Appendix–B

Density of saline waters

The density of saline waters in the Sambhar lake study was calculated based on the TDS–density relationship, assuming that chemical composition of solution remains same over the wide range of salinity. Such relation was obtained for about 12 samples with TDS (determined by summing all major ions) rannging from 9 to 370 g/l and density was determined by weighing the known volume of sample. The TDS–density relationship obtained is given by:

$$\boxed{\text{Density (g/cm}^3) = 0.0007 \cdot \text{TDS (g/l)} + 0.9874}$$

Table 1B: Details of samples collected from the Sambhar lake area

Sample code/Collection period	Location	Sample description
Rain Waters		
Smb1,Smb2 (July 93)	Sambhar town	Two samples over a week interval were collected using clean polyethylene funnel in bottles during July 93
River Waters		
SL #82 (Oct 93)	Sinodiya	~4 km upstream of the lake, open well in river bed of Roopangarh, depth ~3 m
SL #83 (Oct 93)	Bhadun	~ 10 km upstream of the lake, open well in river bed of Roopangarh, depth ~4 m
SL #84 (Oct 93)	Roopangarh	~ 22 km upstream of the lake, open well in river bed of Roopangarh, depth ~19 m
SL #86 (Oct 93)	Dabsi	~6 km upstream of the lake, open well in river bed of Mendha, depth ~2 m
SL #85 (Oct 93)	Naulasia	~16 km upstream of the lake, open well in river bed of Mendha, depth ~3 m
Ground Waters		
SL #10 (Feb 92), #41 (July 92), #54 (Oct 92), #90 (Oct 93)	Gudha Railway Station -do-	closed Tube well, potable water
SL #21 (Feb 92), #39 (July 92), #50 (Oct 92), #62 (Feb 93), #91 (Oct 93)	Sambhar town -do-	open well, potable water, depth ~ 10m

Table 1B: Details of samples collected from the Sambhar lake area (CONTINUED)

Sample code/Collection period	Location	Sample description
Ground Waters		
SL #22 (Feb 92), #40 (July 92), #51 (Oct 92), #61 (Feb 93), #92 (Oct 93)	Sambhar town (Pipe Factory) -do-	Tube well, potable water, depth ~ 11m
SL #17 (Feb 92), #38 (July 92), #48 (Oct 92), #68 (Feb 93), #88 (Oct 93)	Sambhar town (Madarsa School) -do-	open well, brackish water,depth~ 4m
SL #23 (Feb 92), #87 (Oct 93)	Sambhar town (Guest House)	Tube well, potable water
SL #24 (Feb 92)	Sambhar town (Guest House)	Tube well
SL #18 (Feb 92)	Jhapok village	open well, potable water, depth ~10 m
SL #20 (Feb 92)	Korshina village	open well, potable water, depth ~10 m
SL #65 (Feb 93)	Jhag village	Open well, brackish water, depth ~6 m
SL #66 (Feb 93)	Jajota village	Open well, potable water, depth ~8 m

Table 1B: Details of samples collected from the Sambhar lake area (CONTINUED)

Sample code/Collection period	Location	Sample description
Lake Waters		
SL #8 (Feb 92), #28 (July 92), #46 (Oct 92)	Jhapok	Surface water
SL #47 (Oct 92)	Gudha	-do-
SL #52 (Oct 92)	Mata pahar	-do-
SL #55 (Feb 93), #69 (Apr 93), #72 (Apr 93)	Jhapok	-do-
SL #73 (Apr 93), #74 (May 93), #75 (May 93)	Jhapok	-do-
SL #76 (May 93), #77 (May 93), #78 (May 93)	Jhapok	-do-
SL #79 (May 93), #89 (Oct 93)	Jhapok	-do-
Evaporating Pans		
SL #1 (Feb 92), #2 (Feb 92), #3 (Feb 92)	Jhapok	-
SL #4 (Feb 92), #5 (Feb 92), #6 (Feb 92)	-do-	-
SL #7 (Feb 92), #27 (Feb 92)	-do-	-
SL #29 (Mar 92), #30 (Mar 92), #31 (Apr 92)	-do-	Collected from same pan at different times

