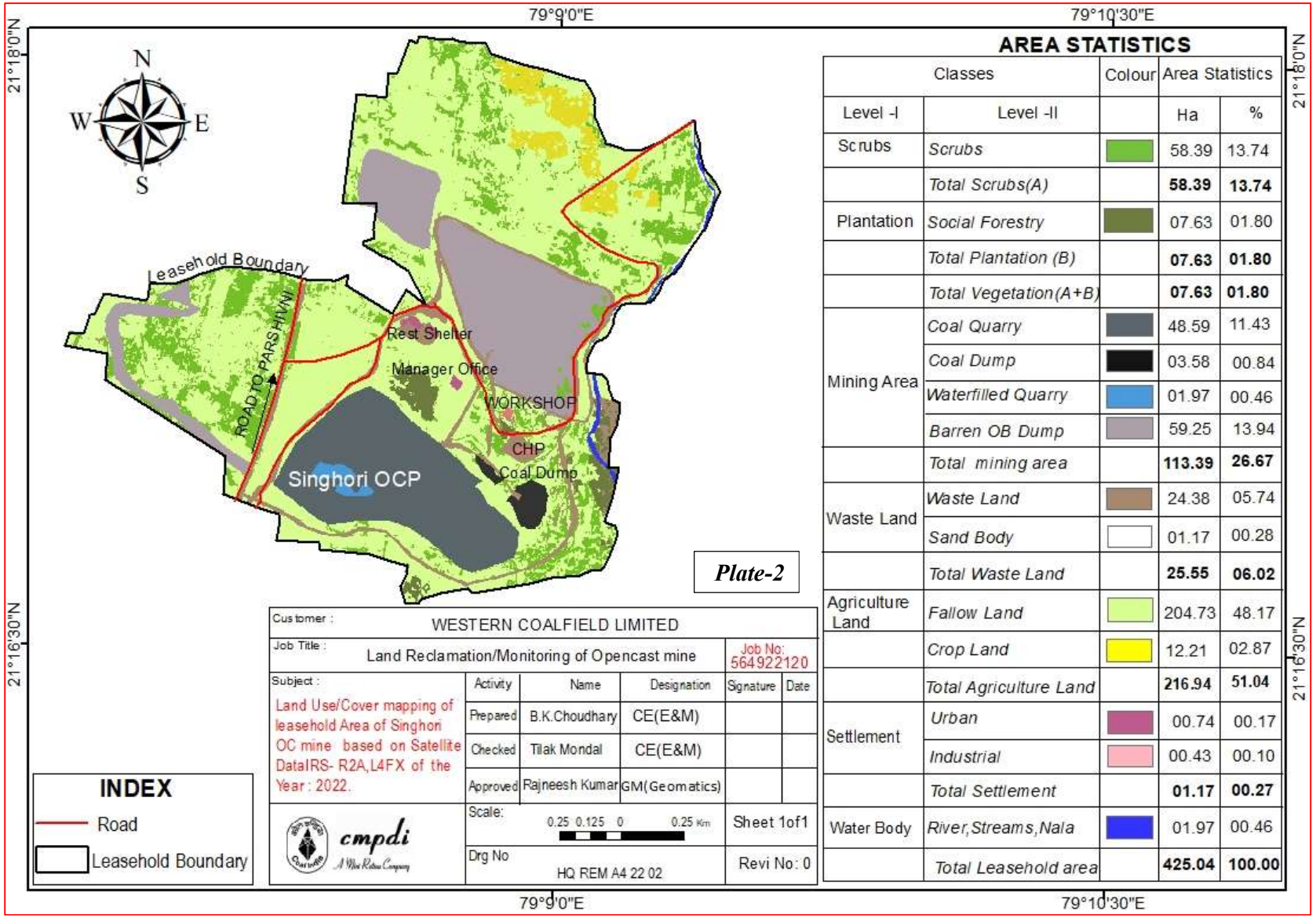
PROJECT-WISE AREA STATISTICS OF LAND USE/COVER CLASSES IN OC MINES OF WCL PRODUCING (<5 M.C.M (COAL +OB)) BASED ON SATELLITE DATA OF THE YEAR 2022

(Area in Hectare)

		BHANEGAON		SINGHORI		MKD-II		NEW SETHIA		GHUGUS		PIMPALGAON		DATLA		GOKUL		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Forest/Tree plantation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	Scrubs	32.17	9.26	58.39	13.74	9.44	3.66	9.76	6.71	66.42	6.51	21.74	4.81	0.56	0.98	55.07	7.28	253.55	7.32
PLANTATION	Social Forestry	20.74	5.97	7.63	1.80	2.57	0.99	10.15	6.98	125.20	12.27	79.62	17.62	0.00	0.00	29.97	3.95	275.88	7.97
	Plantation on OB Dump	16.54	4.76	0.00	0.00	47.14	18.26	7.01	4.82	136.64	13.40	149.76	33.14	0.00	0.00	0.00	0.00	357.09	10.32
	Plantation on Backfill	0.00	0.00	0.00	0.00	0.00	0.00	18.92	13.01	73.22	7.18	0.00	0.00	11.24	19.47	0.00	0.00	103.38	2.99
	Total Plantation *(Green Cover Generated)*	**37.28**	**10.73**	**7.63**	**1.80**	**49.71**	**19.25**	**36.08**	**24.81**	**335.06**	**32.85**	**229.38**	**50.76**	**11.24**	**19.47**	**29.97**	**3.95**	**736.35**	**21.28**
	Plantation on Backfill(Biologically reclaimed)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**18.92**	**13.01**	**73.22**	**7.18**	**0.00**	**0.00**	**11.24**	**19.47**	**0.00**	**0.00**	**103.38**	**2.99**
	Total Vegetation Cover	**69.45**	**19.99**	**66.02**	**15.54**	**59.15**	**22.91**	**45.84**	**31.52**	**401.48**	**39.36**	**251.12**	**55.57**	**11.80**	**20.45**	**85.04**	**11.23**	**989.90**	**28.60**
ACTIVE MINING	Coal Quarry	29.11	8.38	48.59	11.43	0.00	0.00	10.50	7.22	16.04	1.57	29.09	6.44	2.68	4.65	121.49	16.05	257.50	7.44
	Coal Dump	3.04	0.87	3.58	0.84	6.91	2.68	1.21	0.83	3.70	0.36	2.44	0.54	0.00	0.00	17.16	2.27	38.04	1.10
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.98	7.40	55.98	1.62
	Quarry Filled With Water	5.75	1.65	1.97	0.46	0.00	0.00	31.15	21.42	10.85	1.06	22.70	5.02	9.27	16.06	0.73	0.10	82.42	2.38
	Total Area under *Active Mining*	**37.90**	**10.90**	**54.14**	**12.73**	**6.91**	**2.68**	**42.86**	**29.47**	**30.59**	**2.99**	**54.23**	**12.00**	**11.95**	**20.71**	**195.36**	**25.82**	**433.94**	**12.54**
RECLAIMED	Barren OB Dump	53.47	15.39	59.25	13.94	62.92	24.37	3.74	2.57	26.73	2.62	85.64	18.95	0.00	0.00	148.68	19.64	440.43	12.72
	Barren Backfilled Area	1.18	0.34	0.00	0.00	57.75	22.36	30.65	21.07	258.74	25.37	13.34	2.95	25.32	43.85	75.49	9.97	462.47	13.36
	Total Area under *Technical Reclamation*	**1.18**	**0.34**	**0.00**	**0.00**	**57.75**	**22.36**	**30.65**	**21.07**	**258.74**	**25.37**	**13.34**	**2.95**	**25.32**	**43.85**	**75.49**	**9.97**	**462.47**	**13.20**
	Total Area Under Mine Operation	**92.55**	**26.63**	**113.39**	**26.67**	**127.58**	**49.41**	**77.25**	**53.11**	**316.06**	**30.98**	**153.21**	**33.90**	**37.27**	**64.56**	**419.53**	**55.43**	**1336.84**	**38.46**
WASTELAND	Waste Lands	35.10	10.10	24.38	5.74	14.61	5.66	12.75	8.77	136.01	13.33	41.61	9.21	7.53	13.03	50.16	6.63	322.15	9.31
	Fly Ash Pond / Sand Body	2.50	0.72	1.17	0.28	0.00	0.00	3.78	2.60	1.30	0.13	0.00	0.00	0.59	1.02	0.00	0.00	9.34	0.27
	Total Wasteland	**37.60**	**10.82**	**25.55**	**6.02**	**14.61**	**5.66**	**16.53**	**11.37**	**137.31**	**13.46**	**41.61**	**9.21**	**8.12**	**14.05**	**50.16**	**6.63**	**331.49**	**9.58**
WATERBODIES	Reservoir, nallah, ponds	7.82	2.26	1.97	0.46	0.00	0.00	2.66	1.84	7.31	0.72	0.00	0.00	0.56	0.94	4.60	0.61	24.92	0.72
	Total Waterbodies	**7.82**	**2.26**	**1.97**	**0.46**	**0.00**	**0.00**	**2.66**	**1.84**	**7.31**	**0.72**	**0.00**	**0.00**	**0.56**	**0.94**	**4.60**	**0.61**	24.92	0.72
AGRICULTURE	Crop Lands	0.00	0.00	12.21	2.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.98	1.05	20.19	0.58
	Fallow Lands	139.26	40.08	204.73	48.17	56.24	21.78	1.03	0.70	88.64	8.69	0.00	0.00	0.00	0.00	172.16	22.74	662.06	19.13
	Total Agriculture	**139.26**	**40.08**	**216.94**	**51.04**	**56.24**	**21.78**	**1.03**	**0.70**	**88.64**	**8.69**	**0.00**	**0.00**	**0.00**	**0.00**	**180.14**	**23.79**	**682.25**	**19.71**
SETTLEMENTS	Urban Settlement	0.78	0.22	0.74	0.17	0.39	0.14	1.91	1.30	38.10	3.74	1.99	0.44	0.00	0.00	1.08	0.14	43.99	1.27
	Rural Settlement	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.40	2.39	1.73	0.38	0.00	0.00	0.36	0.05	26.49	0.77
	Industrial Settlement	0.00	0.00	0.43	0.10	0.26	0.10	0.23	0.16	6.70	0.66	2.21	0.50	0.00	0.00	16.01	2.12	25.84	0.75
	Total Settlement	**0.78**	**0.22**	**1.17**	**0.27**	**0.65**	**0.24**	**2.14**	**1.46**	**69.20**	**6.79**	**5.93**	**1.32**	**0.00**	**0.00**	**17.45**	**2.31**	**96.32**	2.79
	Grand Total	**347.46**	**100.00**	**425.04**	**100.00**	**258.23**	**100.00**	**145.45**	**100.00**	**1020.00**	**100.00**	**451.87**	**100.00**	**57.75**	**100.00**	**756.92**	**100.00**	**3461.72**	**100.00**

