

**Land Restoration / Reclamation Monitoring of 26 opencast projects
of Western Coalfield Limited producing More than 5 million Cu. M.
(Coal+OB) per annum based on Satellite Data of the Year 2024**

वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घनमीटर (कोल+अधिभार) से अधिक उत्पादन क्षमतावाले २६ खुली खदानों के भूमि पुनरूद्धार हेतु २०२४ के उपग्रह डाटा के आधार पर निगरानी का वार्षिक प्रतिवेदन



Submitted to
Western Coalfields Limited



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**Remote Sensing Cell
Geomatics Division
CMPDI-HQ, Ranchi**



सीएमपीडीआई
मिनी रत्न
cmpdi
Mini Ratna



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कार्यकारी सारांश

1.0 परियोजना

वेस्टर्न कोल्फील्ड्स लिमिटेड के ५ मिलियन घन मीटर (कोल+ अधिभार) से अधिक उत्पादन क्षमतावाली २६ खुली खदानों के पुनरुद्धार हेतु वर्ष २०२४ के उपग्रह डाटा पर आधारित पर सलाना नियमित निगरानी।

उपरोक्त २६ खुली में से १३ परियोजनाएँ जिन्हें भटाड़ी, बेलोरा-नयागांव, बल्लारपुर, जुनाड, कोलारपिम्प्री, हिंदुस्तान लाल्पेथ, गौरी-पौनी, गोंडेगाँव, अदासा (भूमिगत से खुली खदान), भानेगाओं, गोकुल, इन्दर-कामठी एकीकृत और धुपतला खुली खदानों के नाम से जाना जाता है, इन्हें कार्य - आदेश के तहत ५ मिलियन घन मीटर (कोल+ अधिभार) से अधिक क्षमता वाले खदानों के श्रेणी में पहली बार शामिल किया गया है।

2.0 उद्देश्य

भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का उद्देश्य कुल पट्टाक्षेत्र में बैकफील, वृक्षारोपण, सामाजिक वानिकी, सक्रिय खनन क्षेत्र, जल निकास (वाटर ड्रेनेज) बंजर भूमि, कृषि भूमि और जंगल के विभिन्न प्रकार के वितरण प्रणाली के क्षेत्र का आकलन करना है। यह अध्ययन न केवल उपरोक्त सभी खुली खदानों के भूमि पुनरुद्धार (लैंड रिक्लेमेशन) की प्रगति का आकलन में मदद करेगा बल्कि पर्यावरण संरक्षण के लिए आवश्यक उपचारात्मक उपायों को क्रियान्वित करने में भी सहायता करेगा।

3.0 मुख्य निष्कर्ष

- वर्ष २०२४-२०२५ के लिए भूमि पुनरुद्धार (लैंड रिक्लेमेशन) की निगरानी हेतु डब्ल्यू.सी.एल के २६ खुली परियोजनाएँ जिनका नाम सास्ती, दुर्गापुर, मुंगोली, उमरेड, उकनी, नीलजयी, न्यू माजरी, मकरधोकरा ३, पेनगंगा, एकोना १ और २ (एकीकृत), न्यू मजरी भूमिगत से खुली खदान, पौनी-२ (विस्तार), मकरधोकरा १ (विस्तार), भटाड़ी, गोकुल, इन्दर-कामठी एकीकृत तथा धुपतला है। इनका कुल पट्टा क्षेत्र २४२.७३ वर्ग किलोमीटर हैं, जिसमें से ६५.९९ वर्ग किलोमीटर उत्खनित क्षेत्र है जिसमें क्रमशः १९.२४ वर्ग किलोमीटर (२९.१६%) बैकफील क्षेत्र (तकनीकी पुनरुद्धार), ६.०८ वर्ग किलोमीटर (९.२१%) वृक्षारोपण (जैविक पुनरुद्धार) का क्षेत्र तथा ४०.६७ वर्ग किलोमीटर (६१.६३%) सक्रिय खनन क्षेत्र के अंतर्गत पाया गया। इस विश्लेषण से स्पष्ट है कि कुल खुली खदानों के उत्खनित क्षेत्र में से ३८.३७ प्रतिशत का क्षेत्र जैविक और तकनीकी रूप से भूमि पुनरुद्धार का कार्य हो गया है और शेष ६१.६३ प्रतिशत का क्षेत्र सक्रिय खनन के अंतर्गत है। परियोजनावार विवरण तालिका -१ और चित्र-१ दर्शाया गया है (तुलनात्मक अध्ययन के उद्देश्य के लिए तालिका -१ देखें)
- विभिन्न परियोजनाओं के लिए वर्ष २०२३ के सापेक्ष में वर्ष २०२४ में किये गए भूमि पुनरुद्धार की स्थिति की तुलना करने के पश्चात विश्लेषण से यह स्पष्ट है कि भूमि पुनरुद्धार के अंतर्गत वर्ष २०२३ के कुल क्षेत्र २३.२४ वर्ग किलोमीटर से बढ़कर वर्ष २०२४ में २५.३२ वर्ग किलोमीटर हो गया है, २६ खुली परियोजनाओं में से बल्लारपुर खुली खदान में भूमि पुनरुद्धार का कार्य

अधिकतम ८५.९५ प्रतिशत हुआ है अतः इसे शीर्ष स्थान पर रखा गया है इसके बाद क्रमशः सास्ती खुली खदान (८०.७३ प्रतिशत) तथा उमरेड (६६.२५ प्रतिशत) खुली परियोजनाओं का स्थान है।

- वर्ष २०२३ के कुल जैविक भूमि पुनरूद्धार (बैकफ़िल पर वृक्षारोपण) के अंतर्गत का क्षेत्र ५.२६ वर्ग किलोमीटर के तुलना में वर्ष २०२४ में बढ़कर ६.०८ वर्ग किलोमीटर हो गया है जबकि वर्ष २०२३ के तकनीकी पुनरूद्धार (बैकफ़ील के अंतर्गत क्षेत्र) का क्षेत्र १७.९५ वर्ग किलोमीटर से बढ़कर वर्ष २०२४ में १९.२४ वर्ग किलोमीटर हो गया है। भूमि पुनरूद्धार के अंतर्गत २.०८ वर्ग किलोमीटर की यह वृद्धि पर्यावरण संरक्षण के दिशा में वेस्टर्न कोलफील्ड्स लिमिटेड के द्वारा उठाये गए सकारात्मक प्रयासों का परिणाम है।

Executive Summary

- 1.0 Project** Land restoration / reclamation monitoring of 26 opencast coal mines of Western Coalfields Ltd. (WCL) producing 5 million cu.m. and more (Coal+OB) per year based on satellite data, regularly on annual basis. Among 26 opencast coal mines projects, 13 projects namely Bhatadi, Bellora-Naigaon, Ballarpur, Junad, Kolarpimpiri, Hindustan Lalpeth (HLOCM), Gauri- Pauni, Gondegaon, Adasa UG to OC, Bhanegaon, Gokul, Inder Kamptee Amal. and Dhuptala have been included in 2024 for the first time as per the work order, their capacity (Coal+OB) have been increased to category of more than 5 million cubic meter from category of less than 5 million cu.m. per year.
- 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, 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 total leasehold area of 242.73 Km² of 26 projects of WCL viz. Sasti, Durgapur, Mungoli, Umrer, Ukni, Niljai, New Majri. Makardhokra-III, Penganga, Yekona-I & II (Amal), New Majri UG to OC, Pauni-II (Expn.), MKD-I (Expn.), Bhatadi, Bellora-Naigaon, Ballarpur, Junad, Kolarpimpiri, Hindustan Lalpeth (HLOCM), Gauri-Pauni, Gondegaon, Adasa UG to OC, Bhanegaon, Gokul, Inder-Kamptee Amal., and Dhuptala considered for monitoring during 2024-25; the total excavated area is 65.99 Km² out of which 19.24 Km² area (29.16%) is backfilled (Technical Reclamation), 6.08 Km² area (9.21%) has been planted (Biological Reclamation) and 40.67 Km² area (61.63%) is under active mining. It is evident from the analysis that 38.37% area of the OC projects has been reclaimed (biological and technical) and balance 61.63% area is under active mining. Project wise details are given in Table-1 & Fig-1. (For comparison purpose, refer Table-1).
 - On comparing the status of land reclamation for the year 2024 with respect to the year 2023 in different projects, it is evident from the analysis that total area under land reclamation has increased from 23.24 Km² (Yr. 2023) to 25.32 Km² (Yr.2024). Out of 26 projects of WCL, Ballarpur OC ranks on top for land reclamation (85.95%) followed by Sasti OC (80.73%) and Umrer OC (66.25%).
 - Area under biological reclamation (Plantation on backfill) has increased from 5.26 Km² (Yr. 2023) to 6.08 Km² (Yr. 2024) whereas area of technical reclamation (area under backfilling) has increased from 17.98 Km² (Yr. 2023) to 19.24 Km² (Yr. 2024) in WCL. The total increase of 2.08 Km² under reclamation is the result of the efforts of the Western Coalfields Ltd. taken up towards environmental protection

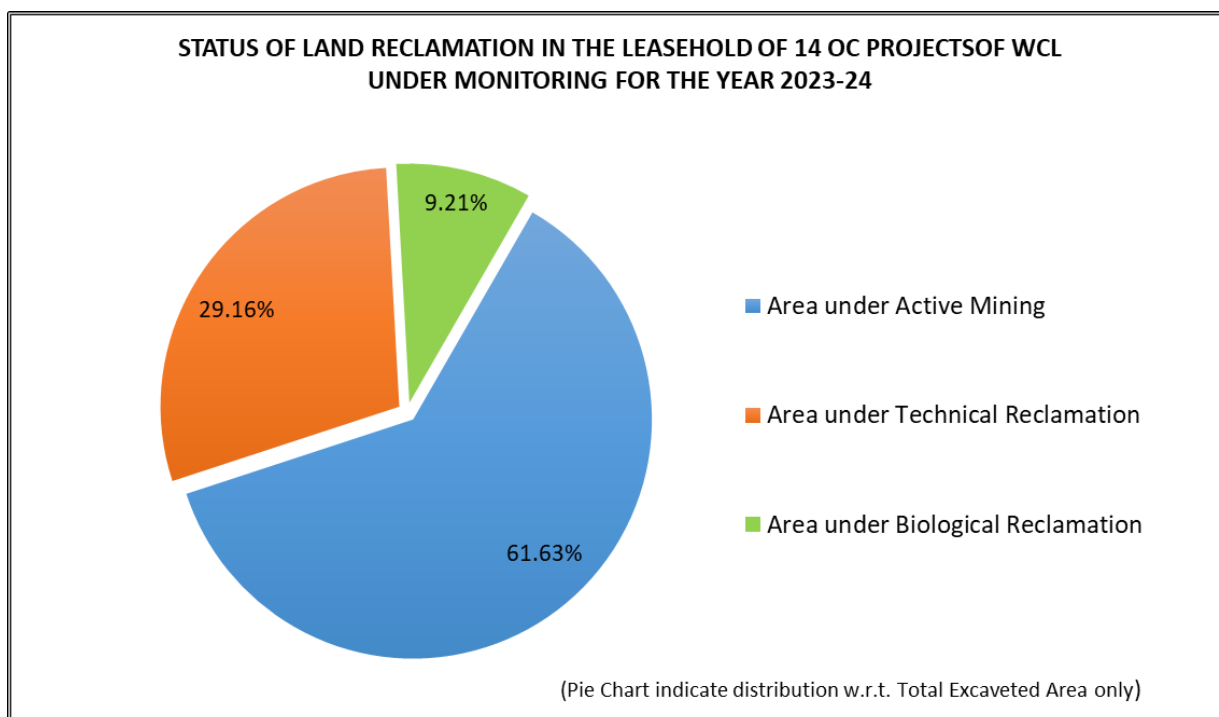


Fig.1: Pie Chart indicating distribution (%) of reclamation activities in 26 OC Mines of WCL

Table-1
Projectwise Land Reclamation Status in Opencast Projects of WCL
 (>5 Million Cubic Metre Coal+OB) based on Satellite Data of the year 2024

(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)	
	A	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
1	Sasti	9.20	11.12	2.72	2.90	0.73	0.62	1.68	1.92	0.68	0.71	0.50	0.84	3.95	4.36	3.09	3.25	3.45	3.52
				68.86%	66.51%	18.48%	14.22%					12.66%	19.27%			33.59%	29.23%	87.34%	80.73%
2	Durgapur	15.50	15.50	1.04	0.96	1.06	1.18	2.81	2.99	1.19	1.26	2.57	2.75	4.67	4.89	5.06	5.43	2.10	2.14
				22.27%	19.63%	22.70%	24.13%					55.03%	56.24%			32.65%	35.03%	44.97%	43.76%
3	Mugoli	12.55	12.55	1.53	1.70	0.17	0.2	1.9	1.98	0.61	0.65	1.95	2.23	3.65	4.13	2.68	2.83	1.70	1.90
				41.92%	41.16%	4.66%	4.84%					53.42%	54.00%			21.35%	22.55%	46.58%	46.00%
4	Umrer	9.45	9.45	1.51	1.47	1.63	1.73	1.45	1.45	2.32	2.32	1.69	1.63	4.83	4.83	5.40	5.50	3.14	3.20
				31.26%	30.43%	33.75%	35.82%					34.99%	33.75%			57.14%	58.20%	65.01%	66.25%
5	Ukni	12.85	12.85	0.54	0.65	0.00	0.00	1.74	1.81	0.86	0.98	2.15	2.15	2.69	2.80	2.60	2.79	0.54	0.65
				20.07%	23.21%	0.00%	0.00%					79.93%	76.79%			20.23%	21.71%	20.07%	23.21%
6	Niljai	17.61	17.61	1.46	1.75	0.13	0.13	2.11	2.23	1.25	1.31	2.99	3.09	4.58	4.97	3.49	3.67	1.59	1.88
				31.88%	35.21%	2.84%	2.62%					65.28%	62.17%			19.82%	20.84%	34.72%	37.83%
7	New Majri	7.74	7.74	1.64	1.82	0.24	0.28	0.97	1.04	1.47	1.47	2.22	2.27	4.10	4.37	2.68	2.79	1.88	2.10
				40.00%	41.65%	5.85%	6.41%					54.15%	51.95%			34.63%	36.05%	45.85%	48.05%
8	MKD-III	9.23	9.23	0.41	0.46	0.00	0.00	0.00	0.25	0.12	0.17	1.09	1.55	1.50	2.01	0.12	0.42	0.41	0.46
				27.33%	22.89%	0.00%	0.00%					72.67%	77.11%			1.30%	4.55%	27.33%	22.89%
9	Penganga	7.63	7.63	0.75	0.84	0.00	0.00	0.49	0.50	0.55	0.68	1.25	1.42	2.00	2.26	1.04	1.18	0.75	0.84
				37.50%	37.17%	0.00%	0.00%					62.50%	62.83%			13.63%	15.47%	37.50%	37.17%
10	Yekona-I&II(Amal)	16.79	16.79	0.01	0.20	0.00	0.00	0.00	0.00	0.03	0.08	1.29	1.64	1.30	1.84	0.03	0.08	0.01	0.20
				0.77%	10.87%	0.00%	0.00%					99.23%	89.13%			0.18%	0.48%	0.77%	10.87%
11	New Majri UG to OC	7.06	7.06	0.00	0.00	0.00	0.00	0.27	0.35	0.37	0.46	1.06	1.44	1.06	1.44	0.64	0.81	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			9.07%	11.47%	0.00%	0.00%
12	Pauni -II (Expn)	10.95	10.95	0.00	0.00	0.00	0.00	0.18	0.25	0.22	0.30	1.34	1.74	1.34	1.74	0.40	0.55	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			3.65%	5.02%	0.00%	0.00%
13	MKD -1 (Expn) OC	6.14	6.14	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	1.57	1.86	1.57	1.86	0.10	0.10	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					100.00%	100.00%			1.63%	1.63%	0.00%	0.00%
	Total-A	142.70	144.62	11.61	12.75	3.96	4.14	13.70	14.87	9.67	10.39	21.67	24.61	37.24	41.50	27.33	29.40	15.57	16.89
				31.18%	30.72%	10.63%	9.98%					58.19%	59.30%			19.15%	20.33%	41.81%	40.70%

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

- Area under Biological Reclamation includes area under plantation done on backfilled area only.
- Area under Technical Reclamation includes areas under barren backfill only.
- Area under Active Mining includes coal quarry, advance quarry & quarry filled with water etc.
- Social forestry and plantation on external OB dump are not included in biological reclamation and are put under other plantation.
- % claculated in respect to total excavated area except for "Total area under plantation" where % is in terms of leasehold area.

Table-1
Projectwise Land Reclamation Status in Opencast Projects of WCL
(>5 Million Cubic Metre Coal+OB) based on Satellite Data of the year 2024

(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									
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11 (=4+5)	
		Prev cycle	2024	Prev cycle	2024	Prev cycle	2024	Prev cycle	2024	Prev cycle	2024	Prev cycle	2024	Prev cycle	2024	Prev cycle	2024	Prev cycle	2024
14	Bhatadi	8.47	8.47	0.39	0.44	0.00	0.00	0.50	0.59	0.43	0.48	0.97	1.12	1.36	1.56	0.93	1.07	0.39	0.44
				28.68%	28.21%	0.00%	0.00%					71.32%	71.79%			10.98%	12.63%	28.68%	28.21%
15	Bellora Naigaon	6.65	6.65	0.73	0.83	0.18	0.20	0.48	0.57	0.32	0.45	1.15	1.20	2.06	2.23	0.98	1.22	0.91	1.03
				35.44%	37.22%	8.74%	8.97%					55.83%	53.81%			14.74%	18.35%	44.17%	46.19%
16	Ballarpur	2.43	2.43	0.76	0.76	0.24	0.28	0.74	0.78	0.10	0.13	0.17	0.17	1.17	1.21	1.08	1.19	1.00	1.04
				64.96%	62.81%	20.51%	23.14%					14.53%	14.05%			44.44%	48.97%	85.47%	85.95%
17	Junad	4.50	4.50	0.37	0.41	0.05	0.12	0.75	0.81	0.34	0.38	0.66	0.67	1.08	1.20	1.14	1.31	0.42	0.53
				34.26%	34.17%	4.63%	10.00%					61.11%	55.83%			25.33%	29.11%	38.89%	44.17%
18	Kolarpimpri	14.89	14.89	0.15	0.21	0.08	0.11	1.35	1.43	0.12	0.16	1.72	1.79	1.95	2.11	1.55	1.70	0.23	0.32
				7.69%	9.95%	4.10%	5.21%					88.21%	84.83%			10.41%	11.42%	11.79%	15.17%
19	HLOCM	3.12	3.12	0.64	0.65	0.06	0.10	0.74	0.76	0.31	0.37	0.48	0.54	1.18	1.29	1.11	1.23	0.70	0.75
				54.24%	50.39%	5.08%	7.75%					40.68%	41.86%			35.58%	39.42%	59.32%	58.14%
20	Gouripouni	6.77	12.91	0.89	0.91	0.60	0.79	2.06	2.55	0.62	0.64	0.95	1.70	2.44	3.40	3.28	3.98	1.49	1.70
				36.48%	26.76%	24.59%	23.24%					38.93%	50.00%			48.45%	30.83%	61.07%	50.00%
21	Gondegaon	7.91	7.91	0.56	0.62	0.00	0.00	0.96	1.22	0.51	0.57	1.49	1.90	2.05	2.52	1.47	1.79	0.56	0.62
				27.32%	24.60%	0.00%	0.00%					72.68%	75.40%			18.58%	22.63%	27.32%	24.60%
22	Adasa UG to OC	5.64	5.64	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.27	0.57	0.80	0.57	0.80	0.14	0.27	0.00	0.00
				0.00%	0.00%	0.00%	0.00%					#####	#####			2.48%	4.79%	0.00%	0.00%
23	Bhanegaon	3.48	3.48	0.01	0.02	0.00	0.00	0.16	0.33	0.20	0.24	0.35	0.69	0.36	0.71	0.36	0.57	0.01	0.02
				2.78%	2.82%	0.00%	0.00%					97.22%	97.18%			10.34%	16.38%	2.78%	2.82%
24	Gokul	7.57	10.02	0.75	0.89	0.00	0.00	0.00	0.00	0.30	0.92	1.78	2.12	2.53	3.01	0.30	0.92	0.75	0.89
				29.64%	29.57%	0.00%	0.00%					70.36%	70.43%			3.96%	9.18%	29.64%	29.57%
25	Inder Kamptee Ama	11.25	7.95	1.12	0.75	0.09	0.34	0.76	1.41	0.85	0.31	1.47	1.62	2.68	2.71	1.70	2.06	1.21	1.09
				41.79%	27.68%	3.36%	12.55%					54.85%	59.78%			15.11%	25.91%	45.15%	40.22%
26	Dhuptala	-	10.14	-	0.00	-	0.00	-	0.25	-	0.30	-	1.74	-	1.74	-	0.55	-	0.00
				-	0.00%	-	0.00%					-	#####			-	5.42%	-	0.00%
	Total-B	82.68	98.11	6.37	6.49	1.30	1.94	8.50	10.70	4.24	5.22	11.76	16.06	19.43	24.49	14.04	17.86	7.67	8.43
				32.78%	26.50%	6.69%	7.92%					60.52%	65.58%			16.98%	18.20%	39.48%	34.42%
	Total- (A+B)	225.38	242.73	17.98	19.24	5.26	6.08	22.20	25.57	13.91	15.61	33.43	40.67	56.67	65.99	41.37	47.26	23.24	25.32
				31.73%	29.16%	9.28%	9.21%					58.99%	61.63%			18.36%	19.47%	41.01%	38.37%

Note : In reference of 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 areas under barren backfill only.
- 3 Area under Active Mining includes coal quarry, advance quarry & quarry filled with water etc.
- 4 Social forestry and plantation on external OB dump are not included in biological reclamation and are put under other plantation.
- 5 % calculated in respect to total excavated area except for "Total area under plantation" where % is in terms of leasehold area.

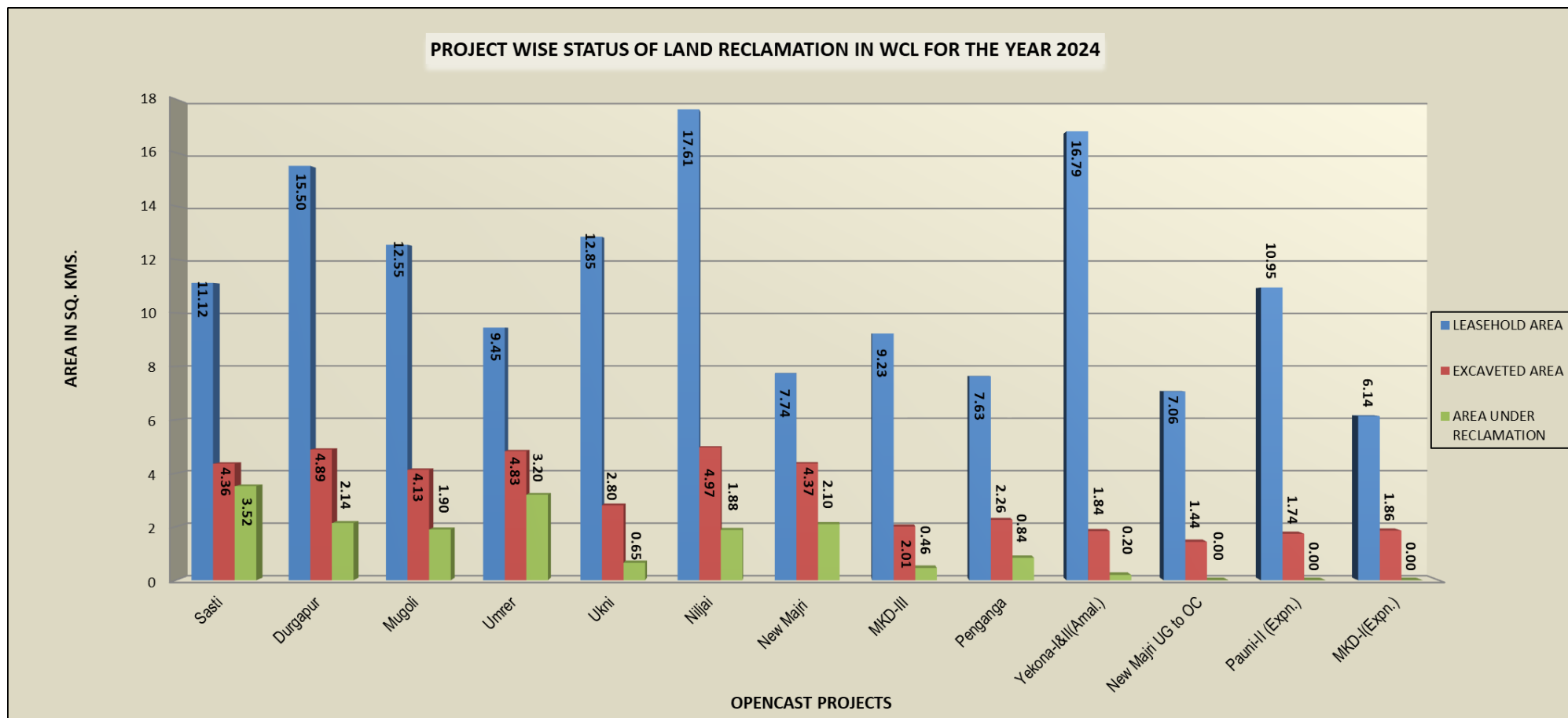


Fig.2: Land reclamation status in 14 OC projects of WCL for the year 2024

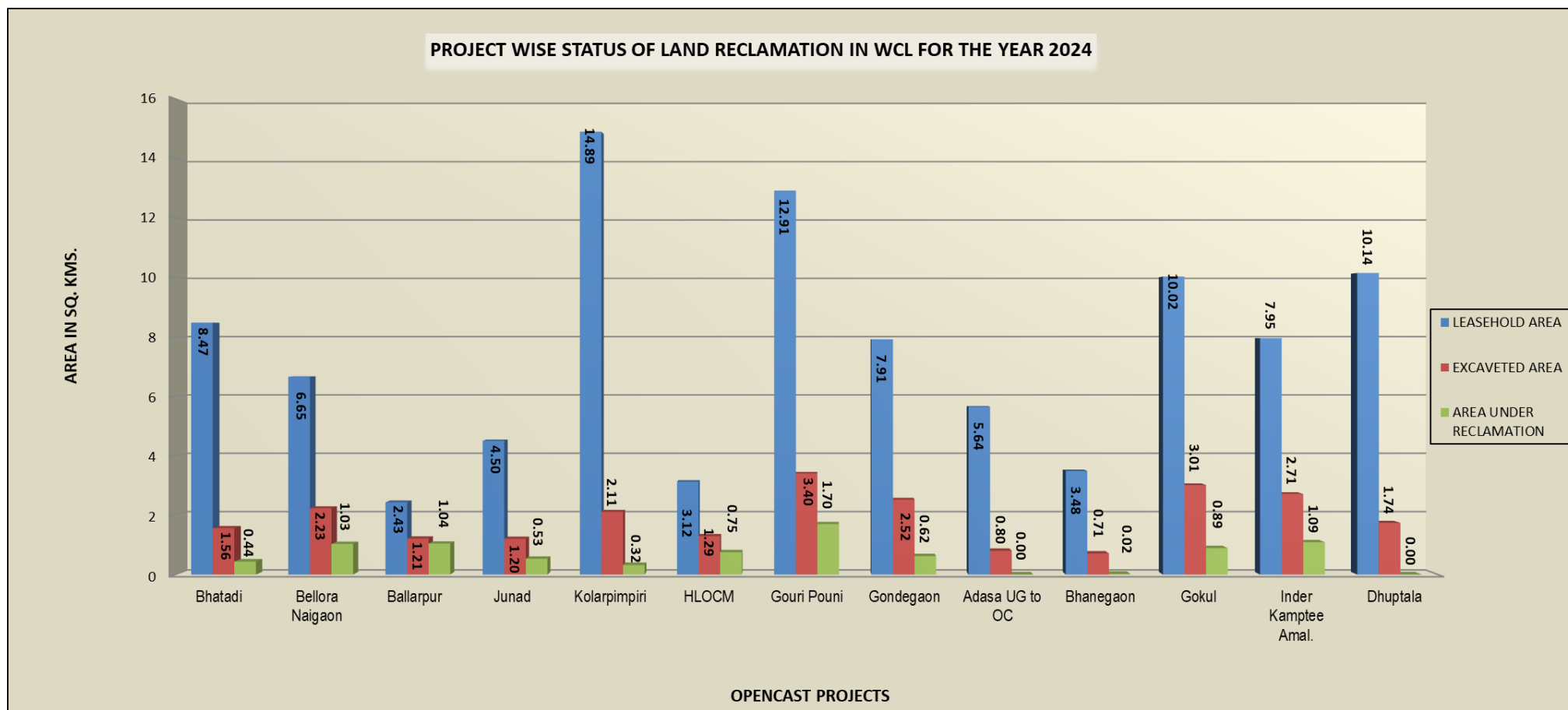


Fig.2: Land reclamation status in 14OC projects of WCL for the year 2024

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/2009/2428dated 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 m³ per annum (coal + OB taken together per annum) based on remote sensing satellite data, regularly on annual basis for sustainable development of mining. Further, another work order vide letter no. CIL/WBP/ENV./2011dated23/08/11was issued by CIL for monitoring of less than 5 million m³ per annum capacity (Coal +OB) projects from the year 2011 at interval of three years. This order has been renewed in CIL letter no. CIL/WBP/Env/2011/4706dated 12.10.2012 for the next five years. Again this work order has been renewed vide letter no. CIL/WBP/Env/2017/DP/8391 dated 22.06.2017 for a period next five years starting from 2017-18 to 2021-22. The work order was renewed vide letter no. CIL/ ENVT/2022-23/W. O/10899 dated 06.07.2022 for a period of 2 more years from 2022-23 to 2023-24. Again the above work order has been renewed vide letter no. CIL/ ENV/11463 dated 03.07.2024 for a period of 3 more years for 2024-25, 2025-26 and 2026-27. The result of land reclamation status of all such mines is put on the websites of **CIL**, (www.coalindia.in), **CMPDI** (www.cmpdi.co.in) and the concerned

coal companies in public domain. Detailed report is 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 2024 carried out for all the OC projects producing more than 5 mcm (Coal+OB) for Western Coalfields Ltd.