Table 1B: Details of samples collected from the Sambhar lake area (CONTINUED)

Sample code/Collection period	Location	Sample description
Evaporating Pans		
#32 (Apr 92), #33 (May 92), #34 (May 92)	Jhapok	same pan at different times
#35 (May 92), #36 (May 92), #37 (May 92)	-do-	-do-
Sub-surface brines		
SL #9 (Feb 92), #11 (Feb 92),	Gudha kyar	open wells, depth ~ 3 m
#12† (Feb 92), #13 (Feb 92)	-do-	
SL #14 (Feb 92), #44 (Oct 92)	Deodani	open wells, depth ~ 3 m
SL #15 (Feb 92), #42 (Oct 92), #58 (Feb 93)	-do-	-do-
SL #16 (Feb 92), #43 (Oct 92), #59 (Feb 93)	-do-	-do-
SL #45 (Oct 92), #60 (Feb 93)	-do-	-do-
SL #49 (Oct 92), #57 (Feb 93)	Main Line Pan work	open wells, depth ~ 5 m
SL #56 (Feb 93), #70 (Apr 93) #80 (June 93)	-do-	Bore well, depth ~ 30 m
SL #63 (Feb 93)	Khakarki	Tube well, depth ~ 50 m
SL #64 (Feb 93)	-do-	Tube well, depth ~ 40 m
SL #71 (Apr 93)	Nawa	Tube well, depth ~ 30 m

† A seeping brine collected from the well SL #9

Table 2B: Major ions, oxygen and uranium isotopes in Sambhar lake water systems

Code	pH	Na meq.ℓ^{-1}	K meq.ℓ^{-1}	Ca meq.ℓ^{-1}	Mg meq.ℓ^{-1}	Cl meq.ℓ^{-1}	SO_4 meq.ℓ^{-1}	Alk meq.ℓ^{-1}	$\delta^{18}O$ ‰	^{238}U $\mu g.kg^{-1}$	$^{234}U/^{238}U$ AR	TDS g.ℓ^{-1}
Rain waters												
Smb1	*	14†	*	*	*	15†	*	*	− 3.2	*	*	0.8†
Smb2	*	37†	*	*	*	34†	*	*	− 6.4	*	*	2.0†
River waters												
SL #82	8.10	19.0	0.09	0.5	0.6	9.9	2.4	9.2	− 4.4	25.6	1.99	1.2
SL #83	8.00	14.8	0.47	0.4	0.4	3.6	0.8	12.4	− 5.0	13.0	2.26	0.9
SL #84	8.00	10.0	0.40	0.3	0.4	2.8	0.6	8.1	− 5.4	11.9	1.88	0.6
SL #85	7.80	24.4	0.29	3.04	4.9	18.0	4.6	10.3	− 4.2	40.8	1.39	1.9
SL #86	8.60	23.7	0.44	0.9	1.2	9.5	3.7	12.4	− 3.6	103.4	1.33	1.5
Groundwaters												
SL #10	7.94	21.5	0.09	3.30	5.34	24.5	1.5	4.4	− 6.5	8.2	1.28	1.8
SL #41	*	3.2	0.09	2.9	2.3	4.1	0.5	4.2	*	*	*	0.6
SL #54	7.40	5.3	0.14	2.3	3.5	7.0	0.6	2.6	− 5.6	*	*	0.6
SL #90	8.00	13.2	0.16	3.8	4.3	14.9	1.1	5.4	− 5.4	7.0	1.26	1.2
SL #17	7.51	144	0.48	6.8	15.9	142	11.7	7.6	− 4.3	71.6	1.46	9.6
SL #38	*	79.2	0.28	4.3	8.1	78.0	7.0	6.0	*	*	*	5.5
SL #48	7.86	75.0	0.30	4.1	8.2	75	5.6	7.0	− 3.8	*	*	5.0
SL #68	*	129.6	0.50	4.6	15.8	152	13.2	8.5	− 3.9	*	*	9.5
SL #88	7.80	92.6	0.34	5.00	9.8	92	7.0	6.5	− 3.0	44.4	1.39	6.1

† Na and Cl concentration in $\mu eq.\ell^{-1}$ and TDS (NaCl) in $mg.\ell^{-1}$. ‡ density calculated based on TDS−Density relationship (see p. 129).
* measurements not made.

