APPENDIX A

SUMMARY OF WELLS IN THE CTSA AND VICINITY

TABLE A.1
Summary of Wells in the CTSA and Vicinity

Cadastrals	Well	ADWR Registration Number	Owner	Use	Completion Date	Total Depth	Measuring Point Elevation[1]	Screened Interval	Screened Material	Status [2]
D-23-24										
21cdd	TM-18	522579	Phelps Dodge	assessment	10/27/88	787.5	5140.57	not completed	Pinal Schist	abandoned
22cda	TM-21	525148	Phelps Dodge	assessment	08/08/89	630	5153.36	not completed	Paleozoic sediments	abandoned
27acc	TM-43	564729	Phelps Dodge	monitoring	11/10/97	830	4956.436	720-800	Morita Formation	active
27acc	TM-43A	564726	Phelps Dodge	monitoring	10/28/97	215	4954.672	108-215	basin fill and Morita Formation	active
27bad	TM-22	525146	Phelps Dodge	assessment	09/09/89	1000	5077.08	900-1000	Paleozoic sediments	abandoned
27dad	TM-43B	565004	Phelps Dodge	monitoring	10/29/97	215	4907.293	130-215	Morita Formation	active
27add	TM-43C	565005	Phelps Dodge	monitoring	11/12/97	270	4940.878	175-270	Morita Formation	active
27bad	TM-44	564730	Phelps Dodge	monitoring	10/26/97	1150	5045.6	1020-1150	Paleozoic limestone	active
27bbc	TM-46	564727	Phelps Dodge	monitoring	12/12/97	1080	5052.694	919-1080	Paleozoic limestone	active
27bdd	TM-23	525555	Phelps Dodge	assessment	08/18/89	220	4961.5	155-215	Morita Formation	abandoned
28add	TM-45	564728	Phelps Dodge	monitoring	11/17/97	520	4998.252	384-520	Morita Formation	active
33bca	TM-9	522577	Phelps Dodge	monitoring	01/26/89	940	4889.12	870-930	Glance Conglomerate	abandoned
33dbc	TM-27	525143	Phelps Dodge	assessment	09/05/89	410	4840.66	306-367	Morita Formation	abandoned
34baa	TM-25	525145	Phelps Dodge	assessment	08/18/89	805	4947.78	not completed	Glance Conglomerate	abandoned
34bbb	GL-3	539782	Phelps Dodge	monitoring	08/11/93	825	4909.115	780-820	Glance Conglomerate	active
34bbb	TM-33	525140	Phelps Dodge	assessment	10/25/89	500	4903.57	not completed	Glance Conglomerate	abandoned
34bda	GL-1	539785	Phelps Dodge	monitoring	08/20/93	833	4915.02	768-808	Glance Conglomerate	active
34cda	TM-26	525144	Phelps Dodge	assessment	09/07/89	800	4917.18	not completed	Glance Conglomerate	abandoned
35abd	TM-35	525139	Phelps Dodge	monitoring	10/03/89	380	4898.88	249-310	Glance Conglomerate	abandoned
35bba	TM-3	522575	Phelps Dodge	monitoring	12/16/88	200	4883.688	150-200	Glance Conglomerate	active
35cbd	593116	593116	City of Bisbee	monitoring	07/16/02	150	4836.59	90-150	limestone (or Glance Conglomerate?)	active
35ccb	TM-28	525142	Phelps Dodge	assessment	08/04/89	140	4813.27	not completed	Glance Conglomerate	abandoned
D-24-23										
13abb	NSD-2	527587	Naco Sanitary District	monitoring	04/26/90	120	4527	95-129	basin fill	active
13abc	AWC-4	616584	Arizona Water Co.	municipal	01/01/59	337	4540		basin fill	active
13abc	AWC-2	616586	Arizona Water Co.	municipal	01/01/55	333	4530		basin fill	active
13abd	AWC-3	616585	Arizona Water Co.	municipal	07/20/56	270	4540		basin fill	active
13abd2	AWC-5	590620	Arizona Water Co.	municipal	06/24/02	1183	4540e	163-603 and 623-1163	basin fill, clay rich sediments to 1140'; volcanic 1140-1163'	active
13baa	NSD-1		Naco Sanitary District	monitoring			4535e			
13bbc	NSD-3	527586	Naco Sanitary District	monitoring	05/07/90	66.32	4515	78-150	basin fill	active
D-24-24										
01ccc	TM-8	522817	Phelps Dodge	monitoring	01/20/89	820	4710.49	757-817	Glance Conglomerate	transferred to land owner
02bcc	TM-4	522693	Phelps Dodge	assessment	01/17/89	175	4770.38	125-175	Glance Conglomerate	abandoned
03caa	TM-29	525141	Phelps Dodge	assessment	08/07/89	140	4759.63	85-140	basin fill and Morita Formation	abandoned
03cab1	TM-29A	525137	Phelps Dodge	assessment	08/08/89	165	4758.08	85-165	basin fill and Morita Formation	abandoned
03cab2	TM-29B	525136	Phelps Dodge	assessment	08/10/89	165	4757.61	85-165	basin fill and Morita Formation	abandoned
03cbd	TM-41		Phelps Dodge	monitoring	1997	210	4760.958	145-200	Morita Formation	active
04aaa	BF-1	539783	Phelps Dodge	monitoring	08/15/93	400	4815.13	325-385	Mixed (25' basin fill, 30' Morita, 5'	active
04aac1	TM-2	522573	Phelps Dodge	monitoring	12/14/88	640	4794.891	280-360	basin fill	active
04aac2	TM-2A	522574	Phelps Dodge	monitoring	02/10/89	925	4794.132	825-925	Glance Conglomerate	active
04bbd	TM-7	522576	Phelps Dodge	monitoring	11/04/88	350	4768.927	259-349	Morita Formation	active
04bdd	BF-2	539786	Phelps Dodge	monitoring	08/05/93	326	4750.37	265-305	basin fill	active (dry)
05bac	TM-10	522696	Phelps Dodge	monitoring	11/06/89	290	4741.2	240-290	Morita Formation	active
05dbb2	SJ-9	602134	Duree/Bullard	domestic	09/06/74	300	4730		basin fill	active
06bcc	TM-15	522699	Phelps Dodge	assessment	01/11/89	325	4711.7	260-320	Morita Formation	transferred to land owner

TABLE A.1
Summary of Wells in the CTSA and Vicinity

Cadastrals	Well	ADWR Registration Number	Owner	Use	Completion Date	Total Depth	Measuring Point Elevation[1]	Screened Interval	Screened Material	Status [2]
07bcb2	TM-14	522816	Phelps Dodge	assessment	01/12/89	215	4626.2	165-215	basin fill	transferred to land owner
08bcc	TM-13	522698	Phelps Dodge	assessment	01/05/89	200	4617.3	140-200	basin fill	transferred to land owner
08dac2	TM-30A	525558	Phelps Dodge	assessment	09/26/89	700	4635.89	not completed	Morita Formation	abandoned
08dad	TM-30	525548	Phelps Dodge	assessment	09/25/89	700	4636.92	not completed	Morita Formation	abandoned
08ddc1	TM-19A	522580	Phelps Dodge	monitoring	11/16/88	700	4632.45	585-695	Morita Formation	active
08ddc2	TM-19	522581	Phelps Dodge	monitoring	11/17/88	210	4626.9	150-210	basin fill	active
09aab1	TM-1	522569	Phelps Dodge	assessment	11/01/88	265	4714.5	215-265	basin fill	abandoned
09aab1	TM-1A	525557	Phelps Dodge	assessment	09/09/89	265	4712.43	204-265	basin fill and Morita Formation	abandoned
09bbc	TM-37	525552	Phelps Dodge	assessment	10/09/89	700	4670.86	464-700	Morita Formation and Glance	abandoned
09bca	MW-1	903992	City of Bisbee/SJWWTF	monitoring	03/02/06	430	4680e	350-410	basin fill	active
09caa	TM-38	525553	Phelps Dodge	assessment	10/03/89	700	4667.97	375-700	Morita Formation	abandoned
09dcc	TM-42		Phelps Dodge	monitoring	1997	250	4654.033	180-250	basin fill and Morita Formation	active
10acd	TM-16	522578	Phelps Dodge	monitoring	12/15/88	115	4705.54	65-115	Morita Formation	active
10cbd	TM-39	525554	Phelps Dodge	assessment	10/22/89	424	4651.71	118-424	Morita Formation	abandoned
10ddd	NWC-4	627685	Naco Water Co	municipal	01/01/26	379	4685		Morita Formation	active
10dcb	BJ-1					220	4680		Morita Formation	unknown
11abd	BJ-2					250	4710		Glance Conglomerate	unknown
11cbc1	BJ-3					430	4720		Glance Conglomerate	unknown
11cbc2	BJ-4					400	4720		Glance Conglomerate	unknown
11cbc3	ELKS	628547	B.P.O. Elks No. 671	domestic	08/18/61	800	4710e		unknown	active
11dac	NWC-5	627696	Naco Water Co	municipal	01/01/60	175	4680		Morita Formation	active
11dcc	BJ-5					318	4660		Glance Conglomerate	unknown
14bcc	TM-6	522695	Phelps Dodge	assessment	01/24/89	200	4695.852	150-200	Morita Formation	transferred to land owner
16aca	TM-17	522700	Phelps Dodge	assessment	01/17/89	200	4631	150-200	Mural Limestone	transferred to land owner
17aaa	GW-47	587635	Garner	domestic	10/12/01	680	4628.11	580-660	Morita Formation	active
17aaa	558557	558557	Garner	domestic	09/04/96	300	4628e	180-220, 240-300	basin fill	unknown
17bbb	637069	637069	Olmstead	domestic	07/29/66	220	4595e		basin fill	active
18aab	TM-11	522815	Phelps Dodge	monitoring	11/18/88	160	4573.1	99-159	basin fill	transferred to land owner
18aad	641802	641802	Grout	domestic	01/01/60	200	4585e		basin fill	active
18add	NWC-3	627684	Naco Water Co	municipal	01/01/30	179	4560e		basin fill	active
18add	NWC-3 replacement	203321	Naco Water Co	municipal	02/22/04	312	4560e	252-312	basin fill	active
18db	802336	802336	City of Bisbee	irrigation	02/14/34	222	4580e		basin fill	active
19bab	NWC-1	627682	Naco Water Co	municipal	09/24/51	215	4620e		basin fill	active
18cd/cad	NWC-2	627683	Naco Water Co	municipal	08/02/59	210	4590e		basin fill	active
18cad	NWC-2 replacement	562944	Naco Water Co	municipal	06/11/97	312	4590e	212-312	basin fill	active
18cca	NWC-6	575700	Naco Water Co	municipal	09/15/99	410	4590e	180-279, 302-340	basin fill	active
18daa	903984	903984	City of Bisbee	monitoring	01/20/06	170	4560	92-152	basin fill	active
20bbd	TM-12	522697	Phelps Dodge	assessment	01/12/89	175	4589.4	121-171	basin fill	transferred to land owner
21aba	TM-5	522694	Phelps Dodge	monitoring	01/13/89	160	4604.463	120-160	basin fill	transferred to land owner

Notes:

[1] ft amsl = feet above mean sea level. Water levels from PD are referenced to a "collar elevation." e = elevation estimated from topographic map

[2] abandoned TM wells were abandoned by 1990

APPENDIX B

HISTORIC WATER LEVELS FOR SELECT WELLS
(Tables B.1 through B.5)

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
AWC-2	D-24-23-13abc	4530	01/21/57	85	4445	ADWR GWSI
AWC-2		4530	09/01/77	90.5	4439.5	ADWR GWSI
AWC-2		4540	11/21/85	91.6	4448.4	Litten, 1987
AWC-2		4530	12/04/90	90.1	4439.9	ADWR GWSI
AWC-2		4530	01/28/98	99.2	4430.8	ADWR GWSI
AWC-2		4530	12/15/99	104	4426	ADWR GWSI
AWC-2		4530	12/04/01	115.3	4414.7	ADWR GWSI
AWC-3	D-24-23-13abd	4540	03/20/68	90.4	4449.6	ADWR GWSI
AWC-3		4540	02/19/86	89.8	4450.2	ADWR GWSI
AWC-3		4540	12/15/99	112.7	4427.3	ADWR GWSI
AWC-3		4540	02/26/01	100.4	4439.6	ADWR GWSI
AWC-4	D-24-23-13abc	4520	02/19/86	85.2	4435	Litten, 1987
AWC-4		4540	12/04/90	95.1	4444.9	ADWR GWSI
AWC-4		4540	01/28/98	103.9	4436.1	ADWR GWSI
AWC-4		4540	12/15/99	107.2	4432.8	ADWR GWSI
AWC-4		4540	12/04/01	115.5	4424.5	ADWR GWSI
BF-1	D-24-24-04aaa		09/16/93		4482.30	SET, 1998
BF-1			10/06/93		4481.30	SET, 1998
BF-1			11/23/93		4482.00	SET, 1998
BF-1			01/04/94		4481.90	SET, 1998
BF-1			06/25/96		4473.90	SET, 1998
BF-1			08/22/96		4473.40	SET, 1998
BF-1			09/25/96		4473.20	SET, 1998
BF-1			10/29/96		4473.15	SET, 1998
BF-1			12/19/96		4473.00	SET, 1998
BF-1			01/29/97		4472.70	SET, 1998
BF-1			02/27/97		4472.75	SET, 1998
BF-1			04/16/97		4472.35	SET, 1998
BF-1			10/10/97		4479.05	SET, 1998
BF-1			01/05/98		4473.80	SET, 1998
BF-1		4820.754	06/01/99	344.05	4476.70	PD file
BF-1		4820.754	03/01/00	345.70	4475.05	PD file
BF-1		4820.754	06/01/00	346.55	4474.20	PD file
BF-1		4820.754	09/01/00	347.20	4473.55	PD file
BF-1		4820.754	12/01/00	348.10	4472.65	PD file
BF-1		4820.754	02/01/01	348.20	4472.55	PD file
BF-1		4820.754	06/01/01	348.25	4472.50	PD file
BF-1		4820.754	10/01/01	348.30	4472.45	PD file
BF-1		4820.754	02/01/02	348.35	4472.40	PD file
BF-1		4820.754	06/01/02	348.20	4472.55	PD file
BF-1		4820.754	09/01/02	348.25	4472.50	PD file
BF-1		4820.754	11/01/02	348.30	4472.45	PD file
BF-1		4820.754	01/01/03	348.10	4472.65	PD file
BF-1		4820.754	05/01/03	347.80	4472.95	PD file
BF-1		4820.754	08/01/03	347.40	4473.35	PD file
BF-1		4820.754	12/01/03	347.30	4473.45	PD file
BF-1		4820.754	02/01/04	347.30	4473.45	PD file
BF-1		4820.754	05/01/04	347.35	4473.40	PD file
BF-1		4820.754	08/01/04	347.30	4473.45	PD file
BF-1		4820.754	11/01/04	347.30	4473.45	PD file
BF-1		4820.754	02/01/05	347.60	4473.15	PD file
BF-1		4820.754	06/01/05	347.65	4473.10	PD file
BF-1		4820.754	09/01/05	347.80	4472.95	PD file
BF-1		4820.754	11/01/05	348.00	4472.75	PD file
BF-1		4820.754	02/01/06	348.10	4472.65	PD file
BF-1		4820.754	05/01/06	348.20	4472.55	PD file
BF-1		4820.754	08/01/06	348.30	4472.45	PD file
BF-2	D-24-24-04bdd		09/16/93		4469.00	SET, 1998
BF-2			10/06/93		4468.40	SET, 1998
BF-2			11/26/93		4468.00	SET, 1998
BF-2			01/04/94		4467.50	SET, 1998
BF-2			06/25/96		4459.00	SET, 1998
BF-2			08/22/96		4458.45	SET, 1998
BF-2			09/25/96		4458.00	SET, 1998
BF-2			10/29/96		4457.90	SET, 1998

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
BF-2			12/19/96		4457.35	SET, 1998
BF-2			01/29/97		4457.05	SET, 1998
BF-2			02/27/97		4456.90	SET, 1998
BF-2			04/16/97		4456.35	SET, 1998
BF-2			10/10/97		4456.70	SET, 1998
BF-2			01/05/98		4456.10	SET, 1998
BF-2		4750.37	06/01/99	290" no water		PD file
BF-2		4750.37	03/01/00	290" no water		PD file
BJ-1	D-24-24-10dcb	4680	11/19/85	133.00	4547.00	Litten, 1987
BJ-1			06/22/88		4546.95	SET, 1998
BJ-2	D-24-24-11abd	4710	11/20/85	14.30	4695.70	Litten, 1987
BJ-2			06/27/88		4648.65	SET, 1998
BJ-3	D-24-24-11cbc1	4720	11/19/85	79.80	4640.20	Litten, 1987
BJ-3			05/10/88		4594.95	SET, 1998
BJ-4	D-24-24-11cbc2	4720	11/19/85	87.60	4640.20	Litten, 1987
BJ-4			05/10/88		4596.38	SET, 1998
BJ-5	D-24-24-11dcc	4660	11/19/85	36.40	4623.60	Litten, 1987
BJ-5			09/02/88		4611.43	SET, 1998
GL-1	D-23-24-34bda		09/16/93		4128.32	SET, 2000
GL-1			10/06/93		4135.32	SET, 2000
GL-1			11/23/93		4133.32	SET, 2000
GL-1			01/04/94		4134.22	SET, 2000
GL-1			04/24/94		4134.00	SET, 2000
GL-3	D-23-24-34bbb		09/16/93		4132.08	SET, 2000
GL-3			10/06/93		4132.98	SET, 2000
GL-3			11/23/93		4134.38	SET, 2000
GL-3			01/04/94		4135.28	SET, 2000
GL-3			04/29/94		4136.00	SET, 2000
GL-3			06/25/96	748.70	4151.30	WMC, 2006
GL-3			08/22/96	745.00	4155.00	WMC, 2006
GL-3			09/25/96	743.70	4156.30	WMC, 2006
GL-3			10/29/96	742.70	4157.30	WMC, 2006
GL-3			12/19/96	741.30	4158.70	WMC, 2006
GL-3			10/10/97	731.95	4168.05	WMC, 2006
GL-3			01/21/98	731.30	4168.70	WMC, 2006
GL-3			05/06/98	727.60	4180.08	WMC, 2006
GL-3			10/01/98	723.80	4183.88	WMC, 2006
GL-3			01/25/99	720.80	4186.88	WMC, 2006
GL-3		4909.115	06/01/99	718.50	4190.62	PD file
GL-3		4909.115	03/01/00	714.70	4194.42	PD file
GL-3		4909.115	06/01/00	711.35	4197.77	PD file
GL-3		4909.115	09/01/00	707.80	4201.32	PD file
GL-3		4909.115	12/01/00	703.05	4206.07	PD file
GL-3		4909.115	02/01/01	700.00	4209.12	PD file
GL-3		4909.115	06/01/01	697.50	4211.62	PD file
GL-3		4909.115	10/01/01	693.20	4215.92	PD file
GL-3		4909.115	02/01/02	690.10	4219.02	PD file
GL-3		4909.115	06/01/02	687.10	4222.02	PD file
GL-3		4909.115	09/01/02	705.55	4203.57	PD file
GL-3		4909.115	11/01/02	712.20	4196.92	PD file
GL-3		4909.115	01/01/03	683.40	4225.72	PD file
GL-3		4909.115	05/01/03	681.55	4227.57	PD file
GL-3		4909.115	08/01/03	680.90	4228.22	PD file
GL-3		4909.115	12/01/03	679.20	4229.92	PD file
GL-3		4909.115	02/01/04	679.00	4230.12	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
GL-3		4909.115	05/01/04	678.60	4230.52	PD file
GL-3		4909.115	08/01/04	676.25	4232.87	PD file
GL-3		4909.115	11/01/04	675.70	4233.42	PD file
GL-3		4909.115	02/01/05	674.50	4234.62	PD file
GL-3		4909.115	06/01/05	674.20	4234.92	PD file
GL-3		4909.115	09/01/05	673.95	4235.17	PD file
GL-3		4909.115	11/01/05	672.10	4237.02	PD file
GL-3		4909.115	02/01/06	671.70	4237.42	PD file
GL-3		4909.115	05/01/06	670.20	4238.92	PD file
GL-3		4909.115	08/01/06	669.00	4240.12	PD file
GW-47		4627.01	02/01/02	184.65	4442.36	PD file
GW-47		4627.01	06/01/02	185.30	4441.71	PD file
GW-47		4627.01	09/01/02	186.00	4441.01	PD file
GW-47		4627.01	11/01/02	186.50	4440.51	PD file
GW-47		4627.01	01/01/03	186.30	4440.71	PD file
GW-47		4627.01	05/01/03	187.50	4439.51	PD file
GW-47		4627.01	12/01/03	187.70	4439.31	PD file
GW-47		4627.01	02/01/04	188.02	4438.99	PD file
GW-47		4627.01	08/01/04	188.90	4438.11	PD file
GW-47		4627.01	11/01/04	189.15	4437.86	PD file
GW-47		4627.01	02/01/05	189.10	4437.91	PD file
GW-47		4627.01	06/01/05	194.30	4432.71	PD file
GW-47		4627.01	09/01/05	189.35	4437.66	PD file
GW-47		4627.01	11/01/05	189.75	4437.26	PD file
MW-1	D-24-24-09bca	4703	08/01/06	240	4463.00	ADWR, 2006
NWC-1	D-24-24-19bb	4600	11/20/85	138	4462	Litten, 1987
NWC-1			05/19/88		4457.25	SET, 1998
NWC-3	D-24-24-18add	4560	03/20/68	91	4469	ADWR GWSI
NWC-3			09/22/77	96	4464	ADWR GWSI
NWC-3			05/18/88		4466.22	SET, 1998
NWC-3 replacement		4560	02/22/04	140	4420.00	ADWR, 2006
NWC-4	D-24-24-10ddd	4685	03/21/69	180.5	4505	ADWR GWSI
NWC-4		4685	09/22/77	216.4	4469	ADWR GWSI
NWC-4		4685	12/05/90	197	4488	ADWR GWSI
NWC-4		4685	09/20/04	173	4512	ADWR GWSI
NWC-5	D-24-24-10ddc2	4680	11/19/85	170	4510.00	Litten, 1987
NWC-5		4680	05/18/88		4586.04	SET, 1998
SJ-9	D-24-24-5dbb2		06/16/88		4479.49	SET, 1998
TM-1	D-24-24-09aab		07/19/89		4487.20	SET, 1998
TM-1A	D-24-24-09aab2	4712.43	11/06/89	225.07	4487.36	ELMA, 1990
TM-2	D-24-24-04aac1		10/18/88		4502.54	SET, 1998
TM-2			01/27/89		4502.39	SET, 1998
TM-2			02/27/89		4501.49	SET, 1998
TM-2			04/06/89		4500.64	SET, 1998
TM-2			05/01/89		4500.99	SET, 1998
TM-2			06/08/89		4499.14	SET, 1998
TM-2			07/13/89		4498.44	SET, 1998
TM-2			09/06/89		4497.44	SET, 1998
TM-2			10/22/89		4498.04	SET, 1998
TM-2		4791.72	11/06/89	294.00	4497.72	ELMA, 1990

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-2			11/06/89		4497.04	SET, 1998
TM-2			01/01/90	294.70	4497.72	WMC, 2006
TM-2			02/01/90	295.55	4496.17	WMC, 2006
TM-2			03/01/90	295.77	4495.95	WMC, 2006
TM-2			11/23/93		4474.74	SET, 1998
TM-2			01/04/94		4474.14	SET, 1998
TM-2			06/25/96		4464.90	SET, 1998
TM-2			08/22/96		4464.45	SET, 1998
TM-2			09/25/96		4464.15	SET, 1998
TM-2			10/29/96		4464.00	SET, 1998
TM-2			12/19/96		4463.60	SET, 1998
TM-2			01/29/97		4463.20	SET, 1998
TM-2			02/27/97		4463.10	SET, 1998
TM-2			07/01/97		4461.75	SET, 1998
TM-2			01/05/98		4460.80	SET, 1998
TM-2		4794.891	06/01/99	332.55	4462.34	PD file
TM-2		4794.891	03/01/00	332.80	4462.09	PD file
TM-2		4794.891	06/01/00	333.20	4461.69	PD file
TM-2		4794.891	09/01/00	333.45	4461.44	PD file
TM-2		4794.891	12/01/00	333.75	4461.14	PD file
TM-2		4794.891	02/01/01	333.90	4460.99	PD file
TM-2		4794.891	06/01/01	334.15	4460.74	PD file
TM-2		4794.891	10/01/01	334.40	4460.49	PD file
TM-2		4794.891	02/01/02	334.50	4460.39	PD file
TM-2		4794.891	06/01/02	334.70	4460.19	PD file
TM-2		4794.891	09/01/02	334.85	4460.04	PD file
TM-2		4794.891	11/01/02	335.00	4459.89	PD file
TM-2		4794.891	01/01/03	335.05	4459.84	PD file
TM-2		4794.891	05/01/03	335.20	4459.69	PD file
TM-2		4794.891	08/01/03	335.35	4459.54	PD file
TM-2		4794.891	12/01/03	335.50	4459.39	PD file
TM-2		4794.891	02/01/04	335.70	4459.19	PD file
TM-2		4794.891	05/01/04	335.85	4459.04	PD file
TM-2		4794.891	08/01/04	335.95	4458.94	PD file
TM-2		4794.891	11/01/04	336.10	4458.79	PD file
TM-2		4794.891	02/01/05	336.45	4458.44	PD file
TM-2		4794.891	06/01/05	336.80	4458.09	PD file
TM-2		4794.891	09/01/05	337.00	4457.89	PD file
TM-2		4794.891	11/01/05	337.15	4457.74	PD file
TM-2		4794.891	02/01/06	337.60	4457.29	PD file
TM-2		4794.891	05/01/06	338.00	4456.89	PD file
TM-2		4794.891	08/01/06	338.50	4456.39	PD file
TM-2A	D-24-24-04aac2		02/24/89		4470.84	SET, 1998
TM-2A			03/03/89		4471.04	SET, 1998
TM-2A			10/22/89		4471.04	SET, 1998
TM-2A			11/30/89		4477.67	SET, 1998
TM-2A		4790.95	11/30/89	312.90	4478.05	ELMA, 1990
TM-2A			11/23/93		4443.60	SET, 1998
TM-2A			01/04/94		4466.30	SET, 1998
TM-2A			06/25/96		4468.15	SET, 1998
TM-2A			08/22/96		4460.35	SET, 1998
TM-2A			09/25/96		4461.00	SET, 1998
TM-2A			10/29/96		4462.30	SET, 1998
TM-2A			12/19/96		4463.25	SET, 1998
TM-2A			01/29/97		4463.25	SET, 1998
TM-2A			02/27/97		4463.00	SET, 1998
TM-2A			04/16/97		4462.30	SET, 1998
TM-2A			10/10/97		4460.70	SET, 1998
TM-2A			01/05/98		4460.20	SET, 1998

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-2A		4794.132	06/01/99	334.80	4459.33	PD file
TM-2A		4794.132	03/01/00	335.50	4458.63	PD file
TM-2A		4794.132	06/01/00	335.20	4458.93	PD file
TM-2A		4794.132	09/01/00	335.00	4459.13	PD file
TM-2A		4794.132	12/01/00	334.85	4459.28	PD file
TM-2A		4794.132	02/01/01	334.80	4459.33	PD file
TM-2A		4794.132	06/01/01	334.80	4459.33	PD file
TM-2A		4794.132	10/01/01	334.85	4459.28	PD file
TM-2A		4794.132	02/01/02	334.80	4459.33	PD file
TM-2A		4794.132	06/01/02	334.95	4459.18	PD file
TM-2A		4794.132	09/01/02	335.20	4458.93	PD file
TM-2A		4794.132	11/01/02	335.60	4458.53	PD file
TM-2A		4794.132	01/01/03	335.60	4458.53	PD file
TM-2A		4794.132	05/01/03	336.15	4457.98	PD file
TM-2A		4794.132	08/01/03	337.00	4457.13	PD file
TM-2A		4794.132	12/01/03	338.10	4456.03	PD file
TM-2A		4794.132	02/01/04	338.50	4455.63	PD file
TM-2A		4794.132	05/01/04	338.95	4455.18	PD file
TM-2A		4794.132	08/01/04	339.55	4454.58	PD file
TM-2A		4794.132	11/01/04	340.80	4453.33	PD file
TM-2A		4794.132	02/01/05	341.05	4453.08	PD file
TM-2A		4794.132	06/01/05	342.40	4451.73	PD file
TM-2A		4794.132	09/01/05	343.10	4451.03	PD file
TM-2A		4794.132	11/01/05	343.30	4450.83	PD file
TM-2A		4794.132	02/01/06	343.30	4450.83	PD file
TM-2A		4794.132	05/01/06	343.30	4450.83	PD file
TM-2A		4794.132	08/01/06	344.10	4450.03	PD file
TM-3	D-23-24-35bba		10/18/88		4762.79	SET, 1998
TM-3			01/27/89		4762.65	SET, 1998
TM-3			03/01/89		4762.19	SET, 1998
TM-3			04/06/89		4761.94	SET, 1998
TM-3			05/02/89		4761.64	SET, 1998
TM-3			06/01/89		4761.54	SET, 1998
TM-3			07/13/89		4761.19	SET, 1998
TM-3			09/06/89		4762.59	SET, 1998
TM-3			10/22/89		4760.79	SET, 1998
TM-3			11/06/89		4765.93	SET, 1998
TM-3		4880.58	11/06/89	114.00	4766.58	ELMA, 1990
TM-3			01/05/94		4771.29	SET, 1998
TM-3			6/25/1996		4759.95	SET, 1998
TM-3			08/22/96		4760.05	SET, 1998
TM-3			09/25/96		4760.10	SET, 1998
TM-3			10/29/96		4760.10	SET, 1998
TM-3			12/19/96		4760.10	SET, 1998
TM-3			01/29/97		4759.60	SET, 1998
TM-3			02/27/97		4759.40	SET, 1998
TM-3			04/16/97		4758.80	SET, 1998
TM-3			10/10/97		4647.70	SET, 1998
TM-3			01/05/98		4647.40	SET, 1998
TM-3		4883.688	06/01/99	121.45	4762.24	PD file
TM-3		4883.688	03/01/00	118.90	4764.79	PD file
TM-3		4883.688	06/01/00	118.40	4765.29	PD file
TM-3		4883.688	09/01/00	117.95	4765.74	PD file
TM-3		4883.688	12/01/00	117.60	4766.09	PD file
TM-3		4883.688	02/01/01	118.00	4765.69	PD file
TM-3		4883.688	06/01/01	118.35	4765.34	PD file
TM-3		4883.688	10/01/01	118.70	4764.99	PD file
TM-3		4883.688	02/01/02	119.10	4764.59	PD file
TM-3		4883.688	06/01/02	120.80	4762.89	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-3		4883.688	09/01/02	121.80	4761.89	PD file
TM-3		4883.688	11/01/02	122.20	4761.49	PD file
TM-3		4883.688	01/01/03	122.60	4761.09	PD file
TM-3		4883.688	05/01/03	122.85	4760.84	PD file
TM-3		4883.688	08/01/03	123.00	4760.69	PD file
TM-3		4883.688	12/01/03	123.65	4760.04	PD file
TM-3		4883.688	02/01/04	123.00	4760.69	PD file
TM-3		4883.688	05/01/04	123.00	4760.69	PD file
TM-3		4883.688	08/01/04	122.85	4760.84	PD file
TM-3		4883.688	11/01/04	122.50	4761.19	PD file
TM-3		4883.688	02/01/05	122.60	4761.09	PD file
TM-3		4883.688	06/01/05	122.90	4760.79	PD file
TM-3		4883.688	09/01/05	122.80	4760.89	PD file
TM-3		4883.688	11/01/05	122.40	4761.29	PD file
TM-3		4883.688	02/01/06	122.45	4761.24	PD file
TM-3		4883.688	05/01/06	122.50	4761.19	PD file
TM-3		4883.688	08/01/06	123.90	4759.79	PD file
TM-4	D-24-24-02bcc		06/23/89		4677.70	SET, 1998
TM-4			11/06/89		4680.88	SET, 1998
TM-4		4770.38	11/06/89	89.30	4681.08	ELMA, 1990
TM-5	D-24-24-21aba		10/18/88		4465.32	SET, 1998
TM-5			11/06/89		4464.42	SET, 1998
TM-5		4598.06	11/06/89	132.85	4465.21	ELMA, 1990
TM-5			06/25/96		4449.65	SET, 1998
TM-5			12/19/96		4448.35	SET, 1998
TM-5			04/16/97		4447.85	SET, 1998
TM-5			10/10/97		4446.70	SET, 1998
TM-5			01/05/98		4446.45	SET, 1998
TM-5		4604.463	06/01/99	153.05	4451.41	PD file
TM-5			09/01/05	no water		PD file
TM-6	D-24-24-14bcc		10/18/88		4531.80	SET, 1998
TM-6			11/06/89		4531.30	SET, 1998
TM-6		4690.22	11/06/89	157.70	4532.52	ELMA, 1990
TM-6			06/25/96		4531.00	SET, 1998
TM-6			12/19/96		4530.90	SET, 1998
TM-6			04/16/97		4530.95	SET, 1998
TM-6			10/10/97		4530.90	SET, 1998
TM-6			01/05/98		4531.05	SET, 1998
TM-6		4695.852	06/29/99	158.40	4537.45	PD file
TM-6		4695.852	03/01/00	158.20	4537.65	PD file
TM-6		4695.852	06/01/00	158.30	4537.55	PD file
TM-6		4695.852	09/01/00	158.40	4537.45	PD file
TM-6		4695.852	12/01/00	158.40	4537.45	PD file
TM-6		4695.852	02/01/02	158.30	4537.55	PD file
TM-6		4695.852	06/01/02	158.30	4537.55	PD file
TM-6		4695.852	10/01/02	158.25	4537.60	PD file
TM-6		4695.852	01/01/03	158.25	4537.60	PD file
TM-6		4695.852	05/01/03	158.30	4537.55	PD file
TM-6		4695.852	08/01/03	158.35	4537.50	PD file
TM-6		4695.852	12/01/03	158.40	4537.45	PD file
TM-6		4695.852	09/01/05	158.70	4537.15	PD file
TM-6		4695.852	11/01/05	158.50	4537.35	PD file
TM-6		4695.852	08/01/06	158.70	4537.15	PD file
TM-7	D-24-24-04bbd		10/18/88		4489.49	SET, 1998
TM-7			01/24/89		4493.89	SET, 1998
TM-7			02/27/89		4492.89	SET, 1998

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-7			04/04/89		4492.16	SET, 1998
TM-7			05/01/89		4492.34	SET, 1998
TM-7			06/06/89		4490.89	SET, 1998
TM-7			07/12/89		4490.39	SET, 1998
TM-7			09/06/89		4489.39	SET, 1998
TM-7			10/22/89		4490.39	SET, 1998
TM-7			11/06/89		4489.39	SET, 1998
TM-7		4766.15	11/06/89	276.18	4489.97	ELMA, 1990
TM-7			07/10/90		4484.40	SET, 1998
TM-7			10/11/90		4483.10	SET, 1998
TM-7			12/04/90	279.20	4491.00	ADWR GWSI
TM-7			01/28/91		4481.55	SET, 1998
TM-7			04/16/91		4480.40	SET, 1998
TM-7			07/15/91		4479.20	SET, 1998
TM-7			10/15/91		4477.85	SET, 1998
TM-7			01/15/92		4476.68	SET, 1998
TM-7			04/06/92		4475.70	SET, 1998
TM-7			07/20/92		4474.50	SET, 1998
TM-7			10/20/92		4473.30	SET, 1998
TM-7			04/19/93		4471.25	SET, 1998
TM-7			07/19/93		4470.25	SET, 1998
TM-7			08/19/93		4470.00	SET, 1998
TM-7			10/19/93		4469.00	SET, 1998
TM-7			01/24/94		4468.45	SET, 1998
TM-7			04/12/94		4467.60	SET, 1998
TM-7			07/19/94		4466.70	SET, 1998
TM-7			10/18/94		4465.70	SET, 1998
TM-7			01/17/95		4464.95	SET, 1998
TM-7			04/18/95		4464.15	SET, 1998
TM-7			07/27/95		4463.00	SET, 1998
TM-7			10/17/95		4462.45	SET, 1998
TM-7			06/25/96		4460.10	SET, 1998
TM-7			08/22/96		4459.50	SET, 1998
TM-7			10/29/96		4459.10	SET, 1998
TM-7			12/19/96		4458.55	SET, 1998
TM-7			01/29/97		4458.20	SET, 1998
TM-7			02/27/97		4458.10	SET, 1998
TM-7			04/16/97		4457.55	SET, 1998
TM-7			07/01/97		4456.80	SET, 1998
TM-7			10/10/97		4456.35	SET, 1998
TM-7			01/05/98		4455.90	SET, 1998
TM-7		4768.927	06/01/99	312.85	4456.07	PD file
TM-7		4768.927	03/01/00	313.50	4455.43	PD file
TM-7		4768.927	06/01/00	314.00	4454.93	PD file
TM-7		4768.927	09/01/00	314.80	4454.13	PD file
TM-7		4768.927	12/01/00	315.80	4453.13	PD file
TM-7		4768.927	02/01/01	315.95	4452.98	PD file
TM-7		4768.927	06/01/01	316.70	4452.23	PD file
TM-7		4768.927	10/01/01	317.25	4451.68	PD file
TM-7		4768.927	02/01/02	318.40	4450.53	PD file
TM-7		4768.927	06/01/02	319.30	4449.63	PD file
TM-7		4768.927	09/01/02	319.70	4449.23	PD file
TM-7		4768.927	11/01/02	319.90	4449.03	PD file
TM-9	D-23-24-33bca	4889.12	03/14/89	766.10	4123.02	ELMA, 1990
TM-10	D-24-24-05bac		10/18/88		4492.22	SET, 1998
TM-10			11/06/89		4481.42	SET, 1998
TM-10		4768.927	11/06/89	260.45	4480.73	ELMA, 1990
TM-10			01/25/94		4471.02	SET, 1998
TM-10			06/25/96		4465.12	SET, 1998

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-11	D-24-24-18aab		10/18/88		4461.04	SET, 1998
TM-11			04/04/89		4459.79	SET, 1998
TM-11			11/06/89		4459.69	SET, 1998
TM-11		4573.10	11/06/89	112.30	4460.80	ELMA, 1990
TM-12	D-24-24-20bbd		10/18/88		4461.99	SET, 1998
TM-12			04/18/89		4461.49	SET, 1998
TM-12			11/06/89		4459.06	SET, 1998
TM-12		4589.44	11/06/89	130.75	4458.69	ELMA, 1990
TM-12			06/25/96		4443.30	SET, 1998
TM-12			12/19/96		4443.05	SET, 1998
TM-12			04/16/97		4442.60	SET, 1998
TM-12			10/10/97		4440.70	SET, 1998
TM-12			01/05/98		4441.10	SET, 1998
TM-13	D-24-24-08bcc2		10/18/88		4461.43	SET, 1998
TM-13			04/17/89		4460.53	SET, 1998
TM-13			11/06/89		4459.94	SET, 1998
TM-13		4617.29	11/06/89	155.70	4461.59	ELMA, 1990
TM-13			01/26/94		4445.73	SET, 1998
TM-13			11/29/01	182.70	4447.30	ADWR GWSI
TM-14	D-24-24-07bcb2		10/18/88		4454.26	SET, 1998
TM-14			04/18/89		4453.36	SET, 1998
TM-14			11/06/89		4448.52	SET, 1998
TM-14		4626.23	11/06/89	180.65	4445.58	ELMA, 1990
TM-15	D-24-24-06bcc		10/18/88		4443.90	SET, 1998
TM-15			04/18/89		4443.35	SET, 1998
TM-15			11/06/89		4443.42	SET, 1998
TM-15		4711.65	11/06/89	267.03	4444.62	ELMA, 1990
TM-15			06/25/96		4429.30	SET, 1998
TM-15			10/29/96		4428.65	SET, 1998
TM-15			06/01/99	284.90	4427.89	WMC, 2006
TM-16	D-24-24-10acd		10/18/88		4620.44	SET, 1998
TM-16			11/06/89		4621.52	SET, 1998
TM-16		4701.12	11/06/89	77.48	4623.64	ELMA, 1990
TM-16			04/06/89		4624.10	SET, 1998
TM-16			10/11/89		4621.60	SET, 1998
TM-16			04/03/90		4621.10	SET, 1998
TM-16			10/17/90		4620.40	SET, 1998
TM-16			04/16/91		4620.80	SET, 1998
TM-16			10/14/91		4620.50	SET, 1998
TM-16			04/06/92		4618.45	SET, 1998
TM-16			04/19/93		4617.00	SET, 1998
TM-16			10/19/93		4616.10	SET, 1998
TM-16			04/12/94		4615.70	SET, 1998
TM-16			04/18/95		4615.50	SET, 1998
TM-16			10/17/95		4615.30	SET, 1998
TM-16			06/25/96		4615.00	SET, 1998
TM-16		4705.54	06/01/99	80.80	4624.70	PD file
TM-16		4705.54	03/01/00	79.25	4626.29	PD file
TM-16		4705.54	06/01/00	78.55	4626.99	PD file
TM-16		4705.54	09/01/00	77.65	4627.89	PD file
TM-16		4705.54	12/01/00	77.10	4628.44	PD file
TM-16		4705.54	02/01/01	76.95	4628.59	PD file
TM-16		4705.54	06/01/01	76.55	4628.99	PD file
TM-16		4705.54	10/01/01	76.20	4629.34	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-16		4705.54	02/01/02	76.00	4629.54	PD file
TM-16		4705.54	06/01/02	76.45	4629.09	PD file
TM-16		4705.54	09/01/02	76.50	4629.04	PD file
TM-16		4705.54	11/01/02	76.60	4628.94	PD file
TM-16		4705.54	01/01/03	76.60	4628.94	PD file
TM-16		4705.54	05/01/03	77.30	4628.24	PD file
TM-16		4705.54	08/01/06	77.85	4627.69	PD file
TM-16		4705.54	12/01/03	78.10	4627.44	PD file
TM-16		4705.54	02/01/04	78.45	4627.09	PD file
TM-16		4705.54	05/01/04	78.80	4626.74	PD file
TM-16		4705.54	08/01/04	79.00	4626.54	PD file
TM-16		4705.54	11/01/04	79.30	4626.24	PD file
TM-16		4705.54	02/01/05	79.50	4626.04	PD file
TM-16		4705.54	06/01/05	79.80	4625.74	PD file
TM-16		4705.54	09/01/05	79.75	4625.79	PD file
TM-16		4705.54	11/01/05	79.75	4625.79	PD file
TM-16		4705.54	02/01/06	79.90	4625.64	PD file
TM-16		4705.54	05/01/06	80.30	4625.24	PD file
TM-16		4705.54	08/01/06	80.75	4624.79	PD file
TM-17	D-24-24-16aca		10/18/88		4468.37	SET, 1998
TM-17			04/17/89		4467.63	SET, 1998
TM-17			11/06/89		4467.54	SET, 1998
TM-17		4631.00	11/06/89	161.35	4469.65	ELMA, 1990
TM-17			01/26/94		4455.07	SET, 1998
TM-18	D-23-24-21cdd	5140.57	11/06/89	658.10	4482.47	ELMA, 1990
TM-19	D-24-24-08ddc1		10/18/88		4473.04	SET, 1998
TM-19			01/30/89		4471.99	SET, 1998
TM-19			03/01/89		4471.44	SET, 1998
TM-19			04/07/89		4471.29	SET, 1998
TM-19			05/02/89		4471.04	SET, 1998
TM-19			06/09/89		4470.44	SET, 1998
TM-19			07/13/89		4469.89	SET, 1998
TM-19			09/06/89		4469.19	SET, 1998
TM-19			10/22/89		4470.04	SET, 1998
TM-19			11/06/89		4468.77	SET, 1998
TM-19		4626.86	11/06/89	157.50	4469.36	ELMA, 1990
TM-19			03/08/90		4467.15	SET, 1998
TM-19			04/04/90		4466.80	SET, 1998
TM-19			07/30/90		4465.34	SET, 1998
TM-19			10/19/90		4464.55	SET, 1998
TM-19			01/31/90		4463.60	SET, 1998
TM-19			04/16/91		4463.00	SET, 1998
TM-19			06/24/91		4462.25	SET, 1998
TM-19			07/16/91		4462.00	SET, 1998
TM-19			10/14/91		4461.00	SET, 1998
TM-19			01/15/92		4460.20	SET, 1998
TM-19			04/06/92		4459.60	SET, 1998
TM-19			01/11/93		4457.35	SET, 1998
TM-19			04/19/93		4456.75	SET, 1998
TM-19			07/21/93		4456.00	SET, 1998
TM-19			10/19/93		4455.10	SET, 1998
TM-19			01/04/94		4454.70	SET, 1998
TM-19			04/12/94		4454.10	SET, 1998
TM-19			07/19/94		4453.30	SET, 1998
TM-19			10/18/94		4452.55	SET, 1998
TM-19			01/17/95		4452.00	SET, 1998
TM-19			10/17/95		4450.00	SET, 1998

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-19			06/25/96		4448.10	SET, 1998
TM-19			08/22/96		4448.05	SET, 1998
TM-19			10/29/96		4447.15	SET, 1998
TM-19A	D-24-24-08ddc2		01/30/89		4472.34	SET, 1998
TM-19A			03/01/89		4471.94	SET, 1998
TM-19A			04/07/89		4471.49	SET, 1998
TM-19A			05/02/89		4471.14	SET, 1998
TM-19A			06/09/89		4470.74	SET, 1998
TM-19A			07/13/89		4470.24	SET, 1998
TM-19A			09/06/89		4469.54	SET, 1998
TM-19A			10/22/89		4470.04	SET, 1998
TM-19A			11/06/89		4469.04	SET, 1998
TM-19A		4627.32	11/06/89	157.25	4470.07	ELMA, 1990
TM-19A			12/04/90	156.70	4482.00	ADWR GWSI
TM-19A			01/04/94		4454.60	SET, 1998
TM-19A			06/25/96		4447.93	SET, 1998
TM-19A			08/22/96		4447.40	SET, 1998
TM-19A			09/25/96		4447.00	SET, 1998
TM-19A			10/29/96		4447.00	SET, 1998
TM-19A			12/19/96		4446.50	SET, 1998
TM-19A			01/29/97		4446.40	SET, 1998
TM-19A			02/27/97		4446.30	SET, 1998
TM-19A			04/16/97		4445.80	SET, 1998
TM-19A			10/10/97		4444.50	SET, 1998
TM-19A			01/05/98		4443.90	SET, 1998
TM-19A		4632.45	06/01/99	185.45	4447.00	PD file
TM-19A		4632.45	03/01/00	186.20	4446.25	PD file
TM-19A		4632.45	06/01/00	186.95	4445.50	PD file
TM-19A		4632.45	09/01/00	187.60	4444.85	PD file
TM-19A		4632.45	12/01/00	188.00	4444.45	PD file
TM-19A		4632.45	02/01/01	188.40	4444.05	PD file
TM-19A		4632.45	06/01/01	188.95	4443.50	PD file
TM-19A		4632.45	10/01/01	189.55	4442.90	PD file
TM-19A		4632.45	02/01/02	190.25	4442.20	PD file
TM-19A		4632.45	06/01/02	191.30	4441.15	PD file
TM-19A		4632.45	09/01/02	191.50	4440.95	PD file
TM-19A		4632.45	11/01/02	191.90	4440.55	PD file
TM-19A		4632.45	01/01/03	192.00	4440.45	PD file
TM-19A		4632.45	05/01/03	192.40	4440.05	PD file
TM-19A		4632.45	08/01/03	192.85	4439.60	PD file
TM-19A		4632.45	12/01/03	193.20	4439.25	PD file
TM-19A		4632.45	02/01/04	193.80	4438.65	PD file
TM-19A		4632.45	05/01/04	194.05	4438.40	PD file
TM-19A		4632.45	08/01/04	194.80	4437.65	PD file
TM-19A		4632.45	11/01/04	195.70	4436.75	PD file
TM-19A		4632.45	02/01/05	195.90	4436.55	PD file
TM-19A		4632.45	06/01/05	196.20	4436.25	PD file
TM-19A		4632.45	09/01/05	196.95	4435.50	PD file
TM-19A		4632.45	11/01/05	198.30	4434.15	PD file
TM-19A		4632.45	02/01/06	197.00	4435.45	PD file
TM-19A		4632.45	05/01/06	196.40	4436.05	PD file
TM-19A		4632.45	08/01/06	197.00	4435.45	PD file
TM-21	D-23-24-22cda	5153.36	11/06/89	333.08	4820.28	ELMA, 1990
TM-22	D-23-24-27bad	5077.08	11/07/89	924.12	4152.96	ELMA, 1990
TM-23	D-23-24-27bdd	4961.50	11/07/89	160.65	4800.85	ELMA, 1990

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-24	D-23-24-27dad	4909.85	11/07/89	56.61	4853.24	ELMA, 1990
TM-25	D 23-24-34baa	4947.78	08/08/89	dry	<4142.78	ELMA, 1990
TM-26	D-23-24-34cda	4917.18	09/07/89	dry	<4117.18	ELMA, 1990
TM-27	D-23-24-33dbc	4840.66	11/07/89	304.49	4536.17	ELMA, 1990
TM-28	D-23-24-35ccb	4813.27	11/06/89	62.68	4750.59	ELMA, 1990
TM-29	D-24-24-03caa		09/06/89		4667.43	SET, 1998
TM-29			10/22/89		4667.28	SET, 1998
TM-29			11/06/89		4671.60	SET, 1998
TM-29		4759.63	11/06/89	87.05	4672.58	ELMA, 1990
TM-29A	D-24-24-03cab1	4758.08	11/06/89	86.12	4671.96	ELMA, 1990
TM-30	D-24-24-08dad		11/07/89		4474.39	SET, 1998
TM-30		4635.89	11/07/89	162.82	4473.07	ELMA, 1990
TM-33	D-23-24-34bbb	4903.57	11/07/89	488.22	4415.35	ELMA, 1990
TM-35	D-24-23-35adb	4898.88	11/06/89	260.99	4637.89	ELMA, 1990
TM-35			10/22/89		4638.48	SET, 1998
TM-35			11/06/89		4638.79	SET, 1998
TM-37	D-24-24-9bbc		11/07/89		4474.26	SET, 1998
TM-37		4670.86	11/07/89	191.9	4479.00	ELMA, 1990
TM-38	D-24-24-9caa		11/06/89		4479.04	SET, 1998
TM-38		4667.97	11/06/89	187.2	4480.77	ELMA, 1990
TM-39	D-24-24-10cbd		11/06/89		4514.44	SET, 1998
TM-39		4671.51	11/06/89	157.19	4514.32	ELMA, 1990
TM-41	D-24-24-03cbd		07/01/97		4599.44	SET, 1998
TM-41			11/06/97		4594.69	SET, 1998
TM-41			01/05/98		4593.29	SET, 1998
TM-41		4760.96	06/01/99	170.40	4590.56	PD file
TM-41		4760.96	03/01/00	171.50	4589.46	PD file
TM-41		4760.96	06/01/00	170.50	4590.46	PD file
TM-41		4760.96	09/01/00	169.10	4591.86	PD file
TM-41		4760.96	12/01/00	167.00	4593.96	PD file
TM-41		4760.96	02/01/01	165.20	4595.76	PD file
TM-41		4760.96	06/01/01	164.55	4596.41	PD file
TM-41		4760.96	10/01/01	163.75	4597.21	PD file
TM-41		4760.96	02/01/02	162.45	4598.51	PD file
TM-41		4760.96	06/01/02	165.00	4595.96	PD file
TM-41		4760.96	09/01/02	167.40	4593.56	PD file
TM-41		4760.96	11/01/02	168.20	4592.76	PD file
TM-41		4760.96	01/01/03	169.80	4591.16	PD file
TM-41		4760.96	05/01/03	171.60	4589.36	PD file
TM-41		4760.96	08/01/03	173.05	4587.91	PD file
TM-41		4760.96	12/01/03	177.90	4583.06	PD file
TM-41		4760.96	02/01/04	179.90	4581.06	PD file
TM-41		4760.96	05/01/04	182.70	4578.26	PD file
TM-41		4760.96	08/01/04	185.20	4575.76	PD file
TM-41		4760.96	11/01/04	188.10	4572.86	PD file
TM-41		4760.96	02/01/05	188.40	4572.56	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-41		4760.96	06/01/05	188.75	4572.21	PD file
TM-41		4760.96	09/01/05	188.85	4572.11	PD file
TM-41		4760.96	11/01/05	189.20	4571.76	PD file
TM-41		4760.96	02/01/06	190.15	4570.81	PD file
TM-41		4760.96	05/01/06	193.10	4567.86	PD file
TM-41		4760.96	08/01/06	No water,194		PD file
TM-42	D-24-24-09dcc		07/01/97		4459.10	SET, 1998
TM-42			11/06/97		4457.25	SET, 1998
TM-42			01/05/98		4457.05	SET, 1998
TM-42		4654.033	06/01/99	196.30	4457.73	PD file
TM-42		4654.033	03/01/00	197.10	4456.93	PD file
TM-42		4654.033	06/01/00	198.10	4455.93	PD file
TM-42		4654.033	09/01/00	198.65	4455.38	PD file
TM-42		4654.033	12/01/00	199.00	4455.03	PD file
TM-42		4654.033	02/01/01	199.30	4454.73	PD file
TM-42		4654.033	06/01/01	199.95	4454.08	PD file
TM-42		4654.033	10/01/01	200.85	4453.18	PD file
TM-42		4654.033	02/01/02	201.45	4452.58	PD file
TM-42		4654.033	06/01/02	202.35	4451.68	PD file
TM-42		4654.033	09/01/02	202.80	4451.23	PD file
TM-42		4654.033	11/01/02	203.00	4451.03	PD file
TM-42		4654.033	01/01/03	203.10	4450.93	PD file
TM-42		4654.033	05/01/03	203.70	4450.33	PD file
TM-42		4654.033	08/01/03	204.10	4449.93	PD file
TM-42		4654.033	12/01/03	204.80	4449.23	PD file
TM-42		4654.033	02/01/04	205.10	4448.93	PD file
TM-42		4654.033	05/01/04	205.60	4448.43	PD file
TM-42		4654.033	08/01/04	205.95	4448.08	PD file
TM-42		4654.033	11/01/04	206.15	4447.88	PD file
TM-42		4654.033	02/01/05	206.30	4447.73	PD file
TM-42		4654.033	06/01/05	206.70	4447.33	PD file
TM-42		4654.033	09/01/05	207.00	4447.03	PD file
TM-42		4654.033	11/01/05	207.60	4446.43	PD file
TM-42		4654.033	02/01/06	208.00	4446.03	PD file
TM-42		4654.033	05/01/06	208.40	4445.63	PD file
TM-42		4654.033	08/01/06	208.90	4445.13	PD file
TM-43	D-23-24-27acc	4956.436	06/01/99	147.30	4809.14	PD file
TM-43		4956.436	03/01/00	147.55	4808.89	PD file
TM-43		4956.436	06/01/00	147.55	4808.89	PD file
TM-43		4956.436	09/01/00	147.55	4808.89	PD file
TM-43		4956.436	12/01/00	147.55	4808.89	PD file
TM-43		4956.436	02/01/01	147.55	4808.89	PD file
TM-43		4956.436	06/01/01	147.50	4808.94	PD file
TM-43		4956.436	10/01/01	147.45	4808.99	PD file
TM-43		4956.436	02/01/02	147.30	4809.14	PD file
TM-43		4956.436	06/01/02	147.60	4808.84	PD file
TM-43		4956.436	09/01/02	147.75	4808.69	PD file
TM-43		4956.436	11/01/02	147.90	4808.54	PD file
TM-43		4956.436	01/01/03	148.10	4808.34	PD file
TM-43		4956.436	05/01/03	148.20	4808.24	PD file
TM-43		4956.436	08/01/03	148.30	4808.14	PD file
TM-43		4956.436	12/01/03	148.70	4807.74	PD file
TM-43		4956.436	02/01/04	148.85	4807.59	PD file
TM-43		4956.436	05/01/04	148.90	4807.54	PD file
TM-43		4956.436	08/01/04	149.05	4807.39	PD file
TM-43		4956.436	11/01/04	149.30	4807.14	PD file
TM-43		4956.436	02/01/05	149.45	4806.99	PD file
TM-43		4956.436	06/01/05	149.70	4806.74	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-43		4956.436	09/01/05	149.80	4806.64	PD file
TM-43		4956.436	11/01/05	149.90	4806.54	PD file
TM-43		4956.436	02/01/06	149.70	4806.74	PD file
TM-43		4956.436	05/01/06	149.80	4806.64	PD file
TM-43		4956.436	08/01/06	149.80	4806.64	PD file
TM-43A	D-23-24-27acc	4954.672	06/01/99	132.95	4821.72	PD file
TM-43A		4954.672	03/01/00	132.80	4821.87	PD file
TM-43A		4954.672	06/01/00	132.70	4821.97	PD file
TM-43A		4954.672	09/01/00	132.65	4822.02	PD file
TM-43A		4954.672	12/01/00	132.65	4822.02	PD file
TM-43A		4954.672	02/01/01	132.50	4822.17	PD file
TM-43A		4954.672	06/01/01	132.35	4822.32	PD file
TM-43A		4954.672	10/01/01	132.20	4822.47	PD file
TM-43A		4954.672	02/01/02	132.10	4822.57	PD file
TM-43A		4954.672	06/01/02	132.20	4822.47	PD file
TM-43A		4954.672	09/01/02	132.40	4822.27	PD file
TM-43A		4954.672	11/01/02	132.70	4821.97	PD file
TM-43A		4954.672	01/01/03	132.70	4821.97	PD file
TM-43A		4954.672	05/01/03	132.75	4821.92	PD file
TM-43A		4954.672	08/01/03	133.00	4821.67	PD file
TM-43A		4954.672	12/01/03	133.40	4821.27	PD file
TM-43A		4954.672	02/01/04	134.40	4820.27	PD file
TM-43A		4954.672	05/01/04	136.25	4818.42	PD file
TM-43A		4954.672	08/01/04	139.55	4815.12	PD file
TM-43A		4954.672	11/01/04	143.00	4811.67	PD file
TM-43A		4954.672	02/01/05	143.10	4811.57	PD file
TM-43A		4954.672	06/01/05	143.00	4811.67	PD file
TM-43A		4954.672	09/01/05	134.30	4820.37	PD file
TM-43A		4954.672	11/01/05	134.30	4820.37	PD file
TM-43A		4954.672	02/01/06	134.50	4820.17	PD file
TM-43A		4954.672	05/01/06	134.25	4820.42	PD file
TM-43A		4954.672	08/01/06	134.30	4820.37	PD file
TM-43B	D-23-24-27dad	4907.293	06/01/99	62.60	4844.69	PD file
TM-43B		4907.293	03/01/00	61.20	4846.09	PD file
TM-43B		4907.293	06/01/00	61.95	4845.34	PD file
TM-43B		4907.293	09/01/00	62.30	4844.99	PD file
TM-43B		4907.293	12/01/00	62.60	4844.69	PD file
TM-43B		4907.293	02/01/01	62.40	4844.89	PD file
TM-43B		4907.293	06/01/01	61.85	4845.44	PD file
TM-43B		4907.293	10/01/01	60.95	4846.34	PD file
TM-43B		4907.293	02/01/02	59.45	4847.84	PD file
TM-43B		4907.293	06/01/02	60.30	4846.99	PD file
TM-43B		4907.293	09/01/02	60.95	4846.34	PD file
TM-43B		4907.293	11/01/02	61.35	4845.94	PD file
TM-43B		4907.293	01/01/03	61.75	4845.54	PD file
TM-43B		4907.293	05/01/03	62.60	4844.69	PD file
TM-43B		4907.293	08/01/03	63.20	4844.09	PD file
TM-43B		4907.293	12/01/03	64.70	4842.59	PD file
TM-43B		4907.293	02/01/04	65.05	4842.24	PD file
TM-43B		4907.293	05/01/04	65.90	4841.39	PD file
TM-43B		4907.293	08/01/04	66.40	4840.89	PD file
TM-43B		4907.293	11/01/04	67.80	4839.49	PD file
TM-43B		4907.293	02/01/05	67.85	4839.44	PD file
TM-43B		4907.293	06/01/05	67.95	4839.34	PD file
TM-43B		4907.293	09/01/05	68.10	4839.19	PD file
TM-43B		4907.293	11/01/05	68.80	4838.49	PD file
TM-43B		4907.293	02/01/06	68.70	4838.59	PD file
TM-43B		4907.293	05/01/06	68.70	4838.59	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-43B		4907.293	08/01/06	69.40	4837.89	PD file
TM-43C	D-23-24-27add	4940.878	06/01/99	72.55	4868.33	PD file
TM-43C		4940.878	03/01/00	73.90	4866.98	PD file
TM-43C		4940.878	06/01/00	73.55	4867.33	PD file
TM-43C		4940.878	09/01/00	73.30	4867.58	PD file
TM-43C		4940.878	12/01/00	73.20	4867.68	PD file
TM-43C		4940.878	02/01/01	73.10	4867.78	PD file
TM-43C		4940.878	06/01/01	73.05	4867.83	PD file
TM-43C		4940.878	10/01/01	72.85	4868.03	PD file
TM-43C		4940.878	02/01/02	72.55	4868.33	PD file
TM-43C		4940.878	06/01/02	72.45	4868.43	PD file
TM-43C		4940.878	09/01/02	72.60	4868.28	PD file
TM-43C		4940.878	11/01/02	72.80	4868.08	PD file
TM-43C		4940.878	01/01/03	72.75	4868.13	PD file
TM-43C		4940.878	05/01/03	72.90	4867.98	PD file
TM-43C		4940.878	08/01/03	73.00	4867.88	PD file
TM-43C		4940.878	12/01/03	73.20	4867.68	PD file
TM-43C		4940.878	02/01/04	73.20	4867.68	PD file
TM-43C		4940.878	05/01/04	73.25	4867.63	PD file
TM-43C		4940.878	08/01/04	73.30	4867.58	PD file
TM-43C		4940.878	11/01/04	73.30	4867.58	PD file
TM-43C		4940.878	02/01/05	73.30	4867.58	PD file
TM-43C		4940.878	06/01/05	73.35	4867.53	PD file
TM-43C		4940.878	09/01/05	73.35	4867.53	PD file
TM-43C		4940.878	11/01/05	73.35	4867.53	PD file
TM-43C		4940.878	02/01/06	73.40	4867.48	PD file
TM-43C		4940.878	05/01/06	73.60	4867.28	PD file
TM-43C		4940.878	08/01/06	73.60	4867.28	PD file
TM-44	D-23-24-27bad	5045.6	01/05/98		4178.53	SET, 2000
TM-44		5045.6	05/06/98		4182.03	SET, 2000
TM-44		5045.6	06/01/99	851.70	4193.90	PD file
TM-44		5045.6	03/01/00	843.70	4201.90	PD file
TM-44		5045.6	06/01/00	834.60	4211.00	PD file
TM-44		5045.6	09/01/00	829.65	4215.95	PD file
TM-44		5045.6	12/01/00	824.00	4221.60	PD file
TM-44		5045.6	02/01/01	821.75	4223.85	PD file
TM-44		5045.6	06/01/01	818.60	4227.00	PD file
TM-44		5045.6	10/01/01	815.40	4230.20	PD file
TM-44		5045.6	02/01/02	812.30	4233.30	PD file
TM-44		5045.6	06/01/02	812.15	4233.45	PD file
TM-44		5045.6	09/01/02	810.30	4235.30	PD file
TM-44		5045.6	11/01/02	808.35	4237.25	PD file
TM-44		5045.6	01/01/03	808.45	4237.15	PD file
TM-44		5045.6	05/01/03	808.50	4237.10	PD file
TM-44		5045.6	08/01/03	808.55	4237.05	PD file
TM-44		5045.6	12/01/03	808.55	4237.05	PD file
TM-44		5045.6	02/01/04	808.85	4236.75	PD file
TM-44		5045.6	05/01/04	809.10	4236.50	PD file
TM-44		5045.6	08/01/04	809.30	4236.30	PD file
TM-44		5045.6	11/01/04	809.55	4236.05	PD file
TM-44		5045.6	02/01/05	809.55	4236.05	PD file
TM-44		5045.6	06/01/05	806.60	4239.00	PD file
TM-44		5045.6	09/01/05	805.75	4239.85	PD file
TM-44		5045.6	11/01/05	800.10	4245.50	PD file
TM-44		5045.6	02/01/06	800.35	4245.25	PD file
TM-44		5045.6	05/01/06	800.90	4244.70	PD file
TM-44		5045.6	08/01/06	800.15	4245.45	PD file

TABLE B.1
Historic Groundwater Elevations for Select Wells, CTSA

Well	Cadastral	Altitude of Measuring Point [1]	Date Sampled	Depth to Water Below Measuring Point [2]	Water Elevation (ft amsl)	Data Source [3]
TM-45	D-23-24-28add	4998.252	06/01/99	484.70	4513.55	PD file
TM-45		4998.252	03/01/00	485.20	4513.05	PD file
TM-45		4998.252	06/01/00	484.95	4513.30	PD file
TM-45		4998.252	09/01/00	484.80	4513.45	PD file
TM-45		4998.252	12/01/00	484.70	4513.55	PD file
TM-45		4998.252	02/01/01	485.00	4513.25	PD file
TM-45		4998.252	06/01/01	485.45	4512.80	PD file
TM-45		4998.252	10/01/01	485.95	4512.30	PD file
TM-45		4998.252	02/01/02	486.50	4511.75	PD file
TM-45		4998.252	06/01/02	486.80	4511.45	PD file
TM-45		4998.252	09/01/02	487.00	4511.25	PD file
TM-45		4998.252	11/01/02	487.20	4511.05	PD file
TM-45		4998.252	01/01/03	487.30	4510.95	PD file
TM-45		4998.252	05/01/03	487.90	4510.35	PD file
TM-45		4998.252	08/01/03	488.15	4510.10	PD file
TM-45		4998.252	12/01/03	488.80	4509.45	PD file
TM-45		4998.252	02/01/04	490 no water		PD file
TM-45		4998.252	05/01/04	490 no water		PD file
TM-45		4998.252	08/01/04	490 no water		PD file
TM-45		4998.252	11/01/04	490 no water		PD file
TM-46	D-23-24-27bbc	5052.694	01/05/98		4178.19	SET, 2000
TM-46		5052.694	05/06/98		4181.09	SET, 2000
TM-46		5052.694	06/01/99	N/A		PD file
TM-46		5052.694	12/01/00	833.00	4219.69	PD file
558557	D-24-24-17aaa		01/29/97	172.40	4455.61	WMC, 2006
558557			01/21/98	174.90	4453.11	WMC, 2006
558557			01/25/99	172.20	4455.81	WMC, 2006
558557		4628.011	06/01/99	178.20	4449.81	PD file
558557		4628.011	03/01/00	178.70	4449.31	PD file
558557		4628.011	06/01/00	179.90	4448.11	PD file
558557		4628.011	09/01/00	180.50	4447.51	PD file
558557		4628.011	12/01/00	181.00	4447.01	PD file
558557		4628.011	02/01/02	182.75	4445.26	PD file
558557		4628.011	06/01/02	183.20	4444.81	PD file
558557		4628.011	09/01/02	183.80	4444.21	PD file
558557		4628.011	11/01/02	184.05	4443.96	PD file
558557		4628.011	01/01/03	184.30	4443.71	PD file
558557		4628.011	05/01/03	185.30	4442.71	PD file
558557		4628.011	12/01/03	185.70	4442.31	PD file
558557		4628.011	02/01/04	186.02	4441.99	PD file
558557		4628.011	08/01/04	186.90	4441.11	PD file
558557		4628.011	11/01/04	187.00	4441.01	PD file
558557		4628.011	02/10/05	187.20	4440.81	PD file
558557		4628.011	06/01/05	187.80	4440.21	PD file
558557		4628.011	09/01/05	187.05	4440.96	PD file
558557		4628.011	11/01/05	188.30	4439.71	PD file
641802	D-24-24-18aad	4585e	08/17/05	141.85	4443.00	PD file
802236	D-24-24-18dbb1	4562	12/06/90	90.6	4471	ADWR GWSI
802236		4562	12/15/99	110.2	4452	ADWR GWSI

Notes:

[1] feet above mean sea level. PD file reports as "collar elevation"; ELMA,1990 reports as "measuring point"; ADWR GWIS, SET (1998, 2000), and WMC 2006 do not report measuring point elevations.

[2] feet above mean sea level. Depths to water are not reported by SET (1998) or SET (2000).