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. Bhoonidhi Portal of ISRO alongside 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 figure-3. Following steps are involved in land reclamation /restoration monitoring:

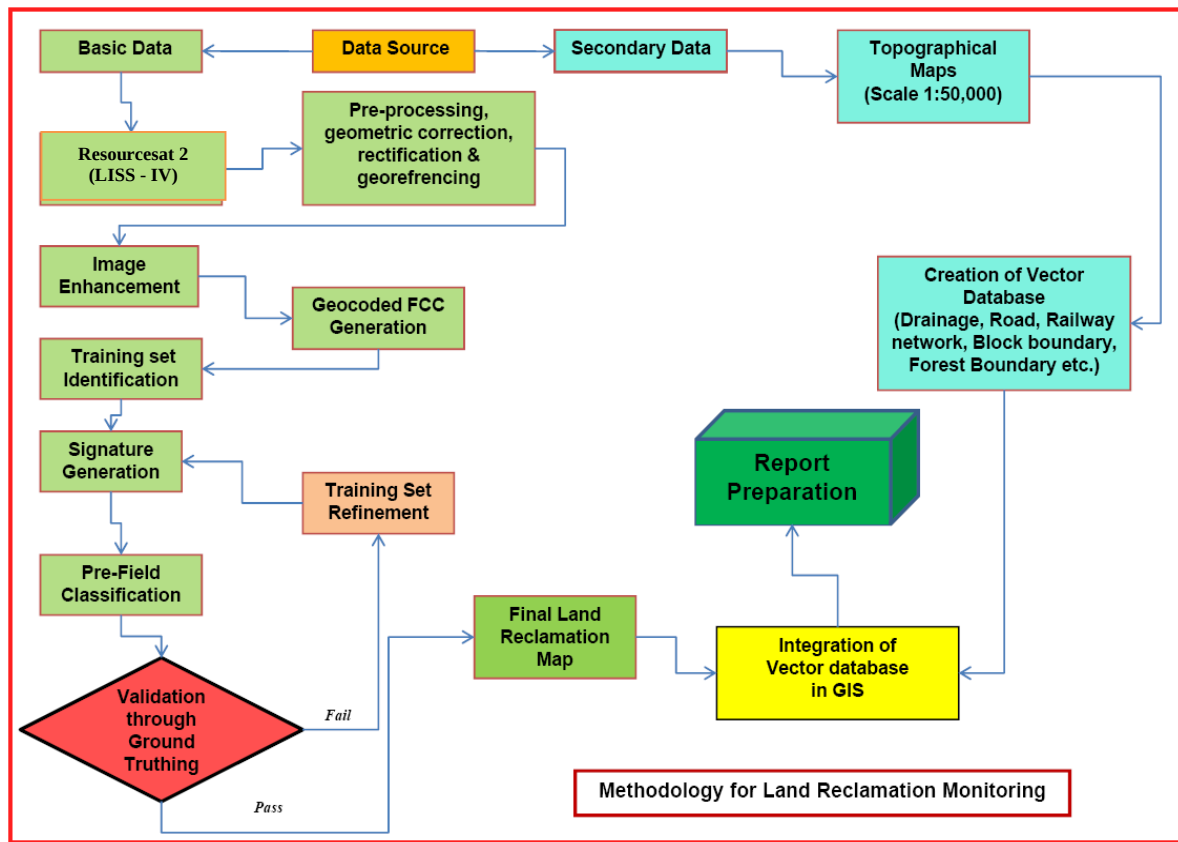


Figure: 3- **Methodology for Land Reclamation Monitoring**

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC or if available downloaded directly from the Bhoonidhi portal. 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 2022 digital image processing s/w and ArcGIS. 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 Sol 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 ERDAS IMAGINE 2022 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.2022 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 ArcGIS Pro 3.4 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 is 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

Twenty-six opencast projects of WCL producing more than 5 million cubic m. (Coal + OB together) have been taken up for land reclamation/ restoration monitoring in 2023-24, based on the Resourcesat-2/2A(L-IV) Satellite data, using

ERDAS Imaging digital image processing s/w, ArcGIS 10.2 and ArcGIS Pro 3.4 platform. Land reclamation monitoring will be carried out regularly on annual basis to assess the progressive status of land reclamation/ restoration in the above OC mines. The report of this study has been uploaded on the websites of CMPDI, CIL & WCL in public domain.

5.0 Land Reclamation Status in Western Coalfields Limited

5.1 Following 26 OC projects producing more than 5 million cubic m. (Coal + OB together) of Western Coalfields Ltd. have been taken up for land reclamation monitoring based on Satellite Data of the year 2024:

- | | |
|----------------------|----------------------|
| ▪ Sasti | ▪ Bhatadi |
| ▪ Durgapur | ▪ Bellora Naigaon |
| ▪ Mungoli | ▪ Ballarpur |
| ▪ Umrer | ▪ Junad |
| ▪ Ukni | ▪ Kolarpimpiri |
| ▪ Niljai | ▪ HLOCM) |
| ▪ New Majri | ▪ Gauri Pauni |
| ▪ MKD-III | ▪ Gondegaon |
| ▪ Penganga | ▪ Adasa UG to OC |
| ▪ Yekona I&II Amal | ▪ Bhanegaon |
| ▪ New Majri UG to OC | ▪ Gokul |
| ▪ Pauni-II (Expn.) | ▪ Inder Kamptee Amal |
| ▪ MKD-I Expn. | ▪ Dhuptala |

5.2 Project wise Land Reclamation status in WCL for the year 2024 is given in Table 1 and also shown graphically in Fig 1. Area statistics of different land use class present in the mine leasehold of the above projects for the year 2024 are shown in the Table 2. Land use maps derived from satellite data are shown in Plate 1-26. This time both local grid and UTM grid is used for map preparation along with all essential

boundaries shape file such as Quarry limit line, Sump, OB Dump, EC Boundary, Plantation area etc. as per the work order from CIL. Year wise changes in the different land use classes based on satellite data are depicted in Bar Charts in Fig.4–29 for the last three years only excluding Dhuptala OC (Sasti UG to OC) as this mine been consider for the land reclamation for the first time in Yr. 2024-25.

- 5.3** Study reveals that 25.32 Km² (38.37%) of excavated area has been under reclamation in the above mentioned mines of WCL out of which 6.08 Km²(9.21%) area has been revegetated and 19.24 Km² (29.16%) area is under backfilling. There is an overall increase of 2.08 Km² in area under reclamation in WCL in the year 2024 with respect to the year 2023, out of which there is an increase of 1.26 Km² in area under technical reclamation (Barren Backfilling) and an increase of 0.82 Km² in area under biological reclamation (Plantation on Backfilled Areas) (Refer Table-1).

In Sasti OC project, plantation on OB has been reduced by 0.11 Km² on account of tree felling and re-handling of backfill for the purpose of coal mining. In Durgapur OC and Umrer OC projects backfill has been reduced by 0.08 Km² and 0.04 Km² respectively as backfill has been converted to biological reclamation. In Inder Kamptee Amalgamated OC project total lease hold area have been decreased from 11.25 Km² to 7.95 Km². In previous cycle Inder OC project and Kamptee OC project had been analyzed separately in different year.

- 5.4** Analysis of satellite data also indicates that total area under active mining has increased from 33.43 Km² (Yr.2023) to 40.67 Km² (Yr.2024). In Umrer OC project area under active mining has reduced due to increase in area under backfilling.
- 5.5** After comparing the satellite data of year 2024 vs. 2023, study also reveals that area under backfilling has increased from 17.98 Km² (Yr.2023) to 19.24 Km² (Yr.2024).

- 5.6** Total area under biological reclamation has increased from 5.26 Km² (Yr.2023) to 6.08 Km² (Yr.2024). There is no biological reclamation in Yekona-I&II (Amal.), New Majri UG to OC, Pauni-II (Expn.), Bhatadi, MKD-I and MKD-III OC, Gondegaon, Adasa UG to OC, Bhanegaon, Gokul, Dhuptala & Penganga OC.
- 5.7** Analysis of satellite data also indicates that total area under plantation (Green Cover) has increased from 41.37 Km² (Yr.2023) to 47.26 Km² (Yr.2024). The increase of 5.89 Km² area under Green Cover areas may be attributed to continuous effort of WCL towards environmental protection.
- 5.8** After comparing the satellite data of year 2024 vs. 2023, it is evident that total area under plantation (Green Cover) in all 26 Opencast Projects has increased. It has been also observed in some of the projects natural vegetation has also started growing on stabilized old backfilled areas and overburden dumps due to high soil fertility.
- 5.9** On comparing the status of land reclamation for the year 2024 with respect to the year 2023 in different projects, it is evident that the total area under reclamation has increased from 23.24 Km² (Yr. 2023) to 25.32 Km² (Yr. 2023).
- 5.10** Out of 26 projects of WCL, maximum area under reclamation is in Ballarpur Opencast Project (85.95%) followed by Sasti OC (80.73%) and Umrer OC (66.25%).

TABLE - 2
Status of Land Use / Reclamation in OC Mines(>5mcu.m) of Western Coalfields Ltd. based on Satellite data of the Year 2024

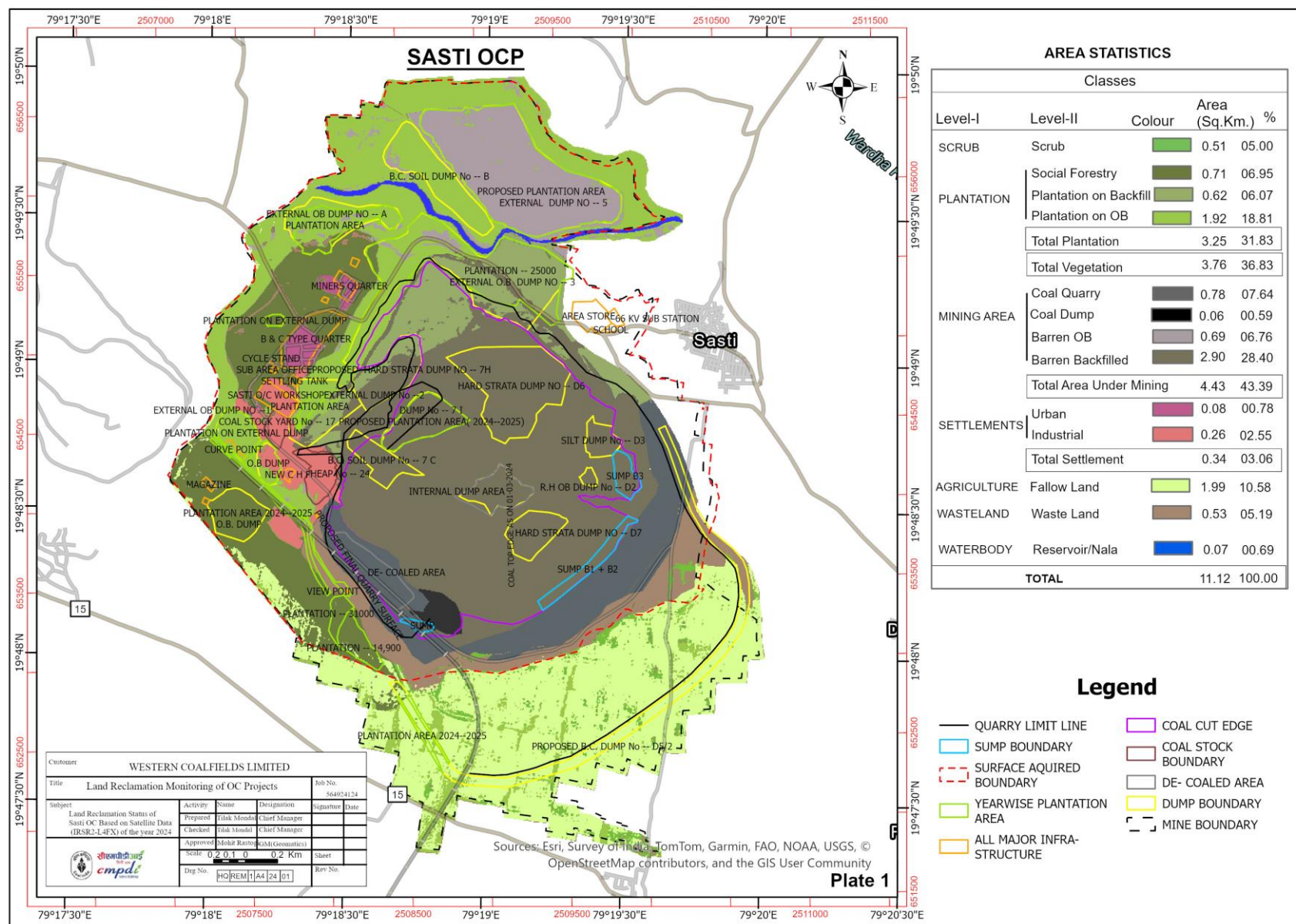
(Area in Sq.Km)

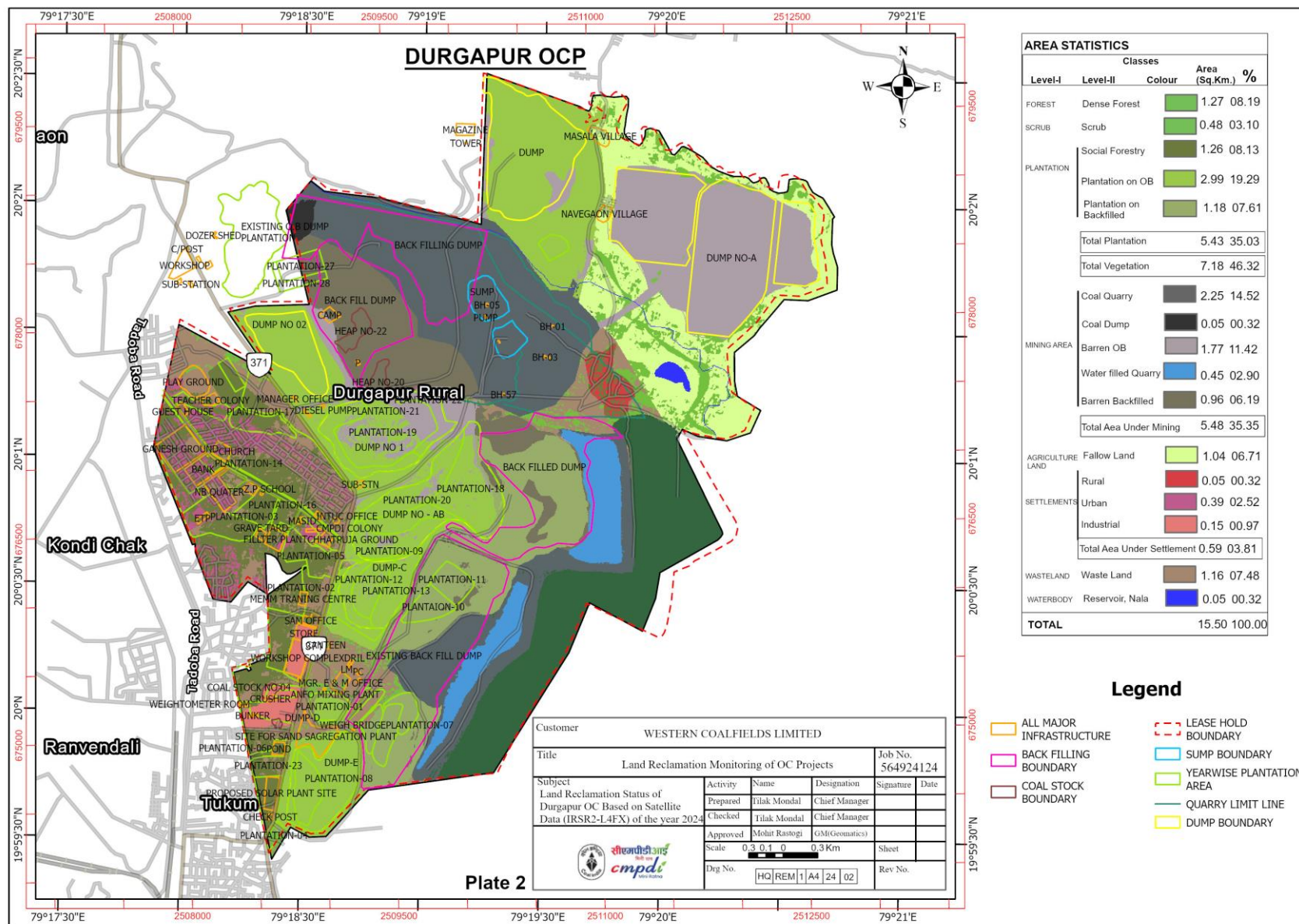
		Sasti		Durgapur		Mungoli		Umrer		Ukni		Nijaja		New Majri		MKD-III		Penganga		Yekona-I&II (Amal)		New Majri Up to OC		Pauni -II (Expn)		MKD-I (Expn.)		Total		
FORESTS	Dense Forest	0.00	0.00	1.27	8.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	0.88
	Open 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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	Total Forest	0.00	0.00	1.27	8.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	0.88	
	Scrub	0.51	5.00	0.48	3.10	1.62	12.91	0.00	0.00	1.53	11.91	1.34	7.61	0.06	0.78	0.54	5.85	0.71	9.31	1.99	11.85	0.68	9.63	0.97	8.86	0.75	12.21	11.18	7.7	
PLANTATION	Social Forestry	0.71	6.95	1.26	8.13	0.65	5.18	2.32	24.55	0.98	7.63	1.31	7.44	1.47	18.99	0.17	1.84	0.68	8.91	0.08	0.48	0.46	6.52	0.30	2.74	0.00	0.00	10.39	7.23	
	Plantation on OB Dump	1.92	18.81	2.99	19.29	1.98	15.78	1.45	15.34	1.81	14.09	2.23	12.66	1.04	13.44	0.25	2.71	0.50	6.55	0.00	0.00	0.35	4.96	0.25	2.28	0.10	1.63	14.87	10.35	
	Plantation on Backfill (Biological Reclamation)	0.62	6.07	1.18	7.61	0.20	1.59	1.73	18.31	0.00	0.00	0.13	0.74	0.28	3.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.14	2.88	
	Total Plantation	3.25	31.83	5.43	35.03	2.83	22.55	5.50	58.20	2.79	21.71	3.67	20.84	2.79	36.05	0.42	4.55	1.18	15.47	0.08	0.48	0.81	11.47	0.55	5.02	0.10	1.63	29.40	20.46	
ACTIVE MINING	Total Vegetation	3.76	36.83	7.18	46.32	4.45	35.46	5.50	58.20	4.32	33.62	5.01	28.45	2.85	36.82	0.96	10.40	1.89	24.77	2.07	12.33	1.49	21.10	1.52	13.88	0.85	13.84	41.85	29.12	
	Coal Quarry	0.78	7.64	2.25	14.52	2.23	17.77	1.52	16.08	1.99	15.49	3.00	17.04	2.27	29.33	1.55	16.79	1.19	15.60	1.43	8.52	1.31	18.56	1.54	14.06	1.86	30.29	22.92	15.95	
	Coal Dump	0.06	0.59	0.05	0.32	0.00	0.00	0.10	1.06	0.10	0.78	0.05	0.28	0.00	0.00	0.00	0.00	0.23	3.01	0.21	1.25	0.13	1.84	0.20	1.83	0.00	0.00	1.13	0.79	
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Quarry Filled With Water	0.00	0.00	0.45	2.90	0.00	0.00	0.01	0.11	0.06	0.47	0.04	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.39	
WASTELANDS	Total Area under Active Mining	0.84	8.23	2.75	17.74	2.23	17.77	1.63	17.25	2.15	16.73	3.09	17.55	2.27	29.33	1.55	16.79	1.42	18.61	1.64	9.77	1.44	20.40	1.74	15.89	1.86	30.29	24.61	17.12	
	Barren OB Dump	0.69	6.76	1.77	11.42	2.15	17.13	0.12	1.27	3.73	29.03	4.46	25.33	0.31	4.01	2.55	27.63	1.35	17.69	2.04	12.15	0.84	11.90	3.17	28.95	0.78	12.70	23.96	16.67	
	Barren Backfilled Area (Technical Reclamation)	2.90	28.40	0.96	6.19	1.70	13.55	1.47	15.56	0.65	5.06	1.75	9.94	1.82	23.51	0.46	4.98	0.84	11.01	0.03	0.18	0.00	0.00	0.00	0.00	0.00	0.00	12.58	8.75	
	Total Area	3.59	35.16	2.73	17.61	3.85	30.68	1.59	16.83	4.38	34.09	6.21	35.26	2.13	27.52	3.01	32.61	2.19	28.70	2.07	12.33	0.84	11.90	3.17	28.95	0.78	12.70	36.54	25.43	
WATERBODIES	Total Area Under Mine Operation	4.43	43.39	5.48	35.35	6.08	48.45	3.22	34.07	6.53	50.82	9.30	52.81	4.40	56.85	4.56	49.40	3.61	47.31	3.71	22.10	2.28	32.29	4.91	44.84	2.64	43.00	61.15	42.55	
	Waste Lands	0.53	5.19	1.16	7.48	0.23	1.83	0.27	2.86	0.75	5.84	0.79	4.49	0.10	1.29	0.15	1.63	1.65	21.63	1.26	7.50	0.26	3.68	0.33	3.01	0.11	1.79	7.59	5.28	
	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.71	0.05	0.46	0.00	0.00	0.10	0.07		
AGRICULTURE	Total Wasteland	0.53	5.19	1.16	7.48	0.23	1.83	0.27	2.86	0.75	5.84	0.79	4.49	0.10	1.29	0.15	1.63	1.65	21.63	1.26	7.50	0.31	4.39	0.38	3.47	0.11	1.79	7.69	5.35	
	Reservoir, nallah, ponds	0.07	0.69	0.05	0.32	0.00	0.00	0.20	2.12	0.00	0.00	0.03	0.17	0.01	0.13	0.00	0.00	0.12	1.57	0.10	0.60	0.03	0.42	0.22	2.01	0.07	1.14	0.90	0.63	
	Total Waterbodies	0.07	0.69	0.05	0.32	0.00	0.00	0.20	2.12	0.00	0.00	0.03	0.17	0.01	0.13	0.00	0.00	0.12	1.57	0.10	0.60	0.03	0.42	0.22	2.01	0.07	1.14	0.90	0.63	
SETTLEMENTS	Crop Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	10.08	0.00	0.00	3.26	19.42	0.87	12.32	0.46	4.20	0.51	8.31	6.03	4.20	
	Fallow Lands	1.08	10.58	1.04	6.71	1.46	11.63	0.00	0.00	1.05	8.17	1.45	8.23	0.00	0.00	2.42	26.22	0.21	2.75	6.34	37.76	2.00	28.33	3.33	30.41	1.96	31.92	22.34	15.55	
	Total Agriculture	1.08	10.58	1.04	6.71	1.46	11.63	0.00	0.00	1.05	8.17	1.45	8.23	0.00	0.00	3.35	36.29	0.21	2.75	9.60	57.18	2.87	40.65	3.79	34.61	2.47	40.23	28.37	19.74	
SETTLEMENTS	Urban Settlement	0.08	0.78	0.39	2.52	0.12	0.96	0.15	1.59	0.00	0.00	0.34	1.93	0.34	4.39	0.00	0.00	0.00	0.00	0.01	0.06	0.07	0.99	0.00	0.00	0.00	0.00	1.50	1.04	
	Rural Settlement	0.00	0.00	0.05	0.32	0.03	0.24	0.00	0.00	0.02	0.16	0.20	1.14	0.00	0.00	0.00	0.00	0.03	0.39	0.03	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.25	
	Industrial Settlement	0.26	2.55	0.15	0.97	0.18	1.43	0.11	1.16	0.18	1.40	0.49	2.78	0.04	0.52	0.21	2.28	0.12	1.57	0.01	0.06	0.01	0.14	0.13	1.19	0.00	0.00	1.89	1.32	
Grand Total	Total Settlement	0.34	3.33	0.59	3.81	0.33	2.63	0.26	2.75	0.20	1.56	1.03	5.85	0.38	4.91	0.21	2.28	0.15	1.97	0.05	0.30	0.08	1.13	0.13	1.19	0.00	0.00	3.75	2.61	
	Grand Total	10.21	100.00	15.50	100.00	12.55	100.00	9.45	100.00	12.85	100.00	17.61	100.00	7.74	100.00	9.23	100.00	7.63	100.00	16.79	100.00	7.06	100.00	10.95	100.00	6.14	100.00	143.71	100.00	

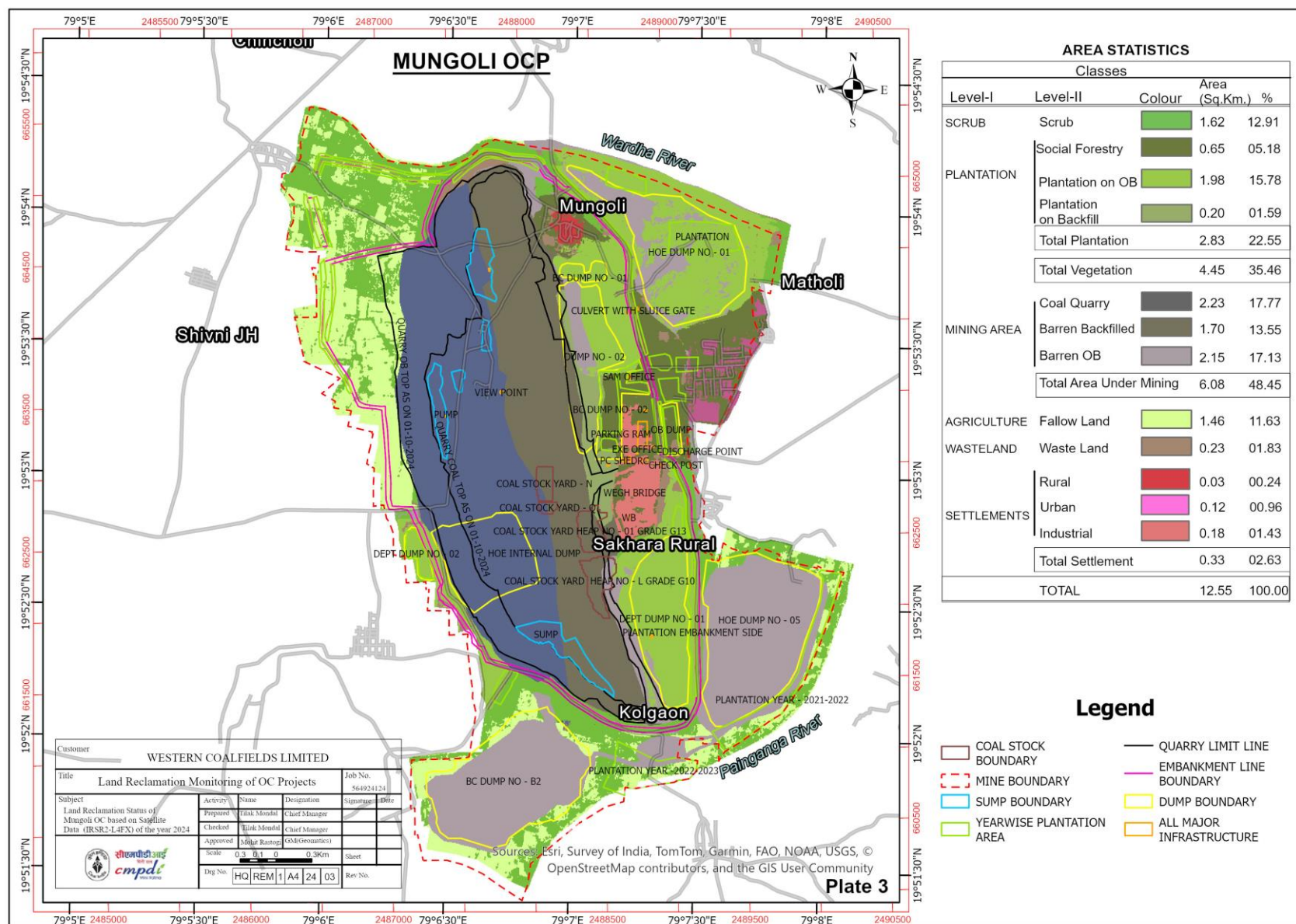
TABLE - 2
Status of Land Use / Reclamation in OC Mines(>5mcu.m) of Western Coalfields Ltd based on Satellite data of the Year 2024

