Land Restoration / Reclamation Monitoring of Open Cast Coal Mines of Mahanadi Coalfields Ltd. Based on Satellite Data for the Year 2010

CMPDI
A Miniratna Company

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Executive Summary

1.0 Project

Land restoration / reclamation monitoring of 11 opencast coal mines of Mahanadi Coalfields Ltd. (MCL) 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 86.36 Km^2 of the 11 opencast projects of MCL viz. Ananata, Balram, Lingaraj, Bharatpur, Bhubaneswari, Jagannath, Hingula, Belpahar, Lakhanpur, Samleswari, Lajkura considered for monitoring during 2010-11; total mined out area is 38.23 Km^2 (44.27%), out of which 13.85 Km^2 area (36.23%) has been planted, 11.04 Km^2 area (28.88%) has been backfilled and 13.34 Km^2 area (34.90%) is under active mining. It is evident from the analysis that 65.11% areas of the OC projects have already been reclaimed and balance 34.90% area is under active mining. Project wise details are given in Table-1 & Fig-1.

- On comparing the status of land reclamation for the year 2010 with respect to the year 2009 in different projects, it is evident from the analysis that area of land reclamation has increased from 17.02 Km^2 (Yr. 2009) to 24.89 Km^2 (Yr.2010). Out of 11 projects of MCL, Lajkura OC ranks on top for land reclamation (76.71%) followed by Lakhanpur (74.10%) and Jagganath (70.20%).

- Area of plantation has increased from 9.47 Km^2 (Yr.2009) to 13.85 Km^2 (Yr.2010) in MCL. This increase in area of plantation is the result of the efforts of the MCL taken up towards environmental protection.

Table - 1

Projectwise Land Reclamation Status in Opencast Projects of MCL based on Satellite Data of the year 2010

Sl. No.	Project		Plantation		Backfill		Active Mining		Total Mined out Area		Total Reclaimed Area	
	Name	Leasehold	(i)		*(ii)*		(iii)		(i+ii+iii)		(i+ii)	
		(i)	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
1	***ANANTA***	4.56	0.78	0.94	0.46	0.83	1.54	1.59	2.79	3.36	1.25	1.77
			28.12	***27.98***	***16.63***	***24.71***	***55.27***	***47.33***			***44.74***	***52.68***
2	***BALRAM***	10.21	1.07	0.92	0.92	1.86	1.66	1.58	3.65	4.36	1.99	2.78
			29.23	***21.11***	***25.26***	***42.67***	***45.52***	***36.24***			***54.49***	***63.77***
3	***LINGRAJ***	7.26	0.63	1.17	0.56	0.99	1.72	1.61	2.91	3.77	1.19	2.16
			21.69	***31.04***	***19.08***	***26.26***	***59.25***	***42.71***			***40.76***	***57.30***
4	***BHARATPUR***	9.43	1.29	2.27	1.44	1.45	1.37	1.98	4.10	5.70	2.74	3.72
			31.49	***39.83***	***35.19***	***43.16***	***33.34***	***58.93***			***66.67***	***65.27***
5	***BHUBANESWARI***	7.33	0.06	0.52	0.16	0.20	0.25	0.33	0.46	1.05	0.22	0.72
			12.07	***49.53***	***34.70***	***19.05***	***53.24***	***31.43***			***46.77***	***68.58***
6	***JAGANNATH***	4.99	1.72	2.02	0.58	0.90	1.70	1.24	3.99	4.16	2.29	2.92
			42.97	***48.56***	***14.40***	***21.64***	***42.64***	***29.81***			***57.37***	***70.20***
7	***HINGULA***	4.83	0.50	0.57	0.27	0.77	1.20	1.12	1.97	2.46	0.76	1.34
			25.30	***23.18***	***13.59***	***31.31***	***61.12***	***45.53***			***38.89***	***54.48***
8	***BELPAHAR***	9.74	1.49	2.13	0.67	0.67	1.39	1.41	3.56	4.21	2.16	2.80
			41.97	***50.60***	***18.86***	***15.92***	***39.18***	***33.50***			***60.83***	***66.51***
9	***LAKHANPUR***	16.20	0.66	1.48	1.13	1.38	1.38	1.00	3.17	3.86	1.78	2.86
			20.73	***38.35***	***35.58***	***35.76***	***43.70***	***25.91***			***56.31***	***74.10***
10	***SAMLESWARI***	7.13	0.88	1.29	0.71	1.18	1.31	1.07	2.90	3.54	1.59	2.47
			30.25	***36.45***	***24.49***	***33.34***	***45.28***	***30.23***			***54.73***	***69.78***
11	***LAJKURA***	4.68	0.41	0.54	0.66	0.81	0.54	0.41	1.61	1.76	1.06	1.35
			25.22	***30.69***	***22.69***	***46.03***	***18.73***	***23.30***			***66.19***	***76.71***
	TOTAL *MCL (11)*	**86.36**	**9.47**	**13.85**	**7.55**	**11.04**	**14.08**	**13.34**	**31.10**	**38.23**	**17.02**	**24.89**
			30.46	***36.23***	***24.29***	***28.88***	***45.27***	***34.90***	***36.01***	***44.27***	***54.74***	***65.11***

Area in Sq.Kms.

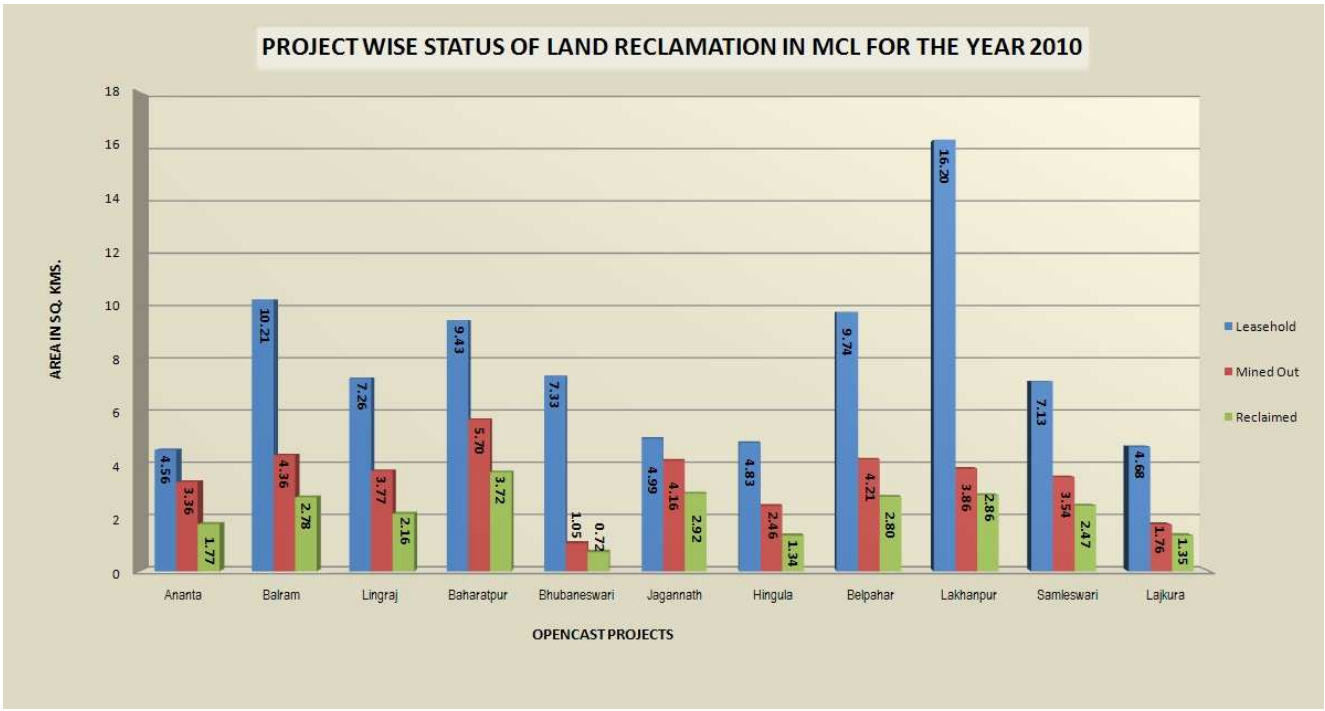


Fig.1: ***Land reclamation status in OC projects of MCL in the year 2010***

1.0 Background

1.1 All human activities are based on the land which is most scarce natural resource in our country. Per capita land availability in India is the lowest owing to high population density and less land mass. Out of total 329 million hectare (mha) land mass of the country, coal mining is limited to only on 0.10% (0.36mha) area. As per XI Plan, to meet the energy demand of the country, coal production would be raised to 680 million tonnes by the end of the year 2011-12 for which about 40,000 hectare of land would have to be acquired for coal mining projects. It has been envisaged that 85% coal production would be from opencast mines, which causes land degradation due to ground breaking. There is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of the coal mining. This will not only mitigate environmental degradation, but would also enable coal companies to offer the restored lands to displaced families which would help in creating a more congenial environment for land acquisition in future.

1.2 Keeping above in view, Coal India Ltd. requested Central Mine Planning & Design Institute (CMPDI), Ranchi who has well equipped remote sensing facilities and capabilities to develop an effective system of surveillance for land reclamation/ restoration for all the opencast coal mines with production of more than 5 million cu. m. per annum (Coal + OB taken together) based remote sensing satellite data, regularly on annual basis for sustainable development of mining operation within command area of CIL and its subsidiaries. The annual land reclamation/restoration status report of all such mines to be put on the website of **CIL**, (www.coalindia.nic.in), **CMPDI** (www.cmpdi.co.in) and the concerned coal companies in public domain. Detail report to be submitted to State Pollution Control Board and MoEF and concerned CIL's subsidiaries. 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.

1.3 Present report is embodying the finding of the study carried out during 2010-11 for the 11 OC projects of Mahanadi Coalfields Limited (MCL). Similar study were taken for the year 2008 an 2009 as well.

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:

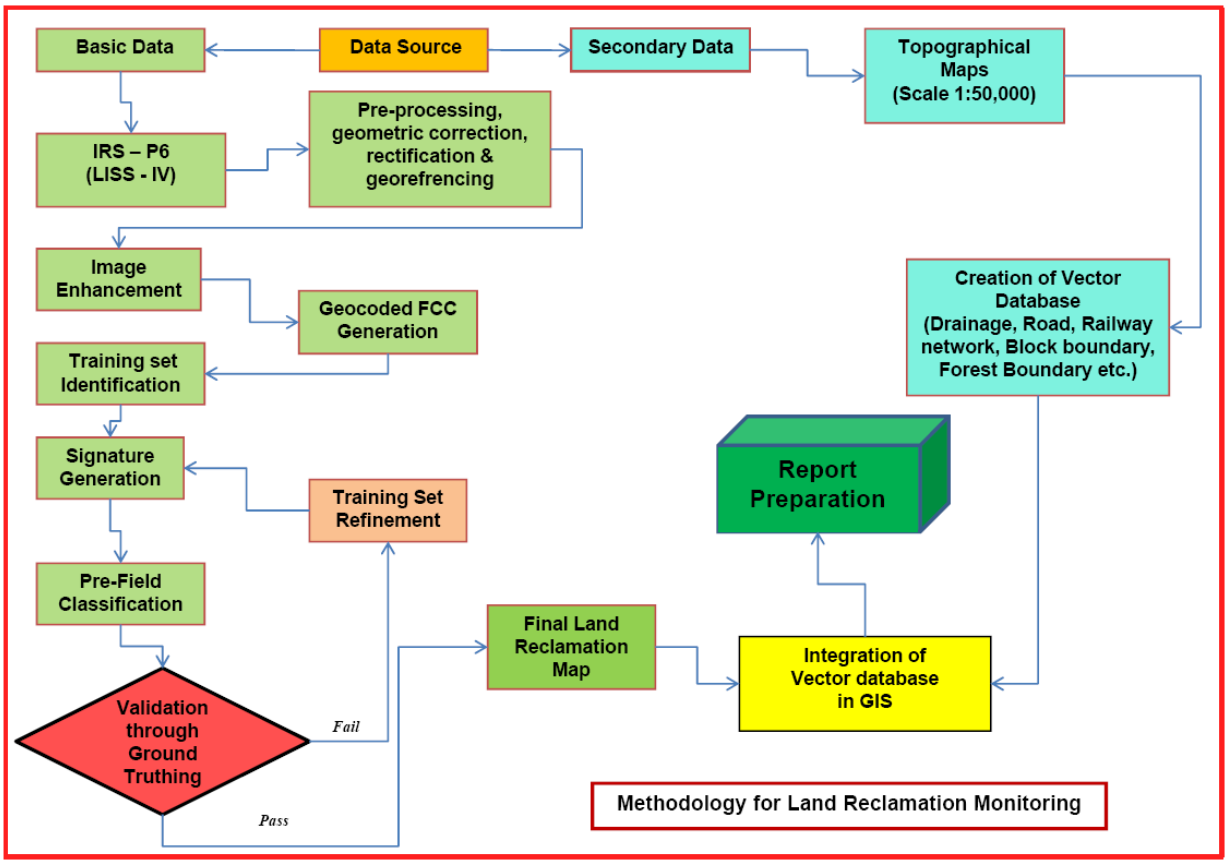


Figure: 1 - ***Methodology for Land Reclamation Monitoring***

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 PCI GEOMATICA / 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, georeferencing is required for correction of image data using ground control points (GCP) to make it compatible to SoI toposheet.

- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using PCI Geomatica / ERDAS IMAGINE 9.3 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 PCI Geomatica v10.1 / ERDAS IMAGINE v. 9.3 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 MCL producing more than 5 million cubic m. (Coal + OB together) during the year 2010 which have been taken up for land restoration / reclamation monitoring based on the *RESOURCESAT-1(L-IV)* satellite data using

ERDAS Imaging digital image processing s/w on GIS platform. Land reclamation monitoring will be carried out regularly on annual basis 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 & MCL in public domain.

5.0 Land Reclamation Status in Mahanadi Coalfields Limited

5.1 Following eleven opencast projects of MCL producing 5 million cubic meter and more (Coal + OB) were taken up for land reclamation monitoring during year 2010-11 based on satellite data of the year 2010.

- Ananata
- Balram
- Lingaraj
- Bharatpur
- Bhubaneswari
- Jagannath
- Hingula
- Belpahar
- Lakhanpur
- Samleswari
- Lajkura

5.2 Area statistics of different land use class present in the mine leasehold of the above projects for the year 2010 are shown in the Table - 5.1. Land use maps derived from satellite data are shown in Plate 5.1 - 5.11. Land reclamation status of the above mentioned 11 projects, were also prepared for the year 2008 and 2009. Year wise changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig.5.1 - 5.11.