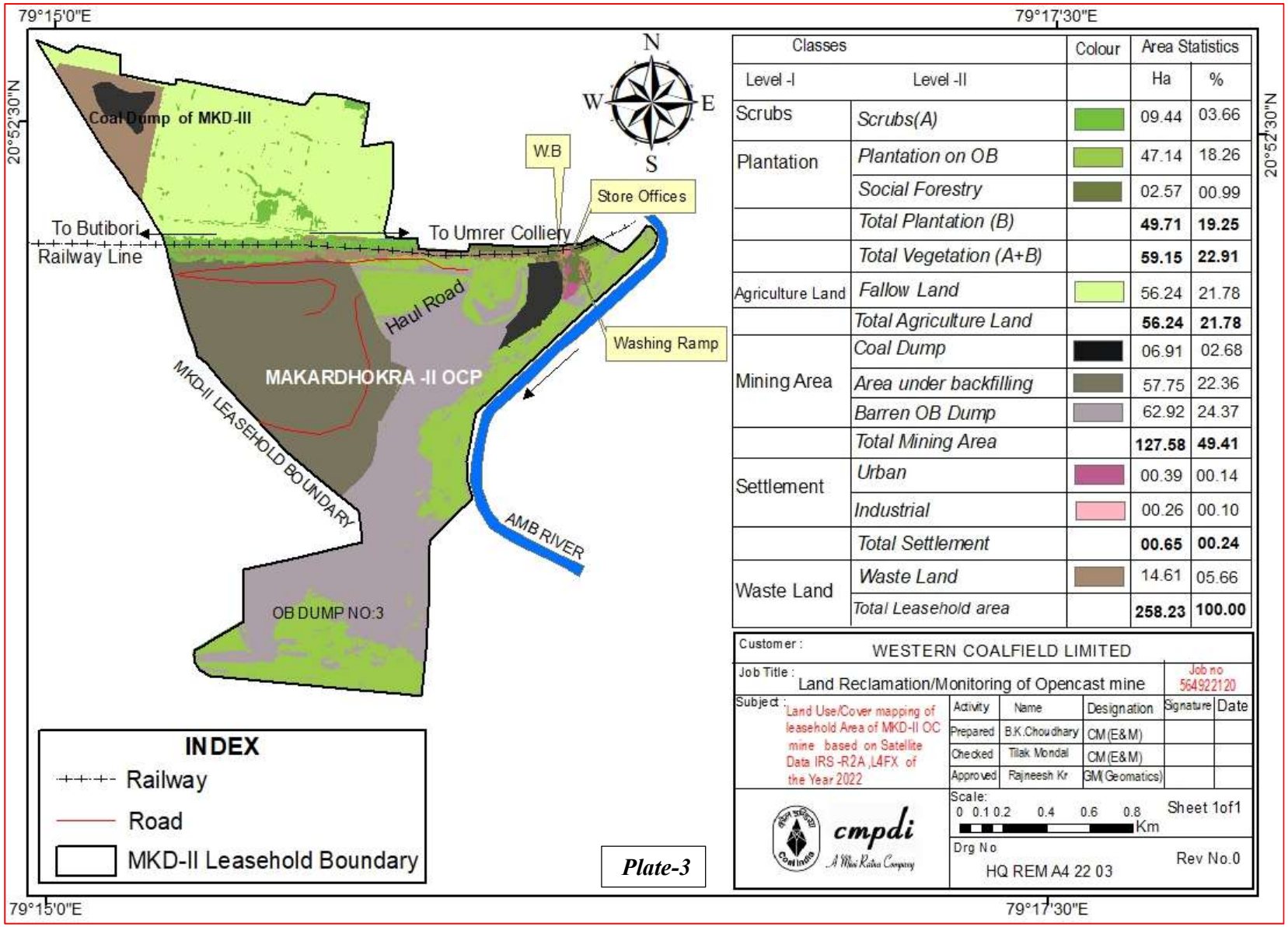


Classes		Colour	Area Statistics	
Level -I	**Level -II**		Ha	%
Scrubs	*Scrubs*		32.17	09.26
	Total Scrubs(A)		**32.17**	**09.26**
Plantation	*Social Forestry*		20.74	05.97
	Plantation on OB		16.54	04.76
	Total Plantation (B)		**37.28**	**10.73**
	Total Vegetation (A+B)		**69.45**	**19.99**
Agriculture Land	*Fallow Land*		139.26	40.08
	Total Agriculture		**139.26**	**40.08**
Mining Area	*Coal Quarry*		29.11	08.38
	Coal Dump		03.04	00.87
	Waterfilled Quarry		05.75	01.65
	Barren OB Dump		53.47	15.39
	Area under backfilling		01.18	00.34
	Total Mining Area		**92.55**	**26.63**
Settlement	*Urban*		00.78	00.22
Waste Land	*Waste Land*		35.10	10.10
	Sand Body		02.50	00.72
	Total Waste Land		**37.60**	**10.82**
Water Body	*River,Nala,Stream etc*		07.82	02.26
	Total Water Body		**07.82**	**02.26**
	Total Leasehold area		**347.46**	**100.00**



AREA STATISTICS

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs*		58.39	13.74
	Total Scrubs(A)		**58.39**	**13.74**
Plantation	*Social Forestry*		07.63	01.80
	Total Plantation (B)		**07.63**	**01.80**
	Total Vegetation(A+B)		**07.63**	**01.80**
Mining Area	*Coal Quarry*		48.59	11.43
	Coal Dump		03.58	00.84
	Waterfilled Quarry		01.97	00.46
	Barren OB Dump		59.25	13.94
	Total mining area		**113.39**	**26.67**
Waste Land	*Waste Land*		24.38	05.74
	Sand Body		01.17	00.28
	Total Waste Land		**25.55**	**06.02**
Agriculture Land	*Fallow Land*		204.73	48.17
	Crop Land		12.21	02.87
	Total Agriculture Land		**216.94**	**51.04**
Settlement	*Urban*		00.74	00.17
	Industrial		00.43	00.10
	Total Settlement		**01.17**	**00.27**
Water Body	*River,Streams,Nala*		01.97	00.46
	Total Leasehold area		**425.04**	**100.00**



Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs(A)*		09.44	03.66
Plantation	*Plantation on OB*		47.14	18.26
	Social Forestry		02.57	00.99
	Total Plantation (B)		**49.71**	**19.25**
	Total Vegetation (A+B)		**59.15**	**22.91**
Agriculture Land	*Fallow Land*		56.24	21.78
	Total Agriculture Land		**56.24**	**21.78**
Mining Area	*Coal Dump*		06.91	02.68
	Area under backfilling		57.75	22.36
	Barren OB Dump		62.92	24.37
	Total Mining Area		**127.58**	**49.41**
Settlement	*Urban*		00.39	00.14
	Industrial		00.26	00.10
	Total Settlement		**00.65**	**00.24**
Waste Land	*Waste Land*		14.61	05.66
	Total Leasehold area		**258.23**	**100.00**

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of Opencast mine — Job no 564922120

