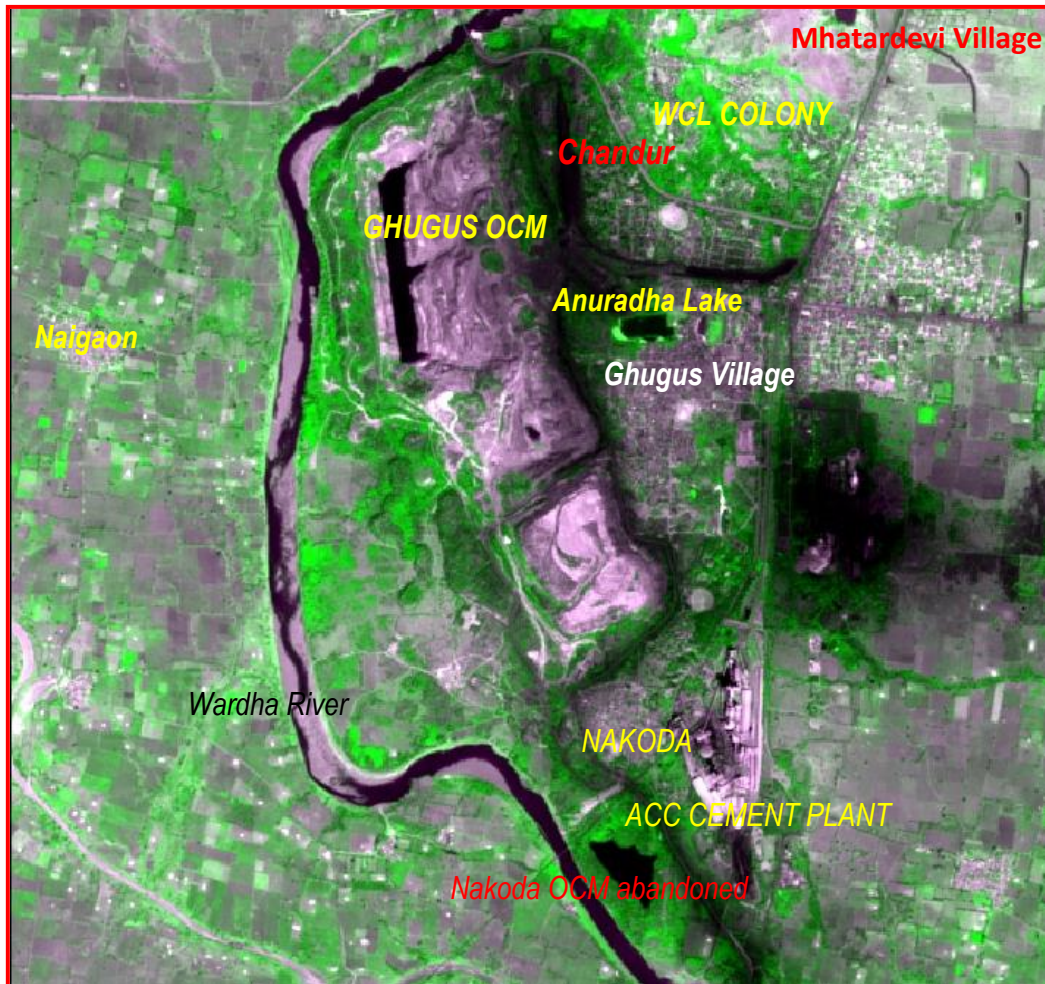


**Land Restoration / Reclamation Monitoring of Open Cast  
Coal Mines (Less than 5 million Cu.m. (OB+ Coal) of WCL  
based on Satellite Data for the Year 2019**



Submitted to:  
**WESTERN COALFIELD LIMITED**  
**FEBRUARY 2020**



**cmpdi**  
*A Mini Ratna Company*

**Land Restoration / Reclamation Monitoring of 11 Open Cast  
Coal Mines (Less than 5 million cu.m. ( OB+ Coal) of WCL  
based on Satellite Data for the Year 2019**

February-2020



**Remote Sensing Cell  
Geomatics Division  
CMPDI Ranchi**

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## Executive Summary

- 1.0 Project** Monitoring of Land restoration / Reclamation monitoring of 11 opencast coal mines of Western Coalfields Ltd. (WCL) producing less than 5 million cu.m. (Coal+OB) annually based on satellite data 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 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**
- Total mine leasehold area of 5716.46 Ha of the 11 opencast projects of WCL viz. Yekona-I & II OC, New Majri UG to OC, Pauni-II OC, Gokul OC, Sighori OC, Bhanegaon OC, Makardhokra –II OC, New Sethia OC, Ghugus OC, Pimpalgaon OC and Datla OC mine taken up for land reclamation monitoring during 2019-20; it is revealed that total excavated area is 923.98 Ha. (16.16%) out of which 88.96 Ha. area (9.63%) has been planted, 422.14 Ha area (45.69%) is under backfilling and balance 412.88 Ha (44.68%) area is under active mining. It is also evident from analysis that 511.10 Ha area (55.32%) has already been reclaimed (biologically and technically). Project wise details are given in Table-1.
  - On comparing the status of 11 projects of WCL for the year 2019 with respect to the year 2016, it is evident from analysis that area under reclamation has increased from 380.98 Ha (Yr2016) to 511.10 Ha (Yr2019). This increase 130.12 Ha in area under reclamation in the year 2019 is mainly due to Ghugus OC where area under reclamation is maximum i.e 323.08 Ha (90.03%). This increase of 130.12 Hectare area under land reclamation in period of three years is the result of sincere effort made by Western Coalfield Ltd towards land reclamation and environmental protection. Status of Land reclamation for the year 2019 in WCL is shown in barchart with help of figure-1.

- Area of Biological reclamation (plantation on backfill) has increased from 56.59 Ha (Yr. 2016) to 88.96 Ha (Yr.2019) whereas area under technical reclamation (backfilling) has increased from 324.39 Ha (Yr.2016) to 422.14 Ha (Yr.2019). figure-1.
- It is important to note that a new Table format in the year 2017 has been designed by Coal India Ltd . with new parameters for Biological & Technical Reclamation. For comparative propose the basic data for the year 2016-17 has been fed into the new format so that it can be compared with the result of year 2019-20 as per the new format.
- Land reclamation of 8 opencast project i.e amalgamated Yekona-I&II OC ,New Majri UG to OC , Pauni II OC Gokul OC ,Singhori OC , Bhanegaon OC Makardhokra-II OC and New Sethia OC were taken up for land reclamation in the year 2016-17 .In addition to these 3 more viz Ghugus OC , Pimpalgaon OC and Datla OC are included for land reclamation in the year 2019-20. Land reclamation monitoring for Ghugus OC and Pimpalgaon OC were carried out on annual basis till year 2017. As per letter vide no डब्लू.सी.एल/मुख्यालय/पर्यावरण/17-AA/260-261dated 14.03.2019 received from WCL, wherein it was mentioned that projects like Ghugus OC & Pimpalgaon OC are to be monitored triennially starting from the year 2019-20 as these two mines are in the process of final closure and will fall under category of mine capacity < 5 mcm (Coal+ OB). Hence in the year 2019, these two opencast projects are included in the category of capacity < 5 mcm (Coal+ OB).
- Out of 11 projects of WCL considered for land reclamation monitoring in the year 2019, leasehold boundary of 06 projects have been updated this year resulting which significant change in shape and total area of leasehold is observed which is shown in table-1. The updation of leasehold of 06 projects are based on keyplan and shape file provided by the respective projects , area of updated leasehold as per record of approved EC provided by WCL through Email. There is no change in leasehold boundary of other 2 projects like MKD-II

OC and Ghugus OC whereas land reclamation monitoring for data OC has been started in the year 2019 and result obtained in the year 2019 will be considered as base data for comparing the status of land reclamation of this mine in the year 2022 i.e at the interval of three years.

**Table-1**  
**Projectwise Land Reclamation Status in Opencast Projects of WCL**  
 (<5 Million cu. M coal+OB) based on Satellite Data of the year 2019-20)

(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, Awanue Plantation Etc.		
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11(=4+5)			
		2016	2019	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019	2016	2019
1	Yekona-I&II	1701.00	680.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.72	0.00	9.72	0.00	0.00	0.00	0.00	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					0.00%	100.00%			0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	New Majri Ugto OC	479.16	479.16	0.00	0.00	0.00	0.00	0.00	0.00	5.70	15.57	30.08	57.92	30.08	57.92	5.70	15.57	0.00	0.00	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			1.19%	3.25%	0.00%	0.00%	0.00%	0.00%
3	Pauni -II OC	316.30	1095.52	0.00	0.00	0.00	0.00	3.86	3.86	0.00	6.52	6.88	24.87	6.88	24.87	3.86	10.38	0.00	0.00	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			1.22%	0.95%	0.00%	0.00%	0.00%	0.00%
4	Gokul	721.68	756.92	0.00	39.85	0.00	0.00	0.00	0.00	1.29	17.50	81.97	118.78	81.97	158.63	1.29	17.50	0.00	0.00	39.85	39.85
				0.00%	25.12%	0.00%	0.00%					100.00%	74.88%			0.18%	2.31%	0.00%	0.00%	25.12%	25.12%
5	Singhori	428.00	425.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.59	0.00	26.82	0.00	26.82	0.00	4.59	0.00	0.00	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					0.00%	100.00%			0.00%	1.08%	0.00%	0.00%	0.00%	0.00%
6	Bhanegaon	348.13	347.46	2.44	2.45	0.00	0.00	0.00	8.75	16.54	16.11	9.51	31.82	11.95	34.27	16.54	24.86	2.44	2.45	2.44	2.45
				20.42%	7.15%	0.00%	0.00%					79.58%	92.85%			4.75%	7.15%	20.42%	7.15%	20.42%	7.15%
7	Makardhokra-II	258.23	258.23	29.26	44.61	2.90	2.90	38.88	58.76	2.85	2.57	21.40	6.91	53.56	54.42	44.63	64.23	32.16	47.51	32.16	47.51
				54.63%	81.97%	5.41%	5.33%					39.96%	12.70%			17.28%	24.87%	60.04%	87.30%	60.04%	87.30%
8	New Sethia	155.28	144.45	17.03	25.99	23.48	23.58	5.88	6.80	11.26	9.53	47.77	40.81	88.28	90.38	40.62	39.91	40.51	49.57	40.51	49.57
				19.29%	28.76%	26.60%	26.09%					54.11%	45.15%			26.16%	27.63%	45.89%	54.85%	45.89%	54.85%
9	Ghugus	1020.00	1020.00	275.66	267.70	30.21	55.38	135.06	135.00	52.26	84.91	49.10	35.77	354.97	358.85	217.53	275.29	305.87	323.08	305.87	323.08
				77.66%	74.60%	8.51%	15.43%					13.83%	9.97%			21.33%	26.99%	86.17%	90.03%	86.17%	90.03%
10	Pimpalgaon	492.98	451.87	0.00	13.33	0.00	0.00	97.60	136.11	84.20	80.32	59.01	46.25	59.01	59.58	181.80	216.43	0.00	13.33	0.00	13.33
				0.00%	22.37%	0.00%	0.00%					100.00%	77.63%			36.88%	47.90%	0.00%	0.00%	0.00%	22.37%
11	Datla	0.00	57.75	0.00	28.21	0.00	7.10	0.00	0.00	0.00	0.00	0.00	13.21	0.00	48.52	0.00	7.10	0.00	0.00	0.00	35.31
				0.00%	58.14%	0.00%	14.63%					0.00%	27.23%			0.00%	12.29%	0.00%	0.00%	0.00%	72.77%
	<b>TOTAL</b>	<b>5920.76</b>	<b>5716.46</b>	<b>324.39</b>	<b>422.14</b>	<b>56.59</b>	<b>88.96</b>	<b>281.28</b>	<b>349.28</b>	<b>174.10</b>	<b>237.62</b>	<b>305.72</b>	<b>412.88</b>	<b>686.70</b>	<b>923.98</b>	<b>511.97</b>	<b>675.86</b>	<b>380.98</b>	<b>511.10</b>	<b>380.98</b>	<b>511.10</b>
				47.24%	45.69%	8.24%	9.63%					44.52%	44.68%	11.60%	16.16%	8.65%	11.82%	55.48%	55.32%	55.48%	55.32%

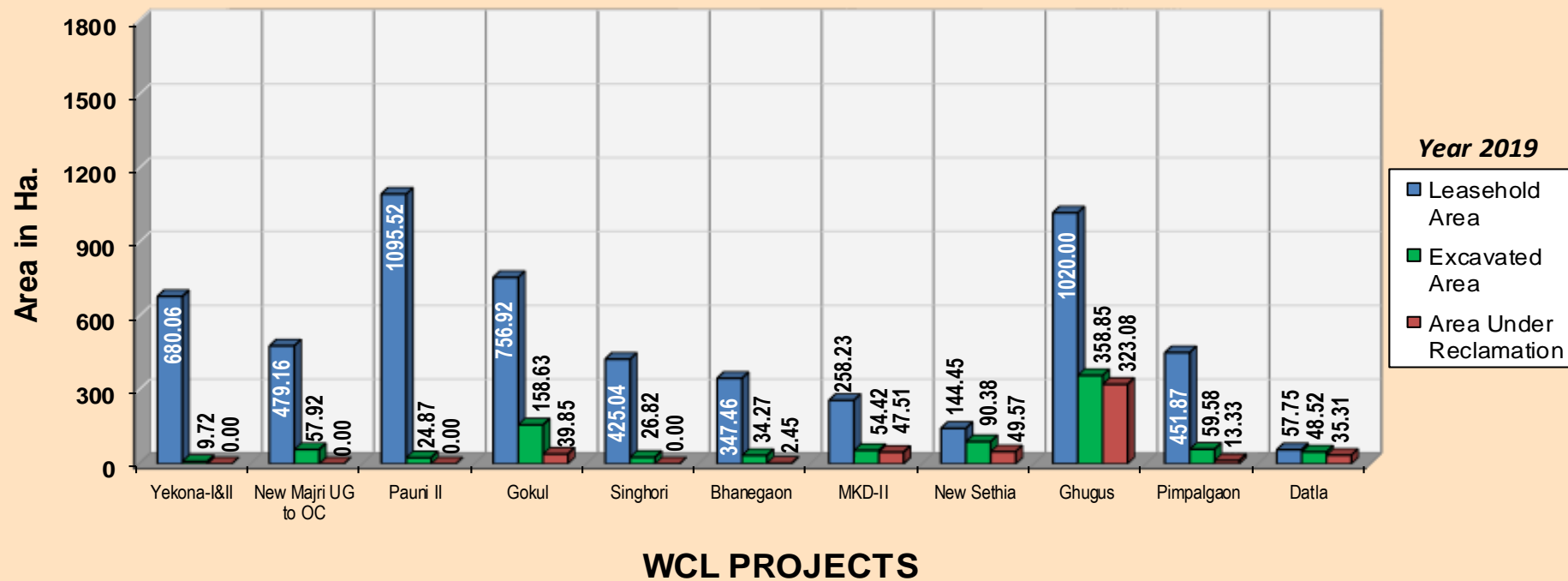
(% is calculated with respected to Excavated Area as applicable)

**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 excavated area except for "Total area under plantation" where % has been calculated in terms of leasehold area.



