

Table 5.5 Measurements and Analysis Results of Water Quality (2)

Sample Number	Temp.	pH	ORP	E.C.	Hg	Cd	Cr	As	Pb	Cu	Mn	Fe	Ni	Zn	SO <sub>4</sub>	Cl
	(C.)		(mV)	S/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
DH-1A	28.8	6.37	209	6.88	0.0021	0.097	1.120	0.010	0.50	0.38	4.99	41.35	0.049	0.66	1258	29376
DH-1B	27.8	6.56	-24	8.15	0.0035	0.104	1.050	0.011	0.42	1.37	3.13	78.24	0.052	1.21	1379	34578
DH-2-S	31.8	7.17	129	3.37	0.0005	0.040	0.693	0.005	0.75	0.11	0.10	0.36	0.035	0.14	990	13209
DH-2-D	31.6	6.79	143	3.30	0.0005	0.037	0.654	0.005	0.78	0.11	0.17	0.31	0.031	0.11	960	13260
DH-3-S	33.6	7.00	124	1.82	0.0005	0.018	0.280	0.006	0.30	0.07	0.10	0.21	0.032	0.15	641	6416
DH-3-D	31.5	7.08	125	1.93	0.0005	0.013	0.285	0.008	0.45	0.10	0.11	0.92	0.030	0.10	689	6569
DH-4S	33.1	6.95	137	2.05	0.0007	0.018	0.218	0.007	0.31	0.07	0.03	0.27	0.037	0.09	641	7150
DH-4D-1	31.9	7.55	65	0.97	0.0007	0.008	0.098	0.007	0.10	0.07	0.17	0.35	0.028	0.34	365	2907
DH-4D-2	32.4	7.98	-188	0.94	0.0007	0.009	0.038	0.008	0.14	0.06	0.16	2.02	0.030	0.21	419	2917
DH-5-S	32.3	7.59	-189	0.23	0.0004	0.006	0.035	0.008	0.03	0.08	0.01	0.22	0.032	0.11	303	494
DH-5D-1	33.3	9.84	-96	2.16	0.0005	0.028	0.879	0.008	1.08	0.10	<0.01	0.20	0.041	0.08	691	7630
DH-5D-2	32.7	8.30	-247	2.94	0.0004	0.037	0.452	0.008	0.55	0.11	0.06	1.74	0.035	0.10	623	13260
DH-6S	31.4	7.06	79	1.08	0.0005	0.004	0.030	0.006	0.12	0.07	<0.01	0.22	0.035	0.07	363	3407
DH-6D-1	32.8	7.20	-191	0.36	0.0007	0.014	0.012	0.008	0.24	0.07	0.90	4.00	0.030	0.16	260	2162
DH-6D-2	32.5	7.10	-202	0.73	0.0006	0.010	0.013	0.009	0.13	0.09	0.96	31.35	0.038	0.16	270	2366
DH-7S	30.2	7.55	99	0.60	0.0004	0.010	0.038	0.007	0.06	0.06	<0.01	0.14	0.032	0.05	949	1153
DH-7D-1	31.6	8.06	-158	0.58	0.0004	0.008	0.048	0.008	0.08	0.06	0.31	0.48	0.030	0.08	898	1224
DH-7D-2	31.8	7.52	-144	0.63	0.0004	0.010	0.009	0.008	0.05	0.06	0.25	0.43	0.034	0.07	948	1306
DH-8S	29.2	7.62	112	0.18	0.0005	0.004	0.029	0.006	0.02	0.01	<0.01	0.34	0.040	0.04	96	361
DH-8D-1	31.1	7.98	68	0.24	0.0005	0.006	0.022	0.005	0.01	0.01	<0.01	0.15	0.010	0.14	143	333
DH-8D-2	31.2	7.74	83	0.24	0.0005	0.005	0.038	0.005	0.04	0.01	<0.01	0.21	0.009	0.09	150	345
DH-8D-3	31.8	7.65	74	0.19	0.0004	0.002	0.010	0.005	0.01	0.01	<0.01	0.18	0.005	0.12	156	351
DH-9-S	29.8	7.72	88	0.07	0.0004	0.003	0.008	0.006	0.02	0.01	<0.01	0.50	0.024	0.09	42	107
DH-9-D	30.9	7.89	97	0.07	0.0004	0.005	0.010	0.006	0.02	0.01	<0.01	0.24	0.028	0.03	43	106
DH-10-S	31.5	8.05	36	0.23	0.0003	0.007	0.047	0.006	0.05	0.08	<0.01	0.11	0.037	0.08	393	404
DH-10-D	31.2	7.85	36	0.31	0.0005	0.006	0.024	0.006	0.03	0.07	<0.01	0.89	0.035	0.08	530	543
DH-11-S	31.9	7.31	76	1.44	0.0005	0.018	0.118	0.013	0.22	0.09	0.06	0.37	0.030	0.38	491	4702
DH-11-D	32.5	7.41	-193	1.48	0.0005	0.020	0.197	0.010	0.19	0.10	0.40	0.35	0.037	0.09	548	4978
DH-12S	32.7	7.65	89	0.35	0.0003	0.002	0.068	0.005	0.04	0.06	<0.01	0.05	0.032	0.05	311	816
DH-12D-1	32.0	8.72	7	0.39	0.0005	0.024	0.293	0.008	0.32	0.11	0.03	2.88	0.034	0.11	232	1122
DH-12D-2	31.6	9.49	-13	0.96	0.0005	0.025	0.248	0.007	0.29	0.10	0.02	2.79	0.038	0.18	596	2183
DH-13-S	31.8	8.17	69	0.11	0.0003	0.004	0.038	0.008	0.01	0.09	<0.01	0.29	0.028	0.37	264	104
DH-13-D	31.7	7.87	84	0.11	0.0003	0.002	0.015	0.008	0.03	0.08	<0.01	1.41	0.034	0.41	251	100
DH-14-S	32.3	8.43	46	0.07	0.0003	0.005	0.009	0.006	0.02	0.02	<0.01	0.27	0.008	0.34	142	49
DH-14-D	31.3	8.00	83	0.07	0.0004	0.005	0.010	0.004	0.02	0.02	0.01	1.51	0.012	1.14	139	45
Minimum	27.8	6.37	-247.0	0.07	0.0003	0.002	0.008	0.004	0.01	0.01	<0.01	0.05	0.005	0.03	42	45
Maximum	33.6	9.84	209.0	8.15	0.0035	0.104	1.120	0.013	1.08	1.37	4.99	78.24	0.052	1.21	1379	34578
Average	31.6	7.69	14.7	1.29	0.0006	0.018	0.204	0.007	0.21	0.11	0.52	5.01	0.031	0.22	491	4744