[3] ADWR GWSI = Arizona Department of Water Resources Ground Water Site Inventory database; ADWR, 2006 = Arizona Department of Water Resources Imaged Records database, downloaded December 15, 2006; PD file = Phelps Dodge water level database; SET = Savci Environmental Technologies WMC = Water Management Consults ELMA = Errol L. Montogmery and Associates

TABLE B.2
Water Elevation Data Used for 1989 Water Level Map [1]

Well	Date	Water Elevation [2]	Cadastrals	Data Source[3]
AWC-2	12/04/90	4439.9	D-24-23-13abc	ADWR GWSI
AWC-4	12/04/90	4444.9	D-24-23-13abc	ADWR GWSI
NWC-1	05/19/88	4457.25	D-24-24-19b	SET, 1998
NWC-3	05/18/88	4466.22	D-24-24-19bb	SET, 1998
NWC-5	05/18/88	4586.04	D-24-24-11cad	SET, 1998
BJ-1	06/22/88	4546.95	D-24-24-10dcb	SET, 1998
BJ-2	06/27/88	4648.65	D-24-24-11abd	SET, 1998
BJ-3	05/10/88	4594.95	D-24-24-11cbc1	SET, 1998
BJ-4	05/10/88	4596.38	D-24-24-11cbc2	SET, 1998
BJ-5	09/02/88	4611.43	D-24-24-11dcc	SET, 1998
SJ-9	06/16/88	4479.49	D-24-24-5-dbb2	SET, 1998
TM-1A	11/06/89	4487.36	D-24-24-09aab2	ELMA, 1990
TM-2	11/06/89	4497.72	D-24-24-04aac1	ELMA, 1990
TM-2A	11/30/89	4478.05	D-24-24-04aac2	ELMA, 1990
TM-3	11/06/89	4766.58	D-23-24-35bba	ELMA, 1990
TM-4	11/06/89	4681.08	D-24-24-02bcc	ELMA, 1990
TM-5	11/06/89	4465.21	D-24-24-21aba	ELMA, 1990
TM-6	11/06/89	4532.52	D-24-24-14bcc	ELMA, 1990
TM-7	11/06/89	4489.97	D-24-24-04bbd	ELMA, 1990
TM-9	03/14/89	4123.02	D-23-24-33bca	ELMA, 1990
TM-10	11/06/89	4480.73	D-24-24-05bac	ELMA, 1990
TM-11	11/06/89	4460.80	D-24-24-18aab	ELMA, 1990
TM-12	11/06/89	4458.69	D-24-24-20-bbd	ELMA, 1990
TM-13	11/06/89	4461.59	D-24-24-08-bcc	ELMA, 1990
TM-14	11/06/89	4445.58	D-24-24-07bcb2	ELMA, 1990
TM-15	11/06/89	4444.62	D-24-24-06bcc	ELMA, 1990
TM-16	11/06/89	4623.64	D-24-24-10acd	ELMA, 1990
TM-17	11/06/89	4469.65	D-24-24-16aca	ELMA, 1990

TABLE B.2
Water Elevation Data Used for 1989 Water Level Map [1]

Well	Date	Water Elevation [2]	Cadastrals	Data Source[3]
TM-18	11/06/89	4482.47	D-23-24-21cdd	ELMA, 1990
TM-19	11/06/89	4469.36	D-24-24-08ddc2	ELMA, 1990
TM-19A	11/06/97	4470.07	D-24-24-08ddc1	ELMA, 1990
TM-21	11/06/89	4820.28	D-23-24-22cda	ELMA, 1990
TM-22	11/07/89	4152.96	D-23-24-27bad	ELMA, 1990
TM-23	11/07/89	4800.85	D-23-24-27bdd	ELMA, 1990
TM-24	11/07/89	4853.24	D-23-24-27dad	ELMA, 1990
TM-26	09/07/89	<4117 (dry)	D-23-24-34-cda	ELMA, 1990
TM-27	11/07/89	4536.17	D-23-24-33dbc	ELMA, 1990
TM-28	11/06/89	4750.59	D-23-24-35ccb	ELMA, 1990
TM-29A	11/06/89	4671.96	D-24-24-3cab1	ELMA, 1990
TM-30	11/07/89	4473.07	D-24-24-08dad	ELMA, 1990
TM-33	11/07/89	4415.35	D-23-24-34bbb	ELMA, 1990
TM-35	11/06/89	4637.89	D-23-24-35abd	ELMA, 1990
TM-37	11/07/89	4479.00	D-24-24-9bbc	ELMA, 1990
TM-38	11/06/89	4480.77	D-24-24-9caa	ELMA, 1990
TM-39	11/06/89	4514.32	D-24-24-10cbd	ELMA, 1990
802236	12/06/90	4471	D-24-24-18dbd1	ADWR GWSI

Notes:

[1] includes 1989 data for TM wells, 1988 data for SJ-9 and NWC wells, and 1990 data for AWC and Bisbee wells.

[2] feet above mean sea level

[3] ADWR GWSI = Arizona Department of Water Resources Ground Water Site Inventory Database, 2005
ELMA=Errol Montgomery and Associates
SET=Savci Environmental Technologies

TABLE B.3
Groundwater Elevation Data Used for 1996 Water Level Map

Well	Cadastral	Date Sampled	Water Elevation[1]	Data Source[2]
BF-1	D-24-24-04aaa	06/25/96	4473.90	SET, 1998
BF-2	D-24-24-04bdd	06/25/96	4459.00	SET, 1998
GL-3	D-23-24-34bbb	06/25/96	4151.30	SET, 1998
TM-2	D-24-24-04aac1	06/25/96	4464.90	SET, 1998
TM-2A	D-24-24-04aac2	06/25/96	4468.15	SET, 1998
TM-3	D-23-24-35bba	06/25/96	4759.95	SET, 1998
TM-5	D-24-24-21aba	06/25/96	4449.65	SET, 1998
TM-6	D-24-24-14bcc	06/25/96	4531.00	SET, 1998
TM-7	D-24-24-04bbd	06/25/96	4460.10	SET, 1998
TM-10	D-24-24-05bac	06/25/96	4465.12	SET, 1998
TM-12	D-24-24-20bbd	06/25/96	4443.30	SET, 1998
TM-15	D-24-24-06bcc	06/25/96	4429.30	SET, 1998
TM-16	D-24-24-10acd	06/25/96	4615.00	SET, 1998
TM-19	D-24-24-08ddc1	06/25/96	4448.10	SET, 1998
TM-19A	D-24-24-08ddc2	06/25/96	4447.93	SET, 1998
TM-41	D-24-24-03cbd	7/1/1997	4599.44	SET, 1998
TM-42	D-24-24-09-9dcc	7/1/1997	4459.10	SET, 1998

Notes:

[1] feet above mean sea level

[2] SET=Savci Environmental Technologies

TABLE B.4
Water Elevations Used for 1999 Water Level Map

Well	Cadastral	Date Sampled	Water Elevation [1]	Data Source [2]
AWC-2	D-24-23-13abc	12/15/99	4426	ADWR GWSI
AWC-3	D-24-23-13abd	12/15/99	4427.3	ADWR GWSI
AWC-4	D-24-23-13abc	12/15/99	4432.8	ADWR GWSI
BF-1	D-24-24-04aaa	06/01/99	4476.7	PD file
BF-2	D-24-24-04bdd	06/01/99	<4460	PD file
Garner	D-24-24-17aaa	06/01/99	4449.81	PD file
GL-3	D-23-24-34bda	06/01/99	4190.62	PD file
TM-2	D-24-24-04aac1	06/01/99	4462.34	PD file
TM-2A	D-24-24-04aac2	06/01/99	4459.33	PD file
TM-3	D-23-24-35bba	06/01/99	4762.24	PD file
TM-5	D-24-24-21aba	06/01/99	4451.41	PD file
TM-6	D-24-24-4bcc	06/01/99	4537.45	PD file
TM-7	D-24-24-04bbd	06/01/99	4456.07	PD file
TM-15	D-24-24-06bcc	06/01/99	4427.89	WMC, 2006
TM-16	D-24-24-10acd	06/01/99	4624.70	PD file
TM-19A	D-24-24-08ddc2	06/01/99	4447.00	PD file
TM-41	D-24-24-03cbd	06/01/99	4590.56	PD file
TM-42	D-24-24-09dcc	06/01/99	4457.73	PD file
TM-43	D-23-24-27acc	06/01/99	4809.14	PD file
TM-43A	D-23-24-27acc	06/01/99	4821.72	PD file
TM-43B	D-23-24-27dad	06/01/99	4844.69	PD file
TM-43C	D-23-24-27add	06/01/99	4868.33	PD file
TM-44	D-23-24-27bad	06/01/99	4193.90	PD file
TM-45	D-23-24-28add	06/01/99	4513.55	PD file
802236	D-24-24-18dbb1	12/15/99	4452	ADWR GWSI

Notes:

[1] feet above mean sea level

[2] ADWR GWSI = Arizona Department of Water Resources Ground Water Site Inventory Database, 2005
PD file = Phelps Dodge water level database
WMC = Water Management Consultants

TABLE B.5
Water Elevations Used for September 2005 Water Level Map

Well	Date Sampled	Water Elevation [1]	Cadastral	Data Source[2]
BF-1	09/01/05	4472.95	D-24-23-04aaa	PD file
GL-3	09/01/05	4235.17	D-23-24-34bda	PD file
Garner Well	09/01/05	4440.96	D-24-24-17aaa	PD file
GW-47	09/01/05	4437.66	D-24-24-17aaa	PD file
TM-2	09/01/05	4457.89	D-24-24-04aac1	PD file
TM-2A	09/01/05	4451.03	D-24-24-04aac2	PD file
TM-3	09/01/05	4760.89	D-23-24-35bba	PD file
TM-6	09/01/05	4537.15	D-24-24-14bcc	PD file
TM-16	09/01/05	4625.79	D-24-24-10acd	PD file
TM-19A	09/01/05	4435.50	D-24-24-08ddc2	PD file
TM-41	09/01/05	4572.11	D-24-24-03cbd	PD file
TM-42	09/01/05	4447.03	D-24-24-09dcc	PD file
TM-43	09/01/05	4480.64	D-23-24-27acc	PD file
TM-43A	09/01/05	4820.37	D-23-24-27acc	PD file
TM-43B	09/01/05	4839.19	D-23-24-27dad	PD file
TM-43C	09/01/05	4867.53	D-23-24-27add	PD file
TM-44	09/01/05	4239.85	D-23-24-27bad	PD file
641802	08/17/05	4443	D-24-24-18dbb1	PD file

Notes:

[1] feet above mean sea level

[2] PD file=Phelps Dodge water level database

APPENDIX C

HISTORIC SULFATE CONCENTRATIONS
CTSA WELLS

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-23-13abc	AWC-2	616586	Arizona Water Co.	domestic	01/01/55	333	03/27/95	15.1	Basin fill	9
	AWC-2						08/06/96	19.4		1
	AWC-2						07/05/00	7.2		9
	AWC-2						07/11/05	12		9
D-24-23-13abd	AWC-3	616585	Arizona Water Co.	domestic	07/20/56	270	01/06/94	22.5	Basin fill	9
	AWC-3						08/06/96	<10		1
	AWC-3						07/05/00	27.3		9
	AWC-3						7/11/05	35.4		9
	AWC-4		Arizona Water Co.	domestic	05/12/05	337	6/1/91	20		9
	AWC-4					1183	7/5/00	23.1		9
	AWC-5		Arizona Water Co.	domestic	06/24/02		8/5/02	9.6		9
D-24-24-04aab	BF-1	539783	Phelps Dodge	monitoring	08/15/93	400	10/06/93	1400	Basin fill, Morita Formation, and Glance Conglomerate	6
	BF-1						11/24/93	1500		6
	BF-1						06/25/96	1400		4
	BF-1						10/23/05	1410		2
D-24-24-04bdc	BF-2	539786	Phelps Dodge	monitoring	08/05/93	326	10/06/93	1900	Basin fill	6
	BF-2						11/23/93	1900		6
	BF-2						06/25/96	2000		4
	BF-2						08/06/96	1280		4
	BF-2						08/06/96	1880		4
D-24-24-11cbc3	ELKS	628547	B.P.O. Elks No.671	domestic	08/18/61	800	06/01/96	340	unknown	1
D-23-24-34bda	GL-1	539785	Phelps Dodge	monitoring	08/20/93	833	11/23/93	310	Glance Conglomerate	6
	GL-1						06/20/96	200		1
D-23-24-34bbb	GL-3	539782	Phelps Dodge	monitoring	08/11/93	825	11/24/93	34	Glance Conglomerate	6
	GL-3						06/25/96	<5		1
	GL-3						10/23/05	36.4		2
D-24-24-09bca	MW-1	903992	San Jose WWTF	monitoring	03/02/06	250	04/12/06	1260	Basin fill	3
D-24-23-13baa2	NSD-1		Naco Sanitary District	monitoring			10/04/01	12.5		10
D-24-23-13abb	NSD-2	527587	Naco Sanitary District	monitoring	05/12/90	120	10/04/01	18.2	Basin fill	10
D-24-23-13bcc	NSD-3	527586	Naco Sanitary District	monitoring	05/12/90	100	04/05/01	109	Basin fill	10

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-24-18add	NWC-3	627684	Naco Water Co	municipal	01/01/30	179	01/08/86	71	Basin fill	4
	NWC-3						08/07/96	109		4
	NWC-3						08/07/96	129		4
	NWC-3						11/05/97	148		7
	NWC-3						12/03/02	215		7
	NWC-3						10/10/05	460		7
	NWC-3						11/08/05	390		7
D-24-24-10ddd	NWC-4	627685	Naco Water Co	capped	01/01/26	379	08/07/96	248	Morita Formation	4
	NWC-4						08/07/96	263		4
	NWC-4						11/06/97	314		7
	NWC-4						08/04/00	280		7
	NWC-4						12/03/02	255		7
	NWC-4						10/10/05	220		7
	NWC-4						11/08/05	200		7
D-24-24-11d	NWC-5	627696	Naco Water Co	domestic	01/01/60	175	08/07/96	78.9	Morita Formation	1
D-24-24-05db	SJ-9	602134	Duree	domestic	09/06/74	351	06/27/96	440	Basin fill	4
D-24-24-09aab1	TM-1	522569	Phelps Dodge	monitoring	11/01/88	265	02/01/89	1650	Basin fill	4
	TM-1						03/02/89	1630		4
	TM-1						04/17/89	1660		4
	TM-1						05/17/89	1450		4
	TM-1						06/23/89	1460		4
	TM-1						07/19/89	1600		4
	TM-1						08/24/89	1620		4
	TM-1						09/19/89	1520		4
	TM-1						10/27/89	1600		4
	TM-1						12/13/89	1500		4
	TM-1						01/08/90	1480		4

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-24-04aac1	TM-2	522573	Phelps Dodge	monitoring	12/14/88	640	01/27/89	2600	Basin fill	5
	TM-2						02/27/89	2500		5
	TM-2						04/06/89	2700		5
	TM-2						05/01/89	2890		5
	TM-2						06/08/89	2900		5
	TM-2						07/13/89	2640		5
	TM-2						08/02/89	2950		5
	TM-2						09/12/89	2700		5
	TM-2						10/16/89	2800		5
	TM-2						11/13/89	2840		5
	TM-2						12/11/89	2700		5
	TM-2						01/04/90	2800		5
	TM-2						11/23/93	2200		6
	TM-2						06/20/96	1200		4
	TM-2						07/18/96	1156		1
	TM-2						08/06/96	1300		1
	TM-2						08/06/96	523		1
	TM-2						07/30/97	1290		1
	TM-2						11/06/97	1210		1
	TM-2						10/21/05	1280		2
D-24-24-04aac2	TM-2A	522574	Phelps Dodge	monitoring	02/10/89	925	02/24/89	640	Glance Conglomerate	5
	TM-2A						03/03/89	26		5
	TM-2A						04/06/89	27		5
	TM-2A						05/01/89	29		5
	TM-2A						06/08/89	27		5
	TM-2A						07/13/89	24		5
	TM-2A						08/07/89	27		5
	TM-2A						09/12/89	26		5
	TM-2A						10/16/89	26		5
	TM-2A						11/13/89	27		5
	TM-2A						12/11/89	26		5
	TM-2A						01/04/90	27		5
	TM-2A						11/23/93	20		4
	TM-2A						06/24/96	15		1
	TM-2A						10/22/05	58.9		2

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-23-24-35bba	TM-3	522575	Phelps Dodge	monitoring	12/16/88	200	01/27/89	155	Glance Conglomerate	5
	TM-3						03/01/89	149		5
	TM-3						04/06/89	153		5
	TM-3						05/02/89	158		5
	TM-3						06/01/89	162		5
	TM-3						07/13/89	152		5
	TM-3						08/08/89	154		5
	TM-3						09/08/89	150		5
	TM-3						10/11/89	146		5
	TM-3						11/13/89	147		5
	TM-3						12/07/89	154		5
	TM-3						01/04/90	150		5
D-24-24-21aba	TM-5	522694	Phelps Dodge	monitoring	01/13/89	160	06/26/96	10	Basin fill	1
D-24-24-14bcc	TM-6	522695	Phelps Dodge	assessment	01/24/89	200	06/26/96	29		1
	TM-6						08/23/05	27.2		2
D-24-24-04bbd	TM-7	522576	Phelps Dodge	monitoring	11/04/88	350	01/24/89	365	Morita Formation	5
	TM-7						02/27/89	485		5
	TM-7						04/04/89	525		5
	TM-7						05/01/89	520		5
	TM-7						06/06/89	510		5
	TM-7						07/12/89	450		5
	TM-7						08/07/89	475		5
	TM-7						09/07/89	480		5
	TM-7						10/10/89	450		5
	TM-7						11/08/89	340		5
	TM-7						12/04/89	460		1
	TM-7						01/03/90	456		1
	TM-7						06/24/96	310		1
	TM-7						08/06/96	311		1
	TM-7						08/06/96	315		1
	TM-7						01/23/97	311		1
	TM-7						07/29/97	271		4
	TM-7						11/06/97	300		1

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-24-05bac	TM-10	522696	Phelps Dodge	monitoring	11/06/89	290	01/30/89	16	Glance Conglomerate	5
	TM-10						03/02/89	16		5
	TM-10						04/07/89	16		5
	TM-10						05/02/89	12		5
	TM-10						06/07/89	17		5
	TM-10						07/14/89	18		5
	TM-10						08/10/89	14		5
	TM-10						09/07/89	15		5
	TM-10						10/10/89	15		5
	TM-10						11/14/89	15		5
	TM-10						12/04/89	15		5
	TM-10						01/03/90	17		5
D-24-24-18aab	TM-11	522815	Phelps Dodge	monitoring	11/18/88	160	01/24/89	9	Basin fill	6
	TM-11						02/27/89	10		6
	TM-11						04/04/89	9		6
	TM-11						05/01/89	10		6
	TM-11						06/06/89	11		6
	TM-11						07/12/89	8		6
	TM-11						08/07/89	7		6
	TM-11						09/07/89	16		6
	TM-11						10/10/89	9		6
	TM-11						11/08/89	9		6
	TM-11						12/04/89	9		6
	TM-11						01/03/90	9		6
D-24-24-20bbd	TM-12	522697	Phelps Dodge	assessment	01/12/89	175	12/04/89	7	Basin fill	1
D-24-24-08bcc	TM-13	522698	Phelps Dodge	assessment	01/05/89	200	02/01/89	430	Basin fill	4
	TM-13						03/02/89	460		4
	TM-13						04/17/89	415		4
	TM-13						05/17/89	380		4
	TM-13						06/19/89	416		4
	TM-13						07/18/89	430		4
	TM-13						08/22/89	440		4
	TM-13						09/12/89	146		4
	TM-13						10/25/89	396		4
	TM-13						01/17/90	450		4

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-24-07bcb2	TM-14	522816	Phelps Dodge	assessment	01/12/89	215	03/10/89	16	Basin fill	4
	TM-14						04/18/89	18		4
	TM-14						05/18/89	19		4
	TM-14						06/19/89	17		4
	TM-14						07/18/89	19		4
	TM-14						08/22/89	19		4
	TM-14						09/12/89	18		4
	TM-14						10/25/89	17		4
	TM-14						01/05/90	20		4
D-24-24-06bcc	TM-15	522699	Phelps Dodge	monitoring	01/11/89	325	06/27/96	14	Morita Formation	1
	TM-15				08/23/05		08/23/05	15.4		1
	TM-15						10/23/05	22.6		2
D-24-24-10acd	TM-16	522578	Phelps Dodge	monitoring	12/15/88	115	01/27/89	510	Morita Formation	5
	TM-16						03/01/89	560		5
	TM-16						04/06/89	555		5
	TM-16						05/03/89	535		5
	TM-16						06/01/89	560		5
	TM-16						07/13/89	540		5
	TM-16						08/08/89	508		5
	TM-16						09/08/89	510		5
	TM-16						10/11/89	500		5
	TM-16						11/13/89	500		5
	TM-16						12/07/89	520		5
	TM-16						01/04/90	520		5
	TM-16						06/27/96	500		1
	TM-16						08/06/96	470		1
	TM-16						08/06/96	553		1
	TM-16						01/23/97	484		1
	TM-16						07/29/97	500		1
	TM-16						11/06/97	506		1
	TM-16						08/23/05	528		2
	TM-16						10/23/05	619		2

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-24-08ddc2	TM-19	522581	Phelps Dodge	monitoring	11/17/88	210	01/30/89	1100	Basin fill	5
	TM-19						03/01/89	1100		5
	TM-19						04/07/89	1180		5
	TM-19						05/02/89	1125		5
	TM-19						06/09/89	1070		5
	TM-19						07/13/89	1120		5
	TM-19						08/08/89	1110		5
	TM-19						09/08/89	1080		5
	TM-19						10/13/89	1200		5
	TM-19						11/14/89	1100		5
	TM-19						12/07/89	1120		5
	TM-19						01/04/90	1120		5
	TM-19						11/23/93	1100		6
	TM-19						06/20/96	1100		4
	TM-19						08/06/96	1120		4
	TM-19						08/06/96	1200		1
	TM-19						01/23/97	1140		1
D-24-24-08ddc1	TM-19A	522580	Phelps Dodge	monitoring	11/16/88	700	01/30/89	50	Morita Formation	5
	TM-19A						03/01/89	54		5
	TM-19A						04/07/89	55		5
	TM-19A						05/02/89	50		5
	TM-19A						06/09/89	55		5
	TM-19A						07/13/89	55		5
	TM-19A						08/08/89	53		5
	TM-19A						09/11/89	58		5
	TM-19A						10/13/89	58		5
	TM-19A						11/14/89	58		5
	TM-19A						12/07/89	58		5
	TM-19A						01/04/90	62		5
	TM-19A						11/23/93	63		6
	TM-19A						06/25/96	56		1
	TM-19A						10/23/05	62.5		2

TABLE C.1
Historic Sulfate Concentrations, CTSA Wells

Cadastrals	Well	ADWR Registration #	Owner	Use	Completion Date	Total Depth	Sample Date	Sulfate mg/L	Screened Material	Data Source [1]
D-24-24-03cbd	TM-41	unknown	Phelps Dodge	monitoring	06/19/05	210	07/30/97	1940	Morita Formation	4
	TM-41						11/06/97	1900		1
D-24-24-09dcc	TM-42	unknown	Phelps Dodge	monitoring	1997	250	07/30/97	985	Basin fill and Morita Formation	1
	TM-42						11/06/97	958		1
	TM-42						10/22/05	656		2
D-23-24-27aac	TM-43	564729	Phelps Dodge	monitoring	11/10/97	830	04/27/98	26	Morita Formation	8
D-23-24-27aac	TM-43A	564726	Phelps Dodge	monitoring	10/28/97	215	03/10/98	1700	Morita Formation	8
D-23-24-27dad	TM-43B	565004	Phelps Dodge	monitoring	10/29/97	215	03/11/98	28	Morita Formation	8
D-23-24-27add	TM43C	565005	Phelps Dodge	monitoring	11/12/97	270	03/11/98	200	Morita Formation	8
D-23-24-27bad	TM-44	564730	Phelps Dodge	monitoring	10/27/97	1150	10/22/05	43.1	Paleozoic Sediments	2
D-23-24-27bbb	TM-46	564727	Phelps Dodge	monitoring	12/12/97	1080	10/23/05	42.4	Paleozoic Sediments	2
D-24-24-18aad	641802	641802	Grout/Weiskopf	domestic	before 1960	200	08/17/05	590	Basin fill	2
D-24-24-17aaa	Garner - old	unknown	Garner	domestic			06/27/96	1100	Basin fill	1
D-24-24-17aaa	558557	558557	Garner	domestic	09/04/96	300	01/23/97	777	Basin fill	1
D-24-24-17aaa	GW-47	587635	Garner	domestic	10/12/01	680	08/16/05	38.7	Morita Formation	2
D-24-24-17bbb	637069	637069	Olmstead	domestic	07/29/66	220	08/06/96	734	unknown	1

Notes:

mg/L = milligram per Liter

[1] data source:

1 = SET, 1999

2 = Weiskopf, 2006, personal communication

3 = Arizona Department of Environmental Quality, 2006

4 = SET, 1998c

5 = Canonie Environmental, 1990

6 = Southwest Groundwater Consultants, 1994

7 = Naco Water Company

8 = SET, 1998b

9 = Geoscience Support Services, Inc. Responses to City of Bisbee's Aquifer Protection Permit No. P-100983 and AZPDES Permit No. AZ0025275

10 = ADEQ File 100833. Aquifer Protection Permit Application, Naco Wastewater Treatment Plan, Naco Sanitary District, Arizona, January 22, 2003

APPENDIX D

ANALYTICAL RESULTS FOR GROUNDWATER SAMPLES
(Tables D.1 and D.2)

TABLE D.1
Analytical Results for Groundwater Samples
Copper Queen Branch-Bisbee, Arizona [5]

Well Name and 55 No.	Date	pH [1]	Turbidity [2]	CO3 [3]	HCO3 [3]	Alkalinity [3]	Hardness	Cl	F	Total N	NO2-N	NO3-N	SO4	TDS	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	Zn
AWC-2 616586	08/6/1996 [4]	7.58	3.03			166	168	17.4	0.29	2.16	<0.10	2.16	19.4	269	<0.001	<0.50	<0.010	0.37	<0.0005	61.3	<0.0010	<0.010	<0.010	<0.10	<0.0005	8.27	8.1	<0.05	20.2	<0.10	<0.005	0.013	<0.005	<0.005	<0.05
AWC-3 616585	08/6/1996 [4]	7.56	0.10			179	163	8.0	0.33	1.61	<0.10	1.61	<10.0	248	<0.001	<0.50	<0.010	0.39	<0.0005	60.4	<0.0010	<0.010	<0.010		<0.0005	2.27	7.6	<0.05	15.7	<0.10	<0.005	0.015	<0.005	<0.005	<0.05
BF-1	10/06/93	6.7		<1	710	710		30	0.06			1.33	1400	2900	<0.010		<0.005	0.042	<0.005	686	<0.0005	<0.010	<0.010	2.6	<0.0002	--	110	0.036	61	<0.020	<0.005	<0.05	<0.005	<0.005	0.025
539783	11/24/93	6.8		<1	706	706		30	0.06			1.25	1500	3000	<0.010		<0.005	0.037	<0.005	693	<0.0005	<0.010	<0.010	1.28	<0.0002	--	109	0.019	63.4	<0.020	<0.005	<0.05	<0.005	<0.005	<0.020
	06/25/96	6.4		<1	737	737		30	<0.05			0.98	1400	2900	<0.010		<0.003	0.032	<0.004	752	<0.0005	0.036	<0.010	<0.05	<0.0002	3.3	102	<0.010	54.6	<0.020	<0.002	<0.05	<0.005	<0.005	<0.05
BF-2	10/06/93	6.4		<1	964	964		33	0.06			1.99	1900	3800	<0.010		<0.005	0.039	<0.005	864	<0.0005	<0.010	<0.010	0.264	<0.0002	--	199	0.224	41.7	<0.020	0.005	<0.05	<0.005	<0.005	1.99
539786	11/23/93	6.9		<1	955	955		34	0.08			2.02	1900	3800	<0.010		<0.005	0.032	<0.005	854	<0.0005	<0.010	<0.010	0.128	<0.0002	--	196	0.225	35.1	<0.020	0.003	<0.05	<0.005	<0.005	11.56
	06/25/96	6.3		<1	987	987		33	<0.05			2.2	2000	3800	<0.010		<0.003	0.031	<0.004	958	<0.0005	0.017	<0.010	<0.05	<0.0002	4.1	206	0.123	30.1	<0.020	<0.002	0.06	<0.005	<0.005	0.325
	8/6/1996	6.1			794			35.8	<1.0			2.3	1280	3800			<0.005		<0.1	864	<0.003	<0.03		<0.1		5	208.0		23.1		<0.005	<0.2	0.007	<0.002	0.30
	08/6/1996 [4]	6.37	0.96			939	3,540	33.0	<0.2	2.17	<0.10	2.17	1880	3,820	<0.001	<0.50	< 0.02	<0.10	<0.0005	913	<0.0010	<0.010	<0.010	<0.10	<0.0005	4.60	209	0.10	25.3	<0.10	<0.005	0.016	0.007	<0.005	0.24
ELKS 628546	06/27/96	7.7		<1.0	220	220		58	0.26			6.2	340	840	<0.010		<0.003	0.038	<0.004	114	<0.0005	0.036	<0.010	<0.050	<0.0002	8.1	45.6	<0.010	52.6	<0.020	<0.002	<0.25	<0.005	<0.005	<0.050
Garner - Old	06/27/96	7.2		ND	219			21	0.14			3.2	1100	2000				0.026		422			ND	ND		3.7	45.6	ND	41.1						0.14
Garner - New 558557	01/23/97	6.95		<1	238	238		21.5	<0.5			3.1	777	1480				<1		356			<0.02	<0.3		6	42.0	<0.02	41.3						<0.04
GL-1	01/23/93	7.4		<1	442	442		21	0.24			1.4	310	940	<0.010		<0.005	0.092	<0.005	209	<0.0005	<0.010	<0.010	3.19	<0.0002	--	56	0.674	20.3	<0.020	<0.002	<0.05	<0.005	<0.005	<0.020
539785	06/20/96	7.1		<1	472	472		18	0.2			2.8	200	860	<0.010		<0.003	0.046	<0.004	175	<0.0005	0.026	<0.010	1.14	<0.0002	2.8	49.5	0.053	20.1	0.022	<0.002	<0.05	<0.005	<0.005	11.4
GL-3	11/24/93	7.4		<1	358	358		21	0.23			<0.06	34	440	<0.010		<0.005	0.444	<0.005	68.1	0.0006	0.045	0.024	38.9	<0.0002	--	31.9	0.829	16.4	0.036	0.034	<0.05	<0.005	<0.005	4.5
539782	06/25/96	7.6		<1	201	201		24	0.4			<0.06	<5	230	<0.010		<0.003	0.166	<0.004	36.1	<0.0005	0.016	<0.010	3.95	<0.0002	2.2	21	0.072	224	<0.020	<0.002	<0.05	<0.005	<0.005	0.675
NWC-3	8/7/96 [4]	7.45	3.60			153	325	21.7	0.27	5.19	<0.10	5.19	129	446	<0.001	<0.50	<0.010	<0.10	<0.0005	116	<0.0010	<0.010	<0.010	<0.10	<0.0005	3.20	14.6	<0.05	27.5	<0.10	<0.005	<0.005	<0.005	<0.005	<0.05
627684	08/07/96	7.45			148			23.3	<1.0			5.2	109	450			0.006		<0.1	109	<0.003	<0.03		<0.1		<5	13.4		21.8		<0.005	<0.2	<0.005	<0.002	<0.04
	11/05/97	7.05		<1	150	150			0.3	5.10	<0.1	5.10	148	390		<2	0.005	<1	<0.1	100	<0.003	<0.03		<0.3	<0.001	<5	14.0	<0.02	30.0	<0.1	0.006	<0.005	<0.005	<0.002	
NWC-4	8/7/96 [4]	7.40	0.05			184	444	40.9	0.34	6.20	<0.10	6.20	263	666	<0.001	<0.50	<0.010	<0.10	<0.0005	123.0	<0.0010	<0.010	<0.010	<0.10	<0.0005	6.89	43.3	<0.05	38.1	<0.10	<0.005	<0.005	0.006	<0.005	0.06
627685	08/07/96	7.41			192	192		45.4	<1.0			6.1	248	668			<0.005		<0.1	118	<0.003	<0.03		<0.1		7	40		30.2		<0.005	<0.2	<0.005	<0.002	0.06
	11/06/97	6.90		<1	180	180			0.30	6.30	<0.1	6.30	314	690		<2	<0.005	<1	<0.1	130.0	<0.003	<0.03		<0.3	<0.001	10.00	50.0	<0.02	38.0	<0.1	<0.005	<0.005	0.005	<0.002	
NWC-5 627696	8/7/96 [4]	7.38	2.8			126	490	180	0.33	26.5	<0.10	26.5	78.9	888	<0.001	<0.50	<0.010	<0.10	<0.0005	158	<0.0010	<0.010	<0.010	<0.10	<0.0005	4.56	33.0	<0.05	25.8	<0.10	<0.005	<0.005	0.006	<0.005	0.19
Olmstead 637069	8/6/96 [4]	7.32	2.8			169	765	21.7	0.22	2.43	<0.10	2.43	687	1340	<0.001	<0.50	<0.010	<0.10	<0.0005	294	<0.0010	<0.010	<0.010	<0.10	<0.0005	4.69	40.7	<0.05	34.4	<0.10	<0.005	0.015	0.007	<0.005	<0.05
Olmstead-Dup	8/6/96 [4]	7.36	2.4			173	851	21.3	0.21	2.45	<0.10	2.45	734	1340	<0.001	<0.50	<0.010	<0.10	<0.0005	326	<0.0010	<0.010	<0.010	<0.10	<0.0005	5.20	44.3	<0.05	37.6	<0.10	<0.005	0.010	0.006	<0.005	<0.05
TM-2	01/27/89	6.7		<2.6	1368			23	0.07			0.2	2600	4895	<0.010		<0.010	<0.1		878	<0.005	<0.010	<0.010	<0.05	<0.0002	7	394	6.4	31		<0.01		<0.005		0.02
522573	02/27/89	6.5		<2.6	1325			26.6	<0.05			0.2	2500	4840	<0.010		<0.010	<0.1		831	<0.005	<0.010	<0.010	<0.05	0.00245	6	391	6.2	33		<0.01		<0.005		<0.01
	04/06/89	6.4		<2.6	1376			37.2	0.06			0.2	2700	5150	<0.010		<0.010	<0.1		800	<0.005	<0.010	0.011	<0.05	<0.0002	5.5	480	10.27	30		<0.01		<0.005		0.025
	05/01/89	6.7		<2.6	1313			29.7	0.08			0.2	2890	5315	<0.010		<0.010	<0.1		893	<0.005	<0.010	<0.010	<0.05	<0.0002	4.8	433	8.69	30		<0.01		<0.005		<0.01
	06/08/89	6.8			1388			26.6	0.06			0.2	2900	5295						820			<0.010		<0.0002	5.7	490	11.8	31						<0.01
	07/13/89	6.3			1340			29.7	<0.05			0.2	2640	5145						760			<0.010			5.4	466	10.33	30						0.015
	08/02/89	6.6			1397			33.3	<0.05			0.1	2950	5530						800			<0.010			5.3	537	13.68	27						<0.01
	09/12/89	6.7			1359			28.3	<0.05			0.2	2700	5135						820						6.1	467	10.62	31						0.02
	10/16/89	6.5			1344			26.9	<0.05			0.2	2800	5160						820						5.2	479	11.78	27						0.021
	11/13/89	6.8			1366			30.8	0.08			0.2	2840	5110						823						5.4	471	11.14	30						0.075
	12/11/89	6.7			1354			28.7	0.05			0.2	2700	5225						784						5.4	494	10.64	28						0.082
	01/04/90	6.6			1317			29.7	0.05			0.2	2800	5100						800						5.4	500	13.3	31						1.04
	11/23/93	6.6		<1	895	895		30	0.06			1.01	2200	3900	<0.010		<0.005	0.016	<0.005	706	<0.0005	<0.010	<0.010	0.029	<0.0002	--	322	4.03	26.3	<0.020	<0.002	<0.05	<0.005	<0.005	<0.020
	06/20/96	6.4		<1	750	750		28	0.09			1.7	1200	2700	<0.050		<0.003	0.022	<0.004	628	<0.0005	0.02	<0.010	<0.05	<0.0002	4.9	147	<0.010	35.6	<0.020	<0.002	<0.05	<0.005	<0.005	0.062
	07/18/96	7.35		0	838	687		26.1	<0.10		<0.10	0.84	1156	2657		<0.10	0.005	<0.10		584	<0.01	<0.05	<0.01	<0.05	<0.001	4.8	142	<0.01	32.0	<0.05	<0.05		<0.001		<0.01
	08/06/96	6.12			700			31.5	<1.0			1.7	523	2,580			<0.005		<0.1	569	<0.003	<0.03		<0.1		5	140		27.8		<0.005	<0.2	<0.005	<0.002	<0.04
	8/6/96 [4]	6.3	3.6			678	1840	27.9	<0.2	1.56		1.56	1300	2600	<0.001	<0.50	<0.010	<0.10	<0.0005	603	<0.0001	<0.010	<0.010	<0.10	<0.0005	7.82	134	<0.05	31.1	<0.10	<0.005	0.015	0.011	<0.005	<0.05
	07/30/97	6.10		<1	606	606		24.0	<0.1	1.50	<0.1	1.5	1290	2,500		<2	<0.005	<1	<0.1	530	<0.05	<0.1		0.3	<0.001	8		<0.1	38.0	<0.1	<0.005	<0.005	<0.005	<0.002	
	11/06/97	6		<1.0	670	670			<0.1	1.30	<0.10	1.3	1210	2,500		<2.0	<0.005	<1.0	<0.1	530	<0.003	<0.03		<0.3	<0.001	7.5	14	0.06	35.0	<0.1	<0.005	<0.005	<0.005	<0.002	

TABLE D.1
Analytical Results for Groundwater Samples
Copper Queen Branch-Bisbee, Arizona [5]

Well Name and 55 No.	Date	pH [1]	Turbidity [2]	CO3 [3]	HCO3 [3]	Alkalinity [3]	Hardness	Cl	F	Total N	NO2-N	NO3-N	SO4	TDS	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	Zn
TM-2A	02/24/89	8.1		<2.6	333			18	0.19			1.3	640	1180	<0.010		<0.010	0.16		184	<0.005	<0.010	<0.010	<0.05	<0.0002	10	85	0.31	62		<0.01		<0.005		<0.01
522574	03/03/89	9.1		15.3	156			9.6	0.42			1.5	26	370	<0.010		<0.010	<0.1		8.4	<0.005	<0.010	<0.010	<0.05	<0.0002	8.3	4.7	0.013	68		<0.01		<0.005		0.082
	04/06/89	9		14.5	146			10.6	0.56			<0.1	27	265	<0.010		<0.010	<0.1		9.2	<0.005	<0.010	0.011	<0.05	<0.0002	5.6	5.2	<0.010	62		<0.01		<0.005		<0.01
	05/01/89	8.8		17.9	133			9.6	0.43			0.2	29	225	<0.010		<0.010	<0.1		8	<0.005	<0.010	<0.010	<0.05	<0.0002	3.7	4.5	<0.010	63		<0.01		<0.005		0.099
	06/08/89	9		19.6	137			7.1	0.49			0.2	27	340				<0.1		7.6			<0.010		<0.0002	4.1	5.3	0.012	64						<0.01
	07/13/89	8.9		12.8	156			12.4	0.45			0.1	24	350						7			<0.010		<0.0002	3.7	5.4	<0.010	66						<0.01
	08/07/89	9		19.6	149			8.1	0.4			0.2	27	335						7.9			<0.010		<0.0002	3.3	6	0.011	66						0.02
	09/12/89	8.9		23	140			8.1	0.42			0.1	26	310						7.7					<0.0002	4	5.5	0.013	68						0.036
	10/16/89	8.6		25.6	136			8.1	0.43			0.1	26	410						9.8					<0.0002	3.5	6.6	0.014	64						0.012
	11/13/89	8.7		23	147			12.4	0.39			0.2	27	280						9					<0.0002	3.4	6.3	0.017	69						0.149
	12/11/89	8.8		10.2	164			9.6	0.28			0.2	26	240						9					<0.0002	3.4	6	0.016	66						0.276
	01/04/90	8.7		9.4	173			9.2	0.28			0.2	27	310						9.4					<0.0002	3.6	6.1	0.013	67						0.219
	11/23/93	8.2		<1	169	169		9.3	0.34			1.76	20	240				0.162	<0.005	19.4	0.0013	<0.010	0.014	4.02	<0.0002	--	7.4	0.132	59.3	<0.020	0.022	<0.05	<0.005	<0.005	1.24
	06/24/96	8.1		<1	173	173		8.7	0.28			0.41	15	240	<0.010		<0.003	0.15	<0.004	15.2	<0.0005	<0.010	<0.010	<0.05	<0.0002	2.4	6.2	0.108	59.3	<0.020	<0.020	<0.05	<0.005	<0.005	0.575
TM-3	01/27/89	8.1		<2.6	250			35	0.26			3.5	155	505	<0.01		<0.01	<0.1		86	<0.005	<0.01	<0.01	<0.05	<0.0002	3.5	34	<0.01	30		<0.01		<0.005		0.02
522575	03/01/89	7.9		<2.6	248			30.4	0.29			3.7	149	525	<0.01		<0.01	<0.1		83	<0.005	<0.01		<0.05	<0.0002	3.4	32	<0.01	29		<0.01		<0.005		<0.01
	04/06/89	8		<2.6	250			35.4	0.34			3.9	153	535	<0.01		<0.01	<0.1		90	<0.005	<0.01	<0.01	<0.05	<0.0002	3.2	35	<0.01	28		<0.01		<0.005		<0.01
	05/02/89	7		<2.6	244			34	0.27			3.6	158	520	<0.01		<0.01	<0.1		94	<0.005	<0.01	<0.01	<0.05	<0.0002	2	33	0.013	28		<0.01		<0.005		<0.01
	06/01/89	8.1			242			32.2	0.29			3.8	162	530						92		<0.01				3.5	32	<0.01	26						<0.01
	06/27/89																																		
	07/13/89	7.8			246			34.3	0.3			3.7	152	505						86		<0.01				3.3	34	<0.01	27						
	08/08/89	8			247			31.5	0.26			3.8	154	495						85		<0.01				3.2	32	<0.01	29						
	09/08/89	8.1			249			34	0.31			3.5	150	505						88		<0.01				3.9	32	<0.01	29						
	10/11/89	7.8			243			31.9	0.35			3.5	146	515						83		<0.01				3.2	34		26						
	11/13/89	8			250			31.9	0.25			4.1	147	520						87						3.2	33		25						
	12/07/89	8.3		6.0	232			33.6	0.3			4	154	515						93						3.4	33		26						
	01/04/90	8.1		<2.6	237			34.3	0.26			4.3	150	495						87						3.5	34		29						
TM-5 522694	06/26/96	7.8		<1.0	147	147		24	0.34			2.1	10	240	<0.010		0.003	0.223	<0.004	50.5	<0.0005	0.014	<0.010	<0.05	<0.0002	1.6	5.6	<0.010	19.8	<0.020	<0.002	<0.05	<0.005	<0.005	<0.050
TM-6 522695	06/26/96	7.9		<1.0	225	225		18	0.82			0.83	29	320	<0.010		<0.003	0.085	<0.004	36.1	<0.0005	0.019	<0.010	<0.05	<0.0002	1.5	18.2	<0.010	54	<0.020	<0.002	<0.05	<0.005	<0.005	<0.050
TM-7 522576	01/24/89	7.9		<2.6	249			23	0.1			2.5	365	805	<0.01		<0.01	<0.1		144	<0.005	<0.01	<0.01	<0.05	<0.0002	2.9	52	0.02	28		<0.01		<0.005		0.02
	02/27/89	7.4		<2.6	261			22.7	0.12			2.4	485	1005	<0.01		<0.01	<0.1		180	<0.005	<0.01	<0.01	<0.05	<0.0002	2.8	55	0.014	34		<0.01		<0.005		<0.01
	04/04/89	7.4		<2.6	258			31.9	0.15			3	525	1025	<0.01		<0.01	<0.1		196	<0.005	<0.01	<0.01	<0.05	<0.0002	2.8	62	0.013	30		<0.01		<0.005		0.012
	05/01/89	7.2		<2.6	266			26.2	0.18			2.6	520	1040	<0.01		<0.01	<0.1		184	<0.005	<0.01	<0.01	<0.05	<0.0002	1.6	64	<0.01	30		<0.01		<0.005		0.014
	06/06/89	7.8			260			24.1	0.06			2.8	510	985						175						2.9	66	0.011	31						<0.01
	07/12/89	7.4			271			25.5	0.09			2.7	450	920						160						2.8	66	0.046	31						<0.01
	08/07/89	7.5			264			23.4	0.05			2.8	475	990						179						2.7	62	0.012	30						<0.01
	09/07/89	7.8			262			25.1	0.11			2.5	480	995						180						3.2	62	<0.01	31						0.024
	10/10/89	7.4			261			21.2	0.06			2.1	450	950						161						2.8	61	<0.01	29						0.152
	11/08/89	7.5			245			28.7	0.09			2.9	340	730						134						2.6	48	<0.01	28						0.1
	12/04/89	8		<2.6	250			25.5	0.16			2.9	460	940	<0.01		<0.01	<0.1		174	<0.005			<0.05	<0.0002	2.8	57	<0.01	28		<0.01		<0.005		0.05
	01/03/90	7.7		<2.6	246			22.7	0.07			3.1	456	900	<0.01		<0.01	<0.1		165	<0.005			<0.05	<0.0002	3.0	60	<0.01	31		<0.005		<0.005		0.022
	06/24/96	7.7		<1	185	185		17	0.17			2.2	310	720	<0.01		<0.003	0.107	<0.004	122	<0.0005	0.029		<0.05	<0.0002	2.3	41.1	<0.01	25.4	<0.020	0.002	<0.05	<0.005	<0.005	<0.050
	08/06/96	7.25			180			17.9	<1			2.1	315	672			<0.010		<0.0005	129	<0.003	<0.03		<0.1		<5	41.7		20.7		<0.005	<0.2	<0.005	<0.002	<0.04
	8/6/1996 [4]	7.30	0.38			173	462	16.4	0.24	2.05	<0.10	2.05	311	691	<0.001	<0.50	<0.010	<0.10	<0.0005	136	<0.0010	<0.010	<0.010	<0.10	<0.0005	2.45	43.5	<0.05	23.6	<0.10	<0.005	0.005	<0.005	<0.005	<0.05
	01/23/97	7.21											311	672																					
	07/29/97	7		<1	178	178		17	0.2	2.1	<0.1	2.1	271	600		<2	<0.005	<1	<0.1	120	<0.05	<0.1		<0.1	<0.001	<5	42	<0.1	28	<0.1	<0.005	<0.005	<0.005	<0.002	
	11/06/97	6.87			172	172			0.2			2	300	580		<2	<0.005	<1.0	<1	120	<0.003	<0.03		<0.3	<0.001	<5	41	<0.02	25	<0.1	0.006	<0.005	<0.005	<0.002	

TABLE D.1
Analytical Results for Groundwater Samples
Copper Queen Branch-Bisbee, Arizona [5]

Well Name and 55 No.	Date	pH [1]	Turbidity [2]	CO3 [3]	HCO3 [3]	Alkalinity [3]	Hardness	Cl	F	Total N	NO2-N	NO3-N	SO4	TDS	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	Zn
TM-10	01/30/89	8.1		<2.6	224			8.1				2.1	16	240	<0.01		<0.01	<0.1		29	<0.005	<0.01	<0.01	<0.05	<0.0002	2.1	20	<0.01	27		<0.01		<0.005		0.02
522696	03/02/89	8		<2.6	218			4.2				1.5	16	235	<0.01		<0.01	0.17		28	<0.005	<0.01	<0.01	<0.05	<0.0002	1.9	18	<0.01	27		<0.01		<0.005		<0.01
	04/07/89	8.1		<2.6	210			7.4				2.3	16	265	<0.01		<0.01	0.165		29	<0.005	<0.01	<0.01	<0.05	<0.0002	1.9	18	<0.01	27		<0.01		<0.005		0.012
	05/02/89	7.9		<2.6	207			<1.8				2.7	12	225	<0.01		<0.01	0.162		25	<0.005	<0.01	<0.01	<0.05	<0.0002	1	18	<0.01	26		<0.01		<0.005		0.018
	06/07/89	8.1			215			3.5				2.2	17	230				0.189		28						2	19		27						<0.01
	07/14/89	8			212			8.1				2.5	18	230				0.198		28						1.9	20		26						<0.01
	08/10/89	8.1			217			5.7				2.7	14	230				0.173		28						1.9	19		27						<0.01
	09/07/89	8.4			191			6.4				3	15	245				0.164		30						2	18.6		26						<0.01
	10/10/89	7.9			213			5.3				2	15	220				0.189		28						1.8	19		26						
	11/14/89	8.4			193			5.3				3	15	240				0.186		28						1.9	20		25						
	12/04/89	8.2			194			7.4				3.4	15	240				0.186		28						1.9	20		26						
	01/03/90	8.3			198			6				3.9	17	215				0.179		28						1.9	19		28						
TM-11	01/24/89	8		<2.6	191			16.6	0.25			1.9	9	240	<0.01		<0.01	0.33		51	<0.005	<0.01	<0.01	<0.05	<0.0002	2.4	8.2	<0.01	13		<0.01		<0.005		0.02
522815	02/27/89	7.9		<2.6	189			14.2	0.3			2.2	10	240	<0.01		<0.01	0.29		53	<0.005	<0.01	<0.01	<0.05	<0.0002	2.2	7.4	0.05	13		<0.01		<0.005		<0.01
	04/04/89	7.8		<2.6	184			18	0.24			2.5	9	225	<0.01		<0.01	0.342		54	<0.005	<0.01	<0.01	<0.05	<0.0002	2.1	8	<0.01	13		<0.01		<0.005		<0.01
	05/01/89	7.5		<2.6	174			17.4	0.31			2.1	10	230	<0.01		<0.01	0.306		50	<0.005	<0.01	<0.01	<0.05	<0.0002	1	7	<0.01	12		<0.01		<0.005		0.015
	06/06/89	8.1			181			14.5	0.3			2.3	11	220				0.349		50						2.2	8.2	<0.01	12						<0.01
	07/12/89	7.7			179			15.6	0.3			2.3	8	220				0.328		50						2	7.3	<0.01	11				<0.005		<0.01
	08/07/89	7.9			179			15.2	0.28			2.3	7	215				0.318		50						2.1	7.3		12				<0.005		<0.01
	09/07/89	8.1			186			13.8	0.32			2.2	16	235				0.293		51						2.4	7.8		14				<0.005		<0.01
	10/10/89	7.7			184			16.3	0.35			1.7	9	210				0.339		51						2	8.9		12				<0.005		
	11/08/89	8			178			16.3	0.27			2.6	9	215				0.324		50						2.1	7.3		13				<0.005		
	12/04/89	8			167			91.1	0.3			2.5	9	230				0.326		47						2.1	7.7		13				<0.005		
	01/03/90	8			176			18.8	0.32			2.7	9	220				0.338		51						2.1	7.5		12				<0.005		
TM-12 522697	06/26/96	7.7		<1.0	181	181		25	0.22			2.7	7	270	<0.010		<0.003	0.421	<0.004	57.7	<0.0005	0.013	<0.010	<0.050	<0.0002	1.8	7.5	<0.010	23.3	<0.020	<0.002	<0.05	<0.005	<0.005	<0.050
TM-15 522699	06/27/96	7.9		<1.0	187	187		7.2	0.39			1.28	14	230	<0.010		0.006	0.167	<0.004	26	<0.0005	0.018	<0.010	<0.050	<0.0002	1.9	16.4	<0.010	30.3	<0.020	<0.002	<0.05	<0.005	<0.005	<0.050
TM-16 522578	01/27/89	7.8		<2.6	258			30.8	0.03			7.4	510	1115	<0.010		<0.01	<0.1		215	<0.005	<0.010	<0.010	<0.010	<0.0002	13	49	<0.01	32		<0.01		<0.005		0.02
	03/01/89	7.5		<2.6	250			27.3	0.07			10	560	1120	<0.010		<0.01	<0.1		220	<0.005	<0.010	<0.010		<0.0002	11	48	<0.01	40		<0.01		<0.005		<0.01
	04/06/89	7.4		<2.6	252			36.5	0.16			7.6	555	1130	<0.010		<0.01	<0.1		220	<0.005	<0.010	<0.010	<0.010	<0.0002	12	53	<0.01	30		<0.01		<0.005		0.012
	05/03/89	7.5		<2.6	249			31.9	0.2			7.6	535	1100	<0.010		<0.01	<0.1		217	<0.005	<0.010	<0.010	<0.010	<0.0002	12.4	48	<0.01	29		<0.01		<0.005		0.011
	06/01/89	7.7			253			29.4	0.05			8.2	560	1115						239						12	46		31				<0.005		<0.01
	07/13/89	7.4			250			30.4	0.16			8.2	540	1115						225						12	52		31				<0.005		<0.01
	08/08/89	7.3			263			28	0.16			8	508	1185						218						12	48		29				<0.005		<0.01
	09/08/89	7.7			261			30.8	0.1			6.8	510	1070						217						12.9	50		28				<0.005		0.017
	10/11/89	7.5			259			28.7	0.05			18.2	500	1070						213						12	52		30				<0.005		0.014
	11/13/89	7.8			259			31.9	0.18			8.2	500	1065						207						12	47		33				<0.005		<0.01
	12/07/89	7.9			248			30.1	0.16			8	520	1080						220						12	47		29				<0.005		0.243
	01/04/90	7.6			248			30.1	<0.05			7.7	520	1065						209						12	50		32				<0.005		0.073
	06/27/96	7.4		<1	206	206		28	0.17			7.1	500	1100	<0.010		<0.003	0.024	<0.004	200	<0.0005	0.033	<0.010		<0.0002	11.1	44.1	<0.01	28.2	<0.020	0.002	<0.25	<0.005	<0.005	<0.050
	08/06/96	7.07			198			30.5	<1.0			7.0	470	1080			<0.005		<0.1	221	<0.003	<0.03		<0.1		13	47.3		24.7		<0.005	<0.2	<0.005	<0.002	<0.04
	08/6/96 [4]	7.24	0.10			194	686	29.2	0.21	7.23	<0.10	7.23	553	1060	<0.001	<0.50	<0.010	<0.10	<0.0005	223	<0.0010	<0.010	<0.010	<0.010	<0.0005	10.7	49.4	<0.05	28.6	<0.10	<0.005	0.008	<0.005	<0.005	<0.05
	01/23/97	7.10											484	1060																					
	07/29/97	6.90		<1	192	192		31.0	0.20	7.40	<0.1	7.40	500	1000		<2	<0.005	<1	<0.1	220	<0.05	<0.1		<0.1	<0.001	15.0	49.0	<0.1	34.0	<0.1	<0.005	<0.005	<0.005	0.002	
	11/06/97	6.88		<1.0	188	188			0.20	7.10	<0.1	7.10	506	970		<2.0	<0.005	<1.0	<0.1	200	<0.003	<0.03		<0.3	<0.001	13	45	<0.02	27	<0.1	<0.005	<0.005	<0.005	<0.002	

TABLE D.1
Analytical Results for Groundwater Samples
Copper Queen Branch-Bisbee, Arizona [5]

Well Name and 55 No.	Date	pH [1]	Turbidity [2]	CO3 [3]	HCO3 [3]	Alkalinity [3]	Hardness	Cl	F	Total N	NO2-N	NO3-N	SO4	TDS	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	Zn
TM-19	01/30/89	7.6		<2.6	290			20.9	0.16			2.3	1100	1935	<0.010		<0.01	<0.1		449	<0.005	<0.010	<0.01	<0.05	<0.0002	5.2	56	<0.01	45		<0.01		<0.005		0.03
522581	03/01/89	7.2		<2.6	287			16.6	<0.05			3.4	1100	1975	<0.010		<0.01	<0.1		432	<0.005	<0.010		<0.05	<0.0002	5.1	56	<0.01	44		<0.01		<0.005		0.03
	04/07/89	7.2		<2.6	275			26.2	0.13			2.4	1180	1955	<0.010		<0.01	<0.1		464	<0.005	<0.010	<0.01	<0.05	<0.0002	5	57	<0.01	43		<0.01		<0.005		0.02
	05/02/89	7.1		<2.6	268			13.8	0.17			2.4	1125	1925	<0.010		<0.01	<0.1		451	<0.005	<0.010	<0.01	<0.05	<0.0002	4	56	<0.01	42		<0.01		<0.005		0.021
	06/09/89	7.5			274			16.6	0.14			2.4	1070	1890						420			<0.01			5	56		44		<0.01				<0.01
	07/13/89	7.1			274			21.2	0.15			2.7	1120	1935						430						4.9	57		44		<0.01				0.013
	08/08/89	7.2			284			19.1	0.15			2.5	1110	1935						454						4.9	56		41		<0.01				0.011
	09/08/89	7.5			280			18.8	0.14			2.3	1080	1920						437						5.6	55		40		<0.01				0.01
	10/13/89	7.2			280			18.4	0.15			2.4	1200	1940						468						4.8	57		43		<0.01				<0.01
	11/14/89	7.8			283			23	0.15			2.6	1100	1950						430						4.7	55		43		<0.01				0.036
	12/07/89	7.5			272			19.8	0.14			2.5	1120	1945						448						4.6	55		41		<0.01				0.105
	01/04/90	7.4			269			19.8	0.15			2.7	1120	1935						448						4.9	56		45		<0.01				0.032
	11/23/93	7.3		<1	197	197		20	0.15			1.93	1100	1900	<0.010		<0.005	0.025	<0.005	419	<0.0005	<0.010	<0.01	0.08	<0.0002	--	50.2	<0.01	40.9	<0.020	<0.002	<0.05	<0.005	<0.005	<0.020
	06/20/96	7.2		<1	207	207		19	0.16			1.8	1100	2100	<0.020		<0.003	0.03	<0.004	427	<0.0005	0.022	<0.01	<0.05	<0.0002	4.3	55.6	<0.01	41.3	<0.020	<0.002	<0.05	<0.005	<0.005	0.065
	08/06/96	6.81			192			19.1	<1.0			1.8	1120	2040			<0.005		<0.1	475	<0.003	<0.03		<0.1		7	58.4		88.9		<0.005	<0.2	<0.005	<0.002	<0.04
	08/6/1996 [4]	7.13	0.30			194	1460	18.6	<0.20	1.84	<0.1	1.84	1200	2070	<0.001	<0.50	<0.010	<0.10	<0.0005	496	<0.0010	<0.010	<0.010	<0.10	<0.0005	4.67	61.0	<0.05	43.5	<0.10	<0.005	0.016	<0.005	<0.005	<0.05
	01/23/97	6.88											1140	2040																					
TM-19A	01/30/89	8		<2.6	233			14.9	0.22			1.7	50	320	<0.01		<0.01	0.18		39	<0.005	<0.01	<0.01	<0.05	<0.0002	2.7	9	<0.01	59		<0.01		<0.005		<0.01
522580	03/01/89	8		<2.6	230			11.7	0.29			1.8	54	320	<0.01		<0.01	0.15		35	<0.005	<0.01		<0.05	<0.0002	2.6	8	<0.01	58		<0.01		<0.005		<0.01
	04/07/89	7.9		<2.6	223			15.2	0.27			1.8	55	345	<0.01		<0.01	0.17		43	<0.005	<0.01	<0.01	<0.05	<0.0002	2.5	9.5	0.013	55		<0.01		<0.005		0.012
	05/02/89	7.7		<2.6	226			9.2	0.23			1.8	50	310	<0.01		<0.01	0.158		41	<0.005	<0.01	<0.01	<0.05	<0.0002	1.5	9.1	0.012	54		<0.01		<0.005		0.024
	06/09/89	8.1			221			11.3	0.27			1.8	55	320				0.176		40						2.6	9.8	0.011	56				<0.005		0.033
	07/13/89	7.6			228			14.2	0.25			1.8	55	330				0.192		40						2.6	10	0.011	57				<0.005		<0.01
	08/08/89	7.8			230			12.7	0.23			1.9	53	335				0.164		41						2.6	9.2	0.01	56				<0.005		<0.01
	09/11/89	7.3			230			13.4	0.27			1.7	58	310				0.17		42						2.9	9.5	0.01	56				<0.005		<0.01
	10/13/89	7.2			228			12	0.25			1.8	58	345				<0.1		42						2.5	16	<0.01	43				<0.005		0.379
	11/14/89	8.4			206			12.4	0.25			2	58	330				0.188		43						2.6	10	0.014	55				<0.005		0.135
	12/07/89	8.4			199			13.8	0.23			2	58	335				0.174		42						2.8	9.5	0.013	53				<0.005		0.107
	01/04/90	8.1			220			14.2	0.23			1.7	62	310				0.153		40						2.7	9.5	0.01	57				<0.005		0.35
	11/23/93	8.2		<1	172	172		15	0.26			1.81	63	310	<0.01		<0.005	0.14	<0.005	42.7	<0.0005	<0.01	<0.01	0.19	<0.0002	--	9.9	0.015	56.1	<0.020	<0.002	<0.05	<0.005	<0.005	<0.020
	06/25/96	7.8		<1	195	195		14	0.21			1.7	56	320	<0.01		<0.003	0.154	<0.004	43.8	<0.0005	<0.01	<0.01	0.103	<0.0002	2.5	10.2	0.011	58.6	<0.020	<0.002	<0.05	<0.005	<0.005	<0.050
TM-41	07/30/97	6.2		<1	800	800		22	0.2	2	<0.1	2	1940	3600		<2	<0.005	<1	<0.1	620	<0.05	<0.1		<0.1	<0.001	28	250	<0.1	47	<0.1	<0.005	<0.005	<0.005	<0.002	
	11/06/97	6.08		<1.0	740	740			0.2	1.8	<0.1	1.8	1900	3500		<2.0	<0.005	<1.0	<0.1	640	<0.003	<0.03		<0.3	<0.001	17	250	0.03	43	<0.10	<0.005	<0.005	0.006	<0.002	
TM-42	07/30/97	6.9		<1	188	188		28	0.3	4.1	<0.1	4.1	985	1700		<2	<0.005	<1	<0.1	290	<0.05	<0.1		<0.1	<0.001	18	95	<0.1	50	<0.1	<0.005	<0.005	<0.005	<0.002	
	11/06/97	6.8		<1.0	182	182			0.30	4.2	<0.1	4.2	958	1600		<2.0	<0.005	<1.0	<0.1	290	<0.003	<0.03		<0.3	<0.001	14	93.0	<0.02	49	<0.1	<0.005	<0.005	0.005	<0.002	

Notes:

[1] *Standard Units*

[2] *Nephelometric Turbidity Unit (NTU)*

[3] *mg/l as $CaCO_3$*

[4] *Sampled by ADEQ*

[5] *Unless Otherwise Noted all Results are in milligrams per Liter (mg/L);*
Data from SET, 1999

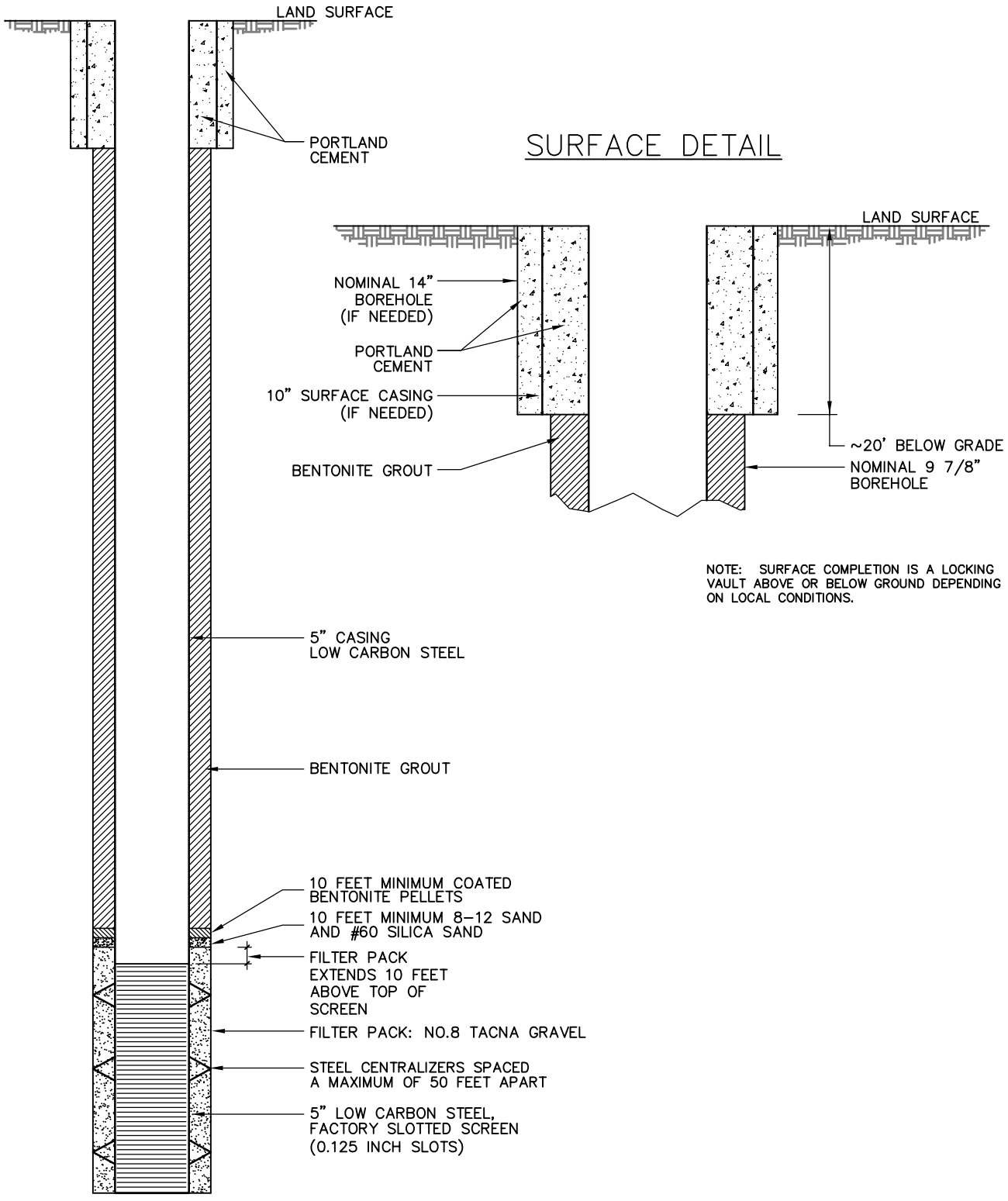
TABLE D.2
Summary of Metal Analyses

	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn	Na	Ni	Pb	Sb	Se	Tl	Zn
DATA FOR ALL WELLS[1]																					
Number Detections	0	0	5	63	0	167	2	14	4	14	1	152	166	55	167	2	7	10	10	1	71
Number Samples	74	25	94	115	56	167	95	98	79	94	97	167	166	126	167	50	103	56	118	56	140
Detection Frequency	0.0%	0.0%	5.3%	54.8%	0.0%	100.0%	2.1%	14.3%	5.1%	14.9%	1.0%	91.0%	100.0%	43.7%	100.0%	4.0%	6.8%	17.9%	8.5%	1.8%	50.7%
Arizona AWQS[2] (mg/L)	NNS	NNS	0.05	2	0.004	NNS	0.005	0.1	NNS	NNS	0.002	NNS	NNS	NNS	NNS	0.1	0.05	0.006	0.05	0.002	NNS
Maximum Detected (mg/L)	na	na	0.006	0.444	na	958	0.0013	0.045	0.024	38.9	**0.0025**	28	537	13.68	224	0.036	0.034	**0.06**	0.011	**0.002**	11.56
# Detections > AWQS	na	na	0	0	0	na	0	0	na	na	1	na	na	na	na	0	0	9	0	0	na
# Non-detects with MDL > AWQS	na	na	0	0	28	na	6	0	na	na	0	na	na	na	na	0	0	31	0	38	na

Notes:
[1] All wells included in Table D.1 of the Work Plan
[2] AWQS = Arizona Aquifer Water Quality Standard (AAC R18-11-106)
mg/L = milligrams per liter
MDL = analytical method detection limit
NNS = no numeric standard
na = not applicable

APPENDIX E

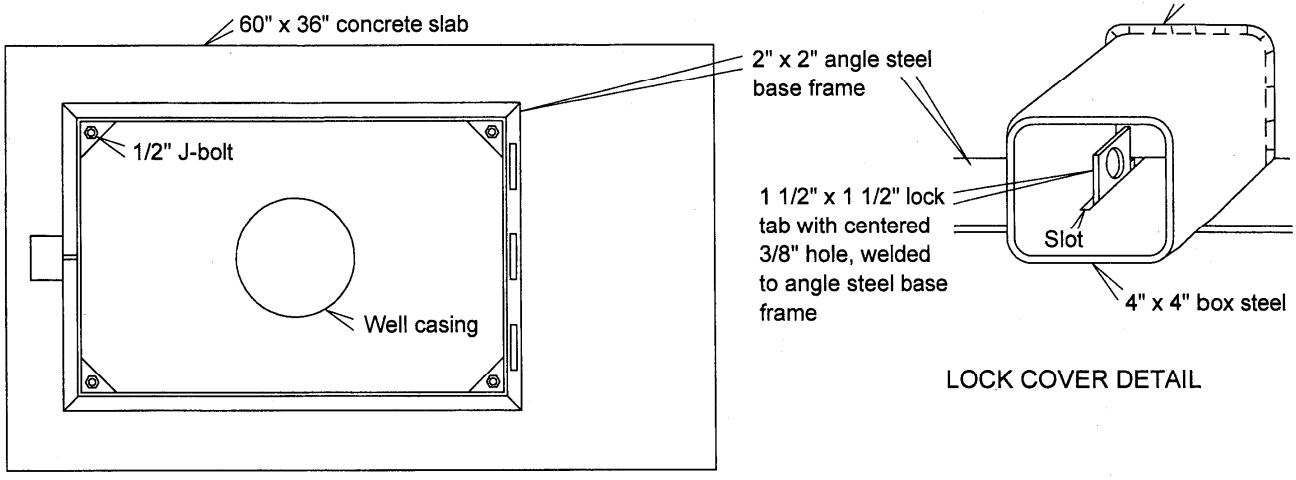
GENERALIZED WELL CONSTRUCTION DIAGRAMS FOR MONITORING WELLS (Figures E.1 and E.2)



HYDRO GEO CHEM, INC.

