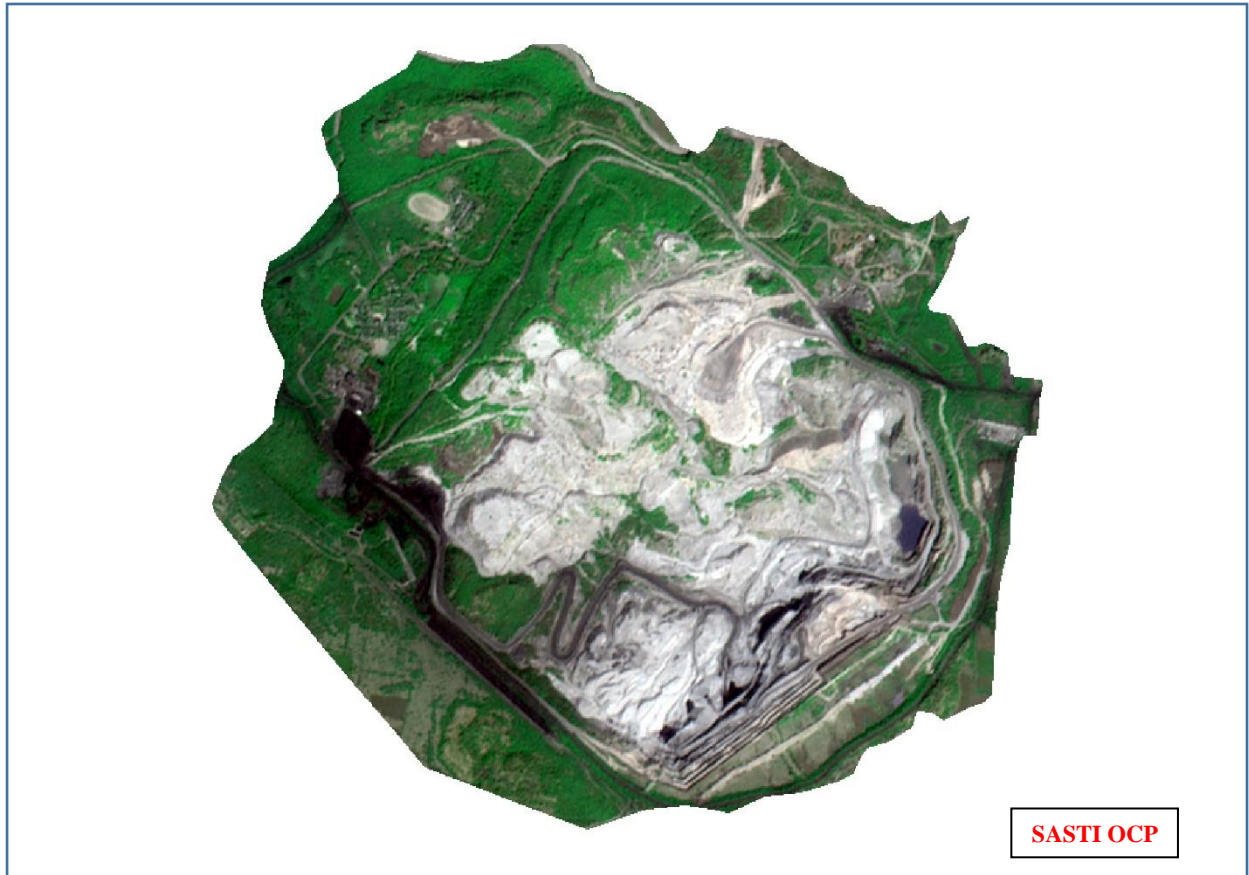


**Land Restoration/Reclamation Monitoring of more than
5 million cu.m. (Coal+OB) Capacity Opencast Coal Mines of Western
Coalfields Limited based on Satellite Data of the Year 2018**



Submitted to
Western Coalfields Limited



cmpdi
A Mini-Ratna Company

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March 2019



**Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi**

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Executive Summary

- 1.0 Project** Land restoration / reclamation monitoring of 10 opencast coal mines of Western Coalfields Ltd. (WCL) producing 5 million cu.m. and more (Coal+OB) per year based on satellite data, regularly on annual basis.
- 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 project. 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 the total mine leasehold area of 101.59 Km² of the 10 opencast projects of WCL viz. Sasti, Padmapur, Durgapur, Mugoli, Umrer, Ukni, Niljai, New Majri, Makardhokra-III and Penganga considered for monitoring during 2018-19; total excavated area is 28.29 Km² out of which 3.23 Km² area (11.42%) has been planted, 6.24 Km² area (22.06%) has been backfilled and 18.82 Km² area (66.53%) is under active mining. It is evident from the analysis that 33.47% areas of the OC projects has been reclaimed (biological and technical) and balance 66.53% area is under active mining. Project wise details are given in Table-1 & Fig-1. (For comparison purpose, refer Total – A in Table-1.)
 - On comparing the status of land reclamation for the year 2018 with respect to the year 2017 in different projects, it is evident from the analysis that area under land reclamation has increased from 7.99 Km² (Yr. 2017) to 9.47 Km² (Yr.2018). Out of 10 projects of WCL, Sasti OC ranks on top for land reclamation (74.18%) followed by Umrer OC (73.36%) and Mugoli OC (25.74%).
 - Area of biological reclamation (plantation) has increased marginally from 2.82 Km² (Yr.2017) to 3.23 Km² (Yr.2018) whereas area of technical reclamation (area under backfilling) has increased from 5.17 Km² (Yr. 2017) to 6.24 Km² (Yr.2018) in WCL. The total increase of 1.48 Km² under reclamation is the result of the efforts of the Western Coalfields Ltd. taken up towards environmental protection.
 - It is important to note that from the year of 2018-19, Makardhokra-III OC and Penganga OC, each having the capacity > 5 mcm (Coal+OB), are included for annual satellite monitoring in place of GhugusOC and Pimpalgaon OC which are in the process of final closure and is falling under < 5 mcm (Coal+OB) capacity

Table-1
Projectwise Land Reclamation Status in Opencast Projects of WCL
(>5 Million cu. M coal+OB) based on Satellite Data of the year 2018

(Area in Sq. Kms.)

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	
				Area under Backfilling		Biological Reclamation		Other Plantations											
				2017	2018	2017	2018	Plantation on Excavated / Backfilled Area	Plantation on External Over Burden Dumps	Social Forestry, Avaneue Plantation Etc.									
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11(=4+5)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
1	Sasti	9.20	9.20	2.15	2.19	0.54	0.54	1.66	1.66	0.57	0.57	0.81	0.95	3.50	3.68	2.77	2.77	2.69	2.73
				61.43%	59.51%	15.43%	14.67%					23.14%	25.82%			30.11%	30.11%	76.86%	74.18%
2	Padmapur	8.29	8.29	0.13	0.18	0.15	0.17	1.70	1.60	0.53	0.71	1.59	1.54	1.87	1.89	2.38	2.48	0.28	0.35
				6.95%	9.52%	8.02%	8.99%					85.03%	81.48%			28.71%	29.92%	14.97%	18.52%
3	Durgapur	11.86	11.86	0.26	0.31	0.40	0.54	2.10	2.33	1.33	1.09	3.85	3.71	4.51	4.56	3.83	3.96	0.66	0.85
				5.76%	6.80%	8.87%	11.84%					85.37%	81.36%			32.29%	33.39%	14.63%	18.64%
4	Mugoli	7.88	7.88	0.24	0.58	0.24	0.12	1.14	1.36	0.26	0.26	2.16	2.02	2.64	2.72	1.64	1.74	0.48	0.70
				9.09%	21.32%	9.09%	4.41%					81.82%	74.26%			20.81%	22.08%	18.18%	25.74%
5	Umrer	9.45	9.45	2.08	1.88	1.39	1.59	1.27	1.32	2.77	2.42	1.07	1.26	4.54	4.73	5.43	5.33	3.47	3.47
				45.81%	39.75%	30.62%	33.62%					23.57%	26.64%			57.46%	56.40%	76.43%	73.36%
6	Ukni	9.94	9.74	0.00	0.00	0.00	0.00	2.10	1.42	0.18	0.68	2.16	2.25	2.16	2.25	2.28	2.10	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			22.94%	21.56%	0.00%	0.00%
7	Niljai	15.30	13.63	0.00	0.48	0.10	0.10	1.16	1.19	1.33	1.31	3.47	3.02	3.57	3.60	2.59	2.60	0.10	0.58
				0.00%	13.33%	2.80%	2.78%					97.20%	83.89%			16.93%	19.08%	2.80%	16.11%
8	New Majri	7.74	7.74	0.31	0.62	0.00	0.17	1.84	1.67	1.35	1.35	3.01	2.85	3.32	3.64	3.19	3.19	0.31	0.79
				9.34%	17.03%	0.00%	4.67%					90.66%	78.30%			41.21%	41.21%	9.34%	21.70%
9	Makardhokra-III	-	16.37	-	0.00	-	0.00	-	0	-	0.02	-	0.65	-	0.65	-	0.02	-	0.00
				-	0.00%	-	0.00%					-	100.00%			-	0.12%	-	0.00%
10	Penganga	-	7.43	-	0.00	-	0.00	-	0	-	0.13	-	0.57	-	0.57	-	0.13	-	0.00
				-	0.00%	-	0.00%					-	100.00%			-	1.75%	-	0.00%
	TOTAL - A	79.66	101.59	5.17	6.24	2.82	3.23	12.97	12.55	8.32	8.54	18.12	18.82	26.11	28.29	24.11	24.32	7.99	9.47
				19.80%	22.06%	10.80%	11.42%					69.40%	66.53%			30.27%	23.94%	30.60%	33.47%
11	Pimpalgaon	4.52	-	0.00	-	0.00	-	1.02	-	0.88	-	0.58	-	0.58	-	1.90	-	0.00	-
				0.00%	-	0.00%	-					100.00%	-			42.04%	-	0.00%	-
12	Ghugus	10.2	-	2.75	-	0.36	-	1.35	-	0.62	-	0.43	-	3.54	-	2.33	-	3.11	-
				77.68%	-	10.17%	-					12.15%	-			22.84%	-	87.85%	-
	TOTAL - B	94.38	101.59	7.92	6.24	3.18	3.23	15.34	12.55	9.82	8.54	19.13	18.82	30.23	28.29	28.34	24.32	11.10	9.47
				26.20%	22.06%	10.52%	11.42%					63.28%	66.53%			30.03%	23.94%	36.72%	33.47%

Note 1 : Penganga OC and Makardhokra-III OC with capacity > 5mcm (Coal+OB) included in this report and to be monitored annually starting from 2018-19 in place of Pimpalgaon OC & Ghugus OC.

Note 2 : 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 % calculated in respect to total excavated area except for "Total area under plantation" where % is in terms of leasehold area.