Red color : Exceeding Omani standard of discharge

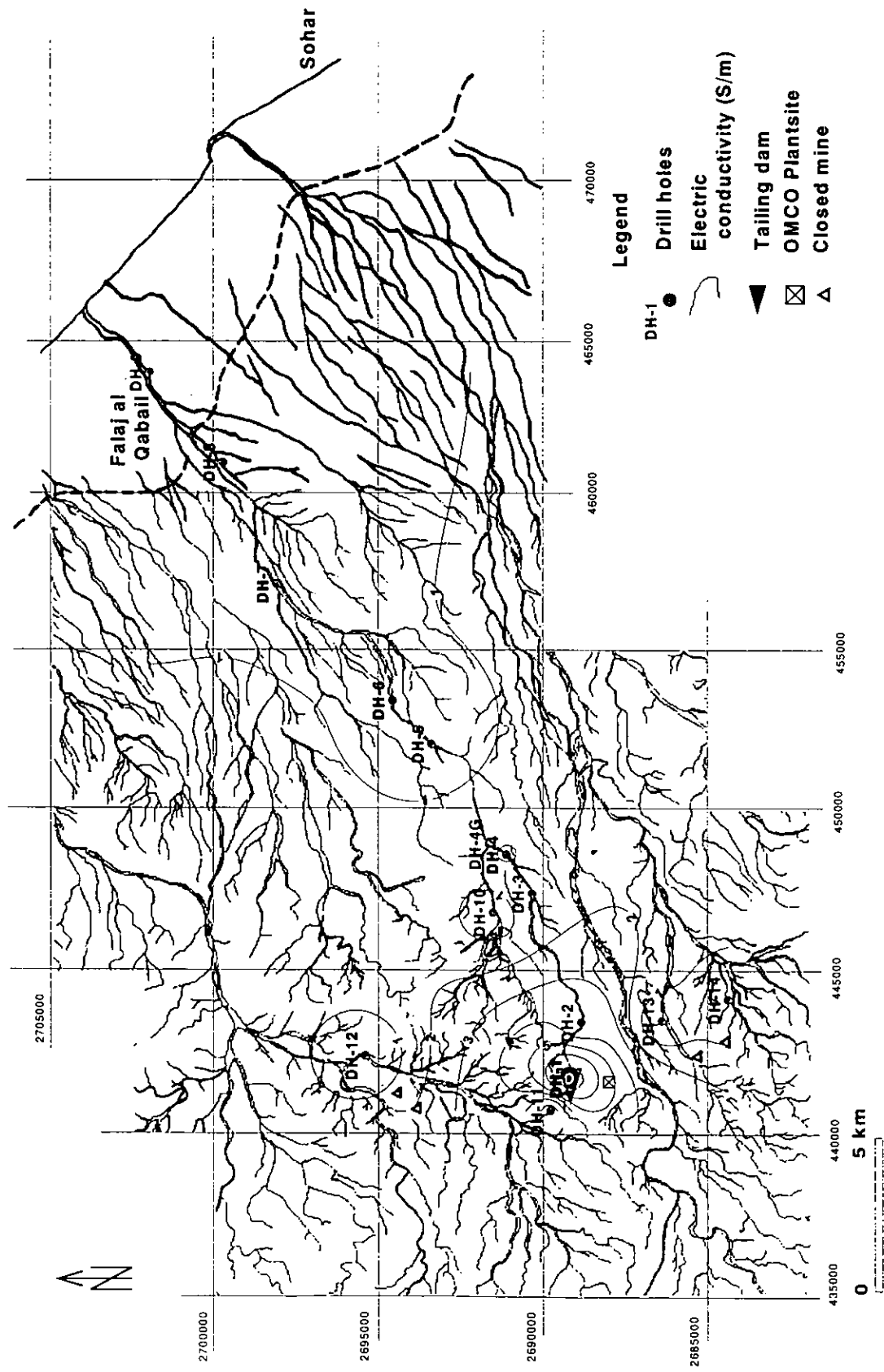


Figure 5.7 Concentration Contour Map of Water Quality in Drill Holes (1)