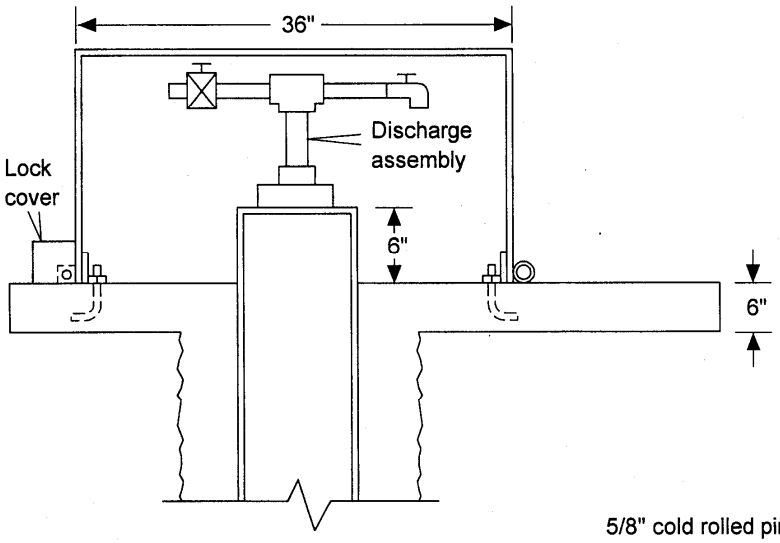
GENERALIZED WELL CONSTRUCTION DIAGRAM FOR MONITOR WELLS

Approved	Date		Date	File Name	Figure
RZ	02/18/08			8720026A	E.1

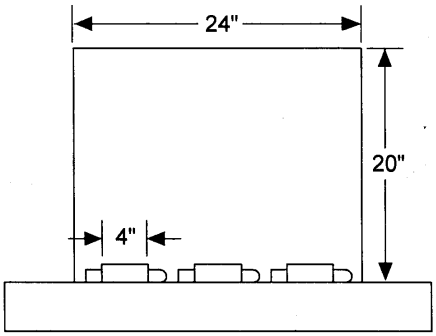


TOP VIEW - COVER REMOVED

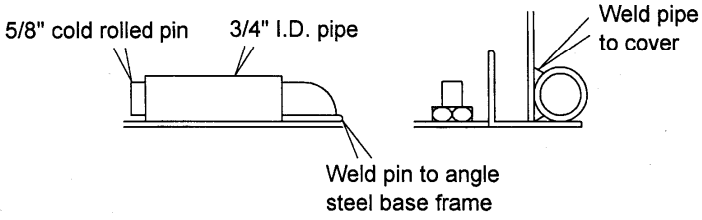
LOCK COVER DETAIL



SIDE VIEW - CROSS SECTION



END VIEW



HINGE DETAIL

NOTES:

Not to scale.

All steel is at least 3/16" thickness, unless otherwise specified.

All bare metal surfaces are painted with two coats of industrial grade oil base primer.

HYDRO GEO CHEM, INC.

WELLHEAD SURFACE COMPLETION

APPROVED	DATE	FIGURE
RKZ	1/24/07	**E.2**

APPENDIX F

QUALITY ASSURANCE PROJECT PLAN

APPENDIX F

QUALITY ASSURANCE PROJECT PLAN
FOR AQUIFER CHARACTERIZATION PLAN

Prepared for:

FREEPORT-MCMORAN CORPORATION COPPER QUEEN BRANCH
36 West Highway 92
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Prepared by:

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July 3, 2008

APPROVAL & DISTRIBUTION SHEET
QUALITY ASSURANCE PROJECT PLAN
FOR AQUIFER CHARACTERIZATION PLAN
COPPER QUEEN BRANCH, COCHISE COUNTY, ARIZONA

_____ Stuart Brown Bridgewater Group, Inc. Project Director (503) 675-5252 date: _____	_____ Michael Jaworski Freeport-McMoRan Corporation Copper Queen Branch Site Manager (520) 432-6209 date: _____
_____ James R. Norris Hydro Geo Chem, Inc. Project Manager (520) 293-1500 ext. 112 date: _____	_____ Daniel R. Simpson Hydro Geo Chem, Inc. Quality Assurance Manager (520) 293-1500 ext. 133 date: _____
_____ Field Technician date: _____	_____ Field Technician date: _____
_____ Laboratory Project Manager date: _____	_____ Laboratory Quality Assurance Manager date: _____
_____ Drilling Subcontractor date: _____	_____ Subcontractor date: _____

ACRONYM AND ABBREVIATION LIST

°C	degrees Celsius
μS/cm	microsiemens per centimeter
ACP	Aquifer Characterization Plan
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
ADWR	Arizona Department of Water Resources
ARS	Arizona Revised Statutes
ASTM	American Society for Testing and Materials
AZPDES	Arizona Pollutant Discharge Elimination System
bgs	below ground surface
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain-of-custody
CQB	Copper Queen Branch
CTSA	Concentration Tailing Storage Area
DGP	De Minimus General Permit
DOT	Department of Transportation
DQI	data quality indicators
DQO	data quality objectives
DTW	depth to water
EPA	U.S. Environmental Protection Agency
FS	feasibility study
ft	feet
HGC	Hydro Geo Chem, Inc.
ID	laboratory identification
LCS	laboratory control sample
MDL	method detection limit
mg/L	milligrams per liter
MO	Mitigation Order on Consent Docket No. P-121-07, dated November 14, 2007
MSHA	Mine Safety and Health Administration
MS/MSD	matrix spike/matrix spike duplicate
OSHA	Occupational Safety and Health Administration
PQL	practical quantitation levels
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure
TDS	total dissolved solids
USCS	Unified Soil Classification System

CROSS-REFERENCE OF QUALITY ASSURANCE ELEMENTS

The following table contains a cross reference between this document and the elements specified by Arizona Department of Environmental Quality (ADEQ) in its *Quality Assurance Project Plan Review*, based on the U.S. Environmental Protection Agency (EPA) *Requirements for Quality Assurance Plans for Environmental Data Operations*, EPA QA/R-5 (EPA, 2001a).

QUALITY ASSURANCE /R-5 ELEMENTS	COMMENT ADDRESSED
A1, Title and Approval Sheet	Cover, Pg. i
A2, Table of Contents	Pg. vii
A3, Distribution List	Pg. I
A4, Project Organization	Section 2, Figure 1
A5, Problem Definition/Background	Section 1.1
A6, Project/Task Description	Section 1.1
A7, Quality Objectives and Criteria for Measurement Data	Section 3
A8, Special Training/Certification	Sections 4.1, 5.1
A9, Documentation and Records	Sections 4.6, 5.7
B1, Sampling Process Design	Sections 4.2, 4.3
B2, Sampling Methods Requirements	Sections 4.2, 4.3
B3, Sample Handling and Custody Requirements	Sections 4.2.3, 5.2
B4, Analytical Methods Requirements	Section 5.3
B5, Quality Control Requirements	Sections 4.2.1.5, 5.4
B6, Instrument/Equipment Testing, Inspection, and Maintenance Requirements	Sections 4.5., 5.5
B7, Instrument/Equipment Calibration and Frequency	Sections 4.5, 5.5
B8, Inspection/Acceptance of Supplies and Consumables	Sections 4.5
B9, Data Acquisition for Non-Direct Measurements	N/A
B10, Data Management	Section 6
C1, Assessments and Response Actions	Sections 4.7, 5.7, 6.4
C2, Reports to Management	Sections 5.6, 6.4
D1, Data Review, Verification, and Validation	Section 6.2
D2, Verifications and Validation Methods	Section 6.2
D3, Reconciliation with User Requirements	Section 6.2

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APPENDICES

1. INTRODUCTION

This Quality Assurance Project Plan (QAPP) describes the quality assurance levels and procedures for field operations and the associated laboratory and data management activities that will be conducted for the Aquifer Characterization Plan (ACP) contained in the *Work Plan to Characterize and Mitigate Sulfate with Respect to Drinking Water Supplies in the Vicinity of the Concentrator Tailing Storage Area, Cochise County, Arizona* (Work Plan). The Work Plan was developed pursuant to Mitigation Order on Consent Docket No. P-121-07 between Phelps Dodge Copper Queen Branch and the Arizona Department of Environmental Quality (ADEQ). In March 2008, Phelps Dodge changed its name to Freeport McMoRan Corporation. Section III.A.2 of the MO states that a QAPP will be provided with the Work Plan. Components of the QAPP are to define, "the sulfate plume characterization and assessment objectives," and describe "the methods, organization, analyses, and quality assurance and quality control" needed to meet the objectives of the Work Plan. Hydro Geo Chem, Inc. (HGC) prepared this QAPP on behalf of Freeport-McMoRan Corporation Copper Queen Branch (CQB).

1.1 Background and Project Description

The Concentration Tailing Storage Area (CTSA) is located in the Bisbee-Naco area approximately 85 miles southeast of Tucson and 3.5 miles southeast of Bisbee, in Cochise County, Arizona. The CTSA comprises the North and South Tailing Impoundments, the former evaporation pond area, and a stormwater containment pond. In the 1980s, groundwater in the

vicinity of the CTSA was found to contain elevated concentrations of sulfate. The origin of the sulfate was identified as seepage from the CTSA into the underlying aquifer.

Groundwater sampling in the CTSA area has identified the presence of a groundwater plume with sulfate concentrations exceeding 250 milligrams per liter (mg/L). The zone of elevated sulfate extends from the base of the former evaporation pond in the CTSA southwestward to Naco and southward to Bisbee Junction.

In November 2007, the MO was finalized to address sulfate attributable to the CTSA. To meet the MO requirements, the Work Plan proposes an ACP and a Feasibility Study (FS) for the sulfate mitigation. The ACP will determine the nature, extent, fate, and transport of sulfate in groundwater and will gather information needed to develop mitigation action alternatives for drinking water supplies consistent with the MO. This QAPP pertains to data collection activities for the ACP for use in characterizing the sulfate plume and conducting the FS.

1.2 Quality Assurance Project Plan Overview

Quality assurance (QA) is a planned, systematic set of activities designed to ensure that a product or service meets defined standards of quality within a stated level of confidence. Quality control (QC) is the routine application of procedures for obtaining prescribed performance standards for monitoring and measuring. This QAPP provides the QA/QC procedures needed to provide confidence that the data generated during ACP activities are appropriate for their intended use, are legally defensible, and are of sufficient quality to support decisions concerning

characterization of sulfate in groundwater and development of the Mitigation Plan. The QA/QC program described in this QAPP covers procedures to be followed for field activities, sample handling, chain-of-custody (COC) documentation, laboratory analyses, and data management.

QA of data collected under the direction of HGC will be governed by this QAPP. This QAPP is designed to be generally consistent with the following documents:

- *EPA Guidance for Quality Assurance Project Plans*, EPA/240/R-02/009. (EPA, 2002a),
- *Guidance on Systematic Planning Using the Data Quality Objective Processes*, EPA/540/B-06/001. (EPA, 2006).
- *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Final* (EPA, 2004).
- *ADEQ Quality Management Plan*, EQR00-01. (ADEQ, 1999).

1.3 Quality Assurance Project Plan Distribution

The HGC QA Manager is responsible for ensuring that each project member has access to the most current version of the QAPP, including all subsequent addenda or revisions. The project members include, but may not be limited to, all individuals named on the signature page of this QAPP and all subcontractors performing field operations and laboratory analyses. The QAPP will be reviewed yearly by the HGC Project Manager to address any changes in data collection requirements. If revisions are made to the QAPP, they will be made under the direction of the HGC Project Manager and a revised document will be issued a sequential revision number and a new signature page.

1.4 Quality Assurance Project Plan Organization

This QAPP begins by describing the project organization and QA responsibilities for ACP activities (Section 2). It then defines the data quality objectives (DQOs) for data generated by activities conducted for the ACP (Section 3). Finally, it gives the QA/QC procedures, for field, analytical laboratory, and data management activities (Sections 4, 5, and 6).

2. PROJECT ORGANIZATION AND RESPONSIBILITIES

An organizational chart indicating the relationships and lines of communication among project participants is provided in Figure F.1. CQB is ultimately responsible for implementing and reporting environmental monitoring activities to be identified for the ACP. HGC will coordinate and oversee groundwater sampling of existing wells for Task 2.2 and the installation, testing, and sampling of new wells for Task 2.3. The roles and responsibilities of the individuals given in Figure F.1 are described below.

2.1 ADEQ Project Manager

The ADEQ Project Manager conducts regulatory oversight of the Work Plan activities and provides regulatory review and approval of documents, reports, plans, schedules, and other communications submitted pursuant to the MO.

2.2 Project Director

The Project Director has the overall responsibly for implementing the Work Plan. The Project Director will direct the schedule and scope of operations and provide fiscal oversight for resources needed for Work Plan activities.

2.3 CQB Project Manager

The CQB Project Manager has responsibility for environmental matters at the CQB property and directs CQB sampling activities. The CQB Project Manager will work with the HGC Project Manager to provide resources for safe implementation of ACP tasks.

2.4 HGC Project Manager

The HGC Project Manager directs field activities for the ACP, ensures that all personnel are properly trained, and ensures adequate resources for the completion of ACP tasks. The HGC Project Manager also works with the HGC QA Manager to provide QA checks of data quality and to implement corrective actions. The HGC Project Manager is responsible for providing final review and approval of documents, reports, plans, schedules, and other communications submitted to ADEQ pursuant to the MO. The HGC Project Manager will periodically review and provide any needed updates to the QAPP.

2.5 HGC QA Manager

The HGC QA Manager reviews data and documentation from ACP activities to ensure compliance with the provisions of this QAPP, initiates corrective actions, and ensures that records are properly stored in HGC files and electronic databases. The HGC QA Manager will also coordinate data transfer with the CQB Project Manger and be responsible for entry of any data collected by CQB into the HGC database.

2.6 Field Technicians

Field technicians are all personnel (geologists, hydrologists, or environmental technicians) performing field activities described in the ACP, including groundwater sampling, lithologic and borehole logging, well construction oversight, and aquifer testing. All field technicians should be adequately trained for the activities that they will perform, and they are responsible for ensuring the quality of their own work, including complete and accurate documentation.

2.7 Laboratory Project Manager

The Laboratory Project Manager ensures that laboratory resources are available, reviews final analytical reports produced by the laboratory, reviews and directs compliance with the QAPP, coordinates scheduling of laboratory analyses, and supervises in-house COC procedures. The Laboratory Project Manager also has the responsibility of submitting analytical reports to HGC.

2.8 Laboratory QA Manager

The Laboratory QA Manager maintains laboratory QA procedures and QA/QC documentation, conducts periodic internal laboratory audits, and recommends corrective actions when necessary. The Laboratory QA Manager is responsible to ensure that laboratory

procedures are in compliance with this QAPP. Section 5 identifies laboratories expected to be used for this project.

2.9 Drilling Subcontractors

Drilling subcontractors are responsible for the specific drilling, well construction, and well sampling activities for which they are contracted. They are also responsible for being properly licensed and trained to perform these activities.

3. DATA QUALITY OBJECTIVES

The primary data collection activities for the ACP are water level measurement, collection and analysis of water quality samples, lithologic logging of boreholes, and aquifer testing. Data collected by these activities will be used by CQB and ADEQ to characterize the extent of sulfate in groundwater and to develop and evaluate mitigation alternatives for drinking water supplies. The overall QA objective is to implement field procedures, laboratory analyses, and reporting that will provide results that are scientifically valid and legally defensible. DQOs are qualitative and quantitative objectives that specify the quality of data needed from a sampling program. Data Quality Indicators (DQIs) aid in this goal by specifying criteria for data types, quality, quantity, and applications that are needed to minimize decision errors due to data uncertainties. This section discusses DQOs, QA deliverables, and the DQIs used to evaluate if the DQOs have been met for field operations and laboratory analyses.

3.1 Data Quality Objectives

The DQOs for this project are:

- Collection of water level data of sufficient quantity and representativeness to evaluate potentiometric conditions during seasonal high (summer) and low (winter) pumping conditions.

- Collection and laboratory analysis of water samples of sufficient quality to define the lateral and vertical distribution of sulfate and to characterize water quality parameters pertinent to the identification and evaluation of potential water treatment technologies for the FS.

- Collection of lithologic information of sufficient accuracy to develop a reliable understanding of subsurface materials.

- Collection of aquifer test data of sufficient quality to estimate hydraulic properties of subsurface materials.

- Water flow rate and volume measurements of sufficient accuracy to support estimation of hydraulic properties and major components of the water budget.

3.2 Quality Assurance of Deliverables

The QA program should ensure the quality of all deliverables from field activities, laboratory analyses, and data processing. The U.S. Environmental Protection Agency (EPA) has identified five levels of QA/QC. The QA/QC level required for a project depends on the purpose of that project and the data deliverables requested. Levels I through IV are defined in Table F.1. Level V refers to non-conventional parameters and is not applicable to this QAPP. The relevance of levels I through IV to this QAPP am discussed below.

- Level I analytical methods are required for field data collection. Field data will be generated using portable instruments that are regularly calibrated. Level I methods will be implemented in the field and include the use of pH, temperature, and electrical conductivity meters, as well as other instruments.

- Level II may be used for screening-level measurements such as in-field sulfate detection. In general, however, Level II is not pertinent to this QAPP because it does not provide adequate accuracy or sensitivity.

- Level III analytical methods are required for the majority of project data collected per this QAPP. For most groundwater samples, the quality of laboratory data must be sufficient to monitor current groundwater conditions. Additionally, the data must be of sufficient quality to meet all objectives identified for this project.

- Level IV consists of a highly accurate and rigorous QA/QC review that would only be undertaken in this project if there was a persistent problem identified with analytical results. HGC may request a Level IV "Contract Laboratory Program (CLP)-equivalent" QC package from the laboratory and independent validation of the data. CQB may request a Level IV "CLP-equivalent" QC package for all or some percentage of the data. Data validation documentation will be consistent with

Laboratory Documentation Required for Data Evaluation as established by EPA Region IX QA Office (2001b).

3.3 Data Quality Indicators

Field and laboratory data will be evaluated using the following DQIs: precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. If laboratory data DQIs do not meet the data acceptance criteria, the reason will be noted in the case narrative submitted to HGC. If DQI acceptance criteria are not met, corrective actions to be taken may include additional sampling and/or re-analysis.

3.3.1 Precision

Precision is "the measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions" (EPA, 2002a). For this QAPP, data precision is measured by calculating the relative percent difference (RPD) of the analytical results for field and laboratory duplicates. RPD is calculated using the following formula:

$$RPD = \frac{x_1 - x_2}{x_m} \times 100 \qquad (1)$$

where x_1 is the analytical result from the original sample
x_2 is the analytical result from the duplicate sample
x_m is the mean of the two samples

Acceptance criteria for precision of laboratory duplicates will be set by method guidance or in-house laboratory limits, whichever is more stringent. The default acceptance criteria for

field duplicates from groundwater samples will be an RPD of less than 20 percent, which is the criteria listed in EPA functional guidelines (EPA, 2004).

3.3.2 Bias

Bias is "the systematic or persistent distortion of measurements that causes consistent errors in one direction" (EPA, 2002a). Bias can be caused by matrix interferences that either enhance or suppress the response of an instrument to the presence of a constituent. Bias is addressed both in the field and in the laboratory by calibration of instruments and consistent application of standardized procedures (Sections 4.5 and 5.4).

3.3.3 Accuracy

Accuracy is "a measure of the overall agreement of a measurement to a known value" (EPA, 2002a). Accuracy can be decreased by errors related to both precision and bias. A measured value is of acceptable accuracy when it does not differ beyond acceptable limits from the true value or the known concentration of a spike or standard. Accuracy of analytical results is measured by calculating the percent recoveries of surrogates, matrix spikes, and blank spikes. Laboratory accuracy is expressed as the percent recovery (%R), calculated as follows:

$$\%R = \frac{x_s - x}{T} \times 100 \qquad (2)$$

where x_s is the measured value of the spiked sample
x is the measured value of the unspiked sample
T is the true value of the spike solution added

Acceptance criteria for laboratory accuracy are set by the stricter of in-house limits or method guidance (Section 5.4).

3.3.4 Representativeness

Representativeness is a qualitative measure that conveys "the degree to which sample data accurately and precisely represents a characteristic of the environmental condition being measured" (EPA, 2002a). Representativeness is best satisfied by ensuring that sampling procedures, locations, and quantities are selected properly. Field data will be considered representative when obtained by adherence to sample identification and collection techniques and decontamination procedures (Section 4.2). In addition, proper laboratory analytical procedures and methods are mandatory to ensure representativeness of field data (Section 5).

3.3.5 Comparability

Comparability is a qualitative expression of the confidence with which one data set is comparable to and/or compatible with previous and subsequent data. Comparability is achieved by adhering to standardized methods and QA procedures established in this QAPP during sample collection, handling, and analysis. The comparability of laboratory data is achieved through compliance with analytical method protocols. Comparability is enhanced when the same laboratory is used to analyze samples from successive sampling events and when data is reported in consistent and standard units of measurement.

3.3.6 Completeness

Completeness is a measure of the amount of valid data needed to be obtained from a sampling campaign or measurement program. Completeness will be expressed as the percentage of the total number of each type of sample or measurement that satisfies the QA/QC criteria for this project. Percent completeness will be calculated as follows:

$$\left(\frac{number\ of\ valid\ data\ obtained}{number\ of\ valid\ data\ possible} \right) \times 100$$

Completeness will be calculated and reported by the HGC QA Manager. Adherence to this QAPP is expected to yield data sets that will be at least 90 percent complete. Common factors that reduce data completeness include the following:

- The laboratory did not analyze the sample for the requested parameter.
- The laboratory did not analyze the sample following the correct method.
- The laboratory did not provide the correct sensitivity.
- The laboratory rejected data due to QC failure.
- The data reviewer rejected data due to QC failure.

3.3.7 Sensitivity

Sensitivity is a measure of "the capability of the method or instrument to discriminate between measurement responses representing different levels of a variable of interest" (EPA, 2002a). Sensitivity requirements for field measurement instruments are as follows:

- Water levels probes = 0.01 foot (ft).
- Temperature meters = 1 degree Celsius (°C).
- pH meters = 0.1 standard units.
- Electrical conductivity meters = 10 microsiemens per centimeter (µS/cm).
- Pressure transducers = 0.01 ft water head or as appropriate for pressure rating.
- Flow meters = 5 percent of measured flow rate.
- Topographic survey instruments = 0.1 ft horizontal and vertical for licensed surveying.
- Borehole depth measurement devices = 0.1 ft.

Sensitivity requirements for analytical laboratories are generally described by the analytical method detection limits (MDLs). A MDL is the minimum amount of an analyte that can be consistently measured and reported with a high degree of confidence that the analyte concentration is above a background response. A practical quantitation limit (PQL) is that amount that can be consistently quantified with acceptable precision and accuracy. Target PQLs for each analyte will be set by method guidance or laboratory specifications, whichever is stricter (Section 5.3).

4. FIELD ACTIVITIES

This section gives the QA procedures that will be used for field activities, including groundwater sampling (water level measurement and water quality sampling), drilling and well construction, and aquifer testing. It also describes the procedures for equipment care, investigation derived waste management, and field documentation. Field activities will be documented in a dedicated field logbook or on field forms as described in Section 4.6.

4.1 Certification and Preliminary Activities

All field staff shall have Occupational Safety and Health Administration (OSHA) 40-hour training and certification as described in the Code of Federal Regulations (CFR), Title 29, Section 1910.120. Staff working within the CQB property boundaries shall also have site-specific hazard awareness training and Mining Safety and Health Administration (MSHA) training as prescribed in 30 CFR Subchapter H. All certified field operations personnel must annually complete OSHA and MSHA refresher courses to maintain their certifications. All personnel and subcontractors will have appropriate licensure and certification as required by law to perform their specific field operation. In particular, drillers will have a current well driller's license issued by the Arizona Department of Water Resources (ADWR).

Prior to starting field activities, the HGC Project Manager will obtain necessary permits, notify property owners of scheduled field activities, and locate all subsurface utilities near areas where drilling will occur. Required permits may include an ADEQ Arizona Pollutant Discharge

Elimination System (AZPDES), De Minimus General Permit (DGP), an ADWR drilling permit, and an ADWR groundwater withdrawal permit. The HGC Project Manager will complete and submit Notice of Intent to Drill Well forms to ADWR for all proposed wells. The HGC Project Manager will locate subsurface utilities by requesting a Blue Stake Survey at least 72 hours, but not more than 2 weeks, prior to drilling.

4.2 Groundwater Sampling Activities

As described in the ACP, groundwater monitoring will be conducted for two purposes: plume monitoring and regional monitoring. Plume monitoring will be conducted at wells proximal to the sulfate plume to track its position and concentration. Regional monitoring will be conducted over a large geographic area than the plume in order to document regional water level and water quality conditions for fate and transport modeling.

The ACP specifies groundwater sampling from existing CQB wells and from existing privately-owned wells. Samples taken from existing wells will be taken from the screened interval of the well without regard to collection depth within the screen (Section 4.2.1). All groundwater sampling activities will be consistent with the procedures outlined in EPA-approved methodologies, ADEQ sampling guidance documents, and this section so that data obtained from the sampling activities is of sufficient quality to meet the DQOs (Section 3). QA procedures for sampling activities are described below. Following the description of QA procedures, protocols for sample handling from the collection site to the analytical laboratory are provided. Sample receipt and handling by the analytical laboratory are discussed in Section 5.2.

4.2.1 Groundwater Sampling from Existing Wells

Groundwater sampling will be conducted in a variety of well types including monitoring wells, active public water supply wells, and private wells. For wells with a dedicated pump, that pump will be used for purging and sampling. If a well does not have a dedicated pump, a decontaminated, portable, submersible pump will be used to purge the well and collect groundwater samples. Prior to sampling, well construction specifications will be obtained from the well owner or ADWR records. Upon arrival at the sampling location, the sampling personnel will document the condition of the well in the field notebook or on a sampling form. Groundwater sampling then will be conducted using the following steps:

1. Depth-to-water (DTW) measurement.
2. Well purging and collection of groundwater indicator parameters.
3. Sample collection and labeling.
4. Equipment decontamination.

QA procedures for these steps are described below.

4.2.1.1 Depth to Water Measurements

Water level measurements will be taken in both pumping and non-pumping wells, if possible. For wells that are not being continuously pumped, the static DTW in wells will be measured prior to purging and sampling and will be recorded as a static pumping level. For wells that are being pumped, the pumping water level will be measured and the DTW will be

recorded as a dynamic water level. The following QA procedures will be followed when making the DTW measurements:

- Use a decontaminated electronic well sounder probe capable of measuring water levels with an accuracy of 0.01 ft (Section 3.3.7).
- Verify the well identification (ID) and check to ensure that measurement equipment is operating properly.
- Record the well ID and, if known, the surface elevation.
- Measure DTW from the measuring point on the top of well casing or from the north side of the top of the inner well casing if the casing has no surveyed measuring point.
- Record the DTW and the height of the measuring point above ground surface to the nearest 0.01 foot.
- Take DTW measurement a second time to verify that a correct measurement has been made. The two measurements should agree to within 0.03 ft.

4.2.1.2 Well Purging and Collection of Indicator Parameters

After taking DTW measurements and prior to taking groundwater samples, the wells will be purged of resident water so that groundwater samples will be representative of water from the formation. The HGC Project Manager will determine the needs for a DGP for purge water once sample locations are selected. While purging the well, groundwater indicator parameters (pH, electrical conductivity, and temperature) will be measured. Groundwater purging and indicator parameter measurements will adhere to the following QA practices:

- Calculate the wetted casing volume based on the DTW measurement and well construction.
- Collect the indicator parameters readings at regular time or pumped volume intervals, and record the readings on a groundwater sampling form.

- If possible, purge the well of three wetted casing volumes and allow indicator parameters to stabilize so that consecutive parameter measurements (collected at approximately one-half casing volumes apart) are within the following: pH - 0.3 standard units, temperature - 2 °C, and electrical conductivity - 100 µS/cm.

- Permit any well that goes dry during pumping to recover at least 50 percent of its starting water elevation prior to groundwater sampling.

No more than five wetted casing volumes need to be pumped regardless of parameter stabilization; however, parameter instability may indicate a problem with the measurement instrument(s). If stabilized parameters cannot be obtained, field instruments will be re-calibrated (Section 4.5.2). For wells that are being pumped when sampling personnel arrive (e.g., production wells), the sampling personnel do not need to purge the well if it has been pumping continuously for a period sufficient to remove three wetted casing volumes. DTW and field parameters should still be measured and recorded.

It may not be possible to purge three wetted casing volumes in all cases due to potential disruption of well service or due to the owner's request. In such cases, the purge volume will be recorded and the reason for the limiting the purge noted.

4.2.1.3 Groundwater Sample Collection

Plume monitoring will be conducted quarterly to document groundwater elevations and sulfate concentrations only at CQB monitoring wells on the CTSA and at private and public supply wells on the margins of the plume. Plume monitoring will continue until the monitoring requirements under the Mitigation Plan become effective.

Regional monitoring will be conducted twice; once in winter and once in summer to characterize any seasonality in water elevations. Samples collected for regional monitoring will be analyzed for a suite of major element constituents to characterize general water quality conditions in addition to sulfate.

Filtered groundwater samples for plume monitoring will be analyzed for sulfate only using the methods describe below. In quarters when regional monitoring occurs, samples from wells identified for plume monitoring will also be analyzed for the expanded suite of constituents used for regional monitoring.

Filtered groundwater samples for regional monitoring will be analyzed for major element ions (calcium, magnesium, sodium, potassium, chloride, sulfate, nitrate, nitrite, and fluoride) for characterizing the general water chemistry. Groundwater samples from select wells may also be analyzed for the following constituents needed to evaluate water treatment for the FS: aluminum, ammonia, barium, chemical oxygen demand, ferrous and total iron, manganese, phosphate, selenium, soluble and colloidal silica, strontium, sulfide, total organic carbon, silt density index, turbidity, and bacteria (total plate count). Table F.2 lists the analytical suites for characterization of general chemistry and for characterization of water treatment constituents. Table F.2 lists analytical methods; target method detection limits; and filtration, preservation, and holding time requirements. All groundwater samples will be field filtered using a 0.45 micron filter to allow analysis of dissolved constituents unless otherwise indicated in Table F.2.

The HGC QA manager will be responsible for ensuring that the analytical laboratory provides appropriate sample containers with any necessary preservatives. Field duplicate samples and field blank samples will be collected periodically for quality control as described in Section 4.2.1.5. QA practices for collecting groundwater samples are as follows:

- Verify that sample containers have been properly prepared, including addition of any preservative required (Table F.2).
- Minimize the lag time between filtered and unfiltered samples by setting up the sample containers near the sampling location and by first taking the filtered sample.
- Install a new (unused) in-line (0.45 µm) filter to the pump discharge and collect a sample from the filtered discharge. If the in-line filter cannot be connected to the pump discharge from the well, collect a sample aliquot, then filter the aliquot using a portable pump and the in-line filter.
- Take the unfiltered samples directly from the pump discharge.

Sample containers do not need to have zero headspace since volatilization of analytes is not a concern.

4.2.1.4 Sample Labeling

Each sample will be uniquely labeled with permanent indelible ink either directly on the container or on a water-proof label that is affixed to the container. Each sample will also be labeled with the date and time of sample collection, the analysis requested, and the preservative used.

4.2.1.5 Field Quality Control Samples

Field QC samples will be collected to verify sampling and analytical precision, accuracy, and representativeness. Two types of field QC samples will be used as QC check samples: field duplicates and field blanks. Field duplicates will be collected to assess analytical precision (Section 3.3.1). Field blanks will be collected to check for the introduction of contamination in sample handling, shipment, storage, or analysis. These field QC samples will be assigned a unique ID so that the laboratory does not know they are QC samples; however, the QC sample IDs will be clearly noted in the field logbook and on the groundwater sampling form. The collection of field duplicates, and field blanks is described below.

- Field Duplicate Samples are samples that are collected at the same time and location as another groundwater sample. The field duplicate and its partner sample will be split samples collected from the same aliquot of water. The field duplicate will be collected by first obtaining a groundwater sample in a large sampling container, and then distributing the water into sample bottles for analysis of like analytes (e.g. fill bottles for anion analysis from the same sample draw). Field duplicates of filtered water will be collected at a frequency of at least one per 20 samples.

- Field Blank Samples will be collected from de-ionized water that is poured directly into a sample container while in the field. Field blank samples will be subject to the same sampling procedures as samples being collected from a designated sampling location, including container type and preparation, storage, and handling. One field blank will be collected for every 20 samples.

- Field Equipment Blank Samples will be collected by pouring deionized water over and through sampling equipment in the field after the equipment has been cleaned. One field equipment blank sample will be collected for every 20 samples from decontaminated equipment.

4.2.1.6 Equipment Decontamination

Properly decontaminated sampling equipment will help prevent errors due to cross-contamination. Prior to the start of sampling, all reusable equipment will be decontaminated. This includes non-dedicated groundwater pumps, reusable bailers, DTW probes, and any other equipment brought onsite. Cleaned equipment should not lie on the ground or any unclean surfaces. Disposable, single-use equipment such as filters, bailers, sampling spigots, and nylon string will be used at a single sample collection location and then discarded.

Environmental sampling conducted during aquifer characterization for the focuses on sulfate and other major element ions (e.g., calcium, magnesium, chloride, bicarbonate). Because the major element ions are nonsorbing and exist at relatively high concentrations in the groundwater, equipment decontamination is not subject to the rigorous protocols that are needed for decontamination when sampling for trace organic and metal compounds. Nevertheless, proper equipment decontamination is important to preserve sample integrity and maintain quality control. The following procedures should be used to decontaminate any reusable equipment involved in sampling.

1. **Decontamination of reusable sampling equipment (e.g., buckets, beakers)**

    a. Use proper personal protective equipment. This includes safety glasses and chemical resistant gloves. Use care while handling detergents.
    b. Scrub exterior of equipment with a non-phosphate detergent/potable water mixture.
    c. Flush interior of equipment with a non-phosphate detergent/potable water mixture.
    d. Rinse interior and exterior of equipment with potable water.
    e. Rinse interior and exterior of equipment with deionized water.
    f. Allow the equipment to air dry.

g. Properly dispose of all disposable sampling and cleaning equipment.

2. Decontamination of mobile monitoring well pumps and pump riser pipe

a Use proper personal protective equipment. This includes safety glasses and chemical resistant gloves. Use care while handling detergents.
b Pressure wash interior and exterior portions of riser pipe with a non-phosphate detergent /potable water mixture.
c Repeat step "b" using potable water.
d Pump a non-phosphate detergent /potable water mixture through the submersible pump
e Repeat step "d" using potable water.
f Allow the exterior of pump and riser pipe to air dry with the exception of probes that must remain moist (e.g. pH probe).
g Properly dispose of all disposable sampling and cleaning equipment.

3. Decontamination of meters and probes

a Use proper personal protective equipment. This includes safety glasses and chemical resistant gloves. Use care while handling detergents.
b Rinse meters and probes with deionized water for several seconds between each reading.
c Rinse containers used for field measurements with deionized water between each reading. If there is residual residue on containers, use a non-phosphate/potable water mixture to manually remove residue. Afterward rinse containers with potable water then deionized water.
d Allow the meters, probes, and containers to air dry.
e Properly dispose of all disposable sampling and cleaning equipment.

4.2.2 Sample Custody and Handling

Groundwater samples will be stored in coolers with ice (4 ºC ± 2º) from the time they are collected until they arrive at the laboratory. COC documentation will be maintained from the time of collection until the samples are analyzed to ensure the defensibility of the results. Further instructions on sample custody and shipping are specified below.

4.2.2.1 Sample Custody and COC Documentation

Samples are in the sampler's custody upon collection. The custody of the samples will be the responsibility of the sampler until the samples are delivered or shipped to the laboratory. A sample is considered to be under a person's custody if one or more of the following conditions are met:

- The sample is in the person's physical possession.
- The sample is in the view of the person after that person has taken possession.
- The sample is secured by that person so that no one can tamper with the sample.
- The sample is secured by that person in an area that is restricted from unauthorized personnel.

Custody of samples will be documented from the time of sample collection to completion of the analyses using COC forms. COC forms will be filled out and will accompany the samples when shipped to the laboratory. The COC form will identify the contents of each shipment. The COC form will remain in the sampler's possession until the samples have been hand delivered or shipped to the laboratory. The sampling team leader or designee will sign the COC form in the "relinquished by" box and note the date and time the samples were relinquished. A properly completed COC form will specify:

- The project name, required signatures, dates, and times that samples were relinquished and accepted.
- Analyses requested, time and date of sampling, and sample matrix.
- Unique field identification of each sample.
- Number of containers submitted.
- Temperatures upon receipt by the analytical laboratory.

4.2.2.2 Sample Shipping

Procedures for packing and transporting samples to the laboratory may vary depending on whether samples are hand delivered to the laboratory by field personnel or delivered via a commercial shipping service such as Federal Express or United Parcel Service. The method of sample shipment will be noted on the COC form. Table F.3 provides a checklist for shipping requirements.

If samples are shipped by a delivery service, all U.S. Department of Transportation (DOT) regulations for packaging and shipment must be followed. Each sample will be packaged and transported according to the procedures outlined below, which meet DOT requirements.

- Ice will be placed in a sturdy plastic bag to prevent leaking. Samples will be protected by bubble wrap, foam, or some other packing material. Sufficient packing material will be used to prevent sample containers from making contact during shipment. Enough ice will be added to maintain the cooler temperature at 4°C ⟨≡~ 2°, until receipt by the laboratory. The plastic bag will be zip-locked or closed with a twist or cable tie.

- The COC records will be signed by the person relinquishing possession of the samples and will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The shipping address will be verified before the samples are relinquished to the courier.

- The cooler will be closed and taped shut with packing tape around both ends.

- The cooler will be transferred to the courier along with a completed shipping bill.

4.3 Drilling and Well Construction Activities

As described in the ACP, drilling and well construction activities will be conducted to install monitoring wells at offsite locations. These activities involve the following:

- Utility Location (Blue Stake)
- Licensure and Permits
- Drilling of boreholes
- Lithologic logging of boreholes
- Reconnaissance water quality sampling of drilling return water
- Well construction
- Well development
- Hydraulic testing and water sampling of new wells

QA procedures for these activities are discussed below.

4.3.1 Licensure and Permits

All drilling, well construction, and well development activities will be performed by a drilling contractor who is licensed by ADWR. Prior to drilling, well development, and hydraulic testing of wells, applicable forms and permits will be filed and obtained from ADWR and ADEQ. These forms and permits may include a Notice of Intent to Drill, a well permit, and a DGP to discharge groundwater to the ground surface. Drilling activities, including drilling progress, setbacks, and milestones will be noted in the field logbook or appropriate forms. The drilling contractor for this project is WDC Exploration and Wells.

4.3.2 Borehole Drilling

Proposed approximate drilling locations are given in the ACP. Locations of proposed new monitoring wells are subject to change depending on land access and results of data collection (Task 2.2). Drilling of new monitoring wells will be accomplished using a variety of drilling methods including air-rotary casing hammer (ARCH), under-reaming casing advance using Stratex® tools, reverse circulation air-rotary, open-hole air rotary, or mud rotary methods. Selection of the drilling method is determined by the site conditions and the need for lithologic and formation water sampling for the particular borehole.

One of the primary objectives of the drilling is to obtain samples of groundwater at the drilling face at regular depth intervals during drilling (Section 4.3.4). The preferred method to accomplish this sampling is a casing advance method (i.e., either ARCH or Stratex) that provides temporary casing of the borehole as it is being advanced into the formation. Air is injected at the drilling face to lift cuttings and formation water out of the borehole. The return air and cuttings travel up the borehole between the temporary casing and the drill rods, preventing interaction with the formation. Borehole integrity is maintained throughout the drilling process by the presence of the temporary casing, which is withdrawn during well construction. Reverse circulation methods have many of the same benefits and may be used for pilothole drilling and formation water sampling if the casing advance methods cannot be used for some reason. The drawback to reverse circulation drilling is that the borehole is too small completion of the well, requiring reaming using mud rotary methods to provide as stable borehole large enough to complete the planned wells.

Mud-rotary methods may be substituted for casing advance or reverse circulation if water sampling is unsuccessful, unstable hole conditions occur, or on the advice of the driller that doing so is necessary to maintain the borehole. Open-hole air rotary methods may be used in bedrock formations if water sampling is unsuccessful or not required at that specific borehole (e.g., if an adjacent borehole has already been drilled and satisfactorily sampled). If additional wells are installed at a borehole location, they will be installed using mud rotary methods in basin fill and possibly open-hole air rotary in bedrock.

The drilling methods outlined here may be modified based on the judgment of the site geologist or recommendations from the drilling contractor. Well design will be based on the results of lithologic sampling and water quality data collected during drilling as described in Section 3.3.3 of the main text.

The site geologist has responsibility of logging the borehole drilling and making sure that boreholes are satisfactorily drilled according to the requirements of the ACP. The site geologist will follow the QA practices given below when logging boreholes.

- Prior to drilling, measure (to ± 0.01 ft) and record the size and length of the drill, sub-assembles, and drill rods. Know and document the relationship between the number of drill rods in the ground and the depth of the borehole.
- Give constant attention to drilling progress, including the number of drill rods in the ground and verify that the driller is in agreement with the depth estimates.
- Immediately discuss any suspected deviations in drilling progress with the driller. Record deviations in the field logbook and immediately report them to the HGC Project Manager.

- Record the following in the field notebook or on the borehole log along with the corresponding depths and times: groundwater depth, observed changes in drilling conditions, and the type and quantity of any materials added to the borehole.

4.3.3 Lithologic Logging

Lithologic logging of boreholes for wells will be conducted by the site geologist. The lithology will be logged at 10-ft intervals or more frequently if needed to note significant changes in material properties. Materials used for lithologic logging will be collected from the air-rotary cyclone or mud return. To ensure comparability between lithologic descriptions between different locations, logging will be conducted according to the specifications of American Society for Testing and Materials (ASTM) D2488-00. A copy of this ASTM standard is provided in Appendix F.1. Logging will, as a minimum, note the following:

- Sample description
- Color (using a Munsell color chart)
- Unified Soil Classification System (USCS) classification symbol or lithologic name
- Grading (for coarse grained soils)
- Estimated percentages of gravel, sand, and fines
- Consistency of dominant size fraction
- Local or geologic name, if applicable
- Degree of rounding/angularity
- Lithology of larger grains
- Reaction with hydrochloric acid

4.3.4 Reconnaissance Groundwater Sampling from Boreholes

Grab samples of groundwater will be collected from the air rotary return for reconnaissance estimation of sulfate concentrations with depth. Grab sampling will commence when the borehole reaches the groundwater table and will continue at approximately 40-ft intervals to the bottom of the borehole if there is sufficient water in the return.

Formation water samples can be collected at discreet intervals using either casing advance or reverse circulation methods. Casing advance methods provide temporary casing that is advanced with the drill bit to case off higher portions of the hole during drilling. When the end of a casing section is reached, drilling stops allowing cuttings and water to be blown out of the hole until it is clear. Formation water can only enter the drill column at the drilling face and it is blown out of the hole between the temporary casing and the drill pipe, preventing adulteration of the sample by formation water from higher in the borehole. Similarly, with reverse circulation, the annulus between the borehole and the double-walled drill pipe is small, enabling formation water at the drilling face to be blown out of the hole in the center of the double-walled pipe where it is isolated from the formation.

Procedures for borehole water sampling are as follows.

- At the end of each section of drill pipe and temporary casing, pull back on the drill bit and purge the borehole of all cuttings and liquids.
- Turn off the air, enabling formation water to enter the borehole at the drilling.
- Resume air circulation to blow the formation water out of the hole.
- Collect return water in a decontaminated container.

- Measure indicator parameters (temperature, pH, and electrical conductivity) as soon as possible so that temperature does not significantly increase.

- Record the indicator parameter measurements in the field notebook along with the name of the boring, the depth of the casing at the time of sample collection, and the date and time of the measurements.

In the event that reconnaissance sampling from the air rotary return is infeasible, reconnaissance water samples may be collected through a temporary well screen or using a straddle packer system depending on the situation. A temporary well screen would consist of 20-foot length of slotted casing placed at the target sampling depth, surrounded by gravel pack, and sealed from the underlying and overlying formation and borehole using bentonite pellets or packers. The temporary well screen would be developed by air lifting, pumping, or bailing to remove at least three wetted borehole volumes in the event of installation by air drilling techniques or until the water is clear in the event of installation in by mud rotary. A straddle packer system may be used in bedrock boreholes where competent conditions exist. The straddle packer would seal off a screened interval which would be purged by pumping or bailing. The use of temporary well screens or a straddle packer for reconnaissance sampling may not be suitable for all sites, but should be capable of providing high quality water samples. Sampling through temporary well screens would be conducted by drilling to a pre-determined depth and setting and sampling temporary well screens at various depths.

The TDS and sulfate concentrations in samples will be estimated by measuring pH and conductivity using an electrical conductivity meter. Filtered water samples for laboratory analysis of sulfate will be collected if sufficient water is available. The labeling and handling of

samples will follow the protocols in Sections 4.2.1.3, except that sample depth will be identified in the sample ID.

4.3.5 Well Construction

Well construction design will be determined by the site geologist in consultation with the HGC Project Manager and the driller. Length and quantity of materials will be determined according to the purpose of the well, site geologic conditions, and the quality of water samples collected during drilling as described in Section 3.3.3 of the main text.

Well casings will be 5-in diameter low-carbon (= 0.3 percent) steel. Schedule 80 PVC may be used for wells less than 500 feet deep, but use of PVC is not anticipated. Annular materials including filter pack, bentonite pellet seals, and bentonite grout will be emplaced through a tremie pipe. From 0 to 20 feet below ground surface (bgs), grout will be a bentonite/cement mixture. To ensure that wells are properly constructed, the field technician will observe the following:

- Prior to well construction, estimate the amount of materials (e.g., well casing, packing material, and grout) needed to construct the well. During well construction, immediately notify the driller of a potential problem if the materials needed for well construction are significantly more or less than estimated.

- Prepare and use a well-construction diagram to monitor the progress of the well construction. Record the progress in the field notebook or on a well construction form.

- Periodically have the driller measure the depth of the filter pack and check to make sure that “bridging” of the packing material does not occur. A tightly fitting rubber surge block may be used in wetted portions of the well screen to compact the filter pack.

- After the filter pack is in place, the well will be pre-developed using air lifting to remove formation materials and drilling mud (if used) from the well. Drilling mud and sediment will be contained at the site and transported to CQB property for disposal. Decanted formation water will be discharged at the site under the terms of a DGP obtained from ADEQ prior to discharge. Air lifting will continue the discharge is relatively sediment free.

Generalized well construction diagrams for monitoring wells are in Appendix E of the Work Plan. Significant standard features of the well design include a 10-foot sump of blank casing below the well screen; No. 8 Tacna gravel filter pack surrounding a well screen with 0.125-inch openings, transition sand consisting of 5 feet of 8-12 sand and 5 feet of No. 60 sand beginning at least 10 feet above the top of the well screen; 10 feet of bentonite pellets followed by high-solids bentonite grout above the transition sand to within 20 feet of the surface to form an annular seal around the blank steel well casing; and a 20-foot surface seal of cement-bentonite grout.

4.3.6 Well Completion

Surface completion of all wells include a watertight well plug or sanitary well seal. The north side of the top of the casing or sounding tube will be notched to establish a permanent measurement point. The measuring point will be surveyed to ± 0.01 ft by a licensed surveyor contracted by CQB to establish a datum for water level measurements. A surface well cover box will be installed around the well casing and cemented in place. The well name and the ADWR well registry number will be stamped into the vault lid or well casing. The well registry number will also be written near the top of the well casing or concrete pad with permanent black marker. After the well is completed, the DTW with be measured and recorded.

4.3.7 Well Development

Following well completion, the well will be developed using the following procedure:

1. Obtain a DGP from ADEQ prior to development pumping, if required.

2. The depth to the bottom of the well (total depth) will be measured to determine whether any sediment has accumulated in the well.

3. The wetted portion of the well screen will be surged with a tightly fitting rubber surge block to dislodge any material finer than the screen slot size.

4. Air lifting or bailing will be used to remove sediments from the well.

5. A temporary submersible pump and sounding tube will be installed in the well for pump development. Turbidity will be monitored during well development. Well development will be considered complete when the pumped groundwater is relatively sediment free or when the turbidity has stabilized.

4.3.8 Hydraulic Testing and Water Sampling

A 10- to 24-hour step rate pumping test and a recovery test will be conducted at each new well to estimate the hydraulic conductivity of the formation. The step test will consist of two 60-minute pumping steps followed by 480 minutes or more of pumping at a maximum constant rate. A detailed description of the test procedure is in Appendix F.2. The pumping test will be conducted using the general guidelines provided below:

1. Obtain a DGP from ADEQ prior to conducting a pumping test.

2. Prior to beginning the test, measure the static water level using a well sounder. Install a pressure transducer below the anticipated drawdown level. Be certain that the transducer has a sufficient pressure range to accurately measure the anticipated drawdown. Measure the static water level with the pressure transducer and verify the transducer water level measurement by using a water level indicator.

3. Select pumping rate(s) for the test to provide the necessary drawdown data and to avoid lowering the water level below the transducer or pump intake. Use a constant pumping rate throughout each step of the step test.

4. Measure DTW levels during the test with a pressure transducer/data logger assembly and periodically verify it with a sounder probe. At a minimum, take measurements according to the following schedule:

Time of Pumping Step	Measurement Interval
0 to 15 minutes	1 minute
15 to 50 minutes	5 minutes
50 to 100 minutes	10 minutes
100 to 500 minutes	30 minutes
Over 500 minutes	60 minutes

5. Ensure that water discharged during the pumping test is directed down gradient of the well so that re-infiltration of the discharge water does not affect the test results.

6. Continue pumping long enough to collect sufficient drawdown data. Ideally, pumping will be continued for 600 minutes or longer; although, the work location or other constraints may dictate a shorter pumping period.

7. After pumping is discontinued, measure the recovery of water levels in the well at frequency intervals similar to those used for the active pumping period. Continue measurements until the water level in the well has recovered to within 90 percent of its pre-pumping level.

During or near the end of each pumping test, a groundwater sample will be collected from the test well using the sample collection and handling procedures in Sections 4.2. Pumping test results will be interpreted using analytical software such as the Well Hydraulics Interpretation Program (HGC, 1987) or AQTESOLV (Hydro Solve, Inc., 2000).

4.4 Investigation-Derived Waste Management

Investigation-derived wastes are expected to consist of purge water, drill cuttings, drilling fluids, and development water. Prior to initiation of field activities, the HGC Project Manager will contact ADEQ to determine the need for a DGP for the release of purge water. DGP is expected to be needed for the release of development water. Cuttings and drilling fluids will be collected in tanks or roll-off containers and stored at an appropriate location within the site according to methods approved by the CQB Project Manger. This may include spreading cuttings on the ground.

4.5 Field Equipment and Consumables

4.5.1 Field Equipment Maintenance and Calibration

The field technician will be responsible for properly maintaining and calibrating all field equipment. Operation, calibration, and maintenance procedures for all equipment will be kept accessible when equipment is being used, calibrated, or serviced. Measurement equipment will be calibrated when it is first used and recalibrated periodically based on the recommendations in the instrument's operations manual. Maintenance practices also will follow the manufacturers' recommendations. All calibration and maintenance will be recorded on a maintenance record that is readily available for reference in the field.

Precautionary measures will be taken to avoid equipment problems. Some precautionary measures are listed below.

- Keep spare parts such as batteries and probes on hand.
- Store equipment in a cool, clean, dry place when not in use.
- Clean equipment after each use.
- Keep sensitive parts covered and protected from potential hazards.
- Inspect equipment for potential problems prior to use.
- Keep battery packs charged.

Should a piece of equipment become inoperable, it will be removed from service and tagged to indicate that repair, recalibration, or replacement is needed. The HGC QA Manager will be notified when equipment needs to be repaired or replaced so that prompt service can be performed or substitute equipment can be obtained. Instrument problems encountered during the field program will be recorded and, if possible, resolved in the field.

4.5.2 Electrical Conductivity, Temperature, and pH Measuring Equipment

A multi-probe meter with automatic temperature correction of electrical conductivity measurements will be used to measure indicator parameters. The instrument will be properly stored and calibrated each day that it is in use. The instrument probes will be triple-rinsed with de-ionized water and stored according to the manufacturer's specifications after use. The electrical conductivity probe will be calibrated before each sampling event using a commercial

standard. Because electrical conductivity measurements may be correlated with, and used for, sulfate ion estimation, electrical conductivity measurements must be accurate and temperature corrected. The pH probe will be calibrated with two standards that have pH values that bracket the anticipated pH values for the samples to be tested. Standards with pH of 7 and 10 will be used for calibration. The calibration will be checked at least once every 4 hours thereafter with the pH 7 standard, and the probe will be recalibrated if the reading is out of the range of 6.7 to 7.3.

4.5.3 Water Level Measuring Equipment

Each electric sounder probe should be checked for accuracy at least once every 3 months. The accuracy will be checked by comparing the depth markings on the probe tape with the markings on a graduated steel tape. The sounder will also be checked after any incident that may alter the instrument's accuracy. If the difference between markings on the steel tape and on the sounder probe tape exceeds 0.05 ft per 100 ft, a correction factor will be determined and applied to DTW measurements. The sounder probe will be kept clean and functional. Portions of the cable that are submerged below fluid levels in wells will be properly cleaned, as described in the decontamination procedures outlined in Section 4.2.1.6.

4.5.4 Pressure Transducers and Data Loggers

The pressure transducer should be capable of measuring water levels with a sensitivity of 0.01 ft, although the transducer accuracy may differ depending on pressure rating. The data

logger may be internal to the pressure transducer or a separate instrument, but it must be programmable to collect pressure data at a minimum frequency consistent with the schedule given in Section 4.3.7. The accuracy of the pressure transducer will be periodically verified using the sounder probe. Data collected by the data logger will be downloaded daily. Maintenance for the pressure transducer/data logger assembly will follow the guidelines of the operations manual. The assembly will be stored in a clean, secure location when not in use.

4.5.5 Flow Meters

Flow meters will be capable of measuring flow rates in the range needed for well development and hydraulic testing. The flow meters will have a sensitivity of approximately 5 percent of the measured flow rate. Maintenance and calibration of flow meters will follow the guidelines of the operations manual.

4.5.6 Consumables

The field technician, under the direction of the HGC QA Manager, has the responsibility for performing daily checks of consumables and for ensuring that there is adequate supply. Consumables include the following:

- Groundwater sampling containers prepared with preservatives.
- Sample identification labels and packing supplies.
- Coolers and ice for sample storage and transport.
- Disposable gloves for groundwater sampling.

- Markers and/or ink pens for sample labeling and for recording field activities.
- Detergent and water for decontamination.
- Laboratory grade de-ionized water for QC samples.

4.6 Field Documentation and Reporting

Field notes will be maintained for all sampling, drilling, well construction, well development, and pump test activities. The field logbook will be a bound, water resistant notebook with consecutively numbered pages. Documentation in the field logbook will be sufficient to reconstruct a field activity, including any corrective actions taken, without relying on memories from field team members. Deviations from the ACP or this QAPP also will be noted in the logbook. Field logbooks will be clearly identified on the cover with the project name and each page of the logbook should note the date that the entry was made. Entries will be made in blue or black ink. Incorrect entries will be crossed out with a single stroke and the change will be initialed and dated by the person making it. Manually recorded data will be transferred to an electronic format after field activities are concluded. Specialized information for some tasks may be recorded on field forms developed for that data type (e.g., groundwater sampling forms, geologic logs, well construction logs). When combined with the field logbook, these comprise the field record for the ACP.

At the end of each day, the carbon copy of the pages of the day's entries in the field logbook will be removed, or the pages will be photocopied, and stored in a secure area. Field forms and any other field checklists also will be photocopied and stored at the end of each day.

This practice will protect against lost data should the logbook or forms be lost or destroyed. Data measured by field instruments and recorded in digital storage devices will be downloaded daily for processing. At least once a week, all data that was collected in the field, including field notes, field forms, checklists, and electronic data, will be presented to the HGC QA Manager for review and verification.

4.7 Field Corrective Action Procedures

Corrective action procedures will be taken for all field non-conformances. Non-conformances are defined as events or measurements that are either unexpected or do not meet established acceptance criteria and that might affect data quality if uncorrected. Examples of non-conformances include:

- Incorrect use of field equipment.
- Field instrument failure.
- Improper sample collection, preservation, and shipment procedures.
- Incomplete field documentation, including COC records.
- Incorrect decontamination procedures.
- Incorrect collection of QC samples.

The appropriate corrective action will depend on the nonconformance. In cases where immediate and complete corrective action can be implemented by field personnel, corrective actions should be completely described in the field logbook. If a nonconformance cannot be completely and immediately corrected in the field, the individual involved with the field activity

will immediately notify the HGC QA Manager and corrective actions will be taken as described in Section 6.5.

5. ANALYTICAL LABORATORY PROCEDURES

Upon receipt of samples from HGC field activities, the analytical laboratory will be responsible for sample handling, analysis, and reporting. Analytical laboratory procedures must be conducted in a consistent, accurate, and quality controlled manner so that the data generated from field activities is useful for achieving the purposes of the Work Plan. This section discusses the following items related to QA of analytical laboratory procedures:

- Licensure
- Sample receipt and handling
- Analytical methods
- Laboratory QC samples
- Laboratory equipment
- Reporting
- Corrective action

Samples collected by HGC will be analyzed by an Arizona Department of Health Services (ADHS) licensed laboratory. Currently, ACZ Laboratories, Inc. of Steamboat Springs, Colorado will conduct analysis of water samples collected for Tasks 1 and 2.2, and Turner Laboratories of Tucson, Arizona will conduct analysis of reconnaissance samples collected for Task 2.3. However, CQB reserves the right to change laboratories for any reason. Analytical laboratory requirements are discussed generically.

5.1 Licensure

The designated analytical laboratory and any laboratories to which sample analyses will be subcontracted shall be licensed by ADHS to perform each analysis requested, unless ADHS licensure is not provided or required for that particular method. If the status of the laboratory's license changes, or if laboratory performance is unsatisfactory, an alternate licensed analytical laboratory may be selected to perform the analyses. A laboratory performing analyses will notify the HGC Project Manager for approval prior to subcontracting analyses to another licensed laboratory. Documentation verifying the subcontracted laboratory's ADHS license must be received by the HGC Project Manager prior to performance of the analytical services.

5.2 Sample Receipt and Handling

When the samples arrive at the laboratory, the laboratory will check samples for label identifications and complete, accurate COC documentation. The sample condition will be checked and recorded on the COC. Any discrepancies between the COC documentation and sample labels, any inaccurate or incomplete sample preservation, or any problem encountered that may compromise the sample integrity must be noted and communicated to the person submitting the samples and to the HGC QA Manager.

A unique laboratory ID number will be assigned to each sample. This number will be cross-referenced to the sample field ID to avoid the possibility of mislabeling. Analytical reports will contain both laboratory ID numbers and field IDs for sample results. Access to the sample

control area will be restricted to prevent unauthorized contact with samples, extracts, or documentation. All samples and extracts will be maintained by the laboratory until at least 30 days following the release of the final report. A detailed description of the laboratory sample receiving, custody, login, and tracking procedures will be contained in the laboratory's QA plan and/or SOP.

Samples may be shipped from one laboratory to another for analysis. Laboratories will package and transport samples as described in Section 4.2.3. The temperature inside the cooler will be checked and documented on the COC by the receiving laboratory upon receipt of the samples. Samples shall then be placed immediately on ice or in a refrigerator at 4 °C ⟨≡~ 2° at the receiving laboratory.

5.3 Analytical Methods

Selected samples collected as part of the ACP will be analyzed for the following major element ions and parameters: calcium, magnesium, sodium, potassium, sulfate, chloride, fluoride, nitrate-nitrite, silica, hardness, total dissolved solids, alkalinity, and pH. Water samples will be analyzed using the methods or equivalent methods specified in Table F.2. If analyses by alternative methods are deemed necessary or more appropriate by the Laboratory Project Manager, they will first be approved by the HGC QA Manager. The following documents can serve as a guide in selecting alternative methods.

- *Analytical Methodologies Designed for Testing Conducted Under the Clean Water Act*, CFR, Title 40, Part 136.

- *National Primary Drinking Water Regulations Analytical Methodologies*, cited in the Federal Register under the National Primary Drinking Water Regulations. These may be used to evaluate groundwater concentrations as they pertain to human receptors of drinking water.

- *Standard Methods for the Examination of Water and Wastewater* American Public Health Association, 1995). These are EPA-approved methods for analysis of inorganic compounds and can be used to evaluate surface water or groundwater samples.

The laboratory performing sample analysis should use the most efficient and cost-effective approach to achieve the accuracy and precision requirements of this QAPP. Target method detection limits (MDLs) are given in Table F.2. If sample dilution is necessary due to a relatively high concentration of an individual compound or if there is interference, the MDLs and other DQIs may not be achieved for every analyte. Similarly, matrix interferences may cause surrogate and analyte recoveries to fall outside of the required percent recoveries listed in the laboratory's SOPs. The laboratory will document all analyte and matrix interferences in all laboratory reports and evaluate the possible matrix effects using ADEQ policy 0154.000 *Addressing Spike and Surrogate Recovery as They Relate to Matrix Effects in Water, Air, Sludge and Soil Matrices* (ADEQ, 1998a). Analytical data will be qualified by the ADEQ Data Qualifiers (Appendix F.2).

If laboratory results are outside any of the method acceptance criteria or the acceptance criteria listed in the laboratory's SOPs, the laboratory will document the deviations in the case narrative. If deviations are the result of laboratory procedures, the laboratory will take the appropriate corrective action, such as re-analysis of samples or a detailed review of instrument output.

5.4 Laboratory Quality Control

QC of laboratory operations consists of documentation of all actions taken by personnel regarding issues such as equipment maintenance, reagent purity, standards traceability, waste disposal, and corrective action systems. These policies should be specified in each laboratory's QA manual. Appendix F.3 and F.4 contain quality assurance procedure for ACZ Laboratories, Inc. and Turner Laboratories, Inc., respectively.

The designated laboratory should be familiar with and follow ADEQ Policies related to QA/QC of laboratory results such as Policy 0154.000, *Addressing Spike and Surrogate Recovery as They Relate to Matrix Effects* (ADEQ, 1998a), and Policy 0155.000, *Analytical Methods Having Provisions for a One-point Calibration and Continuing Calibration Verification Constraints* (ADEQ, 1998b). Laboratory QA/QC procedures will be in accordance with method requirements and as described in each laboratory's QA plan and/or SOP. The laboratories' QA plan and SOP will be provided by the laboratory if requested.

Laboratory QC also includes the routine measurements taken within the laboratory to verify the integrity of analysis, data processing, and record maintenance. The laboratory will analyze internal QC samples as required by the analytical methods to ensure analytical precision, accuracy, and representativeness. Field samples and laboratory QC samples will be analyzed to a minimum reporting limit as specified by the method, or in-house requirements, whichever is stricter. The precision acceptance criteria for those analytes (RPD; Section 3.3.1) and accuracy (percent recovery; Section 3.3.3) also will be based on the stricter of in-house laboratory established limits or method requirements.

Typical laboratory QC samples include blank spikes, laboratory control samples (LCSs), method blanks, surrogates, matrix spike/matrix spike duplicate (MS/MSD) analysis, internal (reference) standards, and duplicate samples. These samples are described below:

- The blank spike is a sample of water demonstrated to be free of matrix interference and has non-detectable concentrations of the target analyte to which a known amount of the analyte is added. ADEQ Policy 0154.000 (ADEQ, 1998a) requires a blank spike and a blank spike duplicate to be analyzed to demonstrate both precision and accuracy when the MSs are unacceptable because of matrix interference. The percent recovery of the blank spike and blank spike duplicate pair is used to evaluate the accuracy and recovery of each preparation and analytical batch, and may be used to establish statistical control of the analysis.

- The LCS is a standard or sample that is derived from a different source (i.e., different vendor or lot number) than the standards that are used to calibrate the instrument. It is used as a cross-check to verify the accuracy of the calibration and typically must be analyzed once for every instrumental calibration (ADEQ Policy 0154.000 (ADEQ, 1998a)).

- A method blank is a sample of water that has non-detectable concentrations of the target analytes. For most methods, at least one method blank is prepared for every batch of 20 samples. The method blank is taken through the entire analytical process as part of the sample batch to demonstrate that contamination did not occur during the testing.

- A surrogate is a compound that is expected to perform similarly to the compounds being analyzed in the laboratory method. The surrogate is not normally found in the environment and can therefore be used to monitor the recovery efficiency of the analytical process.

- The MS/MSD is used to demonstrate both the precision and accuracy of the test and the presence or absence of matrix interferences. The MS/MSD is prepared by spiking a sample with a known concentration of the target compounds and taking it through the entire analytical process as part of the sample batch.

- Internal standards are reference samples that contain a known concentration of the analyte. The internal standards are used to test the accuracy of the instruments and analytical methods.

- Duplicate samples are taken from the same aliquot as the environmental sample being tested. The duplicate sample is analyzed within the same batch and in exactly the same manner as the original aliquot. Duplicate samples evaluate the analytical precision at the concentration of the environmental sample.

5.5 Laboratory Equipment

All laboratory equipment will be maintained and calibrated as described in the laboratory's QA plan and SOPs. Any equipment problems that may affect data quality will be documented in the case narrative. Regular calibration of laboratory instruments is essential to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established detection limits. Each instrument will be calibrated with standard solutions appropriate for the type of instrument and the linear range established for the analytical method. Each analytical method contains requirements for the number and concentration of calibration standards, which are described in the laboratory's QA plan.

ADHS has established criteria for instrument calibration and the quantification of analytes as part of the Laboratory Licensure program. All analyses must be consistent with these requirements, and quantification of analytes must be consistent with the reporting requirements of ADHS (the lowest calibration concentration will be at or below the reporting level). Each calibration will then be verified through the use of statistical tests (e.g., a Pearson's Correlation Coefficient or relative standard deviation calculations), initial and continuing calibration verification standards and blanks, and LCSs prior to the sample results being approved.

5.6 Laboratory Data and Reporting

Laboratories will be expected to provide preliminary analytical data reports within 15 working days of receiving the samples and final reports shortly thereafter. Laboratory data reports will be sent to the HGC QA Manager in hard and electronic formats from the designated laboratory. Analytical laboratories will be expected to store the original hard copy and electronic reports for 5 years. The laboratories will be expected to notify HGC prior to destruction of records. The requirements for the content and the handling of hard and electronic reports are given below.

5.6.1 Hardcopy Data

Analytical data will contain the necessary sample results and QC data to evaluate the DQOs defined for this project (Section 3). Omissions or insufficient levels of detail will be corrected at the laboratory's expense. The laboratory reports will be consistent with EPA Level III documentation (Section 3.2) and include, at a minimum, the following:

- Case narrative (including a complete description of any analytical difficulties or QA/QC deficiencies encountered during sample analysis), sample number cross-reference, COC documentation, and method references.
- Analytical results with cross-reference to analytical batch.
- Surrogate recoveries (as applicable).
- Blank results.
- LCS recoveries.
- Sample spike recoveries.

- Duplicate sample results or duplicate spike recoveries.
- Outliers qualified according to ADEQ Data Qualifiers (Appendix F.2).

The laboratory report, as defined above, will be submitted to the QA Manager for use in the data verification/validation process. If requested, the laboratory will make supporting documentation consistent with EPA Level IV (Section 3.2.). The following QC issues may trigger the need for the submission of Level IV documentation:

- Continued quality issues detected through the data verification/validation process
- Unexpected or unexplained sample results

5.6.2 Electronic Data

An electronic data report will be submitted by the laboratory in a format that is compatible with HGC's database. HGC's QA Manager will verify that the report is in an acceptable format and that all elements needed are present. HGC's QA Manager will enter the analytical data into a spreadsheet or database for verification before it is used in any reports.

