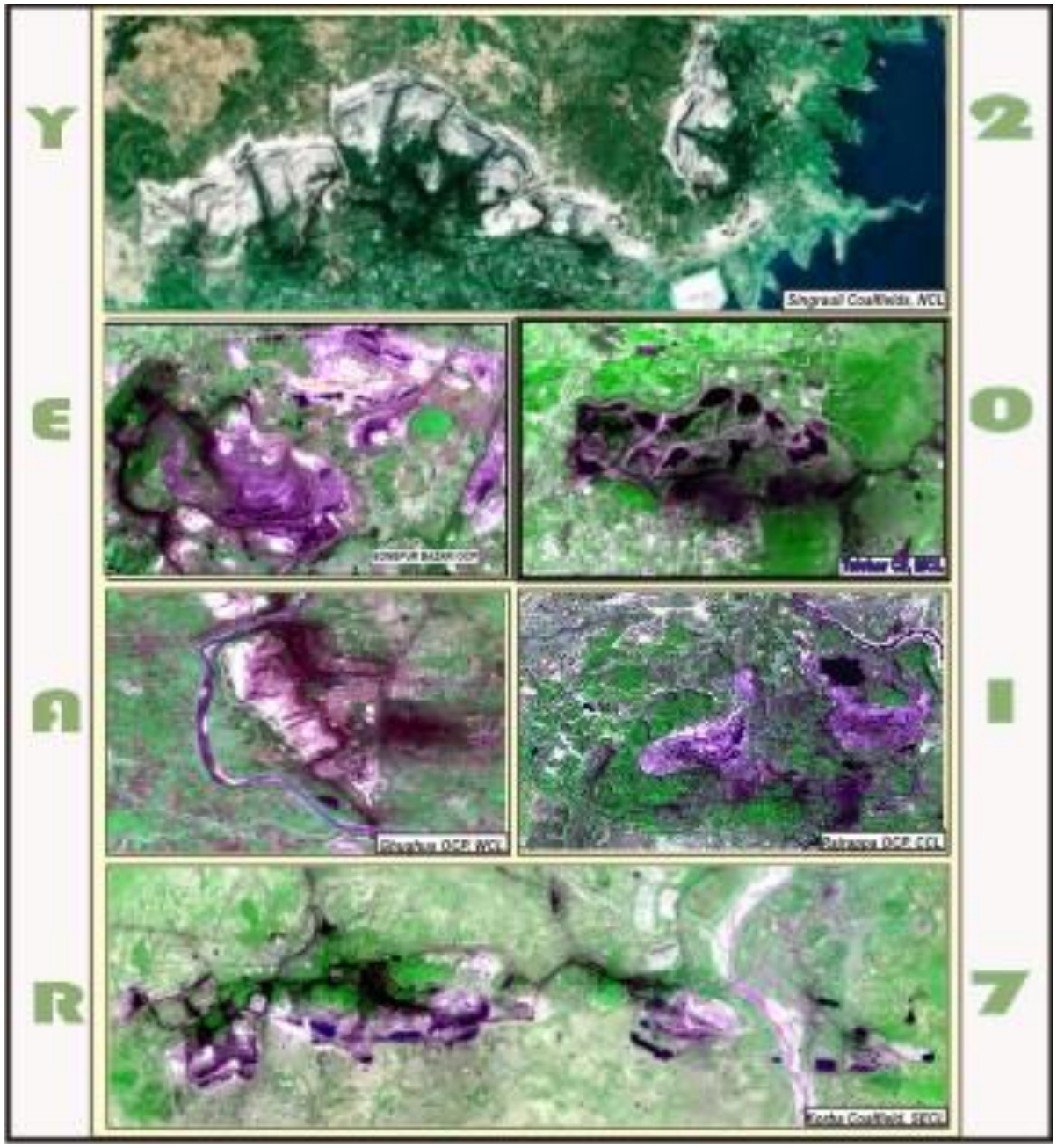
Land Restoration / Reclamation Monitoring of 52 Opencast Coal Mines Projects of CIL producing more than 5 mcm (Coal+OB) based on Satellite Data for the Year 2017



cmpdi
A Mini-Ratna Company

Land Restoration / Reclamation Monitoring of 52 Opencast Coal Mines Projects of CIL producing more than 5 mcm (Coal+OB) based on Satellite Data for the Year 2017

March- 2018

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

Executive Summary

1.0 Project

Land restoration / reclamation monitoring of 52 opencast coal mines in different subsidiaries of Coal India Ltd. (CIL) producing 5 million cu.m. and more (Coal+OB) per year based on satellite data on annual basis.

2.0 Objective

Objective of the land restoration / reclamation monitoring is to assess the area under backfilling, plantation, social forestry, active mining area, water bodies, 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 641.53 Km^2 of the 52 OC projects considered for monitoring during 2017-18; total excavated area is 246.34 Km^2; out of which 59.32 Km^2 area (24.08%) has been planted (Biologically Reclaimed), 93.31 Km^2 area (37.88%) is under backfilling (Technical Reclamation) and 93.71 Km^2 area (38.04%) is under active mining. It is evident from the analysis that 152.63 Km^2 (61.96%) area out of the total excavated area of the 52 OC projects is already under reclamation and balance 93.71 Km^2 (38.04%) area is under active mining. Company wise details are given in Table - 1 & Fig-1.

- On comparing the status of land reclamation carried out in year 2017-18 with respect to years 2016-17 in the 52 Opencast projects of different coal companies, it is evident from the analysis that area under land reclamation has increased from 143.47 Km^2 (Yr. 2016-17) to 152.63 Km^2 (Yr. 2017-18) which includes both plantation (Biological Reclamation) and areas under backfilling (Technical Reclamation). This increase of 9.16 Km^2 area of land reclamation in last one year is the result of the efforts made by CIL's subsidiary companies towards land reclamation. Year wise comparison in land reclamation in different subsidiaries is given in Fig.2.

- It has been observed that in WCL, SECL & BCCL, area under biological reclamation has increased in comparison to previous years whereas in MCL, NCL, CCL & ECL area of biological reclamation has reduced in the leasehold areas of the opencast projects selected for this study primarily because of OB dumping on vegetated OB Dump/ Backfilled /Other areas due to constrain of dumping space.

- It has been observed that in all the subsidiaries of Coal India Limited (CIL), technical reclamation has shown an increasing trend. As compared to the analysis done in the year 2016, it has been found that there has been an overall increase 10.36 Km^2 area commutatively in the year 2017.

- In has been also observed that in subsidiaries like WCL & BCCL, total area under plantation (Green Cover) which includes plantation over backfill, plantation over overburden dumps and plantation done under social forestry etc. has increased as compared to previous year. Overall 24.84% of the total leasehold area of all the subsidiaries of CIL commutatively is under Green Cover.

- It is important to note here that a new table format has been designed by Coal India Ltd. with new parameters for Biological & Technical Reclamation. In case of Biological Reclamation, only plantation on backfilled area is considered. Plantation on over burden dumps and social forestry are shown separately in the new format table. In case of Technical Reclamation, only area under backfilling has been considered.

- For comparative purposes the basic dataset for the year 2016-17 has been fed into the new format so that it can be compared with the results of 2017-18.

Table-1

Company wise Land Reclamation Status in OC projects of CIL
(5 million cu.m. and more Coal +OB) based on Satellite Data of year 2017

(Area in Sq. Kms.)

Sl. No.	Project (Nos.)	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)*	
		2016	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*
1	WCL (10)	95.01	94.38	7.54	7.92	3.06	3.18	14.71	15.34	10.15	9.82	11.50	19.13	22.10	30.23	27.92	28.34	10.60	11.10
				34.12%	26.20%	13.85%	10.52%					52.04%	63.28%			29.39%	30.03%	47.96%	36.72%
2	SECL (10)	157.20	157.20	21.65	23.38	24.94	24.96	10.53	10.89	9.04	8.47	17.83	18.56	64.41	66.90	44.49	44.32	46.59	48.34
				33.61%	34.95%	38.71%	37.31%					27.67%	27.74%			28.30%	28.19%	72.33%	72.26%
3	NCL (10)	174.28	174.28	19.94	23.92	15.57	14.81	11.27	11.07	28.12	27.81	28.75	30.71	64.26	69.44	54.96	53.69	35.51	38.73
				31.03%	34.45%	24.23%	21.33%					44.74%	44.23%			31.54%	30.81%	55.26%	55.77%
4	MCL (13)	86.36	111.44	17.82	19.26	8.56	8.22	3.17	3.06	2.89	3.25	14.51	15.87	40.89	43.35	14.61	14.53	26.38	27.48
				43.59%	44.43%	20.92%	18.96%					35.49%	36.61%			16.92%	13.04%	64.51%	63.39%
5	CCL (05)	48.47	48.47	6.99	7.86	5.71	5.38	4.45	4.01	4.08	3.73	3.75	3.89	16.45	17.13	14.24	13.12	12.70	13.24
				42.49%	45.88%	34.71%	31.41%					22.80%	22.71%			29.38%	27.07%	77.20%	77.29%
6	BCCL (02)	16.32	16.32	3.43	3.71	0.48	0.57	0.26	0.31	0.86	0.88	0.81	0.88	4.72	5.16	1.60	1.76	3.91	4.28
				72.67%	71.90%	10.17%	11.05%					17.16%	17.05%			9.80%	10.78%	82.84%	82.95%
7	ECL (02)	39.44	39.44	5.58	7.26	2.21	2.20	0.26	0.13	1.27	1.25	4.13	4.67	11.92	14.13	3.74	3.58	7.79	9.46
				46.81%	51.38%	18.54%	15.57%					34.65%	33.05%			9.48%	9.08%	65.35%	66.95%
	TOTAL (52)	**617.08**	**641.53**	**82.95**	**93.31**	**60.52**	**59.32**	**44.64**	**44.81**	**56.41**	**55.21**	**81.28**	**93.71**	**224.75**	**246.34**	**161.56**	**159.34**	**143.47**	**152.63**
				36.91%	**37.88%**	**26.93%**	**24.08%**					**36.16%**	**38.04%**			**26.18%**	**24.84%**	**63.84%**	**61.96%**

(% 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 backfilled only
3. Area under Active mining includes coal quarry site, quarry filled with water etc.
4. Social Forestry and Plantation on external OB dump are not included in Biological Reclamation and are put under separate categories as shown in the table.
5. (%) calculated in the above table is in respect of total excavated area except for "Total area under plantation" where % is in terms of leasehold area.

