CHAPTER – 6
HYDROGEOLOGICAL STUDIES

Special attention is given to the understanding of hydro-geological conditions in the Rajpardi mining area. The need to evaluate hydro-geological conditions of the area was felt, as the mining is likely to adversely influence the natural dynamics of the surface and ground water systems. The study is carried out using the conventional understanding of surface drainage, ground water conditions and their mutual relationships. Acid mine water problem is also dealt separately in the chapter.

6.1 Drainage

The regional drainage is shown in the figure 6.1. The rivers and streams in the study area drain from ESE – SE to WNW – NW, ultimately joining the river Narmada. The general drainage pattern is dendritic and at places become rectangular due to structural control. The drainage density is moderate to low. In all the basins i.e, Kaveri, Ratanpur, Hakran and Madhumati, the drainage has developed till 5th order. Hakran, a small stream drains through the middle of the mining area, its 3rd and 4th order streams cut through the mining lease block. This river is seasonal; at places pools of water along the course of Hakran are visible due to the seepage of canal water into the stream.

6.2 Hydrometeorology

The area falls in sub tropical climate zone, having hot summers and moderate winters. The period between June to August witnesses monsoon rains. There is a short term rainfall deficient phase as observed in the rain fall data from 1996 to 2005. The average rainfall for this decadal period is 695mm, owing to the low rainfall years from 1998 to 2002 (Table 6.1 and Figure 6.2), otherwise, the long term average rainfall in the region is 838mm. Summers may register temperatures as high as 43°C, compared to this winters are moderate registering temperatures around 22 ° C. The dominant wind direction in the region is south-west.