5.7 Laboratory Corrective Action Procedures

The internal laboratory corrective action procedures and a description of out-of-control situations requiring corrective action will be contained in the laboratory QA plan. At a minimum, corrective action will be implemented when control chart warnings, control limits, sample holding times are exceeded, or if the method QC requirements are not met. Out-of-control situations that cannot be resolved within 2 days of identification will be reported to HGC. In

addition, a corrective action report, signed by the Laboratory Project Manager and the Laboratory QA Manager, will be provided for the project files. HGC's Project Manager can request the re-analysis of any or all of the data acquired since the system was last in control.

6. DATA MANAGEMENT

Reports and documentation from activities conducted under the direction of HGC will be submitted to the HGC QA Manager. The QA Manager has the responsibility of processing these data and evaluating and maintaining the data quality. The sequence for processing field and analytical data is shown in Figure F.2. This process consists of the following items:

- Data compilation
- Data entry into a spreadsheet or database
- Data review and verification
- Data entry into permanent database
- Reporting
- Corrective Action

6.1 Data Compilation and Entry to Spreadsheet or Database

6.1.1 Field Data

The field logbook and other field forms generated from field activities directed by HGC will be submitted to the HGC QA Manager at least once per week for review. The HGC QA Manager will review the field logbook and field forms using the checklist provided in Table F.4. This review will consist of checking for incomplete documentation and anomalous data entries. The HGC QA Manager will immediately contact the person submitting the field forms to verify

or correct missing or anomalous entries. When the problems are resolved or if no problems are found, the information will be entered into a temporary database for the sampling event.

6.1.2 Laboratory Data

Hardcopy and electronic laboratory reports will be reviewed for completeness (Table F.4). Electronic data deliverables will be entered into a spreadsheet or database for review and verification by the QA Manager. Hardcopy laboratory reports will be stored in HGC's files.

6.2 Data Review, Verification, and Validation

Data verification is "the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements" (EPA 2002b). Data validation is "an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set" (EPA 2002b).

Data validation is not expected for this project. Data validation would require a thorough review of all the field data and/or the analytical laboratory results to provide data documentation consistent with EPA Level IV requirements. This level of review will not be performed unless there are persistent concerns regarding the quality of field or laboratory data. If persistent

concerns do arise and an EPA Level IV package is deemed necessary, 100 percent of the affected data will undergo data validation (Section 6.4).

Results of the data review and verification will be documented and summarized in a data verification report that will be included in the groundwater monitoring reports for Task 2.2. Data collected according to the directives of the MO will be reviewed and verified according to the provisions of this QAPP. It is the responsibility of the HGC QA Manager to resolve any data verification issues identified prior to preparation of groundwater monitoring reports for Task 2.2.

6.2.1 Field Data

The HGC QA Manager will review and verify all field data to evaluate their completeness and check for data anomalies prior to entry into the permanent project database. Where appropriate, DQI's will be evaluated as described in Section 3.3. The data quality assessment checklist, provided in Table F.4, will be completed as part of this review.

6.2.2 Laboratory Data

The HGC QA Manager will verify analytical data by reviewing it for compliance with the QA/QC specifications outlined in the analytical methods and Table F.4 of this QAPP. After the data have been verified, the HGC QA Manager will determine whether the DQOs have been met. Data verification flags will be applied to those sample results that fall outside acceptance criteria specified in the analytical methods, the laboratory SOPs, and this QAPP and therefore did not

meet the DQOs. Data verification flags to be used for this project are defined by the ADEQ Data Qualifiers (Appendix F.5). Data verification flags will indicate whether results are considered anomalous, estimated, or rejected. Only rejected data are considered unusable for decision-making purposes, however, other qualified data may require further verification. All corrective action to be taken by the laboratory should be completed as described in Section 5.7 and 6.5 prior to reporting the data.

6.2.3 Final Data Assessment

All field and laboratory data will undergo a final data assessment (Table F.4). This assessment involves checking data entered into the temporary database with the original data source and, where appropriate, comparing data against time series plots to check for data anomalies. The final assessment also will verify that all QA issues have been resolved and proper corrective actions have been taken.

6.3 Data Storage and Data Transfer

Any data generated by CQB will be shared with HGC so that a comprehensive database of all ACP activities can be maintained. To the degree possible, data transfer should be performed electronically to eliminate human transcription errors. When electronic data transfer is not possible, a staff member will manually input data to the database, and another staff member will proof these manually entered data to ensure that they are correct before they are uploaded and reported. Key data that cannot be verified will be brought to the attention of the

appropriate QA Manager. All reported results are ultimately stored in the permanent project files along with original copies of field notes, monitoring forms, and laboratory reports.

6.4 Reporting

A data verification report will be prepared by the HGC QA Manager for each groundwater monitoring report for Task 2.2, or on another routine basis, as specified by the HGC Project Manager. The report will summarize data flags, document corrective actions, and evaluate the data quality against the DQO's. Each report also will include a summary of any significant QA/QC problems. If data quality problems necessitate data validation and reporting, the content and frequency of such reports will be identified in the verification report.

The HGC QA Manager will assemble a data package for each sampling event or field activity. Where applicable, the data package is to include the following:

- Field documentation of monitoring, sample collection, and handling records (Sections 4.2 and 4.6)
- Field equipment calibration and decontamination records (Sections 4.5.2 and 4.2.1.6)
- QC sample collection records (Section 4.2.1.5)
- COC forms (Section 4.2.2)
- Sample receipt records and shipping bills (Section 4.2.2)
- Laboratory analytical reports including laboratory QC summaries (Sections 5.6)
- Data Quality Assessment Checklist (Table 4)

6.5 Corrective Action

The HGC QA and Project Managers will promptly and thoroughly act to correct any nonconformance that is expected to compromise the quality of the project data. Rapid and effective corrective action minimizes the possibility of questionable data or documentation. All QA problems and corrective actions will be documented by the HGC QA Manager. This documentation will provide a complete record of QA activities and also will help to identify long-term corrective actions that may be necessary. After the source of the error is determined and remedied, the HGC QA Manager will ensure that all suspect data are either deleted from the permanent database or re-collected.

Corrective action procedures will depend on the nonconformance. For a nonconformance that can be easily corrected, immediate corrective actions can be taken in the field or laboratory. Often, the source of the problem is obvious and can be corrected at the time of observation. Nonconformances that have substantial impact on data quality will require the completion of a Corrective Action Request Form (Figure F.3). This form may be filled out by any project individual who suspects that any aspect of data integrity is being compromised by a nonconformance. Each form is limited to a single nonconformance. Copies of the corrective action request form will be given to the HGC Project Manager and be placed in the project file. The HGC Project Manager and QA Manager will meet along with other staff as necessary to discuss the appropriate steps to resolve the problem. Issues that may be discussed include the following:

- Determination of when and how the problem developed
- Assignment of responsibility for problem investigation and documentation
- Determination of the corrective action to be implemented to eliminate the problem
- Development of a schedule for completion of the corrective action
- Assignment of responsibility for implementing the corrective action
- Documentation and verification that the corrective action has eliminated the problem

The HGC QA Manager can require field and/or laboratory activities to be limited, discontinued, or repeated until the corrective action is complete and the nonconformance eliminated. The HGC QA Manager should continue to monitor the status of corrective actions and periodically (as determined in the corrective action report) complete a corrective action status report. This report should briefly describe the problem, the individual who identified it, and list the personnel who are responsible for the determination and implementation of the corrective action. Completion dates for each phase of the corrective action procedure will also be listed in the status report, along with the date for the designated personnel to review and check the effectiveness of the solution. A follow-up date will also be listed to check that the problem has not reappeared. This follow-up will be conducted to ensure that the solution has adequately and permanently corrected the problem.

7. REFERENCES

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TABLES

TABLE F.1
Summary of EPA Analytical Levels

EPA Analytical Level	Type of Analysis	Accuracy	Sensitivity	Level of Documentation
Field Check Level 1	Temperature, pH, and specific conductivity measurement using portable instruments.	**Low;** provides general indication of contamination.	**Low to moderate;** at least sufficient to screen for general levels of ions. Instruments may not be sensitive to some chemicals.	**Low;** often digital readout of final result only or visual indication of concentration range (e.g., by change in color.)
Routine Screening Level II	Preliminary analyses of sulfate using in-field method.	**Moderate;** provides data typically as concentration ranges	**Moderate to high;** sufficient to document presence or absence of selected chemicals.	**Low;** often only the final quantitative results without supporting quality assurance data.
Level III	Analysis of major element ions using standard EPA procedures.	**High;** provides data of known bias and precision for an overall accuracy level that is useful for most applications.	**Moderate to high;** sufficient to document presence or absence of a wide range of chemicals.	**Low to moderate;** summary of quality assurance results is provided but is usually not adequate for an independent verification of results.
Program Specific Level IV	Standard analyses of major element ions using EPA procedures.	**High;** similar accuracy as Level III with a focus on confirmation of results.	**Moderate to high;** similar sensitivity as Level III but most standardized protocols focus on characterization of waste materials.	**Rigorous;** standardized data package of sample and quality assurance results is sufficient for independent verification of results.

The QC requirements may be specially defined for each level. For example:

-- Level I requirements may include running only a standard and a blank.
-- Level II requirements may include a blank and running multiple standards to determine the range.
-- Level III requirements would include the QA/QC required by the method.
-- Level IV requirements would include Level III requirements, plus any additional steps you would like the laboratory to take, such as CLP protocols.

TABLE F.2
Groundwater Sampling and Analysis Requirements

Analyte	Method	MDL (mg/L)	Container	Preservation	Holding Time	Filtered (F), Unfiltered (U)
Constituents for General Chemistry						
pH	EPA 150	N/A	500 mL plastic or glass	N/A	analyze immediately	U
Temperature (C^o)	Thermometric	N/A	500 mL plastic or glass	N/A	analyze immediately	U
Conductivity	Conductance	N/A	500 mL plastic or glass	N/A	analyze immediately	U
TDS	SM 2540C/160.1	10	250 mL HDPE	4º C	7 days	F
Total Alkalinity (as $CaCO_3$)	SM 2320B	2	500 mL HDPE	4º C	14 days	U
Chloride	EPA 300.0	1	250 mL HDPE	4º C	28 days	F
Fluoride	EPA 300.0	0.1	250 mL HDPE	4º C	28 days	F
Nitrate	EPA 300.0	0.02	250 mL HDPE	4º C	48 hours	F
Nitrite	EPA 300.0	0.02	250 mL HDPE	4º C	48 hours	F
Sulfate	EPA 300.0	10	250 mL HDPE	4º C	28 days	F
Calcium	EPA 200.7	0.2	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Magnesium	EPA 200.7	0.2	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Potassium	EPA 200.7	0.3	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Sodium	EPA 200.7	0.3	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Constituents for Water Treatment Evaluation						
Ammonia	EPA 350.1	0.05	500 mL HDPE	4º C; H_2SO_4 to pH < 2	28 days	F
Barium	EPA 200.8	0.0001	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Strontium	EPA 200.7	0.01	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Ferrous Iron	EPA 3500	0.01	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Iron (total)	EPA 200.7	0.02	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	U
Manganese	EPA 200.7	0.005	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Boron	EPA 2007	0.01	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Aluminum	EPA 200.7	0.03	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Phosphate	EPA 365.1	0.01	250 mL HDPE	4º C	48 days	F
Sulfide	EPA 376.2	0.02	125 mL HDPE	4º C; Zn acetate; pH>9 NaOH	7 days	F
Silica (total)	EPA 200.7	0.2	125 mL HDPE	4º C	28 days	U
Silica (soluble)	EPA 200.7	0.2	125 mL HDPE	4º C	28 days	F
Selenium	EPA 200.7	0.004	250 mL HDPE	4º C; HNO_3 to pH < 2	6 months	F
Total organic carbon	EPA 415.1	1	250 mL HDPE	4º C; HCl or H_2SO_4 to pH < 2	28 days	U
Chemical Oxygen Demand	EPA 410.4	10	250 mL HDPE	4º C; H_2SO_4 to pH < 2	28 days	F
Total hardness	SM 2340B	Calculation	N/A	N/A	N/A	F
Silt density index (SDI)	ASTM D4189-82	N/A	500 mL HDPE	N/A	N/A	U
Bacteria (count/ml)	EPA 9222D	1 cfu / 100mL	100 mL HDPE (Sterile)	4º C; H_2SO_4 to pH < 2	24 hrs.	U
Turbidity	EPA 180	N/A	500 mL HDPE	N/A	48 hrs.	U

TABLE F.3
Sample Shipment Checklist

Sample Handling Checklist	Yes	No	Not Applicable
Sample bottles are free of defects and in their original packaging:			
Field Duplicate samples named with unrecognizable IDs and actual locations recorded in field logbook			
Samples labeled with:			
Sample Name/Date (e.g., LE-1-041604)			
Analyses Required			
Sample Matrix			
Filtered or Unfiltered			
Sampler's Initials			
Preservative			
COC filled out with:			
Project Name, required signatures, dates, and times			
Analytical Suite required			
Date and time of sampling, sample IDs, sample matrix			
Number of containers submitted			
QA Sample IDs, matrices, date and time of sampling			
Samples stored on sufficient ice to remain at 4ºC until arrival at lab			
Sample package will not leak during shipment			
Sign COC to relinquish sample custody, remove pink slip, and enclose original in sample shipment			
Samples shipped within 48 hours of collection			

Notes:
COC = Chain of Custody
QA = Quality Assurance
ID = Identification

TABLE F.4
Data Quality Assessment Checklist

	Yes	No	Not Applicable
Data Compilation			
Field Data			
Field Logbook Entries Current			
Field Sampling Forms Completed			
Borehole and Lithologic Logging Forms Completed			
Well Construction Diagrams Completed			
Hydraulic Testing Forms Completed			
Anomalous Data Entries Resolved			
Chain of Custody Forms Completed			
Correct Analyses Requested			
Laboratory Data			
Hard Copy Reports Received			
Electronic Reports Received			
Case Narrative and QC Summaries Included in Report			

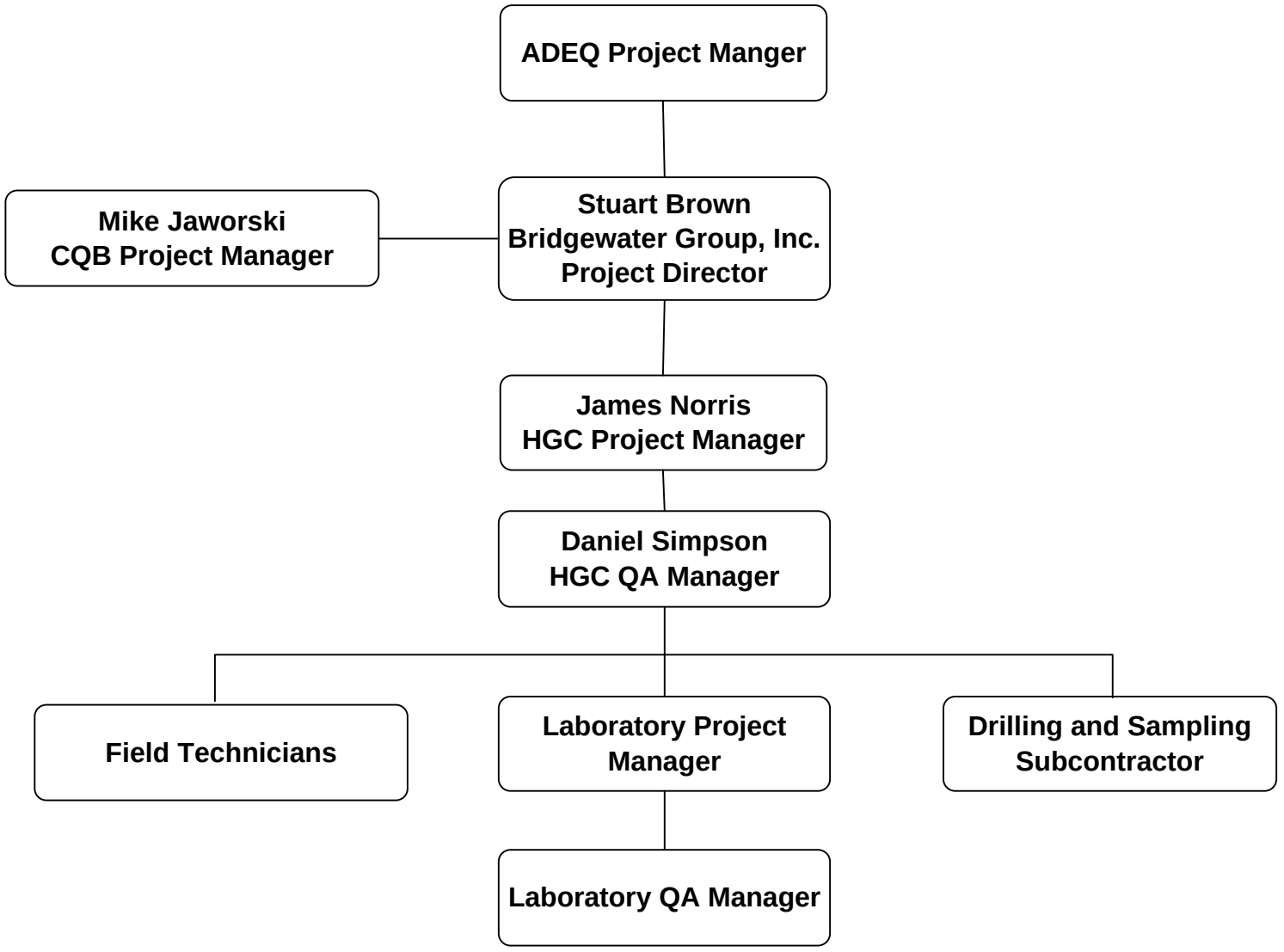
Data Review and Verification			
Field Data **Groundwater Sampling**			
Monitoring Conducted at Correct Locations			
Measuring Point for Water Levels is Consistent			
Field Equipment Calibration Requirements Met			
Field Equipment Decontaminated Before Uses			
Purge Parameters Stabilized Prior to Sample Collection			
QC Samples Taken at Appropriate Frequency			
Drilling and Well Construction			
Lithologic Logging per ASTM Standards			
Reconnaissance Borehole Sampling Completed			
Laboratory Samples			
Wells Properly Constructed			
Hydraulic Testing Properly Conducted			
Laboratory data			
All Required Analyses Performed			
Holding Times and Temperatures Met			
Laboratory QC Samples Within Acceptable Limits			
Field QC Samples Within Acceptable Limits			
MDLs < Target MDLs			

Final Data Quality Assessment Checklist:	Yes	No	Not Applicable
Data Entry Checked Against Original			
Time-Series of Analytical and Field Data Checked for Anomalies			
QA Issues Resolved and Documented			
Corrective Action Taken and Documented			

Notes:

QC = Quality Control
QA = Quality Assurance
MDLs = Method Detection Limits
PQLs = Practical Quantification Limits
RAOs = Mitigation Order Objectives

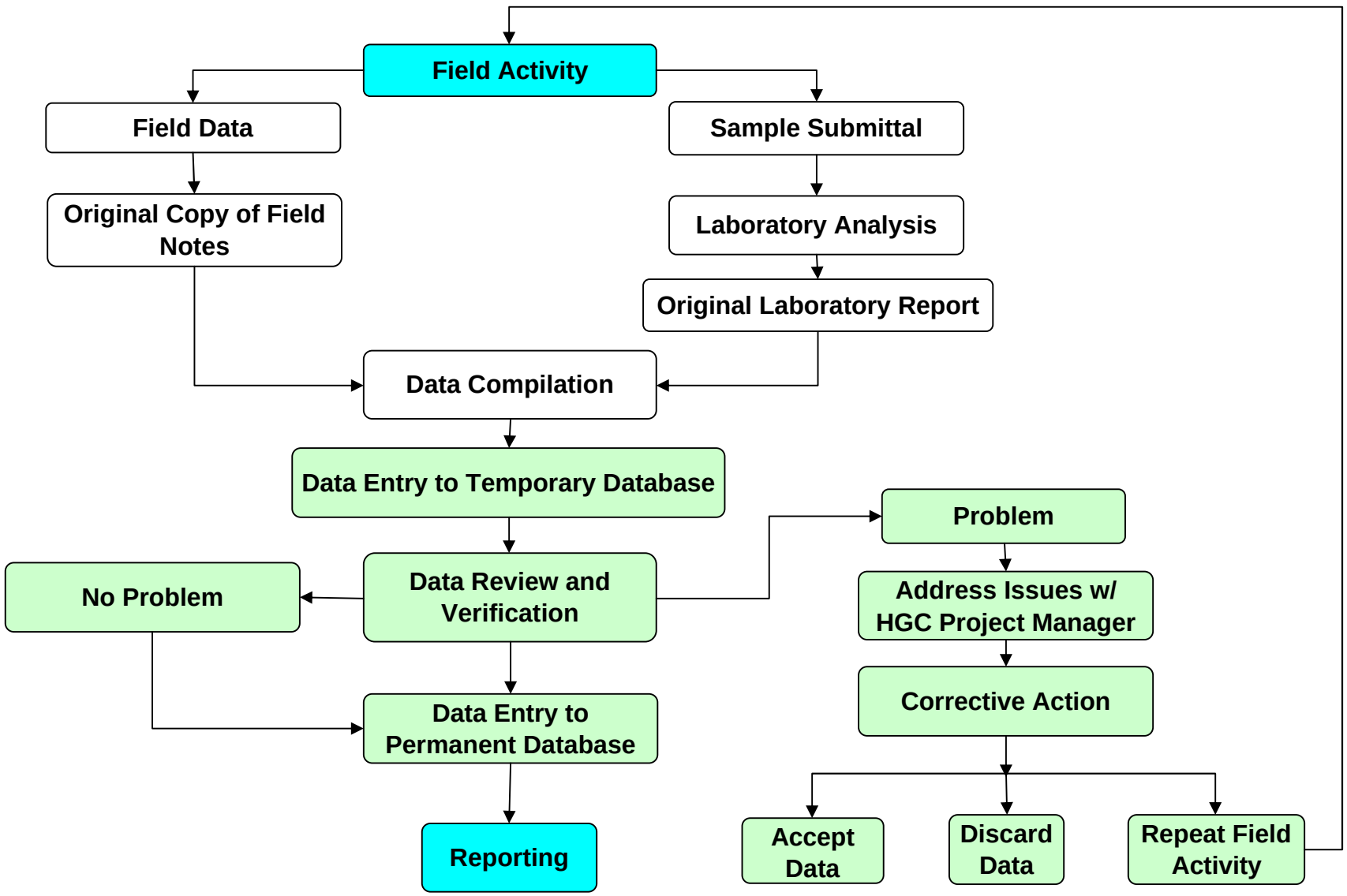
FIGURES



HYDRO GEO CHEM, INC.

ORGANIZATIONAL CHART

APPROVED	DATE	FIGURE
JRN	6/27/07	**F.1**



HYDRO GEO CHEM, INC.

FIELD AND ANALYTICAL DATA PROCESSING SEQUENCE

APPROVED	NWH	DATE	7/6/06	FIGURE	F.2

FIGURE F.3
CORRECTIVE ACTION FORM

Service or Activity:_____Date:_____
_____

Contractor or Support Organization:_____
Date Discovered:_____ Location:_____
Notation in Logbook Vol. No. _____ Page_____ Date_____

Nature of Alteration: Description of Alteration and Apparent Cause:
( )Procedural Deficiency _____
( )Data Deficiency _____
( )Instrumentation Def. _____
( )Other _____

Recommended Disposition: Justification for Recommended Disposition:
( )Accept Deviation _____
( )Modify Plan/Procedure _____
( )Repeat Service/Activity _____
( )Terminate, Recommended Corrective Action:_____
( )Conditional Acceptance*_____
*State Conditions_____
_____
Originator:_____ Organization:_____ Phone: _____
Corrective Action Verification:
( ) Verified (note any appropriate conditions):_____
_____
_____
( ) Cannot verify (note reasons for lack of verification):_____
_____
_____
Project QA:_____ Date:_____
(Use space below for comments or extensions to the above topics.)

APPENDIX F.1

ASTM 2488
DESCRIPTION AND IDENTIFICATION OF SOILS

Designation: D 2488 – 00

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-μm) sieve.

fine—passes a No. 40 (425-μm) sieve and is retained on a No. 200 (75-μm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-μm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula.*

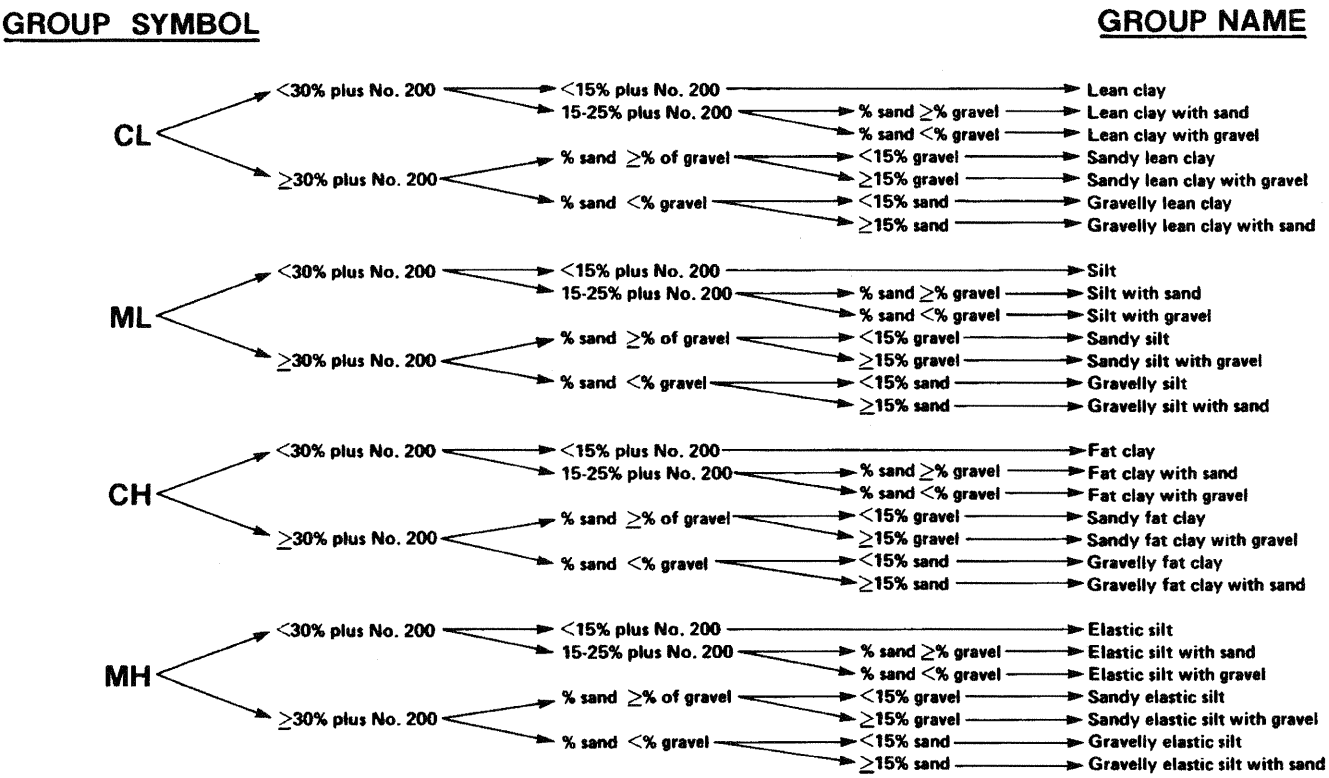
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

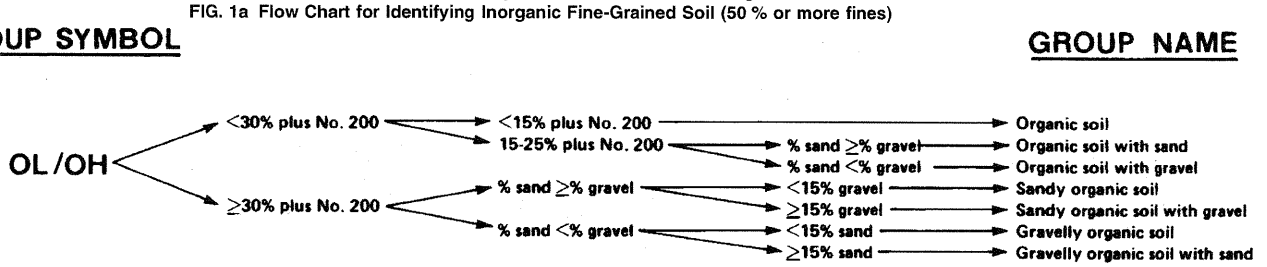
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

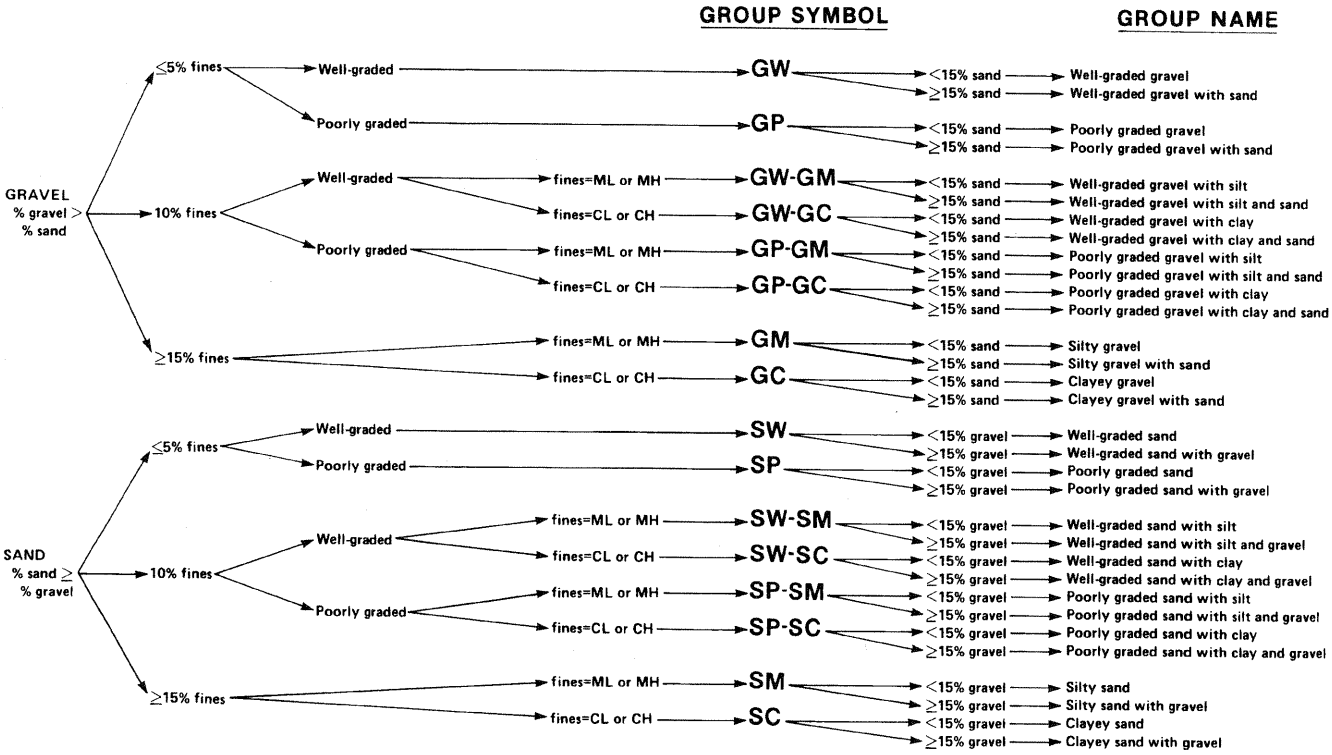
9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the

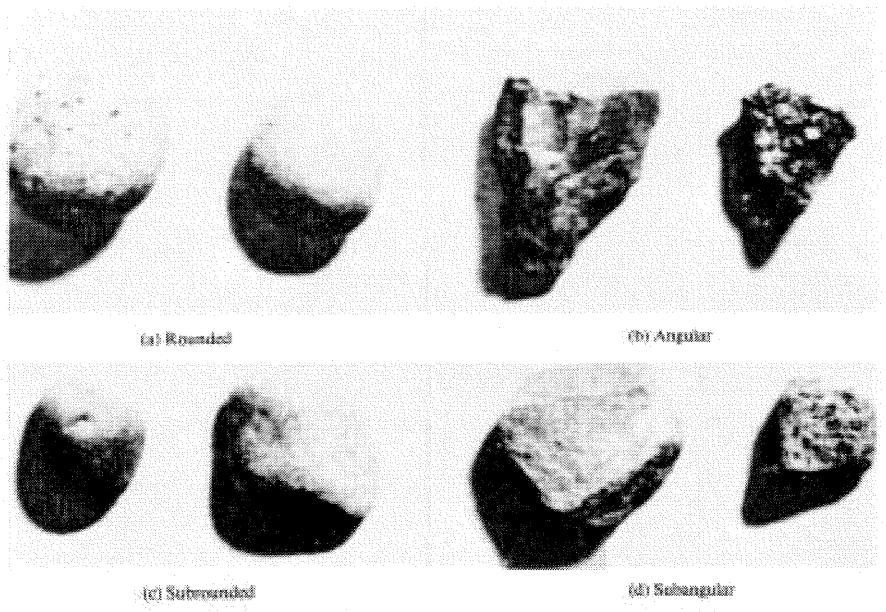


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.	
Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

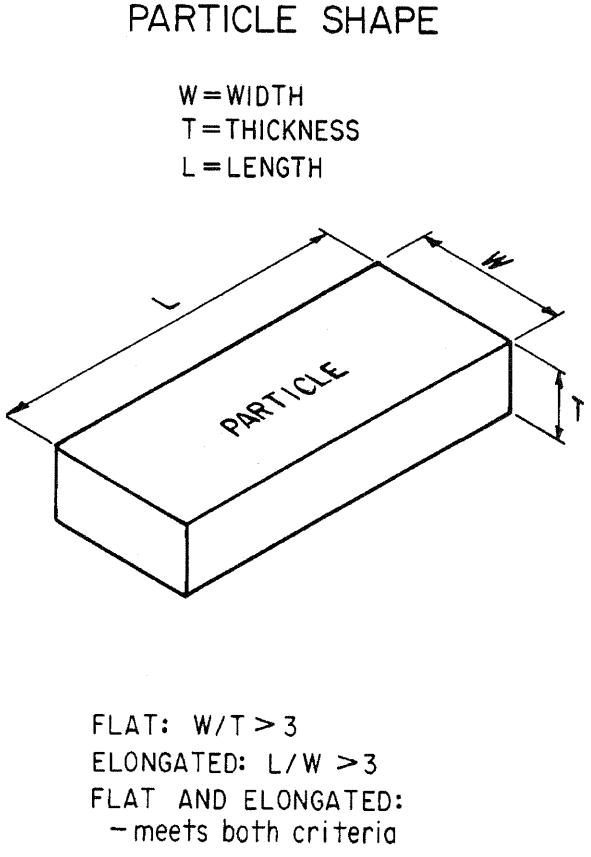


FIG. 4 Criteria for Particle Shape

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A 1/8-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken

shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1993$^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

APPENDIX F.2

AQUIFER TEST PROCEDURES FOR HYDRAULIC TESTING OF NEW AND EXISTING WELLS MITIGATION ORDER ON CONSENT NO. P-121-07

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TABLE

1. OVERVIEW OF WORK

Aquifer tests will be conducted at the conclusion of well development at each new monitoring well installed for Mitigation Order on Consent No. P-121-07. The objective of aquifer testing is to estimate aquifer transmissivity and other hydraulic properties using measurements of the water level response to pumping in the pumped well and any observation well(s). A groundwater sample will be collected from the pumped well during or at the conclusion of the aquifer test to document the concentrations of sulfate and other constituents. Water discharge to surface will be monitored for Clean Water Act compliance under the terms of a De Minimus General Permit (DGP) from Arizona Department of Environmental Quality, if required.

2. GENERAL DESIGN OF AQUIFER TEST

Aquifer testing at each well will consist of a step-rate pumping test and a recovery test. The step test will include measuring water levels while the well is pumped at three successively increasing flow rates. The recovery test will include measuring water levels after pumping is stopped.

Target pumping rates for the step test are 15, 30, and 50 gallons per minute (gpm) for basin fill wells, and 5, 10, and 20 gpm for bedrock wells. The two initial steps will last for a minimum of one hour each and pump at approximately 30% and 60% of the maximum flow rate. The third step will pump for eight to ten hours at the maximum flow rate. At the conclusion of the third step, the pump will be shut off and the recovery of water levels monitored. The duration of the recovery test will equal the duration of total step test pumping.

3. AQUIFER TEST METHOD

The critical parameters to be monitored during a pumping test are water levels during pumping and recovery, barometric pressure, and the pumping rate. Barometric pressure will be monitored regardless of the type of downhole pressure transducer used (either vented or non-vented). The change in water level over time is used to calculate drawdown, or the difference between the static water level at the start of the test and the water level at any time in the test. Drawdown is used in conjunction with measurements of the pumping rate over time to estimate aquifer hydraulic properties. Any corrections to drawdowns needed as a result of barometric pressure fluctuations will be made based on barometric data. Therefore, the water level in pumping and observation well(s), barometric pressure, and the pumping rate are monitored frequently during the aquifer test.

3.1 Pumping Equipment

Verdad Group (Verdad) will equip the pumping well with a submersible pump, air line (for insertion of transducer and water level sounder for manual water level measurements), discharge piping, and a flow meter. The pump will be capable of pumping 50 gpm against a head of 500 feet for basin fill wells, and 20 gpm against a head of 800 feet for bedrock wells. The pump must be fitted with a check valve for the recovery test to be accurate. Verdad will provide and operate a generator to power the pump throughout the aquifer test.

Discharge from the well will be released to either areas of internal drainage for infiltration or to surface water drainage pursuant to a DGP. Verdad will install a discharge line from the pump and equip it with a flow meter in such a way that there is an appropriate length of pipe around the flow meter to avoid turbulence or backflow pressure that can interfere with it operation. The discharge line will be directed to an area of internal drainage or to the drainage identified in the DGP. The discharge line will be set up in a manner that allows periodic measurement of filling time for a graduated 50 gallon drum. Measurements of filling time will be used to calculate the flow rate and to verify flow meter measurements (Section 3.3.2).

3.2 Preparation for Aquifer Test

Preparation for the aquifer test consists of:

- Deployment of equipment for water level and barometric pressure measurement, and
- Testing the pumping system

Downhole monitoring equipment will never be installed until the pump and airline have been installed. Monitoring equipment will not be installed via the airline to depths below the base of the airline.

3.2.1 Equipment for Water Level Measurement

Water levels will be measured in the pumped well and observation well(s) using both pressure transducers and manual soundings.

3.2.1.1 Transducers

Water levels will be measured using either vented or non-vented pressure transducers. Vented transducers measure gauge pressure (water pressure minus barometric pressure) and non-vented transducers measure absolute pressure (water pressure plus barometric pressure). In-Situ LevelTROLL 700 0 to 30 psig (vented), or 0 to 30 psia (non-vented) pressure transducers, or the equivalent, will be used.

Vented transducers will be suspended in wells by a vented cable to the surface. The vented cable provides a reference barometric pressure for the transducer. For this reason, care needs to be taken not to pinch the cable. The cable also allows communication between the transducer and a laptop computer. Non-vented transducers do not have a reference pressure line nor the ability to communicate with the surface and are suspended in wells using nylon cord or light steel cable. The well casing and the cable used to suspend the selected transducer will be marked at a common location to judge whether there is any movement of the cable during the test.

The transducer in the pumped well should be set approximately 40 feet below the water table unless measurements of drawdown during development indicated a larger drawdown should be expected (Note: the 30 psig transducer has a maximum pressure rating of 69 feet of water and should not be submerged deeper than that. The 30 psia transducer should not be submerged more than about 35 feet since it responds to the sum of water pressure and atmospheric pressure). Transducers in observation wells should be suspended approximately 20 feet below the water table. This can be done by lowering the transducer until there is a reading

of submergence and then adding only the length of additional cable needed for desired depth of submergence. Alternately, the depth to water can be measured and marked on the transducer cable along with the desired depth of submergence. Then the transducer can be lowered to the mark on the cable. Either way, the depth of submergence should be recorded in the field notebook.

The transducers remain below the water table during the entire aquifer test. Drawdown at the pumping well can be estimated during development pumping. As a guide for setting transducers, drawdown in observation wells is not expected to exceed 10 feet.

Transducers need to be programmed prior to placement in the well. Programming consists of setting the clock time, measurement units, and measurement frequency. The clock time will be synchronized by setting instruments to a single time piece, the clock in the laptop computer. Table 1 summarizes the programming process. **Transducer measurements in all wells will be recorded at 30 second intervals throughout the aquifer test**. Larger measurement intervals may be needed to stay within the data storage capacity of the transducers if the monitoring period exceeds 20 days.

Vented Transducers will be checked in the field by (1) checking that the unit is powered and communicating with the laptop, and (2) checking the transducer reading by comparing it to a manual measurement of depth to groundwater (remember, the depth to water by manual measurement equals the depth of transducer submergence minus the feet of water over the

transducer). (Non-vented (absolute) pressure transducers cannot be checked once suspended in the well without removal fro the well.)

Transducers will be placed in the well 6 to 12 hours prior to the start of the aquifer test to measure regional water level trend and will be kept in the well until the end of the recovery test. For aquifer tests in which multiple wells are being tested sequentially, transducers can be maintained in the wells throughout the test period unless they need to be pulled to allow pump placement or removal. In all cases, recovery will be monitored for at least the duration of the step test pumping prior to initiation of any additional work.

In the event there are questions regarding proper operation of the transducers, communication software, or program, In-situ has customer service technicians available 24/7 for technical support.

- **In-Situ Customer Service Technicians - 1-800-446-7488**

3.2.1.2 Manual Water Level Measurement

Manual water level measurements will be made in all wells during the step and the recovery tests. The manual measurements will be used to verify transducer readings or to supplement transducer data in the event of transducer malfunction.

Manual measurements should be made with reference to a fixed measuring point established at each well. The depth to water should be measured from the measuring point to the

nearest 0.01 feet. The elevation of the measuring point above the ground surface should be measured and recorded in the field notebook. All measurements should be recorded in the field notebook with the time in hours and minutes synchronized to a single time piece. The time that pumping starts must also be recorded in the field notebook

The static (nonpumping) water level should be measured manually in each well prior to placement and removal of the transducers. Transducers will be deployed in the pumping and observation wells as soon as feasible prior to the aquifer test, preferably at least 12 hours prior to the start of the test. A water level indicator will be installed in the air line of the **pumping** well at the same time as the transducer and cable, and maintained there for the remainder of the aquifer test. A second water level indicator will be used for measurement of **observation** wells.

The schedule for manual water level measurements follows:

- **Manual water level measurements will be made in observation wells at 30 minute intervals throughout the step test.**
- **The water level in the pumped well should be measured manually at 1 minute intervals during the first 5 minutes of each step and then at 10 minute intervals for the remainder of the first two steps and during the first hour of the third step, and every 30 minutes thereafter. The manual measurement will verify transducer measurements which will be at 30-second intervals.**
- **Manual water level measurements will be collected every minute for the first 10 minutes of the recovery test, the every 10 minutes for the remainder of the first hour of the recovery test.**
- **The recovery test can run overnight without manual water level measurements, but the water level should be measured immediately the next morning.**
- **At the completion of the recovery test, water levels will be measured in all wells prior to removing any equipment from the pumped well.**

3.2.2 Barometric Pressure Measurement

Barometric pressure will be monitored during each test regardless of the type of pressure transducer used to measure water levels. A BaroTROLL absolute pressure transducer or equivalent will be used to measure barometric pressure. The BaroTROLL should be suspended in the upper 10 feet of an observation well for the duration of the test. Prior to deployment the BaroTROLL should be synchronized to the clock in the laptop so that it is also synchronized with the transducers used to measure water levels.

3.2.3 Pumping System

Prior to starting the aquifer test, the pumping system should be tested to:

- identify leaks,
- determine the maximum expected pumping rate, and
- calibrate the valve to the step test pumping rates (e.g., 15 gpm, 30 gpm, etc.).

An initial estimate of the maximum flow rate will be available from pumping for well development. The system should be pumped long enough (10 to 15 minutes) to identify and fix leaks, to verify the maximum pumping rate, and to calibrate valve opening for the step test. To calibrate the valve, determine and mark the valve opening that yields the target pumping rate for the step test. Ideally, this preliminary pumping should be completed the day before the aquifer test and the system monitored over night before the test start. If preliminary pumping must be done the day of the test, the aquifer test should not start until the pumping has been shut down for a period of time equal to the duration of the preliminary pumping to allow proper recovery.

3.3 Aquifer Test Procedure

Pumping rates will be held constant through each step of the aquifer test. Once the pump is turned on and the valve opened to the predetermined setting, do not adjust the flow rate further just begin documenting the water levels and the flow rate.

3.3.1 Aquifer Test

The general aquifer test procedure is as follows:

- Complete the preparations described in Section 3.2
- Test all transducers to verify operational status as described in Section 3.2.1.1
- Manually measure static water levels in all wells immediately prior to starting pumping
- Open the valve of the discharge line to the position for the first step

TEST STEP ONE: Record time and start pump

- Record flow meter readings as described in Section 3.3.2
- Manually measure flow rate as described in Section 3.3.2
- Manually measure water levels as described in Section 3.2.1.2
- Check vented transducers with laptop and manual water level measurement to verify operation as described in Section 3.2.1.1

TEST STEP TWO: At test time equal to 60 minutes, record time and open the valve to the position for the second step

- Record flow meter readings as described in Section 3.3.2
- Manually measure flow rate as described in Section 3.3.2
- Manually measure water levels as described in Section 3.2.1.2
- Check vented transducers with laptop and manual water level measurement to verify operation as described in Section 3.2.1.1

TEST STEP THREE: At test time equal to 120 minutes, record time and open the valve to the position for the third step

- Record flow meter readings as described in Section 3.3.2
- Manually measure flow rate as described in Section 3.3.2
- Manually measure water levels as described in Section 3.2.1.2
- Check vented transducers with laptop and manual water level measurement to verify operation as described in Section 3.2.1.1

RECOVERY TEST: At test time equal to at least 600 minutes, record time and shut down pump

- Manually measure water levels as described in Section 3.2.1.2
- Check vented transducers with laptop and manual water level measurement to verify operation as described in Section 3.2.1.1
- Download each transducer to the laptop before leaving the site for the day and immediately copy the transducer files from the laptop to a flash drive
- Continue water level monitoring when returning to the site in the morning
- At the conclusion of the recovery test, download each transducer to the laptop before leaving the site for the day and immediately copy the transducer files from the laptop to a flash drive

If field conditions dictate that the first two steps be run for longer than the times indicated, Step 3 will still be run for at least 480 minutes. The primary basis for terminating the aquifer test will be attainment of at least 40 minutes of pumping in Step 3.

3.3.2 Flow Rate Measurement

All pumping rate measurements will be recorded in the field notebook as to the hour and minute of pump startup and shutdown. The flow rate should be kept constant throughout each step of the test. Flow rates will be measured by the flow meter and manually. Manual flow measurements will used to verify the flow meter measurements. Manual flow measurements will be based on the time to fill a 50 gallon drum.

The test procedure is as follows:

- **Flow meter measurements are recorded every minute for the first 5 minutes of each step to determine flow rate stability.**
- **A manual measurement of flow rate is made after 5 minutes to verify the flow meter readings.**
- **If the flow meter reading is confirmed by the manual flow measurement, the flow meter reading will be recorded every 15 minutes thereafter and checked by manual flow measurements hourly.**
- **If the flow meter is erratic or incorrect (a greater than 15 percent difference from the manual measurements) on a consistent basis, manual flow measurements will be taken every 15 minutes.**

3.3.3 Water Quality Field Parameters During Pumping

The pH and electrical conductivity of discharge will be monitored hourly throughout the step test and prior to collection of the water quality sample (Section 3.4). The pH/conductivity meter will be calibrated at the start of each aquifer test and the calibration checked against standards daily.

3.4 Water Quality Sampling of Pumping Well

A water quality sample will be collected during or near the completion of the third step of the step test. The water sample will be filtered using a 0.45 micron filter. An unfiltered sample will be collected for analysis of sulfate only. The water sample will be shipped to ACZ Laboratories, Inc. and analyzed for the extended list of analytes (calcium, magnesium, potassium, sodium, chloride, sulfate, fluoride, nitrate, nitrite, total dissolved solids, and alkalinity). **To comply with the 48-hour holding time for the nitrate/nitrite analysis, the**

sample should be collected with sufficient time to complete chain of custody paperwork and to drop the sample off at a shipper for overnight shipment with next day delivery.

3.5 Discharge to Surface

Discharge of water to the surface is covered under the DGP. The character, duration, and water quality of the discharge are to be documented pursuant to permit specifications and the best management plan (BMP) for the permit. A copy of the BMP is in Appendix A.

Water quality sampling for the DGP consists of collecting a grab sample for analysis of oil and grease. Additionally, the DGP requires monitoring turbidity and the volume of flow.

3.6 Preliminary Equipment List

- Two water level sounders (of sufficient length to measure depths to water in target wells)
- LevelTROLL vented pressure transducers with 500-foot vent cables or absolute pressure transducers. (Recommend that only absolute transducers be used in wells with depths to water greater than 400 feet)
- BaroTROLL barometric transducer
- Laptop computer with MS Excel and WinSitu programs
- Communication cables to connect LevelTROLLS and BaroTROLL to laptop
- pH/electrical conductivity meter
- turbidity meter
- Watch or stopwatch
- 55 gallon drum with gradations
- Light tools (pliers, wrench, screwdriver)
- 100-foot measuring tape with 0.1-foot markings for measuring the transducer cable
- Light steel cable
- Nylon cord
- Notebook and pens
- Project Quality Assurance/Quality Control Plan

- Project Health and Safety Plan
- De Minimus General Permit for discharge to ground surface
- Padlocks and chain

3.7 Site Security

Whenever the site is vacated by personnel, all equipment should be removed to the maximum degree possible. Equipment that must remain at the site should be secured. This may require chaining certain equipment to an immovable object or chaining equipment together to deter easy removal. Some sites may warrant retaining a security guard for nighttime security during the aquifer test.

TABLE

TABLE 1
Using Win-situ 5

- Open program
- Highlight *Site Data*
    - Right click and choose your site name (i.e. MO-2007-1)
- Go to *File* and choose *connect*
- Synchronize clocks on using prompt on right side of screen
- Go to the *Logging* tab
    - Right click on screen below listed site names of previous tests
    - Choose *New* to bring up Set Up wizard

Setup wizard steps follow:

- Select your site from drop-down menu
- Choose a Log Name and type it into box (i.e. 1a)
- Select parameters and units to log
    - Temperature (C)
    - Depth (ft.)
- Choose a logging method
    - Fast Linear (time intervals less than one minute)
    - Start Condition = scheduled
    - Stop Condition = none
- What do you want the output to be?
    - Ground water (depth)
- Pick specific gravity value
    - Default = 0.999 when you choose ground water with a note that reads, "0.991 to 1.000 depending on temp. and EC. This value represents water at 15 C and 200 microseimens/cm.
- Summary
    - This dialog box show all of the parameters specified and asked for.
    - Click on the check mark to accept.

Note: To download data connect to troll, choose logging tab, highlight your named test and right click on it. Select download. These data will be stored in your site name file from which you can export to CSV which places it into an Excel file that shall be saved on the laptop hard drive and a removable drive.

APPENDIX F.3

QUALITY ASSURANCE PLAN FOR ACZ LABORATORIES, INC.

ACZ Laboratories, Inc.

QUALITY ASSURANCE PLAN

UNCONTROLLED

Effective Date: August 10, 2007

Authorization Signatures and Dates:

Audrey Stover 8-9-07
Audrey Stover, President/CEO

8-9-07
Matt Sowards, Production Manager

Kristen Russell 8-9-07
Kristen Russell, QA/QC Officer

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1 INTRODUCTION

ACZ Laboratories, Inc. is an environmental testing laboratory that provides data to clients primarily for regulatory purposes. Samples are analyzed for compliance with federal programs including the Resource Conservation Recovery Act (RCRA), Safe Drinking Water Act (SDWA), and Clean Water Act (CWA). Environmental compliance and management decisions are based on the analytical data provided, which are critical to the expenditure of large amounts of money; are important to public health safety; are important in evaluating, monitoring, and protecting the environment; and are often essential in litigation. To this effect, analytical data must always be technically sound, accurate, and legally defensible or it is useless to the end user.

An effective Quality Assurance and Quality Control program is the cornerstone of the generation of reliable analytical data. ACZ's Quality Assurance Plan (QAP) outlines the quality assurance and quality control objectives, policies, and procedures determined to be necessary to meet the requirements of the EPA, federal government entities, state agencies, other regulatory authorities, and our clients. This document provides the necessary guidelines to ensure all ACZ employees have sufficient knowledge and training to perform their job responsibilities in a manner that guarantees all data reported to all of our clients is accurate, reliable, technically sound, legally defensible, and impartial.

For data to be accurate, it must be of known and documented quality. The word "quality" has many different meanings, but for the purposes of environmental testing activities can be stated simply as "conformance to requirements." Conforming to requirements allows objective measurements to be applied, rather than subjective opinions, to determine when work is of good quality. *Quality control* refers to all activities that ensure accuracy (i.e. good quality) of the data. It requires action(s) to be taken and is typically included as part of the procedure. *Quality assurance* provides the records of the results obtained from the required action(s) and refers to the ability of the laboratory to demonstrate or prove to an outside party that the quality of the data is what the laboratory states it is. Quality assurance relies heavily on documentation, and to be effective, the documentation must (1) assure the quality control procedures are being implemented as required (2) assure the reported data reflect the sample as it was received, meaning sample mix-up was avoided, the sample was properly preserved prior to analysis, etc. (3) facilitate traceability of an analytical result and (4) be subjected to reasonable precautions to protect data from loss, damage, theft, and internal or external tampering.

Quality Policy Statement: To maintain an effective QA/QC program, continually improve the quality of our environmental testing services, and consistently provide clients with technically sound and legally defensible data in a timely manner, the management of ACZ recognizes the importance of its commitment to:

- Ensuring good professional practice by well-trained and qualified employees with the necessary experience and skills to carry out their organizational functions and to meet or exceed ACZ's standards for the quality and reliability of its testing services.
- Ensuring the data provided to our clients is of known and documented quality, and is accurate and impartial.
- Ensuring that all quality assurance and quality control policies and procedures are communicated to and understood by all employees, and that they are implemented by all employees in their work.
- Ensuring that all aspects of the business operations are conducted in a manner that adheres to the NELAC Standards and all of ACZ's policies and procedures documented in the QAP, SOPs, emails, memos, etc.
- Upholding the spirit and intent of ACZ's Ethics Program and implementing the requirements of the program.

2 QUALITY SYSTEM OBJECTIVES & COMPONENTS

ACZ's QAP provides a framework that guides all technical staff and administrative personnel. The information presented is necessary to ensure all employees perform their duties in a manner that allows the company to achieve its objectives, thereby ensuring the precision, accuracy, completeness, and consistency of the analytical data reported to our clients. This framework is referred to as the Quality System. The Quality System encompasses every documented quality assurance (QA) and quality control (QC) policy and procedure and guides all business functions and laboratory operations by specifying standardized protocols to control both the short-term and long-term activities that influence the quality and defensibility of our testing services.

The Quality System is designed to be appropriate to the type, range and volume of the environmental testing undertaken. The Quality System is not a static entity and must function in a manner that allows for continuous evolution of all aspects of ACZ's business when improvements have been identified and have been determined to be necessary or beneficial. ACZ management recognizes that the staff is comprised of people who possess varied experience and knowledge and can contribute valuable insight and suggestions regarding these improvements. All employees are encouraged to be involved in this process. The following six (6) key elements form the foundation of ACZ's Quality System:

- Documents & Records
- SOPs
- Training
- Audits
- Corrective Actions
- Management Review of the Quality System

2.1 Documents & Records

The entire history of any sample must be readily understood through the associated documentation. To this extent, a formal and systematic control of documents and records is necessary for accurately reconstructing all events pertaining to any sample and for guaranteeing the quality and defensibility of the data. All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities (such as sample receipt, sample preparation, data verification and data reporting) must be documented, and all records, including those pertaining to calibration and test equipment, certificates and reports, must be maintained. Documents and records must be safely stored (protected against fire, theft, loss, deterioration, and vermin), and must be held secure and in confidence to the client for a minimum of five (5) years. Refer to section 10.0 for details regarding the storage and control of ACZ's documents and records.

2.1.1 Documents

A document is a writing that contains information. All documents are reviewed for accuracy, approved for release by authorized personnel, and properly distributed. A document control system subsequently ensures that employees use only the correct and effective version of any form, Standard Operating Procedure (SOP), or other document, which are maintained through ACZ's LabWeb intranet. LabWeb is a computerized document control system based in HTML that can be accessed from any network computer within the facility. Documents can be queried by department and then organized in several ways by clicking the appropriate header. Click on the title of the document to view it as an Adobe Acrobat (*.pdf) file. The PDF has a "read only" qualifier and does not allow changes. Users may view SOPs but the documents may not be saved to another network drive and may not be printed. Forms may be viewed and printed but may not be saved to another network drive.
All documents are categorized by department and are assigned a unique document ID that is printed in either the header or footer section. The ID nomenclature starts with either SOP (procedure) or FRM (form), followed by the 2-letter department code, the unique document number, the month and year of

issue, and the revision. The effective date for any SOP or other document is included on the title page and header section of each subsequent page and indicates the implementation date.

The QA/QC Officer has full responsibility of the Document Control System. Documents can be changed, overwritten, or saved as a different document only by employees with Domain Administer computer rights (primarily IT and QA/QC staff). A new or revised document is reviewed, and following approval, the document control number is updated and the SOP or form is uploaded to Labweb. When a new version of an SOP is added to Labweb, the previous version is removed from the active list, date-stamped and electronically archived in a designated location on the network. This automatic process guarantees that ACZ can retrieve the version that was in effect at any given time. Controlled forms are not currently archived.

2.1.2 Records

A record is any information or data on a particular subject that is collected and preserved. Records are produced on a daily basis and contain original, factual information from an activity or study. For ACZ's purpose, this information may be recorded by the following means: LIMS database, logbooks, raw instrument data, worksheets, and notes (or exact copies thereof) that are necessary for the reconstruction and evaluation of the report of the activity or study. The record management system provides control of records for data reduction, validation, reporting and storage, and also provides control of all laboratory notebooks and logbooks. The system must allow for historical reconstruction of all laboratory activities that produced analytical data, must document the identity of personnel involved in sample receipt, preparation, calibration or testing, and must facilitate the retrieval of all working files and archived records for inspection and verification purposes. At a minimum, the following criteria for records must be met:

1) Instrument logbooks must be kept up-to-date on a daily basis. In general, document all relevant activities when the event occurs.

2) Dilution factors and observations must be recorded at the time they are made, and notes regarding the sample(s) or analysis must be identifiable to the specific task.

3) A detailed description of any departure from a documented procedure, and the reason for the departure, must be provided at the time it is performed.

4) All generated data must be recorded either by an automated data collection system or must be recorded directly, promptly and legibly in permanent ink (blue or black is preferred).

5) Erroneous entries (hard copy or electronic) cannot be destroyed by methods such as erasures, overwritten files or markings. Refer to section 16 for ACZ's error correction protocol.

6) Any change(s) to hard copy records must be clearly initialed and dated by the responsible staff. Changes to electronic records must also be traceable to the individual who made the change, and the reason for the change must be provided.

7) Records generated by computers must have hard copy or write-protected backup copies.

2.2 Standard Operating Procedures

A documented procedure is required for all phases of ACZ's business operations, from sample log-in through sample disposal. A Standard Operating Procedure (SOP) is a written document that details the manner in which an operation, analysis, or action is performed and thoroughly prescribes the techniques and procedures, which are the accepted process for performing certain routine or repetitive tasks. Analytical SOPs must be written with adequate detail to allow someone similarly qualified, other than the analyst(s) who routinely performs the procedure, to reproduce the procedure used to generate the test result. To the extent possible, administrative SOPs [non-technical] must include specific requirements pertaining to the process; however, the procedure itself may be a more general description so as to lend a degree of necessary flexibility to account for client requests and other circumstances, which may be outside of ACZ's control.

Proposed revisions to any test SOP must be noted on the SOP Revision Form (FRMQA030). Proper use of FRMQA030 ensures the SOP continues to include all requirements of the procedure. All procedural revisions must be reviewed and approved by QA/QC prior to implementation. Changes to provide additional clarification, correct typographical errors, etc. do not need to be approved but need to be noted on the revision form to ensure the changes are included during the next revision. Analytical SOPs must be reviewed annually using the SOP Review Form (FRMQA035), and Administrative SOPs must be reviewed regularly and revised if necessary to ensure the information is accurate and reflects current practice. Documenting changes in the controlled copy of any SOP is not permitted. Refer to section 10.5.1 for additional information on SOPs.

SOPs are proprietary documents and ACZ does not distribute them freely. Any copy sent electronically or otherwise to an outside party is considered uncontrolled, and the recipient understands that additional changes can be made without prior notification. The use of uncontrolled copies of SOPs is not permitted on site unless approved by QA/QC, and such documents will be initialed and dated by QA/QC personnel when issued.

Before a new procedure, application, or instrument can be implemented, an SOP must be developed. Following QA/QC review, an effective "working draft" will be issued to allow the user(s) to "fine-tune" the document. If a client requests a procedure for which there is not a published method or an existing SOP, ACZ will utilize the process described in the SOP *Client Service Policies and Procedures* (SOPAD043). Analytical SOPs are written in accordance with the NELAC Standards and must include or reference the following items, where applicable:

1) identification of the test method
2) summary, scope & application of the test method, including matrices & components to be analyzed
3) references, including documents provided by instrument / equipment manufacturer
4) sample collection, preservation, & storage
5) equipment & supplies
6) reagents & standards, including storage conditions & shelf-life for each
7) safety
8) interferences
9) complete procedure, including details and acceptance criteria for initial & continuing calibration
10) data review & assessment, including protocols for handling out-of-control or unacceptable data
11) quality control, including acceptance criteria & corrective action for handling failed quality control
12) calculation equations (dilution factors, RPD, % recovery, etc.) & calibration formulas
13) method detection limit & reporting limit
14) method performance, including Demonstration of Capability and Method Detection Limit procedures
15) pollution prevention & waste management
16) definitions
17) tables, diagrams, flowcharts

2.3 Training

It is the responsibility of ACZ's management to ensure the competence of all employees who perform environmental tests and other specific duties, operate equipment or instrumentation, give opinions and interpretations, evaluate

results, and sign test reports. Additionally, ACZ management is responsible for formulating the goals and policies with respect to the necessary education, training, and skills of all personnel and for providing training that is relevant to the company's present and anticipated tasks.

Employees must possess the appropriate combination of education, experience, and skills to adequately demonstrate a specific knowledge of their particular functions and to carryout those functions in a manner that meets or exceeds ACZ's standards and expectations. Additionally, each staff member must demonstrate an understanding of laboratory operations, test methods, related quality assurance and quality control procedures, and management of records and documents to the extent necessary to successfully perform their job duties.

All full-time and part-time personnel must complete a formal training process for Safety, Ethics, Quality Assurance / Quality Control, and Sexual Harassment on the first day of hire and are subsequently responsible for complying with all requirements that pertain to their organizational functions. For all technical staff, training for analytical procedures must be completed prior to independent generation of client data, including Proficiency Testing samples. In general, any staff member who is undergoing training must be provided with appropriate supervision. It is the responsibility of each supervisor or manager to ensure personnel within his or her department is supervised, competent, and is working in accordance with ACZ's Quality System.

2.3.1 Safety Training

Safety training is scheduled with ACZ's Chemical Hygiene Officer and includes viewing a video of general laboratory safety, a complete review of ACZ's Chemical Hygiene Plan, and a building tour to identify the location of Material Safety Data Sheets, emergency showers, eye wash stations, and emergency exits. Following completion of the training, the employee takes an exam, which allows the CHO to evaluate his/her understanding of the material covered.

2.3.2 Ethics Training

ACZ is committed to fostering and enforcing an ethically sound work environment that encourages the conscientious production of accurate, technically sound and legally defensible data. Initial and follow-up ethics training is required for all full-time and part-time employees (permanent or temporary) as described in ACZ's SOP *Ethics and Proactive Prevention Program* (SOPAD039). Initial training provides a general introduction to ACZ's Ethics program, ACZ's Code of Conduct, Code of Ethics, and zero-tolerance policy. Each new employee is also introduced to the company's Ombudsman. Follow-up training is provided within 30 – 60 days and includes a more in-depth review of unacceptable practices. The employee is required to read SOPAD039 prior to attending the session. On an annual basis, a review of SOPAD039 and exercises in making ethical decisions, as well as other relevant information, are presented to all employees.

2.3.3 QA/QC Training

2.3.3.1 All full-time and part-time employees attend an initial orientation session, which is based on the most current version of ACZ's Quality Assurance Plan [QAP] and focuses on the relationship between quality control, quality assurance, environmental testing, and environmental monitoring.

2.3.3.2 Follow-up training is completed within 30 – 60 days and includes a more detailed review and discussion of QA/QC policies and procedures. By this time, employees are expected to be familiar with their responsibilities and have a general understanding of ACZ's operations. The employee must read ACZ's QAP and any pertinent supporting SOPs prior to attending the training, and should prepare questions in advance, as material in each document will be reviewed and an opportunity to seek clarification will be provided. The supervisor must schedule sufficient time for the employee to read all pertinent documents prior to follow-up training.

2.3.3.3 A performance review will be conducted for a new employee after 90 days from the hire date. The review is conducted by the supervisor and is based on general work performance, supervisor observations, and feedback from the QA/QC department.

2.3.4 Sexual Harassment Training

Sexual Harassment training is required for each new employee and includes viewing a video that demonstrates the identification, reporting, and remediation of harassment issues in the work place.

2.3.5 Technical personnel must be thoroughly trained in the analytical techniques and operating principles for all pertinent method procedures. Under no circumstances may any analyst independently generate or review client data for a test procedure before completing the required training and receiving the explicit approval of the QA/QC department. Section 5 provides details of ACZ's technical training program.

2.3.6 An employee performing only data AREV or SREV functions must be appropriately trained regarding QC requirements, corrective action(s), and data qualification criteria stated in the effective version of the test SOP. The trainee must first read the SOP, and then review all pertinent information with the department supervisor. Items covered during training must be documented using the appropriate form, and both the supervisor and the trainee must sign the form. Thereafter, the effective version of the test SOP must always be used for data review.

2.3.7 Continuing training must be documented and at a minimum, the documentation must certify that the employee has read, understands, and agrees to follow the effective version of a revised SOP or other in-house document. The department manager is required to meet with their staff to review the change(s) and to ensure each employee fully understands the change(s). Training is documented using either FRMQA023 or FRMQA030, whichever is most appropriate.

2.3.8 Training is required for all employees whose activities are affected by any procedural change(s) to an SOP and is considered to be complete once the department supervisor has reviewed the change(s) with all staff members and each employee has subsequently initialed and dated the changed item(s) on the SOP Revision form (FRMQA030). Alternatively, if the revisions have been incorporated into a new effective version of the SOP then training is documented using FRMQA023.

2.3.9 ACZ recognizes the benefit of continuing education and encourages employee participation in advanced training courses, seminars, and professional organizations and meetings.

2.4 Audits

The purpose of any audit is to verify performance and compliance to documented Quality Assurance and Quality Control policies and procedures, and to identify discrepancies when they exist. In the latter case, any problems must be addressed and resolved in an appropriate manner in order to assure the Quality System is continuously improved on all levels.

2.4.1 External Audits

External audits are conducted to ascertain compliance with rules, regulations, and additional criteria for certification, and will have a higher degree of formality than internal audits. Where mandatory records are required, compliance with such will be critically evaluated. The search for any corrective actions and the correction of problems identified in a previous audit will also be an important activity. The ease with which important records and information can be retrieved is a criterion for judgment of the management practices of a laboratory and may dictate the depth of the audit. Individual state agencies, its NELAC Primary Accrediting Authority, and current and potential clients typically audit ACZ.

The on-site assessment is generally a two to four day process during which the regulating agency conducts an entrance interview and tours the facility before performing an in-depth review of documents, workgroups, reports, electronic data files, etc. A critical aspect of the on-site assessment is review and verification of bench-level documentation and analyst interviews to determine actual laboratory practices. It is ACZ's policy to always have QA/QC personnel present during an interview. If necessary, the President or Production Manager may attend the interview. An exit interview is conducted upon completion of all on-site assessment activates, during which observations and findings are reviewed. The agency will submit a final report to ACZ, generally within 30 days, detailing all pertinent findings and recommendations.