**PROJECTWISE LAND RECLAMATION STATUS IN WCL FOR THE YEAR 2019**



**Figure-1 Land Reclamation Status in OC projects producing less than 5mcm (Coal+OB) of WCL in the year 2019**

## **1.0 Background**

- 1.1** Land is the most important natural resource which embodies soil, water, flora and fauna and total ecosystem. All human activities are based on the land which is 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/2011/4706 dated 12.10.2012 to Central Mine Planning & Design Institute (CMPDI), Ranchi, which has well a equipped remote sensing facility and capability to monitor the status of land reclamation for all the opencast coal mines having production of more than 5 million cu. m. per annum (Coal + OB taken together) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining operation within command area of CIL and its subsidiaries. Further, the opencast coal mining project of less than 5 million cu.m per annum capacity (Coal +OB) is also under satellite monitoring from the year 2011 at interval of three years. As per work order no CIL/WBP/Env/2011/4706 dated 12.10.2012 of CIL ,the result of land reclamation status of all such mines to be put on the website of **CIL**, ([www.coalindia.in](http://www.coalindia.in)), **CMPDI** ([www.cmpdi.co.in](http://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 (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 2016 carried out of the 8 OC projects producing less than 5 million cu.m. of (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 2. Following steps are involved in land reclamation /restoration monitoring:

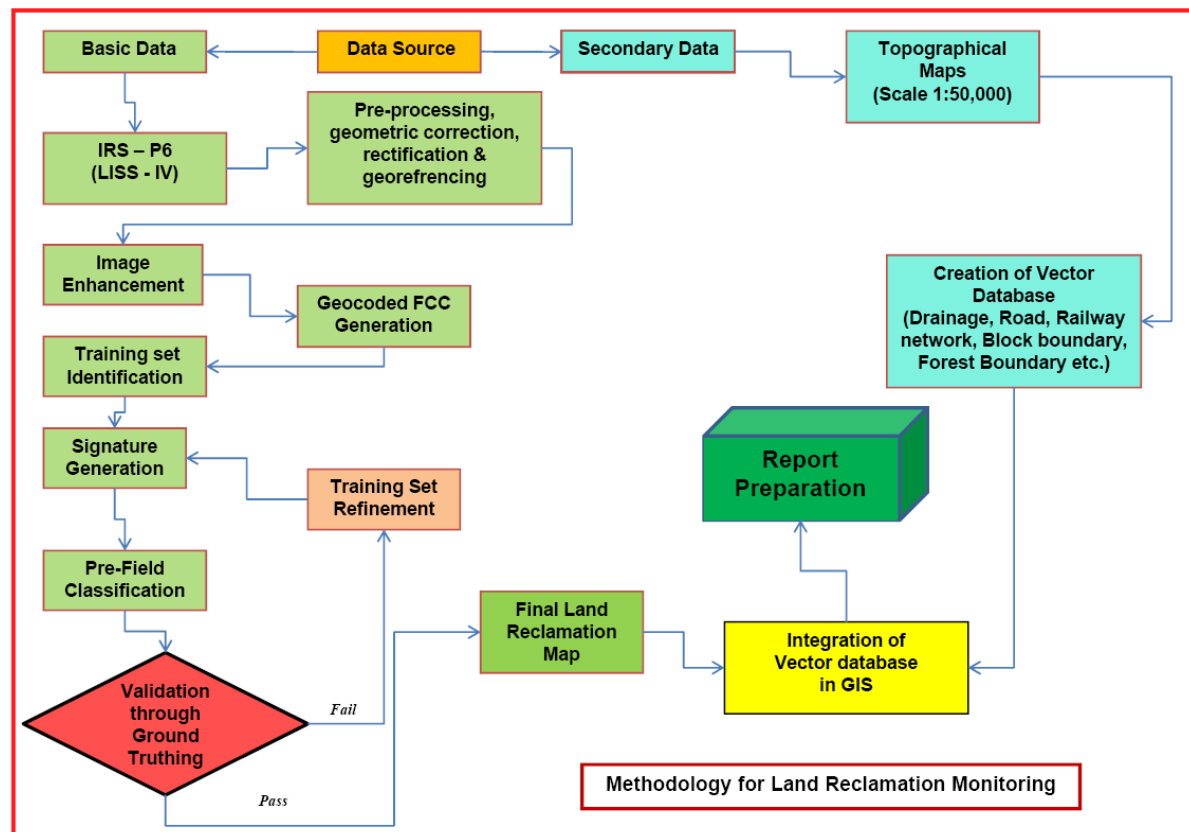


Figure: 2 **Methodology for Land Reclamation Monitoring**

**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, topo sheets are procured for creation of vector database.

**3.2 Satellite Data Processing:** Satellite data are processed using ERDAS IMAGINE 2013 digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Geo-referencing:** 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 Sol topo sheet.

- **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 2014s/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 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 Work Plan**

- 4.1** Eleven opencast projects of WCL producing less than 5 million cubic m. (Coal + OB together) during the year 2019 which have been taken up for land restoration / reclamation monitoring based on the *RESOURCESAT-2A (L4FX)* satellite data using / ERDAS Imaging digital image processing s/w on GIS Vs10.2 platform. Land reclamation monitoring will be carried out triennially to assess the progressive status of land restoration / reclamation in the above opencast mines. The report of this study has been uploaded on the website of CMPDI & CIL in public domain.

## 4.0 Land Reclamation Status in Western coalfields Ltd.

5.1 Following 11 opencast projects of WCL producing less than 5 million cubic m. (Coal+OB) together, were taken up for land reclamation monitoring during the year 2019 -20:

- Yekona-I&II OC
- New Majri UG to OC
- Pauni –II OC
- Gokul OC
- Singhori OC
- Bhanegaon OC
- MKD-II OC
- New Sethia OC
- Ghugus OC
- Pimpalgaon OC
- Datla OC

5.2 Project wise Land reclamation status in WCL is given in table -1 and also graphically in figure-1. Area statistics of different land use classes present in mine leasehold of the above projects for the year 2019 are shown in table-.2. Land use maps derived from satellite data are shown in Plate 5.1-5.11 and different land use classes based on satellite data of the year 2019 are depicted also in Bar Charts in Fig.5.2 – 5.12 for the year 2016 and 2019.

5.3 Study reveals that total excavated area of 923.98 Hectare , 511.10 Hectare (55.32%) area has already been under reclamation by WCL, out of which 88.96 Hectare (9.63%) area has been revegetated and 422.14 (45.69%) area is under backfilling. There is an increase of 130.12 Ha area under reclamation in WCL with respect to the year 2016, out of which 32.37 Ha area increase in biological reclamation (Plantation on backfill) and 97.75 Ha area increase in Technical reclamation (backfilling). It is evident from analysis that area under land reclamation has increased from 380.98 Hectares (Yr.2016) to 511.10 Hectare (Yr.2019) This increase of 130.12 Hectare area under land reclamation in period of three years is the result of sincere

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effort made by Western Coalfield Ltd towards land reclamation and environmental protection. Status of land reclamation for the year 2019 in WCL is shown in bar chart( Figure-1).

- 5.4** Study indicates that there has been overall increase in area under technical reclamation (backfilling) and biological reclamation (plantation on backfill) in the projects of WCL in the year 2019 .But in projects like Yekona-I&II OC, New Majri UG to OC, Pauni-II OC and Singhori OC, backfilling is yet to be started as these are new projects which has been included in this study since 2016.
- 5.5** After analyzing the satellite data of the year 2016vs 2019 it is evident that total area under plantation (Green cover) carried out on backfill , OB Dump as well as under social forestry in all the mines of WCL has increased from 511.97 Hectare to 675.86 Hectare in the span of three year. Out of 11 projects of WCL, the major plantation has been carried out in the Ghugus OC and Pimpalgaon OC which contributes maximum in generating green cover in respective area of WCL. The increase of 163.89 Hectare area in total plantation (Green cover generated) in the span of three year is due to sincere effort made by WCL towards mine land reclamation of opencast mine and protection of environment.
- 5.6** The leasehold boundary of Yekona-I&II , Pauni –II OCP ,Gokul OC, Singhori OC ,New Sethia OC and Bhanegaon OC have been updated this year; out of which significant change in shape and area of leasehold boundary of Yekona-I&II and Pauni-II OC are observed i.e leasehold area of Yekona- I&II OCP has decreased from 1701 Ha in the year 2016 to 680.06 Ha in the year 2019 whereas leasehold area of Pauni-II OCP has increased from 316.30 Ha in the year 2016 to 1095.52 Ha in the year 2019.
- 5.7** Leasehold area of New Sethia opencast mine has decreased from 155.28 Ha(Yr.2016) to 144.45 Ha (Yr.2019) due to change in shape of leasehold boundary resulting which Social forestry has decreased from 11.26 Ha (Yr.2016) to 9.53 Ha (Yr.2019).However there is minor decrease in total area under plantation i.e from 40.62 Ha in the year 2016 to 39.91 Ha in the year 2019.

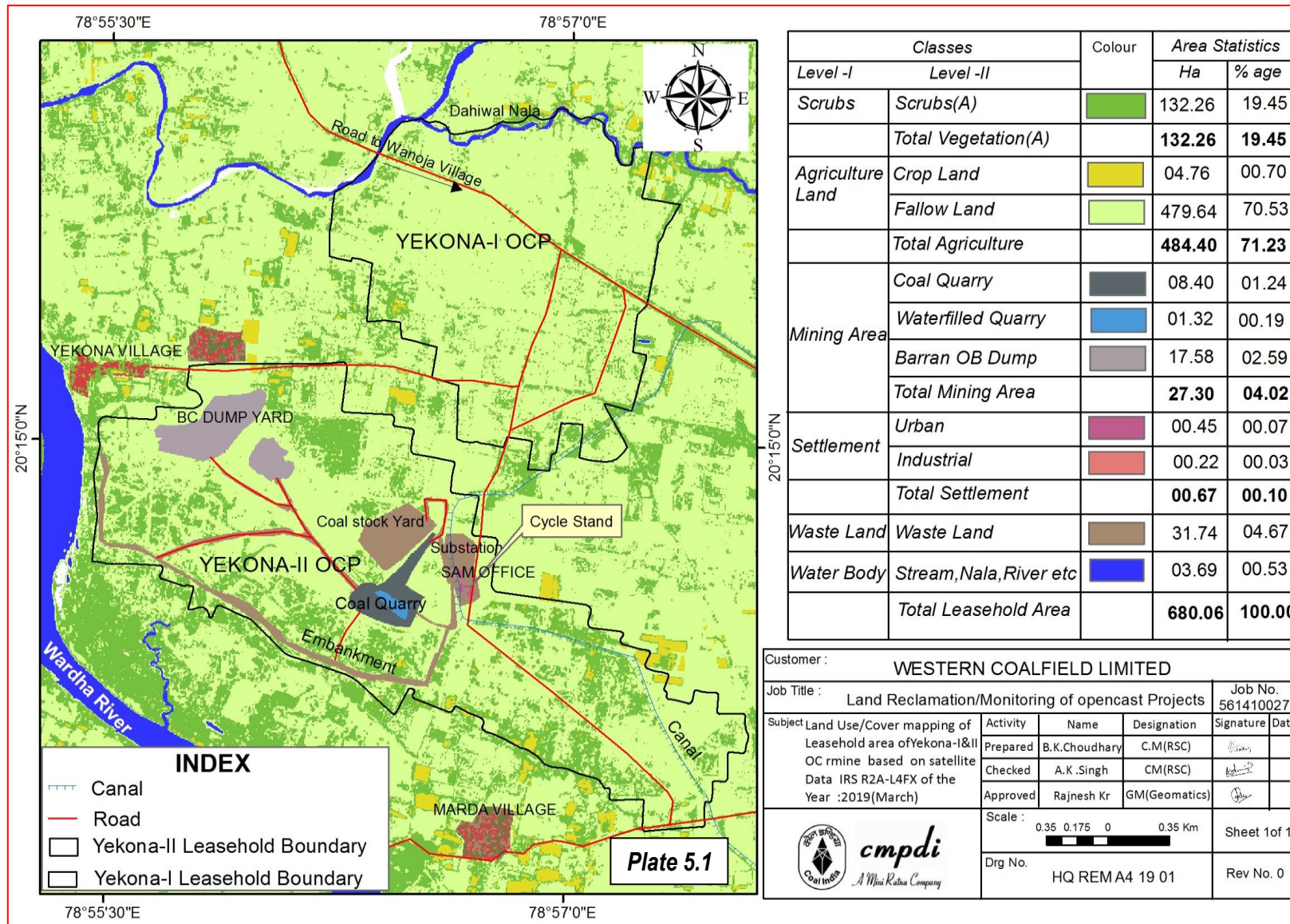


- 5.8** Study indicates that area under technical reclamation in the Ghugus OCP has decreased from 275.66 Ha in the year 2016 to 267.70 Ha in the year 2019 as more backfill area have come under plantation on backfill (Biological reclamation) while total area under plantation (Green Cover) in the Pimpalgaon OCP has increased from 181.80 Ha (Yr.2016) to 216.43 Ha (Yr.2019) This is due to more plantation carried out on barren OB i.e 136.11 Ha in the year 2019 as compared to 97.60 Ha in the year 2016.
- 5.9** Out of 11 projects of WCL, Ghugus OC ranks top for land reclamation (90.03%) followed by MKD-II OCP (87.30%) , Datla OCP (72.77%) ,New Sethia OC (54.85%) and Gokul OC (25.12%).

TABLE - 2  
STATUS OF LANDUSE/RECLAMATION IN OC MINES (<5MCU.M)OF WESTERNCOALFIELD LTD BASED ON SATELLITE DATA OF THE YEAR 2019

(Area in Ha.)