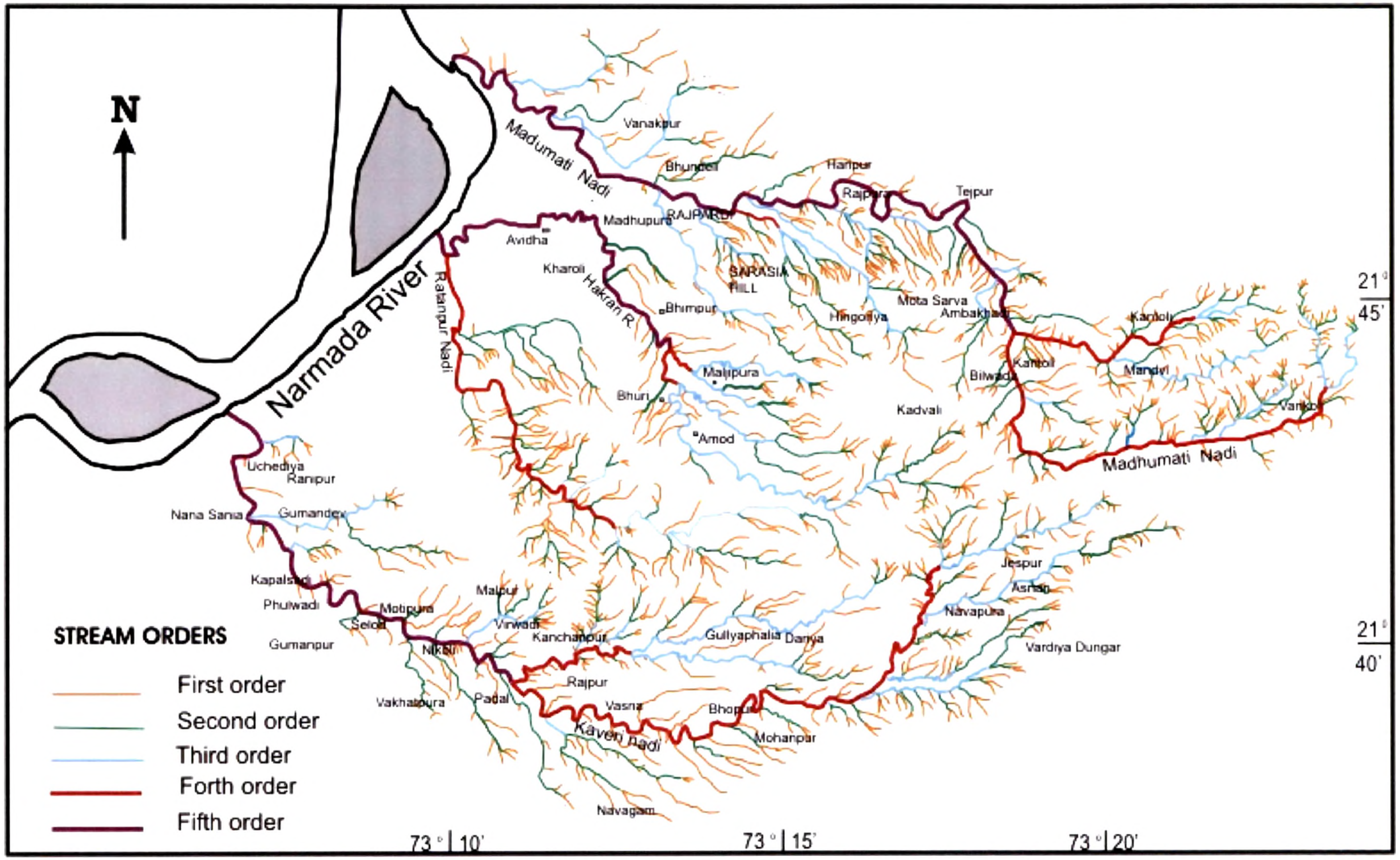

Figure 6.1: Kaveri, Ratanpur, Madhumati river basins

Table 6.1: Decadal rainfall data of Jhagadia station

Year	Rainfall (mm)
1996	571
1997	723
1998	1004
1999	438
2000	366
2001	640
2002	597
2003	916
2004	865
2005	830
Average	**695**

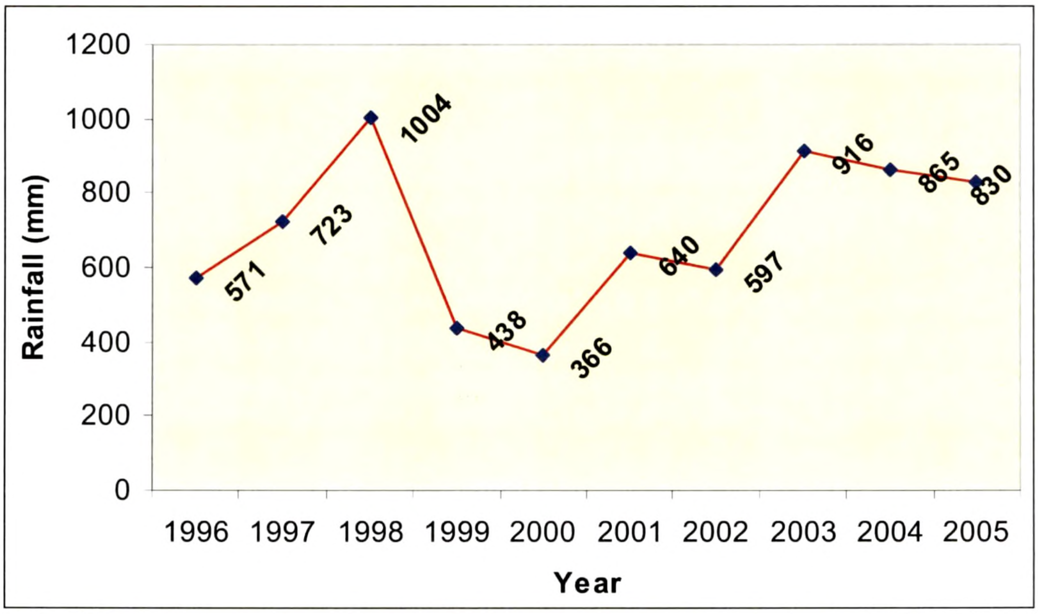

Figure 6.2: Graph showing annual rainfall for 10 years

6.3 Water quality

Water samples from different wells were collected to study the chemical and physical parameters. The sampling was done during the winter, summer and post monsoon times to observe seasonal variability. For computing the water budget, Gujarat Water Resource Development Corporation, Ltd., data is used. The area is divided into core zone (the mining block) and buffer zone (up to a distance of 10 km from the mining block) to see any significant changes in the quality and quantity of surface and ground waters.

The ground waters samples have shown range of physical as well as chemical parameters (Table 6.2 a-e) which are well within the permissible limits of drinking waters (Anon, 1991, Annexure 4). The cation and anion concentrations are moderate and compares well with the water quality of the surrounding areas. The heavy metal concentrations are also either very low or in the non detectable range. The water samples from location nos. 2 and 8, (Table 6.2) representing Amod and Rajpardi villages respectively have also not deviated from normal range of physical and chemical parameters implying no influence of mining on the quality of the ground water. This is on account of the natural hydro-geological conditions in the region. Ground water occurs above the lignite seams, well insulated by clay bands. There is low utilization of ground water due to Karjan canal irrigation provided through canal network in the region. Geo-hydrological details for the sampling locations are shown in the table 6.3. The village wise distributions of wells are shown in table 6.4. The water level fluctuations at the Rajpardi observation well, shows a steady increase in the ground water levels both due to relative increase in the average rainfall in the recent years and low usage of ground water (Figure 6.3).