Upon receipt and review of the agency's report, the QA/QC department will meet with each department manager to develop a corrective action plan, which must be submitted to the agency by the date indicated in their report. Each finding is addressed as a major corrective action as described in section 2.5.2. Employees may not make changes to any laboratory or other practice based on comments or opinions expressed by the regulating agency during an interview or any other stage of the on-site assessment. ACZ will revise polices and procedures as necessary upon completion of the major corrective action process. The audit report and all subsequent corrective actions are thoroughly documented, and all documentation is retained for at least five (5) years.

2.4.2 Internal Audits

ACZ is responsible for the quality of its data and must take reasonable efforts to assure itself and all interested parties of the confidence that can be placed in it. To this extent, internal audits of its activities must be conducted to verify continued compliance with the Quality System. It is the responsibility of the QA/QC Officer to plan, direct, and organize internal audits; however, a trained and qualified individual, independent from the area or system being audited, may be designated by the QA/QC Officer to conduct an internal audit. The area of activity audited, the audit findings, and subsequent corrective actions must be documented, and all documentation must be retained for at least five (5) years.

Whenever any internal audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the test results, timely corrective action must be taken, and the client(s) must be notified in writing, as soon as the extent of the problem can be determined, if investigations show that the laboratory results may have been affected.

At a minimum, internal audits are conducted for the following departments. Method audits performed for all analytical departments listed below encompass both qualitative evaluation of the operational details of the QA/QC program and quantitative evaluation of the accuracy of data generated by the laboratory staff. These evaluations do not include the real-time review of laboratory raw data or final reports for routine quality control sample verification.

- Log-In
- Reporting
- Wet Chemistry Manual
- Wet Chemistry Instrument (Prep and Analytical)
- Inorganic Instrument
- Inorganic Metals Prep
- Soils
- Radiochemistry (Prep and Analytical)
- Organics (Prep and Analytical)

More frequent internal audits may be scheduled depending on the following criteria:

- Number and type of corrective actions filed for a method or activity
- Client complaints
- Continued failure to achieve acceptable results for a Proficiency Testing sample
- Findings from an external audit
- Request from management

All findings from internal audits are directed through ACZ's corrective action system. Each finding is assigned a corrective action number (similar findings may be combined). A general description of the process is as follows:

1) Findings and observations are summarized in a memo.

2) The memo is distributed to the department supervisor, Production Manager, and President.

3) The supervisor reviews the memo with their staff and develops a response for each finding.

4) The supervisor informs the QA/QC Officer of all resolutions and expected implementation date(s) within two (2) weeks from the date indicated in the memo.

Additionally, an in-depth review will be conducted if there is any evidence of inappropriate actions or vulnerabilities related to data integrity. This review shall be handled in a confidential manner until a follow up evaluation, full investigation, or other appropriate actions have been completed and the issue(s) clarified. Refer to ACZ's SOP *Ethics and Proactive Prevention Program* (SOPAD039). All documentation related to the investigation must be maintained for at least five (5) years.

2.4.3 Electronic Data Audits

Periodically ACZ hires a third party auditing firm to perform a full level audit of analytical data, either on-site or off-site. The auditing firm provides ACZ management with a report citing the deficiencies and recommendations. After review of these findings by management, the QA/QC Officer, and the production supervisor, corrective actions are initiated to ensure that any deficiencies are rectified.

2.4.4 Proficiency Testing [PT] Program

ACZ is required to participate in a formal Proficiency Testing Program at the frequency stipulated by regulating agencies. These "performance audits" are facilitated through the introduction of blind samples, purchased from approved vendors. ACZ analyzes PT samples for most accredited parameters twice in a calendar year, with each study being approximately six (6) months apart. These tests are analyte, matrix, and technology specific, but are not method specific, and provide useful information regarding the accuracy of the analytical data being produced. ACZ participates in the Water Supply (WS) study for SDWA, the Water Pollution (WP) study for CWA, the Soil and Underground Storage Tank studies for RCRA, and Radiochemistry PT study for Drinking Water.

Following log-in, the PT sample is prepared by the analyst according to the vendor's instructions and is then analyzed in the same manner as client samples as described by the test SOP. **NOTE:** Analysts must record the date of preparation (and time of preparation if the holding time is $\leq$ 72 hours) on the subsample container and on the associated workgroup bench sheet(s). Analysis must be performed as soon as possible after diluting the concentrate, as indicated in the vendor's instruction pamphlet. Metals analyses must be completed within 48 hours of diluting the concentrate, as indicated in ACZ CAR519.

Data is compiled by the QA/QC department and reported to the vendor no later than the study close date. The vendor evaluates the data as "acceptable," "not acceptable," or "check for error" by comparing the reported values to statistically derived acceptance criteria and issues a report within 21 days from the study close date. Upon receipt of the report, the QA/QC department initiates a major corrective action for the PT study if any "not acceptable" results were reported. Each production supervisor must investigate all "not acceptable" results for their department, indicate possible causes and determine the appropriate corrective action(s) by the designated due date. If necessary, the QA/QC department will order follow-up samples to confirm the system deficiency has been corrected. Refer to ACZ's SOP *Proficiency Testing Program* (SOPAD011) for additional information.

Strict rules apply regarding the exchange of information for any PT sample:

- ACZ shall not send any PT sample, or a portion of a PT sample for accrediting purposes to another laboratory for any analysis.
- ACZ shall not knowingly accept any PT sample or a portion of a PT sample for accrediting purposes from any other laboratory.
- Employees of ACZ shall not discuss PT data results with any other person outside of the laboratory, in particular any person associated with another laboratory.
- Employees of ACZ shall not attempt to obtain the results or assigned values of any PT sample from our PT Provider prior to the close of the study.

2.5 Corrective Action

When any problem, deviation or failure is identified within the Quality System or when any change is made to a previously documented company-wide protocol, a corrective action must be initiated. Corrective actions are a fundamental element of ACZ's QA/QC Program, as a successful Quality System requires the identification of deficiencies and depends on the development, implementation, and documentation of effective contingency plans and resolutions to effectively address the deficiencies.

Problems can ordinarily be classified two ways: 1) undesirable but not critical or 2) critical and requiring immediate action. To this extent, ACZ utilizes two types of corrective actions: Minor and Major. A minor corrective action pertains to any temporary deviation from a policy or procedure and may be initiated by any employee in order to resolve an immediate problem that is isolated or may impact only one workgroup or several related workgroups. Minor corrective actions do not require QA/QC follow-up. Major corrective actions address system-wide errors or failures and require the root cause(s) of the error or failure to be determined and the resolution to be documented and implemented.

2.5.1 Minor Corrective Action

The minor corrective action report (FRMQA001) allows for complete documentation of any temporary deviation from the SOP or other protocol. The employee who initiates the corrective action will complete Section 1 of the report. Documentation must be accurate and must provide a complete detailed explanation of the situation for future reference. The department supervisor should always be informed of the need for a minor corrective action and may provide additional information in the appropriate section. The project manager may also provide additional information in the appropriate section if necessary. QA/QC does not need to close a minor corrective action; however, the employee may review the report with QA/QC personnel and request their signature in the appropriate section.

Complete documentation may be provided either on the workgroup bench sheet or on the data review checklist in lieu of using FRMQA001 if the deviation applies to a limited number of workgroups. Use FRMQA001 if the deviation applies to many workgroups and attach a copy of the completed form to each workgroup before the workgroup is scanned. If the report is generated after the workgroups have been scanned, then the workgroup must be retrieved and rescanned with the report include as part of the data package. In this case, a note is made on the front page of the workgroup package indicating the reason the workgroup was rescanned (i.e. "CAR attached, WG rescanned"). If appropriate, a minor corrective action will be addressed in the case narrative of the client report.

2.5.2 Major Corrective Action

It is the responsibility of the QA/QC Officer to notify laboratory management in writing of departures from the Quality System, and it is the responsibility of the laboratory management to ensure that any corrective action that arises is discharged within the time frame indicated on the corrective action report, or additional communication must be provided to the QA/QC Officer (see item 3 below).

A major corrective action is initiated whenever a system failure has been identified or whenever an audit finding or other circumstance casts doubt on the correctness or validity of the analysis result(s). The client must be notified in writing if their work is affected. The QA/QC department will work with the Project Manager to determine if a revised report must be issued to the client. See ACZ's SOP *Client Service Policies and Procedure* (SOPAD043) for details. A major corrective action may also be initiated when the need for preventive action has been identified (refer to section 2.5.4).
Only QA/QC department personnel may open and close a major corrective action. When opened, the corrective action will be assigned a unique tracking number (referred to as the CAR number) to ensure that ACZ maintains a complete and accessible record of all Quality System deviations or failures, root cause determinations and subsequent resolutions, and preventive actions. All associated documentation must be retained for at least five (5) years as described in Section 10.

Other examples of circumstances requiring a major corrective action include, but are not limited to:

- Contamination trends as indicated by blanks routinely above acceptable levels
- Spikes, surrogates and lab control samples continually outside acceptance limits
- Change to the MDL and/or PQL (RL) for a procedure
- Client inquiries about data anomalies
- "Not Acceptable" Proficiency Testing results
- Results of internal or external audits
- Discrepancies observed at any stage of data review or reporting
- Using expired receivables
- Hold times or deadlines routinely missed
- Evidence of insufficient or inadequate training

Following initiation, the procedure for a major corrective action proceeds to an investigation by the assigned individual to determine the root cause of the problem and to identify possible resolutions to rectify the problem. The action(s) most likely to eliminate the problem and prevent recurrence of the problem must be selected, documented and implemented, and pertinent staff members must be trained, if necessary. Changes resulting from the corrective action will be monitored, if necessary, to ensure the resolution(s) are shown to be effective. A general outline of the procedure is as follows:

1) Initiation: Any employee may initiate a corrective action by notifying QA/QC. The department manager should always be notified first of any problem and then inform QA/QC. If determined to be necessary, QA/QC personnel will open a corrective action and assign a unique tracking number.

2) Assignment: QA/QC assigns the corrective action to the person(s) responsible for performing the "root cause" determination.

3) Investigation and Action: Must be completed within two (2) weeks from the date the corrective action was initiated. The need for an extension must be communicated to the QA/QC department.

    a. The assigned individual(s) perform a "root cause" determination to identify the suspected cause(s) of the problem.

    b. A resolution to correct the problem and prevent its reoccurrence must be determined, and the estimated date by which the resolution will be completed and implemented must be indicated in the appropriate section of the form. Resolution may be done solely by the person(s) who investigated the root cause or it may require input from one or more additional departments.

4) Project Manager Review: If necessary, the PM will determine whether affected data will be accepted or rejected, contact the client, and reissue a revised report if necessary. Project Manager review may not be required for every major corrective action.

5) Conduct additional training if necessary. Training must be documented using the appropriate form and must include a description provided by the person who conducts the training. All trainees are required to sign and date the form to acknowledge he/she has received training, understands the change(s) and agrees to adhere to any change(s) in a policy or procedure.

6) Revise SOP(s). Proposed revisions must be documented on the SOP Revision form (FRMQA030) and approved by QA/QC before trained personnel initial / date and implement the changes. Use FRMQA023 if the changes are incorporated into the SOP and a new effective version is issued.

7) Submit all supporting documentation to QA/QC to be attached to the hard copy of the report.

8) QA/QC reviews the corrective action. If satisfactory, the corrective action is closed and the implementation date is documented in the space provided.

9) If necessary, QA/QC conducts follow-up within two (2) weeks from the implementation date. If the corrective action is determined to be ineffective, then a new major corrective action will be initiated and the process repeated.

2.5.3 Technical Corrective Actions

Technical corrective actions apply to departures or deviations from the quality control parameters stated in individual test SOPs. Each test SOP must include all required quality control that applies to the procedure (as stipulated by the method and other regulatory agencies) as well as the performance frequency, acceptance criteria and corrective action for handling failed quality control measurements. Each SOP must describe the procedures to be followed for reviewing and assessing data, including corrective action for handling out-of-control or unacceptable data. The required protocol for technical corrective actions is summarized below. ACZ's protocols are included within the [ ].

1) identify the individual responsible for assessing each nonconformance and initiating or recommending corrective action [analyst who performs AREV]

2) define how the analyst must treat data if associated quality control measurements are unacceptable [section 12 of SOP]

3) specify how non-conformance and subsequent corrective actions are to be documented [data review checklist]

4) specify how management reviews the corrective actions [reviewed during SREV]

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control then the corrective action described in the SOP must be performed. Alternatively, report data with the appropriate qualifier if reprocessing and reanalysis is not possible. The qualifier must be assigned to any sample(s) associated with the failed quality control measure. A current list of all extended qualifiers is available in the LIMS database and may be accessed by all employees.

2.5.4 Preventive Action

Preventive action is a pro-active process to identify opportunities for improvement rather than reacting to the identification of problems or complaints. Needed improvements and potential source(s) of any

nonconformance, either technical or concerning the Quality System, must be identified and addressed. Examples of preventive action include but are not limited to: maintaining a cross-trained staff; maintaining a supply of spare consumable parts; monitoring the performance of support equipment; performing routine maintenance on instruments; maintaining an adequate supply of standards/reagents; ordering supplies before running out; completing log-in review in a timely manner; ensuring ACZ can perform work before samples are accepted; correcting quotes before samples are logged in; and analyzing samples by the appropriate method.

2.6 Management Review of the Quality System

At least once per calendar year, ACZ's management conducts a review of its Quality System and all activities related to its environmental testing services to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. At a minimum, the review must take the following into account:

- Status, review, and discussion of major corrective actions
- Results of recent PT studies and corrective actions initiated / completed
- Review of recent external audits
- Review of internal audits
- Presentation of ideas to improve efficiency and productivity
- Presentation of ideas to improve service and data quality
- Status of state certifications
- Feedback from clients
- Feedback from employees
- Ethics Program
- Ombudsman
- Changes in the volume and type of work undertaken
- Other pertinent issues

2.6.1 Department Reports

Each department manager completes a Department Report (FRMQA041) prior to the Management Review meeting. Each item on the report is to be evaluated as it pertains to the individual department. FRMQA041 is provided in Appendix D.

2.6.2 Management Review Report

The completed department reports are submitted to ACZ's President by the specified due date, and the information from each report is reviewed and compiled to complete the Management Review Report (FRMQA042). A copy of the completed report is issued to each manager in advance of the Management Review meeting. At a date / time specified by the President, all managers meet as a group to discuss the report. Other formats may be utilized at the President's discretion. All reviews will be appropriately documented and all documentation retained for at least five (5) years as described in section 10 (Control & Storage of Records & Documents). FRMQA042 is provided in Appendix D.

3 ETHICAL AND LEGAL RESPONSIBILITY

All ACZ employees have an ethical and legal responsibility to produce data that is accurate, reliable, and legally defensible. ACZ's proactive program for the prevention and detection of improper, unethical or illegal actions includes the implementation in 2002 of an Ombudsman who acts as a neutral party and serves as a confidential liaison between ACZ employees and upper management regarding questions, problems, complaints, suggestions, or ethical dilemmas.

All employees are educated with regards to ACZ's Code of Conduct and Code of Ethics as well as ACZ's zero-tolerance policy, which is strictly enforced. Additionally, employees are informed about the processes in place to ensure employees are free from any undue internal or external commercial, financial or other pressures that may adversely effect the quality of an employee's work, endanger the trust in the independence of ACZ's judgment, or compromise the integrity of ACZ's environmental testing activities. A more detailed description of all aspects of the ethics program is provided in ACZ's SOP *Ethics and Proactive Prevention Program* (SOPAD039).

ACZ will not tolerate any unethical or improper activities or behavior. Violation of company policies may lead to repercussions ranging from a severe reprimand to termination, and possible criminal prosecution if warranted by the situation. ACZ has access to many resources that may be utilized at any time to help clarify any situation determined to be a "gray area." Employees are strongly encouraged to seek further guidance from a supervisor, ACZ's Ombudsman, President or QA/QC staff whenever doubt is raised. Activities that will not be tolerated include, but are not limited to:

- **Misrepresentation of a procedure or documentation** – Intentionally performing a job duty in a manner that does not comply with a documented procedure, including but not limited to a test SOP or method used for sample analysis; providing inaccurate and misleading documentation associated with a data package or failing to provide the necessary documentation as part of a data package.

- **Falsifying Records** – Providing false information on personal credentials, resumes or educational transcripts, logbooks, raw data and client reports, or creating data without performing the procedure (also known as dry labbing).

- **Improper peak integration** – Intentionally performing improper integration of data chromatograms so quality control samples meet acceptance criteria. This is also known as peak shaving or peak enhancing.

- **Improper clock setting** – Readjusting the computer clock so that it appears samples were analyzed within hold times.

- **Improper representation of Quality Control samples** – Failing to treat batch quality control samples in the same manner as client samples (including Proficiency Testing samples) or misrepresenting any type of quality control sample associated with the preparation batch and/or analytical batch.

- **Improper calibration** – Intentionally performing improper manipulation of calibration data or forging tune data so that it meets acceptance criteria.

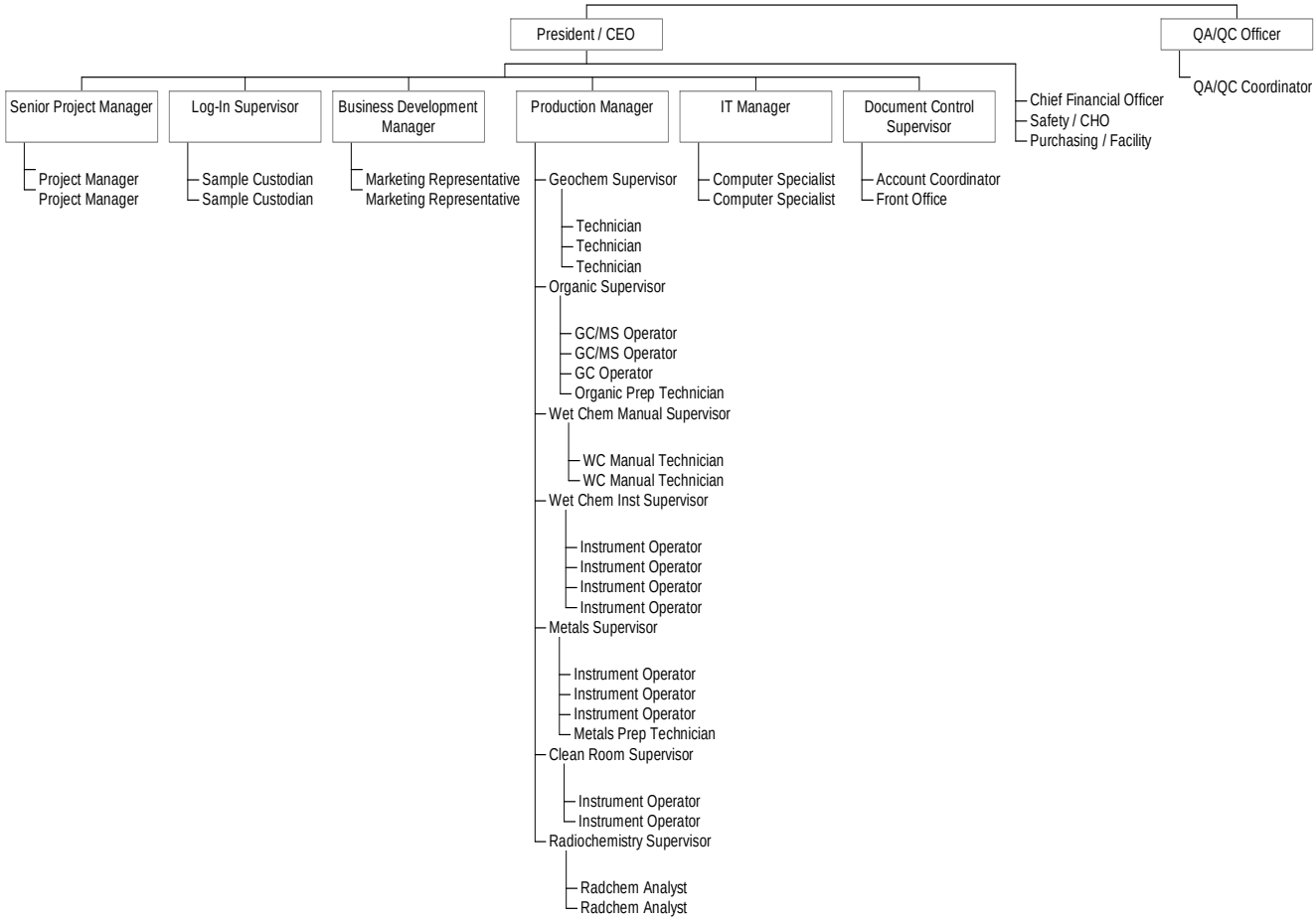
- **File Substitution** – Replacing invalid data with valid data from a different time so the analysis appears to be successful.

4 PERSONNEL AND RESPONSIBILITIES

Due to the nature of regulatory oversight and the increasing demands of the environmental lab industry, QA/QC issues permeate all aspects of our business, the largest and most critical of which are operations (production). On a daily basis, QA/QC and Production must efficiently function together to consistently provide our clients with technically sound and legally defensible data and to ensure the Quality System remains an integral part of all areas within ACZ. The President must rely on regular input and feedback from ACZ's QA/QC Officer and Production Manager, and to this effect, upper management is defined as ACZ's President, QA/QC Officer and Production Manager. It is the responsibility of upper management to document company policies, objectives, systems, programs, procedures, and instructions to the extent necessary to assure the quality and defensibility of all data.

ACZ is organized such that the President also works directly with and relies on input and feedback from the Senior Project Manager, Business Development Manager, Production Supervisors, Document Control Supervisor, IT Manager, Chief Financial Officer, and Chemical Hygiene Officer. These individuals are responsible for managing both the day-to-day operations and long-term goals within their respective areas. It is the responsibility of all managers to ensure that all documented ACZ policies and procedures, including those in the QAP and associated SOPs, are communicated to, understood by, made available to, and implemented by ACZ personnel.

Figure 4-1. Employee Organizational Chart



4.1 President/CEO

The President is ultimately responsible for all analytical and operational activities of the laboratory and must ensure that 1) the laboratory carries out all environmental activities in such a way as to meet the requirements of the NELAC Standards and 2) the laboratory satisfies the needs of the client and the regulatory authorities. General duties involve budgeting for all departments, making decisions on capital equipment and automation; developing company policies and benefits; addressing personnel issues such as hiring, firing, and promotions; and working with clients on various matters. Day-to-day responsibilities include providing direction to all laboratory departments including laboratory operations, accounting, marketing, QA/QC, and client services. Additional responsibilities are as follows:

- Work directly with ACZ's Ombudsman to provide and maintain a mechanism for confidential reporting of ethical/data integrity issues as well as issues that may directly affect current ACZ policies.
- Define the minimal level of qualification, experience, and skills necessary for all laboratory positions.
- Provide the QA/QC Officer with defined responsibility and authority for ensuring the successful development, implementation, and management of ACZ's Quality System.
- Provide the Production Manager with defined responsibility and authority for ensuring the technical operations and provision of resources needed to maintain the required quality of laboratory operations.
- Provide adequate supervision of environmental staff by persons familiar with methods and procedures, purpose of each test, and assessment of the test results.
- Ensure all technical staff has demonstrated capability in the activities for which they are responsible and ensure that the training of each member of the technical staff is kept up-to-date.
- Ensure the QA/QC Officer has access to the highest level of management at which decisions are made on laboratory policy or resources.
- Provide managerial staff the authority and resources needed to discharge their duties.
- Provide technical personnel the resources needed to discharge their duties.
- Specify and document the responsibility, authority, and interrelationship of all personnel who manage, perform or verify work affecting the quality of calibrations and tests.
- Implement appropriate and current guidelines for all lab methods and procedures to ensure data quality and efficiency of analyses. Ensure all method protocols utilized by ACZ meet the QC requirements as established by EPA or other governing agency.
- Document all policies and procedures related to the analytical and operational activities of the laboratory.
- Provide support to technical staff to ensure timely completion of all laboratory work, and develop contingency plans to ensure workflow progresses as planned.
- Meet quarterly (or more often) with the QA/QC Officer and Production Manager.

4.2 QA/QC Officer

The QA/QC Officer reports directly to the President; however, the QA/QC department is considered a separate entity from operations in order to assure data is evaluated objectively and assessments are performed without outside (i.e. managerial) influence. The QA/QC Officer has direct access to the President, and is therefore able to discuss and/or resolve all concerns, policies, etc. related to quality assurance or quality control. The primary responsibility of the QA/QC Officer is to develop, implement, and manage all aspects of ACZ's Quality System, and he/she may take any action necessary to ensure all ACZ employees adhere to all policies, procedures, and objectives documented in ACZ's QAP, SOPs, memorandums, emails, etc. If warranted, the QA/QC Officer has the authority to halt the performance of a single method or the production of a department, and if necessary, the operations of the entire laboratory, and will grant permission to resume when satisfied that the issue(s) have been resolved. Additional responsibilities include but are not limited to those stated in FRMAD060 and the following:

- Review and revise ACZ's QAP and provide training for all employees following approval of a new version.
- Provide QA/QC orientation to new employees.
- Meet quarterly (or more often) with the President and Production Manager.
- Work with department managers to develop and improve training protocols.
- Conduct department training sessions as needed to address specific problems and questions.
- Arrange for or conduct internal audits; notify management of deficiencies; and track corrective actions.
- Organize all external audits; notify management of deficiencies; and assign and track corrective actions.
- Review and approve SOPs (may designate responsibilities to QA/QC Coordinator).
- Meet at least quarterly with Production Supervisors to provide information, respond to questions, etc.
- Manage Proficiency Testing (PT) program (may designate responsibilities to QA/QC Coordinator).
- Coordinate and maintain all regulatory and client certification programs.
- Review and validate a determined percentage of all data packages from Log-in to Reporting.
- Work with marketing/client service representatives on QA/QC aspects of proposals.
- Work with Project Managers and the Production Manager to resolve client feedback regarding data quality.
- Review and maintain records and documentation for audits, certifications and all other QA/QC issues.
- Schedule electronic data audits with third-party.

  <u>Qualifications:</u>

  - General knowledge of the analytical test methods
  - Documented training and/or experience in QA/QC procedures
  - Knowledge of the Quality System as defined under NELAC

4.3 QA/QC Coordinator

The QA/QC Coordinator reports directly to the QA/QC Officer and assists the QA/QC Officer with the development, implementation, and management of the Quality System. Primary job responsibilities are as follows:

- Review and maintain records/documentation for employee training including DOCs, MDLs, etc.
- Provide initial QA/QC orientation to new employees.
- Provide follow-up QA/QC training to new employees.
- Schedule analyses and compile and report data for Proficiency Testing (PT) program, including DMRQA.
- Initiate and track corrective actions related to PT samples and manage all documentation associated with analyses.
- Review and approve SOPs.
- Conduct internal audits, notify management of deficiencies; and track corrective actions.
- Conduct department training sessions as needed to address specific problems and questions.
- Update control chart-generated QC limits in the LIMS database as needed.

Qualifications:

- General knowledge of the analytical test methods
- Documented training and/or experience in QA/QC procedures
- Knowledge of the Quality System as defined under NELAC

4.4 Production Manager

The Production Manager reports directly to the President. General duties involve working with analytical department supervisors on a daily basis to prioritize client projects and QA/QC deadlines and to track sample analyses in order to maintain acceptable turn-around-times for project completion. The Production Manager also addresses personnel, instrumentation, and reagent/supply issues that may affect the completion of the scheduled work and works directly with the QA/QC department to ensure all Quality System requirements pertaining to production are successfully completed in a timely manner. Additional responsibilities are described in FRMAD060.

- Conduct weekly meeting with Production Supervisors to discuss current and upcoming workload, scheduling, priority projects, QC requirements, instrument / equipment issues, personnel, etc.
- Schedule QA/QC work (MDL studies, DOCs, PT sample analysis, SOP revisions, etc.) with department supervisors in order to ensure QA/QC requirements are kept up-to-date.
- Meet at least quarterly with the President and QA/QC Officer.
- Communicate with Project Managers regarding project/instrument status. Notify PMs if problems exist that may affect the project completion date.
- Work with marketing/client service representatives on production aspects of proposals.
- Work with Project Managers and the QA/QC Officer to resolve client feedback regarding data quality.
- Perform checks of sample status using LIMS database to help the laboratory staff meet all established hold times and to determine that analyses can proceed as scheduled to meet required turn around times.
- Provide hands-on support to analysts when necessary to ensure timely completion of all laboratory work, and develop contingency plans to ensure workflow progresses as planned.
- Work with QA/QC Officer to develop and improve training protocols, conduct department work sessions to address specific problems and questions.

  Qualifications:

  - General knowledge of the analytical test methods
  - Minimum four (4) years of laboratory experience
  - Minimum two (2) years of supervisory experience
  - General knowledge of lab-wide systems (including but not limited to log-in and reporting)

4.5 Production Supervisor

Each Production Supervisor is a full-time employee who reports to the Production Manager and exercises day-to-day oversight of laboratory operations for their specific area(s) of expertise. Each supervisor must be familiar with the test methods and related theory and instrumentation, as well as the assessment of results. In addition to monitoring the standards of performance, validity of all analyses, and quality of all data generated in their respective department(s), each supervisor is also responsible for ensuring that a new analyst has successfully completed all training requirements and is adequately prepared to commence work on client samples. Additional responsibilities are described in FRMAD060. If any supervisor is absent for more than 15 consecutive calendar days then another full-time staff member meeting the required qualifications will be assigned to perform the supervisor's duties.

Required Qualifications for a Production Supervisor:

1) Chemical analyses (Organics & Metals): BS or BA in chemical, environmental, biological sciences, physical sciences or engineering, with a minimum of 24 college semester credit hours in chemistry and at least two (2) years of experience in the environmental analysis of representative inorganic and organic analytes for the which the laboratory seeks or maintains accreditation. A masters or doctoral degree in one of the above disciplines may be substituted for one (1) year of experience.

2) Inorganic Chemical analyses (other than Metals): At least an earned associate's degree in the chemical, physical, or environmental sciences, or two (2) years of equivalent and successful college education, with a minimum of 16 college semester credit hours in chemistry and at least two (2) years of experience performing such analyses.

3) Radiological analyses: BS or BA in chemistry, physics, or engineering, with at least 24 college semester credit hours in chemistry and at least two (2) years of experience in the radiological analyses of environmental samples. A masters or doctoral degree may be substituted for one (1) year of experience.

4.6 Business Development Manager

ACZ's Business Development Manager reports directly to the President and supervises all Client Service Representatives, each of who conducts marketing and sales efforts on behalf of ACZ with potential, new and existing clientele, and develops and maintains long-term relationships with customers by working with Project Managers when necessary. Additional responsibilities of the Business Development Manager are described in FRMAD060. ACZ's Client Service staff is authorized to review all contractual agreements with clients, review all proposals and develop price quotations for routine and non-routine analytical projects.

4.7 Project Manager (PM)

The Senior Project Manager reports directly to the President and is responsible for overseeing the PM department. Additional responsibilities of the Senior PM are described in FRMAD060. Each Project Manager serves as the primary laboratory contact for each ACZ client, handles all client service requests, and investigates and resolves any problem brought to ACZ's attention by the customer. In order to provide consistency, each PM is assigned a list of clients, and it is the primary responsibility of each PM to ensure all of their client project needs are managed on a day-to-day basis and met in a timely manner and that all data submitted to the client is of high quality. All PMs work directly with the Production Manager and Production Supervisors regarding client data issues (due dates, hold times, retests, data quality, etc.), with Document Control regarding client reports and with the QA/QC department regarding data quality questions or concerns.

4.8 Instrument Operator

Instrument operators report directly to the respective Production Supervisor. The position involves the analysis of various matrices for trace level contaminants using specialized and technical instrumentation, and each operator must be capable of performing all job duties in an accurate and proficient manner. Education will be verified by providing a copy of a college transcript or diploma, which is maintained in the employee's personnel file. Experience is verified by ACZ's CFO prior to completing the hiring process (verbal or documented verification provided by each reference listed on a resume or application is acceptable). The operator must demonstrate understanding of related theory, mathematics, analytical instrumentation and data interpretation. This work is predominantly intellectual and involves the continuous use of professional and sound judgment. The employee must meet or exceed all requirements for generation of litigation-quality data and must also continue to demonstrate increased proficiency regarding the interpretation of the data as well as the operation and troubleshooting of the assigned instrument(s). These improvements should be attainable through ongoing efforts in-house as well as through specialized instruction at off-site locations. Prerequisites regarding education and experience, as well as job responsibilities and performance expectations are described in FRMAD059. Exceptions pertaining to experience or education will be made on a case-by-case basis.

Qualifications:

- BA or BS in Chemistry or related science or a minimum of 3 years of relevant experience in lieu of degree
- Prior laboratory experience is preferred but is not required.
- Successful completion of training by supervisor or proficient instrument operator

4.8.1 Laboratory Analyst [Technician]

The laboratory technician reports directly to the respective Production Supervisor. The position involves analysis of various matrices using appropriate analytical techniques and support equipment as well as preparation of samples for instrument analyses. Each technician must be capable of performing all job duties in an accurate and proficient manner. Education will be verified by providing a copy of a college transcript or diploma, which is maintained in the employee's personnel file. Experience is verified by ACZ's CFO prior to completing the hiring process (verbal or documented verification provided by each reference listed on a resume or application is acceptable). The technician must demonstrate understanding of related principles and mathematics, must possess common sense and mechanical skills, and must seek professional judgment from the supervisor as necessary. The employee must meet or exceed all requirements for generation of litigation-quality data as well as sample preparation tasks and routine analyses, and must also continue to demonstrate continuous improvements. These improvements should be attainable through ongoing training efforts in-house as well as through training opportunities at off-site locations. Prerequisites regarding education and experience, as well as job responsibilities and performance expectations are described in FRMAD058. Exceptions pertaining to experience or education will be made on a case-by-case basis.

Qualifications:

- BA or BS in Chemistry or related science is preferred but is not required
- Prior laboratory experience is preferred but is not required
- Successful completion of training period by supervisor or proficient technician

4.9 Information Technology (IT) Manager

The Information Systems Manager reports directly to the President and is responsible for the oversight of the IT department regarding the installation and maintenance of ACZ's computer network and all hardware and software and related equipment deployed on the premise. Additional responsibilities are described in FRMAD060. The department is also responsible for developing, maintaining, and improving custom written applications for laboratory automation and efficiency as well as for ACZ's Oracle database, Intranet (Labweb), Internet and electronic diskette deliverables (EDDs).

4.10 Log-In Supervisor

The Log-In Supervisor reports directly to the President and is responsible for the oversight and management of all department personnel and operations. Primary responsibilities include fulfillment and shipment of bottle orders to the client's destination in a timely manner, receipt of all incoming samples, evaluation of all incoming samples against ACZ's Sample Acceptance Policy, entering samples into the LIMS database, and performing timely review of all logged samples. Additional responsibilities are described in FRMAD060.

4.11Document Control Supervisor

The Document Control Supervisor reports directly to the President and is responsible for the oversight of the Document Control department. Primary responsibilities include the generation of client reports and EDDs and the maintenance, organization and control of all hard copy data and records, including workgroup data, client reports, CCOCs, QA/QC records and documents. Additional responsibilities are described in FRMAD060.

4.12Chemical Hygiene Officer

The Chemical Hygiene Officer (CHO) is primarily responsibilities for oversight of ACZ's documented Chemical Hygiene Plan, conducting initial and refresher safety training for all employees, monitoring exposures, and maintaining records for Material Safety Data Sheets, injury reports, chemical exposure reports, etc. Additional responsibilities include as working with management to develop and implement policies to improve the program. The person designated as CHO must have completed at least one basic laboratory safety course and has one year's experience performing laboratory work, preferably with responsibility for at least one area of laboratory safety.

4.13Chief Financial Officer

ACZ's Chief Financial Officer (CFO) is primarily responsible for all financial matters including payroll, accounts receivable, accounts payable and financial statements; monthly and annual balance and profit and loss statements; and assisting with annual budget preparation. In addition, the CFO maintains and monitors the security system and electronic time clock, invoices client projects from the database, updates customer account information, acts as the administrator for 401k/Profit Sharing Plan, maintains and executes the Employee Benefits Manual and assists in hiring process by posting job openings, scheduling qualified candidates for interviews, checking references, and ensuring a new employee provides proof of education.

4.14Purchasing Agent

Primary responsibilities include generating material requisitions and tracking all subsequent purchase orders; inspecting all incoming goods; generating PCNs for all incoming standards, reagents, and chemicals; tracking and maintaining an adequate supply of laboratory consumables.

5 TECHNICAL TRAINING

Prior to the independent generation or review of data for client samples (including PT samples), all analysts must undergo a formal, documented training process. Technical personnel must be thoroughly trained in the analytical techniques and operating principles and procedures for the methods utilized by ACZ. This process includes but is not limited to: reading the associated published method, reading all related SOPs, improving laboratory skills, learning troubleshooting, maintenance, and operating procedures for pertinent equipment and instruments, and creating workgroups and reviewing data through the LIMS database.

It is the responsibility of the department supervisor to determine that a new analyst is properly trained, has successfully completed all initial training requirements and is prepared to commence work on client samples. Under no circumstances may any analyst independently generate client data before receiving the explicit approval of the QA/QC department.

5.1 The effective version of the test SOP provides the framework for training for all sample preparation and analysis. The SOP is typically based on published approved methodologies (EPA or other) and incorporates any necessary activities and protocols not included in the published method(s) as well as requirements stipulated by other regulatory agencies.

5.2 Training for data AREV or SREV only must be documented as specified in section 2.3.6.

5.3 Each employee must be trained either by the department supervisor or by an analyst within the department who is proficient in the area of testing and has been designated by the supervisor. Anyone performing training must meet the following requirements:

1) Documentation of training on the effective version of the test SOP.
2) Documented approval for the analysis.
3) A current IDOC or CDOC.

5.4 Initial training is documented using the Initial Method Training form (FRMQA004). Once training has been completed, the trainee and the instructor fill out the form together to ensure all pertinent information has been addressed and to ensure the trainee comprehends the material and is provided an opportunity to ask questions or request additional training. The trainee's signature is an attestation that he/she has read, understands, and agrees to always follow the effective version of the SOP.

5.5 To demonstrate an aptitude for the procedure, the analyst must perform a successful Initial Demonstration of Capability (IDOC) prior to independent preparation and/or analysis of client samples. Performance is documented using FRMAD023. The data is reviewed initially by the department supervisor and the analyst (AREV), and both individuals must initial and date the review checklist.

5.6 SREV for any preparation workgroup is performed by the department supervisor or a qualified analyst, and SREV for any analytical workgroup is performed by QA/QC.

5.7 Prior to performing an IDOC, a new analyst should be provided sufficient opportunity to practice the procedure. This confirms the analyst understands the procedure and feels comfortable performing the procedure independently. Data associated with any practice is not submitted to QA/QC.

5.8 It is not necessary for the first IDOC attempt to pass; however, the supervisor needs to review the analyst's techniques if multiple attempts do not pass.

5.9 A thorough review of the raw data is performed as part of initial method training and should include particular attention to details not presented in LIMS or on the final report, such as generating final

sample concentration from the instrument response provided in the raw data (if applicable) and verifying correct standard and reagent traceability.

5.10 Where specified by the method or a regulating entity, and as stated in the test SOP, successful demonstration of performance such as Linear Calibration Range determination (LCR) or Method Detection Limit (MDL) study must be completed prior to independent analysis of client samples.

5.11 All initial training documentation must be submitted to the QA/QC department as a complete package. At a minimum, the package must include:

1) Initial Method Training form (FRMQA004), signed by the trainee and instructor (or department supervisor).

2) IDOC documentation:

- ✓ Completed and signed certification statement (FRMAD023)
- ✓ Workgroup bench sheet, raw data, and all supporting documentation

3) If applicable, MDL study for each instrument. Complete FRMAD031 and attach all related raw data and supporting documentation.

4) If applicable, calibration range study for each instrument. Complete FRMQA029 and attach all related raw data and supporting documentation.

5.12 Following review of all pertinent training documentation, QA/QC will issue procedure-specific clearance for the trainee to independently generate and review data for client samples. This permission is tracked and may be viewed on a designated location on the public network drive.

1) Approval for preparation procedures is granted after the instrument data has been reviewed and approved.

2) An unapproved analyst who is "shadowing" the trainer (observing, learning the organization of the lab, reagent room, etc.) may not assist with the procedure, and the workgroup documentation must bear only the initials of the trainer, who is fully responsible for the data.

3) If the analyst has successfully completed training for a procedure and generates client data or reviews client data prior to QA/QC approval, then any workgroup(s) or data review checklist must also bear the initials of a proficient analyst, with current approval for the method, who oversees the analyst's work for the procedure and assumes full responsibility for the data. The primary analyst must always be aware that he/she is responsible for the workgroup. The use of another employee's initials without their explicit approval is not permitted.

5.13 The supervisor is responsible for ensuring the training of each analyst is kept up-to-date. Each analyst must read, understand, and agree to follow the effective version of the SOP and continued proficiency must be demonstrated and documented annually for each analyst.

5.14 Each production supervisor routinely conducts department meetings to discuss procedures, work schedules, resources, questions and concerns, problems, QA/QC, etc.

6 SAMPLE COLLECTION & HOLDING TIMES

Sample collection procedures are well documented by the EPA and other agencies, and ACZ's clients are instructed to provide representative samples whenever possible. ACZ supplies its clients with the containers and other materials necessary to maintain sample integrity (to the extent possible) from the time of collection through analysis. Although ACZ does not perform sample collection activities, each project manager or client service representative will assist a client with specific sampling requirements as needed, or when necessary, will direct a client to other resources. The following sections include general information on sample containers, preservatives and holding times, which are essential components in maintaining the chemical and physical properties possessed by the sample at the time of collection.

6.1 Sampling Containers and Preservatives

The EPA outlines the requirements for sample container types, sample volume and preservation. ACZ inventory includes various sizes of plastic and glass containers that range from pre-sterilized to certified-clean by the supplier. Amber bottles are used when specified by the method. Glass containers are obtained from vendors that specialize in the sales of environmental sample containers, and all non-certified bottles are purchased from reputable lab/industry vendors. Refer to FRMAD045 and FRMAD046 for bottles types and preservation techniques for specific analyses. Refer also to Appendix A for additional information regarding EPA requirements container types and preservation.

All sample containers shipped to our clients are new, contain the appropriate preservative(s), and are color-coded to identify preservation and storage. Out-going containers are packed in clean coolers with a copy of ACZ's Sample Acceptance Policy, general directions for sample collection, bottle labels, ice packs, sampling information, blank chain of custody, return shipping labels, and custody seals. Trip blanks and rinsette water are included when requested by the client or when mandated by a specific analytical method. After samples have been collected they are cooled to a temperature > 0 °C and < 6 °C. Samples that require thermal preservation must be maintained within this temperature range until all analyses have been completed.

6.2 Holding Times

The EPA has conducted lengthy studies of sample degradation versus time to establish a maximum holding time for each method, and the results of these studies are compiled into holding-time tables to provide guidelines for litigation purposes. Data for a sample prepared / analyzed outside of the established holding time are the most difficult to defend in court. Holding times will vary slightly from regulation to regulation, thus further emphasizing the need for a client to consult with their Project Manager prior to sample collection. The holding time begins from the time or date of collection in the field. Appendix A outlines holding times (a hold time stated in 40CFR supersedes the published method). **NOTE**: The sampling date for PT samples is the preparation date, which must be documented on the workgroup and the container of prepared sample.

If ACZ Laboratories, Inc. receives samples past holding times or near the expiration of the holding time, sample analysis will proceed unless the client has indicated on the CCOC that an attempt to contact the client must first be made. Analyses performed outside of holding time will be appropriately qualified on the final report. Holding times $\leq$ 72 hours are calculated based on the hour of the sample date/time. Holding times > 72 hours are calculated based on the day of the sample date/time.

In general, and unless otherwise noted in the test SOP, sample preparation and analysis must be completed within the stated holding time. For analyses that extend beyond the intended scope of the method for an analyte or matrix, the hold time stated in the SOP must be met, or samples must be appropriately qualified.

7 SAMPLE CUSTODY & SAMPLE HANDLING

Sample custody begins with the receipt of sample containers from the client and continues beyond preparation and analysis to the proper disposal of primary and secondary sub-samples. Complete and accurate documentation must be provided at all stages of custody. There are many key elements to sample custody including laboratory security, chain of custody records, sample storage, internal custody logs, sample tracking within the laboratory, control of subcontracted work, and sample disposal.

7.1 Laboratory Security

A secure facility is essential to maintaining sample and data integrity and to providing safety to employees and visitors. ACZ has an electronic security system based on anti-pass back protocols, which controls and limits access to only authorized personnel. The following steps have been taken to ensure this security:

- All entryways are armed and a proximity reader at the east entrance and west shipping entrance allows access to an employee only after he/she passes their card.
- Employees may enter/exit only through the west door at Log-In and the east door next to the lunchroom.
- During normal business hours, public access into the building can be made at the front entrance and the west shipping entrance. Both doors are equipped with a buzzer.
- The outside doors at the west shipping entrance remain unlocked; however, the doors between the vestibule area and sample receiving area are equipped with an anti-pass back system.
- Building access is limited to specific hours of the employee's shifts.
- All employees are required to use their access cards to enter and exit the building.
- If any employee does not have their access card, they must notify ACZ's CFO as soon as possible and must sign in and out during the day using the visitor's register at the front desk. This ensures a record is maintained of which personnel were in the building at any time.
- If employees fail to use their card, the anti-pass back system denies access for that card the next time it is used. The employee must report to ACZ's CFO if this occurs.
- Visitors must enter and exit through the main entrance and must sign the register at the front desk upon arrival and before departure.
- Lab personnel must escort visitors as long as they remain on the premises.
- Emergency Exit doors are to be used only for emergency purposes. If a door is opened, a siren alarm will sound.
- It is against company security policy to loan or transfer access cards to anyone, including other ACZ employees. Employees may not allow a non-shift employee to enter the building.
- Vendors and delivery services enter the building via the west shipping entrance.

7.2 Sample Receipt and Log-in

Upon delivery of samples to ACZ, Log-In personnel evaluate the condition of the cooler and custody seals. The custody seals are then broken to retrieve the Chain of Custody (COC), which must be signed by the sample custodian to document the transfer of possession of the samples to ACZ. Once a cooler is opened, the pH of each sample is checked, if necessary, to verify the method preservation requirements have been met. The pH check is documented along with cooler temperature, radioactivity screen and other pertinent sample information.

Any problems, such as expired hold times, lack of preservative or improper cooler temperature, are noted and the Project Manager must contact the client as soon as possible so that a contingency plan can be initiated if necessary. Samples are logged-in as outlined in the SOP *Sample Receipt & Log-In Procedure / Maintenance of Sample Integrity* (SOPAD016) and are delivered to the assigned storage areas. Following log-in, every project is reviewed by the assigned PM, and upon completion of the review, the client receives an electronic summary, referred to as the "Login Review Report" that details the project information. This summary allows the client an opportunity to make changes to the project before samples are analyzed. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

7.3 Internal Custody Logs

Some clients may specify additional custody tracking of the samples once they have been logged in. Internal custody may require that samples are stored in a manner that ensures limited access. The internal custody log (FRMQA015) shall accompany the samples from log-in through completed analysis. The person responsible for the work signs and dates each entry and/or page in the logbook. When all data from a sample set is compiled, copies of all logbook entries shall be included in the final report package. For projects requiring internal custody, ACZ will adhere to the procedure described in the SOP *Client Service Policies and Procedures* (SOPAD043).

7.4 Sample Tracking

Sample flow through the laboratory is facilitated by the use of an Oracle-based LIMS database (Laboratory Information Management System). Every product (requested analysis) logged into the LIMS for a sample has a specific, pre-determined department path. All products have default paths of at least Login Review and Reporting. Between these two departments, a product may go through, for example, Soil Prep and Metal Analysis or Soil Prep, Organic Prep and GC Analysis. At each department step in a product's path, the status can be updated and viewed at any time. Analytical product statuses are defined below. Additional information regarding sample tracking is available in the SOP *Client Service Policies and Procedures* (SOPAD043).

NEED	Prep or Analysis has not been started
WIP	Prep or Analysis has been started (Work In Progress)
PREP	Sample preparation is complete and sample is ready for analysis
UPLD	Analytical data has been uploaded into LIMS
AREV	Analyst has reviewed and accepted analytical data
SREV	Supervisor has reviewed and accepted analytical data
DONE	Analysis or task has been completed
REDO	Sample requires reanalysis
REDX	Sample requires re-digestion/extraction
CANT	Sample preparation or analysis cannot be performed

8 PROCUREMENT, INVENTORY & TRACEABILITY OF SUPPLIES

8.1 Procurement / Inventory

All consumable supplies are purchased from reputable vendors that have been evaluated for service, quality, and price. To the extent possible, materials traceable to national or international standards of measurement are purchased for use in technical operations. Supplies are purchased using ACZ's purchase order (PO) and inventory system database. The Purchasing Agent is not permitted to make a substitution for any material(s) specifically requested unless the department supervisor approves the substitution. Upon receipt, reagents, chemicals, standards, and other laboratory consumables are stored in the Chemical & Supply Room, which has limited access, or are delivered to the laboratory. Refer to ACZ's SOP *Purchase, Receipt, and Storage of Consumable Materials for Technical Operations* (SOPAD037) for additional information.

8.2 Glassware

ACZ uses only laboratory grade glassware. Prior to use, glassware is cleaned using Alconox® or Chemsolve® (or other appropriate detergent) and then rinsed with Type I water. Glassware for trace metals is subsequently rinsed with 50% Nitric Acid and rinse again with Type I water. Glassware for nutrients is subsequently rinsed with 10% Hydrochloric Acid and then with Type I water. All glassware for organic analyses is washed with Alconox® then rinsed with de-ionized water and kiln-baked. Glassware for radiochemistry analyses is washed first with Contrad70® and then with 50% Nitric Acid and is rinsed with Type I water. Clean glassware must be stored in an enclosed cabinet or other suitable container and/or covered with Parafilm or foil.

8.3 Other Supplies

Routine consumables (centrifuge tubes, autosampler tubes, pipette tips, etc.) are purchased through an automatic system managed by Fisher (RIMS). All other supplies are purchased on an as-needed basis through ACZ's Purchase Order and inventory system database. Refer to SOPAD037 for additional information.

8.4 Traceability of Standards and Reagents

To provide complete traceability, each data package must reference every standard and reagent used for sample preparation or analysis, including but not limited to acids, bases, preservatives, color reagents, pH indicators, buffers, instrument reagents. Each PCN and/or SCN must be documented either on the workgroup bench sheet, data review checklist, or a current standard/reagent form. The open date for all original containers is not tracked in LIMS; however, good laboratory practice dictates that the open date always be noted on the sample container.

8.4.1 Primary Control Number (PCN)

Upon receipt, all stock chemicals, standards, and reagents are assigned a unique PCN in LIMS for tracking and traceability purposes. A label with the PCN and the expiration date is affixed to both the container and the Certificate of Analysis (if applicable). Document Control enters the data for each PCN using the certified value(s) supplied by the vendor, as indicated on the Certificate of Analysis. Because the certified value is entered, the final concentrations for prepared standards may vary slightly from the theoretical value indicated in the test SOP. Non-certified values are not entered and are not used for quality control purposes. Document Control maintains certificates of Analysis, and a copy of the PCN report is generated and maintained. If data for any PCN is to be edited, then complete documentation must be provided as a major corrective action (FRMQA001).
NOTE: Only Document Control and QA/QC personnel are authorized to enter or edit PCN data.

8.4.2 Secondary Control Number (SCN)

To ensure complete traceability, a unique SCN must be created when any intermediate or working standard is prepared from one or more stock solutions, stock chemicals, or intermediate solutions. A standardized format is used for creating the SCN: a two-letter code indicates the lab section and is followed by the prep date and then by a daily sequential number. For example, the SCN **II051128-2** denotes the second standard prepared on November 28, 2005 in the Inorganic Instrument lab. An acceptable alternative is to let LIMS assign a unique number when prompted.

A SCN for any working standard subjected to a LIMS calculation must be created electronically in LIMS. The initial volume and concentration of each constituent and the final volume of the prepared solution are entered in the SCN Wizard program to calculate the final concentration(s) of each analyte using the formula $C_1V_1 = C_2V_2$. The preparation date, expiration date, and preparer's initials are included as part of this electronic record. A hard copy of the SCN report may be affixed to the standard/reagent logbook, depending on individual department practice; however, it is not required.

Prepared reagents do not require a SCN to be created electronically in LIMS; however, preparation must be recorded in the department's designated logbook. At a minimum, the logbook entry must clearly identify what reagent was prepared, its subcomponents, the preparer's initials, the preparation date, and the expiration date. This information is sufficient for color reagents, buffer solutions, instrument reagents, etc. because details of the preparation are stated in the test SOP.

8.5 Preparation and Expiration of Standards and Reagents

8.5.1 Preparation of Standards and Reagents

Refer to individual test SOPs for detailed information regarding standard and reagent preparation. In general, either Class A pipettes or mechanical pipettes are used to measure and dispense aliquots of any solution used to prepare a standard or reagent. Accurate delivery of mechanical pipettes must first be verified as described in ACZ's SOP *Control, Calibration, and Maintenance of Measuring and Test Equipment* (SOPAD013).

The term QS referenced in many test SOPs is the acronym for *Quantity Sufficient* and refers to the addition of appropriate diluent to the solution to achieve the final volume. All containers of prepared reagents and standards stored for more than one day must be properly labeled with the SCN (or other unique identifier), preparation date, and expiration date. Preparation of reagents and standards must be documented as described in 8.4.2.

8.5.2 Expiration of Purchased Standards and Chemicals (PCNs)

In general, purchased liquid standards or reagents are assigned a default expiration date of one year from receipt. When provided, the manufacturer's expiration date will be assigned in lieu of the default expiration date. Solid materials are assigned a default expiration date of five (5) years from receipt.

An expired stock material may continue to be used only if its reliability can be verified. For the purpose of ensuring transparency, the reason for extending the expiration date of a PCN must be documented as a QA/QC Issue Wizard assigned to QA/QC or the Document Control supervisor. Unusable materials must be replaced and the standard or reagent remade as soon as possible. Remove the container from the lab or the supply room and dispose of properly. Contact ACZ's CHO for assistance.

8.5.3 Expiration of Prepared Standards

Storage conditions and shelf life for prepared standards are provided in the individual test SOPs. The following guidelines may be used to determine the shelf life for a prepared standard:

1) A standard that has been prepared in-house may continue to be used after its assigned expiration date for as long as its reliability can been verified. For applicable procedures, instrument response should be considered when determining whether or not a solution is still reliable.

   - In cases where reliability has been verified, the expiration date of the SCN must be updated in LIMS or the standard/reagent logbook.

   - In the event the solution was used prior to updating the SCN then documentation must be provided as part of the workgroup to indicate the solution was used past the shelf life stated in the SOP (a minor corrective action may be used if more than one workgroup is affected). The expired standard must be remade as soon as its reliability becomes questionable – it is the responsibility of the analyst to use their best judgment.

2) The shelf life of any prepared standard with any analyte concentration < 10 mg/L is 90 days from the preparation date. This is a general guideline – if any constituent does not remain in solution for 90 days, then the standard must be prepared more often. If the manufacturer's expiration date for any stock standard is sooner, then the expiration date of the SCN is the manufacturer's expiration date for a single analyte solution or the earliest manufacturer's expiration date for a multiple analyte solution.

3) The shelf life of any prepared standard with analyte concentration $\geq$ 10 mg/L is one year from the preparation date. This is a general guideline – if any constituent does not remain in solution for one year, then the standard must be prepared more often. If the manufacturer's expiration date for any stock standard is sooner, then the expiration date of the SCN is the manufacturer's expiration date for a single analyte solution or the earliest manufacturer's expiration date for a multiple analyte solution.

4) In general there are no manufacturer expiration dates for Radiological isotopes. If provided, these will be used; otherwise, the default expiration date of one year from receipt will be assigned when the material is received and can be subsequently updated at yearly intervals as needed for as long as the material remains useable. Because the shelf life of a radiological isotope is dependent on the half-life, the isotope will be deemed expired when it falls within 3 times the detection limit of the method.

5) In general, prepared Radiochemistry standards expire one year from the preparation date. The solution may be re-evaluated using control charts or other criteria and the expiration date extended by year intervals if the solution is still deemed usable. Refer to the specific test SOP for details.

8.5.4 Expiration of Reagents

In general, a reagent is a solution, other than a surrogate or internal standard, which is used for any step of sample preparation or analysis but does not contain the target analyte(s). Storage conditions and shelf life are stated in the individual test SOPs. The expiration date can be extended for a prepared reagent provided the criteria stated in 8.5.3.1) are met.

9 MAINTENANCE & CALIBRATION OF INSTRUMENTATION & EQUIPMENT

9.1 Maintenance of Instruments and Support Equipment

The best protocol for producing quality work is to prevent errors and non-conformances rather than to react to and correct problems after they occur. An essential part of this protocol is ensuring that all laboratory instrumentation and equipment used for the generation of data has been optimized and is functioning properly before commencing work on client samples. Performing routine maintenance and optimizing instrument-operating conditions prior to sample analysis minimizes instrument downtime, thereby improving productivity and ensuring quality of the data. It is the responsibility of the designated analyst(s) to perform and properly document daily and routine maintenance, instrument optimization, troubleshooting, any instrument servicing or repair, and any repair or replacement of parts.

All manufacturer-prescribed inspection and maintenance must be performed according to the schedule indicated in the operator's manual (or similar) provided by the manufacturer and must be documented either in the instrument logbook or a separate maintenance logbook or on the instrument maintenance checklist (available in LabWeb). ACZ management recognizes that performing all maintenance procedures at the frequency indicated by the manufacturer may not be economically feasible or a significant increase in workload may require the maintenance be performed at a later time if instrument performance is deemed to be acceptable; therefore, at a minimum, the instrument part(s) must be inspected regularly according to the schedule. The analyst must use their professional judgment to determine if maintenance or replacement is necessary at that time. Refer to ACZ's SOP *Control, Calibration and Maintenance of Measuring and Test Equipment* (SOPAD013) for details for each specific instrument or instrument type.

Additionally, all support equipment (any device that may not be the actual test instrument, but is necessary to support laboratory operations) must be monitored regularly to confirm proper functioning. The temperature of all drying ovens, refrigerators, freezers, and incubators must be checked each working day (except Sundays or holidays) and each check recorded on the associated Temperature Logsheet. Refer to SOPAD013 for more detail.

Equipment that has been subjected to overloading or mishandling, gives suspect results or has been shown to be defective or outside specified limits must be taken out of service and FRMAD029 attached to indicate the instrument or equipment is waiting for repair and cannot be used. During this downtime the department supervisor, Production Manager, and Project Manager may collectively determine it is necessary to sub-contract samples until correct performance of the repaired instrument or equipment has been demonstrated by a successful calibration or other suitable test. Document all contact with the manufacturer, as well as all repairs and other services, in the instrument or maintenance logbook to be used as a reference for solving future instrument problems. Additionally, when instrumentation or equipment goes outside of the direct control of the laboratory, the functioning and calibration status must be checked and shown to be satisfactory before it is returned to service. Refer to SOPAD013 for additional information.

To minimize downtime, each laboratory should maintain an adequate inventory of reagents, stock standards, glassware, etc. and should keep a sufficient supply of extra "critical" parts in-house rather than possibly delay sample analysis while waiting for parts to arrive. Keep in mind that parts from a vendor may be back-ordered and will not be available for immediate shipment. Additionally, an MDL study, MDL verification, calibration range determination, etc. must be performed for all methods on each instrument used to analyze client samples. This ensures any "backup" instrument can be utilized for analysis of client samples as soon as needed, rather than delaying production to first successfully complete any QC requirement(s).

9.2 Instrument Calibration

The accuracy of all instrument-generated data is ultimately dependent upon the proper initial calibration of the instrumentation used for any particular analysis. In order to perform quantitative measurements, the initial calibration must be established and verified, at the frequency required by the method or by the manufacturer (whichever is more stringent), before samples are analyzed. In general, calibration or standardization involves defining the relationship between instrument response and the amount or concentration of analyte introduced into the instrument. The graphical depiction of this relationship is referred to as the calibration curve. Calibration frequency must be performed in accordance with the manufacturer's guidelines, test method or other regulatory requirements, or client contract stipulations, whichever is most stringent. Every calibration or standardization must meet the acceptance criteria stated in the SOP and must be subsequently verified by analyzing an initial calibration verification standard (ICV) or other control standard (if specified in the SOP) that contains all target analytes and has been prepared or obtained from a different source than the one used to prepare the calibration standards.[1] Whenever possible, calibration standards and the second-source verification standard should be prepared on different days. If they are prepared concurrently, then another qualified analyst should prepare the second-source verification standard. This eliminates the possibility of the same analyst preparing both solutions incorrectly, an error difficult to detect.

A continuing calibration verification standard (CCV) containing all analytes of interest must be analyzed at the frequency stated in the test SOP to ensure the stability of the initial calibration curve has not varied over time due to any change in the analytical instrument and its detection system, such as instability of standards, instrument cleanliness, column performance, matrix effects, flow changes, and changes within the laboratory environment.

For applicable methods, all initial and continuing calibration steps must be clearly detailed in the test SOP. Additionally, each test SOP must specify the frequency and acceptance limits for the calibration and subsequent verification (ICV and CCV). In general, acceptance criteria are method-specific; however, the SOP may also include requirements of other regulatory agencies. Prior to resuming sample analysis, immediate corrective action must be taken if the calibration, ICV, or CCV is outside of the acceptance criteria. Technical corrective actions are described in the individual test SOPs. Refer also to section 11.2 for additional information.

General calibration guidelines are listed below and detailed information is provided in ACZ's SOP *Maintenance and Control of Calibration and Test Equipment* (SOPAD013).

- Understand the method requirements for calibration (minimum number of standards, etc.)
- Use the correct calibration model (linear, second-order, etc.)
- Include all target analytes in the calibration standards and second-source standard
- Analyze a calibration standard with a concentration less than or equal to the reporting limit.[2]
- Do not remove points from the middle of the calibration (only high or low standard may be dropped).
- Calibration is a single-event process. A retest of a calibration standard must be performed immediately.
- Documentation and resolution of calibration abnormalities is absolutely critical

[1] If a second source standard is not available then a different lot(s) of the same standard(s) may be used. If a different lot is not available then an analyst who did not prepare the calibration standards may prepare the calibration verification standard. The latter is an exception, and an attempt must first be made to purchase a different lot from the same vendor whenever a second-source standard is not commercially available.

[2] In general, the concentration of the low calibration standard is equal to the reporting limit, because lesser values are qualified as estimated; however, actual lab practice may differ and must be stated in the test SOP.

10 CONTROL & STORAGE OF RECORDS & DOCUMENTS

A formal and systematic control of records and documents is necessary for accurately reconstructing the entire history of any sample as well as to guarantee the quality and defensibility of the data. All information pertaining to instrumentation and equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, data verification and data reporting must be documented, must identify all personnel involved, and must be readily understood. All records, including those pertaining to calibration and test equipment, certificates and reports, must be maintained, and the management system must facilitate the retrieval of all working files and archived records for inspection and validation purposes. Documents and records must be safely stored (protected against fire, theft, loss, environmental deterioration, and vermin) and must be held secure and in confidence to the client for a minimum of five (5) years. The hard copy of all records and documents must be maintained in a designated storage area with limited access. To the extent possible, hard copies for the most recent two (2) years are stored on-site, and if necessary, may be moved to off-site storage after two years. Off-site storage conditions must meet the same criteria that apply to on-site storage.

10.1 Workgroups

10.1.1 Changes made to any workgroup record (hardcopy or text file) must be documented.

1) If a workgroup is "dissolved" to change the status then all data must first be deleted, and the workgroup is then either re-reviewed or re-uploaded. In either case, the analyst is prompted in LIMS to provide an explanation of why he/she is performing the task.

2) Changes to text files must be documented in LIMS and on the hard copy of the workgroup.

10.1.2 Workgroup data that is re-uploaded *for any reason* must first be deleted. Use one of the following options in LIMS\Sx Analysis.

1) Choose "Delete workgroup data and set to WIP."

2) In either the AREV or SREV function choose "Errors" and then "Reupload."

If any of the data changes then a new Run Approval report must be printed and attached to the hard copy of the workgroup, and the workgroup must be rescanned.

10.1.3 Document Control or other administrative personnel use a multi-page scanner with its own PDF scanning software to scan all workgroups.

1) Before the workgroup is scanned, the top page is reviewed to make sure it has both the AREV and SREV initials and dates, and that errors have been properly corrected.

2) The person scanning the must initial and date in the lower right hand corner of the front page by the person. This provides a record of the scan date.

3) The workgroup is scanned to the designated network directory and is then moved through an automated process to the appropriate read-only LabWeb directory, which is accessible to all employees. When a workgroup is rescanned, the previous file is maintained. A copy will be automatically created so as not to overwrite any files and will have a letter appended; starting with "A" the first time the workgroup is rescanned. The most current file will not have a letter appended.

10.1.4 The hard copy is filed by workgroup number in a storage box. The front of the full storage box is labeled with the year and the workgroups contained in the box. The first box of each new calendar year is "1." Full boxes are consecutively numbered, transferred to a designated

location and stored in numerical order. The storage room is locked at all times. Access is limited and is tracked through an access logbook.

10.1.5 Workgroups moved to storage may be accessed; however, a checkout card must hold the place of the workgroup in the file and must indicate who removed the workgroup, the workgroup number, and the date the workgroup was removed. When the workgroup is returned, then the checkout card is removed.

10.2 Electronic File Retention & Storage

All electronic records, stored either on instrument computers or on the network, are systematically backed up to tape. These records include Oracle data, instrument raw data, workgroups, client reports, instrument upload files, SOPs and other controlled documents, telephone records/voice mails, and department data. Tape backups are performed incrementally nightly Monday through Thursday, and a complete backup is performed each Friday. The tape from the first Friday of the month is pulled from service and placed in a secure, data-rated, 4-hour fireproof, safe that is located in the CFO's office. On a regular basis, the monthly tapes are moved to ACZ's safety deposit box at a local bank.

10.3 Instrument Data Files

Instrument raw data files are backed up by two different procedures: ACZ's Instrument Data Backup Application (IDBA) and StorActive. IDBA is a mandatory program that accesses local directories from instrument computers. Each night the program retrieves and backs up individual data files from the specified directory on each instrument computer. Refer to ACZ's SOP *Backup and Archive of Instrument Data Files* (SOPAD044) for details. StorActive LiveBackup is a third party program located on its own server that stores any saved version of all files located on any computer that employs LiveBackup (including files with the same name). This program is helpful in case a full restore is necessary or if multiple files overwritten by a saved version need to be retrieved. This program works for any computer utilizing Windows XP as its operating system.

10.4 Client Reports

10.4.1 Client reports are generated and signed electronically and are automatically stored as a PDF at a designated location on the network that has limited access. If a copy of any report exists on the network, and a new report is generated, then the existing copy will be renamed so that it is not overwritten. This way ACZ maintains a copy of all reports generated for a client.

10.4.2 Hardcopy documentation associated with a client project (CCOC, invoice, Login Review Form, etc) is filed by project number and stored in the document storage location.

10.4.3 Electronic Diskette Deliverables (EDD) are stored on the network at a designated location.

10.4.4 Changes to data may be necessary due to reporting requirements. These changes are made after the routine workgroup approval step and may include changes to reporting qualifiers, QC Summary qualifiers, report notes, etc. A record of the change must be made in the project "Change Log." Access the Change Log from the LIMS2000 menu/Reporting/Report Approval form. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

10.4.5 The Change Log must be used when a reported parameter is moved from one workgroup to another. The preferred way to do this is for a PM to either document the necessary changes in the Change Log and then notify the reporting department of the required changes or notify the reporting department immediately that a change is necessary. In the case of the latter, the

reporting department makes the changes and then logs this action in the Change Log. Refer also to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043).

10.4.6 Once a project has been invoiced, the directory on P:\Client is moved to the designated network location as a read-only PDF. If a project is un-invoiced, the project folder is copied to P:\Client where changes can take place.

10.4.7 In general, changes are not allowed to projects (including compilation) if the project has been invoiced. If a change needs to be made, the project must first be un-invoiced. At the time of un-invoicing, the user must provide a reason in LIMS to explain why the project was un-invoiced. This information is then stored in the Oracle database.

10.5 Documents

10.5.1 Standard Operating Procedures

10.5.1.1 Refer to section 2.2 for additional information pertaining to SOPs.

10.5.1.2 The original master copy of each SOP is maintained through a combined effort of QA/QC and Document Control. Master copies are organized in three-ring binders, which are kept in the Document Control office. An SOP Control Form (FRMQA003) is kept with each master copy and indicates each controlled copy of the SOP that was issued as well as the date and to which lab(s) the copies were distributed.

10.5.1.3 When a new version of any SOP becomes effective, the master copy of the previous version is retained and filed in the Document Control office. All controlled copies of the previous version are collected and disposed of. The collect date is documented on the SOP Control Form, which is maintained with the associated master copy SOP.