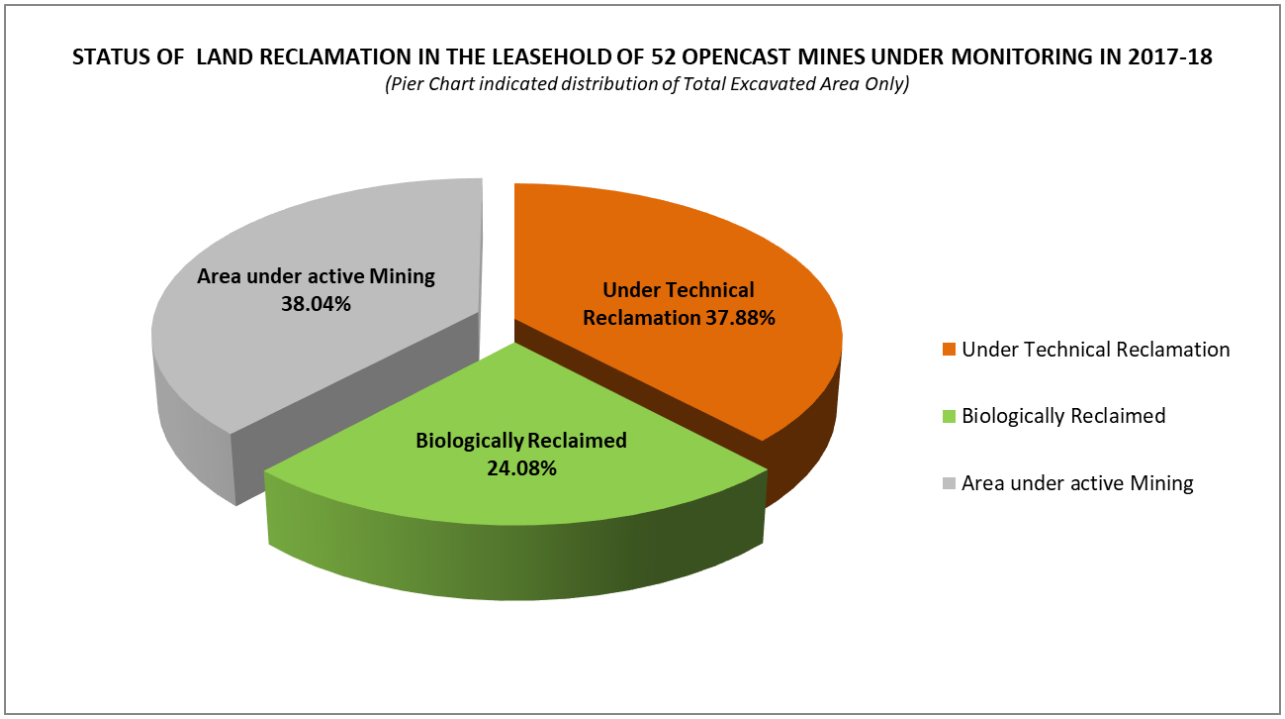


Fig.1 : **Pie Chart showing Status of Land Reclamation in CIL Subsidiaries**

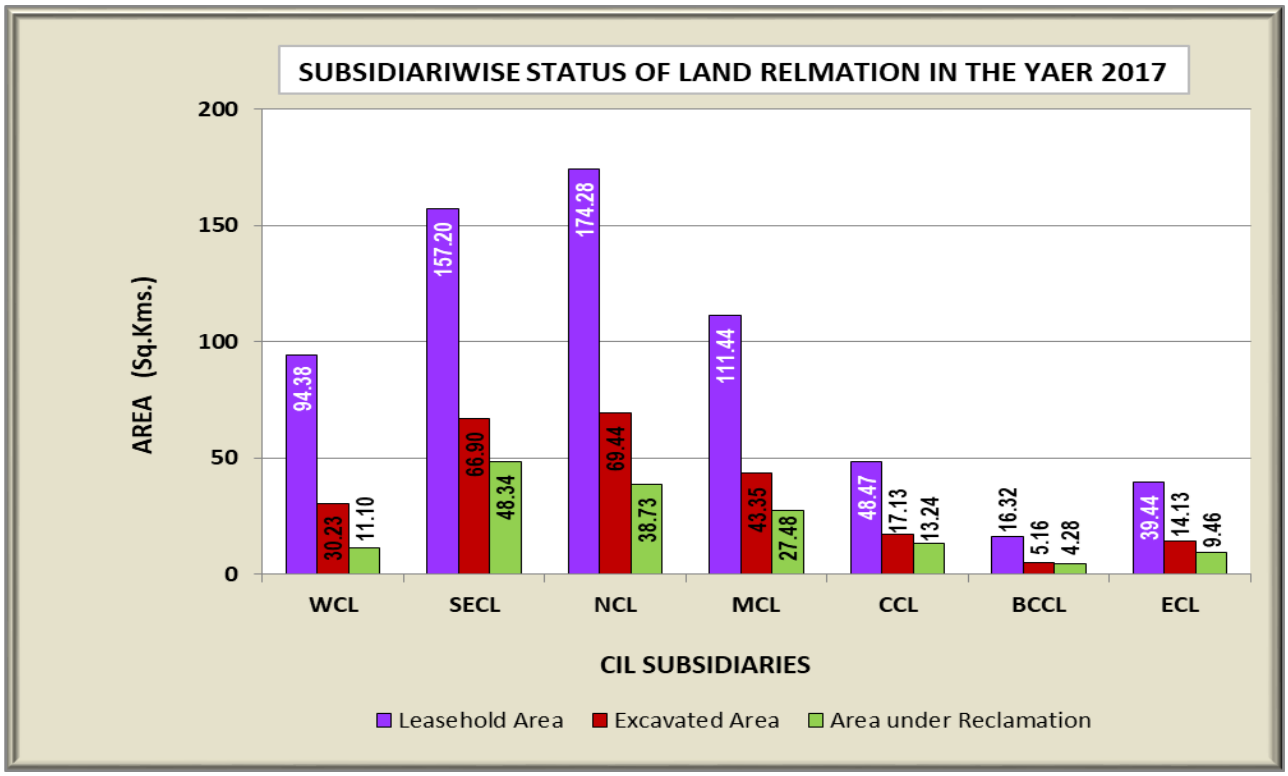


Fig. 2 : **Company wise Land Reclamation Status in the Year 2017**

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.

Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env/2009/2428 dated 29.12.2009 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring land reclamation. status of all the opencast coal mines having production of more than 5 million m^3 per annum (coal + OB taken together per annum) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining. Further, a revised work order was issued vide letter no. CIL/WBP/Env/2011/4706 dated 12.10.2012 from Coal India Limited for the period 2012-13 to 2016-17 which was subsequently followed by another work order vide letter no. CIL/WBP/Env/2017/DP/8477 dated 21.09.2017 from Coal India Limited for the period 2017-18 to 2021-22 for land reclamation monitoring of opencast projects and vegetation cover monitoring of 19 major coalfields. According to this work order, all mines in CIL with output capacity of 5 million cu. m (coal +OB) shall be monitored every year and all mines below this capacity shall be monitored at an interval of 3 years. All coalfields in CIL shall also be monitored at an interval of 3 years as per a defined plan. The result of land reclamation status of all such mines to be put on the website of CIL (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detail report to be submitted to Coal India and respective subsidiaries.

1.2 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.

1.3 CMPDI undertook the above study and the present report is embodying the findings in nutshell carrying out for the 52 opencast projects of different subsidiaries producing 5 million cubic m. coal +OB or more in the year 2017-18. This study is being carried out in since year 2008 on annual basis and progressive changes in the status of land reclamation have been assessed.

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 fig 3. Following steps are involved in land reclamation /restoration monitoring:

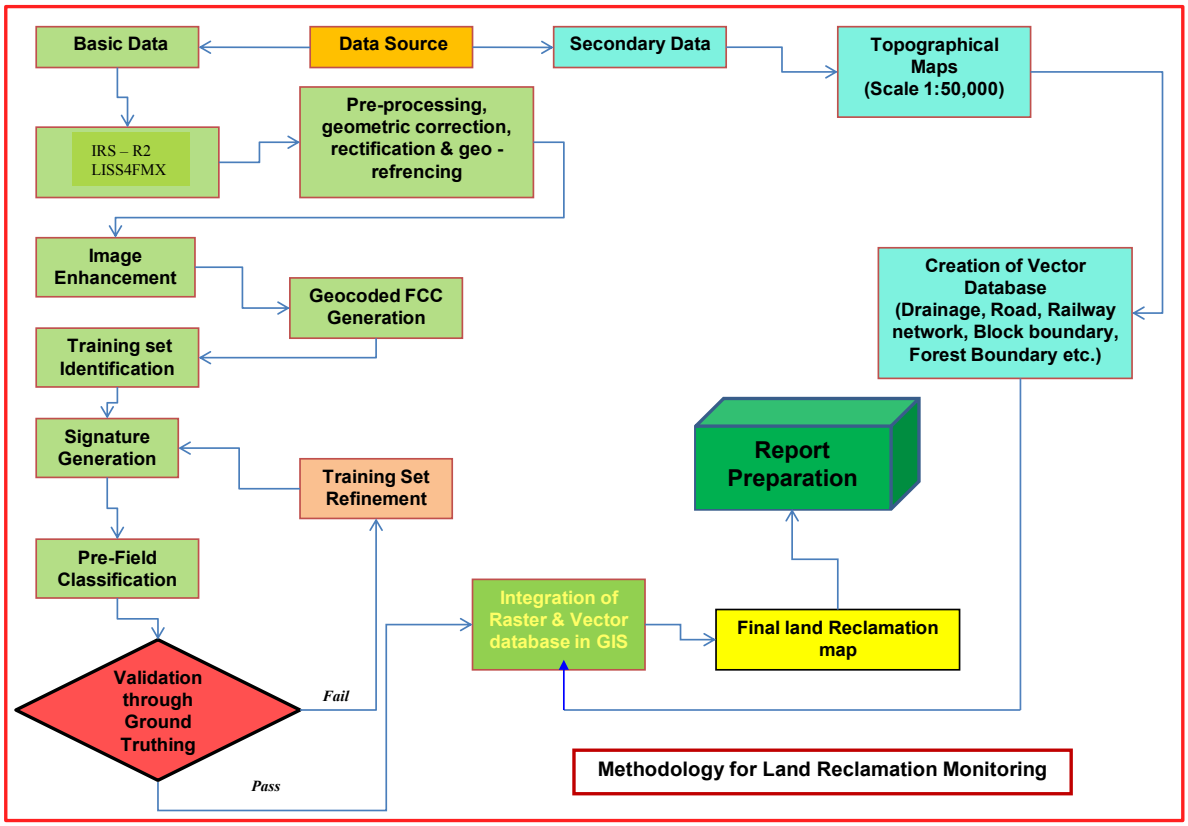


Fig.3 : Methodology for Land Reclamation Monitoring

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 Professional v2014 s/w / PCI Geomatica 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 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 Professional v2014 s/w / PCI Geomatica digital image processing s/w and enhance the image quality for proper 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 Professional v2014/ PCI Geomatica digital image processing s/w.