5.3 Study reveals that out of total 38.23 Km^2 mined out area; 24.89 Km^2 area (65.11%) has already been reclaimed. Out of which 13.85 Km^2 (36.23%) area has been revegitated and 11.04 Km^2 (28.88%) area are backfilled.

5.4 Analysis of satellite data indicates that area of plantation has increased from 9.47 Km^2 (2009) to 13.85 Km^2 (2010). This increase of 4.38 Km^2 plantation areas in one year indicates that MCL is committed for reclamation of mine land for maintaining the ecological balance in the region.

5.5 On comparing the status of land reclamation for the year 2010 with respect to the year 2009 in different projects, it is evident from the analysis that area of land reclamation has increased from 17.02 Km^2 (Yr. 2009) to 24.89 Km^2 (Yr.2010). Out of 11 projects of MCL, Lajkura OC ranks on top for land reclamation (76.71%) followed by Lakhanpur (74.10%) and Jagannath (70.20%).

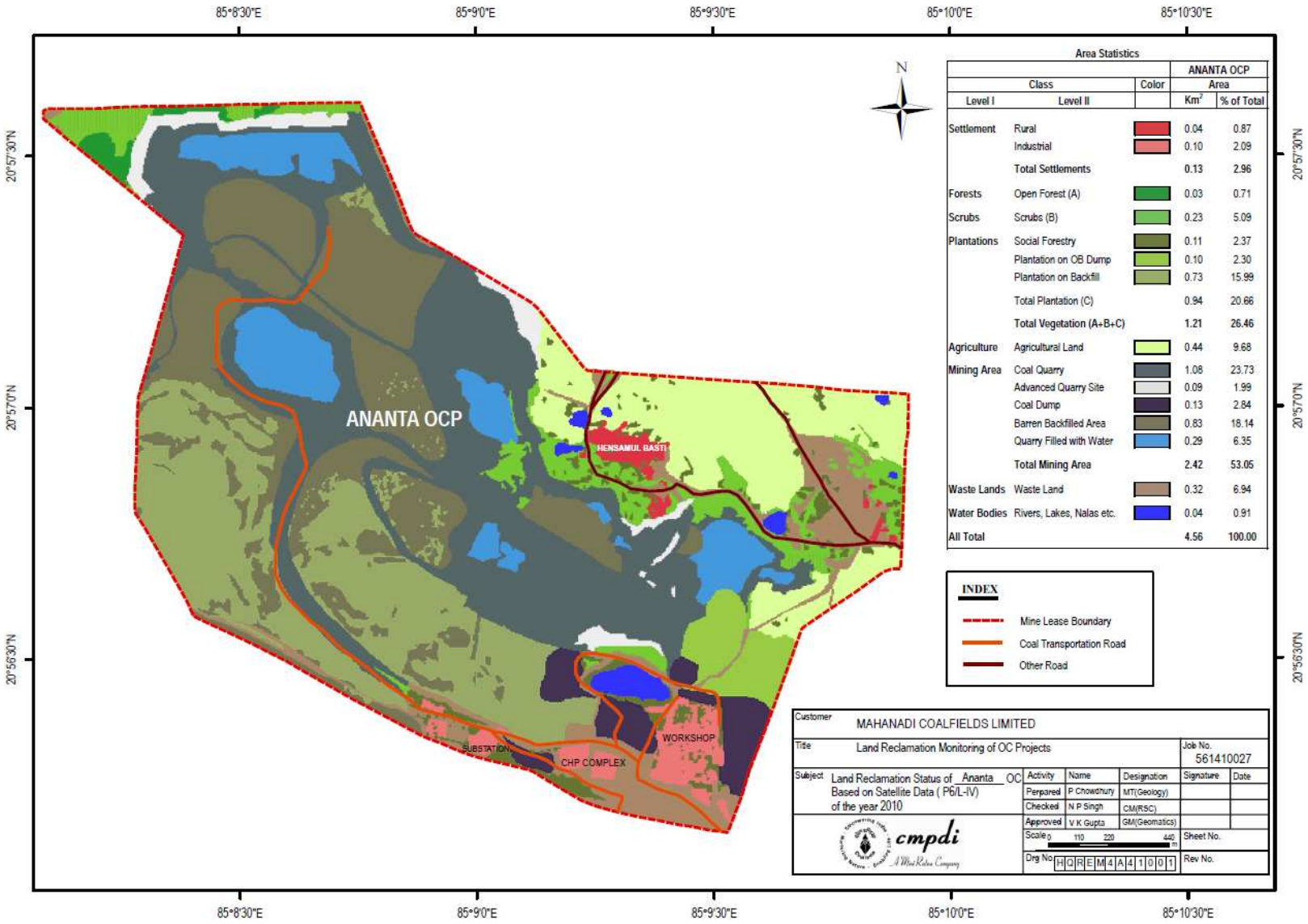
5.6 It has been also observed that in certain projects of MCL viz Ananta, Balram and Hinglua; plantation percentage in the year 2010 has reduced marginally in respect to the previous year i.e. 2009, in spite of increase in plantation area. This has occurred primarily due to increase in total mined out area in those subsidiaries as depicted in Table – 1.

5.7 Out of 11 projects of MCL, Lajkura OC ranks on top for land reclamation (76.71%) followed by Lakhanpur (74.10%) and Jagannath (70.20%).

Table 4.1: STATUS OF LAND RESTORATION / RECLAMATION IN MAHANADI COALFIELD LIMITED BASED ON SATELLITE DATA OF THE YEAR 2010

(Area in Sq. Kms.)

			TALCHER COALFIELDS														IB VALLEY COALFIELDS								Total MCL	
			ANANTA OCP		BALRAM OCP		LINGARAJ OCP		BHARATPUR OCP		BHUBANESWARI OCP		JAGANNATH OCP		HINGULA OCP		BELPAHAR OCP		LAKHANPUR OCP		SAMLESWARI OCP		LAJKURA OCP			
	CLASS	Color	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total	Km²	% of Total
FORESTS	Dense Forest		0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	12.41	0.22	3.09	1.18	25.24	3.45	4.00
	Open Forest		0.03	0.71	0.13	1.24	0.28	3.91	0.81	8.59	1.29	17.60	0.07	1.40	0.00	0.00	0.04	0.41	3.27	20.19	0.46	6.45	0.64	13.69	7.02	8.13
	Total Forest		**0.03**	**0.71**	**0.13**	**1.24**	**0.28**	**3.91**	**0.85**	**9.01**	**1.29**	**17.60**	**0.07**	**1.40**	**0.00**	**0.00**	**0.04**	**0.41**	**5.28**	**32.59**	**0.68**	**9.54**	**1.82**	**38.92**	**10.47**	**12.13**
SCRUBS	**Scrubs (B)**		0.23	5.09	1.95	19.13	1.47	20.28	1.14	12.09	1.07	14.60	0.18	3.61	0.72	14.94	2.39	24.52	2.46	15.16	0.97	13.60	0.51	10.91	13.09	15.16
PLANTATION	Social Forestry		0.11	2.37	0.34	3.35	0.09	1.27	0.37	3.92	0.52	7.09	0.06	1.20	0.18	3.77	0.39	4.01	0.42	2.59	0.16	2.24	0.06	1.26	2.70	3.13
	Plantation on OB Dump		0.10	2.30	0.21	2.09	0.76	10.42	0.83	8.80	0.00	0.00	0.00	0.00	0.16	3.31	0.70	7.19	0.25	1.54	0.47	6.59	0.30	6.42	3.78	4.38
	Plantation on Backfill		0.73	15.99	0.37	3.59	0.33	4.47	1.07	11.35	0.00	0.00	1.96	39.28	0.22	4.63	1.04	10.68	0.81	5.00	0.66	9.26	0.19	3.96	7.37	8.53
	Total Plantation (C)		0.94	20.66	0.92	9.02	1.17	16.16	2.27	24.07	0.52	7.09	2.02	40.48	0.57	11.71	2.13	21.87	1.48	9.14	1.29	18.09	0.54	11.63	13.86	16.05
	Total Vegetation (A+B+C)		**1.21**	**26.46**	**3.00**	**29.40**	**2.93**	**40.34**	**4.26**	**45.17**	**2.88**	**39.29**	**2.27**	**45.49**	**1.29**	**26.65**	**4.56**	**46.81**	**9.22**	**56.89**	**2.94**	**41.23**	**2.87**	**61.46**	**37.42**	**43.34**
AGRICULTURE	**Agricultural Land**		0.44	9.68	2.33	22.85	0.96	13.26	0.63	6.68	3.02	41.20	0.03	0.60	0.70	14.48	0.57	5.85	2.86	17.66	0.41	5.75	0.04	0.86	12.00	13.89
MINING AREA	Coal Quarry		1.08	23.73	0.78	7.62	1.32	18.23	1.15	12.20	0.14	1.91	0.34	6.81	0.32	6.54	1.04	10.68	0.58	3.58	0.78	10.94	0.35	7.49	7.88	9.13
	Advanced Quarry Site		0.09	1.99	0.10	0.95	0.08	1.13	0.05	0.53	0.02	0.27	0.04	0.80	0.01	0.14	0.10	1.03	0.19	1.17	0.06	0.84	0.02	0.43	0.76	0.88
	Coal Dump		0.13	2.84	0.22	2.18	0.21	2.82	0.20	2.12	0.17	2.32	0.23	4.61	0.37	7.61	0.11	1.13	0.11	0.70	0.09	1.26	0.03	0.64	1.87	2.16
	Barren OB dump		0.00	0.00	0.43	4.21	0.39	5.40	0.27	2.86	0.18	2.46	0.00	0.00	0.04	0.89	0.02	0.21	0.02	0.12	0.06	0.84	0.04	0.86	1.46	1.69
	Barren Backfilled Area		0.83	18.14	1.43	13.97	0.60	8.22	1.18	12.51	0.02	0.27	0.90	18.04	0.73	15.13	0.65	6.68	1.36	8.40	1.12	15.71	0.77	16.47	9.58	11.10
	Quarry Filled with Water		0.29	6.35	0.48	4.68	0.00	0.00	0.58	6.15	0.00	0.00	0.63	12.63	0.42	8.73	0.16	1.64	0.12	0.74	0.14	1.96	0.01	0.26	2.83	3.28
	Total Mining Area		**2.42**	**53.05**	**3.44**	**33.62**	**2.60**	**35.82**	**3.43**	**36.37**	**0.53**	**7.23**	**2.14**	**42.89**	**1.89**	**39.04**	**2.08**	**21.36**	**2.38**	**14.72**	**2.25**	**31.56**	**1.22**	**26.13**	**24.37**	**28.23**
WASTELANDS	**Waste Land**		0.32	6.94	0.68	6.70	0.13	1.81	0.70	7.42	0.59	8.05	0.34	6.81	0.73	15.10	1.86	19.14	1.34	8.27	1.24	17.39	0.47	10.05	8.41	9.73
WATER	**Rivers, Lakes, Nalas etc.**		0.04	0.91	0.19	1.87	0.09	1.30	0.14	1.48	0.07	0.95	0.01	0.20	0.13	2.77	0.30	3.08	0.22	1.36	0.08	1.12	0.01	0.21	1.29	1.49
SETTLEMENTS	Rural		0.04	0.87	0.11	1.07	0.03	0.37	0.13	1.38	0.21	2.86	0.00	0.00	0.06	1.32	0.11	1.16	0.11	0.68	0.03	0.42	0.00	0.00	0.83	0.96
	Urban		0.00	0.87	0.02	0.18	0.42	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.52
	Industrial		0.10	2.09	0.43	4.21	0.09	1.30	0.14	1.48	0.03	0.41	0.20	4.01	0.03	0.62	0.24	2.46	0.07	0.43	0.18	2.52	0.06	1.28	1.57	1.82
	Total Settlements		**0.13**	**2.96**	**0.56**	**5.46**	**0.54**	**7.47**	**0.27**	**2.86**	**0.24**	**3.27**	**0.20**	**4.01**	**0.09**	**1.94**	**0.37**	**3.75**	**0.18**	**1.11**	**0.21**	**2.95**	**0.06**	**1.28**	**2.85**	**3.30**
	GRAND TOTAL		**4.56**	**100.00**	**10.21**	**99.90**	**7.26**	**100.00**	**9.43**	**100.00**	**7.33**	**100.00**	**4.99**	**100.00**	**4.83**	**100.00**	**9.74**	**100.00**	**16.20**	**100.00**	**7.13**	**100.00**	**4.68**	**100.00**	**86.35**	**100.00**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85°9'0"E
85°9'30"E
85°10'0"E
85°10'30"E
20°57'30"N
20°57'0"N
20°56'30"N
N
ANANTA OCP
HENSAMUL BASTI
WORKSHOP
CHP COMPLEX
SUBSTATION
Area Statistics
ANANTA OCP
Class
Color
Area
Level I
Level II
Km²
% of Total
Settlement
Rural
0.04
0.87
Industrial
0.10
2.09
Total Settlements
0.13
2.96
Forests
Open Forest (A)
0.03
0.71
Scrubs
Scrubs (B)
0.23
5.09
Plantations
Social Forestry
0.11
2.37
Plantation on OB Dump
0.10
2.30
Plantation on Backfill
0.73
15.99
Total Plantation (C)
0.94
20.66
Total Vegetation (A+B+C)
1.21
26.46
Agriculture
Agricultural Land
0.44
9.68
Mining Area
Coal Quarry
1.08
23.73
Advanced Quarry Site
0.09
1.99
Coal Dump
0.13
2.84
Barren Backfilled Area
0.83
18.14
Quarry Filled with Water
0.29
6.35
Total Mining Area
2.42
53.05
Waste Lands
Waste Land
0.32
6.94
Water Bodies
Rivers, Lakes, Nalas etc.
0.04
0.91
All Total
4.56
100.00
INDEX
Mine Lease Boundary
Coal Transportation Road
Other Road
Customer
MAHANADI COALFIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Ananta OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity
Name
Designation
Signature
Date
Prepared
P Chowdhury
MT(Geology)
Checked
N P Singh
CM(RSC)
Approved
V K Gupta
GM(Geomatics)
cmpdi
A Mini Ratna Company
Scale
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440
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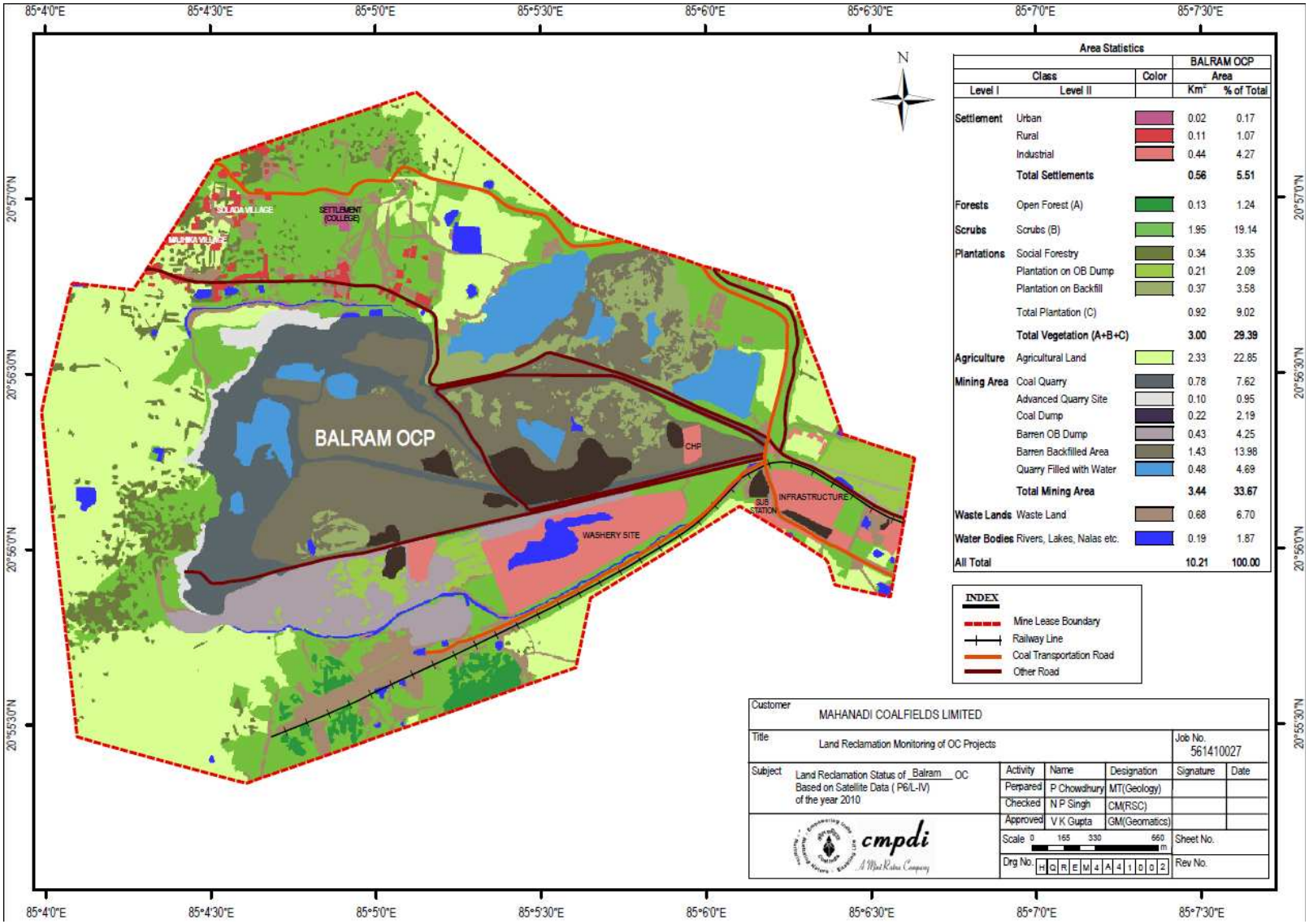
Sheet No.
Drg No
HQREM4A41001
Rev No.

