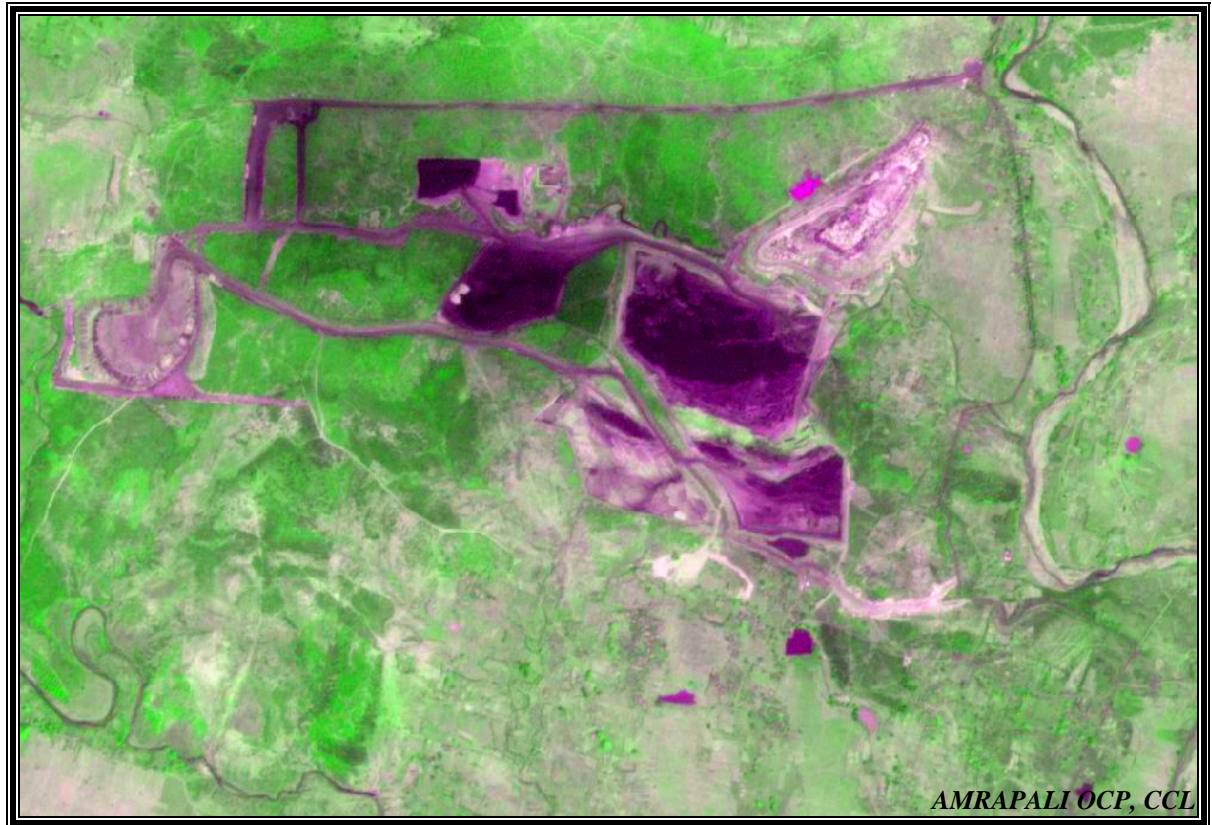


Land Restoration / Reclamation Monitoring of less than
5 m cu. m. (Coal + OB) Capacity Open Cast Coal Mines of
Central Coalfields Limited Based on Satellite Data for the Year 2015



Submitted to:
Central Coalfields Limited



cmpdi
A Mini Ratna Company

Land Restoration / Reclamation Monitoring of less than
5 m. cu. m (Coal + OB) capacity Open Cast Coal Mines of
Central Coalfields Limited Based on Satellite Data for the Year 2015

March-2016



Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

Executive Summary	iv-vi
1.0 Background	1
2.0 Objective	2
3.0 Methodology	2
4.0 Land Reclamation in Central Coalfields Limited	5-6

List of Tables

Table-1	Project wise Land Reclamation Status	v
Table-2	Area Statistics of Land Use Classes in OC Mines	7

List of Plates

Plate-1	Land Use Map of Tetariakhar OCP	08
Plate-2	Land Use Map of Dakra OCP	09
Plate-3	Land Use Map of Magadh OCP	10
Plate-4	Land Use Map of Amrapali OCP	11
Plate-5	Land Use Map of Giddi-A OCP	12
Plate-6	Land Use Map of Pundi OCP	13
Plate-7	Land Use Map of Kedla OCP	14
Plate-8	Land Use Map of Jarangdih OCP	15
Plate-9	Land Use Map of Kathara OCP	16
Plate-10	Land Use Map of Konar OCP	17
Plate-11	Land Use Map of Karo OCP	18
Plate-12	Land Use Map of Karma OCP	19

List of Figures

Figure-1	Bar-Chart of Project wise Land Reclamation Status	vi
Figure-2	Methodology of Land Reclamation Monitoring	02
Figure-3	Bar-Chart of Land Reclamation Status of Tetariakhar OCP	20
Figure-4	Bar-Chart of Land Reclamation Status of Dakra OCP	20
Figure-5	Bar-Chart of Land Reclamation Status of Magadh OCP	21
Figure-6	Bar-Chart of Land Reclamation Status of Amrapali OCP	21
Figure-7	Bar-Chart of Land Reclamation Status of Giddi-A OCP	22
Figure-8	Bar-Chart of Land Reclamation Status of Pundi OCP	22
Figure-9	Bar-Chart of Land Reclamation Status of Kedla OCP	23
Figure-10	Bar-Chart of Land Reclamation Status of Jarangdih OCP	23
Figure-11	Bar-Chart of Land Reclamation Status of Kathara OCP	24
Figure-12	Bar-Chart of Land Reclamation Status of Konar OCP	24
Figure-13	Bar-Chart of Land Reclamation Status of Karo OCP	25
Figure-14	Bar-Chart of Land Reclamation Status of Karma OCP	25

List of Photographs

Photo-1	Quarry site (Teteriakhar OCP)	26
Photo-2	Plantation on OB Dump (Dakra OCP)	26
Photo-3	Quarry site (Magadh OCP)	27
Photo-4	Plantation 2015-16 on OB Dump/Backfill (Amrapali OCP)	27
Photo-5	Plantation on OB Dump (Pundi OCP)	28
Photo-6	Plantation on OB Dump (Kedla OCP)	28
Photo-7	Plantation on Backfill (Jarangdih OCP)	29
Photo-8	Plantation on OB Dump (Kathara OCP)	29
Photo-9	Plantation on OB Dump (Karo OCP)	30
Photo-10	Plantation on Internal OB/Backfill (Karma OCP)	30

Executive Summary

- 1.0 Project** Land restoration / reclamation monitoring of 12 opencast coal mines of Central Coalfields Ltd. (CCL) producing less than 5 million cu. m. (Coal + OB) per year based on satellite data, on every three year 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 land in the leasehold area of the various projects. This will help in assessing the progressive status of mined out 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 9045.85 hectares of the 12 OC projects Viz. Tetriakhar, Dakra, Magadh, Amrapali, Giddi-A, Pundi, Kedla, Jarangdih, Kathara, Konar, Karo & Karma considered for monitoring during year 2015; total excavated area is only 2013.99 ha out of which 589.34 ha area (29.26%) has been planted, 827.05 ha area (41.07%) has been backfilled and 597.60 ha area (29.67%) is under active mining. It is evident from the analysis that 70.33% area of the OC projects have already been reclaimed and balance 29.67% area is under active mining. Project wise details are given in Table-1 & Fig -1.
 - Of the total area reclaimed by CCL, 29.26% is under biological reclamation (plantation) and 41.07% is under technical reclamation. Out of 12 projects of CCL, Dakra OCP ranks on top for land reclamation (87.15%) followed by Kathara OCP (81.34%) and Kedla OCP (79.88%).
 - Magadh, Amrapali and Konar are now operating projects, and the current status has been analyzed.

Table - 1
Projectwise Land Reclamation Status in Opencast Projects of CCL
based on Satellite Data of the year 2015

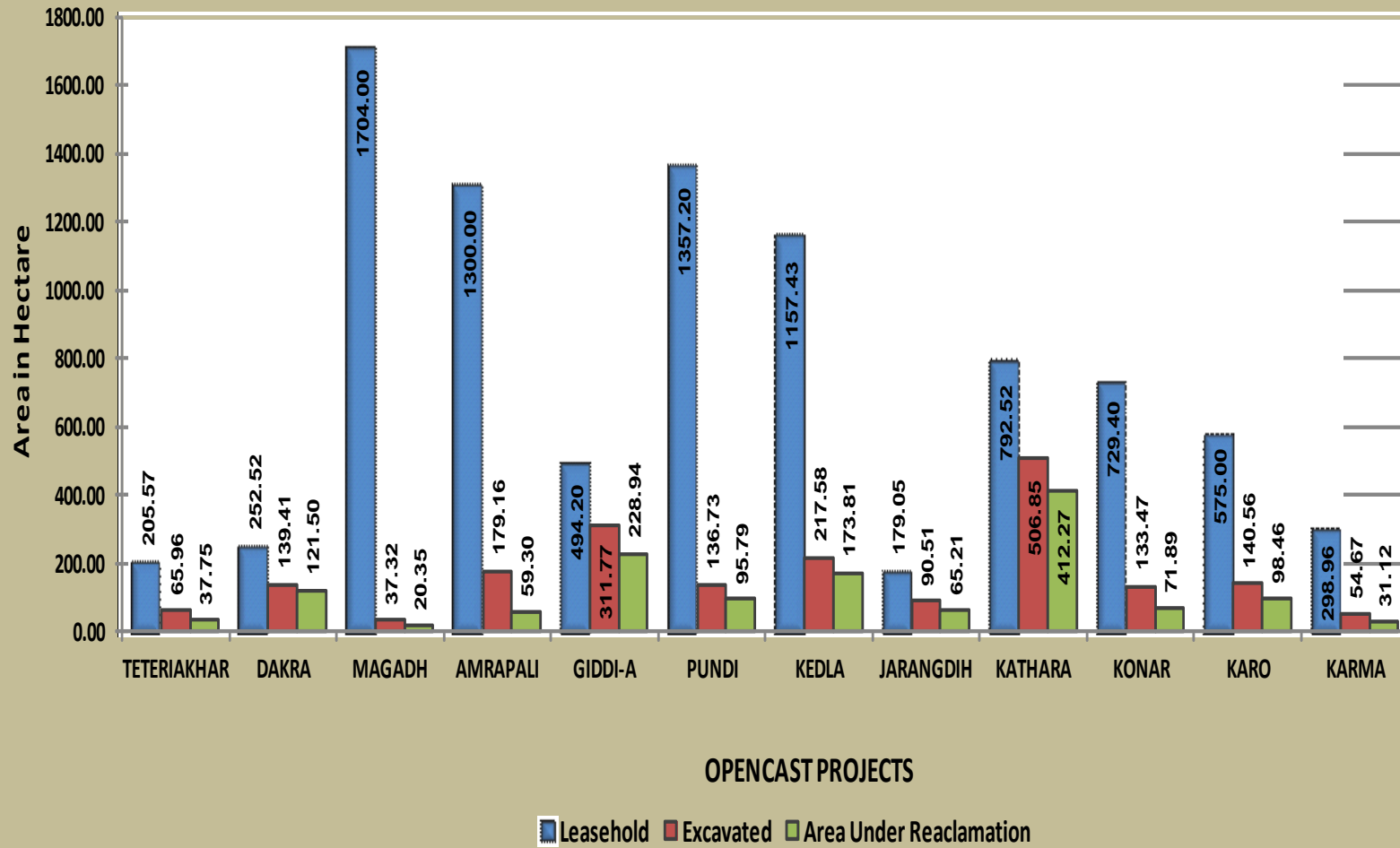
Area in Ha.

