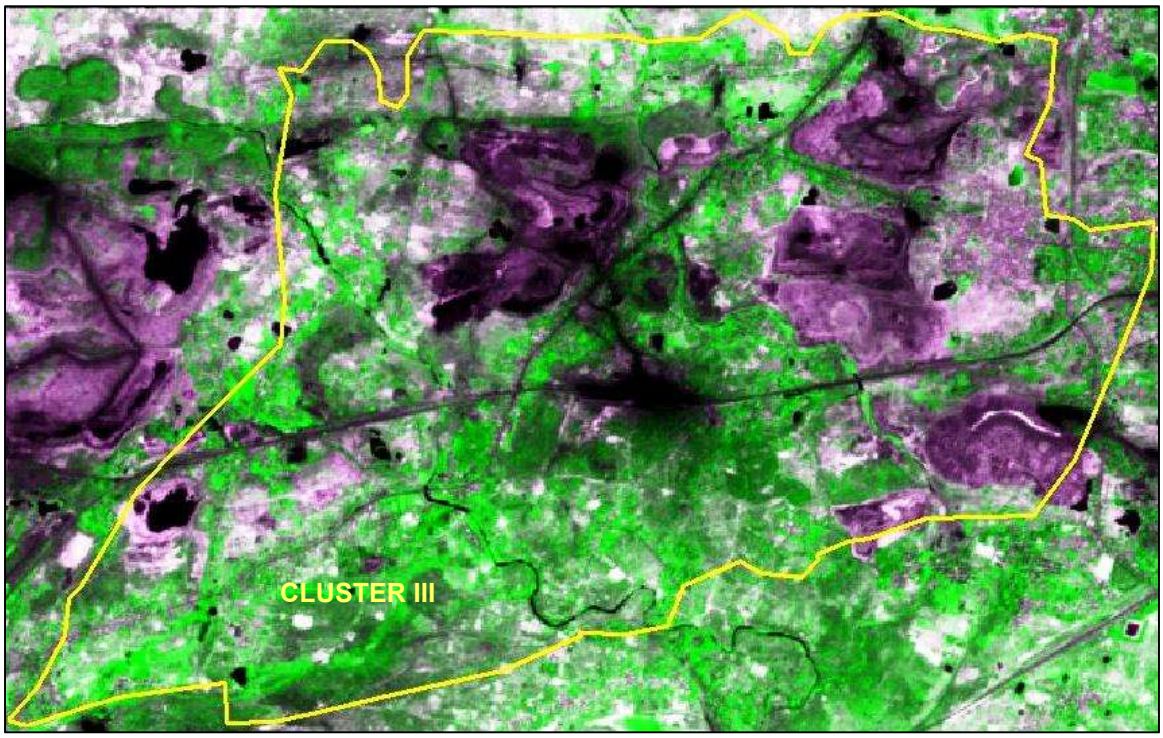
Land Restoration / Reclamation Monitoring of 4 Clusters of Opencast Mines of Bharat Coking Coal Limited producing less than 5 m.cu.m. (Coal + OB) based on Satellite Data for the Year 2017



Submitted to:

Bharat Coking Coal Limited

cmpdi
A Mini-Ratna Company

Land Restoration / Reclamation Monitoring of 4 Clusters of Opencast Mines of Bharat Coking Coal Limited producing less than 5 m.cu.m (Coal + OB) based on Satellite Data for the Year 2017

March-2018

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

Executive Summary iii

1.0 Background 01

2.0 Objective 02

3.0 Methodology 02

4.0 Land Reclamation in Bharat Coking Coal Limited 05

List of Tables

Table-1 Cluster wise Land Reclamation Status iv

Table-2 Area Statistics of Land Use Classes in Clusters 06

List of Plates

Plate-1 Land Use Map of Cluster-III 07

Plate -2 Land Use Map of Cluster-V 08

Plate -3 Land Use Map of Cluster-VIII 09

Plate-4 Land Use Map of Cluster-IX 10

List of Figures

Figure-1 Bar-Chart of Cluster wise Land Reclamation Status v

Figure-2 Methodology of Land Reclamation Monitoring 02

Figure-3 Bar-Chart of Land Reclamation Status of Cluster-III 11

Figure-4 Bar-Chart of Land Reclamation Status of Cluster-V 11

Figure-5 Bar-Chart of Land Reclamation Status of Cluster-VIII 12

Figure-6 Bar-Chart of Land Reclamation Status of Cluster-IX 12

List of Photographs

Photo-1 Ecological Restoration Site (Tetulmari Colliery) 13

Photo-2 Eco-Restoration Site (Rajapur OCP) 13

Photo-3 Social Forestry Plantation (Lodna) 14

Executive Summary

1.0 Project

Land restoration / reclamation monitoring of 4 clusters of Opencast Mines of Bharat Coking Coal Ltd. (BCCL) producing less than 5 million cu. m. (Coal + OB) per year based on satellite data of the year 2017 on three year interval.

2.0 Objective

Objective of the land restoration / reclamation monitoring is to assess the area of backfilling, 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 6576.22 hectares of the 4 Clusters of mines viz. Cluster III, Cluster V, Cluster VIII & Cluster IX considered for monitoring during year 2017-18; total excavated area is 995.60 ha, out of which 31.60 ha (3.17%) has been planted, 457.35 ha (45.94%) area is under backfilling and 506.65 ha (50.89%) area is under active mining. It is evident from the analysis that 49.11% area of the above clusters is under reclamation (biological and technical) and balance 50.89% area is under active mining. Project wise details are given in Table-1 & Fig -1.

- From the analysis of land reclamation for the year 2017 it is evident that the area under technical reclamation is 457.35 Ha. and area under biological reclamation is 31.60 Ha. Out of 4 clusters of BCCL considered for monitoring, Cluster VIII is on top for land reclamation (61.25%) followed by Cluster V (60.13%) and Cluster III (37.06%).

TABLE-1

Cluster wise Land Reclamation Status in Clusters of Bharat Coking Coal Ltd based on satellite data of the year 2017

(Area in Hectare)

Sl. No.	Project	Total Leasehold Area	Technical Reclamation	Plantation			Area under Active Mining	Total Excavated Area	Total Area under Plantation (% Green Cover Generated in Leasehold)	Total Area under Reclamation
				Biological Reclamation	Other Plantations					
			Area under Backfilling	Plantation on Excavated / Backfilled Area	Plantation on External Over Burden Dumps	Social Forestry, Avanue Plantation Etc.				
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9 (=4+5+8)*	*10 (=5+6+7)*	*11(=4+5)*
			2017	*2017*	*2017*	*2017*	*2017*	*2017*	*2017*	*2017*
1	Cluster III	1552.53	55.87	3.89	21.11	128.07	101.5	161.26	153.07	59.76
			34.65%	2.41%			62.94%		9.86%	37.06%
2	Cluster V	1724.52	162.09	7.19	23.85	105.29	112.24	281.52	136.33	169.28
			57.58%	2.55%			39.87%		7.91%	60.13%
3	Cluster VIII	1331.95	161.86	13.72	21.97	24.70	111.06	286.64	60.39	175.58
			56.47%	4.79%			38.75%		4.53%	61.25%
4	Cluster IX	1967.22	77.53	6.80	41.79	168.58	181.85	266.18	217.17	84.33
			29.13%	2.55%			68.32%		11.04%	31.68%
	TOTAL	**6576.22**	**457.35**	**31.60**	**108.72**	**426.64**	**506.65**	**995.60**	**566.96**	**488.95**
			45.94%	**3.17%**			**50.89%**		**8.62%**	**49.11%**