- **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 Work Plan

4.1 Total 52 opencast projects producing 5 million cubic m. and more (Coal + OB together) during the year 2017-18 were taken up for the study. Based on the *RESOURCESAT-2* satellite data, land reclamation / mine closure monitoring was carried out using ERDAS IMAGINE digital image processing s/w and Arc-Info GIS. Baseline data on reclamation of these OC projects of CIL's subsidiaries have been generated and the same has been annually updated since year 2008.

4.2 Besides project wise land reclamation monitoring, coalfield wise vegetation cover monitoring on regional scale has also been planned for the major 28 coalfields of India at regular interval of three years using remote sensing satellite data to assess the regional impact of coal mining and associated industrialization on the land use and vegetation cover in the coalfield. Geo-environmental baseline data for Raniganj, Jharia , East Bokaro, West Bokaro, Karanpura, Singrauli (Moher Sub-basin), Korba, Bisrampur, Shoagpur, Mand-Raigarh, Talcher, Ib Valley , Wardha Valley, Bander , Kamptee, Umrer, Pench Kanhan and Makum coalfields based on the satellite data have been generated and will be monitored regularly at three years interval.

4.3 The list of subsidiary wise 52 opencast projects taken up for Land Reclamation Monitoring based on satellite data of year 2017 is given in table below :

Subsidiary *(No. of Projects)*	**Opencast Projects** *(5 million Cu.m. Coal +OB or more per annum)*
WCL (10)	Sasti, Padmapur, Durgapur, Mugoli, Umrer, Ukni, Niljai, New Majri, Pimpalgaon & Ghugus
SECL (10)	Dipka, Gevra, Kusmunda, Manikpur, Bishrampur, Dugga, Jamuna, Rajnagar, Dhanpuri & Chirimiri
NCL (10)	Amlohri, Nigahi, Jayant, Dudhichua, Khadia, Krishnashila, Bina, Kakri, Jhingurdah, Block-B
MCL (13)	Ananta, Balram, Lingraj, Bharatpur, Bhubaneswari, Jagannath, Hingula, Belpahar, Lakhanpur, Samleswari, Lajkura, Siarmal & Basundhara West Extension
CCL (05)	Ashoka, Piparwar, K.D. Hesalong, Parej East & Rajrappa
BCCL (02)	Block-II, Muraidih
ECL (02)	Sonpur-Bazari, Rajmahal
TOTAL (52)	

4.4 Subsidiary wise land reclamation status of the above mentioned 52 OC projects derived from satellite data for the year 2017 are given in the following pages:

CENTRAL COALFIELDS LIMITED

9.0 Land Reclamation Status in Central Coalfields Ltd.

9.1 Following 5 OC projects producing more than 5 million m^3. (Coal + OB together) of Central Coalfields Ltd. have been taken up during the year 2017-18 for land reclamation monitoring:

- Ashok
- Piparwar
- KD Hesalong
- Rajrappa
- Parej East

9.2 Project wise Land Reclamation status in CCL in the year 2017 is given in Table 9.1 and also shown graphically in Fig 9.1. Area statistics of different land use classes present in OC projects in the year 2017 is given in Table 9.2. Land use maps derived from the satellite data is given in Plate no. 9.1 to 9.5. Changes in land use status are shown in Fig. 9.2 – 9.6 and field photographs showing plantation and backfilled area in mining projects in photo 9.1-9.5.

9.3 Study reveals that 77.29% of excavated area has already come under reclamation by CCL in the above 5 OC projects, out of which 31.41% area has been re-vegetated (Biological Reclamation) and 45.88 % area is under backfilling (Technical Reclamation).

9.4 After analyzing the satellite data of year 2017, it is seen that the plantation carried out on backfilled area, OB dumps as well as under social forestry in all the 5 mines of CCL has reached 13.12 Km^2 till the year 2017.

9.5 It may be seen from the Table.9.1 that area of total reclamation has reached 77.29% of the total excavated area till the year 2017.

TABLE – 9.1

Project wise Land Reclamation Status in OC projects of Central Coalfields Ltd Based on Satellite data of the Year 2017

(Area in Sq. Kms.)

Sl. No.	Project	Total Leasehold Area	Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (%Green Cover Generated in Leasehold)		Total Area under Reclamation	
					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)*	
			2016	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*	*2016*	*2017*
1	**Ashok**	6.75	1.58	1.78	0.96	0.88	0	0	0.34	0.34	0.97	0.93	3.51	3.59	1.30	1.22	2.54	2.66
			45.01%	49.58%	27.35%	24.51%					27.64%	25.91%			19.26%	18.07%	72.36%	74.09%
2	**Piparwar**	11.20	1.72	2.02	1.55	1.35	0.8	0.62	1.65	1.30	1.44	1.46	4.71	4.83	4.00	3.27	3.27	3.37
			36.52%	41.82%	32.91%	27.95%					30.57%	30.23%			35.71%	29.20%	69.43%	69.77%
3	**KDH**	4.50	1.38	1.52	1.33	1.26	0.05	0.03	0.12	0.12	0.36	0.38	3.07	3.16	1.50	1.41	2.71	2.78
			44.95%	48.10%	43.32%	39.87%					11.73%	12.03%			33.33%	31.33%	88.27%	87.97%
4	**Parej East**	6.20	0.44	0.52	0.6	0.64	0.04	0.05	0.09	0.09	0.17	0.27	1.21	1.43	0.73	0.78	1.04	1.16
			36.36%	36.36%	49.59%	44.76%					14.05%	18.88%			11.77%	12.58%	85.95%	81.12%
5	**Rajrappa**	19.82	1.87	2.02	1.27	1.25	3.56	3.31	1.88	1.88	0.81	0.85	3.95	4.12	6.71	6.44	3.14	3.27
			47.34%	49.03%	32.15%	30.34%					20.51%	20.63%			33.85%	32.49%	79.49%	79.37%
	TOTAL	**48.47**	**6.99**	**7.86**	**5.71**	**5.38**	**4.45**	**4.01**	**4.08**	**3.73**	**3.75**	**3.89**	**16.45**	**17.13**	**14.24**	**13.12**	**12.70**	**13.24**
			42.49%	**45.88%**	**34.71%**	**31.41%**					**22.80%**	**22.71%**			**29.38%**	**27.07%**	**77.20%**	**77.29%**

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

***Note**: In reference to 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 Area under Barren Backfilling only.*
3. *Area under **Active Mining** includes Coal Quarry, Advance Quarry Site, Quarry Filled with Water, if any.* Area of Coal Dump has been excluded from Area under Active Mining in this table.
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".*