Table 2B: Major ions, oxygen and uranium isotopes in Sambhar lake water systems

Code	pH	Na $meq.\ell^{-1}$	K $meq.\ell^{-1}$	Ca $meq.\ell^{-1}$	Mg $meq.\ell^{-1}$	Cl $meq.\ell^{-1}$	SO_4 $meq.\ell^{-1}$	Alk $meq.\ell^{-1}$	$\delta^{18}O$ $^o/_{oo}$	^{238}U $\mu g.kg^{-1}$	$^{234}U/^{238}U$ AR	TDS $g.\ell^{-1}$
Groundwaters												
SL #18	7.91	25.2	0.07	1.5	2.6	19.6	1.6	6.8	– 5.0	36.2	1.39	1.8
SL #20	7.85	8.4	0.96	0.72	1.3	2.6	1.4	7.5	– 4.0	6.9	1.98	0.9
SL #21	7.29	21.5	0.44	4.4	3.2	19.6	2.1	5.8	– 5.6	6.3	1.21	1.8
SL #39	*	20.8	0.44	5.12	3.6	19.4	2.2	5.8	– 5.6	*	*	1.8
SL #50	6.65	23.2	0.65	6.2	4.7	23.8	2.6	6.1	– 5.1	*	*	1.9
SL #62	*	19.7	0.44	5.14	3.8	19.2	2.3	5.9	– 4.9	*	*	1.6
SL #91	7.50	19.6	0.52	4.9	3.4	17	2.3	5.9	– 4.9	5.9	1.19	1.5
SL #24	7.15	59.6	0.18	10.5	9.7	64	6.1	5.3	– 5.9	9.4	1.29	4.6
SL #22	7.21	17.6	0.12	5.70	5.3	24.5	1.4	3.9	– 5.7	10.8	1.36	1.8
SL #40	*	16.8	0.10	4.34	4.9	22	1.5	4.7	– 5.4	*	*	1.7
SL #51	5.86	17.5	0.16	7.5	5.7	24.2	1.5	4.2	– 5.8	*	*	1.7
SL #61	*	16.7	0.13	4.4	4.9	21.3	1.7	4.3	– 4.4	*	*	1.5
SL #92	7.40	17.5	0.12	7.6	5.8	22.2	1.8	4.9	– 4.1	7.2	1.24	1.6
SL #23	7.19	6.2	0.04	1.1	1.3	4.9	0.6	4.2	– 5.9	3.6	1.22	0.6
SL #87	8.40	10.3	0.05	3.1	2.5	10.4	0.9	4.9	– 4.5	5.9	1.22	0.9
SL #65	*	141.0	25.0	20.2	35	178	13.3	11.3	– 3.0	57.2	1.78	12.3
SL #66	*	44.0	0.17	3.58	8.4	44	2.6	10.3	– 3.6	21.3	1.67	3.2

† Na and Cl concentration in $\mu eq.\ell^{-1}$ and TDS (NaCl) in $mg.\ell^{-1}$. ‡ density calculated based on TDS–Density relationship (see p.129).
* measurements not made.

Table 2B: Major ions, oxygen and uranium isotopes in Sabhar lake water systems (CONTINUED)