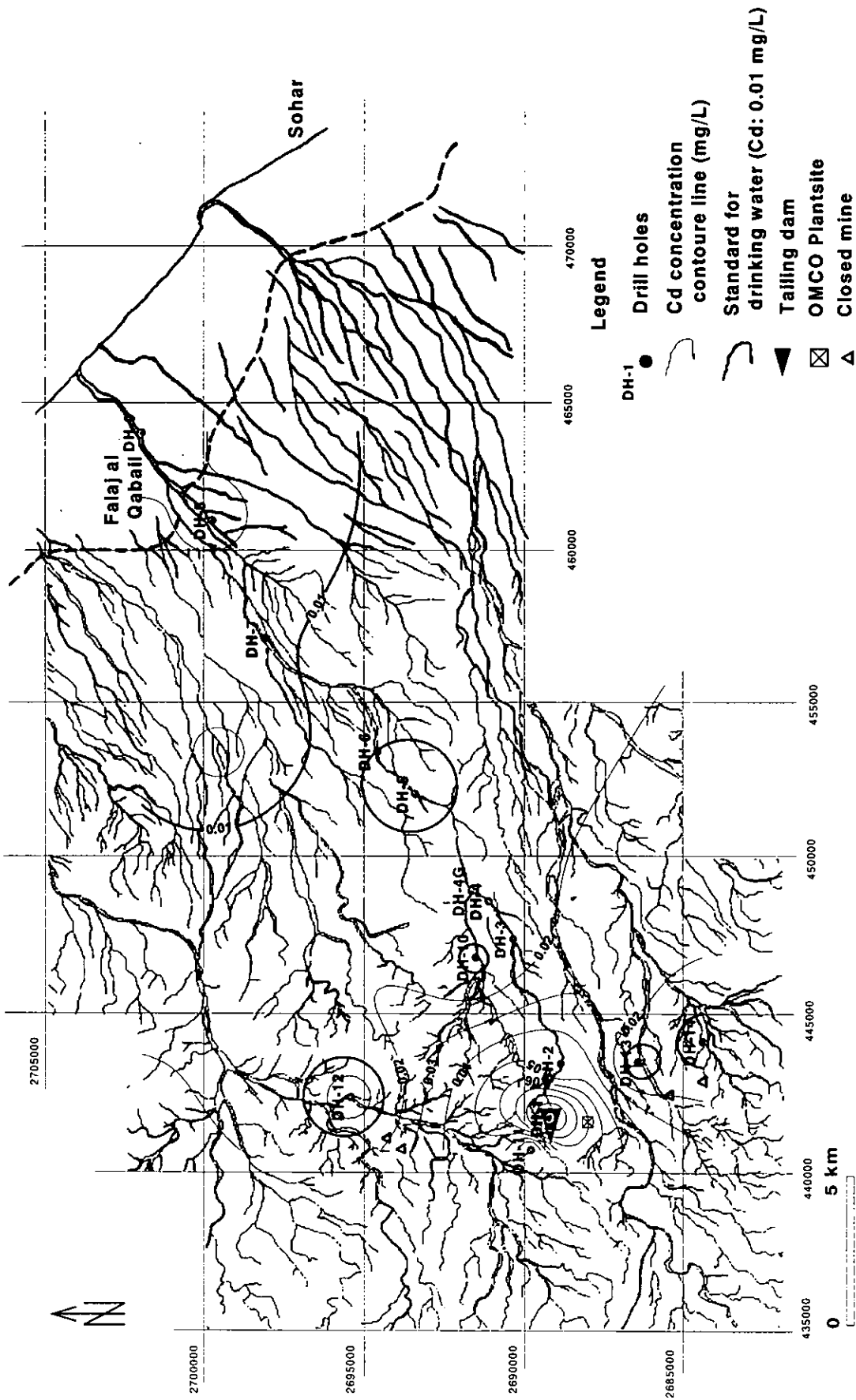


Figure 5.7 Concentration Contour Map of Water Quality in Drill Holes (2)