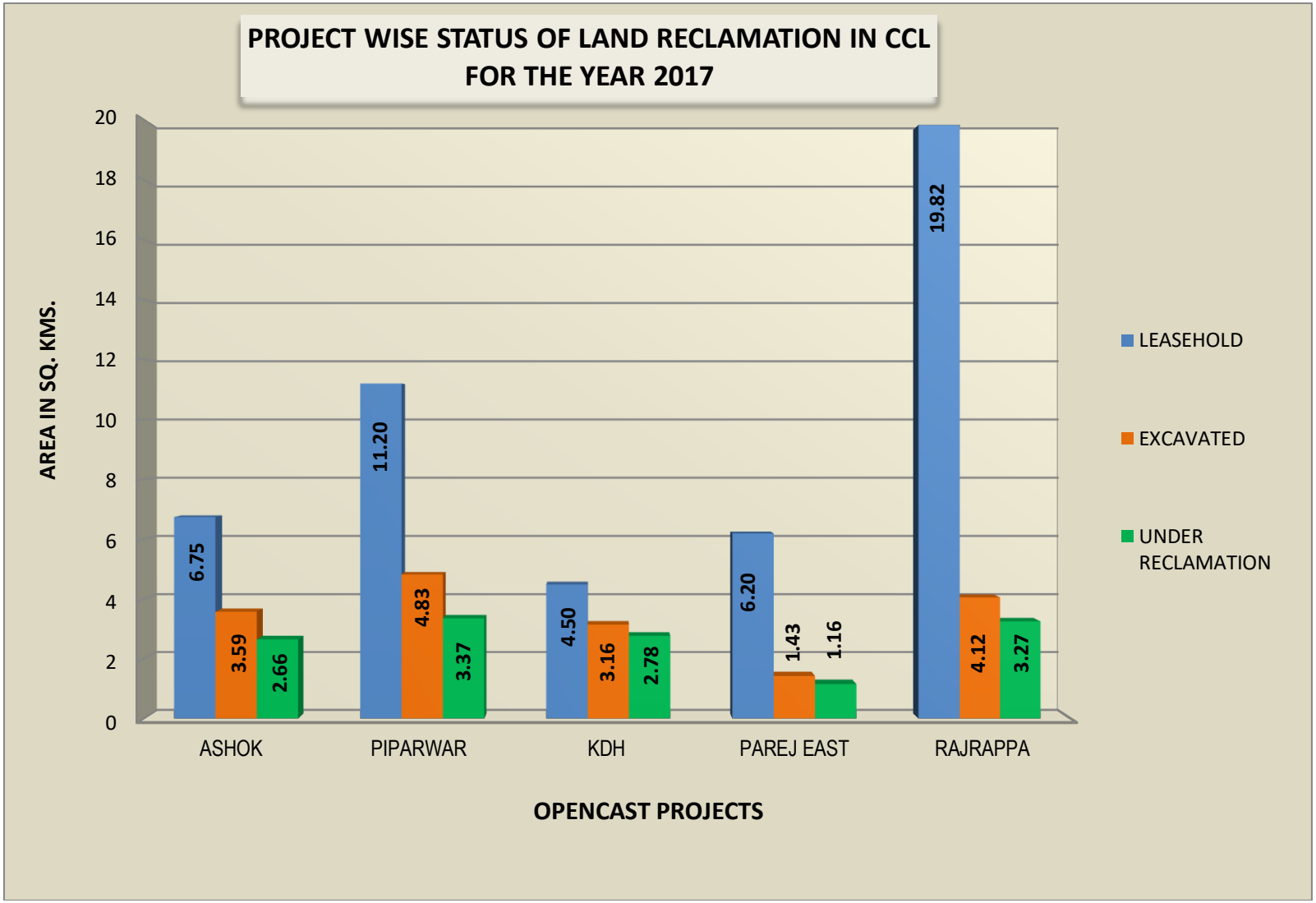


Fig. 9.1 : **Project wise Land Reclamation Status in Year 2017**

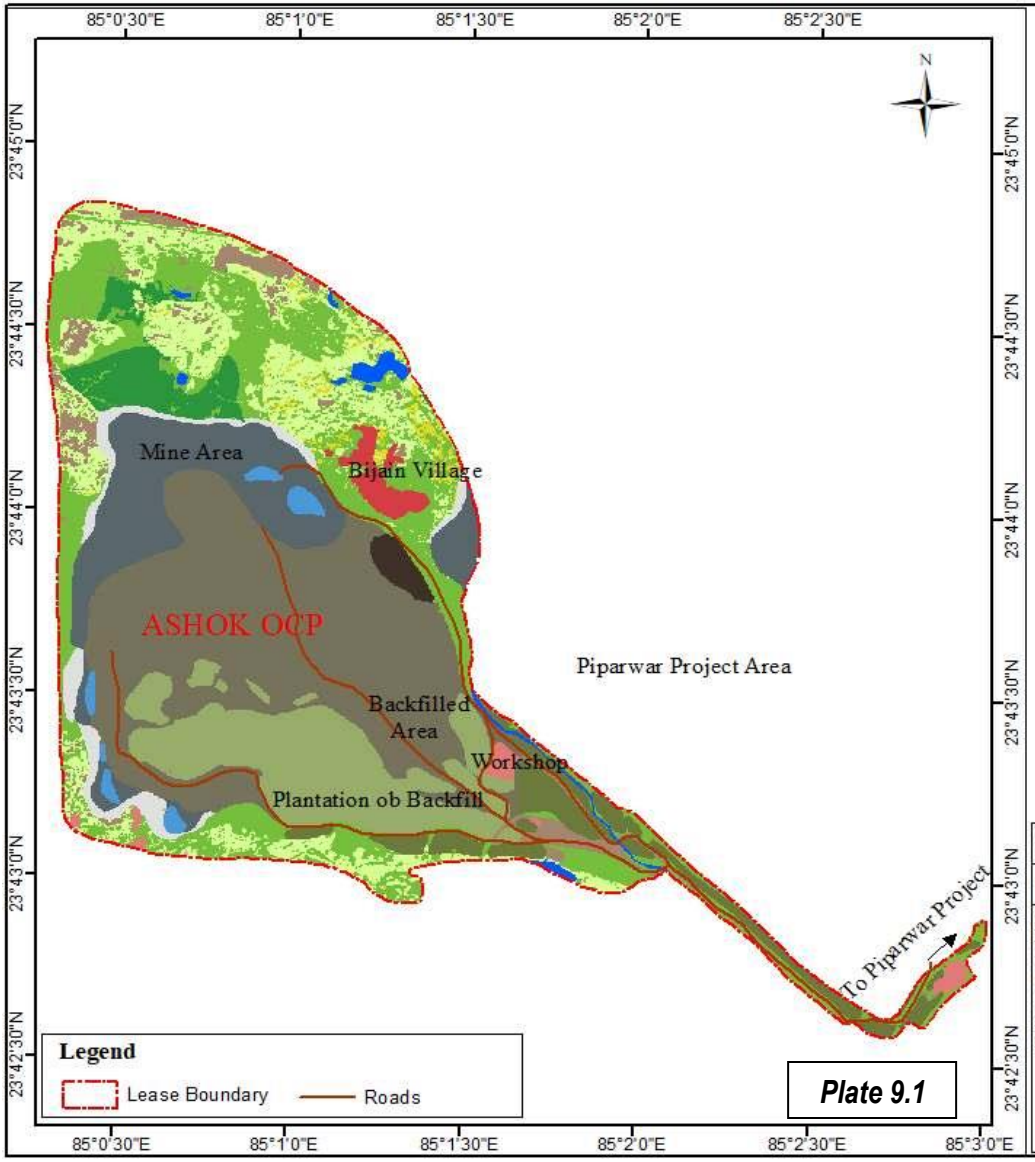
Table 9.2

STATUS OF LAND RECLAMTION IN CENTRAL COALFIELDS LIMITED

BASED ON THE SATELLITE DATA OF THE YEAR 2017

(Area in Sq. Km)

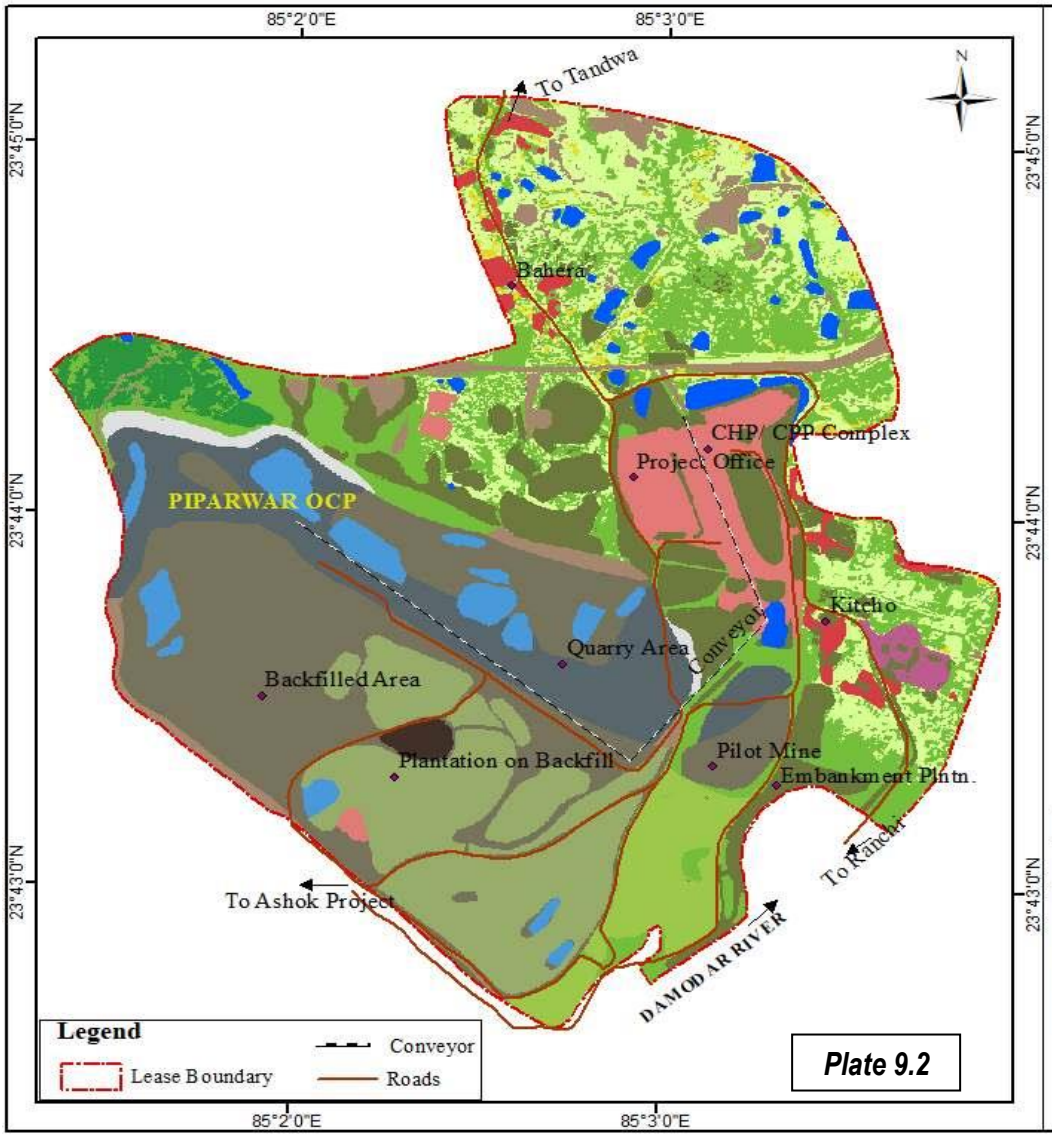
		ASHOK		PIPARWAR		KDH		RAJRAPPA		PAREJ EAST		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.22	3.26	0.16	1.43	0.00	0.00	1.50	7.57	1.31	21.13	3.19	6.58
	Total Forest	**0.23**	**3.26**	**0.16**	**1.43**	**0.00**	**0.00**	**1.50**	**7.57**	**1.31**	**21.13**	**3.19**	**6.58**
	Scrubs	**1.21**	**17.93**	**1.41**	**12.59**	**0.48**	**10.67**	**4.61**	**23.26**	**1.92**	**30.97**	**9.63**	**19.87**
PLANTATION	Social Forestry	0.34	5.04	1.30	11.61	0.12	2.67	1.88	9.49	0.09	1.45	3.73	7.70
	Plantation on OB Dump	0.00	0.00	0.62	5.54	0.03	0.67	3.31	16.70	0.05	0.81	4.01	8.27
	Plantation on Backfill (Biological Reclamation)	0.88	13.04	1.35	12.05	1.26	28.00	1.25	6.31	0.64	10.32	5.38	11.10
	Total Plantation	**1.22**	**18.07**	**3.27**	**29.20**	**1.41**	**31.33**	**6.44**	**32.49**	**0.78**	**12.58**	**13.12**	**27.07**
	Total Vegetation	**2.65**	**39.26**	**4.84**	**43.21**	**1.89**	**42.00**	**12.55**	**63.32**	**4.01**	**64.68**	**25.94**	**53.52**
ACTIVE MINING	Coal Quarry	0.71	10.52	1.02	9.11	0.12	2.67	0.54	2.72	0.19	3.06	2.58	5.32
	Advance Quarry Site	0.16	2.37	0.10	0.89	0.00	0.00	0.16	0.81	0.02	0.32	0.44	0.91
	Quarry Filled With Water	0.06	0.89	0.34	3.04	0.26	5.78	0.15	0.76	0.06	0.97	0.87	1.79
	Total Area under *Active Mining*	**0.93**	**13.78**	**1.46**	**13.04**	**0.38**	**8.45**	**0.85**	**4.29**	**0.27**	**4.35**	**3.89**	**8.03**
	Coal Dump	0.05	0.74	0.06	0.54	0.08	1.78	0.09	0.45	0.11	1.77	0.39	0.80
	Barren OB Dump	0.00	0.00	0.00	0.00	0.26	5.78	0.98	4.94	0.22	3.55	1.46	3.01
	Area Under Backfilling (Technical Reclamation)	1.78	26.37	2.02	18.04	1.52	33.78	2.02	10.19	0.52	8.39	7.86	16.22
	Total Area under *Mine Operation*	**2.76**	**40.89**	**3.54**	**31.62**	**2.24**	**49.79**	**3.94**	**19.87**	**1.12**	**18.06**	**13.60**	**28.06**
WASTELAND	Waste Lands	0.28	4.15	0.54	4.82	0.12	2.67	0.92	4.64	0.24	3.87	2.10	4.33
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.32	0.02	0.04
	Total Wasteland	**0.28**	**4.15**	**0.54**	**4.82**	**0.12**	**2.67**	**0.92**	**4.64**	**0.26**	**4.19**	**2.12**	**4.37**
WATERBODY	Reservoir, Nallah, Ponds	0.06	0.89	0.23	2.05	0.02	0.44	0.03	0.15	0.06	0.97	0.40	0.83
	Total Waterbodies	**0.06**	**0.89**	**0.23**	**2.05**	**0.02**	**0.44**	**0.03**	**0.15**	**0.06**	**0.97**	**0.40**	**0.83**
AGRICULTURE	Crop Lands	0.07	1.04	0.12	1.07	0.00	0.00	0.08	0.40	0.04	0.65	0.31	0.64
	Fallow Lands	0.80	11.85	1.20	10.71	0.02	0.44	1.16	5.85	0.34	5.48	3.52	7.26
	Total Agriculture	**0.87**	**12.89**	**1.32**	**11.79**	**0.02**	**0.44**	**1.24**	**6.26**	**0.38**	**6.13**	**3.83**	**7.90**
SETTLEMENTS	Urban Settlement	0.00	0.00	0.07	0.63	0.02	0.44	0.47	2.37	0.16	2.58	0.72	1.49
	Rural Settlement	0.08	1.19	0.16	1.43	0.00	0.00	0.31	1.56	0.17	2.74	0.72	1.49
	Industrial Settlement	0.05	0.74	0.50	4.46	0.19	4.22	0.36	1.82	0.04	0.65	1.14	2.35
	Total Settlement	**0.13**	**1.93**	**0.73**	**6.52**	**0.21**	**4.67**	**1.14**	**5.75**	**0.37**	**5.97**	**2.58**	**5.32**
	Grand Total	**6.75**	**100.00**	**11.20**	**100.00**	**4.50**	**100.00**	**19.82**	**100.00**	**6.20**	**100.00**	**48.47**	**100.00**