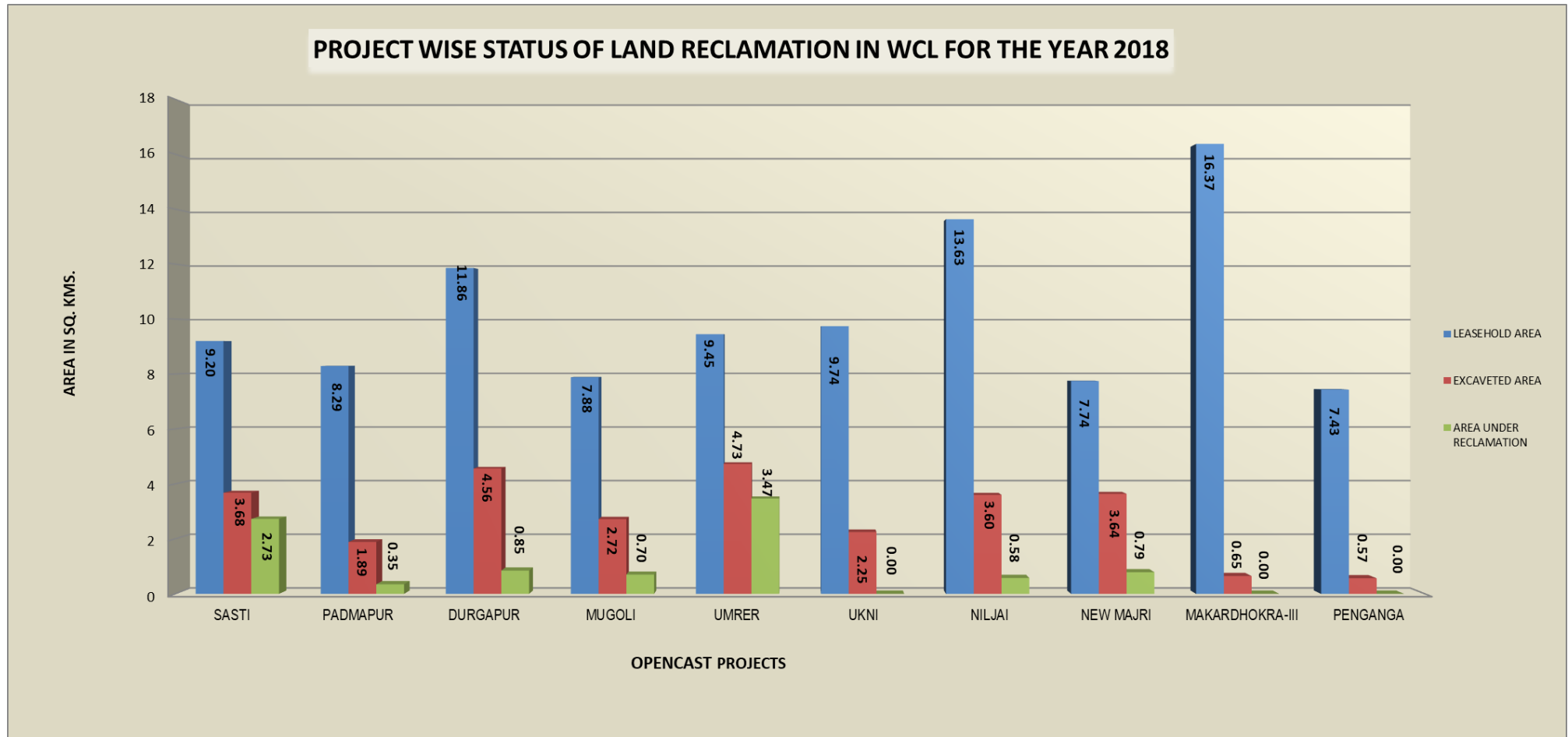


Fig.1: Land reclamation status in OC projects of WCL for the year 2018

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 most scarce 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/2009/2428 dated 29.12.2009 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation. status of all the opencast coal mines having production of more than 5 million m³ per annum (coal + OB taken together per annum) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining. Further, another work order vide letter no. CIL/WBP/ENV./2011 dated 23/08/11 was issued by CIL for monitoring of less than 5 million m³ per annum capacity (Coal +OB) projects from the year 2011 at interval of three years. This order has been renewed in CIL letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 for the next five years. Again this work order has been renewed vide letter no. CIL/WBP/Env/2017/DP/8391 dated 22.06.2017 for a period next five years starting from 2017-18 to 2021-22. The result of land reclamation status of all such mines will be uploaded on the website of 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 (MoEF).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 2018 carried out for all the OC projects producing more 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 Fig 1. Following steps are involved in land reclamation /restoration monitoring:

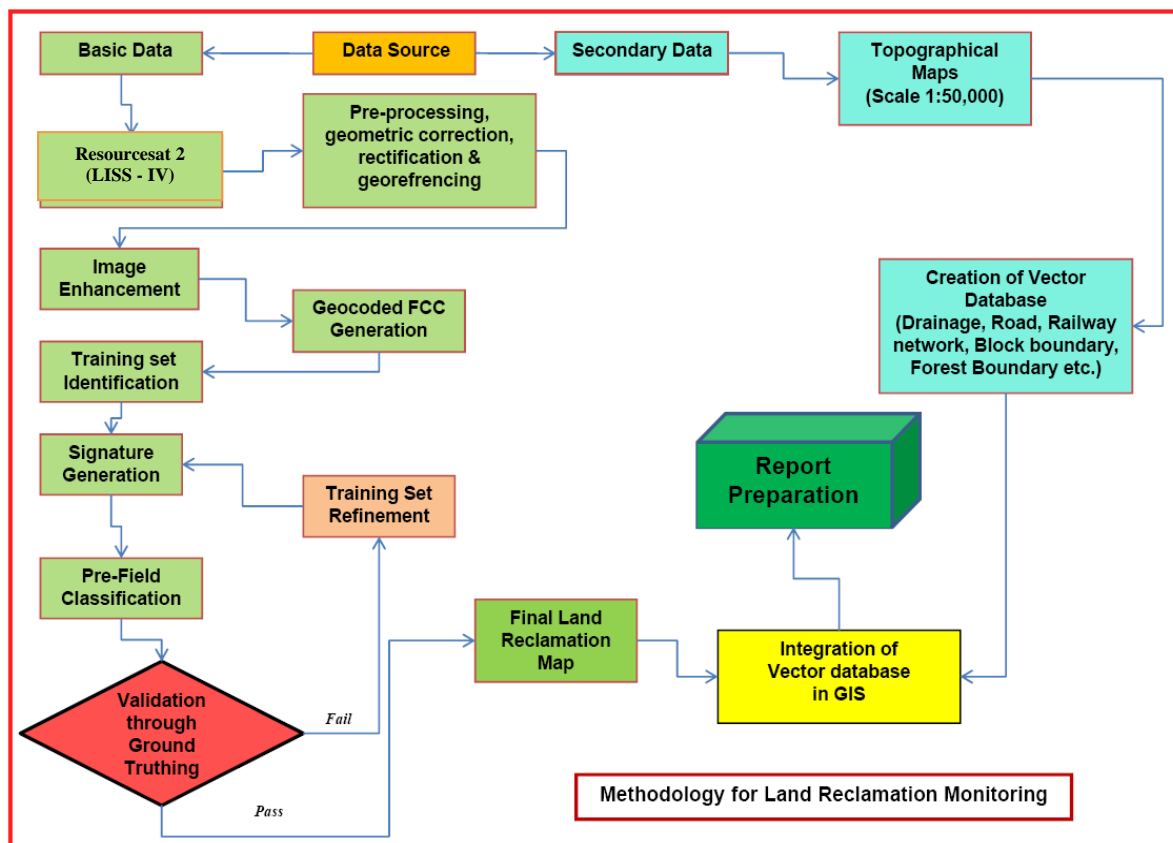


Figure: 2 - **Methodology for Land Reclamation Monitoring**

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, topo sheets are procured for creation of vector database.

3.2 Satellite Data Processing: Satellite data are processed using ERDAS IMAGINE 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, georeferencing is required for correction of image data using ground control points (GCP) to make it compatible to Sol 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 is determined 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 10.2 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 database is created on GIS platform to identify the temporal changes identified from satellite data of different cut-of dates.

4.0 Land Reclamation Status in Western Coalfields Limited

4.1 Following 10 OC projects producing more than 5 million cubic m. (Coal + OB together) of Western Coalfields Ltd. have been taken up for land reclamation monitoring based on Satellite Data of the year 2018:

- Sasti
- Padmapur
- Durgapur
- Mugoli
- Umrer
- Ukni
- Niljai
- New Majri
- Makardhokra-III
- Penganga

4.2 Project wise Land Reclamation status in WCL for the year 2018 is given in Table 1 and also shown graphically in Fig 1. Area statistics of different land use class present in the mine leasehold of the above projects for the year 2018 are shown in the Table 5.2. Land use maps derived from satellite data are shown in Plate 5.1-5.10. Land reclamation monitoring of the above projects except for Makardhokra-III and Penganga OCPs is being done since 2009 on annual basis. Year wise changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig. 5.2–5.11 for the last three years only.

4.3 For the year 2018-19, Makardhokra-III and Penganga OCPs have been included in place of Pimpalgaon and Ghughus OCPs on request from WCL as Pimpalgaon and Ghughus OCPs are in process of final closure and now fall in less than 5 mcm (Coal+OB) category.

- 4.4** Study reveals that 33.47% of excavated area has been under reclamation in the above mentioned mines of WCL out of which 11.42% area has been revegetated and 22.06% area is under backfilling. There is an overall increase of 1.48 Km² in area under reclamation in WCL in the year 2018 with respect to the year 2017, out of which there is an increase of 0.41 Km² in area under biological reclamation (Plantation on Backfilled Areas) and an increase of 1.07 Km² in area under technical reclamation (Barren Backfilling). (Refer Total (A) in Table-1).
- 4.5** Analysis of satellite data also indicates that total area under plantation (Green Cover) has increased from 24.11 Km² (2017) to 24.32 Km² (2018). The increase of 0.21 Km² area under Green Cover areas may be attributed to continuous effort of WCL towards environmental protection.
- 4.6** After comparing the satellite data of year 2018 vs. 2017, it is evident that total area under plantation (Green Cover) in Sasti, Padmapur, Durgapur, Mugoli, Niljai & New Majri Opencast Projects has either increased or remained static whereas there is a marginal decrease in area under plantation/ natural vegetation (Green Cover) in Umrer and Ukni opencast projects. It has been observed in some of the projects natural vegetation has also started growing on stabilized old backfilled areas and overburden dumps due to high soil fertility.
- 4.7** On comparing the status of land reclamation for the year 2018 with respect to the year 2017 in different projects, it is evident that the total area under reclamation has increased from 7.99 Km² (Yr. 2017) to 9.47 Km² (Yr. 2018).
- 4.6** Out of 10 projects of WCL, maximum area under reclamation is in Sasti Opencast Project (74.18%) followed by Umrer OC (73.36%) and Mugoli OC (25.74%).

Table-2

STATUS OF LAND USE/ RECLAMATION IN OC MINES (>5mcu.m) OF WESTERN COALFIELDS LTD BASED ON SATELLITE DATA OF THE YEAR 2018

(Area in Sq Km)

	SASTI		PADMAPUR		DURGAPUR		MUGOLI		UMRER		UKNI		NILJAI		NEW MAJRI		MAKARDHOKRA-III		PENGANGA		TOTAL		
	Area	%	Area	%	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	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	0.00	0.00	0.00	0.00
	Total 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	0.00	0.00	0.00	0.00
SCRUBS	Scrubs	0.68	7.39	0.46	5.55	0.31	2.61	1.39	17.64	0.00	0.00	0.44	4.52	1.00	7.34	0.19	2.45	0.56	3.42	2.05	27.59	7.08	6.97
	Social Forestry	0.57	6.20	0.71	8.56	1.09	9.19	0.26	3.30	2.42	25.61	0.68	6.98	1.31	9.61	1.35	17.44	0.02	0.12	0.13	1.75	8.54	8.41
PLANTATION	Plantation on OB Dump	1.66	18.04	1.60	19.30	2.33	19.65	1.36	17.26	1.32	13.97	1.42	14.58	1.19	8.73	1.67	21.58	0.00	0.00	0.00	0.00	12.55	12.35
	Plantation on Backfill (Biological Reclamation)	0.54	5.87	0.17	2.05	0.54	4.55	0.12	1.52	1.59	16.83	0.00	0.00	0.10	0.73	0.17	2.20	0.00	0.00	0.00	0.00	3.23	3.18
	Total Plantation	2.77	30.11	2.48	29.92	3.96	33.39	1.74	22.08	5.33	56.40	2.10	21.56	2.60	19.08	3.19	41.21	0.02	0.12	0.13	1.75	24.32	23.94
	Total Vegetation	3.45	37.50	2.94	35.46	4.27	36.00	3.13	39.72	5.33	56.40	2.54	26.08	3.60	26.41	3.38	43.67	0.58	3.54	2.18	29.34	31.40	30.91
ACTIVE MINING	Coal Quarry	0.95	10.33	1.33	16.04	3.21	27.07	2.02	25.63	1.03	10.90	2.09	21.46	2.91	21.35	2.73	35.27	0.65	3.97	0.45	6.06	17.37	17.10
	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	0.00	0.00	0.21	2.53	0.45	3.79	0.00	0.00	0.11	1.16	0.06	0.62	0.00	0.00	0.12	1.55	0.00	0.00	0.00	0.00	0.95	0.94
	Coal Dump	0.00	0.00	0.00	0.00	0.05	0.42	0.00	0.00	0.12	1.27	0.10	1.03	0.11	0.81	0.00	0.00	0.00	0.00	0.12	1.62	0.50	0.49
	Total Area Under Active Mining	0.95	10.33	1.54	18.58	3.71	31.28	2.02	25.63	1.26	13.33	2.25	23.10	3.02	22.16	2.85	36.82	0.65	3.97	0.57	7.67	18.82	18.53
Area under Backfilling (Technical Reclamation)	2.19	23.80	0.18	2.17	0.31	2.61	0.58	7.36	1.88	19.89	0.00	0.00	0.48	3.52	0.62	8.01	0.00	0.00	0.00	0.00	6.24	6.14	
Barren OB Dump	0.30	3.26	2.13	25.69	1.58	13.32	1.12	14.21	0.45	4.76	2.95	30.29	2.91	21.35	0.08	1.03	0.88	5.38	0.66	8.88	13.06	12.86	
Total Area Under Mine Operation	3.44	37.39	3.85	46.44	5.60	47.22	3.72	47.21	3.59	37.99	5.20	53.39	6.41	47.03	3.55	45.87	1.53	9.35	1.23	16.55	38.12	37.52	
WASTELANDS	Waste Lands	1.70	18.48	1.09	13.15	1.55	13.07	0.82	10.41	0.15	1.59	0.61	6.26	3.05	22.38	0.37	4.78	0.41	2.50	2.70	36.34	12.45	12.26
	Sand Body	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	0.00	0.00	0.00	0.00
	Total Wasteland	1.70	18.48	1.09	13.15	1.55	13.07	0.82	10.41	0.15	1.59	0.61	6.26	3.05	22.38	0.37	4.78	0.41	2.50	2.70	36.34	12.45	12.26
WATERBODIES	Reservoir, nallah, ponds	0.00	0.00	0.12	1.45	0.00	0.00	0.00	0.00	0.12	1.27	0.00	0.00	0.00	0.00	0.10	1.29	0.00	0.00	0.06	0.81	0.40	0.39
	Total Waterbodies	0.00	0.00	0.12	1.45	0.00	0.00	0.00	0.00	0.12	1.27	0.00	0.00	0.00	0.00	0.10	1.29	0.00	0.00	0.06	0.81	0.40	0.39
AGRICULTURE	Crop Lands	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	4.40	26.88	0.00	0.00	4.40	4.33
	Fallow Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	11.81	0.00	0.00	0.00	0.00	9.37	57.24	1.15	15.48	11.67	11.49
	Total Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	11.81	0.00	0.00	0.00	0.00	13.77	84.12	1.15	15.48	16.07	15.82
SETTLEMENTS	Urban Settlement	0.28	3.04	0.00	0.00	0.29	2.45	0.00	0.00	0.15	1.59	0.00	0.00	0.17	1.25	0.34	4.39	0.00	0.00	0.00	0.00	1.23	1.21
	Rural Settlement	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.38	0.00	0.00	0.08	0.82	0.00	0.00	0.00	0.08	0.49	0.03	0.40	0.22	0.22	
	Industrial Settlement	0.33	3.59	0.29	3.50	0.15	1.26	0.18	2.28	0.11	1.16	0.16	1.64	0.40	2.93	0.00	0.00	0.00	0.00	0.08	1.08	1.70	1.67
	Total Settlement	0.61	6.63	0.29	3.50	0.44	3.71	0.21	2.66	0.26	2.75	0.24	2.46	0.57	4.18	0.34	4.39	0.08	0.49	0.11	1.48	3.15	3.10
Grand Total	9.20	100.0	8.29	100.0	11.86	100.0	7.88	100.0	9.45	100.0	9.74	100.0	13.63	100.0	7.74	100.0	16.37	100.0	7.43	100.0	101.59	100.00	