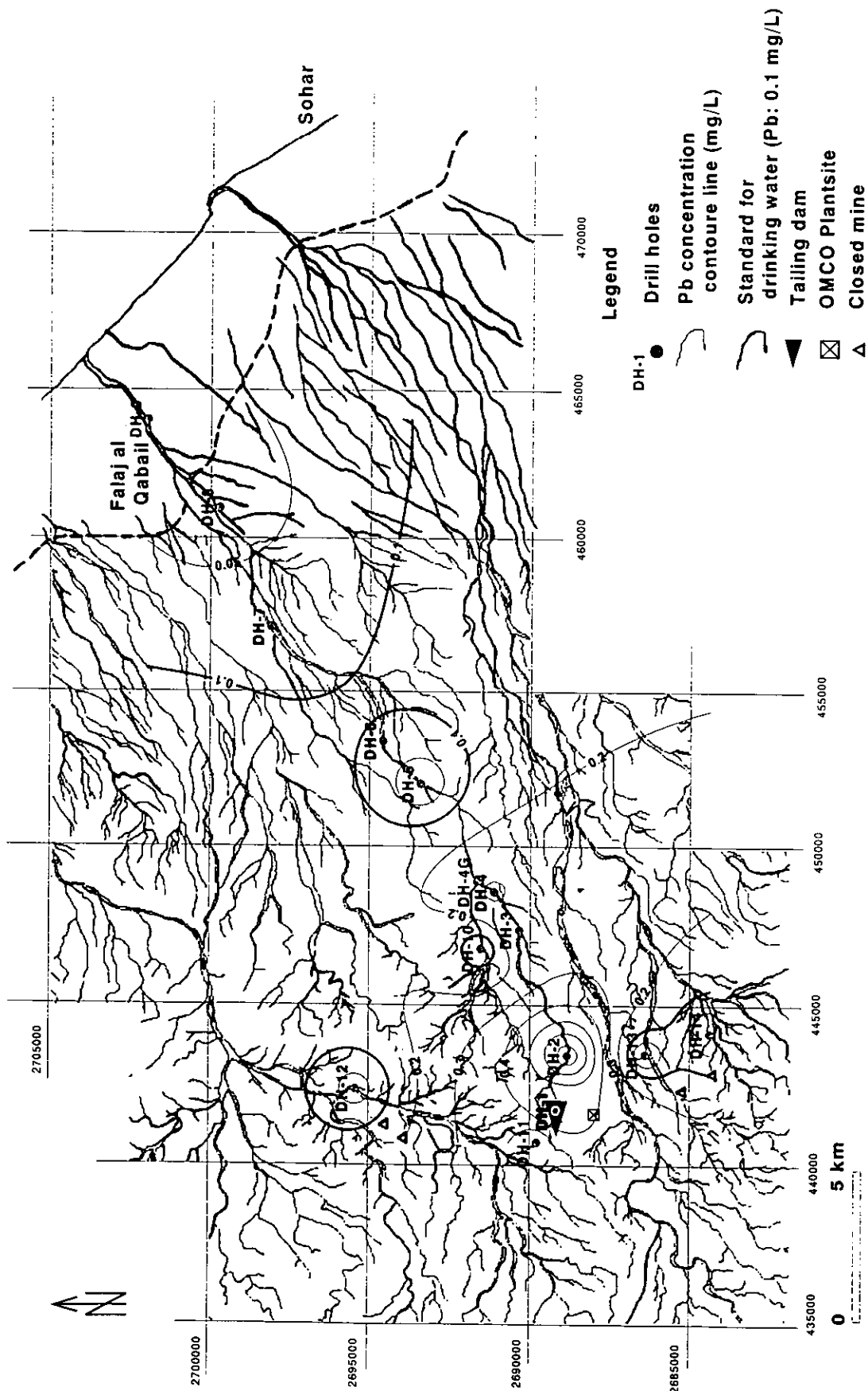


Figure 5.7 Concentration Contour Map of Water Quality in Drill Holes (3)