	Yekona-I&II		New Majri UG to OC		Pauni-II		Gokul		Singhori		Bhanegaon		Makardhokra-II		New Sethia		Ghugus		Pimpagaon		Datla		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	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	0.00	
	<b>Total Forest/Tea Plantation</b>	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	0.00	
SCRUB	Scrubs	132.26	19.45	54.07	11.28	229.67	20.96	81.40	10.75	73.40	17.27	43.54	12.53	9.49	3.68	4.73	3.27	95.41	9.35	21.83	4.83	0.57	0.99	746.37	13.06
	Social Forestry	0.00	0.00	15.57	3.25	6.52	0.60	17.50	2.31	4.59	1.08	16.11	4.64	2.57	1.00	9.53	6.60	84.91	8.32	80.32	17.78	0.00	0.00	237.62	4.16
	Plantation on OB Dump	0.00	0.00	0.00	0.00	3.86	0.35	0.00	0.00	0.00	0.00	8.75	2.52	58.76	22.75	6.80	4.71	135.00	13.24	136.11	30.12	0.00	0.00	349.28	6.11
	Plantation on Backfill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	1.12	23.58	16.32	55.38	5.43	0.00	0.00	7.10	12.30	88.96	1.56	
	<b>Total Plantation(Green Cover generated)</b>	0.00	0.00	15.57	3.25	10.38	0.95	17.50	2.31	4.59	1.08	24.86	7.16	64.23	24.87	39.91	27.63	275.29	26.99	216.43	47.90	7.10	12.30	675.86	11.82
Plantation on backfill	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	1.12	23.58	16.32	55.38	5.43	0.00	0.00	7.10	12.30	88.96	1.56	
<b>Total Vegetation</b>	132.26	19.45	69.64	14.53	240.05	21.91	98.90	13.06	77.99	18.35	68.40	19.69	73.72	28.55	44.64	30.90	370.70	36.34	238.26	52.73	7.67	13.29	1422.23	24.88	
ACTIVE MINING	Coal Quarry	8.40	1.24	57.92	12.09	24.87	2.27	113.66	15.02	25.41	5.98	31.29	9.01	0.00	0.00	19.74	13.67	15.03	1.47	25.09	5.55	5.80	10.04	327.21	5.72
	Coal Dump	0.00	0.00	2.58	0.54	5.29	0.48	17.36	2.29	2.31	0.54	3.08	0.89	7.81	3.02	1.39	0.96	3.73	0.37	2.44	0.54	0.00	0.00	45.99	0.80
	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	0.00	0.00
	Quarry Filled With Water(Sump)	1.32	0.19	0.00	0.00	0.00	0.00	5.12	0.68	1.41	0.33	0.53	0.15	6.91	2.68	21.07	14.59	20.74	2.03	18.72	4.14	7.41	12.82	83.23	1.46
	<b>Total Area under Active Mining</b>	9.72	1.43	60.50	12.63	30.16	2.75	136.14	17.99	29.13	6.85	34.90	10.05	14.72	5.70	42.20	29.22	39.50	3.87	46.25	10.23	13.21	22.86	456.43	7.98
RECLAIMED	Barren OB Dump	17.58	2.59	68.74	14.35	46.03	4.20	140.46	18.56	39.70	9.34	30.90	8.89	53.57	20.75	8.36	5.79	9.46	0.93	107.07	23.69	0.00	0.00	521.87	9.13
	Barren Backfilled Area	0.00	0.00	0.00	0.00	0.00	0.00	39.85	5.26	0.00	0.00	2.45	0.71	44.61	17.28	25.99	17.99	267.70	26.25	13.33	2.95	28.21	48.85	422.14	7.38
	<b>Total Area under Technical Reclamation</b>	0.00	0.00	0.00	0.00	0.00	0.00	39.85	5.26	0.00	0.00	2.45	0.71	44.61	17.28	25.99	17.99	267.70	26.25	13.33	2.95	28.21	48.85	944.01	16.51
<b>Total Area under Mining</b>	27.30	4.02	129.24	26.98	76.19	6.95	316.45	41.81	68.83	16.19	68.25	19.65	112.90	43.73	76.55	53.00	316.66	31.05	166.65	36.87	41.42	71.71	1400.44	24.50	
WASTELAND	Waste Lands	31.74	4.67	47.81	9.98	42.19	3.85	30.26	4.00	9.45	2.22	25.22	7.26	14.73	5.69	15.46	10.70	173.55	17.01	41.00	9.08	7.52	13.03	438.93	7.68
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	14.89	1.36	0.00	0.00	4.01	0.94	2.52	0.73	0.00	0.00	3.95	2.73	1.31	0.13	0.00	0.00	0.59	1.02	27.27	0.48
	<b>Total Wasteland</b>	31.74	4.67	47.81	9.98	57.08	5.21	30.26	4.00	13.46	3.16	27.74	7.99	14.73	5.69	19.41	13.43	174.86	17.14	41.00	9.08	8.11	14.05	466.20	8.16
WATERBODIES	Reservoir, nallah, ponds	3.69	0.53	9.00	1.88	22.26	2.04	4.63	0.62	3.01	0.72	8.28	2.36	0.00	0.00	1.98	1.37	7.31	0.72	0.00	0.00	0.55	0.95	60.71	1.06
	<b>Total Waterbodies</b>	3.69	0.53	9.00	1.88	22.26	2.04	4.63	0.62	3.01	0.72	8.28	2.36	0.00	0.00	1.98	1.37	7.31	0.72	0.00	0.00	0.55	0.95	60.71	1.06
AGRICULTURE	Crop Lands	4.76	0.70	0.00	0.00	14.78	1.35	9.57	1.26	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	29.11	0.51
	Fallow Lands	479.64	70.53	213.23	44.50	684.02	62.44	279.64	36.94	260.80	61.36	174.03	50.09	56.23	21.78	0.39	0.28	89.12	8.74	0.00	0.00	0.00	0.00	2237.10	39.13
	<b>Total Agriculture</b>	484.40	71.23	213.23	44.50	698.80	63.79	289.21	38.20	260.80	61.36	174.03	50.09	56.23	21.78	0.39	0.28	89.12	8.74	0.00	0.00	0.00	0.00	2266.21	39.64
SETTLEMENTS	Urban Settlement	0.45	0.07	7.97	1.66	1.14	0.10	1.08	0.14	0.74	0.17	0.76	0.22	0.39	0.15	0.18	0.12	30.03	2.94	1.99	0.44	0.00	0.00	44.73	0.78
	Rural Settlement	0.00	0.00	0.00	0.00	0.00	0.00	16.02	2.12	0.00	0.00	0.00	0.00	0.00	0.95	0.66	24.57	2.41	2.23	0.49	0.00	0.00	43.77	0.77	
	Industrial Settlement	0.22	0.03	2.27	0.47	0.00	0.00	0.37	0.05	0.21	0.05	0.00	0.00	0.26	0.10	0.35	0.24	6.75	0.66	1.74	0.39	0.00	0.00	12.17	0.21
	<b>Total Settlement</b>	0.67	0.10	10.24	2.13	1.14	0.10	17.47	2.31	0.95	0.22	0.76	0.22	0.65	0.25	1.48	1.02	61.35	6.01	5.96	1.32	0.00	0.00	100.67	1.76
<b>Grand Total</b>	680.06	100.00	479.16	100.00	1095.52	100.00	756.92	100.00	425.04	100.00	347.46	100.00	258.23	100.00	144.45	100.00	1020.00	100.00	451.87	100.00	57.75	100.00	5716.46	100.00	



Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	% age
Scrubs	Scrubs(A)		132.26	19.45
	<b>Total Vegetation(A)</b>		<b>132.26</b>	<b>19.45</b>
Agriculture Land	Crop Land		04.76	00.70
	Fallow Land		479.64	70.53
	<b>Total Agriculture</b>		<b>484.40</b>	<b>71.23</b>
Mining Area	Coal Quarry		08.40	01.24
	Waterfilled Quarry		01.32	00.19
	Barran OB Dump		17.58	02.59
	<b>Total Mining Area</b>		<b>27.30</b>	<b>04.02</b>
Settlement	Urban		00.45	00.07
	Industrial		00.22	00.03
	<b>Total Settlement</b>		<b>00.67</b>	<b>00.10</b>
Waste Land	Waste Land		31.74	04.67
Water Body	Stream, Nala, River etc		03.69	00.53
<b>Total Leasehold Area</b>			<b>680.06</b>	<b>100.00</b>

**INDEX**

- Canal
- Road
- Yekona-II Leasehold Boundary
- Yekona-I Leasehold Boundary

Customer : **WESTERN COALFIELD LIMITED**

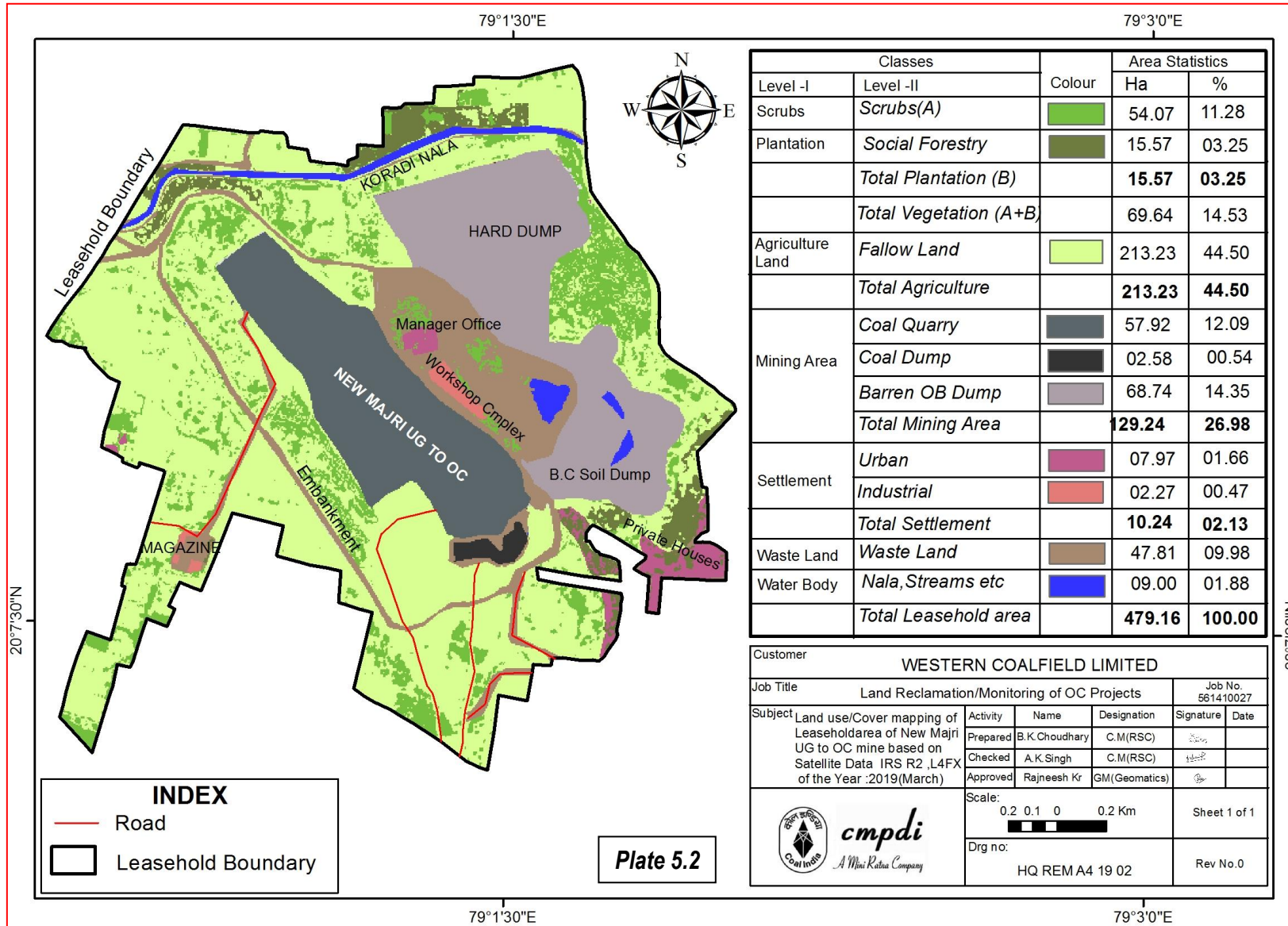
Job Title : **Land Reclamation/Monitoring of opencast Projects** Job No. **561410027**

Subject Land Use/Cover mapping of Leasehold area of Yekona-I&II OC mine based on satellite Data IRS R2A-L4FX of the Year :2019(March)	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.M(RSC)		
	Checked	A.K.Singh	CM(RSC)		
	Approved	Rajesh Kr	GM(Geomatics)		

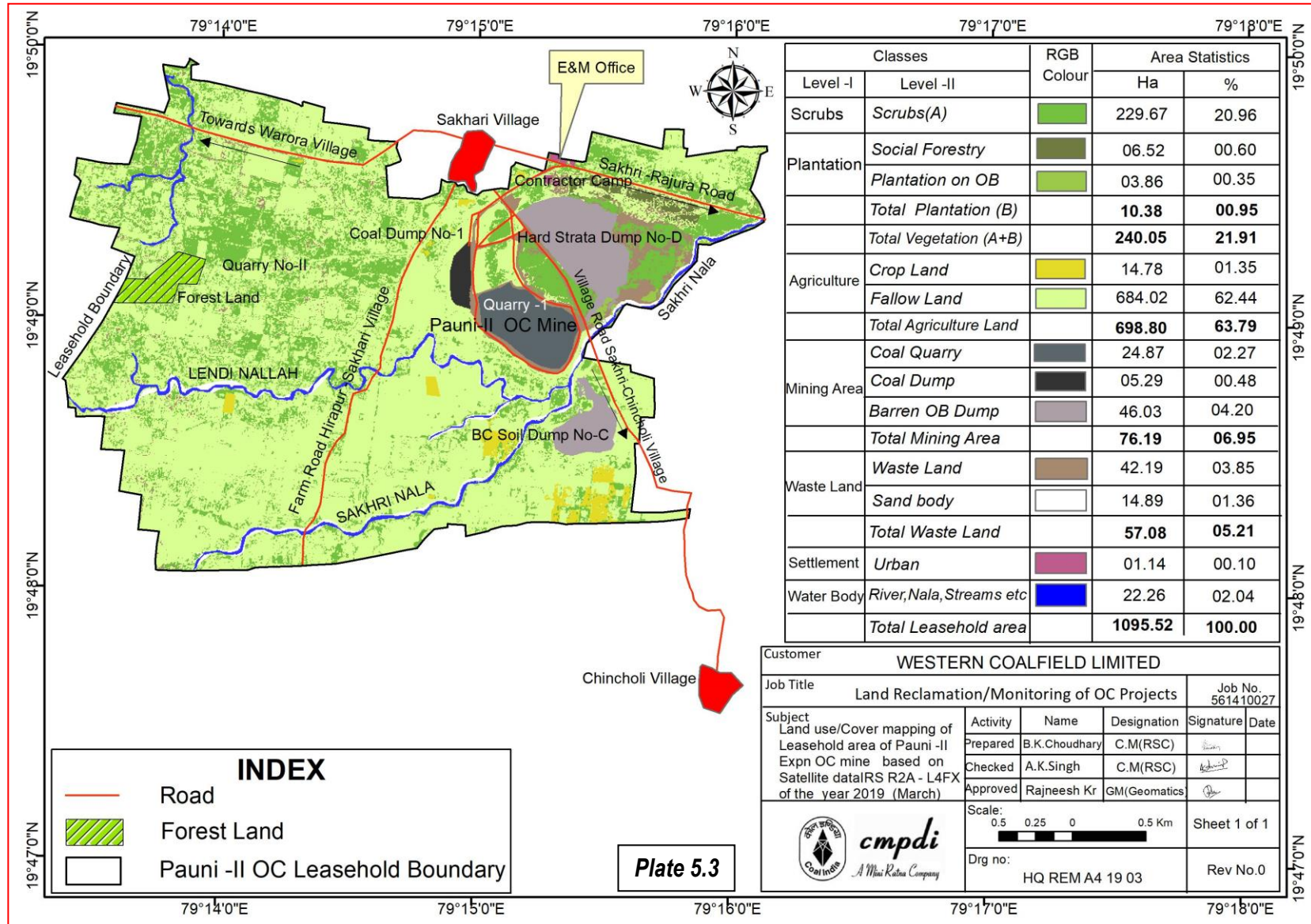
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Drg No. **HQ REMA4 19 01** Rev No. **0**