Subject : Land Use/Cover mapping of leasehold Area of MKD-II OC mine based on Satellite Data IRS -R2A ,L4FX of the Year 2022

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	CM(E&M)		
Checked	Tilak Mondal	CM(E&M)		
Approved	Rajneesh Kr	GM(Geomatics)		

Scale: 0 0.1 0.2 0.4 0.6 0.8 Km — Sheet 1of1

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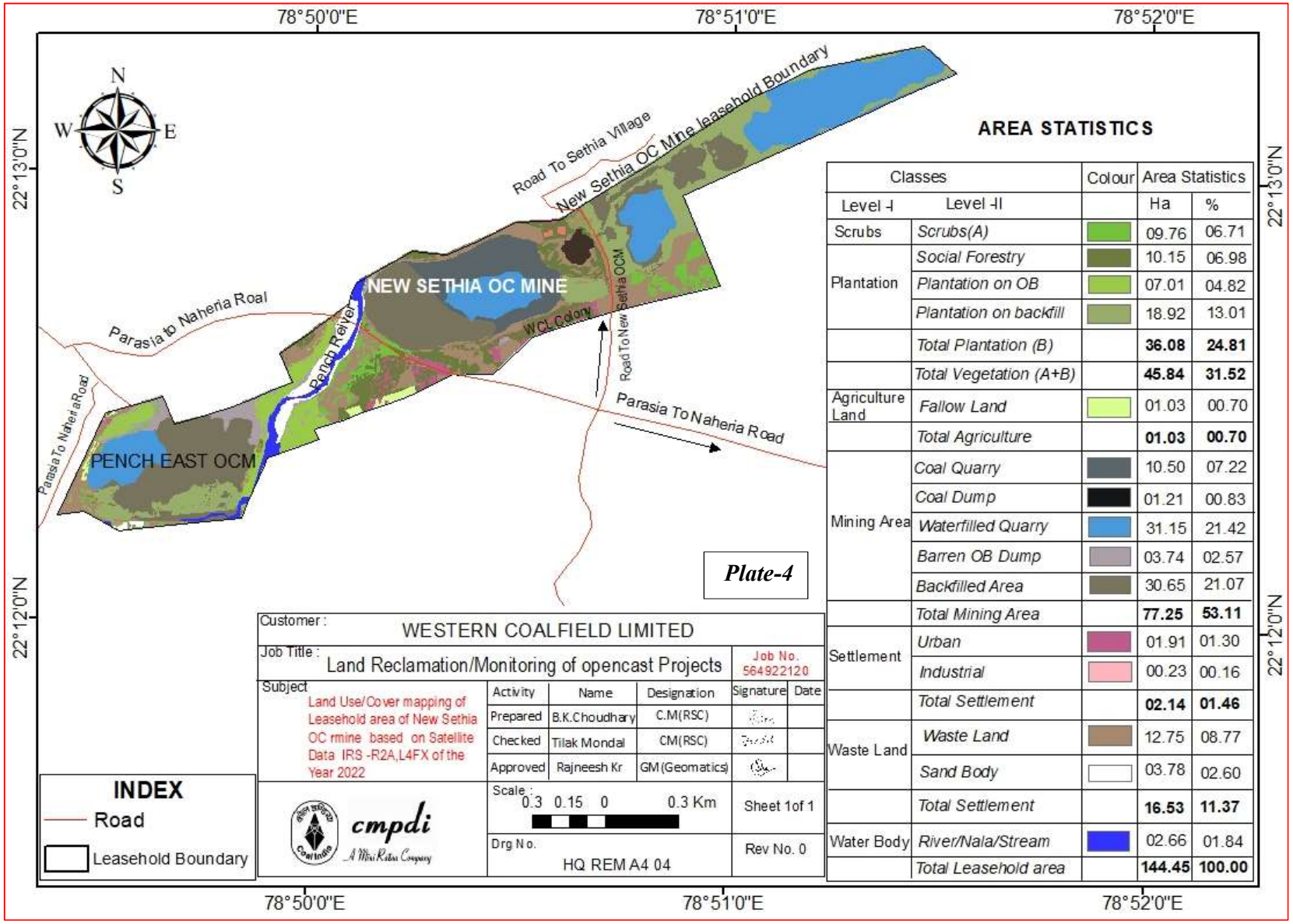
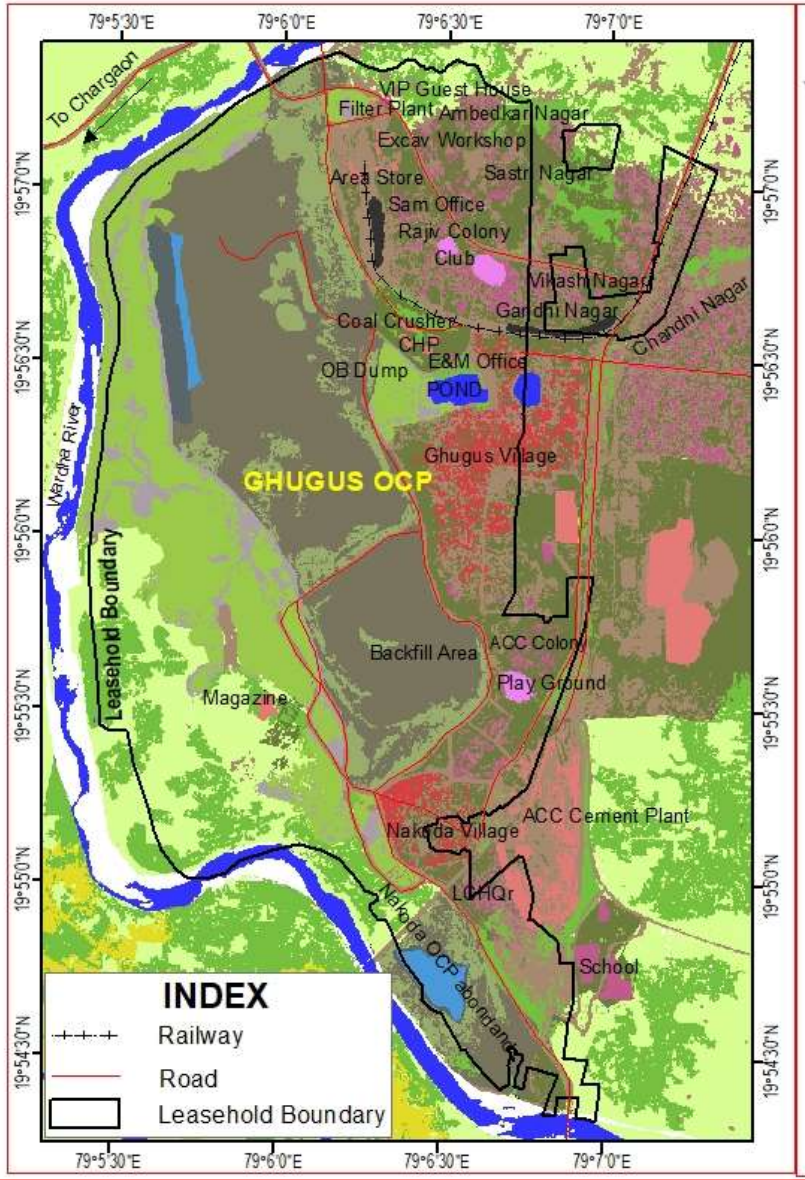


AREA STATISTICS

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs(A)*		09.76	06.71
Plantation	*Social Forestry*		10.15	06.98
	Plantation on OB		07.01	04.82
	Plantation on backfill		18.92	13.01
	Total Plantation (B)		**36.08**	**24.81**
	Total Vegetation (A+B)		**45.84**	**31.52**
Agriculture Land	*Fallow Land*		01.03	00.70
	Total Agriculture		**01.03**	**00.70**
Mining Area	*Coal Quarry*		10.50	07.22
	Coal Dump		01.21	00.83
	Waterfilled Quarry		31.15	21.42
	Barren OB Dump		03.74	02.57
	Backfilled Area		30.65	21.07
	Total Mining Area		**77.25**	**53.11**
Settlement	*Urban*		01.91	01.30
	Industrial		00.23	00.16
	Total Settlement		**02.14**	**01.46**
Waste Land	*Waste Land*		12.75	08.77
	Sand Body		03.78	02.60
	Total Settlement		**16.53**	**11.37**
Water Body	*River/Nala/Stream*		02.66	01.84
	Total Leasehold area		**144.45**	**100.00**



Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs(A)*		*66.42*	*06.51*
Plantation	*Plantation on OB*		*136.64*	*13.40*
	Social Forestry		*125.20*	*12.27*
	Plantation on backfill		*73.22*	*07.18*
	Total Plantation (B)		***335.06***	***32.85***
	Total Vegetation (A+B)		***401.48***	***39.36***
Agriculture Land	*Fallow Land*		*88.64*	*08.69*
	Total Agriculture		***88.64***	***08.69***
Mining Area	*Coal Quarry*		*16.04*	*01.57*
	Coal Dump		*03.70*	*00.36*
	Waterfilled Quarry		*10.85*	*01.06*
	Barren OB Dump		*26.73*	*02.62*
	Backfilled Area		*258.74*	*25.37*
	Total Mining Area		***316.06***	***30.98***
Settlement	*Urban*		*38.10*	*03.74*
	Industrial		*06.70*	*00.66*
	Rural		*24.40*	*02.39*
	Total settlement		***69.20***	***06.79***
Waste Land	*Waste Land*		*136.01*	*13.33*
	Sand Body		*01.30*	*00.13*
	Total waste land		***137.31***	***13.46***
Water Body	*River/Pond/stream etc*		***07.31***	***00.72***
	Total Leasehold area		***1020.00***	***100.00***

Customer : WESTERN COALFIELD LIMITED

Job Title : Reclamation /Monitoring of Opencast mine

Job No: 564922120

Subject : Land Use / Cover mapping of leasehold Area ofGhugus OC mine based on Satellite Data IRS R2 A-L4FX of the year : 2022

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M(E&M)		
Checked	Tilak Mondal	C.M(E&M)		
Approved	Rajneesh Kumar	GM(Geomatics)		

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Sheet 1 of1

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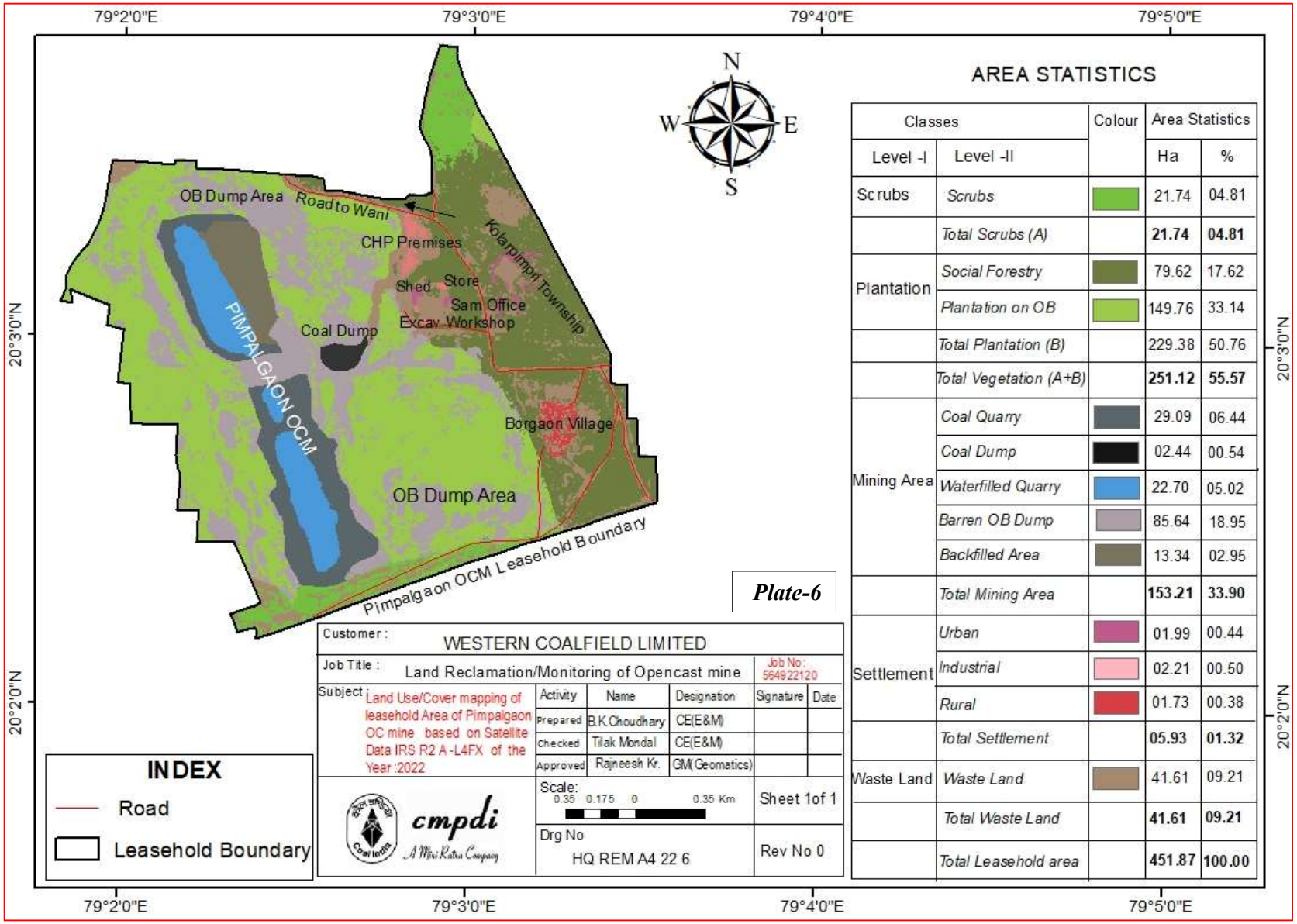
Rev No:0

Plate-5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79°3'0"E
79°4'0"E
79°5'0"E
20°3'0"N
20°2'0"N
N
S
E
W
OB Dump Area
Road to Wani
CHP Premises
Kolarpimpri Township
Shed
Store
Sam Office
Excav. Workshop
Coal Dump
PIMPALGAON OCM
Borgaon Village
OB Dump Area
Pimpalgaon OCM Leasehold Boundary
Plate-6
AREA STATISTICS
Classes
Colour
Area Statistics
Level -I
Level -II
Ha
%
Scrubs
Scrubs
21.74
04.81
Total Scrubs (A)
21.74
04.81
Plantation
Social Forestry
79.62
17.62
Plantation on OB
149.76
33.14
Total Plantation (B)
229.38
50.76
Total Vegetation (A+B)
251.12
55.57
Mining Area
Coal Quarry
29.09
06.44
Coal Dump
02.44
00.54
Waterfilled Quarry
22.70
05.02
Barren OB Dump
85.64
18.95
Backfilled Area
13.34
02.95
Total Mining Area
153.21
33.90
Settlement
Urban
01.99
00.44
Industrial
02.21
00.50
Rural
01.73
00.38
Total Settlement
05.93
01.32
Waste Land
Waste Land
41.61
09.21
Total Waste Land
41.61
09.21
Total Leasehold area
451.87
100.00
INDEX
Road
Leasehold Boundary
Customer :
WESTERN COALFIELD LIMITED
Job Title :
Land Reclamation/Monitoring of Opencast mine
Job No : 564922120
Subject :
Land Use/Cover mapping of leasehold Area of Pimpalgaon OC mine based on Satellite Data IRS R2 A-L4FX of the Year :2022
Activity
Name
Designation
Signature
Date
Prepared
B.K.Choudhary
CE(E&M)
Checked
Tilak Mondal
CE(E&M)
Approved
Rajneesh Kr.
GM(Geomatics)
cmpdi
A Mini Ratna Company
Scale:
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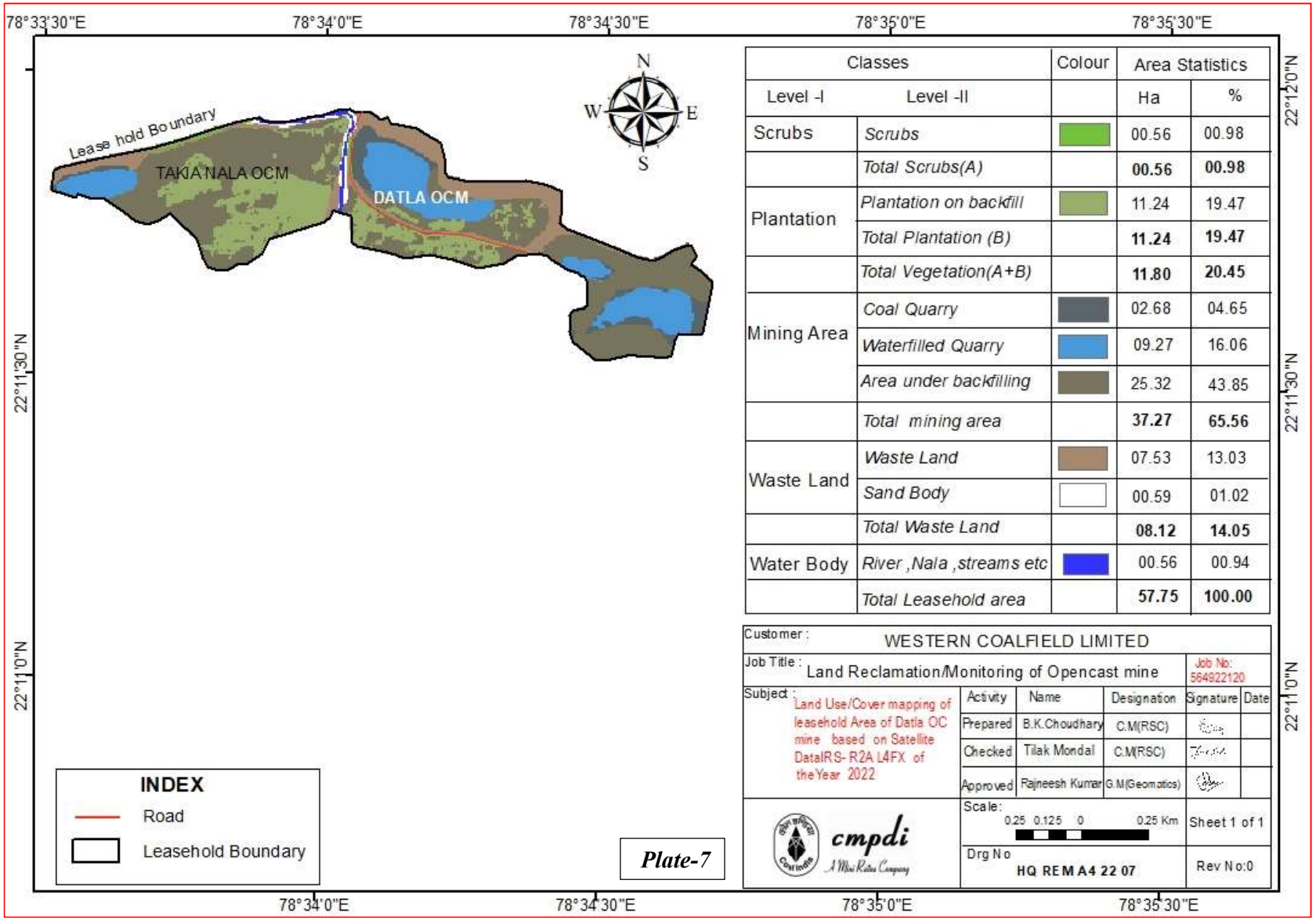
Sheet 1of 1
Drg No
HQ REM A4 22 6
Rev No 0



Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	*Scrubs*		00.56	00.98
	Total Scrubs(A)		**00.56**	**00.98**
Plantation	*Plantation on backfill*		11.24	19.47
	Total Plantation (B)		**11.24**	**19.47**
	Total Vegetation(A+B)		**11.80**	**20.45**
Mining Area	*Coal Quarry*		02.68	04.65
	Waterfilled Quarry		09.27	16.06
	Area under backfilling		25.32	43.85
	Total mining area		**37.27**	**65.56**
Waste Land	*Waste Land*		07.53	13.03
	Sand Body		00.59	01.02
	Total Waste Land		**08.12**	**14.05**
Water Body	*River ,Nala ,streams etc*		00.56	00.94
	Total Leasehold area		**57.75**	**100.00**

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of Opencast mine — Job No: 564922120

Subject : Land Use/Cover mapping of leasehold Area of Datla OC mine based on Satellite DataIRS- R2A L4FX of the Year 2022

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M(RSC)		
Checked	Tilak Mondal	C.M(RSC)		
Approved	Rajneesh Kumar	G.M(Geomatics)		

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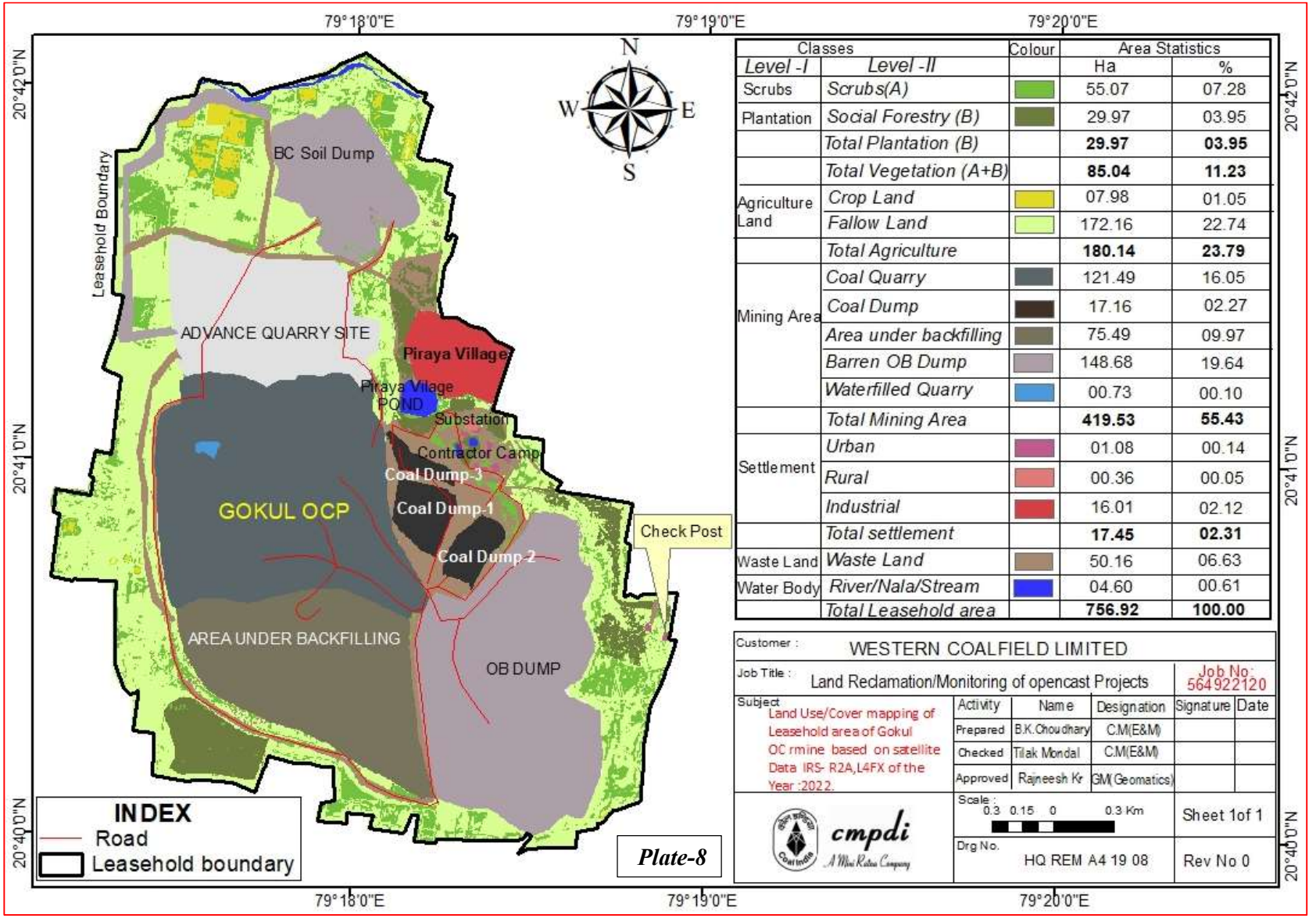

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		55.07	07.28
Plantation	Social Forestry (B)		29.97	03.95
	Total Plantation (B)		**29.97**	**03.95**
	Total Vegetation (A+B)		**85.04**	**11.23**
Agriculture Land	Crop Land		07.98	01.05
	Fallow Land		172.16	22.74
	Total Agriculture		**180.14**	**23.79**
Mining Area	Coal Quarry		121.49	16.05
	Coal Dump		17.16	02.27
	Area under backfilling		75.49	09.97
	Barren OB Dump		148.68	19.64
	Waterfilled Quarry		00.73	00.10
	Total Mining Area		**419.53**	**55.43**
Settlement	Urban		01.08	00.14
	Rural		00.36	00.05
	Industrial		16.01	02.12
	Total settlement		**17.45**	**02.31**
Waste Land	Waste Land		50.16	06.63
Water Body	River/Nala/Stream		04.60	00.61
	Total Leasehold area		**756.92**	**100.00**

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of opencast Projects — Job No: 564922120

Subject: Land Use/Cover mapping of Leasehold area of Gokul OC rmine based on satellite Data IRS- R2A,L4FX of the Year :2022.