Plate 5.1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BALRAM OCP
SETTLEMENT (COLLEGE)
SOLADA VILLAGE
MUDIBIKA VILLAGE
CHP
SUB STATION
INFRASTRUCTURE
WASHERY SITE
Area Statistics
BALRAM OCP
Class
Level I
Level II
Color
Area
Km²
% of Total
Settlement Urban 0.02 0.17
Rural 0.11 1.07
Industrial 0.44 4.27
Total Settlements 0.56 5.51
Forests Open Forest (A) 0.13 1.24
Scrubs Scrubs (B) 1.95 19.14
Plantations Social Forestry 0.34 3.35
Plantation on OB Dump 0.21 2.09
Plantation on Backfill 0.37 3.58
Total Plantation (C) 0.92 9.02
Total Vegetation (A+B+C) 3.00 29.39
Agriculture Agricultural Land 2.33 22.85
Mining Area Coal Quarry 0.78 7.62
Advanced Quarry Site 0.10 0.95
Coal Dump 0.22 2.19
Barren OB Dump 0.43 4.25
Barren Backfilled Area 1.43 13.98
Quarry Filled with Water 0.48 4.69
Total Mining Area 3.44 33.67
Waste Lands Waste Land 0.68 6.70
Water Bodies Rivers, Lakes, Nalas etc. 0.19 1.87
All Total 10.21 100.00
INDEX
Mine Lease Boundary
Railway Line
Coal Transportation Road
Other Road
Customer MAHANADI COALFIELDS LIMITED
Title Land Reclamation Monitoring of OC Projects
Job No. 561410027
Subject Land Reclamation Status of _Balram__ OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity Name Designation Signature Date
Perpared P Chowdhury MT(Geology)
Checked N P Singh CM(RSC)
Approved V K Gupta GM(Geomatics)
cmpdi
A Miniratna Company
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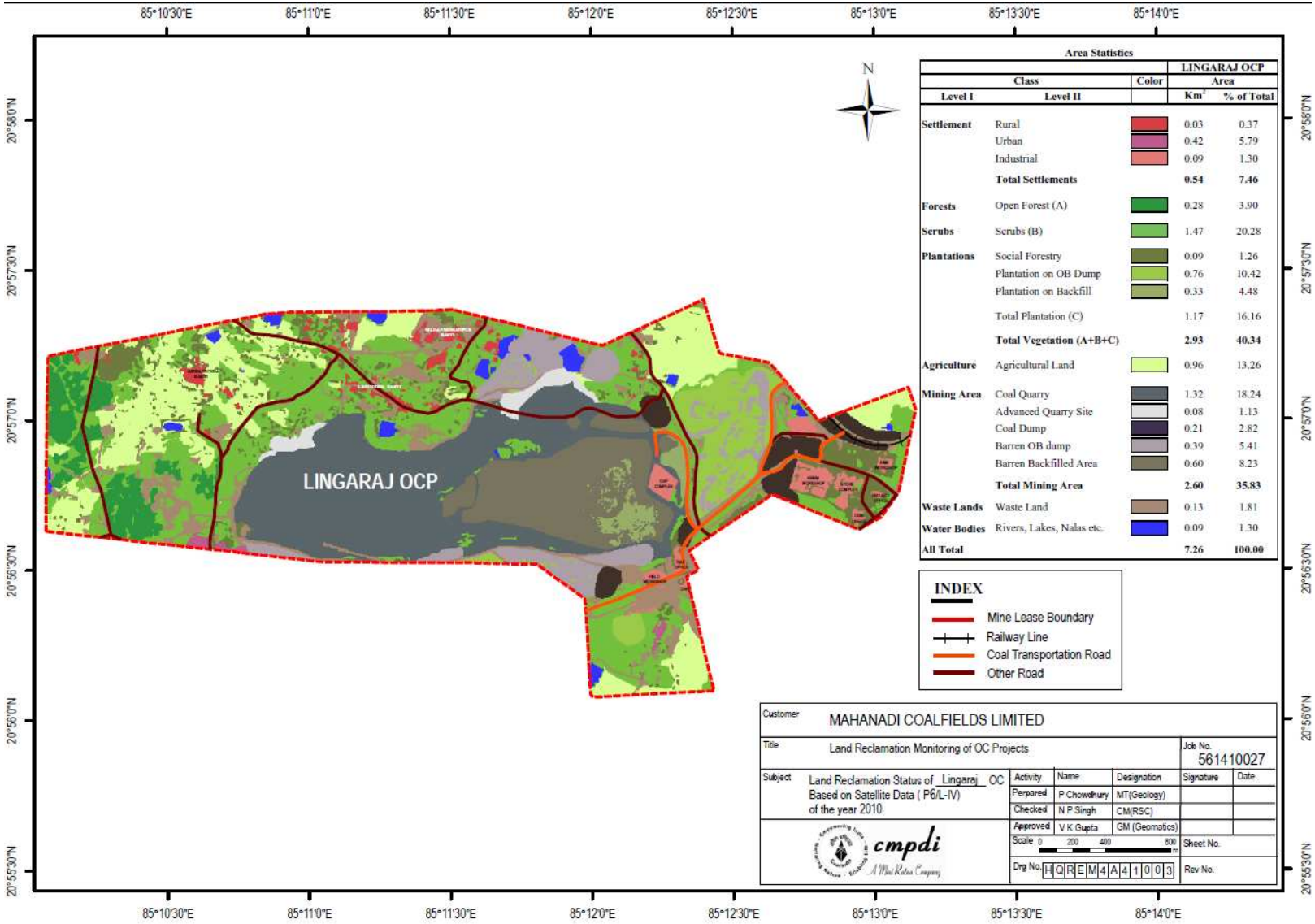
Drg No. HQREM4A4100 2
Rev No.

Plate 5.2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LINGARAJ OCP
Area Statistics
LINGARAJ OCP
Class
Color
Area
Level I
Level II
Km²
% of Total
Settlement
Rural 0.03 0.37
Urban 0.42 5.79
Industrial 0.09 1.30
Total Settlements 0.54 7.46
Forests
Open Forest (A) 0.28 3.90
Scrubs
Scrubs (B) 1.47 20.28
Plantations
Social Forestry 0.09 1.26
Plantation on OB Dump 0.76 10.42
Plantation on Backfill 0.33 4.48
Total Plantation (C) 1.17 16.16
Total Vegetation (A+B+C) 2.93 40.34
Agriculture
Agricultural Land 0.96 13.26
Mining Area
Coal Quarry 1.32 18.24
Advanced Quarry Site 0.08 1.13
Coal Dump 0.21 2.82
Barren OB dump 0.39 5.41
Barren Backfilled Area 0.60 8.23
Total Mining Area 2.60 35.83
Waste Lands
Waste Land 0.13 1.81
Water Bodies
Rivers, Lakes, Nalas etc. 0.09 1.30
All Total 7.26 100.00
INDEX
Mine Lease Boundary
Railway Line
Coal Transportation Road
Other Road
Customer
MAHANADI COALFIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Lingaraj OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity
Name
Designation
Signature
Date
Prepared
P Chowdhury
MT(Geology)
Checked
N P Singh
CM(RSC)
Approved
V K Gupta
GM (Geomatics)
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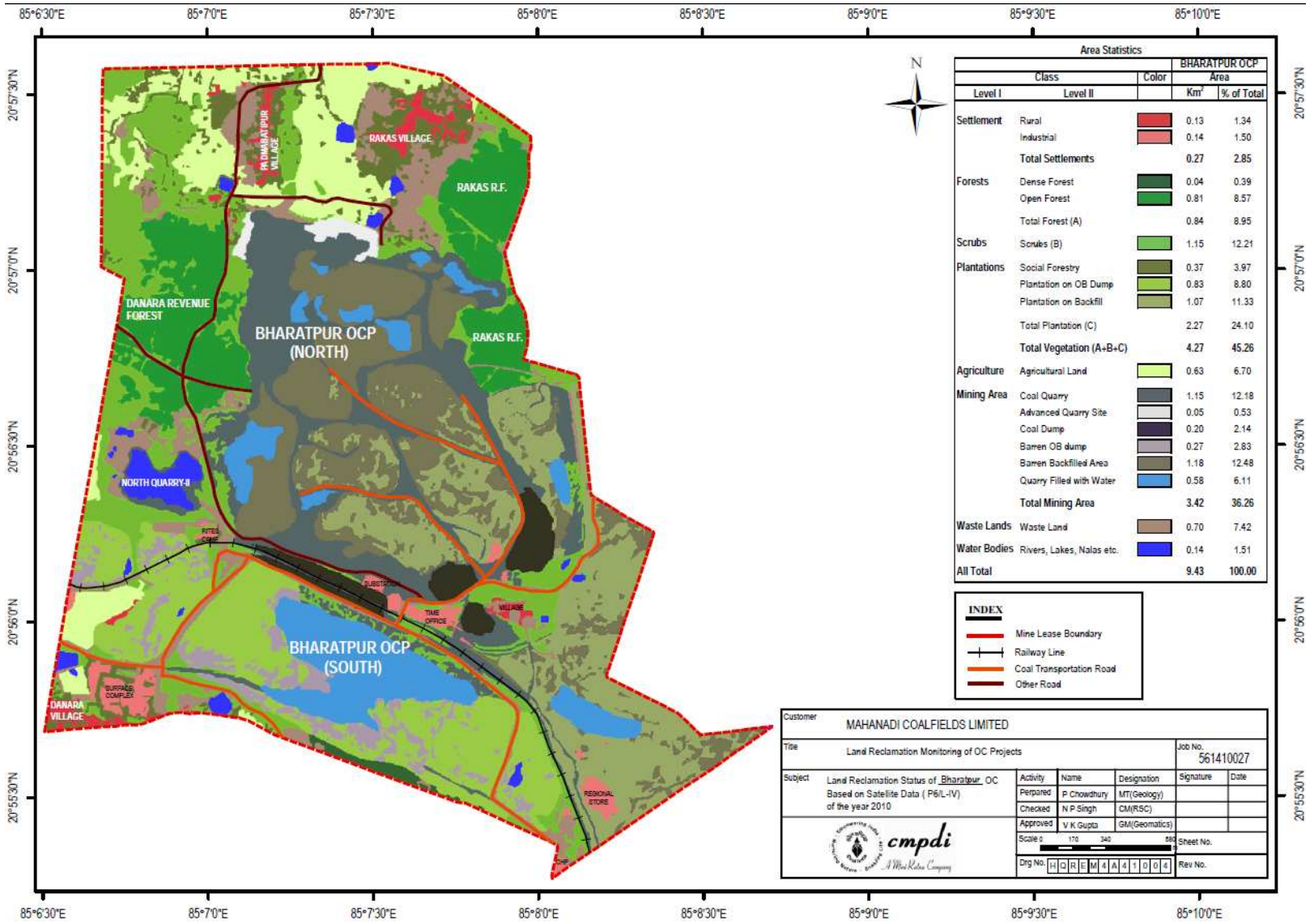
Drg No. HQREM4A41003
Rev No.
cmpdi
A Mini Ratna Company