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

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

1. *Area under Biological Reclamation includes Areas under Plantation done on Backfilled Area Only.*
2. *Area under Technical Reclamation includes Area under Barren Backfilling only*
3. *Area under Active Mining Includes Coal Quarry, Advance Quarry Site, Quarry filled with water etc., if any.*
4. *Social Forestry and Plantation on External OB Dumps are not included in Biological Reclamation and are put under separate categories as shown in the Table above..*
5. *(%) calculated in the above Table is in respect to Total Excavated Area except for ""Total Area under Plantation" where % is in terms of "Leasehold Area".*

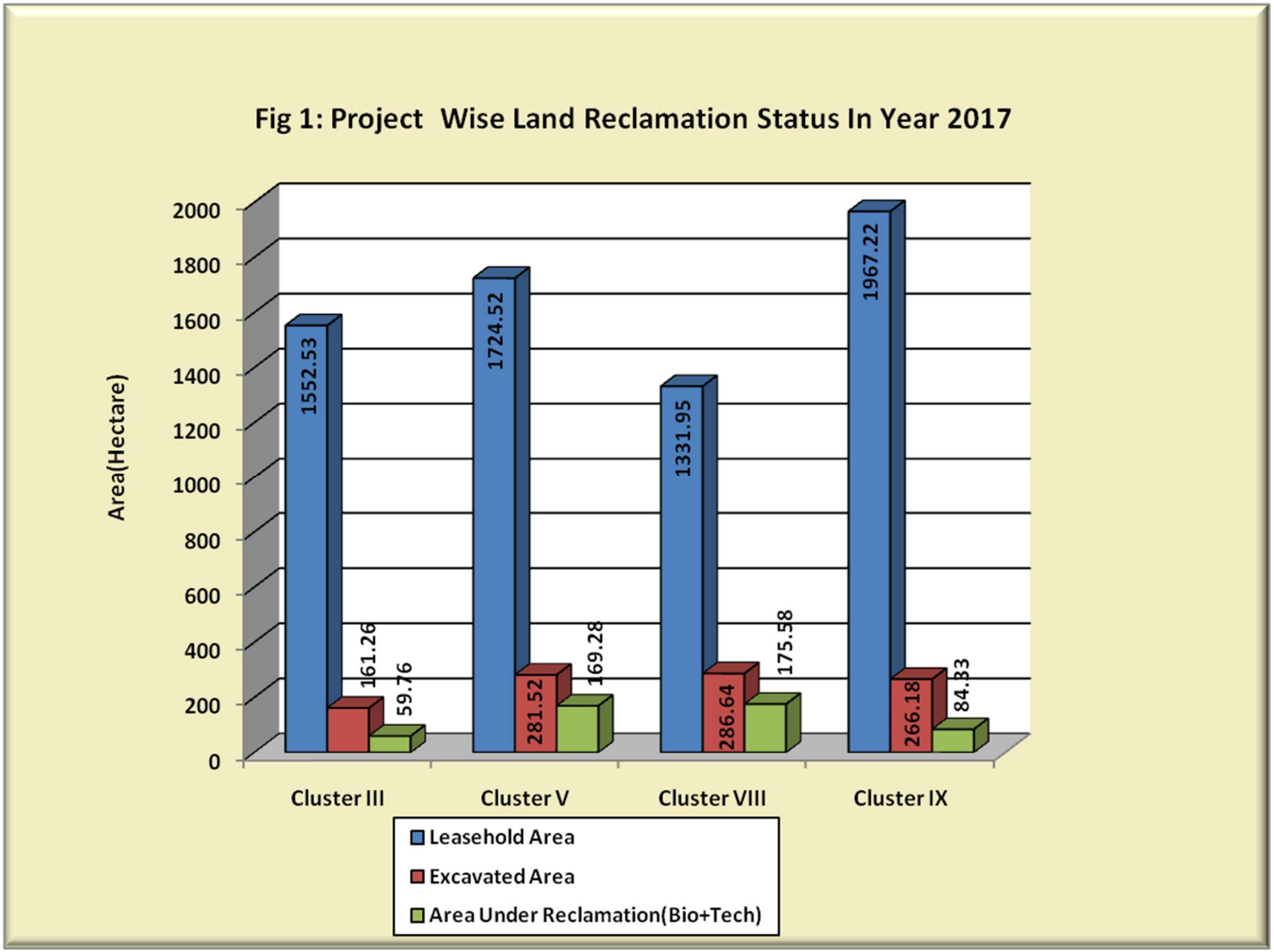


Fig 1: Project Wise Land Reclamation Status In Year 2017
Area(Hectare)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1552.53
161.26
59.76
1724.52
281.52
169.28
1331.95
286.64
175.58
1967.22
266.18
84.33
Cluster III
Cluster V
Cluster VIII
Cluster IX
Leasehold Area
Excavated Area
Area Under Reclamation(Bio+Tech)

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./2017/DP/8477 dated 21/09/17 for monitoring of opencast mines of less than 5 million m^3 per annum capacity (Coal +OB) for the period 2017-18 to 2021-22 at intervals of three years. The result of land reclamation status of all such mines is uploaded on the website of 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 2017 carried out for 4 clusters of Bharat Coking Coal 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:

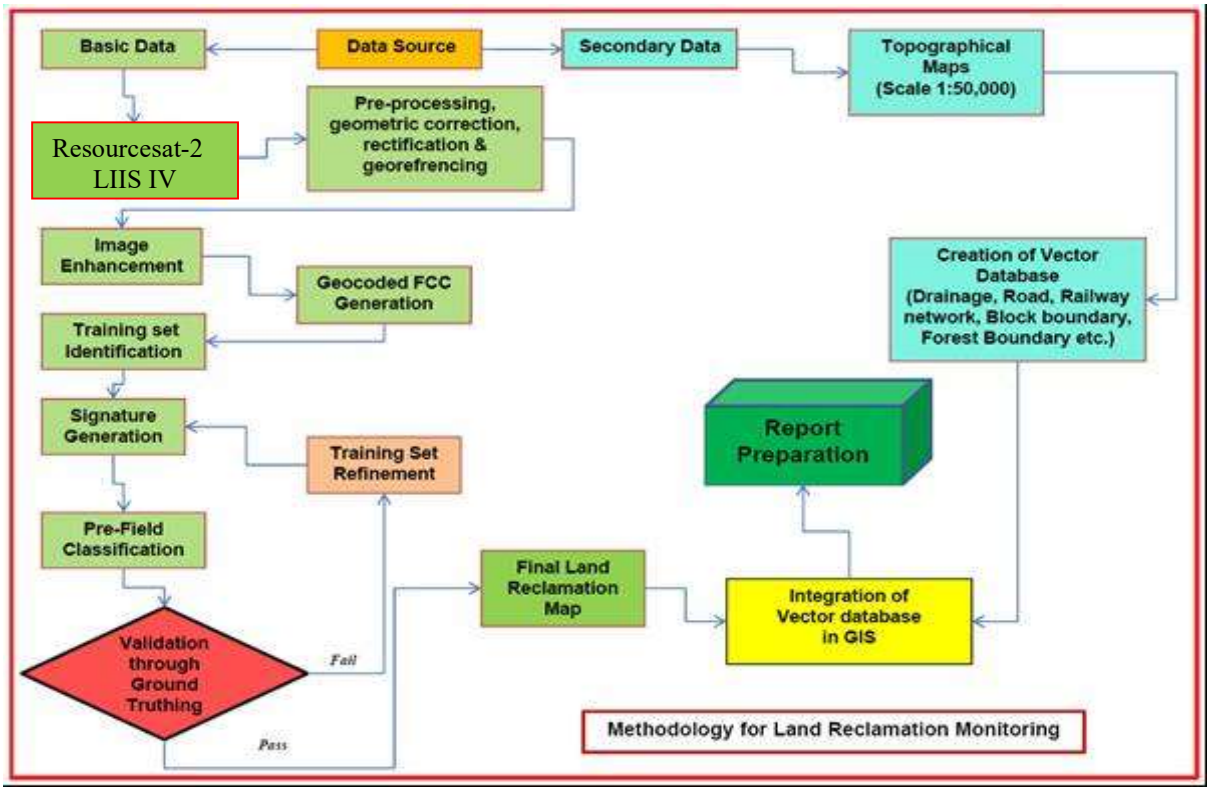


Figure: 2 Methodology for Land Reclamation Monitoring

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, georeferencing 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 2014 s/w and enhance the image quality for interpretation.

- **Training set selection**

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

- **Classification and Accuracy assessment**

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

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE v. 2014 software 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 Bharat Coking Coal Ltd.

4.1 Following 4 clusters of opencast mines producing less than 5 million m^3. (Coal + OB together) of Bharat Coking Coal Ltd. have been taken up during the year 2017-18 for land reclamation monitoring:

- Cluster-III
- Cluster-V
- Cluster-VIII
- Cluster-IX

4.2 Area statistics of different land use classes present in clusters in the year 2017 is given in Table 2. Land use maps derived from the satellite data is given in Plate no. 1 to 4. Land use statuses are shown in Fig. 3 – 6.

4.3 Study reveals that 49.11% of excavated area is under reclamation in the above mentioned clusters of BCCL, out of which 3.17% area has been planted and 45.94% area is under backfilling.

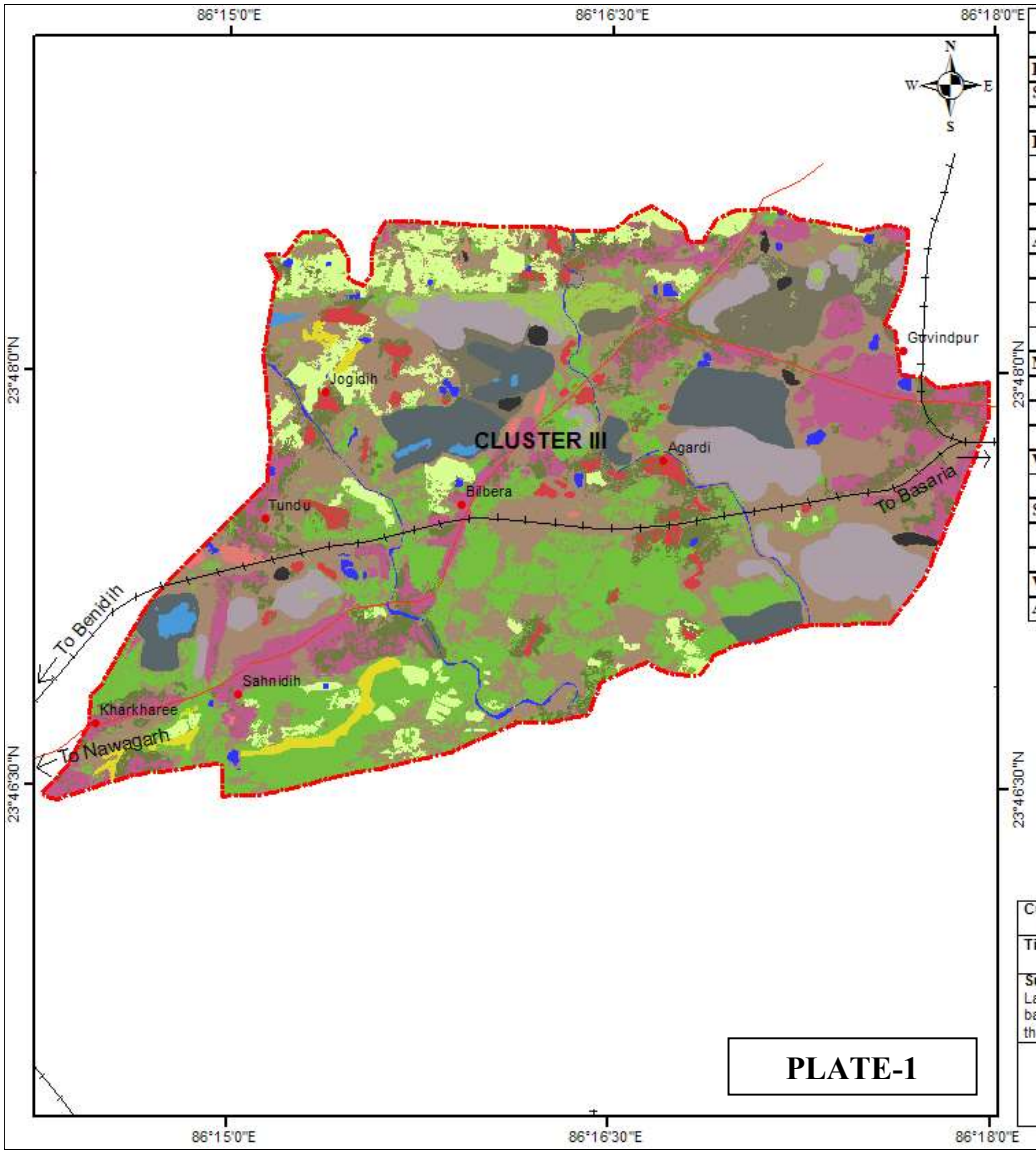
4.4 After analyzing the satellite data of year 2017, it is evident that plantation carried out on backfilled area, OB dumps as well as under social forestry in all the 4 clusters of BCCL taken up for study has reached only 8.62% of the total leasehold area of the above clusters till now. It can also be seen from Table.1 that the total area under reclamation has reached 49.11% of the total excavated area till the year 2017 in the 4 clusters taken up for study.