(% Calculated in terms of Total Excavated Area)

Sl. No.	Project		Biological Reclamation (Plantation/ Vegetation)		Technical Reclamation (Under Backfilling)		Under Active Mining		Total Excavated Area		Area under Reclamation		
	Name	Leasehold i		ii	ii	iii	iii	iv	iv	ii+iii+iv	ii+iii+iv	ii+iii	ii+iii
	Year	2012	2015	2012	2015	2012	2015	2012	2015	2012	2015	2012	2015
1	Teteriakhar	205	205.59	3.46	1.46	3.4	36.29	21.25	28.21	28.11	65.96	6.86	37.75
				12.31	2.21	12.10	55.02	75.60	42.77			24.40	57.23
2	Dakra	252.52	252.52	44.82	38.71	47.05	82.79	26.74	17.91	118.61	139.41	91.87	121.50
				37.79	27.77	39.67	59.39	22.54	12.85			77.46	87.15
3	Magadh *	1571	1704	0.00	0.00	0.00	20.35	0.00	16.97	0.00	37.32	0.00	20.35
				0.00	0.00	0.00	54.53	0.00	45.47			0.00	54.53
4	Amrapali *	1520	1300	0.00	0.00	0.00	59.30	0.00	119.86	0.00	179.16	0.00	59.30
				0.00	0.00	0.00	33.10	0.00	66.90			0.00	33.10
5	Giddi-A	494	494.2	103.04	122.43	106.40	106.51	83.22	82.83	292.66	311.77	209.44	228.94
				35.21	39.27	36.36	34.16	28.44	26.57			71.56	73.43
6	Pundi *	852	1357.2	35.24	38.24	53.28	57.55	43.54	40.94	132.06	136.73	88.52	95.79
				26.68	27.97	40.35	42.09	32.97	29.94			67.03	70.06
7	Kedla *	901	1157.43	11.37	28.51	127.75	145.30	73.51	43.77	212.63	217.58	139.12	173.81
				5.35	13.10	60.08	66.78	34.57	20.12			65.43	79.88
8	Jarangdih *	494.52	179.05	184.57	27.19	34.85	38.02	33.38	25.30	252.80	90.51	219.42	65.21
				73.01	30.04	13.79	42.01	13.20	27.95			86.80	72.05
9	Kathara	792.81	792.52	198.08	228.88	135.82	183.39	127.86	94.58	461.76	506.85	333.90	412.27
				42.90	45.16	29.41	36.18	27.69	18.66			72.31	81.34
10	Konar *	308.69	729.4	0.00	51.27	0.00	20.62	0.00	61.58	0.00	133.47	0.00	71.89
				0.00	38.41	0.00	15.45	0.00	46.14			0.00	53.86
11	Karo *	1204	575	64.40	42.08	30.77	56.38	38.00	42.10	133.17	140.56	95.17	98.46
				48.36	29.94	23.11	40.11	28.53	29.95			71.47	70.05
12	Karma	298.96	298.96	6.85	10.57	27.86	20.55	18.43	23.55	53.14	54.67	34.71	31.12
				12.89	19.33	52.43	37.59	34.68	43.08			65.32	56.92
TOTAL (CCL)		8894.50	9045.87	651.83	589.34	567.18	827.05	465.93	597.60	1684.94	2013.99	1219.01	1416.39
				38.69	29.26	33.66	41.07	27.65	29.67	18.94	22.26	72.35	70.33

* Leasehold is modified in 2015 w.r.t. 2012

Fig. 1: PROJECT WISE STATUS OF LAND RECLAMATION IN CCL FOR THE YEAR 2015



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, M/s. Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 for monitoring of opencast mines of less than 5 million m³ per annum capacity (Coal +OB) from the year 2012 at intervals of three years. The result of land reclamation status of all such mines is to be published on the website of CIL, CMPDI and the concerned coal companies in public domain. Detailed reports are 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 2015 carried out for 12 OC projects of Central Coalfields Ltd. producing less than 5 mcm (Coal+OB) per annum.

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:

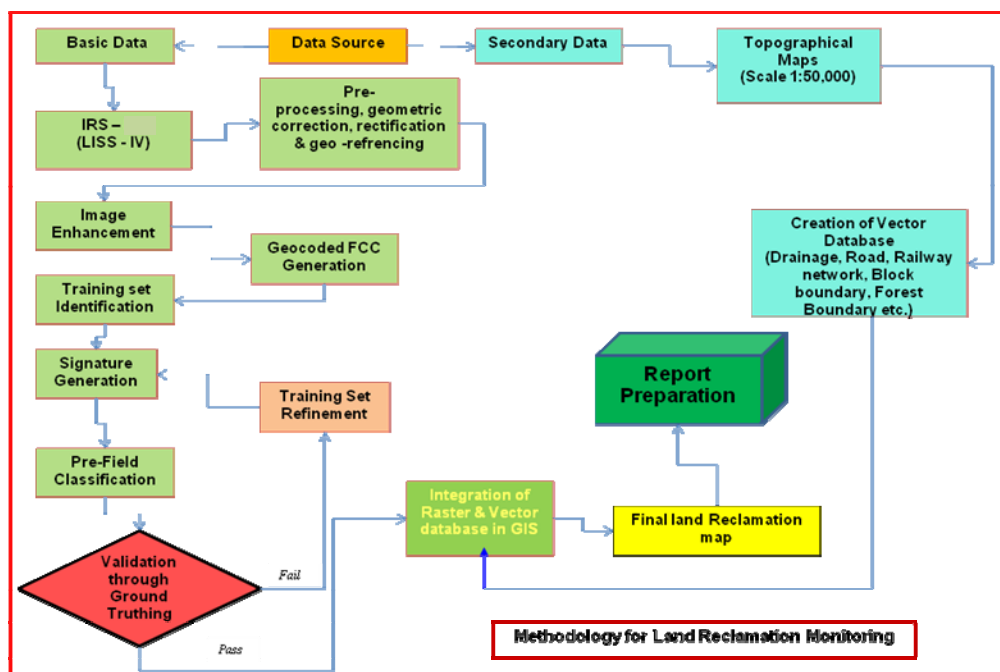


Figure: 2 Methodology for Land Reclamation Monitoring

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 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 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 14 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. 14 software and given in table 2.

- **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-off dates.

4.0 Land Reclamation Status in Central Coalfields Ltd.

4.1 Following 12 OC projects producing less than 5 million m³. (Coal + OB together) of Central Coalfields Ltd. have been taken up during the year 2015 for land reclamation monitoring:

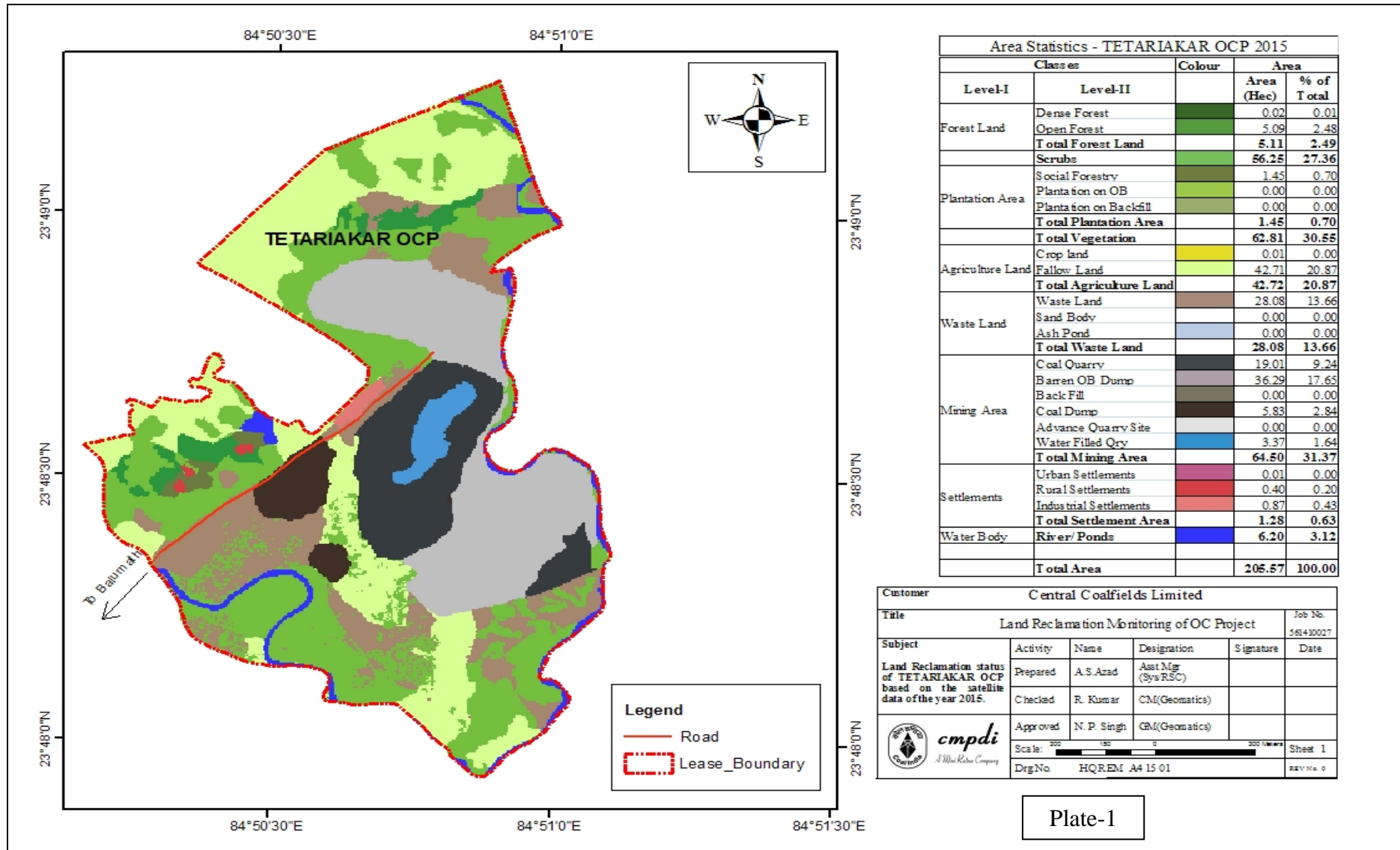
- Teteriakhar
- Dakra
- Magadh
- Amrapali
- Giddi-A
- Pundi
- Kedla
- Jarangdih
- Kathara
- Konar
- Karo
- Karma

4.2 Area statistics of different land use classes present in OC projects in the year 2015 is given in Table 2. Land use maps derived from the satellite data is given in Plate no. 1 to 12. Land use statuses are shown in Fig. 3 – 14 and field photographs showing plantation and backfilled area in mining projects are shown in photos 1-5.

4.3 Leasehold of Konar OCP has increased from 308.69 ha to 729.4 ha due to mine expansion and amalgamation with Khasmahal OCP. Also infrastructural development like washery and FBC plant are coming up in 2015-16. The modification of Karo leasehold is done as per approved project plan for 11/15 mty.

4.4 Study reveals that 70.33% of excavated area has already been reclaimed by CCL in the OC projects, out of which 29.26% area has been planted and 41.07% area are backfilled.

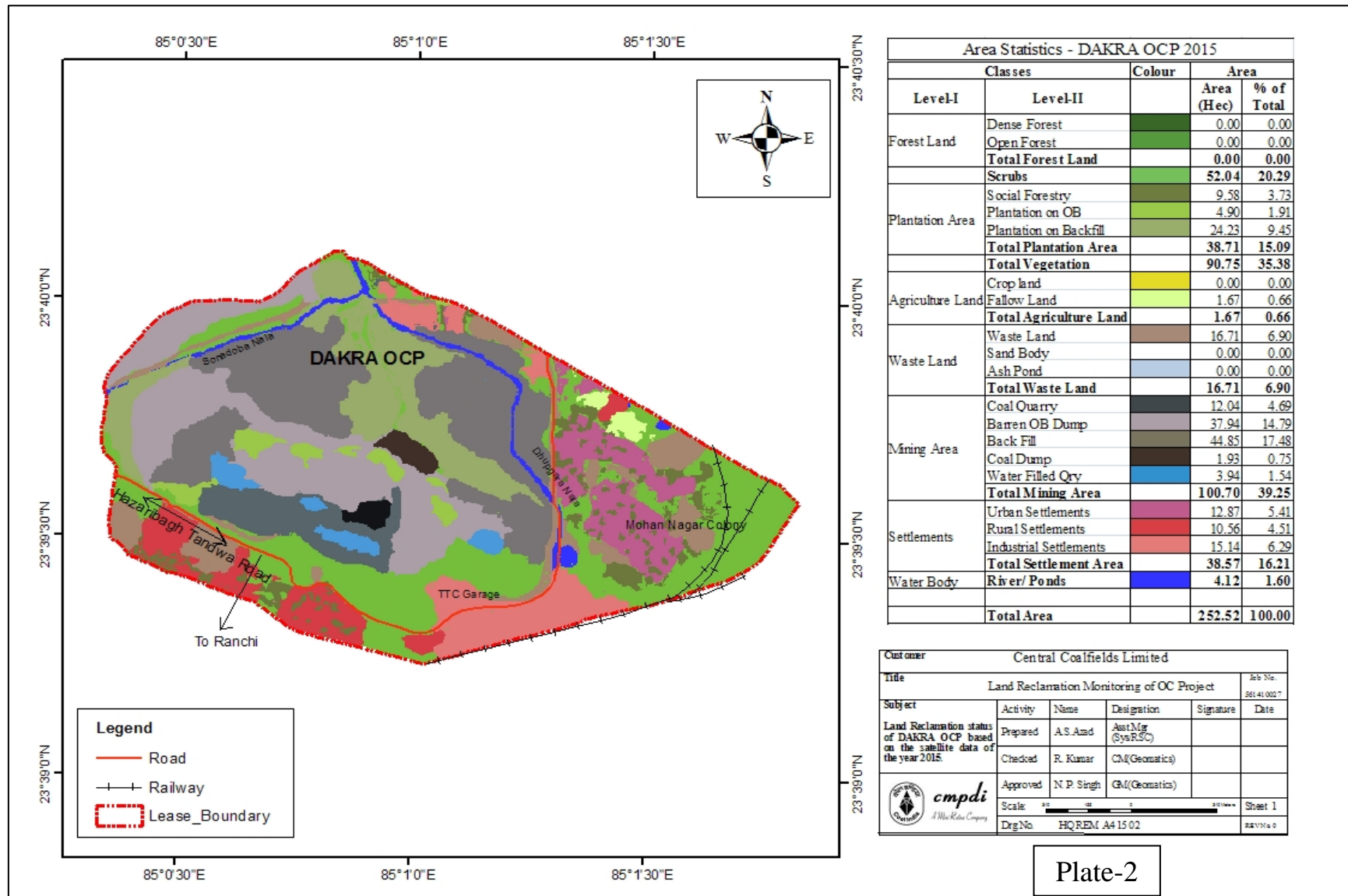
4.5 After analyzing the satellite data of year 2015, it is evident that plantation carried out on backfilled area, OB dumps as well as under social forestry in all the 12 mines of CCL taken up for study, has reached 29.26% till now. It can also be seen from the Table.1 that the total area of reclamation has reached 70.33% till the year 2015.