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M(E&M)		
Checked	Tilak Mondal	C.M(E&M)		
Approved	Rajneesh Kr	GM(Geomatics)		

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Sheet 1of 1

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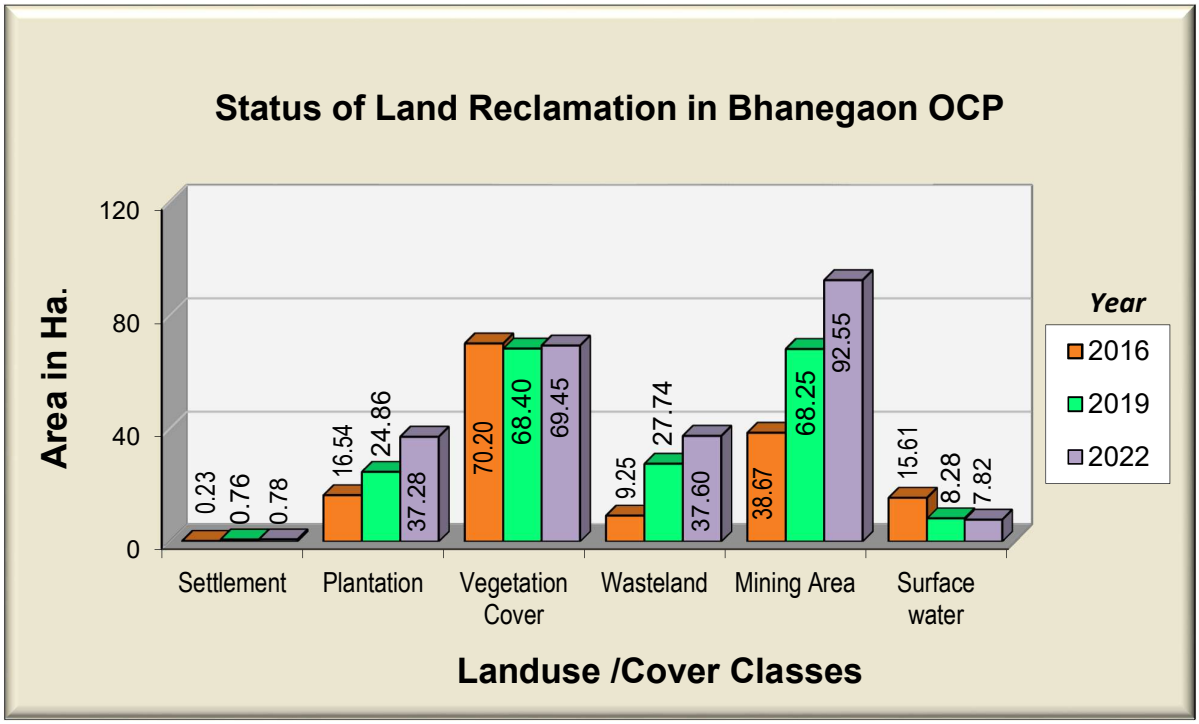
Rev No 0



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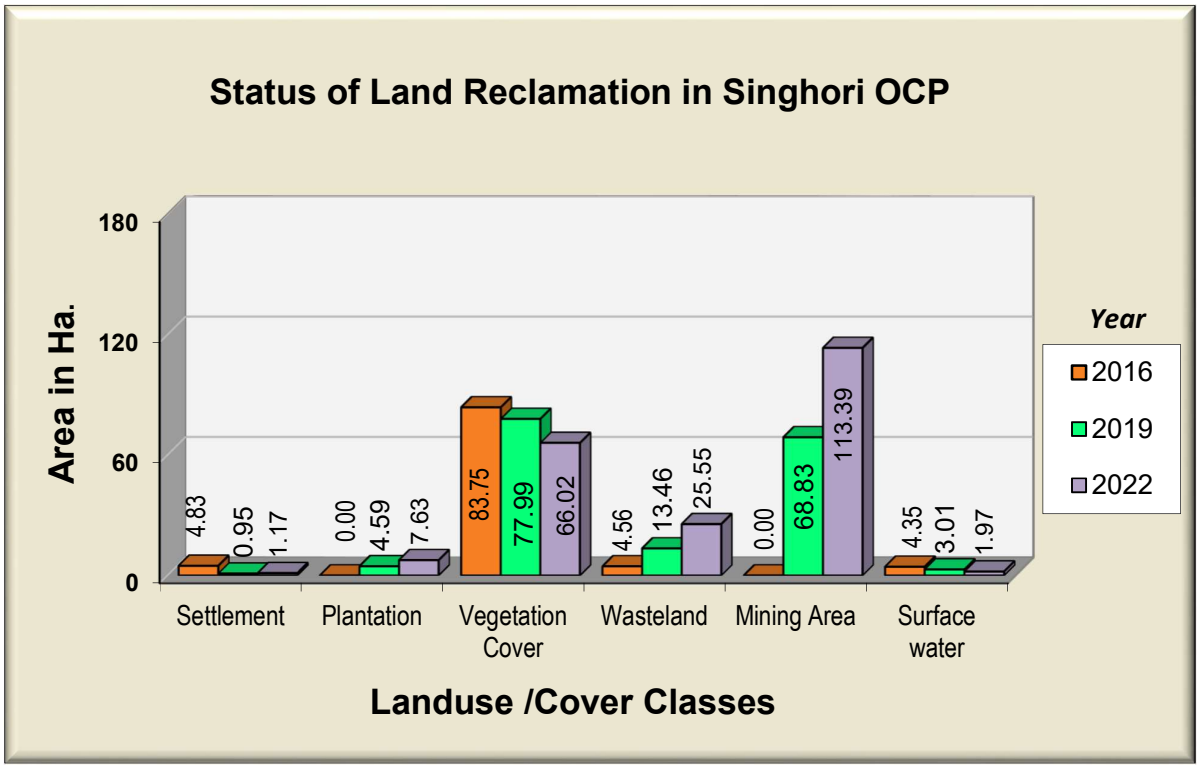

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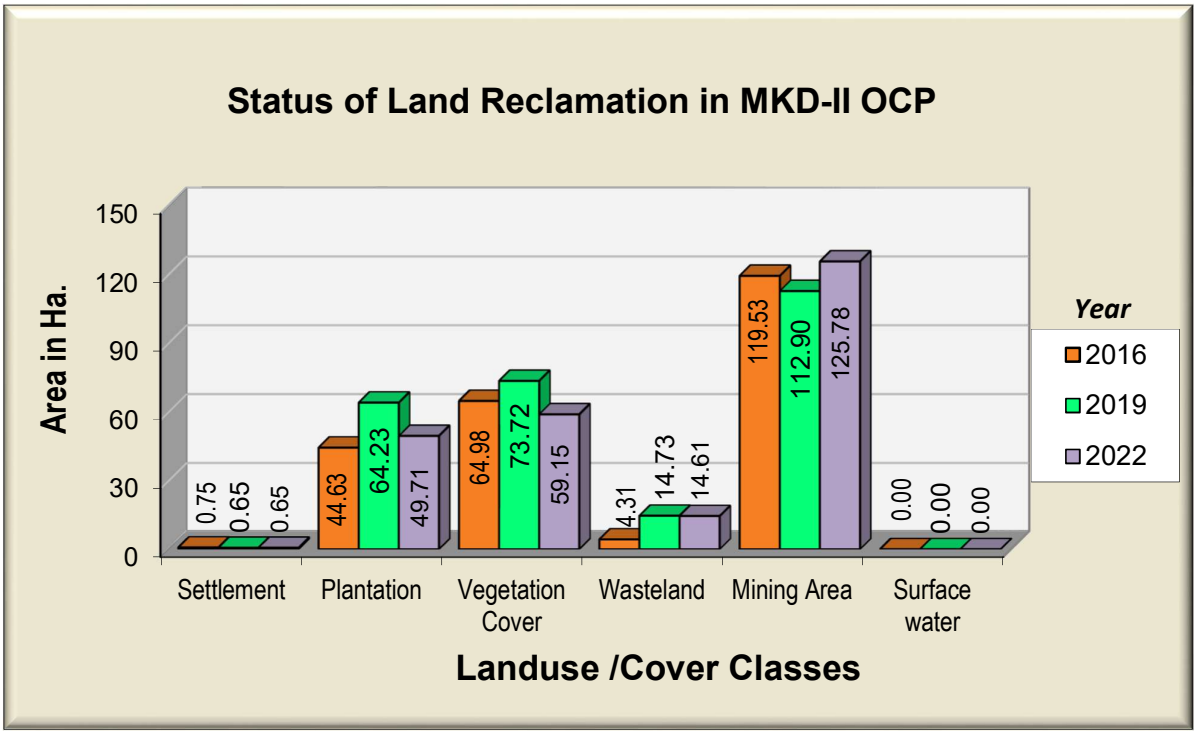