10.5.1.4 A controlled copy of the SOP is kept in each location the procedure is performed.

1) Each lab or department is issued one controlled copy of all relevant SOPs. The controlled copy must not be removed from the assigned area for an extended period of time and may not be photocopied. An additional controlled copy of any SOP or individual replacement pages of any SOP will be distributed upon request.

2) A SOP Revision Form (FRMQA030) is issued with each controlled copy. Any revision to a procedure must be noted on the form and must be approved by QA/QC before changes may be implemented. The revision form is kept in the laboratory SOP binder until the SOP is reviewed and revised. Once the next revision of the SOP becomes effective, the original revision form(s) are maintained with the master copy of the new version.
3) To ensure outdated information is not inadvertently used as a reference, an uncontrolled copy of any SOP is not allowed unless issued by QA/QC. Additionally, an electronic copy of any SOP becomes obsolete and must be deleted from a network drive or email once the effective version has been uploaded to LabWeb.

10.5.2 When documents are found to contain conflicting policies or procedures, the more recent document will be followed.

10.5.3 All controlled forms must be printed from LabWeb and may not be stored on a separate network drive. If photocopies are used then any unused copies of the expired version must be

disposed of as soon as a new version is uploaded to LabWeb. This ensures that the effective version of any controlled form is in use at all times.

10.5.4 Any controlled SOP(s) issued to an employee must collected upon resignation or termination.

10.5.5 Employees utilize an uncontrolled copy of the Ethics SOP or QAP for initial or continuing training purposes. All copies are collected following completion of the training session.

10.5.6 Only Document Control and QA/QC personnel are authorized to enter or edit data for a PCN.

10.5.7 The hard copy of each PCN report generated in LIMS is stored in a three-ring binder that is maintained by the Document Control department.

10.5.8 The original certificate of analysis for any stock material, if provided, is attached to the hard copy PCN report.

10.5.9 Accreditation certificates are scanned as a PDF to a designated network location. The original copy is maintained by Document Control. Certificates are also posted to ACZ's website.

10.5.10 Original calibration certificates and related documentation for support equipment (including but not limited to pipettes, thermometers, and glass micro liter syringes) are maintained by Document Control.

10.5.11 LIMS and other problems pertaining to IT are documented and managed by the electronic system called Issue Wizard. If an employee encounters a problem that requires attention, then that employee will submit a request through Issue Wizard. The request requires a priority to be assigned to the appropriate employee(s) for resolution. This system allows ACZ to track all changes made to computer systems. Reports are routinely generated to evaluate the status and eventual resolution of computer issues.

10.6 Records

10.6.1 Records include, but are not limited to: all logbooks; phone logs; raw data, derived data, and calibration data; training documentation (training forms, MDL studies, DOCs, etc.); proficiency testing results; calibration and certification records; internal audit reports; external audit reports; corrective action reports; management reports; and regulatory correspondence.

10.6.2 Records related to sample log-in are maintained as described in SOPAD016.

10.6.3 Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, dictated observations, and recorded data from automated instruments.

10.6.4 Original copies of records, except those pertaining to analytical data, are maintained by the QA/QC department or Document Control, and access is limited.

10.6.5 Relevant qualifications, training skills, and experience of technical personnel are maintained in the employee's training file.

10.6.6 Records such as transcripts, applications for employment, performance evaluations, etc. are maintained in the personnel files, which are stored in the secured office of the CFO.

10.6.7 The DOC certification statement (FRMAD023) and initial method training form (FRMQA004) are filed with the workgroup if the DOC was logged-in; otherwise, the training form is maintained in the employee's training file and the DOC form is filed with the data package.

10.6.8 Each employee's legal name, legal signature, and initials are documented on the New Employee Checklist (FRMAD043). The form is maintained in the employee's personnel file, which is stored in the Controller's office. A master signature/initial log is maintained for anyone employed at ACZ prior to the implementation of FRMAD043.

10.6.9 Each Organic Instrument ICAL data package is scanned to the designated network directory as a read-only PDF and the hard copy stored in labeled boxes. ICAL information that needs to be attached to any subsequent workgroup(s) must be printed from the PDF.

10.6.10 Logbooks must be maintained and controlled as described in SOPAD013.

10.6.11 Project Managers are responsible for maintaining all emails pertaining to a client and/or project. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043).

10.6.12 Procedural change(s) made to a SOP must be noted on the SOP Revision Form (FRMQA030) and approved by QA/QC prior to implementation. The date of the QA/QC approval denotes the effective date for the change.

10.6.13 Any correction to a hard copy record must be made by crossing through the error with a single line, and the correction must be clearly initialed and dated by the responsible staff. Erroneous entries cannot be destroyed by erasures, other markings or use of Whiteout®.

10.6.14 Changes to electronic records must be traceable to the individual who made the correction, and the reason for the change must be provided. Erroneous entries cannot be destroyed by methods such as overwritten files.

10.6.15 Record Storage and Retention

10.6.15.1 The minimum retention period of five (5) years may be increased dependent upon client request, regulatory requirement, or civil action order.

10.6.15.2 Records stored by a computer must have hard copy or write-protected backup copies.

10.6.15.3 Records stored only on electronic media must be supported by the hardware and software necessary for their retrieval and utilization in the proper format.

10.6.15.4 Records stored on electronic media must be stored in a way to provide protection from electronic or magnetic sources.

10.6.15.5 Scanned workgroups and client reports are backed up to an off-site data vault, which is secure, fireproof, and equipped with electronic data redundancy. Data backups occur daily (including Saturday and Sunday) after 12:00 am. After one year of storage off-site, data is transferred to a DVD, which is stored in a bank safety deposit box until all data on the DVD is at least five (5) years old. Obsolete DVDs are permanently destroyed.

NOTE: Data files that precede June 1, 2005 are stored to tape and/or DVD, which are kept in a bank safety deposit box.

10.6.15.6 If there is a change in ownership and/or a change in location, all records and documents will be made available to all accrediting authorities for five (5) years. Under no circumstances shall any records or documents be destroyed – all records and analyses performed that pertain to NELAC accreditation are subject to inspection by the NELAC accrediting authorities during this five (5) year period. A new owner of ACZ will assume possession of all records and documents.

10.6.15.7 If ACZ goes out of business, all records and documents will be stored and maintained according to protocol in a location to be determined at the time of closure. All records will be maintained for at least five (5) years and will be made available to all accrediting authorities.

10.6.16 Access to Archived Records

10.6.16.1 Access to archived information must be documented with an access log. A log is kept in each storage location, and any person entering a storage location must provide the required information in the log.

10.6.16.2 Hard copy records are stored in a locked environment with limited access. When a record is removed from its location, a "checkout card" must be filled out to indicate who removed the record, the date the record was taken, and a description of the record. The card marks the place in the storage box, and when the record is returned the card is pulled from the box.

10.6.16.3 Any changes to be made to archived data will require assistance from IT to do so.

10.6.16.4 Electronic data that has been archived to a more permanent media (such as tape, CD, or DVD) is stored in a bank safety deposit box. Access is limited and must be documented in the logbook maintained by Document Control.

10.6.17 Record Disposal

10.6.17.1 Records are disposed of in a manner to ensure client confidentiality.

10.6.17.2 Stored records will be reviewed to determine which ones can be destroyed. Any record older than five (5) years from the current date will be destroyed, unless client request, regulatory requirement, or civil action order dictates otherwise.

10.7 Computer Data and Records

10.7.1 Network File Server

Computer files pertaining to all aspects of ACZ's business are stored on a file/print server. To gain access, an employee logs on to the "LAB" domain. Each employee has a unique network user name so that security rules may be enforced. No "guest" logon is permitted. Every employee belongs to a specific "group" and directory security is enforced through privileges granted to these groups. Typically, an employee is granted access to files that pertain to their job functions; otherwise, read-only access or no access is granted.

Data generated and reported by ACZ is extremely confidential and the company may be liable for the consequences of the release of this data to any unauthorized person. The implementation of password security is not arbitrary and ensures data is protected and cannot be disclosed to outside parties. Weak, unchanging passwords make this scenario more likely.

In general, the network will prompt employees to change their password every 30 days. The password must be at least five (5) characters. Numeric characters are optional. Passwords may not be shared with other employees. The use of another employee's password (with the exception of common passwords for shared computers) is grounds for disciplinary action.

10.7.2 LIMS Server

1) Information stored on the LIMS server consists of all sample and client information needed for day-to-day production activities. The information is stored using an Oracle database application. Access is controlled through membership in "groups." Employees may update and change database records according to their job responsibilities. Otherwise, information is restricted to read-only access or no access.

2) No modifications to data can be made through applications not authorized by ACZ's IT department unless a CAR or Issue Wizard is submitted or documentation is provided on the hardcopy of the workgroup. Unauthorized applications include Attached Tables.

3) All tables that track changes (TrackInvoice, TrackWorkgroup, etc.) will be audited on a regular basis by a member of the IT department to ensure sufficient information is being supplied as to why changes occur. The explanations must be professional and specific.

10.7.3 Docs Server

Access to the docs server is read-only and is permitted through Internet Information Services (IIS) authentication and is logged in IIS log files. The server is updated on a regular basis by automated scripts.

11 ELEMENTS OF QUALITY CONTROL

A critical focus of ACZ's quality control policies and protocols involves monitoring sample preparation and measurement processes to determine matrix effects and to evaluate laboratory performance. Quality control samples are typically analyzed with every batch of environmental samples. Each test SOP provides detailed information regarding quality control sample types, acceptance criteria, and corrective actions, if applicable to the procedure, and reflects the requirements of the method and/or other regulatory authorities.

Performance control samples demonstrate precision or accuracy and expose out-of-control events. Matrix-specific control samples indicate possible effects of the matrix on method performance and may also identify data as in-control or out-of-control. Data that is out-of-control dictates corrective action ranging from re-extraction / re-analysis to reporting data with qualifiers. In general, the corrective action specified in the SOP must be performed if any quality control sample does not meet the acceptance criteria. Data associated with failed quality control cannot be qualified after the initial analysis without acceptable justification.

To the extent possible, client samples are reported only if all quality control measures are acceptable. If any measure is outside of the acceptance criteria, and the data will be accepted and reported to the client, then the appropriate data qualifier(s) must be assigned to all associated samples. The list of current extended qualifiers is maintained in the LIMS database.

11.1 Method Performance

11.1.1 Negative Control – Prep Blank (Method Blank)

The prep blank is used to assess possible contamination introduced during sample processing steps. A prep blank is prepared using Type I water or other similar matrix similar that is free of the target analyte(s) and contains all reagents in the same volumes used to prepare the client samples. The prep blank must be prepared, processed and analyzed in the same manner as the associated client samples. Unless specified in the test SOP, sample concentration may not be corrected for the prep blank value.

While the goal is to have no detectable contaminants, each prep blank must be carefully evaluated as to the nature of the interference and the effect on the analysis of each sample in the batch. Contamination in the prep blank results from four principle sources: the environment the analysis is performed in; the reagents used; the supplies and apparatus used; and the analyst performing the analysis. Contamination sources vary and the test SOP must be referenced to determine the appropriate corrective action(s).

When contamination is suspected, the source(s) must be investigated and measures taken to correct, minimize or eliminate the problem, and associated client samples must be reprocessed and reanalyzed. Alternatively, report data with the appropriate qualifier if reprocessing and reanalysis is not possible or if one of the following criteria applies:

i) The concentration of a target analyte in the blank is at or above the acceptance limit and the measured concentration of the analyte in an associated sample is greater than 10 times the measured concentration of analyte in the blank.

ii) The concentration of a target analyte in any associated sample is less than the MDL.

iii) Corrective actions could not be performed or are ineffective. Thoroughly document any corrective action taken and the outcome.

11.1.2 Positive Control

11.1.2.1 Laboratory Fortified Blank (LFB)

An LFB is required for methods that do not include a Laboratory Control Sample but include a fortified matrix (spike). The LFB is an aliquot of reagent water to which a known quantity of each target analyte is added. It is treated exactly like a client sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. When the acceptance criteria for the LFB are exceeded (i.e. high bias) then any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualification.

11.1.2.2 Laboratory Control Sample [LCSW (Water) or LCSS (Soil)]

The performance of both sample preparation and analysis of each sample batch may be monitored by an LCS. The LCS is a matrix-specific standard (whenever possible) of known analyte concentration(s) that may be prepared by the laboratory or purchased pre-made. The LCS must be carried through the entire preparation and analytical schemes with the client samples. Analysis and evaluation of the LCS allows for confirmation of the applicability of the preparation procedure to the analytes. Evaluate data using the following guidelines:

1) When only an LCSW is analyzed, the results must be within the acceptance limits or the entire batch of samples must be re-prepped and retested.

2) An LCSW duplicate (LCSWD) may be prepared and analyzed with the batch, typically in lieu of a matrix duplicate or spike duplicate. Data is acceptable if the LCSW and/or LCSWD is within the acceptance limits and the RPD passes. Associated samples must be re-prepped and reanalyzed if either of the following occurs:

   - LCSW/D RPD fails the acceptance criteria specified in the SOP.
   - % R of both the LCSW and LCSWD is outside the acceptance limits.

3) For a solid or semi-solid matrix, an LCSS and LCSSD are prepared and analyzed.[3] The data is acceptable if the LCSS and/or LCSSD is within the acceptance limits and the RPD passes. Associated samples must be re-prepped and reanalyzed if any of the following occurs:

   - LCSS/D RPD fails the acceptance criteria specified in the SOP.
   - % R of both the LCSS and LCSSD is outside the acceptance limits.
   - MS/D RPD fails the acceptance criteria specified in the SOP (if applicable).

4) When the acceptance criteria for the LCS are exceeded [i.e. high bias] then any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualifier.

5) Refer to section 11.1.3.3 for additional information regarding data assessment for solid-matrix workgroups prepared with both LCSS/LCSSD and MS/MSD.

[3] Corrective action for Recommendation #5 cited in the 2002 ADHS audit report.

11.1.2.3 Radiological Tracers

Radiological tracers are used for Thorium and Uranium analyses. The tracer reacts in the same manner as the target isotope and is used to asses analyte recovery. The tracer is added to client samples, controls, and blanks in accordance with the requirements stipulated in the test SOP. Because the tracer recovery has a direct impact on the LLD, the recovery must be high enough to yield LLDs that are within the scope of the project or meet ACZ's acceptance criteria. Refer to the test SOP for evaluation criteria and corrective action(s) for out-of-control tracer recovery.

11.1.3 Sample Specific Controls

The effect of different sample matrices on the performance of any method can be profound; therefore, matrix spikes, duplicates, and surrogate compounds are analyzed to evaluate matrix effects on data quality. Each SOP includes specific information regarding the usage and evaluation of matrix-specific QC samples and also states the required corrective action to take if any matrix QC fails.

ACZ provides analytical services to numerous and varied clients; therefore, the possibility of routinely favoring one client is highly unlikely. Over the course of time, no single matrix type will always be spiked or duplicated, and no one client will be selected for a high percentage of spiked or duplicated samples. If either of these occurs, it is due entirely to chance. Samples are selected for a workgroup by due date or priority – not by client – and are presented in the workgroup in increasing numerical order according to project number. A client's samples will be grouped together within the batch – in this way, a single client cannot be selected for a spike or duplicate, unless all of the client samples in the batch are from the same project. ACZ recommends that the analyst, to the extent possible, select samples to spike or duplicate that are representative of the workgroup. Analysts are not to associate QC with a client sample known to be or believed to be any type of blank or Proficiency Testing sample. Several exceptions exist for selecting samples for spiking or duplicating:

1) A sample is not spiked or duplicated if the volume is inadequate, and the client sample and QC sample(s) would require dilution; however, if no other option is available then the client sample and QC sample should be prepared and analyzed on the same dilution whenever possible.

2) Use the same weights (or as similar as possible) to prepare duplicates of solid matrix samples.

3) A client may request that one or more of their samples be spiked or duplicated. A "RUN QC" comment is added when the sample is logged in to notify the analyst that QC must be performed for a specific sample or project. If a client requests that their sample(s) be spiked or duplicated then ACZ is obliged to accommodate the client.

4) If TDS data indicates a sample would require dilution, then the sample should not be selected for spiking. Performing dilutions increases the likelihood of introducing error due to pipetting, and it is possible that spike recoveries may be incorrectly influenced by this error. A high TDS value will not influence whether or not a sample is duplicated.

5) A reactive sample is unpredictable and is a poor choice for spiking or duplicating.

6) A PT sample is not a real-world sample and is a poor choice for spiking or duplicating, because the data does not provide any useful information about possible matrix effects. Spike or duplicate a PT sample only when there are no client samples in the workgroup.

11.1.3.1 Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but are not normally found in environmental samples. Surrogates are included in the scope of Organic methods and are used to evaluate accuracy, method performance and extraction efficiency and shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

Whenever a surrogate recovery is outside the acceptance limits, the corrective action(s) stated in the test SOP must be performed. If corrective actions could not be performed or are ineffective, then the appropriate qualifier is applied to the sample results and reported to the client.

11.1.3.2 Matrix Spike Samples

A matrix spike sample (however named) is used to determine the level of bias (accuracy) associated with a particular matrix. For the purposes of this document, "MS" designates a matrix spike, and "MSD" designates a matrix spike duplicate. Spikes are prepared by adding a known and appropriate quantity of each target analyte to a replicate aliquot of client sample.

The required analytical frequency is specified by the method or other regulating entity and is indicated in the test SOP. Each result is evaluated against the acceptance criteria, and matrix effects are determined and reported to the client. The following evaluation criteria apply to spikes that are subjected to processing steps and post-digestion spikes (analytical spikes).

- Percent Recovery (%R) is considered for all spikes.
- %R is evaluated only if the theoretical concentration in the spiked aliquot is greater than or equal to the reporting limit; otherwise, each associated client sample must be reported with the appropriate qualifier, regardless of %R.
- If %R for the MS and/or the MSD is outside of the acceptance limits, the RPD passes, and all other pertinent prep and instrument QC passes, then each associated client sample may be accepted and reported with the appropriate qualification.

11.1.3.3 Matrix Duplicates and Matrix Spike Duplicates

The matrix-specific precision associated with an analysis is determined through the use of a matrix duplicate (DUP) or spike duplicate (MSD), which are performed at a frequency specified by the method or other regulating entity (refer to the specific test SOP). The results are evaluated, and the matrix effect on precision are determined and reported to the client.

- Relative Percent Difference (RPD) is considered for all duplicates except non-drinking water samples for radiochemical analyses (see 12.4.4).
- RPD for a spike duplicate is evaluated only if the observed concentration is greater than or equal to the reporting limit; otherwise each associated client sample must be reported with the appropriate qualifier.
- RPD for a matrix duplicate is evaluated only if the observed concentration is greater than 10 times the MDL; otherwise each associated client sample must be reported with the appropriate qualifier, regardless of RPD.

- In the absence of other contributing factors, a DUP failure for a solid or semi-solid matrix is attributed to non-homogeneity of the sample, and each associated client sample may be reported with the appropriate qualifier.

- For an aqueous matrix, if the DUP fails then all associated samples and the DUP must be retested. If permitted by the instrument software the sample and DUP can be reanalyzed at the end of the analysis in lieu of retesting all associated samples.

- For an aqueous matrix, if the MS/MSD RPD fails then the associated samples must be reanalyzed. If permitted by the instrument software the sample and MS/MSD can be reanalyzed at the end of the analysis in lieu of retesting all associated samples.

- If applicable, evaluate the LCS/LCSD if the RPD fails for a matrix duplicate or spike duplicate. Each associated client sample may be reported with the appropriate qualifier if the LCS/LCSD meets the criteria stated in 11.1.2.2.

- For a solid or semi-solid matrix, if both the LCSS and LCSSD recoveries pass but the RPD fails, then acceptable precision may be demonstrated by a passing RPD for the MS/MSD, and each associated client sample may be reported with the appropriate qualifier.

11.2 Instrument Specific Controls

All data must be associated with a passing instrument calibration and initial calibration verification. To the extent possible, all data must be associated with passing continuing calibration verification. If the initial calibration verification results (ICV/ICB) are outside of the acceptance criteria, then the source(s) of the failure must be identified, corrective action(s) performed if necessary, and the instrument recalibrated before proceeding with sample analysis.

If the continuing calibration verification results (CCV/CCB) do not meet the acceptance criteria then the source(s) of the failure must be identified and corrective action(s) performed, including recalibration if necessary, before continuing with sample analysis. If reanalysis of any sample(s) associated with failing calibration verification is not possible then the associated data must be reported with the appropriate qualification.

For instruments that permit the analysis of subsequent workgroups using the most recent calibration, two (2) consecutive attempts of the opening CCV/CCB are allowed. If both attempts fail to produce acceptable results then the source(s) of the failure must be identified and corrective action(s) performed, including recalibration if necessary, before commencing sample analysis.

Unless stated otherwise by the test SOP, passing calibration verification must always bracket all batch quality control samples, and results for additional instrument check standards, if applicable, must be within the acceptance criteria stated in the SOP. However, when the acceptance criteria for a CCV or CCB are exceeded (i.e. high bias) any associated client sample with a measured concentration less than the MDL may be accepted and reported with the appropriate qualification.

11.3 Other Control Indicators

11.3.1 Internal Standards

Internal Standards (IS) are measured amounts of certain compounds added after preparation or extraction of a sample to be analyzed by GC/MS or ICPMS. The IS is an analyte not likely to be found in the environment and is used in a calibration method to correct sample results affected by column injection losses, purging losses or viscosity effects. The IS is added to client samples, controls and blanks in accordance with the method requirements. When the results are outside of the acceptance limits for applicable quality control samples, corrective actions shall be performed. Once system control has been reestablished, all samples analyzed while the system was malfunctioning shall be reanalyzed. If corrective actions could not be performed or are ineffective then the data for each client sample must be appropriately qualified on the final report.

11.3.2 Trip Blank

The trip blank is a sample container filled in the laboratory with Type I water that is shipped to the collection site in the sample cooler, returned to the laboratory, logged-in, and analyzed in the same manner as the client samples. With the exception of Hg-1631, trip blanks are not opened in the field. If a target analyte is detected in the trip blank then the appropriate data qualifier is applied to pertinent results from those samples returned to ACZ in the same cooler as the trip blank. Trip blanks are typically prepared for Hg-1631, Cyanide, and VOA samples.

11.3.3 Instrument Blank

The instrument blank is an aliquot of Type I water processed only through the instrument steps of sample analysis and is used to determine presence of instrument contamination. For Organic instrument methods, neither surrogate nor IS standards are added.

11.3.4 Equipment Blank

An equipment blank is provided by the client and is used to assess the effectiveness of equipment decontamination procedures. Type I water is poured into (or over) or pumped through the sampling device, collected in a sample container and transported to the lab to be analyzed for all parameters requested for the environmental samples collected at the site. If any target analyte is detected then all associated sample results must be qualified on the final report.

11.3.5 Ambient Blank

The ambient blank consists of Type I water poured into a VOA vial at the sampling site (in the same vicinity as the associated samples). It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared when samples are to be analyzed for VOA analytes and are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection. The frequency of collection for ambient blanks is specified in the client's field-sampling plan and are not required for all projects.

12 EVALUATING QUALITY CONTROL SAMPLES

In general, acceptance criteria for quality control samples are method-specific; however, compliance with the requirements of clients and regulatory or other accrediting agencies must also be demonstrated. Immediate corrective action must be taken if any quality control is outside of the acceptance criteria. Appropriate corrective actions are described in the test SOP. To the extent possible, client samples are reported only if all quality control measurements are acceptable. If a quality control measure is outside of acceptance criteria, and the data must be reported, then all samples associated with the failed QC must be reported to the client with the appropriate data qualifier(s). Clients will occasionally request limits different from those in a published method. If a client has data quality objectives that require modification of our guidelines then we may deviate from those guidelines only if more stringent controls are requested. ACZ's policy is to adhere to the strictest limits as a means of meeting all agency and client requirements.

For methods that do not specify acceptance criteria for any type of quality control measurement, limits may be generated by plotting historical data in a control chart once a minimum of 20 data points is available. A control chart application may be accessed through LIMS and allows the user to create limits, either from a specified number of data points or for a specific time period, that are set at $\pm$ 3 times the standard deviation from the mean percent recovery. Current control limits are also plotted to provide a direct comparison of the two sets of data. New limits developed from a control chart must be documented on FRMQA039 and must be reviewed by the QA/QC department prior to implementation. If the new limits are approved, then QA/QC personnel will update LIMS. Refer to ACZ's SOP *Control Charting Application and Procedure* (SOPAD041) for further details. Default acceptance criteria established by the Arizona Department of Health Services (ADHS) may be used in lieu of generating a control chart to establish limits; however the SOP must specify which limits are in use. [4] **NOTE:** For all data evaluation, final results ending with 1 – 4 are rounded down and results ending with 5 – 9 are rounded up.

12.1 Accuracy

Accuracy is defined as "the degree of agreement of a measured value with the true or expected value of the quantity of concern."[*] Control samples (LCS or LFB) and spiked samples are analyzed with every batch of samples or as stipulated by the specific test SOP to assess accuracy and matrix effects.

- Percent Recovery (%R) for a control sample is calculated as follows:

$$\%R = \frac{M}{S_p} \times 100$$

Where: M = Measured concentration of the control sample
S_p = True value of the control sample

- Percent Recovery (%R) for a spike is calculated as follows:

$$\%R = \frac{M - S}{S_p} \times 100$$

Where: M = Measured concentration of the spiked sample
S = Measured concentration of the sample aliquot
S_p = True value of the spike concentration

12.2 Precision

Precision is defined as "the degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions." Matrix duplicates and spike duplicates are analyzed with every batch of samples or as stipulated by the test SOP to determine the precision associated with the analysis.

[4] ADHS Information Update #87 (July 7, 2005)

[*] "Quality Assurance of Chemical Measurements," Taylor, J., 1987

If any method does not specify acceptance criteria for the RPD, then default criteria of RPD $\leq$ 20 is used (a value that rounds to 20 is acceptable). [5] The Relative Percent Difference (RPD) as an absolute value is calculated as follows:

$$|RPD| = \frac{(S - D)}{[(S + D) / 2]} \times 100$$

Where: S = Sample Value
D = Duplicate Value

12.3 Other Calculations

- Solids Dilution Factor (assume 100% solid for "as received" samples):

  $$\text{Dilution Factor} = \frac{V}{(W)(\%\ \text{solid})}$$

  Where: V = Final digestate volume, in mL
  W = Sample weight used, in g
  %solid = %solid or air dry solid, as a decimal

- Sample Concentration for Solids:

  - wet weight [biota tissue, fruit or vegetable matter, etc.]: $mg/Kg = \frac{DF * C * V}{W}$

  - dry weight [plant matter, grasses, soil, sludge, etc.]: $mg/Kg = SF * C * DF$

    Where: DF = instrument dilution factor
    C = raw data value, in mg/L
    V = Final volume of digestate, in L
    W = sample weight used, in Kg
    SF = soil dilution factor

- Percent Difference for Serial Dilution (SDL):

  $$|\%D| = \frac{[I - (s * 5)]}{I} \times 100$$

  Where: I = initial sample result
  s = serial dilution result (raw data value)

  For SDL calculations in LIMS, "s" is multiplied by 5 and the resulting "reg value" is compared to the "found value" to calculate %D.

[5] ADHS Information Update #87 (July 7, 2005)

12.4 Radiochemistry Calculations

12.4.1 Activity

The results of radioactivity are typically reported in terms of activity per unit volume or mass. Units are normally expressed in picocuries (pCi), which equal 2.22 disintegrations per minute (dpm). Specific formulas to determine activity are in the SOP for each method. The general formula is as follows:

$$C = \frac{R_{net}}{(e)(y)(i)(v)(u)}$$

Where: C = activity per unit volume (pCi/L)
R_{net} = net counts per minute
e = counting efficiency, cpm/dpm
y = chemical yield
i = ingrowth correction factor
v = volume or mass being counted (L)
u = units correction factor, 2.22 for cpm to pCi

12.4.2 Counting Error

Radiochemical data are considered incomplete without reporting associated random and systematic errors. For this reason all radiochemical results should be accompanied by a counting error at the 95% confidence level (1.96*standard deviation). The general counting error formula is as follows:

$$E = \frac{1.96\left(R_o / t_1 + B / t_2\right)^{1/2}}{(e)(y)(i)(v)(u)}$$

Where: E = counting error
R_o = gross sample, cpm
t_1 = sample count duration, min
B = background, cpm
t_2 = background count duration, min
e, y, i, v, and u are as previously defined.

12.4.3 Lower Limit of Detection (LLD)

LLD (also referred to as Minimum Detectable Activity or MDA) is considered the smallest quantity of sample radioactivity that will yield a net count for which there is a pre-determined level of confidence that radioactivity is present. At the 95% confidence level, the following equation calculates the LLD for any single nuclide. The calculation uses the standard deviation for the background counting rate, assuming the sample and background counting rates should be very similar at the LLD. The formula for determining LLD is as follows:

$$LLD_{95} = \frac{4.66 S_b}{(e)(y)(i)(v)}$$

Where : LLD_{95} = Lower limit of detection at the 95% confidence interval
S_b = Standard deviation of the instrument background counting rate, cpm
e, y, i, v, and *u* are as previously defined

12.4.4 Precision

The normalized absolute difference, or Replicate Error Ratio (RER), between the sample and the laboratory duplicate, given by the following equation shall be used to determine that results do not differ significantly when compared to their respective 2* sigma uncertainty.

$$RER = \frac{|Sx - Dup|}{\sqrt{(Sx_{error})^2} + \sqrt{(+(Dup_{error})^2}}$$

Where: Sx = sample concentration in pCi/L
Sx_{error} = sample counting error (in pCi/L) at the 95% confidence level.
Dup = duplicate concentration in pCi/L
Dup_{error} = duplicate counting error (in pCi/L) at the 95% confidence level.

NOTE: For Radchem Drinking Water samples, both RPD and RER are used to evaluate precision. For non-Drinking Water samples, only RER is used; however, data for both RER and RPD are uploaded to LIMS for all analyses. Use the following guidelines to correctly assess precision. Further details are provided in ACZ's Wiki and must be consulted to ensure data for each workgroup is correctly evaluated. Go to LabWeb \ Wiki \ Analytical Departments \ Radio Chemistry.

Drinking Water:

RPD $\leq$ 20, RER < 2.0 – Precision is judged to be in control
RPD $\leq$ 20, RER > 2.0 – Precision is judged to be in control; case narrative required for RER
RPD > 20, [sx] < 5x [LLD], RER < 2.0 – Precision is judged to be in control; qualify data.
RPD > 20, [sx] > 5x [LLD], RER> 2.0 – Precision of the prep batch is questionable.
RPD > 20, [sx] > 5x [LLD], RER < 2.0 – Precision of the prep batch is questionable.

Non-Drinking Water:

RER < 2.0, RPD $\leq$ 20 – Precision is judged to be in control.
RER < 2.0, RPD > 20 – Precision is judged to be in control; RPD must be qualified.
RER > 2.0, RPD $\leq$ 20 – Precision of the sample prep batch is questionable.
RER > 2.0, RPD > 20 – Precision of the sample prep batch is questionable.

13 VALIDATION & REVIEW OF ANALYTICAL DATA

ACZ has the responsibility to always provide the best data possible to ensure our clients can make sound and cost-effective decisions regarding public health and the environment. In order to generate and report reliable data, the analytical systems used need to be properly functioning, and the review process must be conducted in a manner that is logical and reasonable and would be defensible if subjected to legal scrutiny. Decisions regarding data quality must be meaningful and must be backed by good science and sound professional judgments.

The entire validation and review process encompasses more than solely evaluating the final results for client and quality control samples. To this extent, the necessary steps must also be performed *prior* to sample preparation or analysis to ensure the quality of the data. Following sample analysis, data is uploaded to the LIMS database and then submitted to a variety of process chains such as calculations, rounding, application of qualifiers, etc. A multi-level data review process is utilized to verify the uploaded analytical data meets all documented ACZ requirements as well as any client-specific quality objectives. For additional details of the data reduction, review, and validation process, refer to ACZ's SOP *Data Review Process* (SOPAD032). At a minimum, the validation process must include the following steps, as applicable:

- Monitor the expiration dates for all stock, intermediate, and working standards, reagents, and chemicals.
- Prior to analysis, determine that holding times have not been exceeded. Unless otherwise specified by the test SOP, sample preparation and analysis must be completed within the holding time.
- Prior to analyzing samples, verify the correct set-up and operation of the instrument or equipment. Perform calibration, maintenance, and optimization as necessary to ensure proper functioning.
- In general, for QC frequency of 1 per10 or less client samples, the first set of QC is associated with samples 1 – 10. If there are fewer than 20 samples in the workgroup, then the remaining client samples are associated with the second set of QC.
- Before completing workgroup creation, verify the correct PCNs and/or SCNs have been entered. Percent recovery for control samples and spikes is calculated using the information in LIMS for each.
- Verify the proper sub-sample (green dot, yellow dot, etc.) is being used for preparation or analysis.
    - Notify the supervisor or Production Manager as soon as possible if a sample cannot be located.
    - Document on the bench sheet if a sub-sample other than the type indicated in the SOP is used.
- Compare the Log-In number on the sample container to the Log-In number on the bench sheet and make a visible mark next to each sample on the workgroup to indicate the check has been performed.
- Clearly label tubes, beakers, autosampler cups, etc. to identify the sample (and dilution factor, if applicable).
- Manage sample volume to ensure all analyses from a bottle type can be completed.
- Document all dilution factors on the bench sheet at the time the dilution is performed.
- Record complete and accurate observations, as necessary, when an analysis, sample preparation, or sample matrix is unusual or problematic.
- Ensure transcription errors do not occur. Verify all data manually entered into LIMS is correct before completing the upload process.

- The calibration workgroup must be associated with all subsequent workgroups. Record the calibration workgroup number (or calibration file name) on the data review checklist.

- Provide complete traceability for all standards and reagents used for sample preparation and analysis.

- Quality control samples must be treated in the same manner as client sample, including preparation.

- If it is necessary to perform a calculation manually, use the values in the raw data [do not truncate] and then round the final result to no more than three (3) significant figures. If the final result passes the acceptance criteria then pass the QC in LIMS and note on the data review checklist that it passes.

- LIMS performs several additional QC calculations on the approved data including cation/anion balance (CAB) checks, calculated TDS versus actual TDS ratios, and Total versus Dissolved ratios. The Project Manager may update the status of the pertinent sample(s) to REDO if one of these calculations indicates a discrepancy with the associated data.

- If two attempts fail to produce acceptable data then notify the supervisor or Production Manager before taking further action. It may be necessary to first determine if a larger problem is interfering with the analysis. Investigate the problem before qualifying the associated data.

- If there is an indication that the analytical system is out of control then the issue(s) must be investigated. Notify the supervisor immediately. Conduct troubleshooting in an organized manner.

- All data must be reviewed initially in LIMS [AREV] by the analyst who performed the analysis or by another qualified individual who has previously been granted approval. The department supervisor or another qualified individual performs the secondary review [SREV]. The following are data review guidelines:

    1) A data review checklist must be completed during the review process. Verify all items listed and note any errors, problems or non-compliances and the corrective action(s) taken.

    2) If applicable, review the raw data to verify the analytical system was in control and to ensure no anomalies exist. Check for notes on the bench sheet regarding the preparation or analysis.

    3) For client samples and quality control samples, ensure all results are within the measurement range and are bracketed by a passing calibration and passing calibration verification [ICV/ICB or CCV/CCB]. Sample values outside of the measurement range must be appropriately qualified if reanalysis is not possible.

    4) The corrective action specified in the SOP must be performed if any quality control sample does not meet the acceptance criteria. Data associated with failed quality control cannot be qualified after the initial analysis without acceptable justification.

    5) Data is more acceptable if the preparation and analysis was performed within the holding time. If reprep or reanalysis will be conducted outside of the holding time, check first with the supervisor.

    6) Confirm all dilutions are appropriate. A reasonable explanation must be provided on the bench sheet if a sample was diluted and the value is less than the reporting limit (refer also to section 15).

    7) If the initial analysis indicates possible positive or negative matrix interference then the sample(s) should be retested on dilution to confirm. The sample needs to be retested only one time – if a background effect is still evident, then note the event on the data review checklist and qualify the associated data.

8) If a spike fails, determine if the sample concentration is disproportionate to the spike added. If the analyte concentration in the sample is > 4x the spike added then note the failure on the checklist and appropriately qualify the associated samples.

9) If a spike recovery indicates the sample was not spiked, then re-prep / retest all associated samples.

10) Each associated client sample must be appropriately qualified if the matrix spike, matrix duplicate or spike duplicate data cannot be used for validation purposes.

11) Confirm failed QC by verifying the correct PCN or SCN was entered. Make corrections if necessary before proceeding with data review.

12) Verify all assigned qualifiers are appropriate. Does use of a particular qualifier make sense ? Could data be defended using the qualifier(s) assigned to the scenario or problem ?

13) If a case narrative is necessary, the reason for accepting and reporting the data must be sound and logical. Provide sufficient and accurate verbiage to ensure the data is legally defensible.

14) If a sample was retested in the same workgroup, verify the correct data will be reported. All other data for the sample must be failed – LIMS cannot report multiple data for the same sample.

15) Confirm all samples have the correct status (PASS, FAIL, REDO, REDX) before completing the review process. For multi-parameter workgroups, all analytes must have the correct status.

16) Refer also to section 11.0 for data evaluation criteria.

14 DETECTION LEVELS

Current practice identifies several detection levels, each of which has a defined purpose: Instrument Detection Limit (IDL), Method Detection Limit (MDL), and Reporting Limit (RL) or Practical Quantitation Limit (PQL). The MDL and RL (or PQL) are stated in each test SOP and are adjusted accordingly in LIMS when data is uploaded to reflect the use of smaller sample volume (dilution) or larger sample volume (concentration).

14.1 Instrument Detection Limit (IDL)

The IDL is the concentration of substance that produces a signal greater than three standard deviations of the mean noise level or the concentration that can be determined by injecting a standard to produce a signal that is five times the signal-to-noise ratio. The IDL should always be below the MDL and is not used for compliance reporting, but is useful for estimating the amount of analyte needed to produce a signal in order to calculate an estimated method detection level and for comparing the attributes of different instruments.

14.2 Method Detection Limit (MDL)

The EPA defines the MDL as the "minimum concentration of substance that can be measured by a specific testing protocol and reported with 99% confidence that the analyte concentration is greater than zero…" This confidence interval means that any substance detected at a concentration equal to the MDL is 99% likely to be present, but it also means there is a 1% chance that the substance will be considered falsely present (false positive). The MDL procedure is designed so that the probabilities of both false positive and false negative errors are acceptably small; however, the procedure has limitations. Data users must understand the limitations when evaluating low level data and must proceed with caution when interpreting data reported between the MDL and RL in order to minimize the risk of making poor environmental decisions.

MDLs are dependent on variables (temperature, instrument conditions, analysts, matrix, etc.) and are typically determined by processing, preferably over the course of several days, at least seven individual replicates of a fortified blank sample through the method's preparation and analytical schemes. MDLs determined for the same method / matrix / technology must be compared to ensure they are in agreement.

ACZ maintains a current MDL for each method. Unless specified by a method or to meet the needs of a special project or client request, a MDL is considered current if no changes have been made to (1) extraction or analytical procedure, (2) type of column used, if applicable, (3) instrument location, (4) instrument sensitivity (i.e. no major repairs or extensive servicing), and (5) other modifications of this type. A qualitative verification of the MDL must be performed annually for each applicable method, analyte, instrument, and matrix and before a new instrument or method is utilized for client samples. Refer to ACZ's SOP *Demonstration of Capability & Method Detection Limit Studies* (SOPAD001) for additional information.

14.3 Practical Quantitation Limit (PQL) / Reporting Limit (RL)

At the MDL, data is not quantifiable, and the uncertainty is $\pm$ 100% (or $\pm$ MDL). The PQL (RL) represents the lowest quantitative level that can be achieved with good certainty during routine operations. Because data reported at or above the PQL is reproducible, the client or other end user will be assured that the result is valid and independent of variable analytical conditions. This reproducibility allows for comparison of analytical results over a relatively long period of time, which is important to the monitoring of environmental data. ACZ defines the PQL as a value typically 2 – 10 times the MDL. Reported values less than the PQL are qualified as estimated. The region between the MDL and PQL is a continuum of uncertainty, lacking distinct cutoff points, and the error below the PQL is increased to the extent that the statistical validity of the result is questionable.

15 SAMPLE DILUTIONS

Sample dilution may be necessary for one or more of the following reasons: (1) sample concentration exceeds the established measurement range of the procedure / method (2) sample volume or material is limited (3) matrix interference is indicated or suspected (4) sample matrix is reactive (5) aqueous sample contains high sediment (6) color, odor or other physical characteristics are present (7) For ICP and ICPMS, TDS is greater than 2000 mg/L. In all cases, the analyst must use good professional judgment when determining the most appropriate dilution. Whenever possible, analyze a client sample and its associated matrix spike(s) and/or matrix duplicate on the same dilution. If circumstances prohibit retesting, including reanalysis that would occur past the holding time, then the data must be reported with the appropriate qualifier(s).

For samples that contain high concentration of analyte(s), the analyst will use their knowledge of the measurement range of the procedure to determine an optimal dilution that yields quantifiable data with minimal error propagation. In general, prepare the dilution so the final concentration is near the mid-point of the measurement range. A sample must be retested on a smaller dilution if analyte concentration is less than the reporting limit – exceptions must be explained on the bench sheet. For multi-parameter analyses, it may not be possible to report all analytes within the desired range, and the analyst must use their best judgment when determining a reasonable dilution factor.

The following requirements pertain to all dilutions:

- Document all dilution factors on the bench sheet when the dilution is performed
- Assign the appropriate "D" qualifier if data for the diluted sample is less than the reporting limit
- Retest sample on smaller dilution if the result is less than the reporting limit (or document justification for accepting the data on the bench sheet or data review checklist)
- Document the reason for any dilution on the bench sheet [not required for sample values that exceed the measurement range of the procedure]
- Provide accurate documentation for the benefit of preparation of a case narrative, data validation, review by a regulatory agency or other third party, and reconstruction of the sample's history

16 ERROR CORRECTION PROTOCOL

When an error occurs in any type of record it must be crossed out with a **single line**, not erased, deleted, obliterated, or made illegible, and the correct value entered alongside. All changes to hard copy records must be initialed and dated by the person making the correction. Under no circumstances may White-Out® or any other substance be used to conceal data. Concealing or improperly altering data is fraudulent and may be cause for termination from ACZ. Equivalent measures must be taken to avoid loss or change of original data in the case of records stored electronically. Refer to section 10 for details of corrections made to electronic records. The following is an example of proper error correction:

fleece BWC 10-20-06

Mary had a little lamb, it's ~~feet~~ as white as snow. And everywhere that ~~Lary~~ went, the lamb was sure to go.

Mary BWC 10-20-06

17 COMPUTER / AUTOMATED PROCESSES

ACZ employs its proprietary LIMS2000 (Laboratory Information Management System) to acquire, record, process, store and archive our data. It is the primary application for all employees and encompasses the combination of hardware and software throughout the entire facility to provide the interface for tasks such as creating workgroups, reviewing data, and generating client reports. ACZ implements the defined standards of Good Automated Laboratory Practices (GALP) to establish a uniform set of procedures to assure that all LIMS data used by our clients are reliable, credible, and legally defensible.

17.1 Software

The software used to achieve GALP goals is a combination of industry standard commercial software and internally developed applications. Commercial software is purchased through professional and well-developed companies such as Oracle, Microsoft and Lab Vantage Systems that complete sufficient testing and quality control to assure their product(s) functions properly. Internal applications undergo testing before being implemented and distributed throughout the laboratory.

Instrument data is automatically backed up anytime a file is saved through a client-server process running on most instrument PCs. This ability allows ACZ to see any version of a file created or modified during data processing. Electronic records are protected, backed up and archived to prevent unauthorized access or amendment. Refer to section 10.0 of this document and ACZ's SOP *Backup and Archive of Instrument Data Files* (SOPAD044) for details.

17.2 Hardware

ACZ deploys many application servers using industry standard architecture. All critical servers are redundant so that one hardware failure will not cause a system failure. All servers run standard enterprise operating systems such as Microsoft Windows 2000 and SuSE Linux for file and print services, intranet, web hosting, several databases and the phone system. All servers are routinely backed up to tape to maintain a complete historical record of all data generated.

To the extent possible, instrument PCs comply with at least the recommendations of the instrument manufacturer and are connected to ACZ's network allowing transparent backup and access to computers by system administrators. On most instrument computers, a "bare metal" restore of the computer can be done for a minimum of down time in the event of a hardware failure.

17.3 Security

GALP security is controlled through a set of passwords. A log-in name and password are required to access the ACZ's network. User passwords must be at least five characters and must be changed when the user is prompted. Each user has a given set of network rights and is restricted to software necessary to complete their job functions as well as his/her own documents. Refer also to section 10.7.1 for additional information.

A very secure firewall protects the network from the outside world, or, Internet. The only traffic permitted access to the internal network is e-mail and World Wide Web access. Incoming and outgoing E-mail is scanned for viruses, then scanned for inappropriate content and quarantined if necessary. All web traffic that is potentially harmful is blocked by a scanning application running on a proxy server.

18 CLIENT SERVICES

18.1 Subcontracting

ACZ utilizes subcontract labs to perform analyses for various reasons. A subcontracted lab must, at a minimum, adhere to the same quality assurance standards implemented by ACZ and must be NELAC certified for the subcontracted analysis. When applicable, ACZ advises its clients in writing of its intentions to subcontract any portion of the testing to another party. Non-NELAC work performed by a subcontracted lab must be clearly identified in the subcontract lab's report. ACZ scans this report as an attachment to be included as part of ACZ's final report. A comment is added to ACZ's final report indicating which subcontracted laboratory performed the analyses. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

18.2 Data Reporting

Once all analyses and the entire review process have been completed, a client report is generated and submitted for final validation by the Project Manager. If necessary, a case narrative is written describing the details of the project and any non-conformances or other relevant issues. The PM electronically signs the report, and the Document Control department sends the report to the client in an electronic format. At a minimum, the following information appears on an ACZ analytical report:

Client Name	Sample Matrix
Client Address	Parameter/Analyte
Client Contact	Method Reference
Lab Sample ID	Result
Client Sample ID	Units
Client Project ID	LIMS Qualifier (U, B, J, H)
ACZ Report ID	MDL or LLD
Date/Time Sampled	PQL or RL
Date/Time Received	Analyst's Initials
Date/Time Analyzed	Extended Qualifiers (as separate page)

A complete electronic data package contains the analytical reports, the external chain of custody records, sample shipping documentation, and any other relevant project information. Department Reference Sheets explaining acronyms, qualifiers, and method references are also included. All of these documents are an integral part of the final data package and must always be viewed as a whole. To prevent the separation of reports, each page identifies the project number, the sequential page number, and the total number of pages in the data package. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for more detail.

If requested by a client, custom and standard Electronic database deliverables (EDDs) are generated by the Document Control department. These deliverables, containing data in client specified format, are sent by e-mail with the client report. EDDs and analytical reports access data from the same Oracle tables, thus eliminating the possibility of inconsistent results. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for more detail.

18.3 Data Confidentiality

ACZ has an obligation to each client to maintain custody of samples, data, and reports and to keep all data or other information confidential. To uphold this responsibility, ACZ retains custody of the information at all times – data

or other client information obtained by ACZ is not allowed to leave the premises. This includes but is not limited to Chains of Custody, raw data, workgroups, run logs, logbooks, reports, QC summaries, data packages and other media containing data. Client data cannot be released to anyone except the client (as directed on the Chain of Custody) or the client's designated representative, and project data, including any client information, is not to be discussed with anyone other than ACZ employees and/or the client without first receiving written permission from the client. Additionally, client-specific information is not to be documented on raw data, workgroups, logbooks, or other records that may be provided to any client as part of an extended data package. All information must be referenced using only the ACZ log-In number. Refer to ACZ's SOP *Ethics and Proactive Prevention Program* (SOPAD039) for additional details of policies pertaining to confidentiality.

With the rapid advances of computer and information technology, it is possible for an employee to work at home and access the same electronic data and documents they could access while at ACZ. Accessing data from outside of ACZ could potentially compromise security, confidentiality and custody issues. ACZ's policy on external computer access is as follows:

External access to the ACZ network is limited to employees that may need to access information remotely. Employees requiring such access use ACZ's Virtual Private Network (VPN). The VPN client is setup on the employee's computer so that it adheres to ACZ security standards. These standards include (1) a unique user name (2) a password with at least 12 characters, and (3) 128 bit encryption of data to and from the client from the ACZ servers. After the VPN server has authenticated the employee, the employee must logon to the ACZ domain through normal domain security in order to access any ACZ network resources. Most employees initiate a "Remote Desktop" connection to their office PCs, thus ensuring that ACZ data is never accessible from the client PC hard drive. For portable computers that must directly access the ACZ network, an additional security measure is mandatory –any portable ACZ PC must have an additional "BIOS" password. Without the additional password, the PC will not boot. This security measure is in place to prevent the portable PC from being used in case of loss or theft of the computer.

ACZ has implemented the latest available technology to protect our network from malicious attacks. The bridge/router connecting the internal network to the Internet is protected by the latest implementation of a Linux firewall. Only SMTP (e-mail) and HTTP traffic are allowed between the network and the Internet. Exchange server blocks all "dangerous" attachments, such as executables, macros and VB scripts.

18.4 Client Feedback

Handling client feedback is a joint effort between QA/QC, Project Managers, Production Supervisors, and Client Service representatives. If a client has a concern or complaint, either a Project Manager or Client Service Representative takes the call and initiates the feedback procedure by documenting the complaint or problem and requesting the assistance of the Production Supervisor and/or QA/QC Officer. If the issue cannot be easily resolved then it must be documented using FRMAD024, which is routed from the initiator to other appropriate parties, including the QA/QC Officer if necessary. All client feedback is submitted to upper management as part of the Management Review of the Quality System. Refer to ACZ's SOP *Client Service Policies and Procedures* (SOPAD043) for additional information.

19 RADIOCHEMISTRY INSTRUMENTATION

Radioanalytical instrumentation is located adjacent to the radiochemistry prep lab. In order to maintain appropriate temperature control in the instrument lab, separation must be maintained. The door between the two lab areas must be kept closed when not in use. Except as noted, instrument checks and other determinations must be performed and documented annually, or more often if necessary.

NOTE: To eliminate potential contamination, planchets must be stored in a covered container or in a drawer.

19.1 Gas-Flow Proportional Counter

19.1.1 *Instrument Reliability Test (Voltage Plateau Determination)* – The proper voltage plateau for alpha and beta is where the counting rate is consistent (should not exceed > 5% over a 150 volt change in anode voltage).

19.1.2 *Cross Talk (Carryover) Check* - Cross talk is defined as the percentage of alpha counts represented on the beta plateau. Once the amount of cross talk is determined, the cross talk settings are adjusted on the instrument to eliminate cross talk.

19.1.3 *Detector Efficiency Curve (Self Absorption)* - Efficiency curves are graphs plotting counts versus sample density and determine the efficiency of the alpha and beta counter based on sample density. This factor is part of the overall determination of sample activity.

19.1.4 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. Placing an empty planchet in the counting chamber and counting it for as long as the longest sample-counting duration can determine the background rate (or a background check can be completed overnight). An overnight background determination must be completed at least quarterly. The daily background rate must be analyzed daily for each detector.

19.1.5 *Instrument-Response Check Source* - This continuing calibration check verifies the instrument response and stability and is performed daily for each detector. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the check source is outside the ±2 sigma-warning limit, then the variability should be further investigated. If the check source is outside the ±3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. If insufficient data exists for control charts, ±10% of the initial value is considered acceptable.

19.2 Liquid Scintillation Counter

19.2.1 *Optimal Window* - When determining radionuclides by liquid scintillation, it is necessary to select the optimal window by counting a standard for five minutes and generating a sample spectrum. For better clarity, a log scale for the channel number axis should be used. On the graph, the region of interest is determined by the energy of the peak one is trying to quantitate. The optimal window is formed by extending this region by 10% on each side of the alpha peaks.

19.2.2 *Efficiency Quench Curve* – The liquid scintillation instrument, a Beckman LS 6000TA, automatically corrects for quenching by the H - Method. Refer to SOPRC010 for details.

19.2.3 *Background Check* - Two background sources must be checked while preparing the liquid scintillation counter for analysis. The electronic (or instrument) background is the electronic noise of the system and can be determined with an empty counting chamber and a dark vial typically filled with graphite. Count as long as a sample is typically counted. The second source of background is chamber background, which is caused by contamination from instrument parts, counting room construction materials, and/or proximity of radioactive sources. Chamber background can be determined by using a vial containing liquid scintillator and a 10mL volume of Type I water (low background water). For both checks, the counting duration should be equivalent to the longest sample counting duration. Both checks must be performed on a daily basis and recorded in the instrument logbook.

19.2.4 *Instrument-Response Check Source* - This continuing calibration check verifies instrument response and stability and must be performed daily. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ±2 sigma-warning limit then the variability should be further investigated. If the source check is outside the ±3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a new efficiency curve, background checks, and/or instrument maintenance. If insufficient data exists for control charts, ±10% of the initial source value is considered acceptable. The source for this check is a Tritium standard.

19.3 Alpha Spectrometer

19.3.1 *Energy vs. Channel Calibration* - Each alpha spectrometer has a set number of channels associated to it. To associate these channels to a specific alpha particle, the channels must be calibrated. One known calibrated solid source is placed into the detector and analyzed for five minutes to determine its associated channel to its calibrated energy peak. Since the energy is linear across the channels, all of the channels now have an associated energy. This determination is performed on an annual basis, or whenever maintenance is performed that could potentially affect the calibration.

19.3.2 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. Placing an empty planchet in the counting chamber and counting it for as long as the longest sample-counting duration can determine the background rate (or a background check can be completed overnight). An overnight background determination must be completed at least quarterly.

19.3.3 *Instrument-Response Check Source* - This continuing calibration check verifies the instrument response and stability and is performed daily. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ±2 sigma-warning limit, then the variability should be further investigated. If the source check is outside the ±3 sigma out of control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a background check, and/or instrument maintenance. If insufficient data exists for control charts then ±10% of the true value is considered acceptable.

19.4 Gamma Spectrometer

19.4.1 *Background Checks* - Characteristic of most detectors is a background or instrument count rate attributed to cosmic radiation, radioactive contaminants in instrument parts, counting room construction material and/or the proximity of radioactive sources. The background rate can be determined by placing a blank water sample within a Marinelli beaker in the counting chamber

and counting it for as long as the longest sample-counting duration, or a background check can be completed overnight. A background check must be performed for every workgroup.

19.4.2 *Instrument-Response Check Source* - This continuing calibration check verifies instrument response and stability. This check is performed for every workgroup. If the source count is within two standard deviations (sigma) of the previously determined average count rate, instrument reliability and stability is established. If the source rate is outside the ±2 sigma-warning limit, then the variability should be further investigated. If the source check is outside the ±3 sigma control limits, then no further samples should be analyzed until the problem is resolved. Resolution might include a background check, and/or instrument maintenance. If insufficient data exists for control charts then ±10% of the true value is considered acceptable.

APPENDIX A Required Container Type, Preservation Techniques, and Holding Times

Parameter	Container	Preservation [a, b]	Maximum Holding Time [c]
Alkalinity	HDPE or Glass	4 °C	14 days
Acidity	HDPE or Glass	4 °C	14 days
Ammonia (N-NH_3)	HDPE or Glass	4 °C; H_2SO_4 to pH < 2	28 days
Anions	HDPE	4 °C	28 days (Br^-, F^-, Cl^-, SO_4^{2-})
BOD, CBOD	HDPE or Glass	4 °C	48 hours
COD	HDPE or Glass	4 °C; H_2SO_4 to pH < 2	28 days
Color	HDPE or Glass	4 °C	48 hours
Conductivity	HDPE or Glass	4 °C	28 days
Cyanide	HDPE or Glass	4 °C; NaOH to pH > 12	14 days
Chromium (VI)	HDPE or Glass	4 °C	Refer to SOP for holding time
Dissolved Oxygen	Glass	None required	Analyze immediately
Metals (except Cr^{6+}, Hg)	HDPE or Glass	HNO_3 to pH < 2	180 days
Mercury	HDPE or Glass	HNO_3 to pH < 2	28 days
N – NO_2 / NO_3	HDPE or Glass	4 °C; H_2SO_4 to pH < 2	28 days (48 hours if unpreserved)
N – NO_3	HDPE or Glass	4 °C; H_2SO_4 to pH < 2	28 days (48 hours if unpreserved)
N – NO_2	HDPE or Glass	4 °C	48 hours
Nitrogen, Total Kjeldahl	HDPE or Glass	4 °C; H_2SO_4 to pH < 2	28 days
Oil & Grease	Glass	4 °C; HCl or H_2SO_4 to pH < 2	28 days
Orthophosphate	HDPE or Glass	4 °C	48 hours
pH	HDPE or Glass	None required	Analyze immediately
Phenols	Glass	4 °C; H_2SO_4 to pH < 2	28 days
Phosphorus (Total)	HDPE or Glass	4 °C; H_2SO_4 to pH < 2	28 days

Sulfide	HDPE or Glass	4 ^{o}C; Zn acetate + NaOH to pH > 9	7 days

APPENDIX A Continued

Parameter	Container	Preservation	Maximum Holding Time
Sulfite	HDPE or Glass	4 °C; EDTA	Analyze immediately
Settleable Solids	HDPE or Glass	4 °C	48 hours
Total Organic Carbon	Glass only	4 °C; HCl or H_2SO_4 to pH < 2	28 days
Turbidity	HDPE or Glass	4 °C	48 hours
Total Dissolved Solids	HDPE or Glass	4 °C	7 days
Total Suspended Solids	HDPE or Glass	4 °C	7 days
Total Solids	HDPE or Glass	4 °C	7 days
Total Volatile Solids	HDPE or Glass	4 °C	7 days
Radon-222	Glass Vial [d]		4 days
Total Volatile Hydrocarbons	Glass Vial or jar [d]	4 °C; HCl to pH < 2 (water)	Refer to SOP for holding times
Total Petroleum Hydrocarbons	Amber Glass	4 °C	Refer to SOP for holding times
BTEX / MTBE	Glass Vial or jar [d]	4 °C; HCl to pH < 2 (water)	14 days
Organochlorine Pesticides	Glass Vial or jar [d]	4 °C; pH 5 – 9	Refer to SOP for holding times
PCBs	Amber Glass	4 °C	Refer to SOP for holding times
PAHs	Amber Glass	4 °C	Refer to SOP for holding times
BNAs (semi-volatiles)	Amber Glass	4 °C	Refer to SOP for holding times
VOAs (volatiles)	Glass Vial or jar [d]	4 °C; HCl to pH < 2 (water)	Refer to SOP for holding times
TCLP	Glass [d]	4 °C	Refer to SOP for holding times
Radchem (except Rn-222)	HDPE cube	HNO_3 to pH < 2	180 days

a. No pH adjustment for soil
b. Preservation with 0.008% $Na_2S_2O_3$ required only when residual chlorine is present.
c. Unless otherwise specified in the test SOP, complete sample preparation and analysis within holding time.
d. Teflon-lined septa or lid

APPENDIX B Utah BLI Certificate and List of Certified Parameters

State of Utah
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Governor
GARY HERBERT
Lieutenant Governor

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David N. Sundwall, MD
Executive Director

Epidemiology and Laboratory Services
Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories

Bureau of Laboratory Improvement
David B Mendenhall, MPA, MT (ASCP)
Bureau Director

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Recognized

STATE OF UTAH
DEPARTMENT OF HEALTH

ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

CERTIFICATION

is hereby granted to

ACZ Laboratories, Inc.

2773 Downhill Drive
Steamboat Springs CO 80487

Scope of accreditiation is limited to the
State of Utah Accredited Fields of Accreditiation
Which accompanies this Certificate

Continued accredited status depends on successful
Ongoing particitpation in the program

EPA Number: CO00028
Expiration Date: 4/30/2008

Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services

Utah Department of Health

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Bureau Director

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6/1/2007

ACZ Laboratories, Inc.
Bradley Craig
2773 Downhill Drive
Steamboat Springs CO 80487

ID # ACZ
EPA ID: CO00028

Director,

On the basis of your most recent assessment, Proficiency Testing results and continuing compliance with the ELCP requirements, the laboratory listed is certified for environmental monitoring under the Safe Drinking Water Act and authorized to perform the following methods, for the analytes and matrix listed:

Drinking Water

Inorganics and Metals

200.8 [1994]	Antimony
200.8 [1994]	Arsenic
200.8 [1994]	Barium
200.8 [1994]	Beryllium
200.8 [1994]	Cadmium
200.8 [1994]	Chromium
200.8 [1994]	Nickel
200.8 [1994]	Selenium
200.8 [1994]	Thallium
200.8 [1994]	Uranium
245.1 [1994]	Mercury
335.4 [1993]	Cyanide
4500 (F-) C	Fluoride by Ion-Selective Method

Nitrate

353.2 [1993]	Nitrate/Nitrite

Nitrite

353.2 [1993]	Nitrite

Pb/Cu

200.8 [1994]	Copper
200.8 [1994]	Lead

Radionuclides

900.0	Gross Alpha & Beta Radioactivity in Drinking Water Evaporation Technique
900.0	Gross Alpha
900.0	Gross Beta
903.1	Radium 226 in Drinking Water Radon Emanation Technique
904.0	Radium 228 in Drinking Water Radiochemical Technique

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

Utah Department of Health

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Safe Drinking Water Act
Page 2 of 2

The effective date of this certificate letter is: 5/24/2007.

The analytes by method which a laboratory is authorized to perform at any given time will be those indicated in the most recent certificate letter. The most recent certification letter supersedes all previous certification or authorization letters. It is the certified laboratory's responsibility to review this letter for discrepancies. The certified laboratory must document any discrepancies in this letter and send notice to this bureau within 15 days of receipt. This certificate letter will be recalled in the event your laboratory's certification is revoked.

Respectfully,

Patrick F. Lueedtke, MD, MPH.
Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Director of Public Health Laboratories

Bureau of Laboratory Improvement
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Bureau Director

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6/1/2007

ACZ Laboratories, Inc.
Bradley Craig
2773 Downhill Drive
Steamboat Springs CO 80487

ID # ACZ
EPA ID: CO00028

Director,

On the basis of your most recent assessment, Proficiency Testing results and continuing compliance with the ELCP requirements, the laboratory listed is certified for environmental monitoring under the Clean Water Act and authorized to perform the following methods, for the analytes and matrix listed:

Non-Potable Water

Inorganics and Metals

160.4 [1971]	Residue, Volatile (Gravimetric, Ignition at 550-C)
1631 C	Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescense Spectrometry
1664 A [1999]	Oil & Grease and Total Petroleum Hydrocarbons
180.1 [1993]	Turbidity
200.7 [1994]	Aluminum
200.7 [1994]	Antimony
200.7 [1994]	Arsenic
200.7 [1994]	Barium
200.7 [1994]	Beryllium
200.7 [1994]	Boron
200.7 [1994]	Cadmium
200.7 [1994]	Calcium
200.7 [1994]	Chromium, Total
200.7 [1994]	Cobalt
200.7 [1994]	Copper
200.7 [1994]	Iron
200.7 [1994]	Lead
200.7 [1994]	Lithium
200.7 [1994]	Magnesium
200.7 [1994]	Manganese
200.7 [1994]	Molybdenum
200.7 [1994]	Nickel
200.7 [1994]	Potassium
200.7 [1994]	Selenium
200.7 [1994]	Silica
200.7 [1994]	Silver
200.7 [1994]	Sodium
200.7 [1994]	Strontium
200.7 [1994]	Tin
200.7 [1994]	Titanium

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Clean Water Act
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Inorganics and Metals

200.7 [1994]	Vanadium
200.7 [1994]	Zinc
200.8 [1994]	Aluminum
200.8 [1994]	Antimony
200.8 [1994]	Arsenic
200.8 [1994]	Barium
200.8 [1994]	Beryllium
200.8 [1994]	Cadmium
200.8 [1994]	Chromium
200.8 [1994]	Cobalt
200.8 [1994]	Copper
200.8 [1994]	Lead
200.8 [1994]	Manganese
200.8 [1994]	Molybdenum
200.8 [1994]	Nickel
200.8 [1994]	Selenium
200.8 [1994]	Silver
200.8 [1994]	Thallium
200.8 [1994]	Uranium
200.8 [1994]	Vanadium
200.8 [1994]	Zinc
2310 B	Acidity (Nephelometric)
2320 B	Alkalinity (Titration)
2340 B	Hardness (Calculation)
245.1 [1994]	Mercury
2510 B [19th ED]	Conductivity (Laboratory) [SM 19th ED]
2540 B [19th ED]	Total Solids Dried at 103-105-C [SM 19th ED]
2540 C [19th ED	Total Dissolved Solids Dried at 180-C [SM 19th ED]
2540 D [19th ED	Total Suspended Solids Dried at 103-105-C [SM 19th ED]
2540 F [19th ED]	Settleable Solids [SM 19th ED]
300.0 [1993]	Bromide
300.0 [1993]	Chloride
300.0 [1993]	Fluoride
300.0 [1993]	Sulfate
3114 B [19th ED]	Selenium [SM 19th ED]
335.4 [1993]	Cyanide, Total
350.1 [1993]	Nitrogen, Ammonia
3500 (Cr) D [19t	Chromium VI (Colorimetric) [SM 19th ED]
351.2 [1993]	Nitrogen, Total Kjeldahl
353.2 [1993]	Nitrogen, Nitrate-Nitrite
365.1 [1993]	Phosphorous, Total
410.4 [1993]	Chemical Oxygen Demand
420.4 [1993]	Phenolics, Total
4500 (Cl-) E	Chloride (Ferricyanide, Automated)
4500 (CN-) I	Weak Acid Dissociable Cyanide
4500 (F-) C	Fluoride (Ion-Selective Electrode)
4500 (H+) B [19t	pH (Electrometric) [SM 19th ED]
4500 (SO42-) D	Sulfate (Gravimetric, Drying of Residue
5210 B [19th ED]	Biochemical Oxygen Demand 5-Day Test [SM 19th ED]
5210 B [19th ED]	Carboneous Biochemical Oxygen Demand (CBOD) [SM 19th ED]
5310 B [19th ED]	Total Organic Carbon (Combustion-Infrared) [SM 19th ED]

Organics

624	Purgeables
624	Bromodichloromethane

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Organics

624	Bromoform
624	Bromomethane
624	Carbon Tetrachloride
624	Chlorobenzene
624	Chloroethane
624	2-Chloroethylvinyl Ether
624	Chloroform
624	Chloromethane
624	Dibromochloromethane
624	1,2-Dichlorobenzene
624	1,3-Dichlorobenzene
624	1,4-Dichlorobenzene
624	1,1-Dichloroethane
624	1,2-Dichloroethane
624	1,1-Dichloroethene
624	trans-1,2-Dichloroethene
624	1,2-Dichloropropane
624	cis-1,3-Dichloropropene
624	trans-1,3-Dichloropropene
624	Ethylbenzene
624	Methylene Chloride
624	1,1,2,2-Tetrachloroethane
624	Tetrachloroethylene
624	Toluene
624	1,1,1-Trichloroethane
624	1,1,2-Trichloroethane
624	Trichloroethene
624	Trichlorofluoromethane
624	Vinyl Chloride
625	Base/Neutrals and Acids
625	Acenaphthene
625	Acenaphthylene
625	Anthracene
625	Benzidine
625	Benzo(a)anthracene
625	Benzo(b)fluoranthene
625	Benzo(k)fluoranthene
625	Benzo(g,h,i)perylene
625	Benzo(a)pyrene
625	Benzyl Butyl Phthalate
625	bis(2-Chloroethyl)ether
625	bis(2-Chloroethoxy)methane
625	bis(2-Ethylhexyl)phthalate
625	bis(2-Chloroisopropyl)ether
625	4-Bromophenyl Phenyl Ether
625	2-Chloronaphthalene
625	Chrysene
625	Dibenz(a,h)anthracene
625	Di-n-butylphthalate
625	3,3'-Dichlorobenzidine
625	Diethyl phthalate
625	Dimethyl phthalate
625	2,4-Dinitrotoluene
625	2,6-Dinitrotoluene

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Organics	
625	Di-n-octylphthalate
625	Fluoranthene
625	Fluorene
625	Hexachlorobenzene
625	Hexachlorobutadiene
625	Hexachlorocyclopentadiene
625	Hexachloroethane
625	Indeno(1,2,3-cd)pyrene
625	Isophorone
625	Naphthalene
625	Nitrobenzene
625	N-Nitrosodimethylamine
625	N-Nitrosodi-n-propylamine
625	N-Nitrosodiphenylamine
625	Phenanthrene
625	Pyrene
625	1,2,4-Trichlorobenzene
625	4-Chloro-3-methylphenol
625	2-Chlorophenol
625	2,4-Dichlorophenol
625	2,4-Dimethylphenol
625	2,4-Dinitrophenol
625	2-Methyl- 4,6-dinitrophenol
625	2-Nitrophenol
625	4-Nitrophenol
625	Pentachlorophenol
625	Phenol
625	2,4,6-Trichlorophenol
Radiological	
900.0	Gross Alpha
900.0	Gross Beta
903.0	Radium
903.0	radium-226
903.1	radium-226
904.0	radium-228
Solid & Chemical Materials	
Inorganics and Metals	
Sludge	Inorganic Pollutants

The effective date of this certificate letter is: 5/24/2007.