6.4 Ground water balance in the area

Using the hydraulic parameters (Table 6.5a, b, c), well distribution density in the area, draft and recharge data (Source GWRDC), ground water budgeting was attempted.

Water Budget Jhagadia Taluka (Source GWRDC):

(i) Total recharge of water from different sources : 76.58 MCM/yr

(ii) Net Available Recharge (95% of total/gross recharge): 72.75 MCM/yr

(iii) Gross draft (2002) irrigation+Domestic+Industrial of water: 50.42 MCM/yr

(iv) Degree of ground water development : 69.30%

The computed ground water development in the core zone is about 32% and the same in the buffer zone is 36%. This suggests ample availability of ground water, having good physical and chemical quality parameters.

Table 6.2: Groundwater sampling locations

Sr. No.	Locations	Source
1	GMDC Colony	Borewell
2	Amod village	Openwell
3	Damlai village	Borewell
4	Babagor Hill	Borewell
5	Ratanpor Village	Openwell
6	Jhagadia near Panchayat Office	Borewell
7	Bhimpor village	Handpump
8	Rajpardi village	Borewell
9	Vanakpor near Rajpardi	Tubewell
10	Krishnapuri	Handpump
11	Haripura on way to Rajpipla	Handpump
12	Mota Sorva	Handpump
13	Jaspor village	Handpump
14	Amaljhar village	Borewell

Table 6.2a: Physical parameters of the groundwater

Station	pH			Turbidity (NTU)			Conductivity (mS/cm)			T.D.S. (mg/l)			S.S. mg/l			T.S. mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	7.5	8.1	7.9	1.9	3.0	1.9	2.08	1.92	2.26	1105	1126	1306	9	21	13	1114	1147	1319
2	7.3	8.3	7.8	2.7	2.5	1.5	1.63	1.43	1.61	925	989	914	18	13	5	943	1002	919
3	6.8	7.4	7.3	3.0	9.7	2.3	1.66	0.89	1.02	845	443	609	29	169	ND	874	612	602
4	6.8	8.1	7.4	2.5	2.1	3.3	0.8	1.41	0.77	315	767	365	12	5	1	327	772	366
5	7.3	8.2	8.4	2.2	5.8	1.7	1.57	1.6	1.82	805	855	1030	9	77	ND	814	932	1023
6	7.0	8.1	7.5	2.0	3.4	1.3	2.19	2.33	1.88	1385	1362	1105	7	25	ND	1392	1387	1098
7	7.1	7.8	7.2	--	6.5	--	2.01	2.08	1.94	1205	1152	1212	977	45	974	2182	1197	2186
8	7.3	8.3	8.2	2.9	8.6	1.8	2.33	1.76	2.27	1305	924	1325	13	113	-3	1318	1037	1322
9	7.1	7.5	7.6	1.7	0.7	1.7	1.91	0.68	2	1015	315	1142	8	ND	5	1023	312	1147
10	7.4	8.3	7.6	2.0	3.2	1.8	2	2.49	2	1295	1468	1299	7	25	11	1302	1493	1310
11	7.1	7.7	8.0	2.6	8.1	2.1	0.82	0.71	0.6	345	334	288	12	77	ND	357	411	281
12	7.0	7.8	7.8	2.1	0.3	1.3	0.92	0.6	0.73	395	249	356	9	ND	ND	404	242	353
13	6.7	7.7	7.3	2.0	7.8	2.0	1.08	0.78	0.8	515	374	418	10	109	1	525	483	419
14	6.9	7.6	7.0	3.4	4.7	3.7	2.21	1.75	2.21	1165	994	1172	14	44	20	1179	1027	1192

Note:
W – Winter Season
S – Summer Season
P M – Post Monsoon

Table 6.2b: Seasonal variations in the alkalinity and hardness of the groundwater

Station	Alkalinity as $CaCO_3$ mg/l			Hardness as $CaCO_3$ mg/l								
				T			Ca			Mg		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	631	524	524	172	126	130	69	14	27	103	112	103
2	619	522	534	114	224	187	26	12	23	88	212	164
3	363	172	224	480	243	205	302	137	166	178	106	39
4	161	340	164	123	243	111	49	18	60	74	225	51
5	585	612	604	181	77	64	155	14	27	26	63	37
6	395	494	404	428	243	196	189	141	94	239	102	102
7	470	378	475	222	341	226	136	43	135	86	298	91
8	757	328	344	218	181	151	89	59	51	129	122	100
9	526	144	434	756	106	309	354	78	19	402	28	290
10	89	909	92	216	137	219	34	12	37	182	125	182
11	258	214	214	141	164	177	59	35	49	82	129	128
12	323	172	174	290	145	177	158	49	87	132	96	90
13	354	186	174	334	204	253	200	55	102	134	149	151
14	596	284	59.4	458	321	463	204	37	252	254	284	211