**cmpdi**  
A Mini Ratna Company







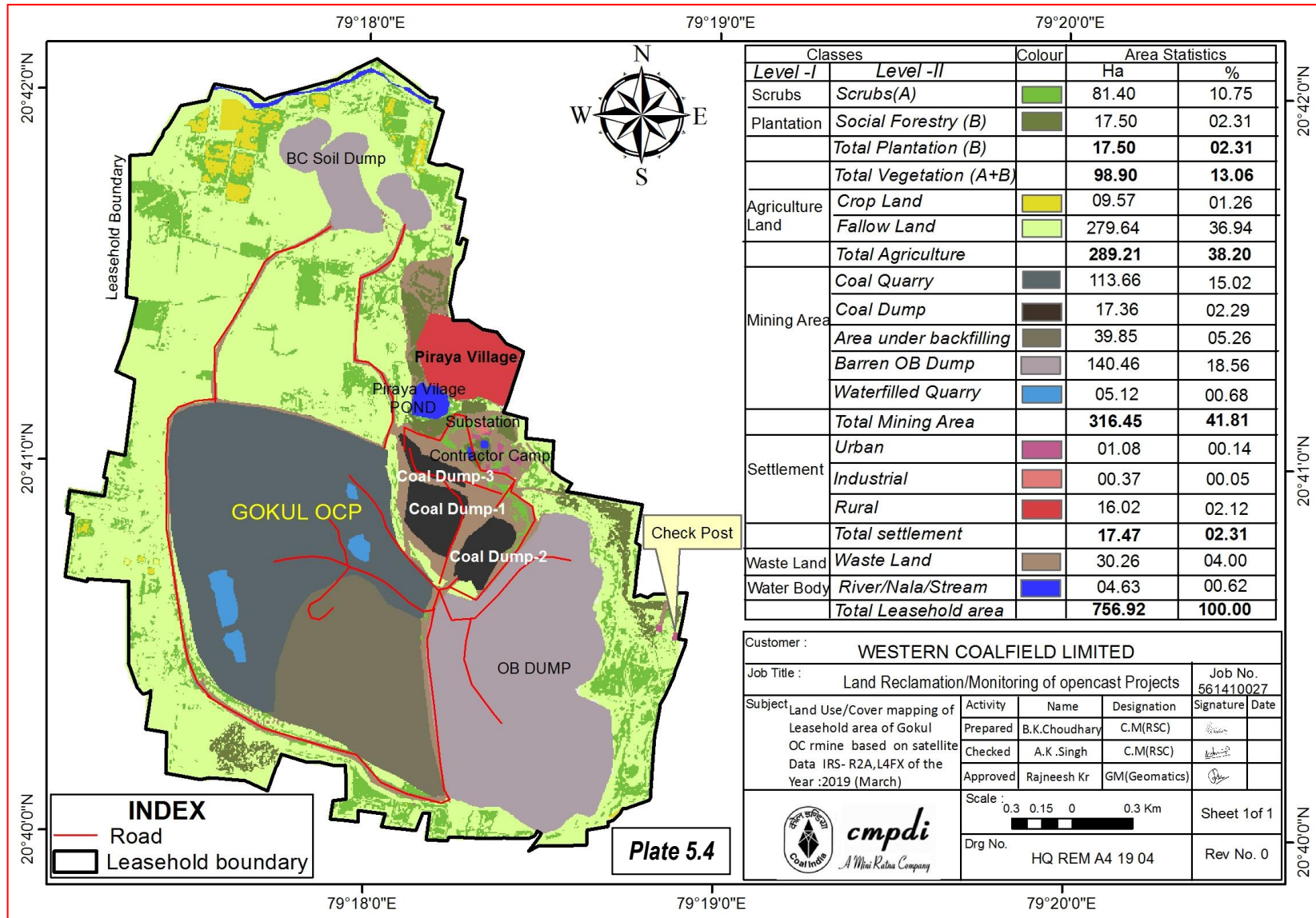
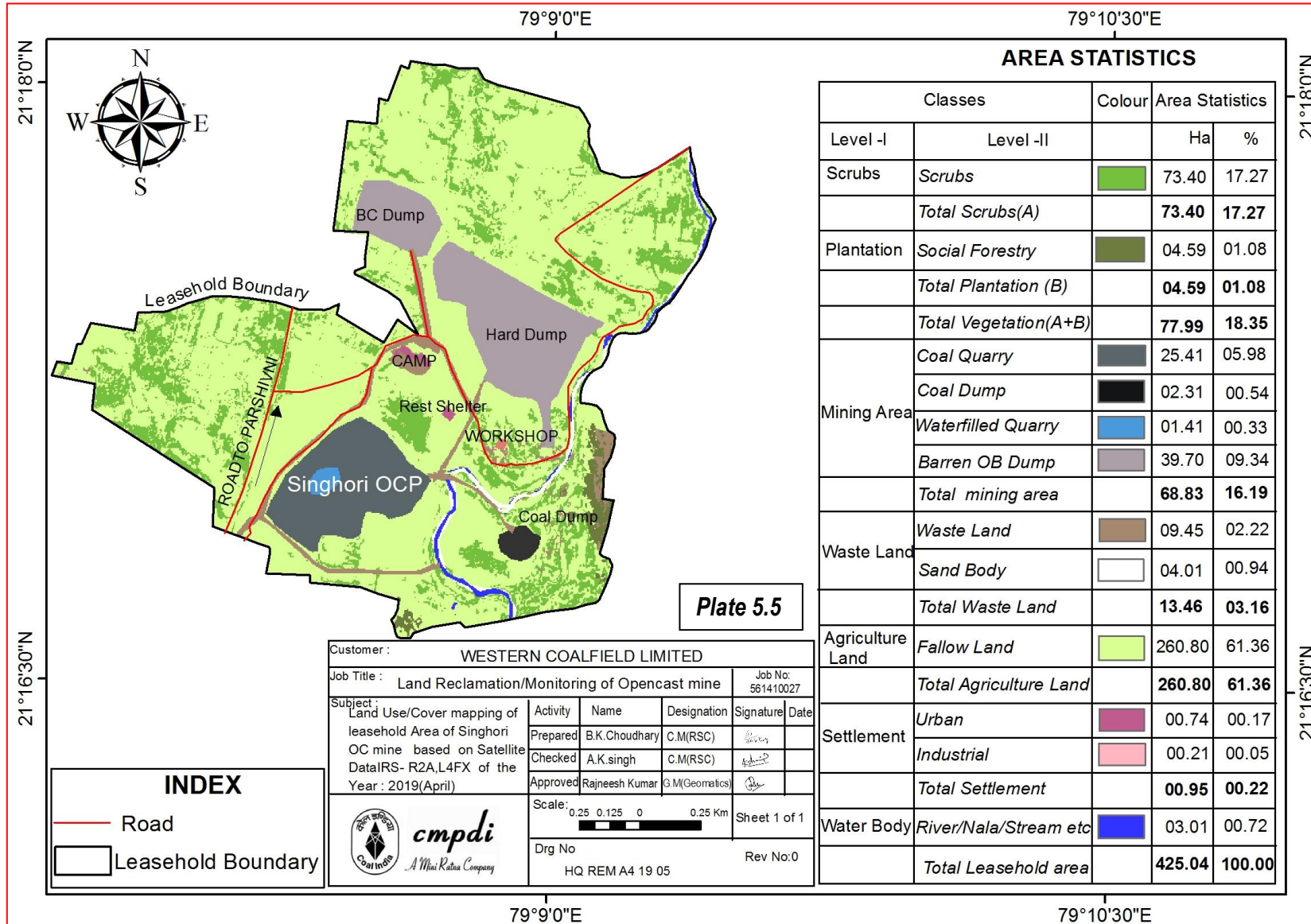


Plate 5.4





**AREA STATISTICS**

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrub	Scrub		73.40	17.27
	<b>Total Scrub(A)</b>		<b>73.40</b>	<b>17.27</b>
Plantation	Social Forestry		04.59	01.08
	<b>Total Plantation (B)</b>		<b>04.59</b>	<b>01.08</b>
	<b>Total Vegetation(A+B)</b>		<b>77.99</b>	<b>18.35</b>
Mining Area	Coal Quarry		25.41	05.98
	Coal Dump		02.31	00.54
	Waterfilled Quarry		01.41	00.33
	Barren OB Dump		39.70	09.34
	<b>Total mining area</b>		<b>68.83</b>	<b>16.19</b>
Waste Land	Waste Land		09.45	02.22
	Sand Body		04.01	00.94
	<b>Total Waste Land</b>		<b>13.46</b>	<b>03.16</b>
Agriculture Land	Fallow Land		260.80	61.36
	<b>Total Agriculture Land</b>		<b>260.80</b>	<b>61.36</b>
Settlement	Urban		00.74	00.17
	Industrial		00.21	00.05
	<b>Total Settlement</b>		<b>00.95</b>	<b>00.22</b>
Water Body	River/Nala/Stream etc		03.01	00.72
	<b>Total Leasehold area</b>		<b>425.04</b>	<b>100.00</b>

**Plate 5.5**

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of Opencast mine Job No: 561410027

Subject : Land Use/Cover mapping of leasehold Area of Singhori OC mine based on Satellite Data/RS- R2A,L4FX of the Year : 2019(April)

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

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Sheet 1 of 1

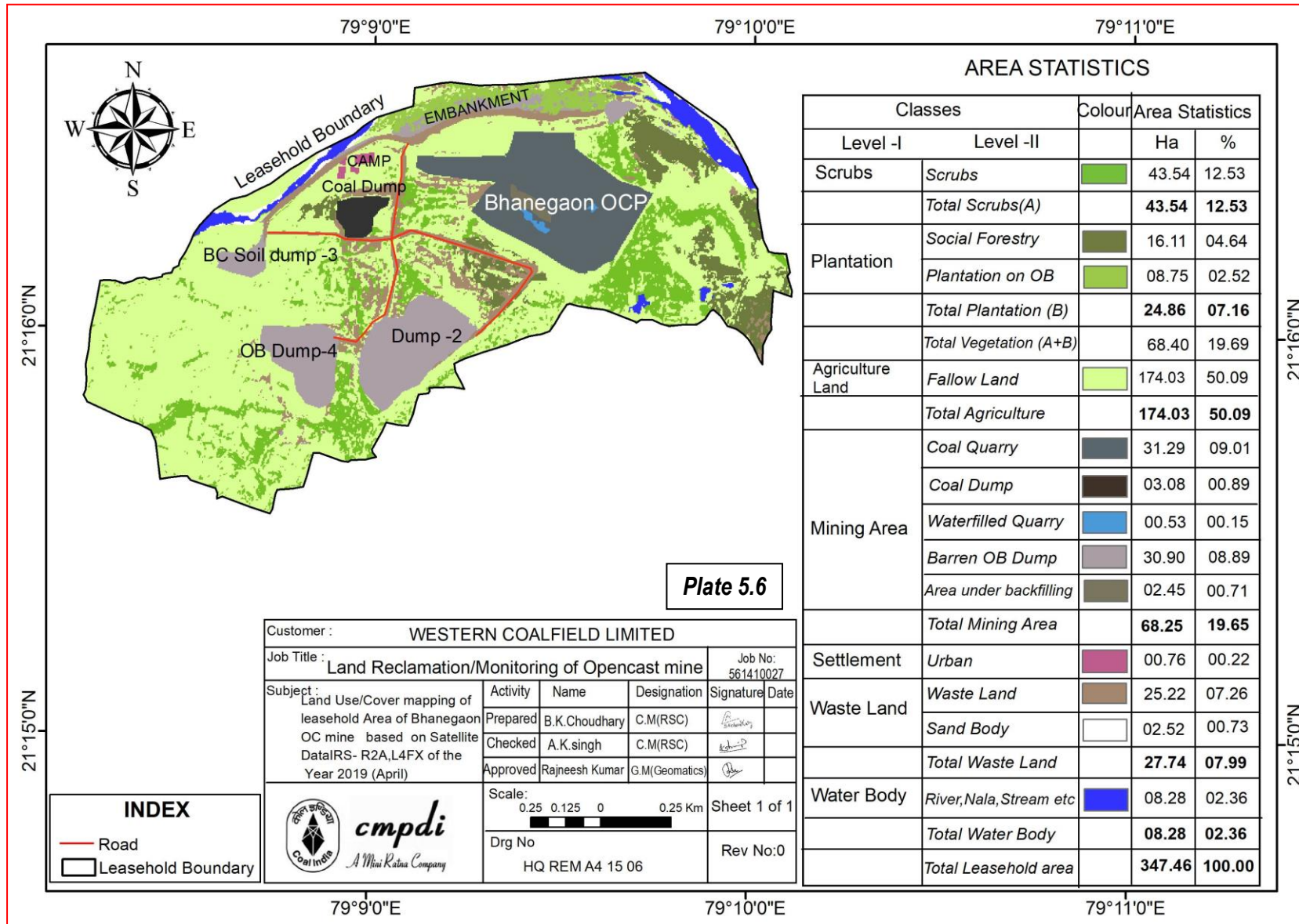
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Road

Leasehold Boundary





**Plate 5.6**

**AREA STATISTICS**

Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs		43.54	12.53
	<b>Total Scrubs(A)</b>		<b>43.54</b>	<b>12.53</b>
Plantation	Social Forestry		16.11	04.64
	Plantation on OB		08.75	02.52
	<b>Total Plantation (B)</b>		<b>24.86</b>	<b>07.16</b>
<b>Total Vegetation (A+B)</b>			68.40	19.69
Agriculture Land	Fallow Land		174.03	50.09
	<b>Total Agriculture</b>		<b>174.03</b>	<b>50.09</b>
Mining Area	Coal Quarry		31.29	09.01
	Coal Dump		03.08	00.89
	Waterfilled Quarry		00.53	00.15
	Barren OB Dump		30.90	08.89
	Area under backfilling		02.45	00.71
<b>Total Mining Area</b>			<b>68.25</b>	<b>19.65</b>
Settlement	Urban		00.76	00.22
Waste Land	Waste Land		25.22	07.26
	Sand Body		02.52	00.73
	<b>Total Waste Land</b>		<b>27.74</b>	<b>07.99</b>
Water Body	River, Nala, Stream etc		08.28	02.36
	<b>Total Water Body</b>		<b>08.28</b>	<b>02.36</b>
	<b>Total Leasehold area</b>		<b>347.46</b>	<b>100.00</b>

