Davoud Feizollahi

From: David Pickett
Sent: Friday, August 05, 2005 2:38 PM
To: Allen Fetter
Subject: UNLV report
Attachments: UNLV Corrosion TR-03-003.pdf; 034JC.008.zip; 034JC.002.zip; 034JC.003.zip; 034JC.004.zip; 034JC.005.zip; 034JC.006.zip; 034JC.007.zip; 034JC.001.zip; My calculations of UNLV data.xls

Follow Up Flag: Follow up
Flag Status: Flagged

Allen,

I've attached the UNLV report I mentioned, as well as some zipped data files I downloaded from their website and some spreadsheet calculations I did. I was trying to extract water chemistry information, specifically ionic strength. It appears to me that they measured high colloid concentrations in high-ionic strength solutions - which is not supposed to happen. Here's the paragraph I wrote for the KTI agreement letter for ENFE 1.06, etc.:

The NRC staff find DOE has, in general, responded to the intent of the agreement. One important source of information on colloid stability in near-field waters, however, has not been fully exploited in evaluating the colloid model abstraction. In a DOE-sponsored project, Zarrabi, et al. (2003) measured water chemistry and colloid contents in waters that had interacted with corroding miniature steel waste packages. Data packages from this project were cited in Bechtel SAIC Company, LLC (2003a, Sections 3.3.2 and 3.4.3; 2003b, Section 6.3.1.3) as the basis for the range of iron corrosion product colloid concentrations generated in the waste package. Zarrabi, et al. (2003) also reported chemical data on the waters bearing these colloids from the miniature waste packages at concentrations of 10 mg/L [10 ppm] and higher. The waters have some chemical characteristics that, according to the DOE abstraction (Bechtel SAIC Company, LLC, 2003a, Figure 3-7), would render colloids unstable and limit them to very low concentrations. These chemical characteristics include pH between 8 and 9 (Zarrabi, et al., 2003, Figure 26) and high ionic strengths (Zarrabi, et al., 2003, pp. 14–15 and 45). In fact, the study concludes, "High salinity of incoming solution increases solid transport out of MWP [miniature waste packages]" (Zarrabi, et al., 2003, p. 51). Although the results have not been fully evaluated and interpreted, it is clear the water chemistry data are relevant to the DOE model of iron oxyhydroxide colloid generation and stability. The model concentration of these particular colloids is especially important for release of plutonium and americium, which attach both reversibly and irreversibly to iron oxyhydroxide colloids (Bechtel SAIC Company, LLC, 2003a, Section 3.4.3).

David

MWP NUMBER	FLOW RATE Week 1 mL / Day	FLOW RATE Week 2 mL / Day	FLOW RATE Week 3 mL / Day	FLOW RATE Week 4 mL / Day	AVERAGE FLOW RATE mL / Day	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)	TOTAL SOLIDS (g)	Dates Of Run	# of Days of trial
BN-25-HS-037A	20.48	32.21	29.42	27.78	27.47	0.0136	0.0054	0.0065	0.0255	12/13/02 - 1/10/03	28
BN-25-HS-037B	24.35	18.82	23.71	22.56	22.36	0.0076	0.0069	0.0053	0.0198	12/13/02 - 1/10/03	28
FN-25-HS-039A	27.41	18.40	24.67	24.74	23.80	0.0124	0.0038	0.0073	0.0235	12/13/02 - 1/10/03	28
FN-25-HS-039B	30.33	13.92	28.83	26.62	24.93	0.0095	0.0040	0.0027	0.0162	12/13/02 - 1/10/03	28
BN-25-LPH-041A	26.85	26.09	23.51	18.74	23.79	0.0091	0.0034	0.0031	0.0156	12/13/02 - 1/10/03	28
BN-25-LPH-041B	31.02	27.30	25.62	19.34	25.82	0.0130	0.0054	0.0106	0.0290	12/13/02 - 1/10/03	28
FN-25-LPH-043A	28.42	24.52	19.07	15.03	21.76	0.0093	0.0035	0.0017	0.0145	12/13/02 - 1/10/03	28
FN-25-LPH-043B	28.36	22.27	16.60	7.81	18.76	0.0077	0.0028	0.0008	0.0113	12/13/02 - 1/10/03	28
BN-25-LPH-HS-045A	29.02	22.03	10.37	32.34	23.44	0.0165	0.0063	0.0040	0.0268	12/13/02 - 1/10/03	28
BN-25-LPH-HS-045B	28.67	25.66	4.35	53.78	28.12	0.0122	0.0031	0.0042	0.0195	12/13/02 - 1/10/03	28
FN-25-LPH-HS-047A	37.96	36.71	2.86	22.62	25.04	0.0315	0.0080	0.0050	0.0445	12/13/02 - 1/10/03	28
FN-25-LPH-HS-047B	26.93	23.94	22.23	9.36	20.62	0.0228	0.0036	0.0026	0.0290	12/13/02 - 1/10/03	28

Sample ID Bath tub w/o shot	Period of Collection Data Range	Number of Days after last measurement	Mass of Material (g) 0.45 um	Mass of Material (g) 0.22 um	Mass of Material (g) 0.10 um	Total Mass (g) per meas. Period	Flow rate mL/day	Volume mL	Conc mg/L total	Conc mg/L 0.22 + 0.10	Conductivity uS
BN-25-HS-037A	12/13/02-12/20/02	7	0.0005	0.0013	0.0021	0.0039	20.48	143.363	27.20	23.72	86333
	12/20/02-12/27/02	7	0.0046	0.0022	0.0033	0.0101	32.21	225.5002	44.79	24.39	89600
	12/27/02-1/3/03	7	0.0046	0.0009	0.0004	0.0059	29.42	205.9249	28.65	6.31	85000
	1/3/2003-1/10/03	7	0.0039	0.0010	0.0007	0.0056	27.78	194.4887	28.79	8.74	88300
BN-25-HS-037B	12/13/02-12/20/02	7	0.0016	0.0028	0.0009	0.0053	24.35	170.4566	31.09	21.71	81267
	12/20/02-12/27/02	7	0.0028	0.0033	0.0024	0.0085	18.82	131.7747	64.50	43.26	84350
	12/27/02-1/3/03	7	0.0014	0.0005	0.0011	0.0030	23.71	165.9547	18.08	9.64	94350
	1/3/2003-1/10/03	7	0.0018	0.0003	0.0009	0.0030	22.56	157.8964	19.00	7.60	87033
FN-25-HS-039A	12/13/02-12/20/02	7	0.0029	0.0011	0.0034	0.0074	27.41	191.8572	38.57	23.45	80000
	12/20/02-12/27/02	7	0.0032	0.0018	0.0014	0.0064	18.40	128.7988	49.69	24.84	81250
	12/27/02-1/3/03	7	0.0019	0.0003	0.0000	0.0022	24.67	172.6853	12.74	1.74	91650
	1/3/2003-1/10/03	7	0.0044	0.0006	0.0025	0.0075	24.74	173.1544	43.31	17.90	81933
FN-25-HS-039B	12/13/02-12/20/02	7	0.0004	0.0021	0.0006	0.0031	30.33	212.2813	14.60	12.72	76333
	12/20/02-12/27/02	7	0.0030	0.0011	0.0006	0.0047	13.92	97.46373	48.22	17.44	73250
	12/27/02-1/3/03	7	0.0032	0.0005	0.0003	0.0040	28.83	201.8373	19.82	3.96	82800
	1/3/2003-1/10/03	7	0.0029	0.0003	0.0012	0.0044	26.62	186.322	23.62	8.05	77800
BN-25-LPH-041A	12/13/02-12/20/02	7	0.0045	0.0011	0.0010	0.0066	26.85	187.9268	35.12	11.17	1699
	12/20/02-12/27/02	7	0.0020	0.0001	0.0020	0.0041	26.09	182.6049	22.45	11.50	1630
	12/27/02-1/3/03	7	0.0003	0.0021	0.0000	0.0024	23.51	164.5403	14.59	12.76	1667
	1/3/2003-1/10/03	7	0.0023	0.0001	0.0001	0.0025	18.74	131.1476	19.06	1.52	1733
BN-25-LPH-041B	12/13/02-12/20/02	7	0.0045	0.0046	0.0001	0.0092	31.02	217.1485	42.37	21.64	1627

	12/20/02-12/27/02	7	0.0075	0.0000	0.0104	0.0179	27.30	191.1073	93.66	54.42	1608
	12/27/02-1/3/03	7	0.0000	0.0008	0.0000	0.0008	25.62	179.3655	4.46	4.46	1604
	1/3/2003-1/10/03	7	0.0010	0.0000	0.0001	0.0011	19.34	135.4038	8.12	0.74	1621
FN-25-LPH-043A	12/13/02-12/20/02	7	0.0048	0.0028	0.0004	0.0080	28.42	198.925	40.22	16.09	1590
	12/20/02-12/27/02	7	0.0023	0.0001	0.0012	0.0036	24.52	171.6231	20.98	7.57	1485
	12/27/02-1/3/03	7	0.0006	0.0006	0.0001	0.0013	19.07	133.485	9.74	5.24	1518
	1/3/2003-1/10/03	7	0.0016	0.0000	0.0000	0.0016	15.03	105.1937	15.21	0.00	1556
FN-25-LPH-043B	12/13/02-12/20/02	7	0.0052	0.0015	0.0000	0.0067	28.36	198.5404	33.75	7.56	1612
	12/20/02-12/27/02	7	0.0017	0.0001	0.0006	0.0024	22.27	155.9005	15.39	4.49	1528
	12/27/02-1/3/03	7	0.0000	0.0011	0.0002	0.0013	16.60	116.2264	11.19	11.19	1564
	1/3/2003-1/10/03	7	0.0008	0.0001	0.0000	0.0009	7.81	54.63612	16.47	1.83	1626
BN-25-HS-HN-045A	12/13/02-12/20/02	7	0.0046	0.0032	0.0014	0.0092	29.02	203.1184	45.29	22.65	82100
	12/20/02-12/27/02	7	0.0036	0.0022	0.0018	0.0076	22.03	154.2097	49.28	25.94	79850
	12/27/02-1/3/03	7	0.0044	0.0004	0.0008	0.0056	10.37	72.57899	77.16	16.53	83750
	1/3/2003-1/10/03	7	0.0039	0.0005	0.0000	0.0044	32.34	226.3588	19.44	2.21	87400
BN-25-HS-HN-045B	12/13/02-12/20/02	7	0.0018	0.0022	0.0018	0.0058	28.67	200.7119	28.90	19.93	82000
	12/20/02-12/27/02	7	0.0036	0.0002	0.0012	0.0050	25.66	179.587	27.84	7.80	81400
	12/27/02-1/3/03	7	0.0017	0.0000	0.0008	0.0025	4.35	30.47217	82.04	26.25	86750
	1/3/2003-1/10/03	7	0.0051	0.0007	0.0004	0.0062	53.78	376.4559	16.47	2.92	87900
FN-25-HS-HN-047A	12/13/02-12/20/02	7	0.0142	0.0035	0.0017	0.0194	37.96	265.7053	73.01	19.57	78567
	12/20/02-12/27/02	7	0.0048	0.0018	0.0022	0.0088	36.71	256.9522	34.25	15.57	76850
	12/27/02-1/3/03	7	0.0019	0.0020	0.0006	0.0045	2.86	20.01049	224.88	129.93	78700
	1/3/2003-1/10/03	7	0.0106	0.0007	0.0005	0.0118	22.62	158.3287	74.53	7.58	84200
FN-25-HS-HN-047B	12/13/02-12/20/02	7	0.0093	0.0026	0.0009	0.0128	26.93	188.5163	67.90	18.57	81467
	12/20/02-12/27/02	7	0.0024	0.0005	0.0010	0.0039	23.94	167.5552	23.28	8.95	83350
	12/27/02-1/3/03	7	0.0023	0.0000	0.0005	0.0028	22.23	155.6293	17.99	3.21	85100
	1/3/2003-1/10/03	7	0.0088	0.0005	0.0002	0.0095	9.36	65.54661	144.94	10.68	88167

Mass Flow Filtered Solids (g/mL)	Mass Flow Duplicate Ave. Filtered Solids (mg/L)	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By MWP Type Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.
		High Saline		**Bathtub**		**High Saline**	
0.0000331	32.3866231	30.8	2.2	32.4	1.1	30.8	5.3
0.0000316				**Flow-through**			
0.0000353	29.2356983			29.2	8.5		
0.0000232							
		Low pH				**Low pH**	
0.0000234	31.7624828	27.2	6.4	**Bathtub**		27.2	8.7
0.0000401				31.8	11.8		
0.0000238	22.6560204			**Flow-through**			
0.0000215				22.7	1.6		
		High Nitrate				**High Nitrate**	
0.0000408	32.8038016	44.8	17.0	**Bathtub**		44.8	16.3
0.0000248				32.8	11.4		
0.0000635	56.8597313			**Flow-through**			
0.0000502				56.9	9.4		

MWP Type	Week	High Saline Conductivity (uS) "A" Package			"B" Package			Average	Std. Dev.	n	Low pH Conductivity (uS) "A" Package			"B" Package	
Bathtub w/o shot	1	78900	87900	92200	79200	79200	85400	83800	5590.349	6	1691	1686	1721	1645	1601
	2	90300	88900		82700	86000		86975	3365.883	4	1597	1663		1577	1639
	3	83100	86900		88900	99800		89675	7165.833	4	1678	1655		1631	1577
	4	85500	94300	85100	85900	90000	85200	87666.67	3739.875	6	1716	1774	1709	1626	1604
Flowthru w/o shot	1	80500	83500	76000	75100	75000	78900	78166.67	3422.085	6	1637	1556	1578	1652	1585
	2	76400	86100		73900	72600		77250	6107.1	4	1477	1493		1538	1517
	3	86100	97200		82800			88700	7543.872	3	1506	1529		1544	1584
	4	82200	81600	82000	77700	78400	77300	79866.67	2299.275	6	1544	1565	1560	1497	1719

HS-High NO3 Conductivity (uS)

	Average	Std. Dev.	n	"A" Package			"B" Package			Average	Std. Dev.	n
1636	1663.333	43.7569	6	83000	81700	81600	82700	82600	80700	82050	868.9074	6
	1619	39.08964	4	78900	80800		80900	81900		80625	1252.664	4
	1635.25	43.3157	4	82500	85000		81700	91800		85250	4587.301	4
1632	1676.833	66.19491	6	89500	82300	90400		87900		87525	3633.524	4
1600	1601.333	36.62604	6	78600	78000	79100	81600	79300	83500	80016.67	2100.873	6
	1506.25	26.80019	4	76400	77300		83000	83700		80100	3781.534	4
	1540.75	32.79609	4	78000	79400		85400	84800		81900	3746.999	4
1663	1591.333	82.76392	6		84200		85700	91200	87600	87175	3022.554	4

MWP NUMBER	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)	TOTAL SOLIDS (g)	Mass Flow Filtered Solids (g/mL)	Mass Flow Filtered Solids (mg/L)	Mass Flow Filtered Solids 0.22 + 0.1 (mg/L)	AVERAGE FLOW RATE mL / Day	**# of Days of trial**
BN-25-C-001A	0.0091	0.0017	0.0006	0.0114	1.52313E-05	15.23	3.07	26.73074467	28
BN-25-C-001B	0.0126	0.002	0.0008	0.0154	2.14819E-05	21.48	3.91	25.60292358	28
BI-25-C-002A	0.005	0.0017	0.0005	0.0072	7.90039E-06	7.90	2.41	32.54810784	28
BI-25-C-002B	0.0062	0.0014	0.0008	0.0084	9.42942E-06	9.43	2.47	31.81530216	28
FN-25-C-003A	0.0229	0.0014	0.0007	0.025	2.64156E-05	26.42	2.22	33.80031409	28
FN-25-C-003B	0.0199	0.0017	0.001	0.0226	2.63394E-05	26.34	3.15	30.64397121	28
FI-25-C-004A	0.0101	0.0013	0.0008	0.0122	1.32819E-05	13.28	2.29	32.80511207	28
FI-25-C-004B	0.0064	0.0015	0.0012	0.0091	1.21853E-05	12.19	3.62	26.67144683	28
BN-25-HS-005A	0.0081	0.0013	0.001	0.0104	1.18321E-05	11.83	2.62	36.62346469	24
BN-25-HS-005B	0.0086	0.0028	0.0026	0.014	2.31076E-05	23.11	8.91	25.24417456	24
BI-25-HS-006A	0.006	0.0016	0.0033	0.0109	1.51127E-05	15.11	6.79	30.05197319	24
BI-25-HS-006B	0.0075	0.0019	0.0042	0.0136	1.79557E-05	17.96	8.05	31.55914272	24
FN-25-HS-007A	0.0069	0.0179	0.0072	0.032	4.42794E-05	44.28	34.73	30.11182222	24
FN-25-HS-007B	0.0078	0.0024	0.0029	0.0131	2.048E-05	20.48	8.29	26.65196254	24
FI-25-HS-008A	0.0051	0.0021	0.0056	0.0128	1.41091E-05	14.11	8.49	37.80074834	24
FI-25-HS-008B	0.0039	0.0017	0.0019	0.0075	8.24305E-06	8.24	3.96	37.9107225	24
BN-25-LPH-009A	0.0193	0.01	0.0115	0.0408	4.989E-05	49.89	26.29	34.07499742	24
BN-25-LPH-009B	0.008	0.003	0.0033	0.0143	1.76155E-05	17.62	7.76	33.8243417	24
BI-25-LPH-010A	0.009	0.0052	0.004	0.0182	2.21475E-05	22.15	11.20	34.24016212	24
BI-25-LPH-010B	0.0108	0.0091	0.0095	0.0294	3.53536E-05	35.35	22.37	34.6499495	24
FN-25-LPH-011A	0.0098	0.003	0.0019	0.0147	1.64222E-05	16.42	5.47	37.29708554	24
FN-25-LPH-011B	0.0152	0.0015	0.0057	0.0224	2.46435E-05	24.64	7.92	37.87344054	24
FI-25-LPH-012A	0.0095	0.0009	0.0018	0.0122	1.82377E-05	18.24	4.04	27.87259586	24
FI-25-LPH-012B	0.015	0.0016	0.0018	0.0184	2.32926E-05	23.29	4.30	32.91456437	24
BN-25-HS-HN-013A	0.0094	0.0037	0.0039	0.017	2.05185E-05	20.52	9.17	34.52173872	24
BN-25-HS-HN-013B	0.0113	0.0014	0.0024	0.0151	2.02355E-05	20.24	5.09	31.09225093	24
BI-25-HS-HN-014A	0.0104	0.0013	0.0022	0.0139	2.15054E-05	21.51	5.42	26.93120131	24
BI-25-HS-HN-014B	0.0098	0.0008	0.0015	0.0121	1.47095E-05	14.71	2.80	34.27493769	24
FN-25-HS-HN-015A	0.0193	0.002	0.0016	0.0229	2.82485E-05	28.25	4.44	33.777599	24
FN-25-HS-HN-015B	0.0158	0.001	0.0026	0.0194	2.77221E-05	27.72	5.14	29.15843785	24
FI-25-HS-HN-016A	0.0162	0.0014	0.002	0.0196	2.21107E-05	22.11	3.84	36.93530082	24
FI-25-HS-HN-016B	0.0065	0.0016	0.0018	0.0099	1.26146E-05	12.61	4.33	32.70021119	24

Sample ID	Pe Da	Mass of Mater 0.45 um	Mass of Mater 0.22 um	Mass of Mater 0.10 um	Total Mass (g) per meas. Period	Days	Volume for step mL (using avg)	conc mg/L 0.45 um	co	conc mg/L 0.10 um	conc mg/L total	conc mg/L 0.22 + 0.10	Conductivity uS
BN-25-C-001A	7/2	0.0036	0.0003	1E-04	0.004	7	187.1152127	19.24	#	0.53	21.38	2.14	319
	7/3	0.0019	0.0002	0	0.0021	7	187.1152127	10.15	#	0.00	11.22	1.07	313
	8/7	0.0022	0.0003	0.0002	0.0027	7	187.1152127	11.76	#	1.07	14.43	2.67	420
	8/1	0.0014	0.0009	0.0003	0.0026	7	187.1152127	7.48	#	1.60	13.90	6.41	298
BN-25-C-001B	7/2	0.0054	0.0006	0.0001	0.0061	7	179.2204651	30.13	#	0.56	34.04	3.91	330
	7/3	0.0036	0.0003	0.0002	0.0041	7	179.2204651	20.09	#	1.12	22.88	2.79	331
	8/7	0.0025	0.0008	0.0004	0.0037	7	179.2204651	13.95	#	2.23	20.64	6.70	367
	8/1	0.0011	0.0003	1E-04	0.0015	7	179.2204651	6.14	#	0.56	8.37	2.23	320
BI-25-C-002A	7/2	0.0027	0.0007	0	0.0034	7	227.8367549	11.85	#	0.00	14.92	3.07	317
	7/3	0.0007	0	0.0003	0.001	7	227.8367549	3.07	#	1.32	4.39	1.32	330
	8/7	0.0011	0.0005	0.0002	0.0018	7	227.8367549	4.83	#	0.88	7.90	3.07	418
	8/1	0.0005	0.0005	0	0.001	7	227.8367549	2.19	#	0.00	4.39	2.19	325
BI-25-C-002B	7/2	0.0029	0.0008	0	0.0037	7	222.7071151	13.02	#	0.00	16.61	3.59	329
	7/3	0.0018	1E-04	0.0002	0.0021	7	222.7071151	8.08	#	0.90	9.43	1.35	340
	8/7	0.0008	0.0003	0.0003	0.0014	7	222.7071151	3.59	#	1.35	6.29	2.69	765
	8/1	0.0007	0.0002	0.0003	0.0012	7	222.7071151	3.14	#	1.35	5.39	2.25	430
FN-25-C-003A	7/2	0.0136	0.0003	0.0002	0.0141	7	236.6021986	57.48	#	0.85	59.59	2.11	262
	7/3	0.004	0	0	0.004	7	236.6021986	16.91	#	0.00	16.91	0.00	263
	8/7	0.0038	0.0008	0.0002	0.0048	7	236.6021986	16.06	#	0.85	20.29	4.23	291
	8/1	0.0015	0.0003	0.0003	0.0021	7	236.6021986	6.34	#	1.27	8.88	2.54	272
FN-25-C-003B	7/2	0.0066	0.0008	0.0003	0.0077	7	214.5077985	30.77	#	1.40	35.90	5.13	268
	7/3	0.0055	0.0001	0.0003	0.0059	7	214.5077985	25.64	#	1.40	27.50	1.86	257
	8/7	0.0048	0.0006	0.0002	0.0056	7	214.5077985	22.38	#	0.93	26.11	3.73	294
	8/1	0.003	0.0002	0.0002	0.0034	7	214.5077985	13.99	#	0.93	15.85	1.86	258
FI-25-C-004A	7/2	0.0062	0.0004	0	0.0066	7	229.6357845	27.00	#	0.00	28.74	1.74	334
	7/3	0.0014	0	0.0001	0.0015	7	229.6357845	6.10	#	0.44	6.53	0.44	293
	8/7	0.0015	0.0004	0.0003	0.0022	7	229.6357845	6.53	#	1.31	9.58	3.05	354
	8/1	0.001	0.0005	0.0004	0.0019	7	229.6357845	4.35	#	1.74	8.27	3.92	314
FI-25-C-004B	7/2	0.0024	0.0005	0.0002	0.0031	7	186.7001278	12.85	#	1.07	16.60	3.75	
	7/3	0.0024	0.0007	0.0007	0.0038	7	186.7001278	12.85	#	3.75	20.35	7.50	
	8/7	0.0006	0.0003	0	0.0009	7	186.7001278	3.21	#	0.00	4.82	1.61	
	8/1	0.001	0	0.0002	0.0012	7	186.7001278	5.36	#	1.07	6.43	1.07	
BN-25-HS-005A	6/1	0.005	0.0003	0.0003	0.0056	7	256.3642529	19.50	#	1.17	21.84	2.34	68600
	6/2	0.0021	0.0006	0.0002	0.0029	7	256.3642529	8.19	#	0.78	11.31	3.12	78000
	7/2	0.0007	1E-04	0.0003	0.0011	7	256.3642529	2.73	#	1.17	4.29	1.56	80000
	7/9	0.0003	0.0003	0.0002	0.0008	3	109.8703941	2.73	#	1.82	7.28	4.55	73300
BN-25-HS-005B	6/1	0.0036	0.0005	0.0005	0.0046	7	176.7092219	20.37	#	2.83	26.03	5.66	72300
	6/2	0.0033	0.0009	0.0003	0.0045	7	176.7092219	18.67	#	1.70	25.47	6.79	95000
	7/2	0.0011	0.0008	0.0013	0.0032	7	176.7092219	6.22	#	7.36	18.11	11.88	103500

	7/9	0.0006	0.0006	0.0005	0.0017	3	75.73252368	7.92	#	6.60	22.45	14.52	94400
BI-25-HS-006A	6/1	0.0025	0.0003	0.0003	0.0031	7	210.3638124	11.88	#	1.43	14.74	2.85	70900
	6/2	0.0032	0.0007	0.0004	0.0043	7	210.3638124	15.21	#	1.90	20.44	5.23	79050
	7/2	1E-04	0	0	1E-04	7	210.3638124	0.48	#	0.00	0.48	0.00	
	7/9	0.0006	0.0006	0.0026	0.0038	3	90.15591958	6.66	#	28.84	42.15	35.49	
BI-25-HS-006B	6/1	0.0022	0.0005	0.0005	0.0032	7	220.9139991	9.96	#	2.26	14.49	4.53	68500
	6/2	0.004	0.0006	0.0003	0.0049	7	220.9139991	18.11	#	1.36	22.18	4.07	92450
	7/2	0.0009	0.0004	0.0008	0.0021	7	220.9139991	4.07	#	3.62	9.51	5.43	100700
	7/9	0.0004	0.0004	0.0026	0.0034	3	94.67742817	4.22	#	27.46	35.91	31.69	102500
FN-25-HS-007A	6/1	0.0038	0.0008	0.0009	0.0055	7	210.7827556	18.03	#	4.27	26.09	8.07	71700
	6/2	0.003	0.016	0.0003	0.0193	7	210.7827556	14.23	#	1.42	91.56	77.33	110000
	7/2	1E-04	0.0011	0.0055	0.0067	7	210.7827556	0.47	#	26.09	31.79	31.31	113200
	7/9	0.0009	0	0.0005	0.0014	3	90.33546667	9.96	#	5.53	15.50	5.53	
FN-25-HS-007B	6/1	0.0021	0.0007	0	0.0028	7	186.5637378	11.26	#	0.00	15.01	3.75	73700
	6/2	0.003	0.0006	0.0003	0.0039	7	186.5637378	16.08	#	1.61	20.90	4.82	110950
	7/2	0.0027	0.0011	0.0026	0.0064	7	186.5637378	14.47	#	13.94	34.30	19.83	111600
	7/9	0	0	0	0	3	79.95588761	0.00	#	0.00	0.00	0.00	
FI-25-HS-008A	6/1	0.0018	0.0005	0.0001	0.0024	7	264.6052384	6.80	#	0.38	9.07	2.27	70100
	6/2	0.0014	0.0005	0.0006	0.0025	7	264.6052384	5.29	#	2.27	9.45	4.16	78000
	7/2	0.0006	0.0006	0.0023	0.0035	7	264.6052384	2.27	#	8.69	13.23	10.96	85000
	7/9	0.0013	0.0005	0.0026	0.0044	3	113.402245	11.46	#	22.93	38.80	27.34	83400
FI-25-HS-008B	6/1	0.0008	0.0006	0	0.0014	7	265.3750575	3.01	#	0.00	5.28	2.26	73700
	6/2	0.001	0.0002	0.0003	0.0015	7	265.3750575	3.77	#	1.13	5.65	1.88	82000
	7/2	0.0008	0.0006	0.0009	0.0023	7	265.3750575	3.01	#	3.39	8.67	5.65	80000
	7/9	0.0013	0.0003	0.0007	0.0023	3	113.7321675	11.43	#	6.15	20.22	8.79	81600
BN-25-LPH-009A	6/1	0.0125	0.0034	0.0019	0.0178	7	238.5249819	52.41	#	7.97	74.63	22.22	1567
	6/2	0.0045	0.0062	0.0073	0.018	7	238.5249819	18.87	#	30.60	75.46	56.60	1781
	7/2	0.0023	0.0004	0.0023	0.005	7	238.5249819	9.64	#	9.64	20.96	11.32	2585
	7/9	0	0	0	0	3	102.2249922	0.00	#	0.00	0.00	0.00	
BN-25-LPH-009B	6/1	0.0034	0.0007	0.0008	0.0049	7	236.7703919	14.36	#	3.38	20.70	6.34	1561
	6/2	0.003	0.0008	0.0012	0.005	7	236.7703919	12.67	#	5.07	21.12	8.45	1652
	7/2	0.0013	0.0002	0.0006	0.0021	7	236.7703919	5.49	#	2.53	8.87	3.38	2055
	7/9	0.0003	0.0013	0.0007	0.0023	3	101.4730251	2.96	#	6.90	22.67	19.71	1950
BI-25-LPH-010A	6/1	0.0066	0.0037	0.0015	0.0118	7	239.6811349	27.54	#	6.26	49.23	21.70	1464
	6/2	0.0018	0.0004	0.0006	0.0028	7	239.6811349	7.51	#	2.50	11.68	4.17	1724
	7/2	0.0004	0.0004	0.0008	0.0016	7	239.6811349	1.67	#	3.34	6.68	5.01	2058
	7/9	0.0002	0.0007	0.0011	0.002	3	102.7204864	1.95	#	10.71	19.47	17.52	
BI-25-LPH-010B	6/1	0.0029	0.0012	0.0007	0.0048	7	242.5496465	11.96	#	2.89	19.79	7.83	1526
	6/2	0.0036	0.006	0.0007	0.0103	7	242.5496465	14.84	#	2.89	42.47	27.62	1860
	7/2	0.0022	0	0.0015	0.0037	7	242.5496465	9.07	#	6.18	15.25	6.18	2170
	7/9	0.0021	0.0019	0.0066	0.0106	3	103.9498485	20.20	#	63.49	101.97	81.77	2020

FN-25-LPH-011A	6/1	0.0045	0.0024	0.0008	0.0077	7	261.0795988	17.24	#	3.06	29.49	12.26	1471
	6/2	0.002	0.0005	0.0004	0.0029	7	261.0795988	7.66	#	1.53	11.11	3.45	1519
	7/2	0.0023	0.0001	0.0005	0.0029	7	261.0795988	8.81	#	1.92	11.11	2.30	1415
	7/9	0.001	0	0.0002	0.0012	3	111.8912566	8.94	#	1.79	10.72	1.79	1337
FN-25-LPH-011B	6/1	0.01	0.0012	0.0017	0.0129	7	265.1140838	37.72	#	6.41	48.66	10.94	1448
	6/2	0.0017	0.0002	0.0005	0.0024	7	265.1140838	6.41	#	1.89	9.05	2.64	1640
	7/2	0.003	0.0001	0.0004	0.0035	7	265.1140838	11.32	#	1.51	13.20	1.89	1326
	7/9	0.0005	0	0.0001	0.0006	3	113.6203216	4.40	#	0.88	5.28	0.88	1298
FI-25LPH-012A	6/1	0.0035	0.0007	0	0.0042	7	195.108171	17.94	#	0.00	21.53	3.59	1417
	6/2	0.002	0	0.0005	0.0025	7	195.108171	10.25	#	2.56	12.81	2.56	1444
	7/2	0.0032	0.0002	0.0008	0.0042	7	195.108171	16.40	#	4.10	21.53	5.13	1294
	7/9	0.0008	0	0.0005	0.0013	3	83.61778757	9.57	#	5.98	15.55	5.98	2110
FI-25LPH-012B	6/1	0.0044	0.0004	0.0003	0.0051	7	230.4019506	19.10	#	1.30	22.14	3.04	1314
	6/2	0.0046	0.0009	0.0006	0.0061	7	230.4019506	19.97	#	2.60	26.48	6.51	1400
	7/2	0.0056	0.0003	0.0006	0.0065	7	230.4019506	24.31	#	2.60	28.21	3.91	1681
	7/9	0.0004	0	0.0003	0.0007	3	98.74369311	4.05	#	3.04	7.09	3.04	1553
BN-25-HS-HN-01:	6/1	0.0069	0.0009	0.0011	0.0089	7	241.6521711	28.55	#	4.55	36.83	8.28	80700
	6/2	0.002	0.0021	0	0.0041	7	241.6521711	8.28	#	0.00	16.97	8.69	90300
	7/2	0	0.0004	0.0001	0.0005	7	241.6521711	0.00	#	0.41	2.07	2.07	80300
	7/9	0.0005	0.0003	0.0027	0.0035	3	103.5652162	4.83	#	26.07	33.80	28.97	
BN-25-HS-HN-01:	6/1	0.0078	0.0006	0	0.0084	7	217.6457565	35.84	#	0.00	38.59	2.76	78800
	6/2	0.0022	0.0007	0	0.0029	7	217.6457565	10.11	#	0.00	13.32	3.22	84000
	7/2	0.0002	1E-04	0.0007	0.001	7	217.6457565	0.92	#	3.22	4.59	3.68	72000
	7/9	0.0011	0	0.0017	0.0028	3	93.2767528	11.79	#	18.23	30.02	18.23	94600
BI-25-HS-HN-014	6/1	0.0078	0.0006	0	0.0084	7	188.5184091	41.38	#	0.00	44.56	3.18	77500
	6/2	0.0006	0.0007	0	0.0013	7	188.5184091	3.18	#	0.00	6.90	3.71	86000
	7/2	0.0011	0	0.0006	0.0017	7	188.5184091	5.83	#	3.18	9.02	3.18	101000
	7/9	0.0009	0	0.0016	0.0025	3	80.79360392	11.14	#	19.80	30.94	19.80	89300
BI-25-HS-HN-014	6/1	0.0055	0.0003	0	0.0058	7	239.9245638	22.92	#	0.00	24.17	1.25	72700
	6/2	0.0032	0.0005	0	0.0037	7	239.9245638	13.34	#	0.00	15.42	2.08	77000
	7/2	0.0007	0	0.0002	0.0009	7	239.9245638	2.92	#	0.83	3.75	0.83	83000
	7/9	0.0004	0	0.0013	0.0017	3	102.8248131	3.89	#	12.64	16.53	12.64	89800
FN-25-HS-HN-01!	6/1	0.0159	0.0011	0.0004	0.0174	7	236.443193	67.25	#	1.69	73.59	6.34	81200
	6/2	0.0016	0.0005	0.0001	0.0022	7	236.443193	6.77	#	0.42	9.30	2.54	88000
	7/2	0.0006	0	0.0005	0.0011	7	236.443193	2.54	#	2.11	4.65	2.11	80000
	7/9	0.0012	0.0004	0.0006	0.0022	3	101.332797	11.84	#	5.92	21.71	9.87	77100
FN-25-HS-HN-01!	6/1	0.0086	0.0003	0.0002	0.0091	7	204.1090649	42.13	#	0.98	44.58	2.45	86100
	6/2	0.0032	0.0007	0.0002	0.0041	7	204.1090649	15.68	#	0.98	20.09	4.41	
	7/2	0.0016	0	0.0009	0.0025	7	204.1090649	7.84	#	4.41	12.25	4.41	87000
	7/9	0.0024	0	0.0013	0.0037	3	87.47531354	27.44	#	14.86	42.30	14.86	100000
FI-25-HS-HN-016	6/1	0.0073	0.0008	0.0002	0.0083	7	258.5471057	28.23	#	0.77	32.10	3.87	76300

	6/2	0.0028	0.0005	0.0004	0.0037	7	258.5471057	10.83	#	1.55	14.31	3.48	82000
	7/2	0.0043	0.0001	0.0008	0.0052	7	258.5471057	16.63	#	3.09	20.11	3.48	87000
	7/9	0.0018	0	0.0006	0.0024	3	110.8059025	16.24	#	5.41	21.66	5.41	80300
FI-25-HS-HN-016	6/1	0.0033	0.0003	1E-04	0.0037	7	228.9014783	14.42	#	0.44	16.16	1.75	76300
	6/2	0.0021	0.0011	0.0005	0.0037	7	228.9014783	9.17	#	2.18	16.16	6.99	97000
	7/2	0.0005	0.0002	0.0006	0.0013	7	228.9014783	2.18	#	2.62	5.68	3.49	88000
	7/9	0.0006	0	0.0006	0.0012	3	98.10063356	6.12	#	6.12	12.23	6.12	89700

MWP Type	Week	J-13 Control Conductivity (uS) "A" Package		"B" Package		Average	Std. Dev.	n	High Saline Conductivity (mS) "A" Package		"B" Package		Average	Std. Dev.	n
Bathtub w/o shot	1	309	329	321	339	325	13	4	69		72		70	3	2
	2	313		331		322	13	2	80	76	82	107	88	14	4
	3	420		367		394	37	2	67	93	104		98	19	3
	4	298		320		309	16	2	73		94		84	15	2
Bathtub with shot	1	320	313	321	337	323	10	4	71		69		70	2	2
	2	330		340		335	7	2	79		92		86	9	2
	3	418		765		592	245	2			101		101		1
	4	325		430		378	74	2			103		103		1
Flowthru w/o shot	1	242	281	254	281	265	20	4	72		74		73	1	2
	2	263		257		260	4	2	##		111		110	1	2
	3	291		294		293	2	2	##		112		112	1	2
	4	272		258		265	10	2							0
Flowthru with shot	1	296	372			334	54	2	70		74		72	3	2
	2	293				293		1	80	76	86	78	80	4	4
	3	354				354		1	76	94	76	84	82	9	4
	4	314				314		1	83		82		83	1	2

Low pH Conductivity (uS) "A" Package		"B" Package		Average	Std. Dev.	n
1567		1561		1564	4	2
1813	1749	1680	1623	1716	83	4
2660	2510	2050	2060	2320	312	4
		1950		1950		1
1464		1526		1495	44	2
1781	1666	1886	1833	1792	94	4
2350	1766	2450	1890	2114	337	4
		2020		2020		1
1471		1448		1460	16	2
1545	1492	1886	1393	1579	214	4
1440	1390	1343	1308	1370	57	4
1337		1298		1318	28	2
1417		1314		1366	73	2
1341	1546	1400		1429	106	3
1307	1281	1787	1575	1488	240	4
2110		1553		1832	394	2

HS-High NO3 Conductivity (mS) "A" Package		"B" Package		Average	Std. Dev.	n
81		79		80	1	2
90		85	82	86	4	3
80		73	71	75	5	3
		95		95		1
78		73		75	3	2
93	78	80	73	81	9	4
94	108	79	87	92	13	4
89		90		90	0	2
81		86		84	3	2
	88			88		1
78	82	90	84	83	5	4
77		##		89	16	2
76		76		76	0	2
84	80		97	87	9	3
81	93	85	91	87	6	4
80		90		85	7	2

Dissolved Oxygen Summary Table

Legend:
BN = Bath Tub Model MWP without Iron Shot
BI = Bath Tub Model MWP with Iron Shot
FN = Flowthru Model MWP without Iron Shot
FI = Flowthru Model MWP with Iron Shot

For Control (J-13):
Week 1 = 7/24/02 - 7/31/02
Week 2 = 7/31/02 - 8/07/02
Week 3 = 8/07/02 - 8/14/02
Week 4 = 8/14/02 - 8/21/02

For HS, LPH, HS-HN:
Week 1 = 6/18/02 - 6/25/02
Week 2 = 6/25/02 - 7/02/02
Week 3 = 7/02/02 - 7/09/02
Week 4 = 7/9/02 - 7/12/02

Sample ID	Date of Measurement	DO (ppm) 1	2	3	4	AVG	Week	A & B AVG	A&B STD De	n		DO (ppm) 1
J-13 Control											**High Saline**	
BN-25-C-001A	Week 1	4.33	4.76	5.12	4.70	4.73	1	4.81	0.38	8	BN-25-HS-005A	3.11
	Week 2	4.63	4.51			4.57	2	4.76	0.23	4		2.79
	Week 3	4.77	4.81			4.79	3	4.81	0.07	4		2.76
	Week 4	5.60	5.52			5.56	4	5.64	0.22	4		3.58
BN-25-C-001B	Week 1	4.45	4.57	5.24	5.34	4.90					BN-25-HS-005B	3.38
	Week 2	4.87	5.03			4.95						3.21
	Week 3	4.74	4.91			4.83						2.22
	Week 4	5.96	5.47			5.72						2.60
BI-25-C-002A	Week 1	4.23	4.19	5.40	5.32	4.79	1	4.80	0.51	8	BI-25-HS-006A	3.63
	Week 2	4.45	4.30			4.38	2	4.61	0.29	4		2.96
	Week 3	4.45	4.45			4.45	3	4.63	0.21	4		1.47
	Week 4	5.61	5.10			5.36	4	5.37	0.24	4		1.53
BI-25-C-002B	Week 1	4.60	4.35	5.16	5.15	4.82					BI-25-HS-006B	3.51
	Week 2	4.95	4.75			4.85						2.75
	Week 3	4.78	4.83			4.81						1.93
	Week 4	5.52	5.24			5.38						2.38
FN-25-C-003A	Week 1	4.43	4.29	5.00	5.09	4.70	1	4.70	0.46	8	FN-25-HS-007A	2.98
	Week 2	5.01	4.87			4.94	2	4.70	0.28	4		1.87
	Week 3	4.59	4.46			4.53	3	4.33	0.24	4		1.44
	Week 4	4.90	5.33			5.12	4	5.19	0.23	4		1.59

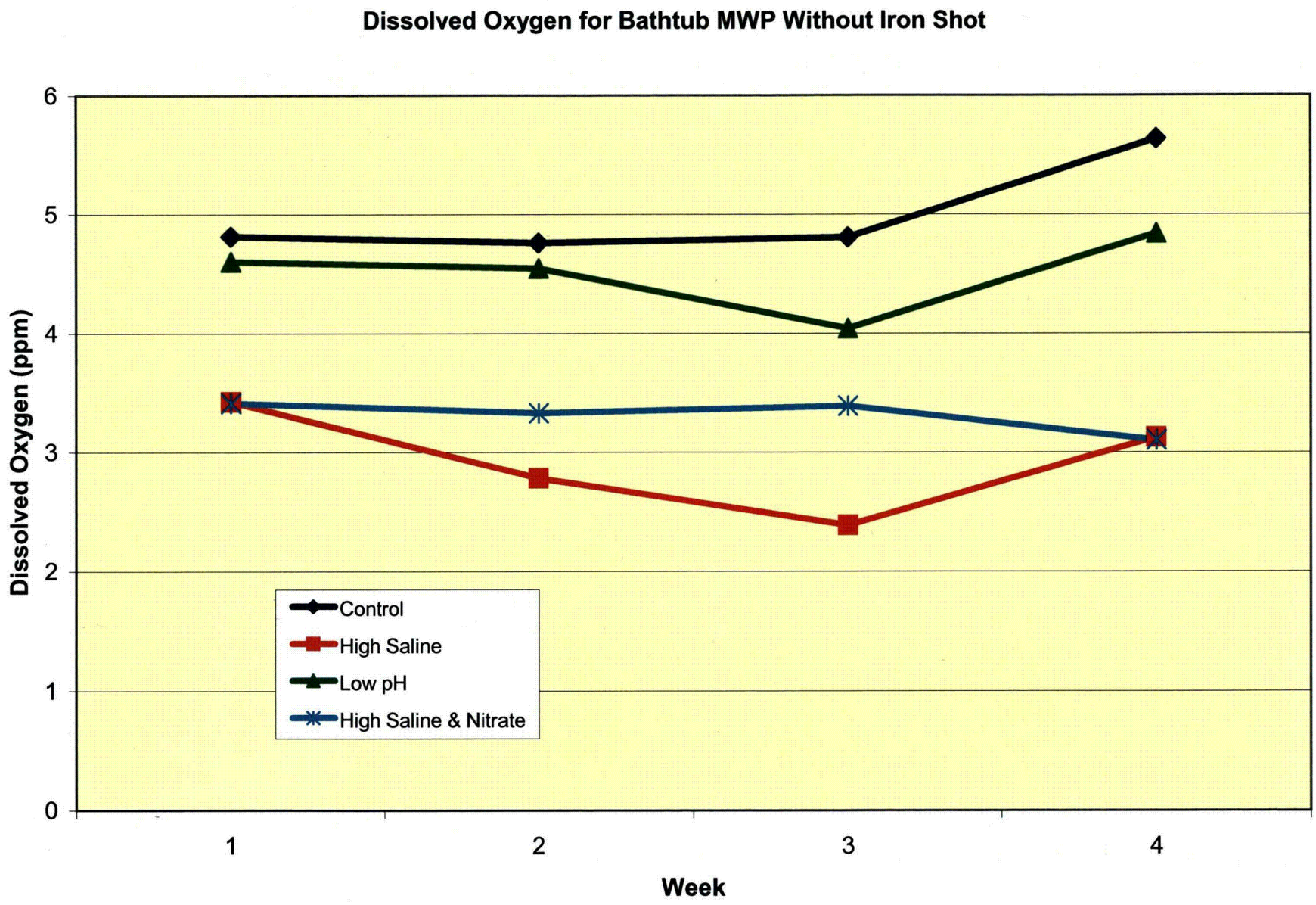
FN-25-C-003B	Week 1	4.15	4.26	5.21	5.19	4.70					FN-25-HS-007B	2.92
	Week 2	4.42	4.51			4.47						1.94
	Week 3	4.22	4.05			4.14						1.45
	Week 4	5.41	5.10			5.26						
FI-25-C-004A	Week 1	4.57	4.85	5.88	5.98	5.32	1	5.00	0.62	8	FI-25-HS-008A	3.18
	Week 2	4.24	4.35			4.30	2	4.42	0.15	4		3.95
	Week 3	4.32	4.40			4.36	3	4.22	0.17	4		2.54
	Week 4	5.54	5.33			5.44	4	5.51	0.21	4		2.86
FI-25-C-004B	Week 1	4.42	4.38	4.99	4.94	4.68					FI-25-HS-008B	3.31
	Week 2	4.54	4.54			4.54						2.44
	Week 3	4.11	4.04			4.08						2.49
	Week 4	5.80	5.38			5.59						2.92

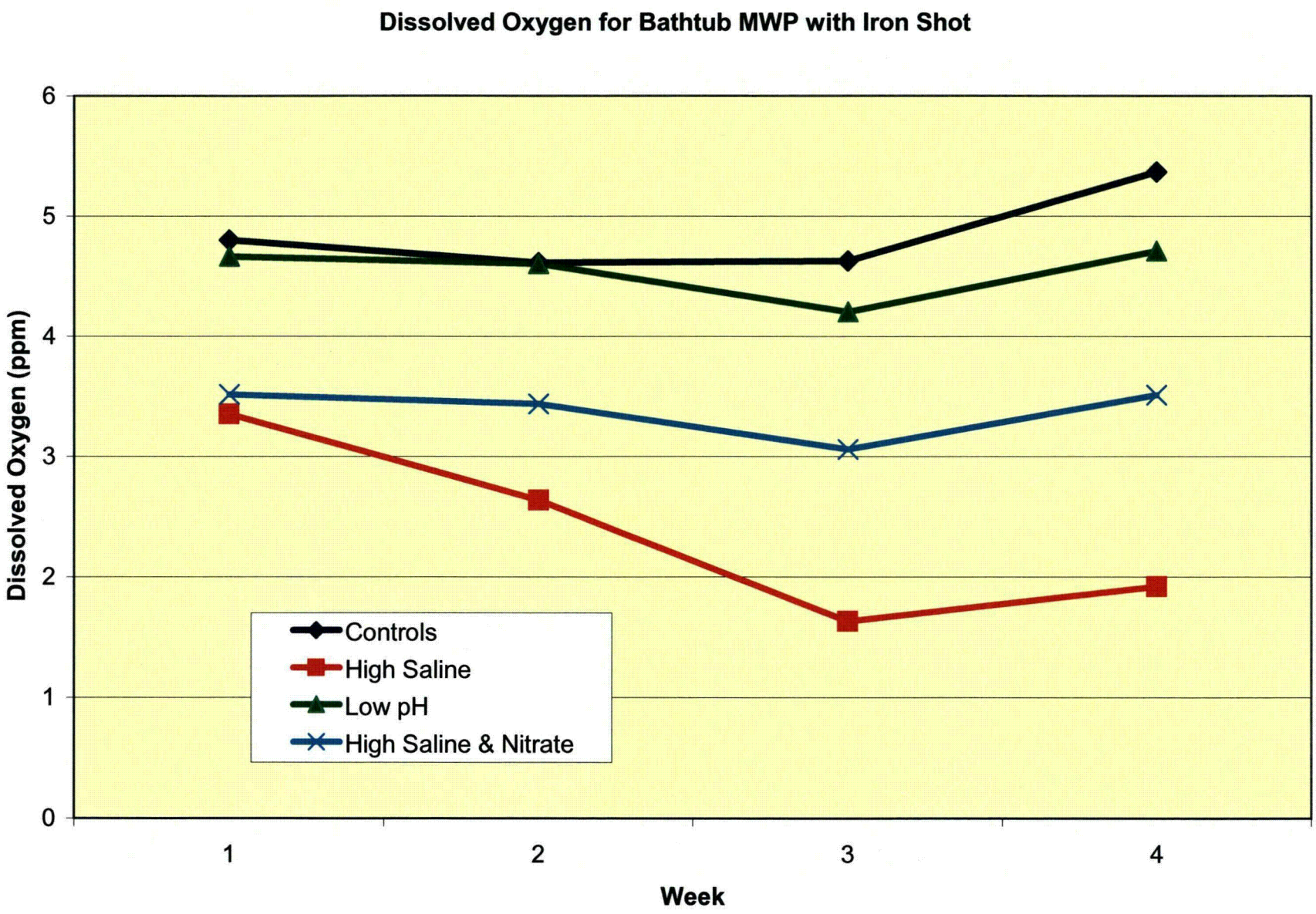
2	3	4	AVG	Week	A & B AVG	stdev	n		1	2	3	4	AVG
								Low pH					
3.13	4.04	3.94	3.56	1.00	3.43	0.36	8	BN-25-LPH-009A	4.44	4.51	4.67	4.72	4.59
2.81	3.05	3.07	2.93	2.00	2.78	0.49	8		4.53	4.44	4.43	4.44	4.46
2.61	2.47	2.48	2.58	3.00	2.39	0.23	8		3.27	3.37	4.65	4.64	3.98
3.52			3.55	4.00	3.13	0.50	4						0.00
3.32	3.24	3.24	3.30					BN-25-LPH-009B	4.40	4.45	4.64	4.98	4.62
3.26	2.11	1.96	2.64						4.49	4.42	4.84	4.77	4.63
2.33	2.17	2.07	2.20						3.66	3.65	4.67	4.41	4.10
2.81			2.71						4.79	4.89			4.84
3.56	3.08	3.24	3.38	1.00	3.35	0.22	8	BI-25-LPH-010A	4.43	4.22	4.65	4.82	4.53
2.89	2.39	2.30	2.64	2.00	2.64	0.24	8		4.60	4.71	4.76	4.76	4.71
1.27			1.37	3.00	1.63	0.31	4		4.07	4.11	4.45	4.41	4.26
1.42			1.48	4.00	1.92	0.52	4		4.63	4.90			4.77
3.49	3.08	3.23	3.33					BI-25-LPH-010B	4.86	4.91	4.68	4.73	4.80
2.77	2.60	2.43	2.64						4.30	4.34	4.67	4.67	4.50
1.85			1.89						3.69	3.69	4.72	4.47	4.14
2.35			2.37						4.59	4.71			4.65
2.99	3.03	3.26	3.07	1.00	3.05	0.10	8	FN-25-LPH-011A	4.15	4.32	4.67	4.72	4.47
1.97	1.95	1.99	1.95	2.00	1.96	0.08	8		4.38	4.41	4.67	4.75	4.55
1.32			1.38	3.00	1.41	0.06	4		3.72	3.74	4.47	4.15	4.02
1.58			1.59	4.00	1.59	0.01	2		4.76	4.62			4.69

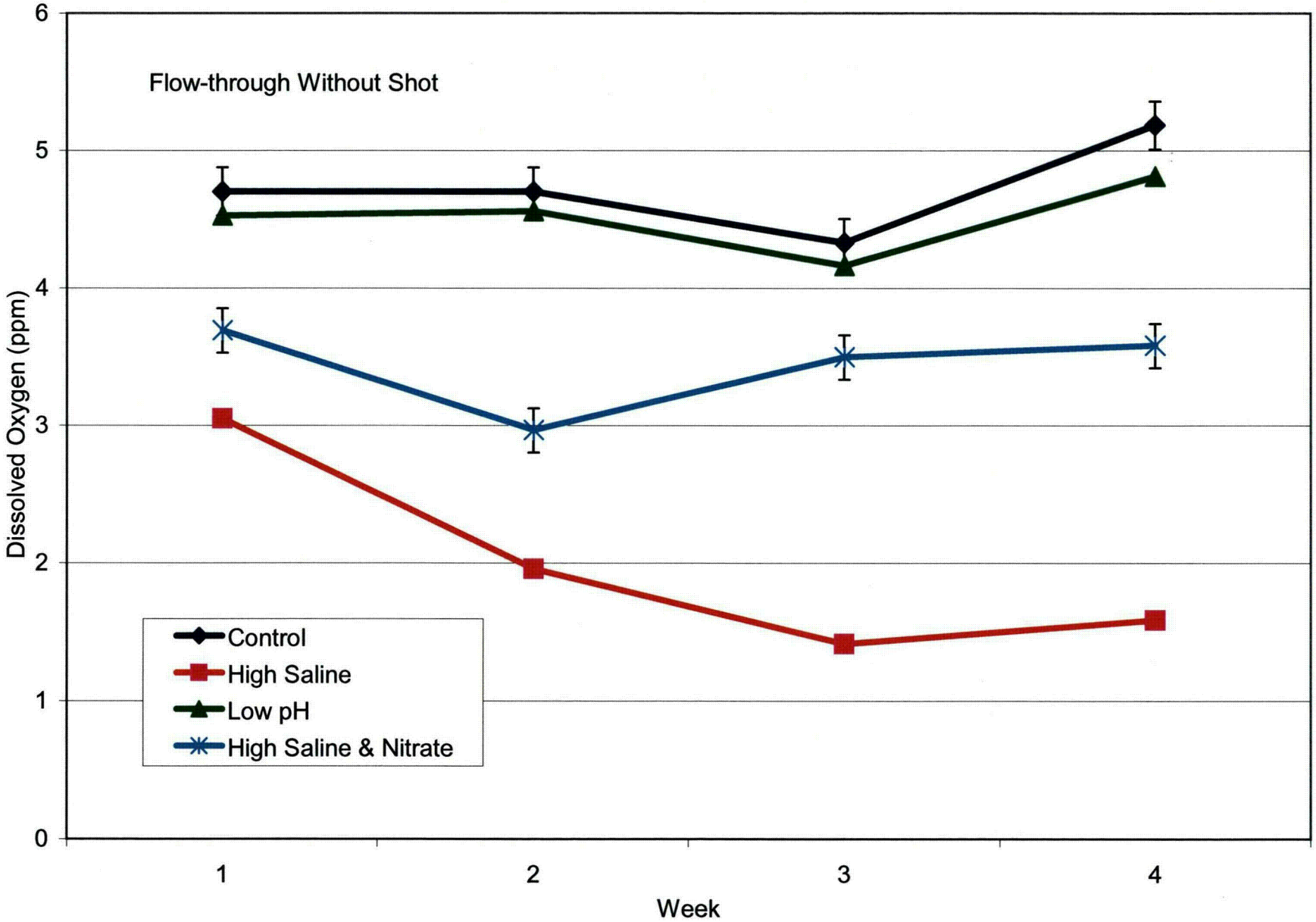
3.11	3.09	3.02	3.04					FN-25-LPH-011B	4.57	4.55	4.60	4.62	4.59
2.11	1.86	1.98	1.97						4.30	4.34	4.77	4.84	4.56
1.44			1.45						4.69	4.31	4.17	4.04	4.30
			0.00						4.83	5.03			4.93
3.15	3.06	3.22	3.15	1.00	3.21	0.10	8	FI-25LPH-012A	4.05	4.07	4.76	4.66	4.39
3.95	2.33	2.36	3.15	2.00	2.80	0.72	8		4.38	4.31	4.77	4.74	4.55
2.66	2.22	2.42	2.46	3.00	2.40	0.16	8		4.38	4.62	4.55	4.62	4.54
2.83			2.85	4.00	2.87	0.04	4		4.55	4.62			4.59
3.34	3.29	3.14	3.27					FI-25LPH-012B	4.07	4.08	4.63	4.57	4.34
2.73	2.35	2.32	2.46						4.35	4.58	4.76	4.90	4.65
2.23	2.35	2.25	2.33						3.87	3.77	4.58	4.58	4.20
2.85			2.89						4.90	4.96			4.93

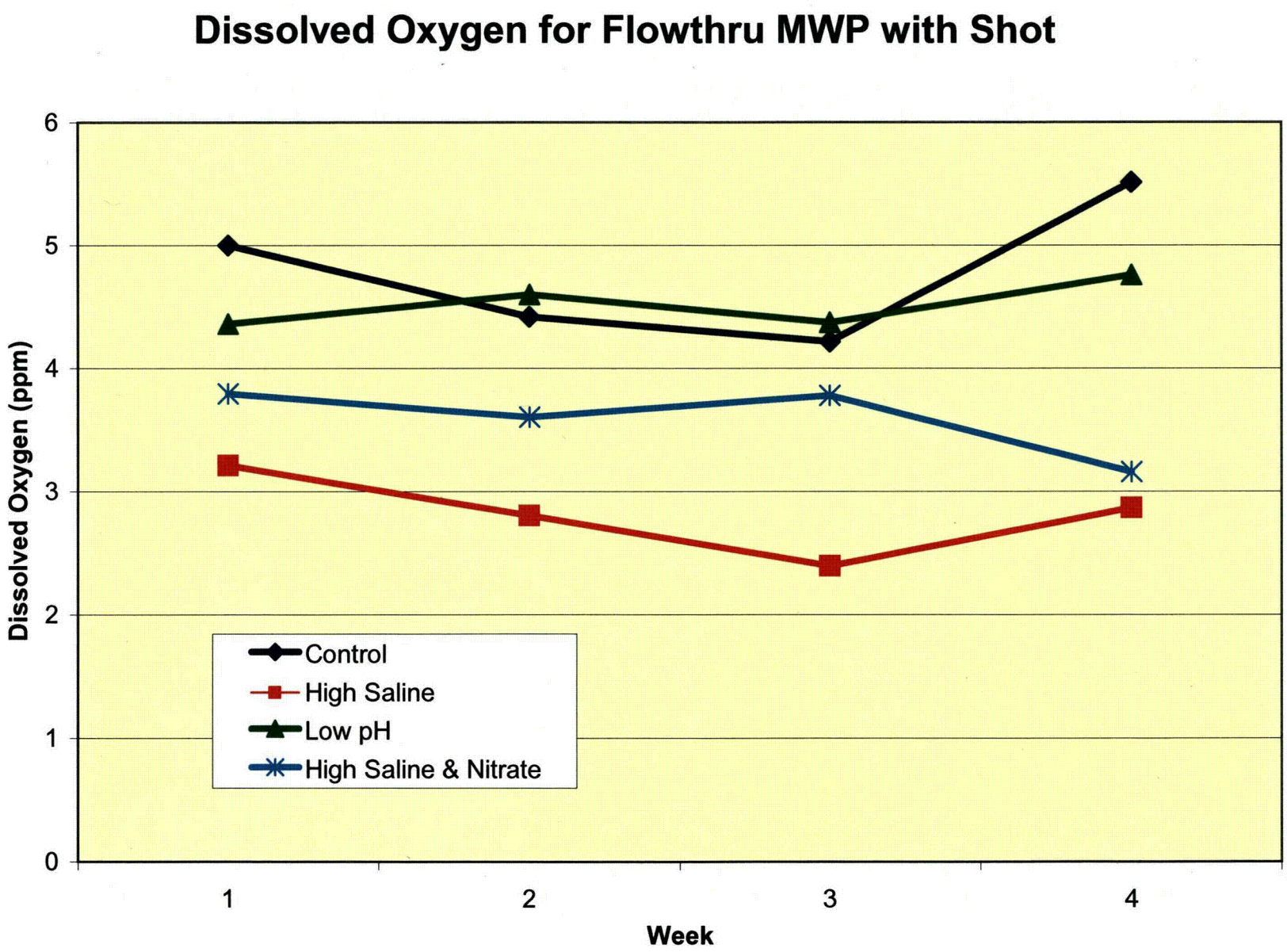
Week	A & B AVG	Stdev	n		1	2	3	4	AVG	Week	A & B AVG	Stdev	n
				High Saline-High NO3									
1.00	4.60	0.19	8	BN-25-LPH-HS-013A	3.24	3.25	3.40	3.47	3.34	1.00	3.41	0.15	8
2.00	4.55	0.17	8		3.79	3.79	3.12	3.15	3.46	2.00	3.33	0.29	8
3.00	4.04	0.61	8		3.31	3.41			3.36	3.00	3.39	0.21	6
4.00	4.84	0.07	2		2.51	2.66			2.59	4.00	3.10	0.30	4
				BN-25-LPH-HS-013B	3.60	3.62	3.32	3.38	3.48				
					3.23	3.11	3.27	3.16	3.19				
					3.58	3.71	3.19	3.19	3.42				
					3.08	3.12			3.10				
1.00	4.66	0.23	8	BI-25-LPH-HS-014A	3.08	3.12	3.25	3.23	3.17	1.00	3.51	0.38	8
2.00	4.60	0.18	8		3.76	3.84	3.24	3.23	3.52	2.00	3.44	0.24	8
3.00	4.20	0.38	8		2.83	2.95	2.60	2.61	2.75	3.00	3.06	0.38	8
4.00	4.71	0.14	4		3.30	3.45			3.38	4.00	3.51	0.10	4
				BI-25-LPH-HS-014B	3.95	3.86	3.87	3.75	3.86				
					3.20	3.37	3.45	3.39	3.35				
					3.61	3.49	3.20	3.18	3.37				
					3.54	3.48			3.51				
1.00	4.53	0.19	8	FN-25-LPH-HS-015A	3.44	3.22	3.82	3.96	3.61	1.00	3.69	0.30	8
2.00	4.56	0.22	8				3.31	3.32	3.32	2.00	2.96	0.37	6
3.00	4.16	0.33	8		3.58	3.54	3.35	3.10	3.39	3.00	3.50	0.21	8
4.00	4.81	0.17	4		3.34	3.67			3.51	4.00	3.58	0.14	4

				FN-25-LPH-HS-015B	3.84	4.11	3.63	3.50	3.77					
					2.69	2.62	2.64	2.50	2.61					
					3.42	3.51	3.73	3.74	3.60					
					3.59	3.57			3.58					
1.00	4.36	0.32	8	FI-25LPH-HS-016A	3.22	4.16	4.01	4.13	3.88		1.00	3.79	0.45	8
2.00	4.60	0.23	8		3.90	4.12	3.53	3.57	3.78		2.00	3.60	0.33	8
3.00	4.37	0.35	8		4.02	4.08	3.52	3.13	3.69		3.00	3.78	0.33	8
4.00	4.76	0.20	4		3.42	3.46			3.44		4.00	3.16	0.17	4
				FI-25LPH-HS-016B	3.68	3.00	4.01	4.13	3.71					
					3.56	3.77	3.15	3.22	3.43					
					3.87	3.98	3.97	3.64	3.87					
					3.13	3.18			3.16					


Dissolved Oxygen for Bathtub MWP Without Iron Shot
Dissolved Oxygen (ppm)
0
1
2
3
4
5
6
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Dissolved Oxygen for Bathtub MWP with Iron Shot
Dissolved Oxygen (ppm)
0
1
2
3
4
5
6
1
2
3
4
Week
Controls
High Saline
Low pH
High Saline & Nitrate


Flow-through Without Shot
Dissolved Oxygen (ppm)
6
5
4
3
2
1
0
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Dissolved Oxygen for Flowthru MWP with Shot
Dissolved Oxygen (ppm)
6
5
4
3
2
1
0
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate

MWP Type	Week	J-13 Control Conductivity (uS) "A" Package	"B" Package	Average	Std. Dev.	n	High Saline Conductivity (mS) "A" Package	"B" Package	Average	Std. Dev.	n	Low pH Conductivity (uS) "A" Package	"B" Package	Average	Std. Dev.	n	HS-High NO3 Conductivity (mS) "A" Package	"B" Package	Average	Std. Dev.	n
Bathtub w/o shot	1	309 329	321 339	325	13	4	69	72	70	3	2	1567	1561	1564	4	2	81	79	80	1	2
	2	313	331	322	13	2	80 76	82 107	88	14	4	1813 1749	1680 1623	1716	83	4	90	85 82	86	4	3
	3	420	367	394	37	2	67 93	104	98	19	3	2660 2510	2050 2060	2320	312	4	80	73 71	75	5	3
	4	298	320	309	16	2	73	94	84	15	2		1950	1950		1		95	95		1
Bathtub with shot	1	320 313	321 337	323	10	4	71	69	70	2	2	1464	1526	1495	44	2	78	73	75	3	2
	2	330	340	335	7	2	79	92	86	9	2	1781 1666	1886 1833	1792	94	4	93 78	80 73	81	9	4
	3	418	765	592	245	2		101	101		1	2350 1766	2450 1890	2114	337	4	94 108	79 87	92	13	4
	4	325	430	378	74	2		103	103		1		2020	2020		1	89	90	90	0	2
Flowthru w/o shot	1	242 281	254 281	265	20	4	72	74	73	1	2	1471	1448	1460	16	2	81	86	84	3	2
	2	263	257	260	4	2	110	111	110	1	2	1545 1492	1886 1393	1579	214	4	88		88		1
	3	291	294	293	2	2	113	112	112	1	2	1440 1390	1343 1308	1370	57	4	78 82	90 84	83	5	4
	4	272	258	265	10	2					0	1337	1298	1318	28	2	77	100	89	16	2
Flowthru with shot	1	296 372		334	54	2	70	74	72	3	2	1417	1314	1366	73	2	76	76	76	0	2
	2	293		293		1	80 76	86 78	80	4	4	1341 1546	1400	1429	106	3	84 80	97	87	9	3
	3	354		354		1	76 94	76 84	82	9	4	1307 1281	1787 1575	1488	240	4	81 93	85 91	87	6	4
	4	314		314		1	83	82	83	1	2	2110	1553	1832	394	2	80	90	85	7	2

"B" Package omitted. See raw data below.