Code	pH	Na meq.ℓ^{-1}	K meq.ℓ^{-1}	Ca meq.ℓ^{-1}	Mg meq.ℓ^{-1}	Cl meq.ℓ^{-1}	SO_4 meq.ℓ^{-1}	Alk meq.ℓ^{-1}	$\delta^{18}O$ ‰	^{238}U $\mu g.kg^{-1}$	$^{234}U/^{238}U$ AR	TDS g.ℓ^{-1}	Density‡ g.cm^{-3}
Lake waters													
SL #8	9.61	3160	2.86	0.13	0.16	2942	308	139	18	662	1.68	196	1.125
SL #28	*	158	0.36	0.98	0.48	142	11	5	- 5.5	15.9	1.51	10.4	0.995
SL #46	8.50	138	0.31	1.27	0.35	130	6	7	- 1.4	9.0	1.66	8.6	0.993
SL #47	8.50	139	0.31	1.26	0.35	122.6	9	7	- 1.0	8.1	1.67	8.8	0.994
SL #52	8.18	151	0.31	1.47	0.40	146	10	7	- 0.5	9.4	1.71	9.3	0.994
SL #55	*	273	0.49	1.54	0.72	273	23	12	4.5	14.8	1.63	17.5	0.999
SL #69	*	603	1.16	0.59	1.32	551	50	28	9.6	25.6	1.61	36.7	1.013
SL #72	*	615	1.75	0.66	1.36	570	52	28	13.0	25.6	1.63	37.7	1.014
SL #73	*	1420	2.19	0.48	1.20	1445	117	58	19.1	67.4	1.68	91.3	1.051
SL #74	*	2120	3.20	0.37	0.79	2135	171	78	19.7	101	1.62	135	1.082
SL #75	*	2410	3.76	0.32	0.94	2530	204	94	21.4	131	1.66	158	1.098
SL #76	*	3540	5.15	0.19	0.59	3268	292	127	24.0	220	1.65	215	1.138
SL #77	*	4550	5.72	0.09	0.69	4042	365	166	18.3	*	*	270	1.176
SL #78	*	5380	14.54	0.06	0.51	4958	438	194	21.5	281	1.65	327	1.216
SL #79	*	6346	23.16	0.06	0.43	4789	896	537	23.0	1117	1.66	376	1.251
SL #89	10.3	658	0.98	0.38	0.05	581	46	22	5.6	51	1.66	39	1.015
Sub-surface brines													
SL #9	8.78	2360	6.79	0.52	0.96	2037	278	100	3.5	398	1.53	143	1.087
SL #11	9.11	3670	12.30	0.03	0.07	2942	562	250	5.1	645	1.59	223	1.143
SL #12	8.78	1800	4.27	0.09	0.36	1546	204	85	3.9	515	1.64	109	1.064
SL #13	9.12	3830	11.47	0.03	0.06	3187	524	272	4.4	339	1.60	235	1.152

* measurements not made. ‡ density calculated based on TDS–Density relationship (see p. 129).

Table 2B: Major ions, oxygen and uranium isotopes in Sabhar lake water systems (CONTINUED)

Code	pH	Na meq.ℓ^{-1}	K meq.ℓ^{-1}	Ca meq.ℓ^{-1}	Mg meq.ℓ^{-1}	Cl meq.ℓ^{-1}	SO_4 meq.ℓ^{-1}	Alk meq.ℓ^{-1}	$\delta^{18}O$ $^o/_{oo}$	^{238}U $\mu g.kg^{-1}$	$^{234}U/^{238}U$ AR	TDS g.ℓ^{-1}	Density‡ g.cm^{-3}
Sub-surface brines													
SL #14	9.42	2690	10.82	0.04	0.09	2206	462	184	3.2	198	1.61	168	1.105
SL #44	10.15	604	2.0	0.15	0.06	455	160	24	– 1.1	*	*	39	1.015
SL #15	9.14	3860	15.64	0.04	0.07	3187	663	261	5.1	248	1.62	242	1.157
SL #42	9.48	3140	13.62	0.03	0.11	2594	528	179	2.5	174	1.66	195	1.124
SL #58	*	3080	13.91	0.02	0.09	2570	578	211	3.8	253	1.61	196	1.125
SL #16	9.08	4020	13.79	0.06	0.09	2942	643	244	5.1	195	1.60	235	1.152
SL #43	9.73	2360	5.46	0.04	0.07	1964	409	101	– 0.3	85	1.65	147	1.09
SL #59	*	3120	9.76	0.02	0.08	2861	558	172	3.8	156	1.57	205	1.131
SL #45	9.52	2650	10.1	0.04	0.08	2206	433	152	1.3	114	1.67	165	1.103
SL #60	*	2820	10.88	0.09	0.08	2425	483	160	3.1	213	1.62	179	1.113
SL #49	8.25	3860	17.56	0.05	0.31	3395	574	82	4.0	22	1.63	240	1.155
SL #57	*	4220	19.35	0.08	0.84	3831	604	78	6.0	10	1.66	265	1.173
SL #56	*	4140	22.13	0.02	0.20	3540	601	255	6.7	104	1.50	258	1.168
SL #70	*	4220	23.90	0.02	0.21	3637	613	260	6.3	118	1.61	264	1.172
SL #80	*	4350	26.24	0.02	0.29	3803	521	272	7.4	*	*	269	1.176
SL #63	*	1140	2.99	20.96	71.92	1103	210	10	– 1.1	192	1.65	77	1.041
SL #64	*	2820	3.41	42.16	151	2958	309	7	1.5	149	2.56	187	1.118
SL #71	*	3580	7.19	0.12	0.05	3152	375	305	6.5	438	1.77	221	1.142