Area Statistics - Ashok OCP (2017)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		0.22	3.26
	Total Forest Area		**0.22**	**3.26**
Scrubs	**Scrubs**		**1.21**	**17.93**
Plantation	Social Forestry		0.34	5.04
	Plantation on Backfill		0.88	13.04
	Plantation on OB Dump		0.00	0.00
	Total Plantation		**1.22**	**18.07**
	Total Vegetation Area		**2.65**	**39.26**
Agriculture	Crop Land		0.07	1.04
	Fallow Land		0.80	11.85
	Total Agriculture Area		**0.87**	**12.89**
Waste Land	Waste Land		0.28	4.15
	Total Waste Land		**0.28**	**4.15**
Mining Area	Coal Quarry		0.71	10.52
	Barren OB Dump		0.00	0.00
	Area Under Backfilling		1.78	26.37
	Water Filled Quarry		0.06	0.89
	Coal Dump		0.05	0.74
	Advance Quarry Site		0.16	2.37
	Total Mining Area		**2.76**	**40.89**
Settlements	Rural Settlement		0.08	1.19
	Urban Settlement		0.00	0.00
	Industrial Settlement		0.05	0.74
	Total Settlement Area		**0.13**	**1.93**
Water Body	**River, Ponds**		**0.06**	**0.89**
		Total	**6.75**	**100.00**

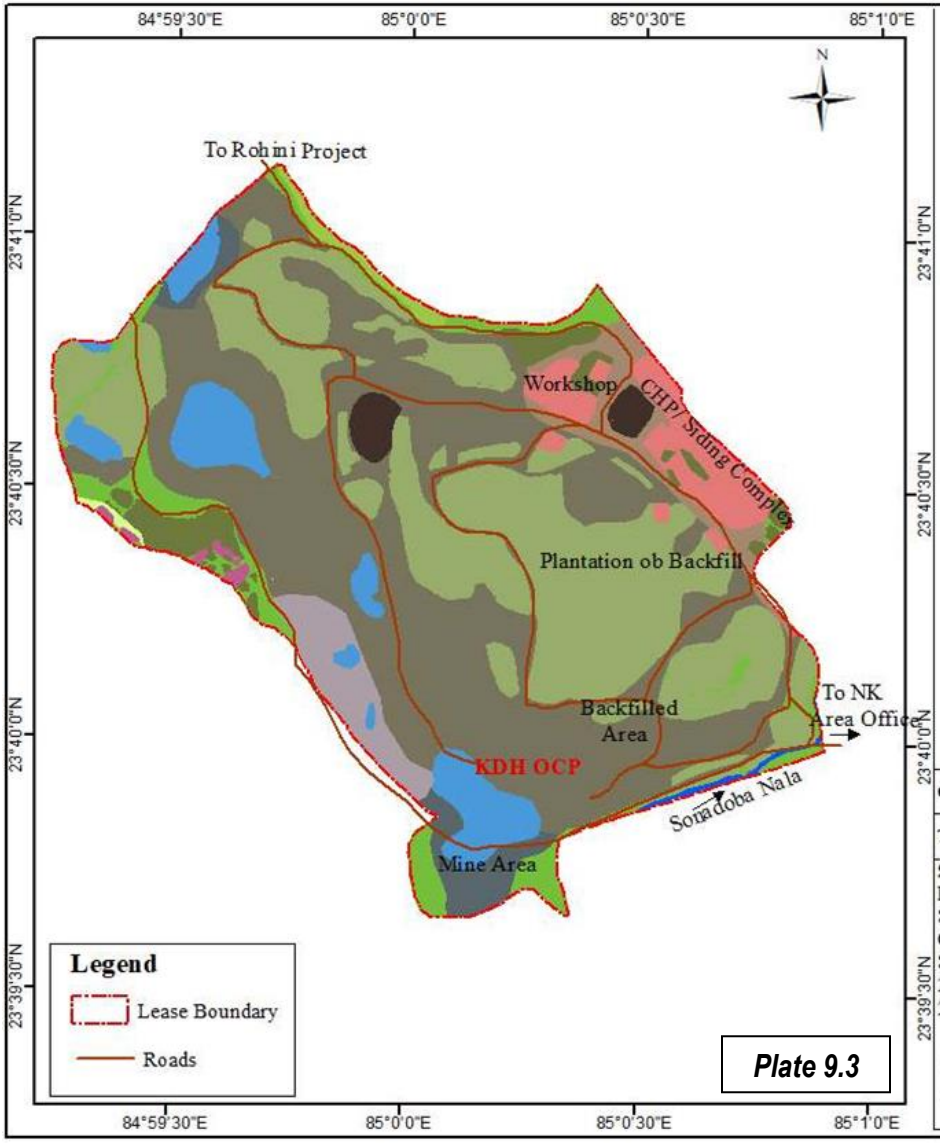
Customer	Central Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject Land Reclamation Status of Ashok OCP based on Satellite Data (RS-2/L-IV) of the year 2017	Activity	Name	Designation	Signature	Date
	Prepared	Hariharalal B	Sr. Mgr(System)		25-3-18
	Checked	A.K. Singh	Ch. Mgr(RSC)		27-3-18
	Approved	R. Kumar	HOD(Geomatics)		28-3-18
cmpdi A Miniratna Company	Scale: 0 0.25 0.5 1 km				Sheet 1
	Drg No. HQ REM 17 3 A4 05				Rev No.0