1	2408 4974	
2	7540	
3	870	
4	670	70.1
		79.9/79.6
		76.2
		75.7
		94
		83.4

Conductivity (mS)

	73.7
	86.6/86.4
	78.4
	76.1
	83.6
	81.6

Conductivity Summary Table.

NOTE: Control and LPH are measured in uS. HS and LPH-HS are measured in mS.

Legend:
uS = microSiemans
mS = milliSiemans
St. Dev. = Standard Deviation
n = number of measurements

Control = J-13 well water
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For Control (J-13):
Week 1 = 7/24/02 - 7/31/02
Week 2 = 7/31/02 - 8/07/02
Week 3 = 8/07/02 - 8/14/02
Week 4 = 8/14/02 - 8/21/02

For HS, LPH, HS-HN:
Week 1 = 6/18/02 - 6/25/02
Week 2 = 6/25/02 - 7/02/02
Week 3 = 7/02/02 - 7/09/02
Week 4 = 7/9/02 - 7/12/02

For Bathtub, No Iron Shot **(BN)**:

SOLUTION	WEEK	/ERAGE CONDUCTIVIT	ST. DEV.	n

Control	1	325	13	4
	2	322	13	2
	3	394	37	2
	4	309	16	2
HS	1	70	3	2
	2	88	14	4
	3	98	19	3
	4	84	15	2
LPH	1	1564	4	2
	2	1716	83	4
	3	2320	312	4
	4	1950		1
LPH-HS	1	80	1	2
	2	86	4	3
	3	75	5	3
	4	95		1

For Bathtub, Iron Shot **(BI)**:

SOLUTION	WEEK	AVERAGE D.O. (ppm)	ST. DEV.	
Control	1	323	10	4
	2	335	7	2
	3	592	245	2
	4	378	74	2
HS	1	70	2	2
	2	86	9	2
	3	101		1
	4	103		1
LPH	1	1495	44	2
	2	1792	94	4

	3	2114	337	4
	4	2020		1
LPH-HS	1	75	3	2
	2	81	9	4
	3	92	13	4
	4	90	0	2

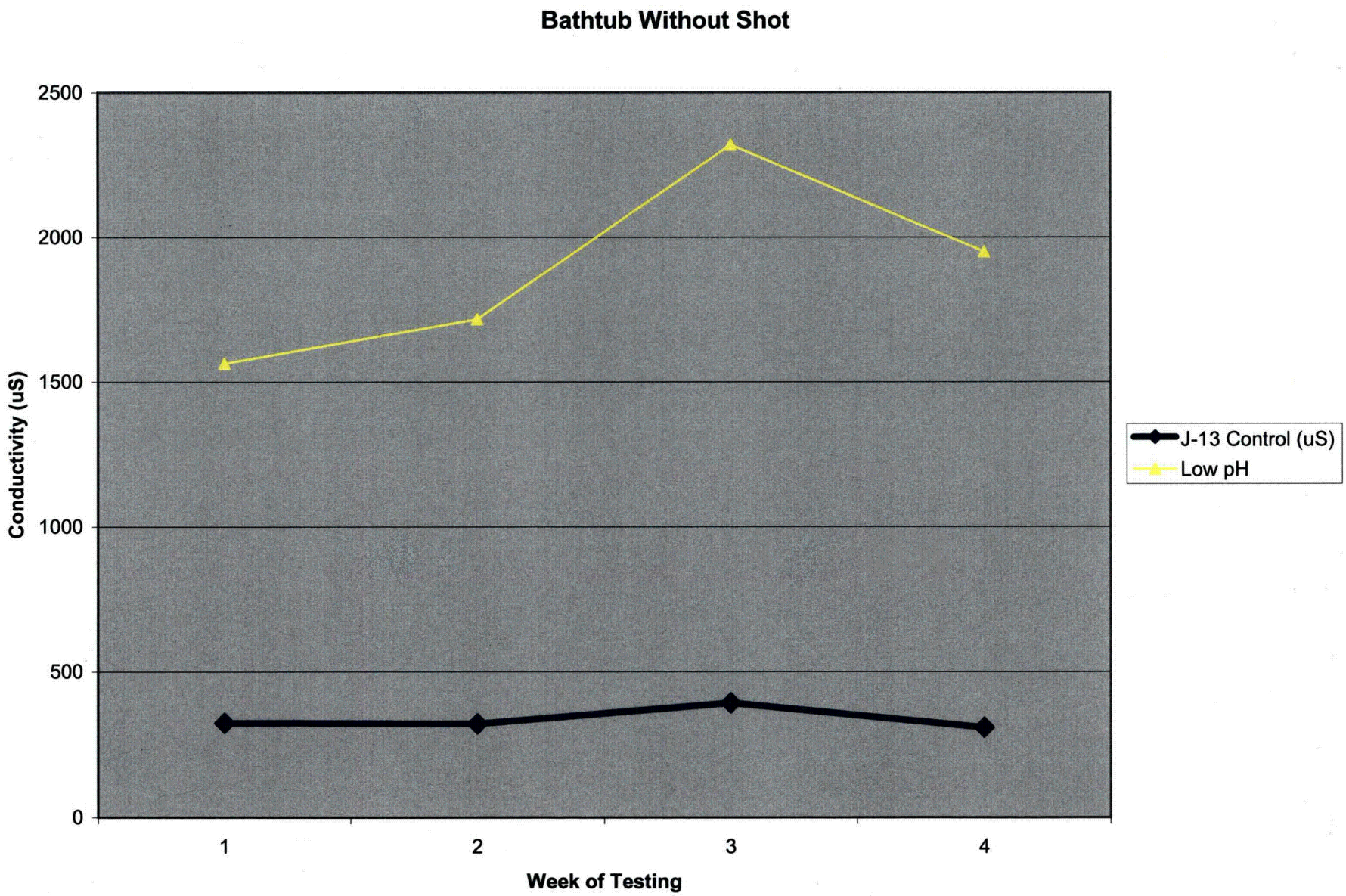
For Flowthru, No Iron Shot **(FN)**:

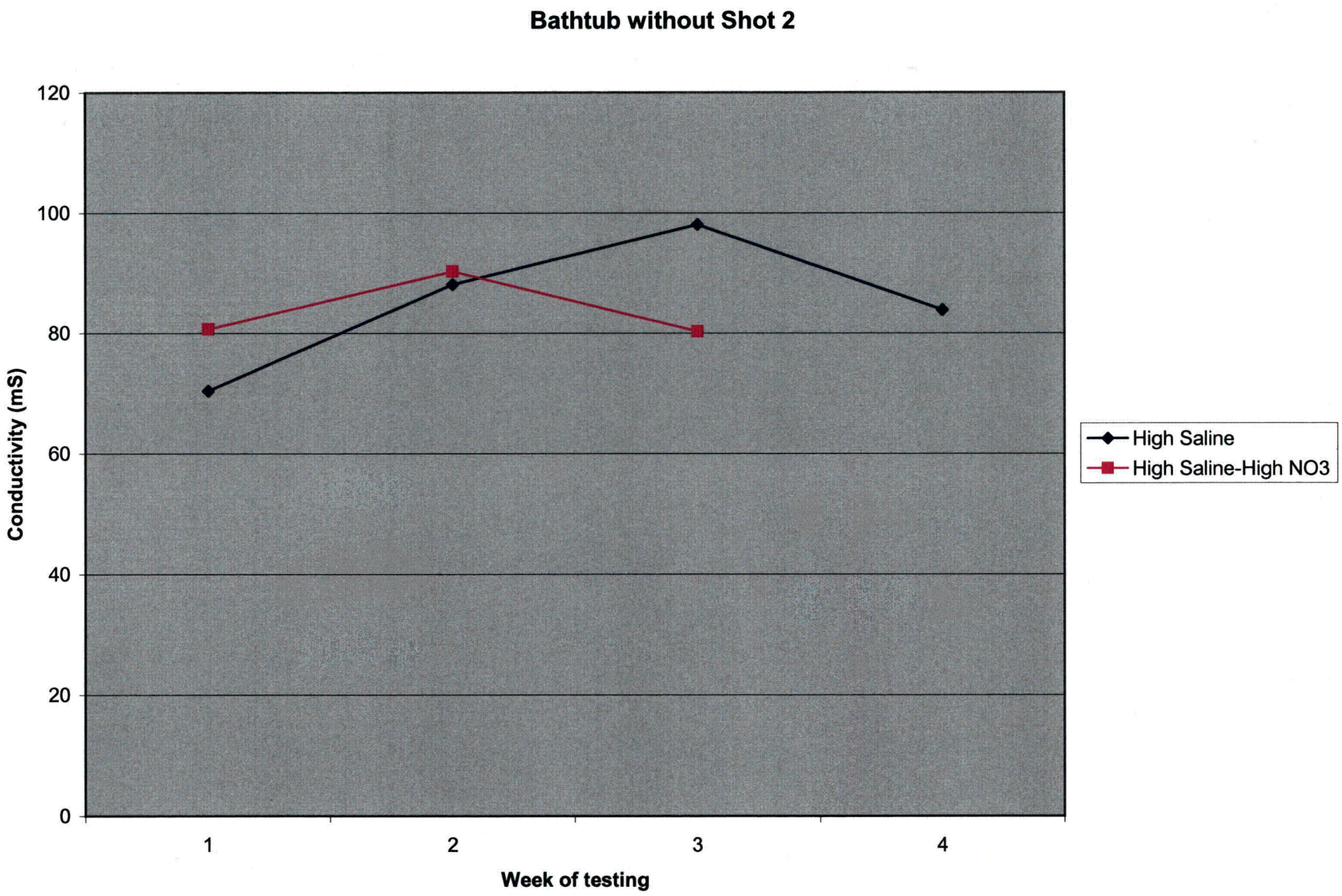
SOLUTION	WEEK	AVERAGE D.O. (ppm)	ST. DEV.	
Control	1	265	20	4
	2	260	4	2
	3	293	2	2
	4	265	10	2
HS	1	73	1	2
	2	110	1	2
	3	112	1	2
	4			0
LPH	1	1460	16	2
	2	1579	214	4
	3	1370	57	4
	4	1318	28	2
LPH-HS	1	84	3	2
	2	88		1
	3	83	5	4
	4	89	16	2

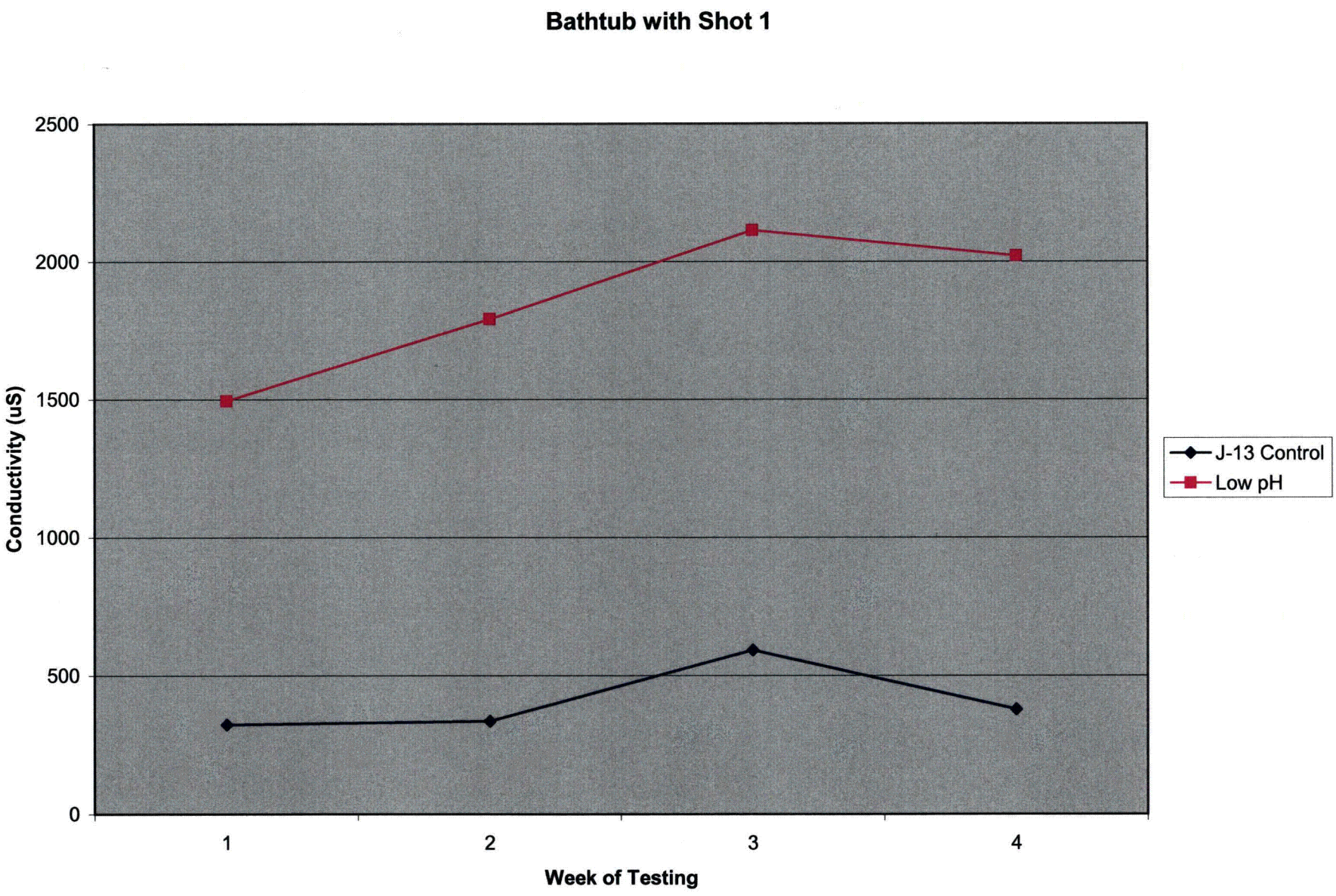
For Flowthru, Iron Shot **(FI)**:

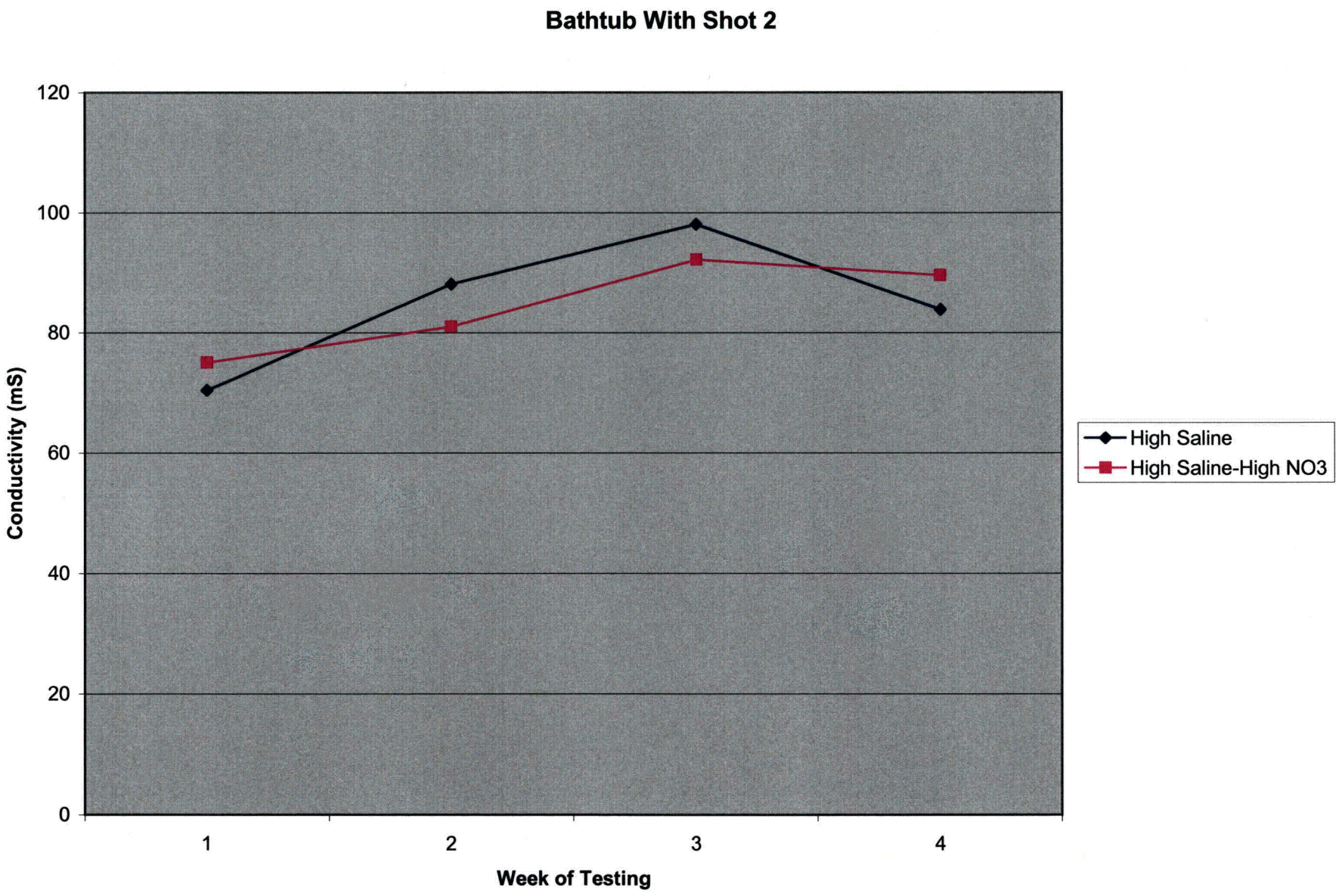
SOLUTION	WEEK	AVERAGE D.O. (ppm)	ST. DEV.

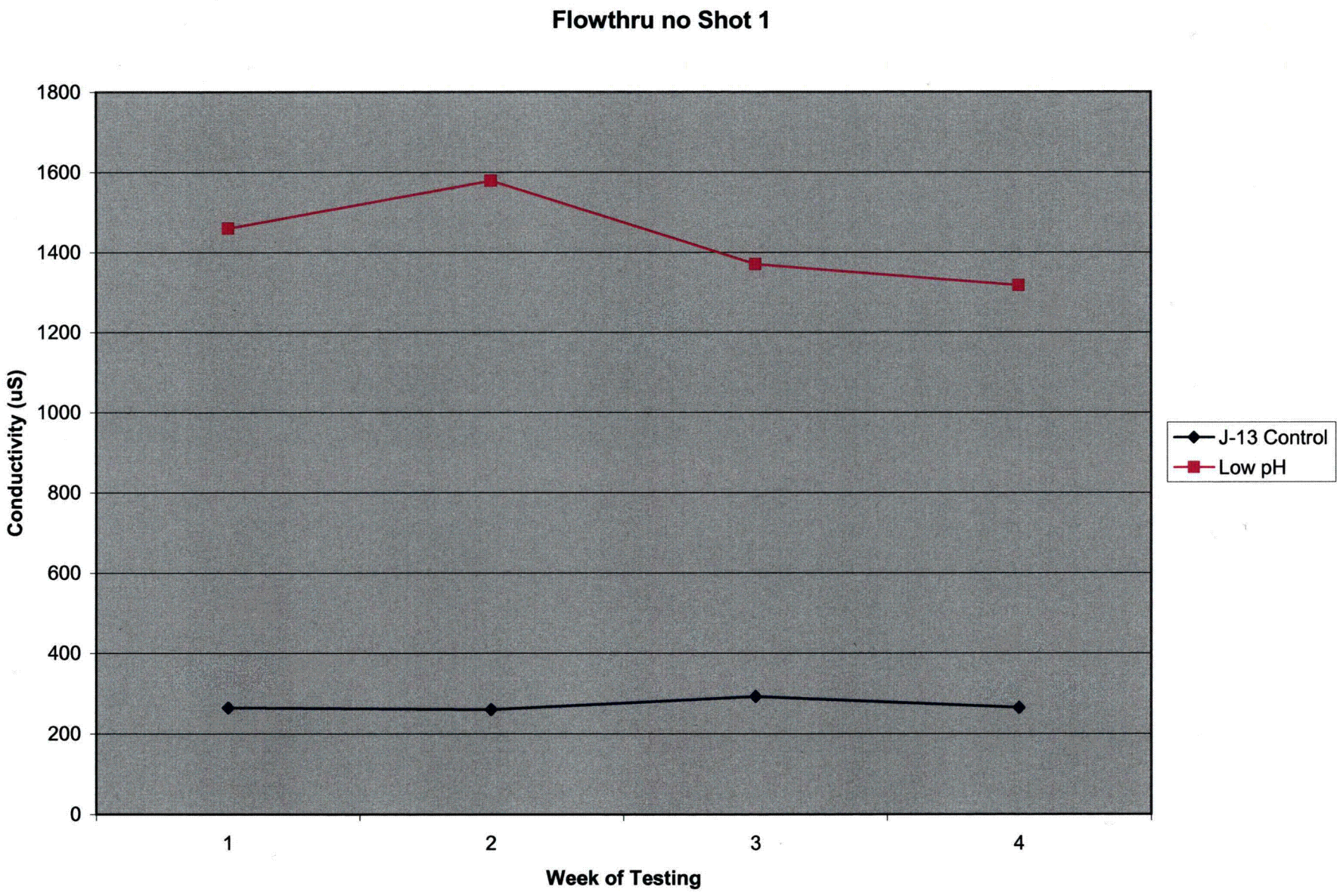
Control	1	334	54	2
	2	293		1
	3	354		1
	4	314		1
HS	1	72	3	2
	2	80	4	4
	3	82	9	4
	4	83	1	2
LPH	1	1366	73	2
	2	1429	106	3
	3	1488	240	4
	4	1832	394	2
LPH-HS	1	76	0	2
	2	87	9	3
	3	87	6	4
	4	85	7	2

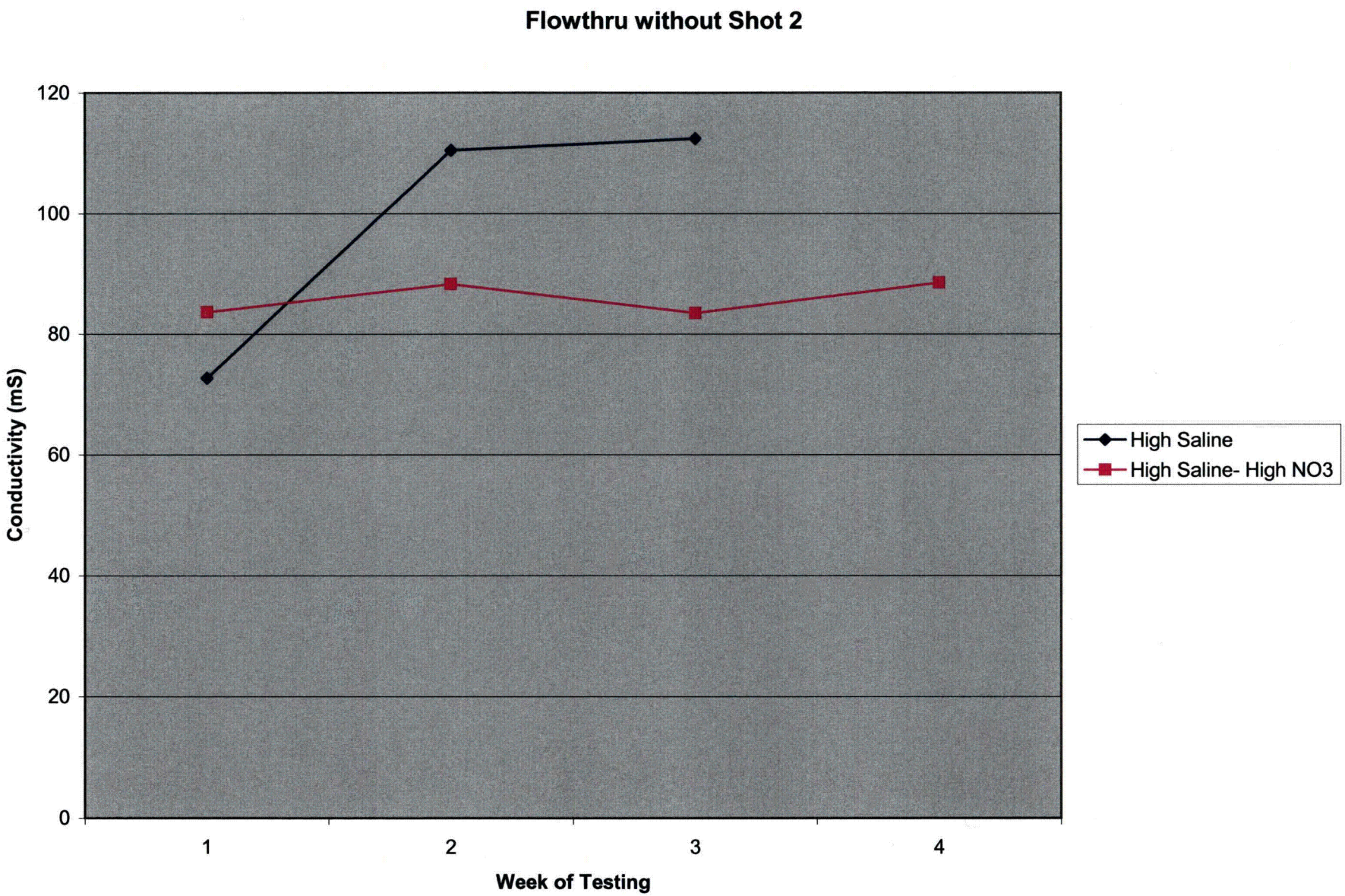

Bathtub Without Shot
2500
2000
1500
1000
500
0
Conductivity (uS)
1
2
3
4
Week of Testing
J-13 Control (uS)
Low pH

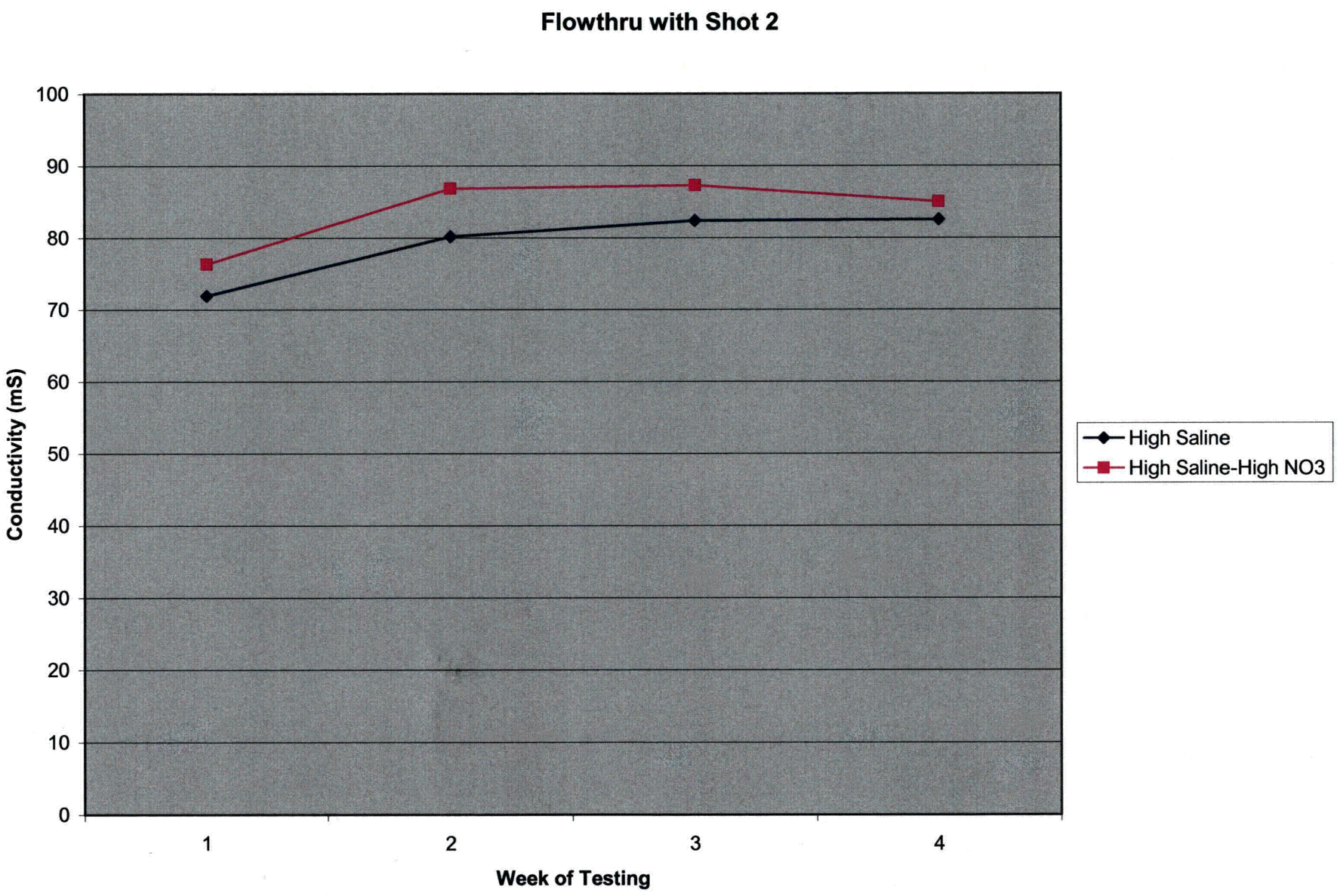

Bathtub without Shot 2
120
100
80
60
40
20
0
Conductivity (mS)
1
2
3
4
Week of testing
High Saline
High Saline-High NO3


Bathtub with Shot 1
2500
2000
1500
1000
500
0
Conductivity (uS)
1
2
3
4
Week of Testing
J-13 Control
Low pH


Bathtub With Shot 2
120
100
80
60
40
20
0
Conductivity (mS)
1
2
3
4
Week of Testing
High Saline
High Saline-High NO3


Flowthru no Shot 1
1800
1600
1400
1200
1000
800
600
400
200
0
Conductivity (uS)
1
2
3
4
Week of Testing
J-13 Control
Low pH


Flowthru without Shot 2
120
100
80
60
40
20
0
Conductivity (mS)
1
2
3
4
Week of Testing
High Saline
High Saline- High NO3


Flowthru with Shot 2
100
90
80
70
60
50
40
30
20
10
0
Conductivity (mS)
1
2
3
4
Week of Testing
High Saline
High Saline-High NO3

pH Source Data

Legend:
BN = Bath Tub Model MWP without Iron Shot
BI = Bath Tub Model MWP with Iron Shot
FN = Flowthru Model MWP without Iron Shot
FI = Flowthru Model MWP with Iron Shot

J-13 Control		**pH readings**						
		1	**2**	**3**	**4**	**5**	**6**	**Average**
BN-25-C-001A	7/24/02 - 7/31/02	8.12	8.13	8.13	8.52	8.53	8.53	8.33
	7/31/02 - 8/7/02	8.56	8.55	8.56				8.56
	8/7/02 - 8/14/02	8.54	8.54	8.5				8.53
	8/14/02 - 8/21/02	8.69	8.69	8.7				8.69
BN-25-C-001B	7/24/02 - 7/31/02	8.30	8.34	8.34	8.47	8.48	8.49	8.40
	7/31/02 - 8/7/02	8.62	8.62	8.63				8.62
	8/7/02 - 8/14/02	8.60	8.59	8.60				8.60
	8/14/02 - 8/21/02	8.62	8.62	8.62				8.62
BI-25-C-002A	7/24/02 - 7/31/02	7.98	8.03	8.03	8.45	8.45	8.47	8.24
	7/31/02 - 8/7/02	8.64	8.71	8.72				8.69
	8/7/02 - 8/14/02	8.67	8.66	8.66				8.66
	8/14/02 - 8/21/02	8.62	8.62	8.62				8.62
BI-25-C-002B	7/24/02 - 7/31/02	8.11	8.12	8.13	8.50	8.51	8.52	8.32
	7/31/02 - 8/7/02	8.68	8.68	8.71				8.69
	8/7/02 - 8/14/02	8.86	8.86	8.87				8.86
	8/14/02 - 8/21/02	8.68	8.71	8.71				8.70
FN-25-C-003A	7/24/02 - 7/31/02	7.85	7.86	7.86	8.27	8.25	8.24	8.06
	7/31/02 - 8/7/02	8.54	8.54	8.55				8.54
	8/7/02 - 8/14/02	8.38	8.38	8.40				8.39
	8/14/02 - 8/21/02	8.50	8.51	8.49				8.50
FN-25-C-003B	7/24/02 - 7/31/02	7.95	7.95	7.95	8.24	8.23	8.23	8.09
	7/31/02 - 8/7/02	8.31	8.31	8.32				8.31
	8/7/02 - 8/14/02	8.41	8.40	8.40				8.40
	8/14/02 - 8/21/02	8.65	8.66	8.66				8.66
FI-25-C-004A	7/24/02 - 7/31/02	7.96	7.97	7.98	8.29	8.31	8.35	8.14
	7/31/02 - 8/7/02	8.45	8.45	8.45				8.45

	8/7/02 - 8/14/02	8.59	8.58	8.58				8.58
	8/14/02 - 8/21/02	8.60	8.60	8.61				8.60
FI-25-C-004B	7/24/02 - 7/31/02	8.82	8.83	8.84	8.39	8.37	8.37	8.60
	7/31/02 - 8/7/02	9.33	9.35	9.34				9.34
	8/7/02 - 8/14/02	8.94	8.94	8.94				8.94
	8/14/02 - 8/21/02	8.81	8.82	8.82				8.82
High Saline		**pH Readings**						
		1	**2**	**3**	**4**	**5**	**6**	**Average**
BN-25-HS-005A	6/18/020 - 6/25/02	8.94	8.95	8.95	8.90	8.90	8.90	8.92
	6/25/02 - 7/2/02	9.38	9.28	9.29	9.29	9.49	9.49	9.37
	7/2/02 - 7/9/02	9.38	9.37	9.36	9.42	9.42	9.42	9.40
	7/9/02 - 7/12/02	9.87	9.87	9.87				9.87
BN-25-HS-005B	6/18/020 - 6/25/02	8.99	8.98	8.99	8.88	8.89	8.89	8.94
	6/25/02 - 7/2/02	9.26	9.28	9.28	9.73	9.73	9.76	9.51
	7/2/02 - 7/9/02	9.43	9.43	9.43	9.38	9.39	9.39	9.41
	7/9/02 - 7/12/02	9.90	9.90	9.90				9.90
BI-25-HS-006A	6/18/020 - 6/25/02	9.00	8.99	8.99	8.88	8.89	8.89	8.94
	6/25/02 - 7/2/02	9.26	9.28	9.28	9.52	9.53	9.53	9.40
	7/2/02 - 7/9/02	9.71	9.71	9.71				9.71
	7/9/02 - 7/12/02	10.09	10.09	10.09				10.09
BI-25-HS-006B	6/18/020 - 6/25/02	8.92	8.92	8.92	8.88	8.89	8.89	8.90
	6/25/02 - 7/2/02	9.24	9.24	9.24	9.60	9.60	9.60	9.42
	7/2/02 - 7/9/02	9.42	9.41	9.41				9.41
	7/9/02 - 7/12/02	9.79	9.79	9.79				9.79
FN-25-HS-007A	6/18/020 - 6/25/02	8.98	8.98	8.99	8.99	8.97	8.97	8.98
	6/25/02 - 7/2/02	9.46	9.47	9.47	9.72	9.72	9.72	9.59
	7/2/02 - 7/9/02	9.62	9.62	9.61				9.62
	7/9/02 - 7/12/02	10.25	10.25	10.25				10.25
FN-25-HS-007B	6/18/020 - 6/25/02	8.97	8.97	8.97	8.97	8.94	8.93	8.96
	6/25/02 - 7/2/02	9.48	9.48	9.48	9.66	9.67	9.67	9.57
	7/2/02 - 7/9/02	9.54	9.53	9.53				9.53
	7/9/02 - 7/12/02							
FI-25-HS-008A	6/18/020 - 6/25/02	9.00	9.00	9.00	8.93	8.93	8.93	8.97
	6/25/02 - 7/2/02	9.28	9.29	9.29	9.49	9.49	9.49	9.39

	7/2/02 - 7/9/02	9.36	9.36	9.36	9.57	9.57	9.57	9.47
	7/9/02 - 7/12/02	9.61	9.61	9.62				9.61
FI-25-HS-008B	6/18/020 - 6/25/02	8.98	8.98	8.98	8.91	8.91	8.91	8.95
	6/25/02 - 7/2/02	9.17	9.17	9.17	9.48	9.48	9.48	9.33
	7/2/02 - 7/9/02	9.33	9.33	9.33	9.39	9.39	9.40	9.36
	7/9/02 - 7/12/02	9.58	9.58	9.58				9.58

Low pH		**pH Readings**						
		1	**2**	**3**	**4**	**5**	**6**	**Average**
BN-25-LPH-009A	6/18/20 - 6/25/02	5.65	5.65	5.66	4.61	4.60	4.59	5.13
	6/25/02 - 7/2/02	4.19	4.15	4.15	4.64	4.62	4.62	4.40
	7/20/2 - 7/9/02	3.11	3.13	3.13	3.04	2.93	2.93	3.05
	7/90/2 - 7/12/02	0.00	0.00	0.00				0.00
BN-25-LPH-009B	6/18/20 - 6/25/02	5.61	5.61	5.60	5.32	5.09	5.08	5.39
	6/25/02 - 7/2/02	4.42	4.41	4.41	4.49	4.49	4.46	4.45
	7/20/2 - 7/9/02	3.77	3.76	3.76	3.28	3.28	3.28	3.52
	7/90/2 - 7/12/02	4.40	4.41	4.41				4.41
BI-25-LPH-010A	6/18/20 - 6/25/02	5.37	5.27	5.26	4.66	4.65	4.63	4.97
	6/25/02 - 7/2/02	4.10	4.09	4.09	4.44	4.41	4.41	4.26
	7/20/2 - 7/9/02	3.82	3.83	3.84	3.33	3.34	3.35	3.59
	7/90/2 - 7/12/02	3.99	3.99	4.00				3.99
BI-25-LPH-010B	6/18/20 - 6/25/02	5.06	5.02	5.01	4.70	4.69	4.68	4.86
	6/25/02 - 7/2/02	4.00	4.01	4.03	4.07	4.02	4.01	4.02
	7/20/2 - 7/9/02	3.43	3.47	3.47	3.72	3.72	3.74	3.59
	7/90/2 - 7/12/02	4.10	4.10	4.10				4.10
FN-25-LPH-011A	6/18/20 - 6/25/02	4.48	4.47	4.46	4.86	4.80	4.79	4.64
	6/25/02 - 7/2/02	4.57	4.57	4.57	4.73	4.90	4.81	4.69
	7/20/2 - 7/9/02	4.25	4.25	4.26	4.65	4.64	4.63	4.45
	7/90/2 - 7/12/02	4.53	4.53	4.53				4.53
FN-25-LPH-011B	6/18/20 - 6/25/02	4.66	4.65	4.64	4.54	4.53	4.52	4.59
	6/25/02 - 7/2/02	4.00	4.01	4.03	4.59	4.53	4.48	4.27
	7/20/2 - 7/9/02	4.33	4.33	4.34	4.58	4.57	4.56	4.45
	7/90/2 - 7/12/02	4.46	4.46	4.47				4.46
FI-25LPH-012A	6/18/20 - 6/25/02	5.45	5.09	5.07	5.08	5.06	5.05	5.13

	6/25/02 - 7/2/02	4.58	4.58	4.58	4.50	4.50	4.50	4.54
	7/20/2 - 7/9/02	4.31	4.31	4.31	4.74	4.72	4.72	4.52
	7/90/2 - 7/12/02	4.34	4.34	4.34				4.34
FI-25LPH-012B	6/18/20 - 6/25/02	5.29	5.27	5.27	5.08	5.17	5.16	5.21
	6/25/02 - 7/2/02	4.40	4.41	4.42	4.60	4.57	4.54	4.49
	7/20/2 - 7/9/02	3.84	3.91	3.91	4.63	4.63	4.63	4.26
	7/90/2 - 7/12/02	4.65	4.64	4.64				4.64

High Saline - High NO3

		pH Readings						
		1	**2**	**3**	**4**	**5**	**6**	**Average**
BN-25-LPH-HS-013A	6/18/20 - 6/25/02	8.91	8.93	8.92	8.71	8.71	8.72	8.82
	6/25/02 - 7/2/02	9.16	9.17	9.17	9.39	9.40	9.40	9.28
	7/20/2 - 7/9/02	9.46	9.38	9.37				9.40
	7/90/2 - 7/12/02	9.77	9.76	9.76				9.76
BN-25-LPH-HS-013B	6/18/20 - 6/25/02	8.96	8.96	8.96	8.79	8.79	8.79	8.88
	6/25/02 - 7/2/02	9.14	9.14	9.14	9.27	9.28	9.28	9.21
	7/20/2 - 7/9/02	9.30	9.30	9.31	9.31	9.31	9.30	9.31
	7/90/2 - 7/12/02	9.76	9.62	9.62				9.67
BI-25-LPH-HS-014A	6/18/20 - 6/25/02	9.15	9.16	9.16	8.79	8.80	8.81	8.98
	6/25/02 - 7/2/02	9.31	9.31	9.32	9.29	9.29	9.29	9.30
	7/20/2 - 7/9/02	9.44	9.43	9.42	9.48	9.48	9.48	9.46
	7/90/2 - 7/12/02	9.65	9.65	9.65				9.65
BI-25-LPH-HS-014B	6/18/20 - 6/25/02	9.00	9.00	9.00	8.91	8.91	8.91	8.96
	6/25/02 - 7/2/02	9.18	9.19	9.19	9.27	9.28	9.28	9.23
	7/20/2 - 7/9/02	9.34	9.34	9.34	9.41	9.41	9.41	9.38
	7/90/2 - 7/12/02	9.65	9.65	9.65				9.65
FN-25-LPH-HS-015A	6/18/20 - 6/25/02	9.11	9.11	9.12	8.98	8.98	8.99	9.05
	6/25/02 - 7/2/02				9.49	9.50	9.50	9.50
	7/20/2 - 7/9/02	9.47	9.47	9.47	9.54	9.52	9.52	9.50
	7/90/2 - 7/12/02	9.70	9.70	9.70				9.70
FN-25-LPH-HS-015B	6/18/20 - 6/25/02	9.05	9.05	9.05	8.86	8.86	8.87	8.96
	6/25/02 - 7/2/02	9.26	9.26	9.26	9.50	9.50	9.51	9.38
	7/20/2 - 7/9/02	9.42	9.42	9.42	9.50	9.51	9.51	9.46
	7/90/2 - 7/12/02	9.73	9.73	9.73				9.73

FI-25LPH-HS-016A	6/18/20 - 6/25/02	9.19	9.20	9.20	8.91	8.92	8.92	9.06
	6/25/02 - 7/2/02	9.28	9.28	9.28	9.41	9.41	9.41	9.35
	7/20/2 - 7/9/02	9.43	9.44	9.44	9.50	9.50	9.50	9.47
	7/90/2 - 7/12/02	9.73	9.73	9.73				9.73
FI-25LPH-HS-016B	6/18/20 - 6/25/02	9.30	9.30	9.30	8.96	8.96	8.96	9.13
	6/25/02 - 7/2/02	9.31	9.31	9.31	9.41	9.41	9.42	9.36
	7/20/2 - 7/9/02	9.41	9.42	9.42	9.54	9.54	9.54	9.48
	7/90/2 - 7/12/02	9.75	9.75	9.75				9.75

Title: pH measurements for effluent solution from miniature waste packages

Legend:
St. Dev. = Standard Deviation
n = number of measurements

Control = J-13 well water
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For Control (J-13):
Week 1 = 7/24/02 - 7/31/02
Week 2 = 7/31/02 - 8/07/02
Week 3 = 8/07/02 - 8/14/02
Week 4 = 8/14/02 - 8/21/02

For HS, LPH, HS-HN:
Week 1 = 6/18/02 - 6/25/02
Week 2 = 6/25/02 - 7/02/02
Week 3 = 7/02/02 - 7/09/02
Week 4 = 7/9/02 - 7/12/02

MWP Model and Solution		Control (J-13) through Bathtub w/o Shot Sample			Bathtub w/o Shot High Saline			Bathtub w/o Shot Low pH			Bathtub w/o Shot LPH-HS		
	Week	001A	001B	Average	005A	005B	Average	009A	009B	Average	013A	013B	Average
Bathtub w/o Shot	1	8.33	8.40	8.37	8.92	8.94	8.93	5.13	5.39	5.26	8.82	8.88	8.85
	2	8.56	8.62	8.59	9.37	9.51	9.44	4.40	4.45	4.42	9.28	9.21	9.25
	3	8.53	8.60	8.56	9.40	9.41	9.40	3.05	3.52	3.28	9.40	9.31	9.35
	4	8.69	8.62	8.66	9.87	9.90	9.89	3.05	4.41	3.73	9.76	9.67	9.72

MWP Model		Bathtub with Shot Control			Bathtub with Shot High Saline			Bathtub with Shot Low pH			Bathtub with Shot LPH-HS		
	Week	002A	002B	Average	006A	006B	Average	010A	010B	Average	014A	014B	Average
Bathtub with Shot	1	8.24	8.32	8.28	8.94	8.90	8.92	4.97	4.86	4.92	8.98	8.96	8.97
	2	8.69	8.69	8.69	9.40	9.42	9.41	4.26	4.02	4.14	9.30	9.23	9.27
	3	8.66	8.86	8.76	9.71	9.41	9.56	3.59	3.59	3.59	9.46	9.38	9.42
	4	8.62	8.70	8.66	10.09	9.79	9.94	3.99	4.10	4.05	9.65	9.65	9.65

MWP Model		*Flowthru w/o Shot* Control			*Flowthru w/o Shot* High Saline			*Flowthru w/o Shot* Low pH			*Flowthru w/o Shot* LPH-HS		
	Week	003A	003B	Average	007A	007B	Average	011A	011B	Average	015A	015B	Average
Flowthru w/o Shot	1	8.06	8.09	8.07	8.98	8.96	8.97	4.64	4.59	4.62	9.05	8.96	9.00
	2	8.54	8.31	8.43	9.59	9.57	9.58	4.69	4.27	4.48	9.50	9.38	9.44
	3	8.39	8.40	8.40	9.62	9.53	9.58	4.45	4.45	4.45	9.50	9.46	9.48
	4	8.50	8.66	8.58	10.25	9.53	9.89	4.53	4.46	4.50	9.70	9.73	9.72

MWP Model		Flowthru with Shot Control			Flowthru with Shot High Saline			Flowthru with Shot Low pH			Flowthru with Shot LPH-HS		
	Week	004A	004B *	Average	008A	008B	Average	012A	012B	Average	016A	016B	Average
Flowthru with Shot	1	8.14	8.14	8.14	8.97	8.95	8.96	5.13	5.21	5.17	9.06	9.13	9.09
	2	8.45	8.45	8.45	9.39	9.33	9.36	4.54	4.49	4.52	9.35	9.36	9.35
	3	8.58	8.58	8.58	9.47	9.36	9.41	4.52	4.26	4.39	9.47	9.48	9.47
	4	8.60	8.60	8.60	9.61	9.58	9.60	4.34	4.64	4.49	9.73	9.75	9.74

*Note: data for BN-25-C-004B not used due to questionable results.

pH Summary Table

Legend:
St. Dev. = Standard Deviation
n = number of measurements
Control = J-13 well water
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For Control (J-13):
Week 1 = 7/24/02 - 7/31/02
Week 2 = 7/31/02 - 8/07/02
Week 3 = 8/07/02 - 8/14/02
Week 4 = 8/14/02 - 8/21/02

For HS, LPH, HS-HN:
Week 1 = 6/18/02 - 6/25/02
Week 2 = 6/25/02 - 7/02/02
Week 3 = 7/02/02 - 7/09/02
Week 4 = 7/9/02 - 7/12/02

For Bathtub, No Iron Shot (BN):

SOLUTION	WEEK	AVERAGE pH	ST. DEV.	n
Control	1	8.37	0.164	12
	2	8.59	0.037	6
	3	8.56	0.041	6
	4	8.66	0.040	6
HS	1	8.93	0.042	12
	2	9.44	0.198	12
	3	9.40	0.026	12
	4	9.89	0.016	6
LPH	1	5.26	0.447	12

	2	4.42	0.175	12
	3	3.28	0.313	12
	4	3.73	0.006	3
HS-HN	1	8.85	0.104	12
	2	9.25	0.106	12
	3	9.35	0.055	9
	4	9.72	0.074	6

For Bathtub, Iron Shot (BI):

SOLUTION	WEEK	AVERAGE pH	ST. DEV.	n
Control	1	8.28	0.22	12
	2	8.69	0.03	6
	3	8.76	0.11	6
	4	8.66	0.05	6
HS	1	8.92	0.05	12
	2	9.41	0.16	12
	3	9.56	0.16	6
	4	9.94	0.16	6
LPH	1	4.92	0.28	12
	2	4.14	0.17	12
	3	3.59	0.21	12
	4	4.05	0.06	6
HS-HN	1	8.97	0.14	12
	2	9.27	0.05	12
	3	9.42	0.05	12
	4	9.65	0.00	6

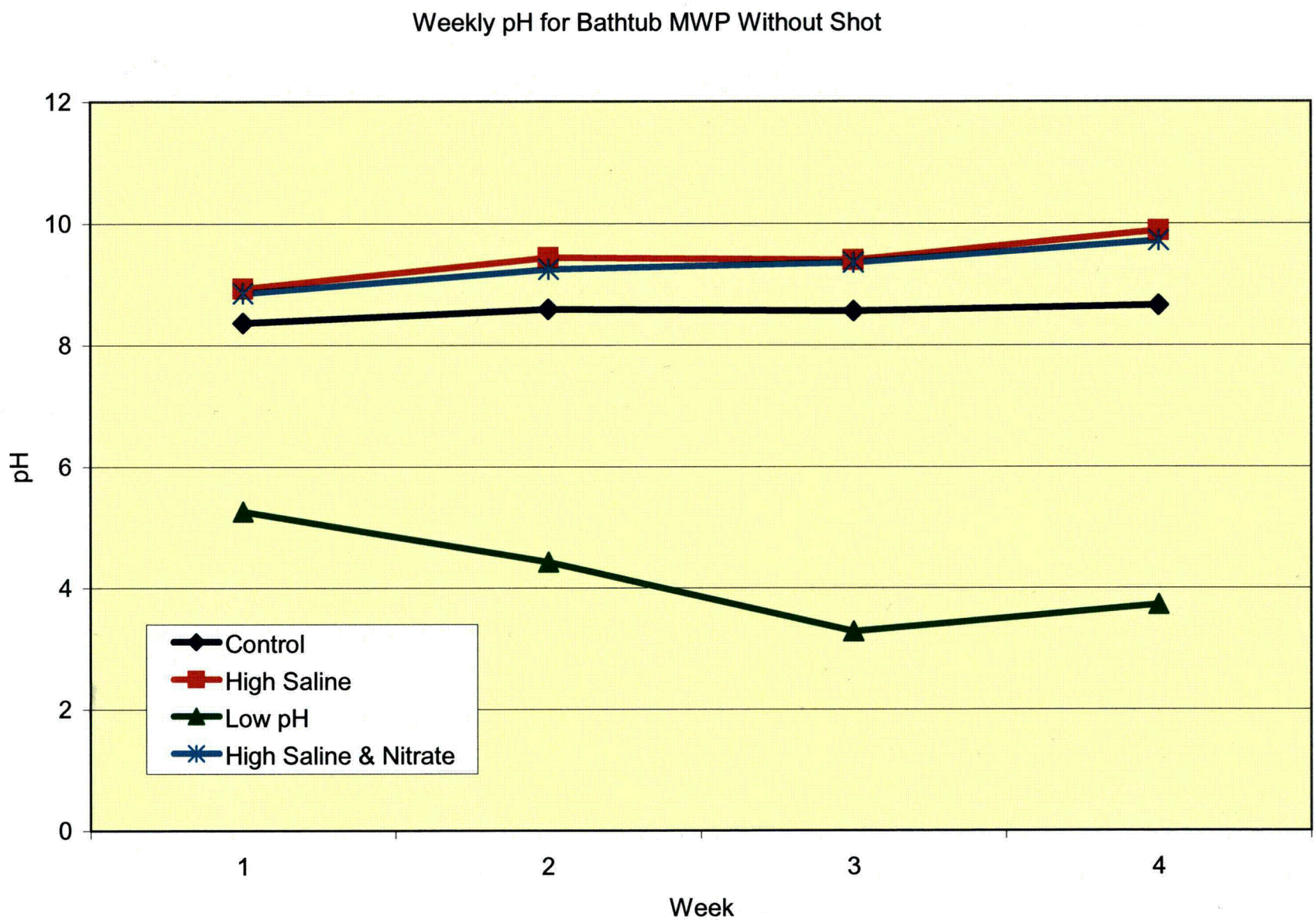
For Flowthru, No Iron Shot (FN):

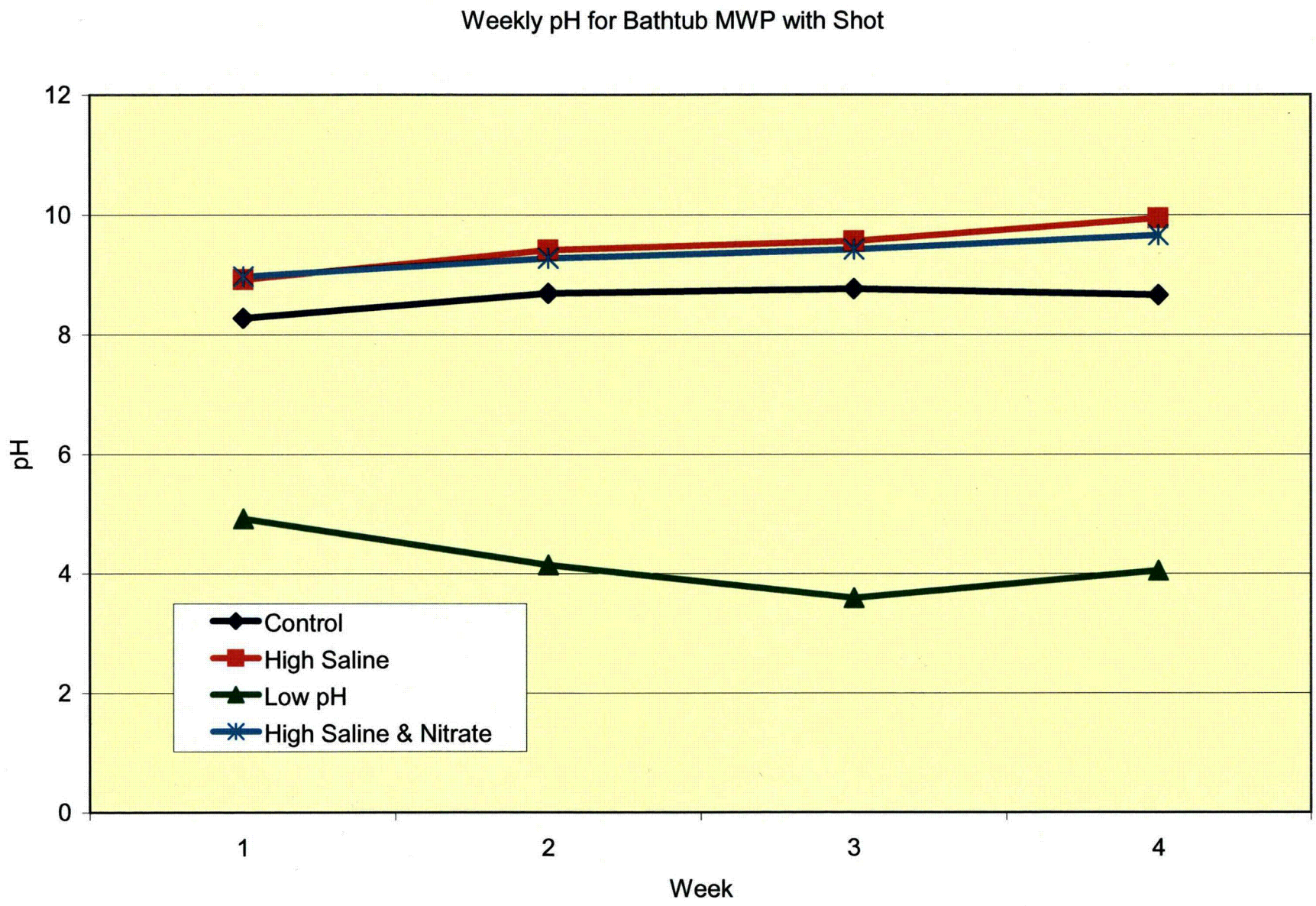
SOLUTION	WEEK	AVERAGE pH	ST. DEV.	n
Control	1	8.07	0.18	12
	2	8.43	0.13	6
	3	8.40	0.01	6
	4	8.58	0.09	6
HS	1	8.97	0.02	12
	2	9.58	0.12	12
	3	9.58	0.05	6
	4	10.25	0.00	3
LPH	1	4.62	0.14	12
	2	4.48	0.31	12
	3	4.45	0.17	12
	4	4.50	0.04	6
HS-HN	1	9.00	0.10	12
	2	9.44	0.12	9
	3	9.48	0.04	12
	4	9.72	0.02	6

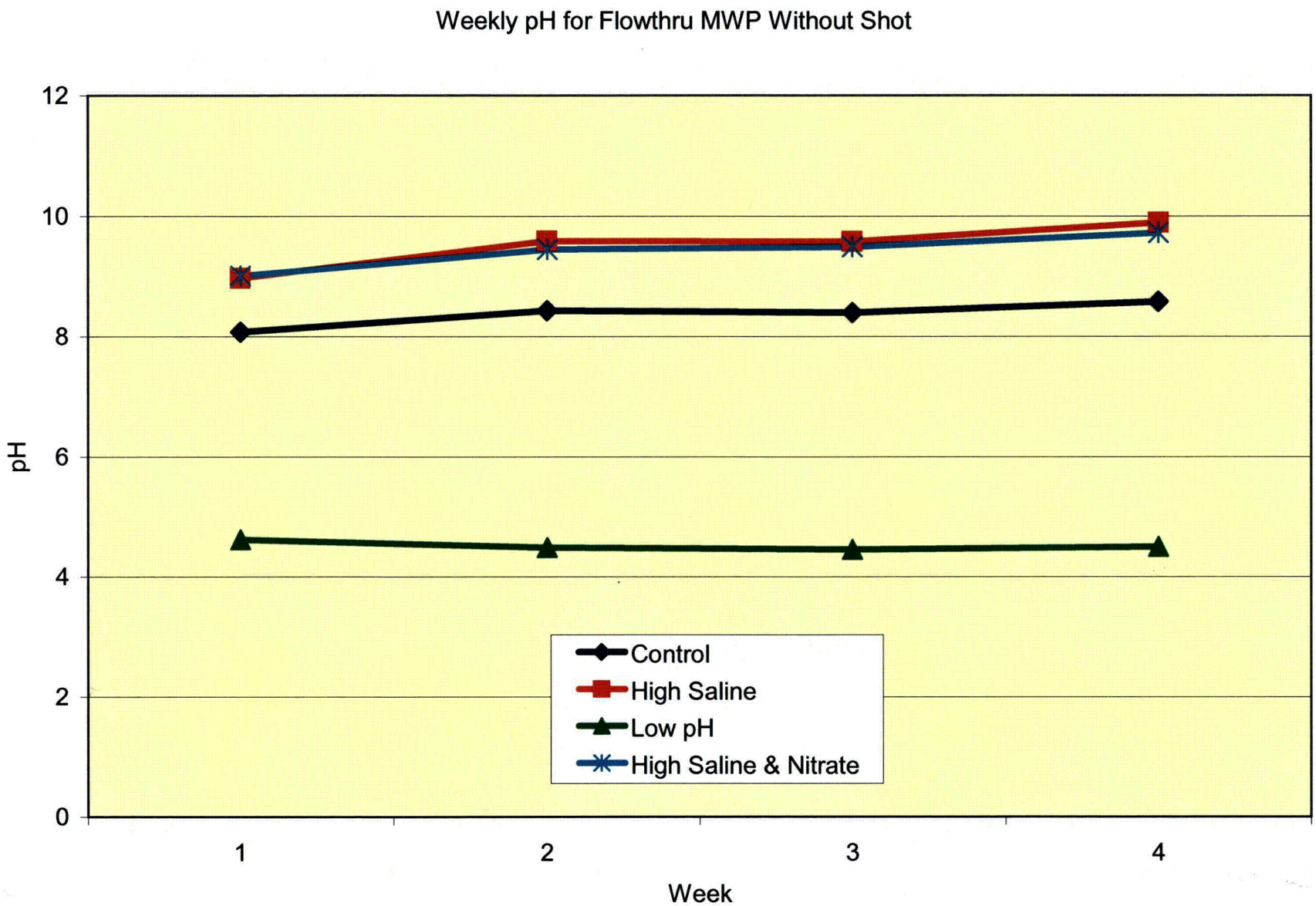
For Flowthru, Iron Shot (FI):

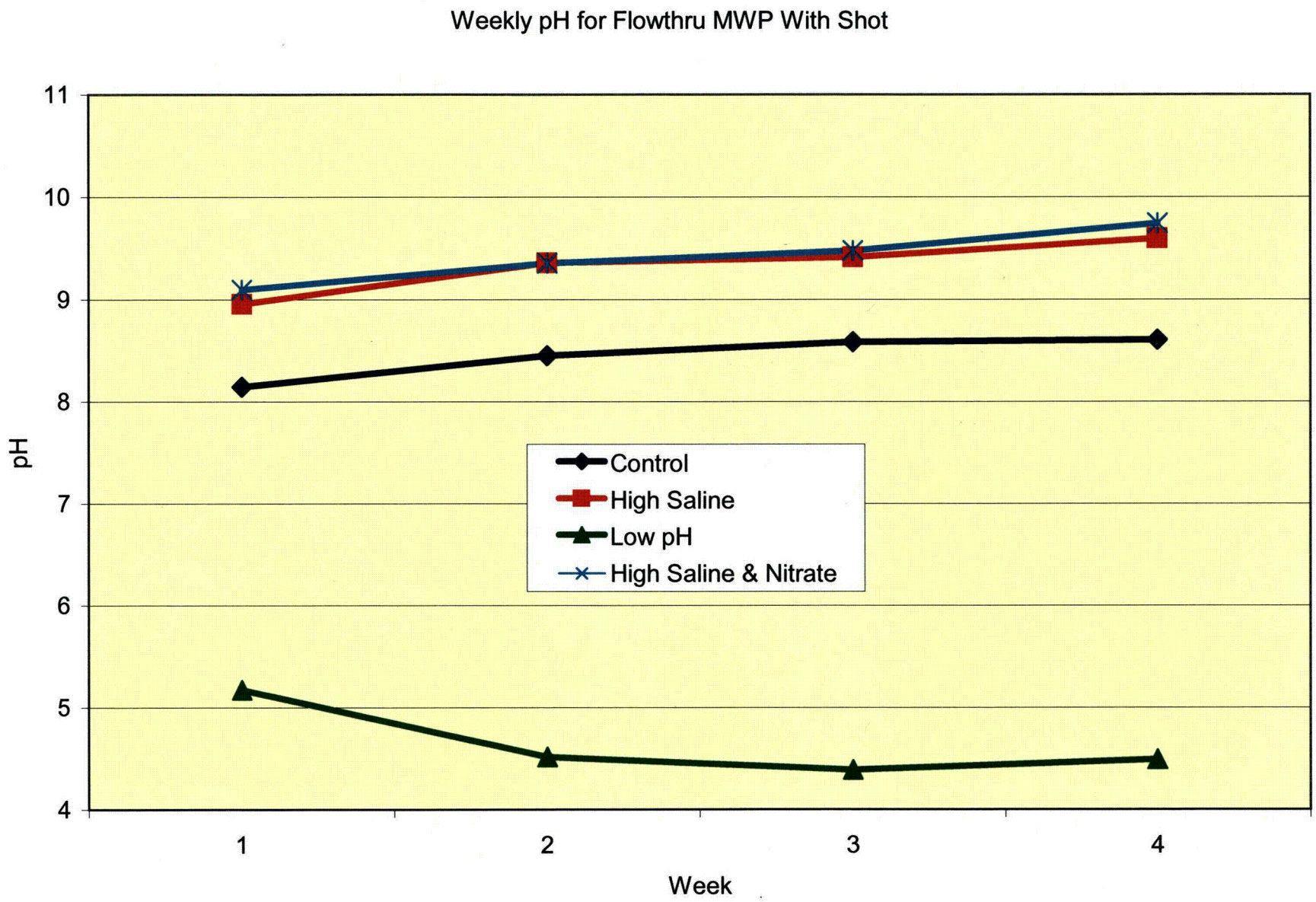
SOLUTION	WEEK	AVERAGE pH	ST. DEV.	n
Control	1	8.37	0.32	12
	2	8.90	0.49	6
	3	8.76	0.20	6
	4	8.71	0.12	6
HS	1	8.96	0.04	12
	2	9.36	0.14	12
	3	9.41	0.10	12
	4	9.60	0.02	6

LPH	1	5.17	0.13	12
	2	4.52	0.07	12
	3	4.39	0.34	12
	4	4.49	0.17	6
HS-HN	1	9.09	0.17	12
	2	9.35	0.06	12
	3	9.47	0.05	12
	4	9.74	0.01	6


Weekly pH for Bathtub MWP Without Shot
12
10
8
6
4
2
0
pH
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Weekly pH for Bathtub MWP with Shot
12
10
8
6
4
2
0
pH
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Weekly pH for Flowthru MWP Without Shot
12
10
8
6
4
2
0
pH
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Weekly pH for Flowthru MWP With Shot
11
10
9
8
7
6
5
4
pH
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate

pH data are included in the Microsoft Excel workbook file "Task 34 pH Data and Graphs Final.xls."