Plate 5.3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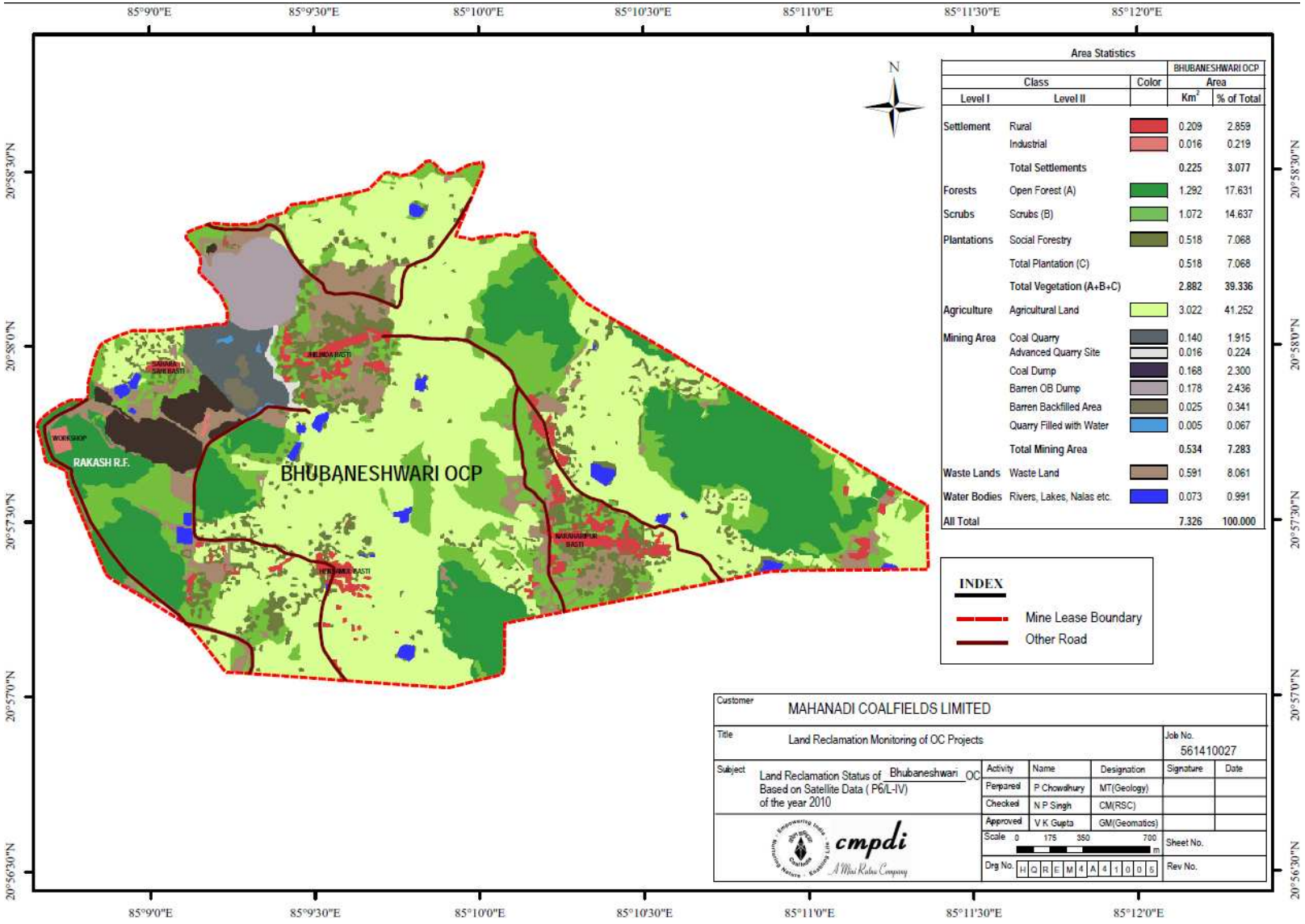
RAKAS VILLAGE
R DHARATPUR VILLAGE
RAKAS R.F.
DANARA REVENUE FOREST
BHARATPUR OCP (NORTH)
RAKAS R.F.
NORTH QUARRY-II
RITES CAMP
SUBSTATION
TIME OFFICE
VILLAGE
BHARATPUR OCP (SOUTH)
DANARA VILLAGE
SURFACE COMPLEX
REGIONAL STORE
DUMP
Area Statistics
BHARATPUR OCP
Class
Color
Area
Level I
Level II
Km²
% of Total
Settlement
Rural 0.13 1.34
Industrial 0.14 1.50
Total Settlements 0.27 2.85
Forests
Dense Forest 0.04 0.39
Open Forest 0.81 8.57
Total Forest (A) 0.84 8.95
Scrubs
Scrubs (B) 1.15 12.21
Plantations
Social Forestry 0.37 3.97
Plantation on OB Dump 0.83 8.80
Plantation on Backfill 1.07 11.33
Total Plantation (C) 2.27 24.10
Total Vegetation (A+B+C) 4.27 45.26
Agriculture
Agricultural Land 0.63 6.70
Mining Area
Coal Quarry 1.15 12.18
Advanced Quarry Site 0.05 0.53
Coal Dump 0.20 2.14
Barren OB dump 0.27 2.83
Barren Backfilled Area 1.18 12.48
Quarry Filled with Water 0.58 6.11
Total Mining Area 3.42 36.26
Waste Lands
Waste Land 0.70 7.42
Water Bodies
Rivers, Lakes, Nalas etc. 0.14 1.51
All Total 9.43 100.00
INDEX
Mine Lease Boundary
Railway Line
Coal Transportation Road
Other Road
Customer
MAHANADI COALFIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Bharatpur OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity
Name
Designation
Signature
Date
Perpared
P Chowdhury
MT(Geology)
Checked
N P Singh
CM(RSC)
Approved
V K Gupta
GM(Geomatics)
cmpdi
A Mini Ratna Company
Scale 0 170 340 680
Sheet No.
Drg No. HQREM44A41004
Rev No.

Plate 5.4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BHUBANESHWARI OCP
RAKASH R.F.
Area Statistics
BHUBANESHWARI OCP
Class
Color
Area
Level I
Level II
Km²
% of Total
Settlement Rural 0.209 2.859
Industrial 0.016 0.219
Total Settlements 0.225 3.077
Forests Open Forest (A) 1.292 17.631
Scrubs Scrubs (B) 1.072 14.637
Plantations Social Forestry 0.518 7.068
Total Plantation (C) 0.518 7.068
Total Vegetation (A+B+C) 2.882 39.336
Agriculture Agricultural Land 3.022 41.252
Mining Area Coal Quarry 0.140 1.915
Advanced Quarry Site 0.016 0.224
Coal Dump 0.168 2.300
Barren OB Dump 0.178 2.436
Barren Backfilled Area 0.025 0.341
Quarry Filled with Water 0.005 0.067
Total Mining Area 0.534 7.283
Waste Lands Waste Land 0.591 8.061
Water Bodies Rivers, Lakes, Nalas etc. 0.073 0.991
All Total 7.326 100.000
INDEX
Mine Lease Boundary
Other Road
Customer
MAHANADI COALFIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Bhubaneshwari OC
Based on Satellite Data (P6/L-IV)
of the year 2010
Activity
Name
Designation
Signature
Date
Prepared
P Chowdhury
MT(Geology)
Checked
N P Singh
CM(RSC)
Approved
V K Gupta
GM(Geomatics)
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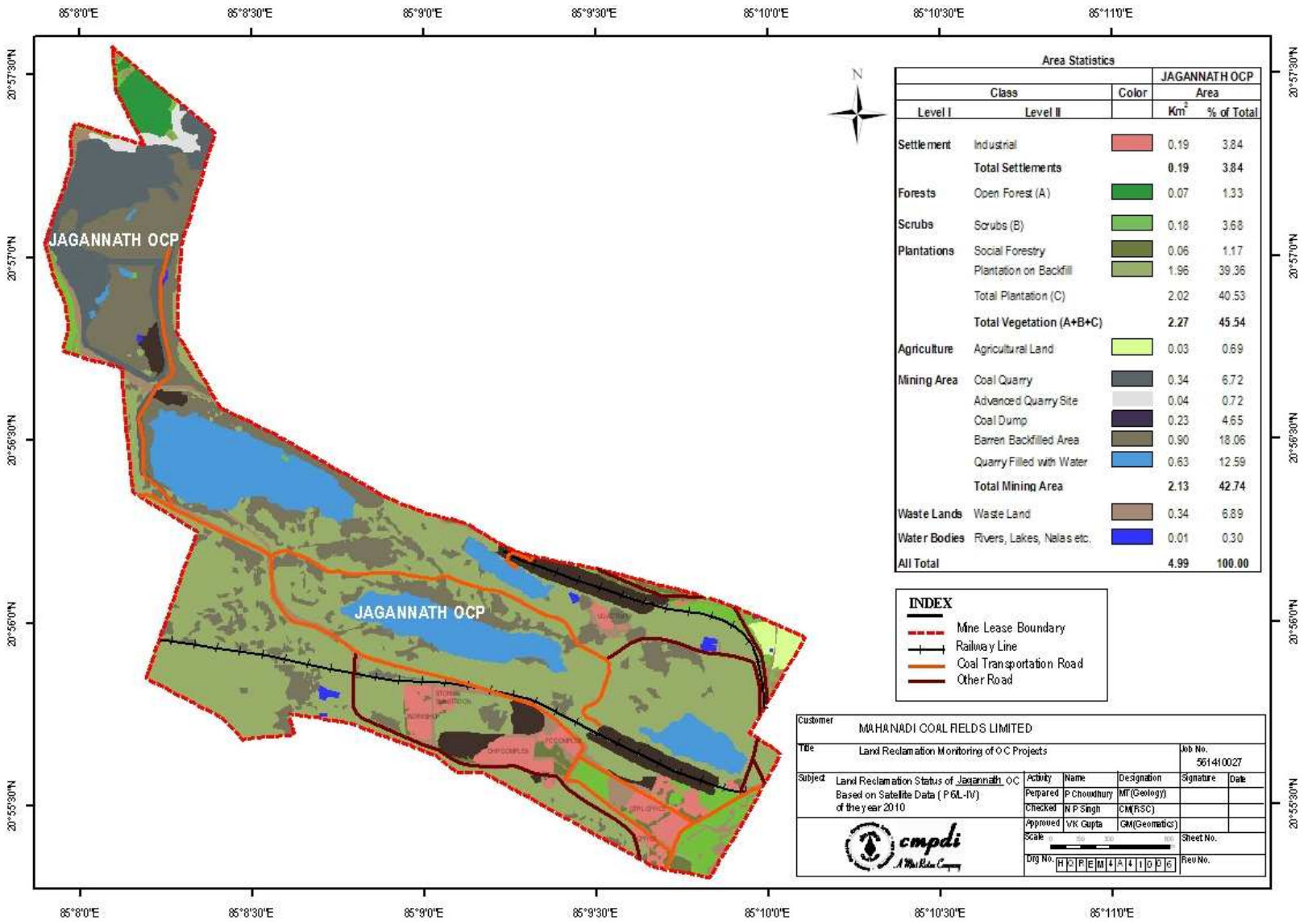
Drg No. HQRCM4A4100 5
Rev No.
cmpdi
A Mini Ratna Company

Plate 5.5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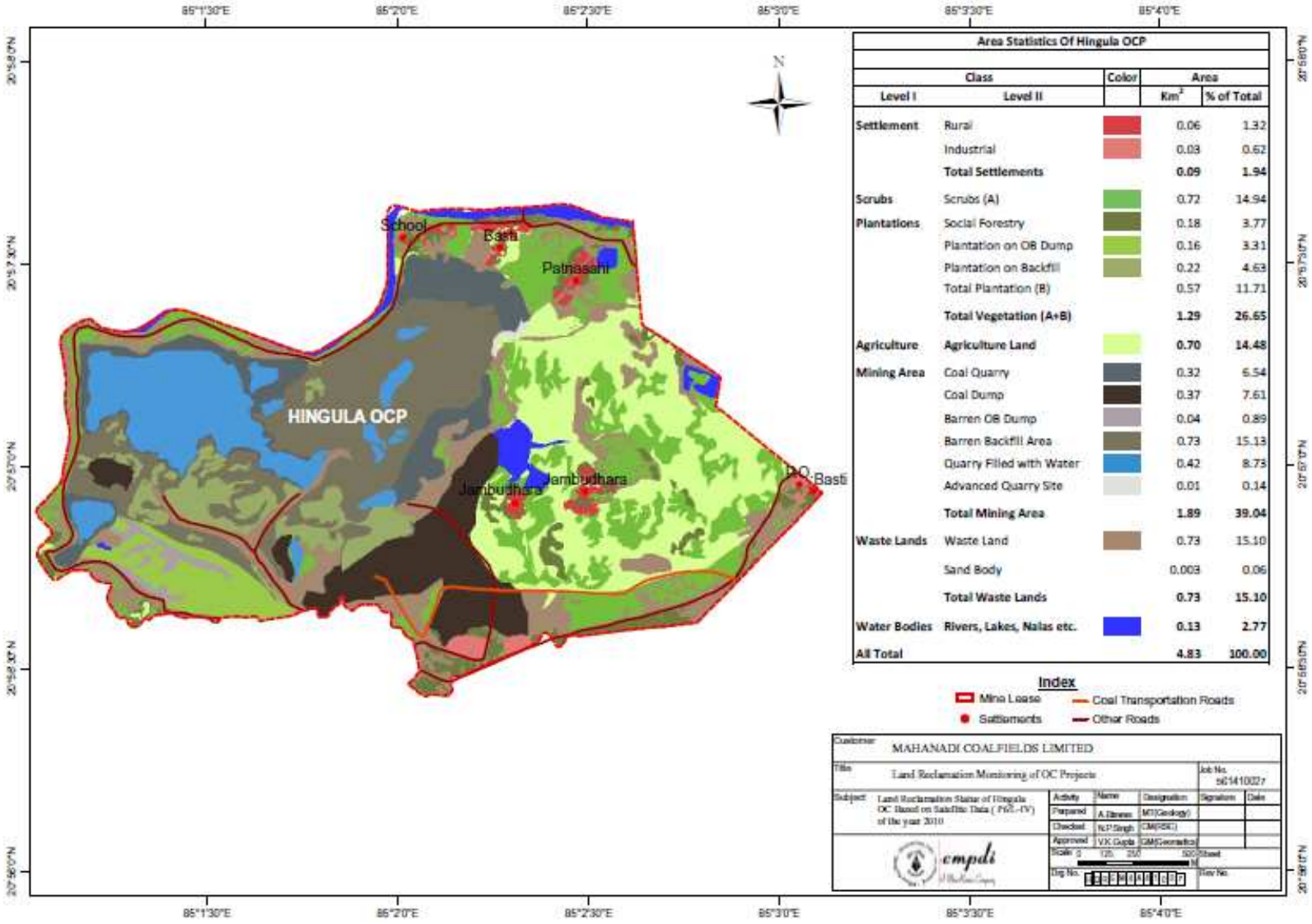
JAGANNATH OCP
JAGANNATH OCP
Area Statistics
JAGANNATH OCP
Class
Color
Area
Level I
Level II
Km2
% of Total
Settlement
Industrial
0.19
3.84
Total Settlements
0.19
3.84
Forests
Open Forest (A)
0.07
1.33
Scrubs
Scrubs (B)
0.18
3.68
Plantations
Social Forestry
0.06
1.17
Plantation on Backfill
1.96
39.36
Total Plantation (C)
2.02
40.53
Total Vegetation (A+B+C)
2.27
45.54
Agriculture
Agricultural Land
0.03
0.69
Mining Area
Coal Quarry
0.34
6.72
Advanced Quarry Site
0.04
0.72
Coal Dump
0.23
4.65
Barren Backfilled Area
0.90
18.06
Quarry Filled with Water
0.63
12.59
Total Mining Area
2.13
42.74
Waste Lands
Waste Land
0.34
6.89
Water Bodies
Rivers, Lakes, Nalas etc.
0.01
0.30
All Total
4.99
100.00
INDEX
Mine Lease Boundary
Railway Line
Coal Transportation Road
Other Road
Customer
MAHANADI COAL FIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Jagannath OC Based on Satellite Data (P6L-IV) of the year 2010
Activity
Name
Designation
Signature
Date
Perpared
P Choudhury
MT(Geology)
Checked
N P Singh
CM(RSC)
Approved
V K Gupta
GM(Geomatics)
Scale
Sheet No.
Drg No.
H Q P E M 4 A 4 1 0 0 6
Rev No.
cmpdi