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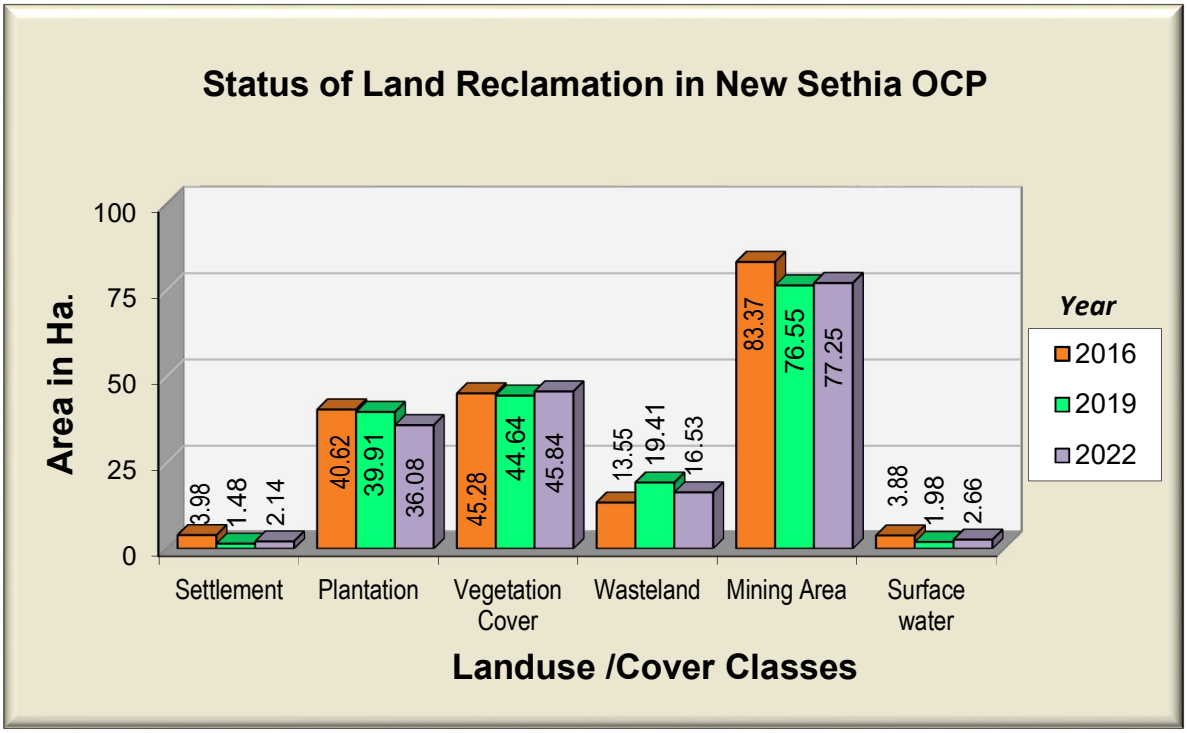

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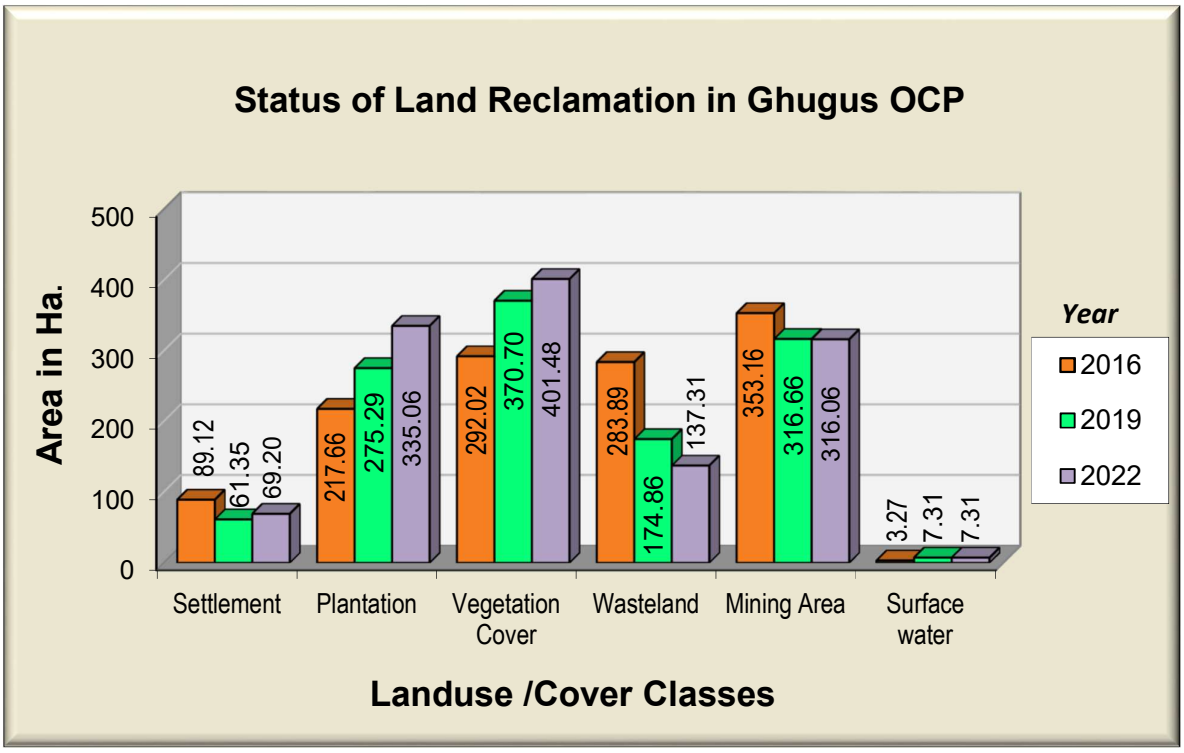

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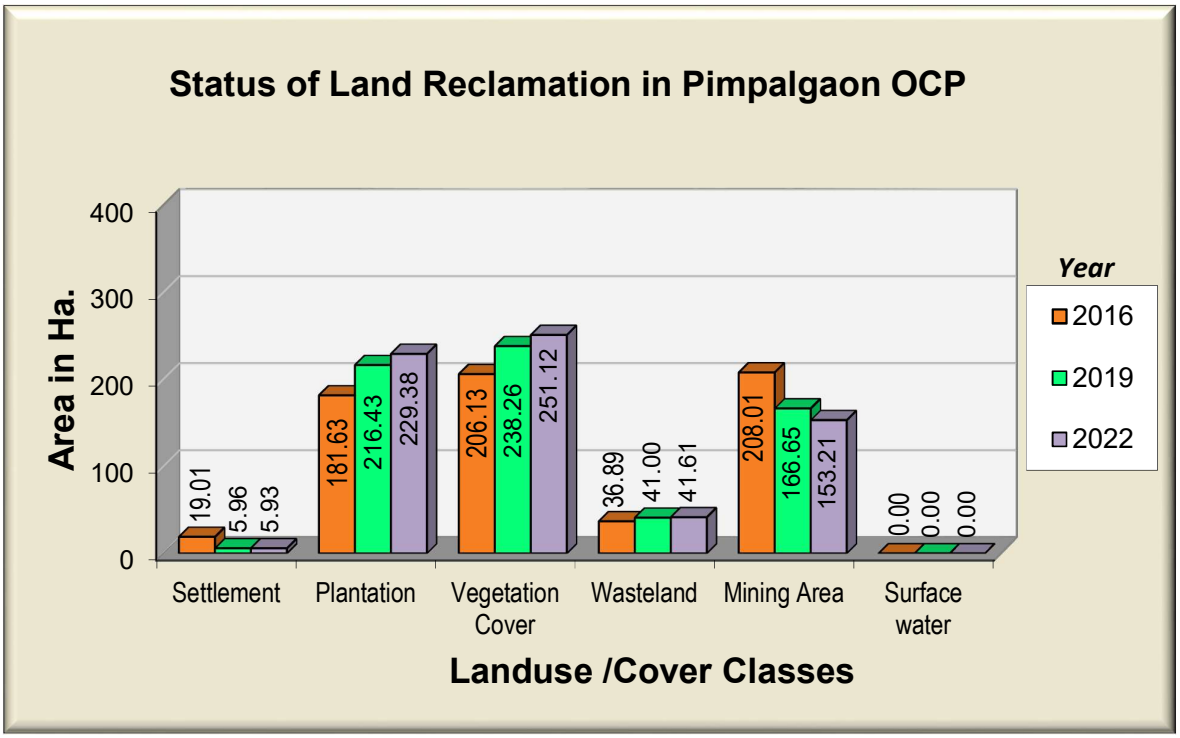