The spreadsheet "pH Source Data" within the file contains the individual results for all the pH measurements, including replicate measurements.

The spreadsheet "pH Chart Data" contains the pH data used in generating the spreadsheet charts (e.g., the data was put in a format that could be easily graphed).

The spreadsheet "pH Data Summary Table" is a summary of the pH information by MWP type (e.g., bathtub – no iron shot), by solution type (e.g., control), and by week. It contains the average pH for the replicate measurements and the duplicate experiments, along with the associated standard deviations.

The spreadsheet "Chart Flowthru with Shot" graphically shows the pH for the flow-through MWP with shot by week for each solution type.

The spreadsheet "Chart Flowthru wo Shot" graphically shows the pH for the flow-through MWP without shot by week for each solution type.

The spreadsheet "Chart Bathtub with Shot" graphically shows the pH for the bathtub MWP with shot by week for each solution type.

The spreadsheet "Chart Bathtub wo Shot" graphically shows the pH for the bathtub MWP without shot by week for each solution type.

Dissolved Oxygen (DO) data are included in the Microsoft Excel workbook file "Task 34 DO Data and Graphs Final.xls."

The spreadsheet "DO Source Data" within the file contains the individual results for all the DO measurements, including replicate measurements.

The spreadsheet "DO Chart Data" contains the DO data used in generating the spreadsheet charts (e.g., the data was put in a format that could be easily graphed).

The spreadsheet "DO Data Summary Table" is a summary of the DO information by MWP type (e.g., bathtub – no iron shot), by solution type (e.g., control), and by week. It contains the average DO for the replicate measurements and the duplicate experiments, along with the associated standard deviations.

The spreadsheet "Chart Flowthru with Shot" graphically shows the DO for the flow-through MWP with shot by week for each solution type.

The spreadsheet "Chart Flowthru wo Shot" graphically shows the DO for the flow-through MWP without shot by week for each solution type.
The spreadsheet "Chart Bathtub with Shot" graphically shows the DO for the bathtub MWP with shot by week for each solution type.

The spreadsheet "Chart Bathtub wo Shot" graphically shows the DO for the bathtub MWP without shot by week for each solution type.

Electrical Conductivity (Conductivity) data are included in the Microsoft Excel workbook file "Task 34 Conductivity Data and Graphs Final.xls."

The spreadsheet "Conductivity Source Data" within the file contains the individual results for all the DO measurements, including replicate measurements.

The spreadsheet "Conductivity Chart Data" contains the conductivity data used in generating the spreadsheet charts (e.g., the data was put in a format that could be easily graphed).

The spreadsheet "Conductivity Data Summary Table" is a summary of the conductivity information by MWP type (e.g., bathtub – no iron shot), by solution type (e.g., control), and by week. It contains the average conductivity for the replicate measurements and the duplicate experiments, along with the associated standard deviations.

The spreadsheet "Chart Flowthru with Shot" graphically shows the conductivity for the flow-through MWP with shot by week for each solution type.

The spreadsheet "Chart Flowthru wo Shot" graphically shows the conductivity for the flow-through MWP without shot by week for each solution type.
The spreadsheet "Chart Bathtub with Shot" graphically shows the conductivity for the bathtub MWP with shot by week for each solution type.

The spreadsheet "Chart Bathtub wo Shot" graphically shows the conductivity for the bathtub MWP without shot by week for each solution type.

TITLE OF DATA:

ICPMS Weight Data and Report Figures with Associated Data

BRIEF DESCRIPTION OF DATA:

Microsoft Excell 2000 Spreadsheet containing select figures and associated data in Task 34 report. passed through a 0.1 micron filter before being measured by ICPMS; "Dissolved" means that the solution was and dissolved oxygen (DO), pH and conductivity data for Week 0 (start of experiment).

ACQUISITION/DEVELOPMENT METHOD:

Four different solutions ("J-13 control", "low pH", "high salt-high nitrate", and "high salt") were pumped into "bath-tub" and "flow-through" carbon steel miniature waste packages (for a detailed description of the experiment see the SIP) and the effluent was collected. The effluent from the miniature waste packages was filtered through 0.45 um, 0.22 um, and 0.10 um filters to determine the total amount of material transported out. The filtrate was then analyzed by ICPMS to determine the concentration of dissolved iron.

DOCUMENT NUMBER OF THE SCIENTIFIC NOTEBOOK THAT DOCUMENTS THE ACQUISITION OR DEVELOPMENT OF THE DATA:

UCCSN-UNLV-032, VOLUME 1, 2, and 3

DATA DEVELOPMENT/ACQUISITION PERIOD:

From: 1/1/2002 To:

PARAMETERS (KEYWORDS):

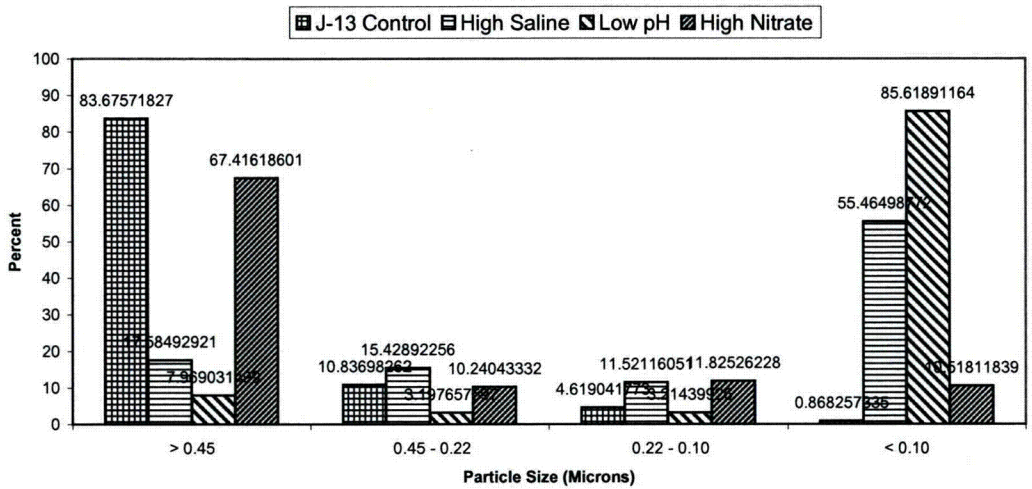
dissolved iron

EXPERIMENT I

MWP	0.45 um Filter (mg)	0.22 um Filter (mg)	0.10 um Filter (mg)	Dissolved Solids (mg)	Total Solids (mg)
Average Mass Calculations by Solution					
J-13 Control					
BN-25-C-001A	5.7	1.1	0.4	0.2	7.3
BI-25-C-002A	3.1	0.9	0.3	0.05	4.4
FN-25-C-003A	14.4	1.1	0.4	0.1	16.0
FI-25-C-004A	6.4	0.8	0.5	0.03	7.7
Average J-13 (	7.4	1.0	0.4	0.1	
Stdev	4.9	0.1	0.1	0.1	
Totals	29.7	3.8	1.6	0.3	35.4
Percents	83.7	10.8	4.6	0.9	100.0
High Saline					
BN-25-HS-005/	5.1	0.8	0.6	7.2	13.8
BI-25-HS-006A	3.8	1.0	2.1	14.5	21.3
FN-25-HS-007/	4.3	11.3	4.5	15.5	35.7
FI-25-HS-008A	3.2	1.3	3.5	14.6	22.7
Average High S	4.1	3.6	2.7	13.0	
Stdev	0.8	5.1	1.7	3.8	
Totals	16.4	14.4	10.8	51.8	93.5
Percents	17.6	15.4	11.5	55.5	100.0
Low pH					
BN-25-LPH-009	12.2	6.3	7.2	91.1	116.8
BI-25-LPH-010/	5.7	3.3	2.5	90.2	101.6
FN-25-LPH-011	6.2	1.9	1.2	115.0	124.2
FI-25-LPH-012/	6.0	0.6	1.1	25.8	33.4
Average Low p	7.5	3.0	3.0	80.5	
Stdev	3.1	2.5	2.9	38.2	
Totals	30.0	12.0	12.1	322.0	376.1
Percents	8.0	3.2	3.2	85.6	100.0
High Nitrate					
BN-25-LPH-HS-	5.9	2.3	2.5	1.8	12.6
BI-25-LPH-HS-(	6.5	0.8	1.4	0.9	9.7
FN-25-LPH-HS-	12.2	1.3	1.0	1.3	15.7
FI-25-LPH-HS-(	10.2	0.9	1.3	1.3	13.7
Average High I	8.7	1.3	1.5	1.4	
Stdev	3.0	0.7	0.6	0.4	
Totals	34.8	5.3	6.1	5.4	51.6
Percents	67.4	10.2	11.8	10.5	100.0

EXPERIMENT II

Average Mass Calculations by Solution



High Saline					
BN-25-HS-037A	8.6	3.4	4.1	7.8	23.9
BN-25-HS-037E	4.8	4.3	3.3	6.2	18.6
FN-25-HS-039A	7.8	2.4	4.6	3.6	18.4
FN-25-HS-039E	6.0	2.5	1.7	3.9	14.1
High Saline Av	6.8	3.2	3.4	5.4	
Stdev	1.7	0.9	1.3	2.0	
Total	27.1	12.7	13.7	21.5	75.0
Percent	36.2	16.9	18.3	28.6	100.0
Low pH					
BN-25-LPH-041	5.7	2.1	2.0	86.7	96.5
BN-25-LPH-041	8.2	3.4	6.7	89.1	107.4
FN-25-LPH-043	5.9	2.2	1.1	82.0	91.1
FN-25-LPH-043	4.8	1.8	0.5	82.0	89.1
Low pH Averag	6.2	2.4	2.6	85.0	
Stdev	1.4	0.7	2.8	3.6	
Total	24.6	9.5	10.2	339.8	384.1
Percent	6.4	2.5	2.7	88.5	100.0
High Nitrate					
BN-25-LPH-HS-	10.4	4.0	2.5	0.5	17.4
BN-25-LPH-HS-	7.7	2.0	2.6	0.6	12.9
FN-25-LPH-HS-	19.8	5.0	3.1	0.5	28.5
FN-25-LPH-HS-	14.4	2.3	1.6	0.4	18.7
High Nitrate Av	13.1	3.3	2.5	0.5	
Stdev	5.3	1.5	0.6	0.1	
Total	52.3	13.2	9.9	2.0	77.5
Percent	67.5	17.1	12.8	2.6	100.0

MWP	0.45 um Filter (mg)	0.22 um Filter (mg)	0.10 um Filter (mg)	Dissolved Solids (mg)	Total Solids (mg)
BN-25-C-001A	5.7	1.1	0.4	0.2	7.3 #
% of Total	78.0	14.6	5.1	2.3	100.0
BI-25-C-002A	3.1	0.9	0.3	0.05	4.4
% of Total	71.7	20.1	7.2	1.1	100.0
FN-25-C-003A	14.4	1.1	0.4	0.1	16.0
% of Total	90.2	6.7	2.8	0.4	100.0

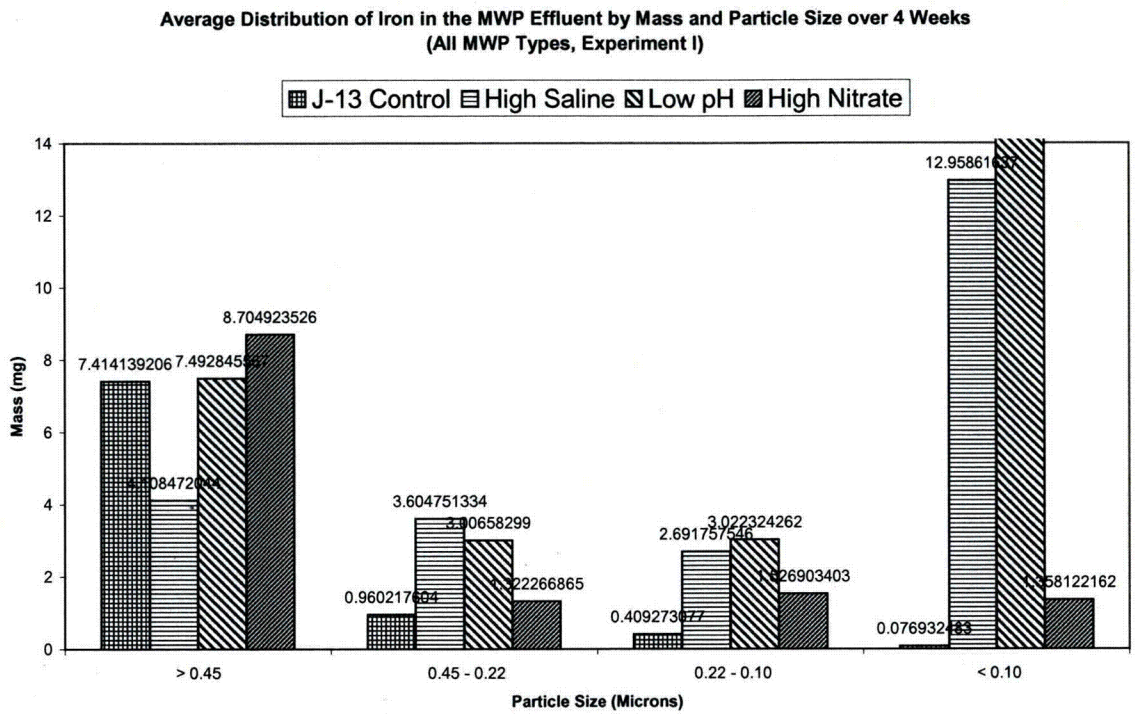
FI-25-C-004A	6.4	0.8	0.5	0.03	7.7	
% of Total	82.5	10.6	6.5	0.4	100.0	
BN-25-HS-005A	5.1	0.8	0.6	7.2	13.8	#
% of Total	37.0	5.9	4.6	52.5	100.0	
BI-25-HS-006A	3.8	1.0	2.1	14.5	21.3	
% of Total	17.7	4.7	9.7	67.8	100.0	
FN-25-HS-007A	4.3	11.3	4.5	15.5	35.7	
% of Total	12.2	31.6	12.7	43.5	100.0	
FI-25-HS-008A	3.2	1.3	3.5	14.6	22.7	
% of Total	14.2	5.8	15.5	64.5	100.0	
BN-25-LPH-009	12.2	6.3	7.2	91.1	116.8	#
% of Total	10.4	5.4	6.2	78.0	100.0	
BI-25-LPH-010A	5.7	3.3	2.5	90.2	101.6	
% of Total	5.6	3.2	2.5	88.7	100.0	
FN-25-LPH-011	6.2	1.9	1.2	115.0	124.2	
% of Total	5.0	1.5	1.0	92.5	100.0	
FI-25-LPH-012A	6.0	0.6	1.1	25.8	33.4	
% of Total	17.9	1.7	3.4	77.0	100.0	
BN-25-LPH-HS-	5.9	2.3	2.5	1.8	12.6	#
% of Total	47.1	18.6	19.6	14.7	100.0	
BI-25-LPH-HS-(	6.5	0.8	1.4	0.9	9.7	
% of Total	67.7	8.5	14.3	9.6	100.0	
FN-25-LPH-HS-	12.2	1.3	1.0	1.3	15.7	
% of Total	77.2	8.0	6.4	8.4	100.0	
FI-25-LPH-HS-(	10.2	0.9	1.3	1.3	13.7	
% of Total	74.6	6.4	9.2	9.7	100.0	

EXPERIMENT I

MWP	0.45 um Filter (mg)	0.22 um Filter (mg)	0.10 um Filter (mg)	Dissolved Solids (mg)	Total Solids (mg)
Average Mass Calculations by Solution					
J-13 Control					
BN-25-C-001A	5.7	1.1	0.4	0.2	7.3
BI-25-C-002A	3.1	0.9	0.3	0.05	4.4
FN-25-C-003A	14.4	1.1	0.4	0.1	16.0
FI-25-C-004A	6.4	0.8	0.5	0.03	7.7
Average J-13 C	7.4	1.0	0.4	0.1	
Stdev	4.9	0.1	0.1	0.1	
Totals	29.7	3.8	1.6	0.3	35.4
Percents	83.7	10.8	4.6	0.9	100.0
High Saline					
BN-25-HS-005A	5.1	0.8	0.6	7.2	13.8
BI-25-HS-006A	3.8	1.0	2.1	14.5	21.3
FN-25-HS-007A	4.3	11.3	4.5	15.5	35.7
FI-25-HS-008A	3.2	1.3	3.5	14.6	22.7
Average High S	4.1	3.6	2.7	13.0	
Stdev	0.8	5.1	1.7	3.8	
Totals	16.4	14.4	10.8	51.8	93.5
Percents	17.6	15.4	11.5	55.5	100.0
Low pH					
BN-25-LPH-009	12.2	6.3	7.2	91.1	116.8
BI-25-LPH-010A	5.7	3.3	2.5	90.2	101.6
FN-25-LPH-011	6.2	1.9	1.2	115.0	124.2
FI-25-LPH-012A	6.0	0.6	1.1	25.8	33.4
Average Low p	7.5	3.0	3.0	80.5	
Stdev	3.1	2.5	2.9	38.2	
Totals	30.0	12.0	12.1	322.0	376.1
Percents	8.0	3.2	3.2	85.6	100.0
High Nitrate					
BN-25-LPH-HS-	5.9	2.3	2.5	1.8	12.6
BI-25-LPH-HS-(	6.5	0.8	1.4	0.9	9.7
FN-25-LPH-HS-	12.2	1.3	1.0	1.3	15.7
FI-25-LPH-HS-(	10.2	0.9	1.3	1.3	13.7
Average High I	8.7	1.3	1.5	1.4	
Stdev	3.0	0.7	0.6	0.4	
Totals	34.8	5.3	6.1	5.4	51.6
Percents	67.4	10.2	11.8	10.5	100.0

EXPERIMENT II

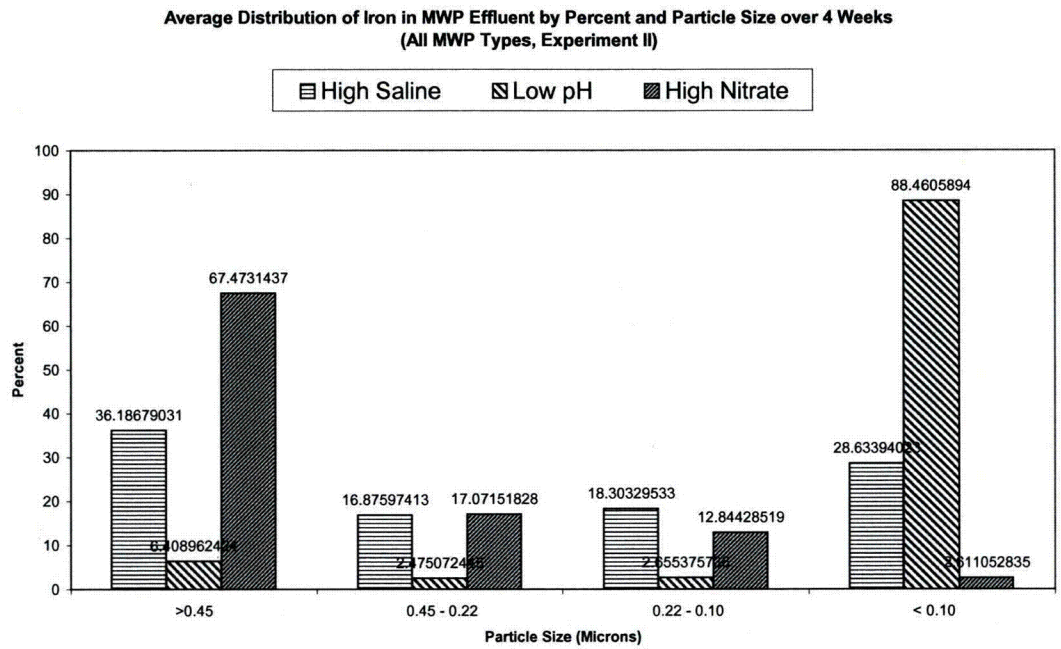
Average Mass Calculations by Solution					
High Saline					
BN-25-HS-037A	8.6	3.4	4.1	7.8	23.9
BN-25-HS-037E	4.8	4.3	3.3	6.2	18.6
FN-25-HS-039A	7.8	2.4	4.6	3.6	18.4
FN-25-HS-039E	6.0	2.5	1.7	3.9	14.1
High Saline Av	6.8	3.2	3.4	5.4	
Stdev	1.7	0.9	1.3	2.0	
Total	27.1	12.7	13.7	21.5	75.0
Percent	36.2	16.9	18.3	28.6	100.0



Low pH					
BN-25-LPH-041	5.7	2.1	2.0	86.7	96.5
BN-25-LPH-041	8.2	3.4	6.7	89.1	107.4
FN-25-LPH-043	5.9	2.2	1.1	82.0	91.1
FN-25-LPH-043	4.8	1.8	0.5	82.0	89.1
Low pH Averag	6.2	2.4	2.6	85.0	
Stdev	1.4	0.7	2.8	3.6	
Total	24.6	9.5	10.2	339.8	384.1
Percent	6.4	2.5	2.7	88.5	100.0
High Nitrate					
BN-25-LPH-HS-	10.4	4.0	2.5	0.5	17.4
BN-25-LPH-HS-	7.7	2.0	2.6	0.6	12.9
FN-25-LPH-HS-	19.8	5.0	3.1	0.5	28.5
FN-25-LPH-HS-	14.4	2.3	1.6	0.4	18.7
High Nitrate Av	13.1	3.3	2.5	0.5	
Stdev	5.3	1.5	0.6	0.1	
Total	52.3	13.2	9.9	2.0	77.5
Percent	67.5	17.1	12.8	2.6	100.0

EXPERIMENT II
Average Mass Calculations by Solution

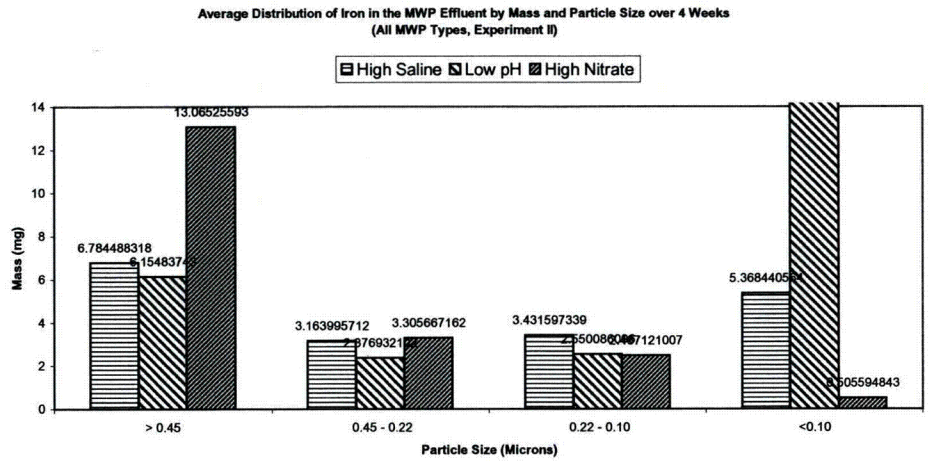
High Saline					
BN-25-HS-037A	8.6	3.4	4.1	7.8	23.9
BN-25-HS-037B	4.8	4.3	3.3	6.2	18.6
FN-25-HS-039A	7.8	2.4	4.6	3.6	18.4
FN-25-HS-039B	6.0	2.5	1.7	3.9	14.1
High Saline Average	6.8	3.2	3.4	5.4	
Stdev	1.7	0.9	1.3	2.0	
Total	27.1	12.7	13.7	21.5	75.0
Percent	36.2	16.9	18.3	28.6	100.0
Low pH					
BN-25-LPH-041A	5.7	2.1	2.0	86.7	96.5
BN-25-LPH-041B	8.2	3.4	6.7	89.1	107.4
FN-25-LPH-043A	5.9	2.2	1.1	82.0	91.1
FN-25-LPH-043B	4.8	1.8	0.5	82.0	89.1
Low pH Average	6.2	2.4	2.6	85.0	
Stdev	1.4	0.7	2.8	3.6	
Total	24.6	9.5	10.2	339.8	384.1
Percent	6.4	2.5	2.7	88.5	100.0
High Nitrate					
BN-25-LPH-HS-045A	10.4	4.0	2.5	0.5	17.4
BN-25-LPH-HS-045B	7.7	2.0	2.6	0.6	12.9
FN-25-LPH-HS-047A	19.8	5.0	3.1	0.5	28.5
FN-25-LPH-HS-047B	14.4	2.3	1.6	0.4	18.7
High Nitrate Average	13.1	3.3	2.5	0.5	
Stdev	5.3	1.5	0.6	0.1	
Total	52.3	13.2	9.9	2.0	77.5
Percent	67.5	17.1	12.8	2.6	100.0



EXPERIMENT II

Average Mass Calculations by Solution

High Saline					
BN-25-HS-037A	8.6	3.4	4.1	7.8	23.9
BN-25-HS-037B	4.8	4.3	3.3	6.2	18.6
FN-25-HS-039A	7.8	2.4	4.6	3.6	18.4
FN-25-HS-039B	6.0	2.5	1.7	3.9	14.1
High Saline Average	6.8	3.2	3.4	5.4	
Stdev	1.7	0.9	1.3	2.0	
Total	27.1	12.7	13.7	21.5	75.0
Percent	36.2	16.9	18.3	28.6	100.0
Low pH					
BN-25-LPH-041A	5.7	2.1	2.0	86.7	96.5
BN-25-LPH-041B	8.2	3.4	6.7	89.1	107.4
FN-25-LPH-043A	5.9	2.2	1.1	82.0	91.1
FN-25-LPH-043B	4.8	1.8	0.5	82.0	89.1
Low pH Average	6.2	2.4	2.6	85.0	
Stdev	1.4	0.7	2.8	3.6	
Total	24.6	9.5	10.2	339.8	384.1
Percent	6.4	2.5	2.7	88.5	100.0
High Nitrate					
BN-25-LPH-HS-045A	10.4	4.0	2.5	0.5	17.4
BN-25-LPH-HS-045B	7.7	2.0	2.6	0.6	12.9
FN-25-LPH-HS-047A	19.8	5.0	3.1	0.5	28.5
FN-25-LPH-HS-047B	14.4	2.3	1.6	0.4	18.7
High Nitrate Average	13.1	3.3	2.5	0.5	
Stdev	5.3	1.5	0.6	0.1	
Total	52.3	13.2	9.9	2.0	77.5
Percent	67.5	17.1	12.8	2.6	100.0

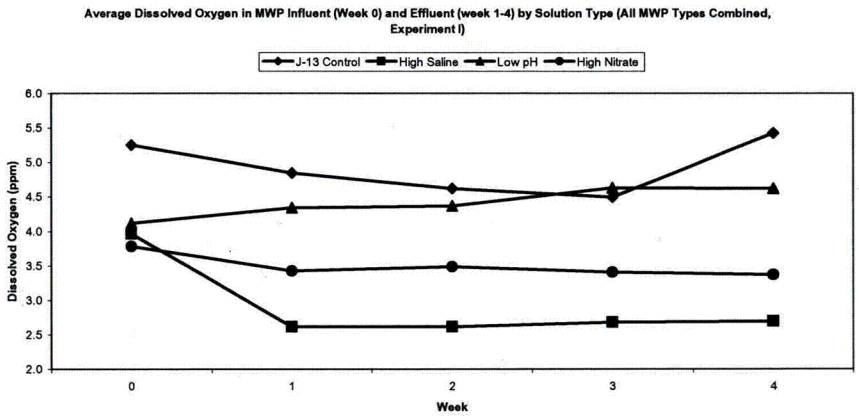


J-13 Control DO (ppm)

	Start	Week 1	Week 2	Week 3	Week 4
BN-25-C-001A			4.63	4.77	5.60
		4.76	4.51	4.81	5.52
		5.12			
		4.70			
BN-25-C-001B					
		4.45	4.87	4.74	5.96
		4.57	5.03	4.91	5.47
	5.23	5.24			
	5.28	5.34			
Bathtub No Shot	**5.26**	**4.88**	**4.76**	**4.81**	**5.64**
BI-25-C-002A					
		4.23	4.45	4.45	5.61
		4.19	4.30	4.45	5.10
		5.40			
		5.32			
BI-25-C-002B					
		4.60	4.95	4.78	5.52
		4.35	4.75	4.83	5.24
	5.23	5.16			
	5.28	5.15			
Bathtub With Shot	**5.26**	**4.80**	**4.61**	**4.63**	**5.37**
FN-25-C-003A					
		4.43	5.01	4.59	4.90
		4.29	4.87	4.46	5.33
		5.00			
		5.09			
FN-25-C-003B		4.15	4.42	4.22	5.41
		4.26	4.51	4.05	5.10
	5.23	5.21			
	5.28	5.19			
Flowthru No Shot	**5.26**	**4.70**	**4.70**	**4.33**	**5.19**
FI-25-C-004A					
		4.57	4.24	4.32	5.54
		4.85	4.35	4.40	5.33
		5.88			
		5.98			
FI-25-C-004B		4.42	4.54	4.11	5.80
		4.38	4.54	4.04	5.38
	5.23	4.99			
	5.28	4.94			
Flowthru With Sho	**5.26**	**5.00**	**4.42**	**4.22**	**5.51**
Bathtub No Shot	5.26	4.88	4.76	4.81	5.64
Bathtub With Shot	5.26	4.80	4.61	4.63	5.37
Flowthru No Shot	5.26	4.70	4.70	4.33	5.19
Flowthru With Shot	5.26	5.00	4.42	4.22	5.51
Average	5.26	4.85	4.62	4.50	5.43

High Saline DO (ppm)

	Start	1	2	3	4
BN-25-HS-005A		3.11	3.13	4.04	3.94
		2.79	2.81	3.05	3.07
		2.76	2.61	2.47	2.48
		3.58	3.52		
BN-25-HS-005B		3.38	3.32	3.24	3.24
		3.21	3.26	2.11	1.96
	3.97	2.22	2.33	2.17	2.07
	3.96	2.6	2.81		
Bathtub No Salt	**3.97**	**2.96**	**2.97**	**2.85**	**2.79**



BI-25-HS-006A		3.63	3.56	3.08	3.24
		2.96	2.89	2.39	2.3
		1.47	1.27		
		1.53	1.42		
BI-25-HS-006B		3.51	3.49	3.08	3.23
		2.75	2.77	2.6	2.43
	3.97	1.93	1.85		
	3.96	2.38	2.35		
Bathtub With Salt	**3.97**	**2.52**	**2.45**	**2.79**	**2.80**
FN-25-HS-007A		2.98	2.99	3.03	3.26
		1.87	1.97	1.95	1.99
		1.44	1.32		
		1.59	1.58		
FN-25-HS-007B		2.92	3.11	3.09	3.02
		1.94	2.11	1.86	1.98
	3.97	1.45	1.44		
	3.96				
Flowthru No Salt	**3.97**	**2.03**	**2.07**	**2.48**	**2.56**
FI-25-HS-008A		3.18	3.15	3.06	3.22
		3.95	3.95	2.33	2.36
		2.54	2.66	2.22	2.42
		2.86	2.83		
FI-25-HS-008B		3.31	3.34	3.29	3.14
		2.44	2.73	2.35	2.32
	3.97	2.49	2.23	2.35	2.25
	3.96	2.92	2.85		
Flowthru With Salt	**3.97**	**2.96**	**2.97**	**2.60**	**2.62**
Bathtub No Salt	**3.97**	**2.96**	**2.97**	**2.85**	**2.79**
Bathtub With Salt	**3.97**	**2.52**	**2.45**	**2.79**	**2.80**
Flowthru No Salt	**3.97**	**2.03**	**2.07**	**2.48**	**2.56**
Flowthru With Salt	**3.97**	**2.96**	**2.97**	**2.60**	**2.62**
Average	**3.97**	**2.62**	**2.62**	**2.68**	**2.69**

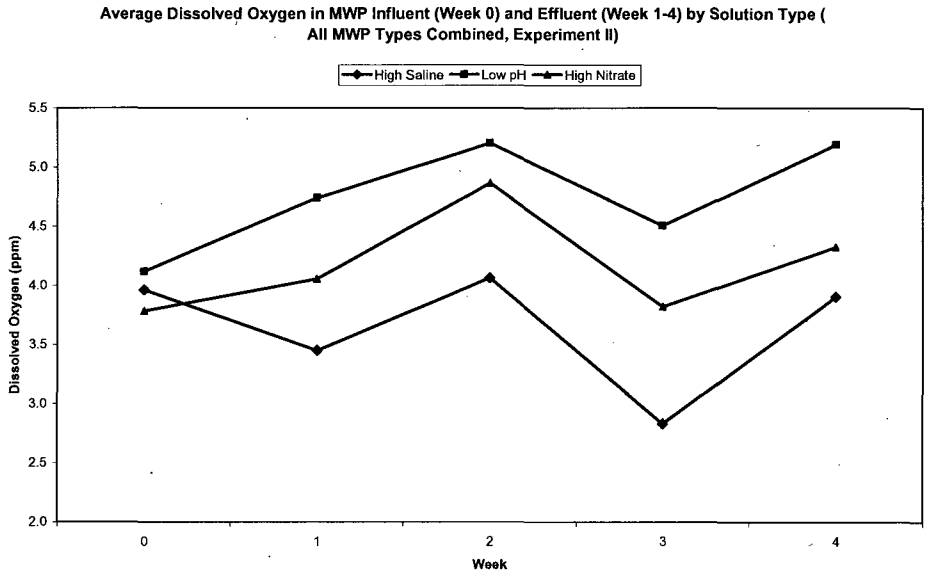
	Start	**1**	**2**	**3**	**4**
Week					
Low pH DO (ppm)					
BN-25-LPH-009A		4.44	4.51	4.67	4.72
		4.53	4.44	4.43	4.44
		3.27	3.37	4.65	4.64
BN-25-LPH-009B		4.40	4.45	4.64	4.98
		4.49	4.42	4.84	4.77
	4.09	3.66	3.65	4.67	4.41
	4.15	4.79	4.89		
Bathtub No Shot	**4.12**	**4.23**	**4.25**	**4.65**	**4.66**
BI-25-LPH-010A		4.43	4.22	4.65	4.82
		4.60	4.71	4.76	4.76
		4.07	4.11	4.45	4.41
		4.63	4.90		
BI-25-LPH-010B		4.86	4.91	4.68	4.73
		4.30	4.34	4.67	4.67
	4.09	3.69	3.69	4.72	4.47
	4.15	4.59	4.71		
Bathtub With Sho	**4.12**	**4.40**	**4.45**	**4.66**	**4.64**
FN-25-LPH-011A		4.15	4.32	4.67	4.72

		4.38	4.41	4.67	4.75
		3.72	3.74	4.47	4.15
		4.76	4.62		
FN-25-LPH-011B		4.57	4.55	4.60	4.62
		4.30	4.34	4.77	4.84
	4.09	4.69	4.31	4.17	4.04
	4.15	4.83	5.03		
Flowthru No Shot	**4.12**	**4.43**	**4.42**	**4.56**	**4.52**
FI-25LPH-012A		4.05	4.07	4.76	4.66
		4.38	4.31	4.77	4.74
		4.38	4.62	4.55	4.62
		4.55	4.62		
FI-25LPH-012B		4.07	4.08	4.63	4.57
		4.35	4.58	4.76	4.90
	4.09	3.87	3.77	4.58	4.58
	4.15	4.90	4.96		
Flowthru With Sh	**4.12**	**4.32**	**4.38**	**4.68**	**4.68**
Bathtub No Shot	4.12	4.23	4.25	4.65	4.66
Bathtub With Shot	4.12	4.40	4.45	4.66	4.64
Flowthru No Shot	4.12	4.43	4.42	4.56	4.52
Flowthru With Sho	4.12	4.32	4.38	4.68	4.68
Average	4.12	4.34	4.37	4.63	4.63

Start Week		**1**	**2**	**3**	**4**
High Saline-High NO3 DO (ppm)					
BN-25-LPH-HS-013A		3.24	3.25	3.40	3.47
		3.79	3.79	3.12	3.15
		3.31	3.41		
		2.51	2.66		
BN-25-LPH-HS-013B		3.60	3.62	3.32	3.38
		3.23	3.11	3.27	3.16
	3.74	3.58	3.71	3.19	3.19
	3.83	3.08	3.12		
Bathtub No Shot	**3.79**	**3.29**	**3.33**	**3.26**	**3.27**
BI-25-LPH-HS-014A		3.08	3.12	3.25	3.23
		3.76	3.84	3.24	3.23
		2.83	2.95	2.60	2.61
		3.30	3.45		
BI-25-LPH-HS-014B		3.95	3.86	3.87	3.75
		3.20	3.37	3.45	3.39
	3.74	3.61	3.49	3.20	3.18
	3.83	3.54	3.48		
Bathtub With Sho	**3.79**	**3.41**	**3.45**	**3.27**	**3.23**
FN-25-LPH-HS-015A		3.44	3.22	3.82	3.96
				3.31	3.32
		3.58	3.54	3.35	3.10
		3.34	3.67		
FN-25-LPH-HS-015B		3.84	4.11	3.63	3.50
		2.69	2.62	2.64	2.50
	3.74	3.42	3.51	3.73	3.74
	3.83	3.59	3.57		
Flowthru No Shot	**3.79**	**3.41**	**3.46**	**3.41**	**3.35**
FI-25LPH-HS-016A		3.22	4.16	4.01	4.13
		3.90	4.12	3.53	3.57
		4.02	4.08	3.52	3.13
		3.42	3.46		
FI-25LPH-HS-016B		3.68	3.00	4.01	4.13
		3.56	3.77	3.15	3.22

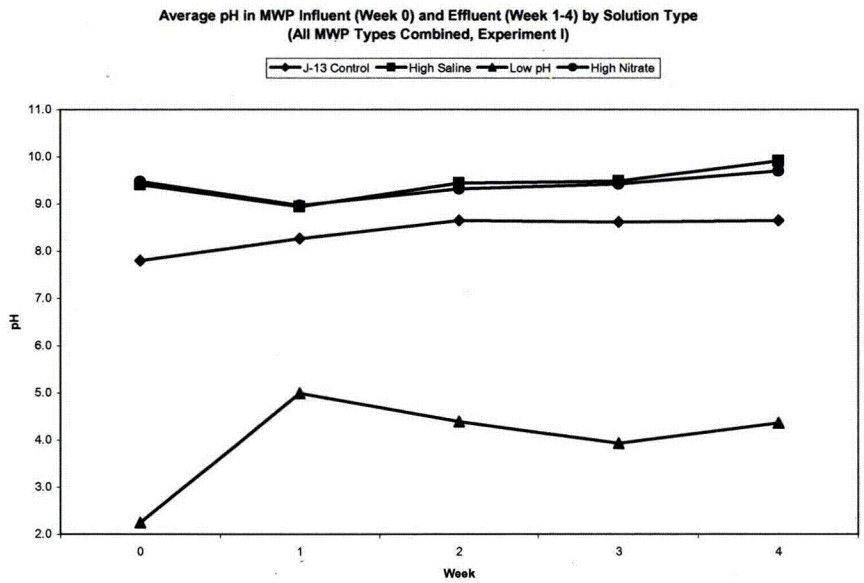
	3.74	3.87	3.98	3.97	3.64
	3.83	3.13	3.18		
Flowthru No Shot	**3.79**	**3.60**	**3.72**	**3.70**	**3.64**
Bathtub No Shot	3.79	3.29	3.33	3.26	3.27
Bathtub With Shot	3.79	3.41	3.45	3.27	3.23
Flowthru No Shot	3.79	3.41	3.46	3.41	3.35
Flowthru No Shot	3.79	3.60	3.72	3.70	3.64
Average	3.79	3.43	3.49	3.41	3.37

	Start	Week 1	Week 2	Week 3	Week 4
High Salt					
Bathtub N0 Shot	3.97	3.30	3.97	2.87	3.58
Flowthru No Shot	3.96	3.61	4.16	2.79	4.22
Average High Salt	3.97	3.45	4.07	2.83	3.90
Low pH					
Bathtub N0 Shot	4.09	4.96	5.85	4.85	5.58
Flowthru No Shot	4.15	4.53	4.56	4.16	4.81
Average Low pH	4.12	4.74	5.20	4.51	5.19
High Nitrate					
Bathtub N0 Shot	3.74	3.96	4.66	3.91	4.14
Flowthru No Shot	3.83	4.16	5.08	3.73	4.51
Average High Nitrate	3.79	4.06	4.87	3.82	4.33



J-13 Control pH

		Start	7/24/02 - 7/31/02	7/31/02 - 8/7/02	8/7/02 - 8/14/02	8/14/02 - 8/21/02
Bathtub No Shot	1	7.80	8.12	8.56	8.54	8.69
	2	7.81	8.13	8.55	8.54	8.69
	3	7.81	8.13	8.56	8.5	8.7
	4		8.52			
	5		8.53			
	6		8.53			
	7		8.30	8.62	8.60	8.62
	8		8.34	8.62	8.59	8.62
	9		8.34	8.63	8.60	8.62
	10		8.47			
	11		8.48			
	12		8.49			
	Average	7.81	8.37	8.59	8.56	8.66
Bathtub With Shot	1	7.80	7.98	8.64	8.67	8.62
	2	7.81	8.03	8.71	8.66	8.62
	3	7.81	8.03	8.72	8.66	8.62
	4		8.45			
	5		8.45			
	6		8.47			
	7		8.11	8.68	8.86	8.68
	8		8.12	8.68	8.86	8.71
	9		8.13	8.71	8.87	8.71
	10		8.50			
	11		8.51			
	12		8.52			
	Average	7.81	8.28	8.69	8.76	8.66
Flowthru No Shot	1	7.80	7.85	8.54	8.38	8.50
	2	7.81	7.86	8.54	8.38	8.51
	3	7.81	7.86	8.55	8.40	8.49
	4		8.27			
	5		8.25			
	6		8.24			
	7		7.95	8.31	8.41	8.65
	8		7.95	8.31	8.40	8.66
	9		7.95	8.32	8.40	8.66
	10		8.24			
	11		8.23			
	12		8.23			
	Average	7.81	8.07	8.43	8.40	8.58
Flowthru With Shot	1	7.80	7.96	8.45	8.59	8.60
	2	7.81	7.97	8.45	8.58	8.60
	3	7.81	7.98	8.45	8.58	8.61
	4		8.29			
	5		8.31			
	6		8.35			
	7		8.82	9.33	8.94	8.81
	8		8.83	9.35	8.94	8.82
	9		8.84	9.34	8.94	8.82
	10		8.39			
	11		8.37			
	12		8.37			
	Average	7.81	8.37	8.90	8.76	8.71
Bathtub No Shot		7.81	8.37	8.59	8.56	8.66
Bathtub With Shot		7.81	8.28	8.69	8.76	8.66
Flowthru No Shot		7.81	8.07	8.43	8.40	8.58
Flowthru With Shot		7.81	8.37	8.90	8.76	8.71
Average		7.81	8.27	8.65	8.62	8.65



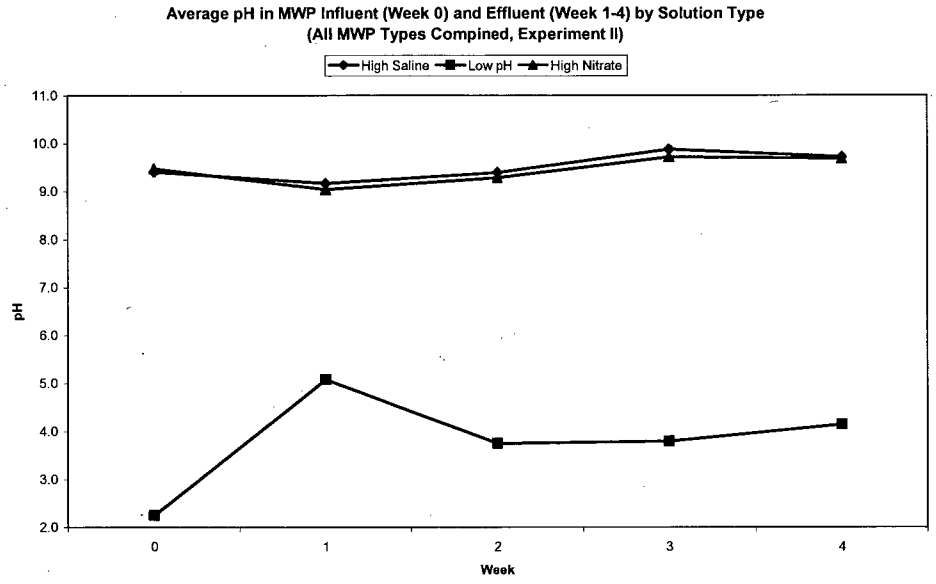
High Saline pH	Week	0	1	2	3	4
		Start	7/24/02 - 7/31/02	7/31/02 - 8/7/02	8/7/02 - 8/14/02	8/14/02 - 8/21/02
Bathtub No Shot	**1**	9.41	8.94	9.38	9.38	9.87
	2	9.41	8.95	9.28	9.37	9.87
	3	9.41	8.95	9.29	9.36	9.87
	4		8.90	9.29	9.42	
	5		8.90	9.49	9.42	
	6		8.90	9.49	9.42	
	7		8.99	9.26	9.43	9.90
	8		8.98	9.28	9.43	9.90
	9		8.99	9.28	9.43	9.90
	10		8.88	9.73	9.38	
	11		8.89	9.73	9.39	
	12		8.89	9.76	9.39	
	Average	9.41	8.93	9.44	9.40	9.89
Bathtub With Shot	**1**	9.41	9.00	9.26	9.71	10.09
	2	9.41	8.99	9.28	9.71	10.09
	3	9.41	8.99	9.28	9.71	10.09
	4		8.88	9.52		
	5		8.89	9.53		
	6		8.89	9.53		
	7		8.92	9.24	9.42	9.79
	8		8.92	9.24	9.41	9.79
	9		8.92	9.24	9.41	9.79
	10		8.88	9.60		
	11		8.89	9.60		
	12		8.89	9.60		
	Average	9.41	8.92	9.41	9.56	9.94
Flowthru No Shot	**1**	9.41	8.98	9.46	9.62	10.25
	2	9.41	8.98	9.47	9.62	10.25
	3	9.41	8.99	9.47	9.61	10.25
	4		8.99	9.72		
	5		8.97	9.72		
	6		8.97	9.72		
	7		8.97	9.48	9.54	
	8		8.97	9.48	9.53	
	9		8.97	9.48	9.53	
	10		8.97	9.66		
	11		8.94	9.67		
	12		8.93	9.67		
	Average	9.41	8.97	9.58	9.58	10.25
Flowthru With Shot	**1**	9.41	9.00	9.28	9.36	9.61
	2	9.41	9.00	9.29	9.36	9.61
	3	9.41	9.00	9.29	9.36	9.62
	4		8.93	9.49	9.57	
	5		8.93	9.49	9.57	
	6		8.93	9.49	9.57	
	7		8.98	9.17	9.33	9.58
	8		8.98	9.17	9.33	9.58
	9		8.98	9.17	9.33	9.58
	10		8.91	9.48	9.39	
	11		8.91	9.48	9.39	
	12		8.91	9.48	9.40	
	Average	9.41	8.96	9.36	9.41	9.60
Bathtub No Shot		9.41	8.93	9.44	9.40	9.89
Bathtub With Shot		9.41	8.92	9.41	9.56	9.94
Flowthru No Shot		9.41	8.97	9.58	9.58	10.25
Flowthru With Shot		9.41	8.96	9.36	9.41	9.60
Average		9.41	8.94	9.45	9.49	9.92

High Saline	Week	0	1	2	3	4
		Start	7/24/02 - 7/31/02	7/31/02 - 8/7/02	8/7/02 - 8/14/02	8/14/02 - 8/21/02
Bathtub No Shot	**1**	2.25	5.65	4.19	3.11	
	2	2.24	5.65	4.15	3.13	
	3	2.24	5.66	4.15	3.13	
	4		4.61	4.64	3.04	
	5		4.60	4.62	2.93	
	6		4.59	4.62	2.93	
	7		5.61	4.42	3.77	4.40
	8		5.61	4.41	3.76	4.41
	9		5.60	4.41	3.76	4.41
	10		5.32	4.49	3.28	
	11		5.09	4.49	3.28	
	12		5.08	4.46	3.28	
	Average	2.24	5.26	4.42	3.28	4.41
Bathtub With Shot	**1**	2.25	5.37	4.10	3.82	3.99
	2	2.24	5.27	4.09	3.83	3.99
	3	2.24	5.26	4.09	3.84	4.00
	4		4.66	4.44	3.33	
	5		4.65	4.41	3.34	
	6		4.63	4.41	3.35	
	7		5.06	4.00	3.43	4.10
	8		5.02	4.01	3.47	4.10
	9		5.01	4.03	3.47	4.10
	10		4.70	4.07	3.72	
	11		4.69	4.02	3.72	
	12		4.68	4.01	3.74	
	Average	2.24	4.92	4.14	3.59	4.05
Flowthru No Shot	**1**	2.25	4.48	4.57	4.25	4.53
	2	2.24	4.47	4.57	4.25	4.53
	3	2.24	4.46	4.57	4.26	4.53
	4		4.86	4.73	4.65	
	5		4.80	4.90	4.64	
	6		4.79	4.81	4.63	
	7		4.66	4.00	4.33	4.46
	8		4.65	4.01	4.33	4.46
	9		4.64	4.03	4.34	4.47
	10		4.54	4.59	4.58	
	11		4.53	4.53	4.57	
	12		4.52	4.48	4.56	
	Average	2.24	4.62	4.48	4.45	4.50
Flowthru With Shot	**1**	2.25	5.45	4.58	4.31	4.34
	2	2.24	5.09	4.58	4.31	4.34
	3	2.24	5.07	4.58	4.31	4.34
	4		5.08	4.50	4.74	
	5		5.06	4.50	4.72	
	6		5.05	4.50	4.72	
	7		5.29	4.40	3.84	4.65
	8		5.27	4.41	3.91	4.64
	9		5.27	4.42	3.91	4.64
	10		5.08	4.60	4.63	
	11		5.17	4.57	4.63	
	12		5.16	4.54	4.63	
	Average	2.24	5.17	4.52	4.39	4.49
Bathtub No Shot		2.24	5.26	4.42	3.28	4.41
Bathtub With Shot		2.24	4.92	4.14	3.59	4.05
Flowthru No Shot		2.24	4.62	4.48	4.45	4.50
Flowthru With Shot		2.24	5.17	4.52	4.39	4.49
Average		2.24	4.99	4.39	3.93	4.36

High Saline pH	Week	0	1	2	3	4

		Start	7/24/02 - 7/31/02	7/31/02 - 8/7/02	8/7/02 - 8/14/02	8/14/02 - 8/21/02
Bathtub No Shot	1	9.48	8.91	9.16	9.46	9.77
	2	9.48	8.93	9.17	9.38	9.76
	3	9.48	8.92	9.17	9.37	9.76
	4		8.71	9.39		
	5		8.71	9.40		
	6		8.72	9.40		
	7		8.96	9.14	9.30	9.76
	8		8.96	9.14	9.30	9.62
	9		8.96	9.14	9.31	9.62
	10		8.79	9.27	9.31	
	11		8.79	9.28	9.31	
	12		8.79	9.28	9.30	
	Average	9.48	8.85	9.25	9.34	9.72
Bathtub With Shot	1	9.48	9.15	9.31	9.44	9.65
	2	9.48	9.16	9.31	9.43	9.65
	3	9.48	9.16	9.32	9.42	9.65
	4		8.79	9.29	9.48	
	5		8.80	9.29	9.48	
	6		8.81	9.29	9.48	
	7		9.00	9.18	9.34	9.65
	8		9.00	9.19	9.34	9.65
	9		9.00	9.19	9.34	9.65
	10		8.91	9.27	9.41	
	11		8.91	9.28	9.41	
	12		8.91	9.28	9.41	
	Average	9.48	8.97	9.27	9.42	9.65
Flowthru No Shot	1	9.48	9.11		9.47	9.70
	2	9.48	9.11		9.47	9.70
	3	9.48	9.12		9.47	9.70
	4		8.98	9.49	9.54	
	5		8.98	9.50	9.52	
	6		8.99	9.50	9.52	
	7		9.05	9.26	9.42	9.73
	8		9.05	9.26	9.42	9.73
	9		9.05	9.26	9.42	9.73
	10		8.86	9.50	9.50	
	11		8.86	9.50	9.51	
	12		8.87	9.51	9.51	
	Average	9.48	9.00	9.42	9.48	9.72
Flowthru With Shot	1	9.48	9.19	9.28	9.43	9.73
	2	9.48	9.20	9.28	9.44	9.73
	3	9.48	9.20	9.28	9.44	9.73
	4		8.91	9.41	9.50	
	5		8.92	9.41	9.50	
	6		8.92	9.41	9.50	
	7		9.30	9.31	9.41	9.75
	8		9.30	9.31	9.42	9.75
	9		9.30	9.31	9.42	9.75
	10		8.96	9.41	9.54	
	11		8.96	9.41	9.54	
	12		8.96	9.42	9.54	
	Average	9.48	9.09	9.35	9.47	9.74
Bathtub No Shot		9.48	8.85	9.25	9.34	9.72
Bathtub With Shot		9.48	8.97	9.27	9.42	9.65
Flowthru No Shot		9.48	9.00	9.42	9.48	9.72
Flowthru With Shot		9.48	9.09	9.35	9.47	9.74
Average		9.48	8.98	9.32	9.43	9.71

	Start	Week 1	Week 2	Week 3	Week 4
High Saline					
Bathtub No Shot	9.41	9.26	9.38	9.80	9.72
Flowthru No Shot	9.41	9.08	9.42	9.96	9.73
Average High Saline	9.41	9.17	9.40	9.88	9.72
Low pH	**2.25**	5.08	3.75	3.80	4.15
Bathtub No Shot	2.25	5.08	3.75	3.80	4.15
Flowthru No Shot	2.25	5.08	3.75	3.80	4.15
Average Low pH	2.25	5.08	3.75	3.80	4.15
High Nitrate					
Bathtub No Shot	9.48	9.01	9.30	9.76	9.66
Flowthru No Shot	9.48	9.09	9.29	9.68	9.71
Average High Nitrate	9.48	9.05	9.29	9.72	9.68



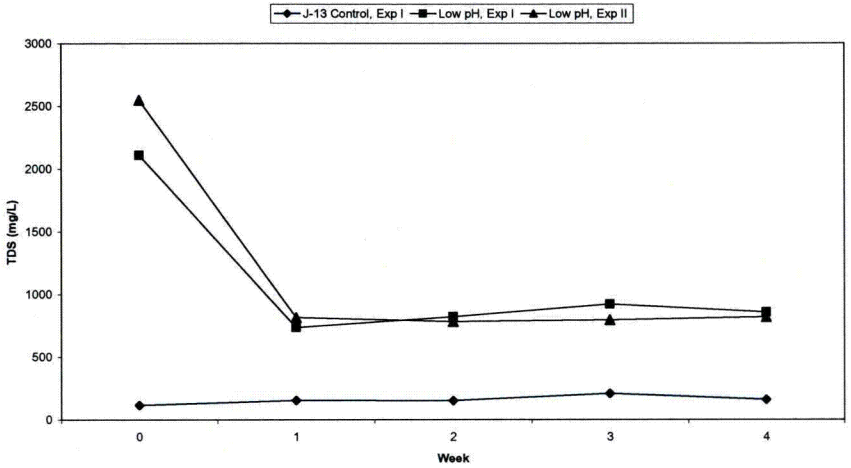
MWP Type	J-13 Control Conductivity (uS)					J-13 Control TDS (mg/L)				
Bathtub w Week	0	1	2	3	4	0	1	2	3	4
"A" Package	235	309	313	420	298	116	154.5	156.5	210.0	149.0
		329					164.5			
"B" Package		321	331	367	320		160.5	165.5	183.5	160.0
		339					169.5			
Bathtub with shot										
"A" Package		320	330	418	325		160.0	165.0	209.0	162.5
		313					156.5			
"B" Package		321	340	765	430		160.5	170.0	382.5	215.0
		337					168.5			
Flowthru w/o shot										
"A" Package		242	263	291	272		121.0	131.5	145.5	136.0
		281					140.5			
"B" Package		254	257	294	258		127.0	128.5	147.0	129.0
		281					140.5			
Flowthru with shot										
"A" Package		296	293	354	314		148.0	146.5	177.0	157.0
		372					186.0			
Average J-13 TDS	235					116	154.1	151.9	207.8	158.4