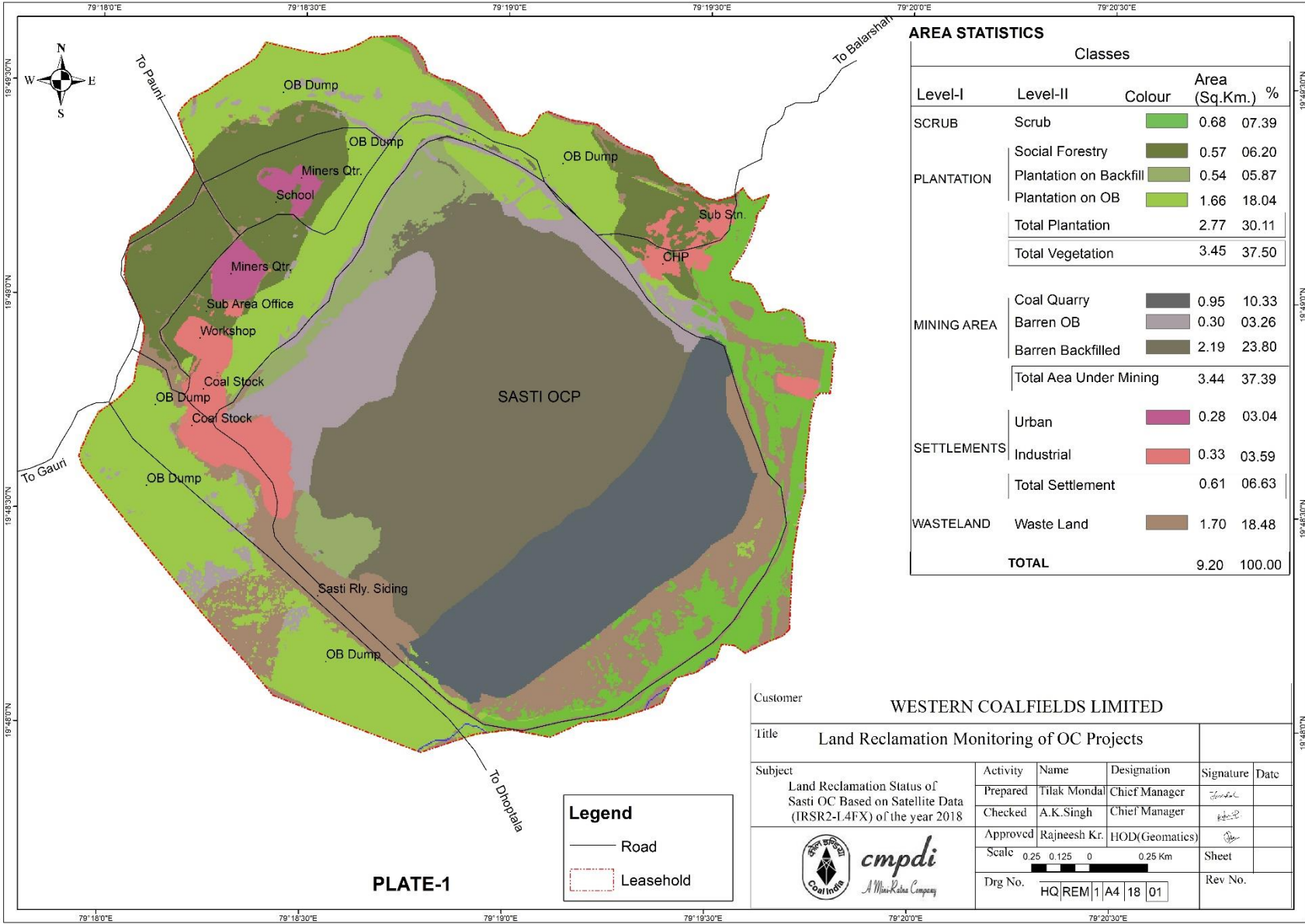


PLATE-1

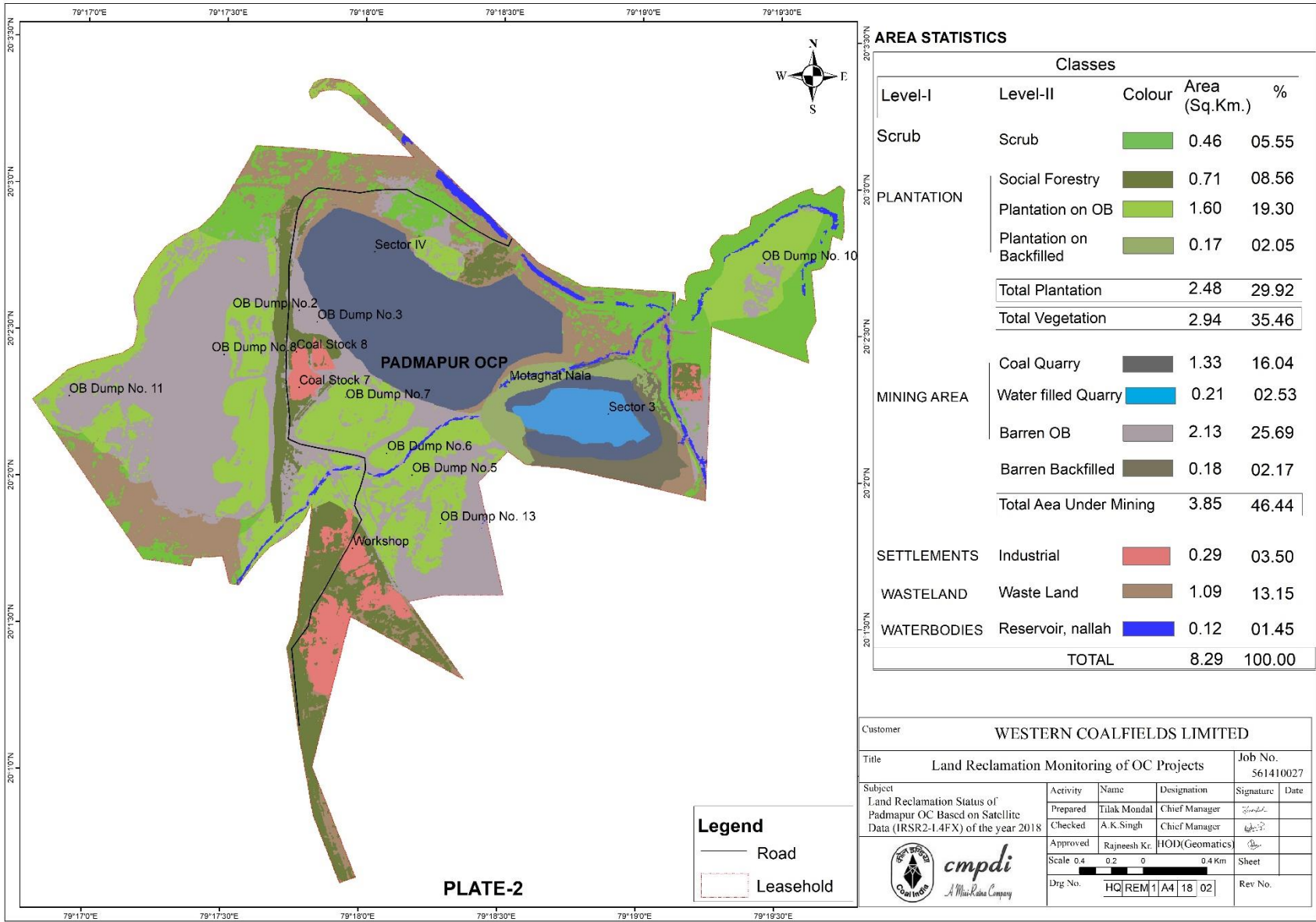
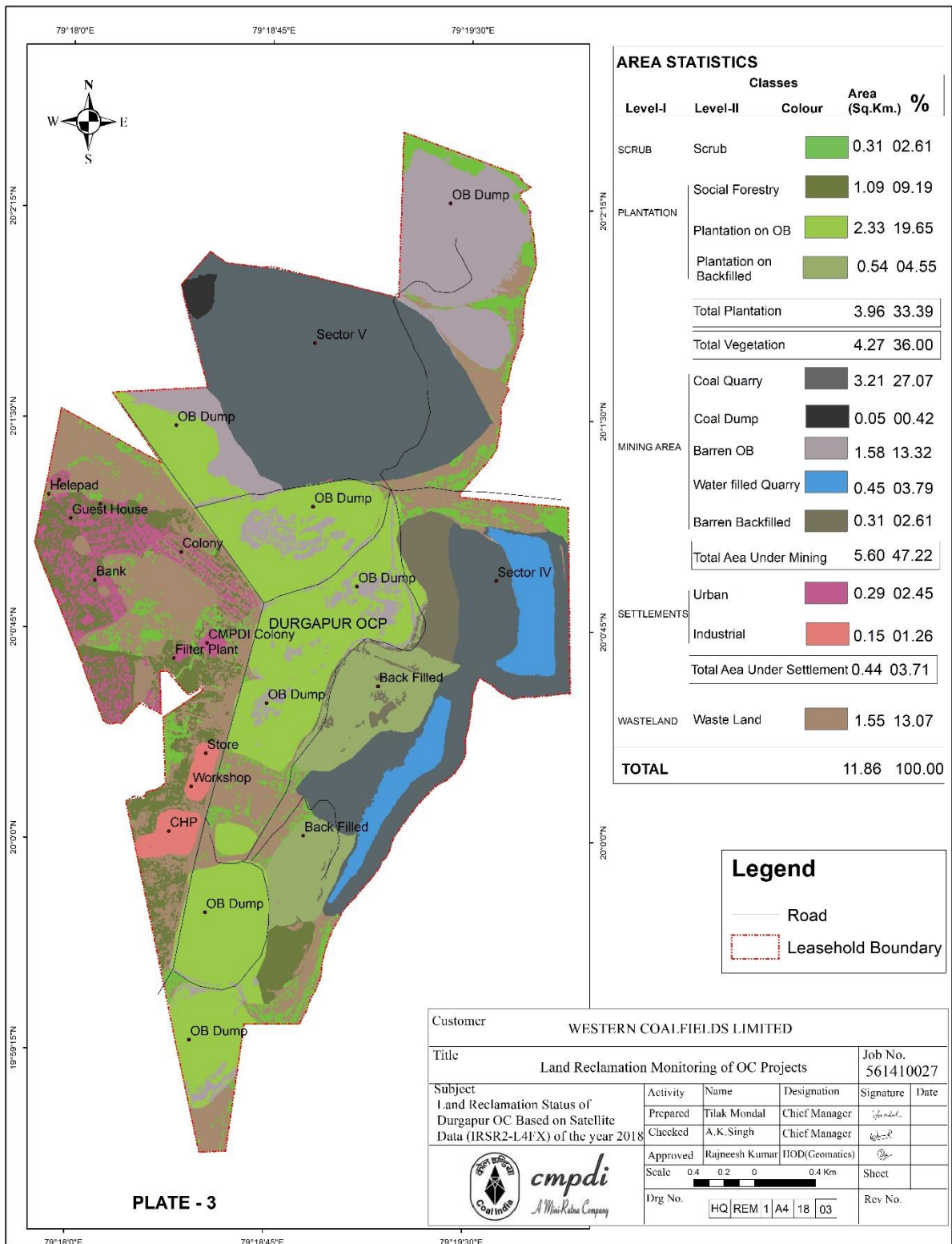
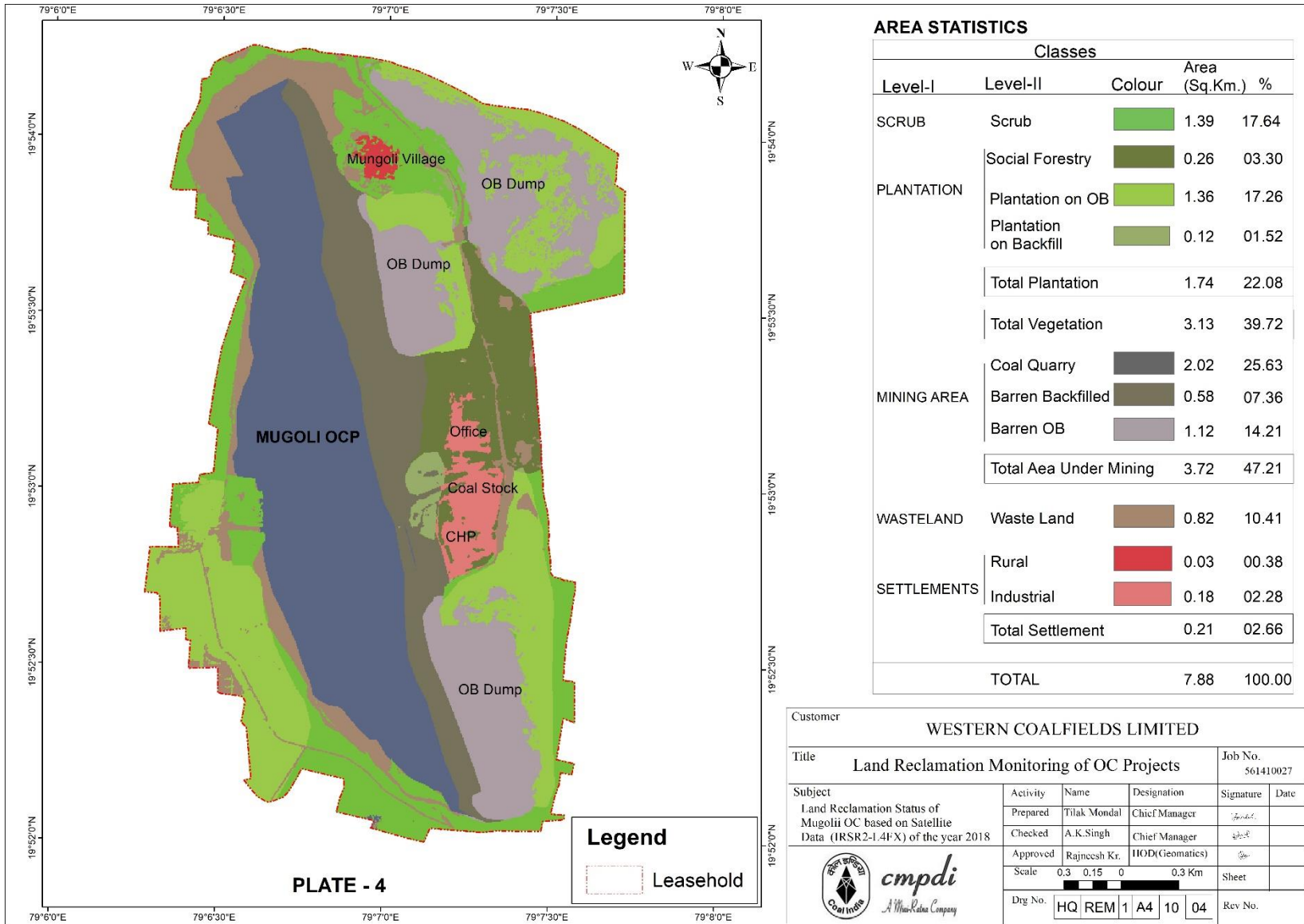