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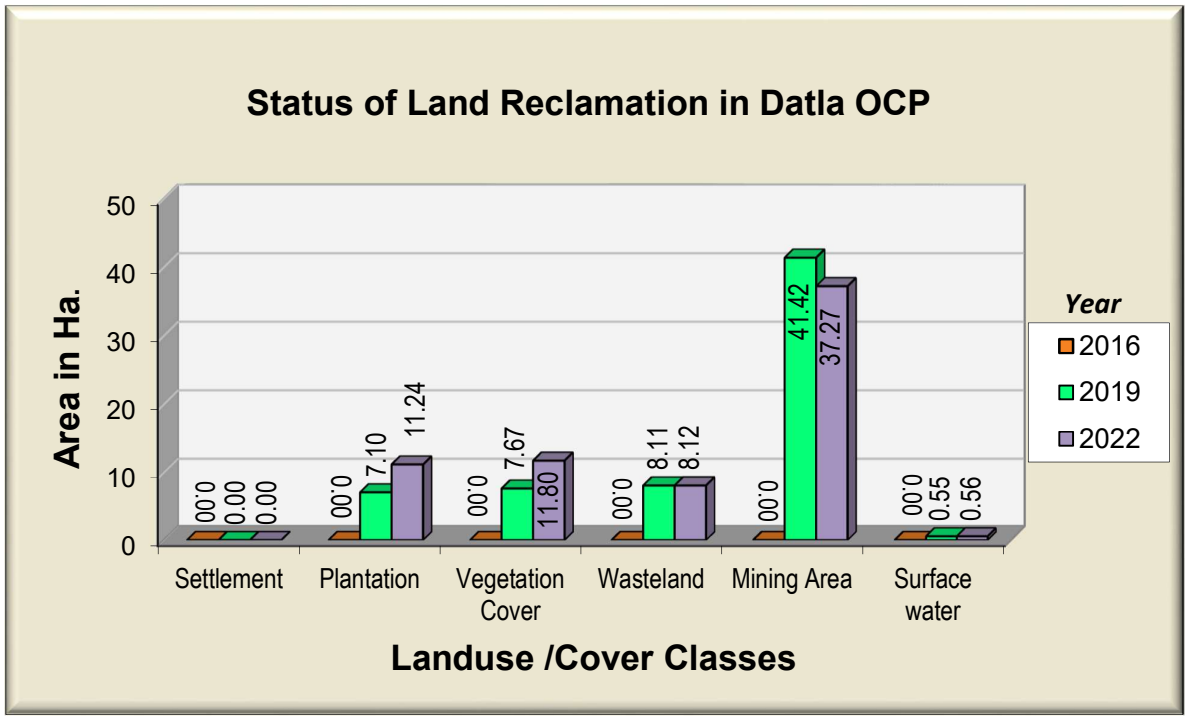

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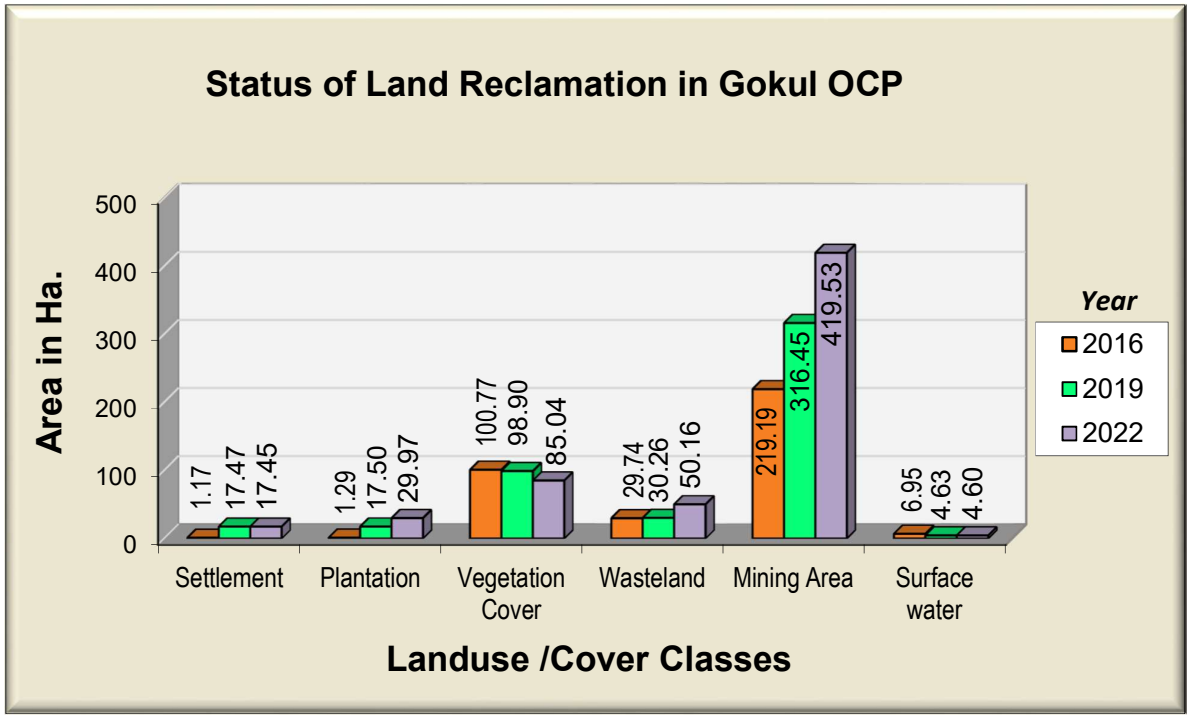

Figure -10

Photo-1: Plantation on embankment in Bhanegaon OCM

Photo-2: Plantation along charcoal transportation Road in Singhori OC

Photo-3: Plantation along coal transportation Road in Singhori OC

Photo-4: Plantation on Barren OB in Makardhokra-II OCM

Photo-5: Plantation near mansarovar in New Sethia OCM

Photo-6: Eco park developed on backfill in New Sethia OCM

Photo-7: Plantation on Barren OB dump in Ghugus OCM

Photo-8: Plantation on embankment in Ghugus OCM

Photo-9: Plantation on embankment in Ghugus OCM

Photo-10: Plantation on backfill in Datla OCM

ABBREVIATIONS

SoI	Survey of India
MoEF & CC	Ministry of Environment, Forest & Climate Change
CIL	Coal India Limited
ECL	Eastern Coalfields Limited
BCCL	Bharat Coking Coal Limited
CCL	Central Coalfields Limited
WCL	Western Coalfields Limited
SECL	South Eastern Coalfields Limited
NCL	Northern Coalfields Limited
MCL	Mahanadi Coalfields Limited
NEC	North Eastern Coalfields
CMPDIL	Central Mine Planning & Design Institute Ltd
NRSC	National Remote Sensing Centre
R2/ R2A	ResourceSat Satellites
LISS - 4	Linear Imaging and Self Scanning Sensor
FCC	False Colour Composite
OCP	Opencast Project
UGP	Underground Project
OB	Over Burden
GCP	Ground Control points
GIS	Geographic Information System
WGS-84	World Geodetic System
UTM	Universal Transverse Mercator

GLOSSARY

Sl.	Term	Definition
1.	Land Reclamation	To manage, reclaim and restore mined out/ degraded land as close as possible to its original stage.
2.	Over Burden	The material that lies above the coal seam/ deposit
3.	Monitoring	A process of evaluation to check or keep record for a period of time.
4.	Opencast Coal Mine	Open-pit mining, also known as opencast mining, is a surface mining technique that extracts minerals from an open pit in the ground.
5.	Social Forestry	Social forestry is the management and protection of forests and afforestation of barren and deforested lands with the purpose of helping environmental, social and rural development. Plantation (Social/ Avenue or other) carried out outside mining area.
6.	Biological Reclamation	Plantation on Backfilled areas (Stablised Internal Dumps)
7.	Technical Reclamation	Area under backfilling (Over burden dumped inside the mine voids) in mining area.
8.	Green Cover Generated	Total Plantation carried out in the lease area of Project. This includes Plantation on Backfill, Plantation on OB and Social Forestry.
9.	Leasehold Area	The area, for which lease is granted for the purpose of undertaking mining and allied operations.
10.	Excavated area	Mined out area which includes active mining, area under backfilling and plantation on backfilled areas
11.	Active Mining	Mining areas which include Coal Quarry, Advance Quarry, Quarry Filled with Water etc.
12.	Environmental Protection	It is the practice of protecting the natural environment by individuals, organizations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to mitigate damage and reverse trends.
13.	Remedial Measure	Any measure or action required or undertaken to investigate, monitor, clean up, remove, treat, prevent, contain or otherwise remediate the presence or release of any hazardous substance or activity.
14.	Systematic Error	Every measurement differing from the true measurement in the same direction, and even by the same amount in some cases.
15.	Geometric Distortion	It refers to the improper positioning of any image with respect to their true geographic position when viewed in a properly scaled common image display plane.

16.	Land Use/ Cover Class	Land cover is what covers the surface of the earth and land use describes how the land is used.
17.	Accuracy	The closeness of agreement between a measured quantity value and a true quantity value.
18.	Environmental Clearance	Environmental Clearance (EC) for any developmental projects like coal mining projects etc. has been made mandatory by the Ministry of Environment, Forests and Climate Change (MoEF & CC) through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986.
19.	Rectification and Geo-referencing	Geo-referencing is the assigning of absolute location of a data point or data points. Geo-rectification refers to the removal of geometric distortions between sets of data points, most often the removal of terrain, platform, and sensor induced distortions from remote sensing imagery.
20.	Image Enhancement	It is the process of modifying digital images so that the results are more suitable for processing or further image analysis.
21.	Training set selection	It is a portion of a data set used to fit or train a model for prediction or classification of values that are known in the training set, but unknown in other (future) data.
22.	Image Classification	It refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps.
23.	Temporal Changes	The 'temporal change' means the change in any entity with a period of time.
24.	Ground Truthing	Collection of primary/ basic information from ground realities for satellite image interpretation and thematic mapping.
25.	Cluster	Group of opencast and/ or underground mines clubbed together for administrative purposes.
26.	Arc GIS	GIS Software used for Map preparation
27.	ERDAS IMAGINE	Satellite Image Data Classification Software

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