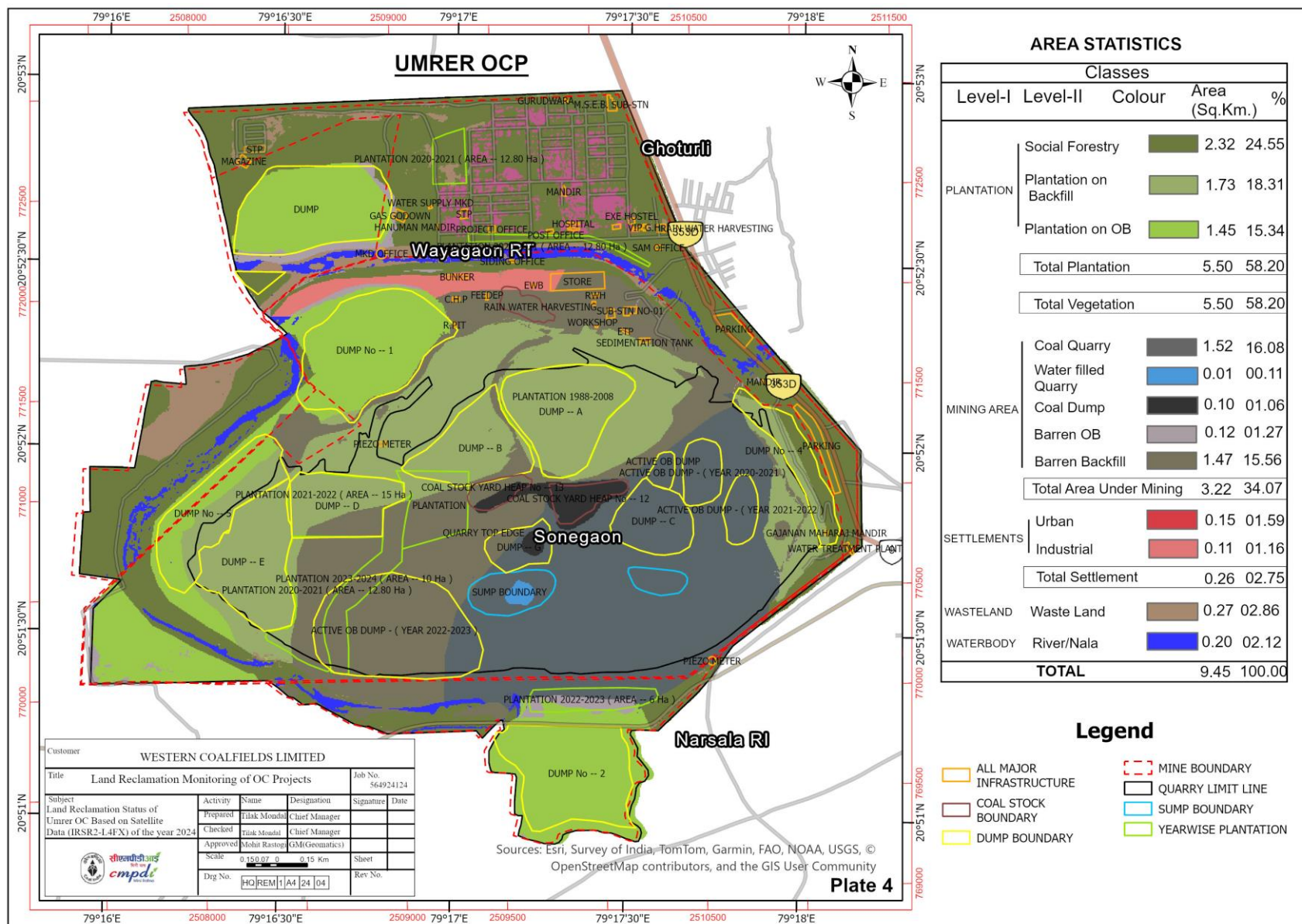
(Area in Sq.Km)

			Bhatadi		Bellora Naigaon		Ballarpur		Junad		Kolar Pimpiri		HLOCM		Gauri-Pouni		Gondegaon		Adasa UG to OC		Dhuptala		Gokul		Bhanegaon		Inder Kamptee		Total	
FORESTS			Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
	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	0.00	0.00	0.00	0.00	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		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS			0.97	11.45	0.53	7.97	0.01	0.41	0.51	11.33	2.40	16.12	0.02	0.64	0.86	6.66	0.33	4.17	0.82	14.54	1.07	10.55	1.06	10.58	0.13	3.74	0.75	12.21	9.46	9.82
	Scrubs																													
PLANTATION	Social Forestry		0.48	5.67	0.45	6.77	0.13	5.35	0.38	8.44	0.16	1.07	0.37	11.86	0.64	4.96	0.57	7.21	0.27	4.79	0.41	4.04	0.92	9.18	0.24	6.90	0.00	0.00	5.02	5.21
	Plantation on OB Dump		0.59	6.97	0.57	8.57	0.78	32.10	0.81	18.00	1.43	9.60	0.76	24.36	2.55	19.75	1.22	15.42	0.00	0.00	0.78	7.69	0.00	0.00	0.33	9.48	0.10	1.63	9.92	10.30
	Plantation on Backfill (Biological Reclamation)		0.00	0.00	0.20	3.01	0.28	11.52	0.12	2.67	0.11	0.74	0.10	3.21	0.79	6.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60	1.66	
	Total Plantation		1.07	12.63	1.22	18.35	1.19	48.97	1.31	29.11	1.70	11.42	1.23	39.42	3.98	30.83	1.79	22.63	0.27	4.79	1.19	11.74	0.92	9.18	0.57	16.38	0.10	1.63	16.54	17.18
Total Vegetation			2.04	24.09	1.75	26.32	1.20	49.38	1.82	40.44	4.10	27.54	1.25	40.06	4.84	37.49	2.12	26.80	1.09	19.33	2.26	22.29	1.98	19.76	0.70	20.11	0.85	13.84	26.00	27.00
ACTIVE MINING	Coal Quarry		0.97	11.45	1.17	17.59	0.13	5.35	0.65	14.44	1.33	8.93	0.49	15.71	1.08	8.37	1.59	20.10	0.74	13.12	0.29	2.86	1.81	18.06	0.64	18.39	1.86	30.29	12.75	13.24
	Coal Dump		0.13	1.53	0.03	0.45	0.04	1.65	0.02	0.44	0.04	0.27	0.05	1.60	0.15	1.16	0.07	0.88	0.06	1.06	0.04	0.39	0.26	2.59	0.02	0.57	0.00	0.00	0.91	0.94
	Advance Quarry Site		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	
	Quarry Filled With Water		0.02	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.42	2.82	0.00	0.00	0.47	3.64	0.24	3.03	0.00	0.00	0.04	0.39	0.05	0.50	0.03	0.86	0.00	0.00	1.27	1.32
	Total Area under Active Mining		1.12	13.22	1.20	18.05	0.17	7.00	0.67	14.89	1.79	12.02	0.54	17.31	1.70	13.17	1.90	24.02	0.80	14.18	0.46	4.54	2.12	21.16	0.69	19.83	1.86	30.29	15.02	15.60
	Barren OB Dump		1.77	20.90	0.45	6.77	0.19	7.82	1.15	25.56	3.58	24.04	0.31	9.94	0.90	6.97	1.62	20.48	0.97	17.20	1.18	11.64	1.52	15.17	0.96	27.59	0.78	12.70	15.38	15.97
	Barren Backfilled Area (Technical Reclamation)		0.44	5.19	0.83	12.48	0.76	31.28	0.41	9.11	0.21	1.41	0.65	20.83	0.91	7.05	0.62	7.84	0.00	0.00	0.00	0.89	8.88	0.02	0.57	0.00	0.00	5.74	5.96	
	Total Area		2.21	26.09	1.28	19.25	0.95	39.09	1.56	34.67	3.79	25.45	0.96	30.77	1.81	14.02	2.24	28.32	0.97	17.20	1.18	11.64	2.41	24.05	0.98	28.16	0.78	12.70	21.12	21.93
	Total Area Under Mine Operation		3.33	39.32	2.48	37.29	1.12	46.09	2.23	49.56	5.58	37.47	1.50	48.08	3.51	27.19	4.14	52.34	1.77	31.38	1.64	16.17	4.53	45.21	1.67	47.99	2.64	43.00	36.14	37.53
WASTE LANDS	Waste Lands		0.57	6.73	0.27	4.06	0.03	1.23	0.22	4.89	0.65	4.37	0.11	3.53	0.41	3.18	0.50	6.32	0.46	8.16	0.68	6.71	0.47	4.69	0.25	7.18	0.11	1.79	4.73	4.91
	Fly Ash Pond / Sand Body		0.05	0.59	0.05	0.75	0.02	0.00	0.04	0.89	0.03	0.20	0.00	0.00	0.06	0.46	0.00	0.00	0.04	0.71	0.05	0.49	0.00	0.00	0.03	0.86	0.00	0.00	0.37	0.38
	Total Wasteland		0.62	7.32	0.32	4.81	0.05	1.23	0.26	5.78	0.68	4.57	0.11	3.53	0.47	3.64	0.50	6.32	0.50	8.87	0.73	7.20	0.47	4.69	0.28	8.05	0.11	1.79	5.10	5.30
	Reservoir, nallah, ponds		0.15	1.77	0.02	0.30	0.02	0.82	0.04	0.89	0.02	0.13	0.08	2.56	0.02	0.15	0.00	0.00	0.05	0.89	0.11	1.08	0.02	0.20	0.08	2.30	0.07	1.14	0.68	0.71
	Total Waterbodies		0.15	1.77	0.02	0.30	0.02	0.82	0.04	0.89	0.02	0.13	0.08	2.56	0.02	0.15	0.00	0.00	0.05	0.89	0.11	1.08	0.02	0.20	0.08	2.30	0.07	1.14	0.68	0.71
AGRICULTURE	Crop Lands		0.00	0.00	0.50	7.52	0.00	0.00	0.00	0.35	2.35	0.00	0.00	0.00	0.00	0.00	0.00	0.70	12.41	1.67	16.47	0.00	0.00	0.00	0.00	0.51	8.31	3.73	3.87	
	Fallow Lands		2.25	26.56	1.58	23.76	0.02	0.82	0.12	2.67	3.99	26.80	0.04	1.28	3.94	30.52	1.08	13.65	1.45	25.71	3.56	35.11	2.80	27.94	0.67	19.25	1.96	31.92	23.46	24.36
	Total Agriculture		2.25	26.56	2.08	31.28	0.02	0.82	0.12	2.67	4.34	29.15	0.04	1.28	3.94	30.52	1.08	13.65	2.15	38.12	5.23	51.58	2.80	27.94	0.67	19.25	2.47	40.23	27.19	28.23
SETTLEMENTS	Urban Settlement		0.02	0.24	0.00	0.00	0.01	0.41	0.01	0.22	0.01	0.07	0.13	4.17	0.00	0.00	0.04	0.51	0.04	0.71	0.07	0.69	0.00	0.00	0.00	0.00	0.00	0.33	0.34	
	Rural Settlement		0.04	0.47	0.00	0.00	0.00	0.01	0.22	0.06	0.40	0.00	0.00	0.05	0.39	0.00	0.00	0.03	0.53	0.02	0.20	0.16	1.60	0.00	0.00	0.00	0.00	0.37	0.38	
	Industrial Settlement		0.02	0.24	0.00	0.00	0.01	0.41	0.01	0.22	0.10	0.67	0.01	0.32	0.08	0.62	0.03	0.38	0.01	0.18	0.08	0.79	0.06	0.60	0.08	2.30	0.00	0.00	0.49	0.51
	Total Settlement		0.08	0.94	0.00	0.00	0.02	0.82	0.03	0.67	0.17	1.14	0.14	4.49	0.13	1.01	0.07	0.88	0.08	1.42	0.17	1.68	0.22	2.20	0.08	2.30	0.00	0.00	1.19	1.24
Grand Total			8.47	100.00	6.65	100.00	2.43	99.18	4.50	100.00	14.89	100.00	3.12	100.00	12.91	100.00	7.91	100.00	5.64	100.00	10.14	100.00	10.02	100.00	3.48	100.00	6.14	100.00	96.30	100.00