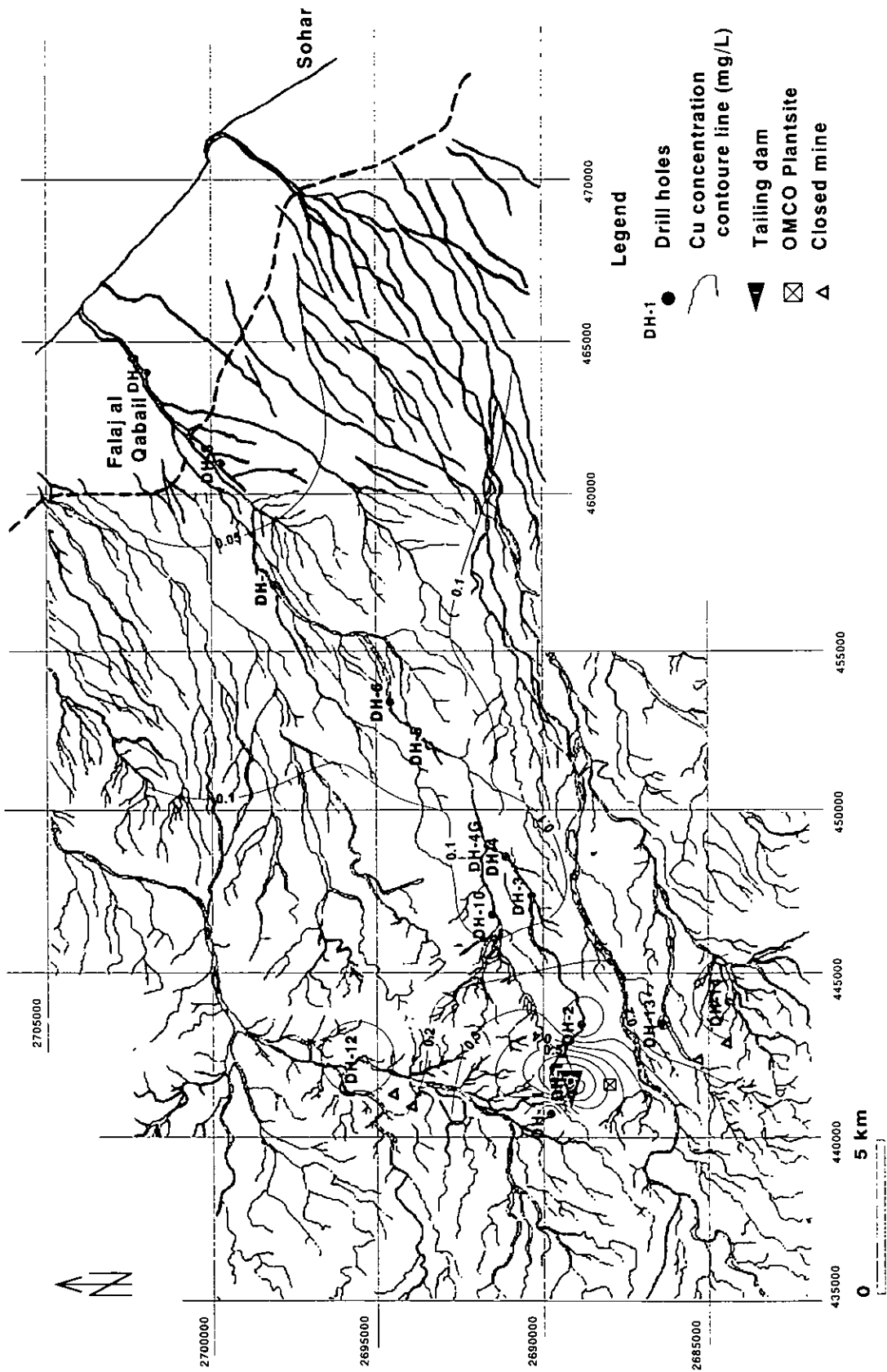


Figure 5.7 Concentration Contour Map of Water Quality in Drill Holes (4)