"B" Packa Not Included, See Original Data Sheet

MWP Type	High Saline Conductivity (mS)					High Saline TDS (g/L)				
Bathtub w Week	0	1	2	3	4	0	1	2	3	4
"A" Package	55.8	69	80	67	73	55.8	34.3	40.2	33.4	36.7
			76	93				37.9	46.3	
"B" Package		72	82	104	94		36.2	40.8	51.8	47.2
			107					53.5		
Bathtub with shot										
"A" Package		71	79				35.5	39.5		
"B" Package		69	92	101	103		34.3	46.2	50.4	51.3
Flowthru w/o shot										
"A" Package		72	110	113			35.9	55.0	56.6	
"B" Package		74	111	112			36.9	55.5	55.8	
Flowthru with shot										
"A" Package		70	80	76	83		35.1	39.9	37.9	41.7
			76	94				38.1	47.0	
		74	86	76	82		36.9	43.2	38.1	40.8
"B" Package			78	84				39.2	41.8	
Average High Saline TDS						27.9	35.8	44.5	46.3	43.5
Average in mg/L						27900	35593.75	44520.45	46344.44	43520

MWP Type	Low pH Conductivity (uS)					Low pH TDS (mg/L)				
	0	1	2	3	4	0	1	2	3	4
Bathtub w Week										
"A" Package	423	1567	1813	2660		2110	783.5	906.5	1330.0	
			1749	2510				874.5	1255.0	
"B" Package		1561	1680	2050	1950		780.5	840.0	1025.0	975.0
			1623	2060				811.5	1030.0	
Bathtub with shot										
"A" Package		1464	1781	2350			732.0	890.5	1175.0	
			1666	1766				833.0	883.0	
"B" Package		1526	1886	2450	2020		763.0	943.0	1225.0	1010.0
			1833	1890				916.5	945.0	
Flowthru w/o shot										
"A" Package		1471	1545	1440	1337		735.5	772.3	720.0	668.5
			1492	1390				746.0	695.0	
"B" Package		1448	1886	1343	1298		724.0	943.0	671.5	649.0

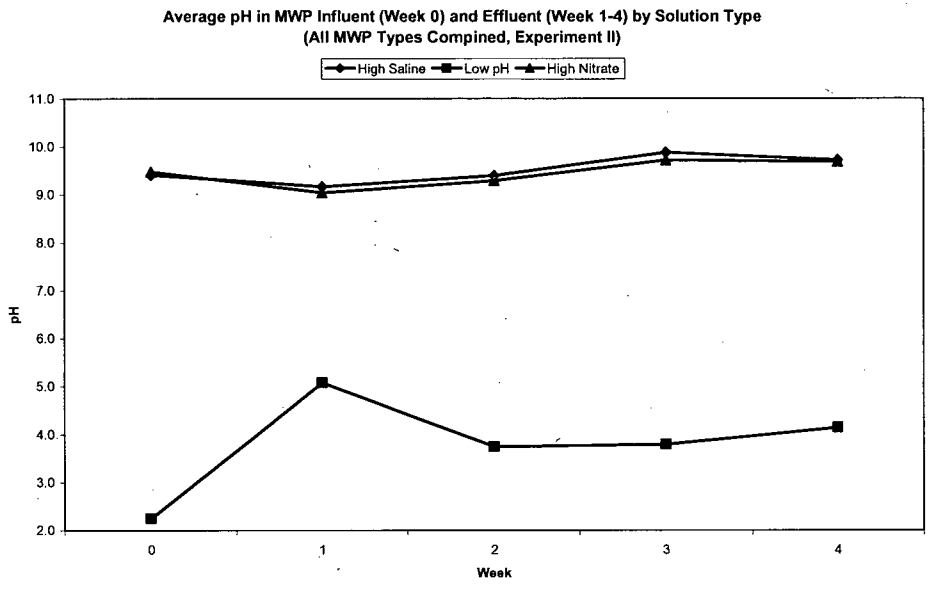
Average TDS in MWP Influent (Week 0) and Effluent (Week 1-4) by Solution Type (All MWP Types, Experiments I and II)



			1393	1308				696.5	654.0	
Flowthru with shot										
"A" Package		1417	1341	1307	2110		708.5	670.3	653.5	1055.0
			1546	1281				773.0	640.5	
		1314	1400	1787	1553		657.0	700.0	893.5	776.5
"B" Package				1575				0.0	787.5	
Average Low pH TDS						2110	736.5	821.1	919.7	855.7

	High Nitrate Conductivity (mS)					High Nitrate TDS (g/L)				
MWP Type										
Bathtub w Week	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
"A" Package	61.3	93	94	89		61	46.5	47.1	44.7	
		78	108				39.2	54.2		
"B" Package		80	79	90			40.0	39.4	44.9	
		73	87				36.4	43.7		
Bathtub with shot										
"A" Package		78	93	94	89		38.8	46.5	47.1	44.7
			78	108				39.2	54.2	
"B" Package		73	80	79	90		36.4	40.0	39.4	44.9
			73	87				36.4	43.7	
Flowthru w/o shot										
"A" Package		81		78	77		40.6		39.0	38.6
			88	82				44.2	41.0	
"B" Package		86		90	100		43.1		44.8	50.0
				84					42.2	
Flowthru with shot										
"A" Package		76	84	81	80		38.2	41.8	40.3	40.2
			80	93				40.2	46.4	
		76		85	90		38.2		42.3	44.9
"B" Package			97	91				48.3	45.6	
Average High Nitrate TDS						30.7	39.7	42.9	43.8	43.9
Average in mg/L						30650	39707.5	42945.45	43823.08	43850

	Start	Week 1	Week 2	Week 3	Week 4
High Saline					
Bathtub No Shot	9.41	9.26	9.38	9.80	9.72
Flowthru No Shot	9.41	9.08	9.42	9.96	9.73
Average High Saline	9.41	9.17	9.40	9.88	9.72
Low pH	**2.25**	5.08	3.75	3.80	4.15
Bathtub No Shot	2.25	5.08	3.75	3.80	4.15
Flowthru No Shot	2.25	5.08	3.75	3.80	4.15
Average Low pH	2.25	5.08	3.75	3.80	4.15
High Nitrate					
Bathtub No Shot	9.48	9.01	9.30	9.76	9.66
Flowthru No Shot	9.48	9.09	9.29	9.68	9.71
Average High Nitrate	9.48	9.05	9.29	9.72	9.68



MWP Type	High Nitrate Conductivity (mS)					High Nitrate TDS (g/L)				
Bathtub w Week	**0**	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**
"A" Package	61.3	93	94	89		61	46.5	47.1	44.7	
		78	108				39.2	54.2		
"B" Package		80	79	90			40.0	39.4	44.9	
		73	87				36.4	43.7		
Bathtub with shot										
"A" Package		78	93	94	89		38.8	46.5	47.1	44.7
			78	108				39.2	54.2	
"B" Package		73	80	79	90		36.4	40.0	39.4	44.9
			73	87				36.4	43.7	
Flowthru w/o shot										
"A" Package		81		78	77		40.6		39.0	38.6
			88	82				44.2	41.0	
"B" Package		86		90	100		43.1		44.8	50.0
				84					42.2	
Flowthru with shot										
"A" Package		76	84	81	80		38.2	41.8	40.3	40.2
			80	93				40.2	46.4	
		76		85	90		38.2		42.3	44.9
"B" Package			97	91				48.3	45.6	
Average High Nitrate TDS						30.7	39.7	42.9	43.8	43.9
Average in mg/L						30650	39707.5	42945.45	43823.08	43850

High Saline

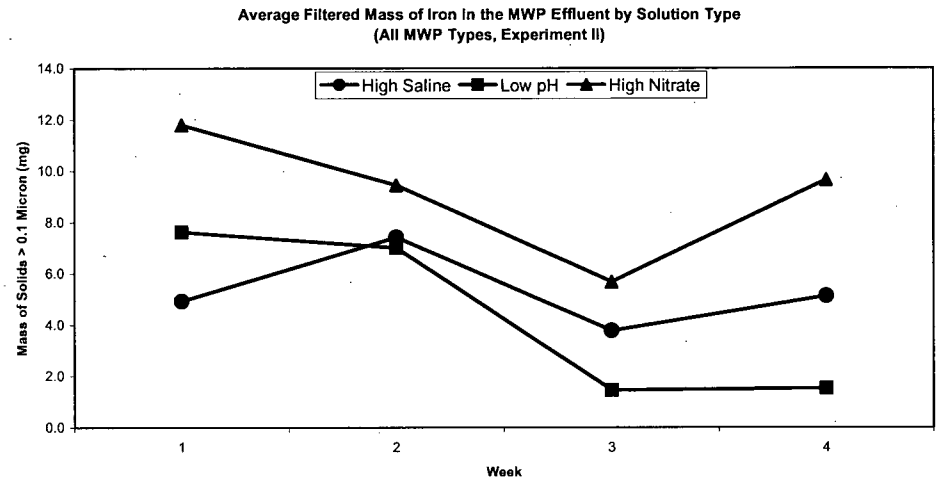
Week	1	2	3	4
Bathtub w/o Shot				
037A	0.0039	0.0101	0.0059	0.0056
037B	0.0053	0.0085	0.0030	0.0030
Flowthru w/o Shot				
039A	0.0074	0.0064	0.0022	0.0075
039B	0.0031	0.0047	0.004	0.0044
Average (mg)	**4.92**	**7.43**	**3.77**	**5.13**

Low pH

Week	1	2	3	4
Bathtub w/o Shot				
041A	0.0066	0.0041	0.0024	0.0025
041B	0.0092	0.0179	0.0008	0.0011
Flowthru w/o Shot				
043A	0.008	0.0036	0.0013	0.0016
043B	0.0067	0.0024	0.0013	0.0009
Average (mg)	**7.63**	**7.00**	**1.45**	**1.53**

High Nitrate

Week	1	2	3	4
Bathtub w/o Shot				
045A	0.0092	0.0076	0.0056	0.0044
045B	0.0058	0.0050	0.0025	0.0062
Flowthru w/o Shot				
047A	0.0194	0.0088	0.0045	0.0118
047B	0.0128	0.0164	0.0101	0.0162
Average (mg)	**11.80**	**9.45**	**5.68**	**9.65**
	0.0028			
	0.0095			



	DO (ppm) Week 0 (start)
Control (J13)	5.26
High Salt	3.97
Low pH	4.12
High Nitrate	3.79

	pH Week 0 (start)
Control (J13)	7.81
High Salt	9.41
Low pH	2.24
High Nitrate	9.48

MWP	AVERAGE FLOW RATE mL / Day	Number Days	Total Flow (mL)	Density (g/mL)	Weight of Solution (g)	ICPMS Average ppm (g/10^6g)	Fe g (g)	Fe mg (mg)	Moles FeO(OH)	FeO(OH) g (g)	FeO(OH) (mg)
BN-25-C-001A	26.73	28	748	0.9975450	747	0.222	0.0002	0.1655	2.9634E-06	0.0003	0.2633101
BI-25-C-002A	32.55	28	911	0.9975450	909	0.052	0.0000	0.0474	8.48024E-07	0.0001	0.075350352
FN-25-C-003A	33.80	28	946	0.9975450	944	0.068	0.0001	0.0639	1.14433E-06	0.0001	0.101678083
FI-25-C-004A	32.81	28	919	0.9975450	916	0.034	0.0000	0.0310	5.54478E-07	0.0000	0.049267626
BN-25-HS-005A	36.62	24	879	1.0685940	939	7.699	0.0072	7.2313	0.000129484	0.0115	11.50520575
BI-25-HS-006A	30.05	24	721	1.0685940	771	18.756	0.0145	14.4557	0.000258845	0.0230	22.99942794
FN-25-HS-007A	30.11	24	723	1.0685940	772	20.104	0.0155	15.5254	0.000278	0.0247	24.70137316
FI-25-HS-008A	37.80	24	907	1.0685940	969	15.083	0.0146	14.6220	0.000261822	0.0233	23.26394849
BN-25-LPH-009A	34.07	24	818	0.9975415	816	111.697	0.0911	91.1212	0.001631622	0.1450	144.9760986
BI-25-LPH-010A	34.24	24	822	0.9975415	820	109.995	0.0902	90.1674	0.001614542	0.1435	143.4585573
FN-25-LPH-011A	37.30	24	895	0.9975415	893	128.739	0.1150	114.9544	0.002058381	0.1829	182.8954165
FI-25-LPH-012A	27.87	24	669	0.9975415	667	38.616	0.0258	25.7682	0.000461407	0.0410	40.9978987
BN-25-LPH-HS-013A	34.52	24	829	1.0661820	883	2.094	0.0018	1.8495	3.3117E-05	0.0029	2.942580773
BI-25-LPH-HS-014A	26.93	24	646	1.0661820	689	1.345	0.0009	0.9270	1.65995E-05	0.0015	1.474933901
FN-25-LPH-HS-015A	33.78	24	811	1.0661820	864	1.531	0.0013	1.3235	2.36983E-05	0.0021	2.105690115
FI-25-LPH-HS-016A	36.94	24	886	1.0661820	945	1.410	0.0013	1.3325	2.38596E-05	0.0021	2.120023069
BN-25-HS-037A	656.6300	27.47	23.9	1.1069	727	10.724	0.0078	7.7942	0.000139563	0.0124	
BN-25-HS-037B	534.4100	22.36	23.9	1.1069	592	10.447	0.0062	6.1797	0.000110655	0.0098	22.23282324
FN-25-HS-039A	568.9000	23.80	23.9	1.1069	630	5.648	0.0036	3.5562	6.36773E-05	0.0057	
FN-25-HS-039B	595.7100	24.93	23.9	1.1069	659	5.981	0.0039	3.9437	7.06157E-05	0.0063	11.93247256
BN-25-LPH-041A	568.6700	23.79	23.9	1.1069	629	137.778	0.0867	86.7227	0.001552862	0.1380	
BN-25-LPH-041B	617.1500	25.82	23.9	1.1069	683	130.486	0.0891	89.1344	0.001596047	0.1418	279.7931154
FN-25-LPH-043A	520.0200	21.76	23.9	1.1069	576	142.424	0.0820	81.9778	0.0014679	0.1304	
FN-25-LPH-043B	448.3800	18.76	23.9	1.1069	496	165.178	0.0820	81.9767	0.001467879	0.1304	260.8557845
BN-25-LPH-HS-045A	560.1700	23.44	23.9	1.1069	620	0.784	0.0005	0.4860	8.70228E-06	0.0008	
BN-25-LPH-HS-045B	671.9500	28.12	23.9	1.1069	744	0.835	0.0006	0.6212	1.11241E-05	0.0010	1.761649375
FN-25-LPH-HS-047A	598.3500	25.04	23.9	1.1069	662	0.706	0.0005	0.4674	8.37019E-06	0.0007	
FN-25-LPH-HS-047B	492.7200	20.62	23.9	1.1069	545	0.821	0.0004	0.4477	8.01622E-06	0.0007	1.455997858

PRINCIPAL INVESTIGATOR:
Kaveh Zarrabi

DATA ORIGINATOR/PREPARER:
James Cizdziel, Susan McMillon, Sandra Elkonz

TASK NUMBER:
34

HAVE THE DATA RECEIVED A TECHNICAL REVIEW THAT ESTABLISHES AND DOUMENTS THE VALIDITY OF THE DATA?
Yes

TITLE OF DATA:
Concentration of dissolved iron in effluent solution from Miniature Waste Package Corrosion Study by ICPMS

BRIEF DESCRIPTION OF DATA:
Microsoft Excell 2000 Spreadsheet containing concentration data for dissolved iron in effluent of MWPs.
"Dissolved" means that the solution was passed through a 0.1 micron filter before being measured by ICPMS

ACQUISITION/DEVELOPMENT METHOD:
Four different solutions ("J-13 control", "low pH", "high salt-high nitrate", and "high salt") were pumped into "bath-tub" and "flow-through" carbon steel miniature waste packages (for a detailed description of the experiment see the SIP) and the effluent was collected. TThe filtrate was then analyzed by ICPMS to determine the concentration of dissolved iron.

DOCUMENT NUMBER OF THE SCIENTIFIC NOTEBOOK THAT DOCUMENTS THE ACQUISITION OR DEVELOPMENT OF THE DATA:
UCCSN-UNLV-032, VOLUME 1, 2, and 3

DATA DEVELOPMENT/ACQUISITION PERIOD:
From: 1/1/2002 To: 3/31/2003

PARAMETERS (KEYWORDS):
dissolved iron

Sample ID	Solution-Type	MWP Configuration	Fe concentration (ppb)	(ppm)
001A WK 1	J-13	Bathtub	642	0.642
002A WK 1	J-13	Bathtub, Iron Shot	47	0.047
003A WK 1	J-13	Flow-Through	258	0.258
004A WK 1	J-13	Flow-Through, Iron Shot	47	0.047
001A WK 2	J-13	Bathtub	176	0.176
002A WK 2	J-13	Bathtub, Iron Shot	108	0.108
003A WK 2	J-13	Flow-Through	ND	ND
004A WK 2	J-13	Flow-Through, Iron Shot	ND	ND
001A WK 3	J-13	Bathtub	ND	ND
002A WK 3	J-13	Bathtub, Iron Shot	23	0.023
003A WK 3	J-13	Flow-Through	ND	ND
004A WK 3	J-13	Flow-Through, Iron Shot	27	0.027
001A WK 4	J-13	Bathtub	59	0.059
002A WK 4	J-13	Bathtub, Iron Shot	30	0.030
003A WK 4	J-13	Flow-Through	ND	ND
004A WK 4	J-13	Flow-Through, Iron Shot	52	0.052
005A WK 1	High Salt	Bathtub	4670	4.670
006A WK 1	High Salt	Bathtub, Iron Shot	5320	5.320
007A WK 1	High Salt	Flow-Through	14400	14.400
008A WK 1	High Salt	Flow-Through, Iron Shot	11060	11.060
005A WK 2	High Salt	Bathtub	809	8.09
006A WK 2	High Salt	Bathtub, Iron Shot	18983	18.983
007A WK 2	High Salt	Flow-Through	32411	32.411
008A WK 2	High Salt	Flow-Through, Iron Shot	16712	16.712
005A WK 3	High Salt	Bathtub	642	6.42
006A WK 3	High Salt	Bathtub, Iron Shot	34249	34.249
007A WK 3	High Salt	Flow-Through	22453	22.453
008A WK 3	High Salt	Flow-Through, Iron Shot	17562	17.562
005B WK 4	High Salt	Bathtub	11620	11.620
006A WK 4	High Salt	Bathtub, Iron Shot	16480	16.480
007A WK 4	High Salt	Flow-Through	11120	11.120
008A WK 4	High Salt	Flow-Through, Iron Shot	15000	15.000
009A WK 1	Low pH	Bathtub	74780	74.780
010A WK 1	Low pH	Bathtub, Iron Shot	23210	23.210
011A WK 1	Low pH	Flow-Through	75370	75.370
012B WK 1	Low pH	Flow-Through, Iron Shot	9020	9.020
009A WK 2	Low pH	Bathtub	620	0.62
010A WK 2	Low pH	Bathtub, Iron Shot	137885	137.885
011A WK 2	Low pH	Flow-Through	172927	172.927
012B WK 2	Low pH	Flow-Through, Iron Shot	34746	34.746
009A WK 3	Low pH	Bathtub	278010	278.01
010A WK 3	Low pH	Bathtub, Iron Shot	174030	174.03
011A WK 3	Low pH	Flow-Through	162600	162.6
012B WK 3	Low pH	Flow-Through, Iron Shot	20500	20.5
009B WK 4	Low pH	Bathtub	93400	93.400
010B WK 4	Low pH	Bathtub, Iron Shot	104900	104.900
011A WK 4	Low pH	Flow-Through	104000	104.000
012A WK 4	Low pH	Flow-Through, Iron Shot	90160	90.160
013A WK 1	Low pH, High Salt	Bathtub	2530	2.530

014A WK 1	Low pH, High Salt	Bathtub, Iron Shot	1110	1.110
015A WK 1	Low pH, High Salt	Flow-Through	1270	1.270
016A WK 1	Low pH, High Salt	Flow-Through, Iron Shot	990	0.990
013A WK 2	Low pH, High Salt	Bathtub	3964	3.964
014A WK 2	Low pH, High Salt	Bathtub, Iron Shot	1949	1.949
015A WK 2	Low pH, High Salt	Flow-Through	2869	2.869
016A WK 2	Low pH, High Salt	Flow-Through, Iron Shot	2039	2.039
013A WK 3	Low pH, High Salt	Bathtub	1220	1.22
014A WK 3	Low pH, High Salt	Bathtub, Iron Shot	1586	1.59
015A WK 3	Low pH, High Salt	Flow-Through	1253	1.25
016A WK 3	Low pH, High Salt	Flow-Through, Iron Shot	1838	1.84
013A WK 4	Low pH, High Salt	Bathtub	660	0.660
014A WK 4	Low pH, High Salt	Bathtub, Iron Shot	740	0.740
015A WK 4	Low pH, High Salt	Flow-Through	730	0.730
016A WK 4	Low pH, High Salt	Flow-Through, Iron Shot	770	0.770
			(ppb)	(ppm)
037A WK 1	High Salt	Bathtub	16000	16.0
037B WK 1	High Salt	Bathtub	16800	16.8
039A WK 1	High Salt	Flow-Through	8000	8.0
039B WK 1	High Salt	Flow-Through	5000	5.0
037A WK 2	High Salt	Bathtub	8700	8.7
037B WK 2	High Salt	Bathtub	9900	9.9
039A WK 2	High Salt	Flow-Through	8100	8.1
039B WK 2	High Salt	Flow-Through	7600	7.6
037A WK 3	High Salt	Bathtub	7800	7.8
037B WK 3	High Salt	Bathtub	10000	10.0
039A WK 3	High Salt	Flow-Through	4600	4.6
039B WK 3	High Salt	Flow-Through	5000	5.0
037A WK 4	High Salt	Bathtub	10400	10.4
037B WK 4	High Salt	Bathtub	5100	5.1
039A WK 4	High Salt	Flow-Through	1800	1.8
039B WK 4	High Salt	Flow-Through	6300	6.3
041A WK 1	Low pH	Bathtub	128900	128.9
041B WK 1	Low pH	Bathtub	105900	105.9
043A WK 1	Low pH	Flow-Through	12900	129.0
043B WK 1	Low pH	Flow-Through	151200	151.2
041A WK 2	Low pH	Bathtub	122200	122.2
041B WK 2	Low pH	Bathtub	120800	120.8
043A WK 2	Low pH	Flow-Through	140300	140.3
043B WK 2	Low pH	Flow-Through	158900	158.9
041A WK 3	Low pH	Bathtub	127400	127.4
041B WK 3	Low pH	Bathtub	131600	131.6
043A WK 3	Low pH	Flow-Through	163900	163.9
043B WK 3	Low pH	Flow-Through	165000	165.0
041A WK 4	Low pH	Bathtub	172700	172.7
041B WK 4	Low pH	Bathtub	163700	163.7
043A WK 4	Low pH	Flow-Through	136500	136.5
043B WK 4	Low pH	Flow-Through	185600	185.6
045A WK 1	Low pH, High Salt	Bathtub	874	0.874
045B WK 1	Low pH, High Salt	Bathtub	789	0.789
047A WK 1	Low pH, High Salt	Flow-Through	596	0.596
047B WK 1	Low pH, High Salt	Flow-Through	1242	1.242

045A WK 2	Low pH, High Salt	Bathtub	816	0.816
045B WK 2	Low pH, High Salt	Bathtub	688	0.688
047A WK 2	Low pH, High Salt	Flow-Through	968	0.968
047B WK 2	Low pH, High Salt	Flow-Through	562	0.562
045A WK 3	Low pH, High Salt	Bathtub	797	0.797
045B WK 3	Low pH, High Salt	Bathtub	1155	1.155
047A WK 3	Low pH, High Salt	Flow-Through	1101	1.101
047B WK 3	Low pH, High Salt	Flow-Through	1185	1.185
045A WK 4	Low pH, High Salt	Bathtub	648	0.648
045B WK 4	Low pH, High Salt	Bathtub	709	0.709
047A WK 4	Low pH, High Salt	Flow-Through	159	0.159
047B WK 4	Low pH, High Salt	Flow-Through	294	0.294

Key:
ND = Not Detected above background
ppm = parts per million
ppb = parts per billion

Waste Package	Week 1	Week 2	Week 3	Week 4	Average	+/-	SD	Units
BN-25-C-001	0.642	0.176	ND	0.059	0.292	+/-	0.308	ppm
BI-25-C-002	0.047	0.108	0.023	0.03	0.052	+/-	0.039	ppm
FN-25-C-003	0.258	ND	ND	ND	ND	+/-	ND	ppm
FI-25-C-004	0.047	ND	0.027	0.052	0.042	+/-	0.013	ppm
BN-25-HS-005	4.67	8.09	6.42	11.62	7.700	+/-	2.963	ppm
BI-25-HS-006	5.32	18.983	34.249	16.48	18.758	+/-	11.913	ppm
FN-25-HS-007	14.4	32.411	22.453	11.12	20.096	+/-	9.491	ppm
FI-25-HS-008	11.06	16.712	17.562	15	15.084	+/-	2.886	ppm
BN-25-LPH-009	74.78	0.62	278.01	93.4	111.703	+/-	117.892	ppm
BI-25-LPH-010	23.21	137.885	174.03	104.9	110.006	+/-	64.384	ppm
FN-25-LPH-011	75.37	172.927	162.6	104	128.724	+/-	46.760	ppm
FI-25-LPH-012	9.02	34.746	20.5	90.16	38.607	+/-	35.944	ppm
BN-25-LPH-HS-013	2.53	3.964	1.22	0.66	2.094	+/-	1.473	ppm
BI-25-LPH-HS-014	1.11	1.949	1.59	0.74	1.347	+/-	0.531	ppm
FN-25-LPH-HS-015	1.27	2.869	1.25	0.73	1.530	+/-	0.927	ppm
FI-25-LPH-HS-016	0.99	2.039	1.84	0.77	1.410	+/-	0.624	ppm
BN-25-HS-037A	16.0	8.7	7.8	10.4	10.7	+/-	3.7	ppm
BN-25-HS-037B	16.8	9.9	10.0	5.1	10.4	+/-	4.8	ppm
FN-25-HS-039A	8.0	8.1	4.6	1.8	5.6	+/-	3.0	ppm
FN-25-HS-039B	5.0	7.6	5.0	6.3	6.0	+/-	1.3	ppm
BN-25-LPH-041A	128.9	122.2	127.4	172.7	137.8	+/-	23.4	ppm
BN-25-LPH-041B	105.9	120.8	131.6	163.7	130.5	+/-	24.5	ppm
FN-25-LPH-043A	129.0	140.3	163.9	136.5	142.4	+/-	15.1	ppm
FN-25-LPH-043B	151.2	158.9	165.0	185.6	165.2	+/-	14.8	ppm
BN-25-LPH-HS-045A	0.874	0.816	0.797	0.648	0.784	+/-	0.096	ppm
BN-25-LPH-HS-045B	0.789	0.688	1.155	0.709	0.835	+/-	0.218	ppm
FN-25-LPH-HS-047A	0.596	0.968	1.101	0.159	0.706	+/-	0.423	ppm
FN-25-LPH-HS-047B	1.242	0.562	1.185	0.294	0.821	+/-	0.467	ppm
J-13 Control Influent					0.001041			ppm
Low pH soln. Influent					0.026258			ppm
High Salt soln. Influent		Lower than detection Limit at 82.536 ppt						
HS-High Nitrate soln. Influent		Lower than detection Limit at 82.536 ppt						

Key:
C = J-13 Control
HS = High Salt
LPH = Low pH
BN = Bathtub, No iron shot
FN = Flow-through, No iron shot
ppm = parts per million
ND = Not Detected above background

Legend:
St. Dev. = Standard Deviation
R. P. D. = Relative Percent Difference
n = number of measurements
Control = J-13 well water
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

MWP Sample ID KEY:
B = Bathtub
F = Flow-Through
N = Without Iron Shot
I = With Iron Shot
25 = 25 degrees Celcius
C = J-13 well water Control
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

Below is a brief description of each worksheet:
Overview and data tracking info: provides summary information, including names of the investigators, task number, and keywords

Legend & worksheet descriptions: contains a list of abbreviations and other information used throughout the spreadsheet.

Solids Data by Filter Size: contains information on the amount of solid material collected sequentially on 0.45, 0.22, and 0.1 micron filters for each experiment on a weekly basis.

Mass flow rate data and calc.: combines information on flow rate of solution through the MWP and the mass of material collected on the filters to give the "mass flow" of corrosion products.

The information is presented on an individual MWP experiment basis and on an average basis for different combined experiments (e.g., control, low pH, etc.).

Mass Transport Summary Table: contains the average of duplicate experiments (i.e., same MWP-type and solution) for the combined mass (in mg) collected for all three filter sizes.

Chart bathtub without shot: contains a chart showing the weight of solids collected (> 0.1 micron; all three filters combined) from effluent of bathtub MWP without shot material added by time (weeks).

Chart flow-through without shot: contains a chart showing the weight of solids collected (> 0.1 micron; all three filters combined) from effluent of flow-through MWP without shot material added by time (weeks).

Chart data: contains the data used to generate the charts.

Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub w/o shot	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-HS-037A	12/13/02-12/20/02	7	12/20/2002	0.1277	0.1282	0.0005	0.1323	0.1336	0.0013	0.1209	0.1230	0.0021	0.0039	0.0039
	12/20/02-12/27/02	7	12/27/2002	0.1296	0.1342	0.0046	0.1308	0.1330	0.0022	0.1210	0.1243	0.0033	0.0101	0.0140
	12/27/02-1/3/03	7	1/3/2003	0.1297	0.1343	0.0046	0.1316	0.1325	0.0009	0.1211	0.1215	0.0004	0.0059	0.0199
	1/3/2003-1/10/03	7	1/13/2003	0.1221	0.1260	0.0039	0.1335	0.1345	0.0010	0.1195	0.1202	0.0007	0.0056	0.0255
	Total					0.0136			0.0054			0.0065	0.0255	
BN-25-HS-037B	12/13/02-12/20/02	7	12/20/2002	0.1275	0.1291	0.0016	0.1326	0.1354	0.0028	0.1208	0.1217	0.0009	0.0053	0.0053
	12/20/02-12/27/02	7	12/27/2002	0.1297	0.1325	0.0028	0.1296	0.1329	0.0033	0.1215	0.1239	0.0024	0.0085	0.0138
	12/27/02-1/3/03	7	1/3/2003	0.1320	0.1334	0.0014	0.1305	0.1310	0.0005	0.1198	0.1209	0.0011	0.0030	0.0168
	1/3/2003-1/10/03	7	1/13/2003	0.1247	0.1265	0.0018	0.1311	0.1314	0.0003	0.1192	0.1201	0.0009	0.0030	0.0198
	Total					0.0076			0.0069			0.0053	0.0198	
Sample ID														
Flowthru w/o shot														
FN-25-HS-039A	12/13/02-12/20/02	7	12/20/2002	0.1322	0.1351	0.0029	0.1320	0.1331	0.0011	0.1215	0.1249	0.0034	0.0074	0.0074
	12/20/02-12/27/02	7	12/27/2002	0.1295	0.1327	0.0032	0.1307	0.1325	0.0018	0.1209	0.1223	0.0014	0.0064	0.0138
	12/27/02-1/3/03	7	1/3/2003	0.1314	0.1333	0.0019	0.1310	0.1313	0.0003	0.1194	0.1194	0.0000	0.0022	0.0160
	1/3/2003-1/10/03	7	1/13/2003	0.1251	0.1295	0.0044	0.1334	0.1340	0.0006	0.1188	0.1213	0.0025	0.0075	0.0235
	Total					0.0124			0.0038			0.0073	0.0235	
FN-25-HS-039B	12/13/02-12/20/02	7	12/20/2002	0.1340	0.1344	0.0004	0.1289	0.1310	0.0021	0.1205	0.1211	0.0006	0.0031	0.0031
	12/20/02-12/27/02	7	12/27/2002	0.1307	0.1337	0.0030	0.1300	0.1311	0.0011	0.1207	0.1213	0.0006	0.0047	0.0078
	12/27/02-1/3/03	7	1/3/2003	0.1315	0.1347	0.0032	0.1301	0.1306	0.0005	0.1202	0.1205	0.0003	0.0040	0.0118
	1/3/2003-1/10/03	7	1/13/2003	0.1234	0.1263	0.0029	0.1314	0.1317	0.0003	0.1187	0.1199	0.0012	0.0044	0.0162
	Total					0.0095			0.0040			0.0027	0.0162	
Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub w/o shot	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-LPH-041A	12/13/02-12/20/02	7	12/20/2002	0.1318	0.1363	0.0045	0.1320	0.1331	0.0011	0.1212	0.1222	0.0010	0.0066	0.0066
	12/20/02-12/27/02	7	12/27/2002	0.1334	0.1354	0.0020	0.1301	0.1302	0.0001	0.1204	0.1224	0.0020	0.0041	0.0107
	12/27/02-1/3/03	7	1/3/2003	0.1342	0.1345	0.0003	0.1322	0.1343	0.0021	0.1211	0.1211	0.0000	0.0024	0.0131
	1/3/2003-1/10/03	7	1/13/2003	0.1235	0.1258	0.0023	0.1323	0.1324	0.0001	0.1185	0.1186	0.0001	0.0025	0.0156
	Total					0.0091			0.0034			0.0031	0.0156	
BN-25-LPH-041B	12/13/02-12/20/02	7	12/20/2002	0.1298	0.1343	0.0045	0.1284	0.1330	0.0046	0.1210	0.1211	0.0001	0.0092	0.0092
	12/20/02-12/27/02	7	12/27/2002	0.1339	0.1414	0.0075	0.1303	0.1303	0.0000	0.1203	0.1307	0.0104	0.0179	0.0271
	12/27/02-1/3/03	7	1/3/2003	0.1326	0.1326	0.0000	0.1313	0.1321	0.0008	0.1212	0.1212	0.0000	0.0008	0.0279
	1/3/2003-1/10/03	7	1/13/2003	0.1249	0.1259	0.0010	0.1322	0.1322	0.0000	0.1193	0.1194	0.0001	0.0011	0.0290
	Total					0.0130			0.0054			0.0106	0.0290	
Flowthru w/o shot														
FN-25-LPH-043A	12/13/02-12/20/02	7	12/20/2002	0.1314	0.1362	0.0048	0.1326	0.1354	0.0028	0.1208	0.1212	0.0004	0.0080	0.0080
	12/20/02-12/27/02	7	12/27/2002	0.1324	0.1347	0.0023	0.1305	0.1306	0.0001	0.1200	0.1212	0.0012	0.0036	0.0116
	12/27/02-1/3/03	7	1/3/2003	0.1236	0.1242	0.0006	0.1326	0.1332	0.0006	0.1206	0.1207	0.0001	0.0013	0.0129
	1/3/2003-1/10/03	7	1/13/2003	0.1252	0.1268	0.0016	0.1317	0.1317	0.0000	0.1189	0.1189	0.0000	0.0016	0.0145
	Total					0.0093			0.0035			0.0017	0.0145	
FN-25-LPH-043B	12/13/02-12/20/02	7	12/20/2002	0.1288	0.1340	0.0052	0.1285	0.1300	0.0015	0.1210	0.1210	0.0000	0.0067	0.0067
	12/20/02-12/27/02	7	12/27/2002	0.1309	0.1326	0.0017	0.1290	0.1291	0.0001	0.1199	0.1205	0.0006	0.0024	0.0091
	12/27/02-1/3/03	7	1/3/2003	0.1257	0.1257	0.0000	0.1320	0.1331	0.0011	0.1204	0.1206	0.0002	0.0013	0.0104
	1/3/2003-1/10/03	7	1/13/2003	0.1251	0.1259	0.0008	0.1323	0.1324	0.0001	0.1214	0.1214	0.0000	0.0009	0.0113
	Total					0.0077			0.0028			0.0008	0.0113	
Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-HS-HN-045A	12/13/02-12/20/02	7	12/20/2002	0.1313	0.1359	0.0046	0.1324	0.1356	0.0032	0.1220	0.1234	0.0014	0.0092	0.0092
	12/20/02-12/27/02	7	12/27/2002	0.1314	0.1350	0.0036	0.1313	0.1335	0.0022	0.1195	0.1213	0.0018	0.0076	0.0168
	12/27/02-1/3/03	7	1/3/2003	0.1289	0.1333	0.0044	0.1319	0.1323	0.0004	0.1204	0.1212	0.0008	0.0056	0.0224
	1/3/2003-1/10/03	7	1/13/2003	0.1232	0.1271	0.0039	0.1319	0.1324	0.0005	0.1223	0.1223	0.0000	0.0044	0.0268
	Total					0.0165			0.0063			0.0040	0.0268	

BN-25-HS-HN-045B	12/13/02-12/20/02	7	12/20/2002	0.1311	0.1329	0.0018	0.1283	0.1305	0.0022	0.1208	0.1226	0.0018	0.0058	0.0058
	12/20/02-12/27/02	7	12/27/2002	0.1313	0.1349	0.0036	0.1298	0.1300	0.0002	0.1198	0.1210	0.0012	0.0050	0.0108
	12/27/02-1/3/03	7	1/3/2003	0.1245	0.1262	0.0017	0.1341	0.1341	0.0000	0.1199	0.1207	0.0008	0.0025	0.0133
	1/3/2003-1/10/03	7	1/13/2003	0.1241	0.1292	0.0051	0.1328	0.1335	0.0007	0.1218	0.1222	0.0004	0.0062	0.0195
	Total					0.0122			0.0031			0.0042	0.0195	
Flowthru														
FN-25-HS-HN-047A	12/13/02-12/20/02	7	12/20/2002	0.1309	0.1451	0.0142	0.1315	0.1350	0.0035	0.1220	0.1237	0.0017	0.0194	0.0194
	12/20/02-12/27/02	7	12/27/2002	0.1315	0.1363	0.0048	0.1316	0.1334	0.0018	0.1198	0.1220	0.0022	0.0088	0.0282
	12/27/02-1/3/03	7	1/3/2003	0.1223	0.1242	0.0019	0.1308	0.1328	0.0020	0.1195	0.1201	0.0006	0.0045	0.0327
	1/3/2003-1/10/03	7	1/13/2003	0.1255	0.1361	0.0106	0.1332	0.1339	0.0007	0.1204	0.1209	0.0005	0.0118	0.0445
	Total					0.0315			0.0080			0.0050	0.0445	
FN-25-HS-HN-047B	12/13/02-12/20/02	7	12/20/2002	0.1300	0.1393	0.0093	0.1297	0.1323	0.0026	0.1218	0.1227	0.0009	0.0128	0.0128
	12/20/02-12/27/02	7	12/27/2002	0.1304	0.1328	0.0024	0.1298	0.1303	0.0005	0.1197	0.1207	0.0010	0.0039	0.0167
	12/27/02-1/3/03	7	1/3/2003	0.1251	0.1274	0.0023	0.1339	0.1339	0.0000	0.1191	0.1196	0.0005	0.0028	0.0195
	1/3/2003-1/10/03	7	1/13/2003	0.1272	0.1360	0.0088	0.1322	0.1327	0.0005	0.1211	0.1213	0.0002	0.0095	0.0290
	Total					0.0228			0.0036			0.0026	0.0290	

MWP NUMBER	FLOW RATE Week 1 mL / Day	FLOW RATE Week 2 mL / Day	FLOW RATE Week 3 mL / Day	FLOW RATE Week 4 mL / Day	AVERAGE FLOW RATE mL / Day	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)	TOTAL SOLIDS (g)	Dates Of Run	# of Days of trial	Mass Flow Filtered Solids (g/mL)	Mass Flow Duplicate Ave. Filtered Solids (mg/L)	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By MWP Type Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.
														High Saline		Bathtub		High Saline	
BN-25-HS-037A	20.48	32.21	29.42	27.78	27.47	0.0136	0.0054	0.0065	0.0255	12/13/02 - 1/10/03	28	0.0000331	32.3866231	30.8	2.2	32.4	1.1	30.8	5.3
BN-25-HS-037B	24.35	18.82	23.71	22.56	22.36	0.0076	0.0069	0.0053	0.0198	12/13/02 - 1/10/03	28	0.0000316				Flow-through			
FN-25-HS-039A	27.41	18.40	24.67	24.74	23.80	0.0124	0.0038	0.0073	0.0235	12/13/02 - 1/10/03	28	0.0000353	29.2356983			29.2	8.5		
FN-25-HS-039B	30.33	13.92	28.83	26.62	24.93	0.0095	0.0040	0.0027	0.0162	12/13/02 - 1/10/03	28	0.0000232							
														Low pH				Low pH	
BN-25-LPH-041A	26.85	26.09	23.51	18.74	23.79	0.0091	0.0034	0.0031	0.0156	12/13/02 - 1/10/03	28	0.0000234	31.7624828	27.2	6.4	Bathtub		27.2	8.7
BN-25-LPH-041B	31.02	27.30	25.62	19.34	25.82	0.0130	0.0054	0.0106	0.0290	12/13/02 - 1/10/03	28	0.0000401				31.8	11.8		
FN-25-LPH-043A	28.42	24.52	19.07	15.03	21.76	0.0093	0.0035	0.0017	0.0145	12/13/02 - 1/10/03	28	0.0000238	22.6560204			Flow-through			
FN-25-LPH-043B	28.36	22.27	16.60	7.81	18.76	0.0077	0.0028	0.0008	0.0113	12/13/02 - 1/10/03	28	0.0000215				22.7	1.6		
														High Nitrate				High Nitrate	
BN-25-LPH-HS-045A	29.02	22.03	10.37	32.34	23.44	0.0165	0.0063	0.0040	0.0268	12/13/02 - 1/10/03	28	0.0000408	32.8038016	44.8	17.0	Bathtub		44.8	16.3
BN-25-LPH-HS-045B	28.67	25.66	4.35	53.78	28.12	0.0122	0.0031	0.0042	0.0195	12/13/02 - 1/10/03	28	0.0000248				32.8	11.4		
FN-25-LPH-HS-047A	37.96	36.71	2.86	22.62	25.04	0.0315	0.0080	0.0050	0.0445	12/13/02 - 1/10/03	28	0.0000635	56.8597313			Flow-through			
FN-25-LPH-HS-047B	26.93	23.94	22.23	9.36	20.62	0.0228	0.0036	0.0026	0.0290	12/13/02 - 1/10/03	28	0.0000502				56.9	9.4		

For Bathtub, No Iron Shot (BN):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
HS	1	4.60	0.0010	2	0.03
	2	9.30	0.0011	2	0.02
	3	4.45	0.0021	2	0.07
	4	4.30	0.0018	2	0.06
	Total	22.65			
LPH	1	7.90	0.0018	2	0.03
	2	11.00	0.0098	2	0.13
	3	1.60	0.0011	2	0.10
	4	1.80	0.0010	2	0.08
	Total	22.30			
HS-HN	1	7.50	0.0024	2	0.05
	2	6.30	0.0018	2	0.04
	3	4.05	0.0022	2	0.08
	4	5.30	0.0013	2	0.03
	Total	23.15			

Fór Flowthru, No Iron Shot (FN):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
HS	1	5.25	0.0030	2	0.08
	2	3.90	0.0012	2	0.04
	3	3.10	0.0013	2	0.06
	4	7.50	0.0022	2	0.04
	Total	19.85			
LPH	1	7.35	0.0009	2	0.02
	2	3.00	0.0008	2	0.04
	3	1.30	0.0000	2	0.00
	4	1.25	0.0005	2	0.06
	Total	12.90			
HS-HN	1	13.25	16.10	0.005	0.04
	2	3.15	6.35	0.003	0.08
	3	1.80	3.65	0.001	0.05
	4	2.95	10.65	0.002	0.02
	Total	21.15	36.75		

Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub w/o shot	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-HS-037A	12/13/02-12/20/02	7	12/20/2002	0.1277	0.1282	0.0005	0.1323	0.1336	0.0013	0.1209	0.1230	0.0021	0.0039	0.0039
	12/20/02-12/27/02	7	12/27/2002	0.1296	0.1342	0.0046	0.1308	0.1330	0.0022	0.1210	0.1243	0.0033	0.0101	0.0140
	12/27/02-1/3/03	7	1/3/2003	0.1297	0.1343	0.0046	0.1316	0.1325	0.0009	0.1211	0.1215	0.0004	0.0059	0.0199
	1/3/2003-1/10/03	7	1/13/2003	0.1221	0.1260	0.0039	0.1335	0.1345	0.0010	0.1195	0.1202	0.0007	0.0056	0.0255
	Total					0.0136			0.0054			0.0065	0.0255	
BN-25-HS-037B	12/13/02-12/20/02	7	12/20/2002	0.1275	0.1291	0.0016	0.1326	0.1354	0.0028	0.1208	0.1217	0.0009	0.0053	0.0053
	12/20/02-12/27/02	7	12/27/2002	0.1297	0.1325	0.0028	0.1296	0.1329	0.0033	0.1215	0.1239	0.0024	0.0085	0.0138
	12/27/02-1/3/03	7	1/3/2003	0.1320	0.1334	0.0014	0.1305	0.1310	0.0005	0.1198	0.1209	0.0011	0.0030	0.0168
	1/3/2003-1/10/03	7	1/13/2003	0.1247	0.1265	0.0018	0.1311	0.1314	0.0003	0.1192	0.1201	0.0009	0.0030	0.0198
	Total					0.0076			0.0069			0.0053	0.0198	
Sample ID														
Flowthru w/o shot														
FN-25-HS-039A	12/13/02-12/20/02	7	12/20/2002	0.1322	0.1351	0.0029	0.1320	0.1331	0.0011	0.1215	0.1249	0.0034	0.0074	0.0074
	12/20/02-12/27/02	7	12/27/2002	0.1295	0.1327	0.0032	0.1307	0.1325	0.0018	0.1209	0.1223	0.0014	0.0064	0.0138
	12/27/02-1/3/03	7	1/3/2003	0.1314	0.1333	0.0019	0.1310	0.1313	0.0003	0.1194	0.1194	0.0000	0.0022	0.0160
	1/3/2003-1/10/03	7	1/13/2003	0.1251	0.1295	0.0044	0.1334	0.1340	0.0006	0.1188	0.1213	0.0025	0.0075	0.0235
	Total					0.0124			0.0038			0.0073	0.0235	
FN-25-HS-039B	12/13/02-12/20/02	7	12/20/2002	0.1340	0.1344	0.0004	0.1289	0.1310	0.0021	0.1205	0.1211	0.0006	0.0031	0.0031
	12/20/02-12/27/02	7	12/27/2002	0.1307	0.1337	0.0030	0.1300	0.1311	0.0011	0.1207	0.1213	0.0006	0.0047	0.0078
	12/27/02-1/3/03	7	1/3/2003	0.1315	0.1347	0.0032	0.1301	0.1306	0.0005	0.1202	0.1205	0.0003	0.0040	0.0118
	1/3/2003-1/10/03	7	1/13/2003	0.1234	0.1263	0.0029	0.1314	0.1317	0.0003	0.1187	0.1199	0.0012	0.0044	0.0162
	Total					0.0095			0.0040			0.0027	0.0162	
Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub w/o shot	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-LPH-041A	12/13/02-12/20/02	7	12/20/2002	0.1318	0.1363	0.0045	0.1320	0.1331	0.0011	0.1212	0.1222	0.0010	0.0066	0.0066
	12/20/02-12/27/02	7	12/27/2002	0.1334	0.1354	0.0020	0.1301	0.1302	0.0001	0.1204	0.1224	0.0020	0.0041	0.0107
	12/27/02-1/3/03	7	1/3/2003	0.1342	0.1345	0.0003	0.1322	0.1343	0.0021	0.1211	0.1211	0.0000	0.0024	0.0131
	1/3/2003-1/10/03	7	1/13/2003	0.1235	0.1258	0.0023	0.1323	0.1324	0.0001	0.1185	0.1186	0.0001	0.0025	0.0156
	Total					0.0091			0.0034			0.0031	0.0156	
BN-25-LPH-041B	12/13/02-12/20/02	7	12/20/2002	0.1298	0.1343	0.0045	0.1284	0.1330	0.0046	0.1210	0.1211	0.0001	0.0092	0.0092
	12/20/02-12/27/02	7	12/27/2002	0.1339	0.1414	0.0075	0.1303	0.1303	0.0000	0.1203	0.1307	0.0104	0.0179	0.0271
	12/27/02-1/3/03	7	1/3/2003	0.1326	0.1326	0.0000	0.1313	0.1321	0.0008	0.1212	0.1212	0.0000	0.0008	0.0279
	1/3/2003-1/10/03	7	1/13/2003	0.1249	0.1259	0.0010	0.1322	0.1322	0.0000	0.1193	0.1194	0.0001	0.0011	0.0290
	Total					0.0130			0.0054			0.0106	0.0290	
Flowthru w/o shot														
FN-25-LPH-043A	12/13/02-12/20/02	7	12/20/2002	0.1314	0.1362	0.0048	0.1326	0.1354	0.0028	0.1208	0.1212	0.0004	0.0080	0.0080
	12/20/02-12/27/02	7	12/27/2002	0.1324	0.1347	0.0023	0.1305	0.1306	0.0001	0.1200	0.1212	0.0012	0.0036	0.0116
	12/27/02-1/3/03	7	1/3/2003	0.1236	0.1242	0.0006	0.1326	0.1332	0.0006	0.1206	0.1207	0.0001	0.0013	0.0129
	1/3/2003-1/10/03	7	1/13/2003	0.1252	0.1268	0.0016	0.1317	0.1317	0.0000	0.1189	0.1189	0.0000	0.0016	0.0145
	Total					0.0093			0.0035			0.0017	0.0145	
FN-25-LPH-043B	12/13/02-12/20/02	7	12/20/2002	0.1288	0.1340	0.0052	0.1285	0.1300	0.0015	0.1210	0.1210	0.0000	0.0067	0.0067
	12/20/02-12/27/02	7	12/27/2002	0.1309	0.1326	0.0017	0.1290	0.1291	0.0001	0.1199	0.1205	0.0006	0.0024	0.0091
	12/27/02-1/3/03	7	1/3/2003	0.1257	0.1257	0.0000	0.1320	0.1331	0.0011	0.1204	0.1206	0.0002	0.0013	0.0104
	1/3/2003-1/10/03	7	1/13/2003	0.1251	0.1259	0.0008	0.1323	0.1324	0.0001	0.1214	0.1214	0.0000	0.0009	0.0113
	Total					0.0077			0.0028			0.0008	0.0113	
Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-HS-HN-045A	12/13/02-12/20/02	7	12/20/2002	0.1313	0.1359	0.0046	0.1324	0.1356	0.0032	0.1220	0.1234	0.0014	0.0092	0.0092
	12/20/02-12/27/02	7	12/27/2002	0.1314	0.1350	0.0036	0.1313	0.1335	0.0022	0.1195	0.1213	0.0018	0.0076	0.0168
	12/27/02-1/3/03	7	1/3/2003	0.1289	0.1333	0.0044	0.1319	0.1323	0.0004	0.1204	0.1212	0.0008	0.0056	0.0224
	1/3/2003-1/10/03	7	1/13/2003	0.1232	0.1271	0.0039	0.1319	0.1324	0.0005	0.1223	0.1223	0.0000	0.0044	0.0268
	Total					0.0165			0.0063			0.0040	0.0268	

BN-25-HS-HN-045B	12/13/02-12/20/02	7	12/20/2002	0.1311	0.1329	0.0018	0.1283	0.1305	0.0022	0.1208	0.1226	0.0018	0.0058	0.0058
	12/20/02-12/27/02	7	12/27/2002	0.1313	0.1349	0.0036	0.1298	0.1300	0.0002	0.1198	0.1210	0.0012	0.0050	0.0108
	12/27/02-1/3/03	7	1/3/2003	0.1245	0.1262	0.0017	0.1341	0.1341	0.0000	0.1199	0.1207	0.0008	0.0025	0.0133
	1/3/2003-1/10/03	7	1/13/2003	0.1241	0.1292	0.0051	0.1328	0.1335	0.0007	0.1218	0.1222	0.0004	0.0062	0.0195
	Total					0.0122			0.0031			0.0042	0.0195	
Flowthru														
FN-25-HS-HN-047A	12/13/02-12/20/02	7	12/20/2002	0.1309	0.1451	0.0142	0.1315	0.1350	0.0035	0.1220	0.1237	0.0017	0.0194	0.0194
	12/20/02-12/27/02	7	12/27/2002	0.1315	0.1363	0.0048	0.1316	0.1334	0.0018	0.1198	0.1220	0.0022	0.0088	0.0282
	12/27/02-1/3/03	7	1/3/2003	0.1223	0.1242	0.0019	0.1308	0.1328	0.0020	0.1195	0.1201	0.0006	0.0045	0.0327
	1/3/2003-1/10/03	7	1/13/2003	0.1255	0.1361	0.0106	0.1332	0.1339	0.0007	0.1204	0.1209	0.0005	0.0118	0.0445
	Total					0.0315			0.0080			0.0050	0.0445	
FN-25-HS-HN-047B	12/13/02-12/20/02	7	12/20/2002	0.1300	0.1393	0.0093	0.1297	0.1323	0.0026	0.1218	0.1227	0.0009	0.0128	0.0128
	12/20/02-12/27/02	7	12/27/2002	0.1304	0.1328	0.0024	0.1298	0.1303	0.0005	0.1197	0.1207	0.0010	0.0039	0.0167
	12/27/02-1/3/03	7	1/3/2003	0.1251	0.1274	0.0023	0.1339	0.1339	0.0000	0.1191	0.1196	0.0005	0.0028	0.0195
	1/3/2003-1/10/03	7	1/13/2003	0.1272	0.1360	0.0088	0.1322	0.1327	0.0005	0.1211	0.1213	0.0002	0.0095	0.0290
	Total					0.0228			0.0036			0.0026	0.0290	

MWP NUMBER	FLOW RATE Week 1 mL / Day	FLOW RATE Week 2 mL / Day	FLOW RATE Week 3 mL / Day	FLOW RATE Week 4 mL / Day	AVERAGE FLOW RATE mL / Day	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)	TOTAL SOLIDS (g)	Dates Of Run	# of Days of trial	Mass Flow Filtered Solids (g/mL)	Mass Flow Duplicate Ave. Filtered Solids (mg/L)	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By MWP Type Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.
														High Saline		Bathtub		High Saline	
BN-25-HS-037A	20.48	32.21	29.42	27.78	27.47	0.0136	0.0054	0.0065	0.0255	12/13/02 - 1/10/03	28	0.0000331	32.3866231	30.8	2.2	32.4	1.1	30.8	5.3
BN-25-HS-037B	24.35	18.82	23.71	22.56	22.36	0.0076	0.0069	0.0053	0.0198	12/13/02 - 1/10/03	28	0.0000316				Flow-through			
FN-25-HS-039A	27.41	18.40	24.67	24.74	23.80	0.0124	0.0038	0.0073	0.0235	12/13/02 - 1/10/03	28	0.0000353	29.2356983			29.2	8.5		
FN-25-HS-039B	30.33	13.92	28.83	26.62	24.93	0.0095	0.0040	0.0027	0.0162	12/13/02 - 1/10/03	28	0.0000232							
														Low pH				Low pH	
BN-25-LPH-041A	26.85	26.09	23.51	18.74	23.79	0.0091	0.0034	0.0031	0.0156	12/13/02 - 1/10/03	28	0.0000234	31.7624828	27.2	6.4	Bathtub		27.2	8.7
BN-25-LPH-041B	31.02	27.30	25.62	19.34	25.82	0.0130	0.0054	0.0106	0.0290	12/13/02 - 1/10/03	28	0.0000401				31.8	11.8		
FN-25-LPH-043A	28.42	24.52	19.07	15.03	21.76	0.0093	0.0035	0.0017	0.0145	12/13/02 - 1/10/03	28	0.0000238	22.6560204			Flow-through			
FN-25-LPH-043B	28.36	22.27	16.60	7.81	18.76	0.0077	0.0028	0.0008	0.0113	12/13/02 - 1/10/03	28	0.0000215				22.7	1.6		
														High Nitrate				High Nitrate	
BN-25-LPH-HS-045A	29.02	22.03	10.37	32.34	23.44	0.0165	0.0063	0.0040	0.0268	12/13/02 - 1/10/03	28	0.0000408	32.8038016	44.8	17.0	Bathtub		44.8	16.3
BN-25-LPH-HS-045B	28.67	25.66	4.35	53.78	28.12	0.0122	0.0031	0.0042	0.0195	12/13/02 - 1/10/03	28	0.0000248				32.8	11.4		
FN-25-LPH-HS-047A	37.96	36.71	2.86	22.62	25.04	0.0315	0.0080	0.0050	0.0445	12/13/02 - 1/10/03	28	0.0000635	56.8597313			Flow-through			
FN-25-LPH-HS-047B	26.93	23.94	22.23	9.36	20.62	0.0228	0.0036	0.0026	0.0290	12/13/02 - 1/10/03	28	0.0000502				56.9	9.4		

MWP Model

Bathtub w/o Shot

	Bathtub w/o Shot High Saline				
Week	037A	037B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0039	0.0053	4.60	0.0010	0.03
2	0.0101	0.0085	9.30	0.0011	0.02
3	0.0059	0.0030	4.45	0.0021	0.07
4	0.0056	0.0030	4.30	0.0018	0.06
Total	0.0255	0.0198	22.65		

	Bathtub w/o Shot Low pH				
Week	041A	041B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0066	0.0092	7.90	0.0018	0.03
2	0.0041	0.0179	11.00	0.0098	0.13
3	0.0024	0.0008	1.60	0.0011	0.10
4	0.0025	0.0011	1.80	0.0010	0.08
Total	0.0156	0.0290	22.30		

	Bathtub w/o Shot LPH-HS				
Week	045A	045B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0092	0.0058	7.50	0.002	0.05
2	0.0076	0.0050	6.30	0.002	0.04
3	0.0056	0.0025	4.05	0.002	0.08
4	0.0044	0.0062	5.30	0.001	0.03
Total	0.0268	0.0195	23.15		

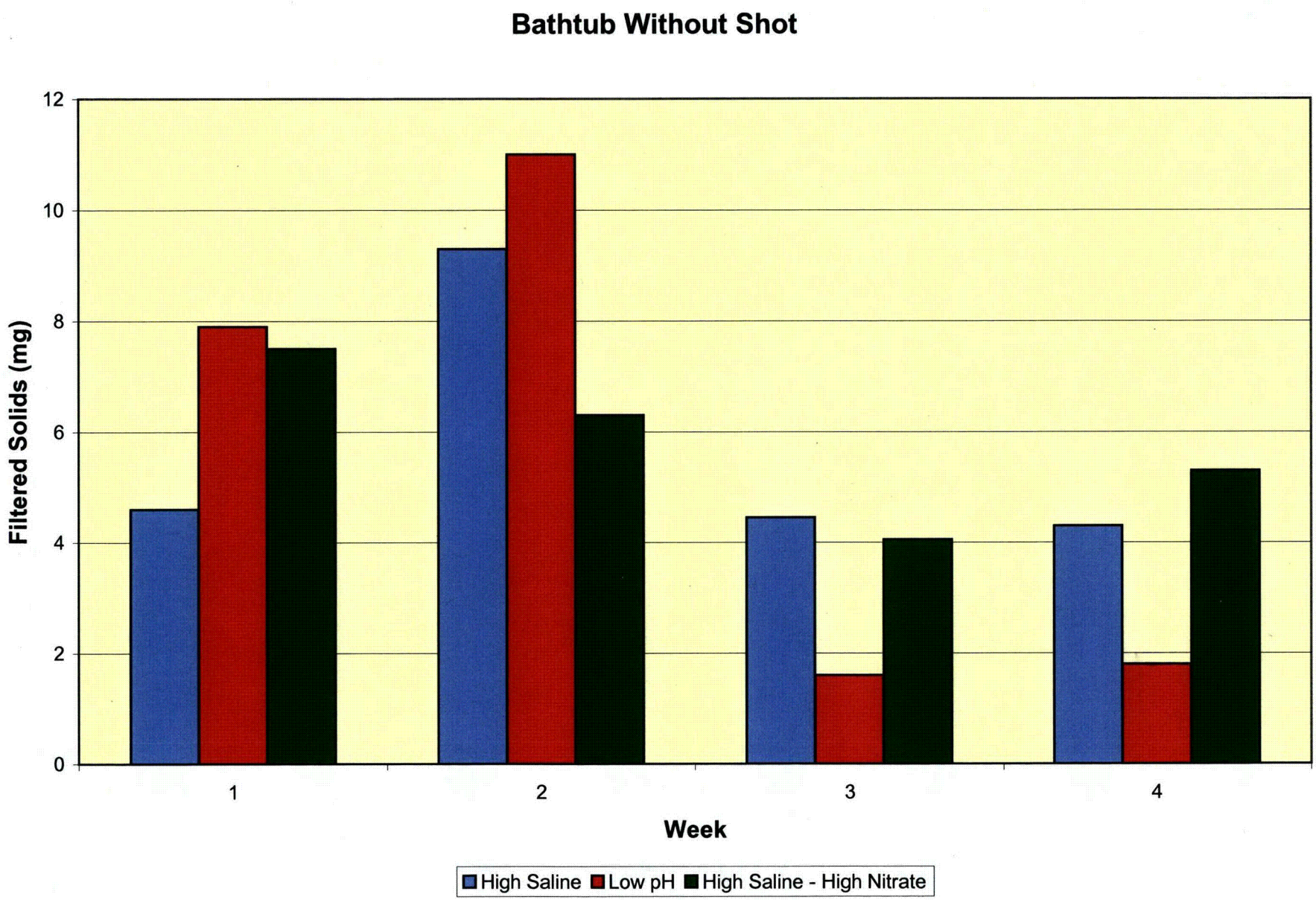
Flowthru w/o Shot

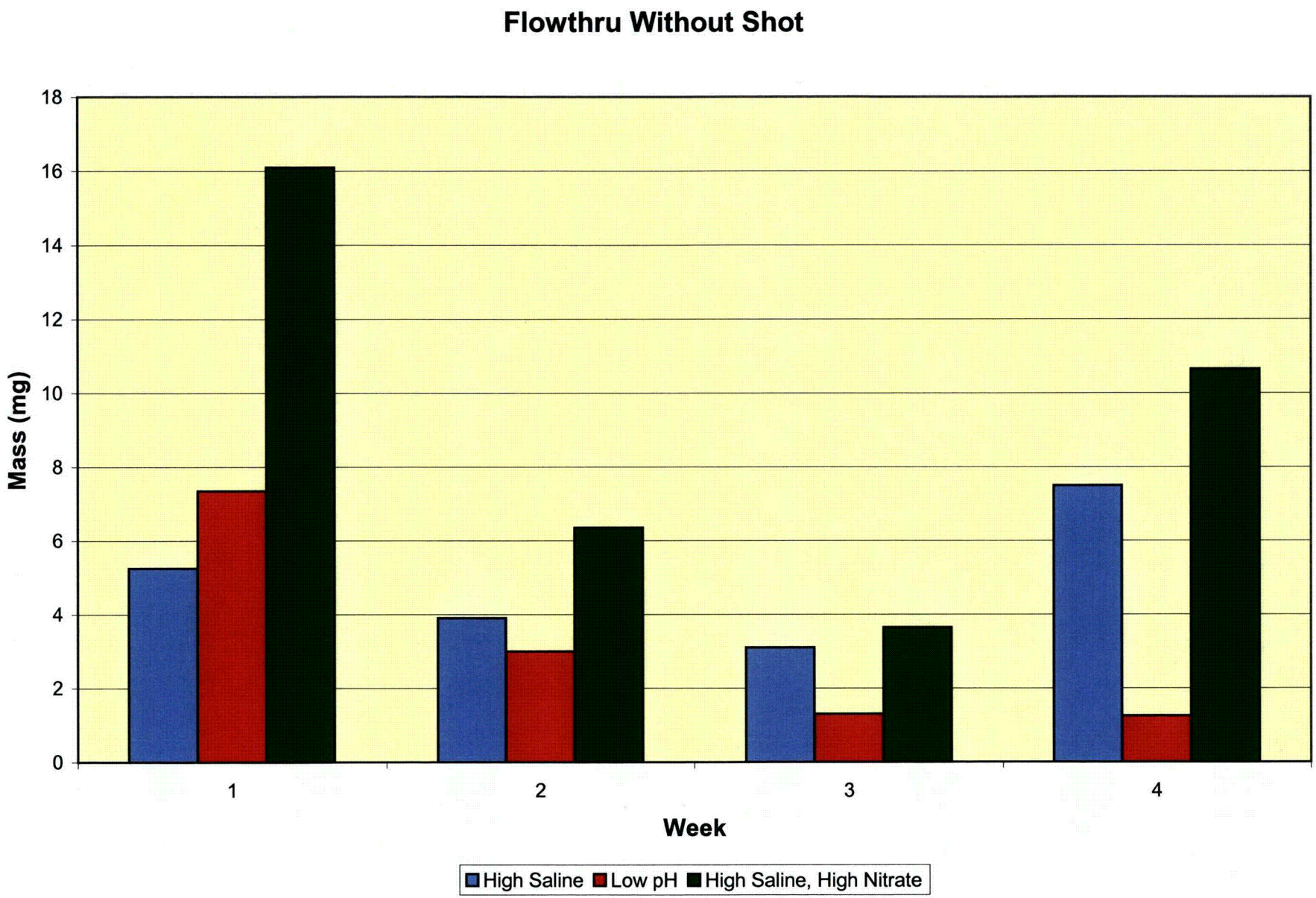
	Flowthru w/o Shot High Saline				
Week	039A	039B	Average(mg)	Std. Dev. (g)	
1	0.0074	0.0031	5.25	0.0030	0.08
2	0.0064	0.0047	3.90	0.0012	0.04
3	0.0022	0.0040	3.10	0.0013	0.06
4	0.0075	0.0044	7.50	0.0022	0.04
Total	0.0235	0.0162	19.85		