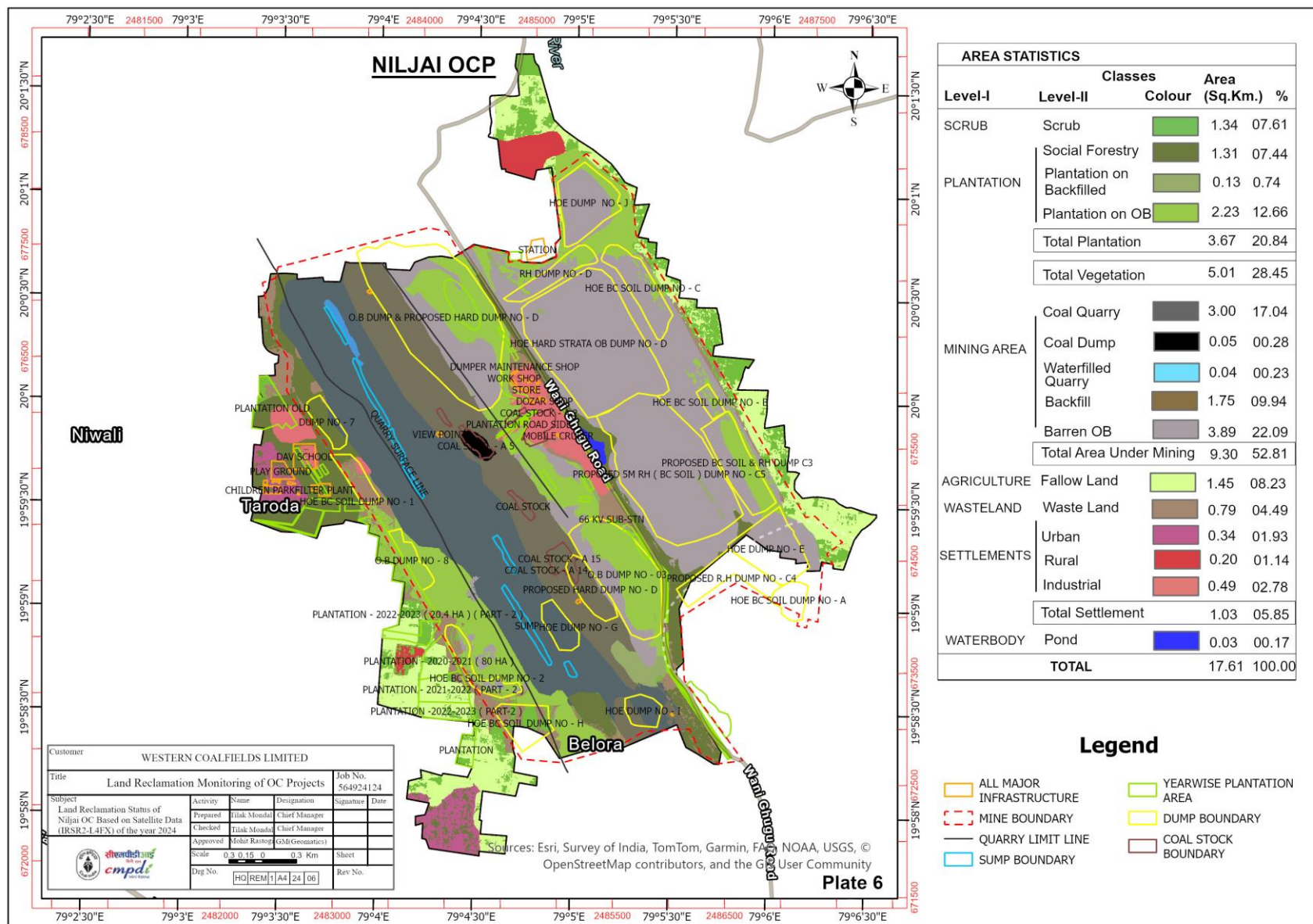


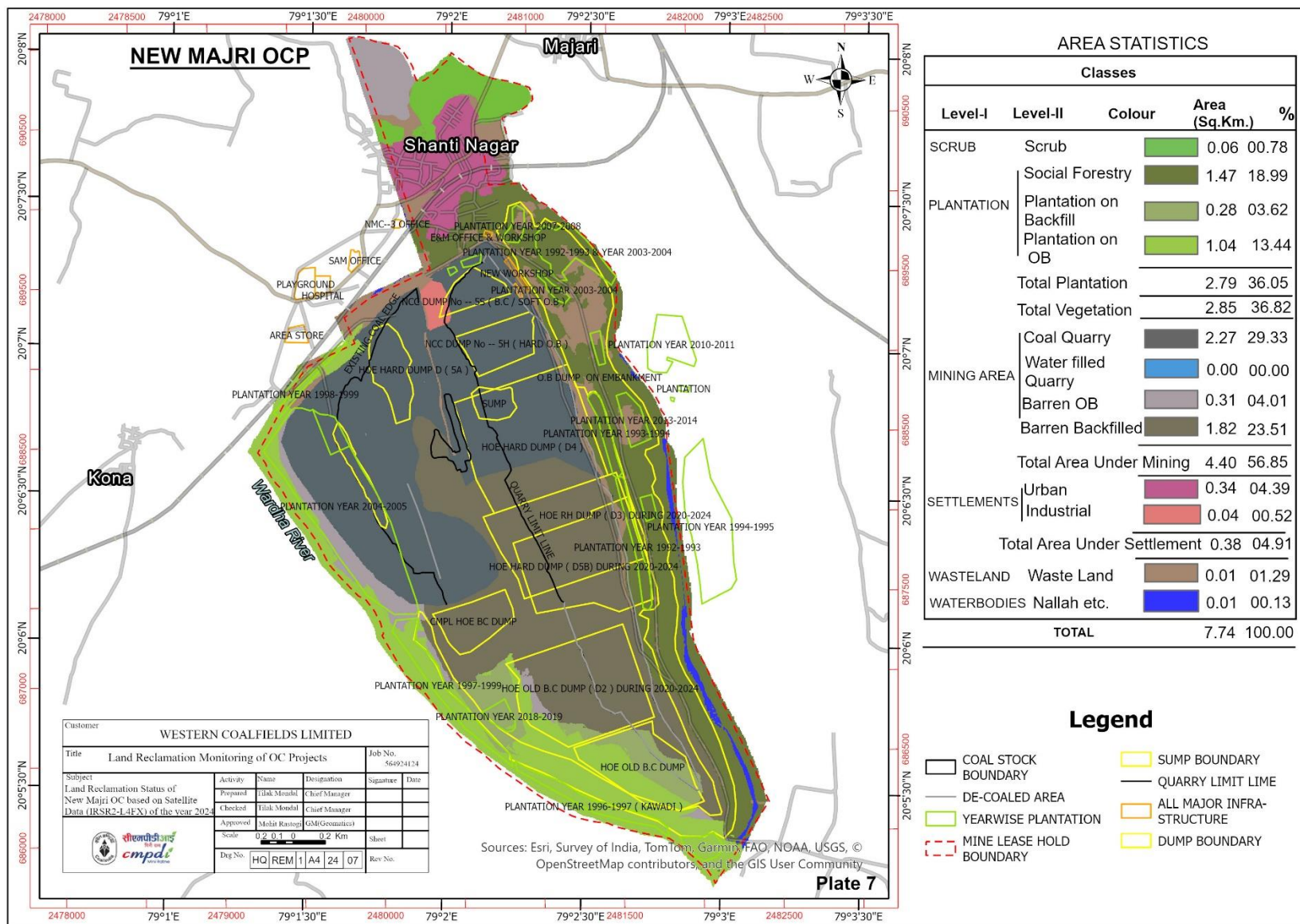


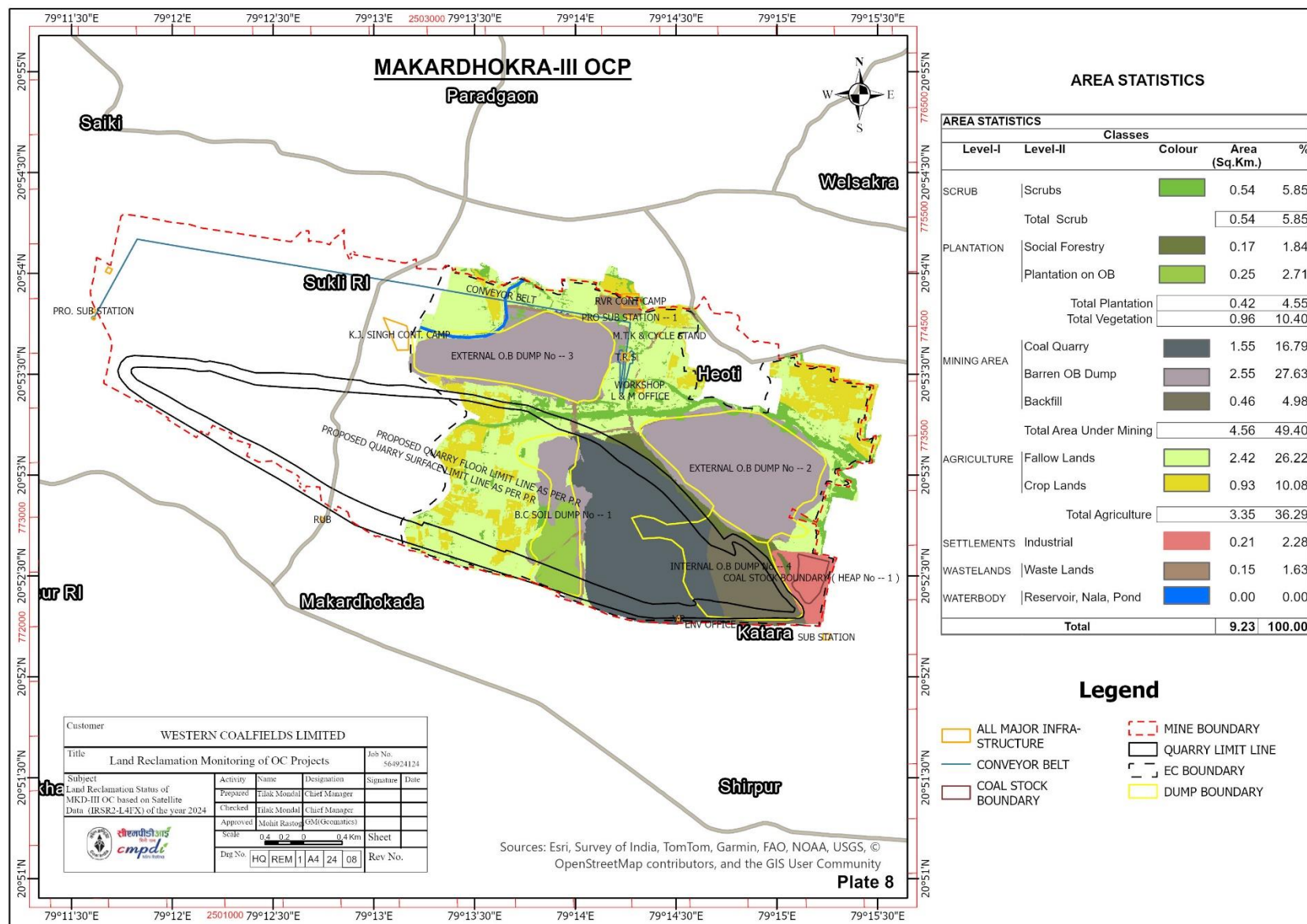


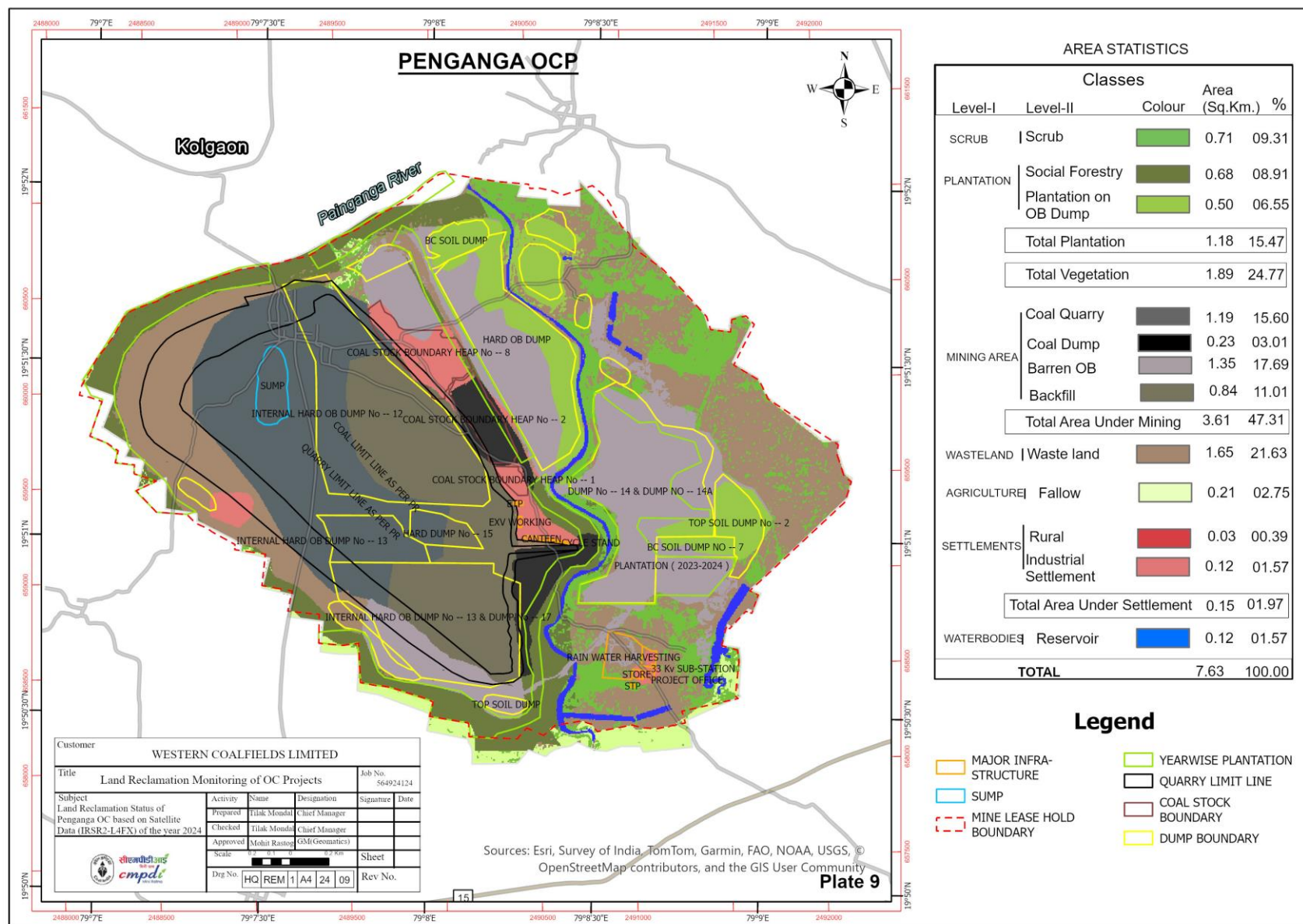


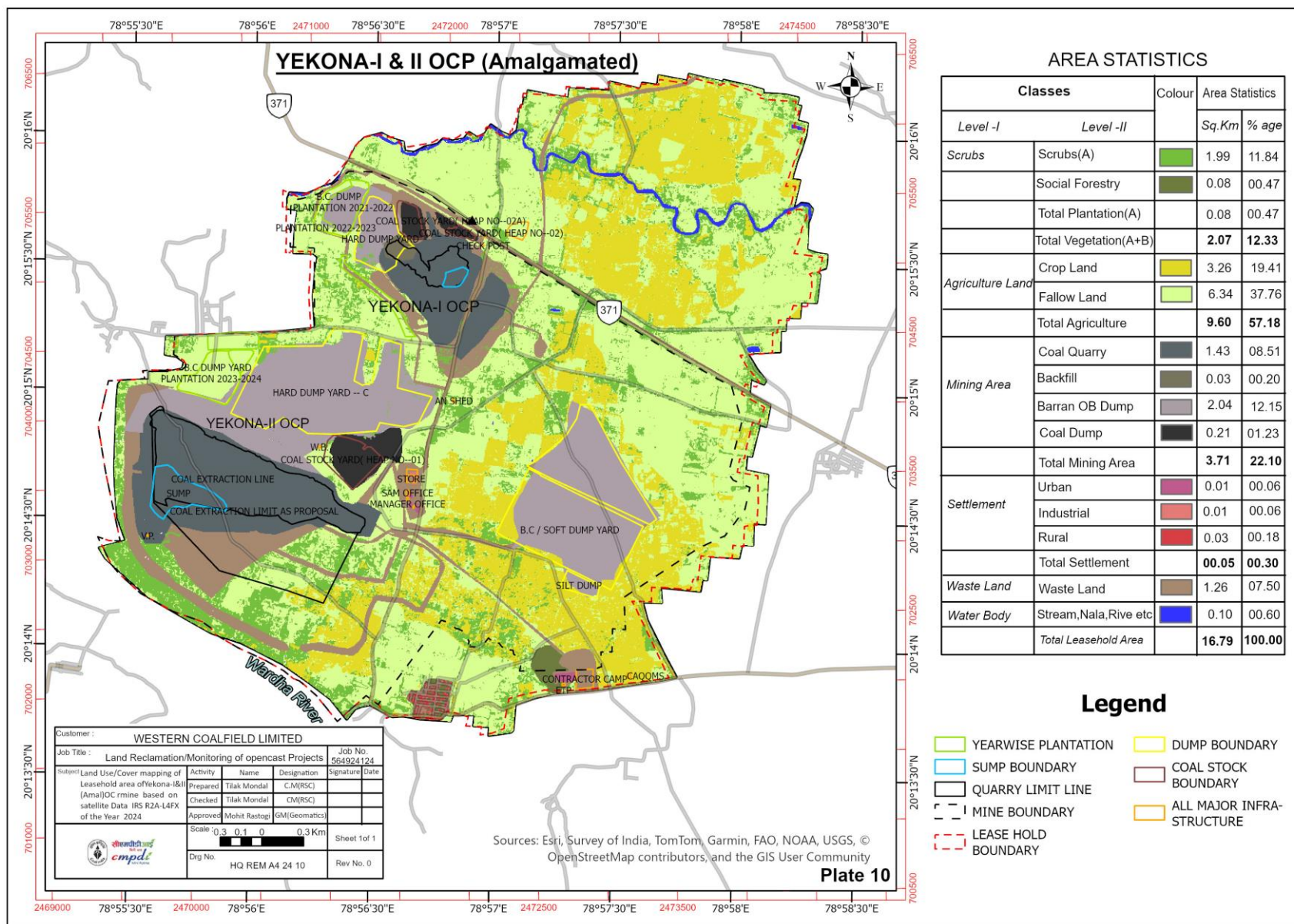


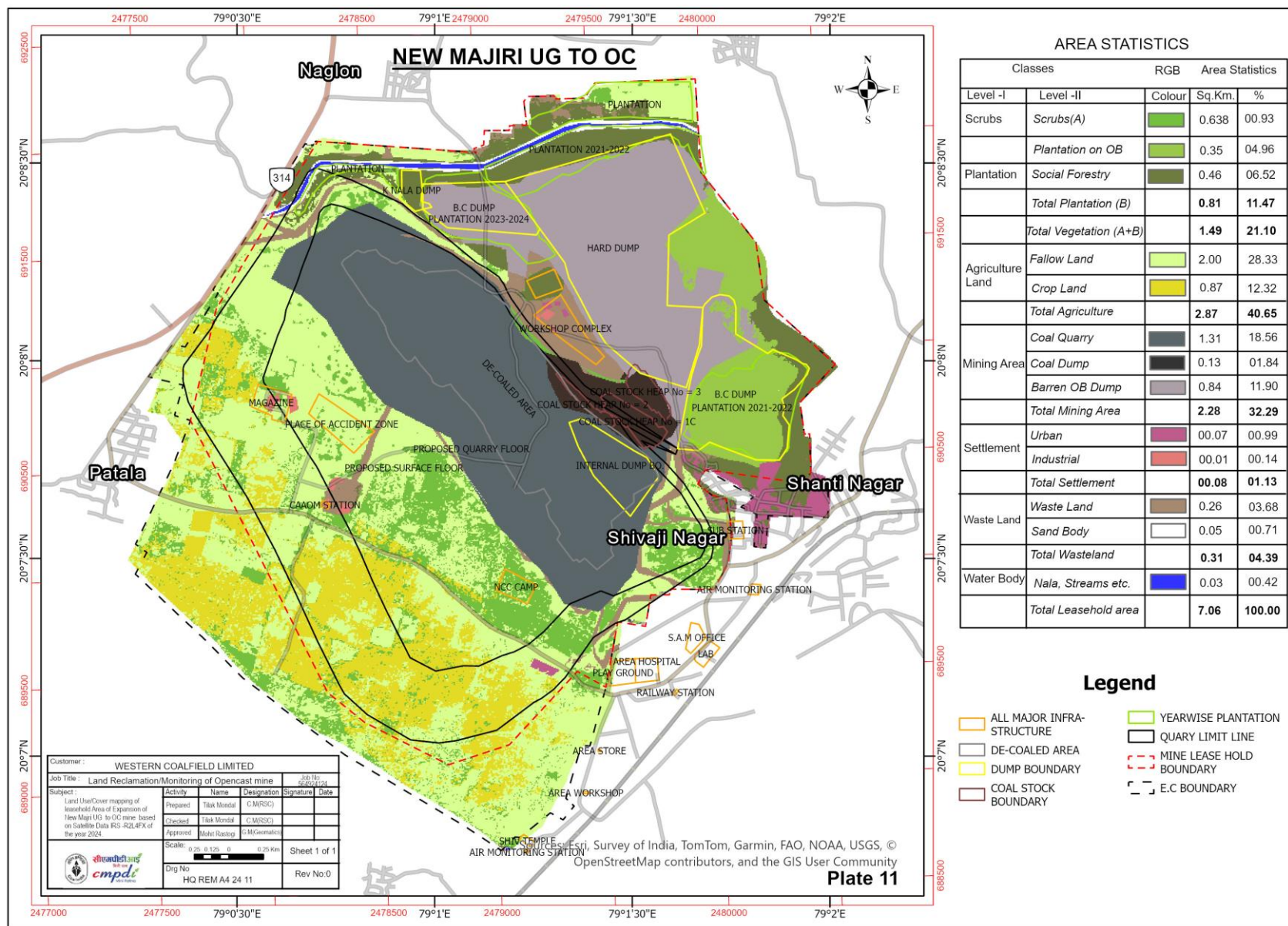


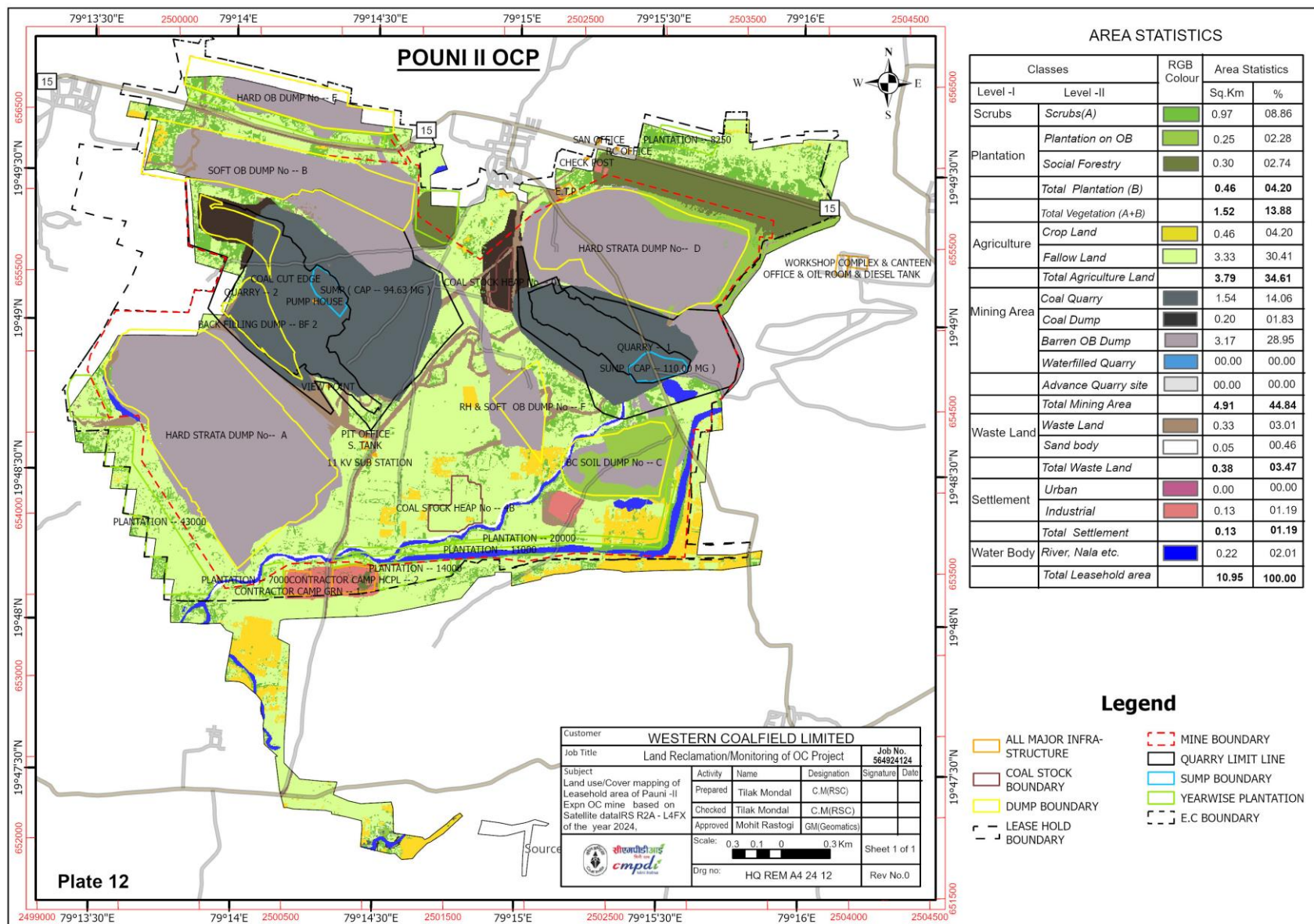


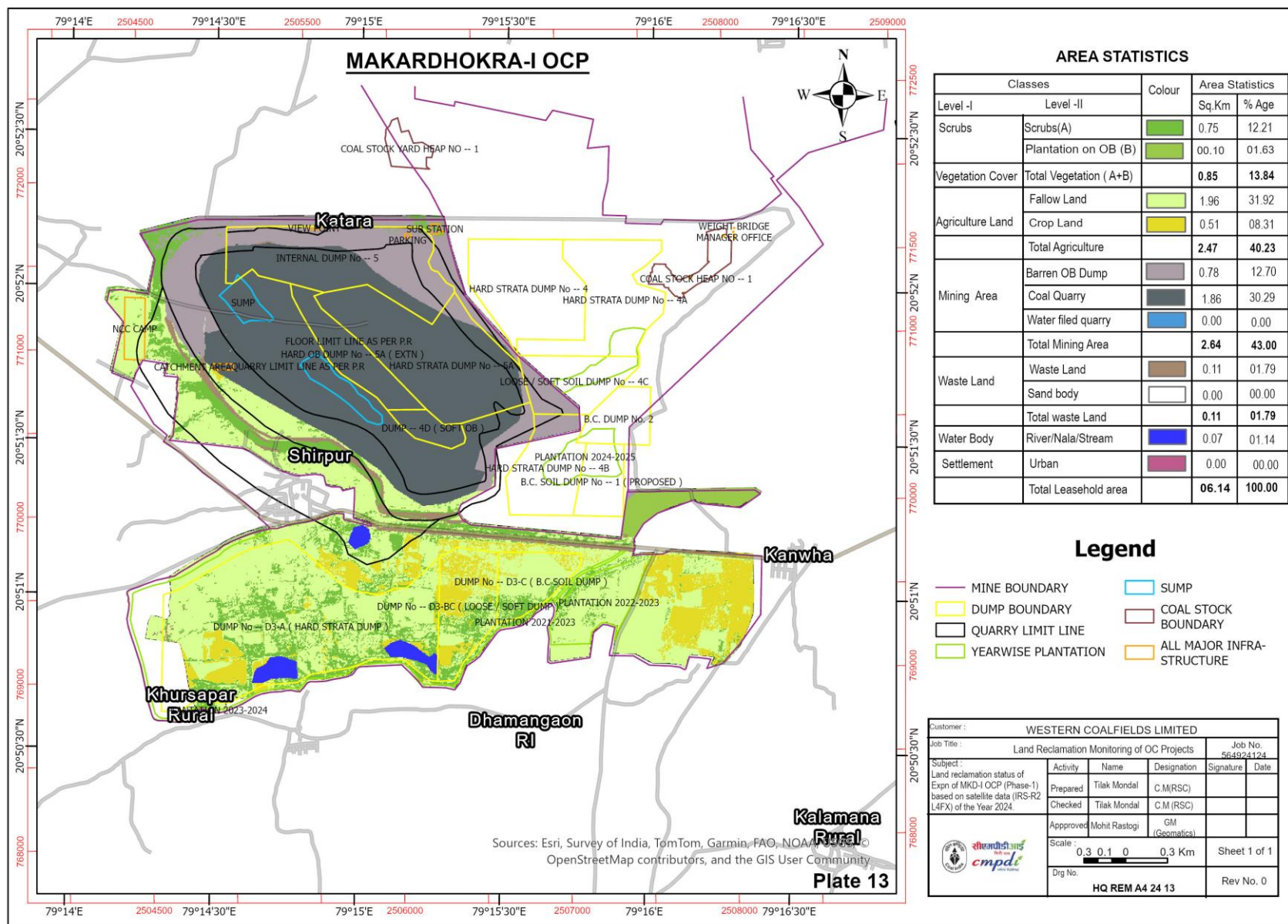


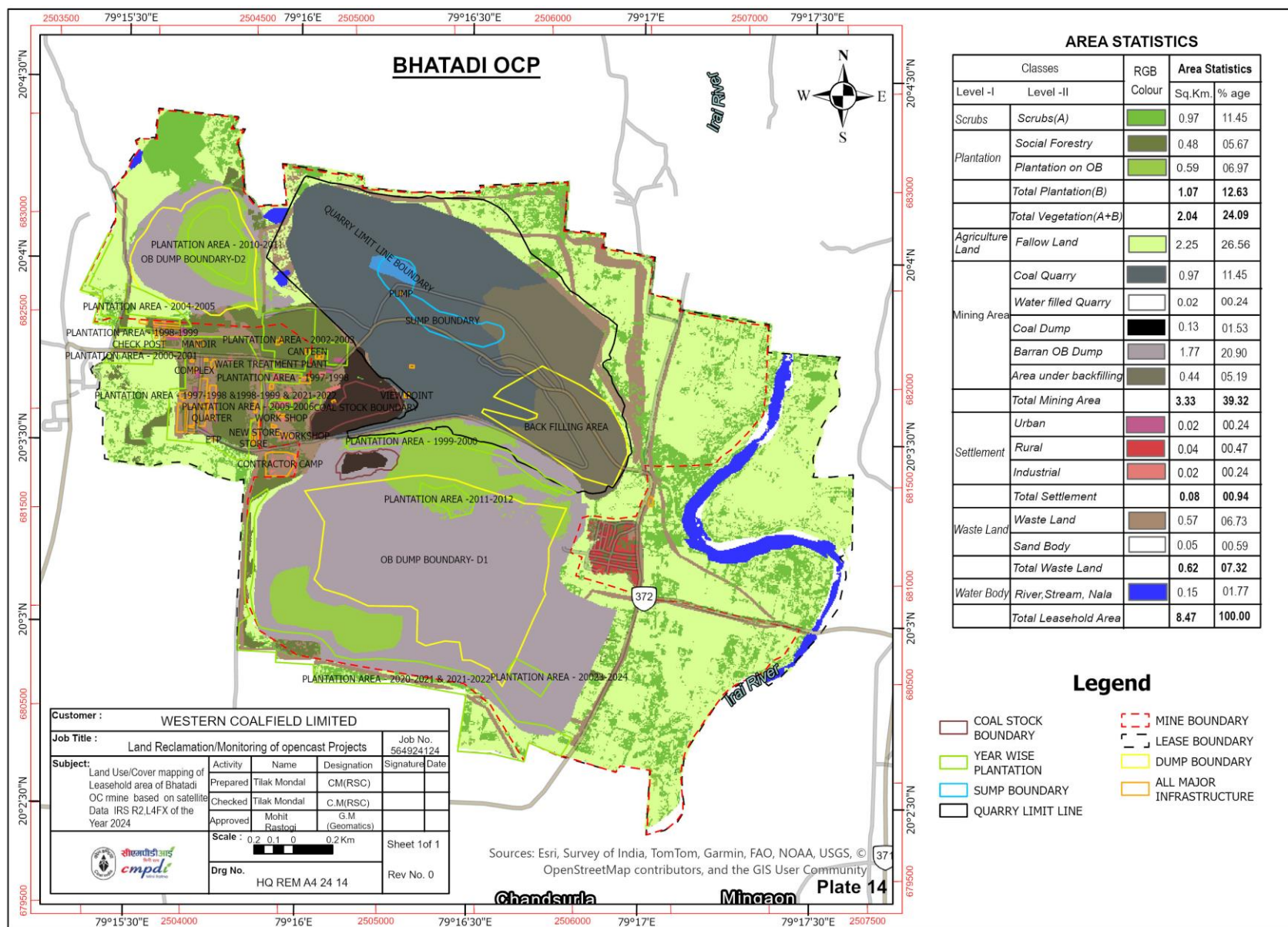


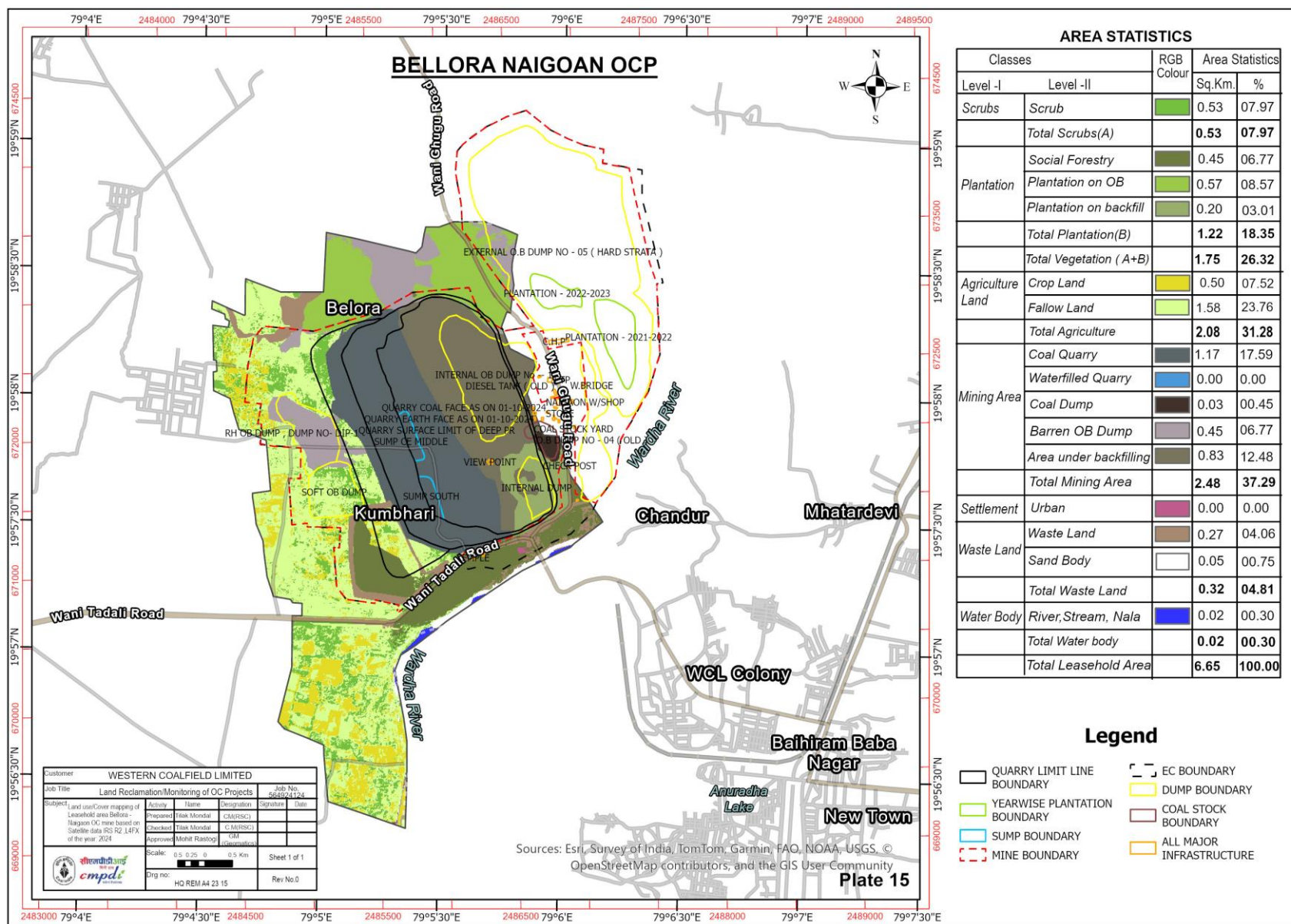






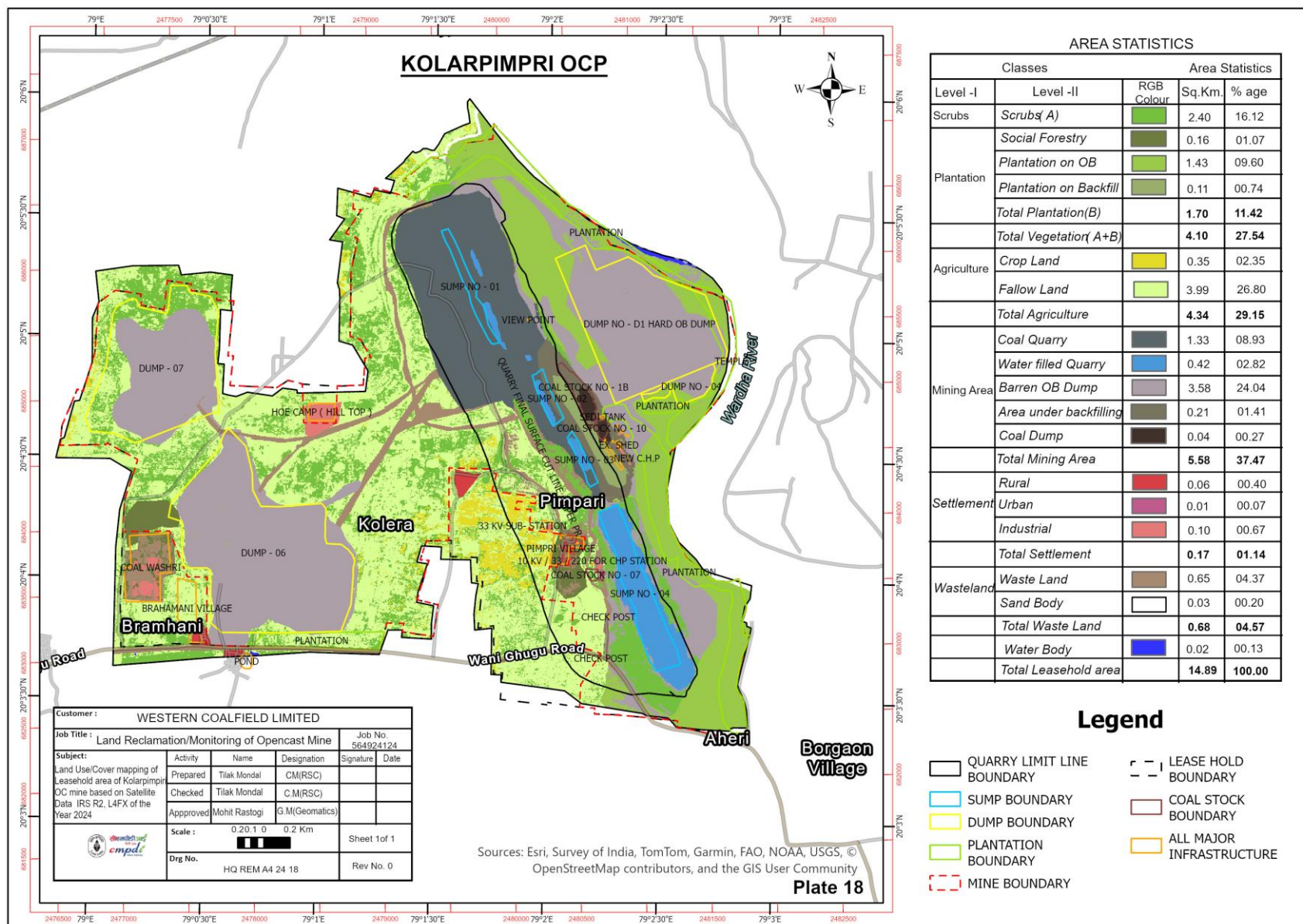


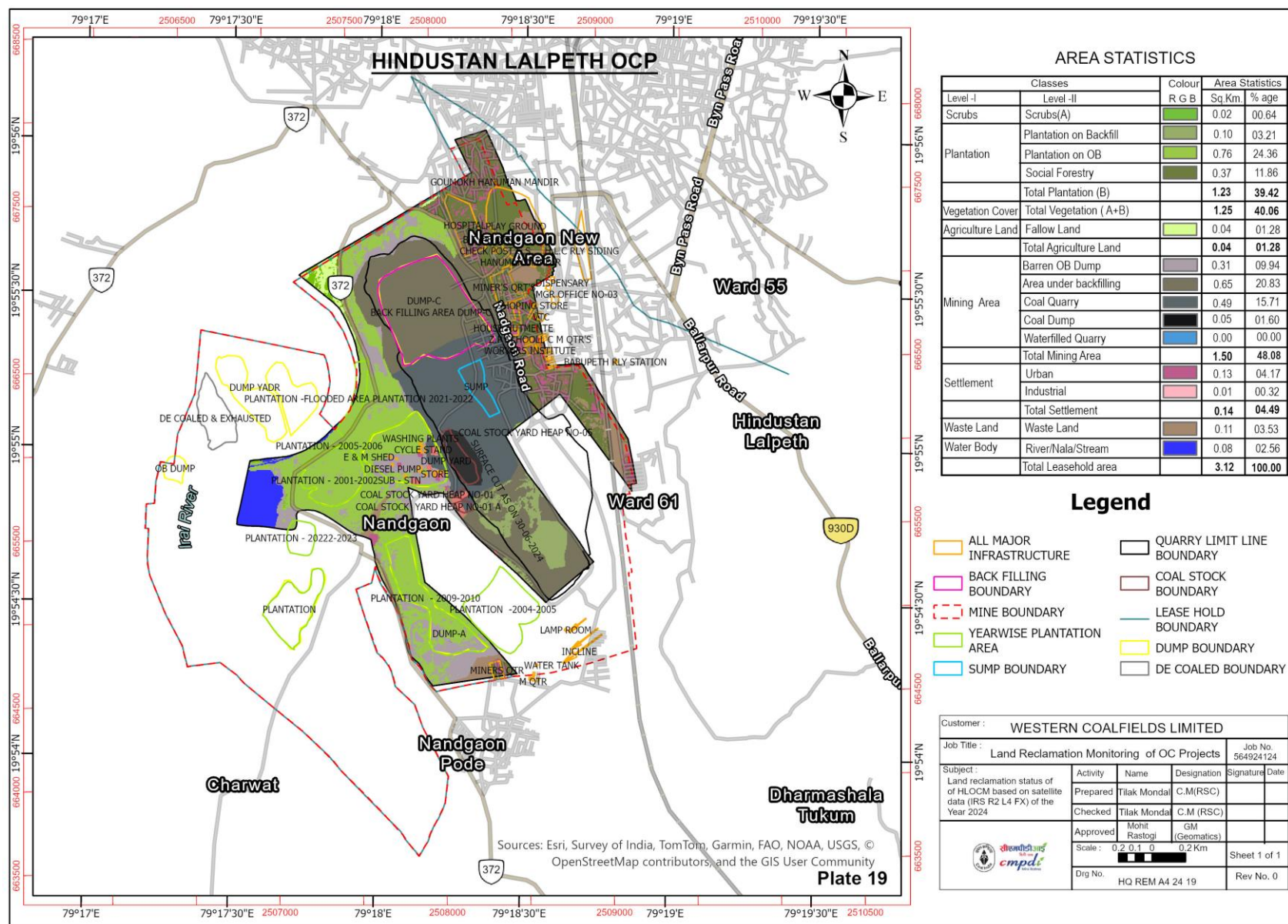