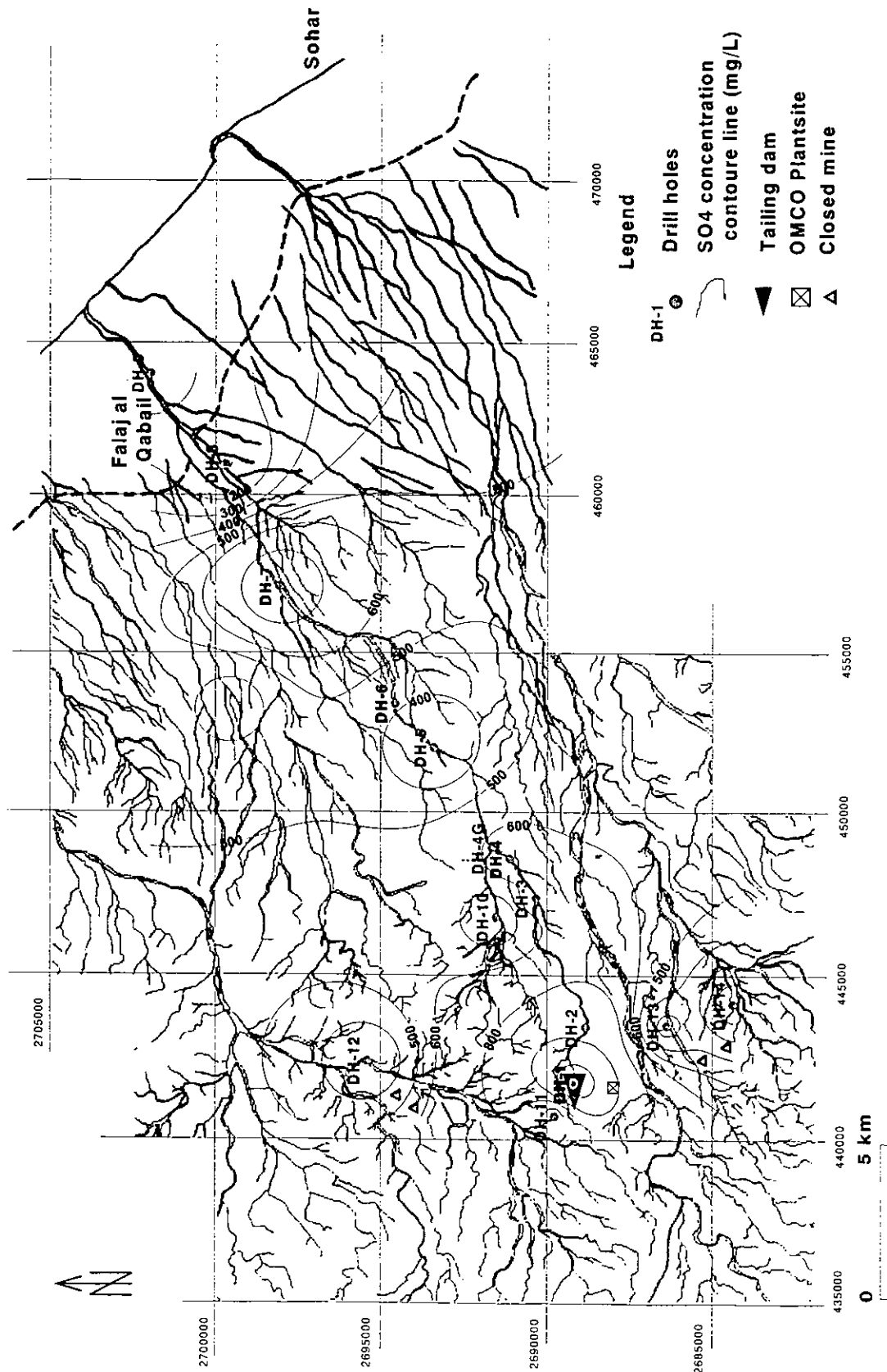


Figure 5.7 Concentration Contour Map of Water Quality in Drill Holes (5)