Area Statistics - TETARIAKAR OCP 2015				
Classes		Colour	Area	
Level-I	Level-II		Area (Hec)	% of Total
Forest Land	Dense Forest		0.02	0.01
	Open Forest		5.09	2.48
	Total Forest Land		5.11	2.49
	Scrubs		56.25	27.36
Plantation Area	Social Forestry		1.45	0.70
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation Area		1.45	0.70
	Total Vegetation		62.81	30.55
Agriculture Land	Crop land		0.01	0.00
	Fallow Land		42.71	20.87
	Total Agriculture Land		42.72	20.87
Waste Land	Waste Land		28.08	13.66
	Sand Body		0.00	0.00
	Ash Pond		0.00	0.00
	Total Waste Land		28.08	13.66
Mining Area	Coal Quarry		19.01	9.24
	Barren OB Dump		36.29	17.65
	Back Fill		0.00	0.00
	Coal Dump		5.83	2.84
	Advance Quarry Site		0.00	0.00
	Water Filled Qry		3.37	1.64
	Total Mining Area		64.50	31.37
Settlements	Urban Settlements		0.01	0.00
	Rural Settlements		0.40	0.20
	Industrial Settlements		0.87	0.43
	Total Settlement Area		1.28	0.63
Water Body	River/ Ponds		6.20	3.12
	Total Area		205.57	100.00

Customer: Central Coalfields Limited					
Title: Land Reclamation Monitoring of OC Project					Job No. 561410027
Subject: Land Reclamation status of TETARIAKAR OCP based on the satellite data of the year 2015.	Activity	Name	Designation	Signature	Date
	Prepared	A. S. Azad	Asst Mgr (Sys/RSC)		
	Checked	R. Kumar	CM(Geomatics)		
	Approved	N. P. Singh	GM(Geomatics)		
Scale: 0 100 200 meters					Sheet 1
DrgNo: HQREM_A4 15 01					REV No: 0

Plate-1



Area Statistics - DAKRA OCP 2015				
Level-I	Level-II	Colour	Area (Hec)	% of Total
Forest Land	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest Land		0.00	0.00
Plantation Area	Scrubs		52.04	20.29
	Social Forestry		9.58	3.73
	Plantation on OB		4.90	1.91
	Plantation on Backfill		24.23	9.45
	Total Plantation Area		38.71	15.09
	Total Vegetation		90.75	35.38
Agriculture Land	Crop land		0.00	0.00
	Fallow Land		1.67	0.66
	Total Agriculture Land		1.67	0.66
Waste Land	Waste Land		16.71	6.90
	Sand Body		0.00	0.00
	Ash Pond		0.00	0.00
	Total Waste Land		16.71	6.90
Mining Area	Coal Quarry		12.04	4.69
	Barren OB Dump		37.94	14.79
	Back Fill		44.85	17.48
	Coal Dump		1.93	0.75
	Water Filled Qty		3.94	1.54
	Total Mining Area		100.70	39.25
Settlements	Urban Settlements		12.87	5.41
	Rural Settlements		10.56	4.51
	Industrial Settlements		15.14	6.29
	Total Settlement Area		38.57	16.21
Water Body	River/ Ponds		4.12	1.60
	Total Area		252.52	100.00

Customer		Central Coalfields Limited			
Title	Land Reclamation Monitoring of OC Project				Job No. 561410027
Subject	Activity	Name	Designation	Signature	Date
	Prepared	A.S.Azad	Asst Mgr (Sys/RSC)		
	Checked	R. Kumar	CAI(Geomatics)		
	Approved	N.P. Singh	CAI(Geomatics)		
Scale		1:50000			Sheet 1
Drg No		HQ/REM. A4 15 02			REVISED

Plate-2

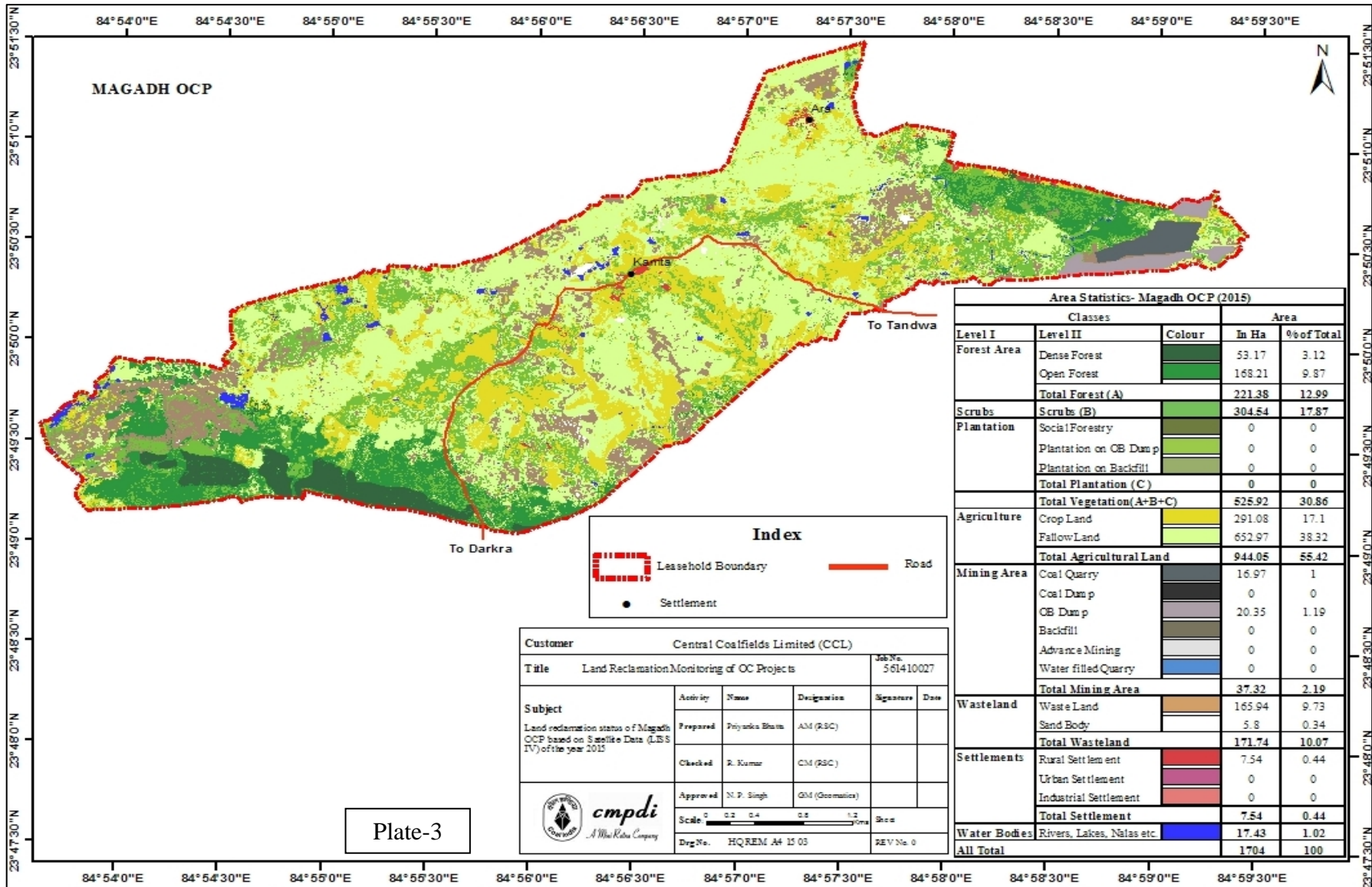
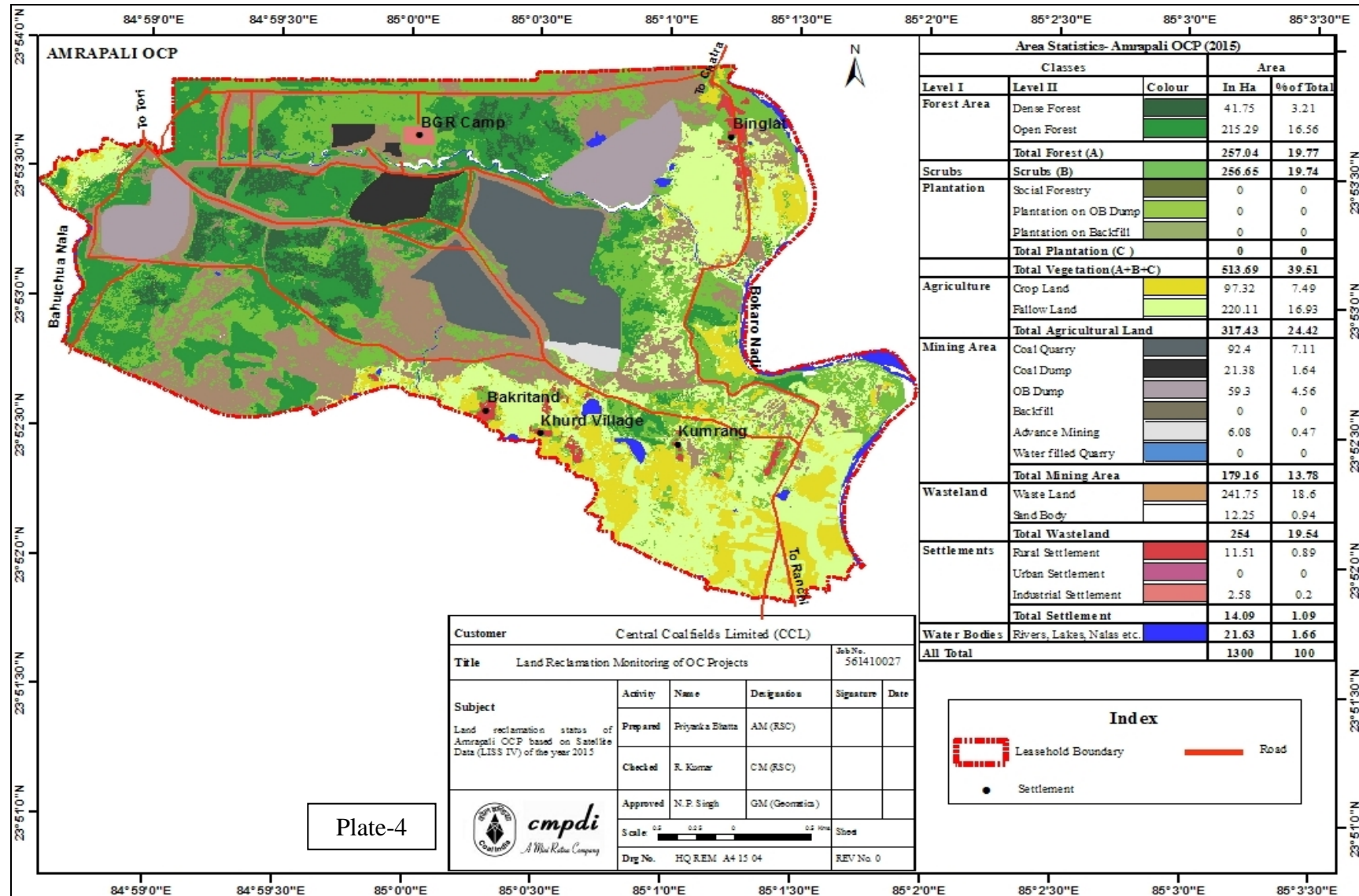
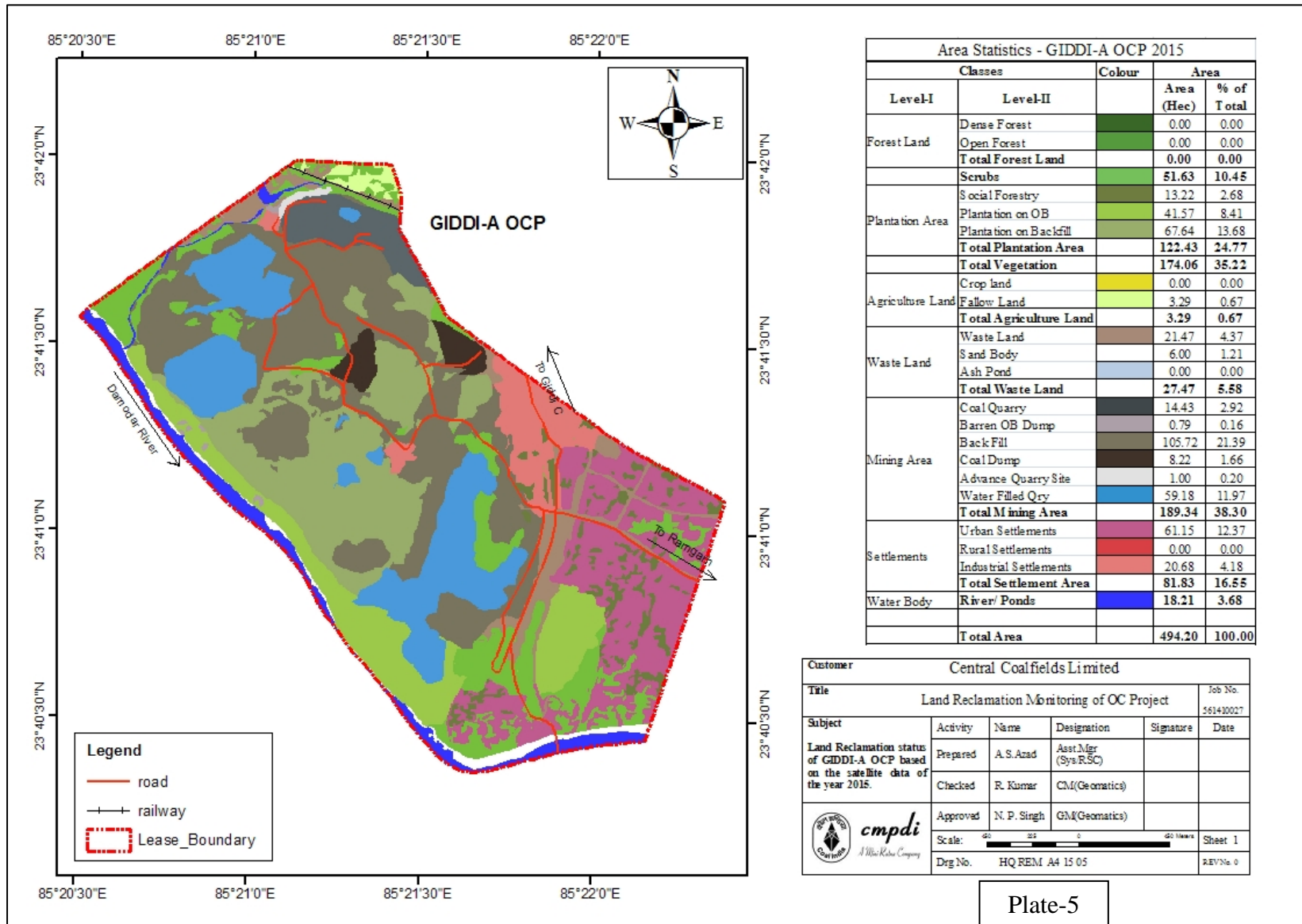