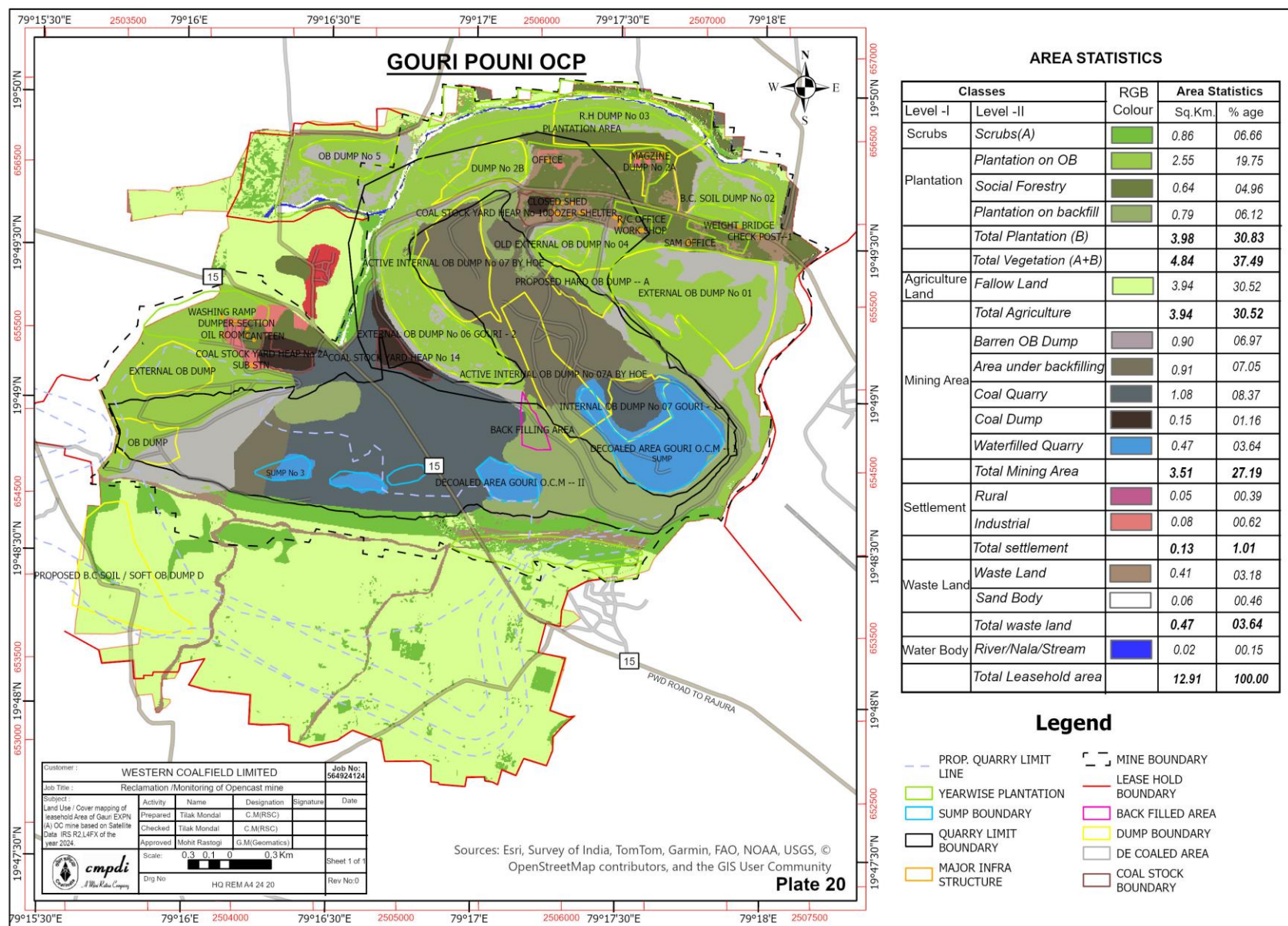


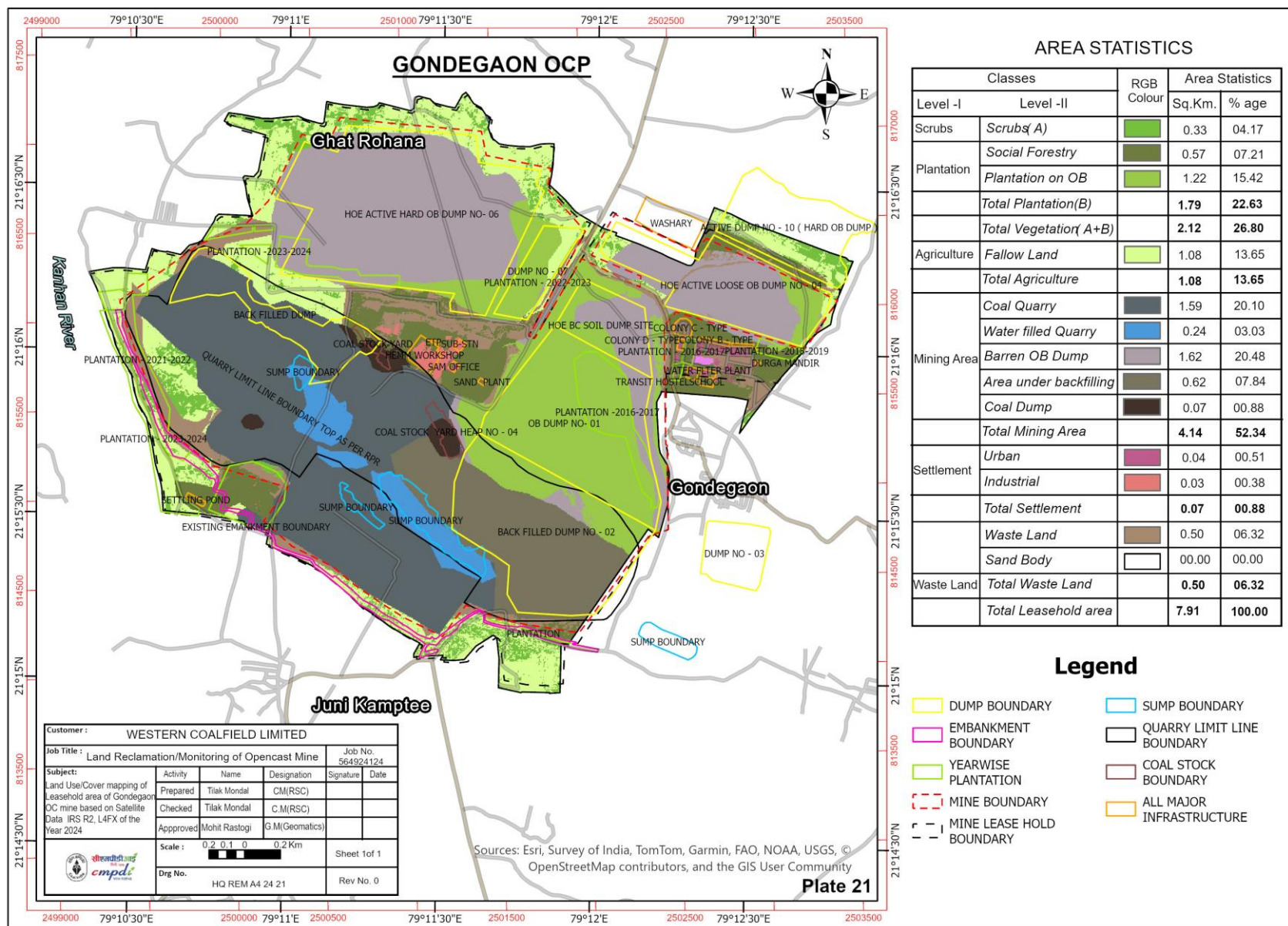


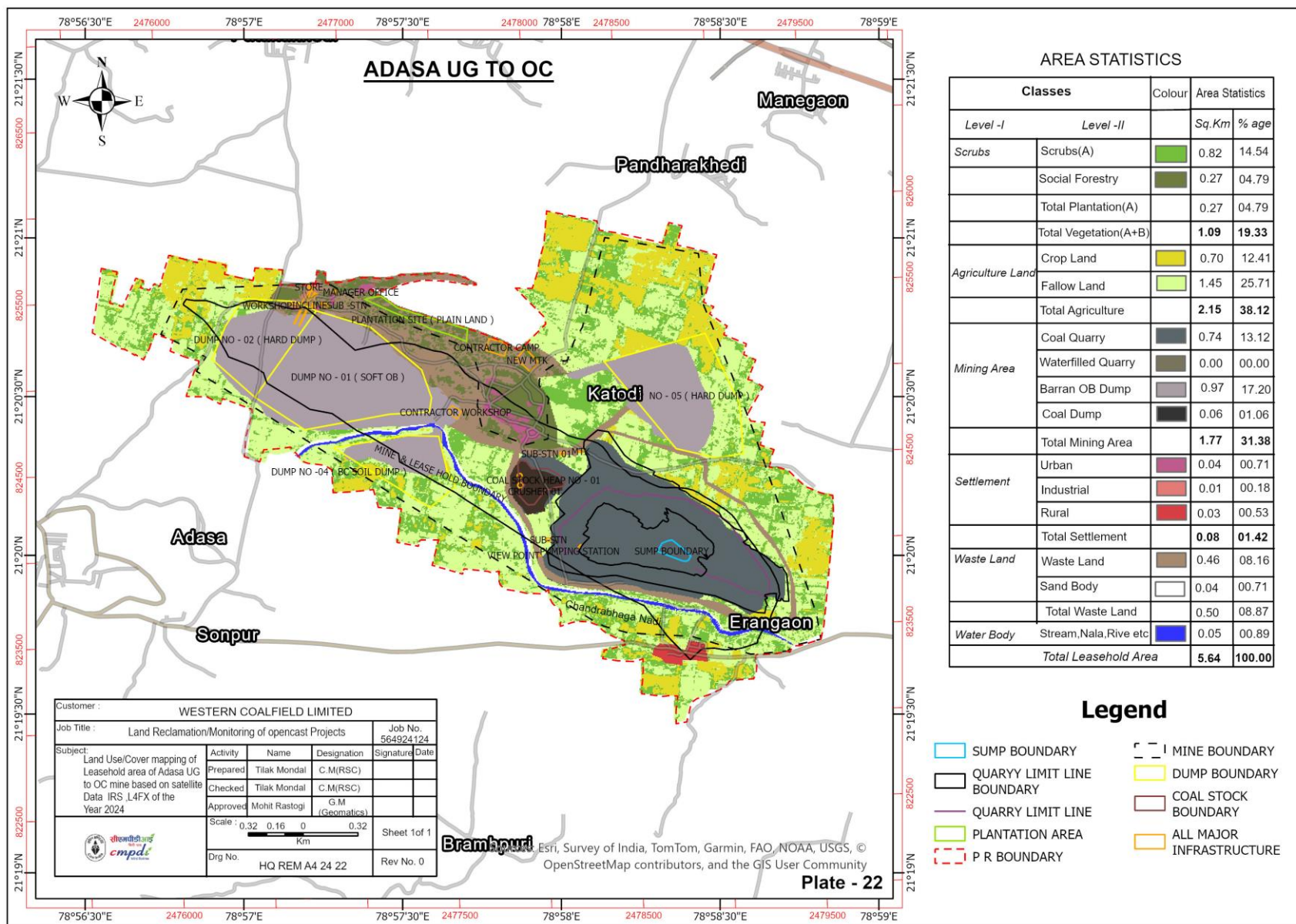




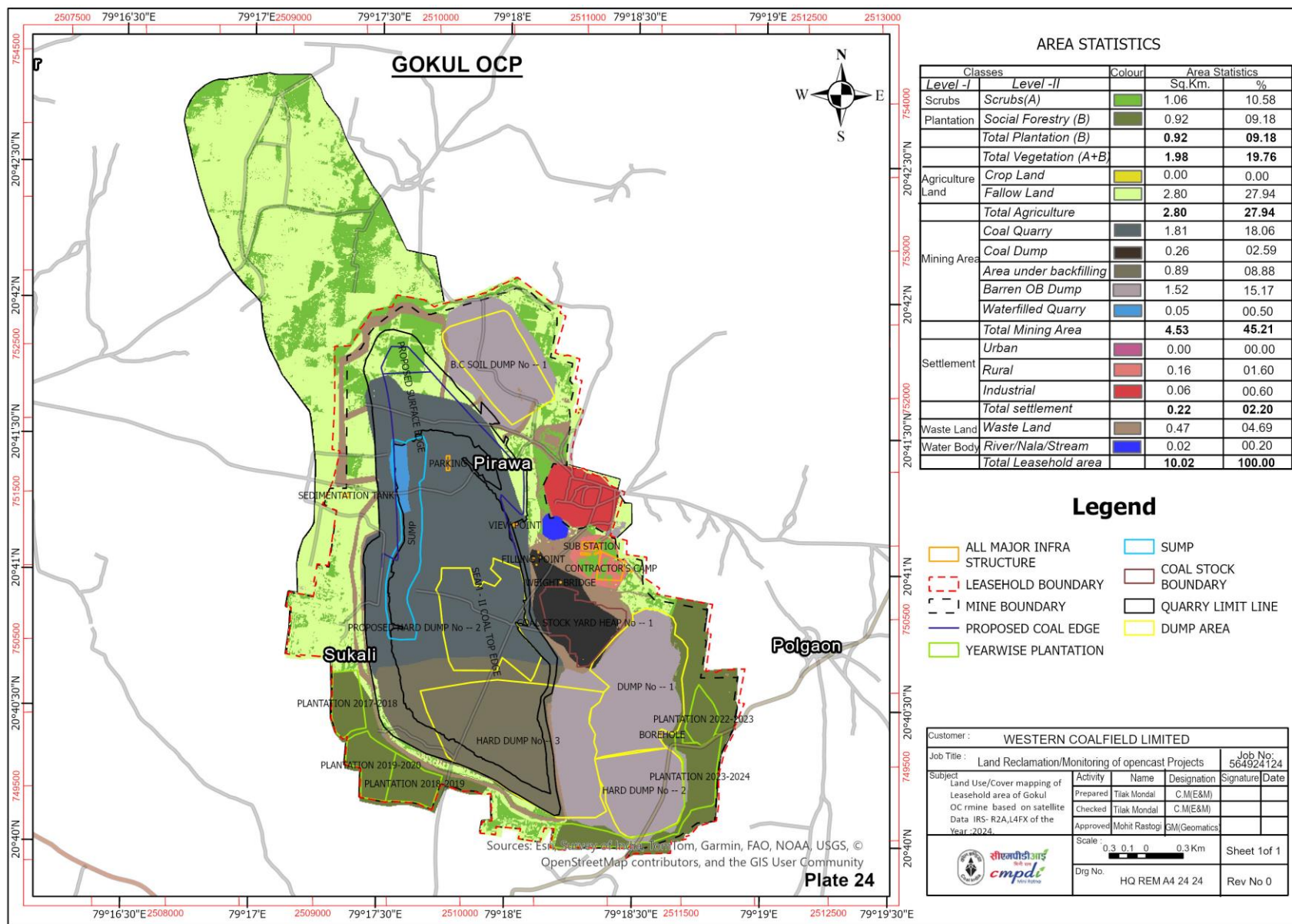


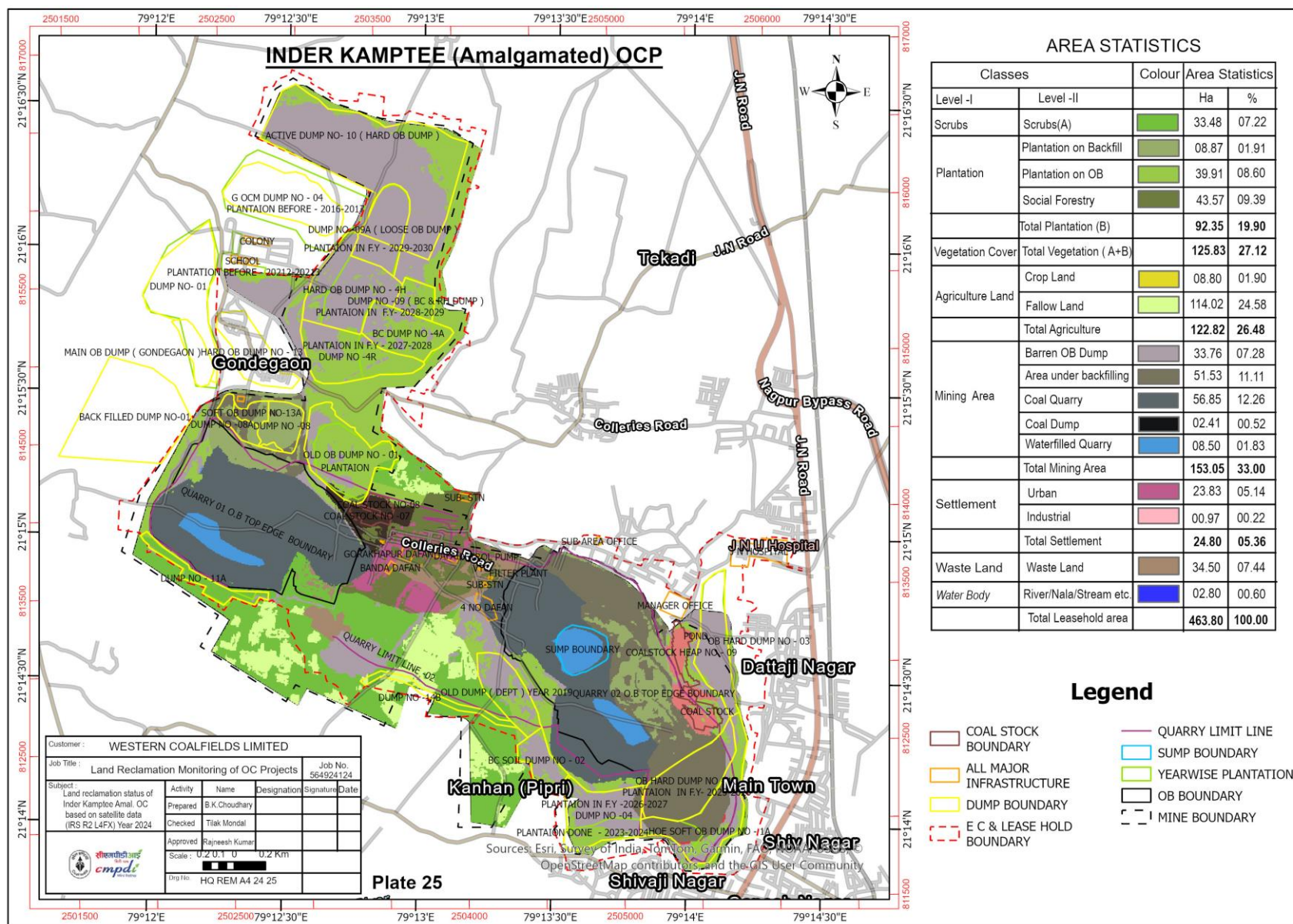


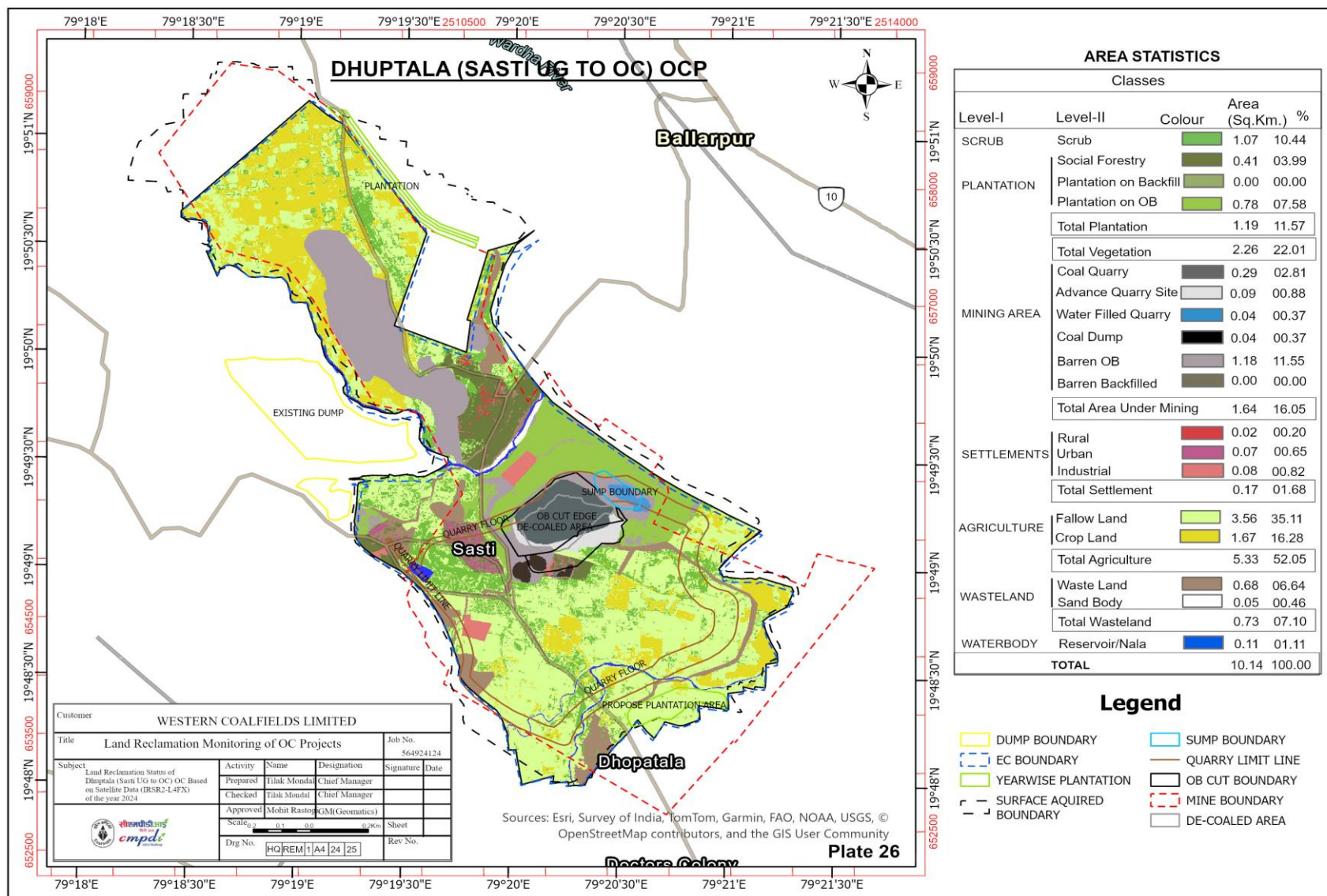












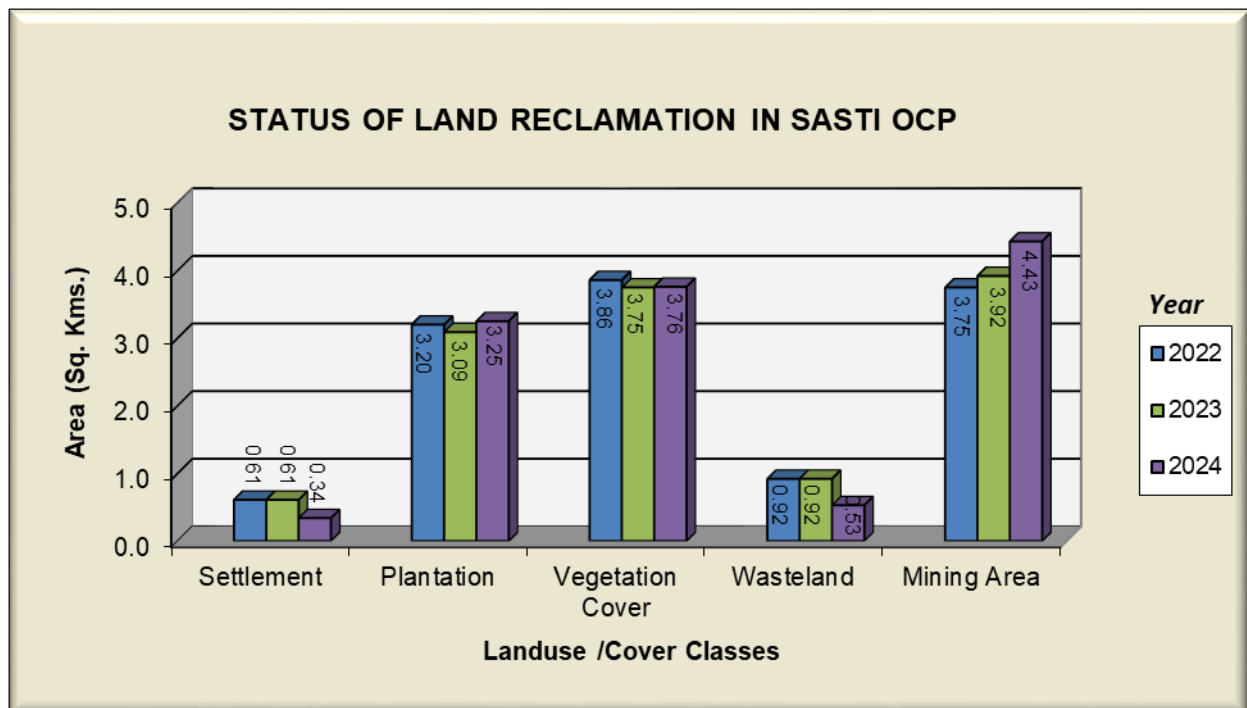


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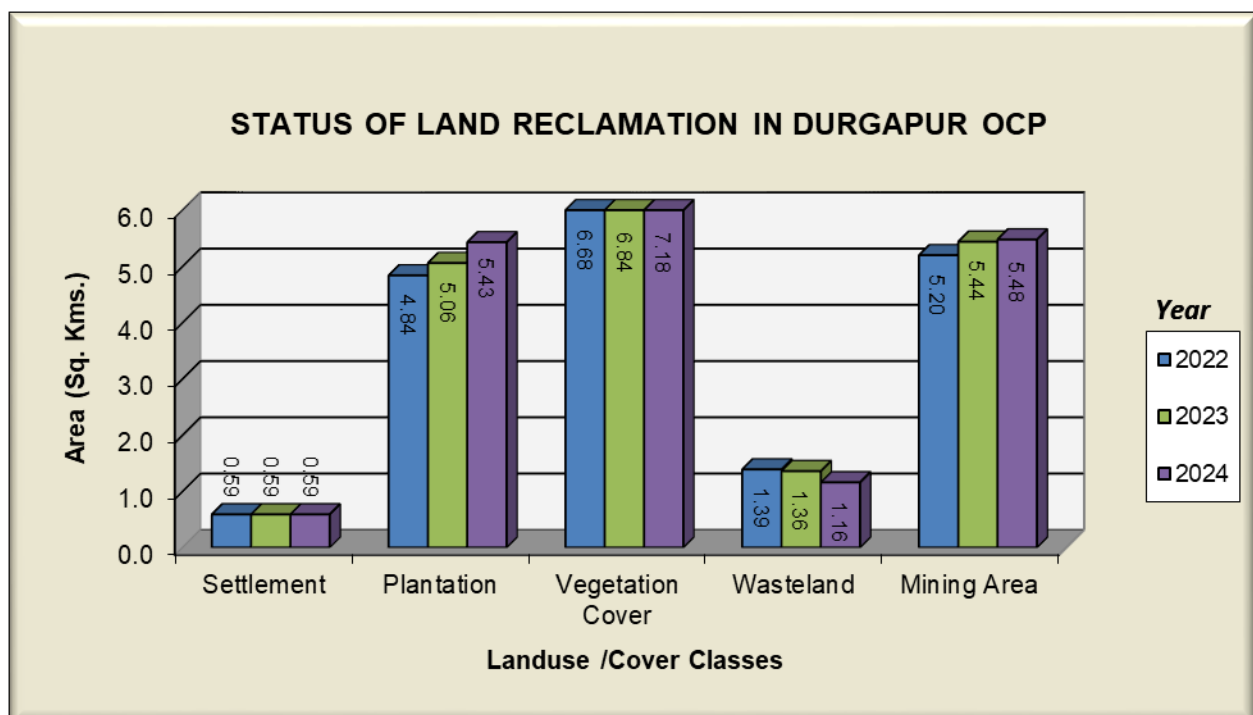


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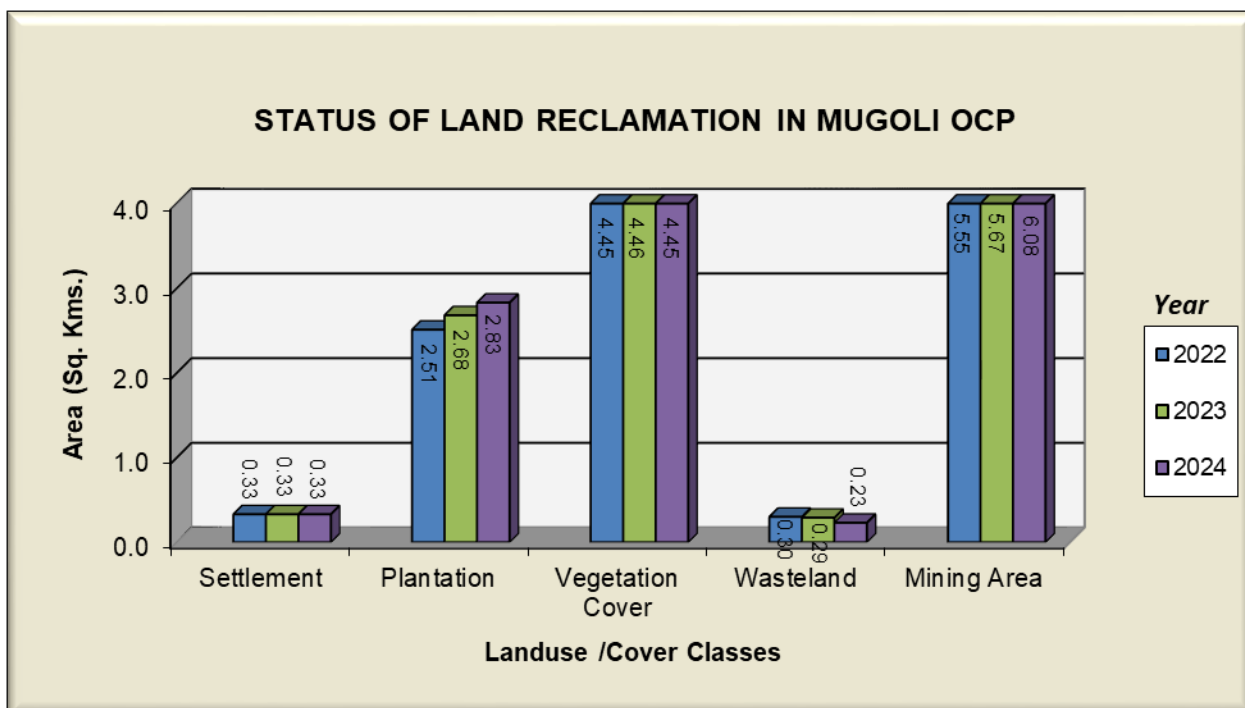