Table 6.2c: Seasonal variations in the major cations and anions of the groundwater

Station	K^+ mg/l			Na^+ mg/l			SO_4^{-} mg/l			Cl^- mg/l			F^- mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	7.5	7.6	7.9	339	354	299	39.5	78	16	228	255	232	0.8	0.58	1.56
2	79	4.6	4.4	265	189	199	65	69	16	109	72	76	1.6	0.46	1.97
3	6.5	5.4	5.2	103	67	57	84	69	35	221	140	113	0.9	0.6	0.98
4	5.1	6.4	5.6	81	169	57	12.6	73	24	88	144	66	0.45	0.8	ND
5	10	7.5	8.5	218	304	257	24.4	65	25	102	92	76	0.7	0.61	0.36
6	13	9.3	7.8	240	339	194	12.5	104	18	399	289	190	0.52	ND	1.08
7	162	8.3	165	254	224	275	263	129	265	230	262	234	0.75	0.56	0.77
8	6.7	6.3	8.2	364	265	349	39	119	164	218	295	382	0.56	0.3	0.9
9	32	4.9	6.6	74	754	399	88	38	54	189	59	175	0.53	0.47	0.69
10	5.5	5.3	5.7	329	432	331	6.6	82	7	140	82	141	0.86	0.57	0.84
11	4.6	4.4	4.8	94	72	32	7.5	30	7	34	45	35	0.38	ND	0.67
12	5.2	4.6	5.2	40	30	20	31	11	16	36	30	45	0.53	0.74	0.78
13	4.8	4.2	4.5	30	132	25	13.6	24	29	55	51	56	0.55	0.53	0.98
14	4.9	4.7	4.8	227	92	224	99	72	13.4	239	172	243	0.75	0.69	0.73

Table 6.2d: Seasonal variations in the heavy metals in the groundwater

Station	Fe mg/l			Ni mg/l			Zn mg/l			Cu mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	0.08	0.08	0.07	0.06	0.07	0.05	ND	ND	ND	ND	ND	ND
3	0.05	0.07	0.04	ND	ND	ND	0.04	0.05	0.04	ND	ND	ND
4	0.52	0.52	0.52	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	0.05	0.07	0.04	ND	ND	ND	ND	ND	ND
6	0.15	0.17	0.15	0.05	0.06	0.05	ND	ND	ND	0.03	0.04	0.03
7	ND	ND	ND	0.09	0.1	0.09	ND	ND	ND	ND	ND	ND
8	ND	ND	ND	ND	ND	0.07	ND	ND	ND	ND	ND	ND
9	0.07	0.03	ND	0.03	0.03	ND	ND	ND	ND	ND	ND	ND
10	0.1	0.09	0.07	ND	ND	ND	0.1	0.12	0.08	ND	ND	ND
11	ND	ND	0.06	0.06	0.06	0.03	0.05	0.05	ND	ND	ND	ND
12	0.22	0.32	0.07	0.07	0.09	ND	0.02	0.03	0.06	0.03	0.03	ND
13	0.05	0.07	ND	ND	ND	0.04	ND	ND	0.03	ND	ND	ND
14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 6.2e: Seasonal variations in the heavy metals in the groundwater

Station	Co mg/l			Mn mg/l			Cr mg/l			Cd mg/l			Pb mg/l		
	W	S	P M	W	S	P M	W	S	P M	W	S	P M	W	S	P M
1	ND	ND	ND	0.03	0.03	0.02	ND	ND	ND	ND	ND	ND	0.03	0.03	0.03
2	0.05	0.06	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	0.07	0.05
3	0.03	0.03	0.03	0.04	0.04	0.04	ND	ND	ND	ND	ND	ND	0.03	0.04	0.03
4	0.04	0.05	0.04	0.03	0.04	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	0.04	0.05	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
6	0.04	0.04	0.04	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	0.03	0.12	0.07	0.03	0.03	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
8	ND	ND	0.1	0.04	0.04	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND
9	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	0.07	0.03	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12	0.03	0.04	0.02	0.05	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
13	ND	ND	ND	0.03	0.03	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND
14	0.08	0.09	0.06	0.04	0.04	0.01	ND	ND	ND	ND	ND	ND	0.03	0.03	0.04