* measurements not made. ‡ density calculated based on TDS–Density relationship (see p. 129).

Table 2B: Major ions, oxygen and uranium isotopes in Sabhar lake water systems (CONTINUED)

Code	pH	Na meq.ℓ^{-1}	K meq.ℓ^{-1}	Ca meq.ℓ^{-1}	Mg meq.ℓ^{-1}	Cl meq.ℓ^{-1}	SO_4 meq.ℓ^{-1}	Alk meq.ℓ^{-1}	$\delta^{18}O$ $^o/_{oo}$	^{238}U $\mu g.kg^{-1}$	$^{234}U/^{238}U$ AR	TDS g.ℓ^{-1}	Density‡ g.cm^{-3}
Evaporating Pans													
SL #1	9.82	1220	2.30	0.26	0.18	981	114	65	10.6	200	1.59	70	1.036
SL #2	9.52	1650	5.73	0.02	0.03	1226	318	618	12.5	536	1.62	115.3	1.068
SL #25	*	4400	26.18	0.09	0.11	*	*	*	*	1415	1.59	325[a]	1.215
SL #3	9.48	6010	19.34	0.04	0.09	4903	819	456	14.0	1198	1.65	365	1.243
SL #26	*	4400	23.04	0.10	0.12	*	*	*	*	1186	1.63	325[a]	1.215
SL #4	9.62	1970	5.92	0.12	0.07	1552	267	178	12.0	569	1.65	119	1.071
SL #5	9.45	2460	5.27	0.34	0.29	2109	257	144	14.1	395	1.64	148	1.091
SL #6[aa]	9.54	6557	31.94	0.10	0.11	4243	1469	819	12.0	2342	1.63	398	1.266
SL #7	9.47	4580	12.58	0.12	0.09	3879	588	334	13.5	925	1.62	281	1.184
SL #27	*	5218	13.76	0.06	0.08	4290	632	328	13.8	1022	1.61	313	1.206
SL #29	*	1460	3.05	0.15	0.21	1237	136	82	11.9	228	1.58	86	1.048
SL #30	*	1580	3.42	0.18	0.23	1382	158	98	12.8	228	1.73	96	1.055
SL #31	*	1740	3.88	0.16	0.25	1503	171	109	13.9	*	*	105	1.061
SL #32	*	2160	4.90	0.15	0.24	1843	207	125	16.7	*	*	129	1.077
SL #33	*	2680	6.19	0.14	0.28	2279	256	166	*	448	1.64	160	1.099
SL #34	*	3850	9.16	0.13	0.29	3273	389	250	21.0	644	1.59	231	1.149
SL #35	*	4730	11.19	0.15	0.38	3952	476	304	23.5	763	1.59	281	1.184
SL #36	*	5260	12.30	0.09	0.43	4413	526	318	24.6	*	*	312	1.206
SL #37	*	6480	23.05	0.09	0.54	4800	1090	658	27.5	1804	1.61	392	1.262

[a] TDS estimated based on Σcation measurements. ‡ density calculated based on TDS–Density relationship (see p. 129).
* measurements not made. [aa] a bittern sample collected from one of the evaporating pans.