	Flowthru w/o Shot Low pH				
Week	043A	043B	Average(mg)	Std. Dev. (g)	
1	0.0080	0.0067	7.35	0.0009	0.02
2	0.0036	0.0024	3.00	0.0008	0.04
3	0.0013	0.0013	1.30	0.0000	0.00
4	0.0016	0.0009	1.25	0.0005	0.06
Total	0.0145	0.0113	12.90		

	Flowthru w/o Shot LPH-HS				
Week	047A	047B	Average(mg)	Std. Dev. (g)	
1	0.0194	0.0128	16.10	0.005	0.04
2	0.0088	0.0039	6.35	0.003	0.08
3	0.0045	0.0028	3.65	0.001	0.05
4	0.0118	0.0095	10.65	0.002	0.02
Total	0.0445	0.0290	36.75		

	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)
Control	0.0091	0.0017	0.0006
	0.0126	0.002	0.0008
	0.005	0.0017	0.0005
	0.0062	0.0014	0.0008
	0.0229	0.0014	0.0007
	0.0075	0.0019	0.0042
	0.0069	0.0179	0.0072
	0.0078	0.0024	0.0029
	0.0051	0.0021	0.0056
	0.0039	0.0017	0.0019
	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0312	0.026	0.0218
LPH	0.0193	0.01	0.0115
Sum:	0.0193	0.01	0.0115
HS-HN	0.0094	0.0037	0.0039
	0.0113	0.0014	0.0024
	0.0104	0.0013	0.0022
	0.0098	0.0008	0.0015
	0.0193	0.002	0.0016
	0.0158	0.001	0.0026
	0.0162	0.0014	0.002
	0.0065	0.0016	0.0018
	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0987	0.0132	0.018


Bathtub Without Shot
Filtered Solids (mg)
12
10
8
6
4
2
0
1
2
3
4
Week
High Saline
Low pH
High Saline - High Nitrate


Flowthru Without Shot
Mass (mg)
0
2
4
6
8
10
12
14
16
18
1
2
3
4
Week
High Saline
Low pH
High Saline, High Nitrate

MWP Model

Bathtub w/o Shot

High Saline

	Week	037A	037B	Average(mg)	Std. Dev. (g)	R.P.D.
Bathtub w/o Shot	1	0.0039	0.0053	4.60	0.0010	0.03
	2	0.0101	0.0085	9.30	0.0011	0.02
	3	0.0059	0.0030	4.45	0.0021	0.07
	4	0.0056	0.0030	4.30	0.0018	0.06
	Total	0.0255	0.0198	22.65		

Flowthru w/o Shot

High Saline

	Week	039A	039B	Average(mg)	Std. Dev. (g)	
Flowthru w/o Shot	1	0.0074	0.0031	5.25	0.0030	0.08
	2	0.0064	0.0047	3.90	0.0012	0.04
	3	0.0022	0.0040	3.10	0.0013	0.06
	4	0.0075	0.0044	7.50	0.0022	0.04
	Total	0.0235	0.0162	19.85		

Bathtub w/o Shot

Low pH

041A	041B	Average(mg)	Std. Dev. (g)	R.P.D.
0.0066	0.0092	7.90	0.0018	0.03
0.0041	0.0179	11.00	0.0098	0.13
0.0024	0.0008	1.60	0.0011	0.10
0.0025	0.0011	1.80	0.0010	0.08
0.0156	0.0290	22.30		

Flowthru w/o Shot

Low pH

043A	043B	Average(mg)	Std. Dev. (g)	
0.0080	0.0067	7.35	0.0009	0.02
0.0036	0.0024	3.00	0.0008	0.04
0.0013	0.0013	1.30	0.0000	0.00
0.0016	0.0009	1.25	0.0005	0.06
0.0145	0.0113	12.90		

Bathtub w/o Shot

LPH-HS

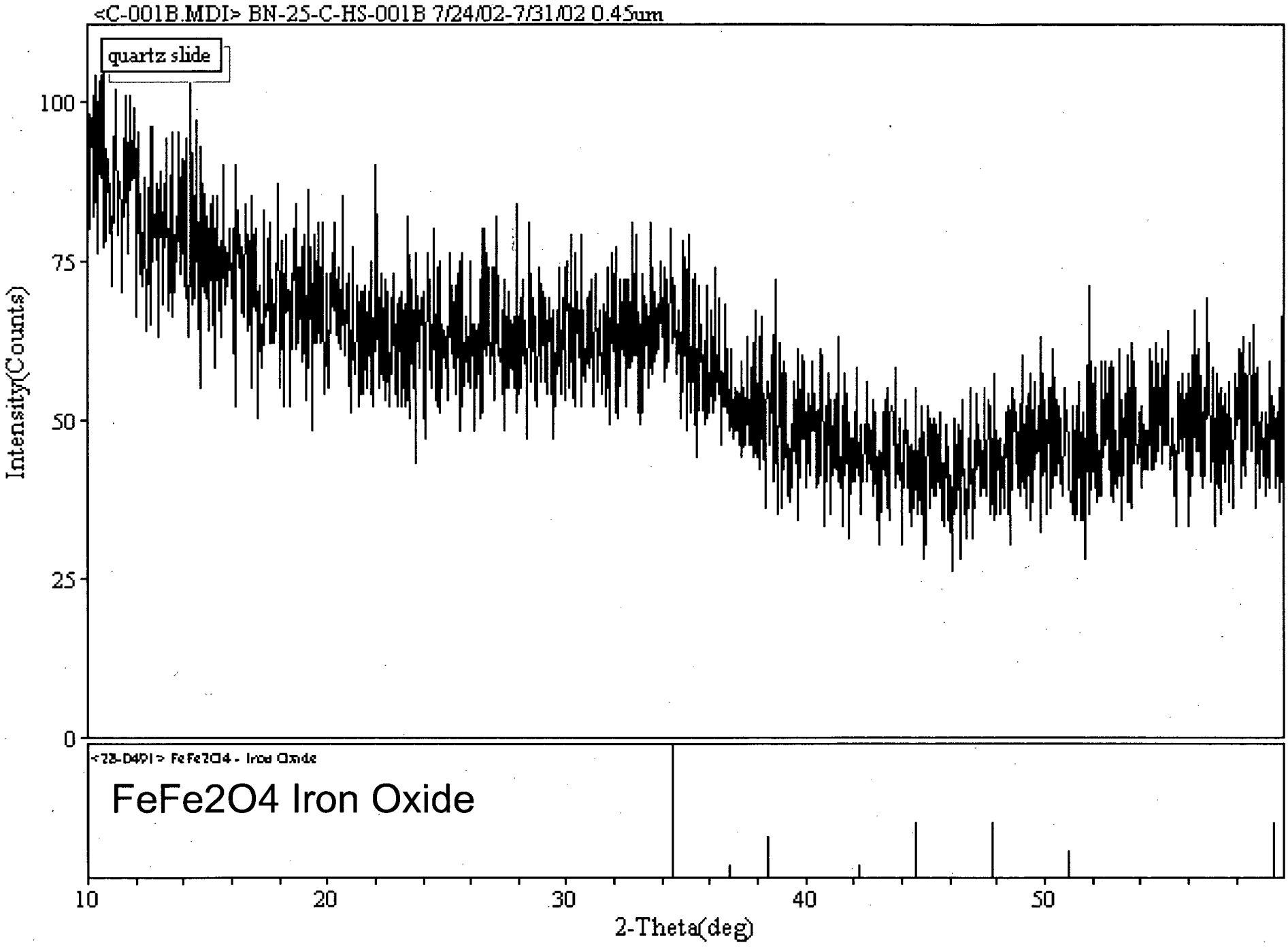
045A	045B	Average(mg)	Std. Dev. (g)	R.P.D.
0.0092	0.0058	7.50	0.002	0.05
0.0076	0.0050	6.30	0.002	0.04
0.0056	0.0025	4.05	0.002	0.08
0.0044	0.0062	5.30	0.001	0.03
0.0268	0.0195	23.15		

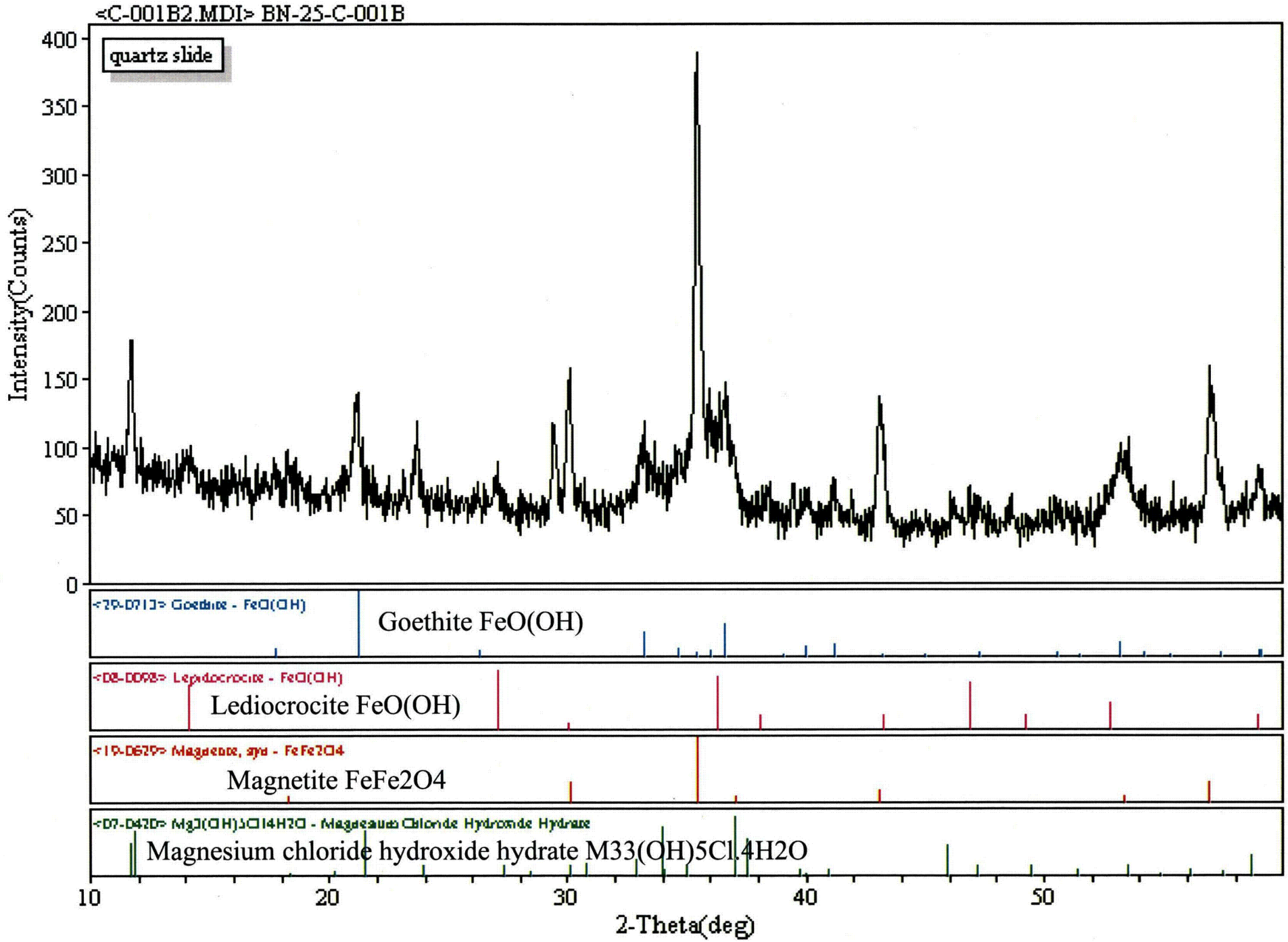
Flowthru w/o Shot

LPH-HS

047A	047B	Average(mg)	Std. Dev. (g)	
0.0194	0.0128	16.10	0.005	0.04
0.0088	0.0039	6.35	0.003	0.08
0.0045	0.0028	3.65	0.001	0.05
0.0118	0.0095	10.65	0.002	0.02
0.0445	0.0290	36.75		

	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)
Control	0.0091	0.0017	0.0006
	0.0126	0.002	0.0008
	0.005	0.0017	0.0005
	0.0082	0.0014	0.0008
	0.0229	0.0014	0.0007
	0.0075	0.0019	0.0042
	0.0069	0.0179	0.0072
	0.0078	**0.0024**	**0.0029**
	0.0051	**0.0021**	**0.0056**
	0.0039	**0.0017**	**0.0019**
	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0312	0.026	0.0218
LPH	0.0193	0.01	0.0115
Sum:	0.0193	0.01	0.0115
HS-HN	0.0094	0.0037	0.0039
	0.0113	0.0014	0.0024
	0.0104	0.0013	0.0022
	0.0098	0.0008	0.0015
	0.0193	0.002	0.0016
	0.0158	0.001	0.0026
	0.0162	0.0014	0.002
	0.0065	0.0018	0.0018
	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0987	0.0132	0.018


<C-001B.MDI> BN-25-C-HS-001B 7/24/02-7/31/02 0.45um
quartz slide
Intensity(Counts)
100
75
50
25
0
<28-0491> FeFe2O4 - Iron Oxide
FeFe2O4 Iron Oxide
10
20
30
40
50
2-Theta(deg)



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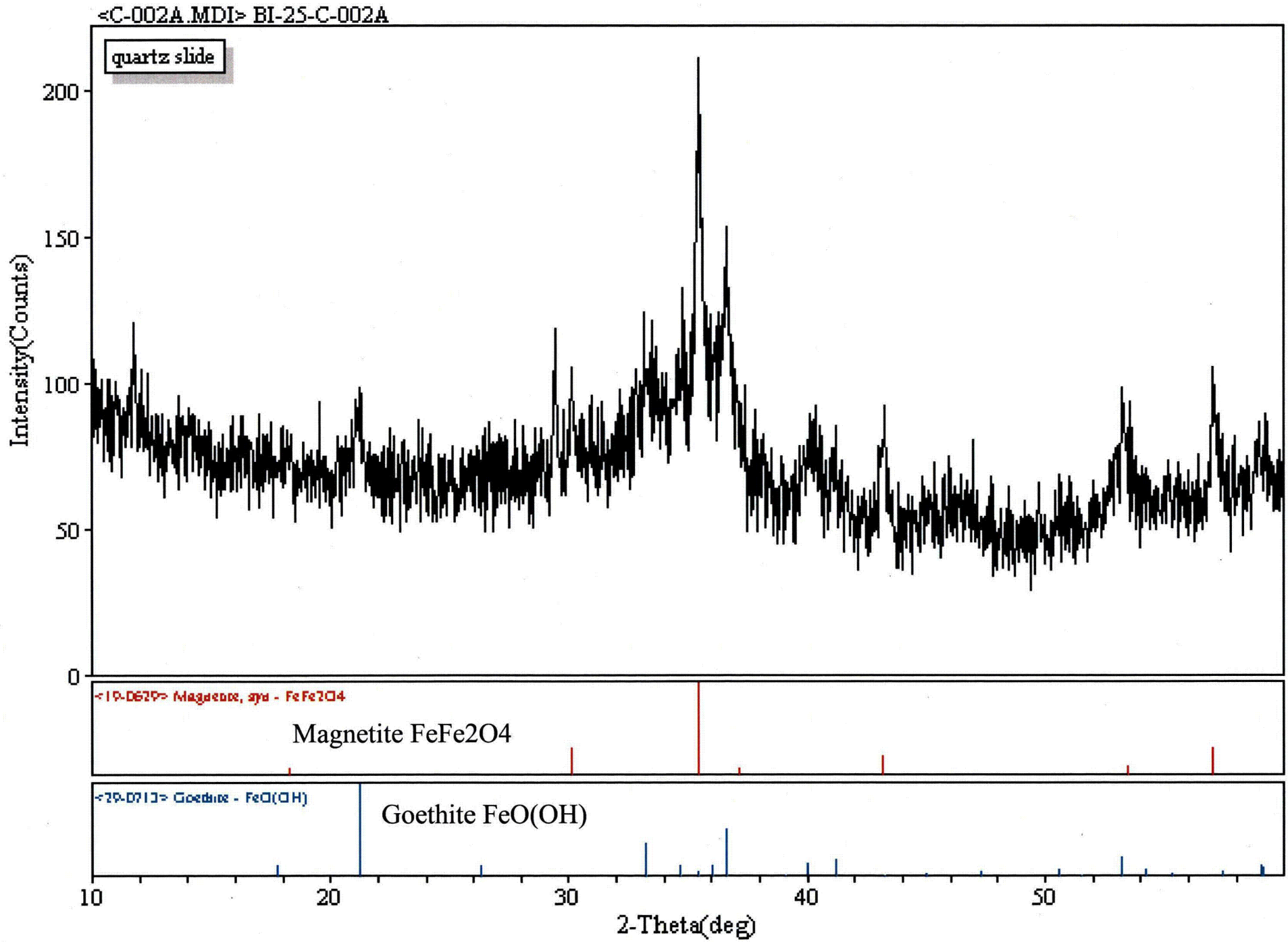
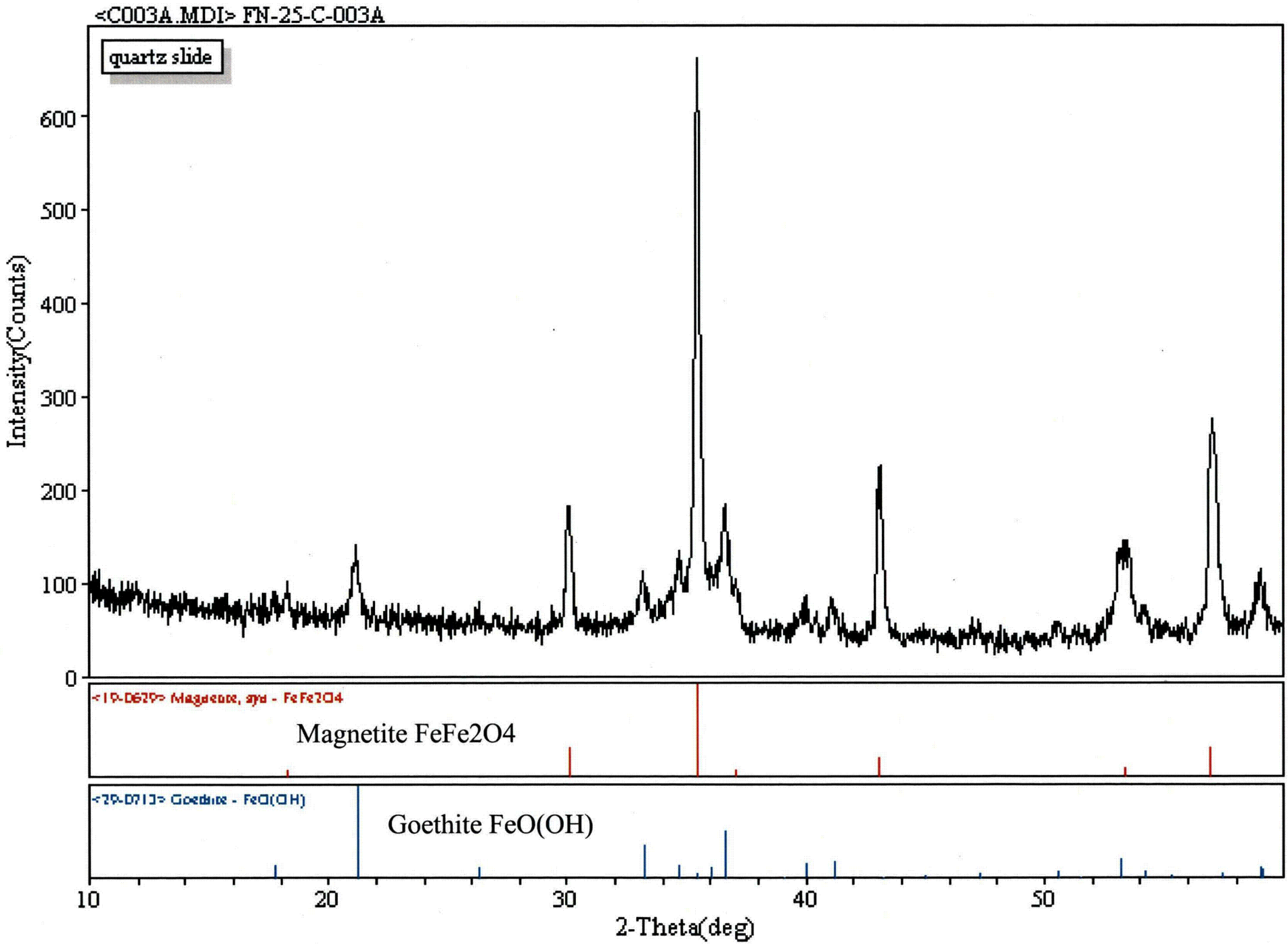
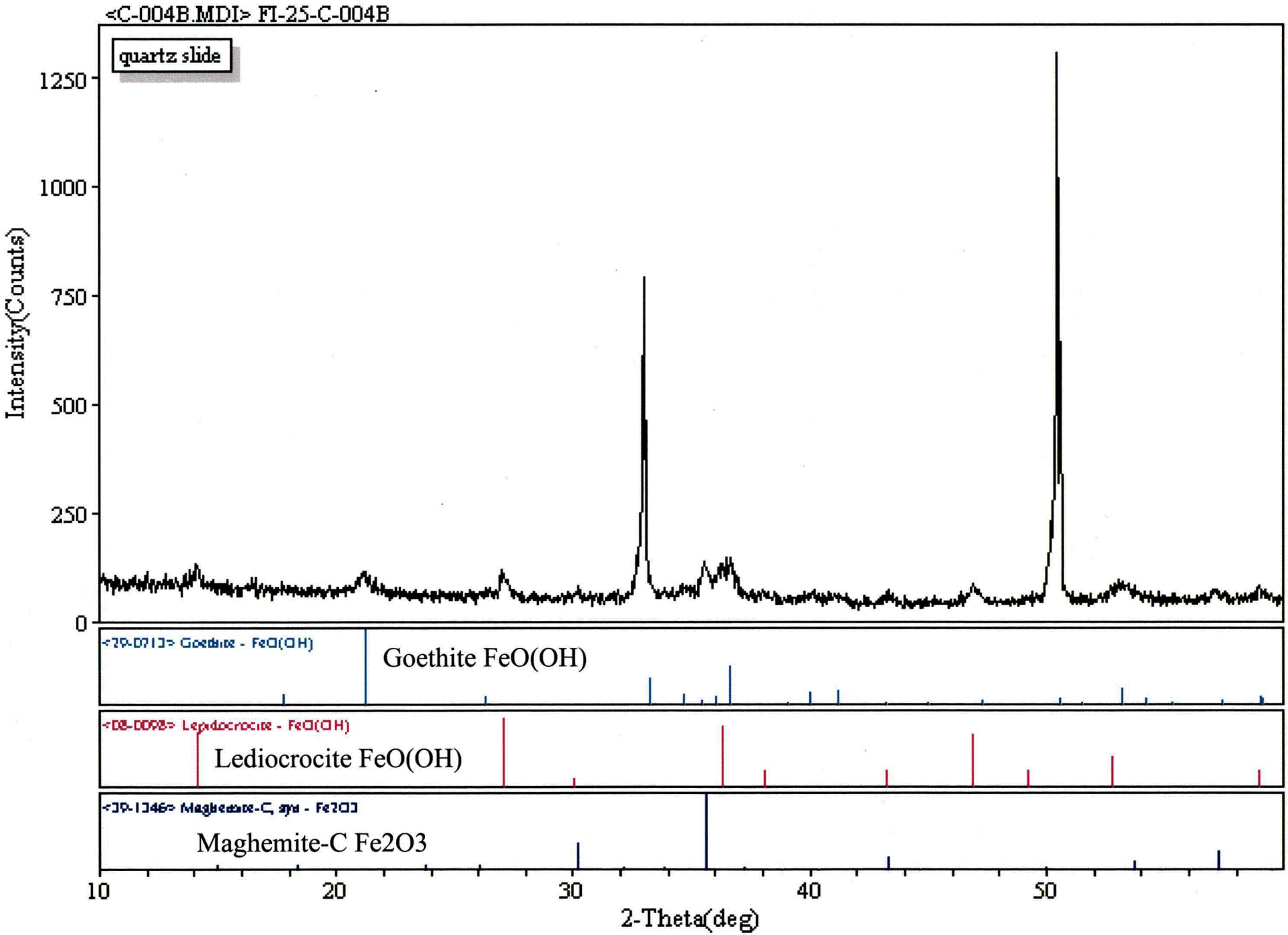

<C-002A.MDI> BI-25-C-002A
quartz slide
Intensity(Counts)
200
150
100
50
0
Magnetite FeFe2O4
Goethite FeO(OH)
10
20
30
40
50
2-Theta(deg)


<C003A.MDI> FN-25-C-003A
quartz slide
Intensity(Counts)
600
500
400
300
200
100
0
Magnetite FeFe2O4
Goethite FeO(OH)
10
20
30
40
50
2-Theta(deg)



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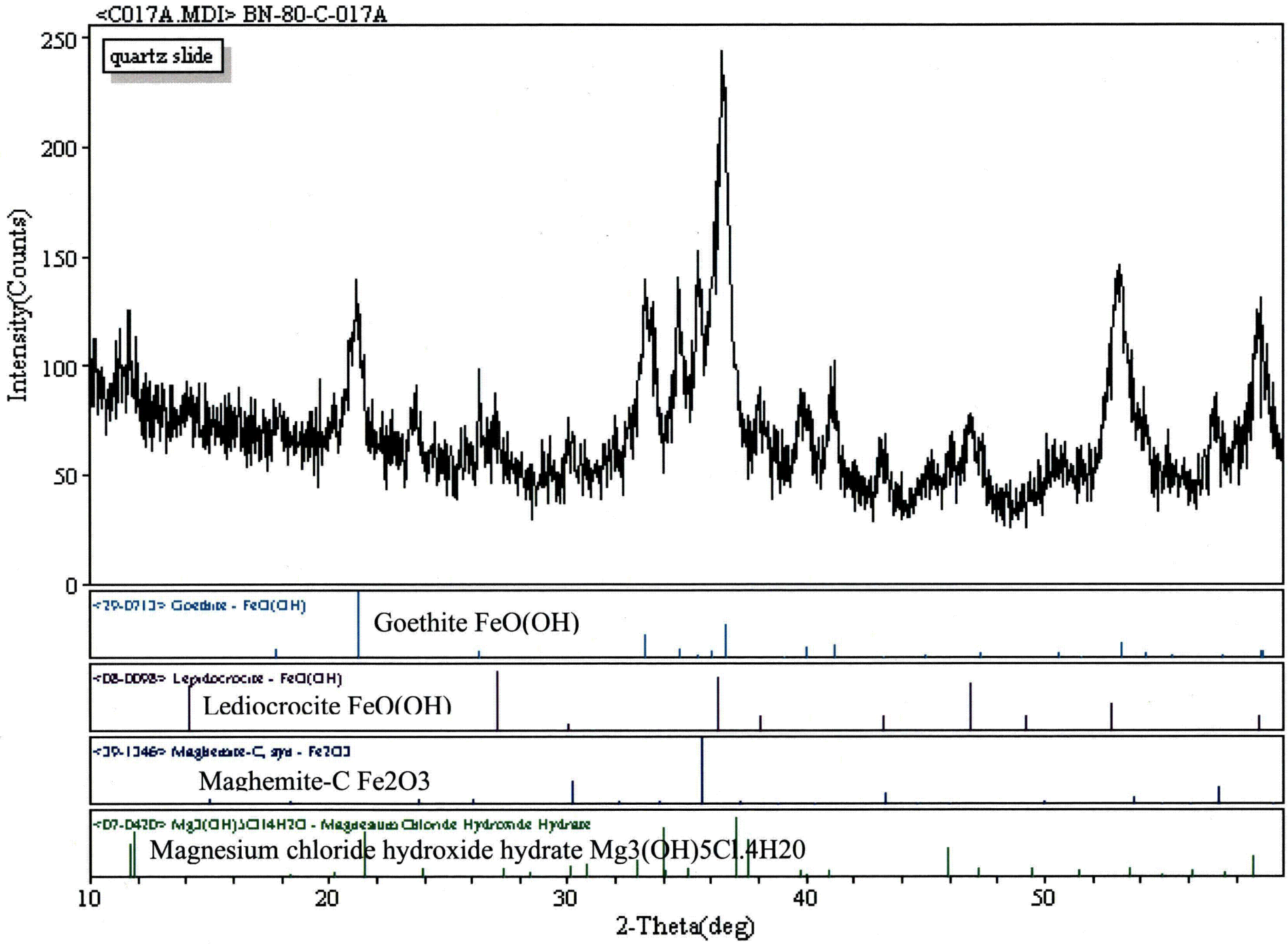
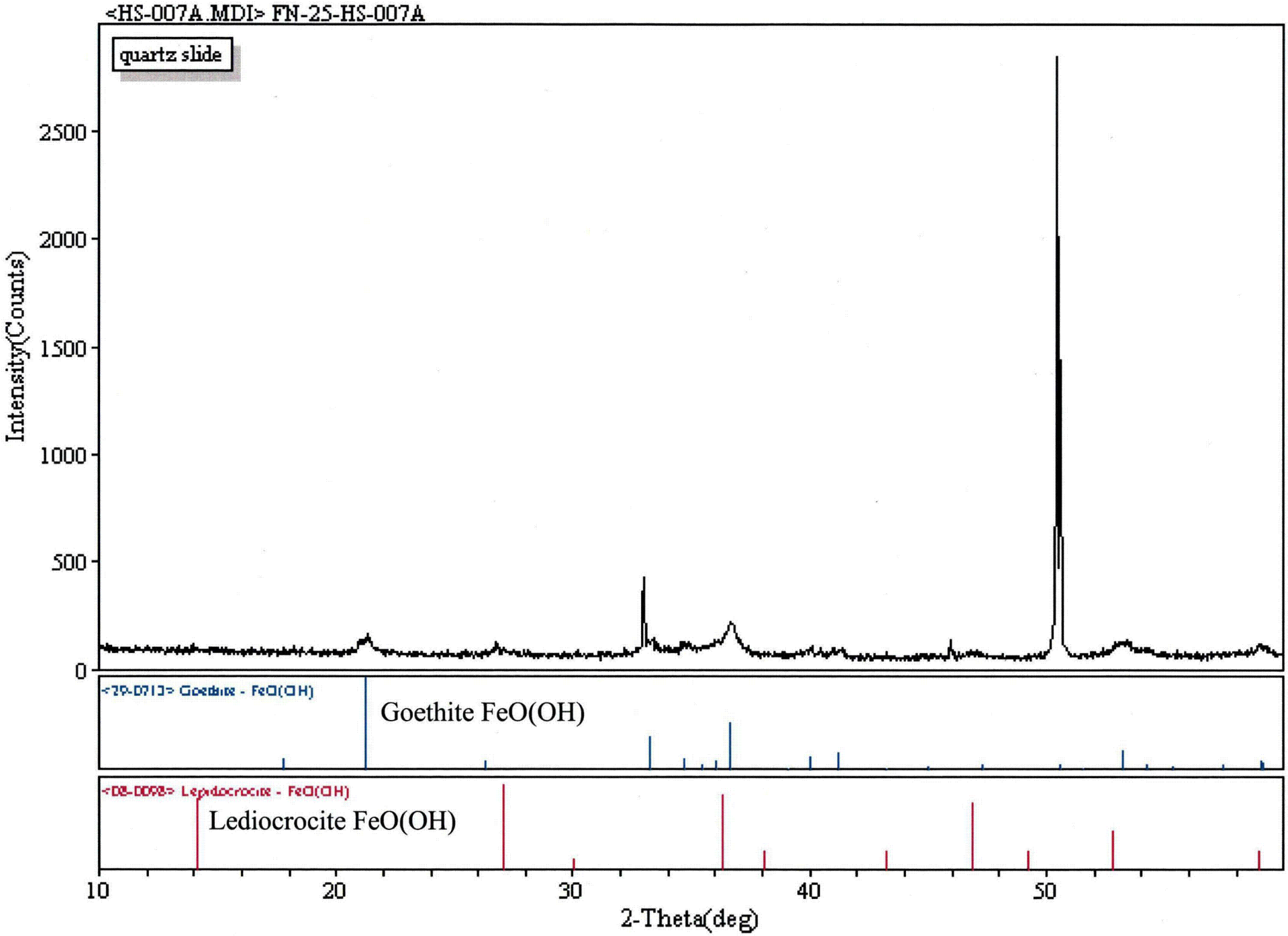
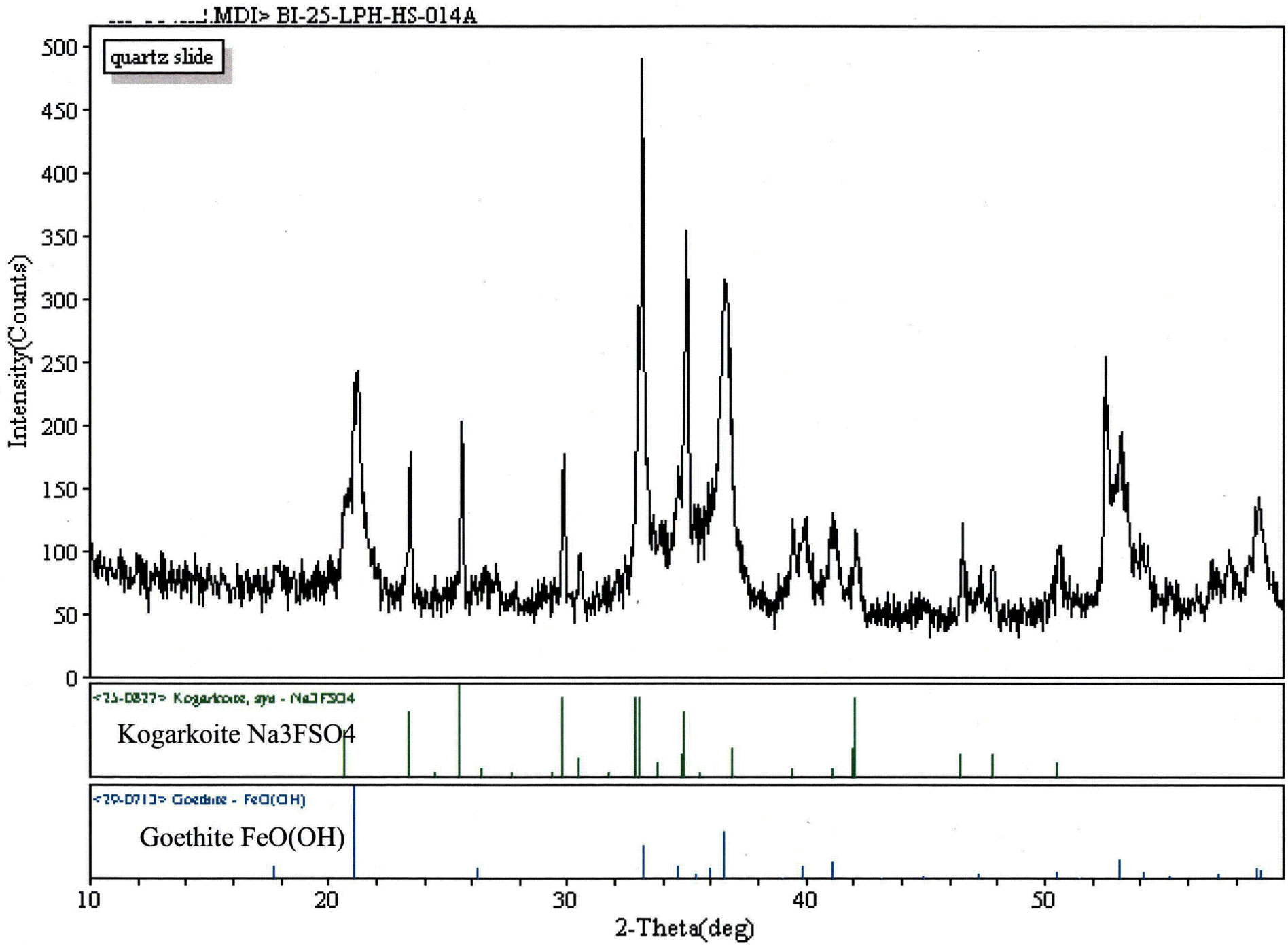

<C017A.MDI> BN-80-C-017A
quartz slide
Intensity(Counts)
250
200
150
100
50
0
Goethite FeO(OH)
Lediocrocite FeO(OH)
Maghemite-C Fe2O3
Magnesium chloride hydroxide hydrate Mg3(OH)5Cl.4H20
10
20
30
40
50
2-Theta(deg)


<HS-007A.MDI> FN-25-HS-007A
quartz slide
Intensity(Counts)
2500
2000
1500
1000
500
0
Goethite FeO(OH)
Lediocrocite FeO(OH)
10
20
30
40
50
2-Theta(deg)



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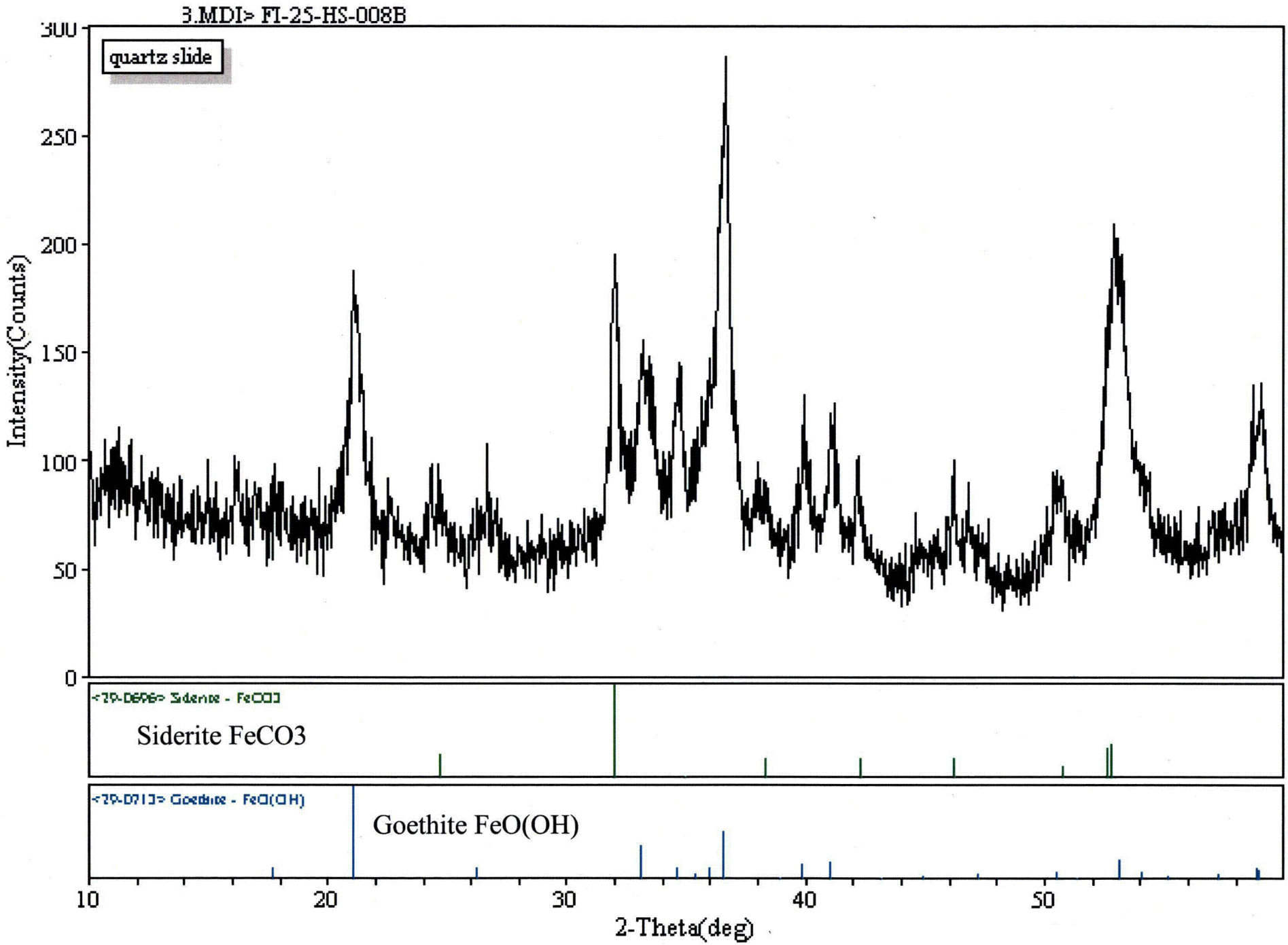
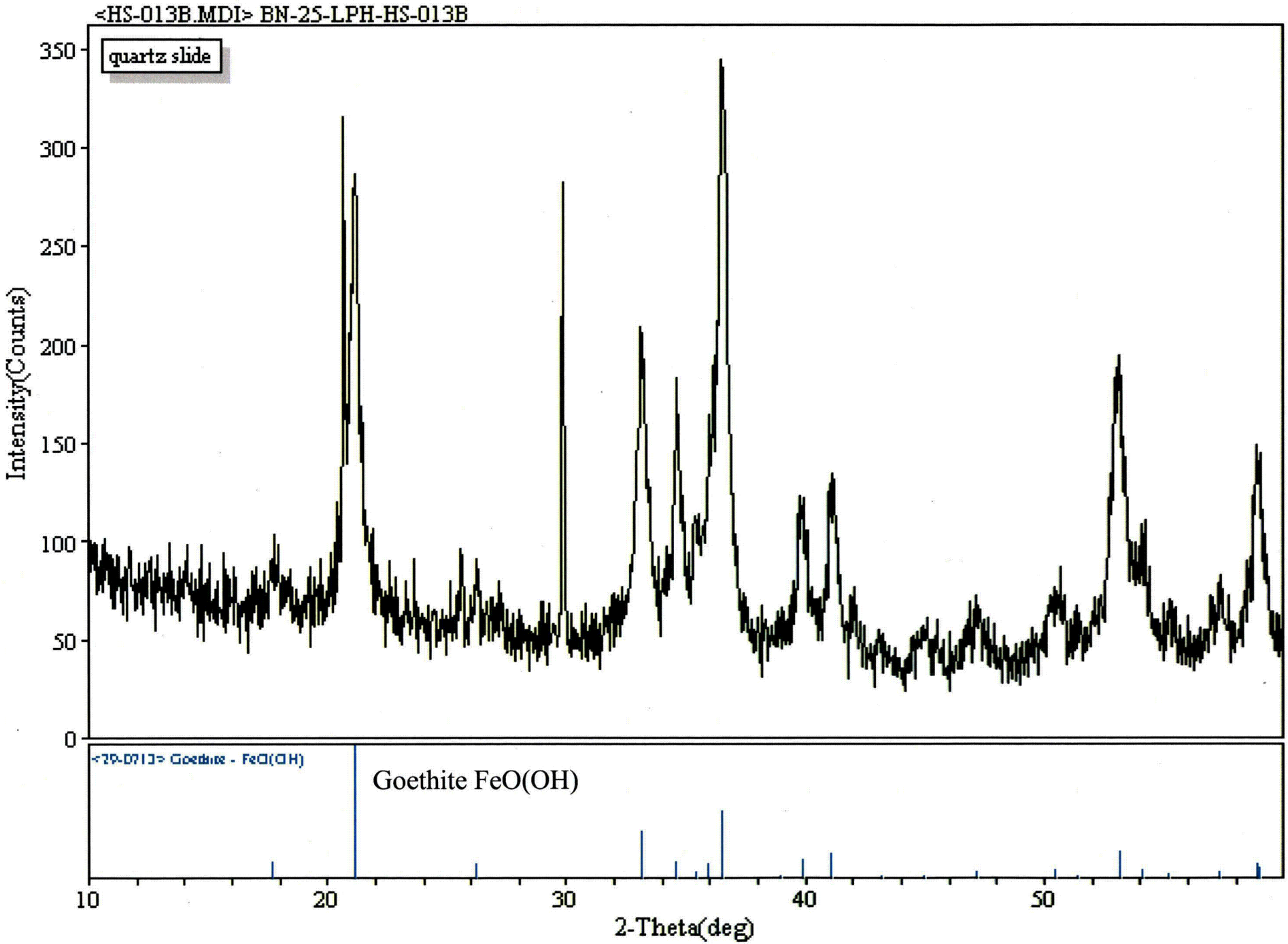
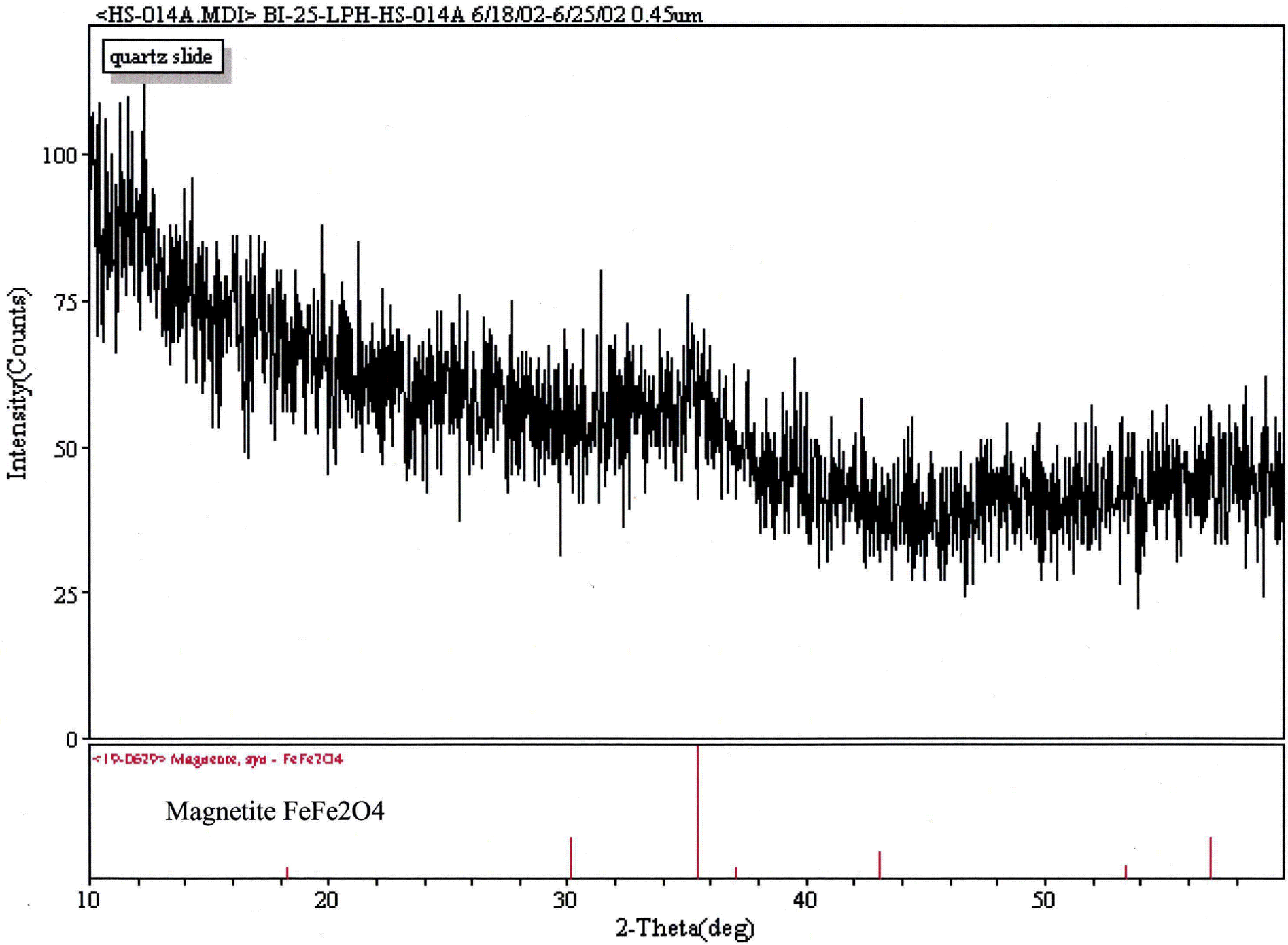
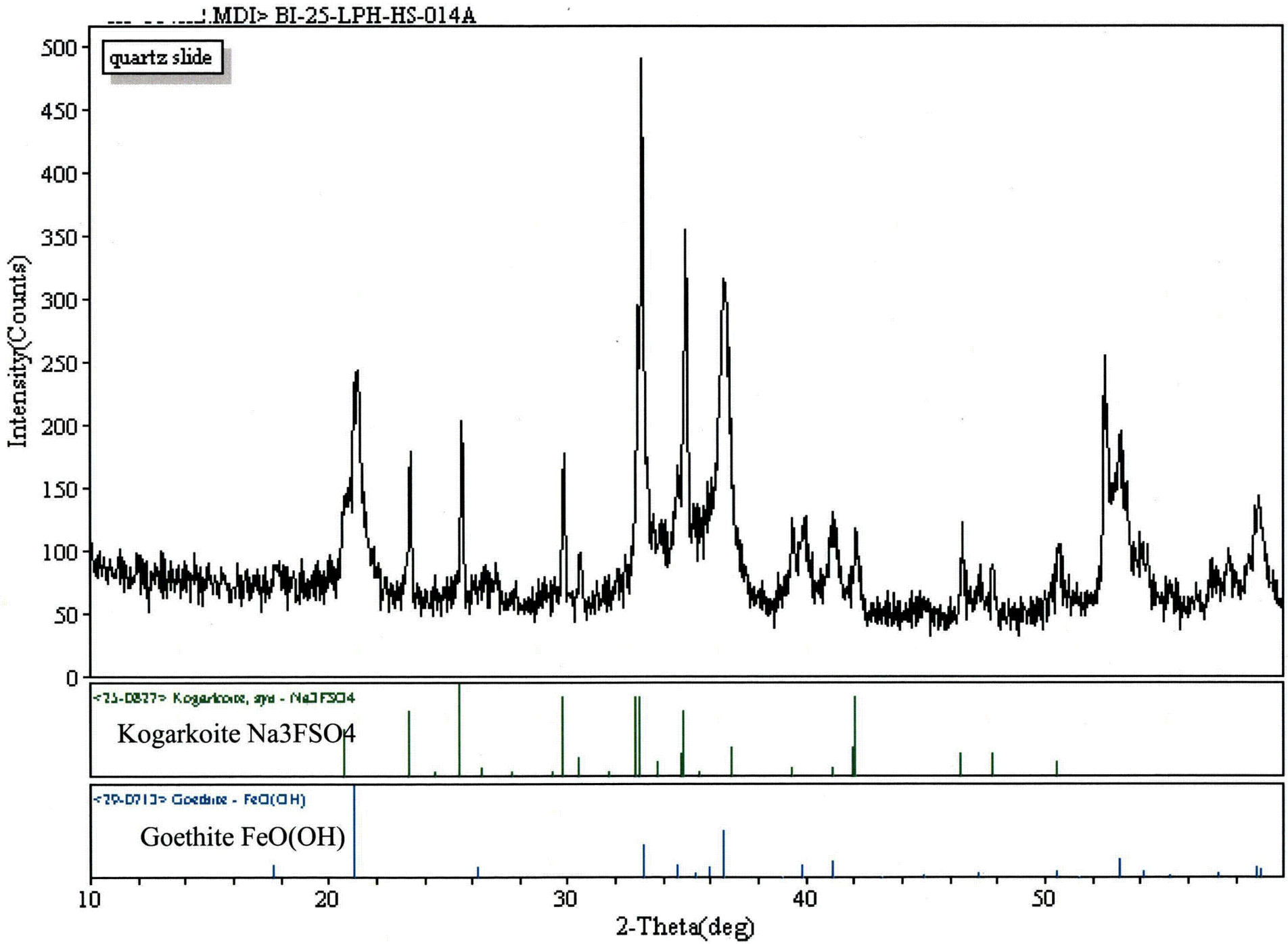
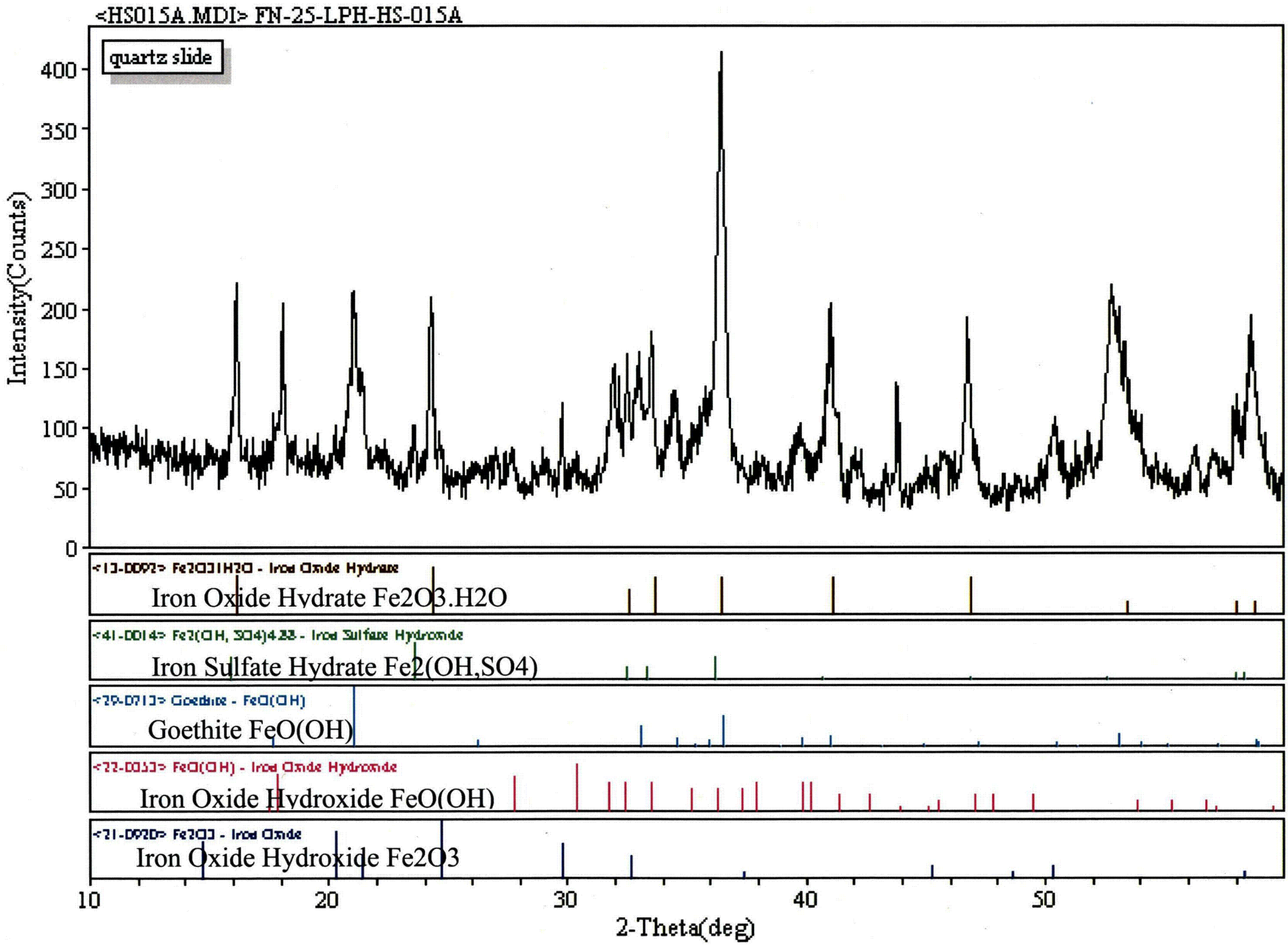
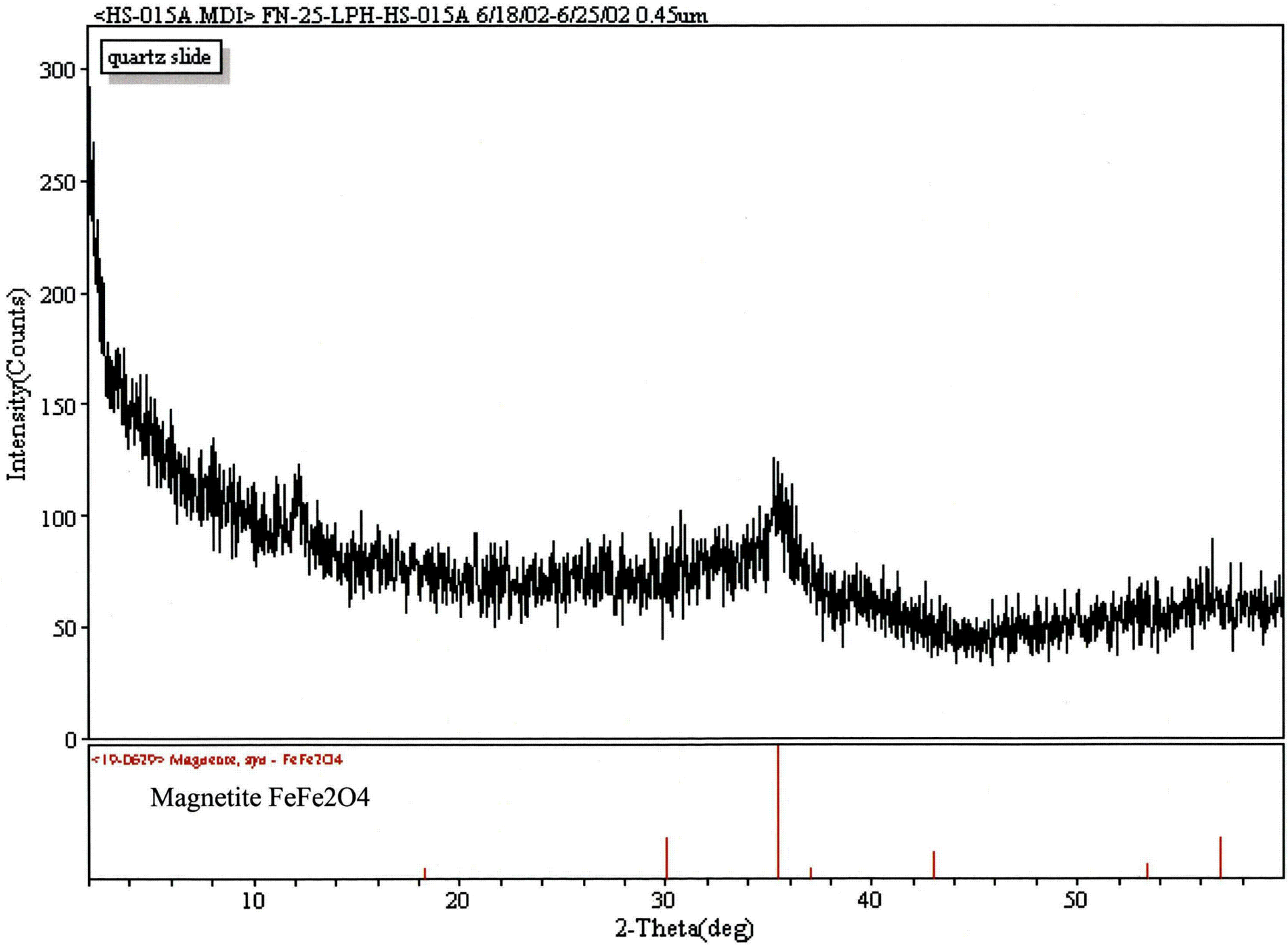

3.MDI> FI-25-HS-008B
quartz slide
Intensity(Counts)
300
250
200
150
100
50
0
Siderite FeCO3
Goethite FeO(OH)
10
20
30
40
50
2-Theta(deg)