Table 2

STATUS OF LAND USE/COVER IN CLUSTERS (<5 m cu .m) OF BHARAT COKING COAL LIMITED BASED ON SATELLITE DATA OF THE YEAR 2017

(Area in Hectare)

		Cluster III		Cluster V		Cluster VIII		Cluster IX		TOTAL	
		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
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	Scrubs	300.05	19.33	344.78	19.99	143.21	10.75	339.86	17.28	1127.90	17.15
PLANTATION	Social Forestry	128.07	8.25	105.29	6.10	24.70	1.85	168.58	8.57	426.64	6.49
	Plantation on OB Dump	21.11	1.36	23.85	1.38	21.97	1.65	41.79	2.12	108.72	1.65
	Plantation on Backfill (Biological Reclamation)	3.89	0.25	7.19	0.42	13.72	1.03	6.80	0.35	31.60	0.48
	Total Plantation	153.07	9.86	136.33	7.90	60.39	4.53	217.17	11.04	566.96	8.62
	Total Vegetation	**453.12**	**29.19**	**481.11**	**27.89**	**203.60**	**15.28**	**557.03**	**28.32**	**1694.86**	**25.77**
	Coal Dump	7.64	0.49	2.55	0.15	7.71	0.58	9.67	0.49	27.57	0.42
ACTIVE MINING	Coal Quarry	93.24	6.00	102.79	5.96	108.02	8.11	178.55	9.08	482.60	7.34
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	8.26	0.53	9.45	0.55	3.04	0.23	3.30	0.17	24.05	0.37
	Total Area under *Active Mining*	**101.50**	**6.53**	**112.24**	**6.51**	**111.06**	**8.34**	**181.85**	**9.25**	**506.65**	**7.70**
	Barren OB Dump	126.20	8.13	151.20	8.77	149.30	11.21	172.19	8.75	598.89	9.11
RECLAIMED	Area Under Backfilling (Technical Reclamation)	55.87	3.60	162.09	9.40	161.86	12.15	77.53	3.94	457.35	6.95
	Total Area under *Technical Reclamation*	**55.87**	**3.60**	**162.09**	**9.40**	**161.86**	**12.15**	**77.53**	**3.94**	**457.35**	**6.95**
	Total Area under Mine Operation	**291.21**	**18.75**	**428.08**	**24.83**	**429.93**	**32.28**	**441.24**	**22.43**	**1590.46**	**24.19**
WATERBODIES	Waste Lands	461.92	29.75	517.23	29.99	443.58	33.30	614.64	31.24	2037.37	30.98
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Wasteland	**461.92**	**29.75**	**517.23**	**29.99**	**443.58**	**33.30**	**614.64**	**31.24**	**2037.37**	**30.98**
	Reservoir, nallah, ponds	17.48	1.13	10.21	0.59	13.15	0.99	20.59	1.05	61.43	0.93
	Total Waterbodies	**17.48**	**1.13**	**10.21**	**0.59**	**13.15**	**0.99**	**20.59**	**1.05**	**61.43**	**0.93**
AGRICULTURE	Crop Lands	17.05	1.10	8.41	0.49	18.05	1.35	0.00	0.00	43.51	0.66
	Fallow Lands	110.04	7.09	37.74	2.19	58.02	4.36	44.49	2.26	250.29	3.81
	Total Agriculture	**127.09**	**8.19**	**46.15**	**2.68**	**76.07**	**5.71**	**44.49**	**2.26**	**293.80**	**4.47**
SETTLEMENTS	Urban Settlement	164.97	10.62	217.50	12.61	97.19	7.30	232.31	11.81	711.97	10.83
	Rural Settlement	30.69	1.98	13.78	0.80	57.00	4.28	47.79	2.43	149.26	2.27
	Industrial Settlement	6.05	0.39	10.46	0.61	11.43	0.86	9.13	0.46	37.07	0.56
	Total Settlement	**201.71**	**12.99**	**241.74**	**14.02**	**165.62**	**12.44**	**289.23**	**14.70**	**898.30**	**13.66**
	Grand Total	**1552.53**	**100.00**	**1724.52**	**100.00**	**1331.95**	**100.00**	**1967.22**	**100.00**	**6576.22**	**100.00**



Area Statistics of Cluster III

Class		Color	Area	
Level I	**Level II**		**Hect**	**% of Total**
Scrubs	**Scrubs (A)**		**300.05**	**19.33**
	Social Forestry		128.07	8.25
Plantations	Plantation on OB Dump		21.11	1.36
	Plantation on Backfill		3.89	0.25
	Total Plantation (B)		**153.07**	**9.86**
	Total Vegetation (A+B)		**453.12**	**29.19**
Agricultural Land	Fallow Land		110.04	7.09
	Crop Land		17.05	1.10
	Total Agricultural Land		**127.09**	**8.19**
	Coal Quarry		93.24	6.00
	Coal Dump		7.64	0.49
Mining Area	Barren OB Dump		126.20	8.13
	Area Under Backfilling		55.87	3.60
	Water Filled Quarry		8.26	0.53
	Total Mining Area		**291.21**	**18.75**
Waste Lands	**Waste Land**		**461.92**	**29.75**
	Industrial		6.05	0.39
Settlement	Urban		164.97	10.62
	Rural		30.69	1.98
	Total Settlements		**201.71**	**12.99**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**17.48**	**1.13**
All Total			**1552.53**	**100.00**

Legend

- Settlements
- Railway Line
- Road
- Cluster III Boundary

Customer: BHARAT COKING COAL LIMITED

Title: Land Reclamation Monitoring of Clusters

Job No. 561410027

Subject: Land Reclamation Monitoring of Cluster III based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.

