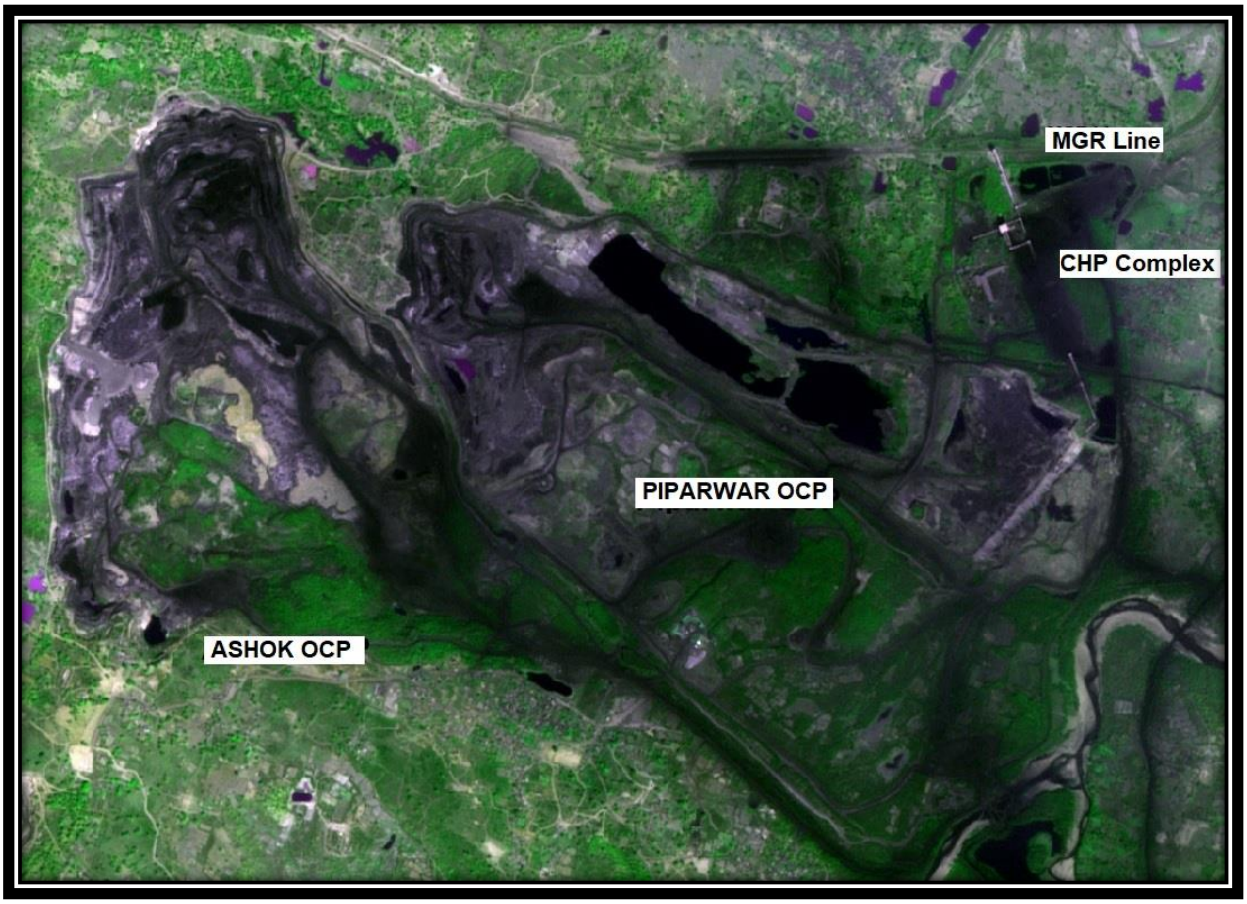
Land Reclamation/ Restoration Monitoring of Opencast Coal Mines of Central Coalfields Limited (CCL) producing more than 5 million cu. m. of (Coal + OB) annually based on Satellite Data of the Year 2019



***Submitted** to*

Central Coalfields Limited

cmpdi

A Mini-Ratna Company

Land Reclamation/ Restoration Monitoring of Opencast Coal Mines of Central Coalfields Limited (CCL) producing more than 5 million cu. m. of (Coal + OB) annually based on Satellite Data of the Year 2019

March - 2020

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

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1.0 Project

Land reclamation/ restoration monitoring of 5 opencast coal mines of Central Coalfields Ltd. (CCL) producing more than 5 million cu. m. (Coal + OB) per year based on satellite data, regularly on annual basis.

2.0 Objective

Objective of the land reclamation/ restoration monitoring is to assess the areas of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest land in the leasehold area of the projects. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3.0 Salient Findings

- Total leasehold area of 5 projects was 51.35 km^2 in 2019. Five OCPs, namely, Ashok, Piparwar, KDH, Parej East and Rajrappa were considered for monitoring during year 2019-20. Total excavated area is only 18.63 Km^2, of which 5.58 Km^2 area (29.95%) has been planted, 9.43 Km^2 area (50.62%) has come under backfilling and 3.62 Km^2 area (19.43%) is under active mining. It is seen from the analysis that 80.57% area of the OC projects have come under reclamation and balance 19.43% area is under active mining. Project wise details are given in Table-1 & Fig -1.

- On comparing the status of land reclamation carried out in year 2019 with respect to year 2018 in different projects, it is seen that area of land reclamation has increased from 14.21 Km^2 (Yr.2018) to 15.01 Km^2 (Yr.2019). The area of total plantation increased from 12.92 Km^2 (Yr.2018) to 12.98 Km^2 (Yr.2019), only marginally due to the felling of trees in some areas for mining & allied purposes (like Piparwar, Rajrappa etc.) even though the plantation done over backfilled area was of 7 ha. Details are given in Table-2.

- Area of biological reclamation (plantation on backfilled area) increased from 5.51 Km^2 to 5.58 Km^2, as a result of measures taken by the company CCL, towards environmental protection.

Status of Land Reclamation in Central Coalfields Limited based on Satellite Data for the Year 2019

(Projects producing more than 5 mcm of Coal + OB annaully)

(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)*	
		2018	*2019*	*2018*	*2019*	*2018*	*2019*	*2018*	*2019*	*2018*	*2019*	*2018*	*2019*	*2018*	*2019*	*2018*	*2019*	*2018*	*2019*
1	**Ashok**	*7.93*	7.93	2.14	2.3	0.91	0.92	0.00	0.00	0.27	0.27	0.61	0.55	3.66	3.77	1.18	1.19	3.05	3.22
				58.47%	61.01%	24.86%	24.40%					16.67%	14.59%			14.88%	15.01%	83.33%	85.41%
2	**Piparwar**	11.20	11.20	2.3	2.56	1.34	1.34	0.52	0.48	1.18	1.17	1.53	1.39	5.17	5.29	3.04	2.99	3.64	3.90
				44.49%	48.39%	25.92%	25.33%					29.59%	26.28%			27.14%	26.70%	70.41%	73.72%
3	**KDH**	*6.20*	6.20	1.52	1.54	1.28	1.31	0.03	0.03	0.20	0.20	0.7	0.71	3.50	3.56	1.51	1.54	2.80	2.85
				43.43%	43.26%	36.57%	36.80%					20.00%	19.94%			24.35%	24.84%	80.00%	80.06%
4	**Parej East**	6.20	6.20	0.64	0.69	0.68	0.69	0.05	0.05	0.09	0.09	0.18	0.18	1.50	1.56	0.82	0.83	1.32	1.38
				42.67%	44.23%	45.33%	44.23%					12.00%	11.54%			13.23%	13.39%	88.00%	88.46%
5	**Rajrappa**	19.82	19.82	2.10	2.34	1.3	1.32	3.10	3.07	1.97	2.04	0.92	0.79	4.32	4.45	6.37	6.43	3.40	3.66
				48.61%	52.58%	30.09%	29.66%					21.30%	17.75%			32.14%	32.44%	78.70%	82.25%
	TOTAL	**51.35**	**51.35**	**8.70**	**9.43**	**5.51**	**5.58**	**3.70**	**3.63**	**3.71**	**3.77**	**3.94**	**3.62**	**18.15**	**18.63**	**12.92**	**12.98**	**14.21**	**15.01**
				47.93%	**50.62%**	**30.36%**	**29.95%**					**21.71%**	**19.43%**			**25.16%**	**25.28%**	**78.29%**	**80.57%**

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

Note: *In reference of the above Table-1, different parameters are classified as follows:*

1 *Leasehols area as per the EC boundary*

2 *Area under* ***Biological Reclamation*** *includes Area under Plantation done on Backfill only*

3 *Area under* ***Technical Reclamation*** *includes Area under Backfilling only*