PLATE-2

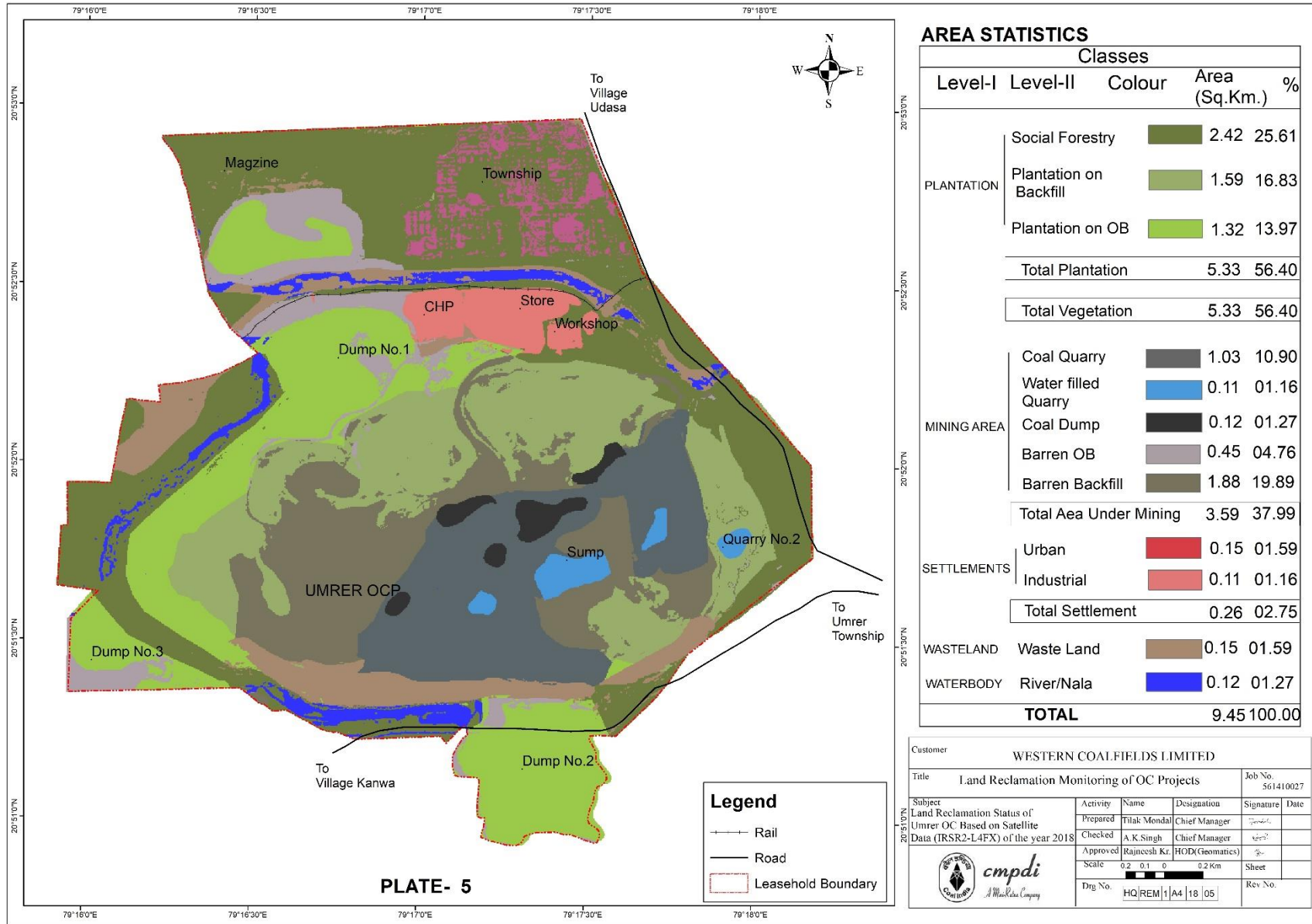


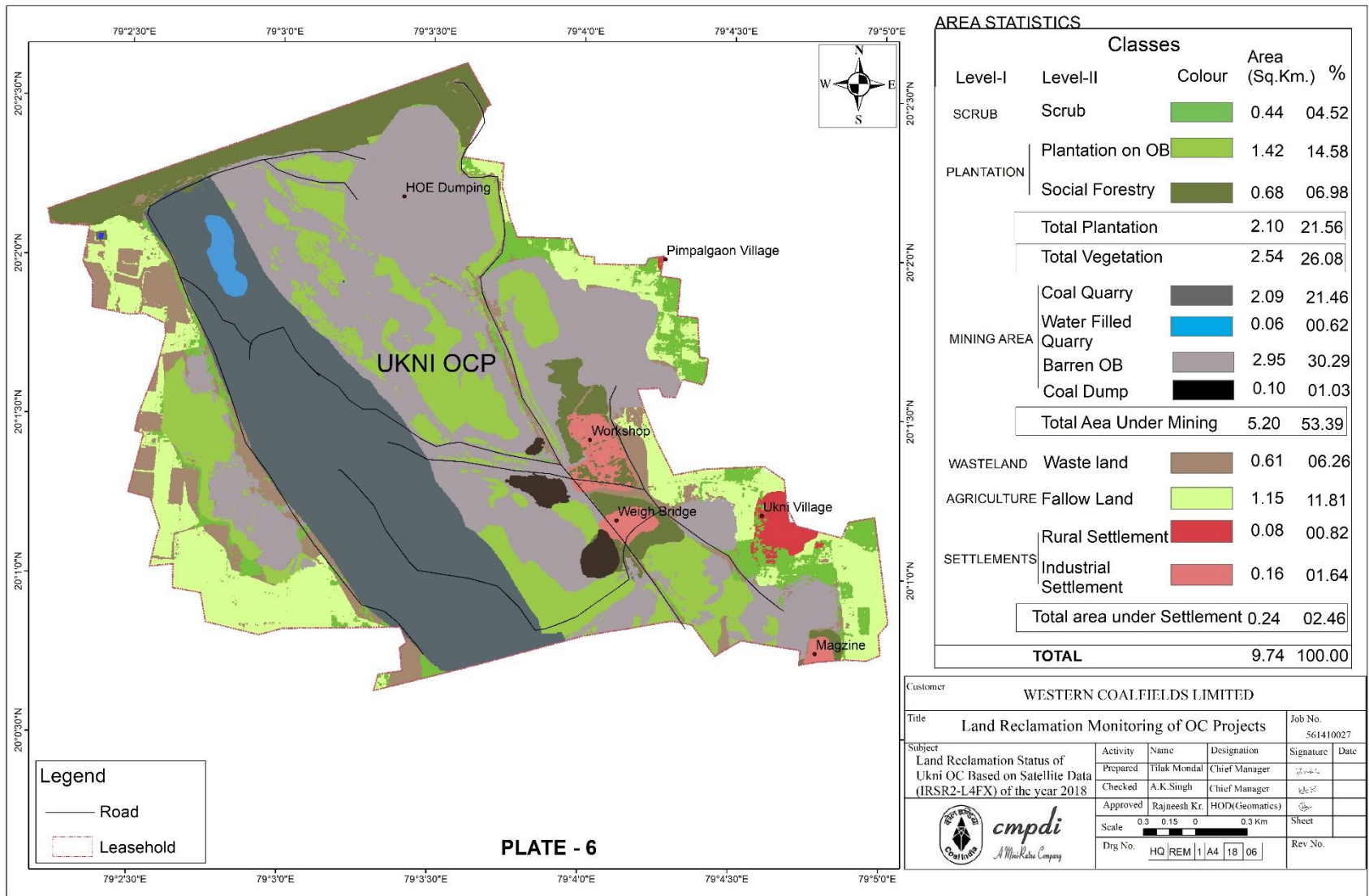


AREA STATISTICS

Classes		Area (Sq.Km.)	%
Level-I	Level-II	Colour	
SCRUB	Scrub		1.39 17.64
	Social Forestry		0.26 03.30
PLANTATION	Plantation on OB		1.36 17.26
	Plantation on Backfill		0.12 01.52
	Total Plantation		1.74 22.08
	Total Vegetation		3.13 39.72
MINING AREA	Coal Quarry		2.02 25.63
	Barren Backfilled		0.58 07.36
	Barren OB		1.12 14.21
	Total Aea Under Mining		3.72 47.21
WASTELAND	Waste Land		0.82 10.41
	Rural		0.03 00.38
SETTLEMENTS	Industrial		0.18 02.28
	Total Settlement		0.21 02.66
TOTAL			7.88 100.00

Customer						WESTERN COALFIELDS LIMITED							
Title						Land Reclamation Monitoring of OC Projects						Job No. 561410027	
Subject		Activity	Name	Designation	Signature	Date							
Land Reclamation Status of Mugolii OC based on Satellite Data (IRS2-1.4'X) of the year 2018		Prepared	Tilak Mondal	Chief Manager									
		Checked	A.K.Singh	Chief Manager									
		Approved	Rajneesh Kr.	HOD(Geomatics)									
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Drg No.		HQ	REM	1	A4	10	04	Rev No.					