Area Statistics - Piparwar OCP (2017)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		0.16	1.43
	Total Forest Area		**0.16**	**1.43**
Scrubs	**Scrubs**		**1.41**	**12.59**
Plantation	Social Forestry		1.30	11.61
	Plantation on Backfill		1.35	12.05
	Plantation on OB Dump		0.62	5.54
	Total Plantation		**3.27**	**29.20**
	Total Vegetation Area		**4.84**	**43.21**
Agriculture	Crop Land		0.12	1.07
	Fallow Land		1.20	10.71
	Total Agriculture Area		**1.32**	**11.79**
Waste Land	Waste Land		0.54	4.82
	Sand Body		0.00	0.00
	Total Waste Land		**0.54**	**4.82**
Mining Area	Coal Quarry		1.02	9.11
	Barren OB Dump		0.00	0.00
	Area Under Backfilling		2.02	18.04
	Water Filled Quarry		0.34	3.04
	Coal Dump		0.06	0.54
	Advance Quarry Site		0.10	0.89
	Total Mining Area		**3.54**	**31.61**
Settlements	Rural Settlement		0.16	1.43
	Urban Settlement		0.07	0.63
	Industrial Settlement		0.50	4.46
	Total Settlement Area		**0.73**	**6.52**
Water Body	**River, Ponds**		**0.23**	**2.05**
		Total	**11.20**	**100.00**

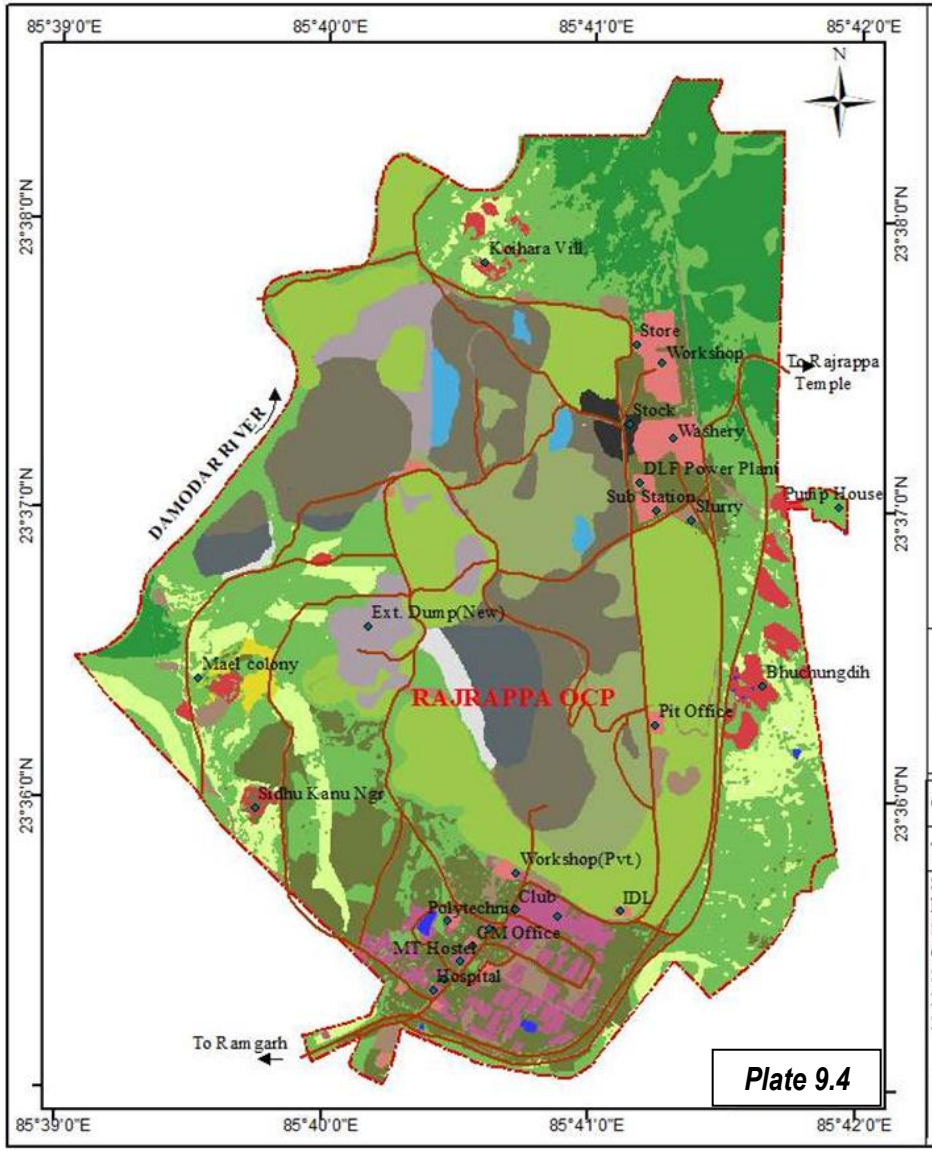
Customer	Central Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject Land Reclamation Status of Piparwar OCP based on Satellite Data (RS-2/L-IV) of the year 2017	Activity	Name	Designation	Signature	Date
	Prepared	Hariharalal B	Sr. Mgr(System)		24-3-18
	Checked	A.K. Singh	Ch. Mgr(RSC)		27-3-18
	Approved	R. Kumar	HOD(Geomatics)		28-3-18
cmpdi	Scale: 0 0.25 0.5 1 km				Sheet 1
	Drg No. HQ REM 17 3 A4 06				Rev No.0



Area Statistics - KDH OCP (2017)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest Area		**0.00**	**0.00**
Scrubs	**Scrubs**		**0.48**	**10.67**
Plantation	Social Forestry		0.12	2.67
	Plantation on Backfill		1.26	28.00
	Plantation on OB Dump		0.03	0.67
	Total Plantation		**1.41**	**31.33**
	Total Vegetation Area		**1.89**	**42.00**
Agriculture	Crop Land		0.00	0.00
	Fallow Land		0.02	0.44
	Total Agriculture Area		**0.02**	**0.44**
Waste Land	Waste Land		0.12	2.67
	Sand Body		0.00	0.00
	Total Waste Land		**0.12**	**2.67**
Mining Area	Coal Quarry		0.12	2.67
	Barren OB Dump		0.26	5.78
	Area Under Backfilling		1.52	33.78
	Water Filled Quarry		0.26	5.78
	Coal Dump		0.08	1.78
	Advance Quarry Site		0.00	0.00
	Total Mining Area		**2.24**	**49.78**
Settlements	Rural Settlement		0.00	0.00
	Urban Settlement		0.02	0.44
	Industrial Settlement		0.19	4.22
	Total Settlement Area		**0.21**	**4.67**
Water Body	**River, Ponds**		**0.02**	**0.44**
		Total	**4.50**	**100.00**

Customer	Central Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject Land Reclamation Status of KDH OCP based on Satellite Data (RS-2/L-IV) of the year 2017	Activity	Name	Designation	Signature	Date
	Prepared	Hariharalal B	Sr. Mgr(System)		19-3-18
	Checked	A.K. Singh	Ch. Mgr(RSC)		21-3-18
	Approved	R. Kumar	HOD(Geomatics)		26-3-18
cmpdi A Miniratna Company	Scale: 0 0.25 0.5 1 km				Sheet 1
	Drg No. HQ REM 17 3 A4 07				Rev No.0



Legend

- Lease Boundary
- Roads

Area Statistics - Rajrappa OCP (2017)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		1.50	7.57
	Total Forest Area		**1.50**	**7.57**
Scrubs	**Scrubs**		**4.61**	**23.26**
Plantation	Social Forestry		1.88	9.49
	Plantation on Backfill		1.25	6.31
	Plantation on OB Dump		3.31	16.70
	Total Plantation		**6.44**	**32.49**
	Total Vegetation Area		**12.55**	**63.32**
Agriculture	Crop Land		0.08	0.40
	Fallow Land		1.16	5.85
	Total Agriculture Area		**1.24**	**6.26**
Waste Land	Waste Land		0.92	**4.64**
	Total Waste Land		**0.92**	**4.64**
Mining Area	Coal Quarry		0.54	2.72
	Barren OB Dump		0.98	4.94
	Area Under Backfilling		2.02	10.19
	Water Filled Quarry		0.15	0.76
	Coal Dump		0.09	0.45
	Advance Quarry Site		0.16	0.81
	Total Mining Area		**3.94**	**19.88**
Settlements	Rural Settlement		0.31	1.56
	Urban Settlement		0.47	2.37
	Industrial Settlement		0.36	1.82
	Total Settlement Area		**1.14**	**5.75**
Water Body	**River, Ponds**		**0.03**	**0.15**
		Total	**19.82**	**100.00**