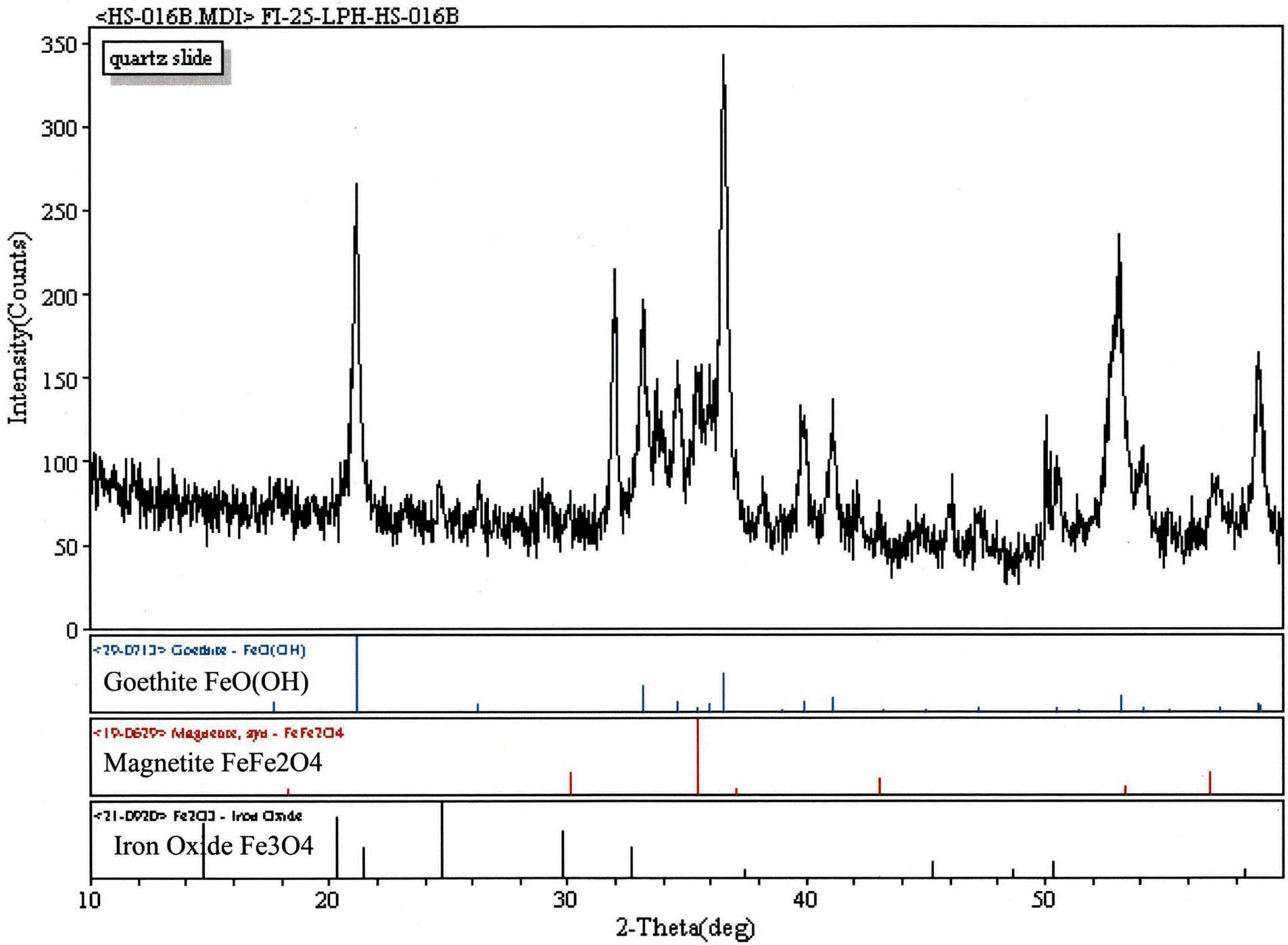

<HS-013B.MDI> BN-25-LPH-HS-013B
quartz slide
Intensity(Counts)
350
300
250
200
150
100
50
0
Goethite FeO(OH)
10
20
30
40
50
2-Theta(deg)

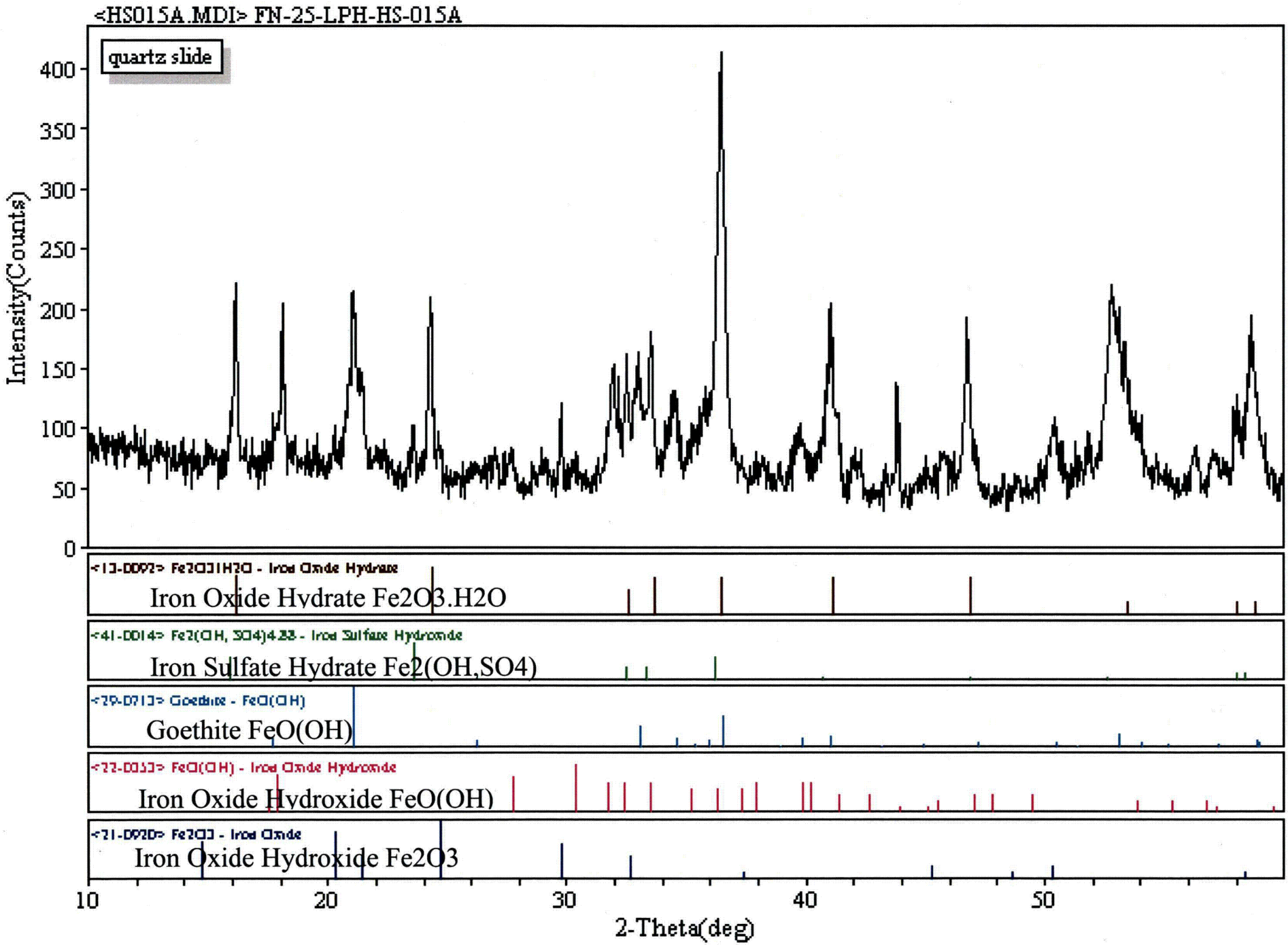

<HS-014A.MDI> BI-25-LPH-HS-014A 6/18/02-6/25/02 0.45um
quartz slide
Intensity(Counts)
100
75
50
25
0
<19-0629> Magnetite, syn - FeFe2O4
Magnetite FeFe2O4
10
20
30
40
50
2-Theta(deg)

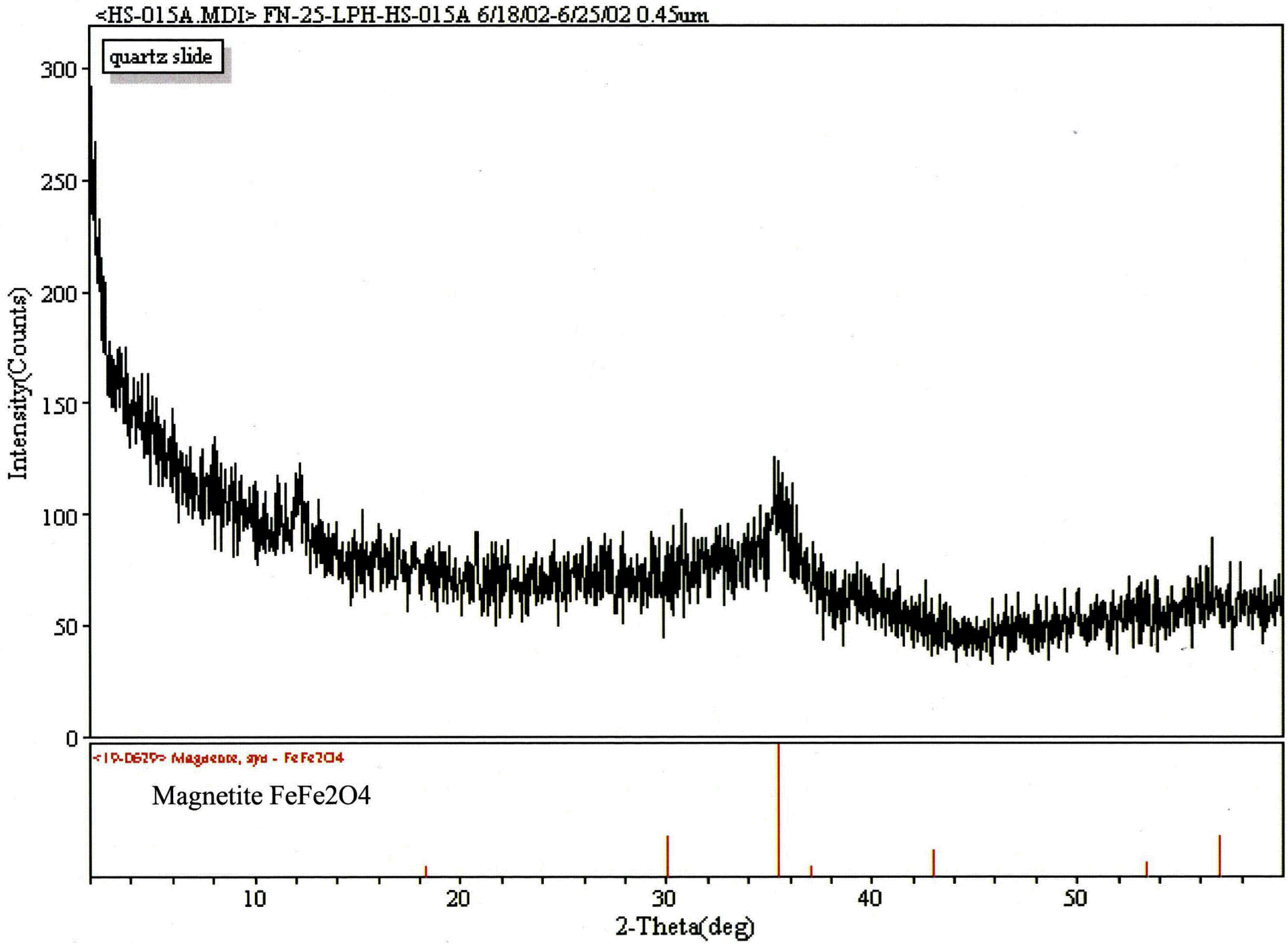

.MDI> BI-25-LPH-HS-014A
quartz slide
Intensity(Counts)
500
450
400
350
300
250
200
150
100
50
0
Kogarkoite Na3FSO4
Goethite FeO(OH)
10
20
30
40
50
2-Theta(deg)

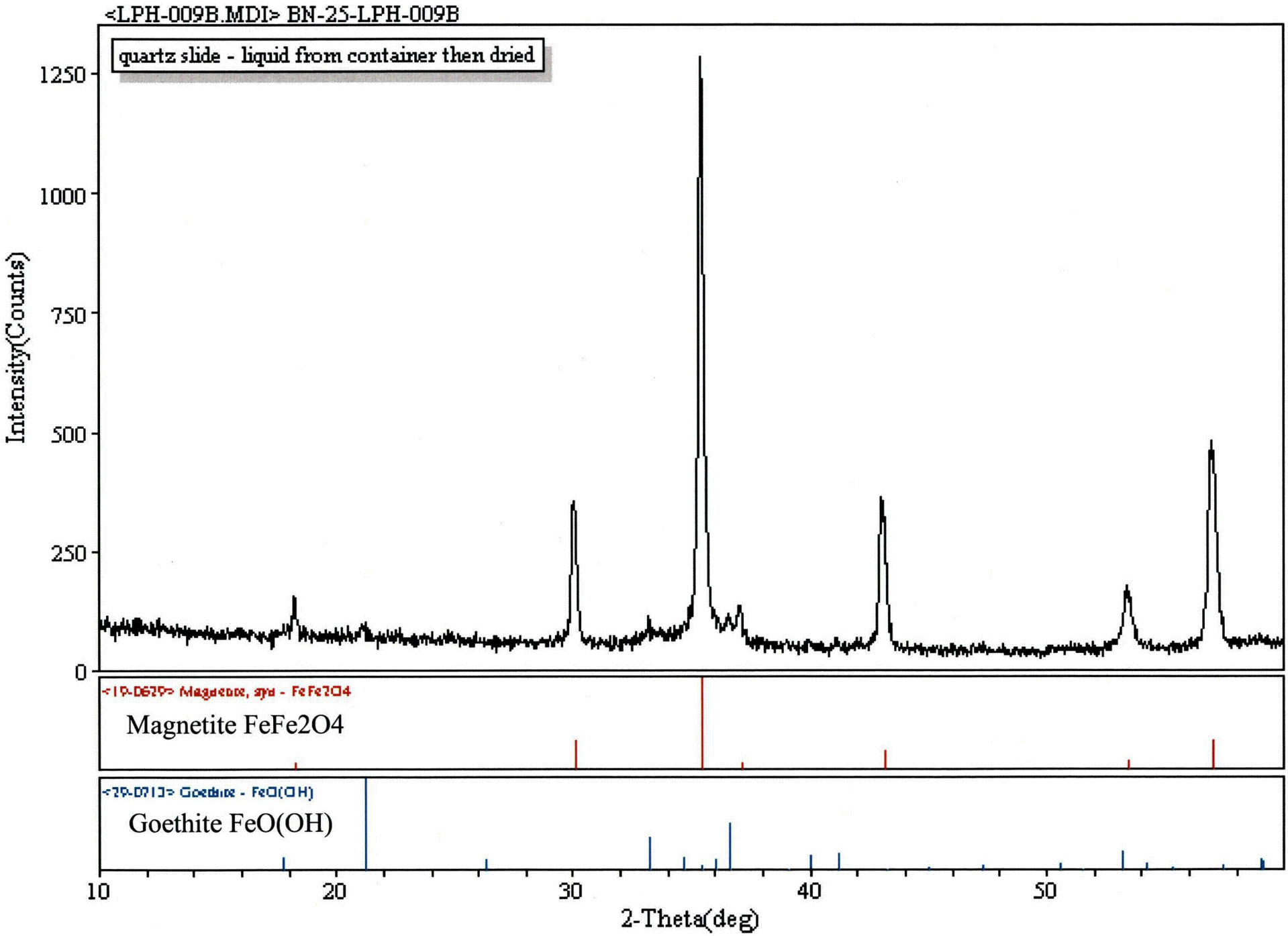

<HS015A.MDI> FN-25-LPH-HS-015A
quartz slide
Intensity(Counts)
400
350
300
250
200
150
100
50
0
Iron Oxide Hydrate Fe2O3.H2O
Iron Sulfate Hydrate Fe2(OH,SO4)
Goethite FeO(OH)
Iron Oxide Hydroxide FeO(OH)
Iron Oxide Hydroxide Fe2O3
10
20
30
40
50
2-Theta(deg)

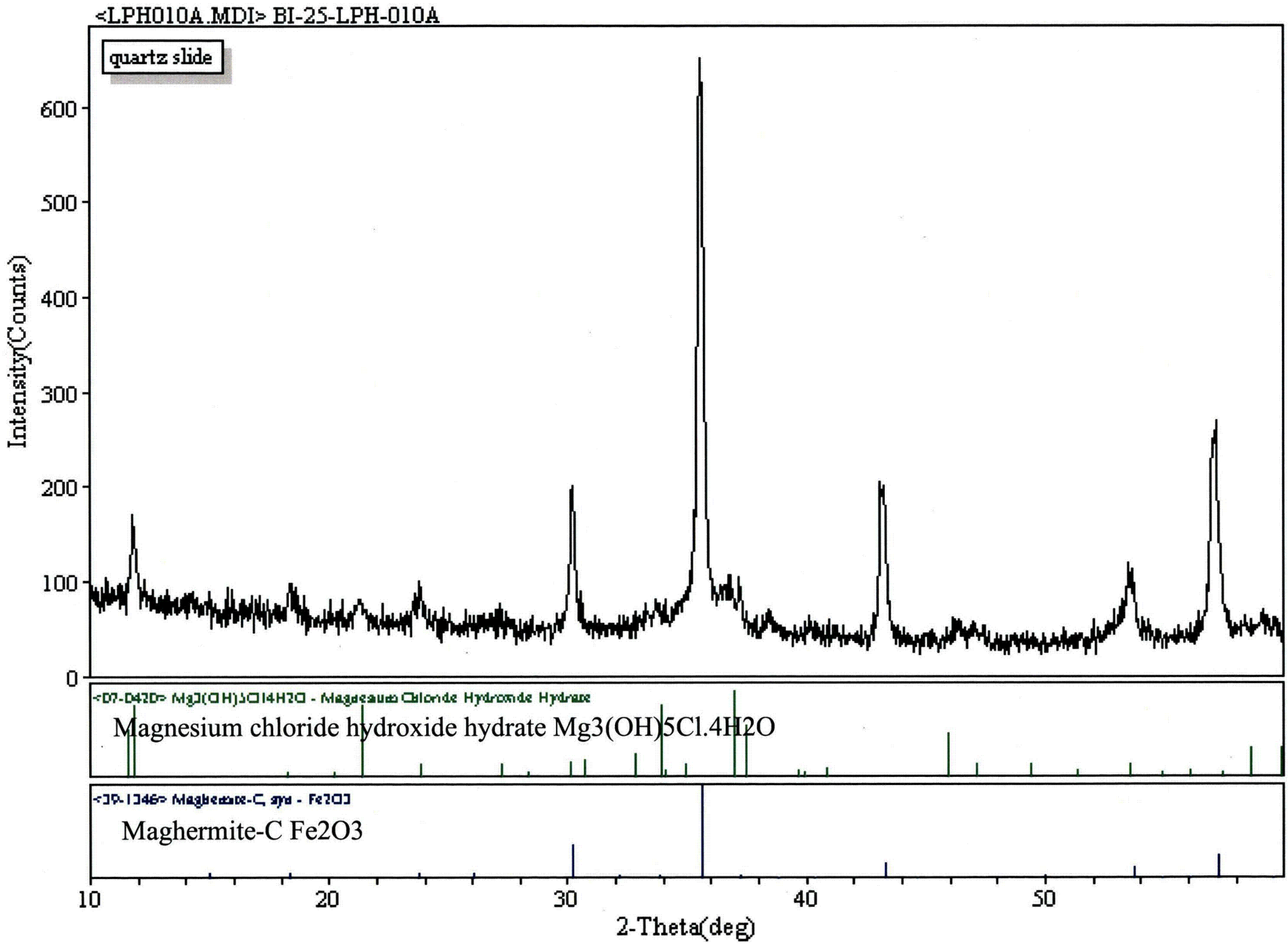

<HS-015A.MDI> FN-25-LPH-HS-015A 6/18/02-6/25/02 0.45um
quartz slide
Intensity(Counts)
300
250
200
150
100
50
0
<19-0629> Magnetite, syn - FeFe2O4
Magnetite FeFe2O4
10
20
30
40
50
2-Theta(deg)

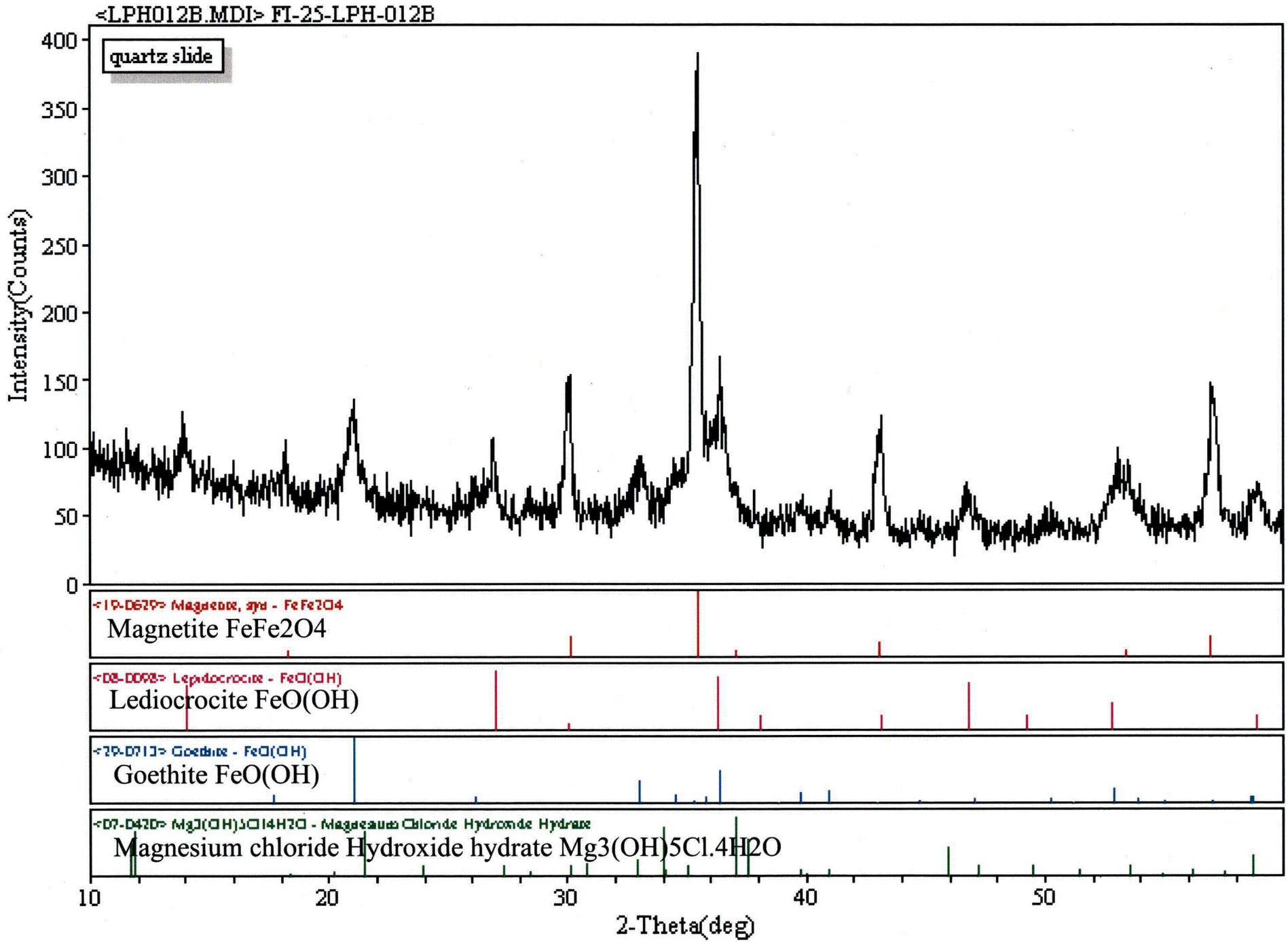

<HS-016B.MDI> FI-25-LPH-HS-016B
quartz slide
Intensity(Counts)
350
300
250
200
150
100
50
0
Goethite FeO(OH)
Magnetite FeFe2O4
Iron Oxide Fe3O4
10
20
30
40
50
2-Theta(deg)


<HS015A.MDI> FN-25-LPH-HS-015A
quartz slide
Intensity(Counts)
400
350
300
250
200
150
100
50
0
Iron Oxide Hydrate Fe2O3.H2O
Iron Sulfate Hydrate Fe2(OH,SO4)
Goethite FeO(OH)
Iron Oxide Hydroxide FeO(OH)
Iron Oxide Hydroxide Fe2O3
10
20
30
40
50
2-Theta(deg)


<HS-015A.MDI> FN-25-LPH-HS-015A 6/18/02-6/25/02 0.45um
quartz slide
Intensity(Counts)
300
250
200
150
100
50
0
Magnetite FeFe2O4
10
20
30
40
50
2-Theta(deg)


<LPH-009B.MDI> BN-25-LPH-009B
quartz slide - liquid from container then dried
Intensity(Counts)
1250
1000
750
500
250
0
Magnetite FeFe2O4
Goethite FeO(OH)
10
20
30
40
50
2-Theta(deg)


<LPH010A.MDI> BI-25-LPH-010A
quartz slide
Intensity(Counts)
600
500
400
300
200
100
0
Magnesium chloride hydroxide hydrate Mg3(OH)5Cl.4H2O
Maghermite-C Fe2O3
10
20
30
40
50
2-Theta(deg)



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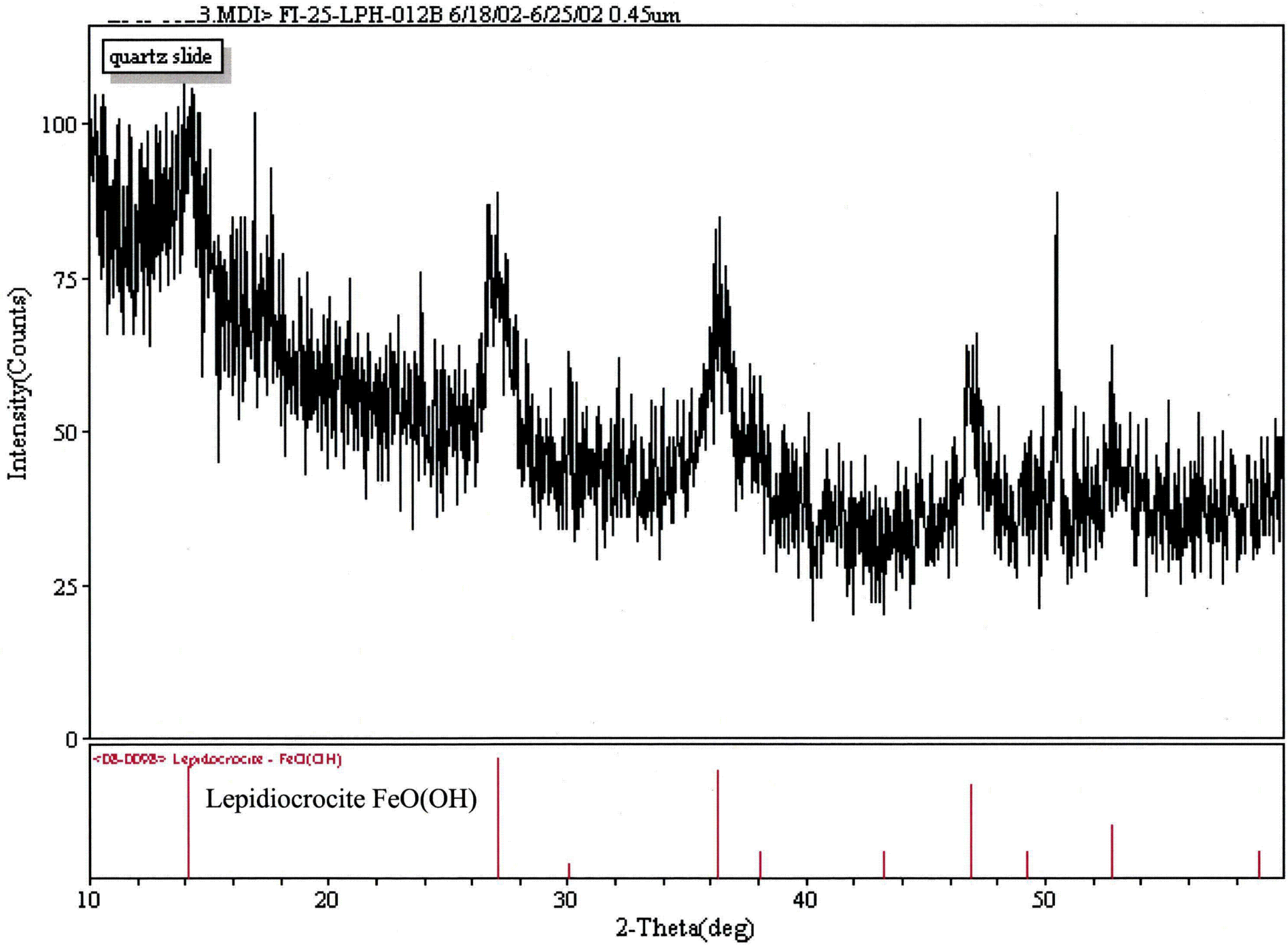

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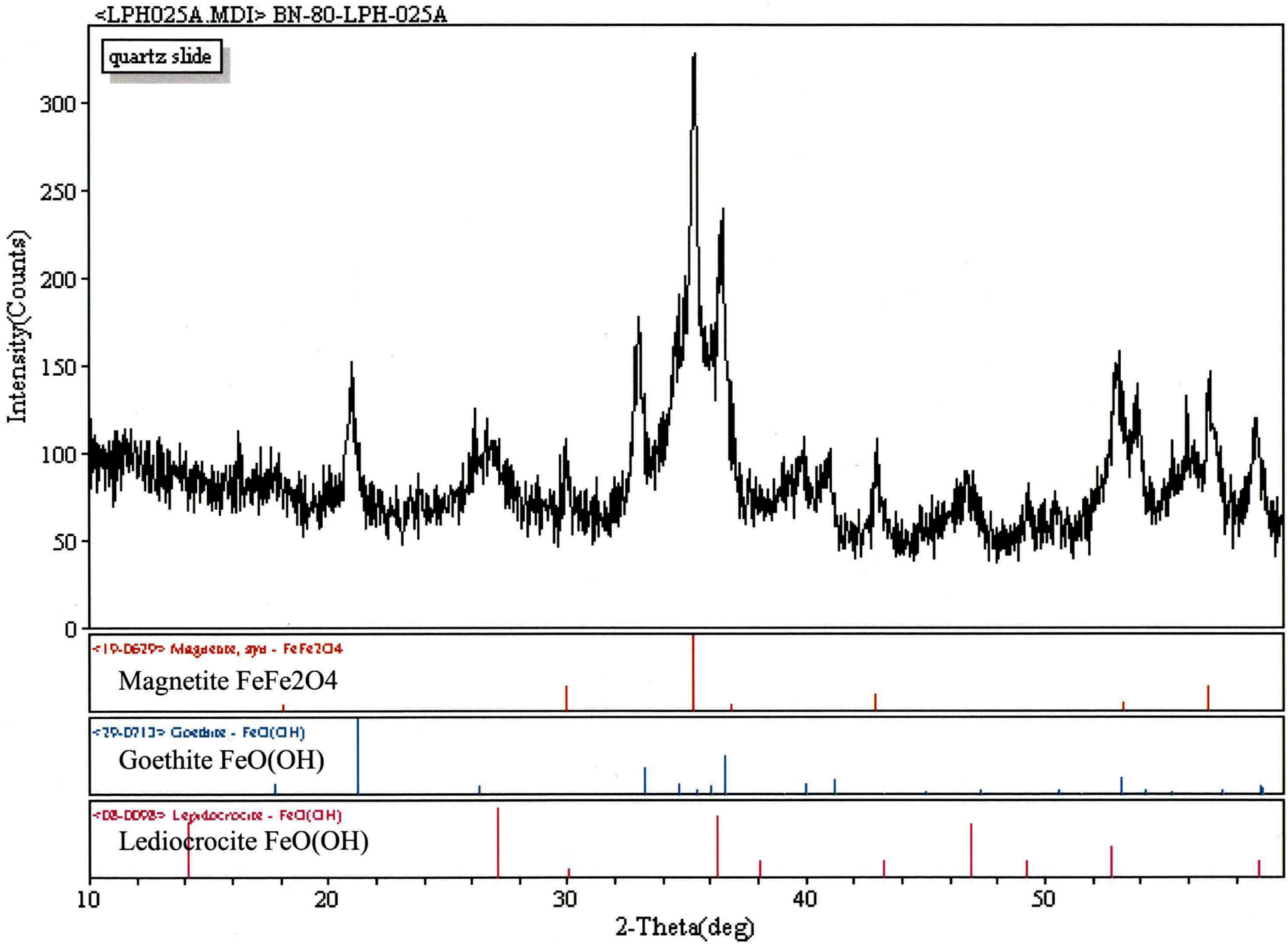

<LPH025A.MDI> BN-80-LPH-025A
quartz slide
Intensity(Counts)
300
250
200
150
100
50
0
Magnetite FeFe2O4
Goethite FeO(OH)
Lediocrocite FeO(OH)
10
20
30
40
50
2-Theta(deg)

Laboratory Report

www.nbmg.unr.edu/lab/

Kaveh Zarrabi
CCSN
6375 W. Charleston Blvd.
Las Vegas NV 89146

Invoice: **LAB-154**
Date: **3 December 2002**

Mineralogy was determined for all samples using X-ray Diffraction analysis. These samples were analyzed after being transferred to a low background quartz slide. All diffractograms were evaluated without background subtraction. The results are as follows:

Description of data: Microsoft Word 2000 document containing data for X-Ray Diffraction of solids and subsequent mineral analyses of filtered solids from the effluent of MWPs collected on 0.45, 0.22, and 0.1 micron filters.

MWP Sample ID key:

B = Bathtub
F = Flow-through
N = Without Iron shot
I = With Iron shot
25 = 25 degrees Celciius
C = J-13 well water control
HS = high salt
LPH = low pH
HS-HN = High Salt – High Nitrate

* See SIP-022 or contact the PI's for more information on the experimental design and results.

FN-25-LPH-HS-015A:	A poorly crystalline material containing magnetite ($FeFe_2O_4$).
FI-25-LPH-012B:	A poorly crystalline material containing lepidiocrocite (FeO(OH)).
BI-25-LPH-HS-014A:	A poorly crystalline material containing magnetite ($FeFe_2O_4$).
BN-25-C-HS-001B:	A poorly crystalline material containing iron oxide ($FeFe_2O_4$). This is similar to BI-25-LPH-HS-014A, but the highest intensity peak at ~34.5° 2θ is slightly offset from the coresponding magnetite peak.
BI-25-C-002A:	A poorly crystalline material containing magnetite ($FeFe_2O_4$) and goethite (FeO(OH)).
FI-25-C-004A:	Contains goethite (FeO(OH)), lediocrocite (FeO(OH)), and maghemite-C (Fe_2O_3).
FN-25-LPH-011A:	Contains goethite (FeO(OH)), lediocrocite (FeO(OH)), magnetite ($FeFe_2O_4$) and possible sodium sulfate hydrate ($Na_2S_2O_6 \bullet 2H_2O$).
FN-25-HS-007A:	Contains goethite (FeO(OH)) and lediocrocite (FeO(OH)).
BI-25-LPH-HS-014A:	Contains goethite (FeO(OH)) and kogarkoite (Na_3FSO_4).
BN-25-HS-005B:	Contains goethite (FeO(OH)) and iron oxide hydrate ($Fe_2O_3 \bullet H_2O$).
BN-25-C-001B:	Contains goethite (FeO(OH)), lediocrocite (FeO(OH)), magnetite ($FeFe_2O_4$) and possible magnesium chloride hydroxide hydrate ($Mg_3(OH)_5Cl \bullet 4H_2O$).
BN-25-LPH-HS-013B:	Contains goethite (FeO(OH)). At 20.66° and 29.87° 2θ are two unidentifiable peaks.
BN-25-LPH-009B:	Contains goethite (FeO(OH)) and magnetite ($FeFe_2O_4$). This sample was collected from liquid that drained from the continer. This liquid was air dried before sampling.
BI-25-LPH-010A:	Contains maghemite-C (Fe_2O_3) and possible magnesium chloride hydroxide hydrate ($Mg_3(OH)_5Cl \bullet 4H_2O$).
FN-25-LPH-HS-015A:	Contains goethite (FeO(OH), iron oxide hydrate ($Fe_2O_3 \bullet H_2O$), iron sulfate hydrate ($Fe_2(OH,SO_4)_{4.88}$), iron oxide hydroxide (FeO(OH)) and iron oxide (Fe_2O_3)..
FN-25-LPH-012B:	Contains goethite (FeO(OH)), lediocrocite (FeO(OH)), magnetite ($FeFe_2O_4$) and possible magnesium chloride hydroxide hydrate ($Mg_3(OH)_5Cl \bullet 4H_2O$).

FI-25-LPH-HS-016B:	Contains goethite (FeO(OH)), magnetite ($FeFe_2O_4$) and iron oxide (Fe_2O_3). At 32.01° 2θ is an unidentifiable peak.
BN-80-LPH-025A:	Contains goethite (FeO(OH)), lediocrocite (FeO(OH)), and magnetite ($FeFe_2O_4$).
FN-25-C-003A:	Contains goethite (FeO(OH)) and magnetite ($FeFe_2O_4$).
BN-80-C-017A:	Contains goethite (FeO(OH)), lediocrocite (FeO(OH)), maghemite-C (Fe_2O_3) and possible magnesium chloride hydroxide hydrate ($Mg_3(OH)_5Cl \bullet 4H_2O$).
FI-25-HS-008B:	Contains siderite ($FeCO_3$) and geothite FeO(OH).
FN-80-HS-023A:	Contains halite (NaCl), niter (KNO_3) and kogarkoite (Na_3FSO_4).
FN-80-LPH-HS-031A:	Contains halite (NaCl), niter (KNO_3), nitratine ($NaNO_3$) and kogarkoite (Na_3FSO_4).

The results of this assay were based solely upon the content of the sample submitted. Any decision to invest should be made only after the potential investment value of the claim or deposit has been determined based on the result of assays of multiple samples of rocks or minerals collected by the prospective investor or by a qualified person selected by him.

Mario Desilets
Assistant Chemist/Geochemist

Legend:
St. Dev. = Standard Deviation
R. P. D. = Relative Percent Difference
n = number of measurements
Control = J-13 well water
HS = High Salt
LPH = Low pH
HS-HN = High Salt-High Nitrate = LPH-HS
LPH-HS= Low pH-High Salt = HS-HN

Run Dates

For Control (J-13):
Week 1 = 7/24/02 - 7/31/02
Week 2 = 7/31/02 - 8/07/02
Week 3 = 8/07/02 - 8/14/02
Week 4 = 8/14/02 - 8/21/02

For HS, LPH, HS-HN:
Week 1 = 6/18/02 - 6/25/02
Week 2 = 6/25/02 - 7/02/02
Week 3 = 7/02/02 - 7/09/02
Week 4 = 7/9/02 - 7/12/02

MWP Sample ID KEY:
B = Bathtub
F = Flow-Through
N = Without Iron Shot
I = With Iron Shot
25 = 25 degrees Celcius
C = J-13 well water Control
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

0.0000 for mass of material on filter indicates there was not enough material to filter.

With exception of BN-25-LPH-009A and 009B, BI-25-LPH-010A and 010B, FN25-LPH-011A and 011B, FI25-LPH-012A and 012B, the results presented are for washed samples.

* See the SIP or scientific notebook, or contact the PI's for more information on the experimental design and results.

Below is a brief description of each worksheet:

Legend: contains a list of abbreviations and other information used throughout the spreadsheet.

Solids Data by Filter Size: contains information on the amount of solid material collected sequentially on 0.45, 0.22, and 0.1 micron filters for each experiment on a weekly basis.

Mass flow rate data and calc.: combines information on flow rate of solution through the MWP and the mass of material collected on the filters to give the "mass flow" of corrosion products. The information is presented on an individual MWP experiment basis and on an average basis for different combined experiments (e.g., control, low pH, etc.).

Mass Transport Summary Table: contains the average of duplicate experiments (i.e., same MWP-type and solution) for the combined mass (in mg) collected for all three filter sizes.

Chart bathtub without shot: contains a chart showing the weight of solids collected (> 0.1 micron; all three filters combined) from effluent of bathtub MWP without shot material added by time (weeks).

Chart bathtub with shot: contains a chart showing the weight of solids collected (> 0.1 micron; all three filters combined) from effluent of bathtub MWP with shot material added by time (weeks).

Chart flow-through with shot: contains a chart showing the weight of solids collected (> 0.1 micron; all three filters combined) from effluent of flow-through MWP with shot material added by time (weeks).

Chart flow-through without shot: contains a chart showing the weight of solids collected (> 0.1 micron; all three filters combined) from effluent of flow-through MWP without shot material added by time (weeks).

Chart data: contains the data used to generate the charts.

Sample ID	Period of Collection Data Range	Number of Days after last measurement	Date of Measurement	Filter Mass (g) 0.45 um	Filter + Material (g) 0.45 um	Mass of Material (g) 0.45 um	Filter Mass (g) 0.22 um	Filter + Material (g) 0.22 um	Mass of Material (g) 0.22 um	Filter Mass (g) 0.10 um	Filter + Material (g) 0.10 um	Mass of Material (g) 0.10 um	Total Mass (g) per meas. Period	Total accu. (g)
Bath tub														
BN-25-C-001A	7/24/02 - 7/31/02	7	07/31/2002	0.1311	0.1347	0.0036	0.1277	0.1280	0.0003	0.1203	0.1204	0.0001	0.0040	0.0040
	7/31/02 - 8/7/02	7	08/08/2002	0.1320	0.1339	0.0019	0.1270	0.1272	0.0002	0.1209	0.1209	0.0000	0.0021	0.0061
	8/7/02 - 8/14/02	7	08/16/2002	0.1301	0.1323	0.0022	0.1325	0.1328	0.0003	0.1231	0.1233	0.0002	0.0027	0.0088
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1341	0.1355	0.0014	0.1324	0.1333	0.0009	0.1237	0.1240	0.0003	0.0026	0.0114
	Total					0.0091			0.0017			0.0006	0.0114	
BN-25-C-001B	7/24/02 - 7/31/02	7	07/31/2002	0.1317	0.1371	0.0054	0.1273	0.1279	0.0006	0.1195	0.1196	0.0001	0.0061	0.0061
	7/31/02 - 8/7/02	7	08/08/2002	0.1311	0.1347	0.0036	0.1320	0.1323	0.0003	0.1200	0.1202	0.0002	0.0041	0.0102
	8/7/02 - 8/14/02	7	08/16/2002	0.1320	0.1345	0.0025	0.1304	0.1312	0.0008	0.1238	0.1242	0.0004	0.0037	0.0139
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1325	0.1336	0.0011	0.1330	0.1333	0.0003	0.1208	0.1209	0.0001	0.0015	0.0154
	Total					0.01260			0.0020			0.0008	0.0154	
Bath tub + Iron shot														
BI-25-C-002A	7/24/02 - 7/31/02	7	07/31/2002	0.1321	0.1348	0.0027	0.1266	0.1273	0.0007	0.1201	0.1201	0.0000	0.0034	0.0034
	7/31/02 - 8/7/02	7	08/08/2002	0.1324	0.1331	0.0007	0.1322	0.1322	0.0000	0.1208	0.1211	0.0003	0.0010	0.0044
	8/7/02 - 8/14/02	7	08/16/2002	0.1315	0.1326	0.0011	0.1333	0.1338	0.0005	0.1233	0.1235	0.0002	0.0018	0.0062
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1324	0.1329	0.0005	0.1313	0.1318	0.0005	0.1195	0.1195	0.0000	0.0010	0.0072
	Total					0.0050			0.0017			0.0005	0.0072	
BI-25-C-002B	7/24/02 - 7/31/02	7	07/31/2002	0.1320	0.1349	0.0029	0.1262	0.1270	0.0008	0.1196	0.1196	0.0000	0.0037	0.0037
	7/31/02 - 8/7/02	7	08/08/2002	0.1340	0.1358	0.0018	0.1322	0.1323	0.0001	0.1206	0.1208	0.0002	0.0021	0.0058
	8/7/02 - 8/14/02	7	08/16/2002	0.1287	0.1295	0.0008	0.1317	0.1320	0.0003	0.1233	0.1236	0.0003	0.0014	0.0072
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1323	0.1330	0.0007	0.1339	0.1341	0.0002	0.1200	0.1203	0.0003	0.0012	0.0084
	Total					0.0062			0.0014			0.0008	0.0084	
Flowthru														
FN-25-C-003A	7/24/02 - 7/31/02	7	07/31/2002	0.1319	0.1455	0.0136	0.1259	0.1262	0.0003	0.1203	0.1205	0.0002	0.0141	0.0141
	7/31/02 - 8/7/02	7	08/08/2002	0.1327	0.1367	0.0040	0.1321	0.1321	0.0000	0.1205	0.1205	0.0000	0.0040	0.0181
	8/7/02 - 8/14/02	7	08/16/2002	0.1306	0.1344	0.0038	0.1328	0.1336	0.0008	0.1227	0.1229	0.0002	0.0048	0.0229
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1324	0.1339	0.0015	0.1319	0.1322	0.0003	0.1195	0.1198	0.0003	0.0021	0.0250
	Total					0.0229			0.0014			0.0007	0.0250	
FN-25-C-003B	7/24/02 - 7/31/02	7	07/31/2002	0.1332	0.1398	0.0066	0.1265	0.1273	0.0008	0.1197	0.1200	0.0003	0.0077	0.0077
	7/31/02 - 8/7/02	7	08/08/2002	0.1304	0.1359	0.0055	0.1331	0.1332	0.0001	0.1206	0.1209	0.0003	0.0059	0.0136
	8/7/02 - 8/14/02	7	08/16/2002	0.1303	0.1351	0.0048	0.1326	0.1332	0.0006	0.1225	0.1227	0.0002	0.0056	0.0192
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1334	0.1364	0.0030	0.1340	0.1342	0.0002	0.1203	0.1205	0.0002	0.0034	0.0226
	Total					0.0199			0.0017			0.0010	0.0226	
Flowthru+ Iron Shot														
FI-25-C-004A	7/24/02 - 7/31/02	7	07/31/2002	0.1315	0.1377	0.0062	0.1279	0.1283	0.0004	0.1206	0.1206	0.0000	0.0066	0.0066
	7/31/02 - 8/7/02	7	08/08/2002	0.1284	0.1298	0.0014	0.1324	0.1324	0.0000	0.1214	0.1215	0.0001	0.0015	0.0081
	8/7/02 - 8/14/02	7	08/16/2002	0.1315	0.1330	0.0015	0.1321	0.1325	0.0004	0.1224	0.1227	0.0003	0.0022	0.0103
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1318	0.1328	0.0010	0.1320	0.1325	0.0005	0.1196	0.1200	0.0004	0.0019	0.0122
	Total					0.0101			0.0013			0.0008	0.0122	
FI-25-C-004B	7/24/02 - 7/31/02	7	07/31/2002	0.1335	0.1359	0.0024	0.1271	0.1276	0.0005	0.1204	0.1206	0.0002	0.0031	0.0031
	7/31/02 - 8/7/02	7	08/08/2002	0.1277	0.1301	0.0024	0.1328	0.1335	0.0007	0.1202	0.1209	0.0007	0.0038	0.0069
	8/7/02 - 8/14/02	7	08/16/2002	0.1322	0.1328	0.0006	0.1323	0.1326	0.0003	0.1235	0.1238	0.0003	0.0012	0.0081
	8/14/02 - 8/21/02	7	8/21 & 22/02	0.1318	0.1328	0.0010	0.1340	0.1340	0.0000	0.1204	0.1207	0.0003	0.0013	0.0094
	Total					0.00640			0.0015			0.0015	0.0094	

Sample ID	Period of Collection Data Range	Number of Days after last measurement	Date of Measurement	Filter Mass (g) 0.45 um	Filter + Material (g) 0.45 um	Mass of Material (g) 0.45 um	Filter Mass (g) 0.22 um	Filter + Material (g) 0.22 um	Mass of Material (g) 0.22 um	Filter Mass (g) 0.10 um	Filter + Material (g) 0.10 um	Mass of Material (g) 0.10 um	Total Mass (g) per meas. Period	Total accu. (g)
Bath tub														
BN-25-HS-005A												0		
	6/18/020 - 6/25/02	7	7/24&25/02	0.1321	0.1371	0.0050	0.1265	0.1268	0.0003	0.1236	0.1239	0.0003	0.0056	0.0056
	6/25/02 - 7/2/02	7	7/24&25/02	0.1269	0.1290	0.0021	0.1279	0.1285	0.0006	0.1229	0.1231	0.0002	0.0029	0.0085
	7/2/02 - 7/9/02	7	7/25&26/02	0.1283	0.1290	0.0007	0.1274	0.1275	0.0001	0.1236	0.1239	0.0003	0.0011	0.0096
	7/9/02 -7/12/02	3	7/25&26/02	0.1282	0.1285	0.0003	0.1321	0.1324	0.0003	0.1216	0.1218	0.0002	0.0008	0.0104
	Total					0.0081			0.0013			0.0010	0.0104	
BN-25-HS-005B														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1323	0.1359	0.0036	0.1258	0.1263	0.0005	0.1240	0.1245	0.0005	0.0046	0.0046
	6/25/02 - 7/2/02	7	7/24&25/02	0.1265	0.1298	0.0033	0.1281	0.1290	0.0009	0.1241	0.1244	0.0003	0.0045	0.0091
	7/2/02 - 7/9/02	7	7/25&26/02	0.1296	0.1307	0.0011	0.1275	0.1283	0.0008	0.1237	0.1250	0.0013	0.0032	0.0123
	7/9/02 -7/12/02	3	7/25&26/02	0.1281	0.1287	0.0006	0.1319	0.1325	0.0006	0.1211	0.1216	0.0005	0.0017	0.0140
	Total					0.0086			0.0028			0.0026	0.0140	
Bath tub + Iron shot														
BI-25-HS-006A														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1319	0.1344	0.0025	0.1263	0.1266	0.0003	0.1226	0.1229	0.0003	0.0031	0.0031
	6/25/02 - 7/2/02	7	7/24&25/02	0.1264	0.1296	0.0032	0.1262	0.1269	0.0007	0.1223	0.1227	0.0004	0.0043	0.0074
	7/2/02 - 7/9/02	7	7/25&26/02	0.1292	0.1292	0.0000	0.1268	0.1268	0.0000	0.1244	0.1244	0.0000	0.0000	0.0074
	7/9/02 -7/12/02	3	7/26&29/02	0.1303	0.1309	0.0006	0.1328	0.1334	0.0006	0.1211	0.1237	0.0026	0.0038	0.0112
	Total					0.0063			0.0016			0.0033	0.0112	
BI-25-HS-006B														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1319	0.1341	0.0022	0.1261	0.1266	0.0005	0.1233	0.1238	0.0005	0.0032	0.0032
	6/25/02 - 7/2/02	7	7/24&25/02	0.1270	0.1310	0.0040	0.1268	0.1274	0.0006	0.1235	0.1238	0.0003	0.0049	0.0081
	7/2/02 - 7/9/02	7	7/25&26/02	0.1290	0.1299	0.0009	0.1274	0.1278	0.0004	0.1242	0.1250	0.0008	0.0021	0.0102
	7/9/02 -7/12/02	3	7/26&29/02	0.1294	0.1298	0.0004	0.1315	0.1319	0.0004	0.1205	0.1231	0.0026	0.0034	0.0136
	Total					0.0075			0.0019			0.0042	0.0136	

Flowthru														
FN-25-HS-007A														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1312	0.1350	0.0038	0.1260	0.1268	0.0008	0.1247	0.1256	0.0009	0.0055	0.0055
	6/25/02 - 7/2/02	7	7/24&25/02	0.1290	0.1320	0.0030	0.1274	0.1434	0.0160	0.1254	0.1257	0.0003	0.0193	0.0248
	7/2/02 - 7/9/02	7	7/25&26/02	0.1298	0.1299	0.0001	0.1268	0.1279	0.0011	0.1236	0.1271	0.0035	0.0047	0.0295
	7/9/02 -7/12/02	3	7/26&29/02	0.1309	0.1318	0.0009	0.1322	0.1322	0.0000	0.1206	0.1211	0.0005	0.0014	0.0309
	Total					0.0078			0.0179			0.0052	0.0309	
FN-25-HS-007B														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1318	0.1339	0.0021	0.1262	0.1269	0.0007	0.1239	0.1239	0.0000	0.0028	0.0028
	6/25/02 - 7/2/02	7	7/24&25/02	0.1285	0.1315	0.0030	0.1264	0.1270	0.0006	0.1250	0.1253	0.0003	0.0039	0.0067
	7/2/02 - 7/9/02	7	7/25&26/02	0.1314	0.1341	0.0027	0.1288	0.1299	0.0011	0.1233	0.1259	0.0026	0.0064	0.0131
	7/9/02 -7/12/02	3	7/26&29/02	0.1293	0.1293	0.0000	0.1327	0.1327	0.0000	0.0000	0.0000	0.0000	0.0000	0.0131
	Total					0.0078			0.0024			0.0029	0.0131	
Flowthru+ Iron Shot														
FI-25-HS-008A														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1333	0.1351	0.0018	0.1269	0.1274	0.0005	0.1232	0.1233	0.0001	0.0024	0.0024
	6/25/02 - 7/2/02	7	7/24&25/02	0.1278	0.1292	0.0014	0.1283	0.1288	0.0005	0.1222	0.1228	0.0006	0.0025	0.0049
	7/2/02 - 7/9/02	7	7/25&26/02	0.1301	0.1307	0.0006	0.1288	0.1294	0.0006	0.1225	0.1248	0.0023	0.0035	0.0084
	7/9/02 -7/12/02	3	7/26&29/02	0.1293	0.1306	0.0013	0.1329	0.1334	0.0005	0.1206	0.1232	0.0026	0.0044	0.0128
	Total					0.0051			0.0021			0.0056	0.0128	
FI-25-HS-008B														
	6/18/020 - 6/25/02	7	7/24&25/02	0.1337	0.1345	0.0008	0.1262	0.1268	0.0006	0.1237	0.1237	0.0000	0.0014	0.0014
	6/25/02 - 7/2/02	7	7/24&25/02	0.1290	0.1300	0.0010	0.1282	0.1284	0.0002	0.1236	0.1239	0.0003	0.0015	0.0029
	7/2/02 - 7/9/02	7	7/25&26/02	0.1296	0.1304	0.0008	0.1263	0.1269	0.0006	0.1232	0.1241	0.0009	0.0023	0.0052
	7/9/02 -7/12/02	3	7/26&29/02	0.1295	0.1308	0.0013	0.1320	0.1323	0.0003	0.1211	0.1218	0.0007	0.0023	0.0075
	Total					0.0039			0.0017			0.0019	0.0075	

Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)
BN-25-LPH-009A														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1306	0.1431	0.0125	0.1268	0.1302	0.0034	0.1236	0.1255	0.0019	0.0178	0.0178
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1295	0.1340	0.0045	0.1292	0.1354	0.0062	0.1240	0.1313	0.0073	0.0180	0.0358
	7/2/02 - 7/9/02		7 7/9&10/02	0.1312	0.1335	0.0023	0.1277	0.1281	0.0004	0.1240	0.1263	0.0023	0.0050	0.0408
	7/9/02 -7/12/02		3 7/16&17/02	0.1308	0.1308	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0408
	Total					0.0193			0.0100			0.0115	0.0408	
BN-25-LPH-009B														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1327	0.1361	0.0034	0.1253	0.1260	0.0007	0.1237	0.1245	0.0008	0.0049	0.0049
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1287	0.1317	0.0030	0.1280	0.1288	0.0008	0.1250	0.1262	0.0012	0.0050	0.0099
	7/2/02 - 7/9/02		7 7/9&10/02	0.1321	0.1334	0.0013	0.1263	0.1265	0.0002	0.1225	0.1231	0.0006	0.0021	0.0120
	7/9/02 -7/12/02		3 7/16&17/02	0.1332	0.1335	0.0003	0.1314	0.1327	0.0013	0.1234	0.1241	0.0007	0.0023	0.0143
	Total					0.0080			0.0030			0.0033	0.0143	
Bath tub + Iron shot														
BI-25-LPH-010A														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1339	0.1405	0.0066	0.1259	0.1296	0.0037	0.1237	0.1252	0.0015	0.0118	0.0118
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1285	0.1303	0.0018	0.1272	0.1276	0.0004	0.1248	0.1254	0.0006	0.0028	0.0146
	7/2/02 - 7/9/02		7 7/9&10/02	0.1313	0.1317	0.0004	0.1280	0.1284	0.0004	0.1244	0.1252	0.0008	0.0016	0.0162
	7/9/02 -7/12/02		3 7/16&17/02	0.1341	0.1343	0.0002	0.1330	0.1337	0.0007	0.1241	0.1252	0.0011	0.0020	0.0182
	Total					0.0090			0.0052			0.0040	0.0182	
BI-25-LPH-010B														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1326	0.1355	0.0029	0.1274	0.1286	0.0012	0.1231	0.1238	0.0007	0.0048	0.0048
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1287	0.1323	0.0036	0.1274	0.1334	0.0060	0.1241	0.1248	0.0007	0.0103	0.0151
	7/2/02 - 7/9/02		7 7/9&10/02	0.1314	0.1336	0.0022	0.1267	0.1267	0.0000	0.1207	0.1222	0.0015	0.0037	0.0188
	7/9/02 -7/12/02		3 7/16&17/02	0.1323	0.1344	0.0021	0.1312	0.1331	0.0019	0.1191	0.1257	0.0066	0.0106	0.0294
	Total					0.0108			0.0091			0.0095	0.0294	
Flowthru														
FN-25-LPH-011A														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1320	0.1365	0.0045	0.1255	0.1279	0.0024	0.1251	0.1259	0.0008	0.0077	0.0077
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1263	0.1283	0.0020	0.1267	0.1272	0.0005	0.1234	0.1238	0.0004	0.0029	0.0106
	7/2/02 - 7/9/02		7 7/9&10/02	0.1317	0.1340	0.0023	0.1276	0.1277	0.0001	0.1224	0.1229	0.0005	0.0029	0.0135
	7/9/02 -7/12/02		3 7/16&17/02	0.1307	0.1317	0.0010	0.1312	0.1312	0.0000	0.1240	0.1242	0.0002	0.0012	0.0147
	Total					0.0098			0.0030			0.0019	0.0147	
FN-25-LPH-011B														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1302	0.1402	0.0100	0.1273	0.1285	0.0012	0.1239	0.1256	0.0017	0.0129	0.0129
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1272	0.1289	0.0017	0.1276	0.1278	0.0002	0.1232	0.1267	0.0035	0.0054	0.0183
	7/2/02 - 7/9/02		7 7/9&10/02	0.1290	0.1320	0.0030	0.1284	0.1285	0.0001	0.1207	0.1211	0.0004	0.0035	0.0218
	7/9/02 -7/12/02		3 7/16&17/02	0.1314	0.1319	0.0005	0.1323	0.1323	0.0000	0.1238	0.1239	0.0001	0.0006	0.0224
	Total					0.0152			0.0015			0.0057	0.0224	
Flowthru+ Iron Shot														
FI-25LPH-012A														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1276	0.1311	0.0035	0.1268	0.1275	0.0007	0.1228	Not filtered	Not filtered	Not filtered due to insufficient sample	
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1274	0.1294	0.0020	0.1275	0.1275	0.0000	0.1239	0.1244	0.0005	0.0025	0.0025
	7/2/02 - 7/9/02		7 7/9&10/02	0.1316	0.1348	0.0032	0.1287	0.1289	0.0002	0.1210	0.1218	0.0008	0.0042	0.0067
	7/9/02 -7/12/02		3 7/16&17/02	0.1316	0.1324	0.0008	0.1310	0.1310	0.0000	0.1245	0.1250	0.0005	0.0013	0.0080
	Total					0.0095			0.0009			0.0018	0.0122	
FI-25LPH-012B														
	6/18/02 - 6/25/02		7 6/25&26/02	0.1284	0.1328	0.0044	0.1278	0.1282	0.0004	0.1213	0.1216	0.0003	0.0051	0.0051
	6/25/02 - 7/2/02		7 7/2 & 3/02	0.1338	0.1384	0.0046	0.1280	0.1289	0.0009	0.1254	0.1260	0.0006	0.0061	0.0112
	7/2/02 - 7/9/02		7 7/9&10/02	0.1308	0.1364	0.0056	0.1272	0.1275	0.0003	0.1196	0.1202	0.0006	0.0065	0.0177
	7/9/02 -7/12/02		3 7/16&17/02	0.1323	0.1327	0.0004	0.1309	0.1309	0.0000	0.1232	0.1235	0.0003	0.0007	0.0184
	Total					0.0150			0.0016			0.0018	0.0184	

Sample ID	Period of Collection	Number of Days	Date of	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Filter Mass (g)	Filter + Material (g)	Mass of Material (g)	Total Mass (g)	Total accu.
Bath tub	Data Range	after last measurement	Measurement	0.45 um	0.45 um	0.45 um	0.22 um	0.22 um	0.22 um	0.10 um	0.10 um	0.10 um	per meas. Period	(g)