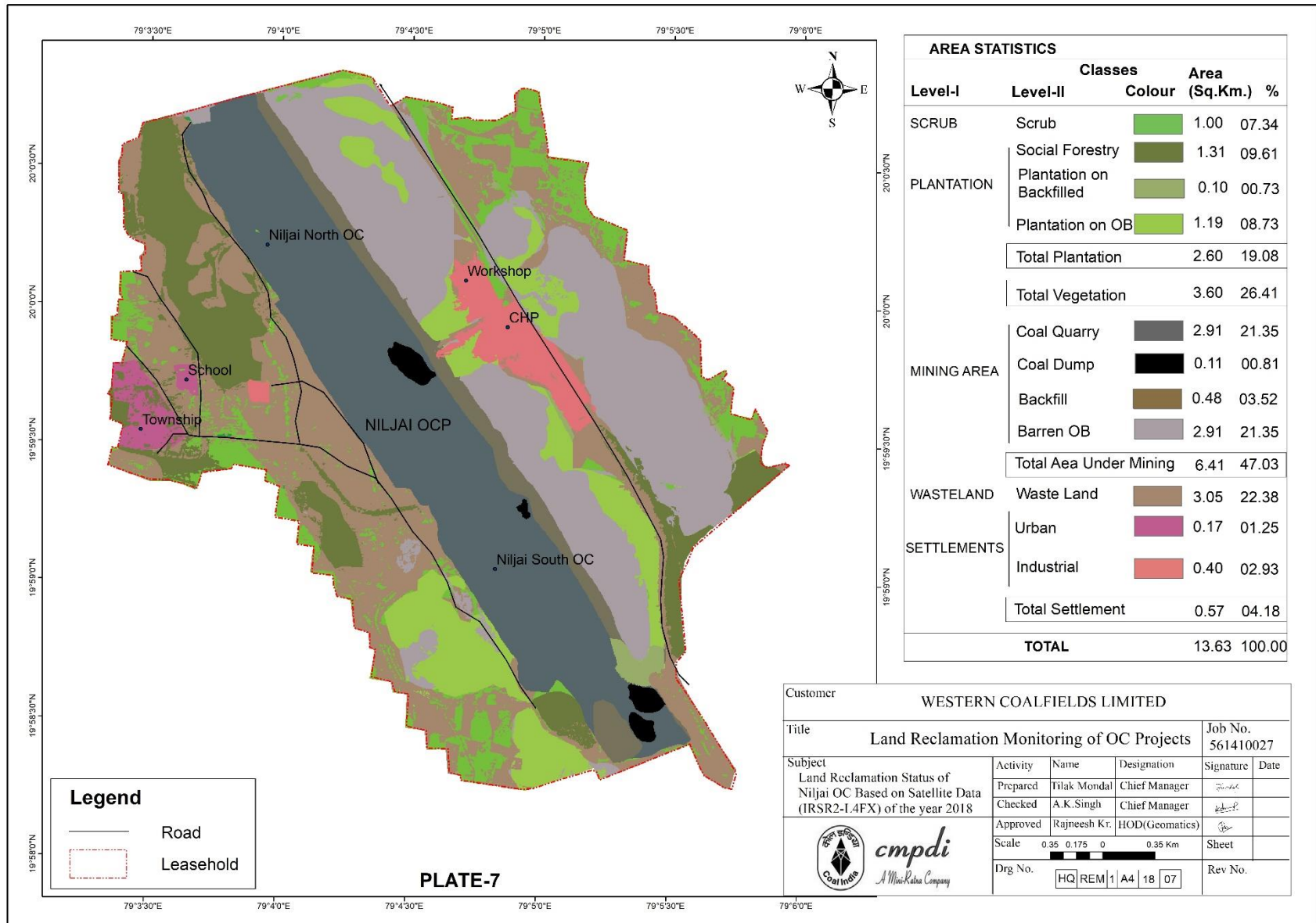


AREA STATISTICS

Classes		Area (Sq.Km.)	%
Level-I	Level-II	Colour	
SCRUB	Scrub		0.44 04.52
PLANTATION	Plantation on OB		1.42 14.58
	Social Forestry		0.68 06.98
	Total Plantation		2.10 21.56
		Total Vegetation	2.54 26.08
MINING AREA	Coal Quarry		2.09 21.46
	Water Filled Quarry		0.06 00.62
	Barren OB		2.95 30.29
	Coal Dump		0.10 01.03
	Total Aea Under Mining		5.20 53.39
WASTELAND	Waste land		0.61 06.26
AGRICULTURE	Fallow Land		1.15 11.81
SETTLEMENTS	Rural Settlement		0.08 00.82
	Industrial Settlement		0.16 01.64
	Total area under Settlement		0.24 02.46
TOTAL			9.74 100.00

Customer					WESTERN COALFIELDS LIMITED	
Title					Land Reclamation Monitoring of OC Projects	
					Job No.	561410027
Subject			Activity	Name	Designation	Signature Date
Land Reclamation Status of Ukni OC Based on Satellite Data (IRSR2-L4FX) of the year 2018			Prepared	Tilak Mondal	Chief Manager	
			Checked	A.K.Singh	Chief Manager	
			Approved	Rajneesh Kr.	HOD(Geomatics)	
			Scale	0 0.15 0 0.3 Km		Sheet
			Drwg No.	HQ REM 1 A4 18 06		Rev No.

PLATE - 6



AREA STATISTICS					
Level-I	Level-II	Classes	Area (Sq.Km.)	%	
		Colour			
SCRUB	Scrub		1.00	07.34	
	Social Forestry		1.31	09.61	
	PLANTATION	Plantation on Backfilled		0.10	00.73
		Plantation on OB		1.19	08.73
Total Plantation			2.60	19.08	
Total Vegetation			3.60	26.41	
MINING AREA	Coal Quarry		2.91	21.35	
	Coal Dump		0.11	00.81	
	Backfill		0.48	03.52	
	Barren OB		2.91	21.35	
	Total Aea Under Mining			6.41	47.03
WASTELAND	Waste Land		3.05	22.38	
SETTLEMENTS	Urban		0.17	01.25	
	Industrial		0.40	02.93	
	Total Settlement			0.57	04.18
TOTAL			13.63	100.00	

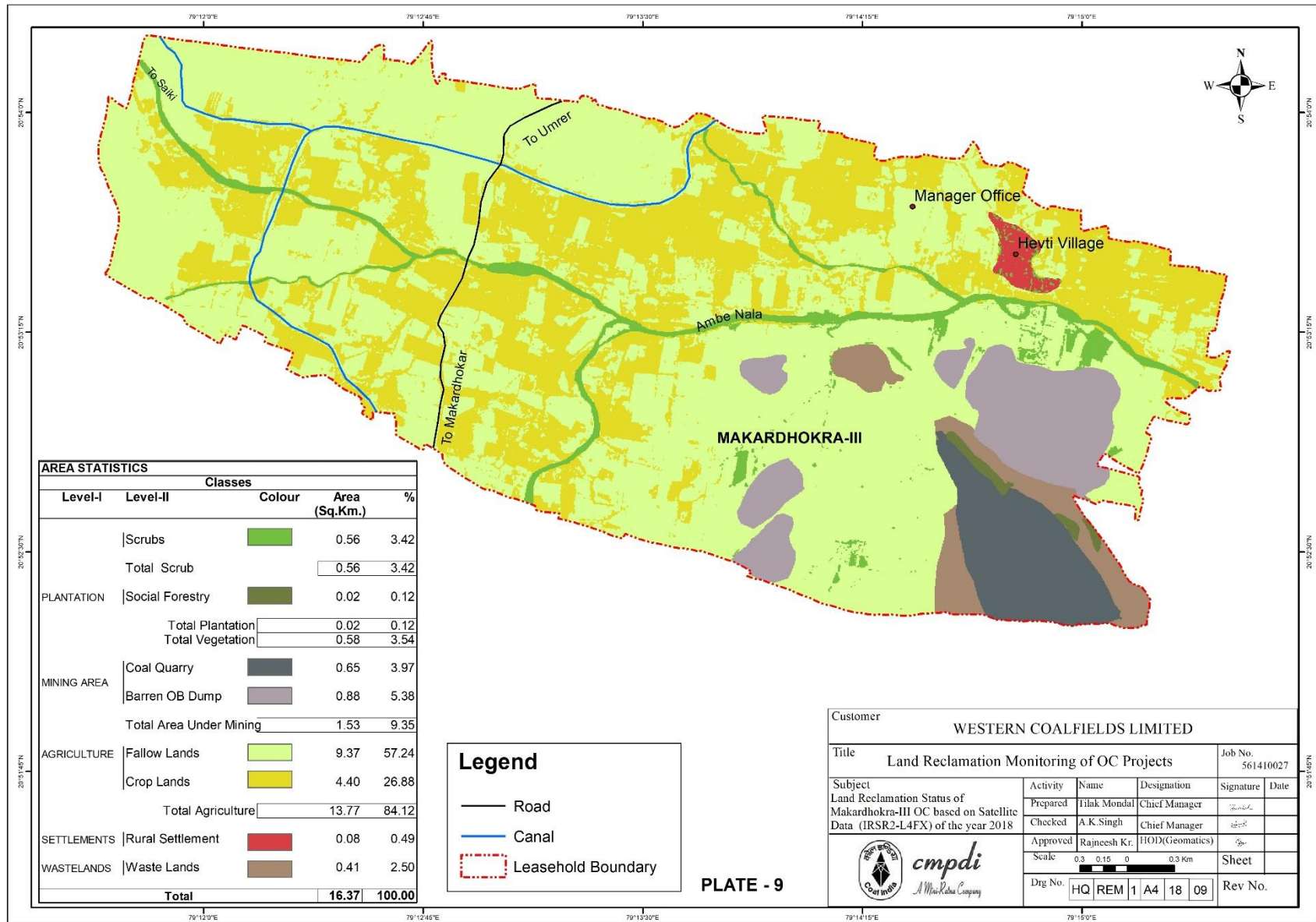
Legend	
	Road
	Leasehold

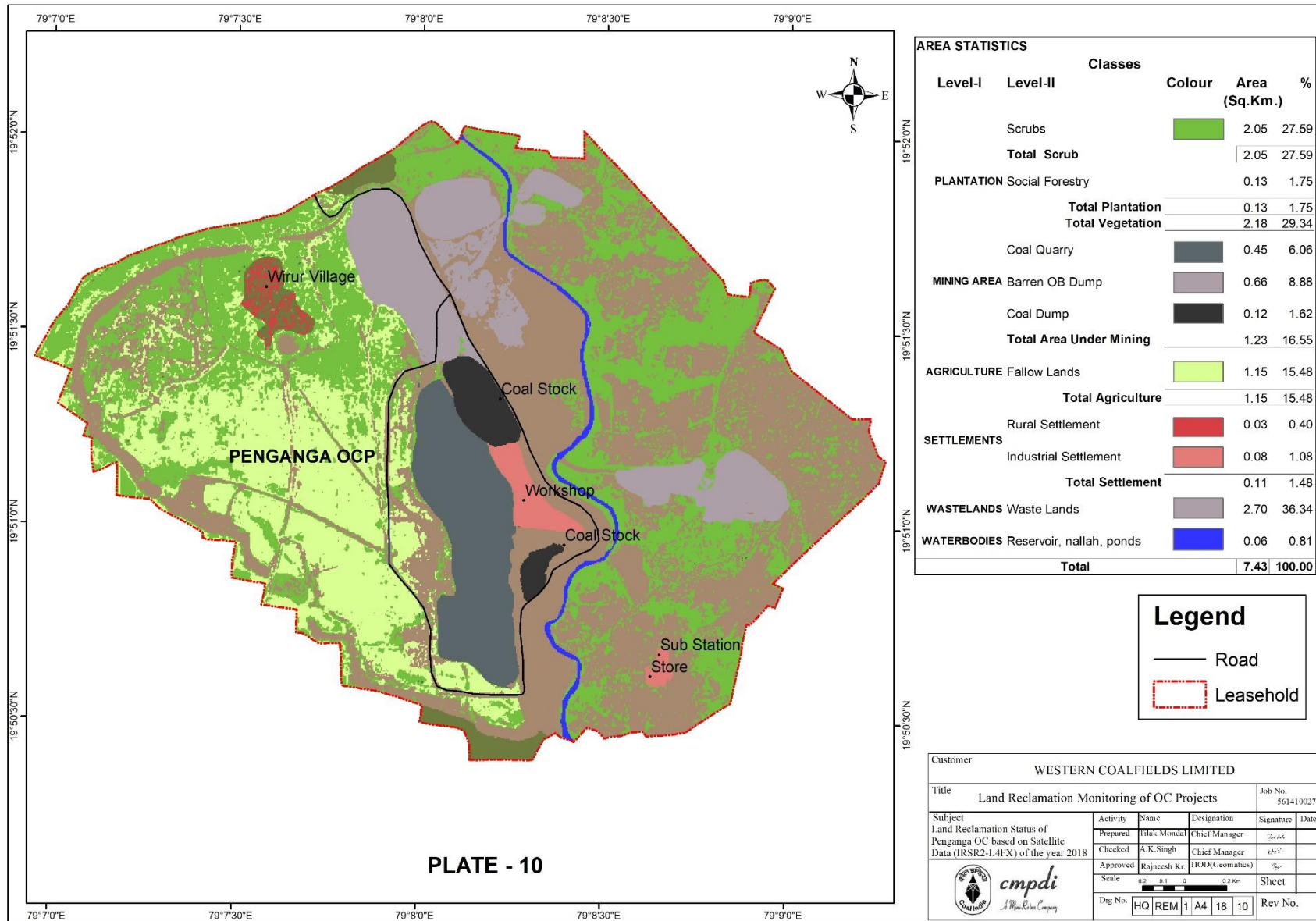
PLATE-7

Customer		WESTERN COALFIELDS LIMITED			
Title		Land Reclamation Monitoring of OC Projects		Job No. 561410027	
Subject Land Reclamation Status of Niljai OC Based on Satellite Data (IRS2-14FX) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	Filak Mondal	Chief Manager		
	Checked	A.K.Singh	Chief Manager		
	Approved	Rajneesh Kr.	HOD(Geomatics)		
Scale		0.35 0.175 0 0.35 Km		Sheet	
Drg No.		HQ REM 1 A4 18 07		Rev No.	