Table 6.3: Geohydrological details of the study area

Sr. No.	Village	Owner Name	Location	Type of Well	Formation	SWL (m)	Discharge (LPM)	Total depth (m)
Core Zone								
1	Amod (Tarsali)	Mohmad Karim Malik	Near School	Tube well	Alluvium	9.05	450	36
2	Amod (Tarsali)	Ahmad Mohmad Ghatwala	Near Village	DCB	Alluvium	10	420	25
3	Amod (Tarsali)	Nanubhai Vasava	Near Pump House	Tube well	Alluvium	13.8	500	40
4	Damlai	Deepak H. Patel	Near Damlai Village	DCB	Alluvium	8.35	480	33.5
5	GMDC Bore 1	GMDC		Tube well	Alluvium	12.6	1000	70
6	GMDC Bore 2	GMDC		Tube well	Alluvium	13.1	980	67
7	GMDC Bore 3	GMDC		Tube well	Alluvium	15.6	1100	85
Buffer Zone								
8	Amalsar	Panchayat Well	In Village	Dug	Alluvium	8.7	300	13.9
9	Padvaniya	Narendrasinh Bhagawansinh Sorthiya	Opp. Bus stop	Dug	Alluvium	5.3	-	15
10	Gundecha	Nanji Sidiya Vasava	Near Canal	Dug	Alluvium	5.8	-	18.5
11	Amod	Ratilal Nagilal Doshi	On LHS of Road Amalsar	Dug	Alluvium	7.6	400	18.9
12	Rajpardi	Panchayat Well	Khari Faliya	Dug	Alluvium	4.7	-	13
13	Khadoli	Panchayat Well	In Village	Tube well	Alluvium	41	600	125
14	Nava Avidha	Panchayat Well	Near Village	Dug	Alluvium	5.6	-	12
15	Pora	Panchayat Well	Near Village	Dug	Alluvium	5.5	-	15.7
16	Vaghpur	Panchayat Well	In Village	Dug	Alluvium	Dry	-	19.2

The distribution of different types of wells in the area around Rajpardi project is shown in Table 6.4.

Table 6.4: Well distribution data of the study area

Sr. No.	Village	Formation	Total No. of wells	Dug	DCB	Bore well	Well with pump sets	Wells without pump sets	SWL Range (m)	T.D. Range (m)	Range of discharge (LPM)
1	Amod (Tarsali)	Alluvium	5	2	2	1	2	3	1.8 to 20	6to96	250 to 700
2	Damlai	Alluvium	7	3	2	2	3	4	7 to 20.5	10 to 70	150 to 750
3	Padvaniya	Alluvium / Trap	5	3	0	2	2	3	5.3 to 19	10 to 65	170 to 470
4	Gundecha	Alluvium / Trap	14	3	2	9	6	8	5.4 to 20.8	7to90	75 to 760
5	Rajpardi	Alluvium	66	20	34	12	44	22	4.2 to 22	7.10 to 100	160 to 800
6	Amalsar	Alluvium / Trap	20	8	1	11	9	11	3.10 to 21	6.8 to 70	150 to 780
7	Khadoli	Alluvium	21	8	2	11	15	6	10.8 to 30.1	10 to 120	200 to 800
8	Avidha	Alluvium	105	15	13	77	90	15	10.5 to 30.25	8 to 120	200 to 850
9	Pora	Alluvium	16	8	1	7	8	8	12.4 to 27	10 to 110	150 to 600

6.5 Hydraulic characteristics of the region

Table 6.5a: Pump test and computed aquifer parameters in the study area

Sr. No.	Village/ Site	Formation	Total Depth (m)	Saturated Thickness H (m)	Diameter	SWL (m)	Draw Down (m)	Discharge (m^3/min)	Pumping Time (min)	Specific Capacity (m^3/min/m)	Transmissibility (m^3/day)	Permeability (m/day)	Radius of Influence (m)	Specific Yield
1	Damlai	Alluvial	33.50	6.00	2.9m+ 150 mm	8.35	11.15	0.480	300	0.043	29.470	4.910	36.00	0.040
2	Amod (Tarsali)	Alluvial	36.00	6.00	150 mm	9.05	5.47	0.450	70	0.082	88.012	14.660	37.62	0.026
3	GMDC Bore1	Aliuvial	70.00	36.00	250 mm	12.6	11.23	1.000	360	0.089	93.630	2.600	38.10	0.140
4	GMDC Bore3	Alluvial	85.00	40.00	250 mm	15.6	8.95	1.100	300	0.1229	138.306	3.457	38.04	0.175