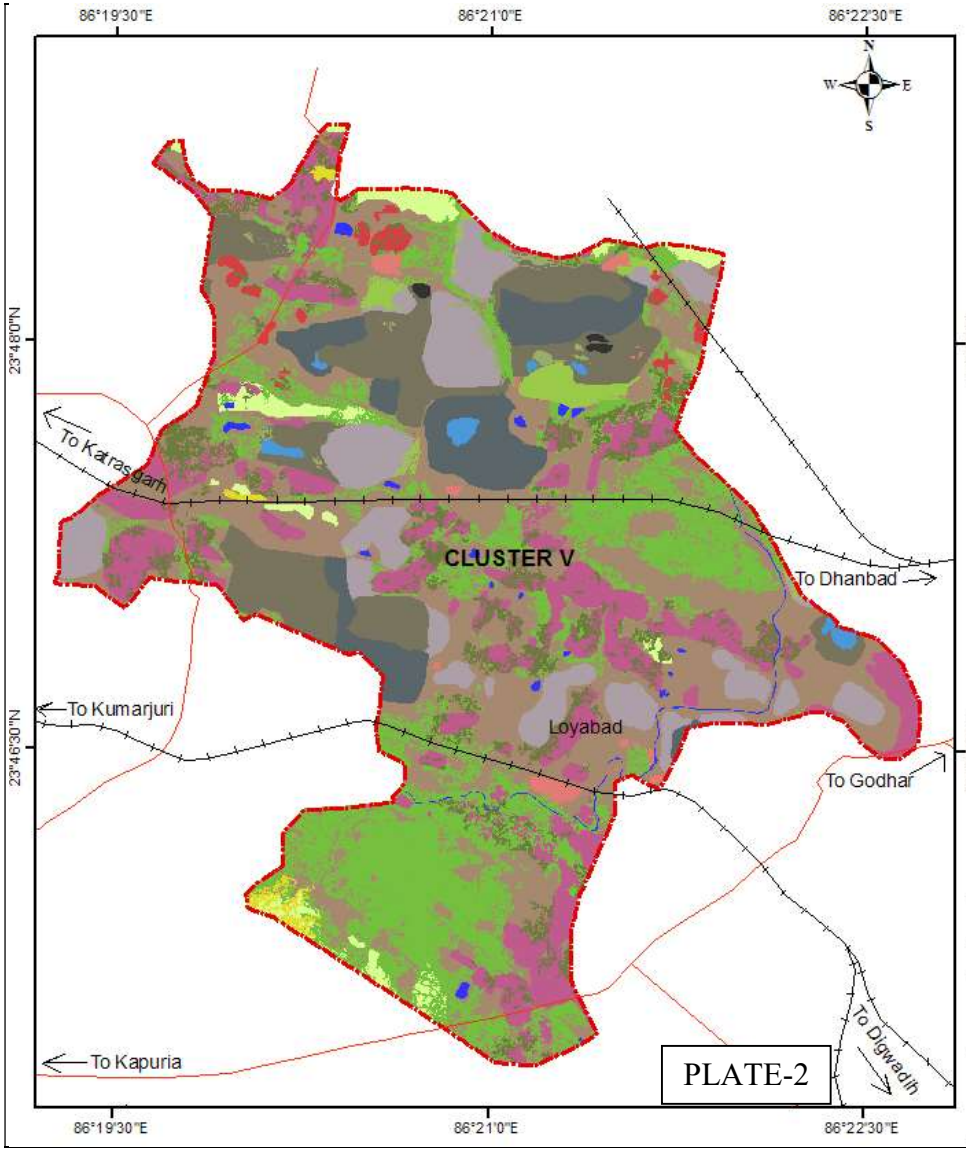
Activity	Name	Desig	Sign	Date
Prepared	A. Panda	AM (Geo)		
Checked	R. Kumar	HOD(Geom)		
Approved	R. Kumar	HOD(Geom)		

cmpdi — A Mini Ratna Company

Scale: 540 270 0 540 M

Sheet

Drg No. HQ REM 4 A4 17 01



Area Statistics of Cluster V				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		344.78	19.99
	Social Forestry		105.29	6.10
Plantations	Plantation on OB Dump		23.85	1.38
	Plantation on Backfill		7.19	0.42
	Total Plantation (B)		136.33	7.90
	Total Vegetation (A+B)		481.11	27.89
Agricultural Land	Crop Land		8.41	0.49
	Fallow Land		37.74	2.19
	Total Agricultural Land		46.15	2.68
	Coal Quarry		102.79	5.96
	Coal Dump		2.55	0.15
Mining Area	Barren OB Dump		151.20	8.77
	Area Under Backfilling		162.09	9.40
	Water Filled Quarry		9.45	0.55
	Total Mining Area		428.08	24.83
Waste Lands	Waste Land		517.23	29.99
	Industrial		10.46	0.61
Settlement	Rural		13.78	0.80
	Urban		217.50	12.61
	Total Settlements		241.74	14.02
Water Bodies	Rivers, Lakes, Nalas etc.		10.21	0.59
All Total			1724.52	100.00

Legend

- Road
- Railway Line
- Cluster V Boundary

Customer: BHARAT COKING COAL LIMITED

Title: Land Reclamation Monitoring of Clusters

Job No. 561410027

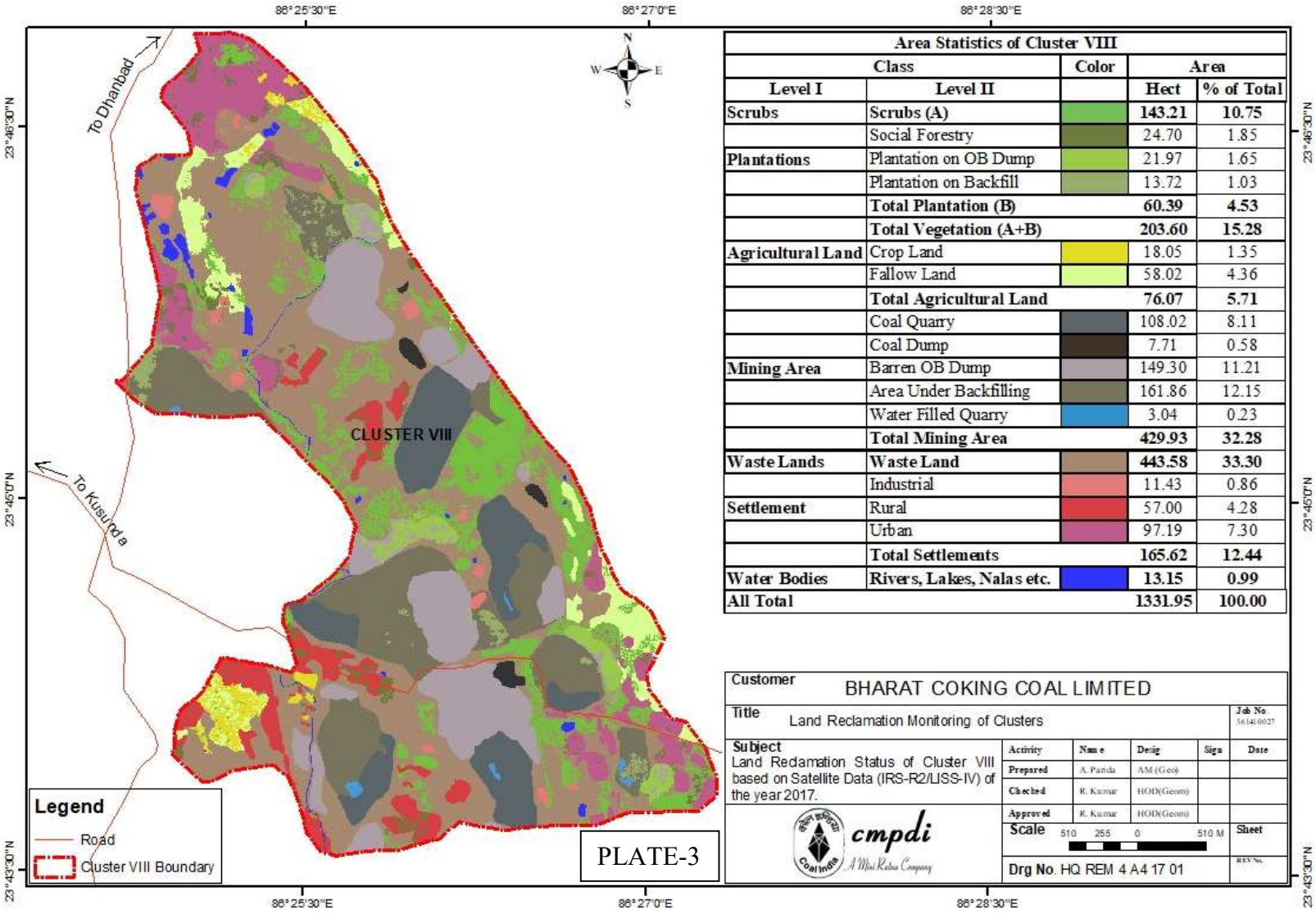
Subject: Land Reclamation Status of Cluster V based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.