BN-25-HS-HN-013A													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1317	0.1386	0.0069	0.1259	0.1268	0.0009	0.1210	0.1221	0.0011	0.0089	0.0089
	6/25/02 - 7/2/02	7 7/24&25/02	0.1344	0.1364	0.0020	0.1274	0.1295	0.0021	0.1235	0.1235	0.0000	0.0041	0.0130
	7/2/02 - 7/9/02	7 7/25&26/02	0.1335	0.1335	0.0000	0.1274	0.1278	0.0004	0.1240	0.1241	0.0001	0.0005	0.0135
	7/9/02 - 7/12/02	3 7/26&29/02	0.1305	0.1310	0.0005	0.1339	0.1342	0.0003	0.1249	0.1276	0.0027	0.0035	0.0170
	Total				0.0094			0.0037			0.0039	0.0170	
BN-25-HS-HN-013B													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1311	0.1389	0.0078	0.1264	0.1270	0.0006	0.1207	0.1207	0.0000	0.0084	0.0084
	6/25/02 - 7/2/02	7 7/24&25/02	0.1339	0.1361	0.0022	0.1274	0.1281	0.0007	0.1232	0.1232	0.0000	0.0029	0.0113
	7/2/02 - 7/9/02	7 7/25&26/02	0.1291	0.1293	0.0002	0.1275	0.1276	0.0001	0.1221	0.1228	0.0007	0.0010	0.0123
	7/9/02 - 7/12/02	3 7/26&29/02	0.1310	0.1321	0.0011	0.1343	0.1343	0.0000	0.1242	0.1259	0.0017	0.0028	0.0151
	Total				0.0113			0.0014			0.0024	0.0151	
Bath tub + Iron shot													
BI-25-HS-HN-014A													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1315	0.1393	0.0078	0.1258	0.1264	0.0006	0.1210	0.1210	0.0000	0.0084	0.0084
	6/25/02 - 7/2/02	7 7/24&25/02	0.1320	0.1326	0.0006	0.1279	0.1286	0.0007	0.1231	0.1231	0.0000	0.0013	0.0097
	7/2/02 - 7/9/02	7 7/25&26/02	0.1330	0.1341	0.0011	0.1273	0.1273	0.0000	0.1204	0.1210	0.0006	0.0017	0.0114
	7/9/02 - 7/12/02	3 7/26&29/02	0.1334	0.1343	0.0009	0.1313	0.1313	0.0000	0.1235	0.1251	0.0016	0.0025	0.0139
	Total				0.0104			0.0013			0.0022	0.0139	
BI-25-HS-HN-014B													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1319	0.1374	0.0055	0.1262	0.1265	0.0003	0.1211	0.1211	0.0000	0.0058	0.0058
	6/25/02 - 7/2/02	7 7/24&25/02	0.1302	0.1334	0.0032	0.1270	0.1275	0.0005	0.1252	0.1252	0.0000	0.0037	0.0095
	7/2/02 - 7/9/02	7 7/25&26/02	0.1312	0.1319	0.0007	0.1276	0.1276	0.0000	0.1235	0.1237	0.0002	0.0009	0.0104
	7/9/02 - 7/12/02	3 7/26&29/02	0.1328	0.1332	0.0004	0.1343	0.1343	0.0000	0.1233	0.1246	0.0013	0.0017	0.0121
	Total				0.0098			0.0008			0.0015	0.0121	
Flowthru													
FN-25-HS-HN-015A													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1347	0.1506	0.0159	0.1264	0.1275	0.0011	0.1232	0.1236	0.0004	0.0174	0.0174
	6/25/02 - 7/2/02	7 7/24&25/02	0.1287	0.1303	0.0016	0.1271	0.1276	0.0005	0.1235	0.1236	0.0001	0.0022	0.0196
	7/2/02 - 7/9/02	7 7/25&26/02	0.1309	0.1315	0.0006	0.1268	0.1268	0.0000	0.1224	0.1229	0.0005	0.0011	0.0207
	7/9/02 - 7/12/02	3 7/26&29/02	0.1329	0.1341	0.0012	0.1306	0.1310	0.0004	0.1229	0.1235	0.0006	0.0022	0.0229
	Total				0.0193			0.0020			0.0016	0.0229	
FN-25-HS-HN-015B													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1329	0.1415	0.0086	0.1261	0.1264	0.0003	0.1226	0.1228	0.0002	0.0091	0.0091
	6/25/02 - 7/2/02	7 7/24&25/02	0.1294	0.1326	0.0032	0.1266	0.1273	0.0007	0.1248	0.1250	0.0002	0.0041	0.0132
	7/2/02 - 7/9/02	7 7/25&26/02	0.1309	0.1325	0.0016	0.1285	0.1285	0.0000	0.1229	0.1238	0.0009	0.0025	0.0157
	7/9/02 - 7/12/02	3 7/26&29/02	0.1325	0.1349	0.0024	0.1348	0.1348	0.0000	0.1245	0.1258	0.0013	0.0037	0.0194
	Total				0.0158			0.0010			0.0026	0.0194	
Flowthru+ Iron Shot													
FI-25-HS-HN-016A													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1345	0.1418	0.0073	0.1267	0.1275	0.0008	0.1245	0.1247	0.0002	0.0083	0.0083
	6/25/02 - 7/2/02	7 7/24&25/02	0.1316	0.1344	0.0028	0.1289	0.1294	0.0005	0.1235	0.1239	0.0004	0.0037	0.0120
	7/2/02 - 7/9/02	7 7/25&26/02	0.1306	0.1349	0.0043	0.1281	0.1282	0.0001	0.1229	0.1237	0.0008	0.0052	0.0172
	7/9/02 - 7/12/02	3 7/26&29/02	0.1306	0.1324	0.0018	0.1311	0.1311	0.0000	0.1240	0.1246	0.0006	0.0024	0.0196
	Total				0.0162			0.0014			0.0020	0.0196	
FI-25-HS-HN-016B													
	6/18/02 - 6/25/02	7 7/24&25/02	0.1340	0.1373	0.0033	0.1267	0.1270	0.0003	0.1237	0.1238	0.0001	0.0037	0.0037
	6/25/02 - 7/2/02	7 7/24&25/02	0.1294	0.1315	0.0021	0.1279	0.1290	0.0011	0.1234	0.1239	0.0005	0.0037	0.0074
	7/2/02 - 7/9/02	7 7/25&26/02	0.1292	0.1297	0.0005	0.1283	0.1285	0.0002	0.1234	0.1240	0.0006	0.0013	0.0087
	7/9/02 - 7/12/02	3 7/26&29/02	0.1299	0.1305	0.0006	0.1353	0.1353	0.0000	0.1243	0.1249	0.0006	0.0012	0.0099
	Total				0.0065			0.0016			0.0018	0.0099	

MWP NUMBER	FLOW RATE Beginning of Run mL / Day	FLOW RATE Middle of Run mL / Day	FLOW RATE End of Run mL / Day	AVERAGE FLOW RATE mL / Day	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)	TOTAL SOLIDS (g)	Dates Of Run	# of Days of trial	Mass Flow Filtered Solids (g/mL)	Mass Flow Duplicate Ave. Filtered Solids (mg/L)
BN-25-C-001A	24.57		28.89	26.73	0.0091	0.0017	0.0006	0.0114	7/24/02 - 8/21/02	28	0.0000152313	18.3565896
BN-25-C-001B	23.98		27.23	25.60	0.0126	0.0020	0.0008	0.0154	7/24/02 - 8/21/02	28	0.0000214819	
BI-25-C-002A	39.21		25.89	32.55	0.0050	0.0017	0.0005	0.0072	7/24/02 - 8/21/02	28	0.0000079004	8.6649091
BI-25-C-002B	37.93		25.70	31.82	0.0062	0.0014	0.0008	0.0084	7/24/02 - 8/21/02	28	0.0000094294	
FN-25-C-003A	36.80		30.80	33.80	0.0229	0.0014	0.0007	0.0250	7/24/02 - 8/21/02	28	0.0000264156	26.3775075
FN-25-C-003B	37.45		23.83	30.64	0.0199	0.0017	0.0010	0.0226	7/24/02 - 8/21/02	28	0.0000263394	
FI-25-C-004A	38.40		27.21	32.81	0.0101	0.0013	0.0008	0.0122	7/24/02 - 8/21/02	28	0.0000132819	12.7336089
FI-25-C-004B	32.32		21.02	26.67	0.0064	0.0015	0.0012	0.0091	7/24/02 - 8/21/02	28	0.0000121853	
BN-25-HS-005A	37.80	29.30	42.77	36.62	0.0081	0.0013	0.0010	0.0104	6/18/02 - 7/12/02	24	0.0000118321	17.4698821
BN-25-HS-005B	8.16	26.55	41.02	25.24	0.0086	0.0028	0.0026	0.0140	6/18/02 - 7/12/02	24	0.0000231076	
BI-25-HS-006A	34.50	16.16	39.50	30.05	0.0063	0.0016	0.0033	0.0112	6/18/02 - 7/12/02	24	0.0000155287	16.7421792
BI-25-HS-006B	41.60	13.30	39.78	31.56	0.0075	0.0019	0.0042	0.0136	6/18/02 - 7/12/02	24	0.0000179557	
FN-25-HS-007A	41.02	9.59	39.73	30.11	0.0078	0.0179	0.0072	0.0329	6/18/02 - 7/12/02	24	0.0000455248	33.0023990
FN-25-HS-007B	36.27	4.26	39.43	26.65	0.0078	0.0024	0.0029	0.0131	6/18/02 - 7/12/02	24	0.0000204800	
FI-25-HS-008A	41.55	30.64	41.21	37.80	0.0051	0.0021	0.0056	0.0128	6/18/02 - 7/12/02	24	0.0000141091	11.1760593
FI-25-HS-008B	39.88	31.41	42.44	37.91	0.0039	0.0017	0.0019	0.0075	6/18/02 - 7/12/02	24	0.0000082431	
BN-25-LPH-009A	37.96	29.70	34.56	34.07	0.0193	0.0100	0.0115	0.0408	6/18/02 - 7/16/02	24	0.0000498900	33.7527357
BN-25-LPH-009B	34.71	30.56	36.20	33.82	0.0080	0.0030	0.0033	0.0143	6/18/02 - 7/16/02	24	0.0000176155	
BI-25-LPH-010A	37.39	30.98	34.35	34.24	0.0090	0.0052	0.0040	0.0182	6/18/02 - 7/16/02	24	0.0000221475	28.7505338
BI-25-LPH-010B	38.49	30.18	35.28	34.65	0.0108	0.0091	0.0095	0.0294	6/18/02 - 7/16/02	24	0.0000353536	
FN-25-LPH-011A	41.27	37.09	33.53	37.30	0.0098	0.0030	0.0019	0.0147	6/18/02 - 7/16/02	24	0.0000164222	20.5328368
FN-25-LPH-011B	40.61	36.89	36.12	37.87	0.0152	0.0015	0.0057	0.0224	6/18/02 - 7/16/02	24	0.0000246435	
FI-25-LPH-012A	33.41	17.26	32.94	27.87	0.0095	0.0009	0.0018	0.0122	6/18/02 - 7/16/02	24	0.0000182377	20.7651866
FI-25-LPH-012B	34.16	28.45	36.13	32.91	0.0150	0.0016	0.0018	0.0184	6/18/02 - 7/16/02	24	0.0000232926	
BN-25-HS-HN-013A	40.86	25.18	37.53	34.52	0.0094	0.0037	0.0039	0.0170	6/18/02 - 7/12/02	24	0.0000205185	20.3769768
BN-25-HS-HN-013B	30.92	24.25	38.11	31.09	0.0113	0.0014	0.0024	0.0151	6/18/02 - 7/12/02	24	0.0000202355	
BI-25-HS-HN-014A	12.84	30.91	37.04	26.93	0.0104	0.0013	0.0022	0.0139	6/18/02 - 7/12/02	24	0.0000215054	18.1074499
BI-25-HS-HN-014B	39.73	25.39	37.71	34.27	0.0098	0.0008	0.0015	0.0121	6/18/02 - 7/12/02	24	0.0000147095	
FN-25-HS-HN-015A	32.12	33.89	35.33	33.78	0.0193	0.0020	0.0016	0.0229	6/18/02 - 7/12/02	24	0.0000282485	27.9853059
FN-25-HS-HN-015B	31.38	20.22	35.87	29.16	0.0158	0.0010	0.0026	0.0194	6/18/02 - 7/12/02	24	0.0000277221	
FI-25-HS-HN-016A	35.29	35.63	39.89	36.94	0.0162	0.0014	0.0020	0.0196	6/18/02 - 7/12/02	24	0.0000221107	17.3626665
FI-25-HS-HN-016B	34.79	26.36	36.95	32.70	0.0065	0.0016	0.0018	0.0099	6/18/02 - 7/12/02	24	0.0000126146	
					0.45 micron	0.22 micron	0.10 micron				sum>	332.1568268
Average	34.61	26.01	37.64	32.15	0.0107	0.0029	0.0029	0.0165			ave>	20.75980167
Std. Dev.	7.71	8.54	2.76	3.80	0.0048	0.0034	0.0026	0.0076				

Mass Flow Ave. By No Shot/Shot Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By MWP Type Filtered Solids (mg/L)	Std. Dev.	Mass Flow Ave. By Solution Filtered Solids (mg/L)	Std. Dev.
No Shot		**Bathtub**		**Control**	
22.4	5.3	13.5	6.2	16.5	7.7
		Flow-through			
		19.6	7.9		
With Shot					
10.7	2.5				
No Shot		**Bathtub**		**HS**	
25.2	14.4	17.1	4.7	19.6	9.4
		Flow-through			
		22.1	16.4		
With Shot					
14.0	4.1				
No Shot		**Bathtub**		**LPH**	
27.1	15.6	31.3	14.5	26.0	6.5
		Flow-through			
		20.6	3.9		
With Shot					
24.8	7.4				
No Shot		**Bathtub**		**HS-HN**	
24.2	4.4	19.2	3.1	21.0	4.9
		Flow-through			
		22.7	7.3		
With Shot					
17.7	4.8				
				20.8	**3.9**

For Bathtub, No Iron Shot (BN):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.	
Control	1	5.05	0.0015	2	0.04	
	2	3.10	0.0014	2	0.06	
	3	3.20	0.0007	2	0.03	
	4	2.05	0.0008	2	0.05	
	Total	13.40				13.40
HS	1	5.10	0.0007	2	0.02	
	2	3.70	0.0011	2	0.04	
	3	2.15	0.0015	2	0.10	
	4	1.25	0.0006	2	0.07	
	Total	12.20				12.20
LPH	1	11.35	0.0091	2	0.11	
	2	11.50	0.0092	2	0.11	
	3	3.55	0.0021	2	0.08	
	4	1.15	0.0016	2	0.20	
	Total	27.55				
HS-HN	1	8.65	0.0004	2	0.01	
	2	3.50	0.0008	2	0.03	
	3	0.75	0.0004	2	0.07	
	4	3.15	0.0005	2	0.02	
	Total	16.05				

For Bathtub, Iron Shot (BI):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
Control	1	3.55	0.0002	2	0.01
	2	1.55	0.0008	2	0.07
	3	1.60	0.0003	2	0.03
	4	1.10	0.0001	2	0.02
	Total	7.80			
HS	1	3.15	0.0001	2	0.00
	2	4.45	0.0006	2	0.02
	3	1.05	0.0015	2	0.20
	4	3.60	0.0003	2	0.01
	Total	12.25			
LPH	1	8.30	0.0049	2	0.08
	2	6.55	0.0053	2	0.11
	3	2.65	0.0015	2	0.08
	4	6.30	0.0061	2	0.14
	Total	23.80			
HS-HN	1	7.10	0.0018	2	0.04

	2	2.50	0.0017	2	0.10
	3	1.30	0.0006	2	0.06
	4	2.10	0.0006	2	0.04
	Total	13.00			

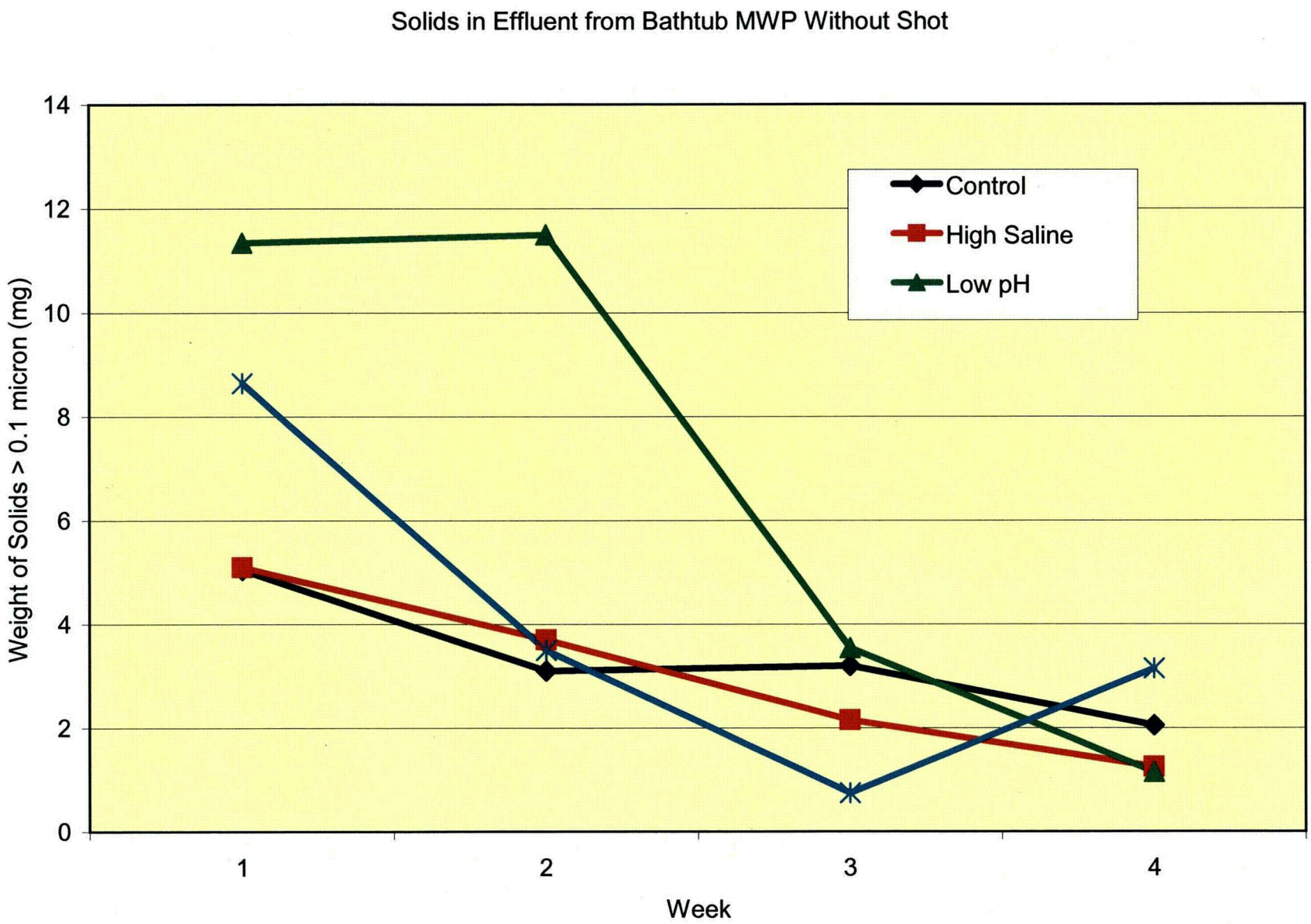
For Flowthru, No Iron Shot (FN):

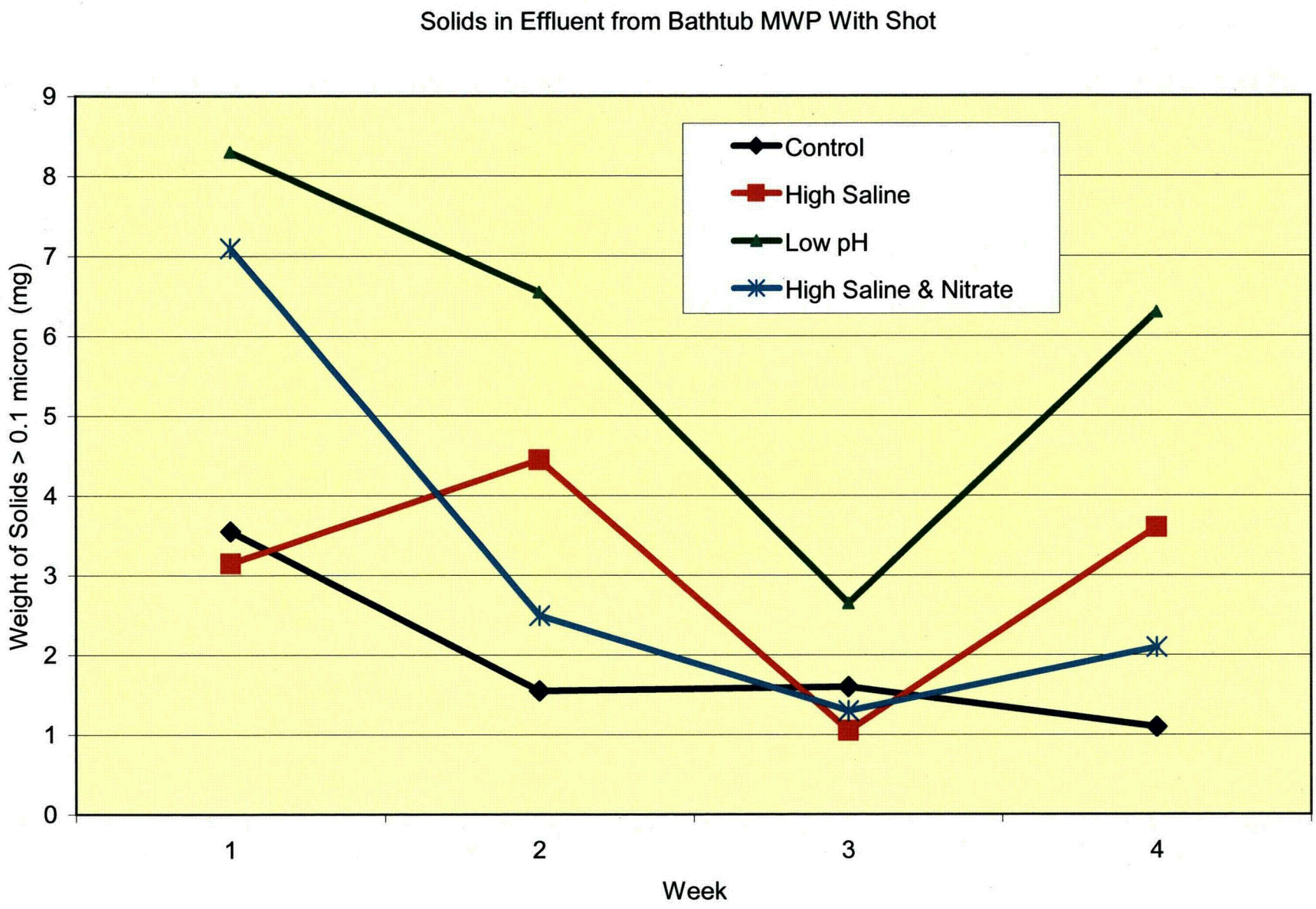
SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
Control	1	10.90	0.0045	2	0.06
	2	4.95	0.0013	2	0.04
	3	5.20	0.0006	2	0.02
	4	2.75	0.0009	2	0.05
	Total	23.80			
HS	1	4.15	0.0019	2	0.07
	2	3.90	0.0109	2	0.39
	3	6.55	0.0002	2	0.00
	4	0.50	0.0004	2	0.10
	Total	22.55			
LPH	1	10.30	0.0037	2	0.05
	2	4.15	0.0018	2	0.06
	3	3.20	0.0004	2	0.02
	4	0.90	0.0004	2	0.07
	Total	18.55			
HS-HN	1	13.25	0.0059	2	0.06
	2	3.15	0.0013	2	0.06
	3	1.80	0.0010	2	0.08
	4	2.95	0.0011	2	0.05
	Total	21.15			

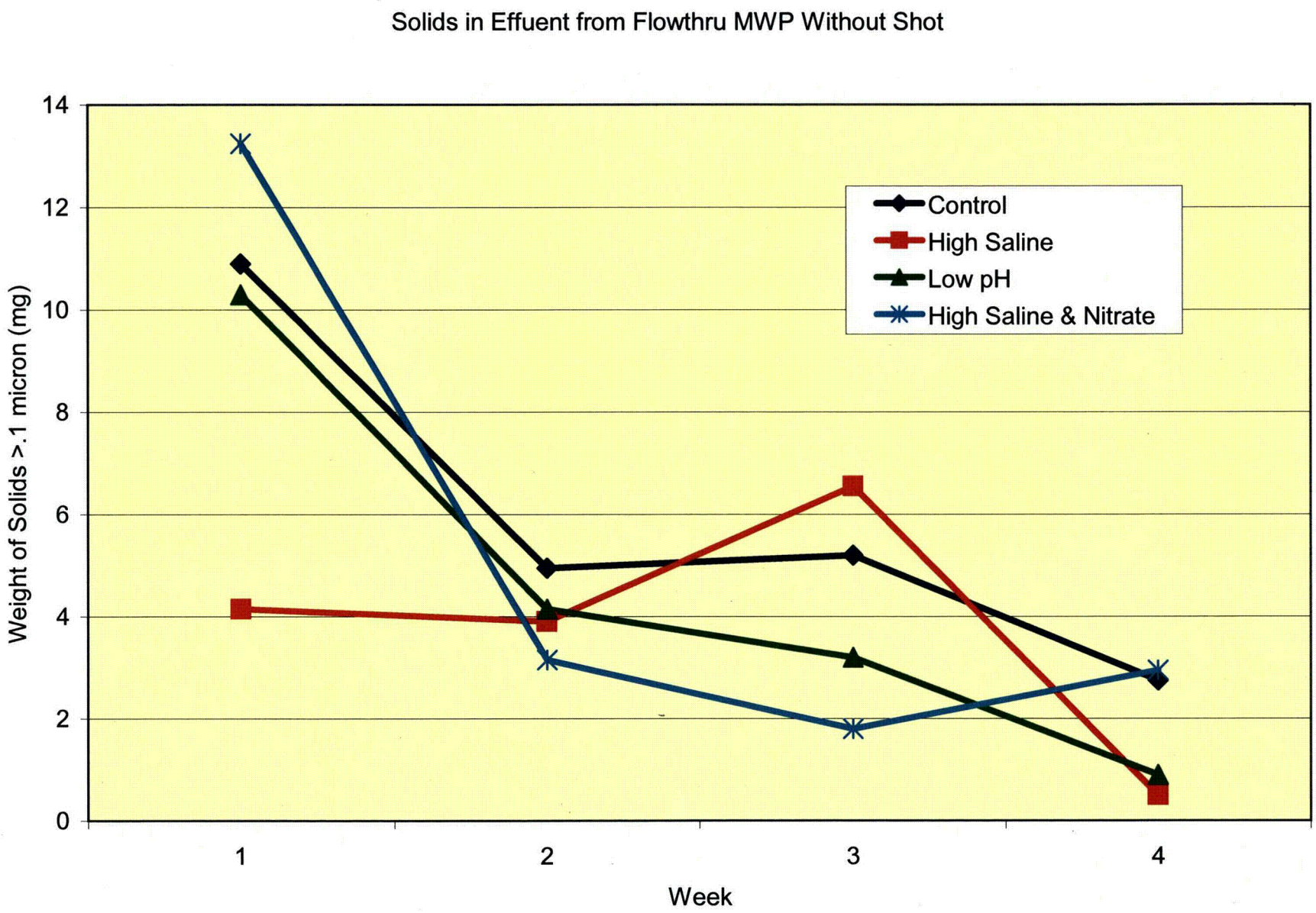
For Flowthru, Iron Shot (FI):

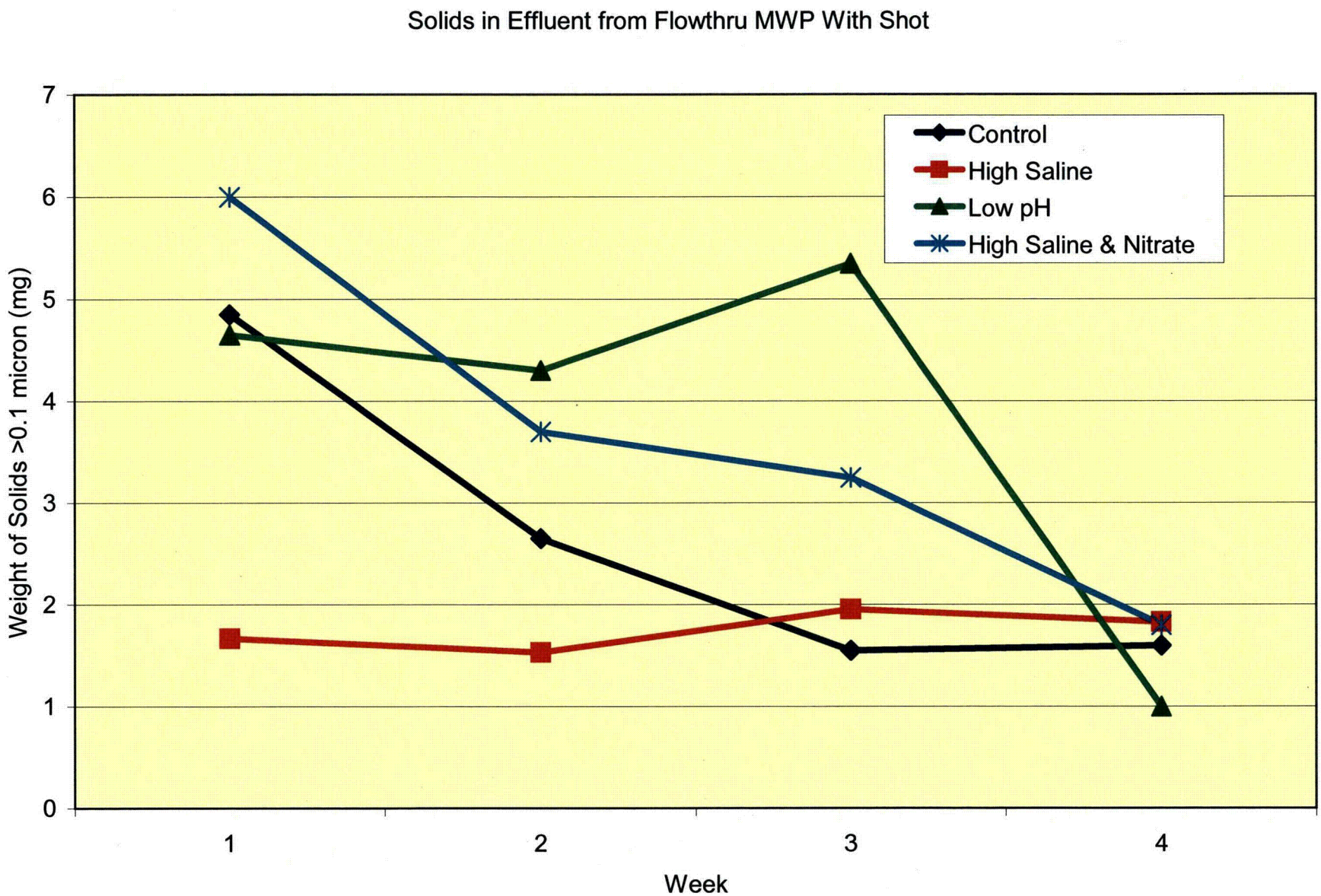
SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
Control	1	4.85	0.0025	2	0.07
	2	2.65	0.0016	2	0.09
	3	1.55	0.0009	2	0.08
	4	1.60	0.0004	2	0.04
	Total	10.65			
HS	1	1.67	0.0004	2	0.03
	2	1.53	0.0000	2	0.00
	3	1.95	0.0005	2	0.04
	4	1.83	0.0007	2	0.05
	Total	3.70			
LPH	1	4.65	0.0006	2	0.02

	2	4.30	0.0025	2	0.08
	3	5.35	0.0016	2	0.04
	4	1.00	0.0004	2	0.06
	Total	15.30			
HS-HN	1	6.00	0.0033	2	0.08
	2	3.70	0.0000	2	0.00
	3	3.25	0.0028	2	0.12
	4	1.80	0.0008	2	0.07
	Total	14.75			


Solids in Effluent from Bathtub MWP Without Shot
Weight of Solids > 0.1 micron (mg)
14
12
10
8
6
4
2
0
1
2
3
4
Week
Control
High Saline
Low pH


Solids in Effluent from Bathtub MWP With Shot
Weight of Solids > 0.1 micron (mg)
0
1
2
3
4
5
6
7
8
9
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Solids in Effuent from Flowthru MWP Without Shot
Weight of Solids >.1 micron (mg)
14
12
10
8
6
4
2
0
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Solids in Effluent from Flowthru MWP With Shot
Weight of Solids >0.1 micron (mg)
0
1
2
3
4
5
6
7
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate

MWP Model

Bathtub w/o Shot
J-13 Control

	Week	001A	001B	Average(mg)	Std. Dev. (g)	R.P.D.
Bathtub w/o Shot	1	0.0040	0.0061	5.0500	0.0015	0.04
	2	0.0021	0.0041	3.1000	0.0014	0.06
	3	0.0027	0.0037	3.2000	0.0007	0.03
	4	0.0026	0.0015	2.0500	0.0008	0.05
	Total	0.0114	0.0154	13.4000		

MWP Model

Bathtub With Shot
Control

	Week	002A	002B	Average(mg)	Std. Dev. (g)	R.P.D.
Bathtub With Shot	1	0.0034	0.0037	3.5500	0.0002	0.01
	2	0.0010	0.0021	1.5500	0.0008	0.07
	3	0.0018	0.0014	1.6000	0.0003	0.03
	4	0.0010	0.0012	1.1000	0.0001	0.02
	Total	0.0072	0.0084	7.8000		

Flowthru w/o Shot
Control

	Week	003A	003B	Average(mg)	Std. Dev. (g)	R.P.D.
Flowthru w/o Shot	1	0.0141	0.0077	10.9000	0.0045	0.06
	2	0.0040	0.0059	4.9500	0.0013	0.04
	3	0.0048	0.0056	5.2000	0.0006	0.02
	4	0.0021	0.0034	2.7500	0.0009	0.05
	Total	0.0250	0.0226	23.8000		

Flowthru with Shot
Control

	Week	004A	004B	Average(mg)	Std. Dev. (g)	R.P.D.
Flowthru with Shot	1	0.0066	0.0031	4.8500	0.0025	0.07
	2	0.0015	0.0038	2.6500	0.0016	0.09
	3	0.0022	0.0009	1.5500	0.0009	0.08
	4	0.0019	0.0013	1.6000	0.0004	0.04
	Total	0.0122	0.0091	10.6500		

Bathtub w/o Shot
High Saline

005A	005B	Average(mg)	Std. Dev. (g)	R.P.D.
0.0056	0.0046	5.1000	0.0007	0.02
0.0029	0.0045	3.7000	0.0011	0.04
0.0011	0.0032	2.1500	0.0015	0.10
0.0008	0.0017	1.2500	0.0006	0.07
0.0104	0.0140	12.2000		

Bathtub w/o Shot
Low pH

009A	009B
0.0178	0.0049
0.018	0.005
0.005	0.0021
0	0.0023
0.0408	0.0143

Bathtub With Shot
High Saline

006A	006B	Average(mg)	Std. Dev. (g)	
0.0031	0.0032	3.1500	0.0001	0.00
0.0040	0.0049	4.4500	0.0006	0.02
0.0000	0.0021	1.0500	0.0015	0.20
0.0038	0.0034	3.6000	0.0003	0.01
0.0109	0.0136	12.2500		

Bathtub With Shot
Low pH

010A	010B
0.0118	0.0048
0.0028	0.0103
0.0016	0.0037
0.002	0.0106
0.0182	0.0294

Flowthru w/o Shot
High Saline

007A	007B	Average(mg)	Std. Dev. (g)	
0.0055	0.0028	4.1500	0.0019	0.07
0.0193	0.0039	3.9000	0.0109	0.39
0.0067	0.0064	6.5500	0.0002	0.00
0.0005	0.0000	0.5000	0.0004	0.10
0.0320	0.0131	22.5500		

Flowthru w/o Shot
Low pH

011A	011B
0.0077	0.0129
0.0029	0.0054
0.0029	0.0035
0.0012	0.0006
0.0147	0.0224

Flowthru with Shot
High Saline

008A	008B	Average(mg)	Std. Dev. (g)	
0.0014	0.0019	1.6687	0.0004	0.03
0.0015	0.0016	1.5316	0.0000	0.00
0.0023	0.0016	1.9548	0.0005	0.04
0.0023	0.0014	1.8311	0.0007	0.05
0.0075	0.0037	3.7000		

Flowthru with Shot
Low pH

012A	012B
0.0042	0.0051
0.0025	0.0061
0.0042	0.0065
0.0013	0.0007
0.0122	0.0184

Average(mg)	Std. Dev. (g)	R.P.D.
11.3500	0.0091	0.11
11.5000	0.0092	0.11
3.5500	0.0021	0.08
1.1500	0.0016	0.20
27.5500		

Average(mg)	Std. Dev. (g)	
8.3000	0.0049	0.08
6.5500	0.0053	0.11
2.6500	0.0015	0.08
6.3000	0.0061	0.14
23.8000		

Average(mg)	Std. Dev. (g)	
10.3000	0.0037	0.05
4.1500	0.0018	0.06
3.2000	0.0004	0.02
0.9000	0.0004	0.07
18.5500		

Average(mg)	Std. Dev. (g)	
4.6500	0.0006	0.02
4.3000	0.0025	0.08
5.3500	0.0016	0.04
1.0000	0.0004	0.06
15.3000		

Bathtub w/o Shot
LPH-HS

013A	013B	Average(mg)	Std. Dev. (g)
0.0089	0.0084	8.65	0.000
0.0041	0.0029	3.50	0.001
0.0005	0.0010	0.75	0.000
0.0035	0.0028	3.15	0.000
0.0170	0.0151	16.05	

Bathtub With Shot
LPH-HS

014A	014B	Average(mg)	Std. Dev. (g)
0.0084	0.0058	7.10	0.002
0.0013	0.0037	2.50	0.002
0.0017	0.0009	1.30	0.001
0.0025	0.0017	2.10	0.001
0.0139	0.0121	13.00	

Flowthru w/o Shot
LPH-HS

015A	015B	Average(mg)	Std. Dev. (g)
0.0174	0.0091	13.25	0.006
0.0022	0.0041	3.15	0.001
0.0011	0.0025	1.80	0.001
0.0022	0.0037	2.95	0.001
0.0229	0.0194	21.15	

Flowthru with Shot
LPH-HS

016A	016B	Average(mg)	Std. Dev. (g)
0.0083	0.0037	6.00	0.003
0.0037	0.0037	3.70	0.000
0.0052	0.0013	3.25	0.003
0.0024	0.0012	1.80	0.001
0.0196	0.0099	14.75	

R.P.D.		Mass Flow mg/L		SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)
0.01					
0.03			Control	0.0091	0.0017
0.07				0.0126	0.002
0.02				0.005	0.0017
				0.0062	0.0014
				0.0229	0.0014
				0.0199	**0.0017**
				0.0101	**0.0013**
				0.0064	**0.0015**
0.04	Control	16.5		0.45 micron	0.22 micron
0.10	High Saline	19.4	Sum:	0.0922	0.0127
0.06	Low pH	26.0			
0.04	High Saline-High Nitrate	21.0	HS	0.0081	0.0013
				0.0086	0.0028
				0.006	0.0016
				0.0075	0.0019
				0.0069	0.0179
				0.0078	**0.0024**
0.06				**0.0051**	**0.0021**
0.06				**0.0039**	**0.0017**
0.08				0.45 micron	0.22 micron
0.05			Sum:	0.0539	0.0317
			LPH	0.0193	0.01
				0.008	0.003
				0.009	0.0052
				0.0108	0.0091
0.08				0.0098	0.003
0.00				**0.0152**	**0.0015**
0.12				**0.0095**	**0.0009**
0.07				**0.015**	**0.0016**
				0.45 micron	0.22 micron
			Sum:	0.0966	0.0343
			HS-HN	0.0094	0.0037
				0.0113	0.0014
				0.0104	0.0013
				0.0098	0.0008
				0.0193	0.002
				0.0158	0.001
				0.0162	0.0014
				0.0065	0.0016
				0.45 micron	0.22 micron
			Sum:	0.0987	0.0132

SOLIDS
ON .10 UM
(g)

0.0006
0.0008
0.0005
0.0008
0.0007
0.001
0.0008
0.0012
0.10 micron
0.0064

0.001
0.0026
0.0033
0.0042
0.0072
0.0029
0.0056
0.0019
0.10 micron
0.0287

0.0115
0.0033
0.004
0.0095
0.0019
0.0057
0.0018
0.0018
0.10 micron
0.0395

0.0039
0.0024
0.0022
0.0015
0.0016
0.0026
0.002
0.0018
0.10 micron
0.018

pH data are included in the Microsoft Excel workbook file "Task 34 pH Data and Graphs Final Dec 02 - Jan 03.xls." Within this file are six worksheets (spreadsheets) described below.

The spreadsheet "Overview and data tracking info" provides summary information, including names of the investigators, task number, keywords, brief description of the data, and IPLV's used.

The spreadsheet "pH Source Data" within the file contains the individual results for all the pH measurements, including replicate measurements.

The spreadsheet "pH Chart Data" contains the pH data used in generating the spreadsheet charts (e.g., the data was put in a format that could be easily graphed).

The spreadsheet "pH Data Summary Table" is a summary of the pH information by MWP type (e.g., bathtub – no iron shot), by solution type (e.g., control), and by week. It contains the average pH for the replicate measurements and the duplicate experiments, along with the associated standard deviations.

The spreadsheet "Chart Flowthru no Shot" graphically shows the pH for the flow-through MWP without shot by week for each solution type.

The spreadsheet "Chart Bathtub no Shot" graphically shows the pH for the bathtub MWP without shot by week for each solution type.

Dissolved Oxygen (DO) data are included in the Microsoft Excel workbook file "Task 34 DO Data and Graphs Final Dec 02 – Jan 03.xls." Within this file are five worksheets (spreadsheets) described below.

The spreadsheet "Overview and data tracking info" provides summary information, including names of the investigators, task number, keywords, brief description of the data, and IPLV's used.

The spreadsheet "DO Source Data" within the file contains the individual results for all the DO measurements, including replicate measurements.

The spreadsheet "DO Data Summary Table" is a summary of the DO information by MWP type (e.g., bathtub – no iron shot), by solution type (e.g., control), and by week. It contains the average DO for the replicate measurements and the duplicate experiments, along with the associated standard deviations.

The spreadsheet "Chart Flowthru no Shot" graphically shows the DO for the flow-through MWP without shot by week for each solution type.

The spreadsheet "Chart Bathtub no Shot" graphically shows the DO for the bathtub MWP without shot by week for each solution type.

Electrical Conductivity (Conductivity) data are included in the Microsoft Excel workbook file "Task 34 Conductivity Data and Graphs Final Dec 02.xls." Within this file are five worksheets (spreadsheets) described below.

The spreadsheet "Overview and data tracking info" provides summary information, including names of the investigators, task number, keywords, brief description of the data, and IPLV's used.

The spreadsheet "Conductivity Source Data" within the file contains the individual results for all the DO measurements, including replicate measurements.

The spreadsheet "Conductivity Data Summary Table" is a summary of the conductivity information by MWP type (e.g., bathtub – no iron shot), by solution type (e.g., control), and by week. It contains the average conductivity for the replicate measurements and the duplicate experiments, along with the associated standard deviations.

The spreadsheet "Chart Flowthru no Shot" graphically shows the conductivity for the flow-through MWP without shot by week for each solution type.
The spreadsheet "Chart Bathtub with Shot" graphically shows the conductivity for the bathtub MWP with shot by week for each solution type.

The spreadsheet "Chart Bathtub no Shot" graphically shows the conductivity for the bathtub MWP without shot by week for each solution type.

pH Source Data

Legend:
BN = Bath Tub Model MWP without Iron Shot
BI = Bath Tub Model MWP with Iron Shot
FN = Flowthru Model MWP without Iron Shot
FI = Flowthru Model MWP with Iron Shot

J-13 Control

	pH readings 1	2	3	4	5	6	Average

High Saline

		pH Readings 1	2	3	4	5	6	7	8	9	Average
BN-25-HS-037A	12/13/02-12/20/02	9.08	9.08	9.08	9.78	9.79	9.79	9.25	9.25	9.26	9.37
	12/20/02-12/27/02	9.29	9.30	9.30	9.40	9.40	9.41				9.35
	12/27/02-1/3/03	9.60	9.61	9.62	9.78	9.79	9.79				9.70
	1/3/2003-1/10/03	9.58	9.58	9.58	9.81	9.81	9.82	9.69	9.69	9.70	9.70
BN-25-HS-037B	12/13/02-12/20/02	9.08	9.08	9.08	9.78	9.79	9.79	9.25	9.25	9.26	9.37
	12/20/02-12/27/02	9.33	9.34	9.35	9.47	9.48	9.48				9.41
	12/27/02-1/3/03	9.78	9.79	9.79	10.01	10.03	10.03				9.91
	1/3/2003-1/10/03	9.60	9.61	9.61	9.86	9.86	9.86	9.74	9.74	9.74	9.74
FN-25-HS-039A	12/13/02-12/20/02	9.00	9.01	9.01	9.05	9.05	9.05	9.32	9.33	9.33	9.13
	12/20/02-12/27/02	9.33	9.34	9.35	9.49	9.49	9.49				9.42
	12/27/02-1/3/03	9.70	9.70	9.70	10.09	10.09	10.09				9.90
	1/3/2003-1/10/03	9.60	9.63	9.63	9.80	9.80	9.81	9.75	9.75	9.76	9.73
FN-25-HS-039B	12/13/02-12/20/02	9.02	9.02	9.02	9.04	9.04	9.04	9.23	9.24	9.24	9.03
	12/20/02-12/27/02	9.35	9.35	9.35	9.48	9.48	9.48				9.42
	12/27/02-1/3/03	9.84	9.84	9.84	10.20	10.20	10.21				10.02
	1/3/2003-1/10/03	9.65	9.66	9.66	9.79	9.79	9.79	9.73	9.73	9.73	9.73

Low pH

		pH Readings 1	2	3	4	5	6	7	8	9	Average
BN-25-LPH-041A	12/13/02-12/20/02	4.70	4.64	4.64	5.65	5.65	5.65	5.97	5.95	5.93	5.16
	12/20/02-12/27/02	4.35	4.3	4.3	3.3	3.18	3.16				3.77
	12/27/02-1/3/03	3.96	3.96	3.83	4.69	4.69	4.68				4.30
	1/3/2003-1/10/03	4.20	4.09	4.05	4.27	4.13	4.09	3.74	3.65	3.63	4.14

BN-25-LPH-041B	12/13/02-12/20/02	4.91	4.82	4.81	5.34	5.10	5.09	4.85	4.78	4.78	5.01
	12/20/02-12/27/02	4.04	4.03	4.02	3.46	3.45	3.42				3.74
	12/27/02-1/3/03	3.76	3.76	3.75	2.84	2.84	2.83				3.30
	1/3/2003-1/10/03	4.17	4.04	4.04	4.24	4.22	4.21	4.22	4.2	4.18	4.15
FN-25-LPH-043A	12/13/02-12/20/02	4.56	4.53	4.53	5.16	5.15	5.13	5.22	5.09	5.02	4.84
	12/20/02-12/27/02	4.80	4.78	4.75	3.84	3.85	3.85				4.31
	12/27/02-1/3/03	3.69	3.65	3.49	2.96	2.92	2.91				3.27
	1/3/2003-1/10/03	4.07	3.98	3.95	4.74	4.63	4.63	4.14	4.14	4.13	4.33
FN-25-LPH-043B	12/13/02-12/20/02	4.14	4.12	4.11	4.85	4.82	4.81	5.53	5.08	5.04	4.48
	12/20/02-12/27/02	4.58	4.50	4.50	3.86	3.77	3.76				4.16
	12/27/02-1/3/03	3.48	3.36	3.36	3.00	3.00	3.00				3.20
	1/3/2003-1/10/03	4.65	4.38	4.37	4.47	4.47	4.46	4.41	4.17	4.17	4.47

High Saline - High NO3		**pH Readings**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Average**
BN-25-LPH-HS-045A	12/13/02-12/20/02	9.03	9.04	9.04	8.95	8.96	8.97	9.13	9.14	9.14	9.00
	12/20/02-12/27/02	9.21	9.22	9.23	9.35	9.36	9.36				9.29
	12/27/02-1/3/03	9.64	9.64	9.64	9.85	9.86	9.86				9.75
	1/3/2003-1/10/03	9.59	9.59	9.59	9.61	9.62	9.62	9.79	9.80	9.80	9.60
BN-25-LPH-HS-045B	12/13/02-12/20/02	9.06	9.07	9.07	8.95	8.96	8.96	9.02	9.07	9.08	9.01
	12/20/02-12/27/02	9.22	9.22	9.22	9.39	9.39	9.39				9.31
	12/27/02-1/3/03	9.63	9.63	9.63	9.90	9.90	9.90				9.77
	1/3/2003-1/10/03	9.75	9.76	9.76	9.65	9.66	9.66	9.98	9.98	9.98	9.71
FN-25-LPH-HS-047A	12/13/02-12/20/02	9.10	9.10	9.10	9.02	9.03	9.03	9.20	9.20	9.21	9.06
	12/20/02-12/27/02	9.27	9.28	9.28	9.40	9.40	9.41				9.34
	12/27/02-1/3/03	9.61	9.62	9.62	9.79	9.79	9.79				9.70
	1/3/2003-1/10/03	9.83	9.84	9.84	9.71	9.71	9.71	10.03	10.04	10.04	9.77
FN-25-LPH-HS-047B	12/13/02-12/20/02	9.14	9.14	9.14	9.07	9.08	9.08	9.17	9.18	9.18	9.11
	12/20/02-12/27/02	9.18	9.18	9.18	9.30	9.31	9.31				9.24
	12/27/02-1/3/03	9.56	9.57	9.57	9.74	9.74	9.75				9.66
	1/3/2003-1/10/03	9.44	9.45	9.45	9.85	9.86	9.86	9.61	9.62	9.62	9.65

pH Summary Table

Legend:
St. Dev. = Standard Deviation
n = number of measurements
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For HS, LPH, HS-HN:
Week 1 = 12/13/02 - 12/20/02
Week 2 = 12/20/02 - 12/27/02
Week 3 = 12/27/02 - 1/3/03
Week 4 = 1/3/03 -1/10/03

For Bathtub, No Iron Shot (BN):

SOLUTION	WEEK	AVERAGE pH	ST. DEV.	n
HS	1	9.26	0.309	18
	2	9.38	0.071	12
	3	9.80	0.154	12
	4	9.72	0.104	18
LPH	1	5.08	0.489	18
	2	3.75	0.463	12
	3	3.80	0.688	12
	4	4.15	0.199	18
HS-HN	1	9.01	0.066	18
	2	9.30	0.081	12
	3	9.76	0.128	12
	4	9.66	0.136	18

For Flowthru, No Iron Shot (FN):

SOLUTION	WEEK	AVERAGE pH	ST. DEV.	n
HS	1	9.08	0.13	18
	2	9.42	0.07	12
	3	9.96	0.21	12
	4	9.73	0.07	18
LPH	1	4.66	0.41	18
	2	4.24	0.44	12
	3	3.24	0.30	12
	4	4.40	0.24	18
HS-HN	1	9.09	0.06	18
	2	9.29	0.08	12
	3	9.68	0.09	12
	4	9.71	0.19	18

Title: pH measurements for effluent solution from miniature waste packages

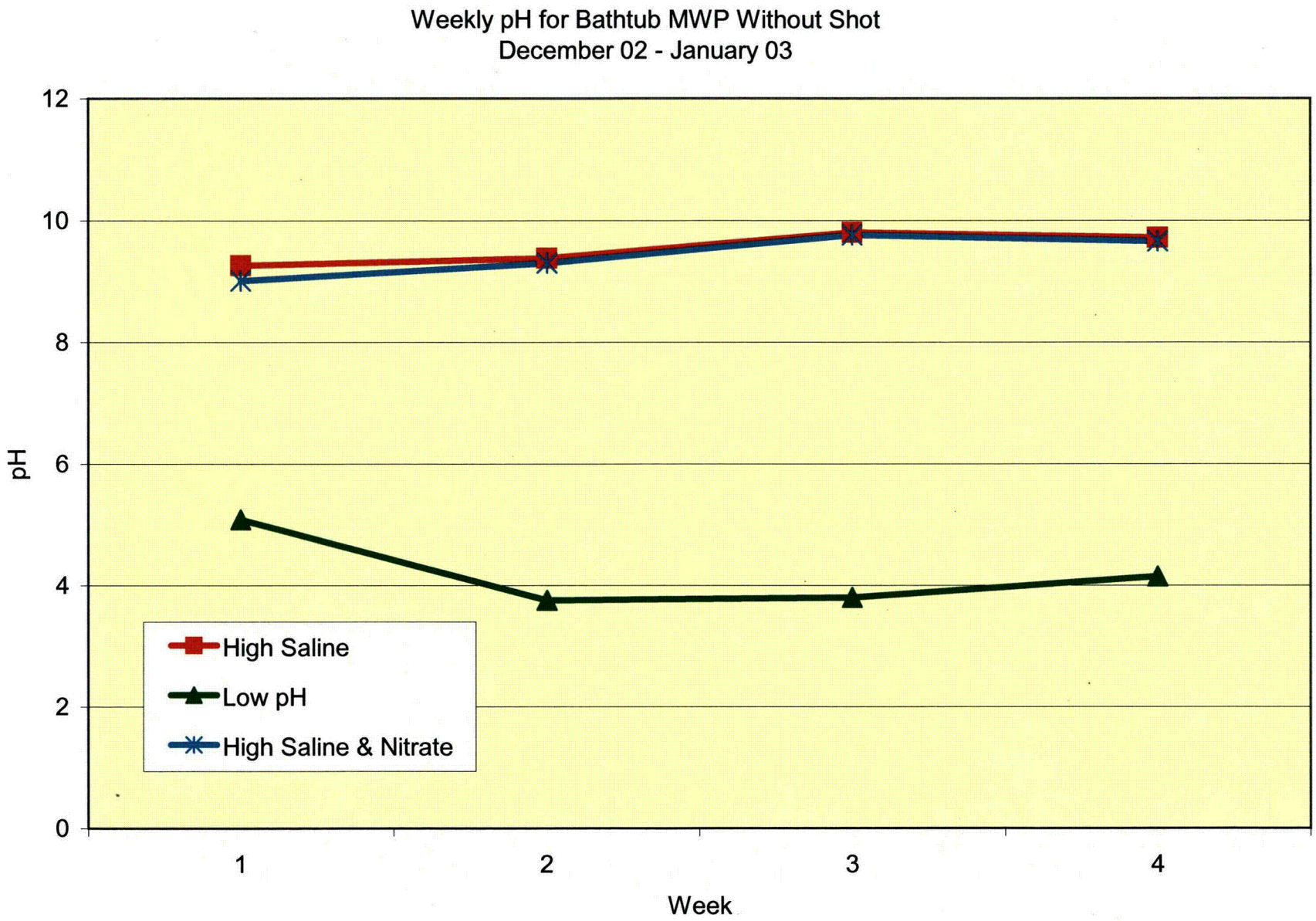
Legend:
St. Dev. = Standard Deviation
n = number of measurements

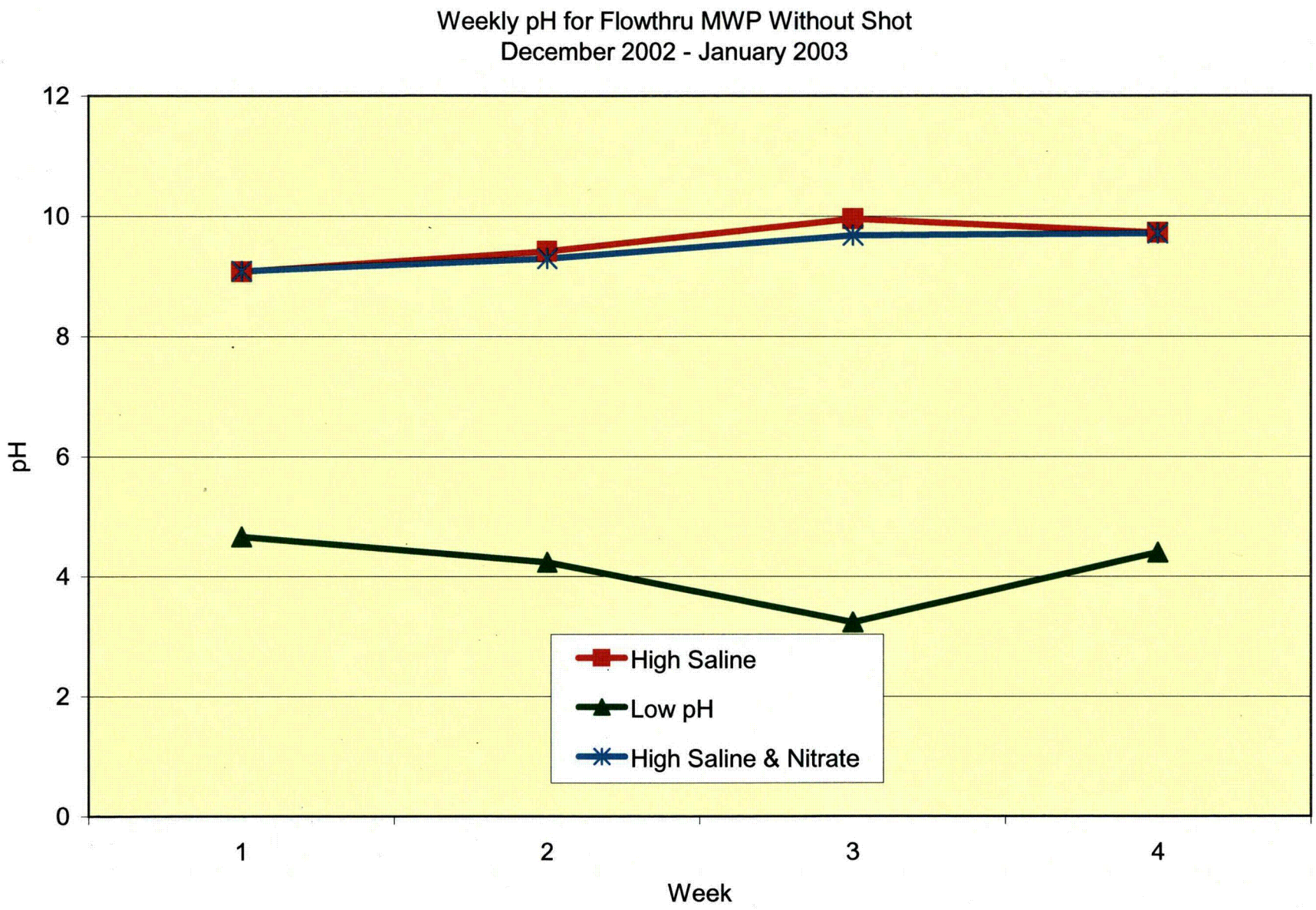
Control = J-13 well water
HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For HS, LPH, HS-HN:
Week 1 = 12/13/02 - 12/20/02
Week 2 = 12/20/02 - 12/27/02
Week 3 = 12/27/02 - 1/3/03
Week 4 = 1/3/03 - 1/10/03

MWP Model and Solution		Bathtub w/o Shot High Saline			Bathtub w/o Shot Low pH			Bathtub w/o Shot LPH-HS		
	Week	037A	037B	Average	041A	041B	Average	045A	045B	Average
Bathtub w/o Shot	1	9.37	9.15	9.26	5.16	5.01	5.08	9.00	9.01	9.01
	2	9.35	9.41	9.38	3.77	3.74	3.75	9.29	9.31	9.30
	3	9.70	9.91	9.80	4.30	3.30	3.80	9.75	9.77	9.76
	4	9.70	9.74	9.72	4.14	4.15	4.15	9.60	9.71	9.66

MWP Model		Flowthru w/o Shot High Saline			Flowthru w/o Shot Low pH			Flowthru w/o Shot LPH-HS		
	Week	039A	039B	Average	043A	043B	Average	047A	047B	Average
Flowthru w/o Shot	1	9.13	9.03	9.08	4.84	4.48	4.66	9.06	9.11	9.09
	2	9.42	9.42	9.42	4.31	4.16	4.24	9.34	9.24	9.29
	3	9.90	10.02	9.96	3.27	3.20	3.24	9.70	9.66	9.68
	4	9.73	9.73	9.73	4.33	4.47	4.40	9.77	9.65	9.71


Weekly pH for Bathtub MWP Without Shot
December 02 - January 03
12
10
8
6
4
2
0
pH
1
2
3
4
Week
High Saline
Low pH
High Saline & Nitrate


Weekly pH for Flowthru MWP Without Shot
December 2002 - January 2003
12
10
8
6
4
2
0
pH
1
2
3
4
Week
High Saline
Low pH
High Saline & Nitrate

Dissolved Oxygen Summary Table

Legend:
BN = Bath Tub Model MWP without Iron Shot
BI = Bath Tub Model MWP with Iron Shot
FN = Flowthru Model MWP without Iron Shot
FI = Flowthru Model MWP with Iron Shot

For HS, LPH, HS-HN:
Week 1 = 12/13/02 - 12/20/02
Week 2 = 12/20/02 - 12/27/02
Week 3 = 12/27/02 - 1/3/03
Week 4 = 1/3/03 -1/10/03

High Saline	DO (ppm) 1	2	3	4	5	6	AVG	Week	A & B AVG	stdev	n
BN-25-HS-037A	2.90	3.18	3.18	3.54	3.48	3.60	3.31	1	3.30	0.25	12
	3.04	2.42	4.73	4.81			3.75	2	3.97	0.96	8
	3.08	3.04	2.88	2.94			2.99	3	2.87	0.29	8
	3.19	3.01	2.58	2.73	4.23	4.23	3.33	4	3.58	0.70	12
BN-25-HS-037B	3.00	3.01	3.23	3.31	3.60	3.51	3.28				
	3.90	3.27	4.77	4.85			4.20				
	2.97	3.18	2.54	2.32			2.75				
	3.00	3.05	4.34	4.14	4.30	4.20	3.84				
FN-25-HS-039A	3.17	2.97	3.58	3.88	4.03	4.06	3.62	1	3.61	0.48	12
	3.18	3.87	5.22	5.12			4.35	2	4.16	0.85	8
	3.22	3.31	2.46	2.45			2.88	3	2.79	0.51	8
	3.32	3.10	4.61	4.64	4.75	4.88	4.21	4	4.22	0.73	12
FN-25-HS-039B	3.18	3.20	3.53	3.45	3.58	4.65	3.60				
	3.30	3.30	4.62	4.65			3.97				
	3.12	3.39	2.22	2.18			2.73				
	3.53	3.23	4.64	5.24	4.47	4.30	4.24				

Low pH	1	2	3	4	5	6	AVG	Week	A & B AVG	Stdev	n
BN-25-LPH-041A	5.01	4.94	4.58	4.80	5.44	5.49	5.04	1	4.96	0.30	12
	4.91	5.05	6.88	7.00			5.96	2	5.85	1.01	8
	4.93	5.07	4.94	4.49			4.88	3	4.85	0.20	8
	4.98	4.85	5.90	6.09	5.98	6.05	5.54	4	5.58	0.53	12
BN-25-LPH-041B	4.94	4.60	4.92	4.86	5.07	5.21	4.93				
	5.00	4.72	6.56	6.68			5.74				
	4.82	4.82	5.06	4.88			4.85				
	4.83	4.84	5.84	5.69	5.94	5.91	5.51				
FN-25-LPH-043A	4.15	4.32	4.67	4.72			4.47	1	4.53	0.19	12
	4.38	4.41	4.67	4.75			4.55	2	4.56	0.22	8
	3.72	3.74	4.47	4.15			4.02	3	4.16	0.33	8
	4.76	4.62					4.69	4	4.81	0.17	12
FN-25-LPH-043B	4.57	4.55	4.60	4.62			4.59				
	4.30	4.34	4.77	4.84			4.56				
	4.69	4.31	4.17	4.04			4.30				
	4.83	5.03					4.93				