AREA STATISTICS

Level-I	Level-II	Classes	Colour	Area (Sq.Km.)	%
		Scrubs		2.05	27.59
		Total Scrub		2.05	27.59
PLANTATION	Social Forestry			0.13	1.75
		Total Plantation		0.13	1.75
		Total Vegetation		2.18	29.34
		Coal Quarry		0.45	6.06
MINING AREA	Barren OB Dump			0.66	8.88
		Coal Dump		0.12	1.62
		Total Area Under Mining		1.23	16.55
AGRICULTURE	Fallow Lands			1.15	15.48
		Total Agriculture		1.15	15.48
		Rural Settlement		0.03	0.40
SETTLEMENTS	Industrial Settlement			0.08	1.08
		Total Settlement		0.11	1.48
WASTELANDS	Waste Lands			2.70	36.34
WATERBODIES	Reservoir, nallah, ponds			0.06	0.81
		Total		7.43	100.00

Legend

- Road
- Leasehold

Customer						WESTERN COALFIELDS LIMITED					
Title						Land Reclamation Monitoring of OC Projects					
						Job No. 561410027					
Subject Land Reclamation Status of Penganga OC based on Satellite Data (RSR2-1.41X) of the year 2018	Activity	Name	Designation	Signature	Date						
	Prepared	Itlak Mondal	Chief Manager								
	Checked	A.K.Singh	Chief Manager								
	Approved	Rajneesh Kr	HOD(Geomatics)								
Scale											
Dwg No.						HQ REM 1 A4 18 10					
						Rev No.					