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of Opencast mine Job No: 561410027

Subject :	Activity	Name	Designation	Signature	Date
Land Use/Cover mapping of leasehold Area of Bhanegaon OC mine based on Satellite Data/RS- R2A,L4FX of the Year 2019 (April)	Prepared	B.K.Choudhary	C.M.(RSC)		
	Checked	A.K.singh	C.M.(RSC)		
	Approved	Rajneesh Kumar	G.M.(Geomatics)		

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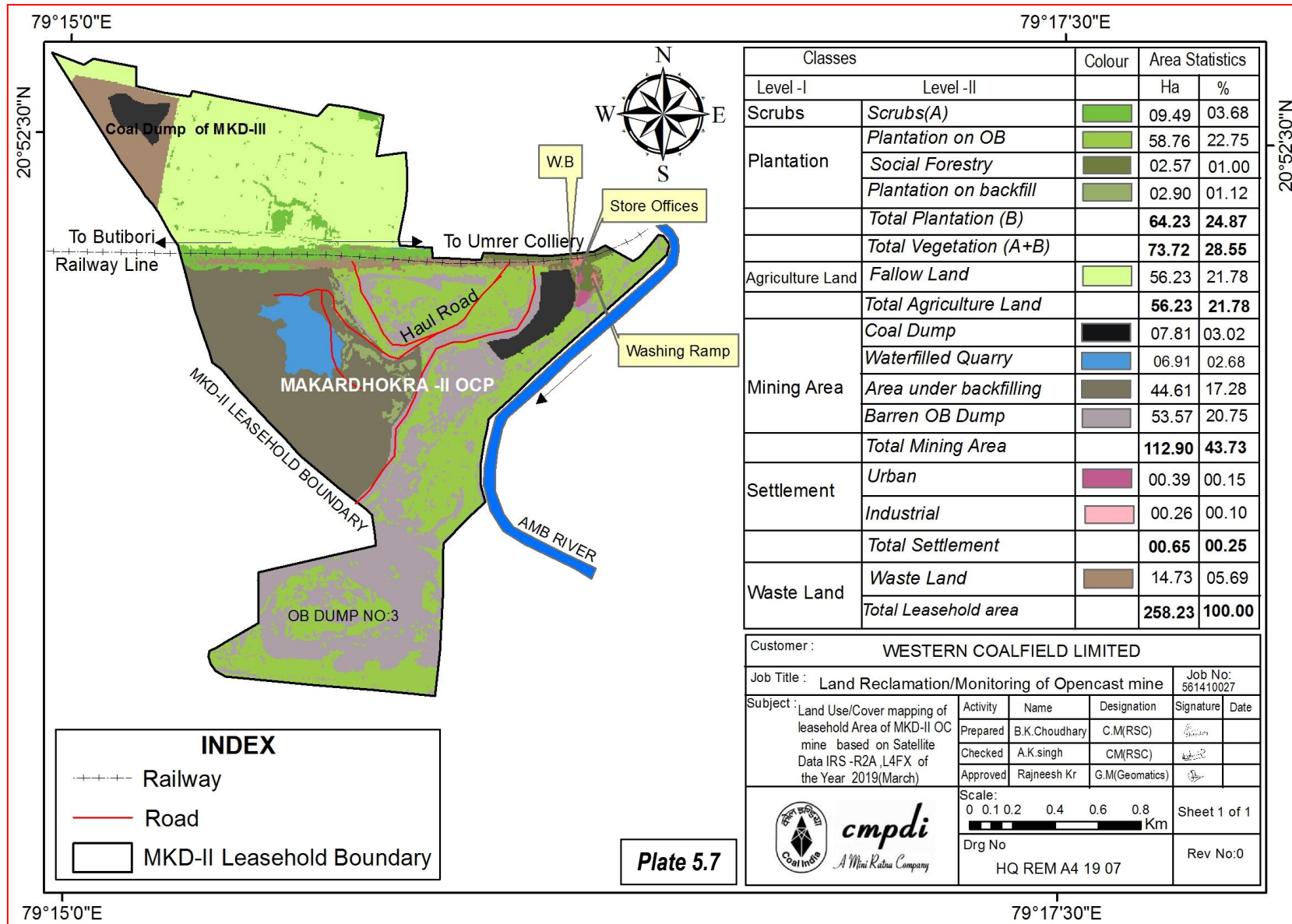
Rev No:0

**INDEX**

- Road
- Leasehold Boundary







Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		09.49	03.68
	Plantation on OB		58.76	22.75
Plantation	Social Forestry		02.57	01.00
	Plantation on backfill		02.90	01.12
	<b>Total Plantation (B)</b>		<b>64.23</b>	<b>24.87</b>
	<b>Total Vegetation (A+B)</b>		<b>73.72</b>	<b>28.55</b>
Agriculture Land	Fallow Land		56.23	21.78
	<b>Total Agriculture Land</b>		<b>56.23</b>	<b>21.78</b>
Mining Area	Coal Dump		07.81	03.02
	Waterfilled Quarry		06.91	02.68
	Area under backfilling		44.61	17.28
	Barren OB Dump		53.57	20.75
	<b>Total Mining Area</b>		<b>112.90</b>	<b>43.73</b>
Settlement	Urban		00.39	00.15
	Industrial		00.26	00.10
	<b>Total Settlement</b>		<b>00.65</b>	<b>00.25</b>
Waste Land	Waste Land		14.73	05.69
	<b>Total Leasehold area</b>		<b>258.23</b>	<b>100.00</b>

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- +++++ Railway
- Road
- MKD-II Leasehold Boundary

**Plate 5.7**

Customer : WESTERN COALFIELD LIMITED

Job Title : Land Reclamation/Monitoring of Opencast mine      Job No: 561410027

Subject : Land Use/Cover mapping of leasehold Area of MKD-II OC mine based on Satellite Data IRS -R2A ,L4FX of the Year 2019(March)

Activity	Name	Designation	Signature	Date
Prepared	B.K.Choudhary	C.M(RSC)		
Checked	A.K.singh	CM(RSC)		
Approved	Rajneesh Kr	G.M(Geomatics)		

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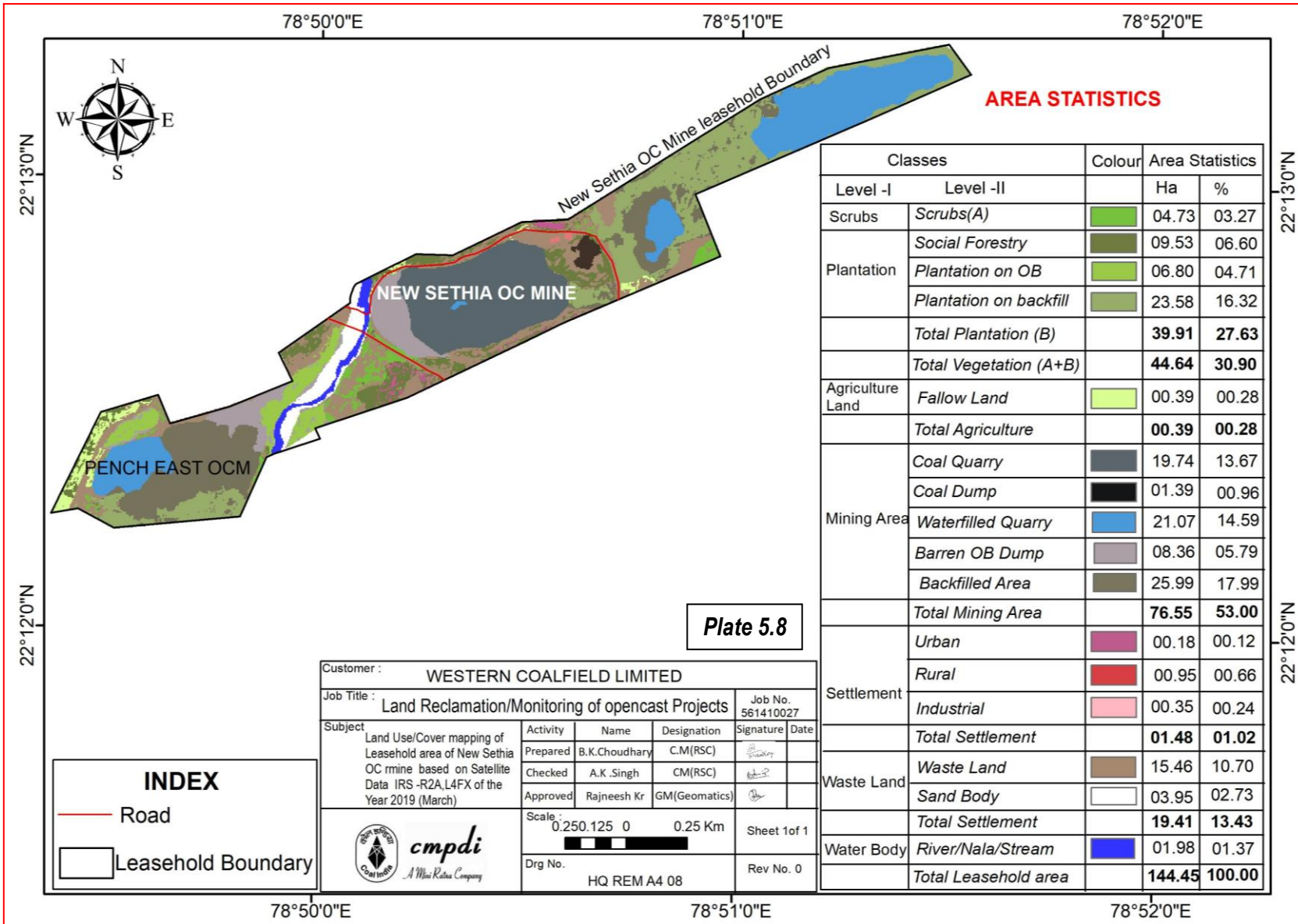


Plate 5.8

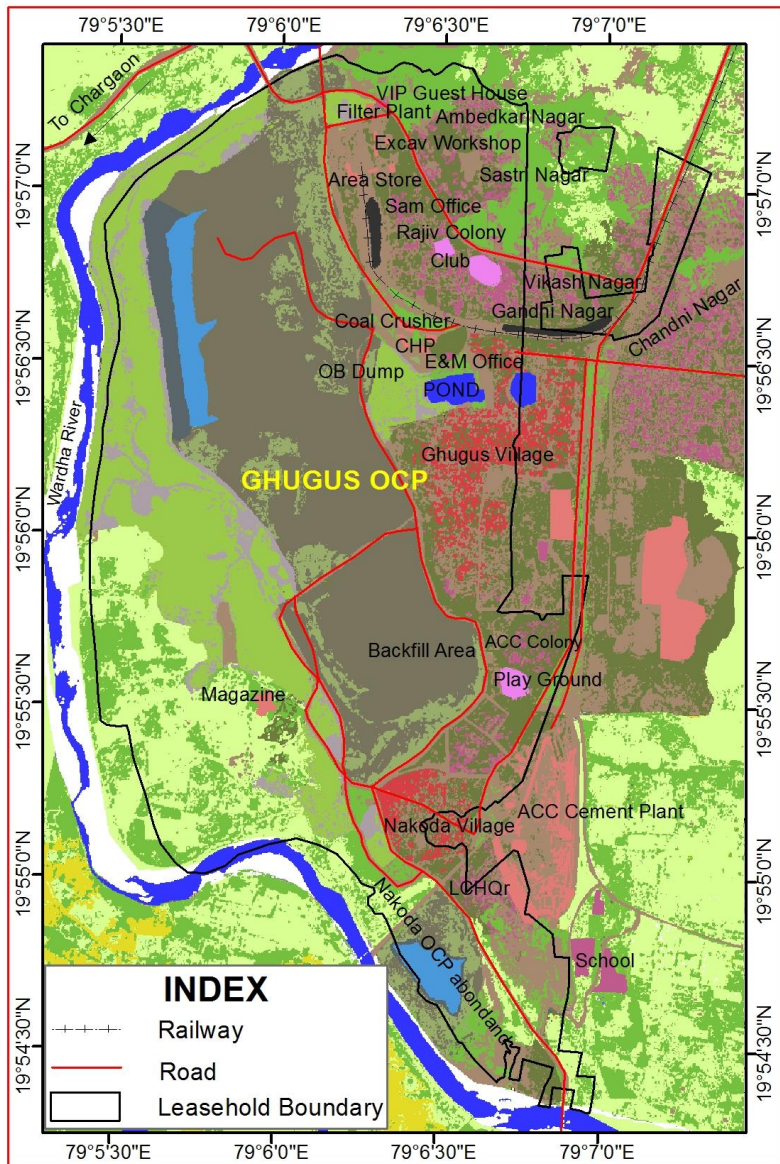
Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation/Monitoring of opencast Projects				Job No. 561410027	
Subject Land Use/Cover mapping of Leasehold area of New Sethia OC mine based on Satellite Data IRS -R2A,L4FX of the Year 2019 (March)	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.M(RSC)		
	Checked	A.K .Singh	CM(RSC)		
	Approved	Rajneesh Kr	GM(Geomatics)		
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- Road
- Leasehold Boundary