Plate-3





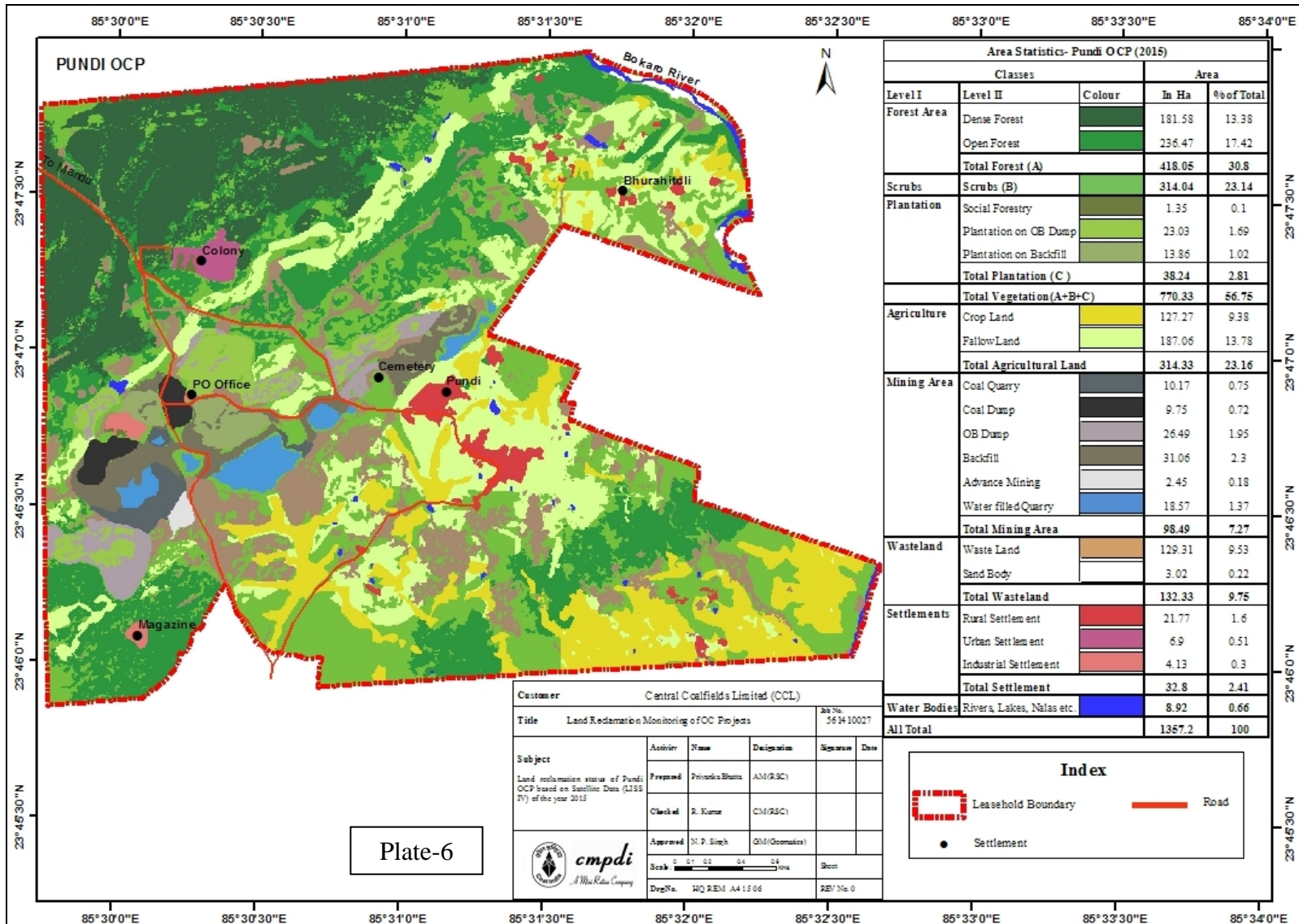


Plate-6

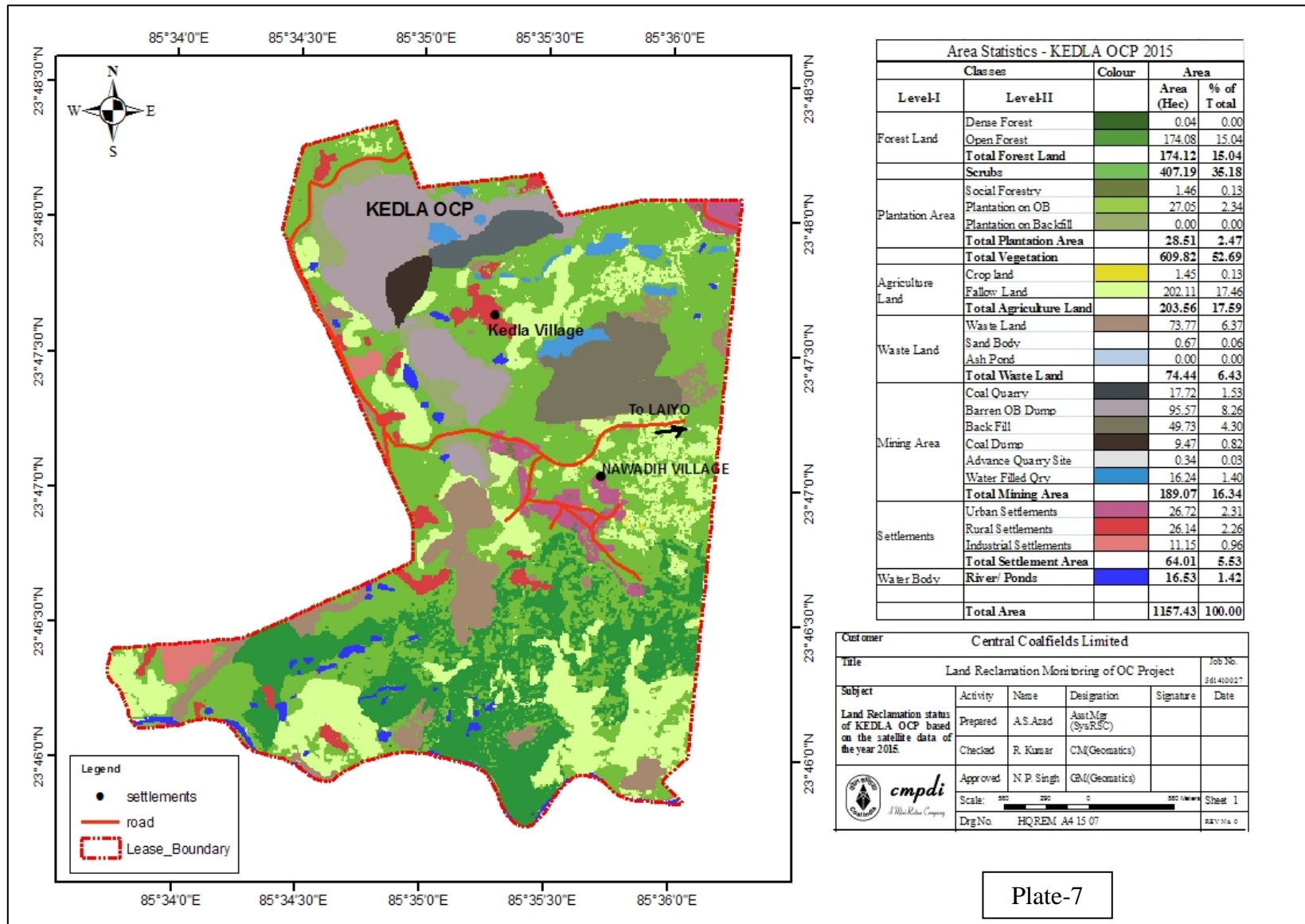


Plate-7

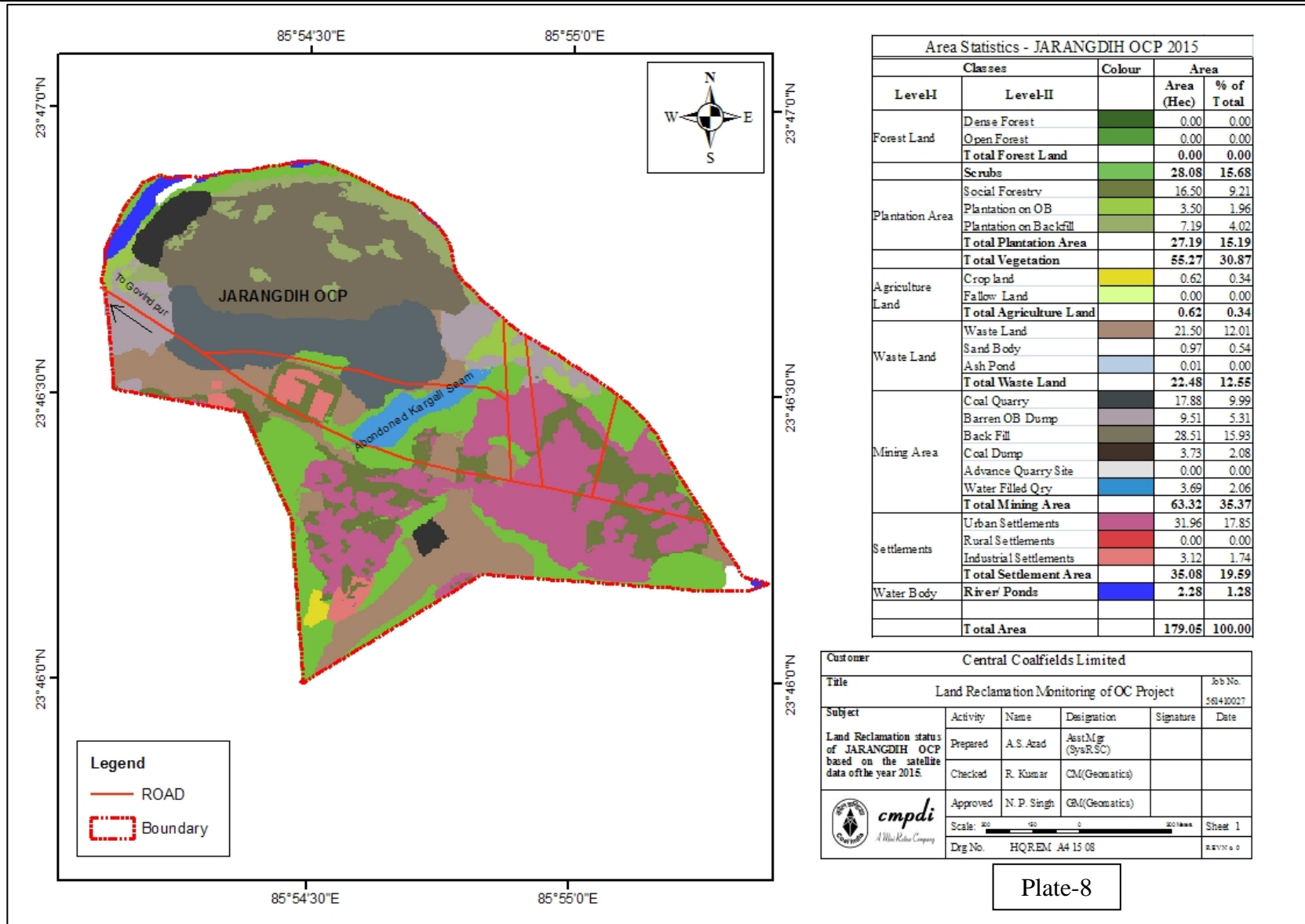


Plate-8