PLATE - 10

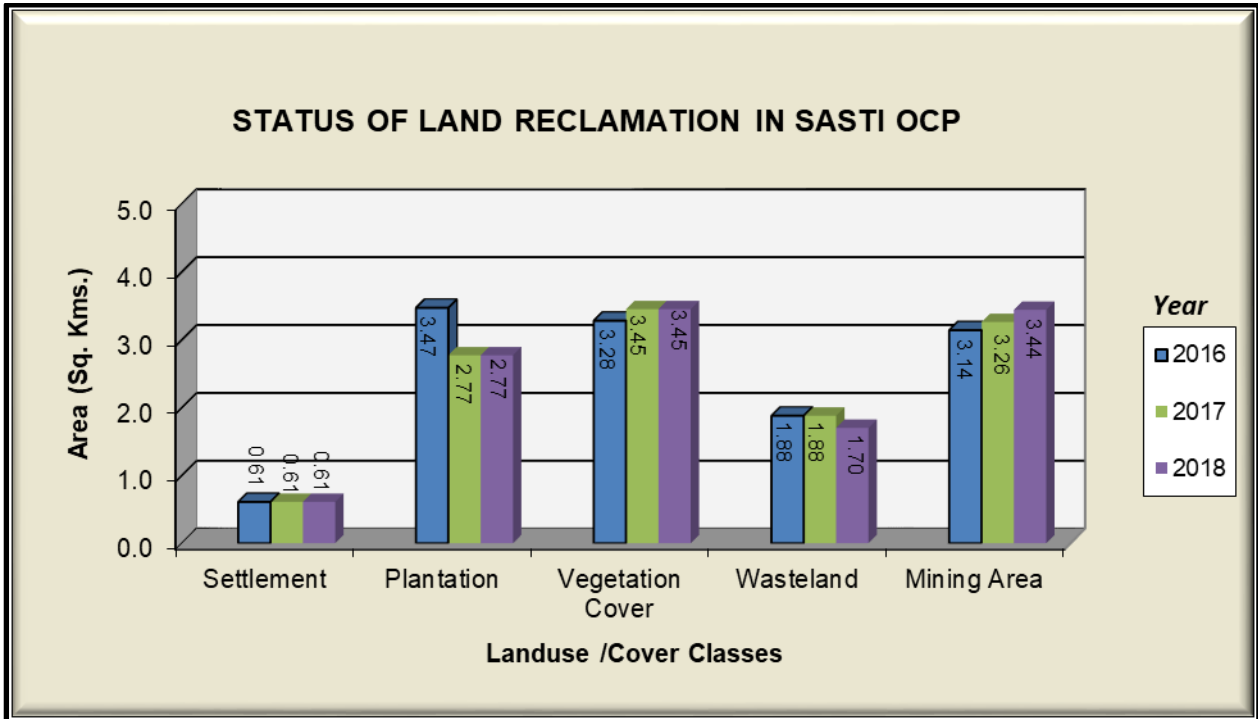


Figure 3

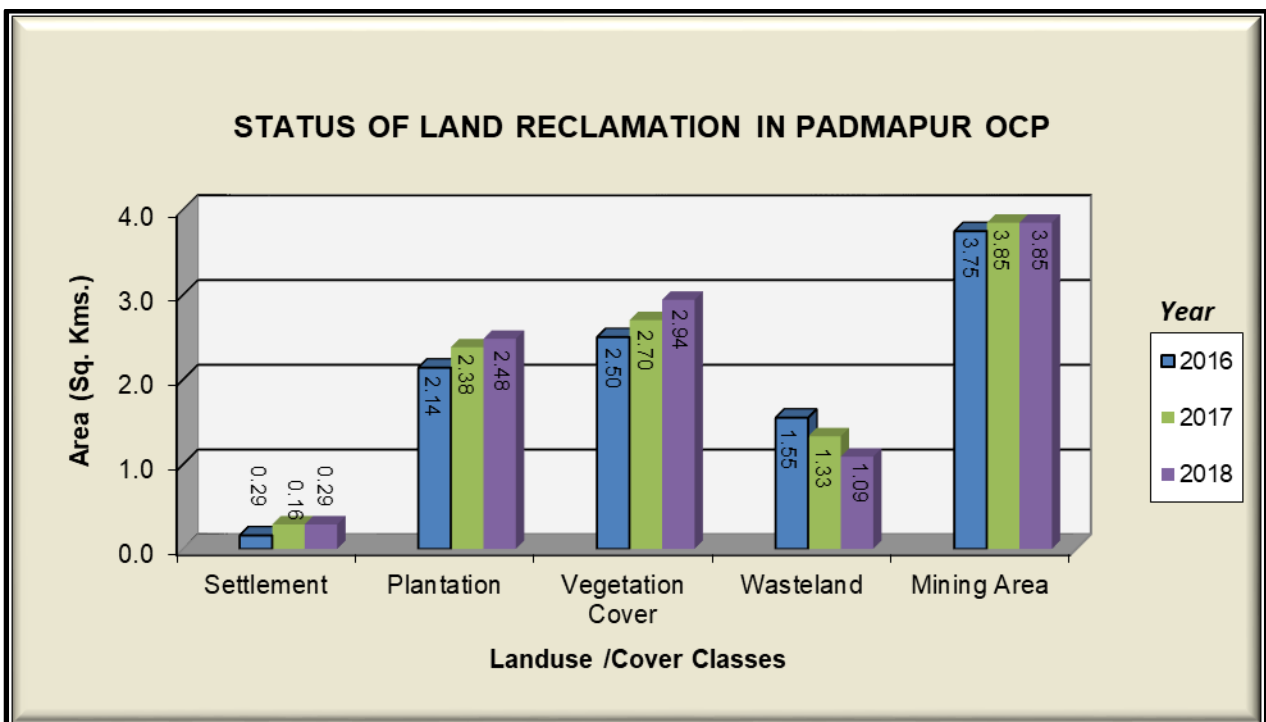


Figure 4

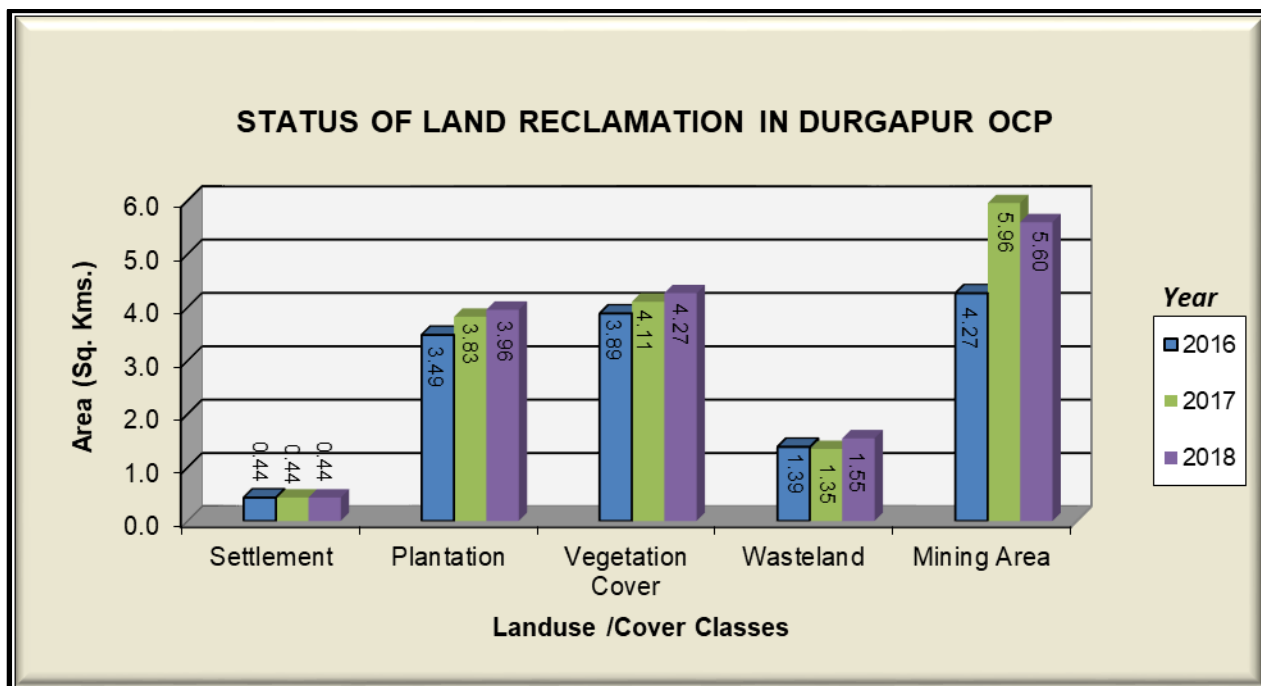


Figure 5

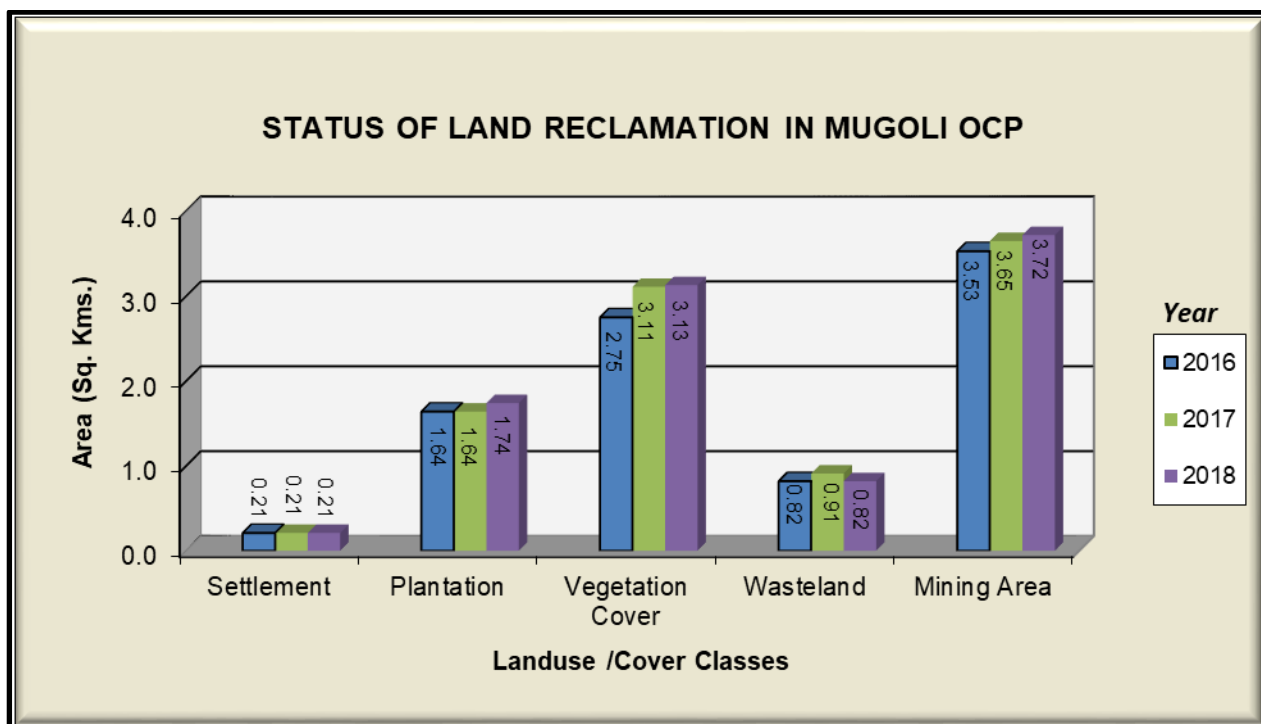


Figure 6

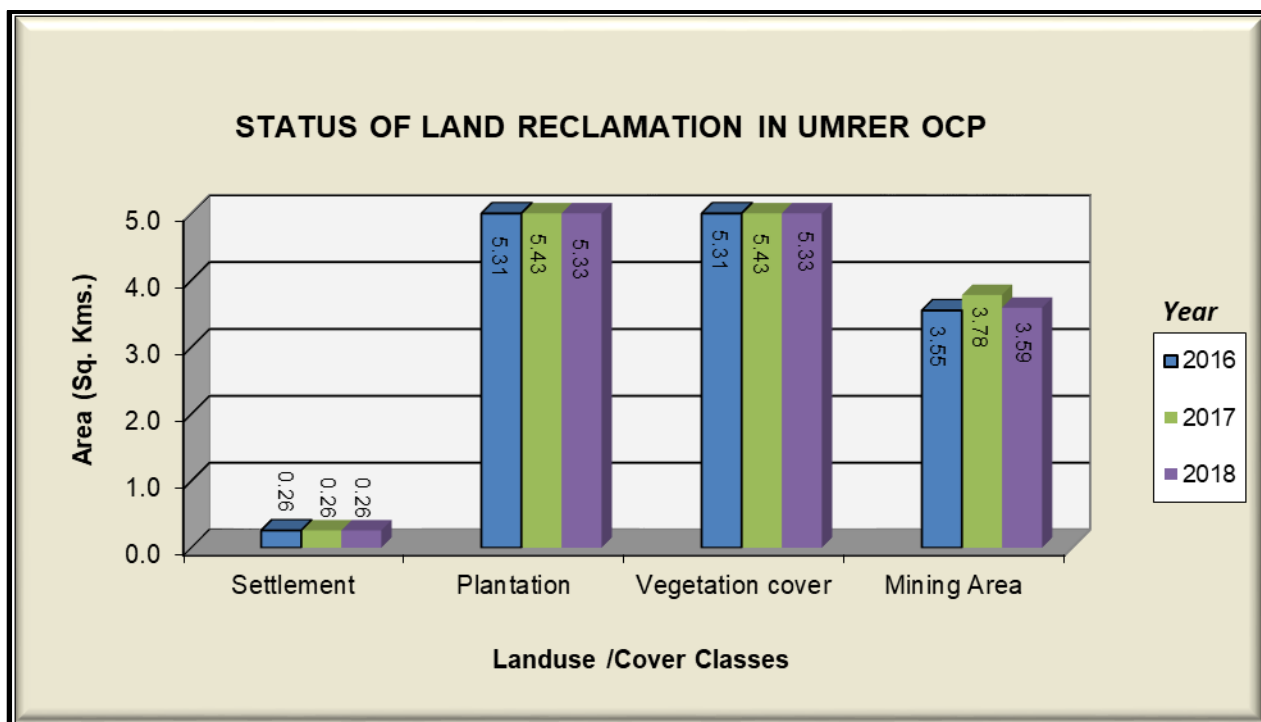


Figure 7

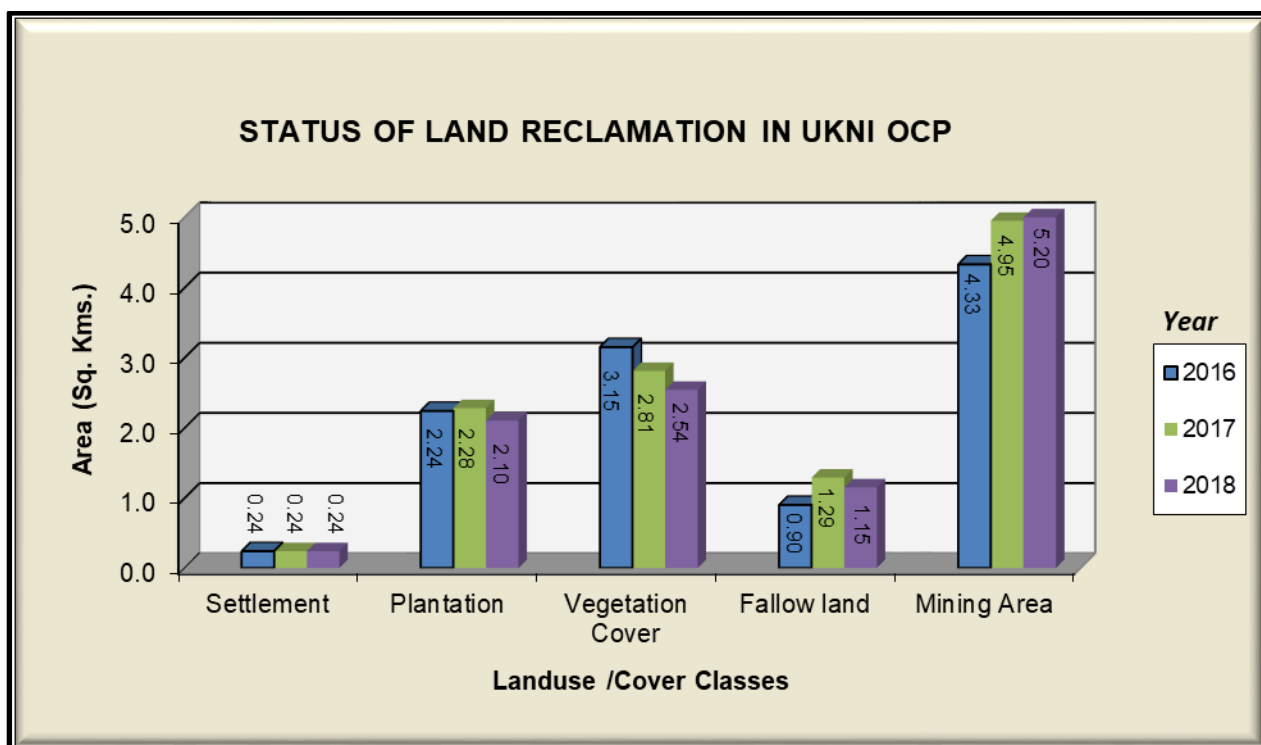


Figure 8

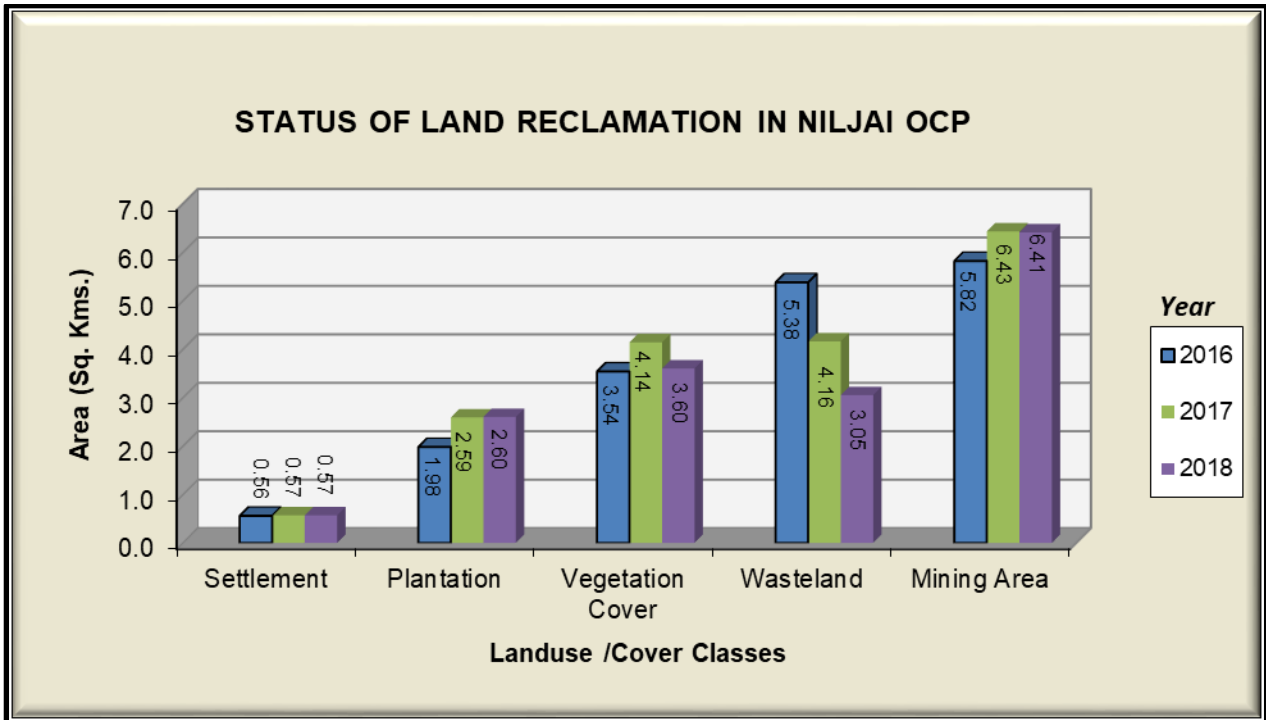


Figure 9

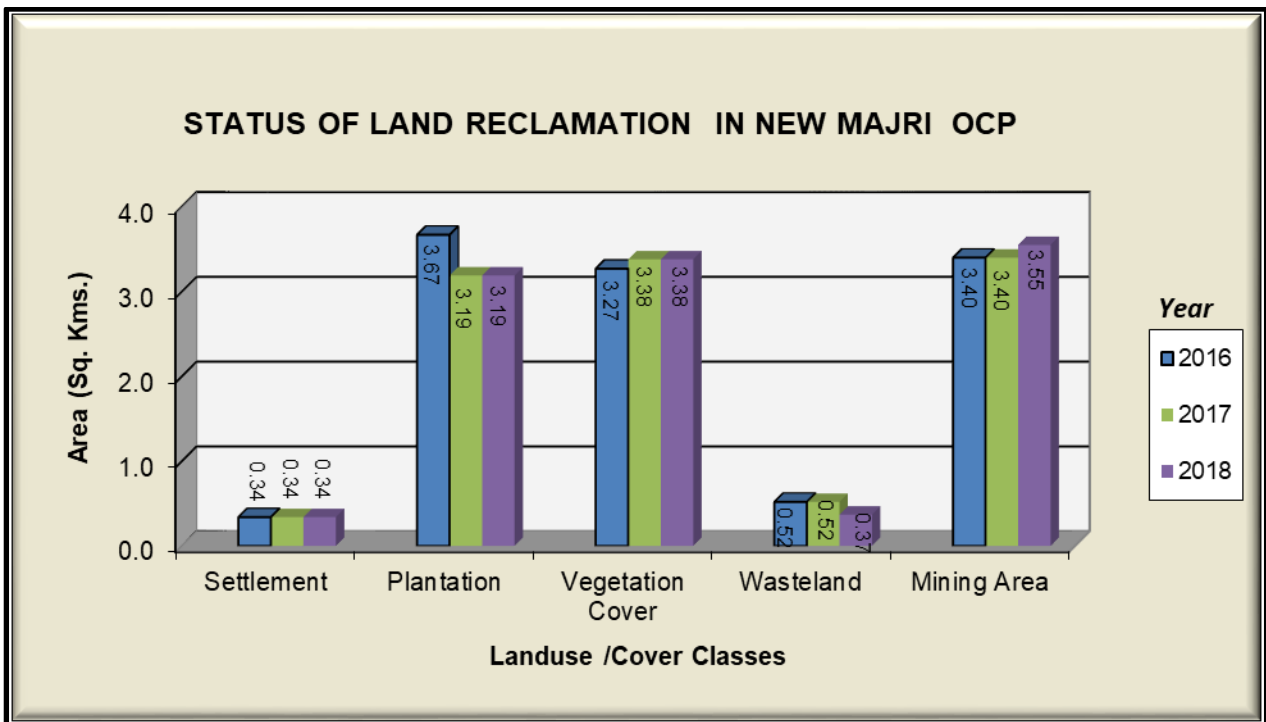


Figure 10

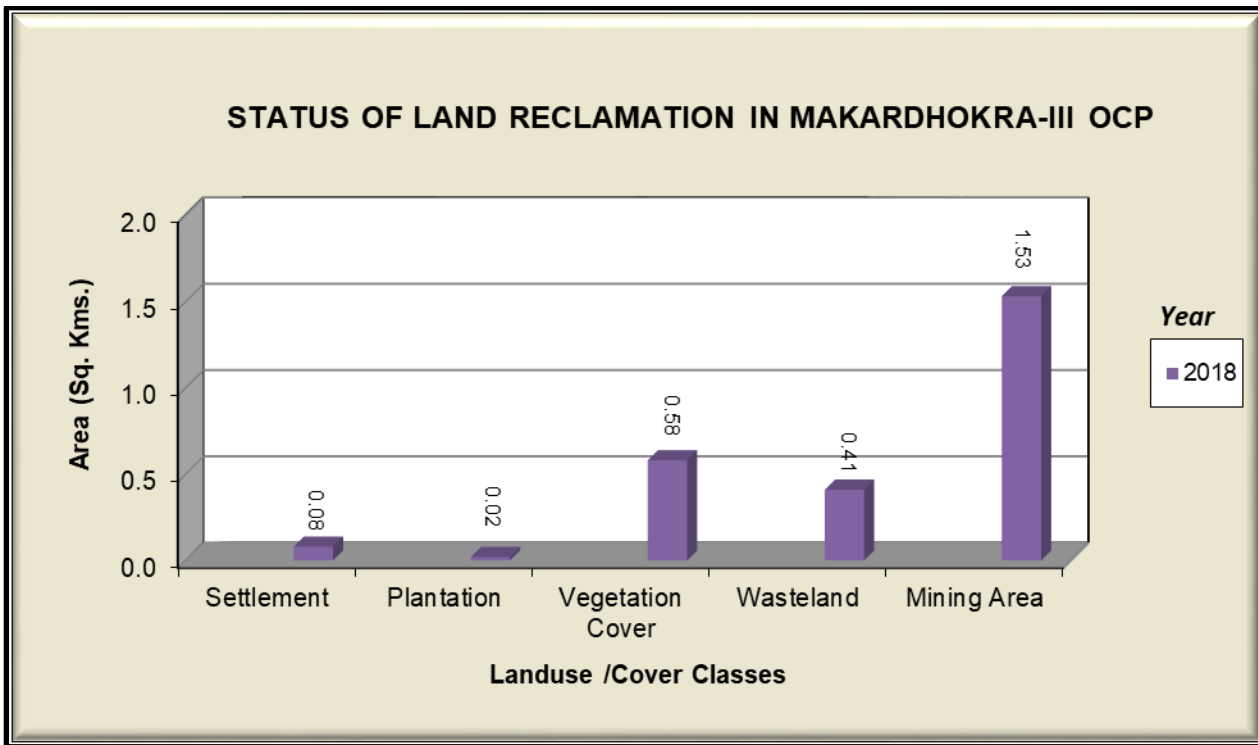


Figure 11

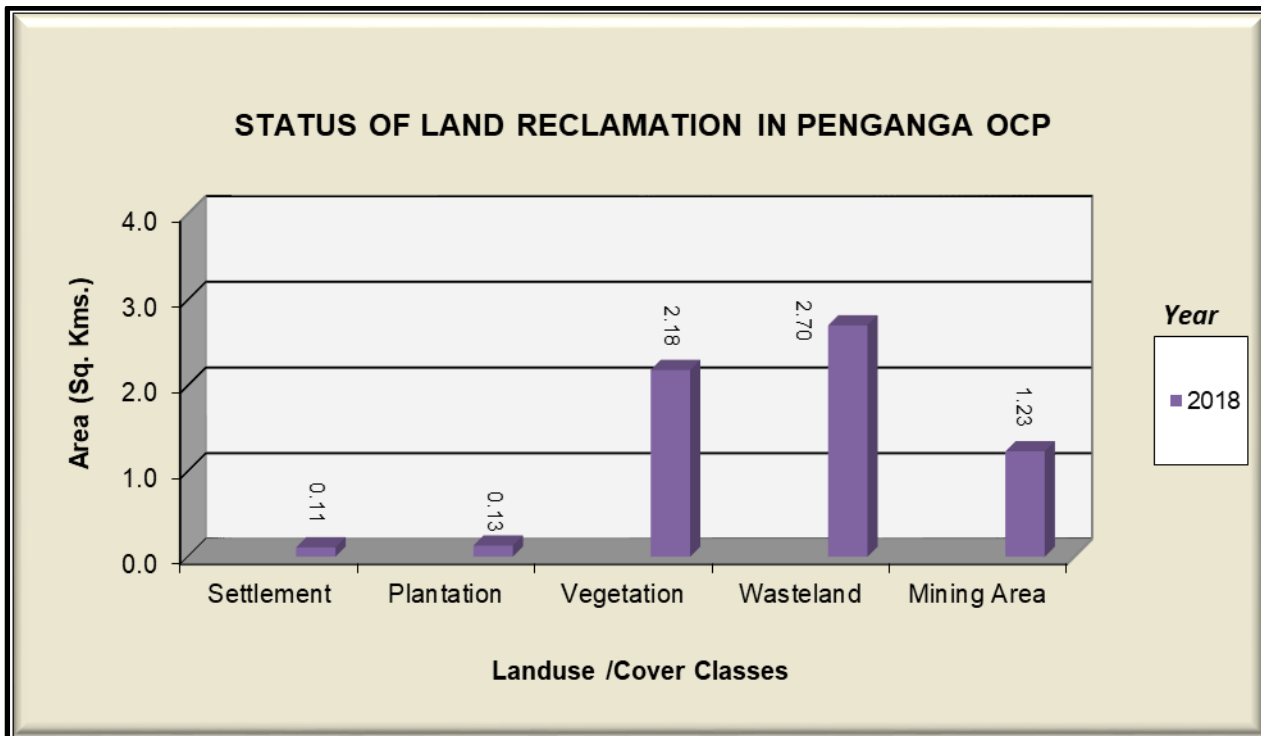
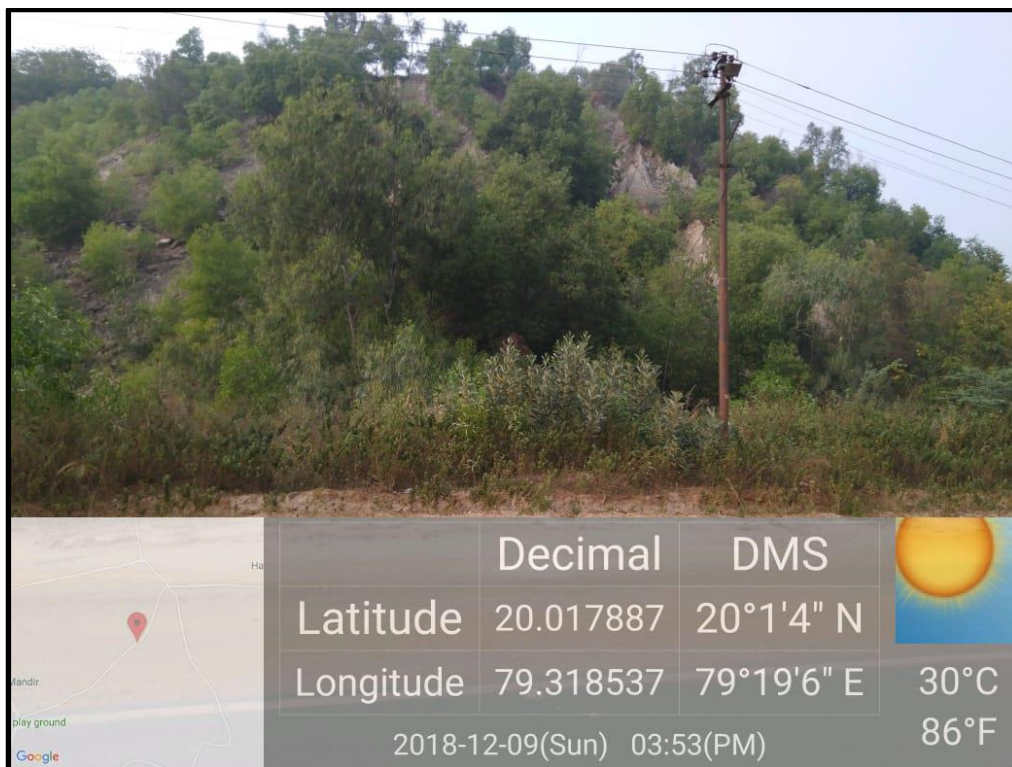


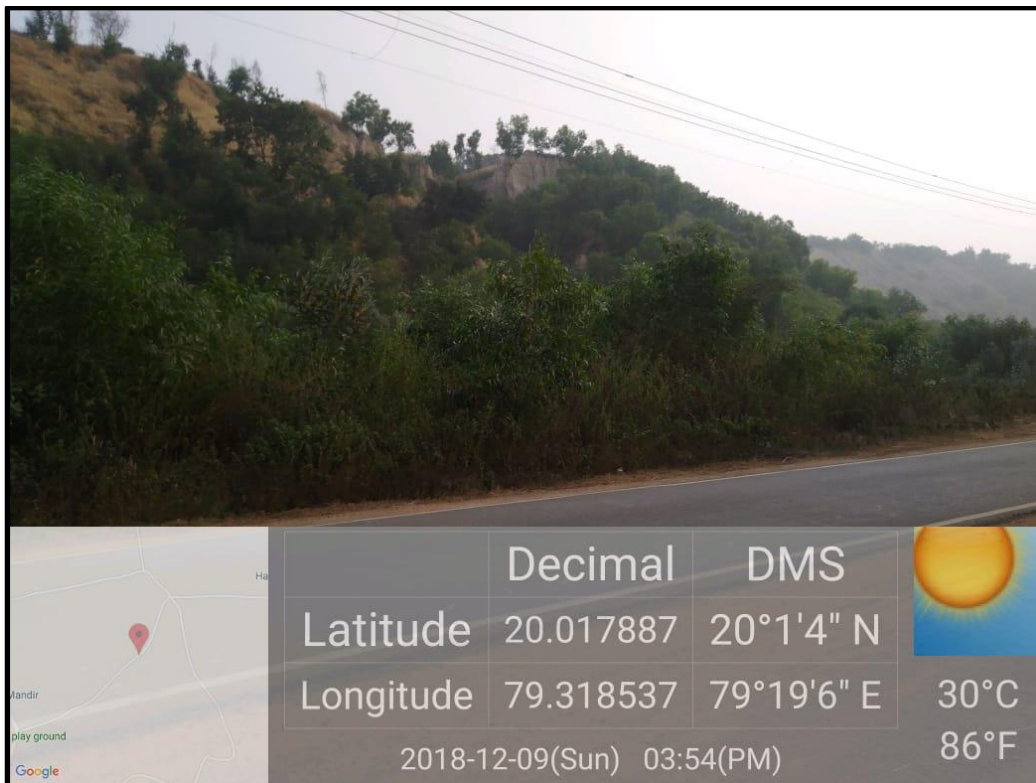
Figure 12