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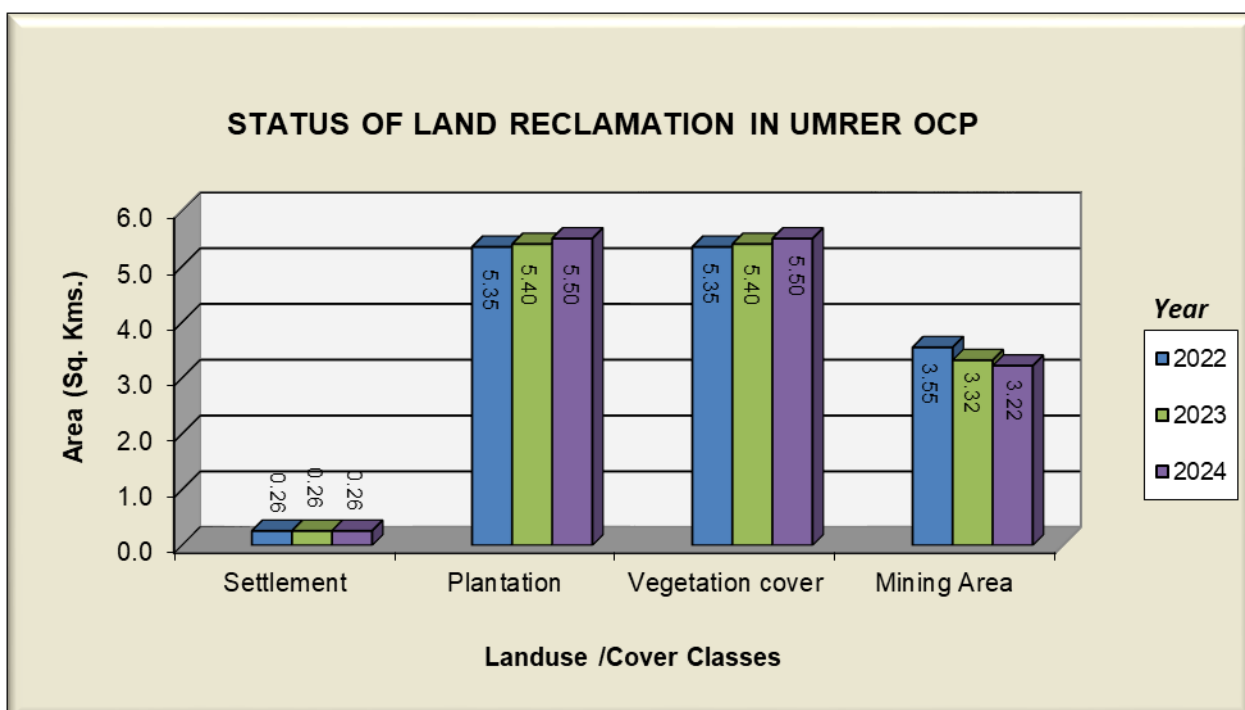


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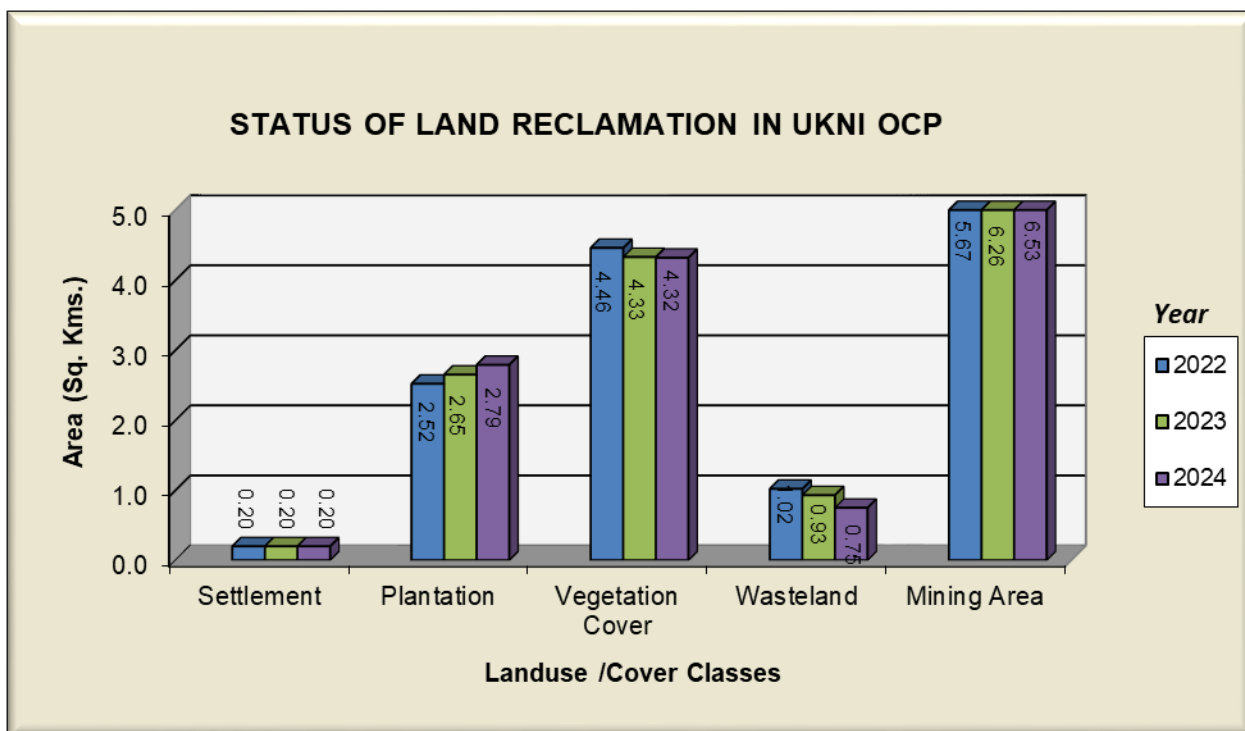


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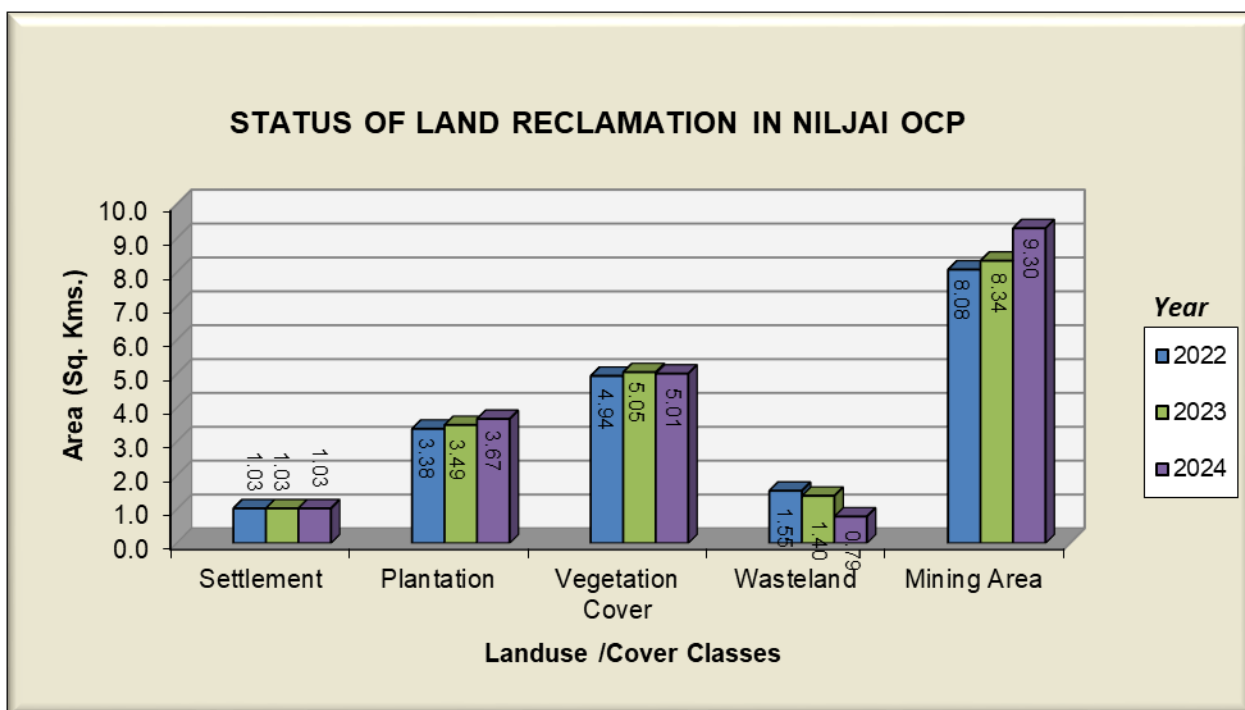


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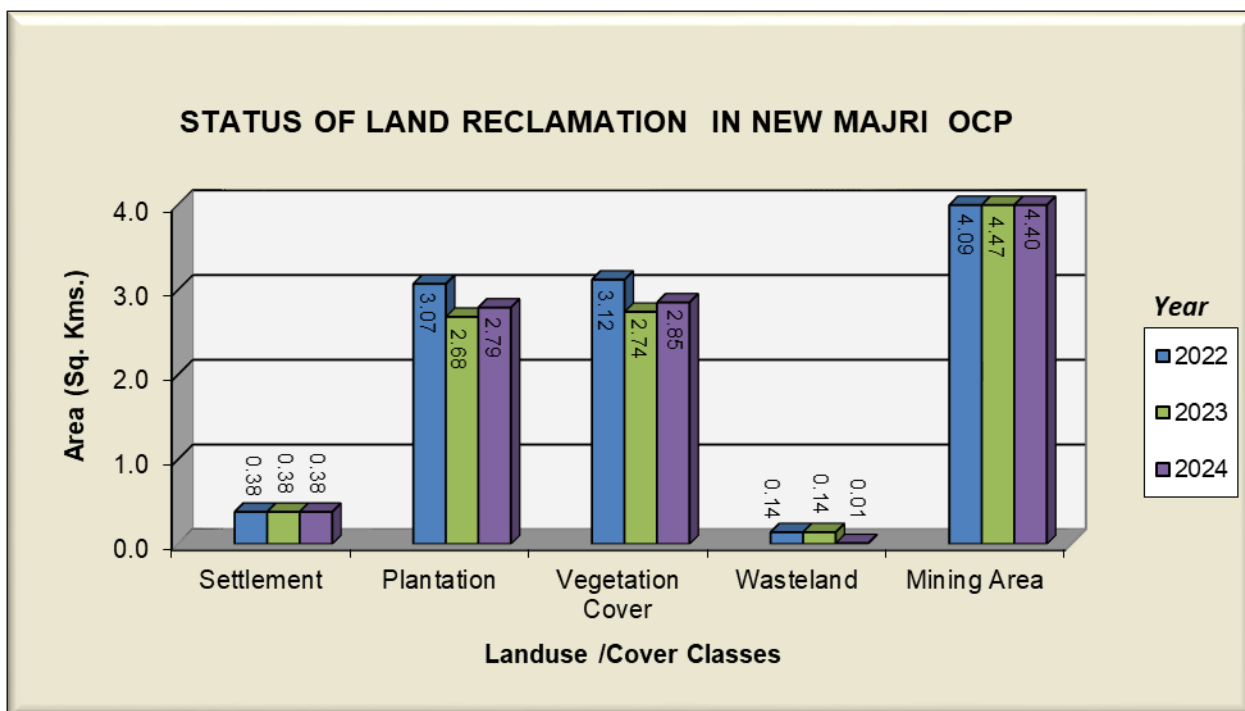


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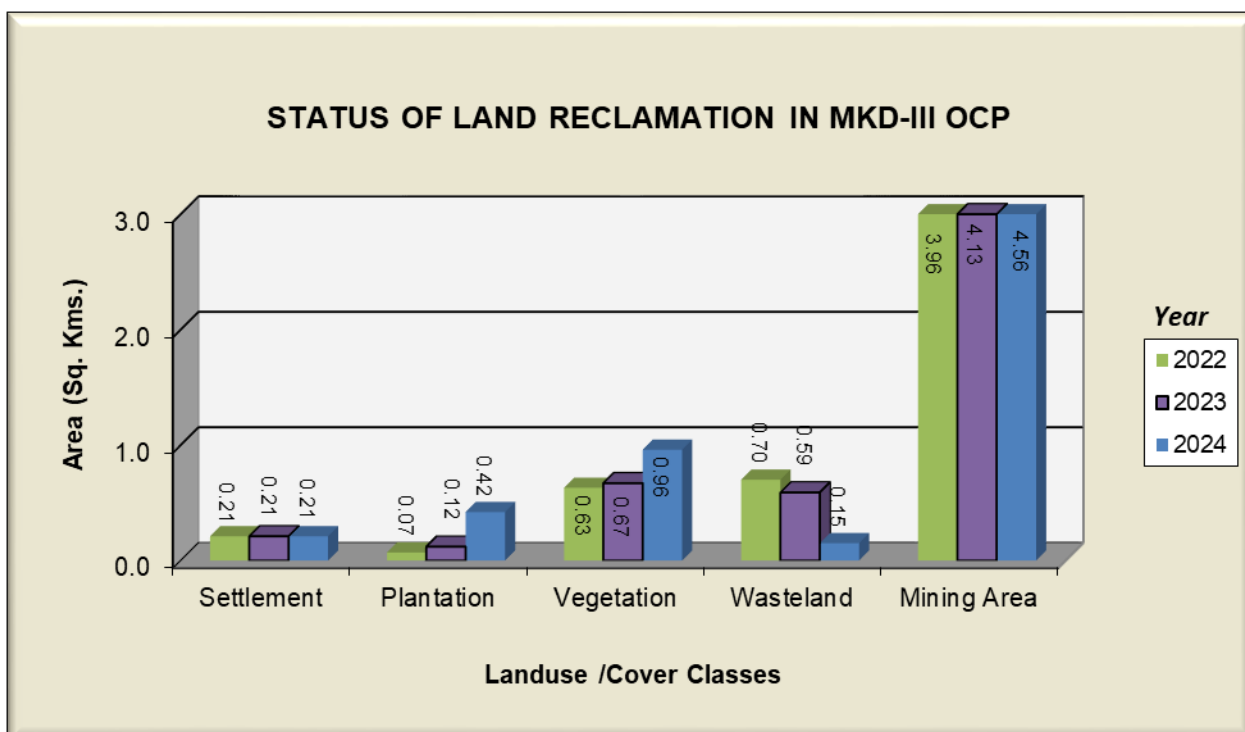


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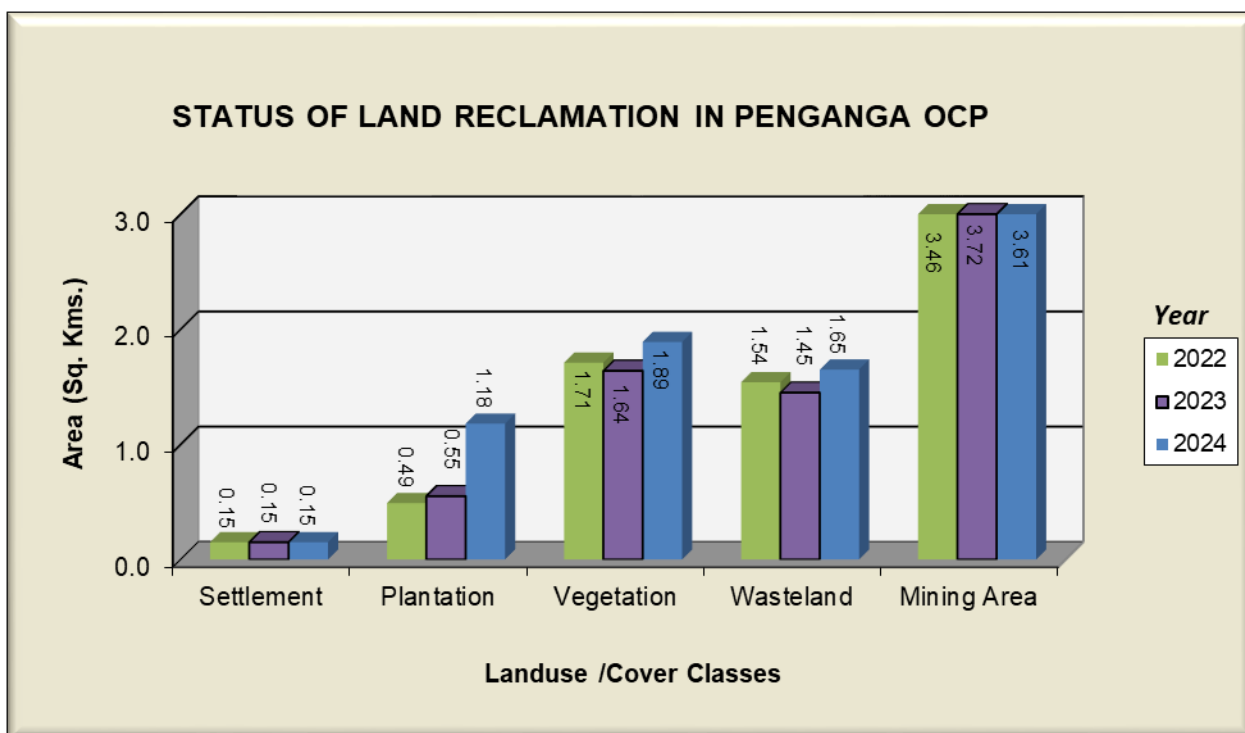


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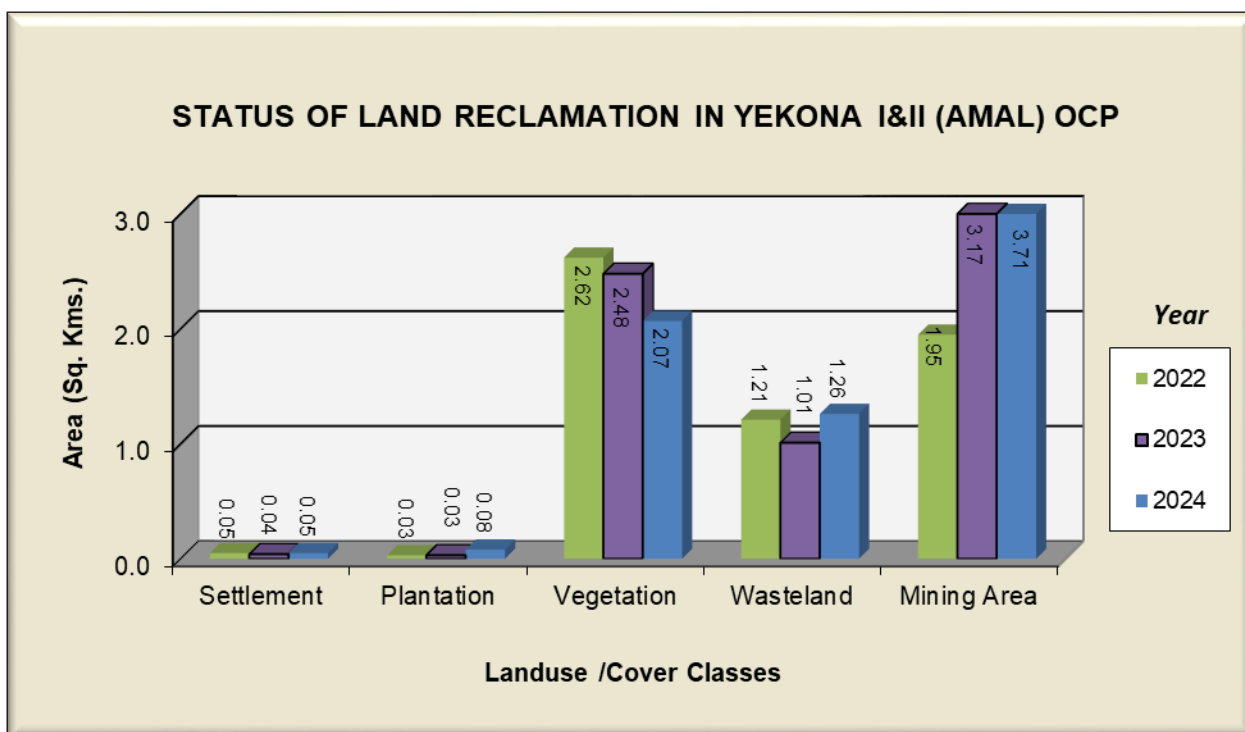


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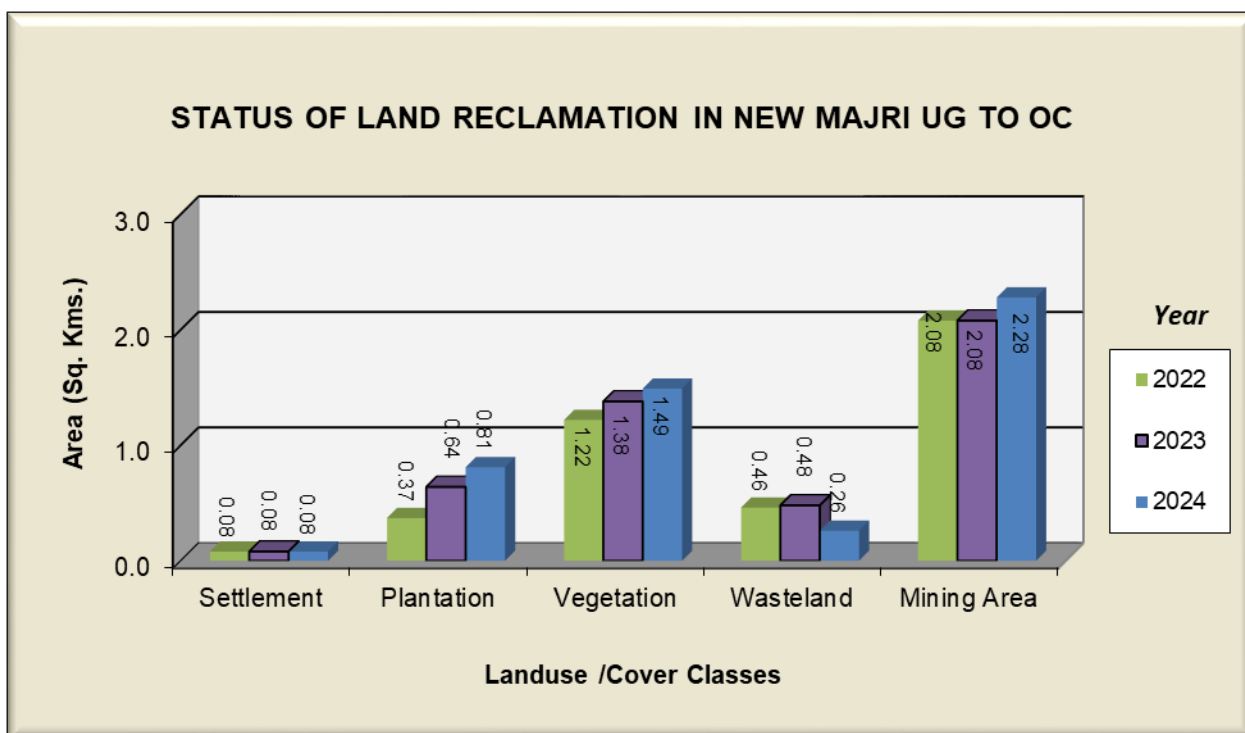


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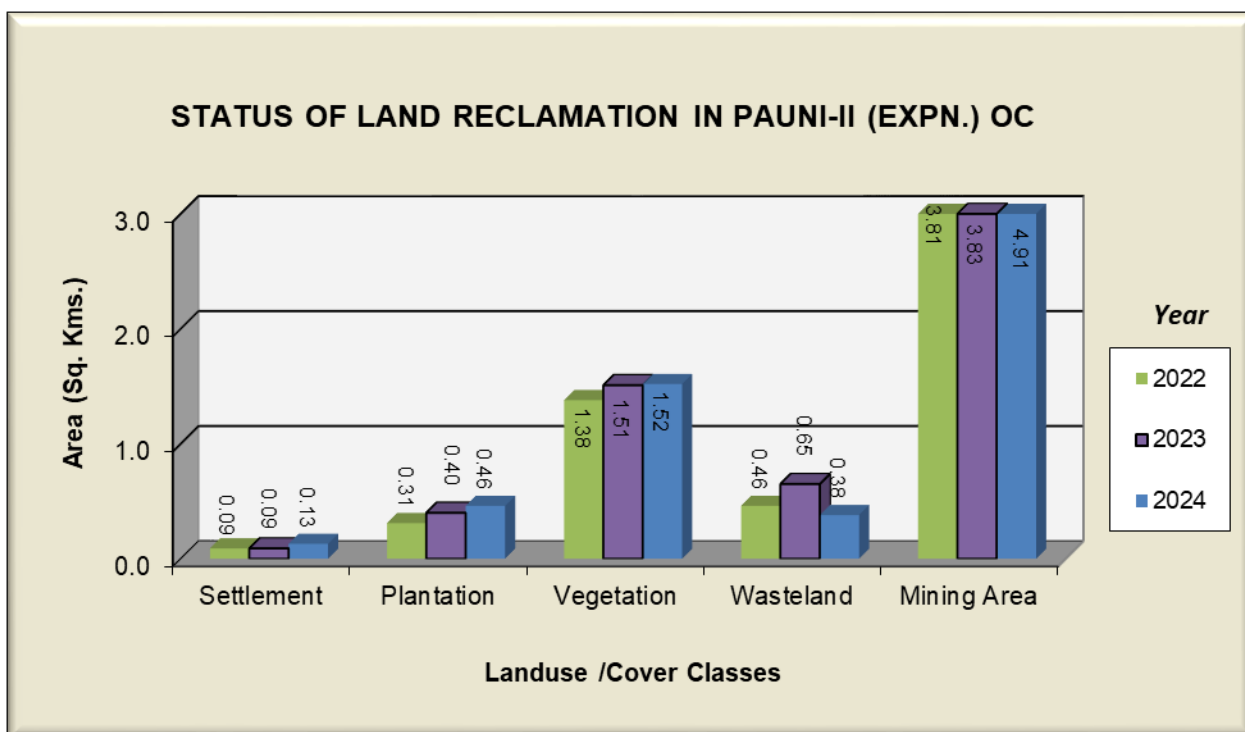


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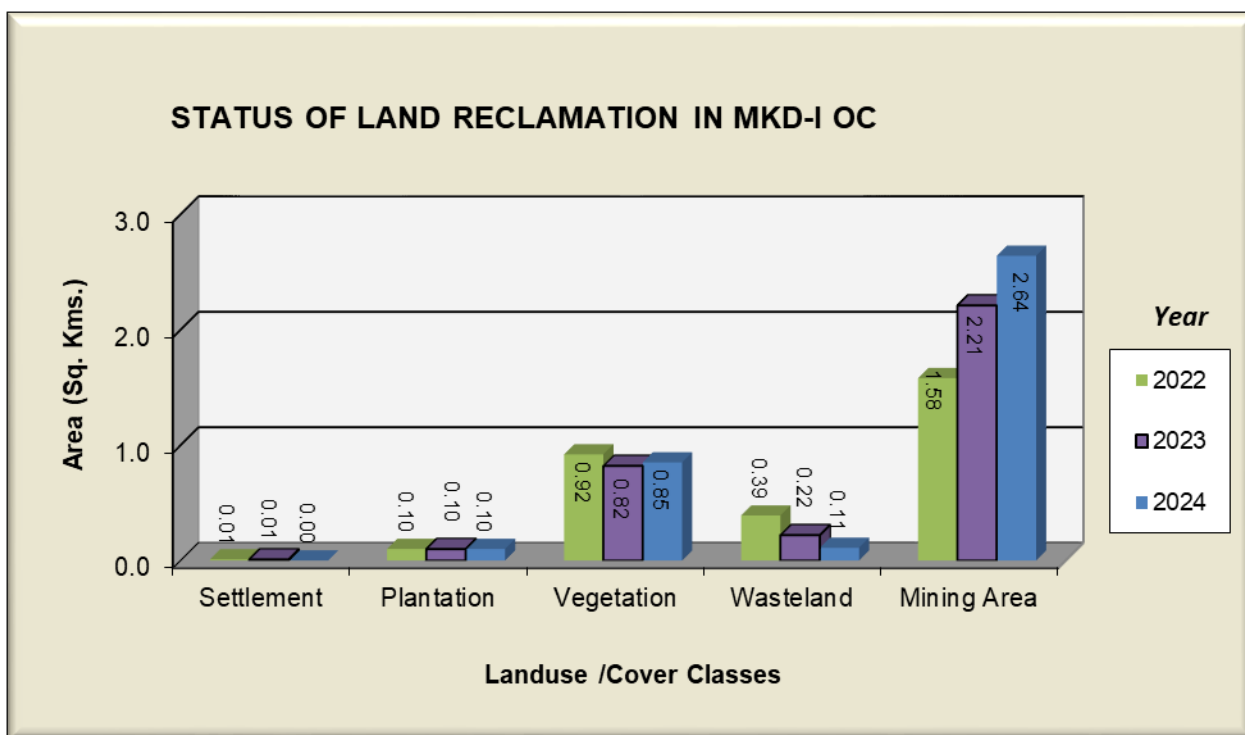


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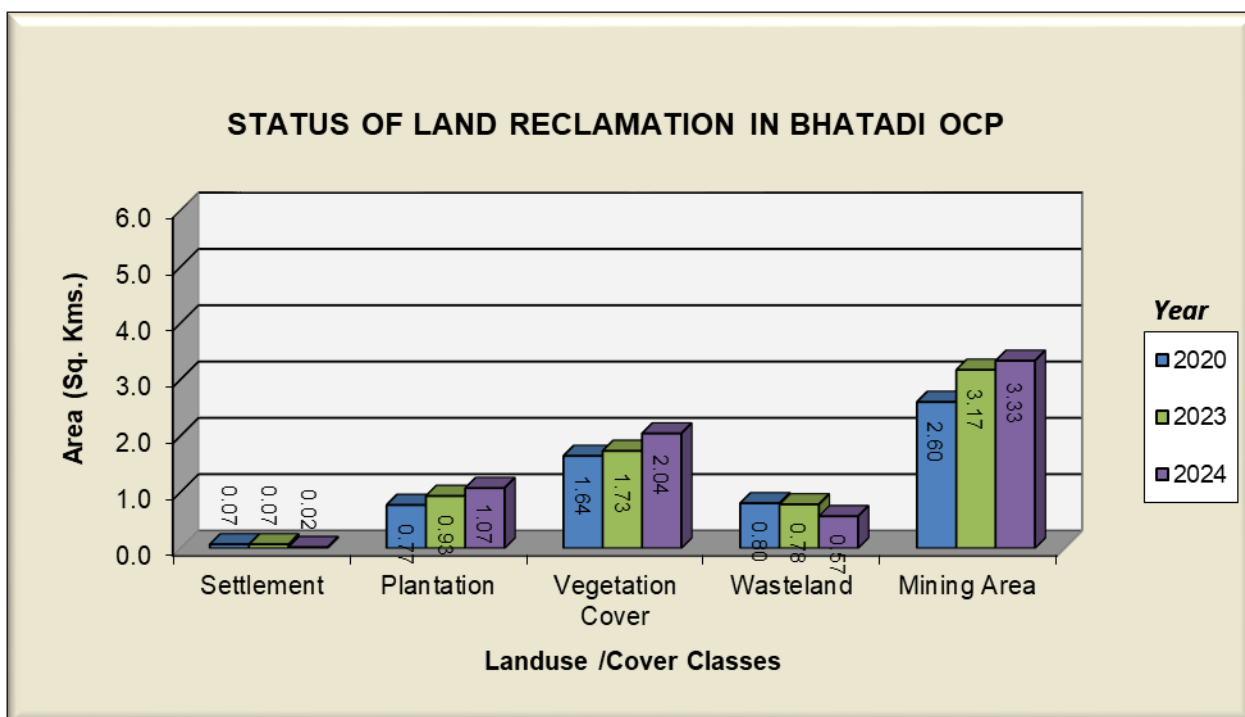