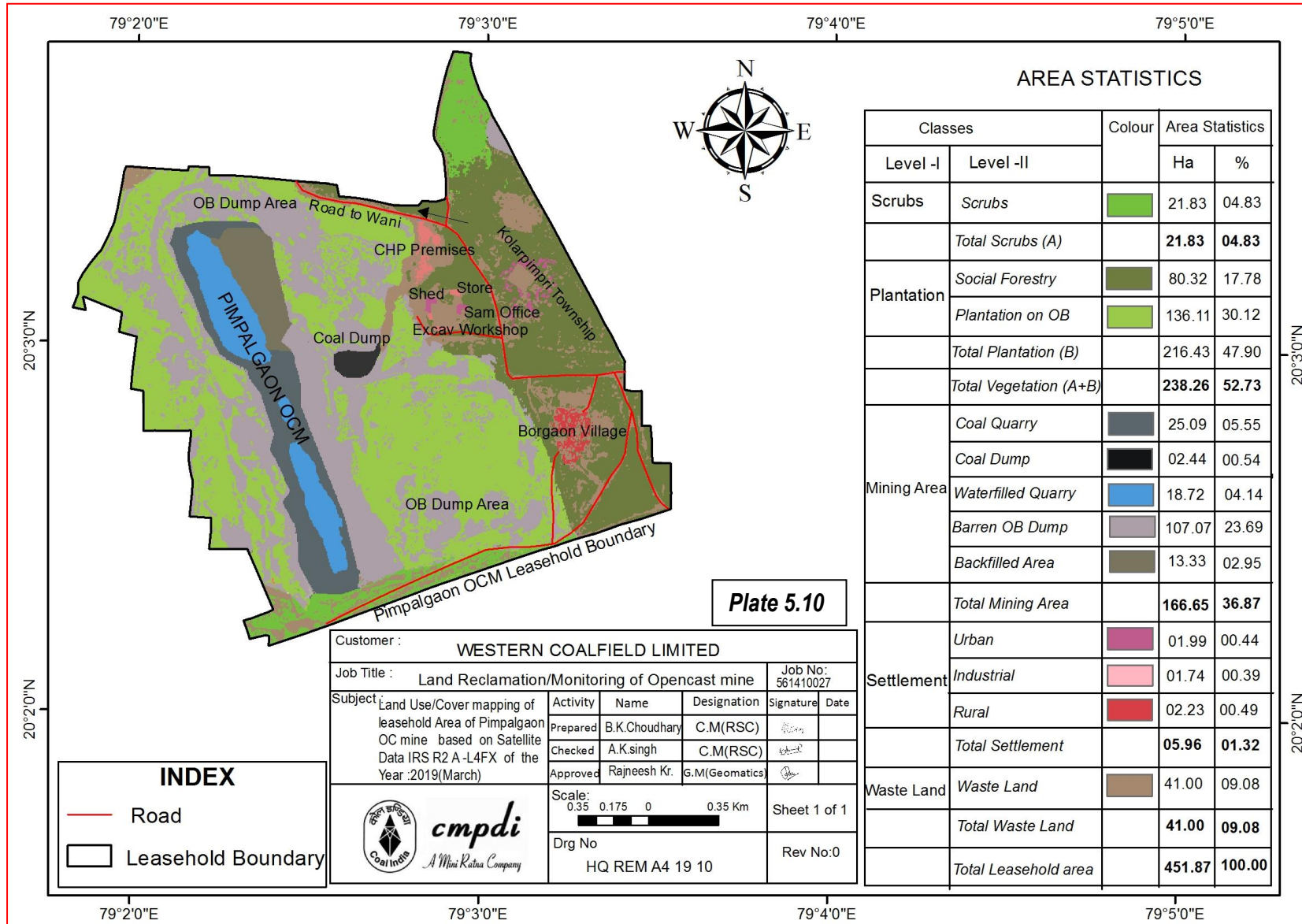
Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs(A)		95.41	09.35
	Plantation			
	Plantation on OB		135.00	13.24
	Social Forestry		89.41	08.32
	Plantation on backfill		55.38	05.43
	<b>Total Plantation (B)</b>		<b>275.29</b>	<b>26.99</b>
	<b>Total Vegetation (A+B)</b>		<b>370.70</b>	<b>36.34</b>
Agriculture Land	Fallow Land		89.12	08.74
	<b>Total Agriculture</b>		<b>89.12</b>	<b>08.74</b>
Mining Area	Coal Quarry		15.03	01.47
	Coal Dump		03.73	00.37
	Waterfilled Quarry		20.74	02.03
	Barren OB Dump		09.46	00.93
	Backfilled Area		267.70	26.25
	<b>Total Mining Area</b>		<b>316.66</b>	<b>31.05</b>
Settlement	Urban		30.03	02.94
	Industrial		06.75	00.66
	Rural		24.57	02.41
	<b>Total settlement</b>		<b>61.35</b>	<b>06.01</b>
Waste Land	Waste Land		173.55	17.01
	Sand Body		01.31	00.13
	<b>Total waste land</b>		<b>174.86</b>	<b>17.14</b>
Water Body	Pond/River		07.31	00.72
	<b>Total Leasehold area</b>		<b>1020.00</b>	<b>100.00</b>

INDEX	
	Railway
	Road
	Leasehold Boundary

Customer :		WESTERN COALFIELD LIMITED			Job No:	561410027
Job Title :		Reclamation /Monitoring of Opencast mine				
Subject :	Activity	Name	Designation	Signature	Date	
Land Use / Cover mapping of leasehold Area of Ghugus OC mine based on Satellite Data IRS R2 A-L4FX of the year March: 2019.	Prepared	B.K.Choudhary	CM(RSC)			
	Checked	A.K.Singh	C.M(RSC)			
	Approved	Rajneesh Kr	G.M(Geomatics)			
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Drg No		HQ REM A4 19 09			Rev No:0	

Plate 5.9





AREA STATISTICS

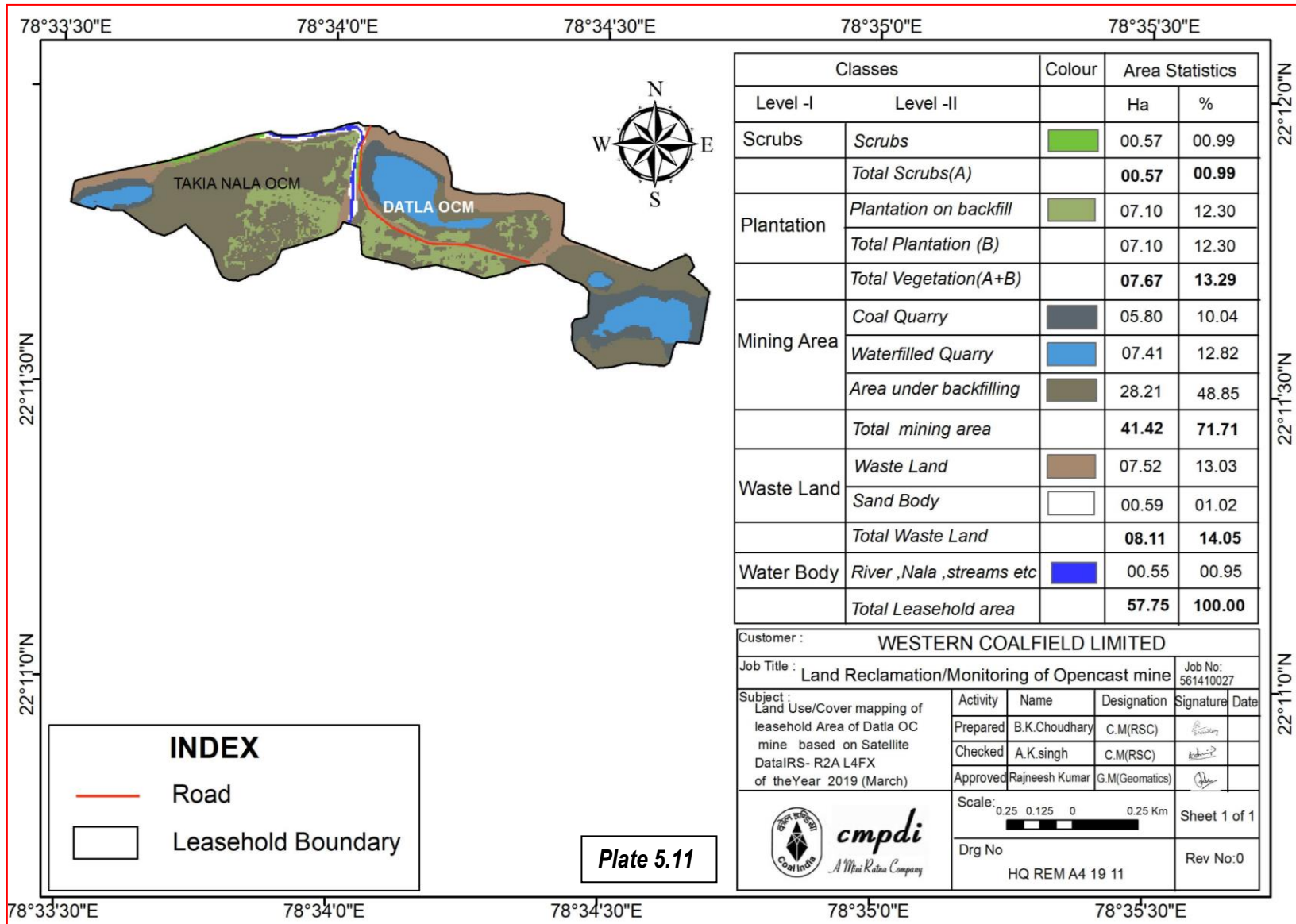
Classes		Colour	Area Statistics	
Level -I	Level -II		Ha	%
Scrubs	Scrubs		21.83	04.83
	<b>Total Scrubs (A)</b>		<b>21.83</b>	<b>04.83</b>
Plantation	Social Forestry		80.32	17.78
	Plantation on OB		136.11	30.12
	<b>Total Plantation (B)</b>		<b>216.43</b>	<b>47.90</b>
	<b>Total Vegetation (A+B)</b>		<b>238.26</b>	<b>52.73</b>
Mining Area	Coal Quarry		25.09	05.55
	Coal Dump		02.44	00.54
	Waterfilled Quarry		18.72	04.14
	Barren OB Dump		107.07	23.69
	Backfilled Area		13.33	02.95
	<b>Total Mining Area</b>		<b>166.65</b>	<b>36.87</b>
Settlement	Urban		01.99	00.44
	Industrial		01.74	00.39
	Rural		02.23	00.49
	<b>Total Settlement</b>		<b>05.96</b>	<b>01.32</b>
Waste Land	Waste Land		41.00	09.08
	<b>Total Waste Land</b>		<b>41.00</b>	<b>09.08</b>
	<b>Total Leasehold area</b>		<b>451.87</b>	<b>100.00</b>

Plate 5.10

Customer : WESTERN COALFIELD LIMITED					
Job Title : Land Reclamation/Monitoring of Opencast mine				Job No: 561410027	
Subject: Land Use/Cover mapping of leasehold Area of Pimpalgaon OC mine based on Satellite Data IRS R2 A -L4FX of the Year :2019(March)	Activity	Name	Designation	Signature	Date
	Prepared	B.K.Choudhary	C.M(RSC)		
	Checked	A.K.singh	C.M(RSC)		
	Approved	Rajneesh Kr.	G.M(Geomatics)		
Scale: 0 0.175 0.35 Km			Sheet 1 of 1		
Drg No HQ REM A4 19 10			Rev No:0		