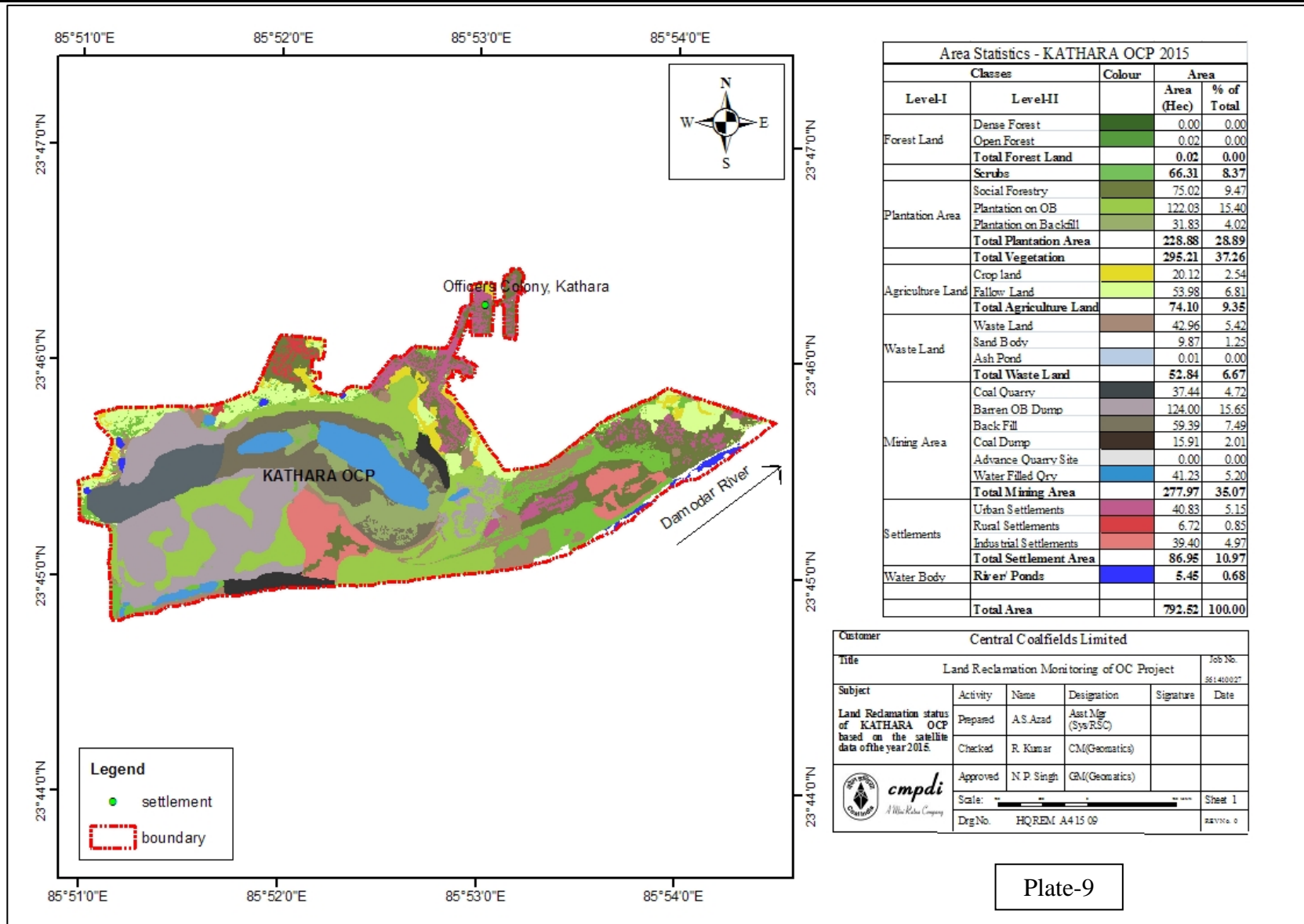
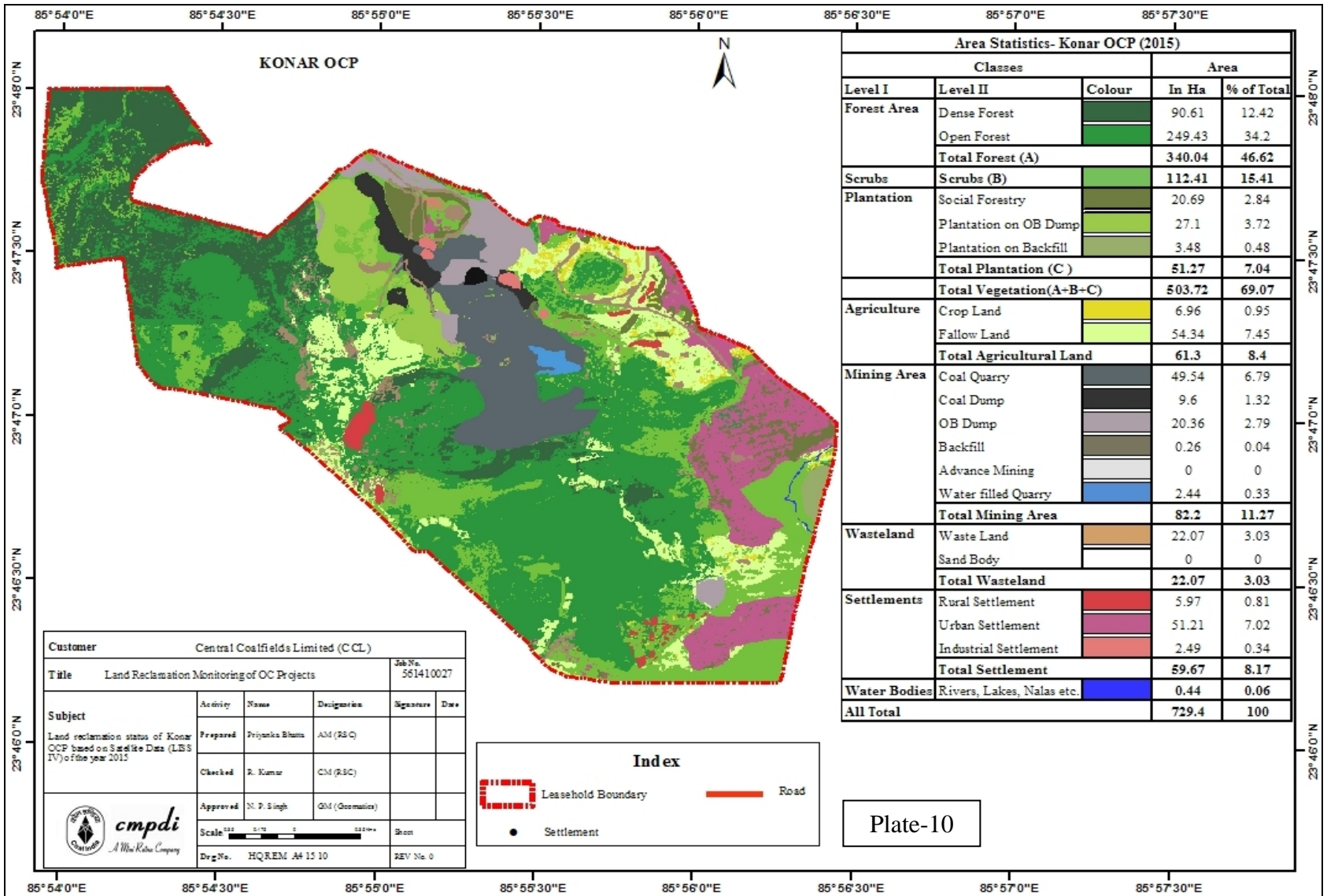
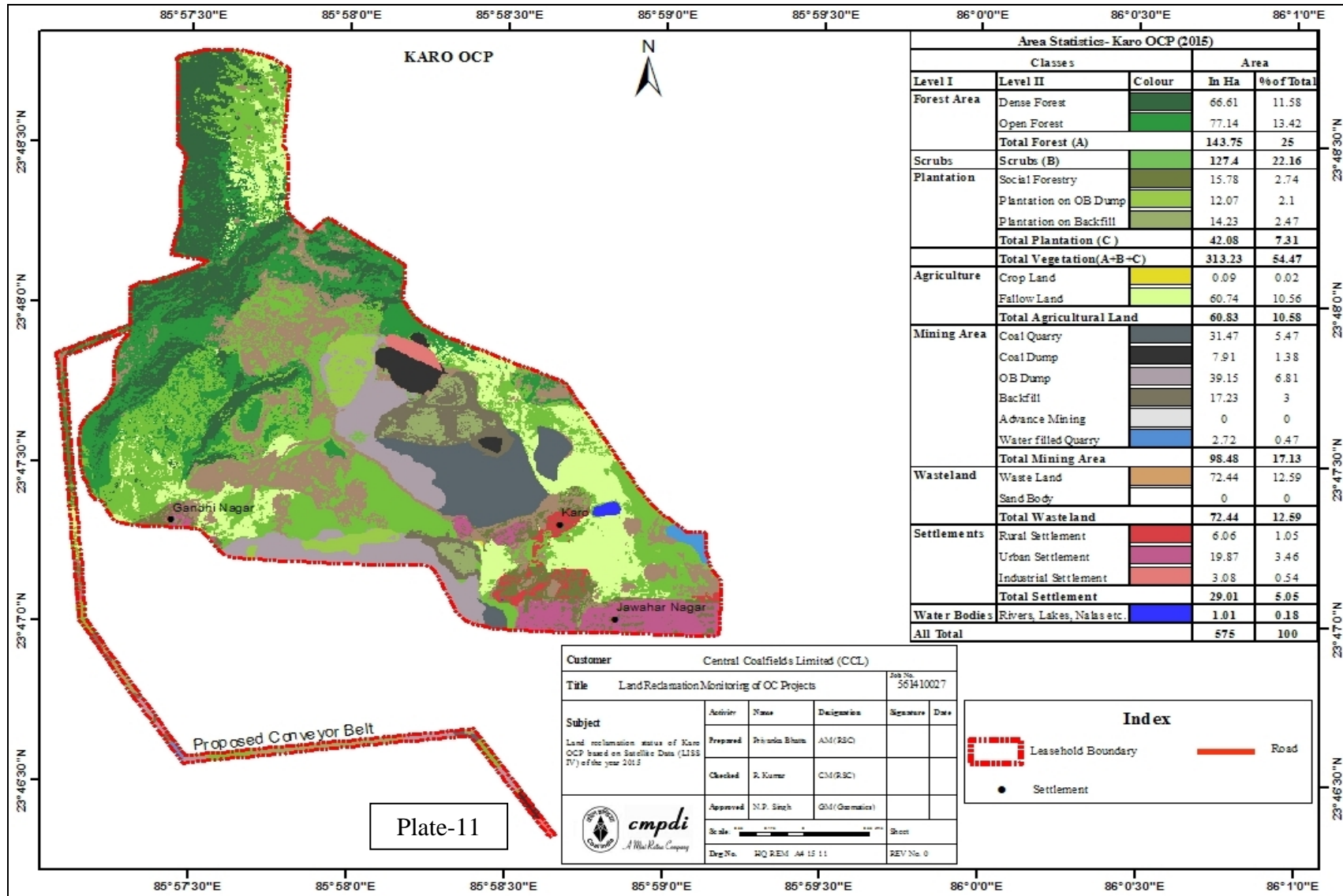
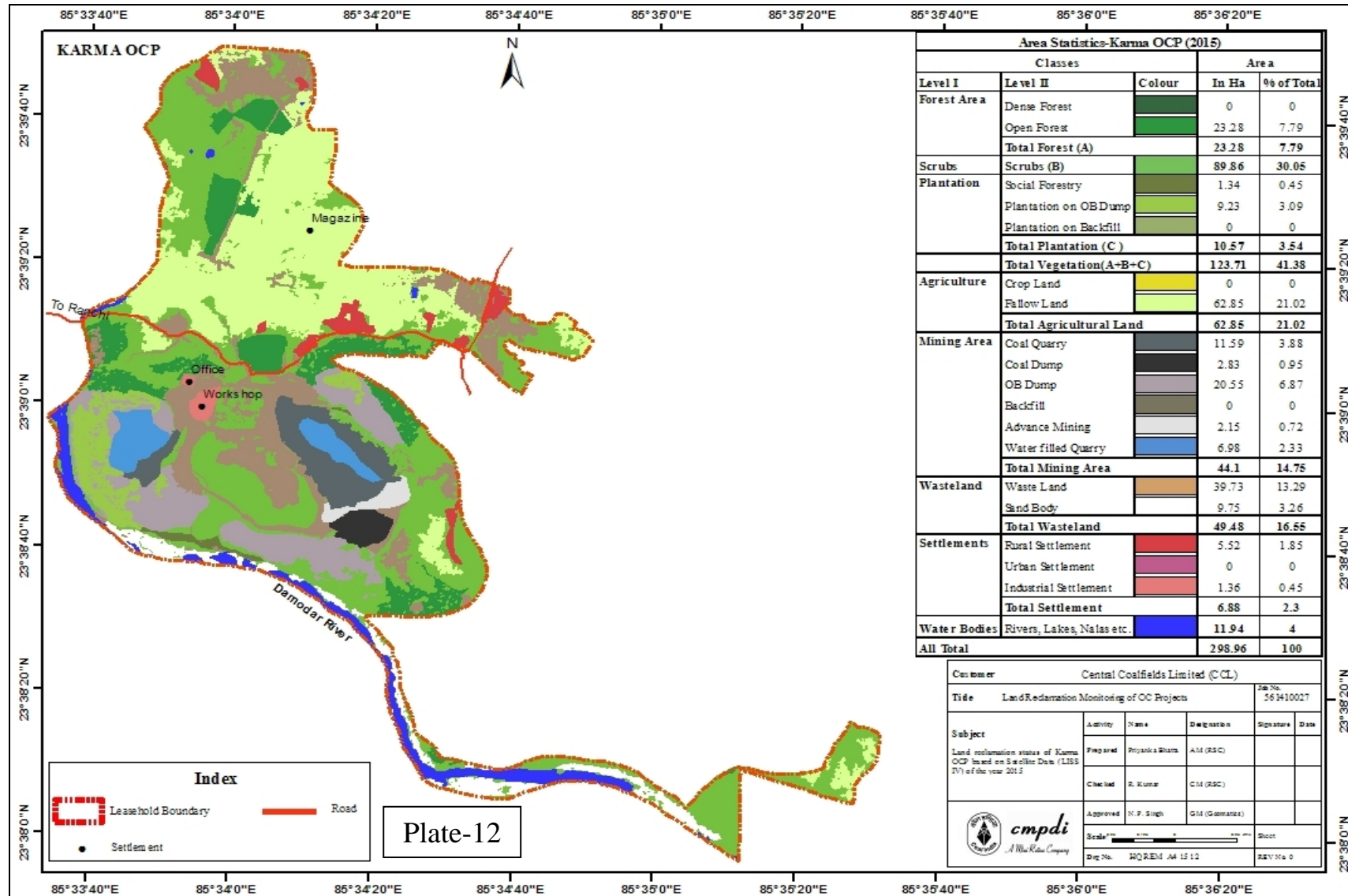