Customer	Central Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject Land Reclamation Status of Rajrappa OCP based on Satellite Data (RS-2/L-IV) of the year 2017	Activity	Name	Designation	Signature	Date
	Prepared	Hariharalal B	Sr. Mgr(System)		19-3-18
	Checked	A.K. Singh	Ch. Mgr(RSC)		23-3-18
	Approved	R. Kumar	HOD(Geomatics)		26-3-18
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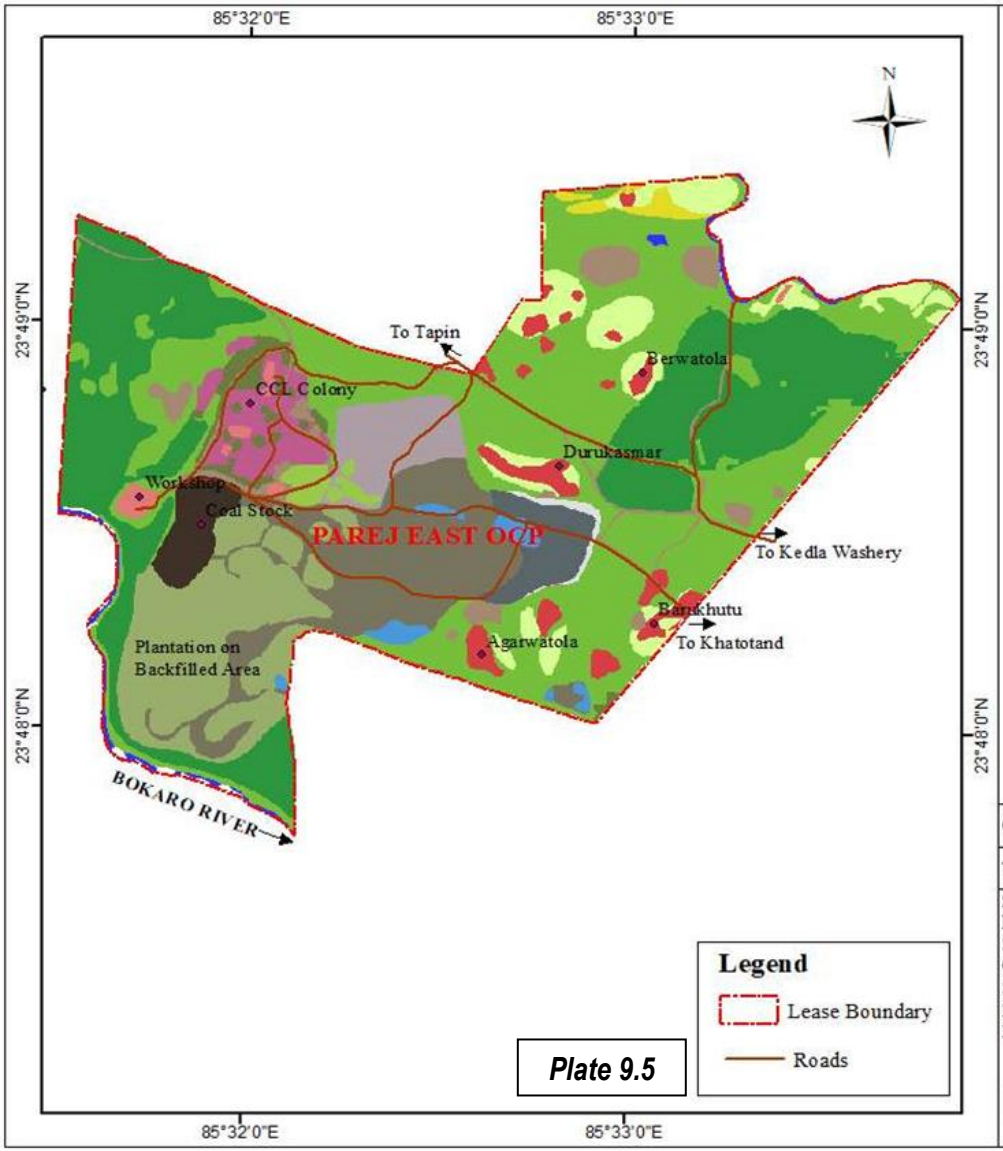

Plate 9.5

Area Statistics - Parej East OCP (2017)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		1.31	21.13
	Total Forest Area		**1.31**	**21.13**
Scrubs	**Scrubs**		**1.92**	**30.97**
Plantation	Social Forestry		0.09	1.45
	Plantation on Backfill		0.64	10.32
	Plantation on OB Dump		0.05	0.81
	Total Plantation		**0.78**	**12.58**
	Total Vegetation Area		**4.01**	**64.68**
Agriculture	Crop Land		0.04	0.65
	Fallow Land		0.34	5.48
	Total Agriculture Area		**0.38**	**6.13**
Waste Land	Waste Land		0.24	3.87
	Sand Body		0.02	0.32
	Total Waste Land		**0.26**	**4.19**
Mining Area	Coal Quarry		0.19	3.06
	Barren OB Dump		0.22	3.55
	Area Under Backfilling		0.52	8.39
	Water Filled Quarry		0.06	0.97
	Coal Dump		0.11	1.77
	Advance Quarry Site		0.02	0.32
	Total Mining Area		**1.12**	**18.06**
Settlements	Rural Settlement		0.17	2.74
	Urban Settlement		0.16	2.58
	Industrial Settlement		0.04	0.65
	Total Settlement Area		**0.37**	**5.97**
Water Body	**River, Ponds**		**0.06**	**0.97**
		Total	**6.20**	**100.00**

Customer	Central Coalfields Limited				
Title	Land Reclamation Monitoring of OC Projects				Job No. 561410027
Subject Land Reclamation Status of Parej East OCP based on Satellite Data (RS-2/L-IV) of the year 2017	Activity	Name	Designation	Signature	Date
	Prepared	Hariharalal B	Sr. Mgr(System)		19-3-18
	Checked	A.K. Singh	Ch. Mgr(RSC)		21-3-18
	Approved	R. Kumar	HOD(Geomatics)		26-3-18
cmpdi A Miniratna Company	Scale: 0 0.25 0.5 1 km				Sheet 1
	Drg No. HQ REM 17 3 A4 09				Rev No.0