Activity	Name	Desig	Sign	Date
Prepared	A. Panda	AM (Geo)		
Checked	R. Kumar	HOD(Geom)		
Approved	R. Kumar	HOD(Geom)		

Scale 460 230 0 460 Meters

Drg No. HQ REM 4 A4 17 01

Sheet



Area Statistics of Cluster VIII				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		143.21	10.75
	Social Forestry		24.70	1.85
Plantations	Plantation on OB Dump		21.97	1.65
	Plantation on Backfill		13.72	1.03
	Total Plantation (B)		60.39	4.53
	Total Vegetation (A+B)		203.60	15.28
Agricultural Land	Crop Land		18.05	1.35
	Fallow Land		58.02	4.36
	Total Agricultural Land		76.07	5.71
	Coal Quarry		108.02	8.11
	Coal Dump		7.71	0.58
Mining Area	Barren OB Dump		149.30	11.21
	Area Under Backfilling		161.86	12.15
	Water Filled Quarry		3.04	0.23
	Total Mining Area		429.93	32.28
Waste Lands	Waste Land		443.58	33.30
	Industrial		11.43	0.86
Settlement	Rural		57.00	4.28
	Urban		97.19	7.30
	Total Settlements		165.62	12.44
Water Bodies	Rivers, Lakes, Nalas etc.		13.15	0.99
All Total			1331.95	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Reclamation Monitoring of Clusters — Job No 561410027

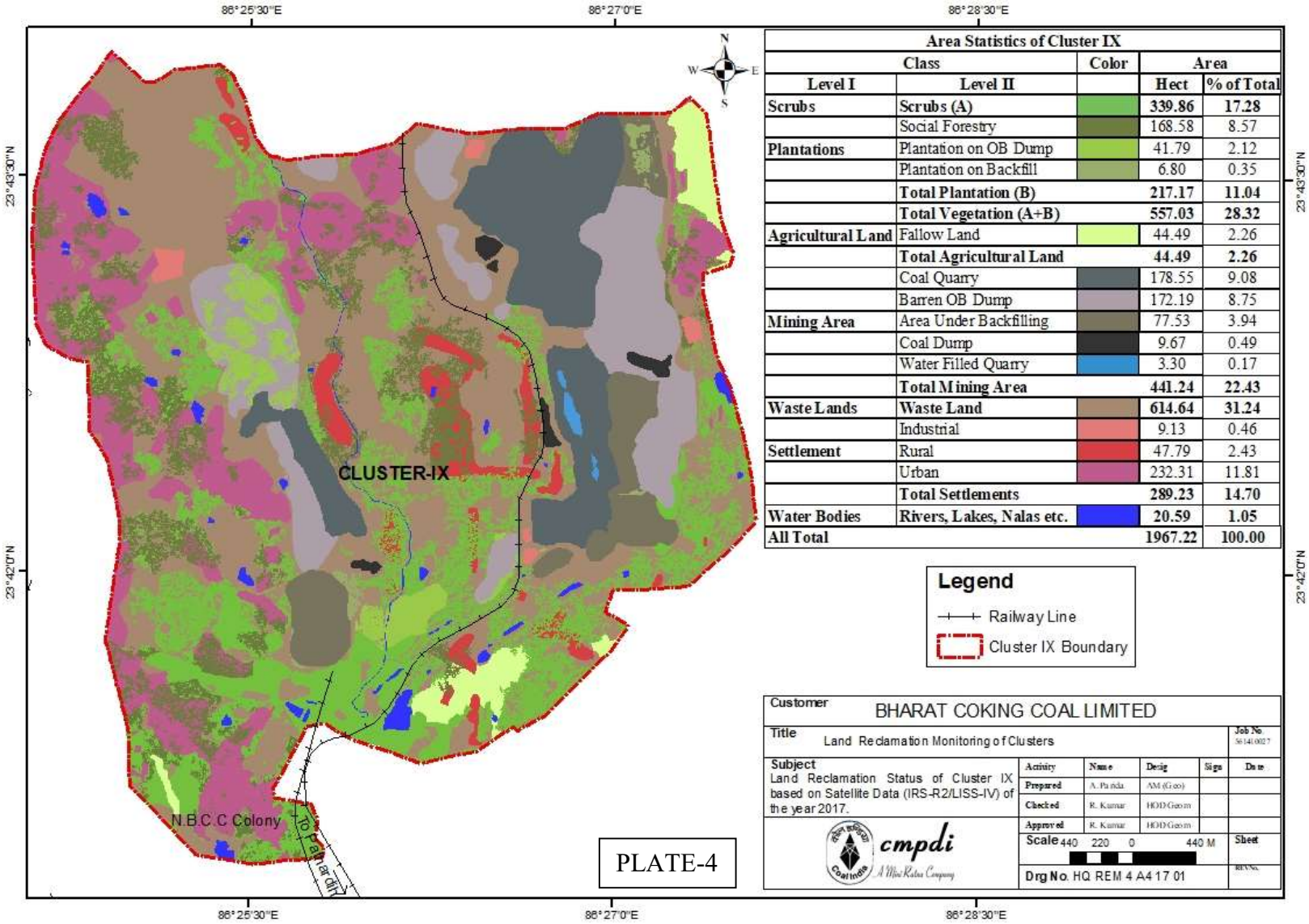
Subject: Land Reclamation Status of Cluster VIII based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.