4 *Area under* ***Active Mining*** *includes Coal Quarry, Quarry filled with water & Advance Quarry Site, if any. Coal dump is excluded*

5 *Social Forestry and Plantation on External OB dumps are not included in Biological Reclamation, and are put under separate categories*

6 *(%) 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.*

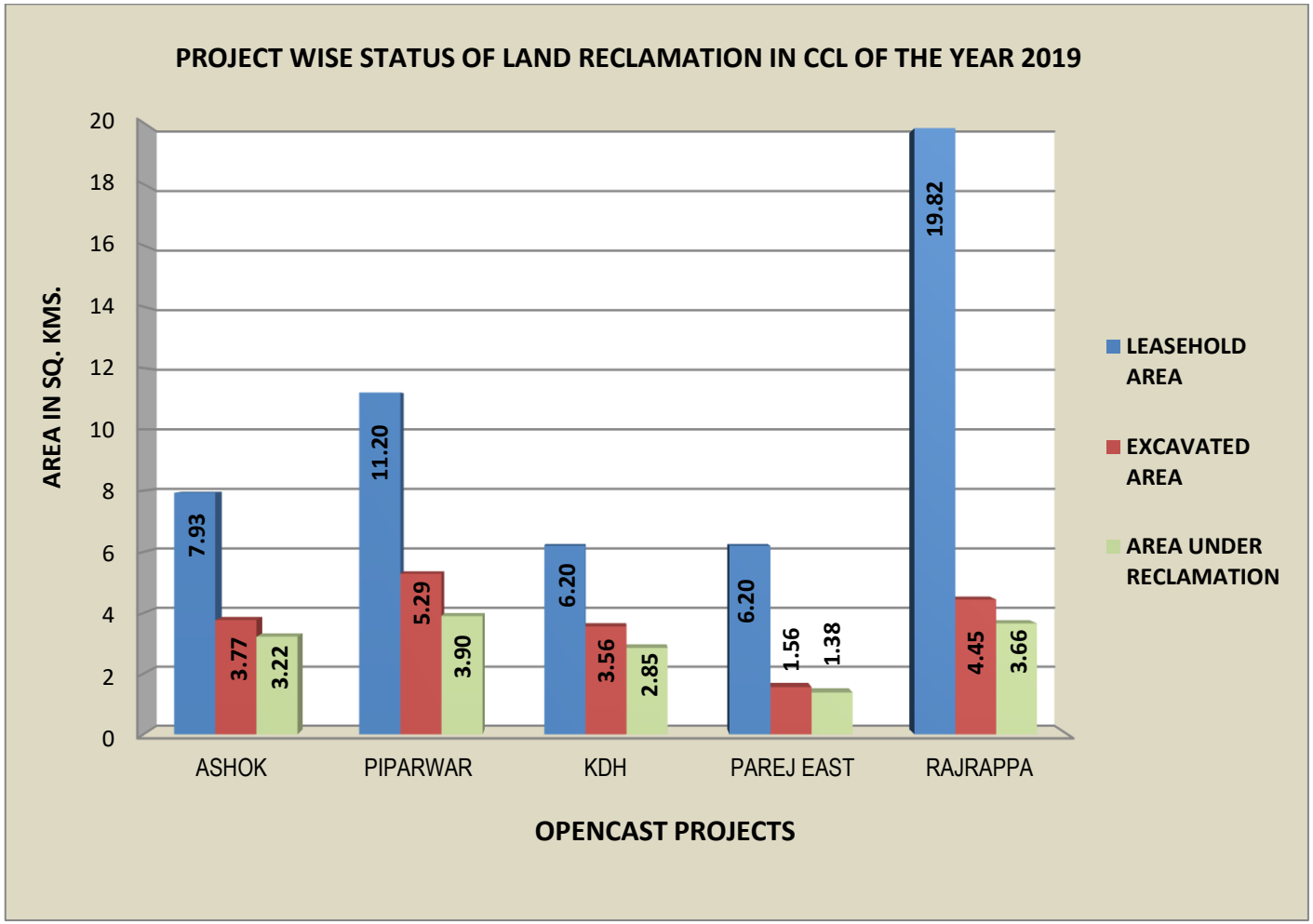


Fig.1 **Project wise Land Reclamation Status in Year 2019**

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 scarcest natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do effect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/Env./2011 dated 12.10.2012 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) regularly on annual basis, and for monitoring of less than 5 million m^3 per annum capacity (Coal +OB) projects at an interval of three years based on remote sensing satellite data, for sustainable development of mining. The work order was renewed vide letter no. CIL/WBP/ENV/2017/DP/8477 dated 21.09.2017 for a period of 5 more years from 2017-18 to 2021-22. The result of land reclamation status of all such mines is to be put on the website of **CIL**, (www.coalindia.in), **CMPDI** (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed report is to be submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all open cast coal mining projects would also comply the statutory requirements of Ministry of Environment, Forest & Climate Change(**MoEF&CC**). 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 2019 carried out for 5 no. of OC projects of capacity more than 5 mcm (coal +OB) for Central Coalfields Ltd. Satellite data of 09-03-2019 of ResourceSat-**2A**, LISS-4, multispectral, 5 mtr. resolution was used for the present monitoring study.

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

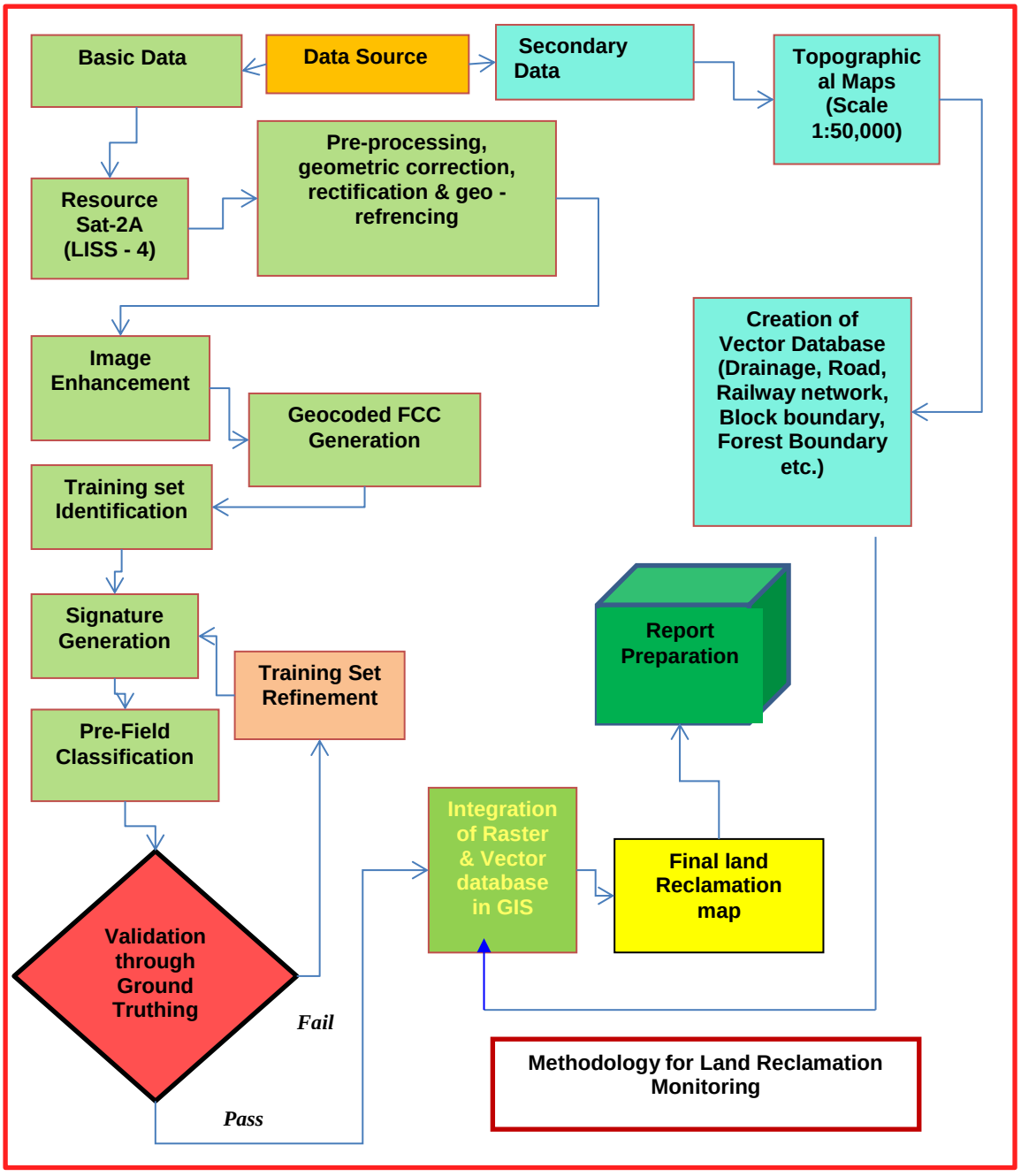


Figure: 2 Methodology for Land Reclamation Monitoring

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 & 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. Digital images may contain geometric distortions, which make them unusable as maps sometimes. Therefore, geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible with new series of SoI toposheet confirming to the WGS-84 datum and UTM projected co-ordinated system.
- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 14.0 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 the findings of ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE 14.0 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 10.2 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. The database, boundary shape files (.shp), kml files and the Maps thus prepared confirm to the WGS-84 datum and UTM projected co-ordinated system.