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Respectfully,

Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories

Bureau of Laboratory Improvement
David B Mendenhall, MPA, MT (ASCP)
Bureau Director

NELAP Recognized

5/11/2007

ACZ Laboratories, Inc.
Bradley Craig
2773 Downhill Drive
Steamboat Springs CO 80487

ID # ACZ
Account # 8003345493

Director,

On the basis of your most recent assessment, Proficiency Testing results and continuing compliance with the ELCP requirements, the laboratory listed is certified for environmental monitoring under the Resource Conservation and Recovery Act and authorized to perform the following methods, for the analytes and matrix listed:

Characteristics

	Solid	Non-Potable Water	
1010 A	✔	✔	Ignitability
1311	✔	✔	Toxicity Characteristic Leaching Procedure Metals
1311	✔	✔	Toxicity Characteristic Leaching Procedure Semi-Volatiles
1311	✔	✔	Toxicity Characteristic Leaching Procedure Volatiles
1312	✔	✔	Synthetic Precipitation Leaching Procedure (TCLP Approval)

Inorganics

	Solid	Non-Potable Water	
9012 B	✔	✔	Total and Amenable Cyanide
9013	✔		Cyanide Extraction Procedure for Solids and Oils
9040 C		✔	pH
9045 D	✔		Soil and Waste pH
9070 A		✔	Total Recoverable Oil and Grease

Metal Digestion

	Solid	Non-Potable Water	
3005 A		✔	Acid Digestion Total Recoverable or Dissolved Metals
3010 A		✔	Acid Digestion for Total Metals
3050 B	✔		Acid Digestion of Sediments, Sludges and Soils
3051 A	✔		Microwave Acid Digestion of Sediment, Sludges, Soils & Oils
3052	✔		Microwave Acid Digestion of Silliceous and Organic Matrixes
3060 A	✔		Alkaline Digestion for Hexavalent Chromium

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Resource Conservation and Recovery Act
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Metals

	Solid	Non-Potable Water	
6010 B	✔	✔	Aluminum
6010 B	✔	✔	Antimony
6010 B	✔	✔	Arsenic
6010 B	✔	✔	Barium
6010 B	✔	✔	Beryllium
6010 B	✔	✔	Boron
6010 B	✔	✔	Cadmium
6010 B	✔	✔	Calcium
6010 B	✔	✔	Chromium
6010 B	✔	✔	Cobalt
6010 B	✔	✔	Copper
6010 B	✔	✔	Iron
6010 B	✔	✔	Lead
6010 B	✔	✔	Lithium
6010 B	✔	✔	Magnesium
6010 B	✔	✔	Manganese
6010 B	✔	✔	Molybdenum
6010 B	✔	✔	Nickel
6010 B	✔	✔	Potassium
6010 B	✔	✔	Selenium
6010 B	✔	✔	Silica
6010 B	✔	✔	Silicon
6010 B	✔	✔	Silver
6010 B	✔	✔	Sodium
6010 B	✔	✔	Strontium
6010 B	✔		Thallium
6010 B	✔	✔	Tin
6010 B	✔	✔	Titanium
6010 B	✔	✔	Vanadium
6010 B	✔	✔	Zinc
6020 [1994]	✔	✔	Aluminum
6020 [1994]	✔	✔	Antimony
6020 [1994]	✔	✔	Arsenic
6020 [1994]	✔	✔	Barium
6020 [1994]	✔	✔	Beryllium
6020 [1994]	✔	✔	Cadmium
6020 [1994]	✔	✔	Chromium
6020 [1994]	✔	✔	Cobalt
6020 [1994]	✔	✔	Copper
6020 [1994]	✔	✔	Lead
6020 [1994]	✔	✔	Manganese
6020 [1994]	✔	✔	Molybdenum
6020 [1994]	✔	✔	Nickel
6020 [1994]	✔	✔	Selenium
6020 [1994]	✔	✔	Silver
6020 [1994]	✔	✔	Thallium
6020 [1994]	✔	✔	Vanadium
6020 [1994]	✔	✔	Zinc
7196 A	✔	✔	Chromium, Hexavalent (Chromium, VI)
7470 A		✔	Mercury
7471 A	✔		Mercury

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Organic Extraction

	Solid	Non-Potable Water	
3510 C		✔	Separatory Funnel Liquid-Liquid Extractions
3520 C		✔	Continuous Liquid-Liquid Extraction
3540 C	✔		Soxhlet Extraction
3550 C	✔		Ultrasonic Extraction
3580 A	✔		Waste Dilution

Organic Instrumentation

	Solid	Non-Potable Water	
8015 B	✔	✔	Diesel Range Organics (DROs)
8015 B	✔	✔	Gasoline Range Organics (GROs)
8015 B	✔	✔	Nonhalogenated Organics Using GC/FID
8021 B	✔	✔	Aromatic and Halogenated Volatiles
8021 B	✔	✔	Benzene
8021 B	✔	✔	Ethylbenzene
8021 B	✔	✔	meta-Xylene
8021 B	✔	✔	ortho-Xylene
8021 B	✔	✔	para-Xylene
8021 B	✔	✔	Toluene
8021 B	✔	✔	Xylenes, Total
8082	✔	✔	Aroclor-1016 [PCB-1016]
8082	✔	✔	Aroclor-1221 PCB-1221]
8082	✔	✔	Aroclor-1232 [PCB-1232]
8082	✔	✔	Aroclor-1242 [PCB-1242]
8082	✔	✔	Aroclor-1248 [PCB-1248]
8082	✔	✔	Aroclor-1254 [PCB-1254]
8082	✔	✔	Aroclor-1260 [PCB-1260]
8082	✔	✔	PCBs
8260 B	✔	✔	1,1,1,2-Tetrachloroethane
8260 B	✔	✔	1,1,1-Trichloroethane
8260 B	✔	✔	1,1,2,2-Tetrachloroethane
8260 B	✔	✔	1,1,2-Trichloroethane
8260 B	✔	✔	1,1-Dichloroethane
8260 B	✔	✔	1,1-Dichloroethylene (-ethene)
8260 B	✔	✔	1,1-Dichloropropene
8260 B	✔	✔	1,2,3-Trichlorobenzene
8260 B	✔	✔	1,2,3-Trichloropropane
8260 B	✔	✔	1,2,4-Trichlorobenzene
8260 B	✔	✔	1,2,4-Trimethylbenzene
8260 B	✔	✔	1,2-Dibromo-3-chloropropane (DBCP, Dibromochloropropane)
8260 B	✔	✔	1,2-Dibromoethane (EDB, Ethylene dibromide)
8260 B	✔	✔	1,2-Dichlorobenzene
8260 B	✔	✔	1,2-Dichloroethane
8260 B	✔	✔	1,2-Dichloropropane
8260 B	✔	✔	1,3,5-Trimethylbenzene
8260 B	✔	✔	1,3-Dichlorobenzene
8260 B	✔	✔	1,3-Dichloropropane
8260 B	✔	✔	1,4-Dichlorobenzene
8260 B	✔	✔	2,2-Dichloropropane
8260 B	✔	✔	2-Chloroethyl Vinyl Ether
8260 B	✔	✔	2-Chlorotoluene

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Organic Instrumentation

	Solid	Non-Potable Water	
8260 B	✔	✔	2-Hexanone
8260 B	✔	✔	4-Chlorotoluene
8260 B	✔	✔	4-Methyl-2-pentanone (MIBK, Isopropylacetone, Hexone)
8260 B	✔	✔	Acetone
8260 B	✔	✔	Acrylonitrile
8260 B	✔	✔	Benzene
8260 B	✔	✔	Bromobenzene
8260 B	✔	✔	Bromochloromethane
8260 B	✔	✔	Bromodichloromethane
8260 B	✔	✔	Bromoform
8260 B	✔	✔	Carbon Disulfide
8260 B	✔	✔	Carbon Tetrachloride
8260 B	✔	✔	Chlorobenzene
8260 B	✔	✔	Chlorodibromomethane [Dibromochloromethane]
8260 B	✔	✔	Chloroethane
8260 B	✔	✔	Chloroform
8260 B	✔	✔	cis-1,2-Dichloroethene (-ethylene)
8260 B	✔	✔	cis-1,3-dichloropropene
8260 B	✔	✔	Dibromomethane
8260 B	✔	✔	Dichlorodifluoromethane
8260 B	✔	✔	Ethylbenzene
8260 B	✔	✔	Hexachlorobutadiene
8260 B	✔	✔	Isopropylbenzene
8260 B	✔	✔	meta-Xylene
8260 B	✔	✔	Methyl bromide [Bromomethane]
8260 B	✔	✔	Methyl chloride [Chloromethane]
8260 B	✔	✔	Methyl Ethyl Ketone (MEK, 2-Butanone)
8260 B	✔	✔	Methyl-t-Butyl Ether (MTBE)
8260 B	✔	✔	Methylene Chloride
8260 B	✔	✔	n-Butylbenzene
8260 B	✔	✔	n-Propylbenzene
8260 B	✔	✔	Naphthalene
8260 B	✔	✔	ortho-Xylene
8260 B	✔	✔	para-Xylene
8260 B	✔	✔	sec-Butylbenzene
8260 B	✔	✔	Styrene
8260 B	✔	✔	tert-Butylbenzene
8260 B	✔	✔	Tetrachloroethylene (Perchloroethylene -ethene)
8260 B	✔	✔	Toluene
8260 B	✔	✔	trans-1,2-Dichloroethylene (-ethene)
8260 B	✔	✔	trans-1,3-Dichloropropylene (-propene)
8260 B	✔	✔	Trichloroethene (Trichloroethylene)
8260 B	✔	✔	Trichlorofluoromethane
8260 B	✔	✔	Vinyl Acetate
8260 B	✔	✔	Vinyl Chloride
8260 B	✔	✔	Volatile Organic Compounds
8260 B	✔	✔	Xylenes, Total
8270 C	✔	✔	1,2,4-Trichlorobenzene
8270 C	✔	✔	1,2-Dichlorobenzene
8270 C	✔	✔	1,3-Dichlorobenzene
8270 C	✔	✔	1,4-Dichlorobenzene

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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ACZ Laboratories, Inc.
Resource Conservation and Recovery Act
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Organic Instrumentation

	Solid	Non-Potable Water	
8270 C	✔	✔	2,4,5-Trichlorophenol
8270 C	✔	✔	2,4,6-Trichlorophenol
8270 C	✔	✔	2,4-Dichlorophenol
8270 C	✔	✔	2,4-Dimethylphenol
8270 C	✔	✔	2,4-Dinitrophenol
8270 C	✔	✔	2,4-Dinitrotoluene (2,4-DNT)
8270 C	✔	✔	2,6-Dinitrotoluene (2,6-DNT)
8270 C	✔	✔	2-Chloronaphthalene
8270 C	✔	✔	2-Chlorophenol
8270 C	✔	✔	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)
8270 C	✔	✔	2-Methylnaphthalene
8270 C	✔	✔	2-Methylphenol (o-cresol, 2-Hydroxytoluene)
8270 C	✔	✔	2-Nitroaniline
8270 C	✔	✔	2-Nitrophenol
8270 C	✔	✔	3,3'-Dichlorobenzidine
8270 C	✔	✔	3-Methylphenol (m-cresol, 3-Hydroxytoluene)
8270 C	✔	✔	3-Nitroaniline
8270 C	✔	✔	4-Bromophenyl Phenyl Ether
8270 C	✔	✔	4-Chloro-3-methylphenol
8270 C	✔	✔	4-Chloroaniline
8270 C	✔	✔	4-Chlorophenyl Phenyl Ether
8270 C	✔	✔	4-Methylphenol (p-cresol, 4-Hydroxytoluene)
8270 C	✔	✔	4-Nitroaniline
8270 C	✔	✔	4-Nitrophenol
8270 C	✔	✔	Acenaphthene
8270 C	✔	✔	Acenaphthylene
8270 C	✔	✔	Anthracene
8270 C	✔	✔	Azobenzene
8270 C	✔	✔	Benzo(a)anthracene
8270 C	✔	✔	Benzo(a)pyrene
8270 C	✔	✔	Benzo(b)fluoranthene
8270 C	✔	✔	Benzo(g,h,i)perylene
8270 C	✔	✔	Benzo(k)fluoranthene
8270 C	✔	✔	Benzoic Acid
8270 C	✔	✔	Benzyl alcohol
8270 C	✔	✔	bis(2-chloroethoxy)methane
8270 C	✔	✔	bis(2-Chloroethyl)ether
8270 C	✔	✔	bis(2-chloroisopropyl)ether
8270 C	✔	✔	bis(2-Ethylhexyl) phthalate (DEHP)
8270 C	✔	✔	Butyl Benzyl Phthalate
8270 C	✔	✔	Chrysene
8270 C	✔	✔	Di-n-butyl phthalate
8270 C	✔	✔	Di-n-octyl Phthalate
8270 C	✔	✔	Dibenzo(a,h)anthracene
8270 C	✔	✔	Dibenzofuran
8270 C	✔	✔	Diethyl Phthalate
8270 C	✔	✔	Dimethyl Phthalate
8270 C	✔	✔	Fluoranthene
8270 C	✔	✔	Fluorene
8270 C	✔	✔	Hexachlorobenzene
8270 C	✔	✔	Hexachlorobutadiene

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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Resource Conservation and Recovery Act
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Organic Instrumentation

	Solid	Non-Potable Water	
8270 C	✔	✔	Hexachlorocyclopentadiene
8270 C	✔	✔	Hexachloroethane
8270 C	✔	✔	Indeno(1,2,3-cd)pyrene
8270 C	✔	✔	Isophorone
8270 C	✔	✔	n-Nitroso-di-n-Propylamine
8270 C	✔	✔	n-Nitrosodimethylamine
8270 C	✔	✔	n-Nitrosodiphenylamine
8270 C	✔	✔	Naphthalene
8270 C	✔	✔	Nitrobenzene
8270 C	✔	✔	Pentachlorophenol
8270 C	✔	✔	Phenanthrene
8270 C	✔	✔	Phenol
8270 C	✔	✔	Pyrene
8270 C	✔	✔	Semivolatile Organic Compounds

Radiochemistry

	Solid	Non-Potable Water	
9310	✔	✔	Gross Alpha and Gross Beta
9315	✔	✔	Alpha Emit Radium Isotope
9320	✔	✔	Radium 228

Volatile Organic Preparation

	Solid	Non-Potable Water	
5030 B		✔	Purge-and-Trap for Aqueous Samples

The effective date of this certificate letter is: 5/1/2007.

The analytes by method which a laboratory is authorized to perform at any given time will be those indicated in the most recent certificate letter. The most recent certification letter supersedes all previous certification or authorization letters. It is the certified laboratory's responsibility to review this letter for discrepancies. The certified laboratory must document any discrepancies in this letter and send notice to this bureau within 15 days of receipt. This certificate letter will be recalled in the event your laboratory's certification is revoked.

Respectfully,

Patrick F. Luedtke, MD, MPH.
Director of Public Health Laboratories
Deputy Director of Epidemiology and Laboratory Services

The expiration for the laboratory's certification is 4/30/2008. The Utah Environmental Laboratory Certification Program (ELCP) encourages clients and data users to verify the most current certification letter for the authorized method. For further assistance please call Lorna Ward 801-584-8469.

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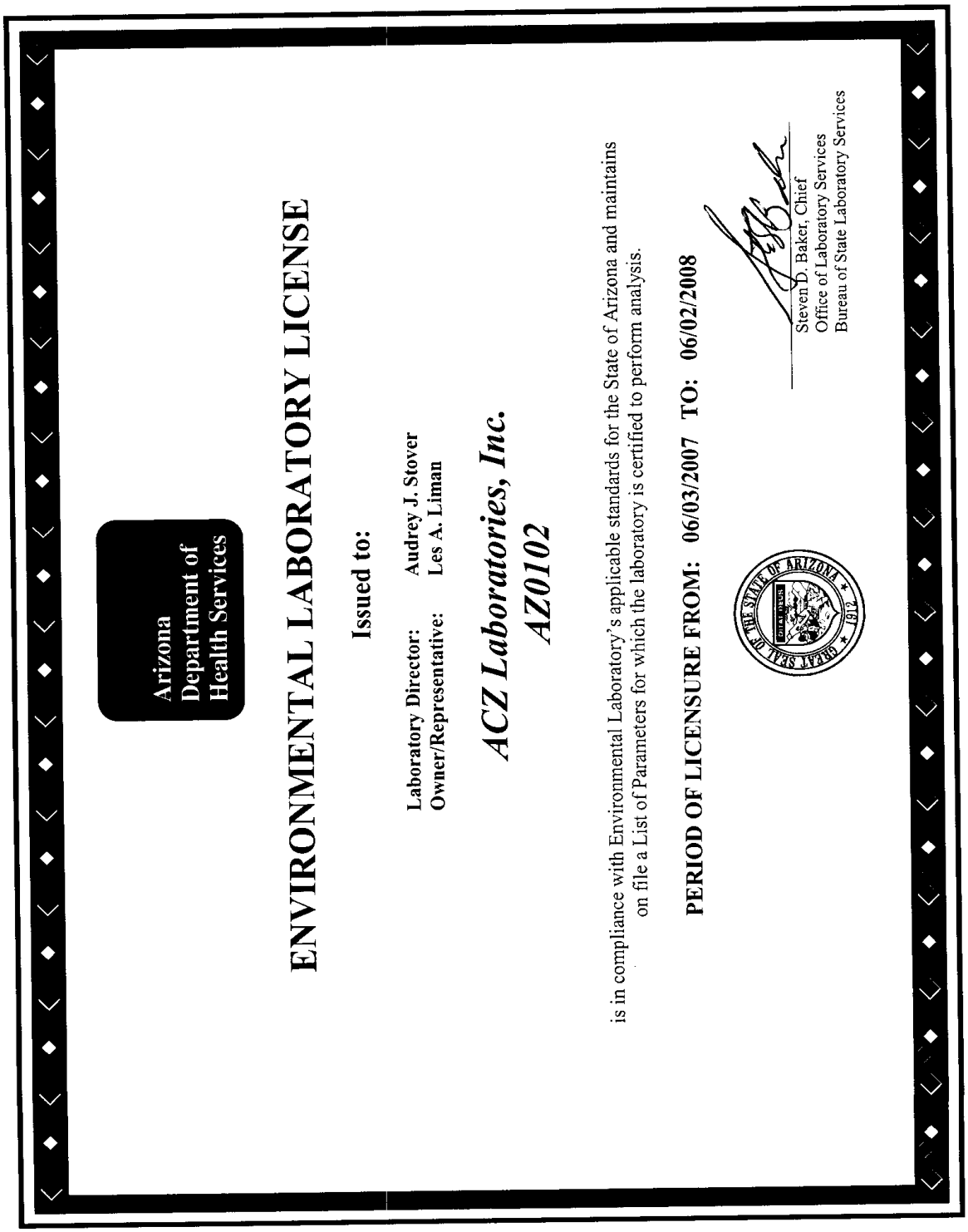
APPENDIX C ADHS Certificate and List of Certified Parameters



Arizona Department of Health Services

ENVIRONMENTAL LABORATORY LICENSE

Issued to:

Laboratory Director: **Audrey J. Stover**
Owner/Representative: **Les A. Liman**

ACZ Laboratories, Inc.
AZ0102

is in compliance with Environmental Laboratory's applicable standards for the State of Arizona and maintains on file a List of Parameters for which the laboratory is certified to perform analysis.

PERIOD OF LICENSURE FROM: 06/03/2007 TO: 06/02/2008

GREAT SEAL OF THE STATE OF ARIZONA 1912

Steven D. Baker, Chief
Office of Laboratory Services
Bureau of State Laboratory Services

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
250 North 17th Avenue, Phoenix, AZ 85007

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Wednesday, June 27 2007

AZ License: **AZ0102**

Lab Director: **Ms. Audrey J. Stover**

Lab Name: ACZ Laboratories, Inc.
Phone: (970) 879-6590
Fax: (970) 879-2216

Program **HW**

Parameter	EPA Method	Billing Code	Cert Date
Alkline Digestion For Hexavalent Chromium	EPA 3060A	PREP2	05/09/07
Alpha-Emitting Radium Isotopes	EPA 9315	RADIO	09/23/97
Aluminum	EPA 6010B	MTL3	06/03/98
Aluminum	EPA 6020	MTL7	04/12/04
Antimony	EPA 6010B	MTL3	05/09/02
Antimony	EPA 6020	MTL7	02/24/97
Aromatic & Halogenated Vocs	EPA 8021B	VOC1	01/15/03
Arsenic	EPA 6010B	MTL3	05/09/02
Arsenic	EPA 6020	MTL7	02/24/97
Barium	EPA 6010B	MTL3	06/03/98
Barium	EPA 6020	MTL7	02/24/97
Beryllium	EPA 6010B	MTL3	05/01/92
Beryllium	EPA 6020	MTL7	02/24/97
Boron	EPA 6010B	MTL3	04/04/06
Cadmium	EPA 6010B	MTL3	06/03/98
Cadmium	EPA 6020	MTL7	02/24/97
Calcium	EPA 6010B	MTL3	06/03/98
Chromium Total	EPA 6010B	MTL3	06/03/98
Chromium Total	EPA 6020	MTL7	02/24/97
Chromium, Hexavalent	EPA 7196A	MTL4	04/12/04
Closed System Purge And Trap Extract. Vocs	EPA 5035A	MISC21	12/05/06
Cobalt	EPA 6010B	MTL3	06/03/98
Cobalt	EPA 6020	MTL7	02/24/97
Continious Liquid-Liquid Extraction	EPA 3520C	PREP2	05/09/02
Copper	EPA 6010B	MTL3	06/03/98
Copper	EPA 6020	MTL7	02/24/97
Corrosivity Ph Determination	EPA 9040C	HAZ1	12/05/06
Cyanide	EPA 9012B	MISC7	12/05/06
Cyanide Extractions For Solids And Oils	EPA 9013A	PREP3	12/05/06
Dissolved In Water	EPA 3005A	PREP1	05/09/02
Gross Alpha And Beta	EPA 9310	RADIO	09/23/97
Hem For Aqueous Samples	EPA 9070A	MISC6	05/09/07
Hem For Sludge,Sediment And Solid Samples	EPA 9071B	MISC6	12/05/06
Hydrogen Ion (Ph)	EPA 9045D	NIA6	12/05/06
Ignitability (Flash Point)	EPA 1010A	HAZ2	12/05/06
Iron	EPA 6010B	MTL3	06/03/98
Lead	EPA 6010B	MTL3	06/03/98
Lead	EPA 6020	MTL7	02/24/97
Lithium	EPA 6010B	MTL3	06/26/02

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Wednesday, June 27 2007

AZ License: AZ0102 **Lab Name: ACZ Laboratories, Inc.**

Program HW

Parameter	EPA Method	Billing Code	Cert Date
Magnesium	EPA 6010B	MTL3	06/03/98
Manganese	EPA 6010B	MTL3	06/03/98
Manganese	EPA 6020	MTL7	02/24/97
Mercury	EPA 7470A	MTL5	06/02/97
Mercury	EPA 7471A	MTL5	05/01/92
Microwave Assisted Digestions	EPA 3015A	PREP1	05/12/03
Microwave Assisted Digestions	EPA 3051	PREP1	06/12/03
Molybdenum	EPA 6010B	MTL3	06/03/98
Nickel	EPA 6010B	MTL3	05/01/92
Nickel	EPA 6020	MTL7	02/24/97
Nonhalogenated Organics Using Gc/Fid	EPA 8015D	VOC4	12/05/06
Paint Filter Liquids Test	EPA 9095B	MISC18	12/05/06
Pcbs By Gc	EPA 8082	SOC9	04/10/03
Potassium	EPA 6010B	MTL3	06/03/98
Purge And Trap For Aqueous Samples	EPA 5030C	PREP2	12/05/06
Radium 228	EPA 9320	RADIO	06/26/02
Sediments, Sludges And Soils	EPA 3050B	PREP1	05/09/02
Semivolatile Compounds By Gc/Ms	EPA 8270C	SOC16	06/03/98
Separatory Funnel Liquid-Liquid Extraction	EPA 3510C	PREP2	05/09/02
Silica	EPA 6010B	MTL3	04/04/06
Silver	EPA 6010B	MTL3	06/03/98
Silver	EPA 6020	MTL7	02/24/97
Sodium	EPA 6010B	MTL3	06/03/98
Soxlhet Extraction	EPA 3540C	PREP2	05/09/02
Splp	EPA 1312	HAZ6	02/15/96
Strontium	EPA 6010B	MTL3	05/09/02
Tclp	EPA 1311	HAZ5	05/01/92
Thallium	EPA 6010B	MTL3	06/26/02
Thallium	EPA 6020	MTL7	02/24/97
Tin	EPA 6010B	MTL3	06/03/98
Titanium	EPA 6010B	MTL3	04/04/06
Total Metals	EPA 3010A	PREP1	05/09/02
Total Recoverable In Water	EPA 3005A	PREP1	05/09/02
Ultrasonic Extraction	EPA 3550B	PREP2	05/09/02
Vocs By Gc/Ms	EPA 8260B	VOC8	06/03/98
Waste Dilution	EPA 3580A	PREP2	05/12/03
Zinc	EPA 6010B	MTL3	06/03/98
Zinc	EPA 6020	MTL7	02/24/97

Total Licensed Parameters in this Program: 77

Program SDW

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Wednesday, June 27 2007

AZ License: AZ0102 **Lab Name: ACZ Laboratories, Inc.**

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Alkalinity	SM 2320B	NIA1	04/10/03
Aluminum	EPA 200.7	MTL3	04/10/03
Antimony	EPA 200.8	MTL7	04/10/03
Arsenic	EPA 200.8	MTL7	04/10/03
Barium	EPA 200.8	MTL7	04/10/03
Beryllium	EPA 200.8	MTL7	04/10/03
Bromide	EPA 300.0	NIIIA1	04/10/03
Cadmium	EPA 200.8	MTL7	04/10/03
Calcium	EPA 200.7	MTL3	04/10/03
Carbon, Total Organic	EPA 5310B	MISC1	04/10/03
Chloride	EPA 300.0	NIIIA1	04/10/03
Chromium Total	EPA 200.8	MTL7	04/10/03
Copper	EPA 200.8	MTL7	04/10/03
Cyanide	EPA 335.4	MISC7	06/26/02
Cyanide	SM 4500 CN F	MISC7	04/10/03
Fluoride	EPA 300.0	NIIIA1	04/10/03
Fluoride	SM 4500-F C	NIB9	04/10/03
Gross Alpha	EPA 900	RADIO	05/12/03
Gross Beta	EPA 900	RADIO	04/10/03
Hardness	SM 2340B	MTL3	05/09/02
Hydrogen Ion (Ph)	SM 4500-H B	NIA6	05/09/07
Iron	EPA 200.7	MTL3	04/10/03
Lead	EPA 200.8	MTL7	04/10/03
Magnesium	EPA 200.7	MTL3	04/10/03
Manganese	EPA 200.7	MTL3	04/10/03
Mercury	EPA 245.1	MTL5	04/10/03
Nickel	EPA 200.8	MTL7	04/10/03
Nitrate	EPA 353.2	NIB1	04/10/03
Nitrite	EPA 353.2	NIIB4	06/26/02
Orthophosphate	EPA 365.1	NIIB5	04/10/03
Preliminary Filtration	SM 3030B	PREP1	12/24/03
Radium 226	EPA 903.1	RADIO	04/10/03
Radium 228	EPA 904	RADIO	04/10/03
Residue, Filterable (Tds)	SM 2540C	NIIA8	04/10/03
Selenium	EPA 200.8	MTL7	04/10/03
Silica	EPA 200.7	MTL3	04/10/03
Silver	EPA 200.8	MTL7	04/10/03
Sodium	EPA 200.7	MTL3	04/10/03
Specific Conductance	SM 2510B	NIA7	04/10/03
Strontium	EPA 200.7	MTL3	04/10/03
Sulfate	EPA 300.0	NIIIA1	04/10/03

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AZ License: AZ0102 **Lab Name: ACZ Laboratories, Inc.**

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Thallium	EPA 200.8	MTL7	04/10/03
Turbidity, Ntu: Nephelometric	EPA 180.1	NIA9	04/10/03
Uranium	EPA 200.8	MTL7	04/13/05
Zinc	EPA 200.7	MTL3	04/10/03

Total Licensed Parameters in this Program: 45

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Acidity	SM 2310B	NIIA1	06/26/02
Alkalinity, Total	SM 2320B	NIA1	06/26/02
Aluminum	EPA 200.7	MTL3	10/16/95
Aluminum	EPA 200.8	MTL7	04/12/04
Ammonia	EPA 350.1	NIIB1	05/01/92
Antimony	EPA 200.7	MTL3	05/09/02
Antimony	EPA 200.8	MTL7	02/24/97
Arsenic	EPA 200.7	MTL3	05/09/02
Arsenic	EPA 200.8	MTL7	02/24/97
Barium	EPA 200.7	MTL3	10/16/95
Barium	EPA 200.8	MTL7	02/24/97
Base/Neutrals And Acids Excluding Pesticides	EPA 625	SOC16	05/12/03
Beryllium	EPA 200.7	MTL3	10/16/95
Beryllium	EPA 200.8	MTL7	02/24/97
Biochemical Oxygen Demand	SM 5210B	DEM1	05/09/07
Boron	EPA 200.7	MTL3	05/01/92
Bromide	EPA 300.0	NIIIA1	09/27/01
Cadmium	EPA 200.7	MTL3	10/16/95
Cadmium	EPA 200.8	MTL7	02/24/97
Calcium	EPA 200.7	MTL3	05/25/94
Chemical Oxygen Demand	EPA 410.4	DEM3	05/01/92
Chloride	EPA 300.0	NIIIA1	05/25/94
Chloride	SM 4500-CL E	NIA2	05/09/07
Chromium Total	EPA 200.7	MTL3	10/16/95
Chromium Total	EPA 200.8	MTL7	02/24/97
Chromium, Hexavalent	SM 3500-CR D	MTL8	05/09/02
Cobalt	EPA 200.7	MTL3	10/16/95
Cobalt	EPA 200.8	MTL7	02/24/97
Copper	EPA 200.7	MTL3	10/16/95
Copper	EPA 200.8	MTL7	02/24/97
Cyanide, Total	EPA 335.4	MISC7	05/08/07
Fluoride	EPA 300.0	NIIIA1	05/09/02
Fluoride	SM 4500-F C	NIB3	05/09/02

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AZ License: AZ0102 **Lab Name: ACZ Laboratories, Inc.**

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Gross Alpha	EPA 900	RADIO	04/10/03
Gross Beta	EPA 900.0	RADIO	04/10/03
Hardness	SM 2340B	NIA5	01/12/06
Hydrogen Ion (Ph)	SM 4500-H B	NIA6	05/09/07
Iron	EPA 200.7	MTL3	10/16/95
Kjeldahl Nitrogen	EPA 351.2	NIIB3	05/09/02
Lead	EPA 200.7	MTL3	10/16/95
Lead	EPA 200.8	MTL7	02/24/97
Lithium	EPA 200.7	MTL3	04/10/03
Magnesium	EPA 200.7	MTL3	05/25/94
Manganese	EPA 200.7	MTL3	10/16/95
Manganese	EPA 200.8	MTL7	02/24/97
Mercury	EPA 1631E	MTL10	04/10/03
Mercury	EPA 245.1	MTL5	10/16/95
Molybdenum	EPA 200.7	MTL3	10/16/95
Molybdenum	EPA 200.8	MTL7	02/24/97
Nickel	EPA 200.7	MTL3	10/16/95
Nickel	EPA 200.8	MTL7	02/24/97
Nitrate-Nitrite (As N)	EPA 353.2	NIB1	05/01/92
Nitrite	EPA 353.2	NIIB4	05/09/07
Oil And Grease, Tph	EPA 1664A	MISC6	12/05/06
Orthophosphate	EPA 365.1	NIIB5	05/01/92
Phenols	EPA 420.4	MISC8	05/09/07
Phosphorus Total	EPA 365.1	NIIB6	05/01/92
Potassium	EPA 200.7	MTL3	05/25/94
Purgeables	EPA 624	VOC8	05/12/03
Radium 226	EPA 903.1	RADIO	04/10/03
Residue Filterable	SM 2540C	NIA8	12/05/06
Residue Nonfilterable	SM 2540D	NIIA5	12/05/06
Residue Total	SM 2540B	NIIA4	12/05/06
Residue Volatile	EPA 160.4	NIIA7	05/01/92
Residue, Settleable Solids	SM 2540F	NIIA6	05/01/92
Selenium	EPA 200.7	MTL3	05/09/02
Selenium	EPA 200.8	MTL7	02/24/97
Selenium	SM 3114B	MTL6	05/09/02
Silica, Dissolved	EPA 200.7	MTL3	05/01/92
Silver	EPA 200.7	MTL3	10/16/95
Silver	EPA 200.8	MTL7	02/24/97
Sodium	EPA 200.7	MTL3	05/25/94
Specific Conductance	SM 2510B	NIA7	05/24/07
Strontium	EPA 200.7	MTL3	05/09/02

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AZ License: AZ0102 **Lab Name: ACZ Laboratories, Inc.**

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Sulfate	EPA 300.0	NIIIA1	05/25/94
Sulfate	SM 4500-SO4 D	NIB3	05/18/05
Thallium	EPA 200.8	MTL7	02/24/97
Tin	EPA 200.7	MTL3	05/09/02
Total Organic Carbon	SM 5310B	MISC1	05/09/07
Turbidity	EPA 180.1	NIA9	05/01/92
Uranium	EPA 200.8	MTL7	02/24/97
Vanadium	EPA 200.7	MTL3	10/16/95
Vanadium	EPA 200.8	MTL7	02/24/97
Zinc	EPA 200.7	MTL3	10/16/95
Zinc	EPA 200.8	MTL7	02/24/97

Total Licensed Parameters in this Program: 85

Instruments	Quantity	Date
GAS CHROMATOGRAPH	4	05/25/94
GAS CHROMATOGRAPH/MASS SPECTROMETER	3	05/09/02
RADIATION COUNTING INSTRUMENT	3	07/11/01
INDUCTIVELY COUPLED PLASMA/MASS SPECTROMETER	3	07/11/01
AUTOMATED AUTOANALYZER	2	05/16/07
ION CHROMATOGRAPH	1	05/09/07
INDUCTIVELY COUPLED PLASMA SPECTROMETER	1	04/04/06
ATOMIC ABSORPTION SPECTROPHOTOMETER	1	05/09/07
MERCURY ANALYZER	1	05/09/02

Softwares
ENVIROQUANT - GCMS
AGILENT - ICP/MS
LEEMAN MERCURY ANALYZER
TJA TRACE-ICP
ENVIROQUANT - HPLC
BERTHOLD LB770 - COUNTER FOR RADIOACTIVITY
TENNELEC LB 5100 - COUNTER FOR RADIOACTIVITY
CANBERRA XLB - COUNTER FOR RADIOACTIVITY

APPENDIX D

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

DEPARTMENT REPORT FOR MANAGEMENT REVIEW OF THE QUALITY SYSTEM

Department: _____ Quarter Ending: _____

OPERATIONS: EVALUATE ALL OPERATIONS (FROM LOG-IN –REPORTING) AS IT PERTAINS TO THE DEPARTMENT

What operations-related issues within the company, including client feedback, have the department encountered during the last quarter? Were any of the issues reoccurring? What actions were taken to resolve the issues? What actions can be taken to reduce/eliminate these issues in the future?

RESOURCES & PERSONNEL: EVALUATE RESOURCES & PERSONNEL AS THEY PERTAIN TO THE DEPARTMENT

Did the department have adequate resources (supplies, instrumentation, facilities, etc.) and properly trained staff for the volume of work? What resources must be available for the work expected next quarter? What obstacles do employees within the department routinely experience that hinder efficiency/productivity?

QUALITY ASSURANCE & QUALITY CONTROL: EVALUATE QA/QC AS THEY PERTAIN TO THE DEPARTMENT

Are any failed QC indicators reoccurring? If so, describe. Were any changes to policies/procedures implemented during the past quarter as a result of corrective and/or preventive actions? If yes, were they effective? If no, what changes would be effective?

MISC: PROVIDE ADDITIONAL FEEDBACK

FRMQA041.08.06.02

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

DATE OF REVIEW : _____

Attendees:

SUITABILITY OF POLICIES & PROCEDURES :

Do ACZ's policies and procedures accurately reflect management's Quality Policy Statement? Are ACZ's policies and procedures effective? If no, what changes are necessary?

REVIEW OF STAFF RESOURCES & TRAINING:

Did ACZ have appropriate staff to handle the volume of work received during the past quarter? Was all staff properly trained and was training documented before a new analyze independently analyzed client samples?

REVIEW OF INSTRUMENTATION / EQUIPMENT, SUPPLIES & CONSUMABLES :

Did ACZ have necessary and properly functioning instrumentation and equipment to perform the volume of work received last quarter? Did ACZ have adequate supplies and consumables on hand to perform the volume of work?

ACZ Laboratories, Inc.
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Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

REVIEW OF RECENT INTERNAL AUDITS:

Did the QA/QC department adhere to its internal audit schedule? Did any department(s) have significant issues? Were corrective actions completed properly and within the agreed time frame? Was follow-up completed for all corrective actions?

REVIEW OF RECENT EXTERNAL AUDITS:

Did the audit report(s) cite any repeat deficiencies? Did any department(s) have significant issues? Were all corrective actions completed properly and within the agreed time frame? Was follow-up completed for all corrective actions?

REVIEW OF RECENT PROFICIENCY TESTING STUDIES:

A) Were all analyte values reported for each study?

WP	NA ☐	Yes ☐	No ☐
WS	NA ☐	Yes ☐	No ☐
RAD	NA ☐	Yes ☐	No ☐
Soil/UST	NA ☐	Yes ☐	No ☐

B) Did ACZ passed 2 out of the 3 most recent PT studies for each analyte?

WP	NA ☐	Yes ☐	No ☐
WS	NA ☐	Yes ☐	No ☐
RAD	NA ☐	Yes ☐	No ☐
Soil/UST	NA ☐	Yes ☐	No ☐

C) Were corrective actions completed within the agreed time frame for all studies?

WP	NA ☐	Yes ☐	No ☐
WS	NA ☐	Yes ☐	No ☐
RAD	NA ☐	Yes ☐	No ☐
Soil/UST	NA ☐	Yes ☐	No ☐

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

REVIEW OF RECENT CORRECTIVE / PREVENTATIVE ACTIONS:

What corrective / preventive actions were implemented during the past quarter? What trends are apparent? Were corrective actions completed within the agreed time frame? Have changes resulting from corrective / preventive actions been implemented? Are they effective?

REVIEW OF CLIENT COMPLAINTS/FEEDBACK:

Did ACZ receive client feedback (positive or negative) during the past quarter? For complaints received, did ACZ adhere to its client complaint policy? Were complaints handled in a manner satisfactory to the client? Were all complaints resolved? What quality indicators are repeated?

REVIEW OF CHANGES IN VOLUME / TYPE OF WORK:

Did ACZ experience a significant change in volume and/or type of work last quarter? How did we do? What improvements can be made? Is ACZ prepared for volume and/or type of work expected next quarter?

REVIEW OF ETHICS PROGRAM:

Were all Ombudsman issues addressed in a timely manner? Were any data intergrity issues/concerns brought to the attention of the Ombudsman issues or dilemmas? Were all employees trained on ACZ's Ethics and Proactive Prevention Program (SOPAD039)? Was follow-up training conducted within the time frame stated in SOPAD039?

ACZ Laboratories, Inc.
2773 Downhill Drive
Steamboat Springs, CO 80487

MANAGEMENT REVIEW OF THE QUALITY SYSTEM

REVIEW OF DEPARTMENTS:

Geochemistry

Clean Room / Prep

Inorganic Inst / Prep

Wet Chemistry Instrument

Wet Chemistry Manual

Organics

Radiochemistry

Log-In

Client Services (Sales / PMs)

Document Control

Information Systems

APPENDIX E REFERENCES UTILIZED BY ACZ

- "NELAC Standards," National Environmental Laboratory Accreditation Conference, (current version).
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," USEPA, Federal Register Vol. 67, No. 205, October 23, 2002.
- "Manual for the Certification of Laboratories Analyzing Drinking Water," USEPA, (current version).
- "Methods for the Chemical Analysis of Water and Wastes," USEPA, EPA-600/4-79-020, March 1983.
- "Test Methods for Evaluating Solid Waste," USEPA, SW-846 Third Edition, Update III, December 1996.
- "Guidelines in Establishing Test Procedures for the Analysis of Wastewater Pollutants," Code of Federal Regulations 40, Parts 136, 141, 143.
- "Quality Assurance of Chemical Measurements," Taylor, J., Lewis Publishers, Michigan, 1987
- "Annual Book of Standards, Water Analysis," ASTM, 1989.
- "Quality Control in Analytical Chemistry," Kateman, G., Vol. 60, 1985.
- "Principles of Environmental Analysis, Analytical Chemistry," Keith, L.H., et al., Vol. 55, 1983.
- "Handbook for Analytical Quality Control in Water and Wastewater Laboratories," USEPA, 1979.
- "Guidance for the Data Quality Assessment: Practical Methods for Data Analysis," USEPA, EPA 600/R-96-084, July 2000.
- "Methods for the Determination of Metals in Environmental Samples," USEPA, EPA 600/4-91-010, June 1991.
- "Methods for the Determination of Metals in Environmental Samples," Supplement I [to EPA 600/4-91-010], USEPA, EPA 600/R-94-111, May 1994.
- "Methods for the Determination of Inorganic Substances in Environmental Samples," USEPA, EPA 600/R-93-100, August 1993.
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA, EPA 821/B-96-005, December 1996.
- "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," USEPA, EPA 600/4-80-032. August 1980.
- "Determination of Lead-210, Thorium, Plutonium and Polonium-210 in Drinking Water: Methods 909, 910, 911, 912," 01A0004860 (Region 1 Library), March 1982.
- "Good Automated Laboratory Practices - Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations" USEPA, 2185, 1995.

APPENDIX F DEFINITIONS OF TERMS

Acceptance Criteria: specified limits places on characteristics of an item, process, or service defined in requirement documents.

Accreditation: verification by a competent, disinterested, third party that a laboratory possesses the capability to produce accurate test data, and that it can be relied upon in its day-to-day operations to maintain high standards of performance.

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator.

Analytical Spike (AS): an aliquot of client sample to which a known amount of target analyte is added and that demonstrates the absence or presence of interference in the matrix. The AS is prepared exactly the same way as the LFB, only spiking into sample instead of reagent blank, and is not prepped (digested) prior to analysis. The AS may also be referred to as a post-digestion spike.

Analytical System: the combination of events, techniques, and procedures used to generate analytical results.

Audit: a systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.

Batch: environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same matrix, meeting the above criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of 20 or less prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group.

All required QC samples must be prepared and/or analyzed with each batch at the frequency required by the method, even if there are less than 20 client samples in the batch. If the workgroup has more than 20 samples, then sufficient batch QC must be analyzed for additional samples. Every batch of environmental samples is assigned a unique (i.e. traceable) six-digit numerical identifier called the LIMS Workgroup number.

Blank: a sample that has not been exposed to the analyzed sample stream utilized to monitor contamination during sampling, transport, storage, or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. See also Equipment Blank, Field Blank, Instrument Blank, Method Blank, Reagent Blank. Refer to section 11.3 for types of blanks.

Blind Sample: a sub-sample for analysis with a composition known to the submitter. The analyst or laboratory may know the identity of the sample but not its composition. It is used to test the analyst or laboratory's proficiency in the execution of the measurement process.

Calibration: to determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of applied calibration standard should bracket the range of planned or expected sample measurements.

Calibration Curve: the graphical relationship between the known values, such as concentrations, or a series of calibration standards and their instrument responses.

Case Narrative: Additional documentation provided in the client report that describes any abnormalities and deviations that may affect the analytical results and summarizes any issues in the data package that need to be highlighted for the data user to help them assess the usability of the data.

Chain of Custody Form: a legal record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses.

Continuing Calibration Blank (CCB): the same solution as the calibration blank, it detects baseline drift in the calibration of the instrument. When specified by the method, analyze a CCB immediately after each CCV, including the final CCV.

Continuing Calibration Verification (CCV): a solution of method analytes of known concentrations used to confirm the continued calibration of the instrument. The CCV is analyzed at the frequency indicated in the test SOP.

Corrective Action: the action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e. the data meet specified acceptance criteria)

Data Reduction: the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form.

Demonstration of Capability (DOC): a procedure to establish the ability of the analyst to generate acceptable accuracy [and precision, if applicable].

Detection Limit: the lowest concentration or amount of target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value (see Method Detection Limit).

Document Control: the act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Equipment Blank: a sample of analyte-free media that has been used to rinse common sampling equipment to check the effectiveness of decontamination procedures.

False Positive (Type I or alpha error): concluding that a substance is present when it truly is not.

False Negative (Type II or beta error): concluding that a substance is not present when it truly is.

Field Blank: a blank prepared in the field by filling a clean container with Type I water and appropriate preservative, if any, for the specific sampling activity being undertaken.

Holding Time (Maximum Allowable Holding Time): the maximum time that samples may be held prior to analysis and still be considered valid or not compromised.

Initial Calibration Blank (ICB): a solution identical to the calibration blank and confirms the absence of background contamination in the calibration blank. When specified by the method, an ICB is analyzed immediately after the ICV.

Initial Calibration Verification (ICV): a solution of method analytes of known concentrations intended to determine the validity of the instrument calibration. The ICV must be analyzed immediately after each calibration and must be prepared from a source independent of the calibration standards, preferably purchased from a different manufacturer.

Instrument Blank: an aliquot of Type I water or solvent processed through the instrument steps of the measurement process; used to determine presence of instrument contamination.

Internal Standard (IS): a known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

Laboratory Fortified Blank (LFB): a reagent blank spiked with a known concentration of analyte. The LFB is analyzed exactly like a sample and determines whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements.

Legal Chain of Custody Protocols: procedures employed to record the possession of samples from the time of sampling until analysis and are performed at the special request of the client. These protocols include the use of a Chain of Custody form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Linear Dynamic Range (LDR): concentration range over which the instrument response to analyte is linear.

Matrix Duplicate (DUP): a second aliquot of a client sample that is prepared and analyzed in the same manner as all other samples in the same workgroup. The DUP demonstrates the precision of the method.

Matrix Spike (spiked sample or fortified sample): a sample prepared by adding a known amount of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes (MS or LFM) are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate: a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Maximum Contamination Limit (MCL): the numerical value expressing the maximum permissible level of contaminant in water that is delivered to any user of a public water system.

May: denotes permitted action, but not required action.

Method Blank: a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as client samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for the sample analyses.

Method Detection Limit: the minimum concentration of an analyte, in a given fortified matrix, that can be measured and reported with 99% confidence that the concentration is greater than zero.

Must: denotes a requirement.

The NELAC Institute (TNI): a voluntary organization of state and federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories.

Outlier (Statistical): an observation or data point that deviates markedly from other members of the population.

Performance Audit: the routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.

Preservation: refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample.

Protocol: a detailed written procedure [SOP] for laboratory operation that must be strictly followed.

Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality.

Quality Control: the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Manual [QAP]: a document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products, and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance and quality control.

Quantitation Limit [Reporting Limit, Practical Quantitation Limit]: level, concentration, or quantity of a target variable (i.e. target analyte) below which data is reported as estimated. The quantitation limit may or may not be statistically determined, or may be an estimate that is based upon analyst experience or judgment.

Raw Data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for reconstructing and evaluating the report of the activity or study.
Reagent Blank (method reagent blank): a sample consisting only of Type I water and reagent(s) without the target analyte(s) or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.

Reference Method: a method of known and documented accuracy and precision issued by an organization recognized as competent to do so (EPA, etc.). The reference method is included on the client report.

Sample Tracking: procedures employed to record the possession of the samples from the time of sampling until analysis, reporting, and archiving. These procedures include the use of a Chain of Custody form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.

Sensitivity: the capability of a method or instrument to discriminate between measurement responses representing different levels (i.e. concentrations) of a variable of interest.

Shall: denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there is no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

Should: denotes a guideline of recommendation whenever noncompliance with the specification is permissible.

Signal to Noise Ratio (S/N): a dimensionless measure of the relative strength of an analytical signal (S) to the average strength of the background instrumental noise (N) for a particular sample.

Spike: a known amount of target analyte added to a blank sample or client sub-sample; used to determine the recovery efficiency or for other quality control purposes.

Standard Deviation: the measure of the degree of agreement (precision) among replicate analyses of a sample. The population standard deviation (n degrees of freedom) should only be used for more than 25 data points; otherwise, when referenced, standard deviation implies sample standard deviation (n-1 degrees of freedom).

Standard Operating Procedure (SOP): a written document which details the manner in which an operation, analysis, or action is performed. The techniques and procedures are thoroughly prescribed in the SOP and are the accepted process for performing certain routine or repetitive tasks.

Supervisor [however named]: the individual designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training, and experience to perform the required analyses.

Surrogate (SURR): a substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.

Test Method: adoptions of a scientific technique for a specific measurement problem, as documented in a laboratory SOP or published by a recognized authority.

Traceability: the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

APPENDIX G TECHNICAL DIRECTORS

Name	Department	Degree
James Rhudy	Organics	BA, Molecular Biology; BA, Biochemistry
Steve Pulford	Metals, Clean Room	BS, Chemical Engineering
Billy Grimes	Metals, Inorganic Inst, Wet Chemistry Manual	BA, Biology
Carol Poirot	Wet Chemistry Instrument, Radiochemistry	BS, Physics; MS, Material Sciences
Lee Thompson	Geochemistry	BS, Microbiology

APPENDIX F.4

QUALITY ASSURANCE MANUAL FOR TURNER LABORATORIES, INC.

Quality Assurance Plan

Revision #19

March 17, 2008

Turner Laboratories, Inc.
2445 N. Coyote Drive
Tucson, Arizona
(520) 882-5880 / (520) 882-9788

Arizona License #AZ0066

Copy #: _____

Issued to: _____

Date Issued: _____

Approved by: Shari Bauman
Shari L. Bauman, Laboratory Director — 3/25/08 Date

Nancy D. Turner
Nancy D. Turner, President — 3/25/08 Date

UNCONTROLLED

Table of Contents

Section 1 Introduction

Turner Laboratories, Inc. (Turner Laboratories) is a professional, independent, full-service laboratory that performs chemical and microbiological testing on a wide variety of sample matrices, including ground and surface water, wastewater, soils, sediments, sludges, industrial and hazardous wastes, and other materials.

This Quality Assurance Plan (QAP) has been developed to provide information on the general procedures, practices, and methods of compliance that Turner Laboratories implements to assure that the highest achievable standards are met.

The information in this QAP has been organized to conform to the requirements specified in the Arizona Administrative Register, A.A.C. R9-14-601 et seq. (December 2006), and the Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition, EPA 815-R-05-004, (January 2005).

Section 1.1 Quality Policy

It is the policy of Turner Laboratories to ensure that all analytical data generated and processed will be scientifically sound, legally defensible, of known and documented quality, and will accurately reflect the materials tested. This is accomplished by implementing quality control procedures that are monitored and assessed during the entire analytical process. Personnel shall be fully qualified to perform the analyses through the combination of education, training and experience. The equipment and supplies shall be obtained as needed to provide for the utilization of established technology and methodology. The performance of personnel and equipment will be continuously monitored and documented. Corrective action must be implemented and documented immediately if a quality problem arises.

Implementation of this QAP is the responsibility of all employees within Turner Laboratories.

Section 1.2 Quality System

The purpose of the Quality Assurance (QA) program at Turner Laboratories is to ensure that our clients are provided with analytical data that is scientifically sound, legally defensible, and of known and documented quality. The concept of Quality Assurance can be extended to the general business operations of Turner Laboratories, and is expressed in the vision statement, issued under the authority of the President.

The objective of the quality assurance program at Turner Laboratories is to assure the accuracy and precision of all analytical results. Turner Laboratories has established specific quality assurance objectives for accuracy and precision that is used to determine the acceptability of the data. These objectives are method and matrix dependant and are provided in the standard operating procedures. Verification that these objectives have been achieved is recorded in the supporting documentation (raw data) and/or in the final report.

Section 2.0 Organization

Section 2.1 Facility

Turner Laboratories features over 8,400 square feet of laboratory equipped with state-of-the-art analytical and administrative support equipment. The laboratory has been designed and constructed to provide safeguards against cross-contamination of samples and is arranged according to work function, which enhances the efficiency of analytical operations. The ventilation system has been specially designed to meet the needs of the analyses performed in each work space. Turner Laboratories also ensures that good housekeeping and facilities maintenance are performed.

In addition, the laboratory work areas are designed for safe and efficient handling of a variety of sample types. These specialized areas (and access restrictions) include:

- Shipping and Receiving
- Sample Management Office, including controlled-access sample storage areas
- Metals Sample Preparation Area
- Metals Laboratory: ICP-AES, GFAA, CVAA
- Water Chemistry & General Chemistry Laboratory
- Semi-Volatile Organics Sample Preparation Area
- Semi-Volatile Organics Laboratory: GC, GC/MS, GC/ECD
- Volatile Organics Laboratory: GC/MS (2)
- Microbiology Laboratory
- Laboratory Management, Client Service, Report Generation and Administration
- Data Archival, Data Review and support functions areas
- Information Technology (IT) and Laboratory Information Management System (LIMS)

In addition, the designated areas for sample receiving, refrigerated sample storage, dedicated sample container preparation and shipping provide for the efficient and safe handling of a variety of sample types. The laboratory is equipped with state-of-the-art analytical and administrative support equipment. The equipment and instrumentation are appropriate for the procedures in use. Appendix C lists all the major analytical equipment illustrating the laboratory's overall capabilities and depth.

Turner Laboratories Contingency Plan consists of, but not limited to the following:

- Analysis of samples on back-up instrumentation
- Subcontract samples to a certified laboratory
- Ensure that qualified staff are available to perform the necessary work

Section 2.2 Responsibilities

Turner Laboratories is committed to the excellence of data quality and providing an environment that fosters such quality. Every person employed at Turner Laboratories is responsible for improving and maintaining the quality of our analytical services. Responsibilities of key positions within the laboratory are described below. A chart showing the laboratory organization and lines of responsibility is included in Appendix A.

- The **Laboratory Director** has overall responsibility for all elements of the laboratory's technical operations, implementation of the QAP, and ensuring that all data reported by the laboratory meets the objectives of the QAP. This laboratory director or his/her designee performs a final quality assurance review on all final reports issued by the laboratory.

- The **Inorganics Laboratory Supervisor** and the **Organics Laboratory Supervisor** supervise and train the analysts. They also ensure that the quality of all data reported by their laboratories meets the objectives of the QAP, and they ensure the accuracy, completeness, and timely review of standard operating procedures (SOP) for all procedures used.

- The **Quality Assurance Officer** is responsible for the implementation of the QAP in the laboratory. The quality assurance officer reports directly to the laboratory director and has the following general duties: ensures that the QAP is up to date and reflects current laboratory policy; ensures that SOPs are completed and reviewed for all test methods; performs regular, random reviews of data generated by the laboratory; ensures that internal audits of the laboratory are conducted as specified in the QAP; keeps abreast of regulatory changes and ensures that the laboratory remains in compliance; ensures that control charting of QC data occurs and that limits are updated regularly, where required; and, ensures that personnel complete the proper documentation for tests they perform (i.e. MDL studies, initial demonstration of capabilities, etc.).

- The **Sample Management Officer** ensures that sample management procedures meet our QAP objectives and ensures the accuracy, completeness, and timely review of SOPs for all sample management procedures. The sample management officer is responsible for the login of samples into LIMS.

- The **Administrative Assistant** supervises and schedules the work of the field sampling personnel. This employee also maintains contracts and technical records, and holds selected project management responsibilities.

- **Analysts** perform testing according to established SOPs and methods and ensure that the data quality meets specified criteria.

All analysts are required to provide a summary of their education and experience relevant to the compliance testing they will perform. The summaries are retained in their personnel training record and are subject to inspection by regulatory agencies. Documentation must include academic training, experience, specific qualifications for the position, certifications, and other specialized training.

Section 3 Personnel Qualifications

3.1 Personnel Training

Qualifications of personnel are retained in personnel training files. Documentation must include academic training, experience, specific qualifications for the position, certifications, and other specialized training.

The employees' quality assurance orientation must be performed at the start of employment. The training is documented in the personnel training file. The orientation includes the review, but not limited, to the following:

- Orientation to the facility and facility policies;
- Review of the Turner Laboratories' Safety Manual;
- Review of the Quality Assurance Plan (QAP); and
- Review of the data integrity, applicable methods and Standard Operating Procedures (SOP) for the testing to be performed.

Before reporting results, the analyst must document that he/she has completed the following:

- Training in the use of the instrumentation and appropriate techniques used for compliance testing. The training may be in-house, classroom experience, or manufacturer's training. Records must indicate the place, date and length of training;
- Completion of all activities as required in the method criteria for initial demonstration of capability;
- Successful analysis of unknown quality control sample and/or proficiency evaluation sample (sample may be prepared in-house as a blind sample to the analyst or may be purchased from an external source).

Documentation of these training requirements are maintained in the employee's personnel training record, as outlined in the Turner Laboratories Policy Statement, Policy No. 4 pertaining to the maintenance of personnel training records.

Section 3.2 Laboratory Ethics

One of the most important aspects of the success of Turner Laboratories is the emphasis placed on the integrity of the data provided and services performed. To promote product quality, employees are required to comply with certain standards of conduct and ethical practices. The following examples of Turner Laboratories' policy are representative of these standards, include but not limited to the following:

- Under no circumstances is the willful act of fraudulent manipulation of analytical data condoned. Such acts are to be reported immediately to senior management for appropriate corrective action. Unless specifically required in writing by a client, alteration, deviation or omission of written contractual requirements is not permitted. Such changes must be in writing and approved by senior management.

- Falsification of data in any form will not be tolerated. While much analytical data is subject to professional judgment and interpretation, outright falsification, whenever observed or discovered, will be documented, and appropriate remedies and punitive measures will be taken toward those individuals responsible. Employee discipline is progressive in its severity and each situation is handled individually in that the discipline is designed to fit the circumstances. Potential disciplinary actions may include a verbal warning, written warning, a second written notice (more severe and more strongly worded than a warning), and suspension without pay, demotion, or termination.

- It is the responsibility of all Turner Laboratories employees to safeguard sensitive company and client information. The nature of our business and the well being of our company and of our clients is dependent upon protecting and maintaining proprietary company/client information. All information, data, and reports (except that in the public domain) collected or assembled on behalf of a client is treated as confidential. Information may not be given to third parties without the consent of the client. Unauthorized release of confidential information about the company or its clients is taken seriously and is subject to formal disciplinary action.

As part of this commitment, every employee at Turner Laboratories signs and abides by a fraud-disclosure form that reads as follows:

> "If I should become aware of any of the following conditions or events by anyone during my employment at Turner Laboratories, I agree to notify the principals of Turner Laboratories immediately:
>
> 1. Short-cutting of any procedural steps, or QA/QC falsification;
> 2. Altering data in any manner whatsoever;
> 3. Altering time records to avoid missed holding times;
> 4. Any condition that would, if known, result in the rejection of any analytical report by any regulatory agency - federal, state or local.
>
> "Should it become known that any information has been suppressed by any employee that could endanger the State operating license of Turner Laboratories or affect the ability to produce accurate scientific measurements, counsel will be retained by Turner Laboratories for possible legal action."

Turner Laboratories makes every attempt to ensure that employees are free from any commercial, financial, or other undue pressures that might affect their quality of work.

Section 3.3 Client Confidentiality

Turner Laboratories professional ethics require that each employee maintain the highest degree of confidentiality when handling client affairs. Turner Laboratories shall ensure that all client documents and test results are confidential. In order to maintain this professional confidence, no employee shall disclose client information to outsiders, including other clients or third parties and members of one's own family.

Turner Laboratories has instituted procedures for protecting client confidentiality. A unique internal control number is assigned to individual samples by the LIMS. The assigned number is the primary mechanism for tracking a given sample through the laboratory system.

Under no circumstance will outside requests for client material be fulfilled unless prior written permission is received from the client to the Laboratory Director.

All employees at Turner Laboratories have signed a confidentiality agreement form regarding the information provided in this section that reads as follows:

"If I become aware of any of the above mentioned events during my employment at Turner Laboratories, I agree to notify the principals of Turner Laboratories immediately. Should it become known that any information has been disclosed by an employee, the employee will be terminated and counsel will be retained by Turner Laboratories for possible legal action."

Section 4 Documents and Records

Section 4.1 Controlled Documents

Turner Laboratories has an established document control system that forms part of the quality system. Controlled documents are those documents and data that are required for the operation of the quality system. These documents must be controlled by being replaced in whole when revised. The controlled documents include, but are not limited to:

- Quality Assurance Plan (QAP)
- Standard Operating Procedures (SOPs)
- Instrument Logbooks
- Standard Preparation Logbooks
- Nonconformance/Corrective Action Documents
- Instrument Maintenance Logbooks

Copies of controlled documents that are released, such as the Quality Assurance Plan and Standard Operating Procedures will be marked "Uncontrolled" and are not numbered. The control of the controlled documents is documented in an access log.

Section 4.2 Document Signatures

Controlled documents must have approval signatures. The Quality Assurance Plan will have the signature of the President and Laboratory Director. The Standard Operating Procedures will have the signatures of the Laboratory Director, Quality Assurance Manager, and analyst. Final reports that are issued by the laboratory will have the signature of the laboratory director or his/her designee that performs a final quality assurance review.

Section 4.3 Document Review and Revisions

The QAP is reviewed on an annual basis unless regulatory change necessitates an earlier revision. The SOPs are reviewed on an annual basis. Other QA documents that may require revision are reviewed during internal QA audit and are revised as needed.

Any revisions to controlled QA documents are prepared by the Laboratory Director. The QA Manager will review the document. All changes to records are signed or initialed by the responsible staff. Corrections are indicated by on-line mark through with a signature or initials.

Section 4.4 Document Retention & Disposal

The original observations, calculations and derived data, calibration records, audit reviews and the client reports retained for a minimum of five (5) years. The files are achieved in boxes according to department, instrument and/or client with inclusive dates. After 5 years of archival (unless the client or contract specifies otherwise), eligible archives (not including SOPs or QAP) are purged and destroyed. Disposal of purged materials is accomplished by shredding/destruction of the material.

Turner Laboratories archiving system includes all of the following items for each set of analyses performed:

- Benchsheets describing sample preparation (if appropriate) and analysis;
- Instrument parameters (or reference to the data acquisition method);
- Sample analysis sequence;
- Instrument printouts, including chromatograms and peak integration reports for all samples, standards, blanks, spikes and reruns;

- Logbook ID number for the appropriate standards;
- Copies of report sheets submitted to the work request file; and
- Copies of Nonconformity and Corrective Action Reports, if necessary.

Individual sets of analyses are identified by analysis date and service request number. Since many analyses are performed with computer-based data systems, the final sample concentrations can be automatically calculated. If additional calculations are needed, they are written on the integration report or securely stapled to the chromatogram, if done on a separate sheet.

In the event that Turner Laboratories should go out of business or be bought by another company, all clients will be notified immediately. Client records will be handled by one of the following:

- If the client wishes to have control of their data, they will be given the original copies.
- If another company buys Turner Laboratories and the client wishes to have control of their data, they will receive the original copies and an exact copy (with proper documentation) will be retained by the purchaser. The purchaser will be responsible for retaining the data for the remainder of the applicable time.

Section 4.5 Computer Hardware & Software

Turner Laboratories utilizes the commercially purchased Omega Laboratory Information Management System (LIMS). The LIMS is a secure, password protected database. The Laboratory Director monitors the analytical activities and database performance. Changes to the LIMS are controlled by the Laboratory Director. The electronic instrument files, LIMS and server system are electronically backed-up on a routine basis.

Documentation is maintained to demonstrate the validity of the software. For software that performs numerical manipulations, the results are verified by either hand calculations or using another software program.

All purchased software must be used in accordance with the terms of its software license.

Section 5 Processes & Operations

Section 5.1 Sampling

The quality of analytical results depends largely upon the quality of procedures used to collect and transport samples. Turner Laboratories does not sample substances, materials or products for subsequent environmental testing under the accreditation program. Turner Laboratories recommends to their clients to follow appropriate methodology and regulations, such as the requirements specified in 40 CFR Part 136 or the US EPA's SW-846.

Turner Laboratories suggest to clients to consider the following:

- Sample matrix;
- Quantity of sample needed for testing;
- Type of container;
- Type of sample preservation;
- Transport time;
- Storage (holding) time; and
- Complete documentation for chain-of-custody purposes.

At the clients' request, Turner Laboratories provides the following:

- Sample containers with the appropriate preservatives as specified in the applicable standard operating procedure;
- Shipping containers;
- Chain-of-custody forms; and
- Custody seals.

Where obtaining sample aliquots from a submitted sample is carried out as part of a test method, Turner Laboratories follows the appropriate procedures and techniques to obtain representative sub samples. Any deviation from standard procedures is recorded on the data package.

Section 5.2 Handling of Samples

The chain-of-custody is a system for tracing the possession of a sample from collection to final disposition. This system is implemented to protect the interests of the laboratory and the client. Changes to the sample custody must be recorded on a chain-of-custody form and must accompany the sample at all times.

Turner Laboratories requires clients to submit a completed chain-of-custody form with each sample or group of samples for analysis.

The chain-of-custody program consists of the following:

- The established protocol for sampling will be followed for all chain-of-custody samples. Sample containers and preservatives should adhere to EPA and/or other appropriate requirements;

- At the time of sampling, the sampler completes the information on the chain-of-custody form, including date, time, client's name, sample name, sample matrix, number of containers, required tests, and signature;

- At all times after sampling, the sample must be in either the actual physical possession of the currently responsible individual or under laboratory control;

- When a client delivers the sample to Turner Laboratories, Turner Laboratories staff documents all subsequent changes of possession that occurs;

- Responsibility for a particular sample concludes for one party at the point when delivery is documented to the next responsible party (the receiving laboratory or commercial carrier); and

- If the sample is to be transported to another laboratory (for testing not performed by Turner Laboratories), the carrier is selected based on holding time criteria. The delivery is documented and transfer of possession to the carrier on the chain-of-custody form or by retention of applicable shipping documents.

Complete sample handling procedures are available in Turner Laboratories SOP SC-1.

Section 5.3 Sample Receipt and Management

Established standard operating procedures for receiving samples ensure that the samples are received and logged into the laboratory that all associated documentation (including chain-of-custody forms) is complete and consistent with the samples received, and that storage and tracking are conducted so that the samples' integrity is maintained.

Verification of sample integrity is documented upon sample receipt on the Sample Receipt Checklist and requires the following conditions:

- The sample is clearly identified and matches the description on the chain-of-custody form;
- The condition of samples and sample containers meets method specifications;
- A sufficient quantity of sample is available so that all required tests can be performed;
- The sample is received within the specified holding time, and temperature requirement; and
- Preservation is confirmed by the analyst conducting the method.

If there is doubt as to the suitability of a sample or when the sample does not conform to the description provided, or the environmental test required is not specified in detail, Turner Laboratories will consult the client for further instructions before preceding and the discussion shall be recorded on the sample receipt checklist that is retained with the work order.

At Turner Laboratories, each sample is logged into the laboratory information management system (LIMS), a secure, password protected database that facilitates tracking and reporting of samples. The LIMS assigns a unique chronological laboratory identification number to each sample, and the sample management technician adds pertinent information concerning collection date and time, matrix, container, preservation, and required tests. The unique identification number is also documented in the sample record logbook. All sample receipt documentation is retained with the sample work order through to final reporting and then retained electronically.

The sample management technician affixes labels to the sample container(s) with the unique laboratory identification number and stores the sample until analysis (under refrigeration if required). Samples with expedited turn-around times or whose tests have short holding times are given directly to the appropriate analysts. The laboratory director or qualified designee reviews the work order for completeness and indicates approval electronically in the LIMS system.

To facilitate timely analysis of samples, the analysts generate daily backlog and/or holding time reports.

Turner Laboratories retains samples for thirty days after completion of analyses (unless other arrangements have been made) and then disposes of them using approved disposal practices (QAP Section 4.4). Complete sample receipt and management procedures are available in Turner Laboratories SOPs SC-1, SC-2 and SC-3.

Section 5.4 Standard Operation Procedures (SOPs)

Turner Laboratories employs methods and analytical procedures from a variety of sources. The primary method references are USEPA SW-846, Third Edition and Updates I, II, IIA, IIB, and III for hazardous wastes and USEPA 600/4-79-020. 600/4-88-039, 600/R-93-100, 600/R-94-111 and supplements and Standard Method for the Examination of Water and Wastewater. Other published procedures such as state-specific methods or in-house methods may be used. The implementation of methods by Turner Laboratories is described in the SOPs for each specific method. A list of the Turner Laboratories' SOPs and methods are provided in Appendix E.