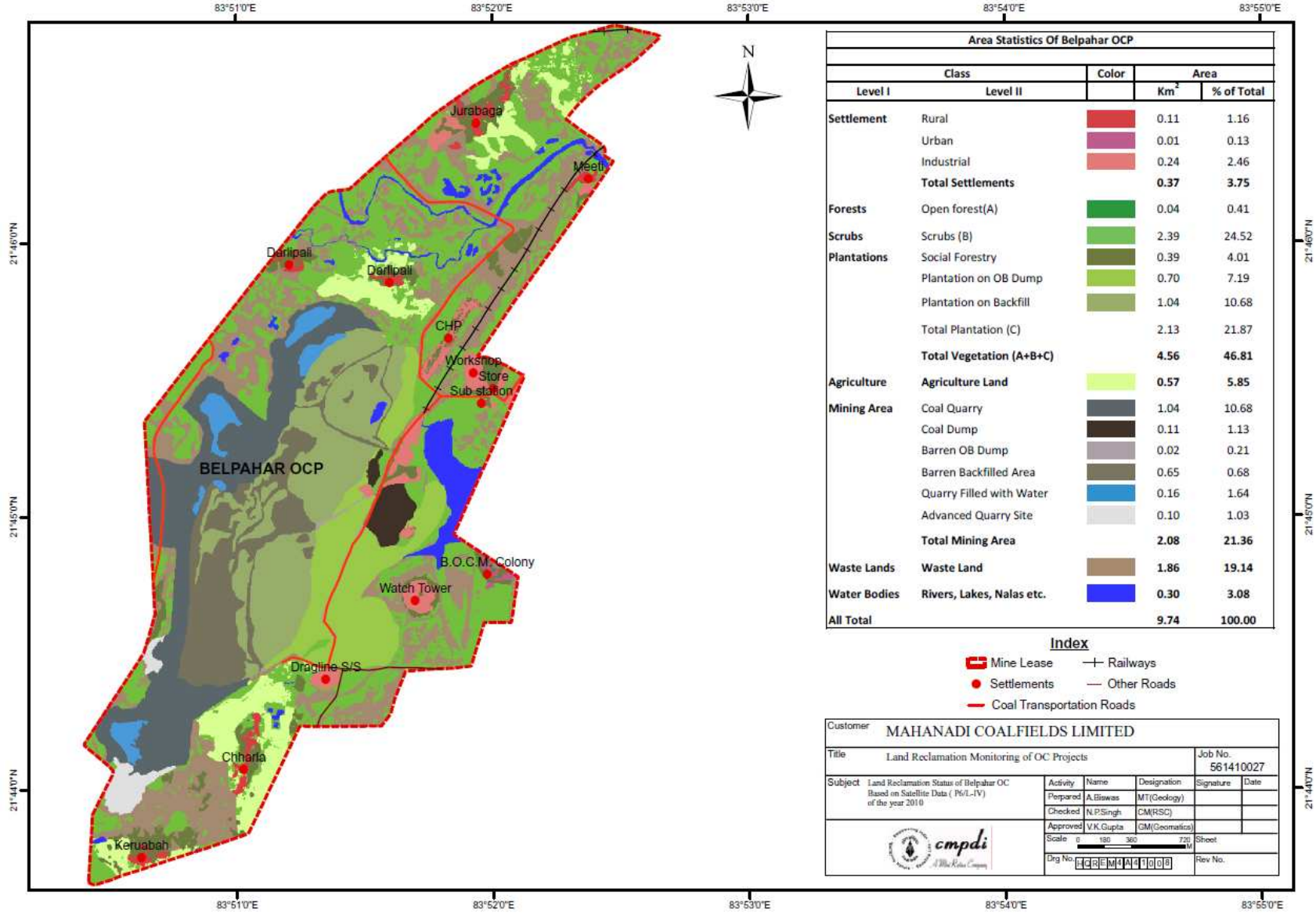
Plate 5.6



Area Statistics Of Hingula OCP

Class		Color	Area	
Level I	Level II		Km²	% of Total
Settlement	Rural		0.06	1.32
	Industrial		0.03	0.62
	Total Settlements		**0.09**	**1.94**
Scrubs	Scrubs (A)		0.72	14.94
Plantations	Social Forestry		0.18	3.77
	Plantation on OB Dump		0.16	3.31
	Plantation on Backfill		0.22	4.63
	Total Plantation (B)		0.57	11.71
	Total Vegetation (A+B)		**1.29**	**26.65**
Agriculture	**Agriculture Land**		**0.70**	**14.48**
Mining Area	Coal Quarry		0.32	6.54
	Coal Dump		0.37	7.61
	Barren OB Dump		0.04	0.89
	Barren Backfill Area		0.73	15.13
	Quarry Filled with Water		0.42	8.75
	Advanced Quarry Site		0.01	0.14
	Total Mining Area		**1.89**	**39.04**
Waste Lands	Waste Land		0.73	15.10
	Sand Body		0.003	0.06
	Total Waste Lands		**0.73**	**15.10**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**0.13**	**2.77**
All Total			**4.83**	**100.00**

Plate 5.7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Meeti
Darlipali
Darlipali
CHP
Workshop
Store
Sub station
BELPAHAR OCP
B.O.C.M. Colony
Watch Tower
Dragline S/S
Chharla
Keruabah
Area Statistics Of Belpahar OCP
Class
Color
Area
Level I
Level II
Km²
% of Total
Settlement
Rural
0.11
1.16
Urban
0.01
0.13
Industrial
0.24
2.46
Total Settlements
0.37
3.75
Forests
Open forest(A)
0.04
0.41
Scrubs
Scrubs (B)
2.39
24.52
Plantations
Social Forestry
0.39
4.01
Plantation on OB Dump
0.70
7.19
Plantation on Backfill
1.04
10.68
Total Plantation (C)
2.13
21.87
Total Vegetation (A+B+C)
4.56
46.81
Agriculture
Agriculture Land
0.57
5.85
Mining Area
Coal Quarry
1.04
10.68
Coal Dump
0.11
1.13
Barren OB Dump
0.02
0.21
Barren Backfilled Area
0.65
0.68
Quarry Filled with Water
0.16
1.64
Advanced Quarry Site
0.10
1.03
Total Mining Area
2.08
21.36
Waste Lands
Waste Land
1.86
19.14
Water Bodies
Rivers, Lakes, Nalas etc.
0.30
3.08
All Total
9.74
100.00
Index
Mine Lease
Railways
Settlements
Other Roads
Coal Transportation Roads
Customer
MAHANADI COALFIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Belpahar OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity
Name
Designation
Signature
Date
Perpared
A.Biswas
MT(Geology)
Checked
N.P.Singh
CM(RSC)
Approved
V.K.Gupta
GM(Geomatics)
Scale
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Sheet
Drg No.
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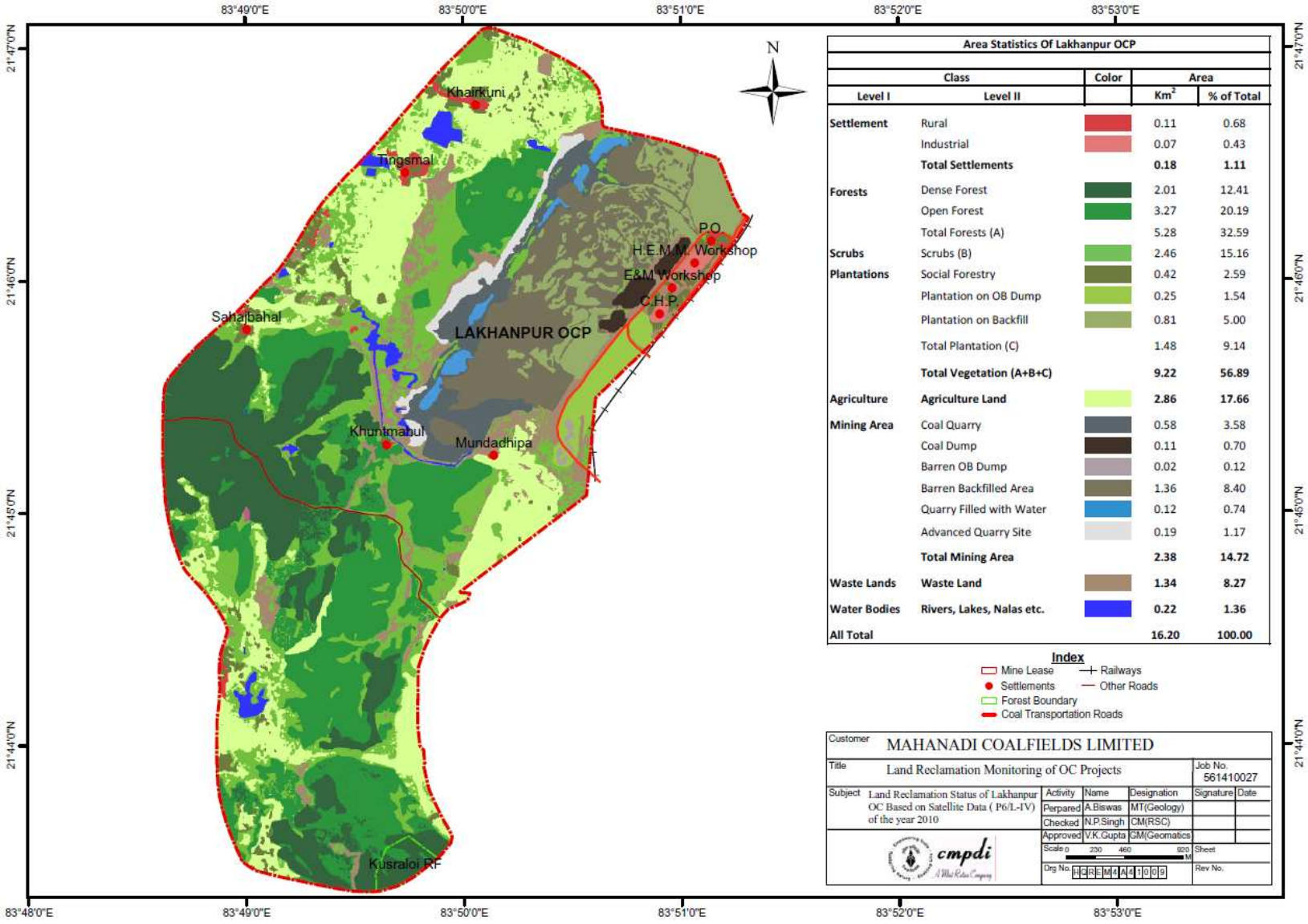
Rev No.