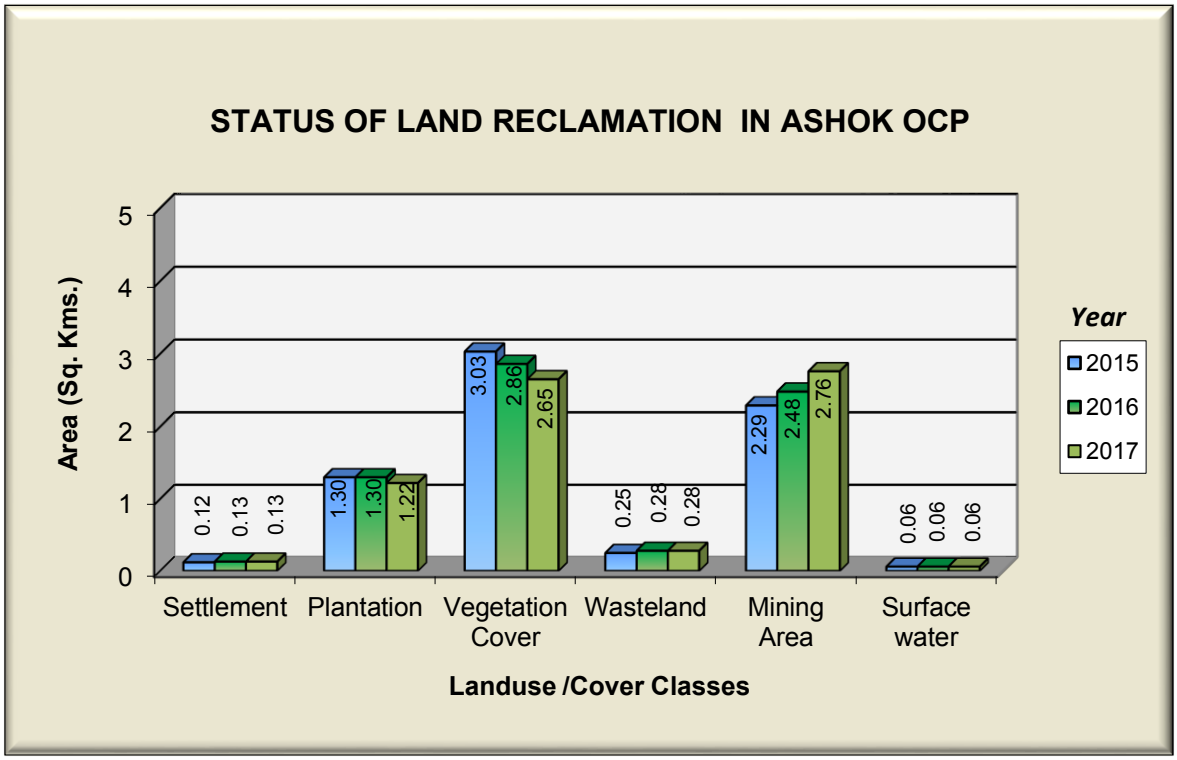

Figure 9.2

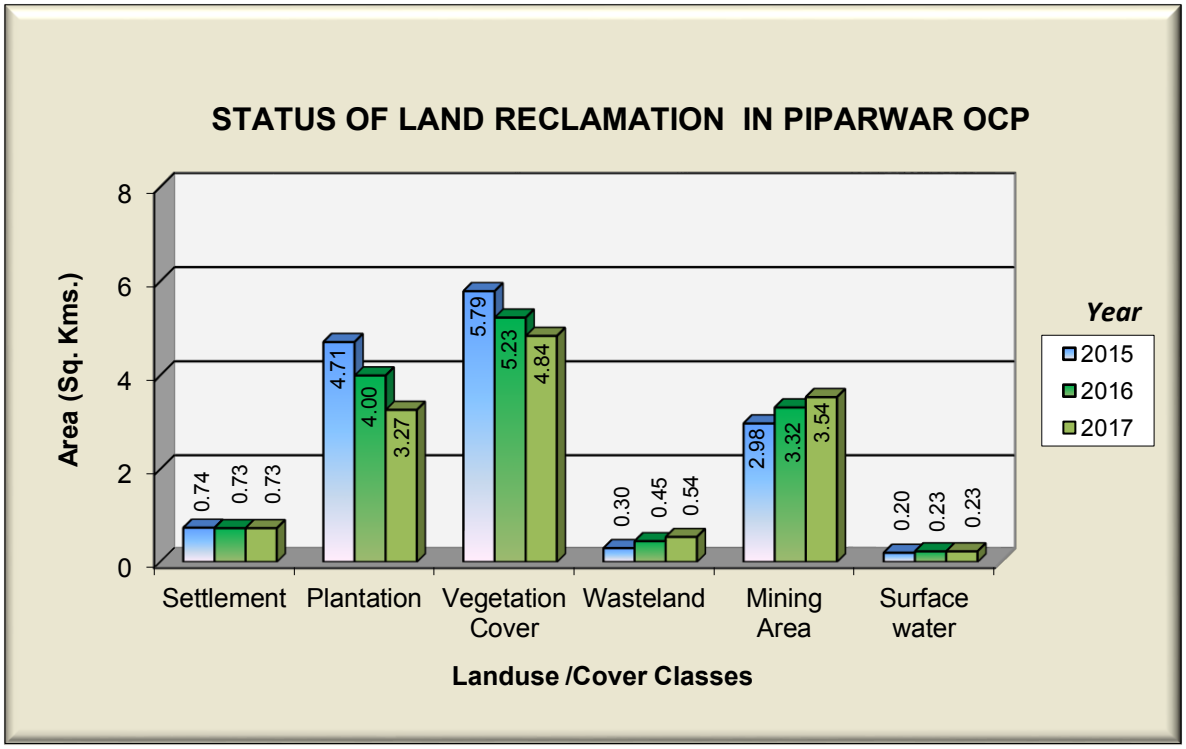

Figure 9.3

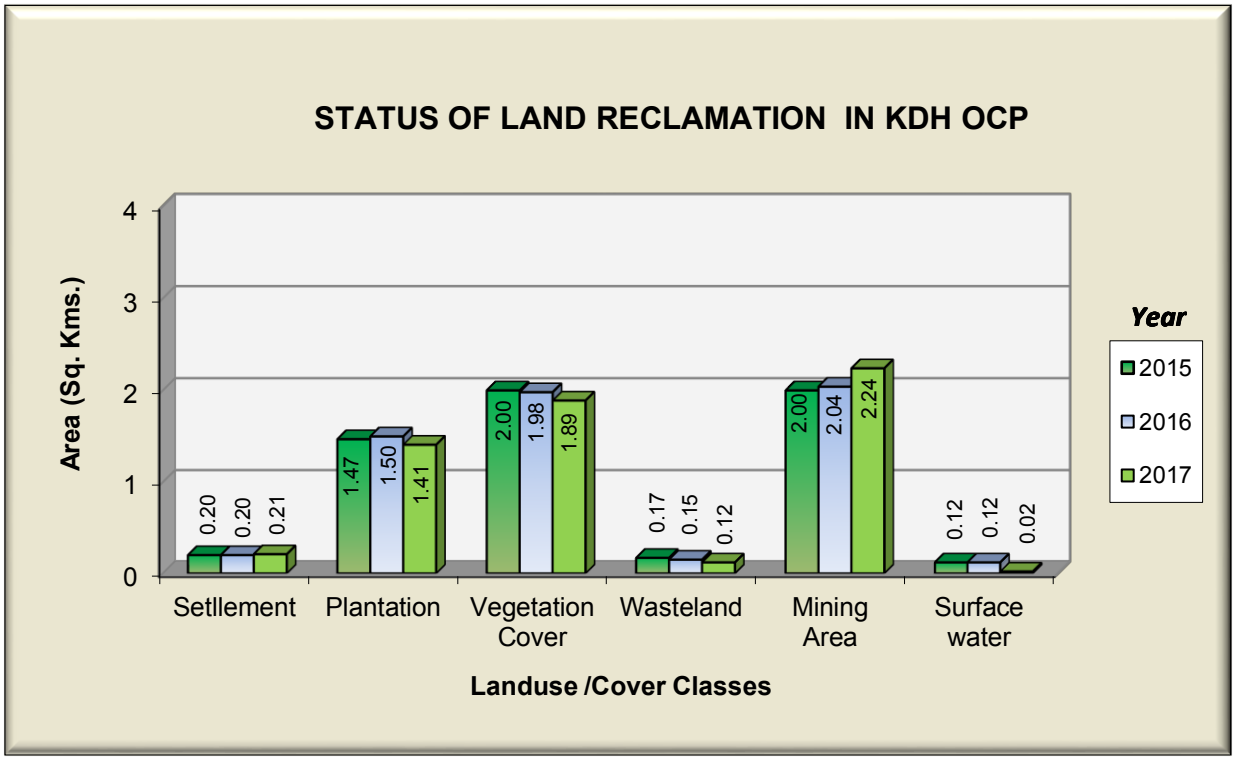

Figure 9.4

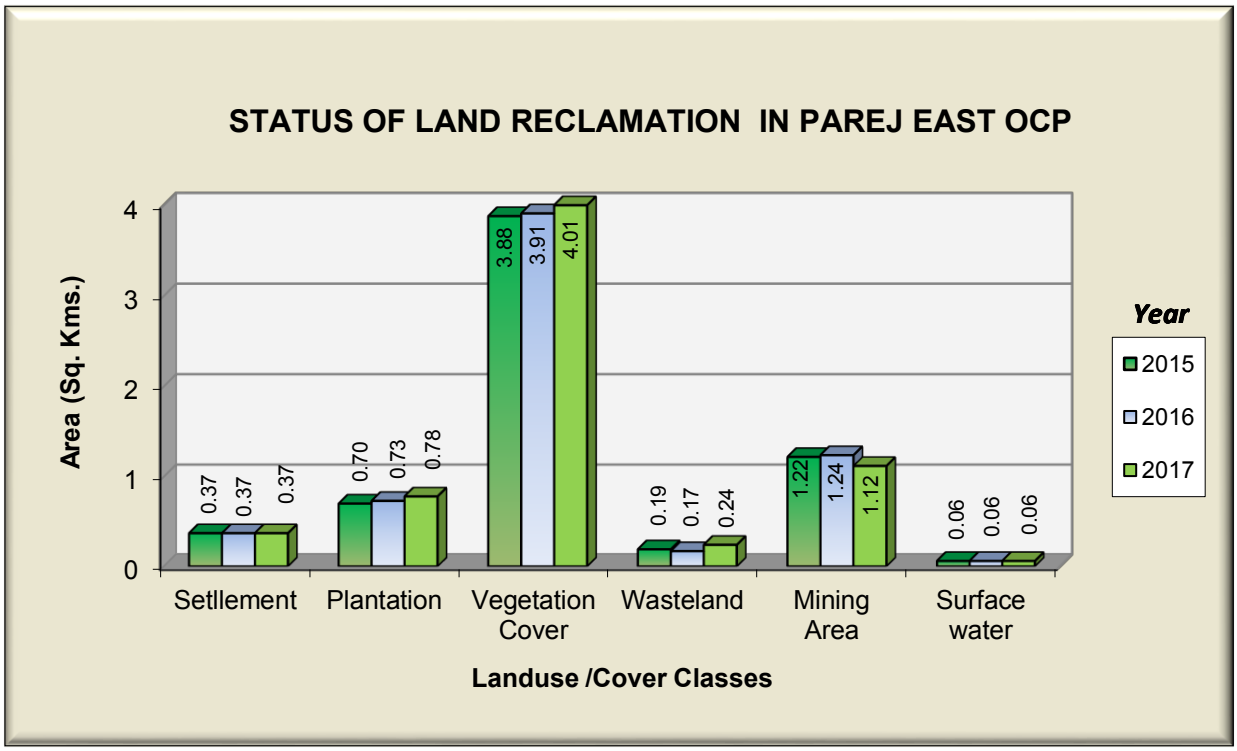

Figure 9.5

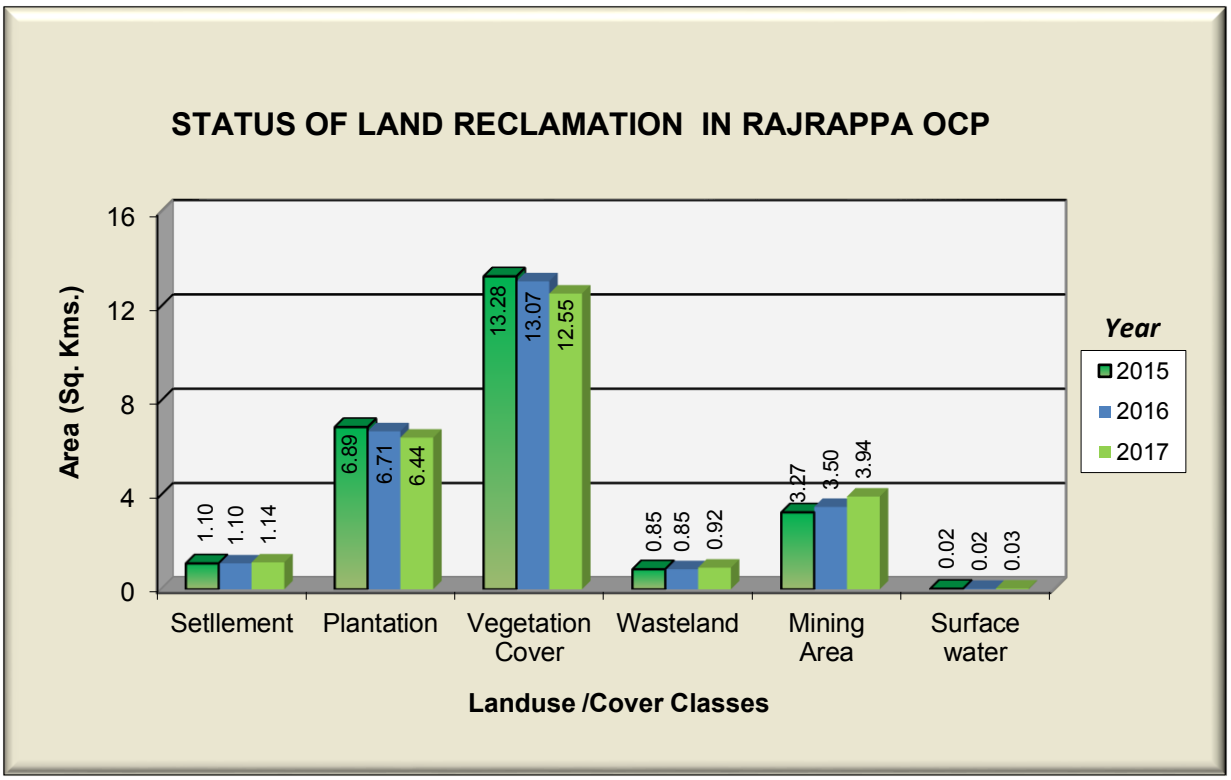
STATUS OF LAND RECLAMATION IN RAJRAPPA OCP
Area (Sq. Kms.)
16
12
8
4
0
1.10
1.10
1.14
6.89
6.71
6.44
13.28
13.07
12.55
0.85
0.85
0.92
3.27
3.50
3.94
0.02
0.02
0.03
Setllement
Plantation
Vegetation Cover
Wasteland
Mining Area
Surface water
Landuse /Cover Classes
Year
2015
2016
2017

Figure 9.6

Photograph 9.1:**Plantation on Backfilled Area inAshok OCP**

Photograph 9.2 : **Eco Park developed on Reclaimed Area - Piparwar OCP**

Photograph 9.3 : **Plantation in Piparwar OCP**

Photograph 9.4 : **Plantation in KDH OCP**

Photograph 9.5 : Plantation on Backfilled Area- Parej East OCP

Photograph 9.6 : **Plantation on OB- Rajrappa OCP**

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