Turner Laboratories maintains standard operating procedures (SOPs) and policies for all analytical procedures used at Turner Laboratories, including compliance and non-compliance methods. The protocols to monitor quality control and the acceptance criteria are provided for each method in each SOP.

All current and previous versions of SOPs and policies are retained in the quality assurance officer's office. The current SOPs are also available in the Laboratory Directors office and in each of the laboratories.

SOPs are reviewed at least once a year by the laboratory supervisors, the quality assurance officer, and the laboratory director. Minor changes, additions, and deletions are annotated on the procedure itself, and before changes are put into use for testing, the laboratory supervisor approves, dates, and initials them. A finalized copy of a SOP should be completed within 30 days for any major modifications.

Review of a SOP is documented by the reviewer's signature on the cover page; review of a policy is documented by the reviewer's signature at the bottom of the policy. These signatures document the SOPs or policy's acceptability as of the review date. New procedures are reviewed, dated, and signed when they are implemented. Each SOP refers to the mandated methodology.

Section 6 Calibration Procedures

All equipment used for environmental testing at Turner Laboratories are operated, maintained and calibrated according to the manufacturer's guidelines and recommendations, as well as to criteria set forth in the applicable analytical methodology. Operation and calibration are performed by personnel who have been properly trained in these procedures. Documentation of calibration information is maintained in appropriate reference files.

Brief descriptions of the calibration procedures for our major laboratory equipment and instruments are described below. Records are maintained to provide traceability of reference materials.

Any item of the equipment which has been subjected to overloading or mishandling, or has been shown by verification or otherwise to be defective; is taken out of service until it has been repaired or is replaced by new equipment. The equipment is placed back in service only after verifying by calibration that the equipment performs satisfactorily. An evaluation of the effect of this defect on previous calibrations or tests is made and documented appropriately. Calibration verification is performed according to in the applicable analytical methodology. Calibration verification procedures and criteria are listed in the appropriate SOP. Documentation of calibration verification is maintained in appropriate reference files.

Section 6.1 Chemical Standards

Analysis standards prepared from stock solutions are stored in containers consistent with their stability. The containers are labeled with the standard number, expiration date, concentration of analyte(s) and the preparers' initials. Only the highest quality chemicals are used as reference materials. Whenever possible, standard solutions will be traceable to national standards such as NIST or EPA certified reference materials. The type and standard preparation information is provided in the specific method SOP.

A standards log book is used to document the sources of primary standards, lot numbers of primary standards, date of receipt, expiration date, method of preparation of working stock standards, date of preparation of working standard, and the analysts initials. The procedure used for preparation of reagents is also documented in the standards logbook and includes weights, volumes, dilutions, and source of the stock solution or chemical reagent and lot numbers. Certification of manufacturer's analysis and/or traceability of primary standards/sources to EPA certified standards are retained in the laboratory.

Section 6.2 Temperature Control Devices

Temperatures are monitored and recorded for all of the temperature-regulating support equipment such as sample refrigerators, freezers, and standards refrigerators. Temperature record sheets contain daily-recorded temperatures, identification and location of equipment, and acceptance criteria.

All thermometers are identified according to location and serial number, and the calibration of these thermometers is checked annually against a National Institute of Standards and Technology (NIST) certified thermometer. The NIST thermometer should be recalibrated at least every 5 years or whenever the thermometer has been exposed to temperature extremes.

Infrared (IR) temperature detection devises should be verified annually using a NIST certified thermometer. Each day of use, a single check of the IR should be made by checking the temperature of a bottle of water at the temperature of interest that contains a calibrated thermometer. The temperature check is to be recorded on Temperature record sheets.

Section 6.3 Analytical Balance

The calibration of the analytical balance is performed daily, monthly and annually. The specific procedures are provided in Turner Laboratories' Policy No. 1.

Section 6.4 Pipets

The calibration of autopipettors used in the preparation of primary and secondary standards must be calibrated on the day the standards are prepared within +2 % of the set value. The pipets must be calibrated at the highest and lowest settings used. The results of all calibration verifications are recorded on worksheets and retained in the laboratory.

Section 6.5 Instruments

The accuracy of a chemical analysis is dependant on the quality of reference standards and reagents used during the preparation and analysis of the sample. The calibration procedures, frequency of initial and continuing verification and criteria for evaluation of calibration data are described in the individual methods. Detailed requirements are contained within the applicable SOP.

All instrument calibrations are documented in logbooks or data packages.

Section 7.0 Quality Control

Quality Control (QC) is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the established requirements. Individual methods require certain quality control criteria and acceptance, and are described in detail in the associated SOP.

Section 7.1 Method Detection Limit

The Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. An MDL study requires that all sample processing steps of the analytical method be included in the determination of the method detection limit. Turner Laboratories establishes MDL's for each applicable method and analyte reported by the laboratory. Turner Laboratories revalidates these MDL's based on method set time frames or every 2 years, whichever is more frequent.

Turner Laboratories follows the procedures as described in 40 CFR, Part 136, Appendix B, Definition and Procedures for the Determination of the Method Detection Limit. This procedure is summarized in Turner Laboratories' Policy No. 5.

Section 7.2 Practical Quantitation Limit

The Practical Quantitation Limit (PQL) is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. It is generally 3 to 10 times the MDL.

Section 7.3 Initial Demonstration of Capability

Each analyst must initially analyze 4 replicates of a standard/Laboratory Control Sample prior to the analysis of samples. The analyte(s) shall be diluted in a volume of clean quality system matrix. The mean recoveries and standard deviations for each analyte is calculated and compared with method or in-house limits as appropriate.

The Demonstration of Capability must be completed at any time there is a significant change in instrument type, personnel or test method.

The analysis of actual samples only begins if all parameters meet the acceptance criteria. If one or more of the tested parameters fail the acceptance criteria, the analyst will either determine the source of the problem and repeat the test for all parameters or repeat the test for the parameters that failed. Repeat failure will initiate the review of the methodology, correction of the problem and repeat analysis of all parameters.

Section 7.4 Quality Control Procedures

The specific types, frequencies, and processes for quality control sample analysis are described in detail in method-specific standard operating procedures. In each specific SOP, the sample types and frequencies are described in detail and brief descriptions are provided below.

Section 7.4.1 Method Blank (Laboratory Reagent Blank)

The method blank is either analyte-free water, subjected to the entire analytical process. The method blank is analyzed to demonstrate that the analytical system itself is not contaminated with the analyte(s) being measured. The method blank results should be below the Practical Quantitation Limit (PQL). Otherwise,

corrective action must be taken. A method blank is included with the analysis of every sample preparation batch, every 20 samples, or as stated in the method, whichever is more frequent.

Section 7.4.2 Calibration Blanks

For some methods, calibration blanks are prepared along with calibration standards to create a calibration curve. Calibration blanks are free of the analyte of interest and, where applicable, provide the zero point of the calibration curve.

Section 7.4.3 Continuing Calibration Blanks

Continuing calibration blanks (CCBs) are solutions of analyte-free water, reagent, or solvent that are analyzed in order to verify the system is contamination-free when CCV standards are analyzed. The frequency of CCB analysis is either once every ten samples or as indicated in the method, whichever is greater.

Section 7.4.4 Calibration Standards

Calibration standards are solutions of known concentration prepared from primary standard solutions that are, in turn, prepared from stock standard materials. Calibration standards are used to calibrate the instrument response with respect to analyte concentration. Standards are analyzed in accordance with the requirements stated in the particular method being used.

Section 7.4.5 Initial Calibration Verification Standards

Initial calibration verification standards (ICVs) are standards that are analyzed after calibration with newly prepared standard(s) but prior to sample analysis, in order to verify the validity and accuracy of the standards used in the calibration. Once it is determined that there is no reference material defect or systematic error in preparation of the calibration standard(s), standards are considered valid and may be used for subsequent calibrations and quantitative determinations (as expiration dates and methods allow). The ICV standards are prepared from materials obtained from a source independent of that used for preparing the calibration standards ("second-source"). ICVs are also analyzed in accordance with method-specific requirements.

Section 7.4.6 Continuing Calibration Verification Standards

Continuing calibration verification standards (CCVs) are mid-range standards that are analyzed in order to verify that the calibration of the analytical system is still acceptable. The frequency of CCV analysis is either once every ten samples, or as indicated in the method.

Section 7.4.7 Internal Standards

Internal standards are known amounts of specific compounds that are added to each sample following sample preparation or extraction. Internal standards are generally used for GC/MS and ICP-MS procedures to correct sample results that have been affected by changes in instrument conditions or changes caused by certain matrix effects. The requirements for evaluation of internal standards are specified in each method and SOP.

Section 7.4.8 Surrogates

Surrogates are organic compounds which are similar in chemical composition and chromatographic behavior to the analytes of interest, but which are not normally found in environmental samples. Depending on the analytical method, one or more of these compounds is added to method blanks, calibration and check standards, and samples (including duplicates, matrix spike samples, duplicate matrix spike samples and laboratory control samples) prior to extraction and analysis in order to monitor the method performance on each sample.

The percent recovery is calculated for each surrogate, and the recovery is a measurement of the overall method performance. The percent recovery is compared to the acceptance criteria per the method. Where criteria are not established the acceptance criteria shall be based upon internal criteria. If the surrogate recoveries are outside of acceptance criteria, appropriate corrective action should be followed.

Section 7.4.9 Laboratory Control Samples (Laboratory Fortified Blanks)

The laboratory control sample (LCS) is an aliquot of analyte-free water to which known amounts of the method analyte(s) is (are) added. A reference material of known matrix type, containing certified amounts of target analytes, may also be used as an LCS. The LCS sample is prepared and analyzed in the same analytical batch, and in exactly the same manner, as the other routine samples per the method or regulatory requirements. An LCS is prepared and analyzed at a minimum frequency of one LCS per 20 samples, with every analytical batch or as stated in the method, whichever is more frequent.

The percent recovery (% REC.) of the target analytes in the LCS are compared to the acceptance criteria per the method. The percent recovery assists in determining whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements at the required reporting limit. Comparison of batch-to-batch LCS analyses enables the laboratory to evaluate batch-to batch precision and accuracy. Acceptance criteria for LCS analyses are obtained through the use of control charts.

The LCS is prepared in duplicate as the LCSD. The relative percent difference between an LCS and LCSD is a measure of the precision for a given method and analytical batch. LCS/LCSD samples are performed at a minimum frequency of one per batch or per 20 samples.

Section 7.4.10 Matrix Spikes (Laboratory Fortified Sample Matrix)

Matrix spiked samples are aliquots of samples to which a known amount of the target analyte (or analytes) has been added. The samples are then prepared and analyzed in the same analytical batch, and in exactly the same manner as are routine samples. The stock solutions used for spiking the sample(s) are purchased and prepared independently of calibration standards. The spike recovery measures the effects of interferences caused by the sample matrix and reflects the accuracy of the method for the particular matrix in question. For the appropriate methods, matrix spiked samples are prepared and analyzed at a minimum frequency of one spiked sample (and one duplicate spiked sample, if appropriate) per 20 samples and determined based on the clients data quality objectives.

Depending on the method of analysis, a matrix spiked sample and duplicate matrix spiked sample (MS/MSD) are analyzed. The relative percent difference between an MS and MSD is a measure of the precision for a given method and analytical batch. Depending on the method of analysis, MS/MSD samples are performed at a minimum frequency of one set per 20 samples.

Section 7.4.11 Interference Check Samples

An interference check sample (ICS) is a solution containing both interfering and analyte elements of known concentration that can be analyzed to verify background and interelement correction factors in metals

analyses. The ICS is prepared to contain known concentrations of interfering elements that will provide an adequate test of the correction factors. The ICS is spiked with the elements of interest at concentrations of approximately ten times the instrument detection limits. The ICS is analyzed at the beginning and end of an analytical run or every eight hours, whichever is more frequent, and the results must be within ± 20% of the true values.

Section 7.4.12 Post Digestion Spikes

Post digestion spikes are samples prepared for metals analyses that have an analyte spike added to determine if matrix effects may be a factor in the results. The spike addition should produce a method-specified minimum concentration above the instrument detection limit. A post digestion spike is analyzed with each batch of samples and recovery criteria are specified for each method.

Section 7.5 Calculations

The Standard Operating Procedures include equations for the calculations that are applicable to each particular method. Several common calculations follow:

Section 7.5.1 Accuracy

Accuracy is the closeness or nearness of a data point or analytical result measured by the test method to the true value. Accuracy is expresses as a percentage of recovery (R) of the true value.

Accuracy of the Laboratory Control Samples is as follows:

$$\%\,R = \left(\frac{\text{Value of Spike in Pure water}}{\text{Value of Added Spike}} \right) \times 100$$

The matrix spike recovery is calculated according to:

$$\%\,R = \left(\frac{\text{Value of Spike Sample - Value of Unspiked Sample}}{\text{Value of Added Spike}} \right) \times 100$$

Section 7.5.2 Precision

Precision is the reproducibility of an analytical procedure resulting from replicate analyses of homogeneous sample regardless of the true value. The precision of a matrix spike sample (MS) and a matrix spiked duplicate (MSD) or by the analysis of replicate aliquots of a sample. Duplicates are used for those tests that are not amenable to spiking.

Precision is determined by calculation the Relative Percent Difference (%RPD) between the MS and MSD as follows:

$$\%\text{RPD} = \left(\frac{(X_1 - X_2)}{\left(\frac{X_1 + X_2}{2} \right)} \right) \times 100$$

Section 7.5.3 Control Limits and Charting

The generation of control charts is routinely performed at Turner Laboratories. Surrogate, Matrix Spike and LCS recoveries are monitored and charted. New control limits are generated periodically. The control charts are used to monitor the data generated to identify various trends in the analytical results. If trends in the data are perceived, various means of corrective action may then be employed in order to prevent future problems with the analytical system(s).

Control limits are also calculated for methods that do not have prescribed quality control limits. After review of the data by the Quality Assurance Manager, the new acceptance limits determined from the control charting replaces the previous limits and data is assessed using the new values. These control limits are updated when new statistical limits are generated for the appropriate surrogate, laboratory control sample, and matrix spike compounds (typically once a year) or when method prescribed limits change.

Section 7.5.4 Representativeness

Representativeness is the degree to which the field sample represents the overall sample site or material. This can be extended to the sample itself, in that representativeness is the degree to which the subsample that is analyzed represents the entire field sample submitted for analysis. Analytical SOPs specify appropriate sample handling and sample sizes to further ensure the sample aliquot that is analyzed is representative in entire sample.

Section 8.0 Data Reduction, Validation, and Reporting

Section 8.1 Data Reduction and Validation

All analysts performing testing must use the established, approved procedures and quality control mechanisms required by the procedure. If any aberrant or non-compliance results appear for the analyses or for the quality control, the analyst must follow the steps outlined in the QAP Section 15.

Results are generated by the analyst who performs the analysis and works up the data. All observations, data and calculations are recorded at the time they are made. All data is initially reviewed and processed by analysts using appropriate methods (e.g., chromatographic software, instrument printouts, hand calculation, etc.). Equations used for calculation of results are provided in the applicable analytical SOPs. The resulting data set is either manually entered (e.g., titrimetric or microbiological data) into an electronic report form in LIMS. The hardcopy version of the analytical report is then reviewed by the analyst for accuracy and forwarded to the supervisor, for secondary review.

All data calculations are written on printed data forms or provided on computer printouts, using the unique sample identification number assigned to the sample(s). When the entire data set has been found to be acceptable, a final copy of the report is printed and signed by the designated laboratory staff.

The laboratory director is responsible for all testing conducted in the laboratory, including the day-to-day analytical results and quality control practices. The data's integrity is reviewed based on the quality control parameters listed in the standard operating procedures. To ensure that the following five requirements have been met, the laboratory director reviews analytical results and the accompanying quality control documentation before releasing the final reports.

- The established monitoring programs have been conducted as required;
- All documentation is complete for sample test results and the associated quality control;
- Test results are reasonable according to historical data or special conditions for the sample;
- The quality control data are acceptable according to established ranges and other criteria; and
- The results have been transcribed without error.

The integrity of data is verified using a variety of measures, including method blanks, duplicate sample analyses, matrix spikes, and laboratory control samples. The calibration data, accuracy of check standards, system sensitivity, preventive maintenance documentation (equipment integrity), data transcriptions, and calculations are also reviewed. The quality control parameters vary per method and are provided in the individual SOPs.

Final, signed reports are issued only after they have been completely reviewed for accuracy, completeness, and appropriateness. Any exceptions from common practice or anomalies in the test results or accompanying quality assurance program are provided in the Case Narrative section of the final report.

Section 8.1 Reporting Procedures

The results of each test or series of tests carried out by Turner Laboratories are reported accurately, clearly, unambiguously and objectively and in accordance with the method conducted. The final reports are generated using the LIMS following the procedures in SOP- ADM-4. The final reports format includes the following:

- laboratory name, address, contact information,
- the assigned unique laboratory identification number,
- name and address of client,
- identification of method(s) used,

- client identification,
- date of sample receipt,
- sampling date and time,
- the environmental test result, unit of measurement, analysts initials, analysis date and time
- narrative clearly identified for any nonconformance, deviations, interpretations
- name, function and signature authorizing report, and date of issue
- a statement that the report shall not be reproduced except in full without written approval of the laboratory
- laboratory accreditation

Test results performed by subcontractors shall be clearly identified in the report and provided to the client on the signed subcontractor's stationary.

In the case of electronic transmission of results by facsimile or email, Turner Laboratories assures that all the responsible steps are taken to preserve confidentiality.

Amendments to the final report after issuance shall be made in the form of a "Revised Report" and will be clearly identified as such.

Section 9 Procurement of Quality Products

Quality products are products used in the laboratory that must meet a minimum quality requirement, such as gases, water, solvents, standards and sample/laboratory containers. Turner Laboratories purchases products that have certificates of analyses, certificates of cleanliness, etc. from reputable vendors. All certificates are retained on-site.

The procedure for the purchase, reception and storage of reagents and consumables can be found in the Turner Laboratories' Policy No 8.

Section 9.1 Subcontract of Laboratory Services

Turner Laboratories will subcontract laboratory services for analyses that Turner Laboratories is not certified to report or in situations where the instrument is not conforming to Quality Control Protocol. Only Arizona or NELAP accredited laboratories will be used for subcontract services. The laboratory performing the subcontracted work shall be indicated in the final report and non-NELAP accredited work shall be identified.

A subcontractor registry is maintained by the laboratory.

Section 10 Project Requirements

Turner Laboratories reviews all projects that are procured. The President and Laboratory Director review all materials associated with the project prior to quoting the project. When it is necessary to use methods not covered by standard methods, these methods are subject to agreement with the client.

When a customer requests a modification to a (such as a change in reporting limit, addition or deletion of target analyte(s), etc.), the project chemist handling that project must discuss the proposed deviation with the department manager in charge of the analysis and obtain their approval to accept the project. The project chemist is responsible for documenting the approved or allowed deviation from the standard operating procedure by placing a detailed description of the deviation attached to the quotation or in the project file and also providing an appropriate comment on the service request when the samples are received.

The goal is to ensure that Turner Laboratories can meet the client requirements before project initiation. Project correspondence is retained by the Laboratory Director.

Section 10.1 Client Services

Continuous improvement is a process in which management philosophy and operating methodology are committed to quality improvement in the organization. The following elements are essential to management:

- A focus on the needs of the customer or client
- Effective communication of customer needs among all participants
- Top management commitment, support and direction
- Reliance on standards and measures of performance to demonstrate satisfaction of customer needs.

Client complaints are received through the Laboratory Director and are recorded in the client files. The Laboratory Director communicates with the client to determine the details of the inquiries, including technical data problems, turn around time issues, etc.

Section 11 Audits

Quality audits are an essential part of the Turner Laboratories' quality assurance program. Audits of laboratories are performed to assess the degree of compliance to policies, procedures, and standards. There are two types of audits: System Audits are conducted to qualitatively evaluate the operational details of the QA program, and Performance Audits are conducted by analyzing performance evaluation samples in order to quantitatively evaluate the outputs of the various measurement systems.

Section 11.1 System Audits

The system audit examines the presence and appropriateness of laboratory systems. External system audits of Turner Laboratories are conducted regularly by various regulatory agencies and clients. Additionally, internal system audits of Turner Laboratories are conducted regularly. The internal audit procedures are described in Turner Laboratories' Policy No. 6.

The results of each audit are reported to the Laboratory Director for review and comment. Any deficiencies noted by the auditor are summarized in the audit report and corrective action is identified to correct each deficiency within a specified time period. All audit and review findings, and corrective actions are documented and retained by the Laboratory Director. Should problems impacting data quality be found during an internal audit, any client whose data is adversely impacted will be given written notification if not already provided.

Electronic data audits may be performed in conjunction with hardcopy data audits following the procedures outlined in SOP ADM-5. The electronic audits focus on organic chromatographic data and include an examination of audit trails, peak integrations, calibration practices and files, GCMS tuning data, peak response data, use of appropriate files, and other components of the analysis. The audit also verifies that the electronic data supports the hardcopy reported data.

Section 11.2 Performance Audits

Turner Laboratories also participates in the analysis of inter-laboratory proficiency testing (PT) samples. Participation in PT studies is performed on a regular basis and is designed to evaluate all analytical areas of the laboratory, to assess the accuracy and precision of the laboratory procedures and results. Turner Laboratories participates in performance evaluation programs, including the Water Pollution (WP) and Water Supply (WS) programs. A summary of our performance in these programs is included in Appendix D. All proficiency testing raw data and reports are retained by the Laboratory Director.

Section 12 Preventative Maintenance Activities

Preventative maintenance is a crucial element of Turner Laboratories' quality assurance program. The major instruments such as GC/MS systems, atomic absorption spectrometers, analytical balances, inductively coupled plasma emission spectrophotometers, and gas chromatographs are maintained either by qualified in-house personnel or under commercial service contracts. All instruments are operated and maintained according to the instrument operating manuals.

All routine and special maintenance activities pertaining to the instruments are recorded in instrument maintenance logbooks. The maintenance logbooks used at Turner Laboratories contain extensive information about the instruments used at the laboratory. When performing maintenance on an instrument (whether preventive or corrective), additional information about the problem, attempted repairs, etc. is also recorded in the notebook. Typical logbook entries include the following information:

- Details and symptoms of the problem;
- Repairs and/or maintenance performed;
- Description and/or part number of replaced parts;
- Source(s) of the replaced parts;
- Analyst's signature and date; and
- Demonstration of return to analytical control.

If equipment has been subjected to overloading or mishandling, has been shown to be defective or outside specified limits, the equipment is considered to be out of service until it has been repaired and shown by calibration or testing to be performing correctly.

The instrument maintenance activities are recorded in instrument run logs or maintenance logs. All instruments are operated and maintained according to the instrument operating manuals, method requirements, and specific Turner Laboratories policies where applicable.

Specific preventative maintenance procedures and schedules are discussed in the applicable SOPs.

Section 13 Nonconformance and Corrective Action Procedures

Turner Laboratories does not use any equipment, instrumentation, or reagents until these have been validated with the appropriate checks. However, at some time the laboratory may need to address anomalous results. A nonconformance is defined as any unapproved or unplanned deviation from standard operating procedure or policy. If there is failure to meet established quality assurance objectives, immediate corrective action is initiated.

Specific control limits and corrective action activities are described in the standard operating procedures and/or in the references listed therein.

The steps in the corrective action process are as follows:

- Identify the problem. When check results do not fall within the established criteria, or if a sample gives an unexpected result, the situation is defined as out-of-control. In such a case, the analyst must identify the reason for the disparity before any test results can be considered valid;
- Determine the cause of the problem;
- Implement corrective action;
- Verify that the problem has been corrected; and
- Document the problem, the action taken, and the subsequent in-control situation.

Corrective action may take several forms, including calculation checks, instrument maintenance and operation checks, review of analytical technique and methodology, and re-analysis of controls and samples. Corrective actions for specific instrumentation and equipment are indicated in the manufacturers' maintenance requirements. Corrective action for procedural quality assurance checks is delineated in the methodology.

Problems in analysis and corrective actions are documented on the raw data (chromatograms or reports), laboratory benchsheets, or instrument logs. If problems develop in any testing procedure that cannot be resolved through the corrective action performed, the samples for that test are referred to another laboratory until the problem is brought under control. If the analyses have been affected, the laboratory will notify the client immediately.

No sample results should be released until the test system is shown to be operating correctly. If it is not possible to correct the problem within established time frames, all test samples should be sent to an appropriately licensed, contract reference laboratory until the problem has been resolved.

The quality assurance officer or laboratory director has the necessary authority to stop work in the event of an out-of-control situation.

All nonconformance and corrective action activities are documented by the QA Manager or the Laboratory Director and retained by the Laboratory Director.

Section 14 Licensed Parameters

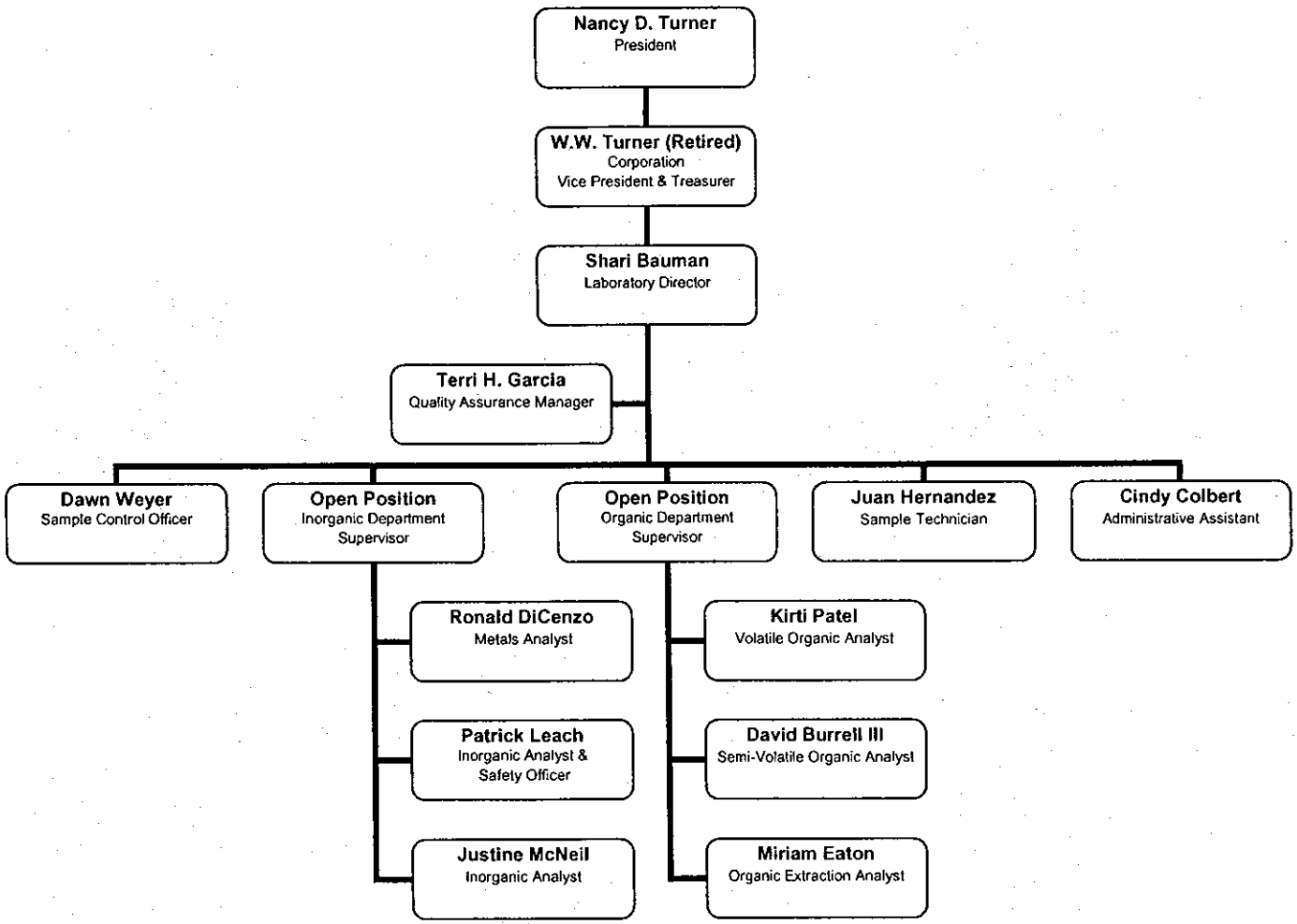
Appendix B contains copies of our current Arizona Department of Health Services "Environmental Laboratory License" and the list of licensed parameters and approved methods, differentiated by program (for example, drinking water or wastewater). This list demonstrates our capability for compliance testing. Additional capabilities may exist for non-compliance testing.

The laboratory license is prominently displayed at the laboratory facility.

APPENDIX A

Organizational Chart

Turner Laboratories, Inc. – February 2008



APPENDIX B

ADHS Environmental Laboratory License and List of Licensed Parameters/Approved Methods

Arizona Department of Health Services

ENVIRONMENTAL LABORATORY LICENSE

Issued to:

Laboratory Director: Shari Bauman
Owner/Representative: Nancy D. Turner

Turner Laboratories, Inc.
AZ0066

is in compliance with Environmental Laboratory's applicable standards for the State of Arizona and maintains on file a List of Parameters for which the laboratory is certified to perform analysis.

PERIOD OF LICENSURE FROM: 03/24/2008 TO: 03/23/2009

Steven D. Baker, Chief
Office of Laboratory Services
Bureau of State Laboratory Services

Arizona Department of Health Services
Office of Laboratory Licensure, Certification & Training
2 North 17th Avenue, Phoenix, AZ 85007
Thursday, December 20 2007

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AZ License: AZ0066
Lab Director: Ms. Shari Bauman

Lab Name: Turner Laboratories, Inc.
Phone: (520) 882-5880
Fax: (520) 882-9788

Program HW

Parameter	EPA Method	Billing Code	Cert Date
Aluminum	EPA 6010B	MTL3	05/13/98
Antimony	EPA 6010B	MTL3	05/13/98
Arsenic	EPA 6010B	MTL3	05/13/98
Barium	EPA 6010B	MTL3	05/13/98
Beryllium	EPA 6010B	MTL3	05/13/98
C10-C32 Hydrocarbons	8015AZ1	VOC4	02/09/99
Cadmium	EPA 6010B	MTL3	05/13/98
Calcium	EPA 6010B	MTL3	05/13/98
Chromium Total	EPA 6010B	MTL3	05/13/98
Closed System Purge And Trap Extract. Vocs	EPA 5035A	PREP2	12/05/06
Cobalt	EPA 6010B	MTL3	05/13/98
Continious Liquid-Liquid Extraction	EPA 3520C	PREP2	05/13/98
Copper	EPA 6010B	MTL3	05/13/98
Corrosivity Ph Determination	EPA 9040C	HAZ1	12/05/06
Corrosivity Ph Determination	EPA 9041A	NIA6	11/15/97
Dissolved In Water	EPA 3005A	PREP1	11/15/97
Flashpoint Determination	EPA 1030	HAZ2	05/01/02
Hydrogen Ion (Ph)	EPA 9045D	NIA6	12/05/06
Ignitability (Flash Point)	EPA 1010A	HAZ2	12/05/06
Iron	EPA 6010B	MTL3	05/13/98
Lead	EPA 6010B	MTL3	05/13/98
Magnesium	EPA 6010B	MTL3	05/13/98
Manganese	EPA 6010B	MTL3	05/13/98
Mercury	EPA 7470A	MTL5	03/02/92
Mercury	EPA 7471A	MTL5	11/15/97
Molybdenum	EPA 6010B	MTL3	05/13/98
Nickel	EPA 6010B	MTL3	05/13/98
Organochlorine Pesticides By Gc	EPA 8081A	SOC9	05/13/98
Paint Filter Liquids Test	EPA 9095B	MISC18	12/05/06
Pcbs By Gc	EPA 8082	SOC9	05/12/98
Pcbs In Waste Oil	600/4-81-045	SOC9	03/03/98
Potassium	EPA 6010B	MTL3	05/13/98
Purge And Trap For Aqueous Samples	EPA 5030C	PREP2	12/05/06
Sediments, Sludges And Soils	EPA 3050B	PREP1	05/13/98
Selenium	EPA 6010B	MTL3	05/13/98
Semivolatile Compounds By Gc/Ms	EPA 8270C	SOC16	05/13/98
Silver	EPA 6010B	MTL3	05/13/98
Sodium	EPA 6010B	MTL3	05/13/98
Spip	EPA 1312	HAZ6	08/08/94

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License: AZ0066 Lab Name: Turner Laboratories, Inc.

Program HW

Parameter	EPA Method	Billing Code	Cert Date
Sulfuric Acid/Permanganate Cleanup	EPA 3665A	PREP2	05/13/98
Tclp	EPA 1311	HAZ5	03/02/92
Thallium	EPA 6010B	MTL3	05/13/98
Tin	EPA 6010B	MTL3	05/13/98
Total Metals	EPA 3010A	PREP1	06/15/98
Total Recoverable In Water	EPA 3005A	PREP1	11/15/97
Ultrasonic Extraction	EPA 3550B	PREP2	05/13/98
Vanadium	EPA 6010B	MTL3	05/13/98
Vocs By Gc/Ms	EPA 8260B	VOC8	05/13/98
Zinc	EPA 6010B	MTL3	05/13/98

Total Licensed Parameters in this Program: 49

Program SDW

Parameter	EPA Method	Billing Code	Cert Date
Alkalinity	SM 2320B	NIA1	10/27/93
Aluminum	EPA 200.7	MTL3	07/16/96
Antimony	EPA 200.9	MTL2	10/01/96
Arsenic	EPA 200.9	MTL2	07/16/96
Barium	EPA 200.7	MTL3	10/08/92
Beryllium	EPA 200.7	MTL3	11/30/94
Cadmium	EPA 200.7	MTL3	10/08/92
Cadmium	EPA 200.9	MTL2	03/01/96
Calcium	EPA 200.7	MTL3	10/08/92
Chloride	EPA 300.0	NIIIA1	03/02/92
Chlorinated Pesticides, Herbicides By Gc-Ecd	EPA 508.1	SOC9	12/20/07
Chlorine	HACH 8167	NIA3	02/17/98
Chromium Total	EPA 200.7	MTL3	10/08/92
Chromium Total	EPA 200.9	MTL2	03/01/96
Color	SM 2120B	NIA4	03/02/92
Copper	EPA 200.7	MTL3	10/08/92
Corrosivity	SM 2330B	NIA5	03/02/92
Cyanide	EPA 335.4	MISC7	10/06/97
Edb And Dbcp	EPA 504.1	SOC5	11/14/97
Fluoride	EPA 300.0	NIIIA1	07/16/96
Fluoride	SM 4500-F C	NIB9	03/02/92
Haloacetic Acids	EPA 552.2	SOC25	07/11/05
Hardness	EPA 200.7, CA&MG	MTL3	12/05/02
Heterotrophic Bacteria	SIMPLATE	MIC9	09/20/06
Hydrogen Ion (Ph)	EPA 150.1	NIA6	03/02/92
Iron	EPA 200.7	MTL3	10/08/92
Lead	EPA 200.9	MTL2	03/02/92

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rogram SDW

Parameter	EPA Method	Billing Code	Cert Date
Magnesium	EPA 200.7	MTL3	10/08/92
Manganese	EPA 200.7	MTL3	10/08/92
Mercury	EPA 245.1	MTL5	11/21/97
Nickel	EPA 200.7	MTL3	11/30/94
Nitrate	EPA 300.0	NIIIA1	03/02/92
Nitrite	EPA 300.0	NIIIA1	12/23/93
Orthophosphate	EPA 300.0	NIIIA1	07/16/96
Residue, Filterable (Tds)	SM 2540C	NIIA8	07/16/06
Selenium	EPA 200.9	MTL2	07/16/96
Silica	EPA 200.7	MTL3	07/16/96
Silica	SM 4500-SI D	MISC13	07/16/96
Silver	EPA 200.7	MTL3	10/08/92
Sodium	EPA 200.7	MTL3	10/08/92
Specific Conductance	SM 2510B	NIA7	03/18/98
Strontium	EPA 200.7	MTL3	10/08/92
Sulfate	EPA 300.0	NIIIA1	03/02/92
Thallium	EPA 200.9	MTL2	03/01/96
Total Coliforms And E. Coli By Colilert	SM 9223B	MIC3	07/25/06
Turbidity, Ntu: Nephelometric	EPA 180.1	NIA9	03/02/92
Vocs By Gc-Ms	EPA 524.2	VOC1	01/15/03
Zinc	EPA 200.7	MTL3	10/08/92

Total Licensed Parameters in this Program: 48

rogram WW

Parameter	EPA Method	Billing Code	Cert Date
Acrolein & Acrylonitrile - App For Screen Only	EPA 624	VOC8	12/05/06
Alkalinity, Total	SM 2320B	NIA1	10/27/93
Aluminum	EPA 200.7	MTL3	10/08/92
Ammonia	EPA 350.1	NIIB1	03/02/92
Antimony	EPA 200.7	MTL3	10/08/92
Antimony	EPA 200.9	MTL2	12/05/06
Arsenic	EPA 200.7	MTL3	10/08/92
Barium	EPA 200.7	MTL3	02/14/95
Base/Neutrals And Acids Excluding Pesticides	EPA 625	SOC16	03/02/92
Beryllium	EPA 200.7	MTL3	10/08/92
Biochemical Oxygen Demand	SM 5210B	DEM1	07/13/06
Boron	EPA 200.7	MTL3	10/08/92
Bromide	EPA 300.0	NIIIA1	03/02/92
Cadmium	EPA 200.7	MTL3	10/08/92
Calcium	EPA 200.7	MTL3	10/08/92
Chemical Oxygen Demand	EPA 410.4	DEM3	03/02/92

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License: AZ0066 Lab Name: Turner Laboratories, Inc.

Program WW

Parameter	EPA Method	Billing Code	Cert Date
Chloride	EPA 300.0	NIIIA1	03/02/92
Chlorine Residual Total	HACH 8167	NIA3	12/05/06
Chlorine Total Residual	HACH 10014	NIA3	06/24/08
Chromium Total	EPA 200.7	MTL3	10/08/92
Chromium, Hexavalent	HACH 8023	MTL4	02/17/98
Cobalt	EPA 200.7	MTL3	10/08/92
Copper	EPA 200.7	MTL3	10/08/92
Cyanide Amenable To Chlorination	SM 4500-CN G	MISC7	12/05/06
Cyanide, Total	SM 4500-CNCE	MISC34	12/05/06
E. Coli By Colilert Mpn	SM 9223B	MIC3	08/02/04
Fluoride	EPA 300.0	NIIIA1	11/15/97
Fluoride	SM 4500-F C	NIB3	03/02/92
Hardness	EPA 200.7	MTL3	12/05/02
Iron	EPA 200.7	MTL3	10/08/92
Kjeldahl Nitrogen	EPA 351.1	NIIB3	03/02/92
Lead	EPA 200.7	MTL3	10/08/92
Magnesium	EPA 200.7	MTL3	10/18/96
Manganese	EPA 200.7	MTL3	10/08/92
Mercury	EPA 245.1	MTL5	02/27/97
Molybdenum	EPA 200.7	MTL3	10/08/92
Nickel	EPA 200.7	MTL3	10/08/92
Nitrate	EPA 300.0	NIIIA1	03/02/92
Nitrite (As N)	EPA 300.0	NIIIA1	03/02/92
Oil And Grease	EPA 1664A	MISC6	05/03/04
Organochlorine Pesticides And Polychlorinated Biphenyls	EPA 608	SOC9	03/02/92
Orthophosphate	HACH 8048	NIIB8	02/17/98
Oxygen, Dissolved	SM 4500-O G	NIA12	12/05/06
Phenols	EPA 420.1	MISC8	02/26/01
Phosphorous Total	HACH 8190	NIIB6	02/17/98
Potassium	EPA 200.7	MTL3	10/08/92
Purgeables	EPA 624	VOC8	11/15/97
Residue Filterable	SM 2540C	NIIA8	07/16/96
Residue Nonfilterable	SM 2540D	NIIA5	07/16/96
Residue Total	SM 2540B	NIIA4	12/05/06
Residue Volatile	EPA 160.4	NIIA7	03/02/92
Residue, Settleable Solids	SM 2540F	NIIA6	12/05/06
Selenium	EPA 200.7	MTL3	10/08/92
Silica, Dissolved	EPA 200.7	MTL3	03/02/92
Silica, Dissolved	SM 4500-SI D	MISC13	12/05/06
Silver	EPA 200.7	MTL3	10/08/92

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rogram WW

Parameter	EPA Method	Billing Code	Cert Date
Sodium	EPA 200.7	MTL3	10/08/92
Specific Conductance	SM 2510B	NIA7	12/05/06
Strontium	EPA 200.7	MTL3	10/15/96
Sulfate	EPA 300.0	NIIIA1	03/02/92
Sulfide	SM 4500-S F	MISC33	12/05/06
Thallium	EPA 200.7	MTL3	11/15/97
Thallium	EPA 200.9	MTL2	12/05/06
Tin	EPA 200.7	MTL3	10/08/92
Total Organic Carbon	SM 5310C	MISC1	12/05/06
Turbidity	EPA 180.1	NIA9	03/02/92
Vanadium	EPA 200.7	MTL3	10/08/92
Zinc	EPA 200.7	MTL3	10/08/92

Total Licensed Parameters in this Program: 68

Instruments	Quantity	Date
GAS CHROMATOGRAPH/MASS SPECTROMETER	3	10/05/95
GAS CHROMATOGRAPH	2	09/04/02
ATOMIC ABSORPTION SPECTROPHOTOMETER	1	09/04/02
ATOMIC ABSORPTION - COLD VAPOR	1	03/29/07
ION CHROMATOGRAPH	1	02/26/01
INDUCTIVELY COUPLED PLASMA SPECTROMETER	1	09/25/92

Softwares
PERKIN ELMER - ICP

APPENDIX C

List of Major Analytical Equipment

Organic Laboratory

Gas Chromatographs

- Hewlett-Packard 5890 with Dual ECD Detectors with Chemstation (EnviroQuant) Data System and HP 7673 Autosampler Trap – Indirectly linked to LIMS
- Hewlett-Packard 5890 with PID/FID Detectors with Chemstation (EnviroQuant) Data System and HP 7673 Autosampler Trap – Indirectly linked to LIMS
- Agilent 6890N with Dual Micro ECD Detectors with Chemstation (EnviroQuant) Data System, and Agilent 7683 B Autosampler

Gas Chromatograph/Mass Spectrometers

- Hewlett-Packard 5890/5972 with Chemstation (EnviroQuant) Data System, Tekmar ALS-2016/3000 Purge and Trap– Indirectly linked to LIMS
- Hewlett-Packard 5890/5971 with Chemstation (EnviroQuant) Data System, HP 7673 Autosampler – Indirectly linked to LIMS
- Hewlett-Packard 5890/5971 with Chemstation (EnviroQuant) Data System, OI 4560 Purge and Trap, Precision PTA-30 Vial Autosampler– Indirectly linked to LIMS

Total Organic Carbon Analyzer

- Dohrmann Phoenix 8000 UV-Persulfate TOC Analyzer with TOC Talk Software

Inorganic Laboratory

Inductively Coupled Argon Plasma Atomic Emission Spectrometer

- Perkin-Elmer Model 3000 XL, with Win Lab Data System – Data downloaded directly to LIMS

Atomic Absorption Spectrophotometers

- Perkin-Elmer Simma 6000 Graphite Furnace – Indirectly linked to LIMS
- Perkin Elmer FIMS 100 Automated Mercury Cold Vapor Analyzer

Ion Chromatograph

- Dionex DX-120 Liquid Chromatograph with Dionex Peaknet Software

Oxygen Meters

- YSI Model 5000

pH and Specific Ion Meter

- Orion SA 720 ISE Meter
- SympHony pH Meter
- Hannah EC 215

Spectrophotometers

- Bausch & Lomb Spectronic 20 (3)
- Hach DR-2000

Turbidimeters

- Hannah HI 93703
- Fisher DRT 100 (2)

Other Equipment

- Horizon Technology DryVap Concentrator System (2)
- Midi-Vap 3000
- Analytical Balances
- Automatic Composite Samplers (5) and Flow Module
- Flash Point Testers (2)
- Incubators
- Microscopes
- Ovens

Oil and Grease Equipment

- Horizon Technology SPE-DEX 3000 XL Automated Extractor System
- Horizon Technology Speed VAP II 9000 Solvent Evaporation System

MPN

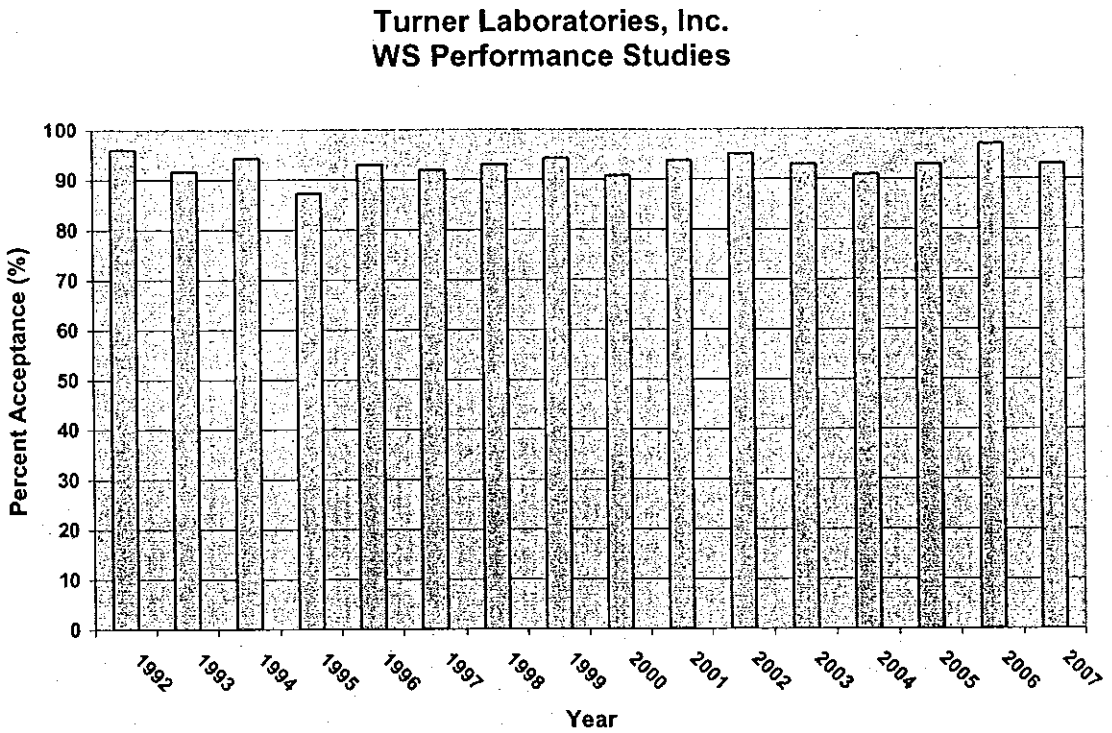
- IDEXX Quanti Tray/2000

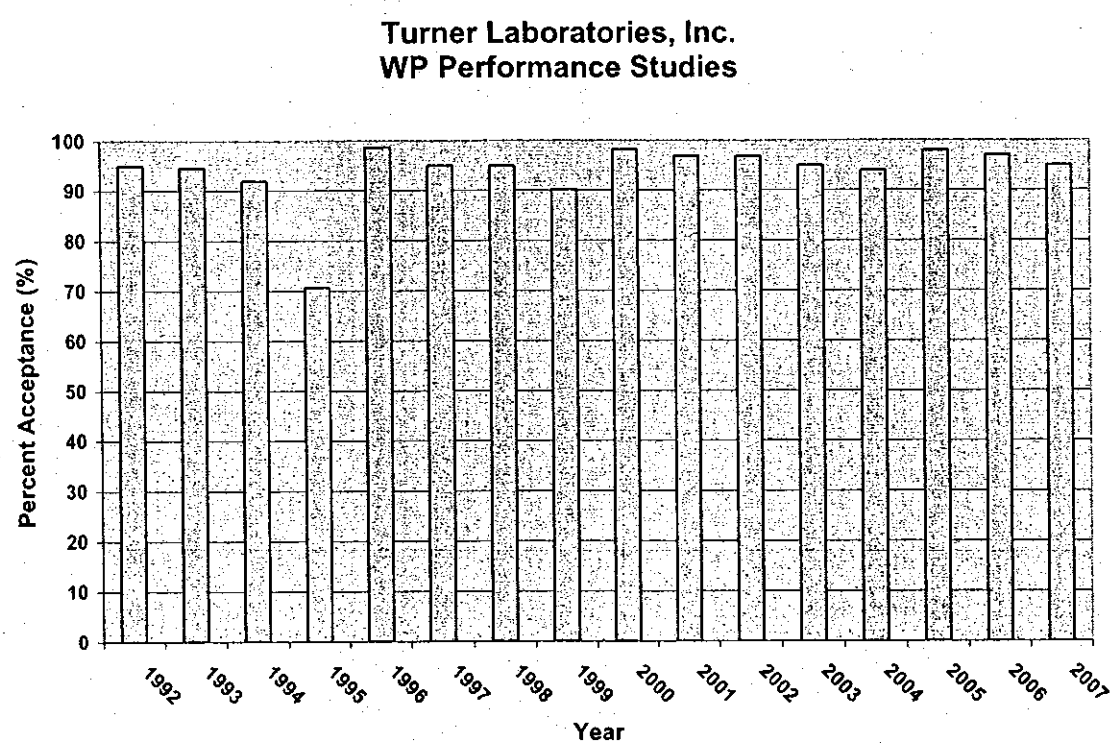
Data Management Software System

- Omega System by Khemia Corporation with 18 networked PCs - Utilized for complete laboratory information management from sample receipt to final hardcopy report. Capable of generating electronic deliverables in various formats.

APPENDIX D

Summary of Turner Laboratories' WP & WS Performance


Turner Laboratories, Inc.
WS Performance Studies
Percent Acceptance (%)
100
90
80
70
60
50
40
30
20
10
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year


Turner Laboratories, Inc.
WP Performance Studies
Percent Acceptance (%)
100
90
80
70
60
50
40
30
20
10
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year

APPENDIX E

Turner Laboratories' List of Standard Operating Procedures

LIST OF STANDARD OPERATING PROCEDURES

Department	SOP No.	SOP Title	Referenced Method	Comments
Sample Control	SC-1	Sample Receiving	---	
	SC-2	Shipping of Sub-Contract Samples	---	
	SC-3	Bottle Orders	---	
Microbiology	MICRO-1	NOT IN USE	---	Not in Use
	MICRO-2	Total/Fecal Coliform-MTF/MPN	SM 9221	Not in Use
	MICRO-3	Total/E. Coli Coliform-Colilert	SM 9223B	
	MICRO-4	Total/E. Coli Coliform-MPN by Quanti-Tray 2000	SM 9223B	
	MICRO-5	Heterotrophic Plate Count-HPC by SimPlate	SM 9251B	
Metals	METAL-1	Sample Prep., Metals in Water and WW (E200.2)	EPA 200.2	
	METAL-2	Sample Prep., Total/Dissolved. Metals in Water by ICP (E3005A)	EPA 3005A	
	METAL-3	Sample Prep., Total Metals in Solids by ICP and GFAA (E3050B)	EPA 3050B	
	METAL-4	Arsenic by GFAA	EPA 7060A/7000A	Not in Use
	METAL-5	TCLP (E1311)	EPA 1311	
	METAL-6	SPLP (E1312)	EPA 1312	
	METAL-7	Metals in Water and Soil by ICP (E200.7/6010B)	EPA 200.7/6010B	
	METAL-8	Metals by GFAA	EPA 200.9	
	METAL-9	Mercury by CVAA (E245.1/7470A/7471A)	EPA 245.1/ 7470A/7471A	
	METAL-10	Lead by GFAA (E7421)	EPA 7421	Not in Use
	METAL-11	Selenium by GFAA (E7740)	EPA 7740	Not in Use
Inorganics	INORG-1	Glassware Cleaning, Inorganics	---	
	INORG-2	Alkalinity	SM 2320B	
	INORG-3	Anions	EPA 300.0	
	INORG-4	Ammonia	EPA 350.1	
	INORG-5	BOD	SM 5210B	
	INORG-6	COD	EPA 410.4	
	INORG-7	Chlorine	HACH 8167	
	INORG-8	Hexavalent Chromium	HACH 8023	
	INORG-9	Color	SM 9120B	
	INORG-10	Conductivity	SM 2510B	
	INORG-11	Analytical Balance and Scale Use	---	
	INORG-12	Cyanide, Amenable	EPA 335.1/ SM 4500-CN-G	

LIST OF STANDARD OPERATING PROCEDURES (continued)

Department	SOP No.	SOP Title	Referenced Method	Comments
Inorganics	INORG-13	Cyanide	EPA 335.2/ SM 4500CN BE	
	INORG-14	Cyanide, WAD	SM 4500-CN-I	Not for Compliance
	INORG-15	Dissolved Oxygen	SM 4500-O-G	
	INORG-16	Exchangeable Sodium	---	Not for Compliance
	INORG-17	Flashpoint	EPA 1010A	
	INORG-18	Fluoride, Electrode	SM 4500-F-C	
	INORG-19	Hardness	SM2340B Calc	
	INORG-20	Minimum Resistivity	ARIZ 236A	Not for Compliance
	INORG-21	Oil and Grease, Gravimetric	EPA 413.1	Not in Use
	INORG-22	Oil and Grease, Infrared	EPA 413.2	Not in Use
	INORG-23	Paint Filter Liquids Test	EPA 9095B	
	INORG-24	pH - Water	EPA 150.1	
	INORG-25	pH - Solids	EPA 9040B/ 9041A/9045D	
	INORG-26	Phosphorous, Total and Orthophosphate	HACH 8048/8190	
	INORG-27	Reactivity	EPA SW-846 Chp 7. Sec. 7.3.1/7.3.4	
	INORG-28	Silica, Dissolved	SM 4500-Si-D	
	INORG-29	Soluble Salts	ARIZ 237A	Not for Compliance
	INORG-30	Sulfate, Gravimetric	SM 4500-SO4-D	Not in Use
	INORG-31	Sulfide, Titrimetric, Iodometry	SM 4500	
	INORG-32	Total Dissolved Solids	SM 2540C	
	INORG-33	Total Suspended Solids	SM 2540D	
	INORG-34	Total Solids	EPA 160.3	
	INORG-35	Volatile Solids	EPA 160.4	
	INORG-36	Settable Solids	EPA 160.5	
	INORG-37	Total Kjeldahl Nitrogen	EPA 351.1	
	INORG-38	Total Petroleum Hydrocarbons-Soil, Infrared	EPA 418.1AZ	Not in Use
	INORG-39	Total Petroleum Hydrocarbons-Water, Infrared	EPA 418.1	Not in Use
	INORG-40	Total Organic Carbon	SM 5310C	
	INORG-41	Turbidity	EPA 180.1	
	INORG-42	Field pH	---	
	INORG-43	Total Recoverable Phenolics	EPA 420.1	
	INORG-44	NOT IN USE	---	Not in Use
	INORG-45	Ignitability of Solids	EPA 1030	
	INORG-46	Oil & Grease & TPH SPE	EPA 1664A	

LIST OF STANDARD OPERATING PROCEDURES (continued)

Department	SOP No.	SOP Title	Referenced Method	Comments
Organics	ORG-1	Glassware Cleaning, Organics	---	
	ORG-2	EDB/DBCP in Drinking Water, Extraction	EPA 504.1	
	ORG-3	EDB/DBCP in Drinking Water, GC Analysis	EPA 504.1	
	ORG-4	PCBs in Oil, GC Analysis	EPA 600/4-81-045	
	ORG-5	NOT IN USE	---	Not in Use
	ORG-6	NOT IN USE	---	Not in Use
	ORG-7	Pesticides/PCBs in Water, Extraction	EPA 350C/3665A/ 8081A/8082/608	
	ORG-8	Pesticides/PCBs in Water, GC Analysis	EPA 608	
	ORG-9	NOT IN USE		Not in Use
	ORG-10	Pesticides/PCBs, Sonication Extraction	EPA 3550P/8081A/8082	
	ORG-11	NOT IN USE		Not in Use
	ORG-12	Semi-volatiles, Acid Extractables, Extraction	EPA 625	
	ORG-13	Semi-volatiles, BN Extractables, Extraction	EPA 625	
	ORG-14	Semi-volatiles in Waste Water, GCMS Analysis	EPA 625	
	ORG-15	NOT IN USE	---	Not in Use
	ORG-16	Semivolatiles in Waste, Sonication Extraction	EPA 3550B/8270C	
	ORG-17	Semivolatiles in Wastes, Waste Dilution Extraction	EPA 3580A	
	ORG-18	Semi-volatiles in Waste, GCMS Analysis	EPA 8270C	
	ORG-19	TPH, Fuel Fingerprint, GC Analysis	EPA 8015	Not for Compliance
	ORG-20	Total Petroleum Hydrocarbons, GC Analysis	8015AZR1	
	ORG-21	Volatiles in Drinking Water, GCMS Analysis	EPA 524.2	
	ORG-22	Volatiles in Waste Water, GC Analysis	EPA 601/602	Not in Use
	ORG-23	Volatiles, ATM in Waste Water, GC Analysis	EPA 602M	Not in Use
	ORG-24	Volatiles in Waste Water, GCMS Analysis	EPA 624	
	ORG-25	Volatiles in Water and Waste, GC Analysis	EPA 8021B	Not in Use
	ORG-26	Volatiles in Water and Waste, GCMS Analysis	EPA 8260B	

LIST OF STANDARD OPERATING PROCEDURES (continued)

Department	SOP No.	SOP Title	Referenced Method	Comments
Organics	ORG-27	Volatiles in Water, GCMS Analysis	EPA 8260B	
	ORG-28	Semi-volatile, Acid Extractables in Water, Extraction	EPA 3520C/8270C	
	ORG-29	Semi-volatile, BN Extractables in Water, Extraction	EPA 3520C/8270C	
	ORG-30	Pesticides/PCBs, Waste Dilution Extractions	EPA 350A/8081A/8082	
	ORG-31	Methanol in Water, GC Analysis	EPA 8015B Mod.	Not in Use
	ORG-32	Pesticides in Water and Waste, GC Analysis	EPA 8081A	
	ORG-33	PCBs in Water and Waste, GC Analysis	EPA 8082	
	ORG-34	Glutaraldehyde in Waste Water, GCMS Analysis	EPA 625	
	ORG-35	Glutaraldehyde, Neutral Extraction in Wastewater	EPA 625	
	ORG-36	Haloacetic Acids in Drinking Water, Extraction	EPA 552.2	
	ORG-37	Haloacetic Acid in Drinking Water, GC Analysis	EPA 552.2	
	ORG-38	TCLP Extraction	EPA 1311	
	ORG-39	Petroleum Hydrocarbons in Water, GC Analysis	8015 AZ R1- Mod	Not for Compliance
	ORG-40	Solid Phase Extraction	EPA 3535/508.1/608/1311/ 8081/8081	
	ORG-41	Chlorinated Pesticides, Herbicides & Organohalides	EPA 508.1	
Administrative	ADM-1	Data Entry into LIMS	---	
	ADM-2	Data Verification & Data Validation	---	
	ADM-3	Manual Integration of Chromatographic Peaks	---	
	ADM-4	Data Deliverables	---	
	ADM-5	Electronic Data Auditing	---	

APPENDIX F

Turner Laboratories' List of Policies

LIST OF POLICIES

Policy No.	Policy Statement Title
Policy No. 1	Calibration of the Mettler AE50 Analytical Balance
Policy No. 2	Air Monitoring in the Microbiology Laboratory
Policy No. 3	The Verification of Sterility of Micro Sample Containers
Policy No. 4	Maintenance of Personnel Training Records
Policy No. 5	Method Detection Limit Studies
Policy No. 6	Internal Laboratory Audit
Policy No. 7	Determination of Expiration Dates on Standards and Reagents
Policy No. 8	Characterization of Wastes: Hazardous and Non-Hazardous
Policy No. 9	Purchasing, Receiving, Inspection, Inventory, and Storage of Laboratory Materials
Policy No. 10	Client Complaints
Policy No. 11	Record Retention
Policy No. 12	Subcontract of Laboratory Services
Policy No. 13	Nonconformance and Corrective Action Procedures
Policy No. 14	Document Control Procedures

APPENDIX F.5

ADEQ DATA QUALIFIERS

Arizona Laboratory Data Qualifiers

Revision 1.0
03/20/2002

(Developed by the Technical Subcommittee of the Arizona Environmental Laboratory Advisory Committee. This is a revised list with additional qualifiers added to the original list dated 12/11/2000)

Microbiology:

A1 = Too numerous to count.

A2 = Sample incubation period exceeded method requirement.

A3 = Sample incubation period was shorter than method requirement.

A4 = Target organism detected in associated method blank.

A5 = Incubator/water bath temperature was outside method requirements.

A6 = Target organism not detected in associated positive control.

A7 = Micro sample received without adequate headspace.

Method blank:

B1 = Target analyte detected in method blank at or above the method reporting limit.

B2 = Non-target analyte detected in method blank and sample, producing interference.

B3 = Target analyte detected in calibration blank at or above the method reporting limit.

B4 = Target analyte detected in blank at/above method acceptance criteria.

B5 = Target analyte detected in method blank at or above the method reporting limit, but below trigger level or MCL.

B6 = Target analyte detected in calibration blank at or above the method reporting limit, but below trigger level or MCL.

B7 = Target analyte detected in method blank at or above the method reporting limit. Concentration found in the sample was 10 times above the concentration found in the method blank.

Confirmation:

C1 = Confirmatory analysis not performed as required by the method.

C2 = Confirmatory analysis not performed. Confirmation of analyte presence established by site historical data.

C3 = Qualitative confirmation performed. See case narrative.

C4 = Confirmatory analysis was past holding time.

C5 = Confirmatory analysis was past holding time. Original result not confirmed.

Dilution:

D1 = Sample required dilution due to matrix interference. See case narrative.

D2 = Sample required dilution due to high concentration of target analyte.

D3 = Sample dilution required due to insufficient sample.

D4 = Minimum reporting level (MRL) adjusted to reflect sample amount received and analyzed.

Estimated concentration:

E1 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not possible due to insufficient sample.

E2 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to sample matrix.

E3 = Concentration estimated. Analyte exceeded calibration range. Reanalysis not performed due to holding time requirements.

E4 = Concentration estimated. Analyte was detected below laboratory minimum reporting level (MRL).

E5 = Concentration estimated. Analyte was detected below laboratory minimum reporting level (MRL), but not confirmed by alternate analysis.

E6 = Concentration estimated. Internal standard recoveries did not meet method acceptance criteria.

E7 = Concentration estimated. Internal standard recoveries did not meet laboratory acceptance criteria.

Hold time:

H1 = Sample analysis performed past holding time. See case narrative.

H2 = Initial analysis within holding time. Reanalysis for the required dilution was past holding time.

H3 = Sample was received and analyzed past holding time.

H4 = Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.

BOD:

K1 = The sample dilutions set-up for the BOD analysis did not meet the oxygen depletion criteria of at least 2 mg/L. Any reported result is an estimated value.

K2 = The sample dilutions set up for the BOD analysis did not meet the criteria of a residual dissolved oxygen of at least 1 mg/L. Any reported result is an estimated value.

K3 = The seed depletion was outside the method acceptance limits.

K4 = The seed depletion was outside the method and laboratory acceptance limits. The reported result is an estimated value.

K5 = The dilution water D.O. depletion was > 0.2 mg/L.

K6 = Glucose/glutamic acid BOD was below method acceptance criteria.

K7 = A discrepancy between the BOD and COD results has been verified by reanalysis of the sample for COD.

K8 = Glucose/glutamic acid BOD was above method acceptance levels.

Laboratory fortified blank/blank spike:

L1 = The associated blank spike recovery was above laboratory acceptance limits. See case narrative.

L2 = The associated blank spike recovery was below laboratory acceptance limits. See case narrative.

L3 = The associated blank spike recovery was above method acceptance limits. See case narrative.

L4 = The associated blank spike recovery was below method acceptance limits. See case narrative.

Note: The L1, L2, L3 & L4 footnotes need to be added to all corresponding analytes for a sample.

Matrix spike:

M1 = Matrix spike recovery was high, the method control sample recovery was acceptable.

M2 = Matrix spike recovery was low, the method control sample recovery was acceptable.

M3 = The accuracy of the spike recovery value is reduced since the analyte concentration in the sample is disproportionate to spike level. The method control sample recovery was acceptable.

M4 = The analysis of the spiked sample required a dilution such that the spike concentration was diluted below the reporting limit. The method control sample recovery was acceptable.

M5 = Analyte concentration was determined by the method of standard addition (MSA).

M6 = Matrix spike recovery was high. Data reported per ADEQ policy 0154.000.

M7 = Matrix spike recovery was low. Data reported per ADEQ policy 0154.000.

General:

N1 = See case narrative.

N2 = See corrective action report.

Sample quality:

Q1 = Sample integrity was not maintained. See case narrative.

Q2 = Sample received with head space.

Q3 = Sample received with improper chemical preservation.

Q4 = Sample received and analyzed without chemical preservation.

Q5 = Sample received with inadequate chemical preservation, but preserved by the laboratory.

Q6 = Sample was received above recommended temperature.

Q7 = Sample inadequately dechlorinated.

Q8 = Insufficient sample received to meet method QC requirements. QC requirements satisfy ADEQ policies 0154 and 0155.

Q9 = Insufficient sample received to meet method QC requirements.

Q10= Sample received in inappropriate sample container.

Q11= Sample is heterogeneous. Sample homogeneity could not be readily achieved using routine laboratory practices.

Duplicates:

R1 = RPD exceeded the method control limit. See case narrative.

R2 = RPD exceeded the laboratory control limit. See case narrative.

R3 = Sample RPD between the primary and confirmatory analysis exceeded 40%. Per EPA Method 8000B, the higher value was reported.

R4 = MS/MSD RPD exceeded the method control limit. Recovery met acceptance criteria.

R5 = MS/MSD RPD exceeded the laboratory control limit. Recovery met acceptance criteria.

R6 = LFB/LFBD RPD exceeded the method control limit. Recovery met acceptance criteria.

R7 = LFB/LFBD RPD exceeded the laboratory control limit. Recovery met acceptance criteria.

R8 = Sample RPD exceeded the method control limit.

R9 = Sample RPD exceeded the laboratory control limit.

Surrogate:

S1 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits.

S2 = Surrogate recovery was above laboratory and method acceptance limits.

S3 = Surrogate recovery was above laboratory acceptance limits, but within method acceptance limits. No target analytes were detected in the sample.

S4 = Surrogate recovery was above laboratory and method acceptance limits. No target analytes were detected in the sample.

S5 = Surrogate recovery was below laboratory acceptance limits, but within method acceptance limits.

S6 = Surrogate recovery was below laboratory and method acceptance limits. Reextraction and/or reanalysis confirms low recovery caused by matrix effect.

S7 = Surrogate recovery was below laboratory and method acceptance limits. Unable to confirm matrix effect.

S8 = The analysis of the sample required a dilution such that the surrogate concentration was diluted below the method acceptance criteria. The method control sample recovery was acceptable.

S9 = The analysis of the sample required a dilution such that the surrogate concentration was diluted below the laboratory acceptance criteria. The method control sample recovery was acceptable.

S10 = Surrogate recovery was above laboratory and method acceptance limits. See Case narrative.

S11 = Surrogate recovery was high. Data reported per ADEQ policy 0154.000.

S12 = Surrogate recovery was low. Data reported per ADEQ policy 0154.000.

Method/analyte discrepancies:

T1 = Method promulgated by EPA, but not by ADHS at this time.

T2 = Cited ADHS licensed method does not contain this analyte as part of method compound list.

T3 = Method not promulgated either by EPA or ADHS.

T4 = Tentatively identified compound. Concentration is estimated and based on the closest internal standard.

Calibration verification:

V1 = CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.

V2 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample. The sample could not be reanalyzed due to insufficient sample.

V3 = CCV recovery was above method acceptance limits. This target analyte was detected in the sample, but the sample was not reanalyzed. See case narrative.

V4 = CCV recovery was below method acceptance limits. The sample could not be reanalyzed due to insufficient sample.

V5 = CCV recovery after a group of samples was above acceptance limits. This target analyte was not detected in the sample. Acceptable per EPA Method 8000B.

V6 = Data reported from one-pont calibration criteria per ADEQ policy 0155.000.

V7 = Calibration verification recovery was above the method control limit for this analyte, however the average % difference or % drift for all the analytes met method criteria.

V8 = Calibration verification recovery was below the method control limit for this analyte, however the average % difference or % drift for all the analytes met method criteria.

Calibration:

W1 = The % RSD for this compound was above 15%. The average % RSD for all compounds in the calibration met the 15% criteria as specified in EPA method 8000B.