Overview

The References section is provided as a direct result of requests from our customers to once again include this information in our tooling publication. We've gathered an extensive collection of unit conversions, volumes, specifications, and other general information related to subsurface investigations to help you on the job. To the best of our knowledge, the information in this section is accurate.

Table of Contents

Unit Conversions

Unit Conversion Table

	To Convert	Multiply by	To obtain
Length	mm	0.1	cm
	cm	0.01	m
	in	2.54	cm
	ft	0.3048	m
	mi	1.6093	km
Area	in^2	6.452	cm^2
	in^2	6.452E-04	m^2
	ft^2	0.0929	m^2
	yd^2	0.8361	m^2
	acre	0.4047	hectare
	acre	4047	m^2
	acre	43560	ft^2
	sq. mile	640	acre
	sq. mile	2.59	km^2
Volume	in^3	16.39	cm^3
	in^3	5.79E-04	ft^3
	ft^3	0.02832	m^3
	ft^3	28.32	liter
	ft^3	7.4805	U.S. gal
	U.S. gal	231	in^3
	U.S. gal	3.785E-03	m^3
	U.S. gal	3.785	liter
Discharge	ft^3/s	0.02832	m^3/s
	ft^3/s	28.32	liter/s
	ft^3/s	448.8	U.S. gal/min
	U.S. gal/min	6.309E-05	m^3/s
	U.S. gal/min	6.309E-02	liter/s
Velocity	ft/s	30.48	cm/s
	ft/s	0.3048	m/s
	mi/h	0.447	m/s
	mi/h	1.609	km/h
Force	lb_f	4.448	N
Mass	lb_m	0.4536	kg
Weight Density	lb_f/ft^3	157.1	N/m^3
Mass Density	lb_m/ft^3	16.02	kg/m^3
Hydraulic Conductivity	ft/s	0.3048	m/s
	U.S. gal/day/ft^2	4.72E-07	m/s
	ft/day	3.527E-06	m/s
	ft/day	0.3048	m/day
Permeability	ft^2	0.0929	m^2
	darcy	9.87E-13	m^2
Transmissivity	ft^2/s	0.0929	m^2/s
	U.S. gal/day/ft	1.438E-07	m^2/s
Pressure	kPa	1000	N/m^2 or Pa
	MPa	1.00E+06	N/m^2 or Pa
	MPa	10.443	tons / ft^2
	MPa	20.886	kips / ft^2
	psi	6895	N/m^2 or Pa
	lb/ft^2	47.88	N/m^2 or Pa
	tons/ft^2	95760	N/m^2 or Pa
	atm	101300	N/m^2 or Pa
	atm	1.013	bar
	atm	14.7	psi
	To Obtain	**Divide by**	**To Convert**

Temperature Conversion Table

T= Temperature C= Celcius F=Farenheit K= Kelvin

T/C= T/K-273.15 T/C=5/9(T/F-32) T/F=9/5(T/C)+32

T/K	T/C	T/F
3.15	-270	-454
13.15	-260	-436
23.15	-250	-418
33.15	-240	-400
43.15	-230	-382
53.15	-220	-364
63.15	-210	-346
73.15	-200	-328
83.15	-190	-310
93.15	-180	-292
103.15	-170	-274
113.15	-160	-256
123.15	-150	-238
133.15	-140	-220
143.15	-130	-202
153.15	-120	-184
163.15	-110	-166
173.15	-100	-148
183.15	-90	-130
193.15	-80	-112
203.15	-70	-94
213.15	-60	-76
223.15	-50	-58
233.15	-40	-40
234.15	-39	-38.2
235.15	-38	-36.4
236.15	-37	-34.6
237.15	-36	-32.8
238.15	-35	-31
239.15	-34	-29.2
240.15	-33	-27.4
241.15	-32	-25.6
242.15	-31	-23.8
243.15	-30	-22
244.15	-29	-20.2
245.15	-28	-18.4
246.15	-27	-16.6
247.15	-26	-14.8
248.15	-25	-13
249.15	-24	-11.2
250.15	-23	-9.4
251.15	-22	-7.6
252.15	-21	-5.8
253.15	-20	-4
254.15	-19	-2.2
255.15	-18	-0.4
256.15	-17	1.4
257.15	-16	3.2
258.15	-15	5
259.15	-14	6.8
260.15	-13	8.6
261.15	-12	10.4
262.15	-11	12.2
263.15	-10	14
264.15	-9	15.8
265.15	-8	17.6
266.15	-7	19.4
267.15	-6	21.2
268.15	-5	23
269.15	-4	24.8
270.15	-3	26.6
271.15	-2	28.4
272.15	-1	30.2
273.15	0	32
274.15	1	33.8
275.15	2	35.6
276.15	3	37.4
277.15	4	39.2
278.15	5	41
279.15	6	42.8
280.15	7	44.6
281.15	8	46.4
282.15	9	48.2
283.15	10	50
284.15	11	51.8
285.15	12	53.6
286.15	13	55.4
287.15	14	57.2
288.15	15	59
289.15	16	60.8
290.15	17	62.6
291.15	18	64.4
292.15	19	66.2
293.15	20	68
294.15	21	69.8
295.15	22	71.6
296.15	23	73.4
297.15	24	75.2
298.15	25	77
299.15	26	78.8
300.15	27	80.6
301.15	28	82.4
302.15	29	84.2
303.15	30	86
304.15	31	87.8
305.15	32	89.6
306.15	33	91.4
307.15	34	93.2
308.15	35	95
309.15	36	96.8
310.15	37	98.6
311.15	38	100.4
312.15	39	102.2
313.15	40	104
314.15	41	105.8
315.15	42	107.6
316.15	43	109.4
317.15	44	111.2
318.15	45	113
319.15	46	114.8
320.15	47	116.6
321.15	48	118.4
322.15	49	120.2
323.15	50	122
324.15	51	123.8
325.15	52	125.6
326.15	53	127.4
327.15	54	129.2
328.15	55	131
329.15	56	132.8
330.15	57	134.6
331.15	58	136.4
332.15	59	138.2
333.15	60	140
334.15	61	141.8
335.15	62	143.6
336.15	63	145.4
337.15	64	147.2
338.15	65	149
339.15	66	150.8
340.15	67	152.6
341.15	68	154.4
342.15	69	156.2
343.15	70	158
344.15	71	159.8
345.15	72	161.6
346.15	73	163.4
347.15	74	165.2
348.15	75	167
349.15	76	168.8
350.15	77	170.6
351.15	78	172.4
352.15	79	174.2
353.15	80	176
354.15	81	177.8
355.15	82	179.6
356.15	83	181.4
357.15	84	183.2
358.15	85	185
359.15	86	186.8
360.15	87	188.6
361.15	88	190.4
362.15	89	192.2
363.15	90	194
364.15	91	195.8
365.15	92	197.6
366.15	93	199.4
367.15	94	201.2
368.15	95	203
369.15	96	204.8
370.15	97	206.6
371.15	98	208.4
372.15	99	210.2
373.15	100	212
383.15	110	230
393.15	120	248
403.15	130	266
413.15	140	284
423.15	150	302
433.15	160	320
443.15	170	338
453.15	180	356
463.15	190	374
473.15	200	392
483.15	210	410
493.15	220	428
503.15	230	446
513.15	240	464
523.15	250	482
533.15	260	500
543.15	270	518
553.15	280	536
563.15	290	554
573.15	300	572
583.15	310	590
593.15	320	608
603.15	330	626
613.15	340	644
623.15	350	662
633.15	360	680

Riser, Tubing and Borehole Volumes

Internal Volume of Schedule 40 PVC Riser

1 cubic foot= 1728 cubic inches
7.48 gallons
1 foot = 30.48 centimeters

Internal Volume Based on Minimum I.D.

Nominal Diameter	Min. O.D.		Min. I.D.		PER LINEAR FOOT Volume			PER LINEAR METER Volume			Volume
	inches	cm	inches	cm	$in.^3$	ft^3	gallons	cm^3	liters	$meter^3$	Liters/ft
0.5	0.84	2.13	0.62	1.58	3.62	2.10E-03	0.016	196.1	0.196	1.96E-04	0.060
0.75	1.05	2.67	0.804	2.04	6.09	3.53E-03	0.026	326.9	0.327	3.27E-04	0.10
1	1.315	3.34	1.029	2.61	9.98	5.78E-03	0.043	535.0	0.535	5.35E-04	0.16
1.25	1.66	4.22	1.36	3.45	17.43	1.01E-02	0.075	934.8	0.935	9.35E-04	0.28
1.5	1.9	4.83	1.59	4.04	23.83	1.38E-02	0.103	1281.9	1.28	1.28E-03	0.39
2	2.375	6.03	2.047	5.2	39.49	2.29E-02	0.171	2123.7	2.12	2.12E-03	0.65
2.5	2.875	7.3	2.445	6.21	56.34	3.26E-02	0.244	3028.8	3.03	3.03E-03	0.92
3	3.5	8.89	3.042	7.73	87.21	5.05E-02	0.378	4693.0	4.69	4.69E-03	1.43
4	4.5	11.43	3.998	10.16	150.65	8.72E-02	0.652	8107.3	8.11	8.11E-03	2.47
4.5	4.95	12.57	4.454	11.31	186.97	1.08E-01	0.809	10046.5	10.05	1.00E-02	3.06
5	5.563	14.13	5.016	12.74	237.13	1.37E-01	1.03	12747.6	12.75	1.27E-02	3.89
6	6.625	16.83	6.031	15.32	342.81	1.98E-01	1.48	18433.5	18.43	1.84E-02	5.62
8	8.625	21.91	7.941	20.17	594.32	3.44E-01	2.57	31952.3	31.95	3.20E-02	9.74
10	10.75	27.31	9.976	25.34	937.96	5.43E-01	4.06	50431.8	50.43	5.04E-02	15.4
12	12.75	32.39	11.889	30.2	1332.18	7.71E-01	5.77	71631.6	71.63	7.16E-02	21.8