INDEX	
	Road
	Leasehold Boundary







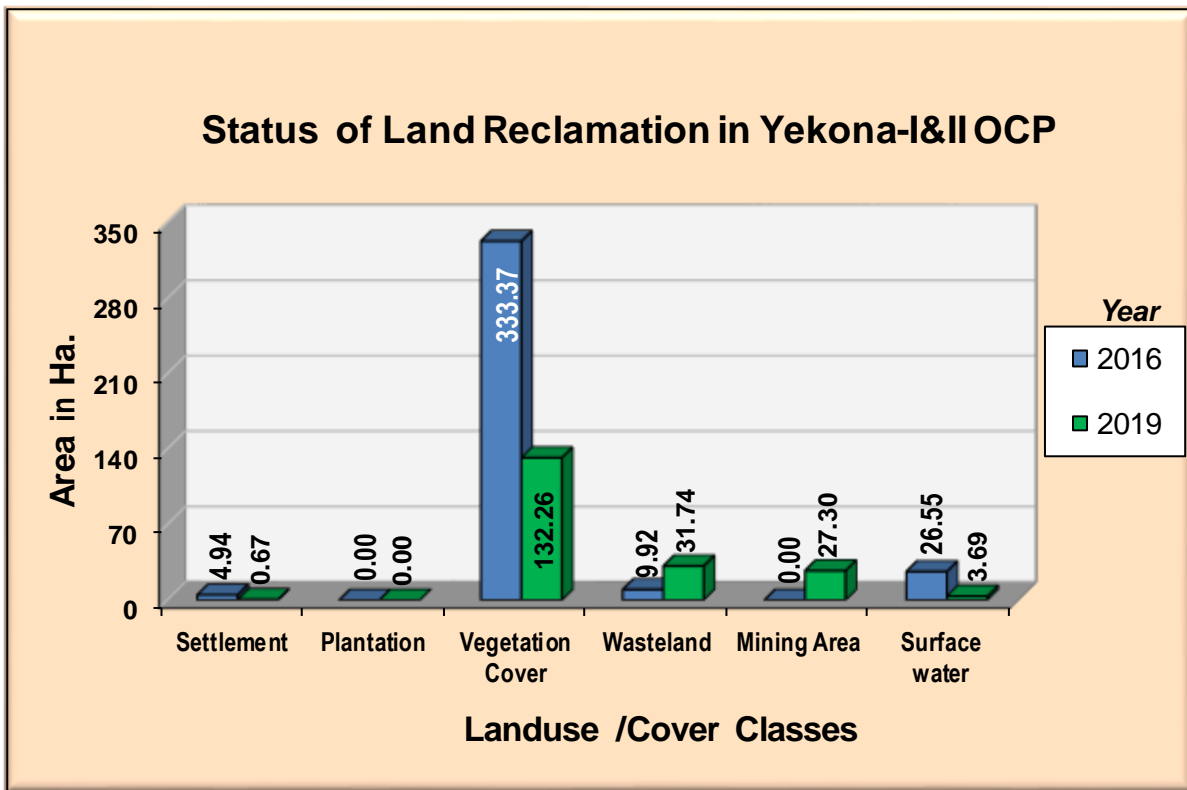


Figure 5.2

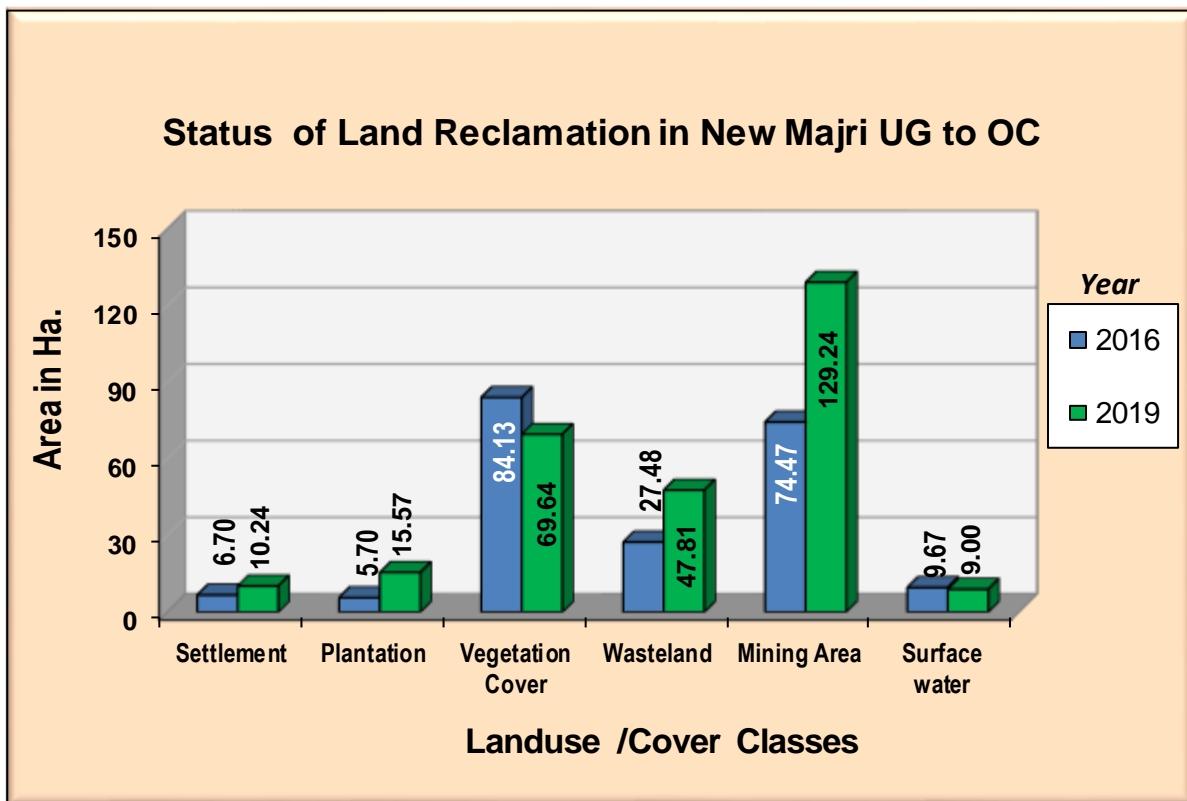


Figure 5.3

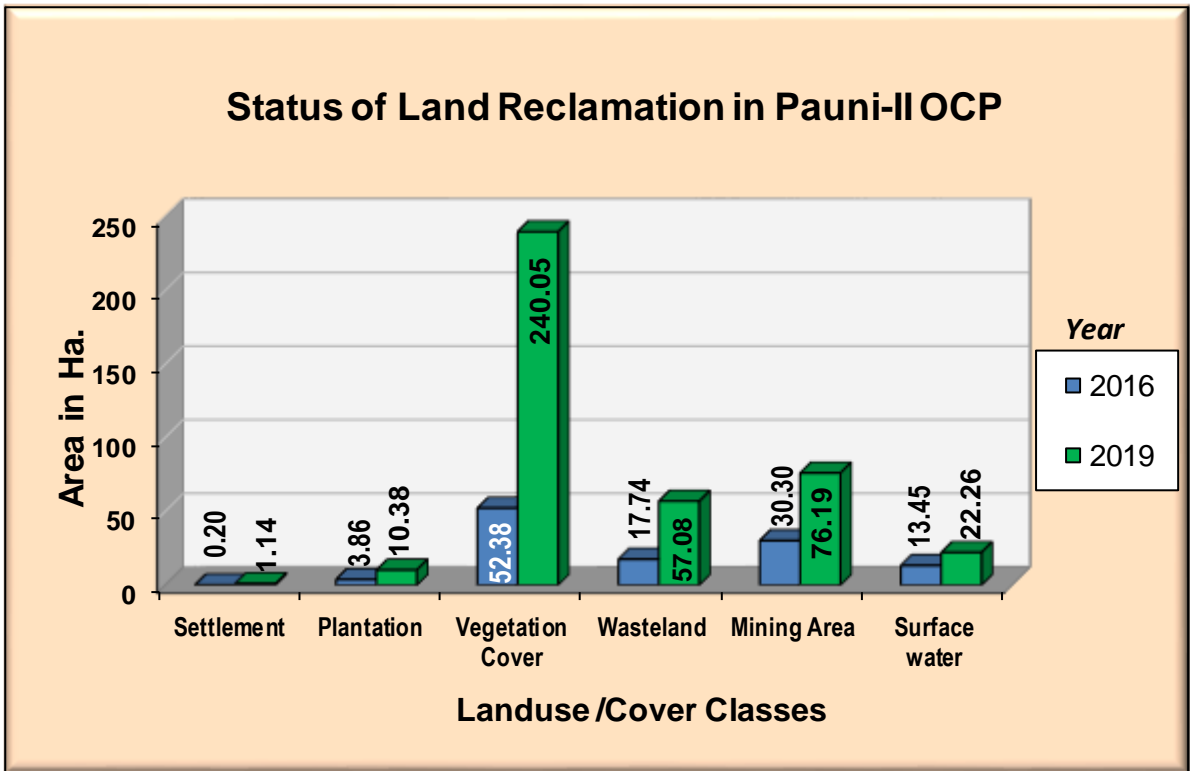


Figure 5.4

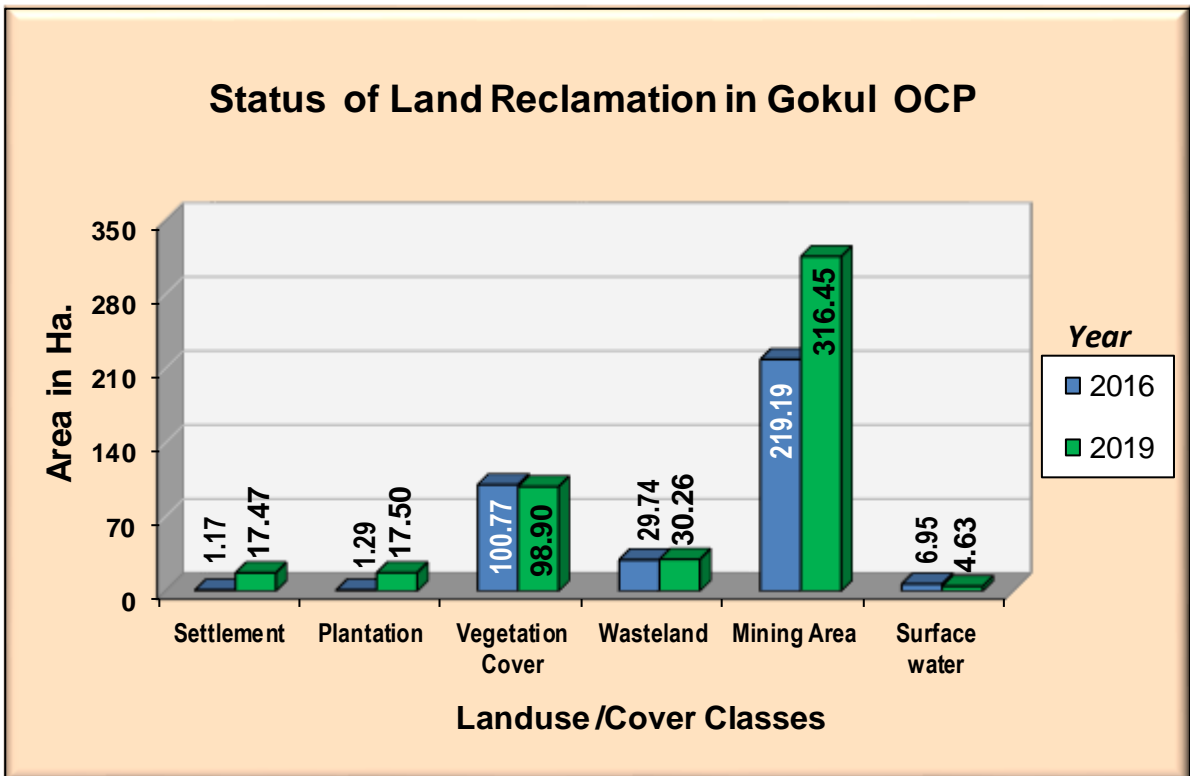


Figure 5.5

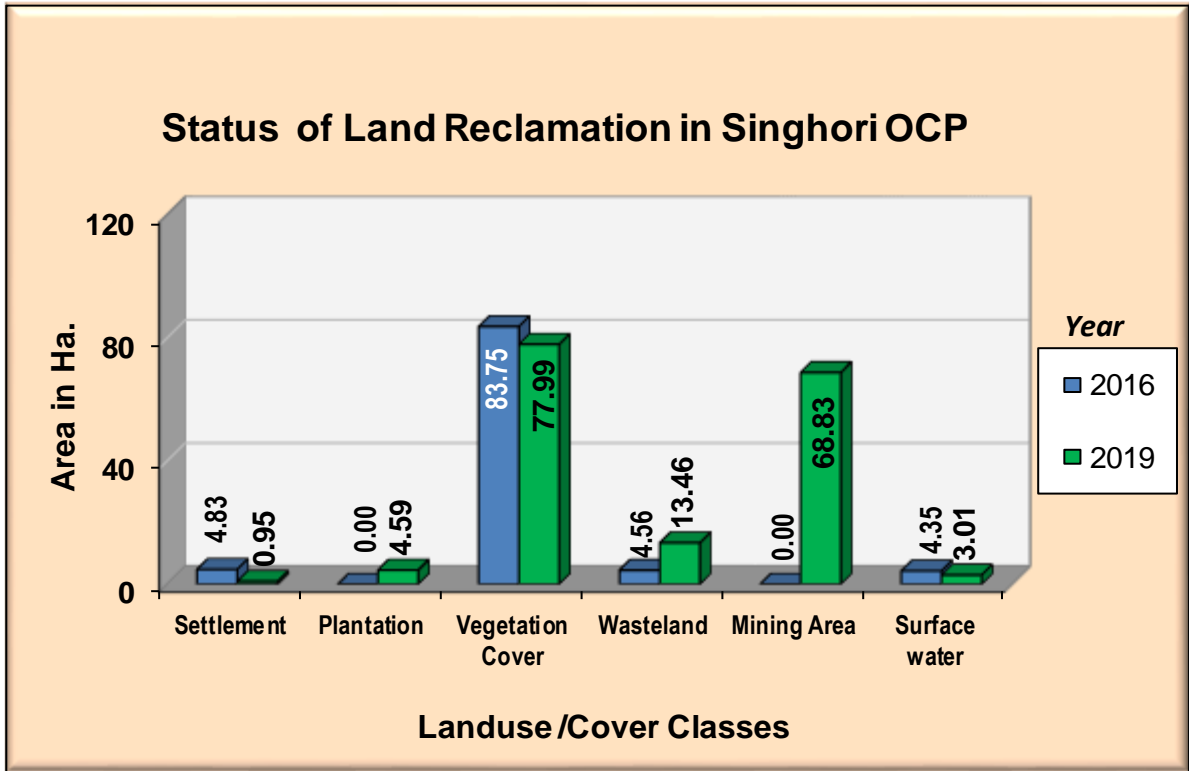


Figure 5.6

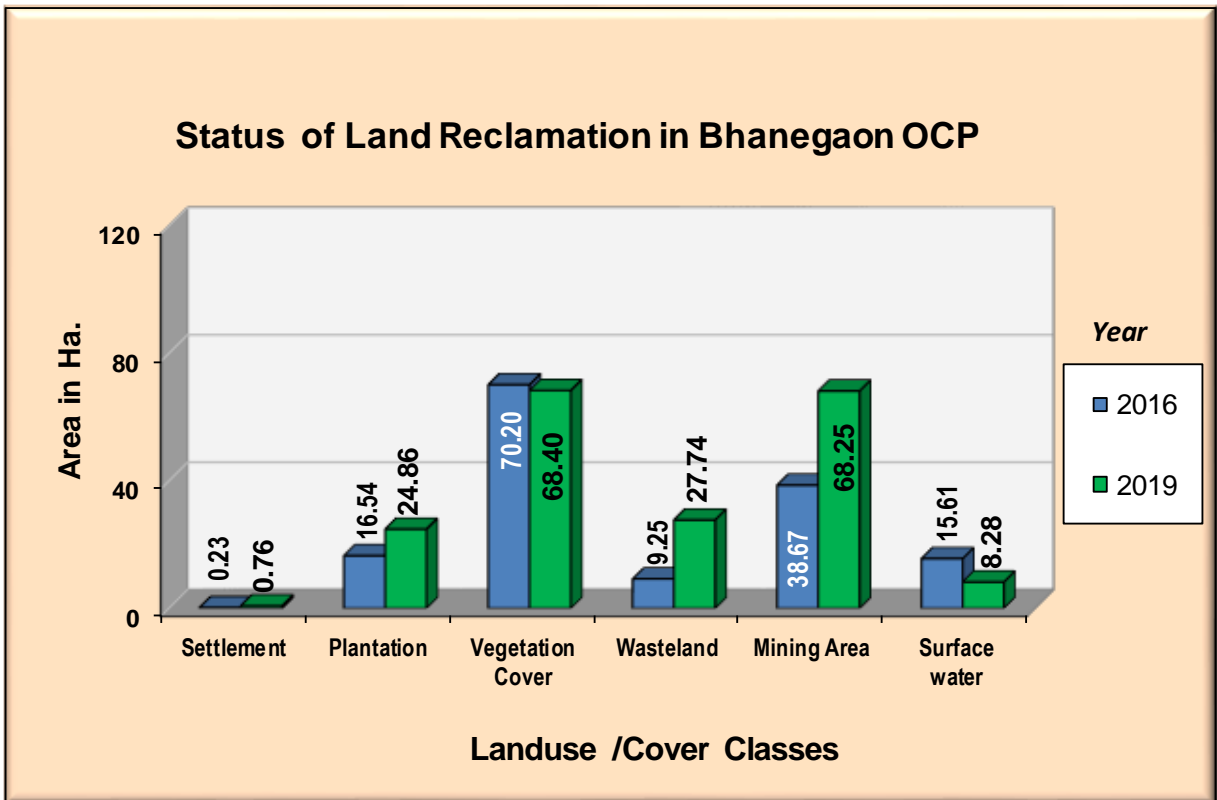


Figure -5.7



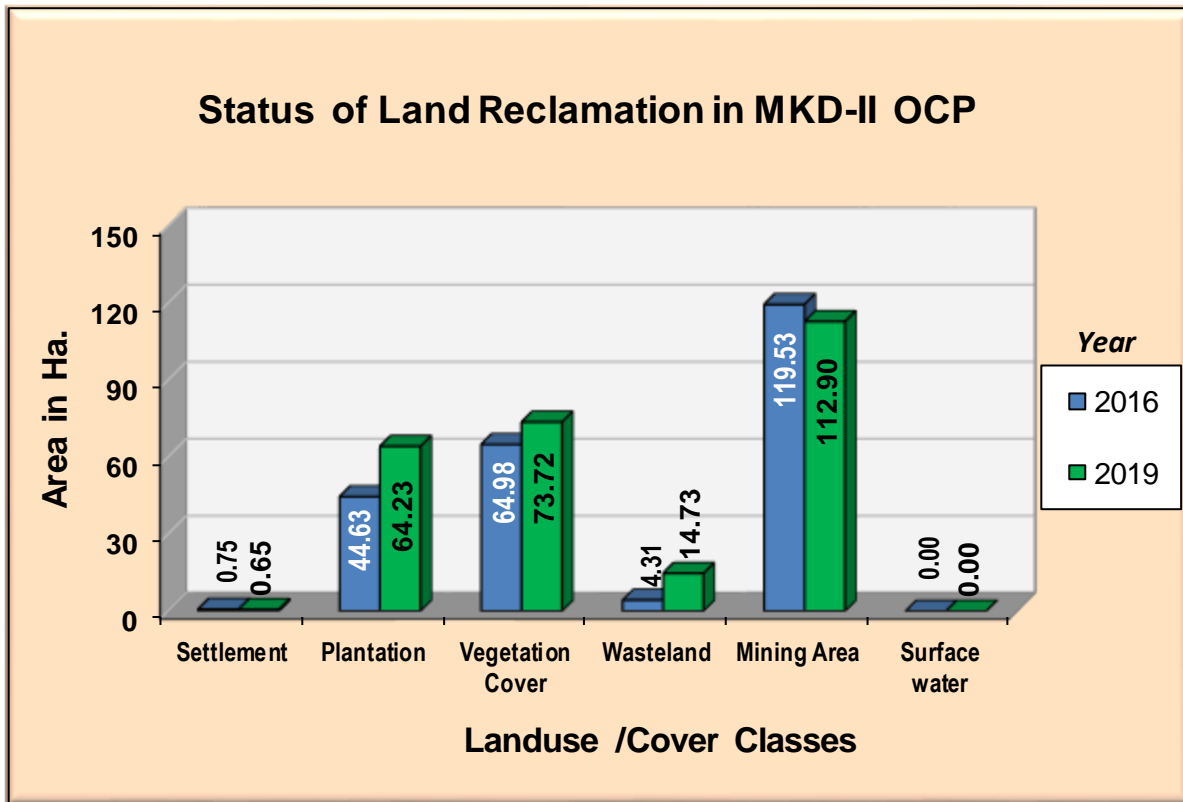


Figure-5.8

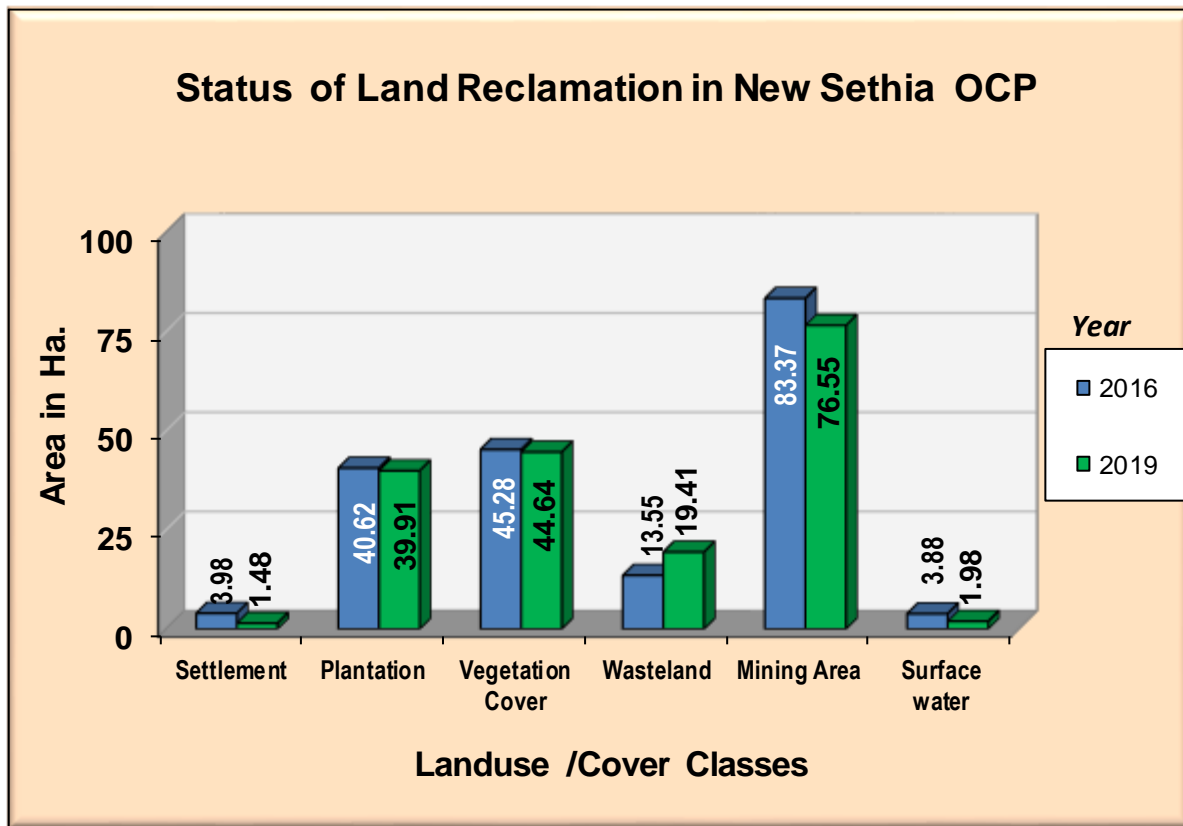


Figure-5.9

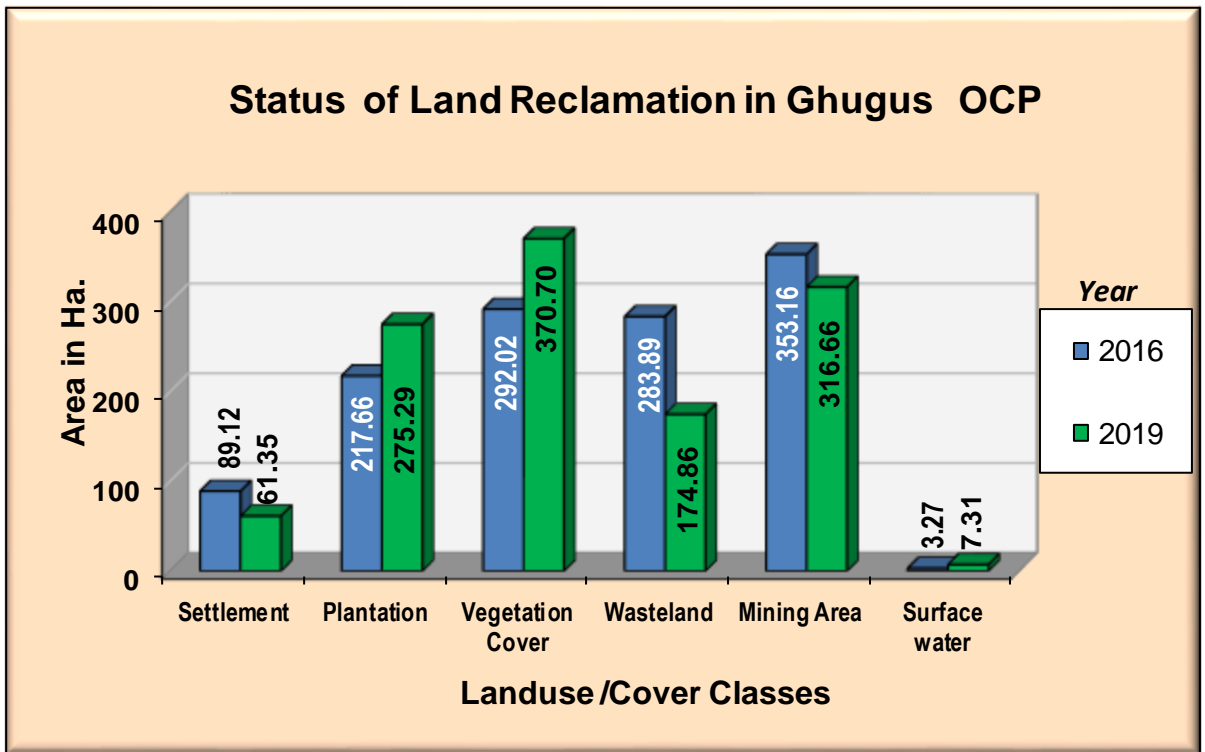


Figure-5.10

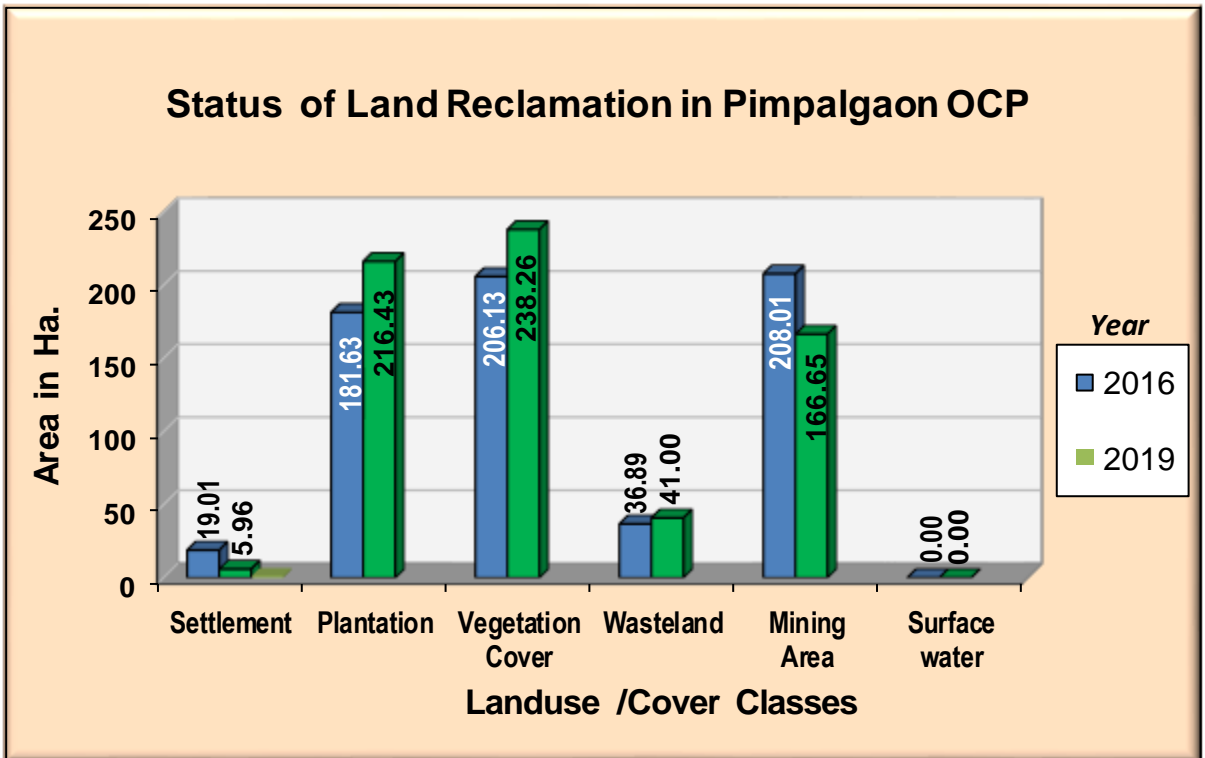


Figure-5.11

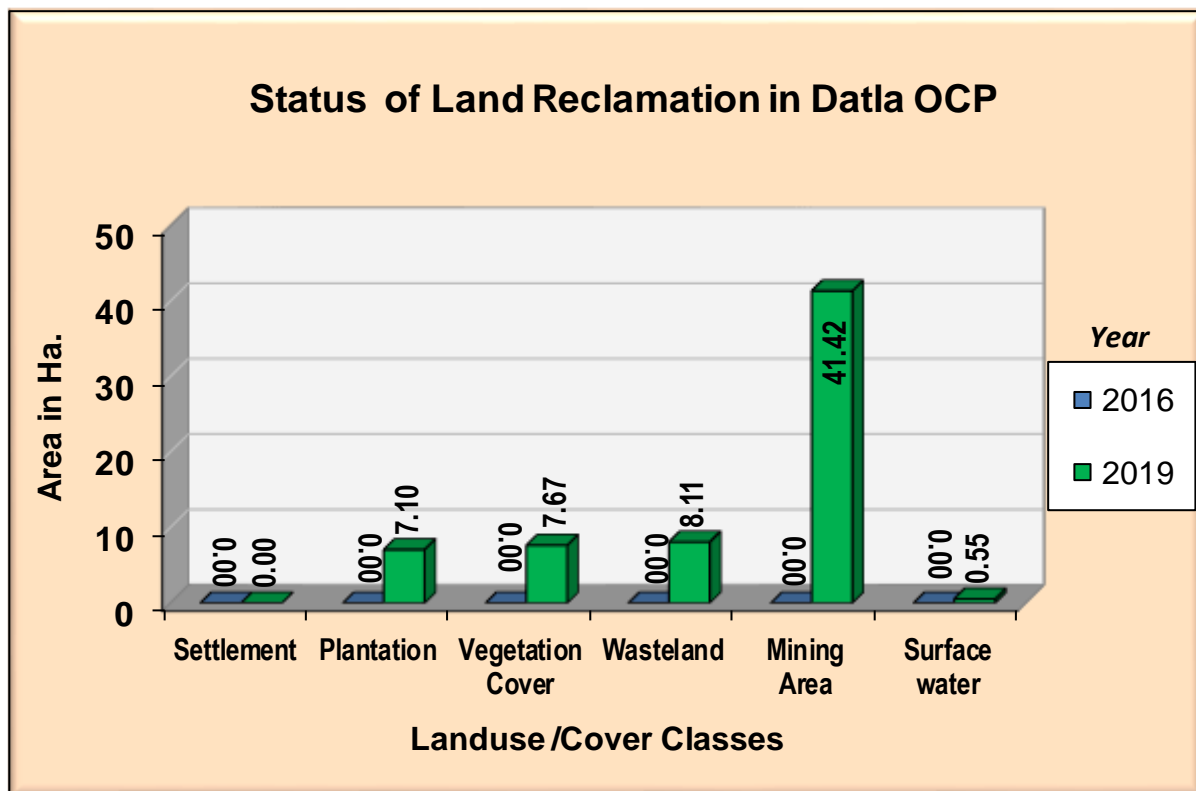


Figure-5.12



Photograph :1 Plantation on embankment in Bhanegaon opencast mine



Photograph :2 Plantation under Social Forestry in Singhori Opencast mine





**Photograph :3 Plantation on backfill in New Sethia opencast mine.**



**Photograph : 4 Plantation on embankment in MKD-II opencast mine.**



**Photograph :5 Plantation on Barren OB in MKD-II opencast mine.**



**Photograph :6 Plantation under Social Forestry in Pauni-II Opencast mine**





Photograph :7 Plantation on Barren OB Dump in Pimpalgaon Opencast mine



Photograph :8 Plantation on Barren OB Dump in Ghugus Opencast mine



*cmpdi*

*A Mini Ratna Company*