4.0 Land Reclamation Status in Central Coalfields Ltd.

4.1 Following 5 OC projects of Central Coalfields Ltd. producing more than 5 million m^3. (Coal + OB) annually have been taken up for land reclamation monitoring based on satellite data of the year 2019.

1. Ashok 2. Piparwar 3. KD Hesalong(KDH) 4. Rajrappa & 5. Parej East

4.2 Study based on Satellite data of the year 2019 reveals that 15.01 Km^2 (80.57%) of excavated area has already come under reclamation in the above 5 OC projects of CCL, out of which 9.43 Km^2 (50.62%) area is under backfilling (Technical Reclamation) and 5.58 Km^2 (29.95%) area has been re-vegetated (Biological Reclamation).

4.3 Study reveals that the area under barren backfilling (Technical Reclamation) has increased from 8.70 Km^2 in 2018 to 9.43 Km^2 in 2019. All the 5 projects of CCL selected for monitoring for the year 2019-20 are showing an increasing or static trend in technical reclamation.

4.4 Analysis of satellite data also indicates that the area of plantation (Biological Reclamation) has increased from 5.51 Km^2 (Yr. 2018) to 5.58 Km^2 (Yr. 2019). This increase in Biological Reclamation reflects continuous efforts on part of CCL for environmental protection.

4.5 The area of total reclamation has reached 15.01 Km^2 or 80.57% of the total excavated area till the year 2019 as compared to 14.21 Km^2 (78.29%) in 2018.

4.6 It is seen that the total area under plantation (Green Cover) which includes plantation carried out on backfilled area, OB dumps as well as Plantation on Social Forestry in all the 5 mines of CCL has increased by 0.06 Km^2 in the year 2019, as compared to the year 2018. It is important to mention here that Piparwar area has developed & well maintained an eco-restoration park called "**Kayakalp Vatika**" at Piparwar OCP.

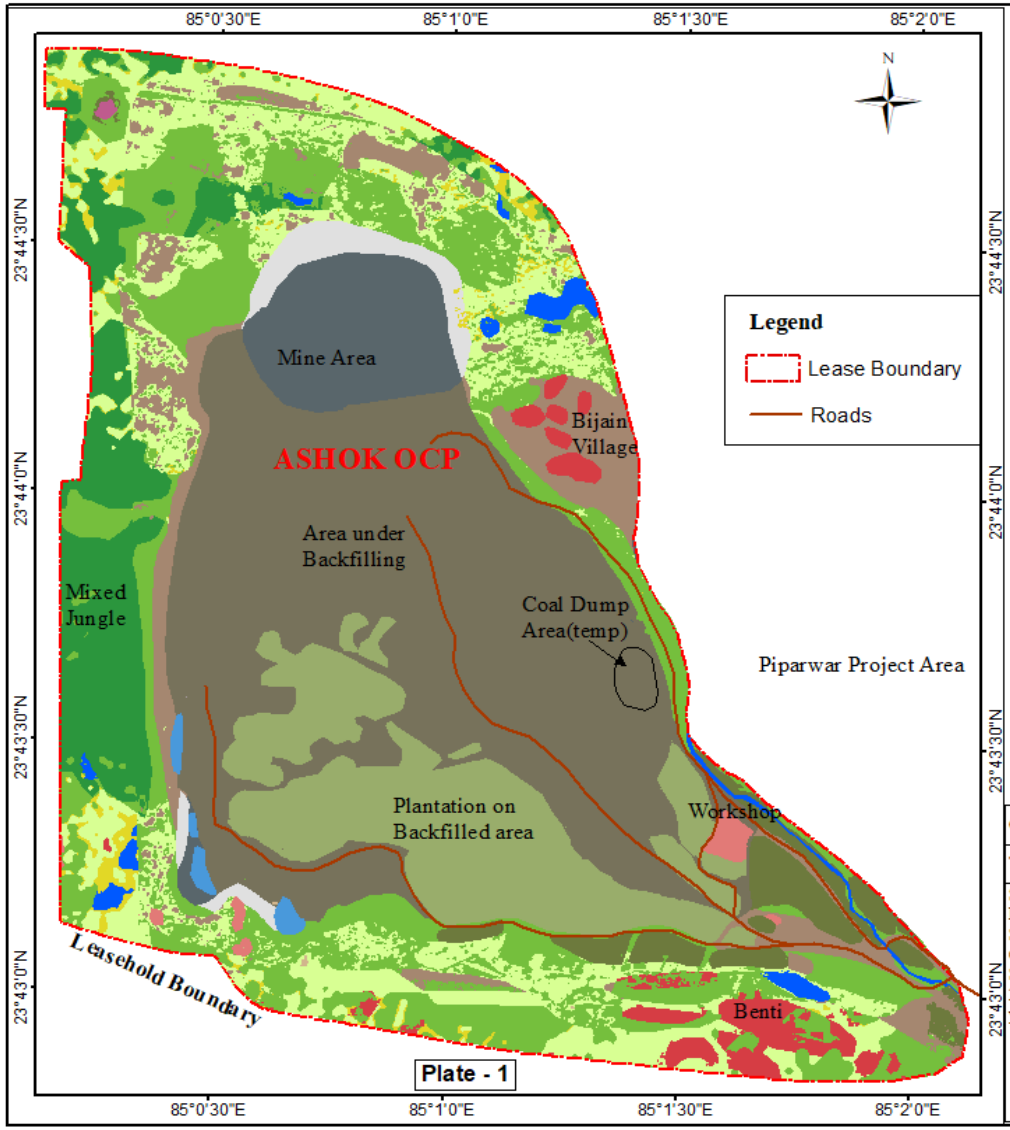
4.7 Out of 5 projects of CCL, Parej East OC ranks on top for land reclamation (88.46%) followed by Ashok OC (85.41%), Rajrappa OC (82.25%), KDH (80.06%) and Piparwar OC (73.72%).

TABLE - 2

Status of Land Use / Reclamation in OC Mines(>5m.cu.m) of Central Coalfields Ltd. based on Satellite data of the Year 2019

(Area in Sq. Km)