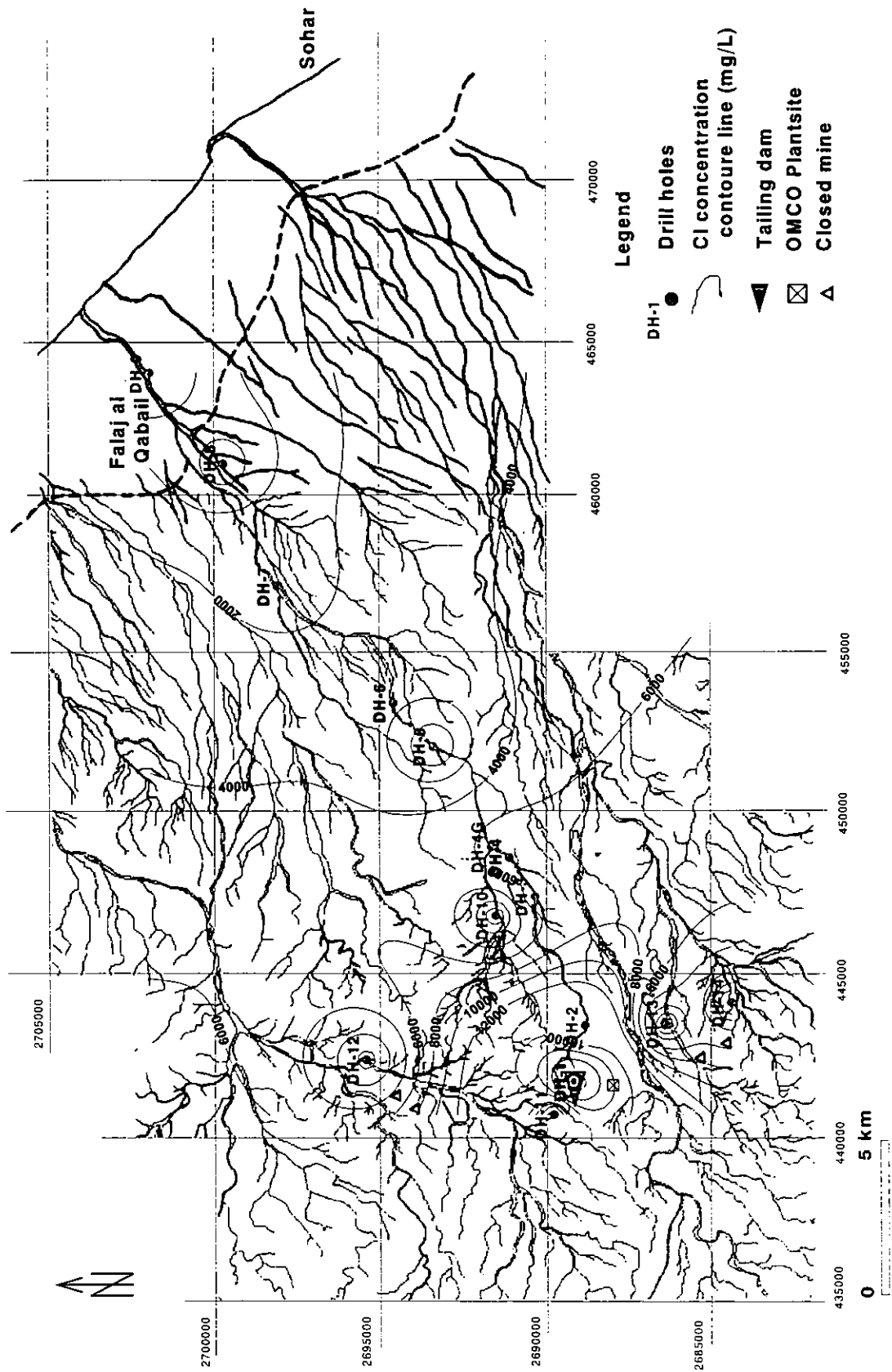


Figure 5.7 Concentration Contour Map of Water Quality in Drill Holes (6)

- Nickel (Ni) concentrations range from 0.005 to 0.058 mg/L.
- Zinc (Zn) concentrations range from 0.03 to 1.42 mg/L with the high concentrations being obtained from seepage out of the tailings dam. All other samples indicated lower value not exceeding 0.1mg/L.
- Sulfate (SO<sub>4</sub>) concentrations range from 42 to 1,483 mg/L with the higher concentrations being obtained from seepage out of the tailings dam, including its downstream area DH-7 and DH-12. All other samples indicated lower values not exceeding 500 mg/L.
- Chloride (Cl) concentrations range from 45 to 34,578 mg/L with the higher concentration being obtained from seepage out of the tailings dam, including its downstream area DH-5 and DH-12 and the northwestern part of the tailings dam. The northwestern part of the tailing dam corresponds to the upstream reach of Wadi Bani Umar al Gharbi. High chloride concentrations in this area are caused by leakage out of the tailings dam.