Activity	Name	Desig	Sign	Date
Prepared	A. Panda	AM (Geo)		
Checked	R. Kumar	HOD(Geom)		
Approved	R. Kumar	HOD(Geom)		

Scale: 510 255 0 510 M — Sheet

Drg No. HQ REM 4 A4 17 01 — REV No.

cmpdi — A Mini Ratna Company



Area Statistics of Cluster IX				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		339.86	17.28
	Social Forestry		168.58	8.57
Plantations	Plantation on OB Dump		41.79	2.12
	Plantation on Backfill		6.80	0.35
	Total Plantation (B)		217.17	11.04
	Total Vegetation (A+B)		557.03	28.32
Agricultural Land	Fallow Land		44.49	2.26
	Total Agricultural Land		44.49	2.26
	Coal Quarry		178.55	9.08
	Barren OB Dump		172.19	8.75
Mining Area	Area Under Backfilling		77.53	3.94
	Coal Dump		9.67	0.49
	Water Filled Quarry		3.30	0.17
	Total Mining Area		441.24	22.43
Waste Lands	Waste Land		614.64	31.24
	Industrial		9.13	0.46
Settlement	Rural		47.79	2.43
	Urban		232.31	11.81
	Total Settlements		289.23	14.70
Water Bodies	Rivers, Lakes, Nalas etc.		20.59	1.05
All Total			1967.22	100.00

Legend

- Railway Line
- Cluster IX Boundary

Customer: BHARAT COKING COAL LIMITED

Title: Land Reclamation Monitoring of Clusters — Job No. 561410027

Subject: Land Reclamation Status of Cluster IX based on Satellite Data (IRS-R2/LISS-IV) of the year 2017.

Activity	Name	Desig	Sign	Date
Prepared	A. Panda	AM (Geo)		
Checked	R. Kumar	HOD Geom		
Approved	R. Kumar	HOD Geom		

cmpdi — A Mini Ratna Company

Scale 440 220 0 440 M

Drg No. HQ REM 4 A4 17 01

Sheet

REVN.