Borehole Volumes

1 cubic foot= 1728 cubic inches
7.48 gallons
1 foot = 30.48 centimeters

Bore Hole Diameter		PER LINEAR FOOT Volume			PER LINEAR METER Volume			Volume
inches	centimeters	$in.^3$	ft^3	gallons	cm^3	liters	$meter^3$	Liters/ft
1.00	2.54	9.42	0.005	0.041	506.7	0.507	5.07E-04	0.154
1.25	3.18	14.73	0.009	0.064	791.7	0.792	7.92E-04	0.24
1.50	3.81	21.21	0.012	0.092	1140	1.14	1.14E-03	0.35
1.75	4.45	28.86	0.017	0.125	1552	1.55	1.55E-03	0.47
2.00	5.08	37.70	0.022	0.163	2027	2.03	2.03E-03	0.62
2.125	5.40	42.56	0.025	0.184	2288	2.29	2.29E-03	0.70
2.25	5.72	47.71	0.028	0.207	2565	2.57	2.57E-03	0.78
2.50	6.35	58.90	0.034	0.255	3167	3.17	3.17E-03	0.97
3.00	7.62	84.82	0.049	0.367	4560	4.56	4.56E-03	1.39
3.25	8.26	99.55	0.058	0.431	5352	5.35	5.35E-03	1.63
3.50	8.89	115.45	0.067	0.500	6207	6.21	6.21E-03	1.89
3.75	9.53	132.54	0.077	0.574	7126	7.13	7.13E-03	2.17
4.00	10.16	150.80	0.087	0.653	8107	8.11	8.11E-03	2.47
4.50	11.43	190.85	0.110	0.826	10261	10.3	1.03E-02	3.13
6.00	15.24	339.29	0.196	1.469	18241	18.2	1.82E-02	5.56
7.625	19.37	547.96	0.317	2.372	29460	29.5	2.95E-02	8.98
8.00	20.32	603.19	0.349	2.611	32429	32.4	3.24E-02	9.88
8.25	20.96	641.47	0.371	2.777	34488	34.5	3.45E-02	10.51
9.625	24.45	873.12	0.505	3.779	46942	46.9	4.69E-02	14.31
10.00	25.40	942.48	0.545	4.080	50671	50.7	5.07E-02	15.44
12.00	30.48	1357.17	0.785	5.875	72966	73.0	7.30E-02	22.24

Monitoring Well Purge Volumes

Per Linear foot of Saturated Filter Pack
Assuming 30% Porosity for Filter Pack
Schedule 40 PVC Internal Volume

Bore Hole Diameter (in.)	Sch. 40 PVC Nominal Casing Size (in.)	Purge Volume (per linear foot of saturated filter pack)			
		in.³	ft³	gallons	liters
1	0.5	4.46	0.003	0.019	0.073
1.25	0.5	6.05	0.003	0.026	0.099
	0.75	7.39	0.004	0.032	0.121
1.5	0.5	7.99	0.005	0.035	0.131
	0.75	9.34	0.005	0.040	0.153
	1	11.45	0.007	0.050	0.187
2	0.5	12.94	0.007	0.056	0.212
	0.75	14.28	0.008	0.062	0.234
	1	16.40	0.009	0.071	0.268
	1.5	24.93	0.014	0.108	0.409
2.125	0.5	14.40	0.008	0.062	0.236
	0.75	15.74	0.009	0.068	0.258
	1	17.86	0.010	0.077	0.292
	1.5	26.39	0.015	0.114	0.433
2.5	0.5	19.30	0.011	0.084	0.317
	0.75	20.65	0.012	0.089	0.338
	1	22.76	0.013	0.099	0.373
	1.5	31.29	0.018	0.135	0.513
	2	41.21	0.024	0.178	0.676
3	0.75	28.42	0.016	0.123	0.465
	1	30.54	0.018	0.132	0.500
	1.5	39.07	0.023	0.169	0.640
	2	48.99	0.028	0.212	0.803
	2.5	58.42	0.034	0.253	0.957
3.25	1	34.95	0.020	0.151	0.572
	1.5	43.48	0.025	0.188	0.713
	2	53.41	0.031	0.231	0.875
	2.5	62.84	0.036	0.272	1.03
4.25	1	56.16	0.033	0.243	0.92
	1.5	64.69	0.037	0.280	1.06
	2	74.61	0.043	0.323	1.22
	2.5	84.04	0.049	0.364	1.38
6	2	125.33	0.073	0.543	2.05
	2.5	134.76	0.078	0.583	2.21
	3	154.37	0.089	0.668	2.53
	4	195.18	0.113	0.845	3.20
8	2	204.50	0.118	0.885	3.35
	2.5	213.93	0.124	0.926	3.51
	3	233.53	0.135	1.011	3.83
	4	274.35	0.159	1.188	4.50
8.25	2	215.99	0.125	0.935	3.54
	2.5	225.41	0.130	0.976	3.69
	3	245.02	0.142	1.061	4.02
	4	285.83	0.165	1.237	4.69

PVC Riser Displaced Volume Per Linear Foot

Based on Minimum OD
1 gallon = 3.785 liters

Nominal Casing Size (in.)	Minimum Casing OD (in.)	in.³	ft³	gallons	liters
0.5	0.84	6.65	0.0038	0.029	0.109
0.75	1.05	10.39	0.0060	0.045	0.170
1	1.315	16.30	0.0094	0.071	0.267
1.5	1.9	34.02	0.0197	0.147	0.557
2	2.375	53.16	0.0308	0.230	0.871
2.5	2.875	77.90	0.0451	0.337	1.28
3	3.5	115.45	0.067	0.500	1.89
4	4.5	190.85	0.110	0.826	3.13
4.5	4.95	230.93	0.134	1.000	3.78
5	5.563	291.67	0.169	1.26	4.78
6	6.625	413.66	0.239	1.79	6.78
8	8.625	701.12	0.406	3.03	11.49
10	10.75	1089.15	0.630	4.71	17.84
12	12.75	1532.12	0.887	6.63	25.10

Riser, Tubing and Borehole Volumes

1/8 in. ID x 1/4 in. OD Tubing Well Purge Volumes
Geoprobe® TB12T (Teflon®)

Well Depth	Volume Constant	Single Well	Purge Volume*	Purge Volume
(ft)	(mL/ft)	Volume (ml)	(mL)	(L)
1	2.41	2.41	7.23	0.00723
2	2.41	4.82	14.46	0.01446
3	2.41	7.23	21.69	0.02169
4	2.41	9.64	28.92	0.02892
5	2.41	12.05	36.15	0.03615
6	2.41	14.46	43.38	0.04338
7	2.41	16.87	50.61	0.05061
8	2.41	19.28	57.84	0.05784
9	2.41	21.69	65.07	0.06507
10	2.41	24.1	72.3	0.0723
11	2.41	26.51	79.53	0.07953
12	2.41	28.92	86.76	0.08676
13	2.41	31.33	93.99	0.09399
14	2.41	33.74	101.22	0.10122
15	2.41	36.15	108.45	0.10845
16	2.41	38.56	115.68	0.11568
17	2.41	40.97	122.91	0.12291
18	2.41	43.38	130.14	0.13014
19	2.41	45.79	137.37	0.13737
20	2.41	48.2	144.6	0.1446
21	2.41	50.61	151.83	0.15183
22	2.41	53.02	159.06	0.15906
23	2.41	55.43	166.29	0.16629
24	2.41	57.84	173.52	0.17352
25	2.41	60.25	180.75	0.18075
26	2.41	62.66	187.98	0.18798
27	2.41	65.07	195.21	0.19521
28	2.41	67.48	202.44	0.20244
29	2.41	69.89	209.67	0.20967
30	2.41	72.3	216.9	0.2169
31	2.41	74.71	224.13	0.22413
32	2.41	77.12	231.36	0.23136
33	2.41	79.53	238.59	0.23859
34	2.41	81.94	245.82	0.24582
35	2.41	84.35	253.05	0.25305
36	2.41	86.76	260.28	0.26028
37	2.41	89.17	267.51	0.26751
38	2.41	91.58	274.74	0.27474
39	2.41	93.99	281.97	0.28197
40	2.41	96.4	289.2	0.2892
41	2.41	98.81	296.43	0.29643
42	2.41	101.22	303.66	0.30366
43	2.41	103.63	310.89	0.31089
44	2.41	106.04	318.12	0.31812
45	2.41	108.45	325.35	0.32535
46	2.41	110.86	332.58	0.33258
47	2.41	113.27	339.81	0.33981
48	2.41	115.68	347.04	0.34704
49	2.41	118.09	354.27	0.35427
50	2.41	120.5	361.5	0.3615

* Three Well Volume Purge

0.17 in. ID x 0.25 in. OD Tubing Well Purge Volumes
Geoprobe® TB17L (Polyetheylene)

Well Depth	Volume Constant	Single Well	Purge Volume*	Purge Volume
(ft)	(mL/ft)	Volume (ml)	(mL)	(L)
1	4.5	4.5	13.5	0.0135
2	4.5	9	27	0.027
3	4.5	13.5	40.5	0.0405
4	4.5	18	54	0.054
5	4.5	22.5	67.5	0.0675
6	4.5	27	81	0.081
7	4.5	31.5	94.5	0.0945
8	4.5	36	108	0.108
9	4.5	40.5	121.5	0.1215
10	4.5	45	135	0.135
11	4.5	49.5	148.5	0.1485
12	4.5	54	162	0.162
13	4.5	58.5	175.5	0.1755
14	4.5	63	189	0.189
15	4.5	67.5	202.5	0.2025
16	4.5	72	216	0.216
17	4.5	76.5	229.5	0.2295
18	4.5	81	243	0.243
19	4.5	85.5	256.5	0.2565
20	4.5	90	270	0.27
21	4.5	94.5	283.5	0.2835
22	4.5	99	297	0.297
23	4.5	103.5	310.5	0.3105
24	4.5	108	324	0.324
25	4.5	112.5	337.5	0.3375
26	4.5	117	351	0.351
27	4.5	121.5	364.5	0.3645
28	4.5	126	378	0.378
29	4.5	130.5	391.5	0.3915
30	4.5	135	405	0.405
31	4.5	139.5	418.5	0.4185
32	4.5	144	432	0.432
33	4.5	148.5	445.5	0.4455
34	4.5	153	459	0.459
35	4.5	157.5	472.5	0.4725
36	4.5	162	486	0.486
37	4.5	166.5	499.5	0.4995
38	4.5	171	513	0.513
39	4.5	175.5	526.5	0.5265
40	4.5	180	540	0.54
41	4.5	184.5	553.5	0.5535
42	4.5	189	567	0.567
43	4.5	193.5	580.5	0.5805
44	4.5	198	594	0.594
45	4.5	202.5	607.5	0.6075
46	4.5	207	621	0.621
47	4.5	211.5	634.5	0.6345
48	4.5	216	648	0.648
49	4.5	220.5	661.5	0.6615
50	4.5	225	675	0.675