Plate 5.8



Area Statistics Of Lakhanpur OCP

Class		Color	Area	
Level I	Level II		Km²	% of Total
Settlement	Rural		0.11	0.68
	Industrial		0.07	0.43
	Total Settlements		**0.18**	**1.11**
Forests	Dense Forest		2.01	12.41
	Open Forest		3.27	20.19
	Total Forests (A)		5.28	32.59
Scrubs	Scrubs (B)		2.46	15.16
Plantations	Social Forestry		0.42	2.59
	Plantation on OB Dump		0.25	1.54
	Plantation on Backfill		0.81	5.00
	Total Plantation (C)		1.48	9.14
	Total Vegetation (A+B+C)		**9.22**	**56.89**
Agriculture	**Agriculture Land**		**2.86**	**17.66**
Mining Area	Coal Quarry		0.58	3.58
	Coal Dump		0.11	0.70
	Barren OB Dump		0.02	0.12
	Barren Backfilled Area		1.36	8.40
	Quarry Filled with Water		0.12	0.74
	Advanced Quarry Site		0.19	1.17
	Total Mining Area		**2.38**	**14.72**
Waste Lands	**Waste Land**		**1.34**	**8.27**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**0.22**	**1.36**
All Total			**16.20**	**100.00**

Index

- Mine Lease
- Railways
- Settlements
- Other Roads
- Forest Boundary
- Coal Transportation Roads

Customer	MAHANADI COALFIELDS LIMITED				
Title	Land Reclamation Monitoring of OC Projects			Job No. 561410027	
Subject	Land Reclamation Status of Lakhanpur OC Based on Satellite Data (P6/L-IV) of the year 2010	Activity	Name	Designation	Signature / Date
		Perpared	A.Biswas	MT(Geology)	
		Checked	N.P.Singh	CM(RSC)	
		Approved	V.K.Gupta	GM(Geomatics	
	cmpdi	Scale 0 230 460 920 M		Sheet	
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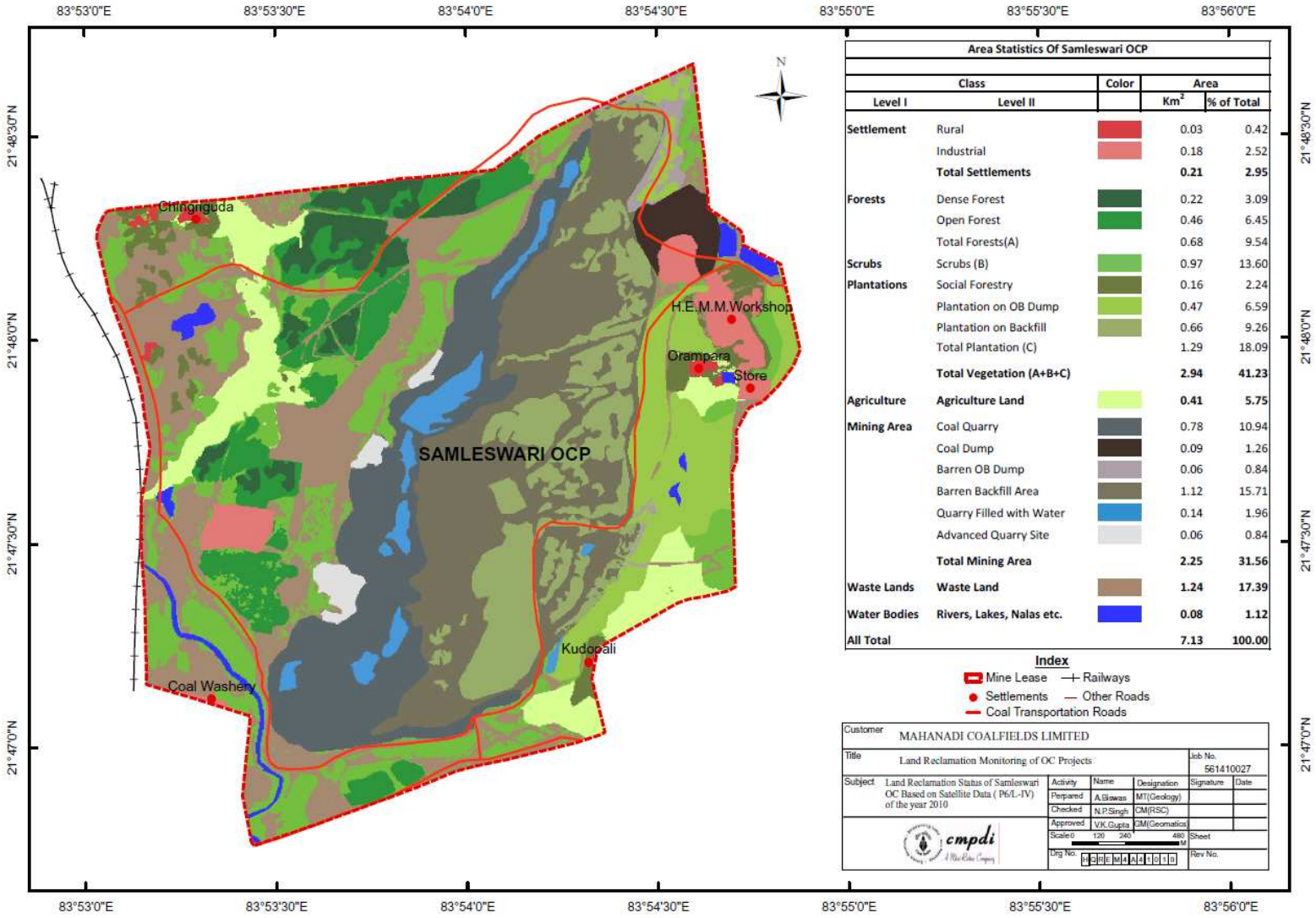
Plate 5.9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N
Chingriguda
H.E.M.M.Workshop
Orampara
Store
SAMLESWARI OCP
Kudopali
Coal Washery
Area Statistics Of Samleswari OCP
Class
Color
Area
Level I
Level II
Km²
% of Total
Settlement
Rural
0.03
0.42
Industrial
0.18
2.52
Total Settlements
0.21
2.95
Forests
Dense Forest
0.22
3.09
Open Forest
0.46
6.45
Total Forests(A)
0.68
9.54
Scrubs
Scrubs (B)
0.97
13.60
Plantations
Social Forestry
0.16
2.24
Plantation on OB Dump
0.47
6.59
Plantation on Backfill
0.66
9.26
Total Plantation (C)
1.29
18.09
Total Vegetation (A+B+C)
2.94
41.23
Agriculture
Agriculture Land
0.41
5.75
Mining Area
Coal Quarry
0.78
10.94
Coal Dump
0.09
1.26
Barren OB Dump
0.06
0.84
Barren Backfill Area
1.12
15.71
Quarry Filled with Water
0.14
1.96
Advanced Quarry Site
0.06
0.84
Total Mining Area
2.25
31.56
Waste Lands
Waste Land
1.24
17.39
Water Bodies
Rivers, Lakes, Nalas etc.
0.08
1.12
All Total
7.13
100.00
Index
Mine Lease
Railways
Settlements
Other Roads
Coal Transportation Roads
Customer
MAHANADI COALFIELDS LIMITED
Title
Land Reclamation Monitoring of OC Projects
Job No.
561410027
Subject
Land Reclamation Status of Samleswari OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity
Name
Designation
Signature
Date
Perpared
A.Biswas
MT(Geology)
Checked
N.P.Singh
CM(RSC)
Approved
V.K.Gupta
GM(Geomatics)
cmpdi
Scale
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Sheet
Drg No.
M S R E M 4 A 4 S 0 1 0
Rev No.

Plate 5.10

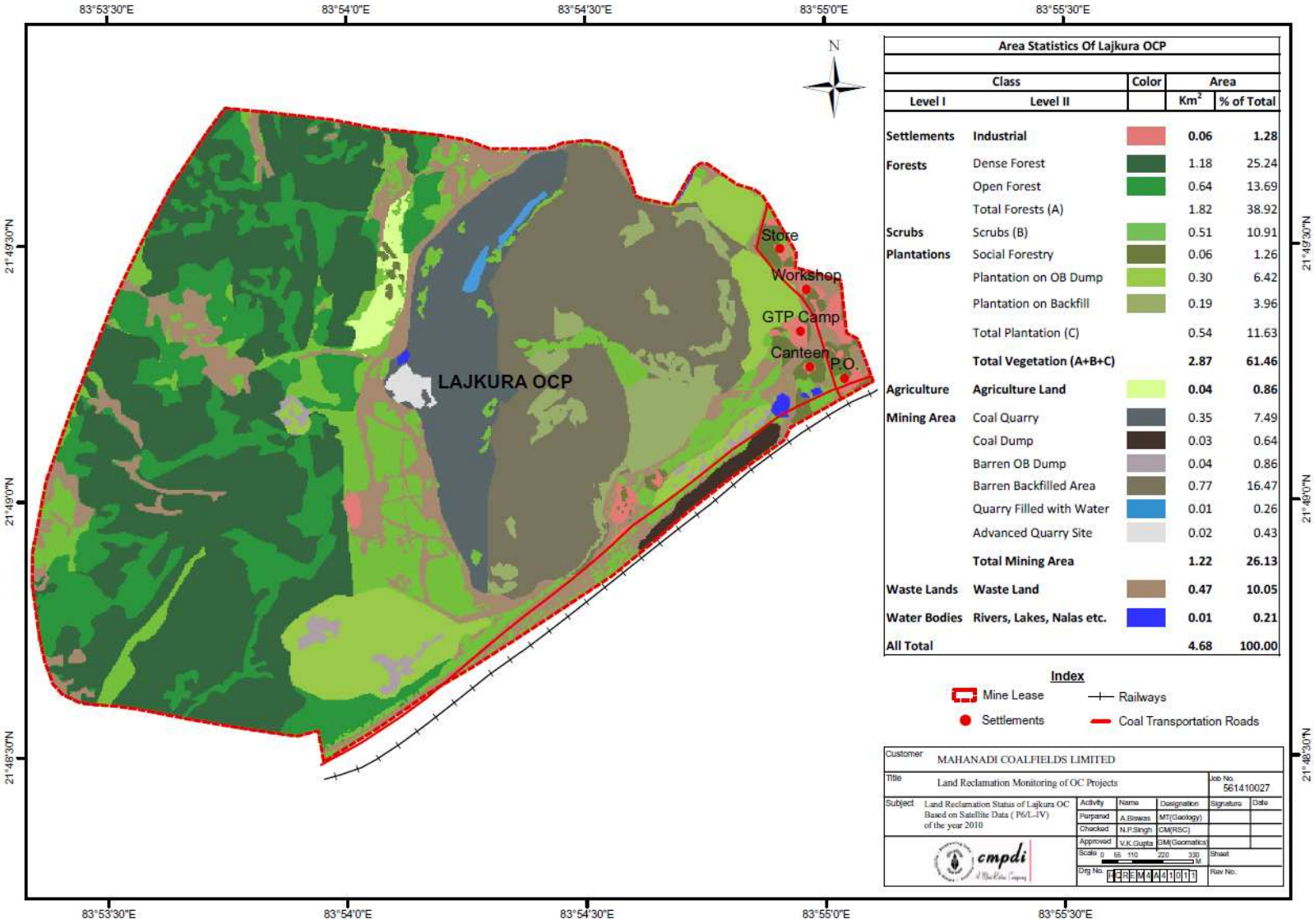
83°53'30"E
83°54'0"E
83°54'30"E
83°55'0"E
83°55'30"E
21°49'30"N
21°49'0"N
21°48'30"N
N
Store
Workshop
GTP Camp
Canteen
P.O.
LAJKURA OCP
Area Statistics Of Lajkura OCP
Class
Level I
Level II
Color
Area
Km²
% of Total
Settlements Industrial 0.06 1.28
Forests Dense Forest 1.18 25.24
Open Forest 0.64 13.69
Total Forests (A) 1.82 38.92
Scrubs Scrubs (B) 0.51 10.91
Plantations Social Forestry 0.06 1.26
Plantation on OB Dump 0.30 6.42
Plantation on Backfill 0.19 3.96
Total Plantation (C) 0.54 11.63
Total Vegetation (A+B+C) 2.87 61.46
Agriculture Agriculture Land 0.04 0.86
Mining Area Coal Quarry 0.35 7.49
Coal Dump 0.03 0.64
Barren OB Dump 0.04 0.86
Barren Backfilled Area 0.77 16.47
Quarry Filled with Water 0.01 0.26
Advanced Quarry Site 0.02 0.43
Total Mining Area 1.22 26.13
Waste Lands Waste Land 0.47 10.05
Water Bodies Rivers, Lakes, Nalas etc. 0.01 0.21
All Total 4.68 100.00
Index
Mine Lease
Railways
Settlements
Coal Transportation Roads
Customer MAHANADI COALFIELDS LIMITED
Title Land Reclamation Monitoring of OC Projects
Job No. 561410027
Subject Land Reclamation Status of Lajkura OC Based on Satellite Data (P6/L-IV) of the year 2010
Activity Name Designation Signature Date
Prepared A.Biswas MT(Geology)
Checked N.P.Singh GM(RSC)
Approved V.K.Gupta GM(Geomatics)
cmpdi
Scale 0 55 110 220 330 M
Shaat
Drg No. E R E M 4 A 4 1 0 1 1
Rev No.