Source: GWRDC

Table 6.5b: Pump test and computed aquifer parameters in the study area

Sr. No.	Village	Formation	Total Depth (m)	SWL (m)	Saturated Thickness H (m)	Area (m^2)	Draw Down (m)	Discharge in (m^3/min)	Pumping time (min)	Specific Capacity (m^3/min/ m)	Transmissibility (m^3/day)	Permeability (m/day)	Radius of Influence (m)	Specific yield
1	Nana Sanja	Alluvium	13.08	10.75	2.33	5.51	1.09	0.26	160.00	0.24	224.57	96.38	45	0.077
2	Randadi	Alluvium	14.05	11.33	2.72	5.51	2.35	0.59	180.00	0.25	231.23	85.01	71	0.089
3	Anjoy	Hard Rock	8.50	7.45	1.05	7.06	0.94	0.03	35.00	0.03	27.68	26.36	22	0.0016
4	Galiba	Hard Rock	8.45	5.35	3.10	13.64	2.68	0.23	70.00	0.09	70.04	22.59	45	0.0047

Table 6.5c: Water budget for the core and buffer zones

	Area km^2	Avg. water level fluctuation	Sp. Yield %	Rainfall infiltration %	Recharge MCM	Draft MCM	Ground water balance	Stage of development %
Core	5.00	5.14	9.5	20	2.80	0.925	1.96	32
Buffer	332.6	4.80	3.5	08	57.57	20.84	36.73	36

6.6 Ground water monitoring

The data for last 10 years (Source GWRDC) has given an insight in to the water level fluctuation at different locations in the study area. The overall characteristic of most of the monitoring stations, show a steady state condition of water levels, thereby suggesting low use of ground water in the region and also good surface water recharge condition. This is well illustrated in the Rajpardi hydrograph (Figure 6.3).

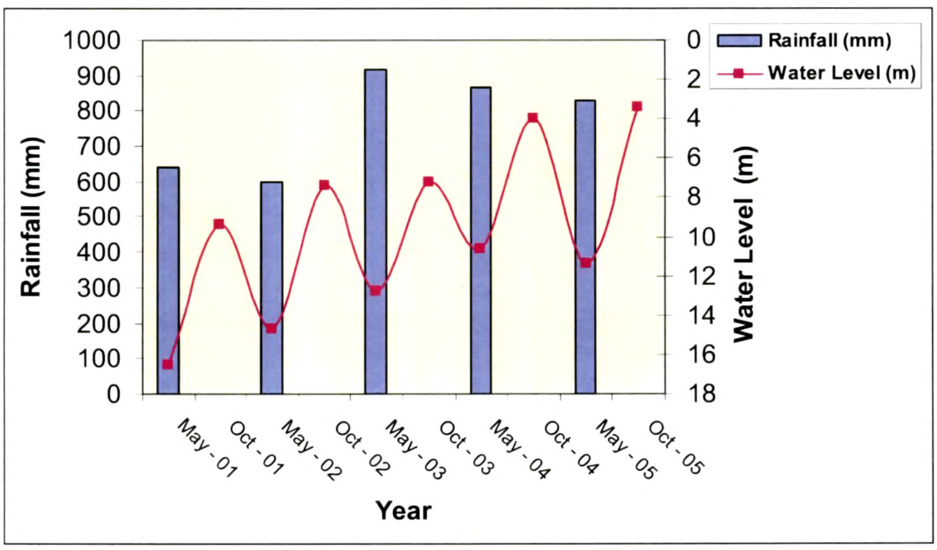

Figure 6.3: Hydrograph of Rajpardi location

6.7 Aquifer conditions in the study area

The main aquifer in the mining block comprises of conglomerates and gritty sandstones overlying the lignite seams, insulated by clay bands. The beds dip in the flow direction of the ground water, preventing the intersection of water table with the sedimentary horizons. The reduced water level contour prepared from the water table depth (Table: 6.7) clearly indicate the general ground water flow direction is SE-NW (Figure 6.4).

Table: 6.7 Details of Water Level at Jhagadia Taluka during pre and post monsoon.