* Three Well Volume Purge

3/16 in. ID x 1/4 in. OD Tubing Well Purge Volumes Geoprobe® TB17T (Teflon®)

Well Depth	Volume Constant	Single Well	Purge Volume*	Purge Volume
(ft)	(mL/ft)	Volume (ml)	(mL)	(L)
1	5.43	5.43	16.29	0.01629
2	5.43	10.86	32.58	0.03258
3	5.43	16.29	48.87	0.04887
4	5.43	21.72	65.16	0.06516
5	5.43	27.15	81.45	0.08145
6	5.43	32.58	97.74	0.09774
7	5.43	38.01	114.03	0.11403
8	5.43	43.44	130.32	0.13032
9	5.43	48.87	146.61	0.14661
10	5.43	54.3	162.9	0.1629
11	5.43	59.73	179.19	0.17919
12	5.43	65.16	195.48	0.19548
13	5.43	70.59	211.77	0.21177
14	5.43	76.02	228.06	0.22806
15	5.43	81.45	244.35	0.24435
16	5.43	86.88	260.64	0.26064
17	5.43	92.31	276.93	0.27693
18	5.43	97.74	293.22	0.29322
19	5.43	103.17	309.51	0.30951
20	5.43	108.6	325.8	0.3258
21	5.43	114.03	342.09	0.34209
22	5.43	119.46	358.38	0.35838
23	5.43	124.89	374.67	0.37467
24	5.43	130.32	390.96	0.3909
25	5.43	135.75	407.25	0.40725
26	5.43	141.18	423.54	0.42354
27	5.43	146.61	439.83	0.43983
28	5.43	152.04	456.12	0.45612
29	5.43	157.47	472.41	0.47241
30	5.43	162.9	488.7	0.4887
31	5.43	168.33	504.99	0.50499
32	5.43	173.76	521.28	0.52128
33	5.43	179.19	537.57	0.53757
34	5.43	184.62	553.86	0.55386
35	5.43	190.05	570.15	0.57015
36	5.43	195.48	586.44	0.58644
37	5.43	200.91	602.73	0.60273
38	5.43	206.34	619.02	0.61902
39	5.43	211.77	635.31	0.63531
40	5.43	217.2	651.6	0.6516
41	5.43	222.63	667.89	0.66789
42	5.43	228.06	684.18	0.68418
43	5.43	233.49	700.47	0.70047
44	5.43	238.92	716.76	0.71676
45	5.43	244.35	733.05	0.73305
46	5.43	249.78	749.34	0.74934
47	5.43	255.21	765.63	0.76563
48	5.43	260.64	781.92	0.78192
49	5.43	266.07	798.21	0.79821
50	5.43	271.5	814.5	0.8145

* Three Well Volume Purge

1/4 in. ID Tubing Well Purge Volumes Geoprobe® TB25L (Poly) and TB25T (Teflon®)

Well Depth	Volume Constant	Single Well	Purge Volume*	Purge Volume
(ft)	(mL/ft)	Volume (ml)	(mL)	(L)
1	9.65	9.65	28.95	0.02895
2	9.65	19.3	57.9	0.0579
3	9.65	28.95	86.85	0.08685
4	9.65	38.6	115.8	0.1158
5	9.65	48.25	144.75	0.14475
6	9.65	57.9	173.7	0.1737
7	9.65	67.55	202.65	0.20265
8	9.65	77.2	231.6	0.2316
9	9.65	86.85	260.55	0.26055
10	9.65	96.5	289.5	0.2895
11	9.65	106.15	318.45	0.31845
12	9.65	115.8	347.4	0.3474
13	9.65	125.45	376.35	0.37635
14	9.65	135.1	405.3	0.4053
15	9.65	144.75	434.25	0.43425
16	9.65	154.4	463.2	0.4632
17	9.65	164.05	492.15	0.49215
18	9.65	173.7	521.1	0.5211
19	9.65	183.35	550.05	0.55005
20	9.65	193	579	0.579
21	9.65	202.65	607.95	0.60795
22	9.65	212.3	636.9	0.6369
23	9.65	221.95	665.85	0.66585
24	9.65	231.6	694.8	0.6948
25	9.65	241.25	723.75	0.72375
26	9.65	250.9	752.7	0.7527
27	9.65	260.55	781.65	0.78165
28	9.65	270.2	810.6	0.8106
29	9.65	279.85	839.55	0.83955
30	9.65	289.5	868.5	0.8685
31	9.65	299.15	897.45	0.89745
32	9.65	308.8	926.4	0.9264
33	9.65	318.45	955.35	0.95535
34	9.65	328.1	984.3	0.9843
35	9.65	337.75	1013.25	1.01325
36	9.65	347.4	1042.2	1.0422
37	9.65	357.05	1071.15	1.07115
38	9.65	366.7	1100.1	1.1001
39	9.65	376.35	1129.05	1.12905
40	9.65	386	1158	1.158
41	9.65	395.65	1186.95	1.18695
42	9.65	405.3	1215.9	1.2159
43	9.65	414.95	1244.85	1.24485
44	9.65	424.6	1273.8	1.2738
45	9.65	434.25	1302.75	1.30275
46	9.65	443.9	1331.7	1.3317
47	9.65	453.55	1360.65	1.36065
48	9.65	463.2	1389.6	1.3896
49	9.65	472.85	1418.55	1.41855
50	9.65	482.5	1447.5	1.4475

* Three Well Volume Purge

Riser, Tubing and Borehole Volumes

5/16 in. ID x 3/8 in. OD Tubing Well Purge Volumes Geoprobe® TB30T (Teflon®)

Well Depth	Volume Constant	Single Well	Purge Volume*	Purge Volume
(ft)	(mL/ft)	Volume (ml)	(mL)	(L)
1	15.08	15.08	45.24	0.04524
2	15.08	30.16	90.48	0.09048
3	15.08	45.24	135.72	0.13572
4	15.08	60.32	180.96	0.18096
5	15.08	75.4	226.2	0.2262
6	15.08	90.48	271.44	0.27144
7	15.08	105.56	316.68	0.31668
8	15.08	120.64	361.92	0.36192
9	15.08	15.08	45.24	0.04524
10	15.08	150.8	452.4	0.4524
11	15.08	165.88	497.64	0.49764
12	15.08	180.96	542.88	0.54288
13	15.08	196.04	588.12	0.58812
14	15.08	211.12	633.36	0.63336
15	15.08	226.2	678.6	0.6786
16	15.08	241.28	723.84	0.72384
17	15.08	256.36	769.08	0.76908
18	15.08	271.44	814.32	0.81432
19	15.08	286.52	859.56	0.85956
20	15.08	301.6	904.8	0.9048
21	15.08	316.68	950.04	0.95004
22	15.08	331.76	995.28	0.99528
23	15.08	346.84	1040.52	1.04052
24	15.08	361.92	1085.76	1.08576
25	15.08	377	1131	1.131
26	15.08	392.08	1176.24	1.17624
27	15.08	407.16	1221.48	1.22148
28	15.08	422.24	1266.72	1.26672
29	15.08	437.32	1311.96	1.31196
30	15.08	452.4	1357.2	1.3572
31	15.08	467.48	1402.44	1.40244
32	15.08	482.56	1447.68	1.44768
33	15.08	497.64	1492.92	1.49292
34	15.08	512.72	1538.16	1.53816
35	15.08	527.8	1583.4	1.5834
36	15.08	542.88	1628.64	1.62864
37	15.08	557.96	1673.88	1.67388
38	15.08	573.04	1719.12	1.71912
39	15.08	588.12	1764.36	1.76436
40	15.08	603.2	1809.6	1.8096
41	15.08	618.28	1854.84	1.85484
42	15.08	633.36	1900.08	1.90008
43	15.08	648.44	1945.32	1.94532
44	15.08	663.52	1990.56	1.99056
45	15.08	678.6	2035.8	2.0358
46	15.08	693.68	2081.04	2.08104
47	15.08	708.76	2126.28	2.12628
48	15.08	723.84	2171.52	2.17152
49	15.08	738.92	2216.76	2.21676
50	15.08	754	2262	2.262

* Three Well Volume Purge

3/8-in. ID x 1/2-in. OD Tubing Well Purge Volumes Geoprobe® TB37L (Polyetheylene)