Plate 5.11

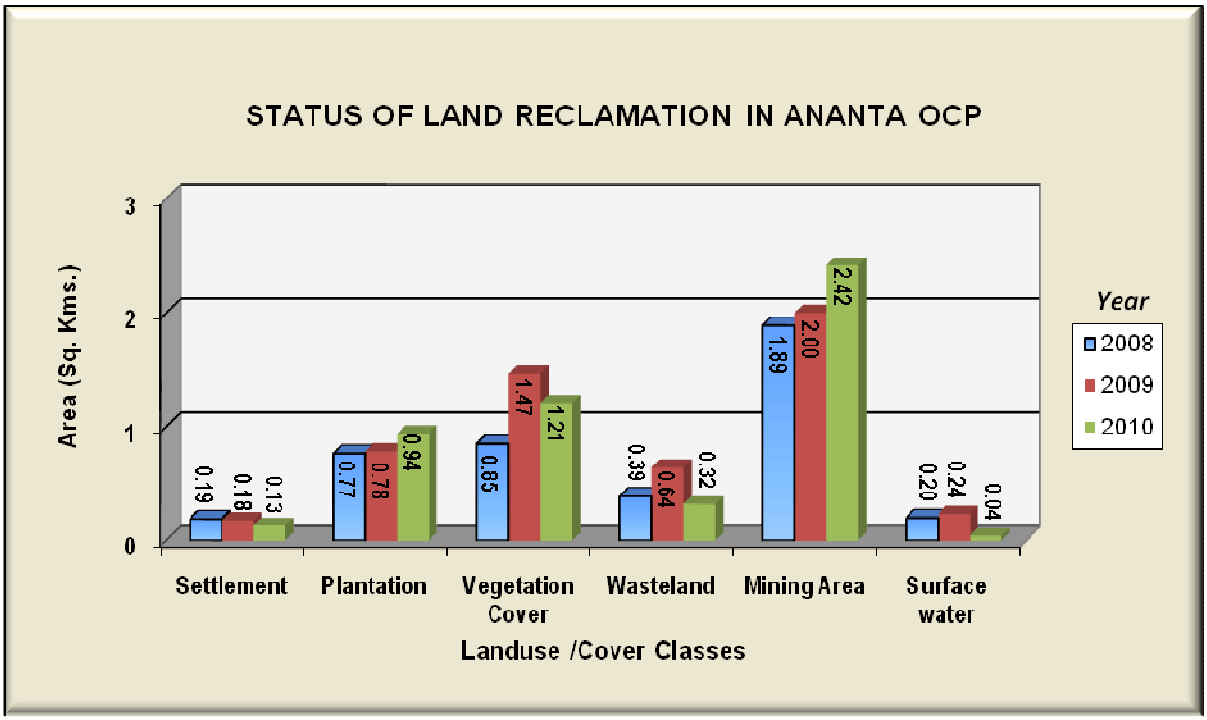

Figure 5.1

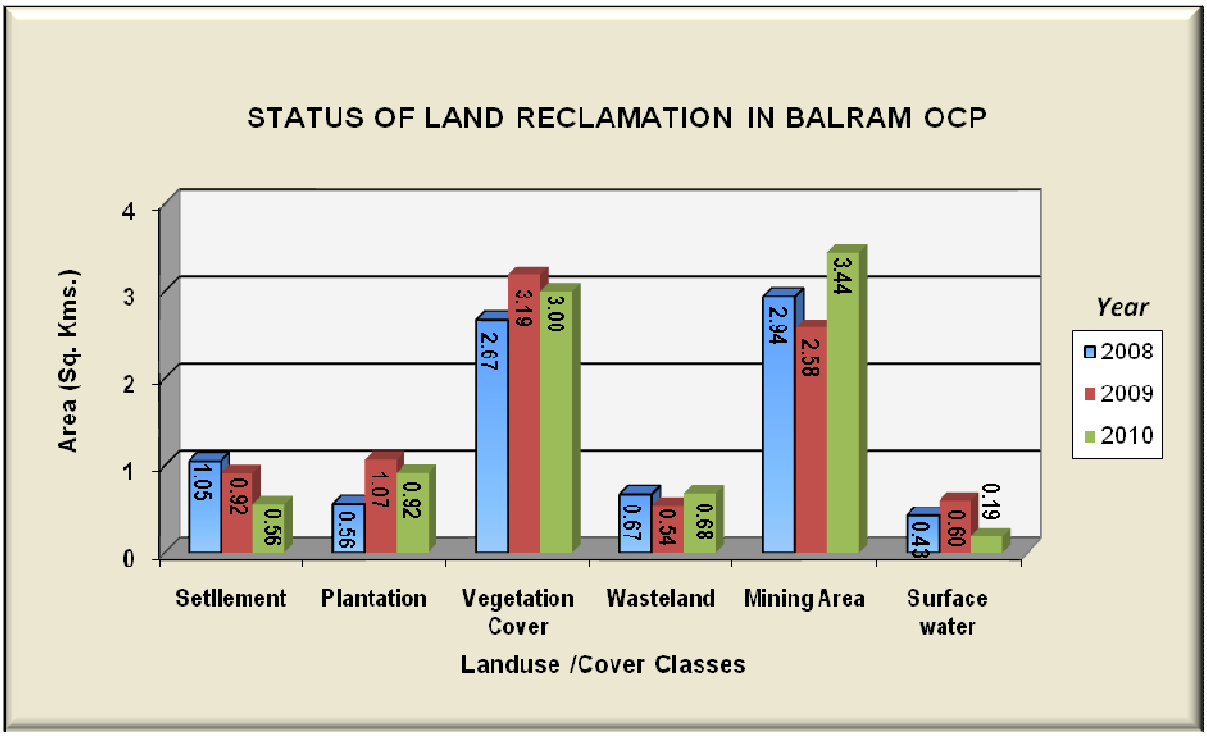

Figure 5.2

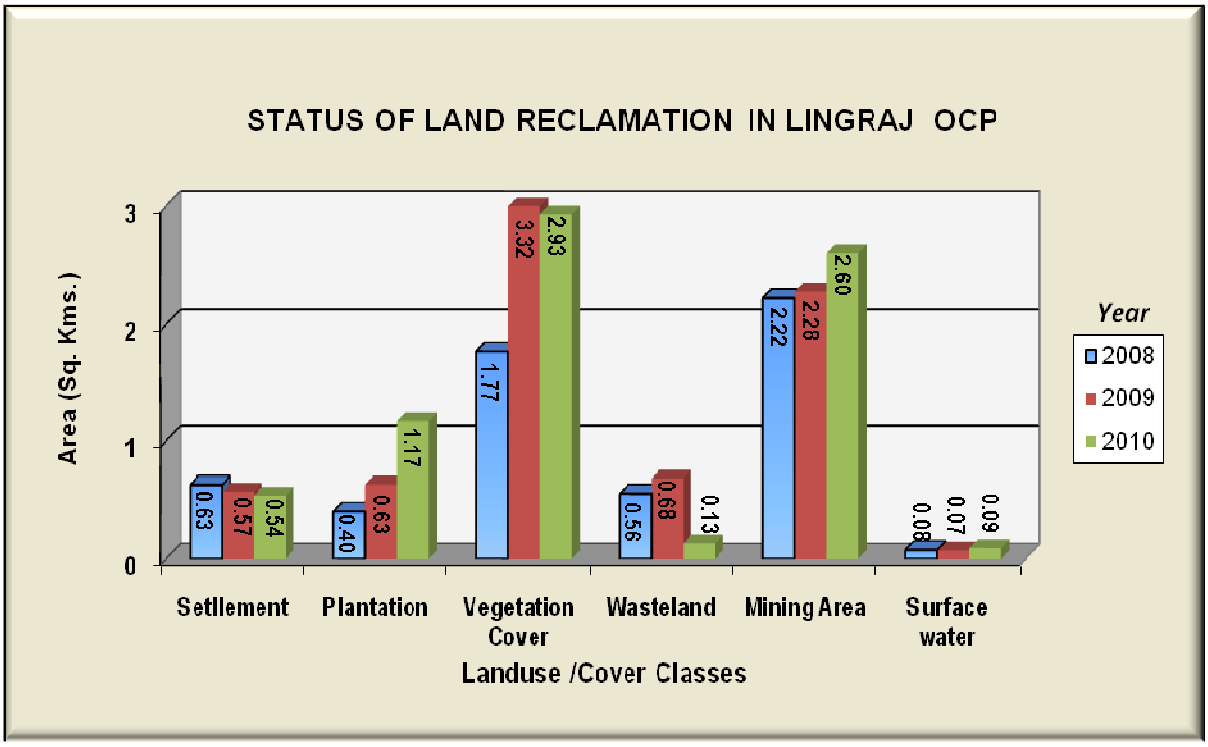

Figure 5.3

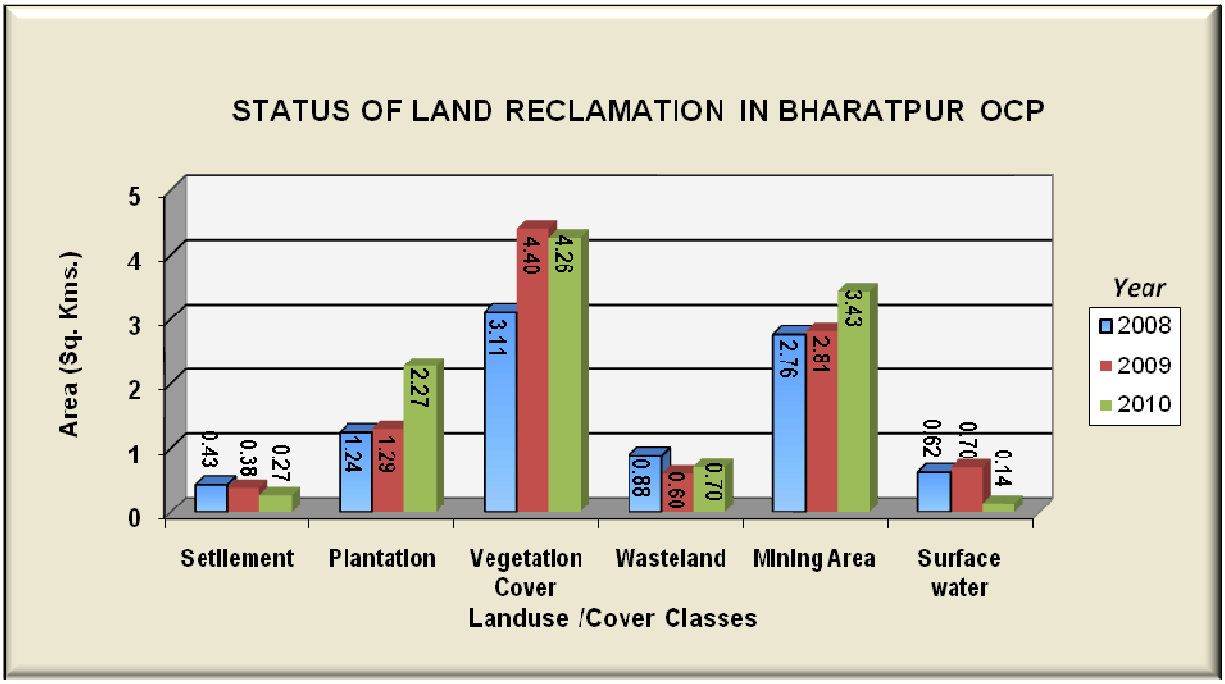

Figure 5.4

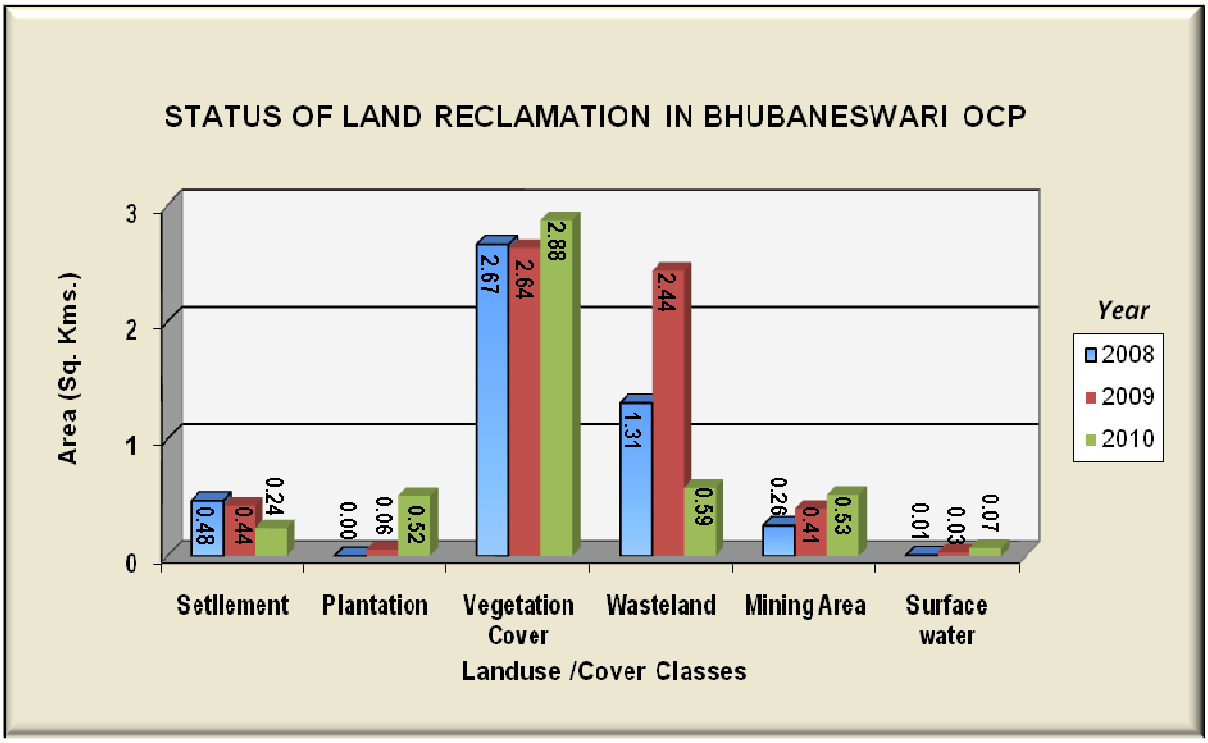

Figure 5.5

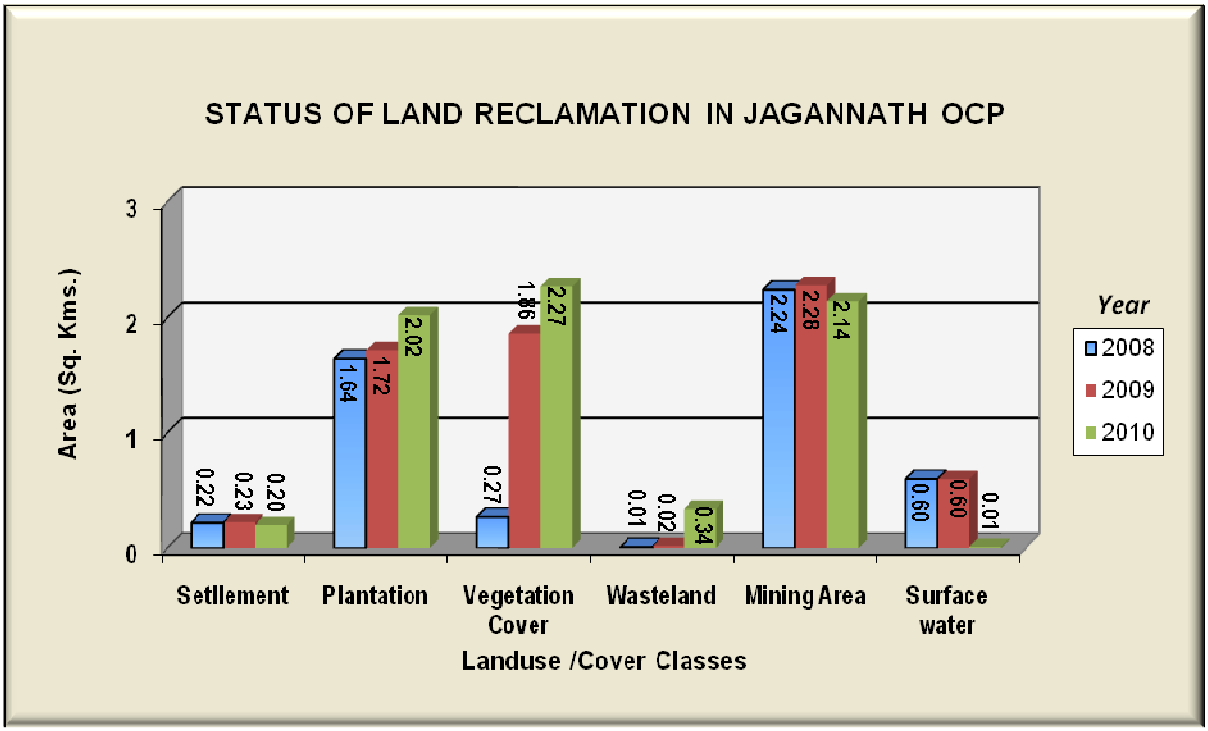

Figure 5.6

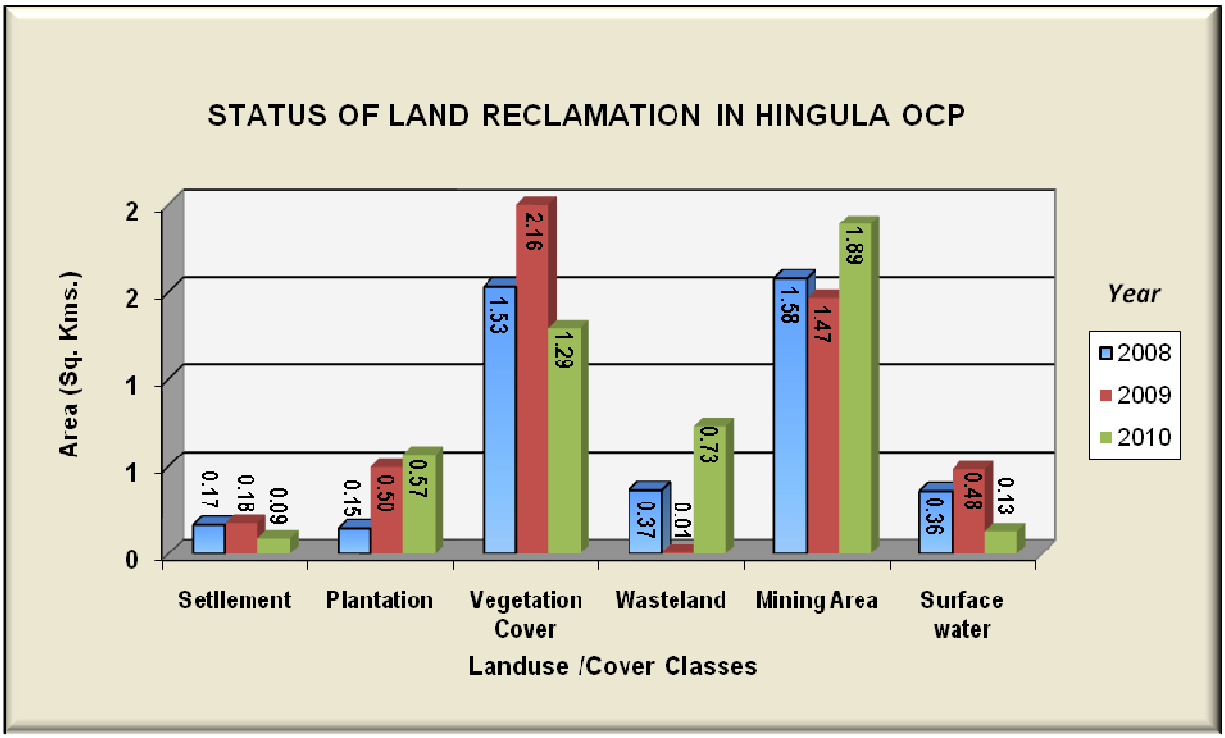

Figure 5.7

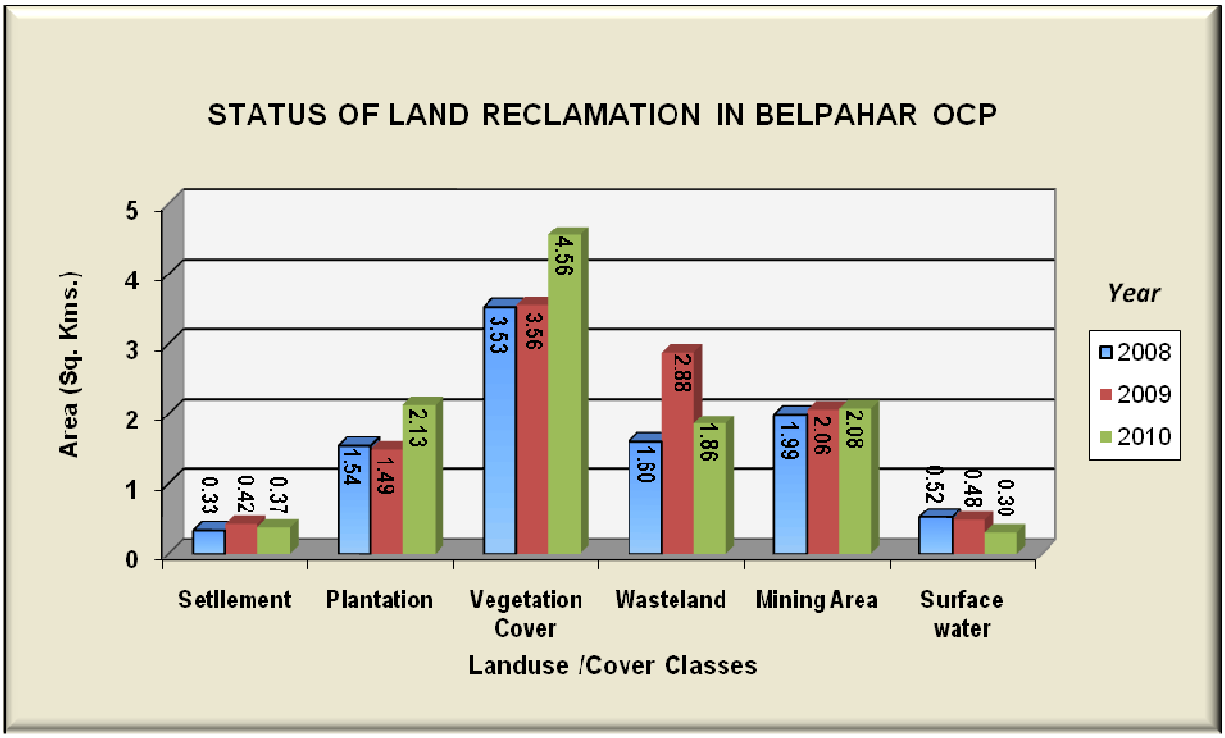

Figure 5.8

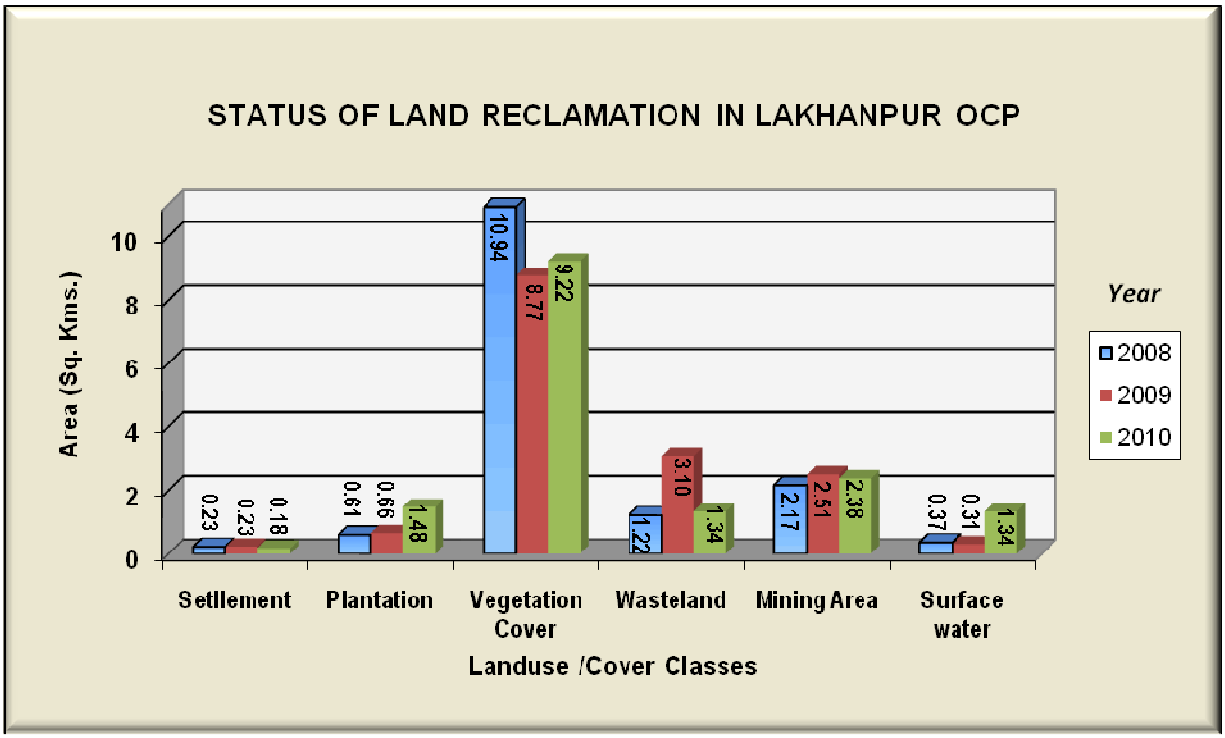