Plate-9







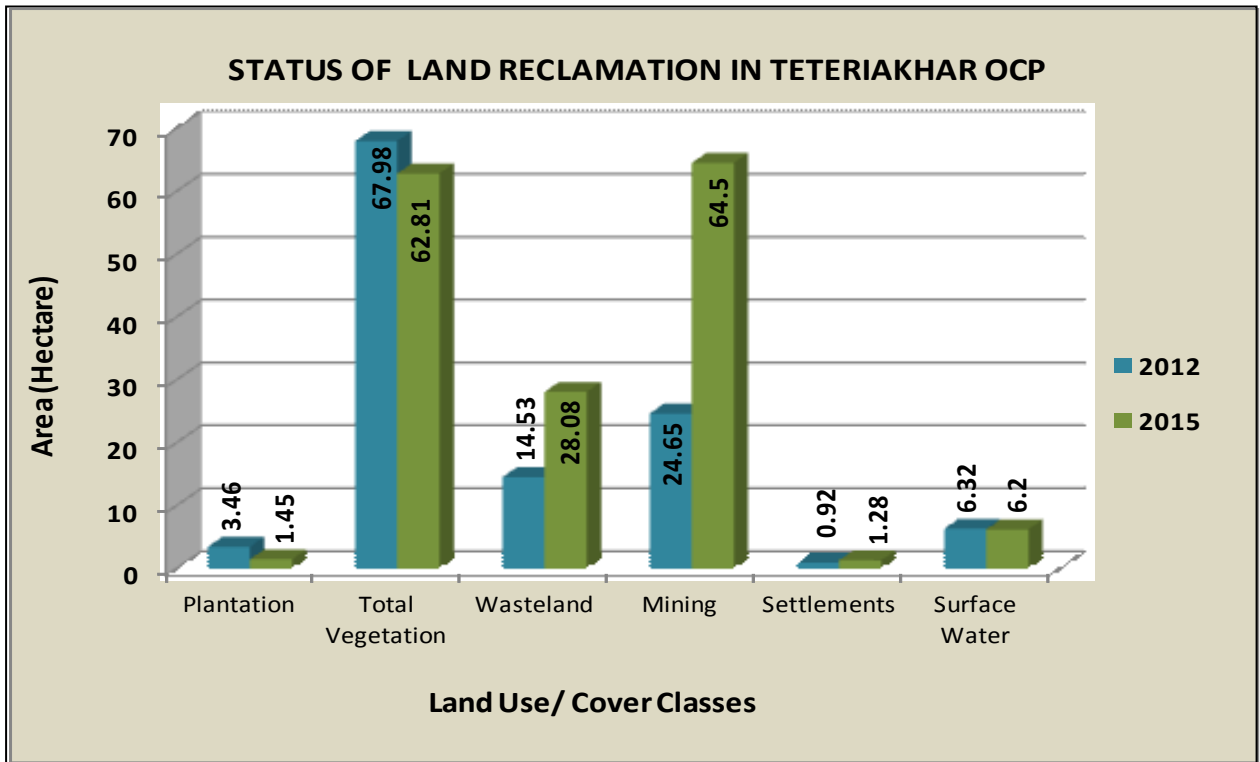


Figure - 3

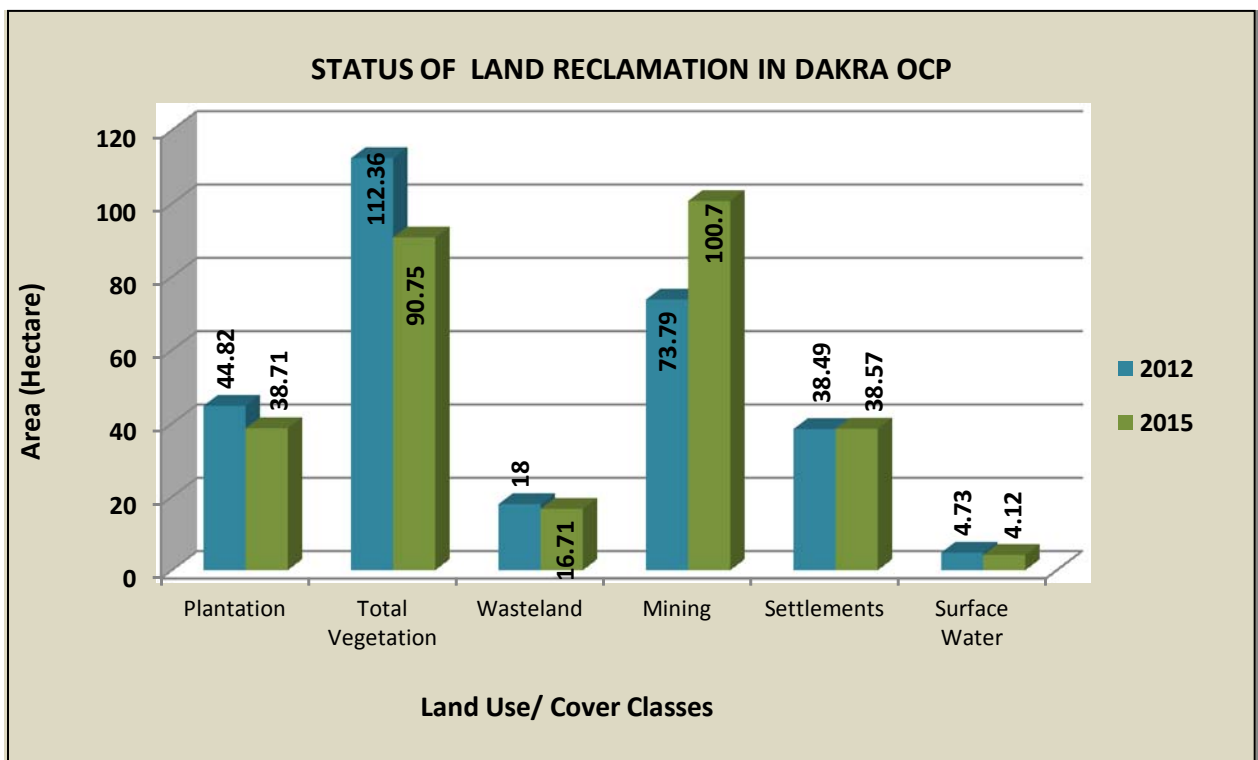


Figure - 4

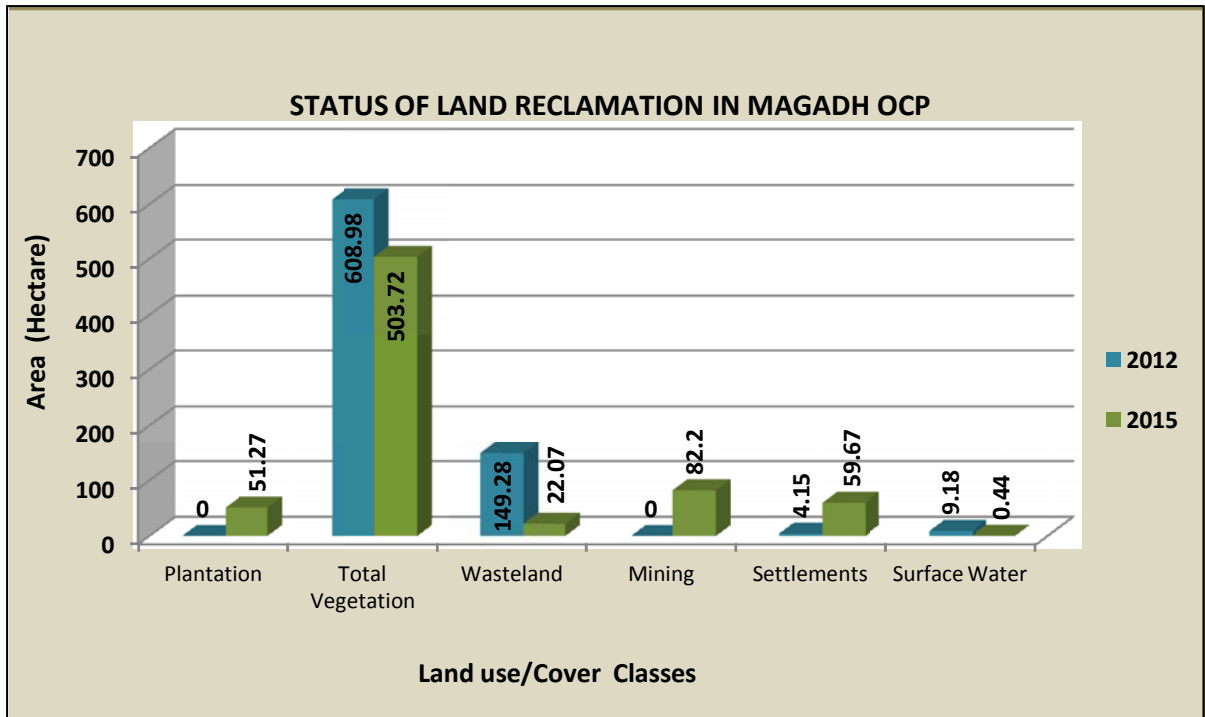


Figure - 5

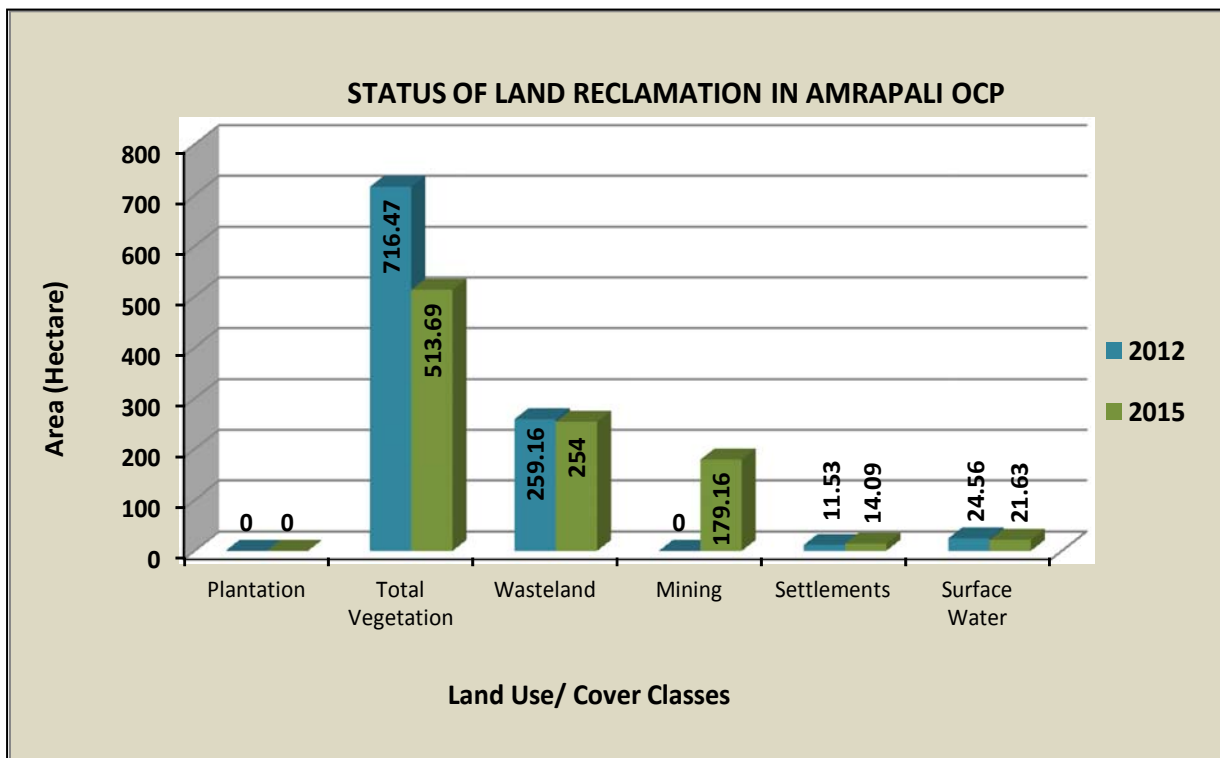


Figure - 6

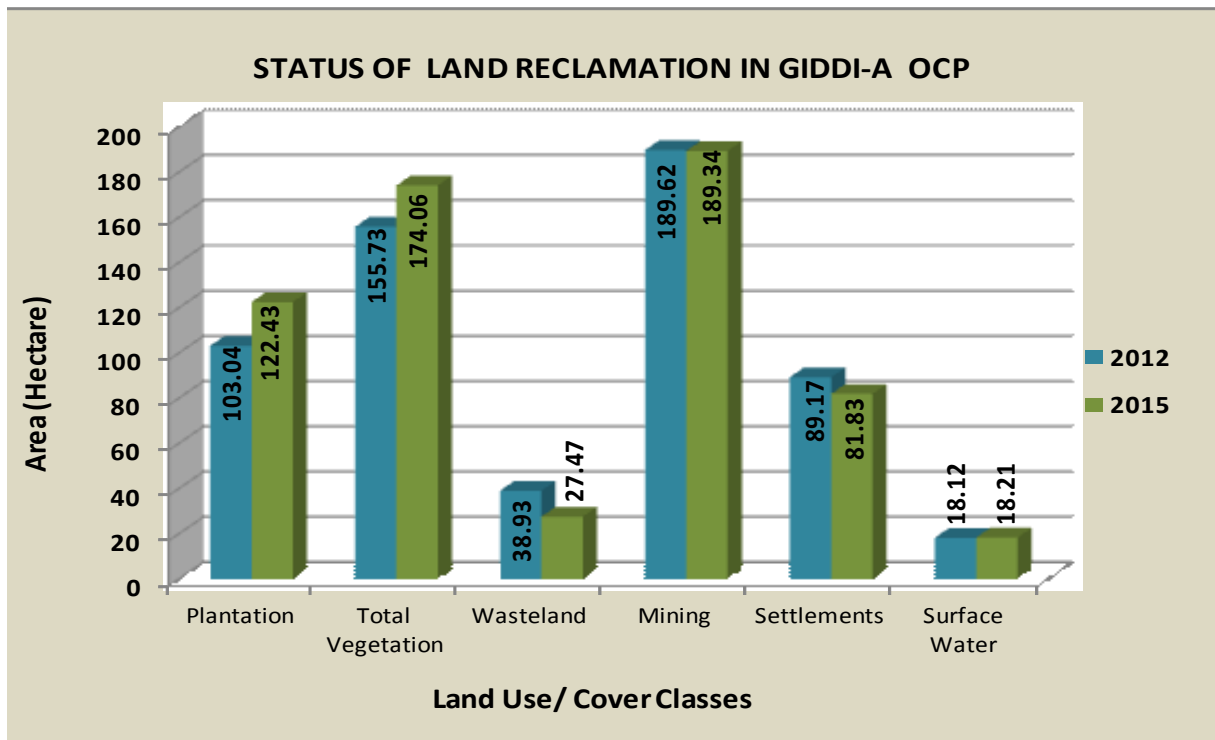


Figure - 7

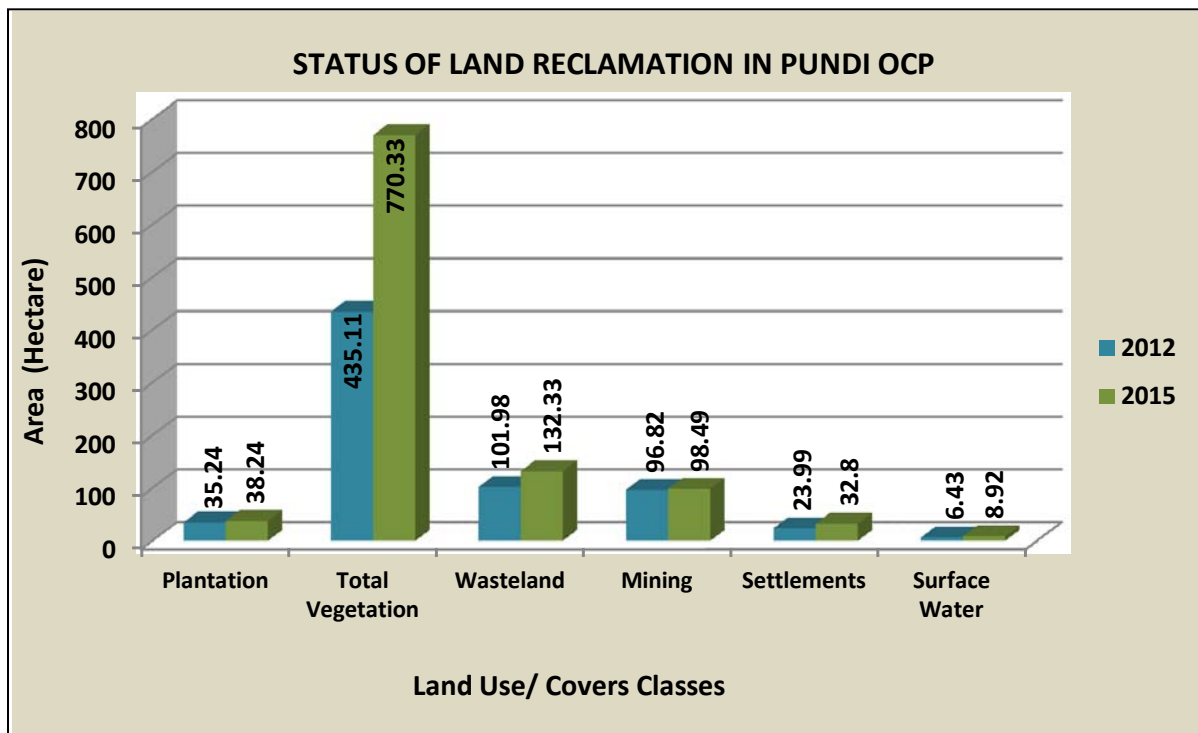


Figure - 8

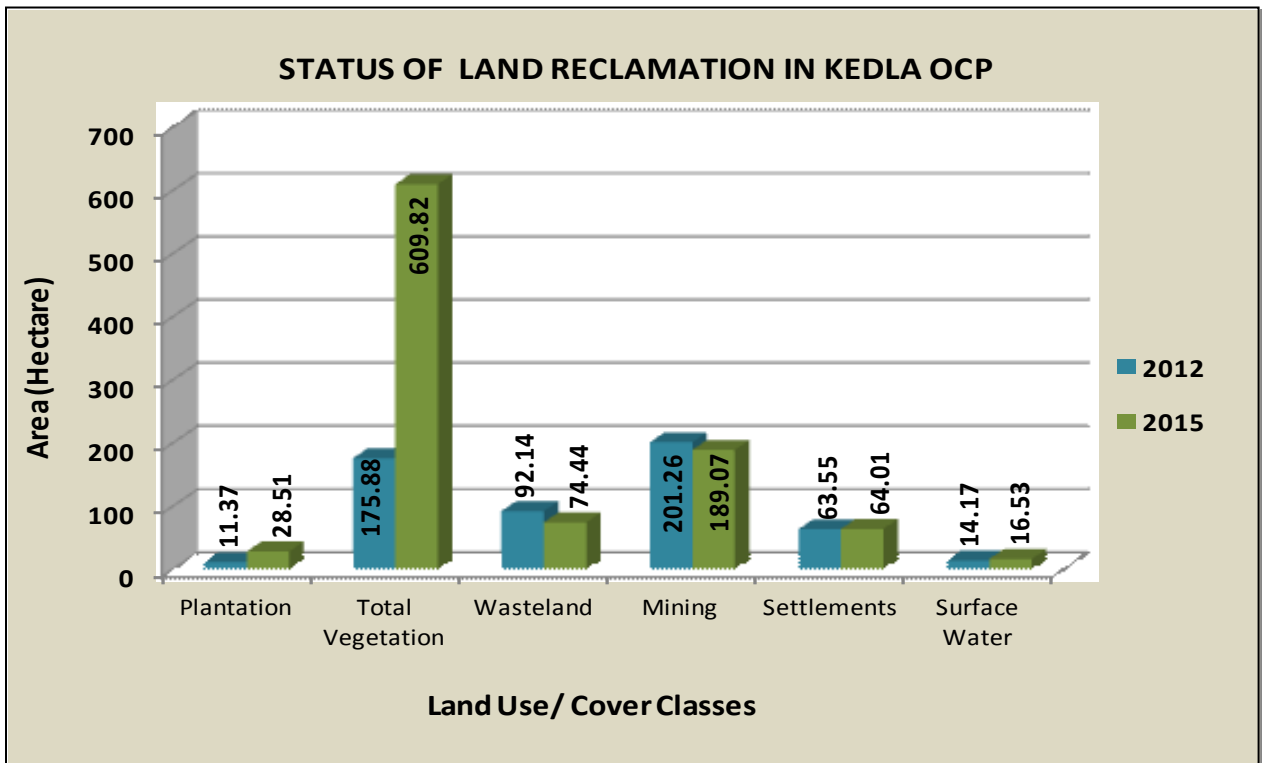


Figure - 9

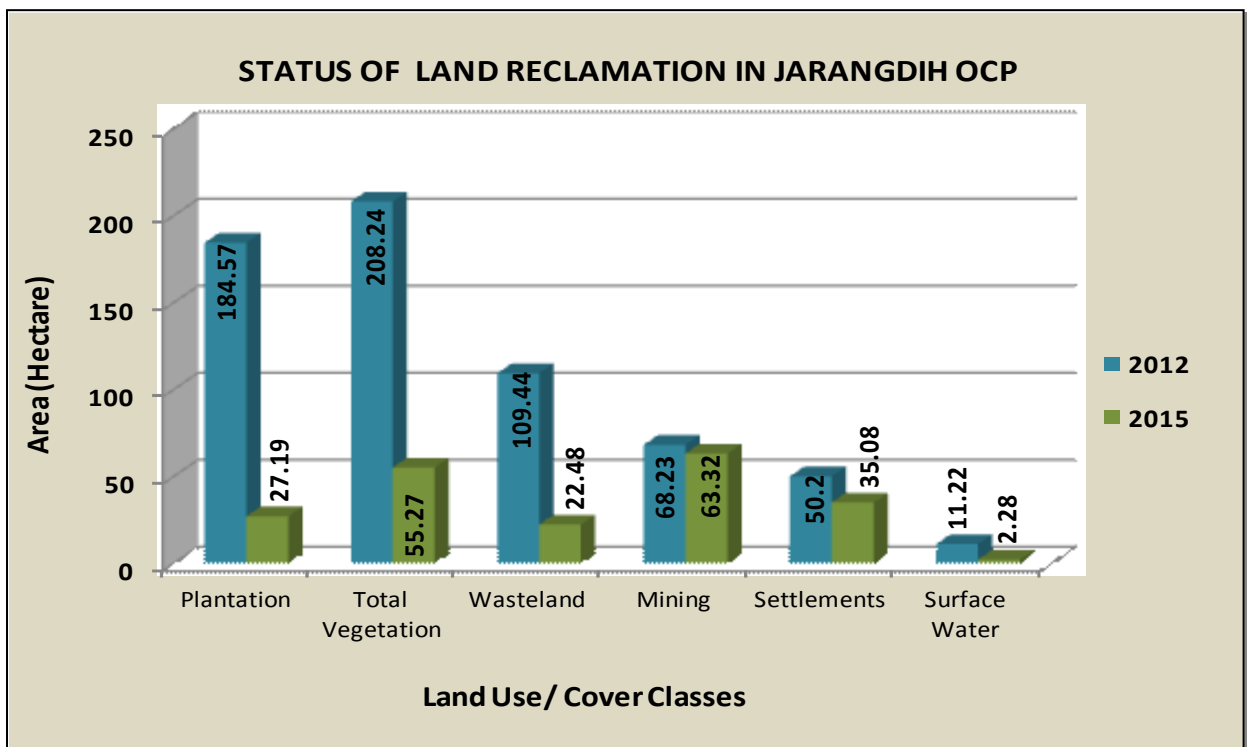


Figure - 10

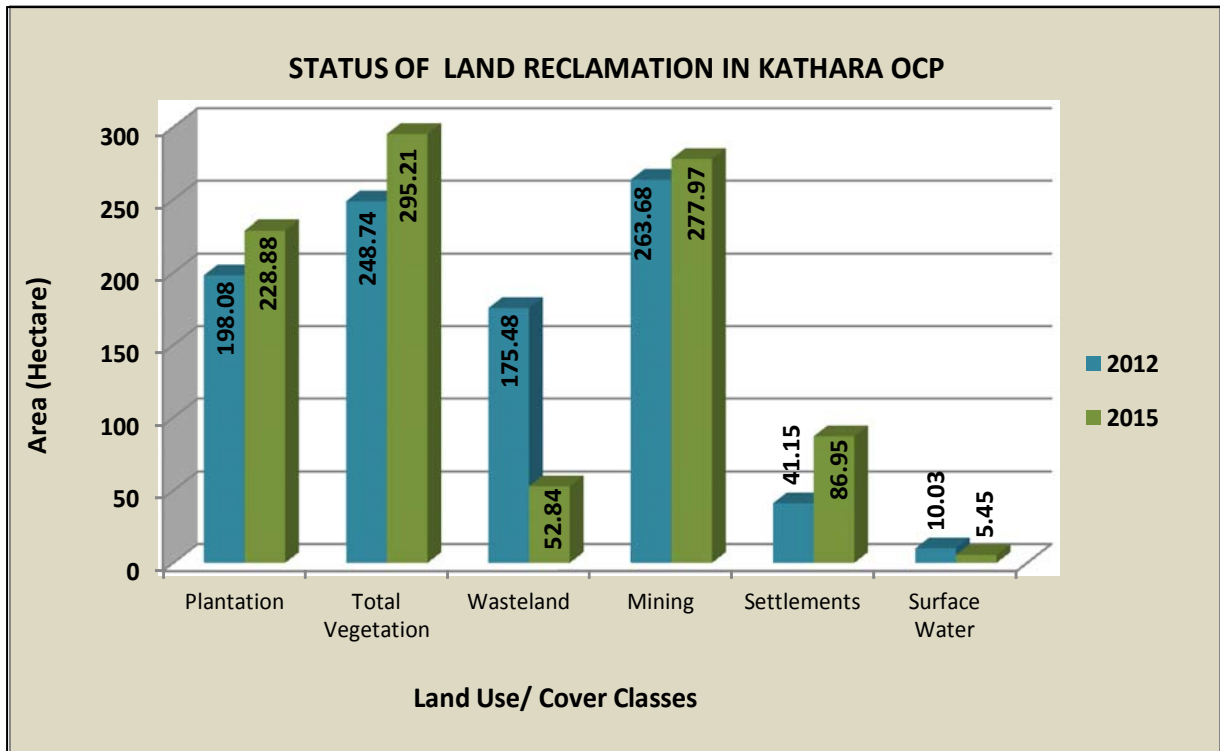