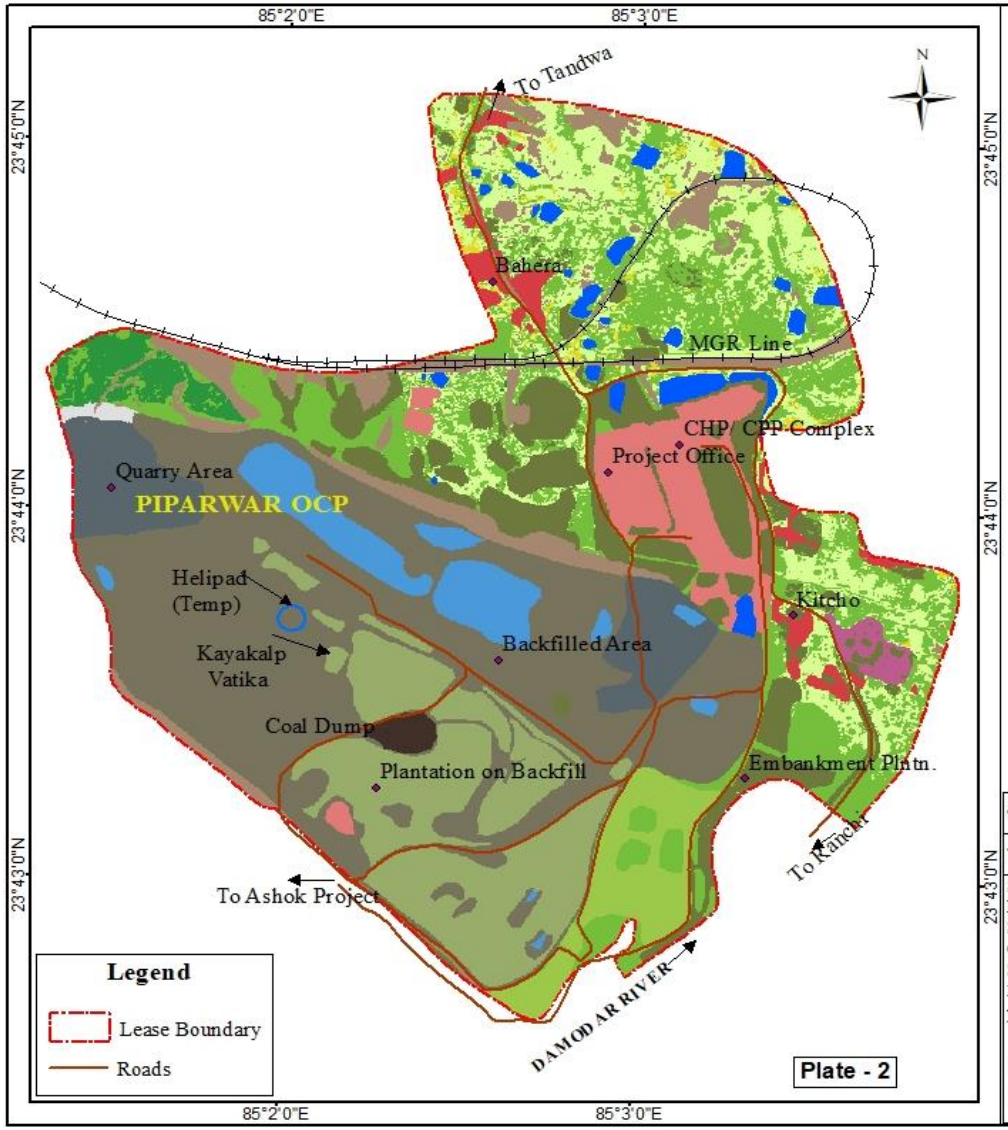
		ASHOK		PIPARWAR		KDH		RAJRAPPA		PAREJ EAST		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.49	6.18	0.18	1.61	0.20	3.23	1.48	7.47	1.31	21.13	3.66	7.13
	Total Forest	**0.49**	**6.18**	**0.18**	**1.61**	**0.20**	**3.23**	**1.48**	**7.47**	**1.31**	**21.13**	**3.66**	**7.13**
	Scrubs	**1.54**	**19.42**	**1.22**	**10.89**	**0.84**	**13.55**	**4.70**	**23.71**	**1.87**	**30.16**	**10.17**	**19.81**
PLANTATION	Social Forestry	0.27	3.40	1.17	10.45	0.20	3.23	2.04	10.29	0.09	1.45	3.77	7.34
	Plantation on OB Dump	0.00	0.00	0.48	4.29	0.03	0.48	3.07	15.49	0.05	0.81	3.63	7.07
	Plantation on Backfill (Biological Reclamation)	0.92	11.60	1.34	11.96	1.31	21.13	1.32	6.66	0.69	11.13	5.58	10.87
	Total Plantation	**1.19**	**15.01**	**2.99**	**26.70**	**1.54**	**24.84**	**6.43**	**32.44**	**0.83**	**13.39**	**12.98**	**25.28**
	Total Vegetation	**3.22**	**40.61**	**4.39**	**39.20**	**2.58**	**41.61**	**12.61**	**63.62**	**4.01**	**64.68**	**26.81**	**52.21**
ACTIVE MINING	Coal Quarry	0.40	5.04	0.88	7.86	0.18	2.90	0.44	2.22	0.10	1.61	2.00	3.89
	Advance Quarry Site	0.12	1.51	0.03	0.27	0.09	1.45	0.09	0.45	0.03	0.48	0.36	0.70
	Quarry Filled With Water	0.03	0.38	0.48	4.29	0.44	7.10	0.26	1.31	0.05	0.81	1.26	2.45
	Total Area under *Active Mining*	**0.55**	**6.93**	**1.39**	**12.42**	**0.71**	**11.45**	**0.79**	**3.98**	**0.18**	**2.90**	**3.62**	**7.05**
	Coal Dump	0.00	0.00	0.06	0.54	0.05	0.81	0.07	0.35	0.10	1.61	0.28	0.55
	Barren OB Dump	0.00	0.00	0.00	0.00	0.03	0.48	0.67	3.38	0.18	2.90	0.88	1.71
	Area Under Backfilling (Technical Reclamation)	2.30	29.00	2.56	22.86	1.54	24.84	2.34	11.81	0.69	11.13	9.43	18.36
	Total Area under *Mine Operation*	**2.85**	**35.94**	**4.01**	**35.80**	**2.33**	**37.58**	**3.87**	**19.53**	**1.15**	**18.55**	**14.21**	**27.67**
WASTELAND	Waste Lands	0.47	5.93	0.65	5.80	0.25	4.03	1.02	5.15	0.26	4.19	2.65	5.16
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.03	0.48	0.00	0.00	0.02	0.32	0.05	0.10
	Total Wasteland	**0.47**	**5.93**	**0.65**	**5.80**	**0.28**	**4.52**	**1.02**	**5.15**	**0.28**	**4.52**	**2.70**	**5.26**
WATERBODY	Reservoir, Nallah, Ponds	0.09	1.13	0.19	1.70	0.07	1.13	0.02	0.10	0.05	0.81	0.42	0.82
	Total Waterbodies	**0.09**	**1.13**	**0.19**	**1.70**	**0.07**	**1.13**	**0.02**	**0.10**	**0.05**	**0.81**	**0.42**	**0.82**
AGRICULTURE	Crop Lands	0.08	1.01	0.10	0.89	0.00	0.00	0.00	0.00	0.04	0.65	0.22	0.43
	Fallow Lands	1.02	12.86	1.10	9.82	0.63	10.16	1.18	5.95	0.31	5.00	4.24	8.26
	Total Agriculture	**1.10**	**13.87**	**1.20**	**10.71**	**0.63**	**10.16**	**1.18**	**5.95**	**0.35**	**5.65**	**4.46**	**8.69**
SETTLEMENTS	Urban Settlement	0.00	0.00	0.07	0.63	0.11	1.77	0.47	2.37	0.16	2.58	0.81	1.58
	Rural Settlement	0.16	2.02	0.19	1.70	0.02	0.32	0.30	1.51	0.16	2.58	0.83	1.62
	Industrial Settlement	0.04	0.50	0.50	4.46	0.18	2.90	0.35	1.77	0.04	0.65	1.11	2.16
	Total Settlement	**0.20**	**2.52**	**0.76**	**6.79**	**0.31**	**5.00**	**1.12**	**5.65**	**0.36**	**5.81**	**2.75**	**5.36**
	Grand Total	**7.93**	**100.00**	**11.20**	**100.00**	**6.20**	**100.00**	**19.82**	**100.00**	**6.20**	**100.00**	**51.35**	**100.00**



Area Statistics - Ashok OCP (2019)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		0.49	6.18
	Total Forest Area		**0.49**	**6.18**
Scrubs	**Scrubs**		**1.54**	**19.42**
Plantation	Social Forestry		0.27	3.40
	Plantation on Backfill		0.92	11.60
	Plantation on OB Dump		0.00	0.00
	Total Plantation		**1.19**	**15.01**
	Total Vegetation Area		**3.22**	**40.61**
Agriculture	Crop Land		0.08	1.01
	Fallow Land		1.02	12.86
	Total Agriculture Area		**1.10**	**13.87**
Waste Land	Waste Land		0.47	5.93
	Total Waste Land		**0.47**	**5.93**
Mining Area	Coal Quarry		0.40	5.04
	Area Under Backfilling		2.30	29.00
	Water Filled Quarry		0.03	0.38
	Coal Dump		0.00	0.00
	Advance Quarry Site		0.12	1.51
	Total Mining Area		**2.85**	**35.94**
Settlements	Rural Settlement		0.16	2.02
	Urban Settlement		0.00	0.00
	Industrial Settlement		0.04	0.50
	Total Settlement Area		**0.20**	**2.52**
Water Body	**River, Ponds**		**0.09**	**1.13**
		Total	**7.93**	**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-2A/L-IV) of the year 2019	Activity	Name	Designation	Signature	
	Prepared	Hariharalal B	Sr. Mgr(System)		
	Checked	A.K. Singh	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi A Mini Ratna Company	Scale: 0 0.25 0.5 1 km				Sheet 1
	Drg No. HQ REM 19 3 A4 05				Rev No.0