Village	May-96	Oct-96	May-97	Oct-97	May-98	Oct-98	May-99	Oct-99	May-00	Oct-00	May-01	Oct-01	May-02	Oct-02	May-03	Oct-03	May-04	Oct-04	May-05	Oct-05
Avidha	10.70	8.35	10:45	6.50	6.60	5.32	9.90	9.00	13.00	12.90	12.46	10.50	11.30	8.00	11.10	6.00	9.85	8.55	10.50	3.76
Mulad	10.16	10.00	9.20	7.16	9.80.	4.00	8.96	7.20	10.00	9.80	11.20	9.76	11.10	7.56	11.50	6.86	10.06	6.54	10.26	4.56
Padvania	12.85	4.70	8.80	4.75	6.70	3.65	5.90	5.30	8.60	6.80	7.70	6.60	6.70	3.90	6.40	6.15	7.75	3.55	6.90	2.20
Prakhad	16.70	14.80	14.85	13.70	15.10	13.90	15.60	13.40	17.70	16.70	17.80	15.50	16.95	12.65	18.00	12.15	14.15	11.00	12.80	9.92
Sarsa	13.40	9.60	12.25	10.00	12.70	7.75	11.20	11.20	15.00	13.10	15.50	11.00	15.20	10.40	16.30	10.90	14.60	7.70	14.20	6.36
Wadkhuta	3.88	2.08	3.83	2.18	4.00	1.00	4.10	2.20	4.30	4.00	6.23	2.78	5.58	1.78	7.20	4.98	6.02	2.03	6.00	0.83
Waghpura	16.30	15.20	13.80	12.20	16.00	9.50	11.00	10.95	14.00	13.40	18.40	12.20	17.10	13.14	13.45	8.20	14.50	4.90	12.45	5.81
Wanthewad	9.50	6.80	8.40	6.50	6.50	3.40	5.90	4.30	7.40	5.70	9.10	6.30	6.65	4.30	6.30	5.70	7.55	6.00	6.20	3.95
Indor					17.20	12.58	16.25	11.35	17.15	15.70	18.95	14.76	18.35	14.15	18.75	14.40	18.75	15.05	18.50	13.40
Jhagadia					18.45	12.56	16.40	15.15	16.65	16.01	21.02	17.48	20.72	16.75	21.10	13.10	17.15	12.65	17.85	10.52
Kolivada					13.05	8.94	12.40	9.10	14.75	14.25	19.47	11.25	18.40	9.35	19.76	10.90	18.90	11.10	19.25	7.63
Rajpardi											16.43	9.35	14.70	7.40	12.76	7.25	10.65	3.95	11.40	3.38