#### 5.4.2 Relationship of Water Qualities between Shallow and Deep Groundwater

Water samples of shallow and deep groundwater were taken from each drill hole except DH-1. From wells deeper than 50m, water samples from the shallow and deep layers were obtained (Table 5.6).

Heavy metal concentrations in shallow and deep groundwater were roughly the same in the cases of Hg, Cd, Cr, As, Ni, Mn, Zn, and SO<sub>4</sub>. Deep groundwater generally indicated higher concentrations of Pb, Cu, Fe and Cl. The tendency for these metals to be higher in the deep groundwater was especially pronounced in the case of DH-5 and DH-12.

Table 5.6 Sampling Points of Groundwater

Drill hole No.		Sampling depth (m)	Drill hole No.		Sampling depth (m)
DH-1A		-34.00	DH-8D	DH-8D1	-18.00
DH-1B		-19.00		DH-8D2	-35.00
DH-2	DH-2S	-8.50		DH-8D3	-65.00
	DH-2D	-47.50	DH-9	DH-9S	-10.00
DH-3	DH-3S	-5.00		DH-9D	-45.00
	DH-3D	-26.50	DH-10	DH-10S	-9.00
DH-4S		-8.00		DH-10D	-36.00
DH-4D	DH4D1	-8.00	DH-11	DH-11S	-11.00
	DH4D2	-45.00		DH-11D	-25.00
DH-5	DH-5S	-9.00	DH-12S		-6.80
	DH-5D	-36.00	DH-12D	DH-12D1	-7.00
DH-6S		-13.00		DH-12D2	-46.00
DH-6D	DH-6D1	-13.00	DH-13	DH-13S	-10.50
	DH-6D2	-55.00		DH-13D	-45.00
DH-7S		-11.50	DH-14	DH14S	-10.50
DH-7D	DH-7D1	-11.50		DH-14D	-35.00
	DH-7D2	-55.00			
DH-8S		-18.00			