Table 3B: Ra, ^{210}Po and ^{210}Pb radionuclides in Sambhar lake water systems

Code	^{226}Ra (dpm.kg^{-1})	$^{228}Ra/^{226}Ra$ (Activity Ratio)	^{210}Po (dpm.kg^{-1})	^{210}Pb (dpm.kg^{-1})	$^{210}Po/^{210}Pb$ (Activity Ratio)
Groundwaters					
SL #10	.21 ±.01	2.14 ± 0.19	.009±.001	.031±.003	.290±.043
SL #90	.36 ±.01	1.59 ± 0.09	.011±.001	.032±.002	.339±.035
SL #17	1.32 ±.08	1.59 ± .05	.027±.002	.037±.002	.729±.067
SL #88	1.05 ±.03	1.18 ± .04	.013±.001	.065±.003	.205±.013
SL #18	.31±.03	1.04 ±.10	.011±.002	.075±.003	.147±.027
SL #20	1.41 ±.04	10.37 ±.24	.033±.003	.216±.006	.153±.015
SL #21	.71 ±.04	.65 ± .05	.019±.002	.089±.005	.213±.025
SL #91	.58 ±.01	.57 ± .04	.011±.001	.097±.004	.108±.008
SL #22	.60 ±.02	.63 ± .05	.019±.002	.049±.003	.388±.047
SL #92	.56 ±.01	.63 ± .04	.003±.001	.126±.004	.231±.004
SL #23	.31 ±.02	–	.004±.001	.028±.002	.143±.037
SL #87	.52 ±.02	.57 ±.04	.003±.0004	.036±.002	.085±.001
SL #24	.48 ±.01	2.59 ±0.10	.011±.002	.022±.002	.500±.102
River waters					
SL #82	.13 ±.01	1.08 ± .23	–	–	–
SL #83	.49 ±.01	5.76 ± .19	–	–	–
SL #84	.19 ±.01	6.16 ± .38	–	–	–
SL #85	.37 ±.01	1.51 ± .09	–	–	–
SL #86	.18 ±.01	1.59 ± .14	–	–	–

- indicates measurement not made

Table 3B: Ra,^{210}Po and ^{210}Pb radionuclides in lake waters (CONTINUED)

Code	^{226}Ra (dpm.kg^{-1})	^{228}Ra/^{226}Ra (Activity Ratio)	^{210}Po (dpm.kg^{-1})	^{210}Pb (dpm.kg^{-1})	^{210}Po/^{210}Pb (Activity Ratio)
Lake and evaporating pans					
SL #1	.40 ±.02	2.06 ± .13	–	–	–
SL #2	.62 ±.03	3.27 ± .20	–	–	–
SL #3	.45 ±.01	2.99 ± .20	–	–	–
SL #4	.66 ±.01	2.04 ± .10	–	–	–
SL #5	.59 ±.03	2.34 ± .11	–	–	–
SL #7	.39 ±.04	3.14 ± .21	–	–	–
SL #8	.32 ±.03	1.87 ± .12	–	–	–
SL #89	.23±.01	1.61 ± .12	1.21 ± .21	.61±.02	1.99±.07
SL #25	–	–	8.16 ± .22	2.68±.06	3.04±.11
SL #26	–	–	7.58 ± .24	2.86±.07	2.64±.10
SL #27	–	–	8.94 ± .29	7.34±.15	1.22±.05
Sub-surface brines					
SL #9	1.25 ±0.05	3.41 ± .10	.26±.01	.12±.01	2.19 ± .26
SL #11	1.78 ±.12	3.04 ± .10	.48±.02	.55±.02	.87±.05
SL #13	1.67 ±.07	–	.16 ±.01	.16 ± .01	.97 ± .07
SL #14	1.28 ±.09	1.75 ± .10	.29±.02	.56±.01	.51±.04
SL #15	1.36 ±.08	2.00 ±.10	.06±.01	.10±.01	.61±.02
SL #16	.80 ±0.06	2.71 ± .13	.05±.01	.06±.01	.85±.09

- indicates measurement not made