Area Statistics - Piparwar OCP (2019)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		0.18	1.61
	Total Forest Area		**0.18**	**1.61**
Scrubs	**Scrubs**		**1.22**	**10.89**
Plantation	Social Forestry		1.17	10.45
	Plantation on Backfill		1.34	11.96
	Plantation on OB Dump		0.48	4.29
	Total Plantation		**2.99**	**26.70**
	Total Vegetation Area		**4.39**	**39.20**
Agriculture	Crop Land		0.10	0.89
	Fallow Land		1.10	9.82
	Total Agriculture Area		**1.20**	**10.71**
Waste Land	Waste Land		0.65	5.80
	Sand Body		0.00	0.00
	Total Waste Land		**0.65**	**5.80**
Mining Area	Coal Quarry		0.88	7.86
	Barren OB Dump		0.00	0.00
	Area Under Backfilling		2.56	22.86
	Water Filled Quarry		0.48	4.29
	Coal Dump		0.06	0.54
	Advance Quarry Site		0.03	0.27
	Total Mining Area		**4.01**	**35.80**
Settlements	Rural Settlement		0.19	1.70
	Urban Settlement		0.07	0.63
	Industrial Settlement		0.50	4.46
	Total Settlement Area		**0.76**	**6.79**
Water Body	**River, Ponds**		**0.19**	**1.70**
		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-2A/L-IV) of the year 2019	Activity	Name	Designation	Signature	
	Prepared	Hariharalal B	Sr. Mgr(System)		
	Checked	A.K. Singh	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
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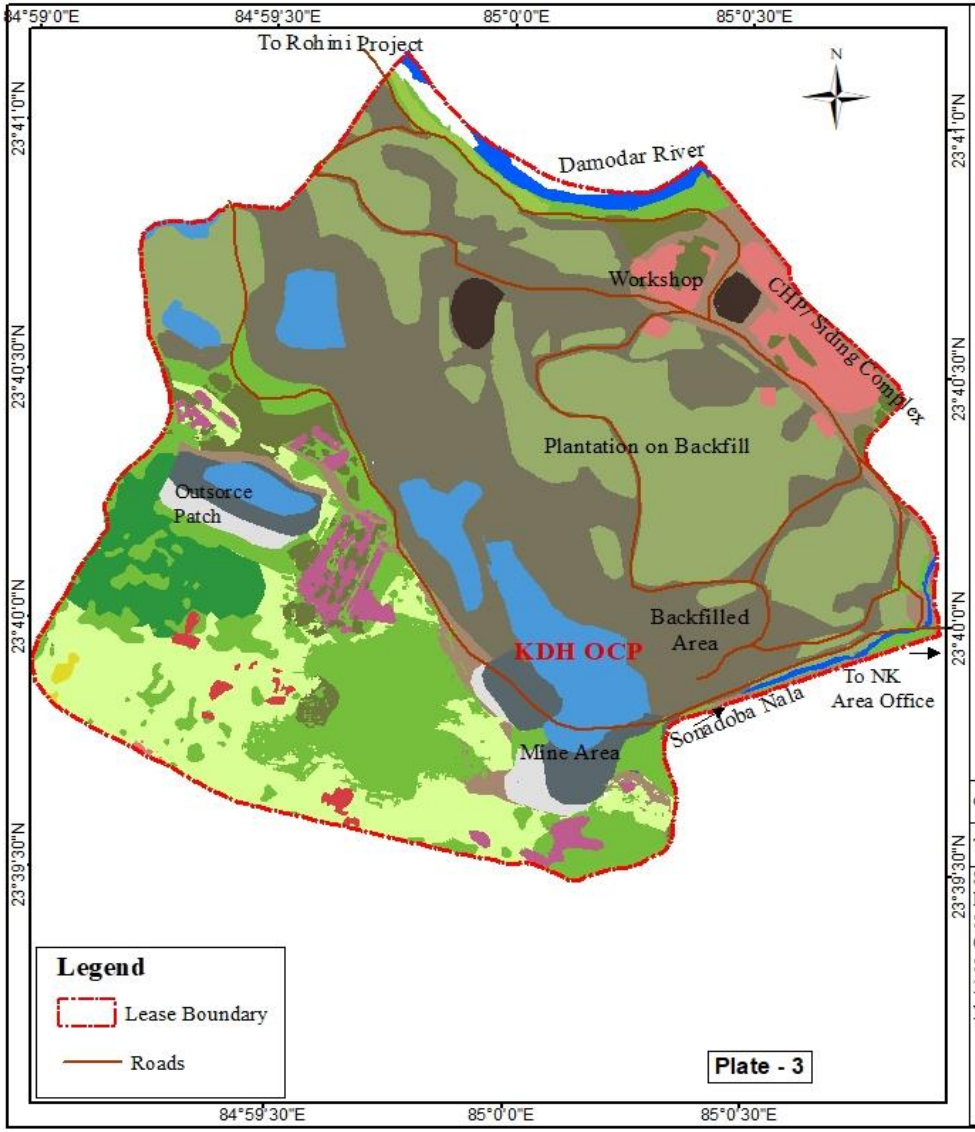
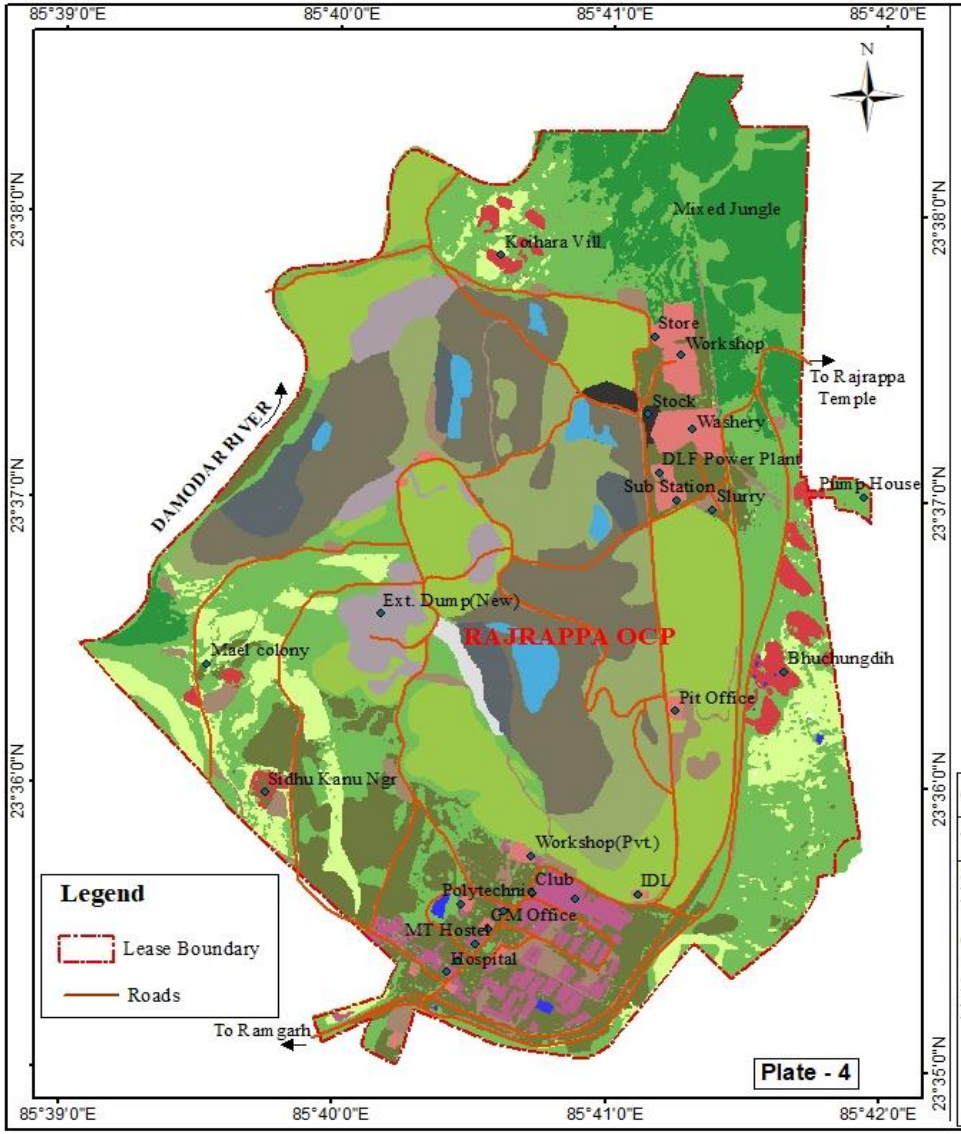
	Drg No. HQ REM 193 A4 06				Rev No.0