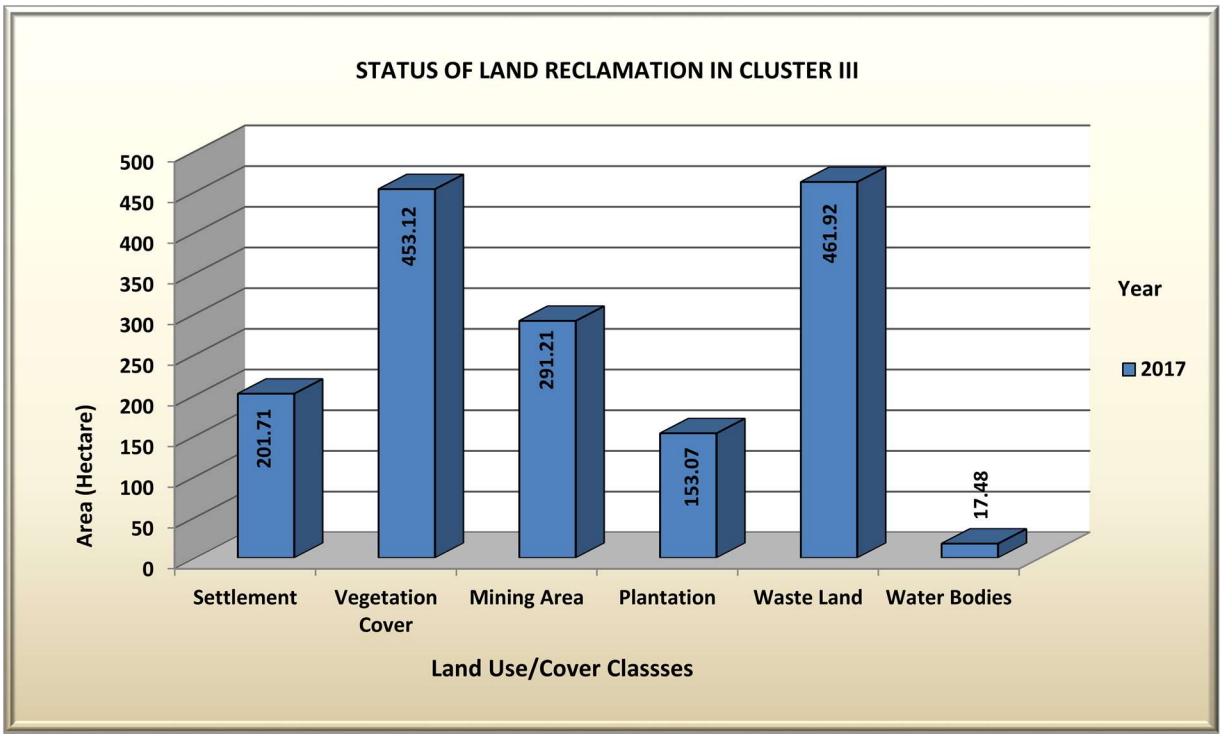


FIGURE - 3

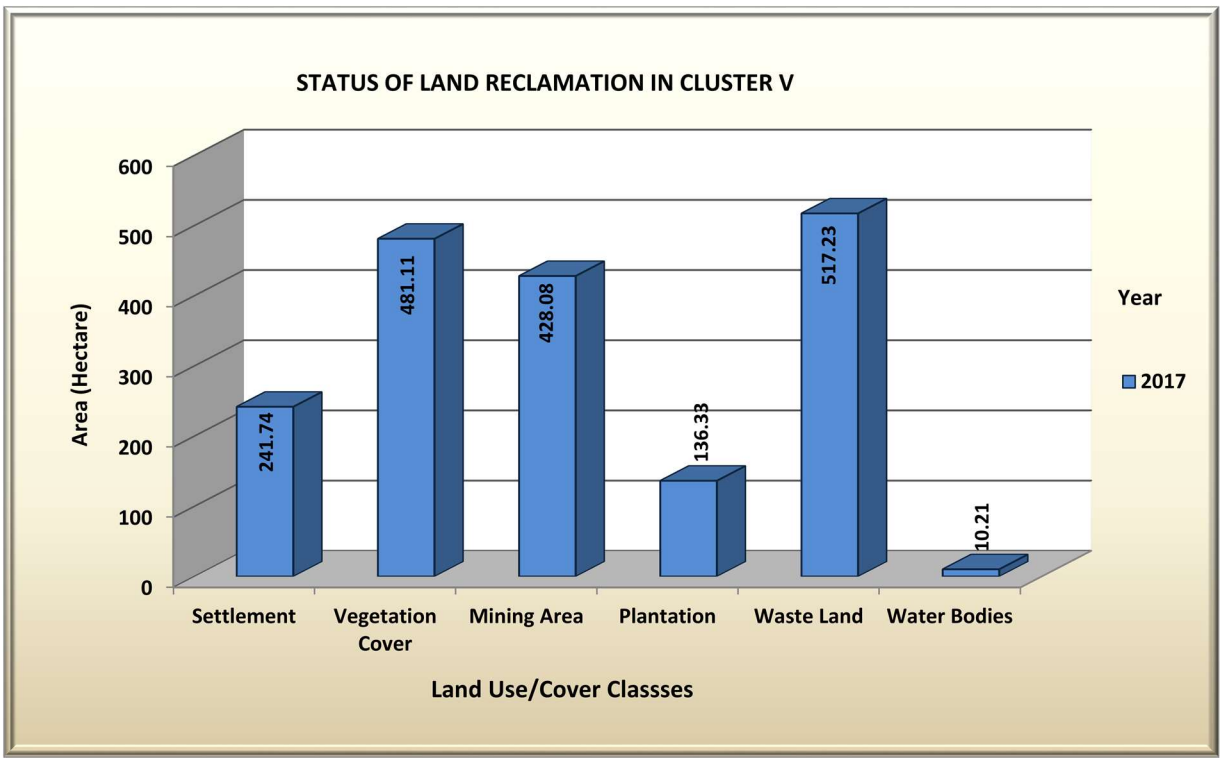


FIGURE - 4

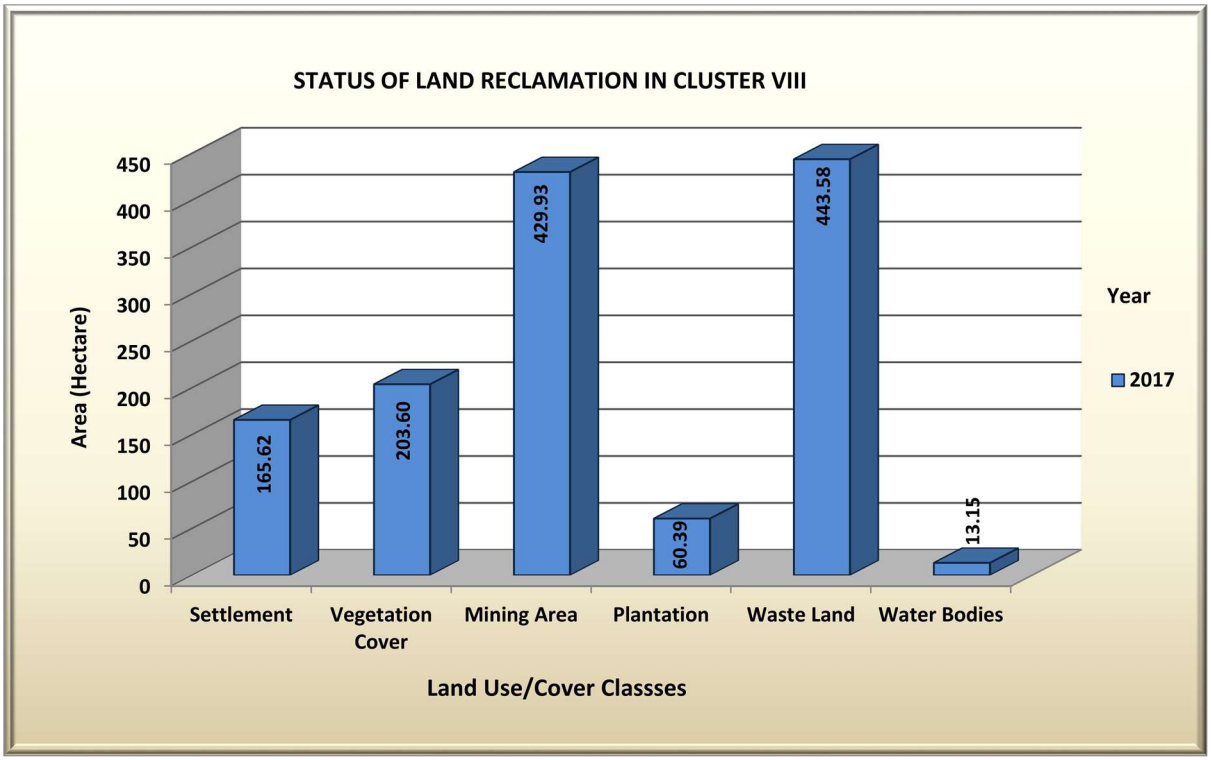


FIGURE –5

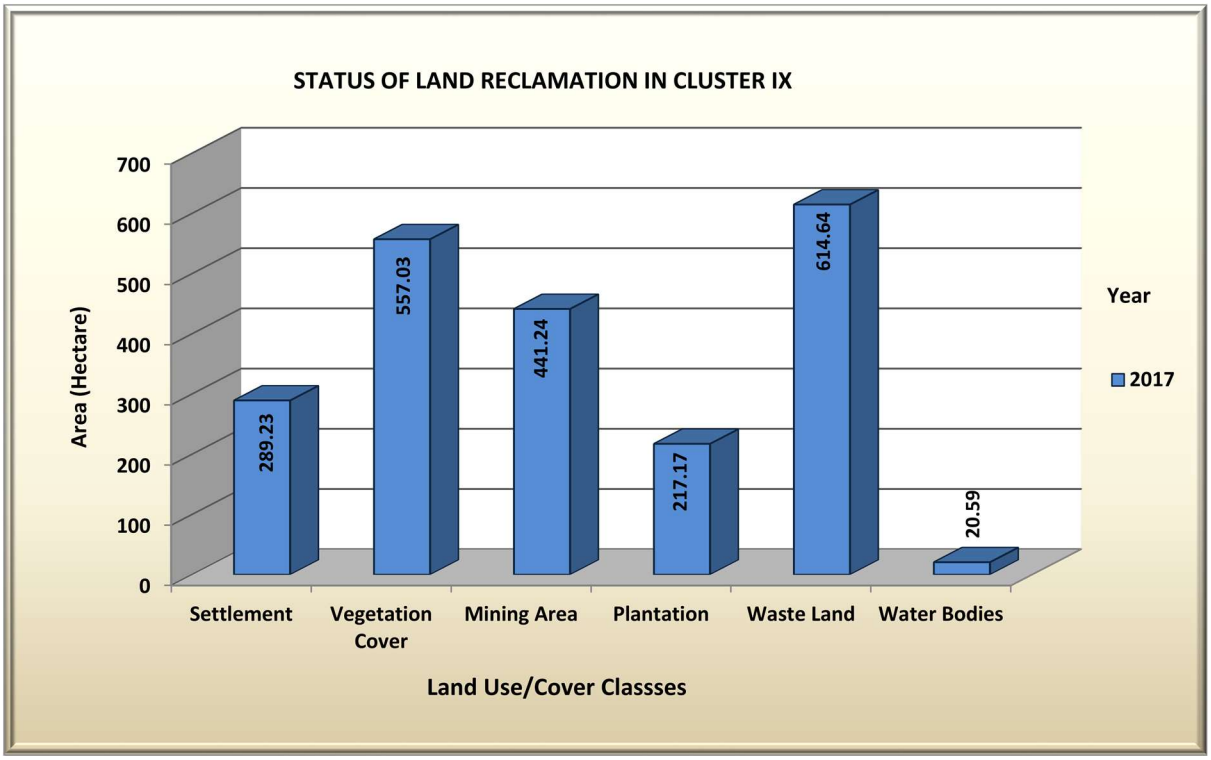


FIGURE-6

Photo 1: Ecological Restoration Site (Tetulmari Colliery)

Photo 2: Eco-Restoration Site (Rajapur OCP)

Photo 3: Social Forestry Plantation (Lodna)

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