Well Depth	Volume Constant	Single Well	Purge Volume*	Purge Volume
(ft)	(mL/ft)	Volume (ml)	(mL)	(L)
1	21.7	21.7	65.1	0.0651
2	21.7	43.4	130.2	0.1302
3	21.7	65.1	195.3	0.1953
4	21.7	86.8	260.4	0.2604
5	21.7	108.5	325.5	0.3255
6	21.7	130.2	390.6	0.3906
7	21.7	151.9	455.7	0.4557
8	21.7	173.6	520.8	0.5208
9	21.7	15.08	45.24	0.04524
10	21.7	217	651	0.651
11	21.7	238.7	716.1	0.7161
12	21.7	260.4	781.2	0.7812
13	21.7	282.1	846.3	0.8463
14	21.7	303.8	911.4	0.9114
15	21.7	325.5	976.5	0.9765
16	21.7	347.2	1041.6	1.0416
17	21.7	368.9	1106.7	1.1067
18	21.7	390.6	1171.8	1.1718
19	21.7	412.3	1236.9	1.2369
20	21.7	434	1302	1.302
21	21.7	455.7	1367.1	1.3671
22	21.7	477.4	1432.2	1.4322
23	21.7	499.1	1497.3	1.4973
24	21.7	520.8	1562.4	1.5624
25	21.7	542.5	1627.5	1.6275
26	21.7	564.2	1692.6	1.6926
27	21.7	585.9	1757.7	1.7577
28	21.7	607.6	1822.8	1.8228
29	21.7	629.3	1887.9	1.8879
30	21.7	651	1953	1.953
31	21.7	672.7	2018.1	2.0181
32	21.7	694.4	2083.2	2.0832
33	21.7	716.1	2148.3	2.1483
34	21.7	737.8	2213.4	2.2134
35	21.7	759.5	2278.5	2.2785
36	21.7	781.2	2343.6	2.3436
37	21.7	802.9	2408.7	2.4087
38	21.7	824.6	2473.8	2.4738
39	21.7	846.3	2538.9	2.5389
40	21.7	868	2604	2.604
41	21.7	889.7	2669.1	2.6691
42	21.7	911.4	2734.2	2.7342
43	21.7	933.1	2799.3	2.7993
44	21.7	954.8	2864.4	2.8644
45	21.7	976.5	2929.5	2.9295
46	21.7	998.2	2994.6	2.9946
47	21.7	1019.9	3059.7	3.0597
48	21.7	1041.6	3124.8	3.1248
49	21.7	1063.3	3189.9	3.1899
50	21.7	1085	3255	3.255

* Three Well Volume Purge

Probe Rod, Sonic Casing, & HSA Internal Volumes

Internal Volume Calculations (Probe Rods & Sonic Casing)

				PER LINEAR FOOT			PER LINEAR METER			
Rod OD	Rod ID	Rod OD	Rod ID	Volume			Volume			Volume
Inches		cm		in.³	ft³	gallons	cm³	liters	meter³	Liters/ft
1.00	0.5	2.54	1.27	2.36	0.001	0.010	126.7	0.127	1.27E-04	0.0386
1.25	0.625	3.18	1.59	3.68	0.002	0.016	197.9	0.198	1.98E-04	0.060
1.50	0.625	3.81	1.59	3.68	0.002	0.016	197.9	0.198	1.98E-04	0.060
1.75	0.75	4.45	1.91	5.30	0.003	0.023	285.0	0.285	2.85E-04	0.087
2.125	1.5	5.40	3.81	21.21	0.012	0.092	1140	1.140	1.14E-03	0.35
2.25	1.5	5.72	3.81	21.21	0.012	0.092	1140	1.140	1.14E-03	0.35
3.25	2.625	8.26	6.67	64.94	0.038	0.281	3492	3.492	3.49E-03	1.06
3.50	2.75	8.89	6.99	71.27	0.041	0.309	3832	3.832	3.83E-03	1.17
3.75	3	9.53	7.62	84.82	0.049	0.367	4560	4.560	4.56E-03	1.39
4.50	3.75	11.43	9.53	132.5	0.077	0.574	7126	7.126	7.13E-03	2.17
6.00	5.25	15.24	13.34	259.8	0.150	1.124	13966	14.0	1.40E-02	4.26
7.625*	6.875	19.37	17.46	445.5	0.258	1.928	23950	23.9	2.39E-02	7.30
9.625**	8.835	24.45	22.44	735.7	0.426	3.185	39552	39.6	3.96E-02	12.06

* Nom. 8-in.
** Nom. 10-in.

Internal Volume Calculations (Hollow Stem Augers)

				PER LINEAR FOOT			PER LINEAR METER			
HSA OD	HSA ID	HSA OD	HDA ID	Volume			Volume			Volume
Inches		cm		in.³	ft³	gallons	cm³	liters	meter³	Liters/ft
7.625	4.25	19.37	10.80	170.2	0.099	0.737	9152	9.2	9.15E-03	2.79
9.625	6.25	24.45	15.88	368.2	0.213	1.594	19793	19.8	1.98E-02	6.03
12.00	8.25	30.48	20.96	641.5	0.371	2.777	34488	34.5	3.45E-02	10.51

Earth Materials

Unified Soil Classification System

Major Divisions				Group Symbols	Typical Names	Field Identification Procedures (excluding particles larger than 3 inches and basing fractions on estimated weights)			Information Required for Describing Soils
1	2			3	4	5			6
Coarse-grained Soils More than half of material is larger than No. 200 sieve size.	The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size.	(For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size.)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions, and drainage characteristics. Give typical name: Indicate approximate percentage of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2 in. maximum size; rounded and subangular sand grains, course to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).
					GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
				Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixture.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
					GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification see CL below).		
		Sands More than half of coarse fraction is smaller than No. 4 sieve size.		Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate sizes missing.		
					SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
				Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
					SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
							Identification Procedures on Fraction Smaller than No. 40 Sieve Size		
							Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)
Fine-grained Soils More than half of material is smaller than No. 200 sieve size.		Silts and Clays Liquid limit is less than 50			ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. Give typical name; indicate degree and character of plasticity; amount and maximum size of coarse grains; color in wet condition; odor, if any; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Clayey silt, brown; slighty plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML).
					CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium	
					OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight	
		Soils and Clays Liquid limit is greater than 50			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium	
					CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High	
					OH	Organic clays and silts of medium to high plasticity.	Medium to high	None to very slow	Slight to medium	
Highly Organic Soils				PT	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.			

U.S. Standard Sieves

Opening	Sieve	Opening	Sieve	Opening	Sieve
mm	No.	mm	No.	mm	No.
16		2	10	0.25	60
13.2		1.7	12	0.212	70
11.2		1.4	14	0.18	80
9.5		1.18	16	0.15	100
8		1	18	0.125	120
6.7		0.85	20	0.106	140
5.6	3-1/2	0.71	25	0.09	170
4.75	4	0.6	30	0.075	200
4	5	0.5	35	0.063	230
3.35	6	0.425	40	0.053	270
2.8	7	0.355	45	0.045	325
2.36	8	0.3	50	0.038	400

Sample Classification Chart

Moisture Content	
Dry	Little to no perceptible moisture.
Damp	Some perceptible moisture. Not compactable.
Moist	Compactable.
Wet	Above compactable range.
Saturated	Pores. Voids filled with water.
▼	Water table (at time of drilling).

Soil Consistency Based on Standard Penetration Test (SPT)

Density				
Coarse-Grained Soils : Density		Fine-Grained Soils : Consistency		
Very loose	0-4	Very Soft	0-2	Very easily - inches
Loose	4-10	Soft	2-4	Easily-inches
Medium Dense	10-30	Medium Stiff	4-8	Moderate effort - inches
Dense	30-50	Stiff	8-15	Indented easily
Very dense	>50	Very stiff	15-30	Indented by nail
		Hard	>30	Difficult by nail
SPT (2" OD/1 3/8" ID Spoon, 140lb. Hammer, 30" Drop)				

Plasticity	
Nonplastic	No wire formable.
Slightly Plastic	Wire formable but soil remains easily deformable.
Plastic	Wire formable, moderate pressure required.
Very Plastic	Wire formable, much pressure required.
Extremely Hard	Resistant to pressure, not broken by hands.

Hydraulic Conductivity of Earth Materials

Ranges of intrinsic permeabilities and conductivities for unconsolidated sediments

Material	Intrinsic Permeability (darcys)	Conductivity (cm/sec)
Clay	10^{-6} - 10^{-3}	10^{-9} - 10^{-6}
Silt, sandy silts, clayey sands, till	10^{-3} - 10^{-1}	10^{-6} - 10^{-4}
Well-sorted sands, glacial outwash	1 - 10^{2}	10^{-3} - 10^{-1}
Well-sorted gravel	10 - 10^{3}	10^{-2} - 1

Conversion values for hydraulic conductivity

1 gal/day/ft^2	= 0.0408 m/day
1 gal/day/ft^2	= 0.134 ft/day
1 gal/day/ft^2	= 4.72 x 10^{-5} cm/sec
1 ft/day	= 0.305 m/day
1 ft/day	= 7.48 gal/day/ft^2
1 ft/day	= 3.53 x 10^{-4} cm/sec
1 cm/sec	= 864 m/day
1 cm/sec	= 2,835 ft/day
1 cm/sec	= 21,200 gal/day/ft^2
1 m/day	= 24.5 gal/day/ft^2
1 m/day	= 3.28 ft/day
1 m/day	= 1.16 x 10^{-3} cm/sec

Porosity Ranges for Sediments

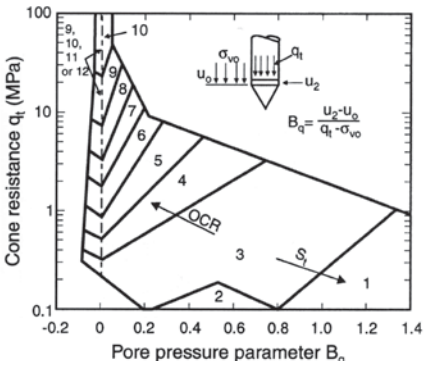
Well sorted sand or gravel	25-50%
Sand and gravel, mixed	20-35%
Glacial till	10-20%
Silt	35-50%
Clay	33-60%

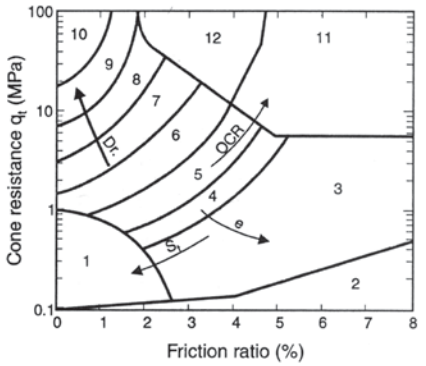
Typical Height of Capillary Fringe

Material	Typical Pore Radius	Capillary Height
Gravel, course	2.0 mm	0.8 cm
Sand, course	0.5 mm	3.0 cm
Sand, fine	0.05 mm	30.0 cm
Silt	0.01 mm	1.5 m
Clay	0.005 mm	3.0 m

In Situ Measurements

CPT: Soil Behavior Classification System





1. Sensitive fin grained
2. Organic material
3. Clay
4. Silty clay to clay
5. Clayey silt to silty clay
6. Sandy silt to clayey silt
7. Silty sand to sandy silt
8. Sand to silty sand
9. Sand
10. Gravelly sand to sand
11. Very stiff fine grained*
12. Sand to clayey sand*

** Overconsolidated or cemented.*

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J. (1986) "Use of piezometer cone data." Proceedings of the ASCE Specialty Conference InSitu '86. Use of InSitu Tests in Geotechnical Engineering, Blacksburg, 1263-80, American Society of Civil Engineers (ASCE).