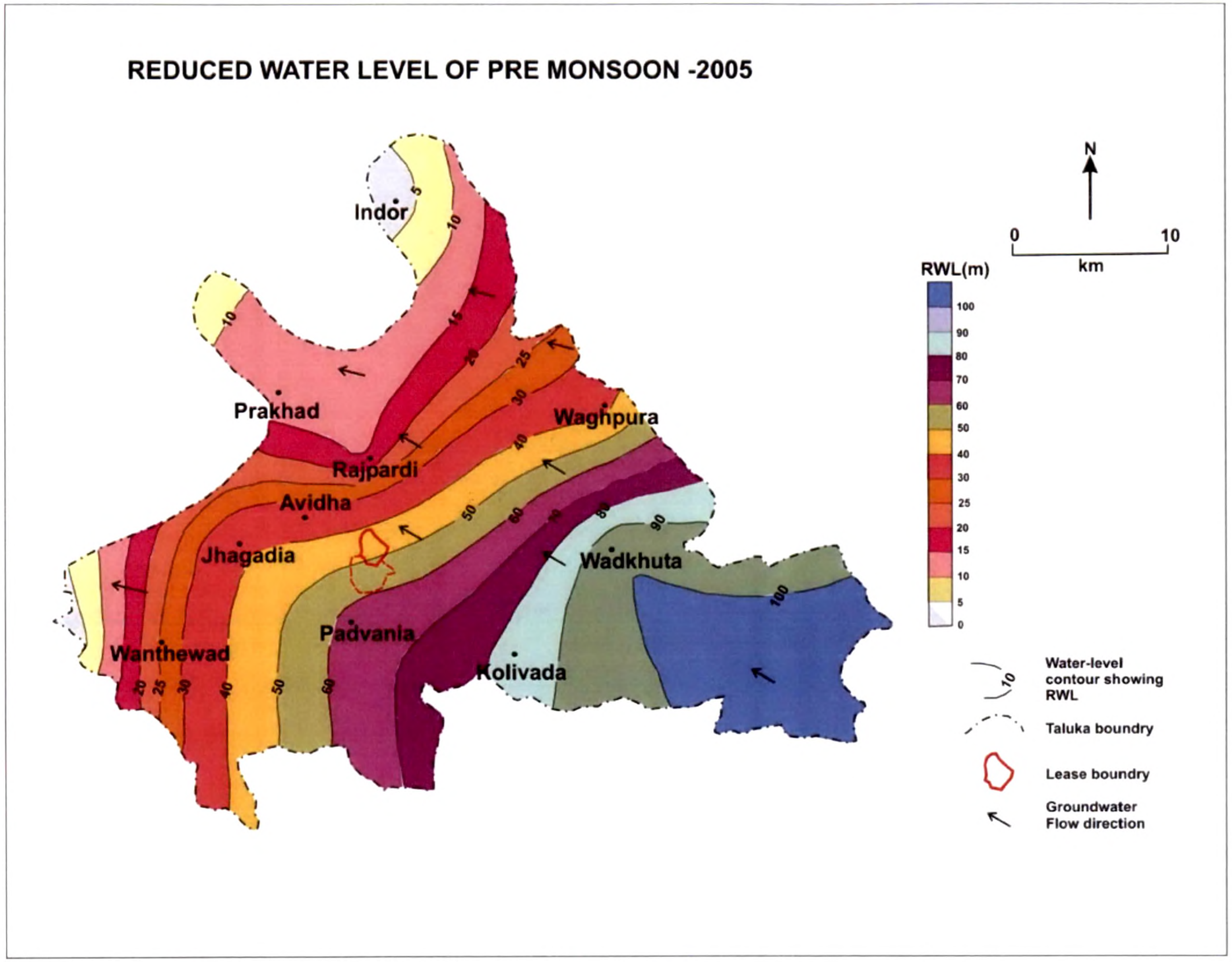

Figure 6.4 Ground Water flow direction prepared from Reduce Water Level contours of Jhagaida Taluka.

6.8 Effect of mining

The groundwater flow at Rajpardi is from southeast to northwest, which is in accordance with the surface drainage, which ultimately empties into river Narmada. The surface drainage cuts through the mining block to join the Narmada River. Both quality and quantity (Figure 6.2) have shown steady state condition. The water table conditions in the mine area are difficult to ascertain, though there is continuous discharge of ground water in the mine pit. To reduce this, discharge pumps have been fixed in the mine and water is released into Hakran stream.

Rajpardi being at an elevation of 60m and above, the surface drainage flows from ESE to WNW, passing through the centre of the lease area. The mine does not receive any surface inflow except in low lying pits. The Hakran stream has been diverted southwest to facilitate the mining operations.

6.9 Acid Mine Water

Oxygen, water and sulfur rich minerals are necessary for the generation of acid water in the mine. Hence by preventing air and water from coming in contact with these natural materials, the formation of acidic water can be prevented (Anon, 1994).

The mine wastewater generated from lignite mine is of two types (1) acid mine water (Photo 6.1) and (2) mine drainage water. The mine drainage water mainly from the aquifer is continuously pumped out during mining operations. Dust extraction and suppression systems and sanitation would also give rise to some waste water.

The estimated quantity of the domestic wastewater generated from the mine colony is about 75 m^3/day.

Photo-6.1: Acid mine water pond, Rajpardi

Photo-6.2: Discharging of treated acid mine water into the Hakran stream

The acid mine water has the following characteristics (Table 7.4a – g);

- Low pH (≈ 2.5 to 2.8)
- High concentration of heavy metals like Fe, Mn, Al, etc.
- High sulphate content amongst anions
- Absence of organic matter

The discharged mine water into Hakran River (Photo-6.2) has shown slightly acidic pH, proper monitoring of this water is needed to avoid its adverse influence on biological communities. Effects may range from reduction in diversity of flora and fauna.

The acid mine drainage generated in the Amod and Bhuri blocks is continuously neutralized, treated and is used in dust suppression and greenbelt development. Contaminated water is prevented from entering in to the nearby nallas and the treated water is sufficiently used within the mine site. Hence, there is little scope of adverse impact on the natural water bodies, flora and fauna due to acid mine water.

The $75m^3$/day of domestic sewage is treated in a sewage treatment plant consisting of series of septic tanks followed by an oxidation pond and the treated water is used for the plantations within the colony. No untreated sewage / wastewater is discharged into any nearby natural water bodies or the streams.

Due to the occurrence of clay layer below the acid mine water pond, there is very little scope for the percolation of acidic water to deeper horizons. Due to the prevalence of carbonate matrix in the sands, the acid water is getting neutralized and part of this water is used in the mining operations such as dust suppression etc.The high clay content in the sediments also serves as absorbent/ adsorbent medium for heavy metals, hence preventing their dispersion to the surroundings.

The overall hydrogeological conditions have not shown adverse changes due to the mining activity. Even the natural hydrogeological setting has ensured that the ground water doesn't interact with the acid mine water. No major environmental impacts are envisaged as far as water environment in the region is concerned.

The acid mine water accumulating in the pond is suitably neutralized by the application of carbonate rich sediments. The clayey horizon below the acid water pond prevents the seepage of acidic water, high in heavy metals from leaching downwards. The lime treated water is reused in the dust suppression by sprinkling this water on the vehicular tracks in the mine.