Figure 17

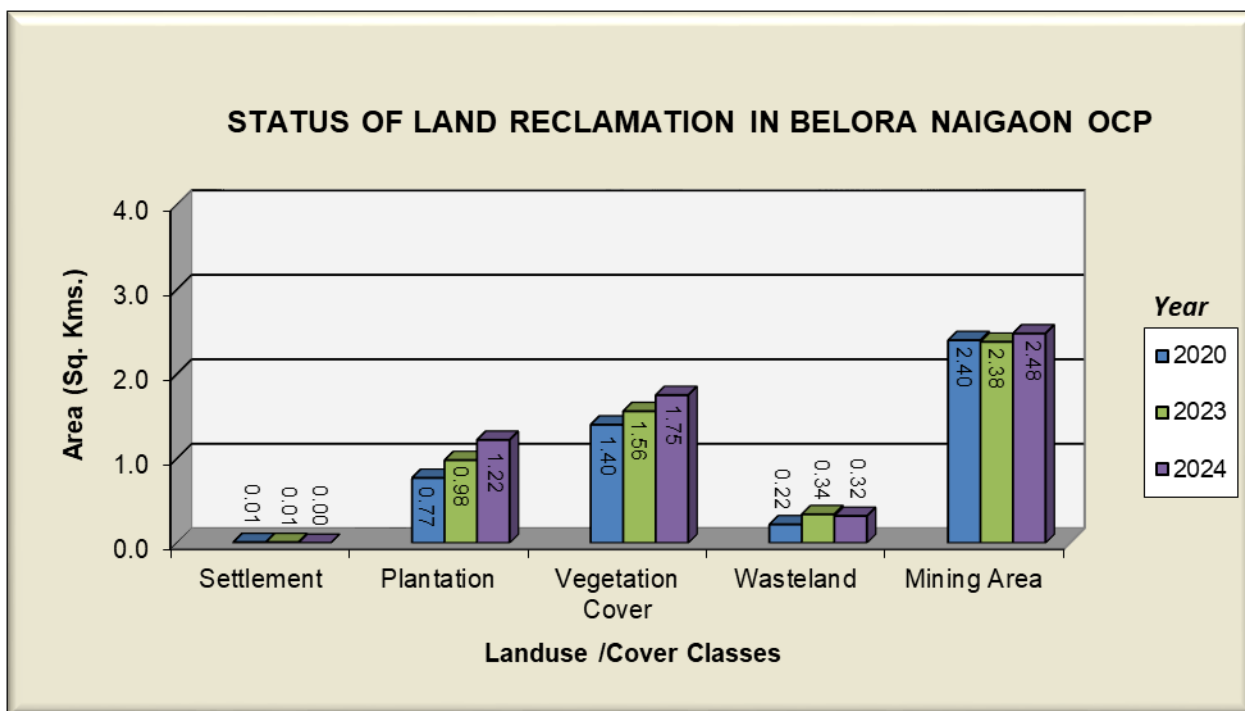


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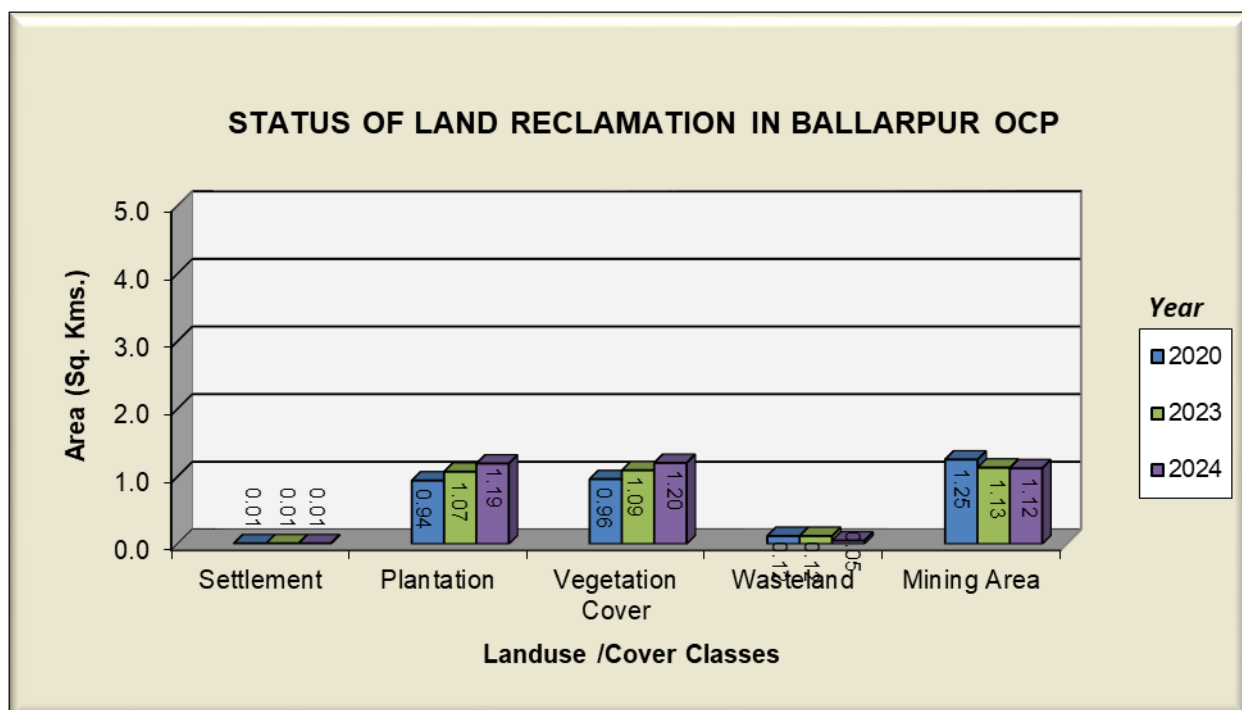


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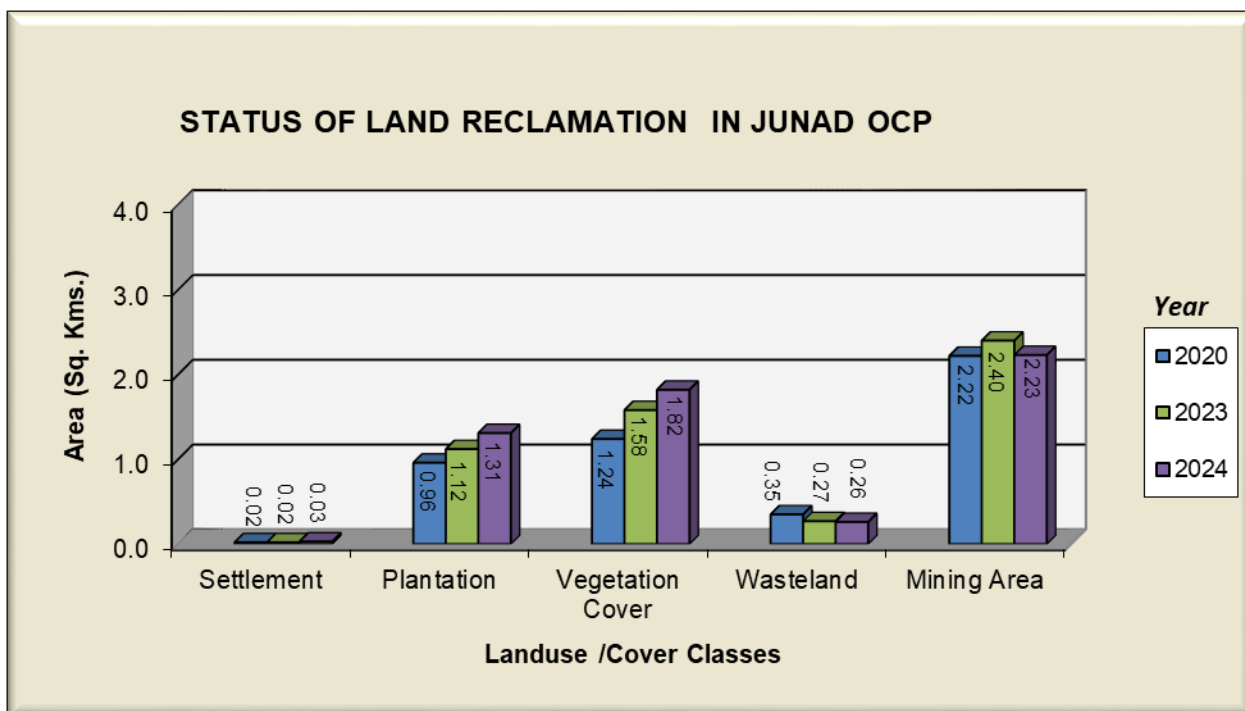


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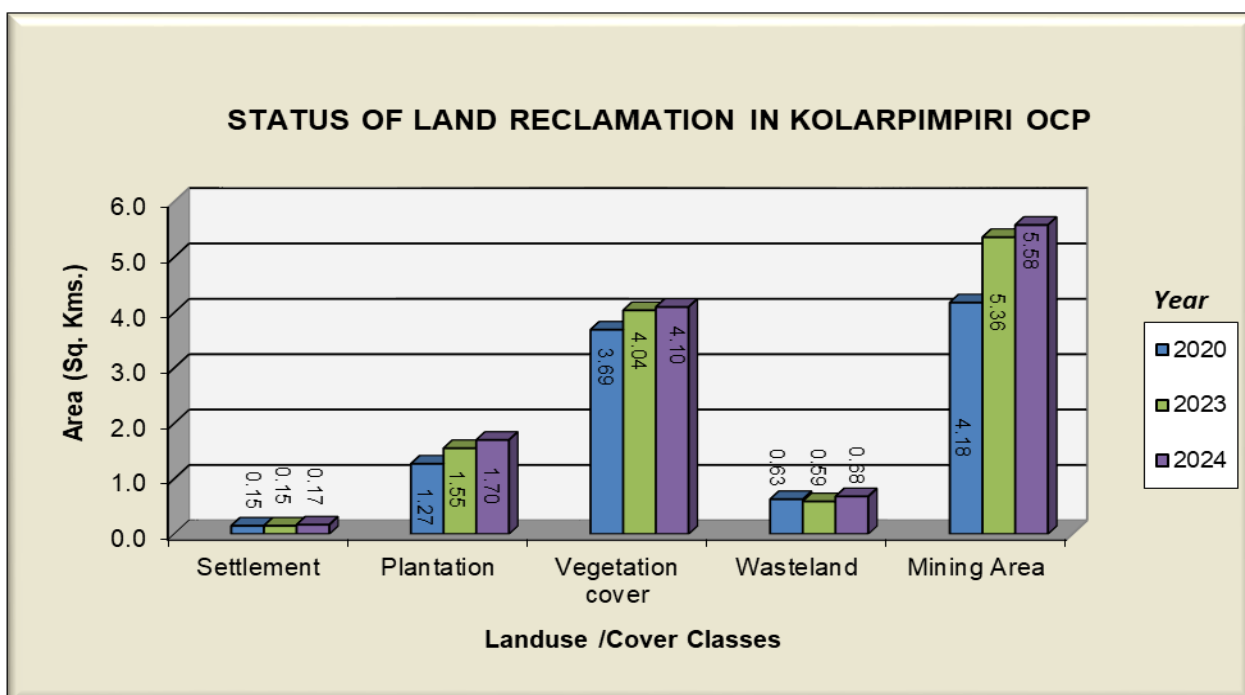


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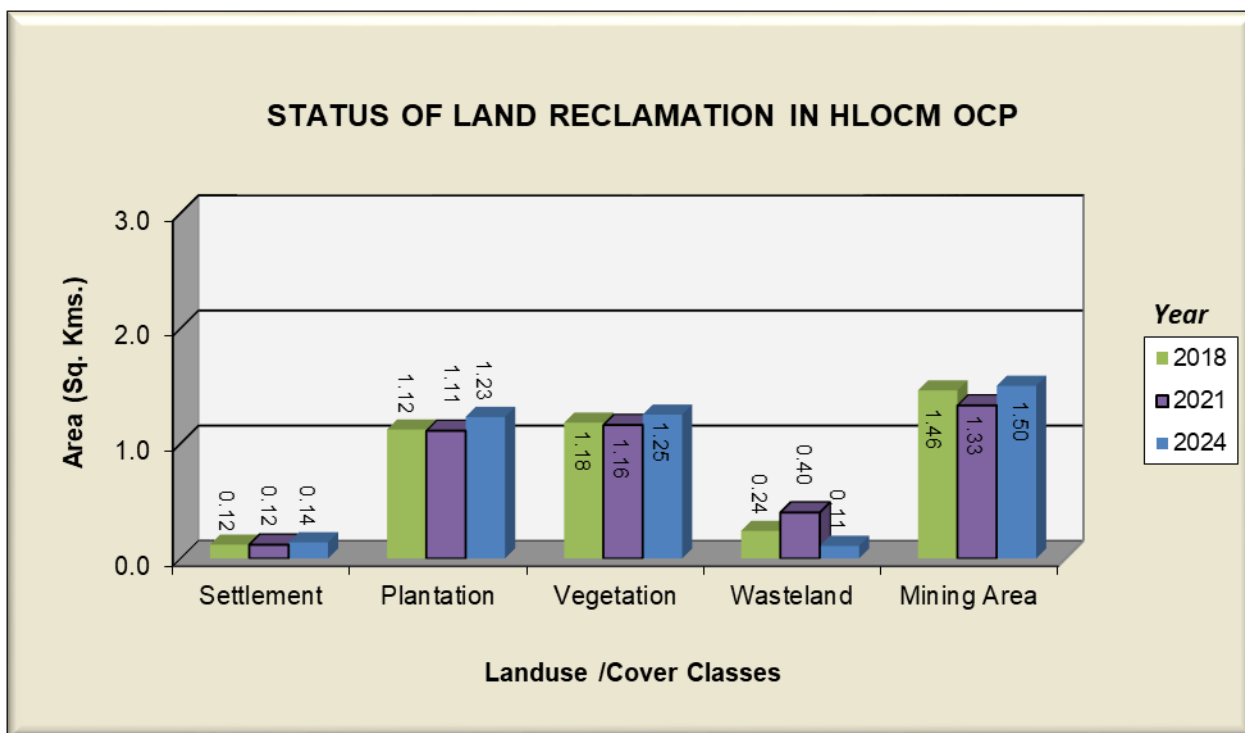


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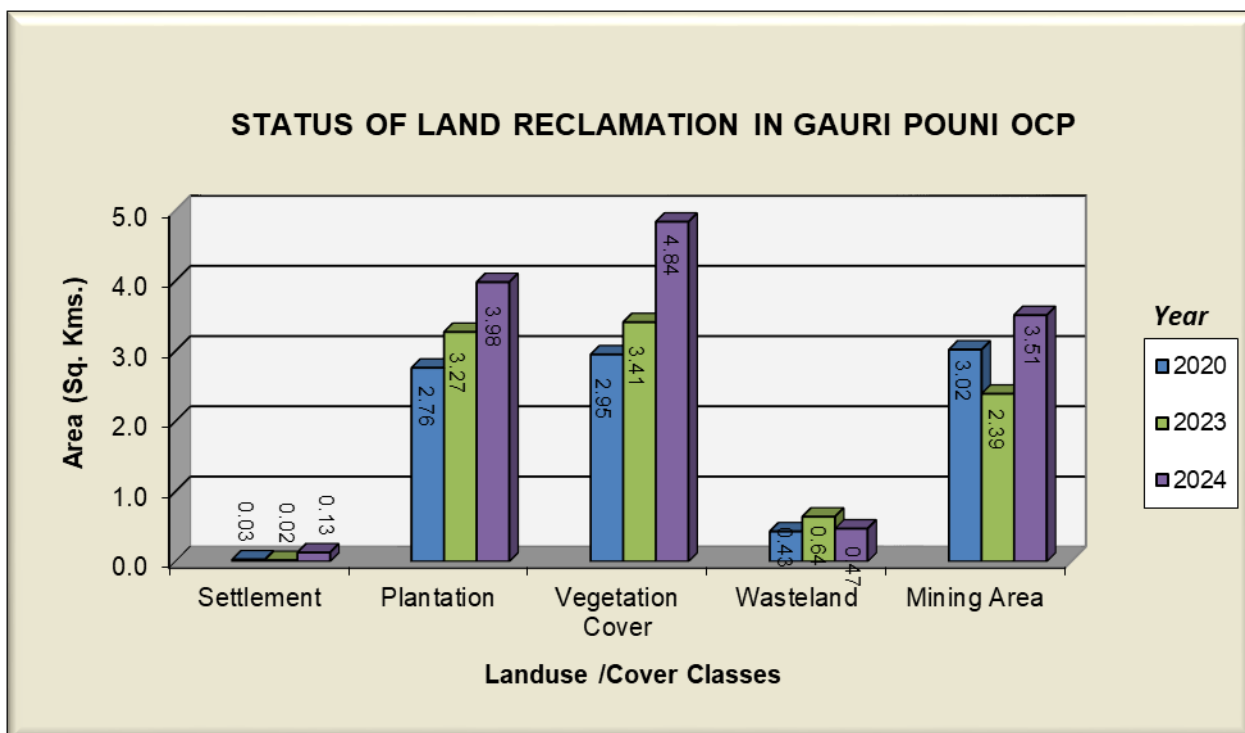


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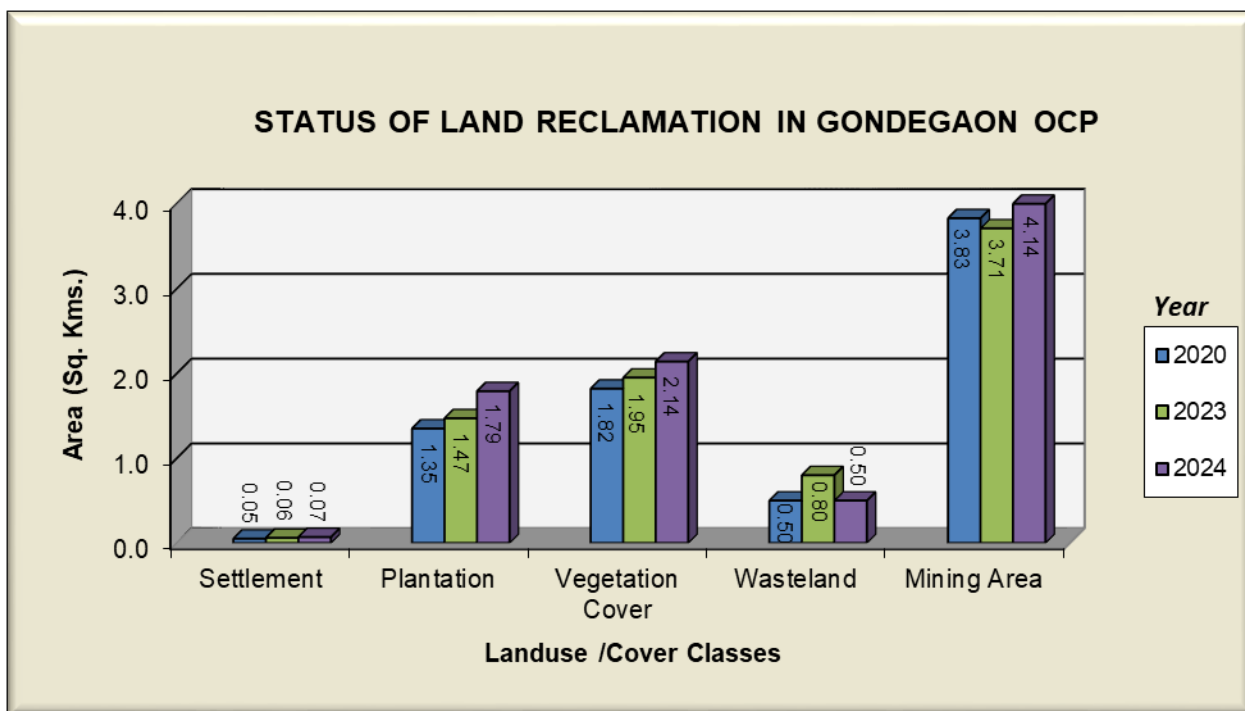


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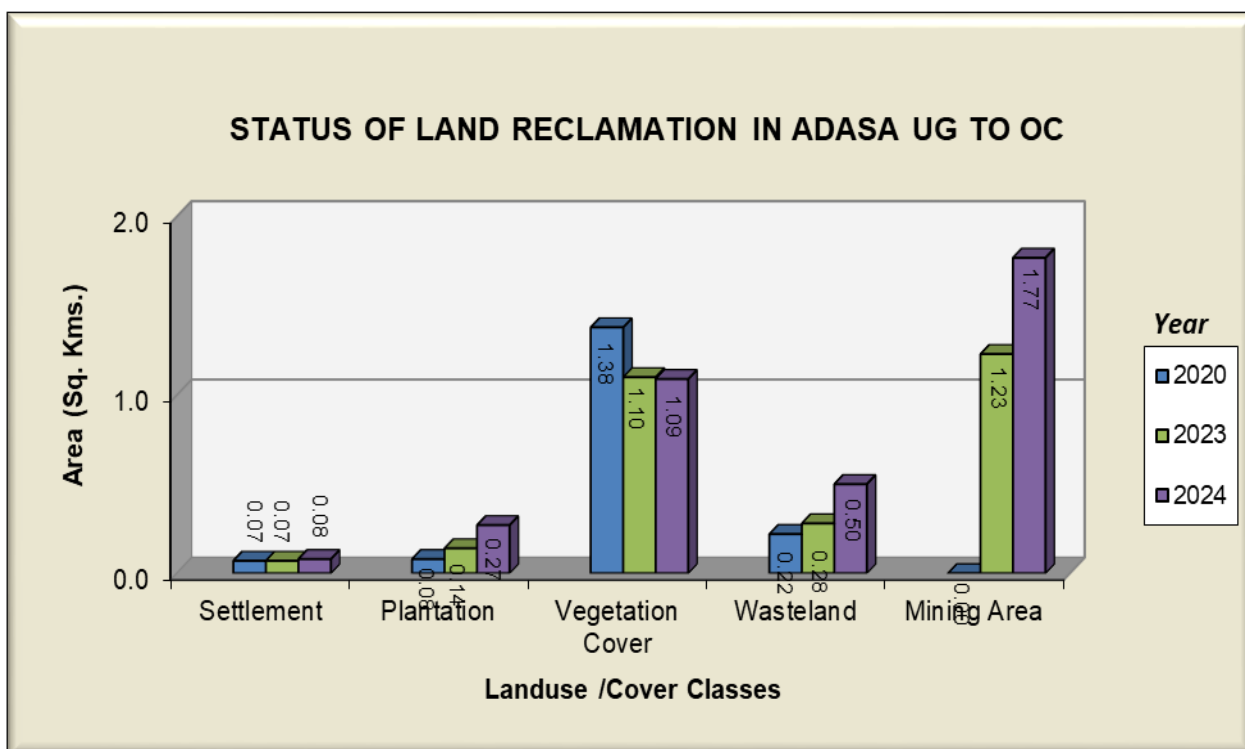


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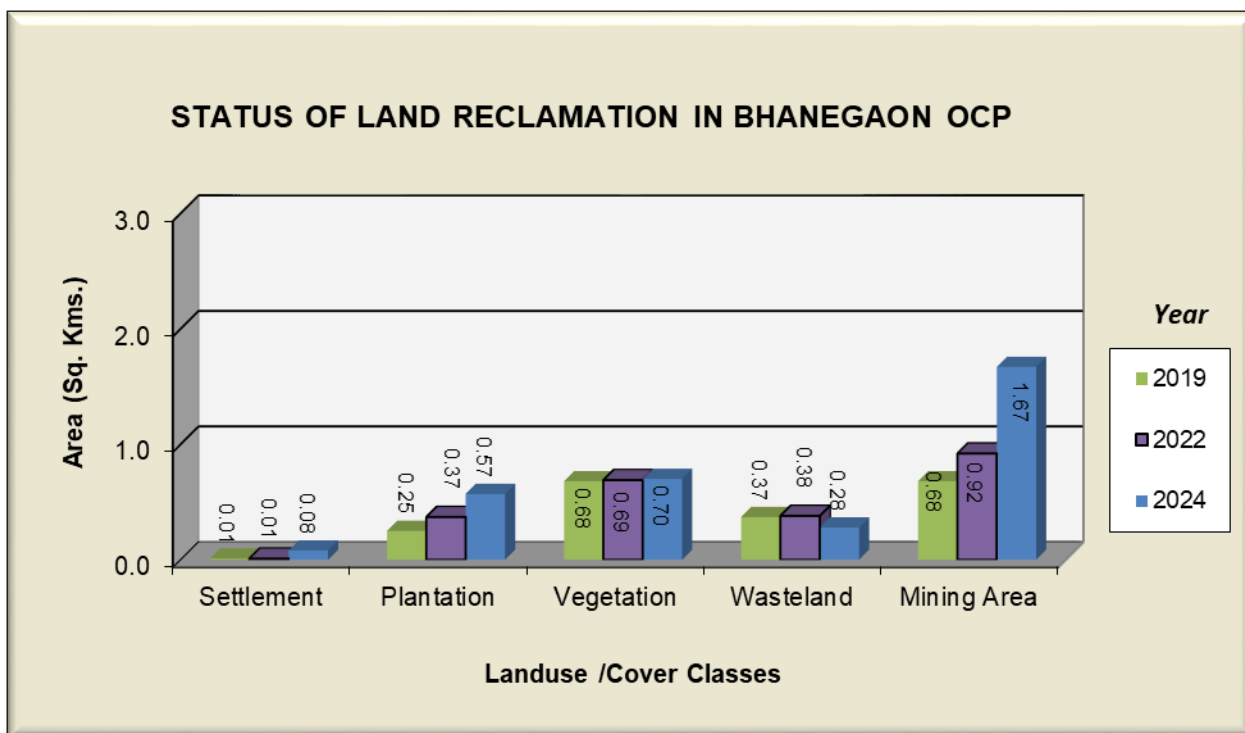


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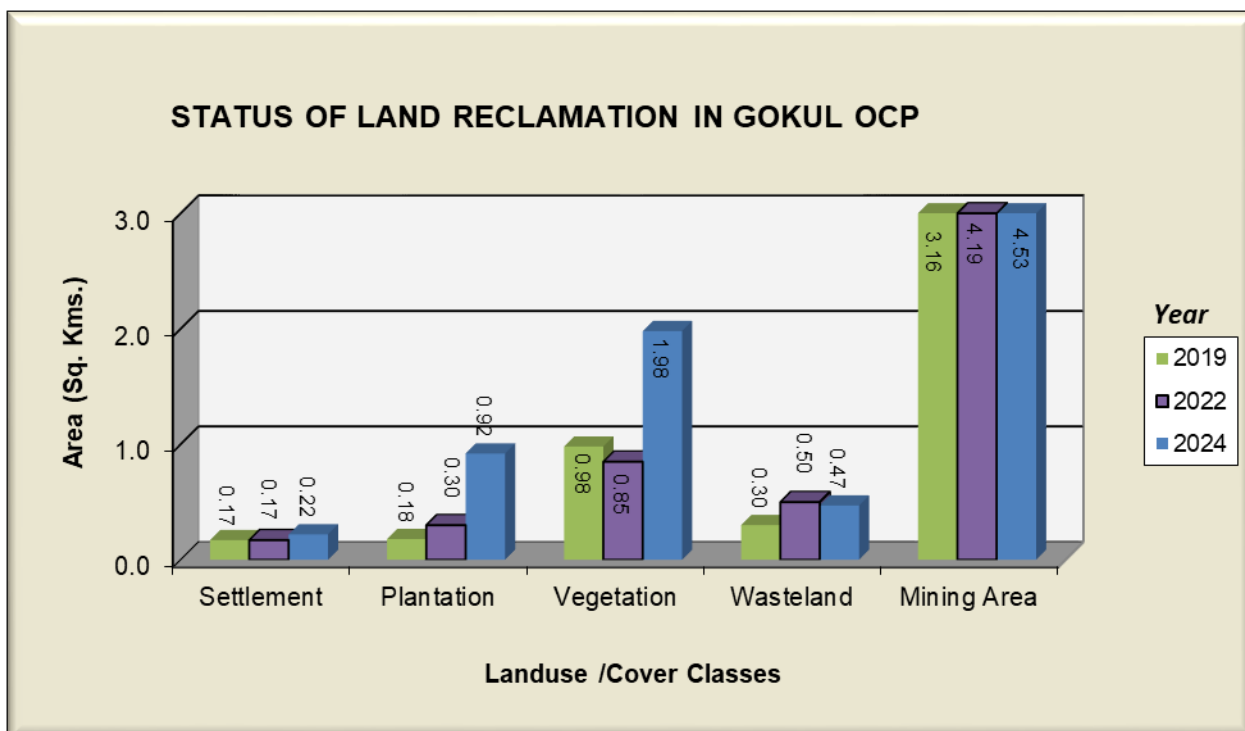