CPT: Depth to Groundwater Formula

Depth to groundwater table = Depth cone – Depth below groundwater table

Depth cone = Depth of CPT probe during pore pressure dissipation test

Depth below groundwater table $= u_o / \gamma_w$

u_o = static pore pressure from dissipation data

γ_w = unit weight of water

Unit weight of water at 10°C / 50°F

9.81 kN/m^3 = 0.00981 MN/m^3
62.4 lb/ft^3

(Roberson, J., and Crowe, C., Engineering Fluid Mechanics, Houghton Mifflin Co., Boston, 1993)

CPT: Pressure/Force Conversion Tables

10 cm² Cone

Tip Resistance			Force$_{Tip}$	Sleeve Resistance			Force$_{sleeve}$
MPa	PSI	TSF	lbs	MPa	PSI	TSF	lbs
1	145	10.4	225	0.05	7.3	0.5	169
5	725.2	52.2	1124	0.1	14.5	1	337
10	1450.3	104.4	2248	0.2	29	2.1	674
20	2900.7	208.9	4496	0.4	58	4.2	1349
30	4351	313.3	6745	0.6	87	6.3	2023
40	5801.3	417.7	8993	0.8	116	8.4	2698
50	7251.6	522.1	11241	1	145	10.4	3372
60	8702	626.6	13489	1.2	174	12.5	4047
70	10152.3	731	15737	1.4	203	14.6	4721
80	11602.6	835.4	17986	1.6	232.1	16.7	5396
90	13052.9	939.8	20234	1.8	261.1	18.8	6070
100	14503.3	1044.3	22482	2	290.1	20.9	6745

MPa: Mega Pascal PSI: pounds per square inch TSF: tons per square foot

1 MPa = 10^6 N/m^2
1 lb. = 4.448 N

Cross-Sectional Area of Tip: 0.001 m^2
Surface Area of Sleeve: 0.015 m^2

$$\text{Force}_{Tip}\text{ (lb)} = \text{Tip Resistance (MPa)} \times \frac{10^6 \frac{N}{m^2}}{1\text{ MPa}} \times 0.001 m^2 \times \frac{1\text{ lb}}{4.448\text{ N}}$$

$$\text{Force}_{sleeve}\text{ (lb)} = \text{Sleeve Resistance (MPa)} \times \frac{10^6 \frac{N}{m^2}}{1\text{ MPa}} \times 0.015 m^2 \times \frac{1\text{ lb}}{4.448\text{ N}}$$

CPT: Pressure/Force Conversion Tables

15 cm² Cone

Tip Resistance			Force$_{Tip}$	Sleeve Resistance			Force$_{sleeve}$
MPa	PSI	TSF	lbs	MPa	PSI	TSF	lbs
1	145	10.4	337	0.05	7.3	0.5	253
5	725.2	52.2	1686	0.1	14.5	1	506
10	1450.3	104.4	3372	0.2	29	2.1	1012
20	2900.7	208.9	6745	0.4	58	4.2	2023
30	4351	313.3	10117	0.6	87	6.3	3035
40	5801.3	417.7	13489	0.8	116	8.4	4047
50	7251.6	522.1	16862	1	145	10.4	5058
60	8702	626.6	20234	1.2	174	12.5	6070
70	10152.3	731	23606	1.4	203	14.6	7082
80	11602.6	835.4	26978	1.6	232.1	16.7	8094
90	13052.9	939.8	30351	1.8	261.1	18.8	9105
100	14503.3	1044.3	33723	2	290.1	20.9	10117

MPa: Mega Pascal PSI: pounds per square inch TSF: tons per square foot

1 MPa = 10^6 N/m^2
1 lb. = 4.448 N

Cross-Sectional Area of Tip: 0.0015 m^2
Surface Area of Sleeve: 0.0225 m^2

$$\text{Force}_{Tip}\text{ (lb)} = \text{Tip Resistance (MPa)} \times \frac{10^6 \frac{N}{m^2}}{1\text{ MPa}} \times 0.0015 m^2 \times \frac{1\text{ lb}}{4.448\text{ N}}$$

$$\text{Force}_{sleeve}\text{ (lb)} = \text{Sleeve Resistance (MPa)} \times \frac{10^6 \frac{N}{m^2}}{1\text{ MPa}} \times 0.0225 m^2 \times \frac{1\text{ lb}}{4.448\text{ N}}$$

CPT: CPT Probe Specifications

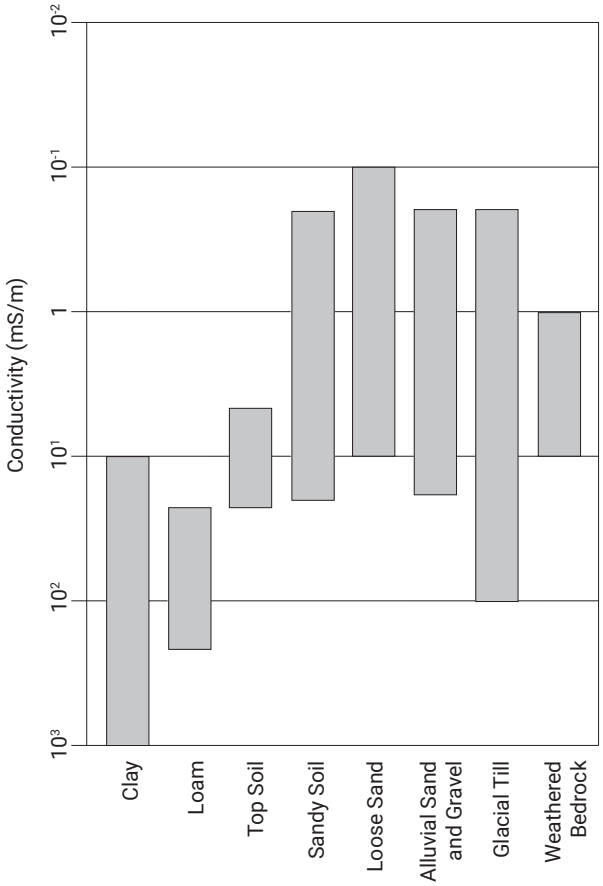
10 cm² cone

Cone:	60 degree apex angle
Cone section area:	10 cm²
Friction surface:	150 cm²
Area factor a:	0.58
Area factor b:	0.014

15 cm² cone

Cone:	60 degree apex angle
Cone section area:	15 cm²
Friction surface:	225 cm²
Area factor a:	0.73
Area factor b:	0.0

Electrical Conductivity of Earth Materials



Electrical Resistivity/Conductivity Ranges of Common Soil Materials

	Resistivity Range ohm-meter		Conductivity Range mS/m	
Clay	1	100	10	1000
Topsoil	50	300	3	20
Loose Sand	500	5000	0.2	2
Gravel	100	6000	0.17	10
Weathered Bedrock	100	1000	1	10

Data from Field Geophysics by John Milsom, 1989.

To convert Earth Resistivity in ohm-meters to Soil Conductivity (SC) in mS/m:

SC = 1000/Resistivity

(mS/m is the same thing as a mmho/m)

General Rules for Soil Electrical Conductivity (EC) Log Interpretation[a]:

In fresh water formations when electrically conductive clays[b] predominate the fine grained fraction of the formation:

1. If the electrical conductivity changes, then a change has occurred in either the soil material or its pore water.
2. In this setting, EC generally increases with increasing clay content.
3. In this setting, an increase in EC generally indicates a decrease in permeability
4. In most settings, the depth of the water table is not evident from EC logs. However, the water table may be observed if it occurs in a clean sand or gravel.
5. In general, for fresh water formations, the change in EC due to pore water content[c] is secondary in effect to the change in clay content.

Notes:

a) Conduct targeted coring of the formation at all sites (not locations) to verify EC log interpretation. If significant changes are observed in EC at a specific location additional cores targeted at the zone of change should be obtained to verify formation conditions.

b) Not all clay minerals exhibit high electrical conductance. When low EC clays are present it may be difficult to distinguish clay rich zones from sands and gravels. Under these conditions running HPT logs with EC would be the most effective way to define changes in formation permeability and lithology.

c) Brines and other groundwater (or injected remediation fluids) with elevated dissolved solids content can overwhelm natural formation EC making it difficult or impossible to define formation lithology based solely on an EC log. Under these conditions running HPT logs with EC would be the most effective way to define changes in formation permeability and lithology, as well as identify brine impacted zones in the formation.

Selected ASTM Standards for Field Operators

In the following pages you'll find selected ASTM Standards categorized by:

1. Direct Push Methods
2. Cone Penetration Testing Methods
3. Standard Penetration Test (SPT) Methods
4. Soil Sampling Field Methods
5. Ground Water Sampling and Monitoring Field Methods
6. Field Methods for Soil Gas Sampling
7. Site Investigation Methods
8. Corrective Actions and Remedial Methods
9. Drilling Methods
10. Decontamination Methods
11. Grouting Methods

Individual Guides, Practices, and Standards may be purchased from ASTM (American Society for Testing and Materials) located at:

100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Tel: 610-832-9585
Website: www.astm.org

Standards can be purchased as pdf files online at: www.astm.org

Most of the soil Standards are contained in 2015 Annual Book of ASTM Standards, Section 4: Construction, Volume 04.09, Soil and Rock (II), volume 11.04 (Environmental Assessment), or in a compilation of Standards titled ASTM Standards on Ground Water and Vadose Zone Investigations.