Photograph-1: Plantation on Internal OB/Backfill (Sasti OCP)



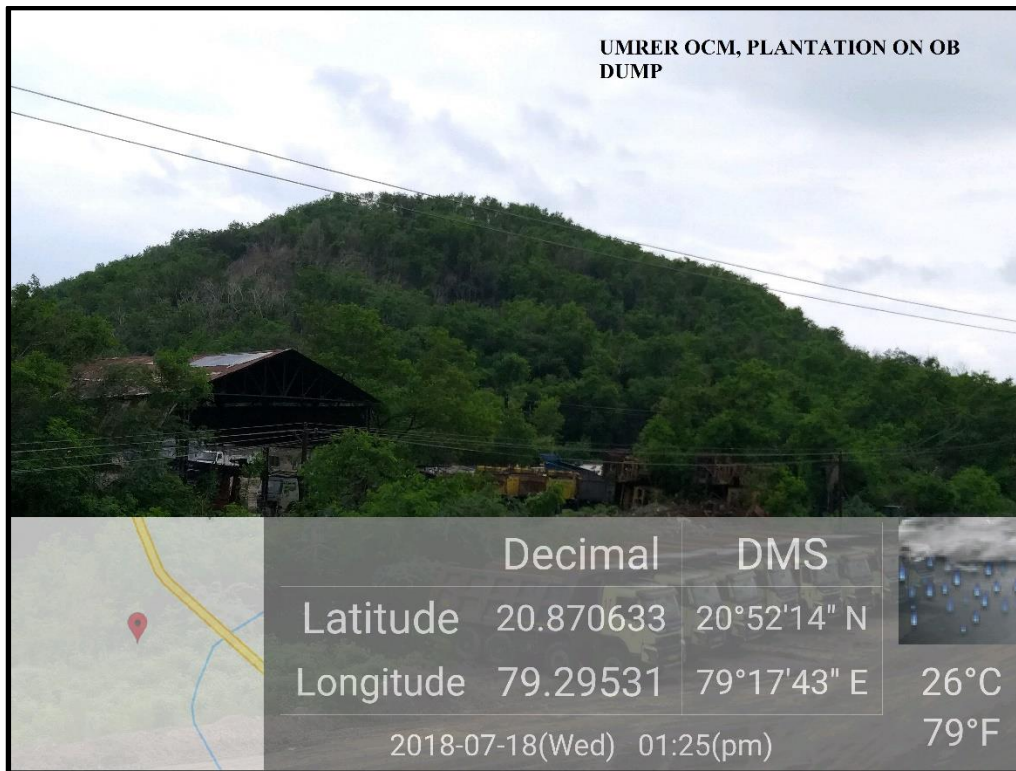
Photograph-2: Plantation on External OB dump (Padmapur OCP)



Photograph-3: Plantation on External OB dump of (Durgapur OCP)



Photograph-4: Plantation on External OB dump (Mugoli OCP)



Photograph-5: Plantation on External OB dump (Umrer OCP)



Photograph-6: Plantation on External OB dump (Ukni OCP)



Photograph-7: Plantation along road (Niljai OCP)



Photograph-8: Plantation along embankment (New Majri OCP)



Photograph-9: Social forestry (Makardhokra-III OCP)



Photograph-10: Avenue Plantation (Penganga OCP)



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