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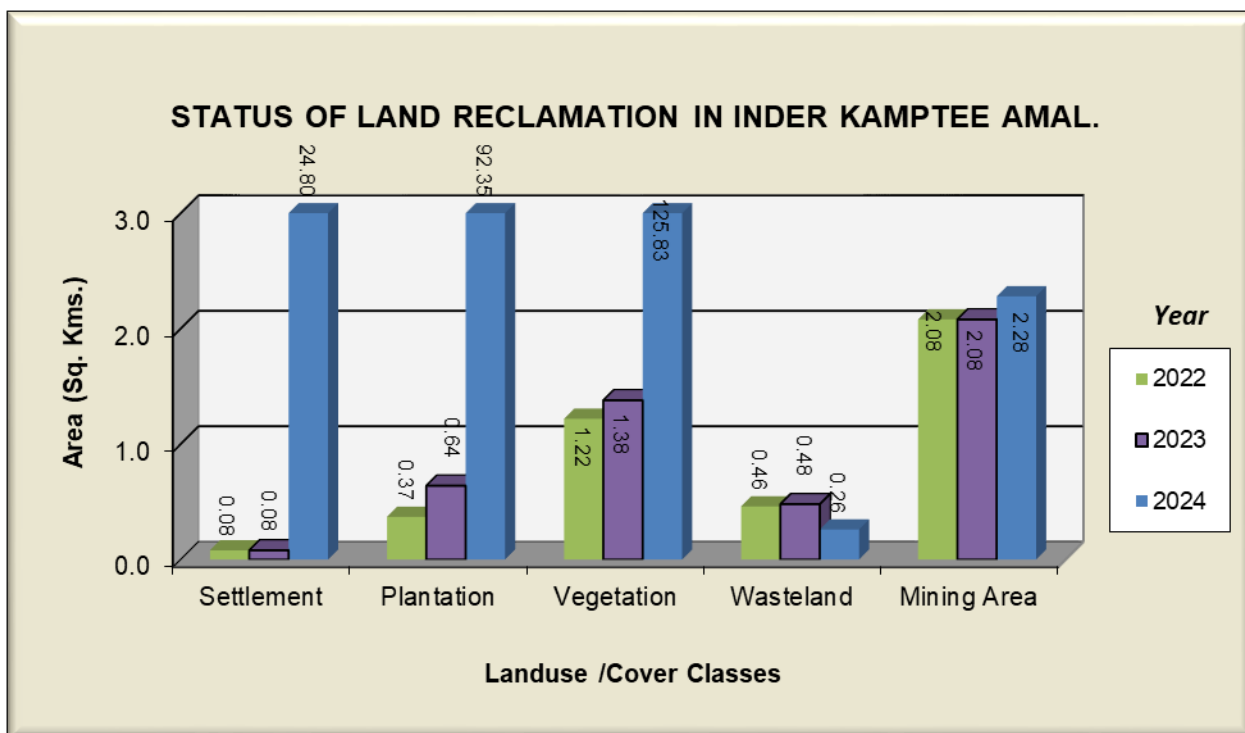


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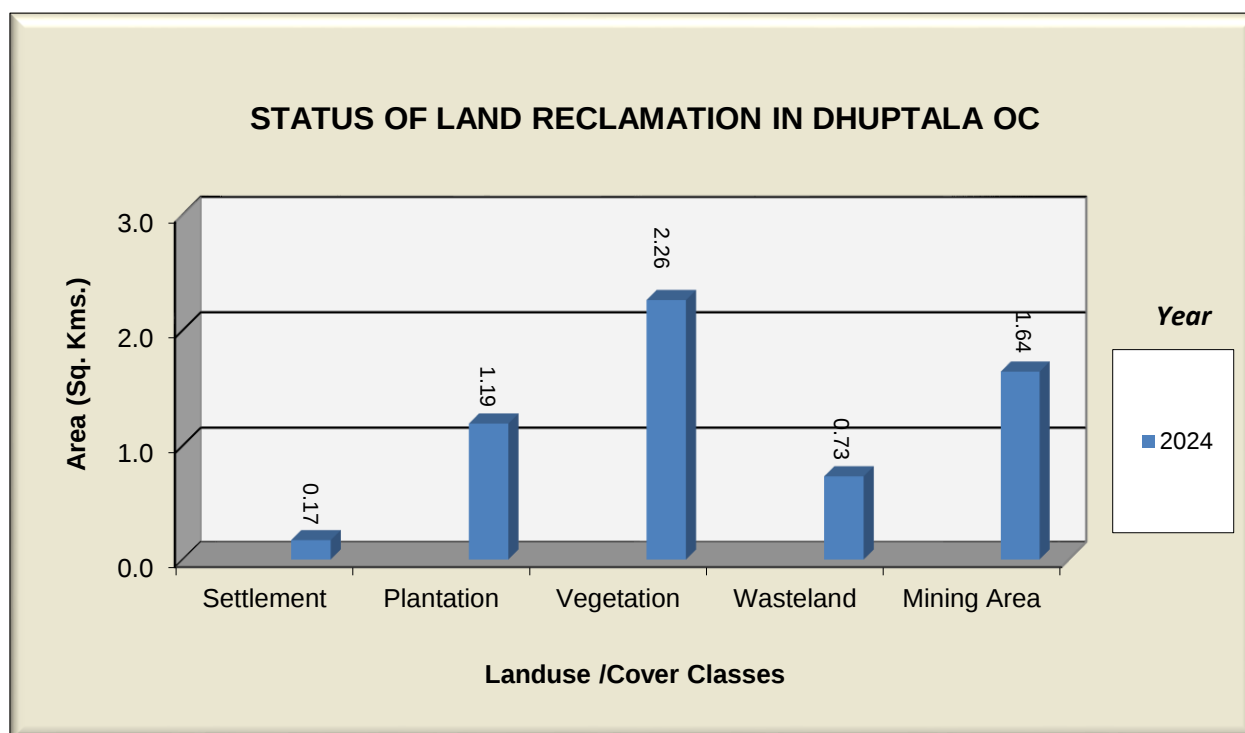


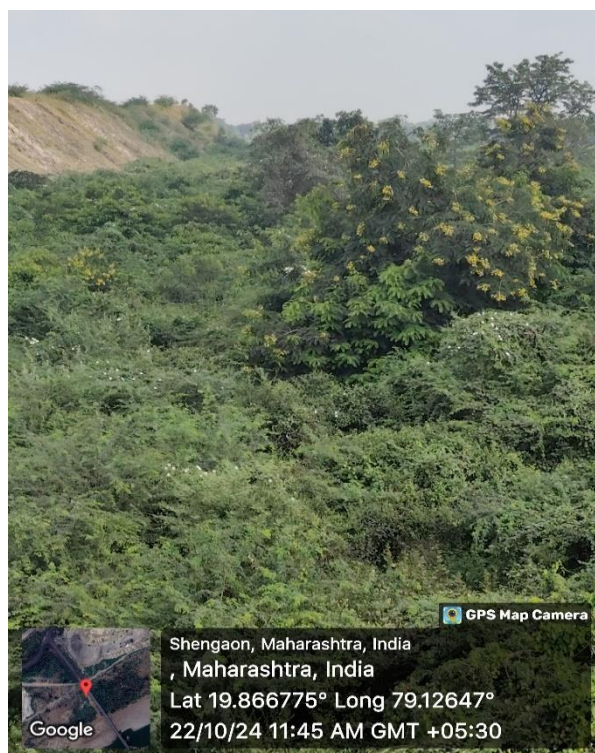
Figure 29



Photograph-1: Plantation on Internal OB/Backfill (Sasti OCP)



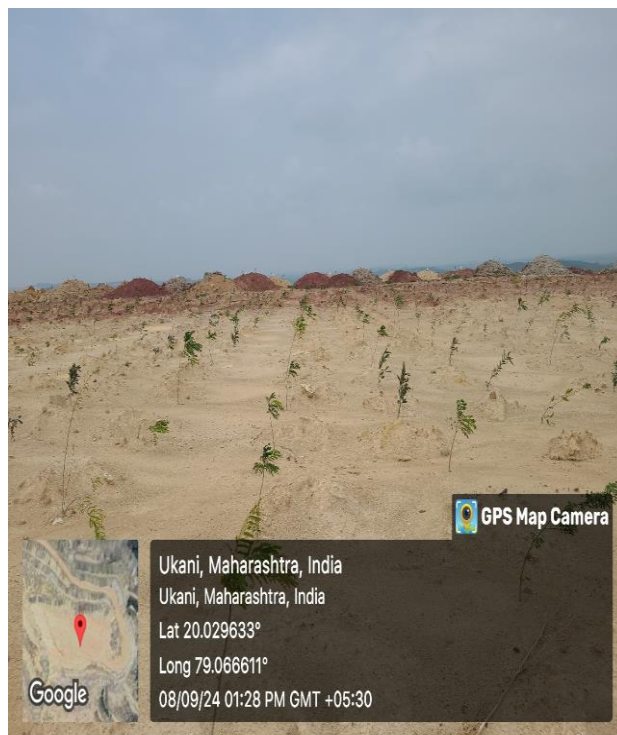
Photograph-2: Avenue Plantation (Durgapur OCP)



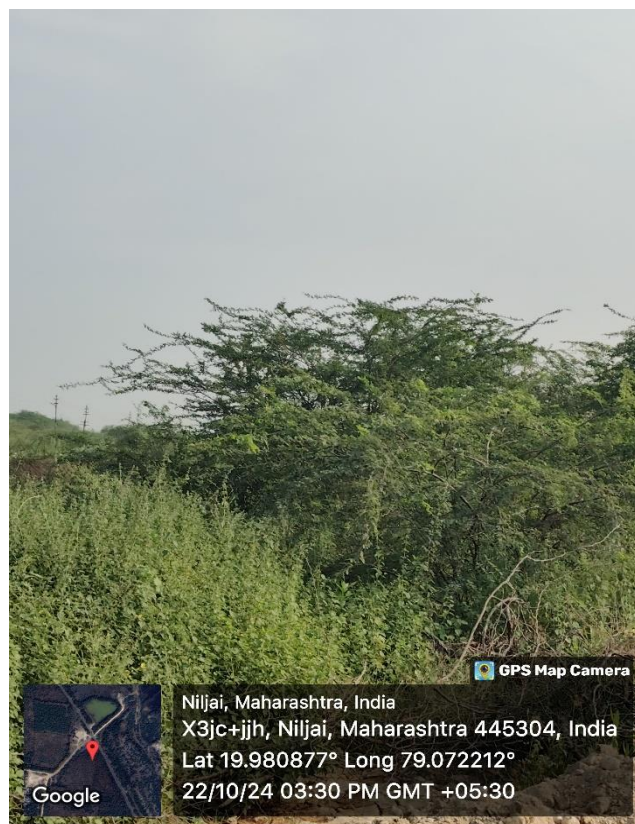
Photograph-3: Plantation (Mungoli OCP)



Photograph-4: Avenue Plantation (Umrer OCP)



Photograph-5: Plantation on OB Dump (Ukni OCP)



Photograph-6: Plantation on OB dump (Niljai OCP)



Photograph-7: Plantation on OB dump (New Majri OCP)



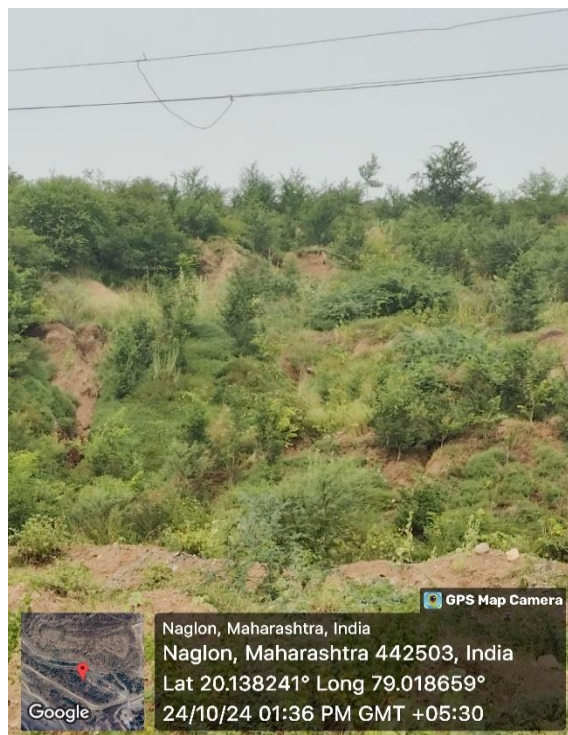
Photograph-8: Plantation on OB dump (MKD-III OCP)



Photograph-9: Plantation on Embankment (Penganga OCP)



Photograph-10: Avenue plantation (Yekona I&II OC)



Photograph-11: Plantation on OB dump New Majri UG to OC



Photograph-12: Social Forestry (Pauni-II OCP)



Photograph-13: Social Forestry (MKD-I OC)



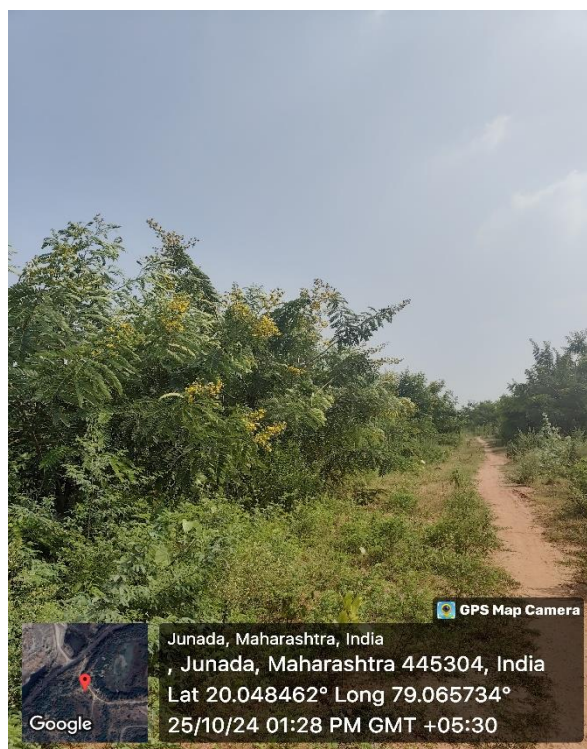
Photograph-14: Avenue plantation (Bhatadi OCP)



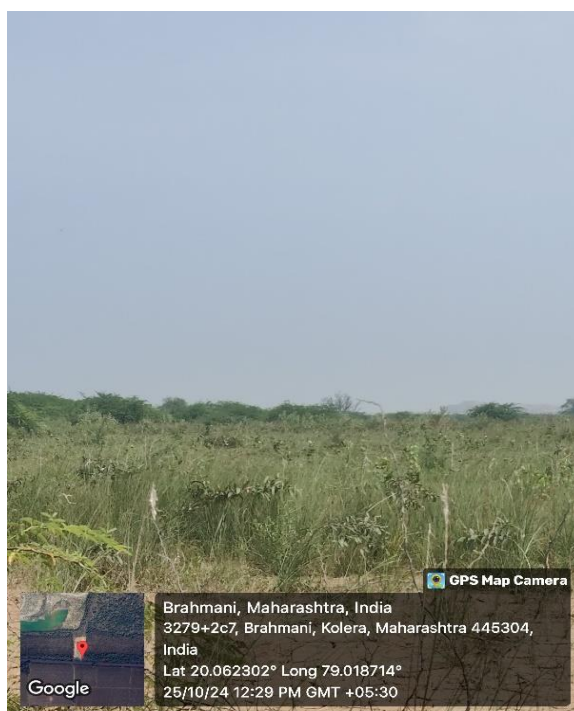
Photograph-15: Social Forestry (Bellora Naigaon OCP)



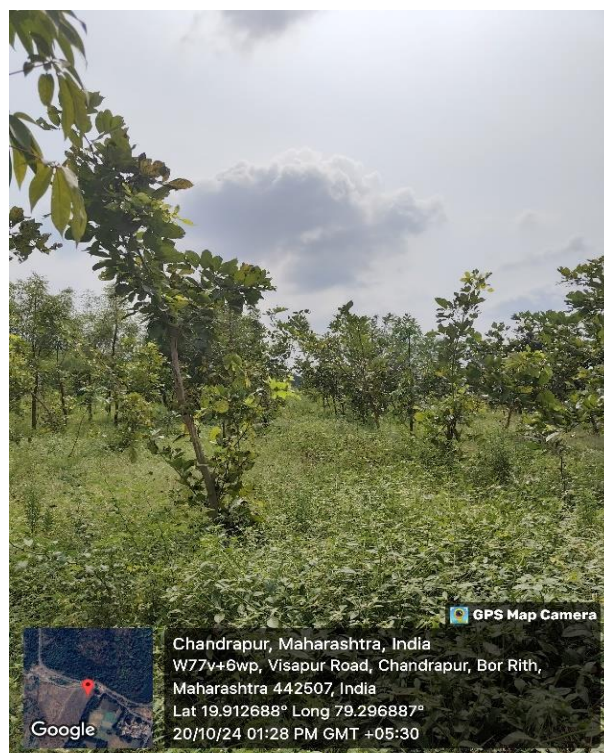
Photograph-16: Social Forestry (Ballarpur OCP)



Photograph-17: Social Forestry (Junad OCP)



Photograph-18: Avenue plantation (Kolarpimpri OCP)



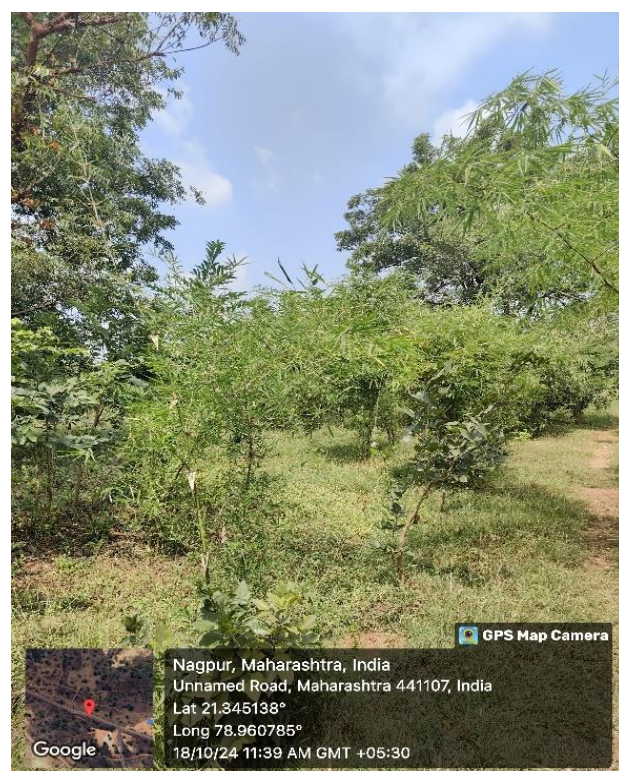
Photograph-19: Social Forestry (HLOCM OCP)



Photograph-20: Plantation (Gauri Pauni OCP)



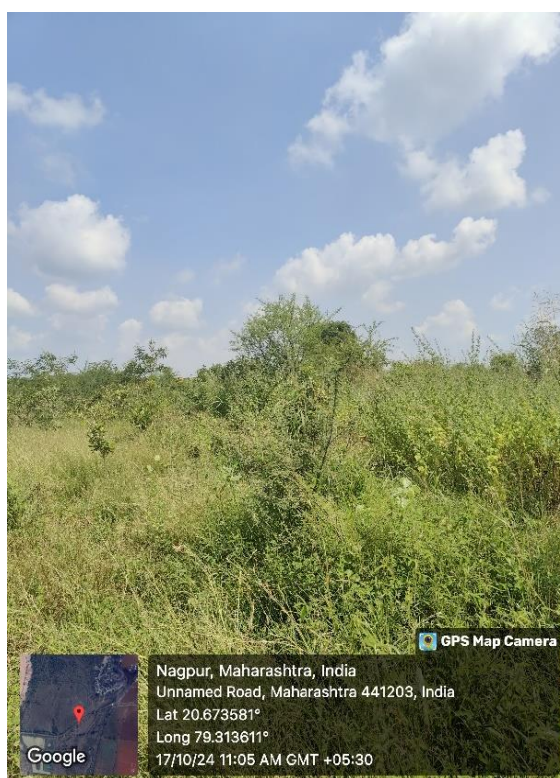
Photograph-21: Plantation on External OB dump (Gondegaon OCP)



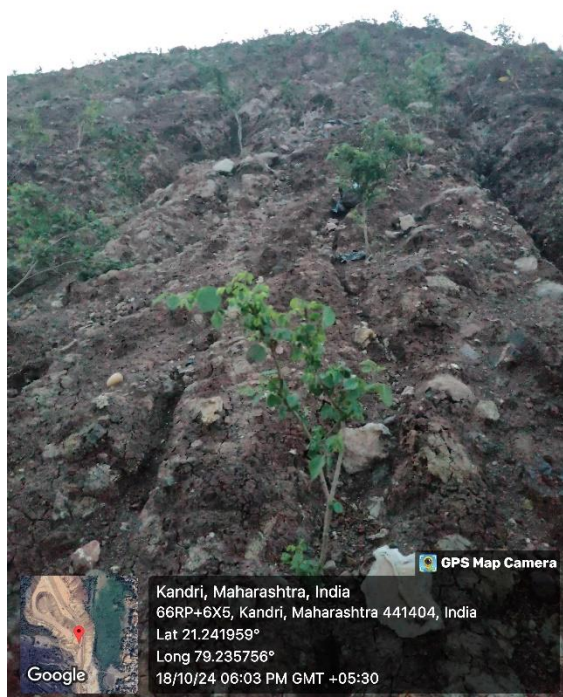
Photograph-22: Social Forestry (Adasa UG to OC)



Photograph-23: Social Forestry (Bhanegaon OC)



Photograph-24: Social Forestry (Gokul OC)



Photograph-25: Plantation on External OB dump (Inder Kamptee OC)



Photograph-26: Avenue plantation (Dhuptala OC)

शब्द-कोष

1	Land Reclamation	भूमि पुनरुद्धार
2	Over Burden	अधिभार
3	Monitoring	निगरानी
4	Report	प्रतिवेदन
5	Executive Summary	कार्यकारी सारांश
6	Opencast Mine	खुली खदान
7	Objective	उद्देश्य
8	Methodology	कार्य प्रणाली अथवा प्रक्रिया
9	Table	तालिका
10	List of Tables	तालिकाओं की सूची
11	Map	मानचित्र
12	Social Forestry	सामाजिक वानिकी
13	Plantation	पौधारोपण
14	Million	घनमीटर
15	Background	पृष्ठभूमि
16	Planning	योजनाबद्ध
17	Asses	आकलन
18	Status	स्थिति
19	Regularly	निरंतर
20	Satellite	उपग्रह
21	Subsidiary	अनुषांगिक
22	Production	उत्पादन
23	Biological Reclamation	जैविक पुनरुद्धार
24	Technical Reclamation	तकनीकी पुनरुद्धार

25	Leasehold Area	पट्टा क्षेत्र
26	Excavated Area	उत्खनन क्षेत्र
27	Active mining	सक्रिय खनन
28	Environmental Protection	पर्यावरण संरक्षण
29	Remedial Measure	उपचारात्मक उपाय
30	Interval	अंतराल
31	Systematic Error	व्यवस्थित त्रुटियाँ।
32	Error	अशुद्धियाँ
33	Curvature	वक्रता
34	Geometric	ज्यामितिक
35	Distortion	विरूपण
36	Plantation	पौधारोपण
37	Capacity	क्षमता
38	Software	सॉफ्टवेयर
39	Class	वर्ग
40	Accuracy	सटीकता
41	Statistical Separation	सांख्यिकीय पृथक्करण
42	Cubic meter	घनमीटर
43	Depicted	दर्शाया गया
44	Percentage	प्रतिशत
45	Salient Findings	मुख्य निष्कर्ष
46	Methodology	पद्धति
47	Data Procurement	डाटा क्रय
48	Satellite data Processing	उपग्रह डेटा प्रसंस्करण
49	Rectification and geo-referencing	सुधार और भूसन्दर्भ-

50	Image enhancement	छविगुण - बृद्धि
51	Training set selection	प्रशिक्षण सेट का चयन
52	Classification and Accuracy assessment	वर्गीकरण और मूल्यांकन की सटीकता
53	Area calculation	क्षेत्र गणना
54	Temporal	लौकिक
55	Processing	प्रसंस्करण
56	Overlay of Vector data base	वेक्टर डेटा बेस का अरोपन
57	Area calculation	क्षेत्रगणना-
58	Pre-field map preparation	क्षेत्र जाने के पहले नक्शे की तैयारी
59	Ground Truthing	भू-सत्यापन
60	Ground Information	भू-सूचना
61	Interpretation	व्याख्या
62	Eco-system	पारिस्थितिकी तंत्र
63	Minor	मामुली
64	Water Drainage	जल निकास
65	Interval	अंतराल
66	Maximum	अधिकतम
67	Coal field	कोयला क्षेत्र
68	Design	परिकल्पना
69	Superimpose	आरोपित
70	Update	अद्यतनीकरण/नवीनीकरण
71	Cumulative	संचयित
72	Embankment	तटबंध
73	Cluster	खुली तथा भूमिगत खदानों के समूह

ABBREVIATIONS

Sol	Survey of India
MoEF&CC	Ministry of Environment, Forest & Climate Change
CIL	Coal India Limited
ECL	Eastern Coalfields Limited
BCCL	Bharat Coking Coal Limited
CCL	Central Coalfields Limited
WCL	Western Coalfields Limited
SECL	South Eastern Coalfields Limited
NCL	Northern Coalfields Limited
MCL	Mahanadi Coalfields Limited
NEC	North Eastern Coalfields
CMPDIL	Central Mine Planning & Design Institute Ltd
NRSC	National Remote Sensing Centre
R2/ R2A	ResourceSat Satellites
LISS - 4	Linear Imaging and Self Scanning Sensor
FCC	False Colour Composite
OCP	Opencast Project
UGP	Underground Project
OB	Over Burden
GCP	Ground Control points
GIS	Geographic Information System
WGS-84	World Geodetic System
UTM	Universal Transverse Mercator

GLOSSARY

Sl.	Term	Definition
1.	Land Reclamation	To manage, reclaim and restore mined out/ degraded land as close as possible to its original stage.
2.	Over Burden	The material that lies above the coal seam/ deposit
3.	Monitoring	A process of evaluation to check or keep record for a period of time.
4.	Opencast Coal Mine	Open-pit mining, also known as opencast mining, is a surface mining technique that extracts minerals from an open pit in the ground.
5.	Social Forestry	Social forestry is the management and protection of forests and afforestation of barren and deforested lands with the purpose of helping environmental, social and rural development. Plantation (Social/ Avenue or other) carried out outside mining area.
6.	Biological Reclamation	Plantation on Backfilled areas (Stabilized Internal Dumps)
7.	Technical Reclamation	Area under backfilling (Over burden dumped inside the mine voids) in mining area.
8.	Green Cover Generated	Total Plantation carried out in the lease area of Project. This includes Plantation on Backfill, Plantation on OB and Social Forestry.
9.	Leasehold Area	The area, for which lease is granted for the purpose of undertaking mining and allied operations.
10.	Excavated area	Mined out area which includes active mining, area under backfilling and plantation on backfilled areas
11.	Active Mining	Mining areas which include Coal Quarry, Advance Quarry, Quarry Filled with Water etc.
12.	Environmental Protection	It is the practice of protecting the natural environment by individuals, organizations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to mitigate damage and reverse trends.
13.	Remedial Measure	Any measure or action required or undertaken to investigate, monitor, clean up, remove, treat, prevent, contain or otherwise remediate the presence or release of any hazardous substance or activity.
14.	Systematic Error	Every measurement differing from the true measurement in the same direction, and even by the same amount in some cases.

15.	Geometric Distortion	It refers to the improper positioning of any image with respect to their true geographic position when viewed in a properly scaled common image display plane.
16.	Land Use/Cover Class	Land cover is what covers the surface of the earth and land use describes how the land is used.
17.	Accuracy	The closeness of agreement between a measured quantity value and a true quantity value.
18.	Environmental Clearance	Environmental Clearance (EC) for any developmental projects like coal mining projects etc. has been made mandatory by the Ministry of Environment, Forests and Climate Change (MoEF& CC) through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986.
19.	Rectification and Geo-referencing	Geo-referencing is the assigning of absolute location of a data point or data points. Geo-rectification refers to the removal of geometric distortions between sets of data points, most often the removal of terrain, platform, and sensor induced distortions from remote sensing imagery.
20.	Image Enhancement	It is the process of modifying digital images so that the results are more suitable for processing or further image analysis.
21.	Training set selection	It is a portion of a data set used to fit or train a model for prediction or classification of values that are known in the training set, but unknown in other (future) data.
22.	Image Classification	It refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps.
23.	Temporal Changes	The 'temporal change' means the change in any entity with a period of time.
24.	Ground Truthing	Collection of primary/ basic information from ground realities for satellite image interpretation and thematic mapping.
25.	Cluster	Group of opencast and/ or underground mines clubbed together for administrative purposes.
26.	Arc GIS	GIS Software used for Map preparation
27.	ERDAS IMAGINE	Satellite Image Data Classification Software



सीएमपीडीआई
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