Area Statistics - KDH OCP (2019)				
Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		0.20	3.23
	Total Forest Area		**0.20**	**3.23**
Scrubs	**Scrubs**		**0.84**	**13.55**
Plantation	Social Forestry		0.20	3.23
	Plantation on Backfill		1.31	21.13
	Plantation on OB Dump		0.03	0.48
	Total Plantation		**1.54**	**24.84**
	Total Vegetation Area		**2.58**	**41.61**
Agriculture	Crop Land		0.00	0.00
	Fallow Land		0.63	10.16
	Total Agriculture Area		**0.63**	**10.16**
Waste Land	Waste Land		0.25	4.03
	Sand Body		0.03	0.48
	Total Waste Land		**0.28**	**4.52**
Mining Area	Coal Quarry		0.18	2.90
	Barren OB Dump		0.03	0.48
	Area Under Backfilling		1.54	24.84
	Water Filled Quarry		0.44	7.10
	Coal Dump		0.05	0.81
	Advance Quarry Site		0.09	1.45
	Total Mining Area		**2.33**	**37.58**
Settlements	Rural Settlement		0.02	0.32
	Urban Settlement		0.11	1.77
	Industrial Settlement		0.18	2.90
	Total Settlement Area		**0.31**	**5.00**
Water Body	**River, Ponds**		**0.07**	**1.13**
		Total	**6.20**	**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-2A/L-IV) of the year 2019	Activity	Name	Designation	Signature	
	Prepared	Hariharalal B	Sr. Mgr(System)		
	Checked	A.K. Singh	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 km			Sheet 1
	Drg No.	HQ REM 19 3 A4 07			Rev No.0



Area Statistics - Rajrappa OCP (2019)

Classes		Colour	Area	
Level-I	Level-II		Area (Km^2)	% of Total
Forest Area	Dense Forest		0.00	0.00
	Open Forest		1.48	7.47
	Total Forest Area		**1.48**	**7.47**
Scrubs	**Scrubs**		**4.70**	**23.71**
Plantation	Social Forestry		2.04	10.29
	Plantation on Backfill		1.32	6.66
	Plantation on OB Dump		3.07	15.49
	Total Plantation		**6.43**	**32.44**
	Total Vegetation Area		**12.61**	**63.62**
Agriculture	Crop Land		0.00	0.00
	Fallow Land		1.18	5.95
	Total Agriculture Area		**1.18**	**5.95**
Waste Land	Waste Land		1.02	**5.15**
	Total Waste Land		**1.02**	**5.15**
Mining Area	Coal Quarry		0.44	2.22
	Barren OB Dump		0.67	3.38
	Area Under Backfilling		2.34	11.81
	Water Filled Quarry		0.26	1.31
	Coal Dump		0.07	0.35
	Advance Quarry Site		0.09	0.45
	Total Mining Area		**3.87**	**19.53**
Settlements	Rural Settlement		0.30	1.51
	Urban Settlement		0.47	2.37
	Industrial Settlement		0.35	1.77
	Total Settlement Area		**1.12**	**5.65**
Water Body	**River, Ponds**		**0.02**	**0.10**
		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-2A/L-IV) of the year 2019	Activity	Name	Designation	Signature	
	Prepared	Hariharalal B	Sr. Mgr(System)		
	Checked	A.K. Singh	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
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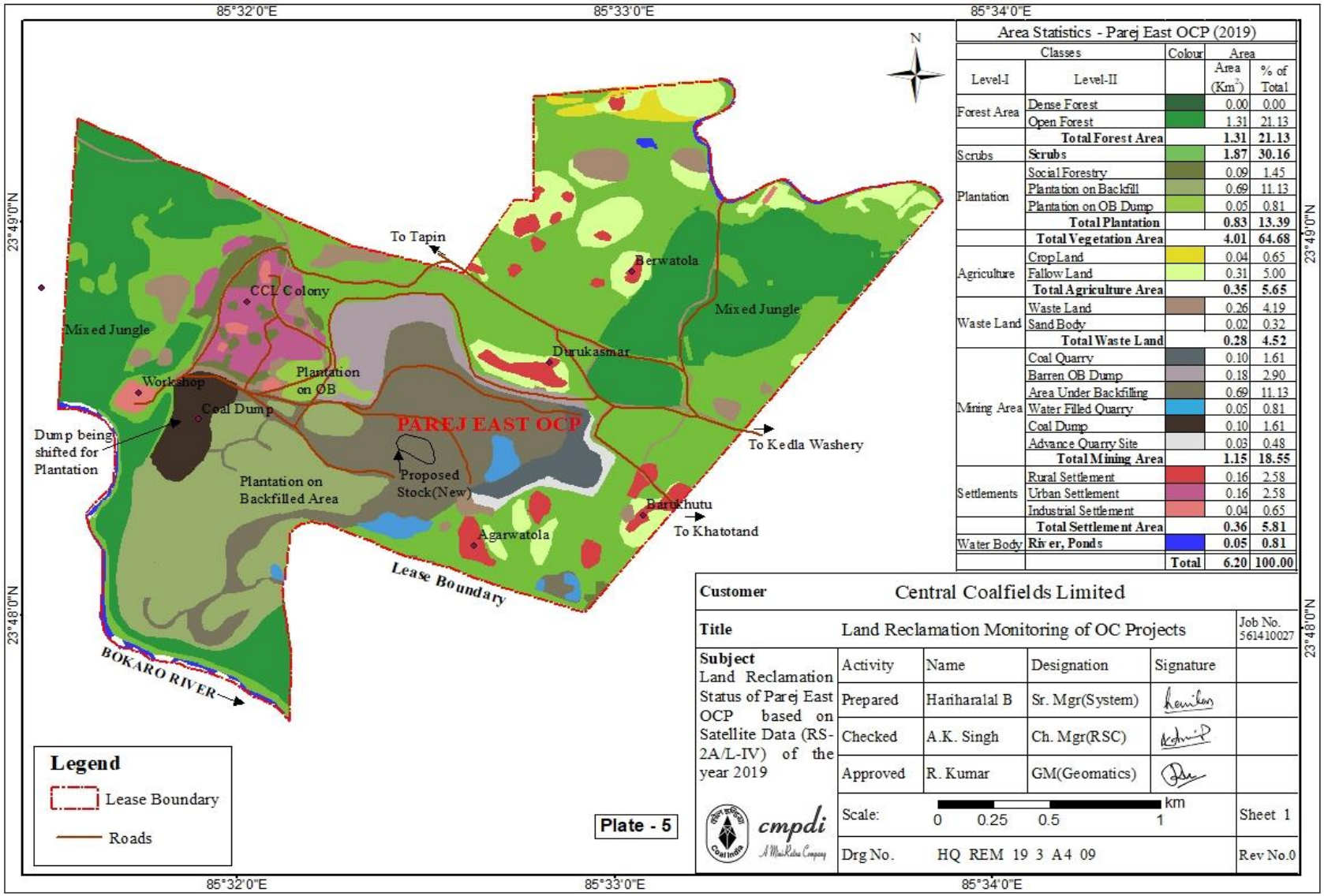
	Drg No. HQ REM 19 3 A4 08				Rev No.0



Area Statistics - Parej East OCP (2019)

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**		**1.87**	**30.16**
Plantation	Social Forestry		0.09	1.45
	Plantation on Backfill		0.69	11.13
	Plantation on OB Dump		0.05	0.81
	Total Plantation		**0.83**	**13.39**
	Total Vegetation Area		**4.01**	**64.68**
Agriculture	Crop Land		0.04	0.65
	Fallow Land		0.31	5.00
	Total Agriculture Area		**0.35**	**5.65**
Waste Land	Waste Land		0.26	4.19
	Sand Body		0.02	0.32
	Total Waste Land		**0.28**	**4.52**
Mining Area	Coal Quarry		0.10	1.61
	Barren OB Dump		0.18	2.90
	Area Under Backfilling		0.69	11.13
	Water Filled Quarry		0.05	0.81
	Coal Dump		0.10	1.61
	Advance Quarry Site		0.03	0.48
	Total Mining Area		**1.15**	**18.55**
Settlements	Rural Settlement		0.16	2.58
	Urban Settlement		0.16	2.58
	Industrial Settlement		0.04	0.65
	Total Settlement Area		**0.36**	**5.81**
Water Body	**River, Ponds**		**0.05**	**0.81**
		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-2A/L-IV) of the year 2019	Activity	Name	Designation	Signature	
	Prepared	Hariharalal B	Sr. Mgr(System)		
	Checked	A.K. Singh	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
	Scale:	0 0.25 0.5 1 km			Sheet 1
	Drg No.	HQ REM 19 3 A4 09			Rev No.0