1. Direct Push Methods

D6001	Standard Guide for Direct-Push Groundwater Sampling for Environmental Site Characterization
D6282	Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations
D6724	Standard Guide for Installation of Direct Push Groundwater Monitoring Wells
D6725	Standard Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers
D7242	Standard Practice for Field Pneumatic Slug (Instantaneous Change in Head) Tests to Determine Hydraulic Properties of Aquifers with Direct Push Groundwater Samplers
D7352	Standard Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe (MIP)
D8037	Standard Practice for Direct Push Hydraulic Logging for Profiling Variations of Permeability in Soils

2. Cone Penetration Testing Methods

D3441	Standard Test Method for Mechanical Cone Penetration Testing of Soils
D5778	Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils
D6067	Standard Practice for Using the Electronic Piezocone Penetrometer Tests for Environmental Site Characterization

3. Standard Penetration Test (SPT) Methods

D1586	Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils
D4633	Standard Test Method for Energy Measurement for Dynamic Penetrometers

4. Soil Sampling Field Methods

C998	Standard Practice for Sampling Surface Soil for Radionuclides
D1556	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D1587	Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
D2573	Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils
D2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
D3385	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer
D3404	Standard Guide for Measuring Matric Potential in Vadose Zone Using Tensiometers
*D3550**	*Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils (Withdrawn 2016)*
D4220	Standard Practices for Preserving and Transporting Soil Samples (geotechnical samples)
D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D4429	Standard Test Method for CBR (California Bearing Ratio) of Soils in Place
D4547	Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds
*D4564**	*Standard Test Method for Density and Unit Weight of Soil in Place by the Sleeve Method (Withdrawn 2013)*
D4696	Standard Guide for Pore-Liquid Sampling from the Vadose Zone
D4700	Standard Guide for Soil Sampling from the Vadose Zone
D4914	Standard Test Methods for Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit
D4944	Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester
D5093	Standard Test Method for Field Measurement of Infiltration Rate Using Double-Ring Infiltrometer with Sealed-Inner Ring
D5195	Standard Test Method for Density of Soil and Rock In-Place at Depths Below Surface by Nuclear Methods
D5220	Standard Test Method for Water Mass per Unit Volume of Soil and Rock In-Place by the Neutron Depth Probe Method

D5298	Standard Test Method for Measurement of Soil Potential (Suction) Using Filter Paper
D5434	Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock
G57	Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

5. Ground Water Sampling and Monitoring Field Methods

D1498	Standard Test Method for Oxidation-Reduction Potential of Water
D4448	Standard Guide for Sampling Ground-Water Monitoring Wells
*D4750**	*Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well) (Withdrawn 2010)*
D5092	Standard Practice for Design and Installation of Groundwater Monitoring Wells
D5521	Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers
D5979	Standard Guide for Conceptualization and Characterization of Groundwater Systems
D6089	Standard Guide for Documenting a Groundwater Sampling Event

6. Field Methods for Soil Gas Sampling

D7663	Standard Practice for Active Soil Gas Sampling in the Vadose Zone for Vapor Intrusion Evaluations
D7648	Standard Practice for Active Soil Gas Sampling for Direct Push or Manual-Driven Hand-Sampling Equipment
D7758	Standard Practice for Passive Soil Gas Sampling in the Vadose Zone for Source Identification, Spatial Variability Assessment, Monitoring, and Vapor Intrusion Evaluations

7. Site Investigation Methods

*D5730**	*Standard Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Groundwater (Withdrawn 2013)*
D5995	Standard Guide for Environmental Site Characterization in Cold Regions
D6235	Standard Practice for Expedited Site Characterization of Vadose Zone and Groundwater Contamination at Hazardous Waste Contaminated Sites
E1527	Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process
E1528	Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process
E1903	Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process

8. Corrective Actions and Remedial Methods

E1739	Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites
E1943	Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites

9. Drilling Methods

D1452	Standard Practice for Soil Exploration and Sampling by Auger Borings
D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
D5079	Standard Practices for Preserving and Transporting Rock Core Samples
D6286	Standard Guide for Selection of Drilling Methods for Environmental Site Characterization

10. Decontamination Methods

D5088	Standard Practice for Decontamination of Field Equipment Used at Waste Sites
D5608	Standard Practices for Decontamination of Sampling and Non Sample Contacting Equipment Used at Low Level Radioactive Waste Sites

11. Grouting Methods

D5299	Standard Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities

12. Others to Remember:

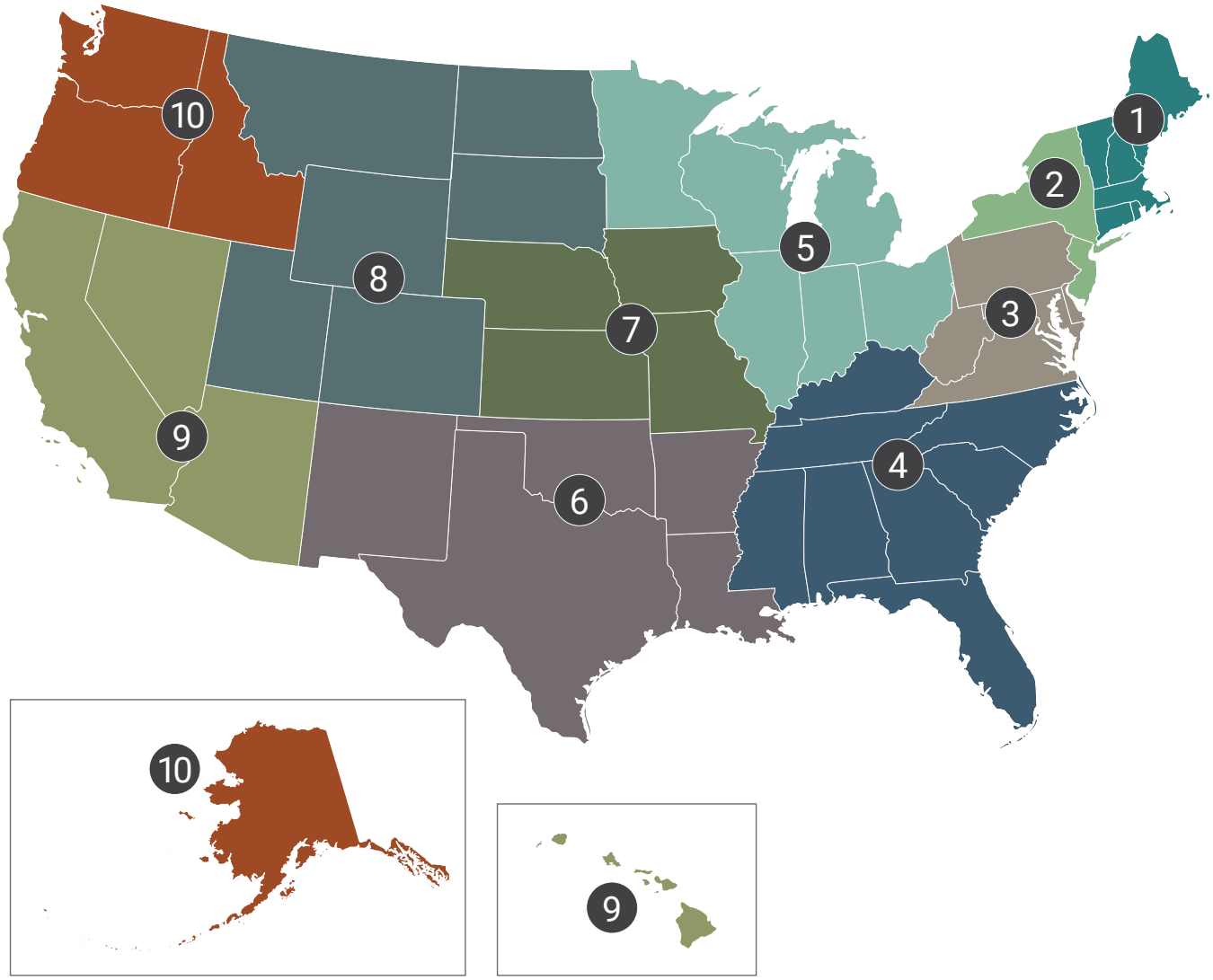
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

**Standard has been withdrawn with no replacement (for informational purposes only)*

Visit www.astm.org for updates and changes to these standards.

EPA Regions & Locations

There are ten EPA regional offices across the United States. For more information, visit **www.epa.gov**



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Phone: (617) 918-1111
Toll free within Region 1: (888) 372-7341

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Visit www.epa.gov for full contact information or for any changes to the listed information.