Figure - 11

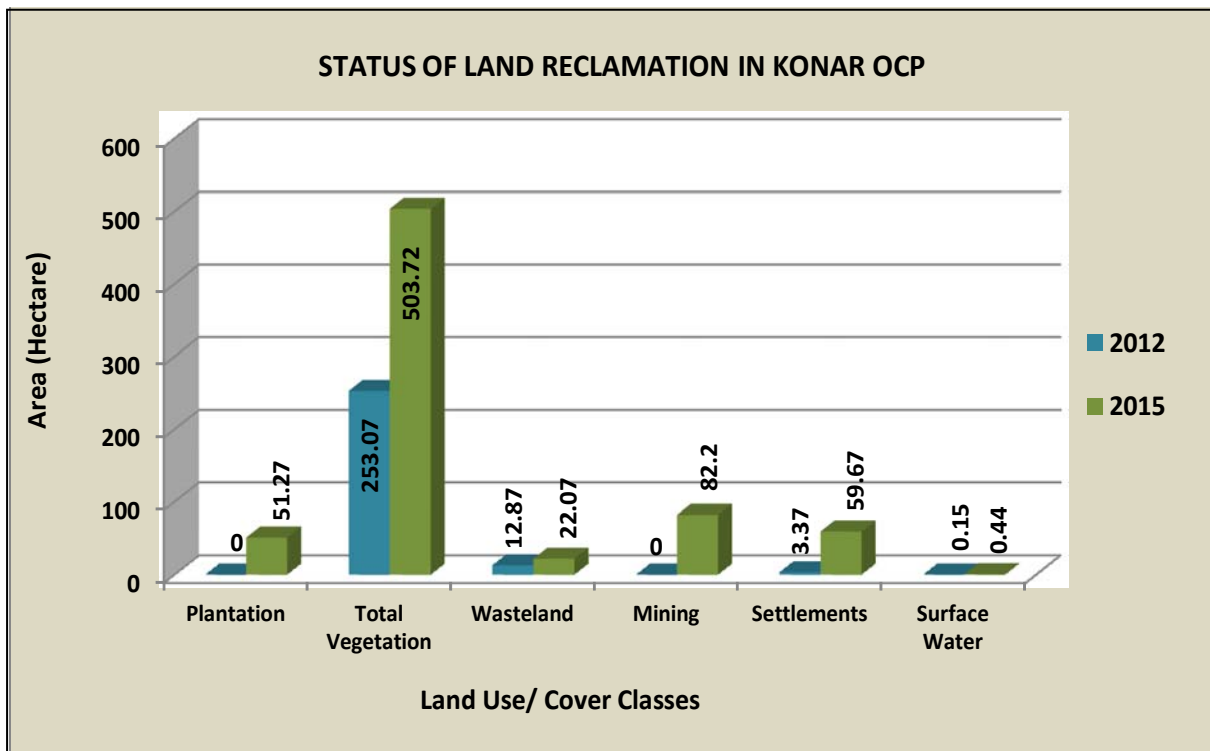


Figure - 12

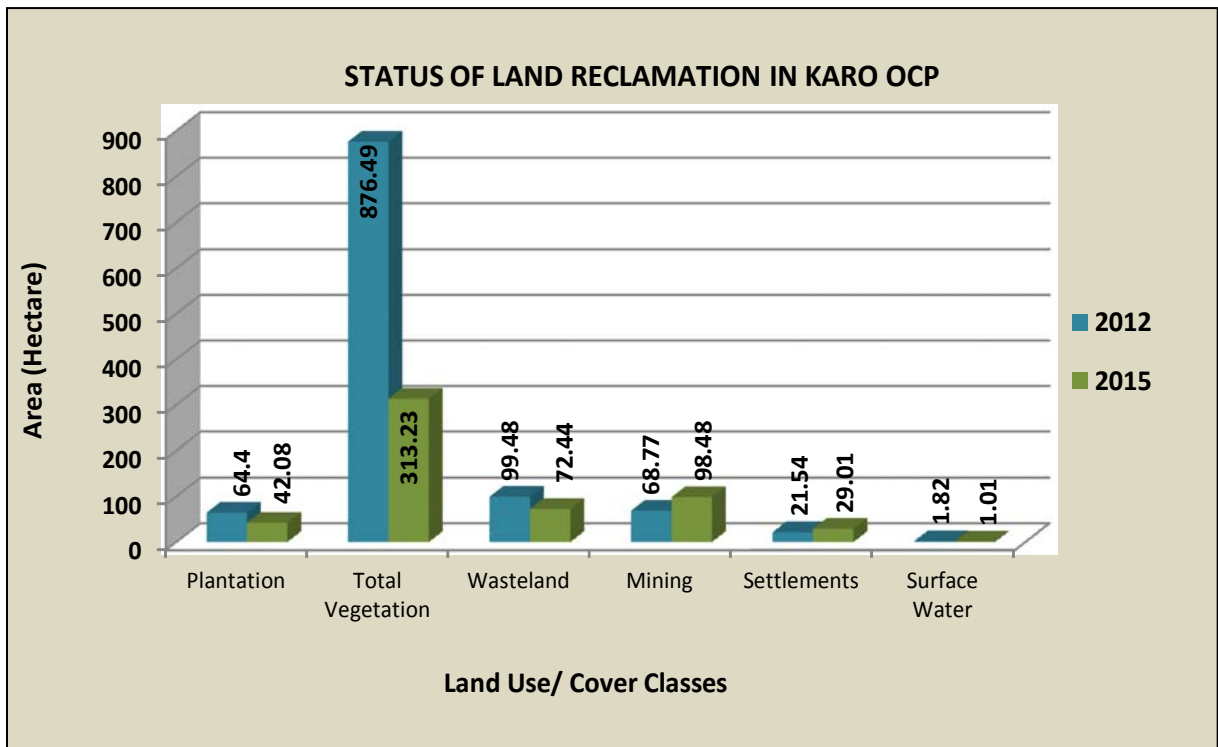


Figure - 13

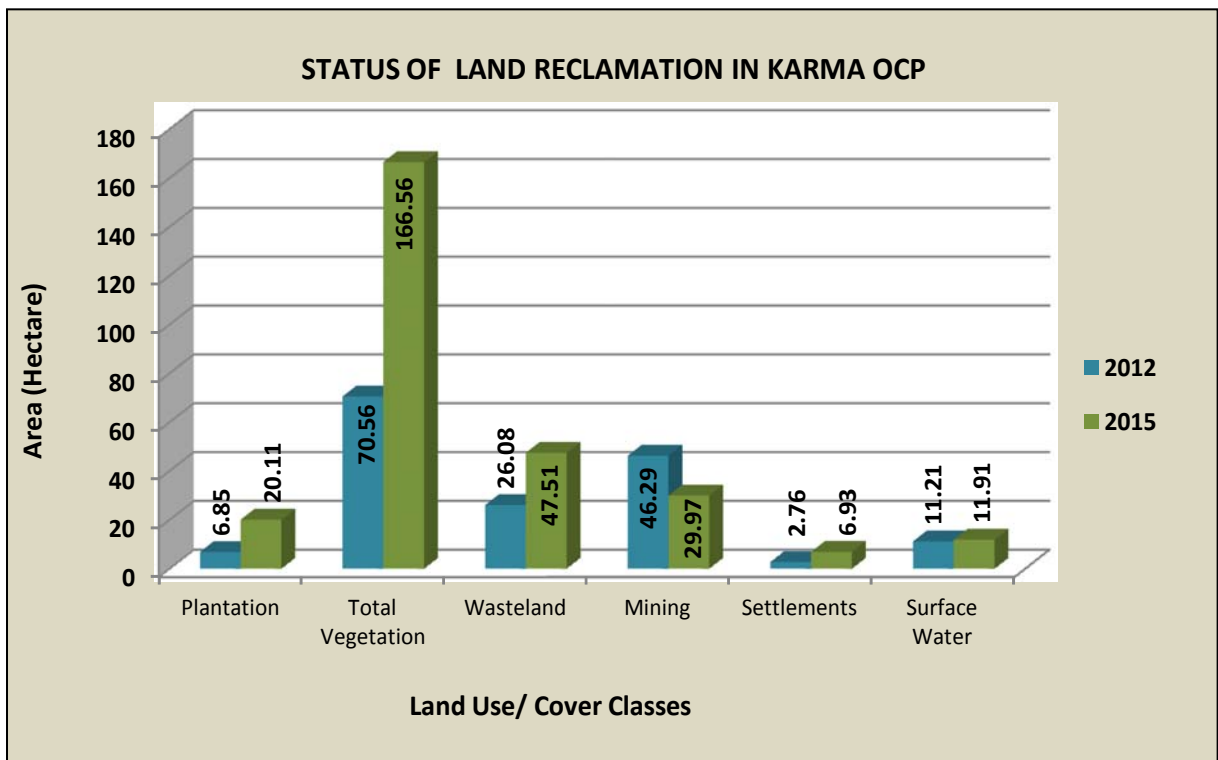


Figure - 14



Photo 1: Quarry site (Teteriakhar OCP)



Photo 2: Plantation on OB Dump (Dakra OCP)



Photo 3: Quarry site (Magadh OCP)



Photo 4: Plantation 2015-16 on OB Dump/Backfill (Amrapali OCP)



Photo 5: Plantation on OB Dump (Pundi OCP)



Photo 6: Plantation on OB Dump (Kedla OCP)



Photo 7: Plantation on Backfill (Jarangdih OCP)



Photo 8: Plantation on OB Dump (Kathara OCP)



Photo 9: Plantation on OB Dump (Karo OCP)



Photo 10: Plantation on Internal OB Dump/Backfill (Karma OCP)



cmpdi
A Mini-Ratna Company

Central Mine Planning & Design Institute Ltd.

(A Subsidiary of Coal India Ltd.)

Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand

Phone : (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851

Website : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in