Figure 5.9

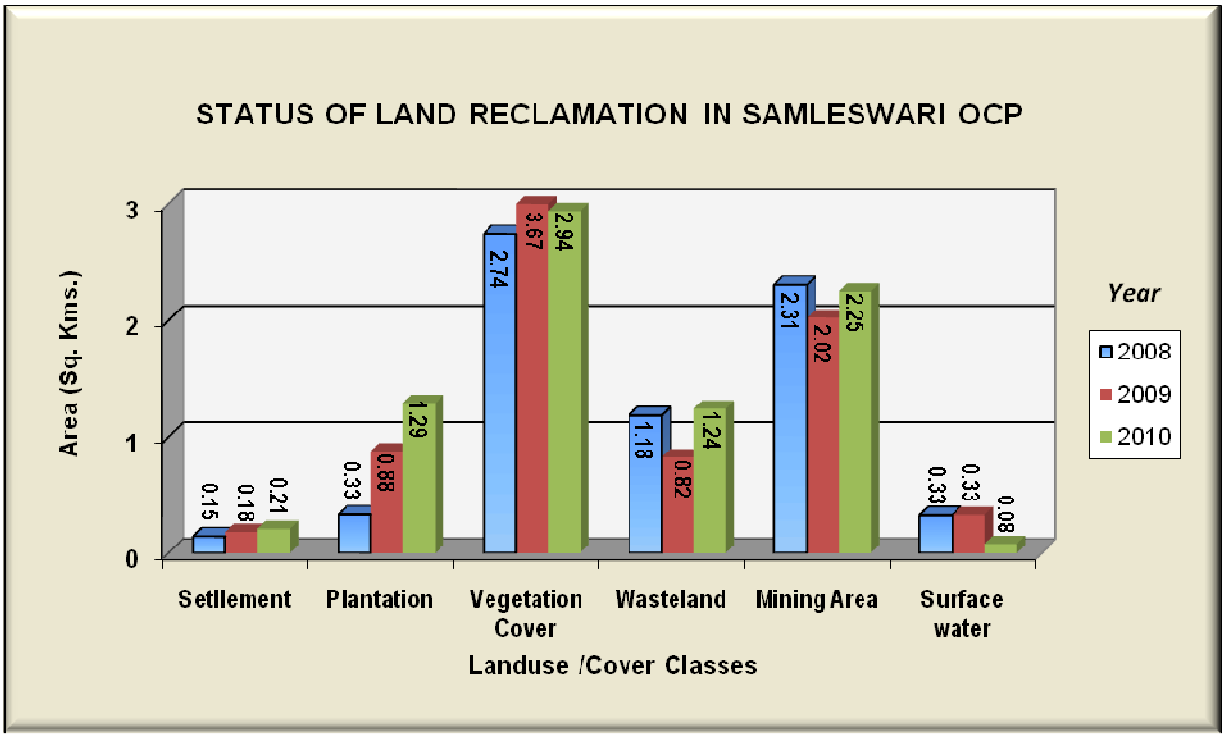

Figure 5.10

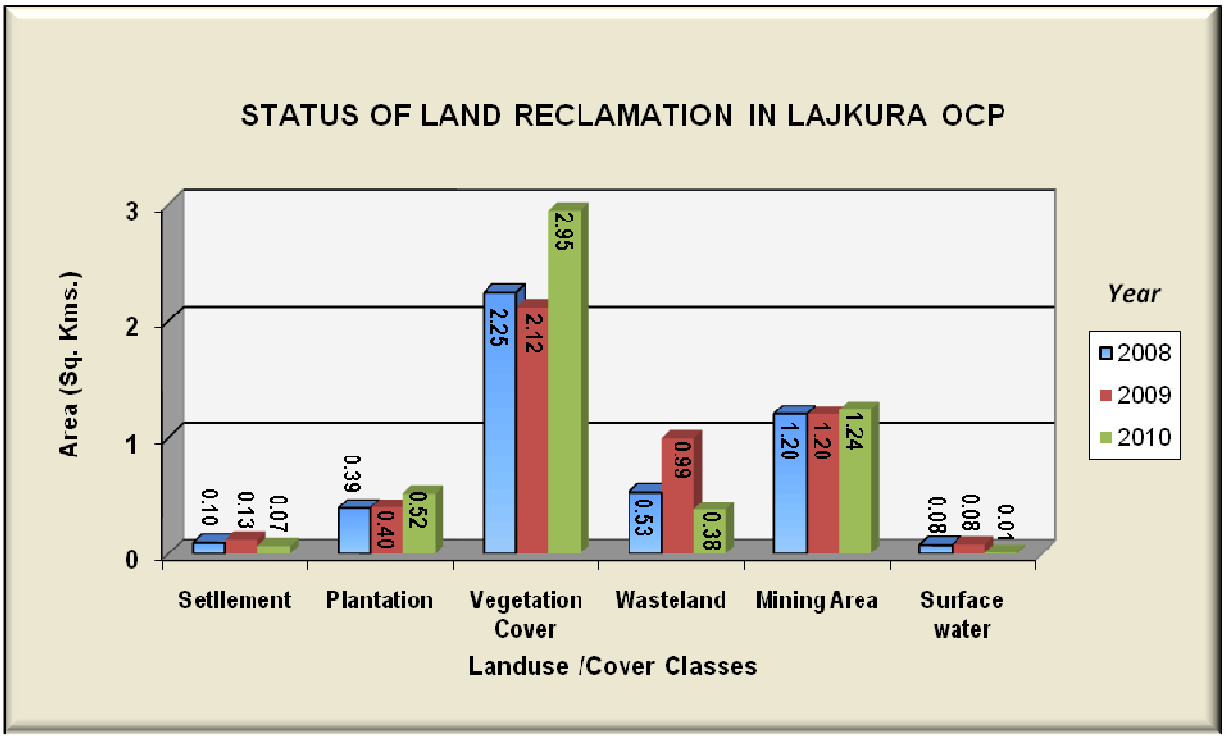
STATUS OF LAND RECLAMATION IN LAJKURA OCP
Area (Sq. Kms.)
3
2
1
0
0.10
0.13
0.07
0.39
0.40
0.52
2.25
2.12
2.95
0.53
0.99
0.38
1.20
1.20
1.24
0.08
0.08
0.01
Setllement
Plantation
Vegetation Cover
Wasteland
Mining Area
Surface water
Landuse /Cover Classes
Year
2008
2009
2010

Figure 5.11

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