Chemistry

Selected Organic Compounds

Compound	Abbreviation
carbon tetrachloride	carbon tet
1,1-dichloroethane	1,1-DCA
1,2-dichloroethane	1,2-DCA
ortho-dichlorobenzene	O-DCB
meta-dichlorobenzene	M-DCB
para-dichlorobenzene	P-DCB
1,1-dichloroethene	1,1-DCE
cis-1,2-dichloroethene	cis,1,2-DCE
trans-1,2-dichloroethene	trans,1,2-DCE
1,2-dichloropropane	1,2-DCP
ethylene dibromide	EDB
Freon-11	F-11
Freon-12	F-12
Freon-113	F-113
methylene chloride	methylene Cl
perchloroethene or tetrachloroethene	PCE
1,1,1-trichloroethane	1,1,1-TCA
1,1,2-trichloroethane	1,1,2-TCA
1,2,4-trichlorobenzene	1,2,4-TCB
trichloroethene	TCE
orthoxylene	O-xylene
metaxylene	M-xylene
paraxylene	P-xylene

Physical Properties of Selected Organic Compounds

Compound	Mol. Wt.	Liquid Dens. (g/ml)[1]	Vap Press mm Hg @ T°C	Norm BP (°C)
benzene	78.12	0.879	76 (20)	80.1
bromoform	252.77	2.9	10 (34)	149.5
butane	58.13	0.579		-0.5
carbon tet	158.32	1.594	90 (20)	76.54
chlorobenzene	112.56	1.107	10 (22.2)	131
chloromethane	50.49	0.916	3800 (22)	-24.2
chloroform	119.39	1.483	160 (20)	61.7
1,1-DCA	98.96	1.176	300 (20)	57.28
1,2-DCA	98.96	1.235	61 (20)	83.47
O-DCB	147.01	1.3	1 (20)	180.5
M-DCB	147.01	1.283	1 (12.1)	173
P-DCB	147.01		10 (54.8)	174.12
1,1-DCE	96.95	1.218	500 (20)	37
cis,1,2-DCE	96.95	1.284	400 (41)	60.3
trans,1,2-DCE	96.95	1.256	400 (30)	47.5
1,2, -DCP	112.99	1.156	40 (19)	96.37
EDB	187.87	2.179	11 (20)	131.36
ethane[2]	30.07			-88.63
ethyl benzene	106.17	0.867	7 (20)	136.2
F-11	137.38	1.47 (25)	700 (20)	23.7
F-12	120.91	1.31 (25)	4250 (20)	-29.79
F-113	187.38	1.56 (25)	220 (20)	47.97
heptane	100.21	0.684	35 (20)	98.42
hexane	86.18	0.66	120 (20)	68.95
isooctane	114.23	0.692	40 (20.7)	99.2
methane[2]	16.04			-164
methylene Cl	84.94	1.327	349 (20)	40
octane	114.23	0.702	11 (20)	125.66
PCE	165.83	1.623	14 (20)	121
pentane	72.15	0.626	430 (20)	36.1
propane[2]	44.11			-42.07
1,1,1-TCA	133.41	1.339	100 (20)	74.1
1,1,2-TCA	133.41	1.44	30 (25)	113.77
1,2,4-TCB	181.46		1 (38.4)	208.4
TCE	131.39	1.464	100 (31)	87
toluene	92.15	0.867	10 (20)	110.6
O-xylene	106.17	0.88	5 (20)	144.4
M-xylene	106.17	0.861	6.5 (20)	138.4
P-xylene	106.17	0.864	6 (20)	139.1
vinyl chloride	62.5	0.91	2530 (20)	-13.37

[1]Liquid density is given for a temperature of 20°C unless otherwise noted.

[2]Gas at standard temperature and pressure.

Grout Specifications

Weight of Bentonite to Make Bentonite Slurry (20%, 25%, or 30%)

$$B = \frac{SW}{(1 - S)}$$

B = Bentonite (lbs. or kg.)
S = Percent solids (expressed as a decimal)
W = Water (lbs. or kg.)

English Units			
Water (gal.)	20% Bentonite (lbs.)	25% Bentonite (lbs.)	30% Bentonite (lbs.)
1	2.1	2.8	3.6
2	4.2	5.6	7.1
3	6.3	8.3	10.7
4	8.3	11.1	14.3
5	10.4	13.9	17.9
6	12.5	16.7	21.4
7	14.6	19.5	25
8	16.7	22.2	28.6
9	18.8	25	32.2
10	20.9	27.8	35.7

Metric Units			
Water (liters)	20% Bentonite (kg)	25% Bentonite (kg)	30% Bentonite (kg)
1	0.25	0.33	0.43
5	1.25	1.67	2.14
10	2.5	3.33	4.29
15	3.75	5	6.43
20	5	6.67	8.57
25	6.25	8.33	10.71
30	7.5	10	12.86
35	8.75	11.67	15
40	10	13.33	17.14

NOTE: The Nebraska Grout Study found that bentonite slurries often desiccate (dry out) and crack in the vadose zone and as such will not provide an effective long-term seal in many soil and geologic settings above the water table. For further information on this topic see this link: https://www.nationaldriller.com/articles/88484-drilling-fluids-the-nebraska-study-in-a-nutshell . A full copy of the Nebraska Grout Study report can be purchased at this link: https://marketplace.unl.edu/nemaps/nebraska-grout-task-force-in-situ-study-of-grout-material-2001-2006-and-2007-dye-tests.html .

Examples of Common Types of Grout

The following table contains examples of grout mixes that you may find useful. Contact your local regulatory authority to confirm the grout mix that is required for your site investigation.

Mix	Cement[1] (lbs.)	Water (gal.)	Bentonite[2] (lbs. or %)
Neat Cement, ASTM[3]	94	6-7	--
Cement + Bentonite, ASTM[4]	94	6-7	3-5%
Neat Cement, New Jersey[5]	94	5.2	--
Cement + Bentonite, New Jersey[5]	94	8.3	5.3% / 5 lbs.
Bentonite Slurry (25%), New Jersey[5]	--	18	50 lbs.
Cement + Bentonite (4%), Louisiana[6]	94	7.8	3.8 lbs.
Cement + Bentonite (5%), Louisiana[6]	94	8.5	4.7 lbs.
Cement + Bentonite (6%), Louisiana[6]	94	9.1	5.6 lbs.
Cement + Bentonite (7%), Louisiana[6]	94	9.8	6.6 lbs.
Bentonite Slurry, Louisiana[6]	--	--	25%

1 Type I Portland cement (ASTM C 150).

2 Bentonite powder (200 mesh) recommended for use with Geoprobe® piston pumps.

3 American Society of Testing and Materials (ASTM), 2016. ASTM D 5092 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers: 2016 Annual Book of ASTM Standards, Vol. 0408. Philadelphia, PA.

4 American Society for Testing and Materials (ASTM), 2016. ASTM D 5299 Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities: 2016 Annual Book of ASTM Standards, Vol. 04.08 Philadelphia, PA.

5 State of New Jersey, Department of Environmental Protection and Energy, Water Supply Element, Procedures for Drilling and Sealing Boring / Probe Holes, (Memorandum), January 8, 1990 (Revised 3/94).

6 Louisiana Department of Environmental Quality and Louisiana Department of Transportation and Development, Construction of Geotechnical Boreholes and Groundwater Monitoring Systems (Handbook), May 1993.

Volume of Open Annulus (per Linear foot)

Bore Hole Diameter (inches)	Nominal Casing Size/PVC (inches)	Volume of Annulus per linear foot					per linear foot	
		$in.^3$	ft^3	gallons	liters	Liters/m	Pounds of sand	Pounds of water
1	0.5	2.77	0.0016	0.012	0.045	0.149	0.16	0.1
1.25	0.5	8.08	0.0047	0.035	0.132	0.434	0.47	0.29
	0.75	4.34	0.0025	0.019	0.071	0.233	0.25	0.16
1.5	0.5	14.56	0.0084	0.063	0.238	0.782	0.84	0.53
	0.75	10.81	0.0063	0.047	0.177	0.581	0.63	0.39
	1	4.91	0.0028	0.021	0.08	0.264	0.28	0.18
2	0.5	31.05	0.02	0.13	0.509	1.669	1.8	1.12
	0.75	27.31	0.02	0.12	0.447	1.468	1.58	0.99
	1	21.4	0.01	0.09	0.351	1.15	1.24	0.77
	1.5	3.68	0.002	0.02	0.06	0.198	0.21	0.13
2.125	0.5	35.91	0.02	0.16	0.588	1.93	2.08	1.3
	0.75	32.17	0.02	0.14	0.527	1.729	1.86	1.16
	1	26.26	0.02	0.11	0.43	1.412	1.52	0.95
	1.5	8.54	0.005	0.04	0.14	0.459	0.49	0.31
2.5	0.5	52.25	0.03	0.23	0.856	2.809	3.02	1.89
	0.75	48.51	0.03	0.21	0.795	2.608	2.81	1.75
	1	42.61	0.02	0.18	0.698	2.29	2.47	1.54
	1.5	24.88	0.01	0.11	0.408	1.338	1.44	0.9
	2	5.74	0.003	0.02	0.094	0.309	0.33	0.21
3	0.75	74.43	0.04	0.32	1.22	4.001	4.31	2.69
	1	68.53	0.04	0.3	1.123	3.684	3.97	2.47
	1.5	50.8	0.03	0.22	0.832	2.731	2.94	1.83
	2	31.66	0.02	0.14	0.519	1.702	1.83	1.14
	2.5	6.92	0.004	0.03	0.113	0.372	0.4	0.25
3.25	1	83.25	0.05	0.36	1.364	4.475	4.82	3.01
	1.5	65.53	0.04	0.28	1.074	3.522	3.79	2.37
	2	46.39	0.03	0.2	0.76	2.494	2.68	1.68
	2.5	21.65	0.01	0.09	0.355	1.164	1.25	0.78
4.25	1	153.94	0.09	0.67	2.522	8.275	8.91	5.56
	1.5	136.21	0.08	0.59	2.232	7.322	7.88	4.92
	2	117.07	0.07	0.51	1.918	6.293	6.78	4.23
	2.5	92.33	0.05	0.4	1.513	4.964	5.34	3.33
6	2	286.13	0.17	1.24	4.688	15.38	16.6	10.33
	2.5	261.39	0.15	1.13	4.283	14.05	15.1	9.44
	3	223.84	0.13	0.97	3.667	12.03	13	8.08
	4	148.44	0.09	0.64	2.432	7.98	8.6	5.36
8	2	550.03	0.32	2.38	9.012	29.57	31.8	19.9
	2.5	525.29	0.3	2.27	8.606	28.24	30.4	19
	3	487.73	0.28	2.11	7.991	26.22	28.2	17.6
	4	412.34	0.24	1.78	6.756	22.17	23.9	14.9
8.25	2	588.31	0.34	2.55	9.639	31.63	34	21.2
	2.5	563.57	0.33	2.44	9.234	30.3	32.6	20.4
	3	526.02	0.3	2.28	8.618	28.28	30.4	19
	4	450.62	0.26	1.95	7.383	24.22	26.1	16.3

Grout Specifications

Volume of Grout to Fill Probe Hole (in English Units) [1]

This information applies to the GP350 and GP300 Injection / Grout Systems. Data listed is the volume for each cylinder (these systems each have two cylinders).

Remember: 1) Each pump stroke is approx. 13 in^3 in volume.
2) 1 gallon = 231 in^3.
3) It takes approx. 18 cylinder strokes to pump 1 gallon.