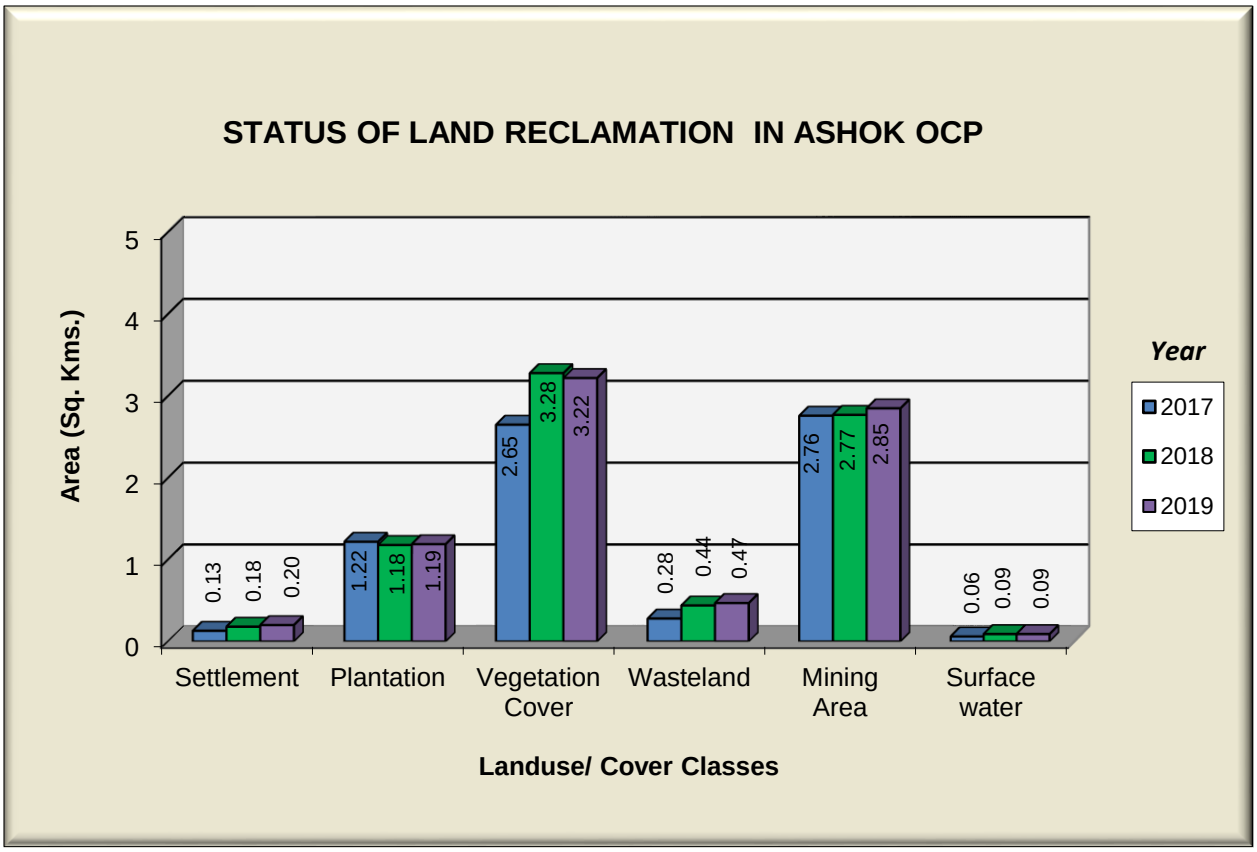


Figure 3

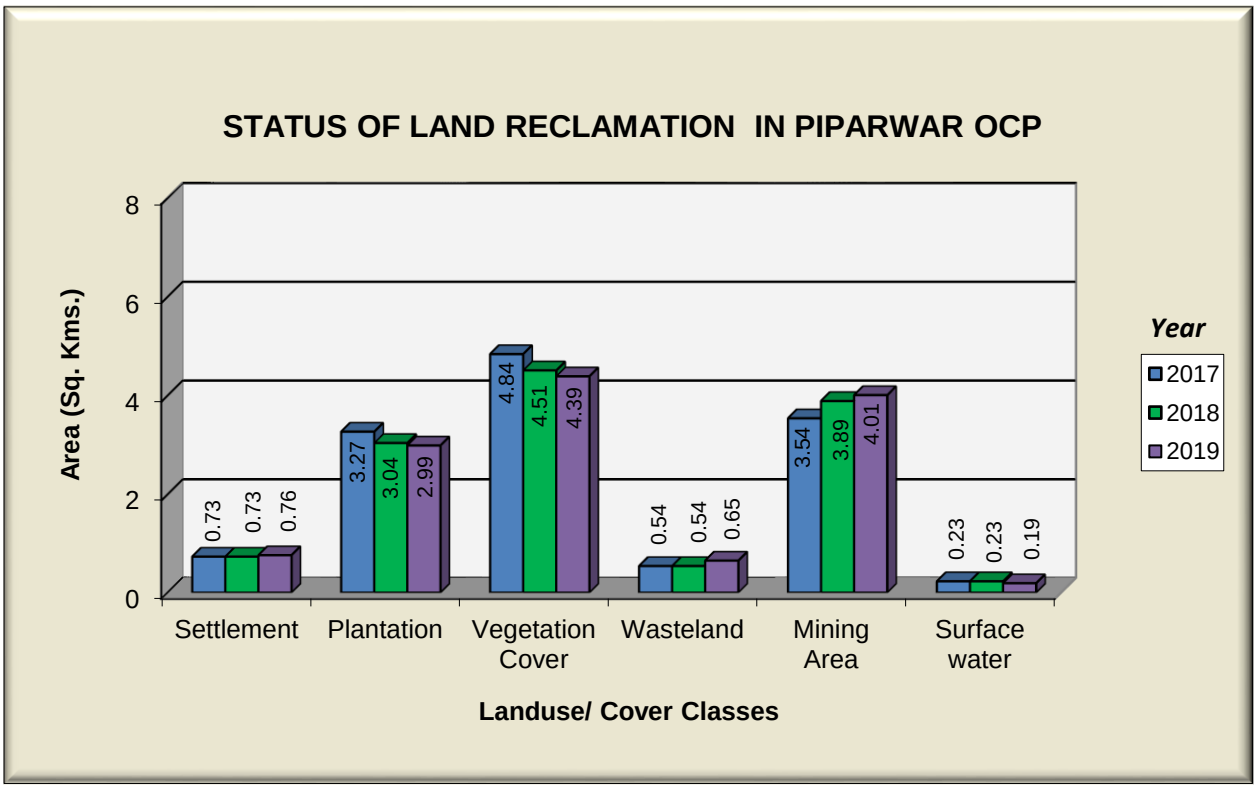


Figure 4

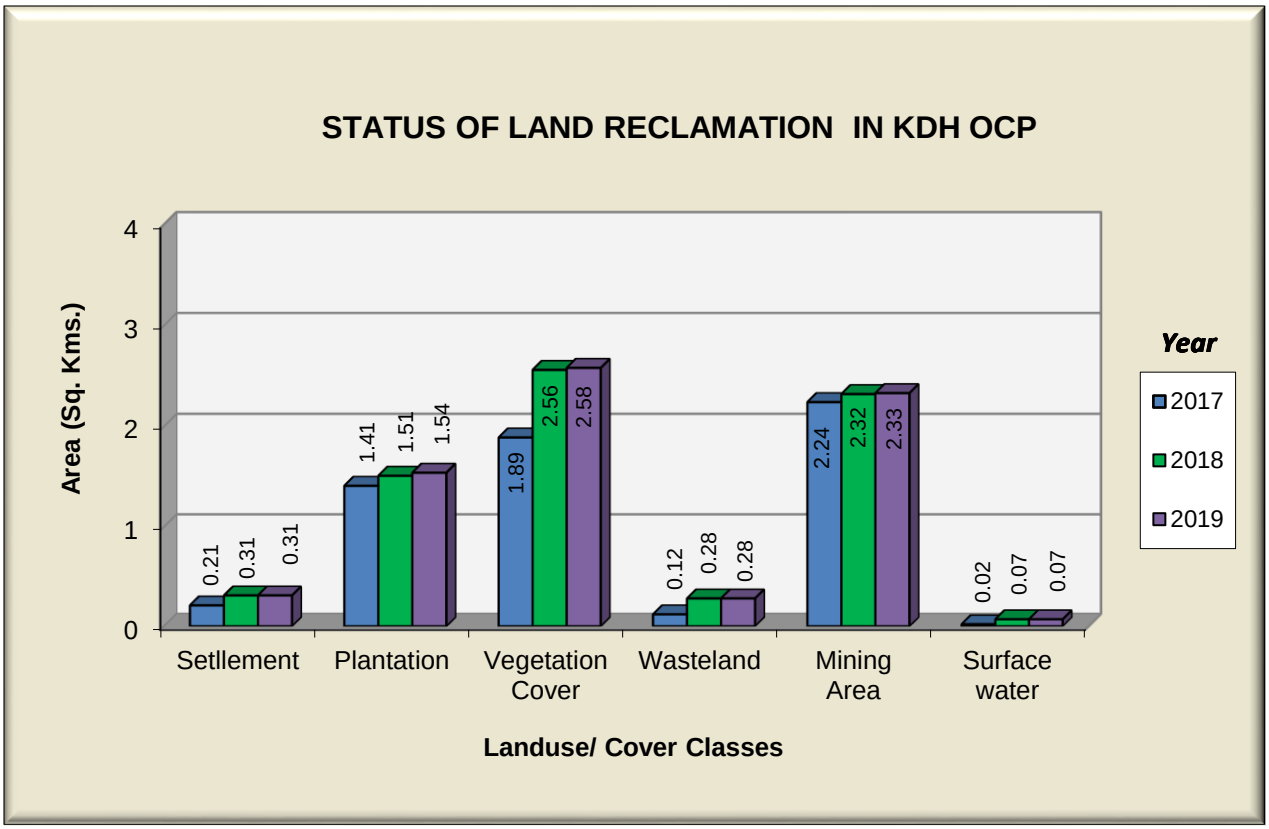


Figure 5

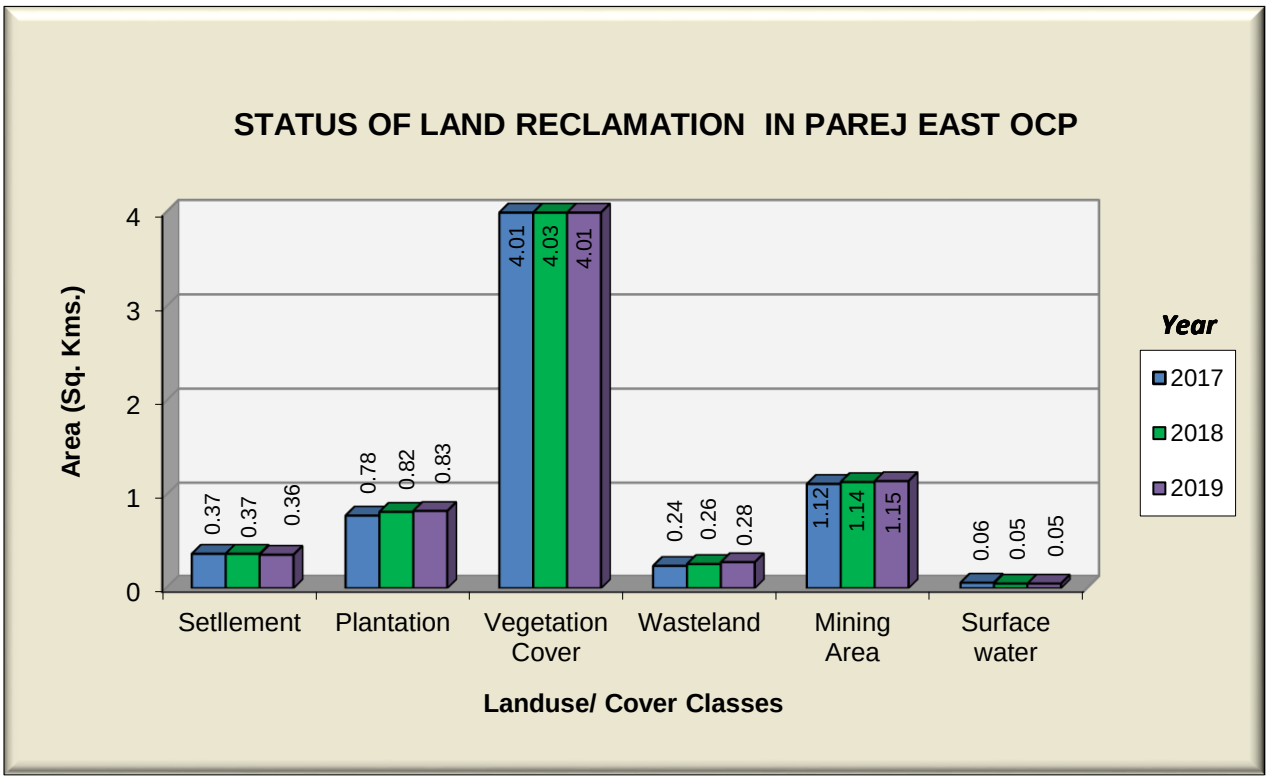


Figure 6

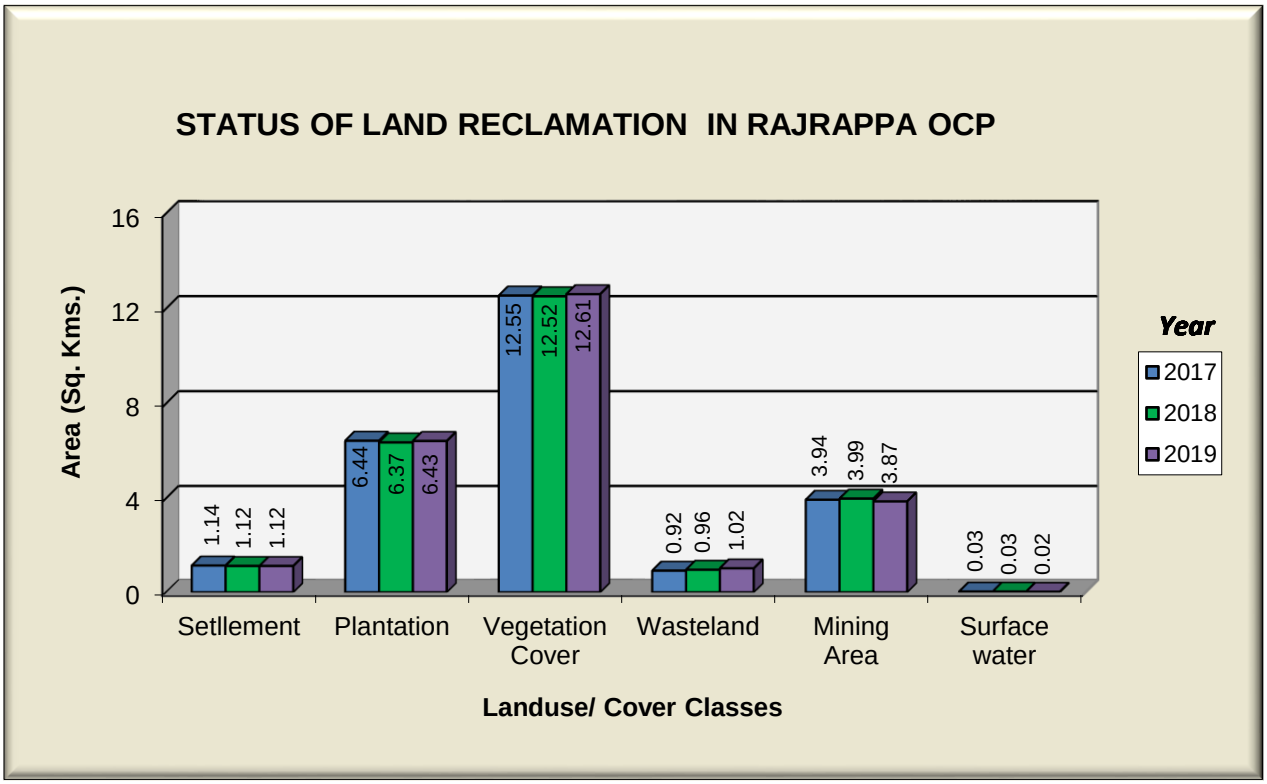

STATUS OF LAND RECLAMATION IN RAJRAPPA OCP
Area (Sq. Kms.)
16
12
8
4
0
1.14
1.12
1.12
6.44
6.37
6.43
12.55
12.52
12.61
0.92
0.96
1.02
3.94
3.99
3.87
0.03
0.03
0.02
Setllement
Plantation
Vegetation Cover
Wasteland
Mining Area
Surface water
Landuse/ Cover Classes
Year
2017
2018
2019

Figure 7

P-1 Plantation on Backfilled area - Ashok OCP

P-2 Kayakalp Vatika, Eco Restn. park on Backfilled area - Piparwar OCP

P-3 Plantation on Backfilled Area - Piparwar OCP

P-4 Plantation on Backfilled Area - KDH OCP

P-5 Plantation on Backfilled Area- Parej East OCP

P-6 Plantation on Backfilled Area- Rajrappa OCP

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