Hole Diameter = 1.00 in.			Hole Diameter = 1.25 in.			Hole Diameter = 1.50 in.			Hole Diameter = 1.75 in.		
Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)	Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)	Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)	Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)
1	<0.0	1	1	0.1	2	1	0.1	2	1	0.1	2
2	0.1	2	2	0.1	3	2	0.2	4	2	0.3	5
3	0.1	3	3	0.2	4	3	0.3	5	3	0.4	7
4	0.2	3	4	0.3	5	4	0.4	7	4	0.5	9
5	0.2	4	5	0.3	6	5	0.5	9	5	0.6	12
10	0.4		10	0.6		10	0.9		10	1.3	
15	0.6		15	1		15	1.4		15	1.9	
20	0.8		20	1.3		20	1.8		20	2.5	
25	1		25	1.6		25	2.3		25	3.1	
30	1.2		30	1.9		30	2.8		30	3.8	
35	1.4		35	2.2		35	3.2		35	4.4	
40	1.6		40	2.5		40	3.7		40	5	
45	1.8		45	2.9		45	4.1		45	5.6	
50	2		50	3.2		50	4.6		50	6.3	
55	2.2		55	3.5		55	5		55	6.9	
60	2.4		60	3.8		60	5.5		60	7.5	
65	2.7		65	4.1		65	6		65	8.1	
70	2.9		70	4.5		70	6.4		70	8.8	
75	3.1		75	4.8		75	6.9		75	9.4	
80	3.3		80	5.1		80	7.3		80	10	

Hole Diameter = 2.00 in.			Hole Diameter = 2.25 in.			Hole Diameter = 2.50 in.			Hole Diameter = 3.50 in.		
Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)	Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)	Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)	Depth (feet)	Volume (gallons)	Pump Strokes (apprx. #)
1	0.2	3	1	0.2	4	1	0.3	5	1	0.5	9
2	0.3	6	2	0.4	8	2	0.5	10	2	1	18
3	0.5	9	3	0.6	11	3	0.8	14	3	1.5	27
4	0.7	12	4	0.8	15	4	1	19	4	2	36
5	0.8	15	5	1	19	5	1.3	23	5	2.5	45
10	1.6		10	2.1		10	2.5		10	5	
15	2.4		15	3.1		15	3.8		15	7.5	
20	3.3		20	4.1		20	5.1		20	10	
25	4.1		25	5.2		25	6.4		25	12.5	
30	4.9		30	6.2		30	7.6		30	15	
35	5.7		35	7.2		35	8.9		35	17.5	
40	6.5		40	8.3		40	10.2		40	20	
45	7.3		45	9.3		45	11.5		45	22.5	
50	8.2		50	10.3		50	12.7		50	25	
55	9		55	11.4		55	14		55	27.5	
60	9.8		60	12.4		60	15.3		60	30	
65	10.6		65	13.4		65	16.6		65	32.5	
70	11.4		70	14.5		70	17.8		70	35	
75	12.2		75	15.5		75	19.1		75	37.5	
80	13		80	16.5		80	20.4		80	40	

[1] Loss of fluid to the formation is common, especially in coarse-grained materials. Based on site specific experience, the operator may need to prepare 10% to 20% excess volume to account for loss to the formation.

Volume of Grout to Fill Probe Hole (in Metric Units)[1]

Remember: 1) Each pump stroke is approx. 0.2 Liters in volume.
2) It takes approx. 5 cylinder strokes to pump 1Liter.

Hole Diameter = 25.4 mm			Hole Diameter = 31.8 mm			Hole Diameter = 38.1 mm			Hole Diameter = 44.5 mm		
Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)	Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)	Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)	Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)
0.5	0.3	2	0.5	0.4	2	0.5	0.6	3	0.5	0.8	5
1	0.5	3	1	0.8	4	1	1.1	6	1	1.6	10
2	1		2	1.6		2	2.3		2	3.2	19
4	2		4	3.2		4	4.6		4	6.4	
6	3		6	4.8		6	6.8		6	9.6	
8	4.1		8	6.4		8	9.1		8	12.8	
10	5.1		10	7.9		10	11.4		10	16.0	
12	6.1		12	9.5		12	13.7		12	19.2	
14	7.1		14	11.1		14	16		14	22.4	
16	8.1		16	12.7		16	18.2		16	25.6	
18	9.1		18	14.3		18	20.5		18	28.8	
20	10.1		20	15.9		20	22.8		20	32.0	
22	11.1		22	17.5		22	25.1		22	35.2	
24	12.2		24	19.1		24	27.3		24	38.4	
26	13.2		26	20.6		26	29.6		26	41.6	
28	14.2		28	22.2		28	31.9		28	44.8	
30	15.2		30	23.8		30	34.2		30	48.0	

Hole Diameter = 50.8 mm			Hole Diameter = 57.2 mm			Hole Diameter = 63.5 mm			Hole Diameter = 88.9 mm		
Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)	Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)	Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)	Depth (meters)	Volume (liters)	Pump Strokes (apprx. #)
0.5	1	6	0.5	1.3	7	0.5	1.6	8	0.5	3.1	16
1	2	11	1	2.6	13	1	3.2	16	1	6.2	31
2	4.1		2	5.1		2	6.3		2	12.4	
4	8.1		4	10.3		4	12.7		4	24.8	
6	12.2		6	15.4		6	19		6	37.2	
8	16.2		8	20.5		8	25.3		8	49.6	
10	20.3		10	25.7		10	31.7		10	62	
12	24.3		12	30.8		12	38		12	74.4	
14	28.4		14	36		14	44.3		14	86.9	
16	32.4		16	41.1		16	50.6		16	99.3	
18	36.5		18	46.2		18	57		18	111.7	
20	40.5		20	51.4		20	63.3		20	124.1	
22	44.6		22	56.5		22	69.6		22	136.5	
24	48.6		24	61.6		24	76		24	148.9	
26	52.7		26	66.8		26	82.3		26	161.3	
28	56.7		28	71.9		28	88.6		28	173.7	
30	60.8		30	77.1		30	95		30	186.1	

[1] Loss of fluid to the formation is common, especially in coarse-grained materials. Based on site specific experience, the operator may need to prepare 10% to 20% excess volume to account for loss to the formation.

Grout Specifications

Volume of Grout to Fill Geoprobe® Monitoring Well Annulus [1]

0.5-in. x 1.4-in. OD (12.7 mm x 35.6 mm)

For 0.5-in. x 1.4-in. OD Monitoring Wells		For 12.7 mm x 35.6 mm OD Monitoring Wells	
Riser Diameter (inches) = 0.8 *Probe Hole Diameter (inches) = 2.5*		Riser Diameter (mm) = 20.3 Probe Hole Diameter (mm) = 63.5	
Depth (feet)	**Volume (gallons)**	**Depth (meters)**	**Volume (liters)**
10	2.3	2	5.7
15	3.4	4	11.4
20	4.6	6	17.1
25	5.7	8	22.7
30	6.9	10	28.4
35	8	12	34.1
40	9.2	14	39.8
45	10.3	16	45.5
50	11.4	18	51.2
55	12.6	20	56.8
60	13.7	22	62.5
65	14.9	24	68.2
70	16	26	73.9
75	17.2	28	79.6
80	18.3	30	85.3
85	19.4		
90	20.6		
95	21.7		
100	22.9		

Remember: Subtract length of screen and grout barrier from well depth.

1.0-in. x 2.5-in. OD (25.4 mm x 63.5 mm)

For 1.0-in. x 2.5-in. OD Monitoring Wells		For 25.4 mm x 63.5 mm OD Monitoring Wells	
Riser Diameter (inches) = 1.3 *Probe Hole Diameter (inches) = 3.6*		Riser Diameter (mm) = 33.0 Probe Hole Diameter (mm) = 91.4	
Depth (feet)	**Volume (gallons)**	**Depth (meters)**	**Volume (liters)**
10	4.6	2	11.4
15	6.9	4	22.8
20	9.2	6	34.2
25	11.5	8	45.6
30	13.8	10	57
35	16.1	12	68.4
40	18.4	14	79.8
45	20.7	16	91.2
50	23	18	102.7
55	25.3	20	114.1
60	27.6	22	125.5
65	29.9	24	136.9
70	32.2	26	148.3
75	34.5	28	159.7
80	36.8	30	171.1
85	39.1		
90	41.4		
95	43.7		
100	46		

Remember: Subtract length of screen and grout barrier from well depth.

Volume of Grout to Fill Cone Penetrometer Hold with Grouting Tool (GT10252) [1]

Using Geoprobe's CPT Grouting Tool (GT10252) and 1.25-in. probe rods			Using Geoprobe's CPT Grouting Tool (GT10252) and 31.8 mm probe rods		
	Probe Hole + Rods			Probe Hole + Rods	
Depth (feet)	**Volume (gallons)**	**Pump Strokes (apprx. #)**	**Depth (meters)**	**Volume (liters)**	**Pump Strokes (apprx. #)**
1	0.2	3	0.5	1	6
2	0.3	6	1	2.1	11
3	0.5	9	2	4.1	
4	0.7	12	4	8.3	
5	0.8	15	6	12.4	
10	1.7		8	16.5	
15	2.5		10	20.7	
20	3.3		12	24.8	
25	4.2		14	28.9	
30	5		16	33	
35	5.8		18	37.2	
40	6.7		20	41.3	
45	7.5		22	45.4	
50	8.3		24	49.6	
55	9.2		26	53.7	
60	10		28	57.8	
65	10.8		30	62	
70	11.7				
75	12.5				
80	13.3				

Remember (English Units):

1) Each pump stroke is approx. 13 in^3 in volume.

2) 1 gallon = 231 in^3.

3) It takes approx. 18 cylinder strokes to pump 1 gallon.

Remember (Metric Units):

1) Each pump stroke is approx. 0.2 Liters in volume.

2) It takes approx. 5 cylinder strokes to pump 1 Liter.

[1] Loss of fluid to the formation is common, especially in coarse-grained materials. Based on site specific experience, the operator may need to prepare 10% to 20% excess volume to account for loss to the formation.