High Saline-High NO3	1	2	3	4	5	6	AVG	Week	A & B AVG	Stdev	n
BN-25-LPH-HS-045A	3.52	3.80	4.20	4.41	3.79	3.91	3.81	1	3.98	0.34	12
	3.88	4.19	5.37	5.35			4.70	2	4.86	0.59	8
	3.65	3.87	3.98	3.73			3.86	3	3.91	0.20	8
	3.59	3.54	4.92	4.82	4.56	4.60	4.34	4	4.14	0.63	12
BN-25-LPH-HS-045B	3.99	3.43	4.42	4.30	3.81	3.85	3.97				
	4.25	4.17	5.02	5.02			4.62				
	3.95	4.26	3.90	4.02			3.96				
	3.50	3.52	4.14	4.22	4.96	5.17	4.25				
FN-25-LPH-HS-047A	4.03	4.03	4.50	4.48	3.99	4.30	4.22	1	4.16	0.30	12
	4.25	4.07	5.82	5.70			4.96	2	5.08	0.90	8
	3.72	4.00	3.73	3.73			3.80	3	3.73	0.12	8
	4.06	4.24	4.61	4.81	5.25	5.42	4.73	4	4.51	0.53	12
FN-25-LPH-HS-047B	3.60	3.73	4.51	4.41	4.02	4.25	4.09				
	4.38	4.29	6.06	6.05			5.20				
	3.64	3.75	3.63	3.64			3.67				
	3.91	3.77	4.52	4.54	5.08	4.88	4.45				

Dissolved Oxygen Summary Table

Legend:
D.O. = Dissolved Oxygen
ppm = parts-per-million
St. Dev. = Standard Deviation
n = number of measurements

HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For HS, LPH, HS-HN:
Week 1 = 12/13/02 - 12/20/02
Week 2 = 12/20/02 - 12/27/02
Week 3 = 12/27/02 - 1/3/03
Week 4 = 1/3/03 -1/10/03

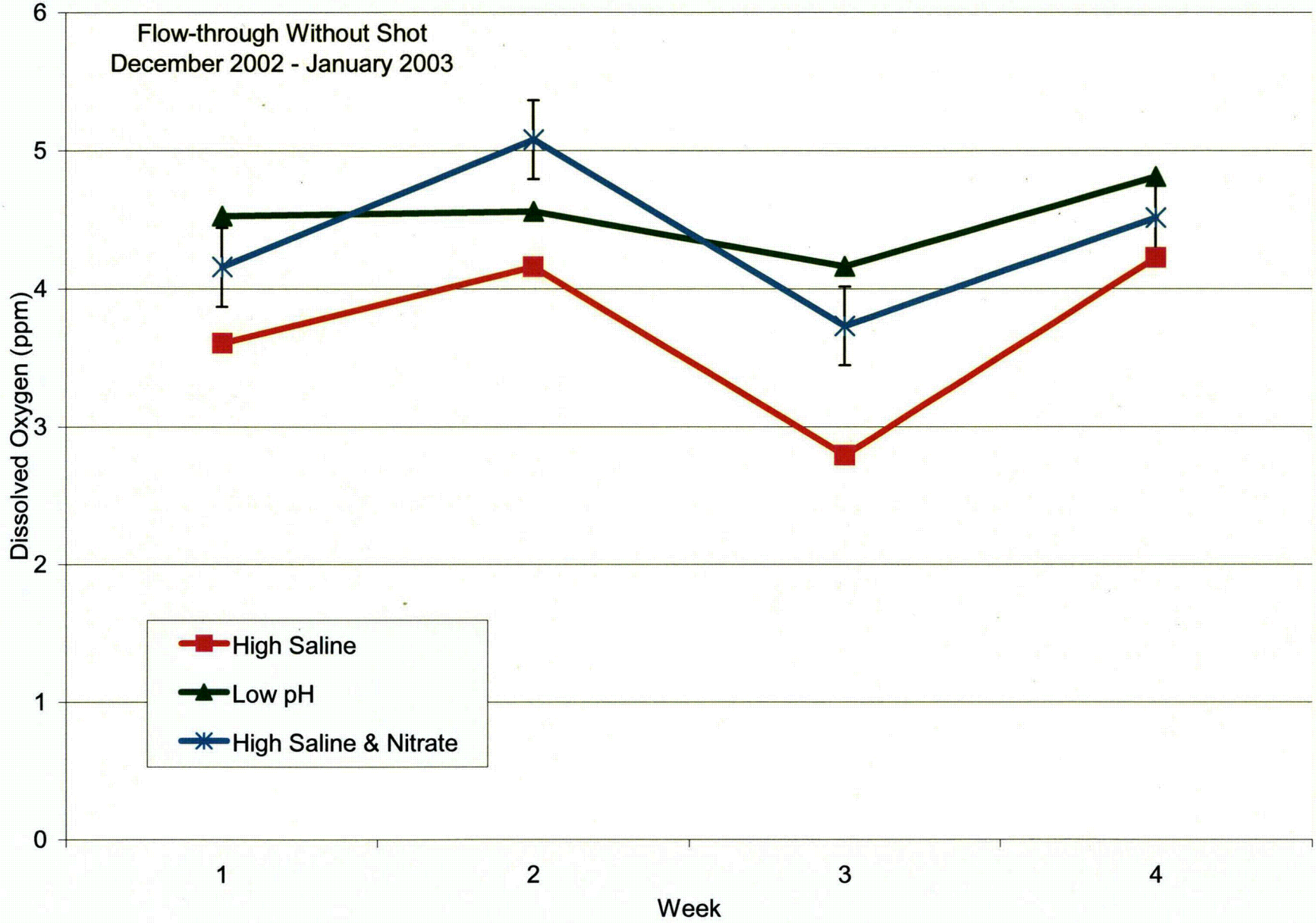
For Bathtub, No Iron Shot (BN):

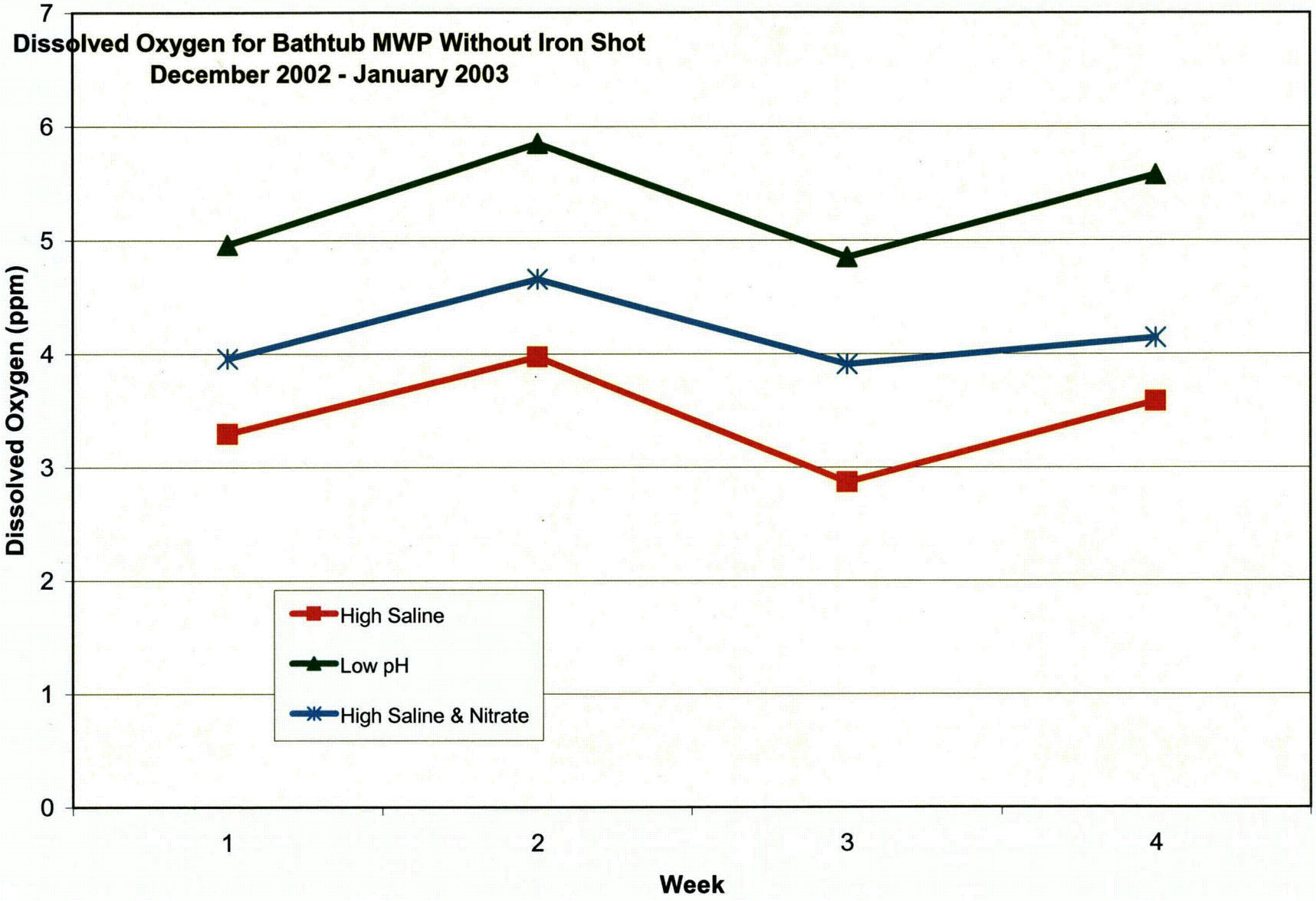
SOLUTION	WEEK	AVERAGE D.O. (ppm)	ST. DEV.	n
HS	1	3.30	0.25	12
	2	3.97	0.96	8
	3	2.87	0.29	8
	4	3.58	0.70	12
LPH	1	4.96	0.30	12
	2	5.85	1.01	8
	3	4.85	0.20	8
	4	5.58	0.53	12
HS-HN	1	3.96	0.34	12
	2	4.66	0.59	8
	3	3.91	0.20	8
	4	4.14	0.63	12

For Flowthru, No Iron Shot **(FN)**:

SOLUTION	WEEK	AVERAGE D.O. (ppm)	ST. DEV.	n
HS	1	3.61	0.48	12
	2	4.16	0.85	8
	3	2.79	0.51	8
	4	4.22	0.73	12
LPH	1	4.53	0.19	12
	2	4.56	0.22	8
	3	4.16	0.33	8

	4	4.81	0.17	12
HS-HN	1	4.16	0.30	12
	2	5.08	0.90	8
	3	3.73	0.12	8
	4	4.51	0.53	12


Flow-through Without Shot
December 2002 - January 2003
Dissolved Oxygen (ppm)
6
5
4
3
2
1
0
1
2
3
4
Week
High Saline
Low pH
High Saline & Nitrate


Dissolved Oxygen for Bathtub MWP Without Iron Shot
December 2002 - January 2003
Dissolved Oxygen (ppm)
0
1
2
3
4
5
6
7
1
2
3
4
Week
High Saline
Low pH
High Saline & Nitrate

MWP Type	Week	High Saline Conductivity (uS) "A" Package			"B" Package			Average	Std. Dev.	n	Low pH Conductivity (uS) "A" Package			"B" Package			Average	Std. Dev.	n	HS-High NO3 Conductivity (uS) "A" Package			"B" Package			Average	Std. Dev.	n
Bathtub w/o shot	1	78900	87900	92200	79200	79200	85400	83800	5590	6	1691	1686	1721	1645	1601	1636	1663	44	6	83000	81700	81600	82700	82600	80700	82050	869	6
	2	90300	88900		82700	86000		86975	3366	4	1597	1663		1577	1639		1619	39	4	78900	80800		80900	81900		80625	1253	4
	3	83100	86900		88900	99800		89675	7166	4	1678	1655		1631	1577		1635	43	4	82500	85000		81700	91800		85250	4587	4
	4	85500	94300	85100	85900	90000	85200	87667	3740	6	1716	1774	1709	1626	1604	1632	1677	66	6	89500	82300	90400		87900		87525	3634	4
Flowthru w/o shot	1	80500	83500	76000	75100	75000	78900	78167	3422	6	1637	1556	1578	1652	1585	1600	1601	37	6	78600	78000	79100	81600	79300	83500	80017	2101	6
	2	76400	86100		73900	72600		77250	6107	4	1477	1493		1538	1517		1506	27	4	76400	77300		83000	83700		80100	3782	4
	3	86100	97200		82800			88700	7544	3	1506	1529		1544	1584		1541	33	4	78000	79400		85400	84600		81900	3747	4
	4	82200	81600	82000	77700	78400	77300	79667	2299	6	1544	1565	1560	1497	1719	1653	1591	83	6		84200		85700	91200	87600	87175	3023	4

85500
94300
85100

Conductivity Summary Table.

Legend:
uS = microSiemans
mS = milliSiemans
St. Dev. = Standard Deviation
n = number of measurements

HS = High Salt
LPH = Low pH
HS-HN = High Salt - High Nitrate

For HS, LPH, HS-HN:
Week 1 = 12/13/02 - 12/20/02
Week 2 = 12/20/02 - 12/27/02
Week 3 = 12/27/02 - 1/3/03
Week 4 = 1/3/03 -1/10/03

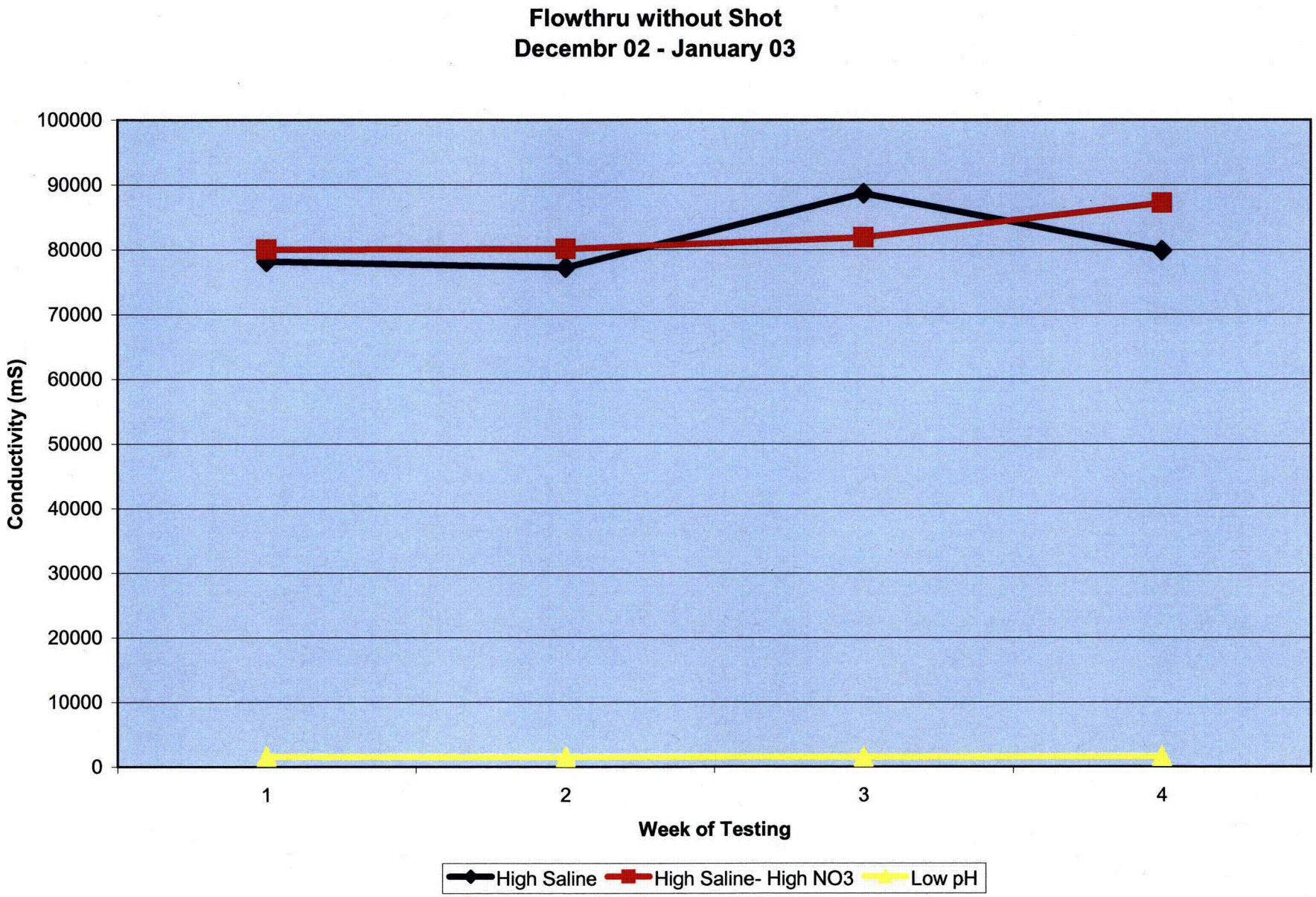
For Bathtub, No Iron Shot **(BN)**:

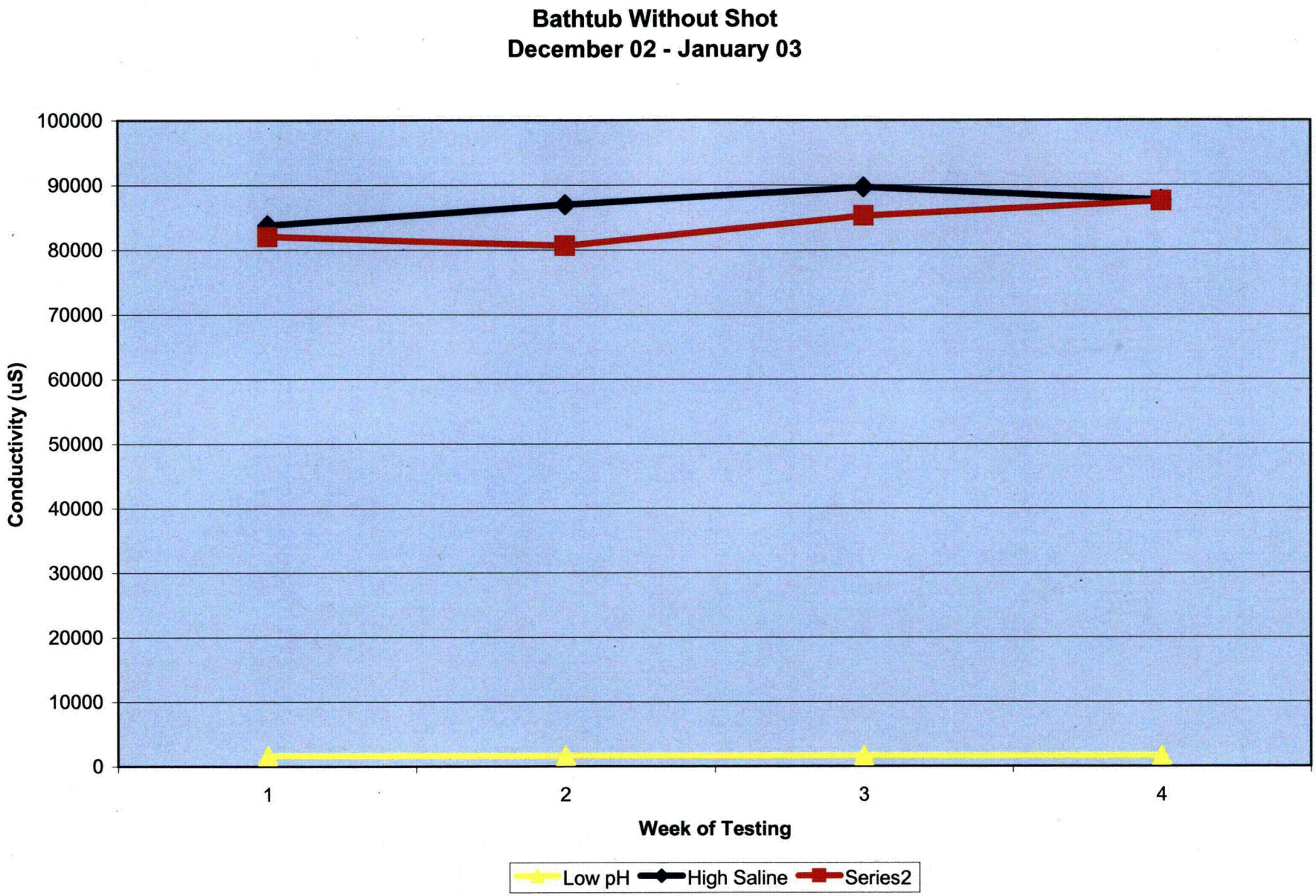
SOLUTION	WEEK	AVERAGE CONDUCTIVITY (uS)	ST. DEV.	n
HS	1	83800	5590	6
	2	86975	3366	4
	3	89675	7166	4
	4	87667	3740	6
LPH	1	1663	44	6
	2	1619	39	4
	3	1635	43	4
	4	1677	66	6
LPH-HS	1	82050	869	6
	2	80625	1253	4
	3	85250	4587	4
	4	87525	3634	4

For Flowthru, No Iron Shot **(FN)**:

SOLUTION	WEEK	AVERAGE CONDUCTIVITY (uS)	ST. DEV.	
HS	1	73	1	2

	2	110	1	2
	3	112	1	2
	4			0
LPH	1	1460	16	2
	2	1579	214	4
	3	1370	57	4
	4	1318	28	2
LPH-HS	1	84	3	2
	2	88		1
	3	83	5	4
	4	89	16	2


Flowthru without Shot
Decembr 02 - January 03
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Conductivity (mS)
1
2
3
4
Week of Testing
High Saline
High Saline- High NO3
Low pH


Bathtub Without Shot
December 02 - January 03
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Conductivity (uS)
1
2
3
4
Week of Testing
Low pH
High Saline
Series2

CORROSION AND MASS TRANSPORT PROCESSES IN CARBON STEEL MINIATURE WASTE PACKAGES

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Task 34

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Summary

In this study, we have systematically investigated corrosion and mass transport processes in carbon steel miniature waste packages (MWP) in dynamic systems (water in, water out) under varying chemical conditions. The MWP were fabricated to have similar configuration to the DOE Spent Nuclear Fuel (SNF) waste package and that individual components to be in scale with each other compare to the SNF waste package. Two MWP configurations were studied: a "bathtub" model and a "flow-through" model. By slowly dripping 4 different solutions (groundwater obtained from well water J-13 located near Yucca Mountain, and J-13 water adjusted to low-pH, high-salinity, and high salinity-high nitrate) into the MWP, we were able to investigate the manner of oxidation, identify transported minerals contained in the effluent, and characterize the mass transport in terms of particle size.

Manner of oxidation. Through time-lapse digital photography, we were able to document the process of corrosion within a glass walled MWP. Formation of colored corrosion products including short-lived colored complexes was noted. A sequence of possible corrosion products was proposed. The availability of oxygen and limitation of diffusion through corrosion products lowers the rate of the corrosion process. In most cases the MWP exit hole sealed within 4 weeks of water introduction, resulting in overflow from the top of the MWP. This self-sealing is likely due to the larger molar volume of the corrosion products. The overflow water traveled on the outer surface of the MWP and hung at bottom before dripping out. Under these conditions corrosion to the bottom of the MWP was observed and eventual bottom failure is likely. It is recommended an addition of a skirt to the actual waste packages to deflect water away from the waste package.

Identification of Transported Minerals. Through X-Ray Diffraction and Scanning Electron Microscopy studies of solids in the MWP effluent, we discovered that secondary minerals, such as goethite were prevalent. Many of these corrosion products were amorphous and would expect to have different properties (buffering, sorption) compared to more crystalline minerals. Individual particles ranged from about 0.2 to 0.8 μm in diameter and larger conglomerates of particles up to several μm in diameter were also present.

Mass Transport of Solids. The greatest mass of solids transported out of the MWP occurred under acidic conditions followed by the control (J-13) solution. The salt (high ionic strength) solutions were more variable due to experimental difficulties but appear not to enhance the corrosion process. The nature of the transported material also differed by solution-type. As expected, most of the iron (>80%) was found in the dissolved state under acidic conditions, while solids (>0.45μm in diameter) dominated in the effluent of the other solutions.

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KEY FOR SELECT ABBREVIATIONS

BN = Bathtub with No-shot
FN = Flow-through with No-shot
BI = Bathtub with Iron-shot
FI = Flow-through with Iron-shot
HS = High Salt
LPH = Low pH
HS-HN= High Salt – High Nitrate
C = "Control" (J13 well water)
25 = 25°C
80 = 80°C

UCCSN DATA ID TRACKING NUMBERS

034JC.001 Changes of pH, Conductivity, and Dissolved Oxygen in effluent solution during Miniature Waste Package Corrosion

034JC.002 Mass Transport of solids in effluent solution during Miniature Waste Package Corrosion

034JC.003 Graphical X-Ray Diffractometer Data and Mineral Analysis of Filtered Solids from effluent solution during Miniature Waste Package Corrosion.

034JC.004 Mass Transport of solids in effluent solution during Miniature Waste Package Corrosion: Second Experimental Run

034JC.005 Changes of pH, Conductivity, and Dissolved Oxygen in effluent solution during Miniature Waste Package Corrosion: Second Experimental Run

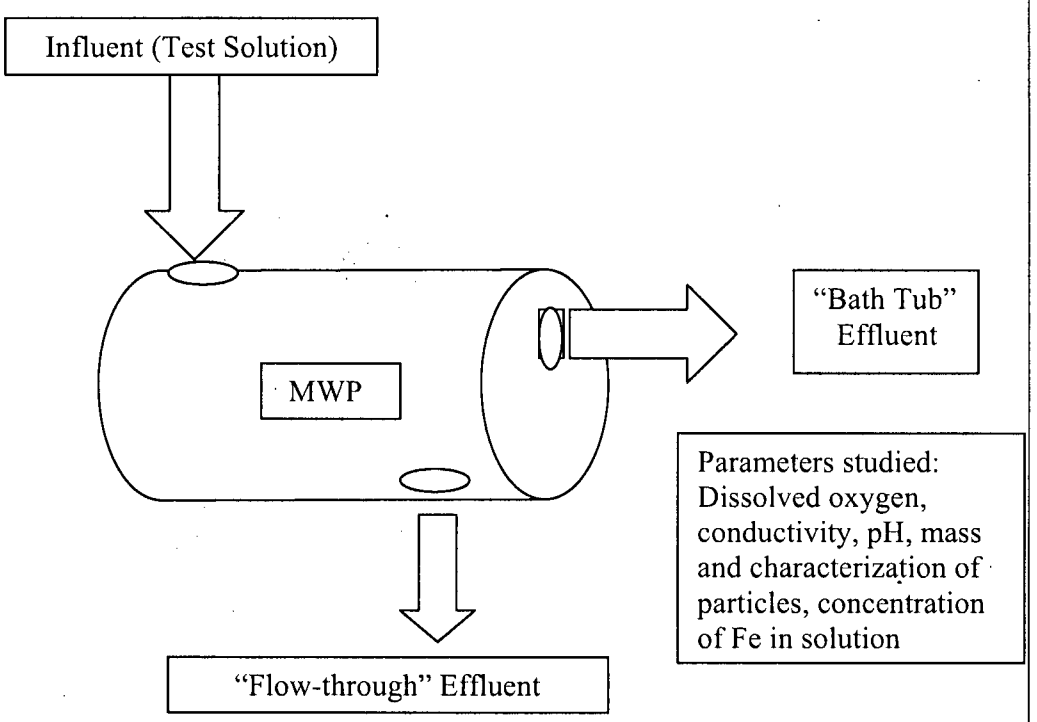
034JC.006 Concentration of dissolved iron in effluent solution from Miniature Waste Package Corrosion Study by ICPMS

034JC.007 ICPMS weight data for iron concentration calculations and report figures and tables

1. Introduction

The potential Monitored Geologic Repository is a system under study for disposal of spent nuclear fuel (SNF) at the proposed Yucca Mountain, Nevada site. Contact of groundwater with the waste package over time (hundreds or thousands of years) could initiate corrosion and possible losses of structural materials, neutron absorbers, and fuel materials. In this study, we designed and fabricated a replica miniature waste package (MWP) composed entirely of carbon steel, and introduced groundwater collected from well J-13 (located near Yucca Mountain), as well as J-13 groundwater adjusted to low pH, high saline, and high saline and nitrate conditions. The purpose was to evaluate corrosion and mass transport processes in a dynamic system under varying chemical conditions and experimental parameters. A schematic of the experiment is given in Fig. 1.

Figure 1. Schematic of Miniature Waste Package Experiment



While the major structural material of the actual SNF waste package is stainless steel and alloys (Composition in Table 1), we have employed carbon steel to speed the corrosion process. The oxidation products of carbon steel may include a variety of minerals such as hematite (Fe_2O_3), goethite (FeOOH), and magnetite (Fe_3O_4). The newly formed minerals could potentially influence the waste package by slowing down the flow of groundwater

and thus influence the extent of oxidation. They may also be transported by groundwater flow outside the waste package, possibly as colloidal particles. If these processes continue without sealing the waste package, then, over the years large amounts of the steel could convert to corrosion products and leave the waste package. The volume of corrosion products will be replaced with groundwater, which may act as a neutron moderator and increase the likelihood of criticality within the package.

Table 1. Typical composition (Wt %) of some potential waste package materials[1]

Element	A516 Carbon Steel	304L Stainless Steel	316L Stainless Steel	C22-Alloy
Carbon	0.30	0.03	0.03	0.015
Manganese	1.025	2.00	2.0	0.50
Phosphorous	0.035	0.045	0.045	0.02
Sulfur	0.035	0.03	0.03	0.02
Silicon	0.275	0.75	0.75	0.08
Chromium	-	19.0	17.0	21.25
Nickel	-	10.0	12.0	54.765
Molybdenum	-	-	2.5	13.5
Nitrogen	-	0.1	0.1	-
Iron	98.33	68.045	65.545	4.0
Cobalt	-	-	-	2.5
Tungsten	-	-	-	3.0
Vanadium	-	-	-	0.35

[1] CRWMS M&O (1999). Non-Q, for information only.

In addition, water may gradually dissolve the fissile components and neutron absorbers and transport them outside the waste package as solutes or adsorbed species on colloidal iron oxyhydroxide particles. The formation of iron oxyhydroxide may also reduce the void volume within the waste package due to its larger molar volume and low solubility compared with iron. Such a scenario is supported by the existence of natural analogs in the environment (e.g., buried nails and sunken ships). If, however, iron oxyhydroxides are removed or solubilized, the waste package may require the addition of more neutron absorbers like B_4C control rods or Alloy 22 with gadolinium. Therefore, it is important to identify oxidation patterns of steel components within the waste package, and to identify and quantify the amounts of solid materials that could be transported out. To that end, the primary objectives of this study were to: (1) evaluate the "manner of oxidation" in the MWP under varying conditions of pH and conductivity, (2) identify formed

minerals, and (3) measure the amount of material transported by water flowing out of the MWP.

2. Experimental Design

In designing this study it was evident that variability of the system could influence experimental results. The main source of systematic errors was from operation of analytical instruments. The random errors could be variation in the pumping of test solutions. Existence of dynamic conditions inside the MWP could effect entrainment or settling of corrosion particles inside MWP. In addition, existence of preferential pathways for incoming water traveling through MWP contributes to differences in rate of corrosion and transport of solids from MWP.

Table 2 is the basic matrix representing samples that were analyzed in this study (EXP I). However, a concern was raised on efficiency of "washing" process in removing salts that could have been recrystallized on the papers. As a result, EXP I was repeated (EXP II) on selected samples contained high concentration of salts. Both sets of data are presented in this report. However, for "high salt" samples, results from EXP II were used in discussions. Drip rates onto the MWP were selected to be as close to those expected at Yucca Mountain. The estimates of water drip rates that are expected to enter the drift were obtained from a study (BSC 2003) where moderate rate was 0.015 m^3/year and high rate was 0.15 m^3/year.

Both "Bath Tub" and "Flow-through" experiments have a similar setup, except the location of the water exit hole. Three sets of experiments were conducted with each MWP. In one set of experiments the pH of the water inflow was changed to simulate pH changes that could occur due to dissolution of glass in DOE's Glass Pour Canisters (GPC) and Stainless Steel components of the waste packages. In the next set of experiments, saline J-13 well water was used to simulate saline seepage water. The last set of experiments simulated waste packages with or without iron shot (used to reduce void volume in the WP). Table 2 is a summary of experiments that were performed for each model. Each experiment was conducted at 25°C, except for a few select experiments at 80°C. The experiments were continued until transport of solids ceased or achieved a steady state.

Table 2: Experimental Matrix for "Bath Tub" and "Flow-through" Models for 25°C and 80°C

Water Flow pH Characteristics*	MWP
J-13 Well Water (Control)	No Iron shot
J-13 Well Water (Control)	With Iron shot
Low pH, J-13 Well Water	No Iron shot
Low pH, J-13 Well Water	With Iron shot
High Salt J-13 Well Water	No Iron shot
High Salt J-13 Well Water	With Iron shot
High Salt-High Nitrate J-13 Well Water	No Iron shot
High Salt-High Nitrate J-13 Well Water	With Iron shot

3. Materials and Methods

3.1 Selection and Preparation of Test Solutions

An important factor in assessing the performance and safety of the potential nuclear waste repository at Yucca Mountain is the composition of drift water that might seep onto waste packages over time and initiate corrosion and mass transport. We have selected four different solutions to introduce to our MWP based on possible chemical scenarios that could be encountered within a breached waste package and to evaluate the effects of high salt, high salt-high nitrate, and low pH on potential corrosion and tranport processes.

J-13 Well Water (Control Solution). J-13 is a well located near Yucca Mountain. Groundwater from this well was selected because it is commonly used as a reference water in the Yucca Mountain Project. Groundwater was collected after pumping three well-volumes and after stabilization of pH and conductivity was achieved. Water from this well has been collected and analyzed periodically over the last two decades and its composition (Table 3) has been stable over this span (CRWMS M&O 2000a). For this study, the water was collected into 10 L polypropylene containers and transported with ice in coolers to the laboratory. There it was stored at 4°C until the start of the experiment. The water was used unaltered as the "control" solution and to prepare the other test solutions (below) (I = 0.00249).

Table 3. Composition of J-13 Well Water[1]	
Component	**Concentration[2]**
Na^+	45.8
K^+	5.04
Ca^{++}	13.0
Mg^{++}	2.01
NO_3^-	8.78
Cl^-	7.14
F^-	2.18
SO_4^{2-}	18.4
Si	28.5
PO_4^{3-}	0.12
Alkalinity[3]	128.9
PH	7.41

[1] CRWMS M&O (2000a). Non-Q, for corroborative use only.
[2] mg/l, except for pH and alkalinity.
[3] mg/HCO_3^-.

High Saline Solution: Solutions with high salt content have been shown to enhance corrosion (Trefz et al. 1996). Salts, mostly chlorides, are expected to be present in pores at the repository site when heat generated from waste packages drives off pore water early in the life of repository. As the repository environment cools, condensed water can redissolve salt remaining in the pores. This will result in formation of a relatively saline solution that can come in contact with the waste package. Our high saline test solution was prepared, in part, based on information from Rosenberg et al. (1999) who reported on the evaporative chemical evolution of synthetic J-13 water. It was prepared by adding NaCl (100.8857 g), $NaHCO_3$ (433.8497 g), NaF (33.5978 g), KNO_3 (109.7600), and Na_2SO_4 (232.1714 g) to 10 L of J-13 water and stirring until fully dissolved. Each salt was reagent grade and obtained from JT Baker (I = 1.3705).

Low pH: Low pH is relevant because hydrogen ion can be generated by hydrolysis of some brine components and steels. Low pH conditions could occur in the repository environment due to a variety of scenarios. Many simulation studies on criticality and in-package chemistry show corrosion of carbon and stainless steel to cause the pH of the solution to drop. Dissolution of the Department of Energy's Glass Pour Canisters, and

corrosion of the C22 alloy and stainless steel components of the waste packages, which contain significant amounts of chromium and molybdenum, could produce more acid, per volume, than carbon steel alone (CRWMS M&O 2000c). Thus, the low pH test solution was selected to mimic time periods in the corrosion process in which low pH is expected to be encountered. For this study, the low pH solution was prepared by adding 10 mL of ultra pure nitric acid (Ultrex II; JT Baker; Lot #H51548) to 10 L of J-13 well water. The pH of the resulting solution was 1.89 (I = 0.00223).

***High Saline – High Nitrate*:** A high salt-high nitrate solution was selected to include the possibilty of additional formation of nitrate due to radiolysis inside the waste package. In such a solution nitrate ions may play a more important role in the corrosion process than other anions. The high saline – high nitrate solution was prepared by adding 260 mL of ultra pure nitric acid (same acid as before) to 10 L of the high salt solution (prepared as before) to give an initial pH of 6.5 (I = 1.3953).

3.2 Design and Fabrication of Miniature Waste Packages

Miniature Waste Packages (MWP) were designed and fabricated to study the corrosion and transport processes under dynamic flow at two temperature regimes (25°C and 80°C). The MWP were constructed from low alloy steel (carbon steel). Table 4 shows the chemical analysis of carbon steel provided by the manufacturer. The use of carbon steel, rather than stainless steel, expedited the oxidation process and allowed us to carry out experiments within a reasonable time-frame (~28 days).

Table 4. Composition of Carbon Steel Used In MWP Fabrication[1]

Element (%)	Pipes and End Caps[2]	Basket and Rods[3]
Carbon	0.15	0.06
Manganese	0.73	0.25
Phosphorous	0.016	0.011
Sulfur	0.004	0.005
Silicon	0.014	0.007
Nickel	-	0.01
Aluminum	-	0.041
Copper	-	0.01
Iron	99.09	99.64
Cobalt	-	0.002
Vanadium	-	0.002

[1] Data from manufacturer. Non-Q, for corroborative use only.
[2] Searing Industries (Rancho Cucamonga, CA)
[3] California Steel Industries (Fontana,CA)

In our study, the MWP were also prepared to have interior features similar to the actual waste package containing DOE spent nuclear fuel (SNF) (Table 5). Each carbon steel MWP consisted of two pipes, an exterior pipe with end cap and a smaller internal pipe with five structural components added to simulate the "basket" inside the DOE SNF waste package, and rods placed in the internal pipe and basket areas to simulate glass pore canisters (GPC) and DOE canisters that would be present in the actual waste packages. In some of the MWP, in addition to explained internal features, iron shot were used to mimic design considerations to reduce void volume inside the actual waste packages. Figure 2 and Figure 3 exhibit side and end view of glass walled, iron shot packed MWP. Several such MWP were constructed with a glass exterior to allow study of internal oxidation patterns (see "Manner of Oxidation" below). When necessary, the MWP were sealed using Teflon tape and silicone sealant to prevent unwanted leaks and focus the flow-through the entrance and exit holes.

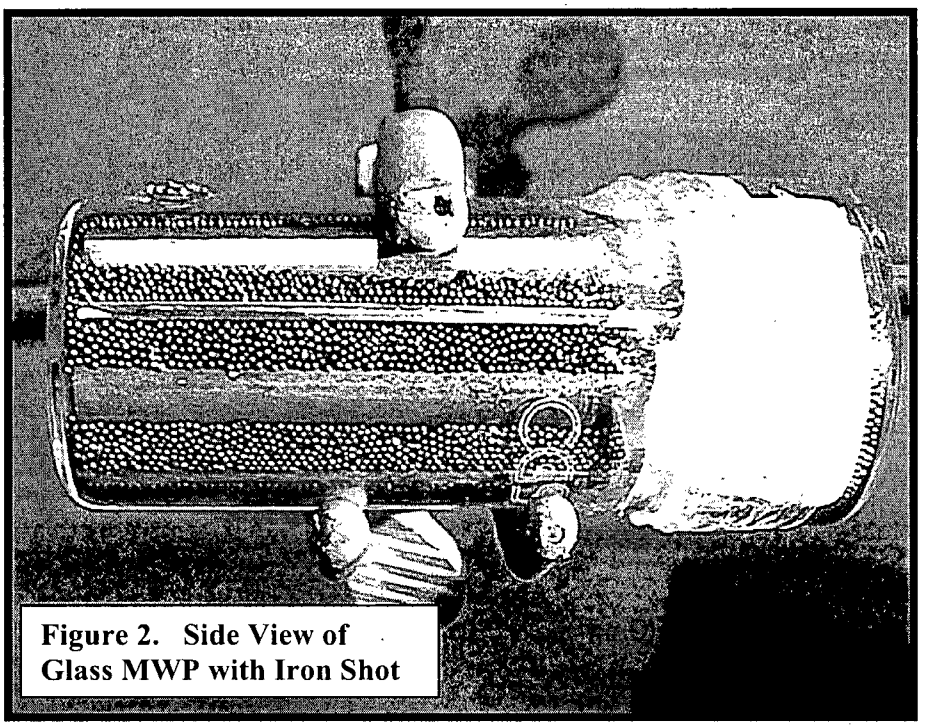


Figure 2. Side View of Glass MWP with Iron Shot

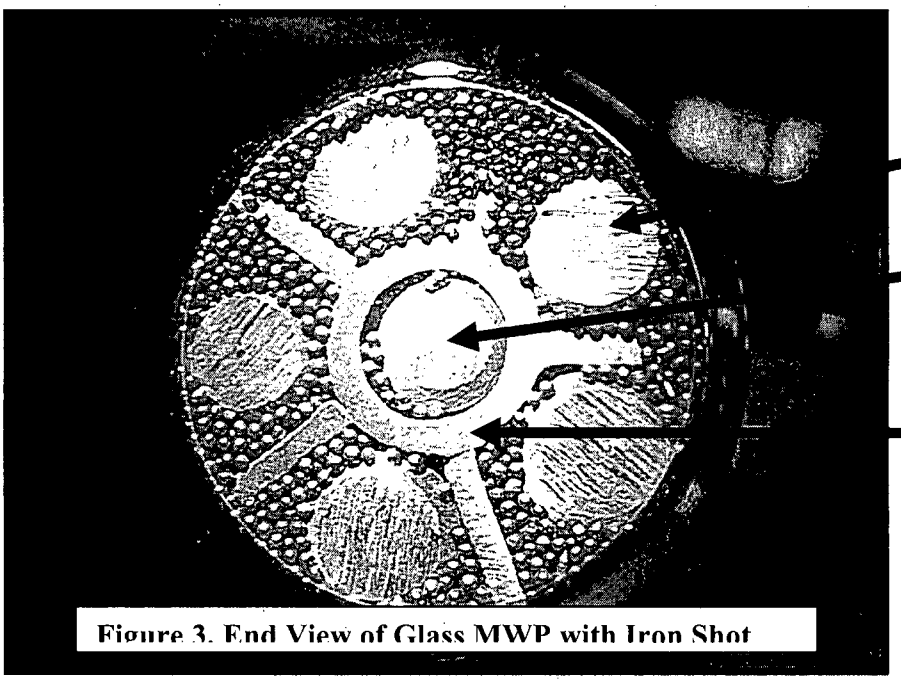


Figure 3. End View of Glass MWP with Iron Shot

Table 5. Dimensions and reduction factors for the actual waste package[1] versus the miniature waste package.				
Component	Unit	Actual WP	MWP	Reduction Factor
I.D. of shell	cm	188.3	2.66	71
O.D. of basket core	cm	56.5	1.03	55
I.D. of basket core	cm	50.15	0.68	73
DOE Canister	cm	45.72	0.64	72
GPC Canister	cm	60.96	0.79	77
Inner shell surface area	cm^2	2.354×10^5	68.98	3400
Basket surface area[2]	cm^2	4.892×10^5	137.4	3560
DOE Canister surface area	cm^2	4.680×10^4	15.8	2960
GPC Canister surface area	cm^2	6.387×10^4	20.0	3200
Total surface area[2,3]	cm^2	1.138×10^6	339	3360
Total volume	cm^3	8.439×10^6	42.5	1.986×10^5
[1] Non-Q, for corroborative use only; [2] Includes dividers for MWP				

Bathtub and flow-through models. "Bathtub" and "flow-through" configurations were employed to mimic different types of outflows from breached MWP (see Fig. 1). In the bathtub model, the test solution was introduced into the MWP from the top and exited from an opening in the end cap. In this scenario, most of the interior was flooded, i.e. saturated with water. In the flow-through model, test solution was again introduced from the top of the package, but exited instead from the bottom. In this configuration, the interior of the MWP was not necessarily entirely saturated with solution. For select experiments, a fine grain iron shot (1.5 mm average diameter with a density of 4.485 g/cm^3; Metaltec Steel Co., Canton, MI) was added to fill the void space within the MWP. The quantity of iron shot present in each MWP was determined by weight. Figures 4 and 5 show the side and end views of a glass MWP filled with iron shot. The glass MWP were used primarily to observe the "manner of oxidation" occurring within the MWP during the experiments.

3.3 Introduction of Test Solutions to the Miniature Waste Packages

We introduced the test solutions to the MWP using a peristaltic pump (Carter 12/8 Cassette Pump, Model 740128; Manostat; Barrington, IL) (Fig. 4). The average flow rate was 29.9 ± 5.1 (1 S.D.) (range: 18.8 to 37.9 mL/day), which is similar to the estimated

rate of water movement at Yucca Mountain (CRWMS M&O 2000b). The solutions were delivered with flexible tubing "cassette links" of either 0.25 or 0.89 mm inside diameter. The cassette links were coupled with Teflon tubing of similar diameter on both ends to span the distance between the pump and the solutions on one side and between the pump and the MWP on the other side. The pump is equipped with 12 cassettes allowing 12 separate flows to be used for the experiment. To prevent the tubing from floating to the surface of the test solution reservoir, we passed the transfer tubing through a hole bored in the bottom of a 100 mL polypropylene graduated cylinder and set the graduated cylinder into the solution reservoir.

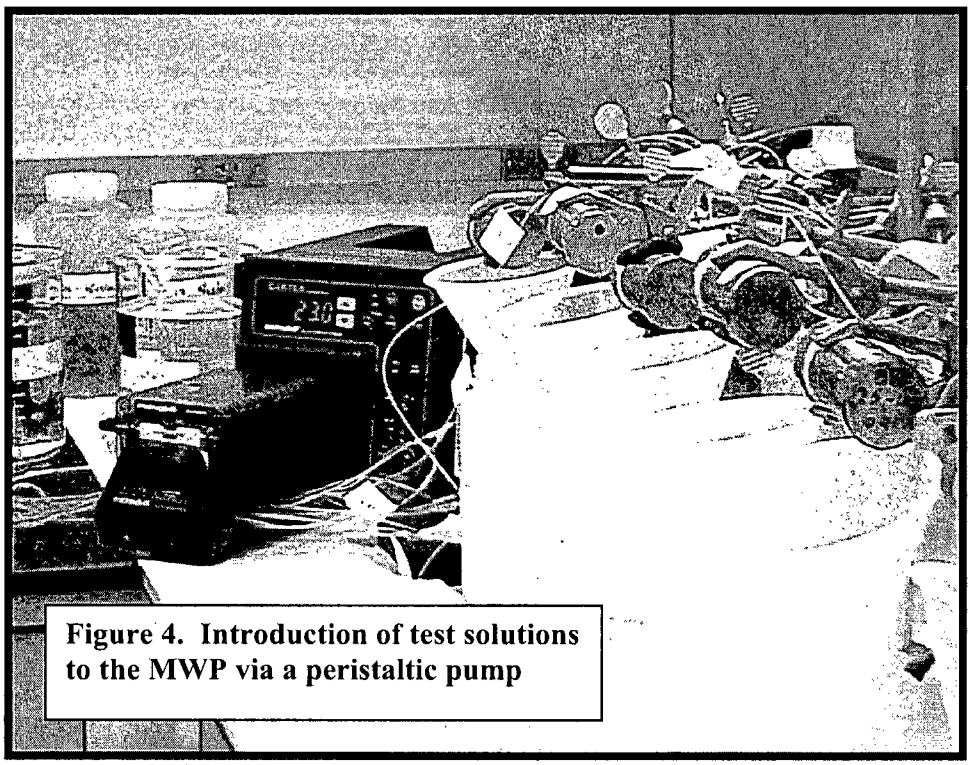


Figure 4. Introduction of test solutions to the MWP via a peristaltic pump

The pump was calibrated in accordance with UNLV-IPLV-053 (Determination of Flow Rate Using the Carter Cassette Pump). Briefly, for calibration the pump was operated over a timed interval of at least 4 hours transferring solution to a weighed beaker. The flow rate (mL/day) was determined by dividing the mass of solution transferred (grams) by the time (days), and dividing the result by the density of the solution (g/mL).

3.4 Monitoring of pH, Conductivity and Dissolved Oxygen

Influent (time 0) and effluent from the MWP were monitored during the experiment for changes in pH, conductivity, and dissolved oxygen (DO) on at least a weekly basis. The measurements were taken using standard procedures and in accordance with IPLV-012 (Measurement of Total Dissolved Solids, Conductivity, Alkalinity, and pH in Water Samples) and IPLV-056 (Measurement of Dissolved Oxygen in Water Samples). The pH and conductivity (μSm) was determined with a standard meter (Corning Model 442;

Corning, NY). Dissolved oxygen was determined with a standard DO meter (VWR; Plainsfield, NJ) and reported in ppm.

3.5 Segregation and Quantification of Suspended Solids in the Effluent

Sequential Filtration. To segregate and quantify suspended solids in the MWP effluent, the effluent was collected on a weekly basis into 250 mL polypropylene containers and filtered sequentially through previously weighed (to the nearest 0.0001g) Teflon filters (Durapore; Millipore Corporation) with pore sizes of 0.45 μm, 0.22 μm, and 0.10 μm, respectively. Next, the filters were allowed to air dry, reweighed, and amount of filtered solids (in grams) was determined by difference. The filtrate (the solution remaining after passing through the 0.10 μm filter) was saved for determination of "dissolved" iron (see Dissolved Iron below).

The filters from the high saline and high saline – high nitrate solutions required "washing" to remove (dissolved) salt that tended to recrystallize on the filters. This was needed to obtain an accurate measure of the quantity of corrosion products in the MWP effluent. In the initial tests (EXP I) with these solutions, the filters were first dried and subsequently washed with approximately 500 mL of de-ionized water (>18.3MΩ; Nanopure, Dubuque, IA). The filters were then allowed to dry again and a final weight was taken. In subsequent tests (EXP II), after completing the filtering and saving the filtrate, the filters were additionally washed with approximately 250 mL of de-ionized water (prior to drying). They were then dried and the final weight taken.

Dissolved Iron. MWP influent (i.e., test solutions) and effluent were analyzed by sector field inductively coupled plasma mass spectrometry (ICP-MS; VG Axiom, Wilshire, UK) to determine the concentration of dissolved iron. This device produced signals of ~ 10^6 counts/sec for 1 μg/L ^{54}Fe and a m/z 220.5 background of < 0.5 counts/sec using a self-aspirating PFA capillary nebulizer (CPI International, Santa Rosa, CA). The Axiom's sample introduction system consisted of a cyclonic spray chamber followed in series by a water-cooled bead impact spray chamber.

Briefly, select samples were diluted approximately 1:300 with 1% nitric acid (SeaStar, Seattle WA) gravimetrically (by analytical balance). The dilutions were necessary to decrease the quantity of total dissolved solids (particularly for the salt solutions) to prevent instrumental drift due to buildup of material on the cones of the ICP-MS interface, and to decrease the concentration of the iron in solution so that it was in the working (calibration) range. Prior to analyses, the solutions were spiked to ~1 ppb with ^{89}Y which acted as the internal standard. Instrumental parameters, gas flows and torch position, were optimized daily. Data were collected in the scan mode at m/z 54 using a dwell time of 0.4 ms, 40 points per mass spectral peak, over a m/z interval of 3 peak widths. Three acquisitions were collected for each sample solution. The instrument was calibrated using commercially available (NIST traceable) mixed element standards solutions (Ultra-Scientific and Perkin Elmer Corporation; Norwalk, CT). For quality control, each set of samples was accompanied by a blank and a standard reference

material (NIST 1640 or 1643d). A resolving power of approximately 3000 (medium resolution) was used to resolve isobaric interferences for iron.

3.6 Characterization of Transported Material

X-Ray Diffraction Analyses. Selected filters were forwarded to the Nevada Bureau of Mines and Geology at the University of Nevada Reno for X-ray Diffraction (XRD) analysis (Philips 3100 Automated Diffractometer) to identify mineral components (IPLV-046; Operation of X-Ray Diffractometer).

Particle Size Distribution. Particle sizes of the filtered solids were estimated by inspecting select filters with a scanning electron microscope (Joel JSM-5600, Jeol Inc., Peabody, MA) at the University of Nevada Las Vegas Geology Department. An EDS spectra was used to help identify the particles (e.g., iron oxides or salt crystals).

3.7 Manner of Oxidation

A digital video camera (JVC Inc., Model GR-DV2000) was used to document corrosion patterns of the MWP throughout the experiment for both the glass and carbon-steel MWP.

3.8 Experimental Phases Discussed in the Report

Experiments were conducted in three distinct phases: Scoping, Experiment I, and Experiment II. In the Scoping phase, we developed the MWP and did some initial testing of procedures and equipment. During this phase, we used several MWP with glass exteriors to study the manner of oxidation through time-lapse photography within the confines of the MWP. The second phase (Experiment I) conducted during the summer of 2002 focused on introducing the four test solutions into the carbon-steel MWP and subsequent effluent collection and analyses. The third phase (Experiment II) was conducted during the Winter of 2002-2003 and essentially replicated the first experiment (utilizing some of the experience we gained in experiment I) except that we did not include J-13 due to limited supply and pump-related issues.

3.9 Control of electronic data

Data, such as conductivity and pH, were manually entered into electronic spreadsheets for processing. The data was transferred directly from the notebook usually on the same day it was collected. Each data was visually inspected upon entering the values and later spot-checked to verify that there were no mistakes made in the transfer. Data was stored on the HRC network server, which is backed up nightly. In addition, data was protected through use of passwords and secured offices and laboratories.

4. Results and Discussion

4.1 Manner of Oxidation

The oxidation patterns within the MWP varied by model configuration (i.e., bathtub versus flow-through) and solution chemistry (e.g., pH and salinity). A digital camera recorded the external corrosion patterns of the MWP at various stages of the experiment. Selected images, highlighting attributes of the corrosion process, are presented in this section. The images proved useful in studying the "manner of oxidation" of the MWP. Figures 6, 7 and 8 present a typical MWP and the setup for flow-through and bathtub MWP experiments. The experiments were conducted at 25 and 80 °C. Figure 9 presents the setup for the 80 °C experiment. However, no liquid exited from MWP at this temperature, even at 100% humidity levels. Consequently, there were no more experiments conducted and no data will be reported for this temperature.

Low pH experiments of the bathtub and flow-through resulted in formation of corrosion products that appeared to consist of smaller size suspended particles (Figures 10 and 11). Upon clogging of exit holes especially in the bathtub models the overflow caused severe corrosion on the exterior surface of the MWP, especially at the bottom where overflow water collected before dripping (Fig. 12)

In the high salt experiments (both with and without iron shot), the bathtub models accumulated oxidation products at the exit hole and in most cases completely clogged the exit hole by the end of the fourth week (Figs. 13 and 14). This self-sealing is likely due to the larger molar volume of the corrosion products. Gu et al (1999) studied zero valence iron as permeable reactive barriers and concluded that precipitation of iron oxyhydroxides could count for void volume reduction of 10-15% of iron packed columns and could reduce porosity to 0.42 from the original porosity of 0.5. The flow-through model experiments resulted in formation of salt crystals at and near the bottom exit hole. Recrystalization of salt on the exterior of MWP could cause accelerated corrosion at the later times (Fig. 15). This is important because excessive corrosion, especially in the bottom, will promote corrosion and, over time, increase the likelihood of bottom failure.

Glass walled MWP were used to evaluate internal corrosion patterns. Figures 16 and 17 shows the result of J-13 inflow over a span of 32 days. Formation of reddish brown, green and black corrosion products of iron is evident. The interior of the MWP appears to corrode at a higher rate compared to the portion of the rods touching the glass walls. Poor circulation of water where the rods contacted the glass may have produced conditions that resulted in formation of a black corrosion product. We believe this to be magnetite because when a magnet was placed against the glass wall, the black corrosion products were attracted to it. Magnetite (Fe_3O_4) is known to be a black paramagnetic mineral. Through time-lapse digital photography, we were able to document corrosion patterns including formation of a thin-layer of corrosion products on the rods and dividers within MWP. In addition, we observed the entrainment of smaller corrosion products out of MWP and settling of larger corrosion particles on the bottom of the MWP.

MWP, where the exit hole clogged resulted in overflow of solution at the entrance site, spillage around the MWP, and eventually drip from the bottom. Thus, a skirt composed of stainless steel or other corrosion resistant material, positioned around the bottom of the actual waste package to deflect dripping water away from the bottom of the waste package may prevent or delay corrosion of the waste package, particularly at the bottom which is more susceptible to degradation (Fig 5).

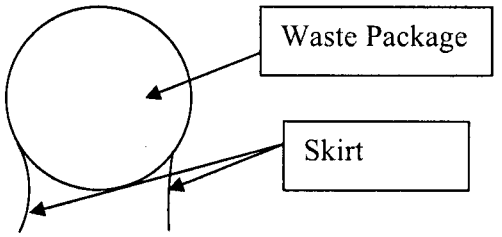


Figure 5. Addition of Skirt to the Sides of Waste package

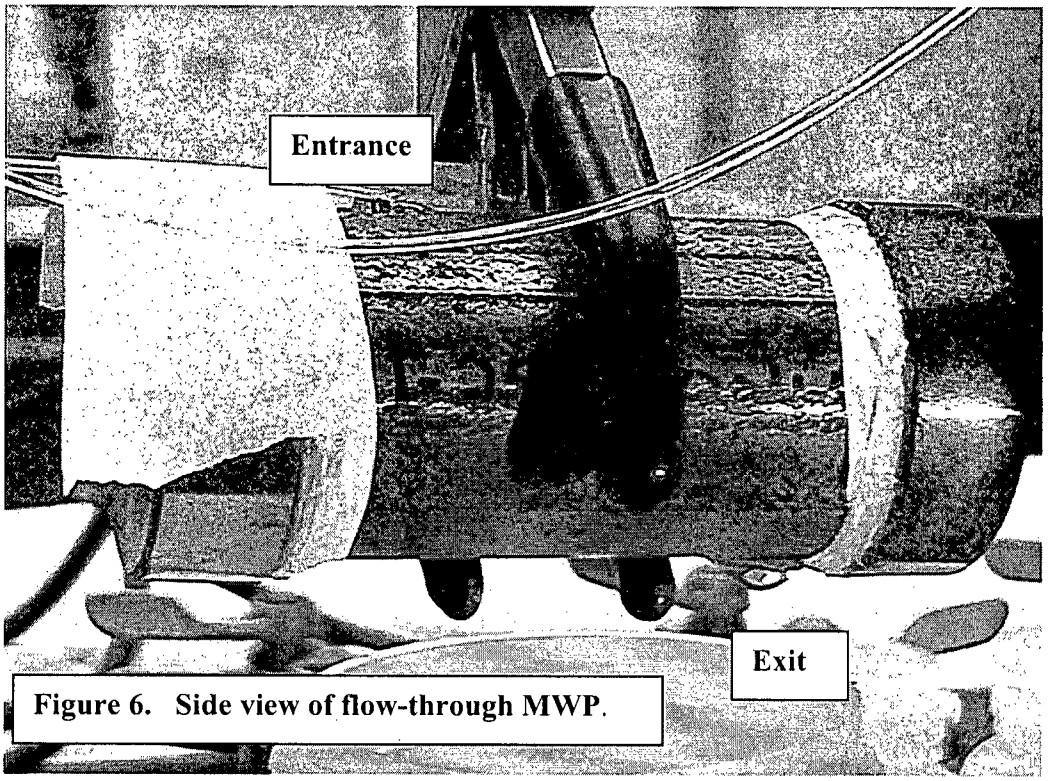


Figure 6. Side view of flow-through MWP.

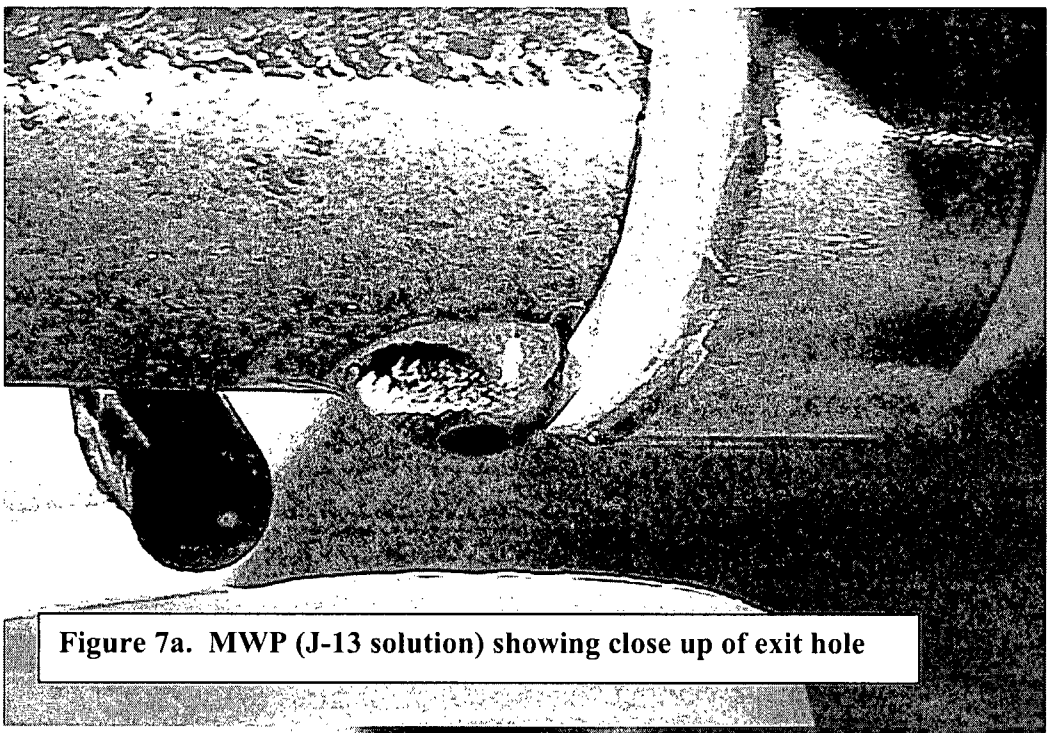


Figure 7a. MWP (J-13 solution) showing close up of exit hole

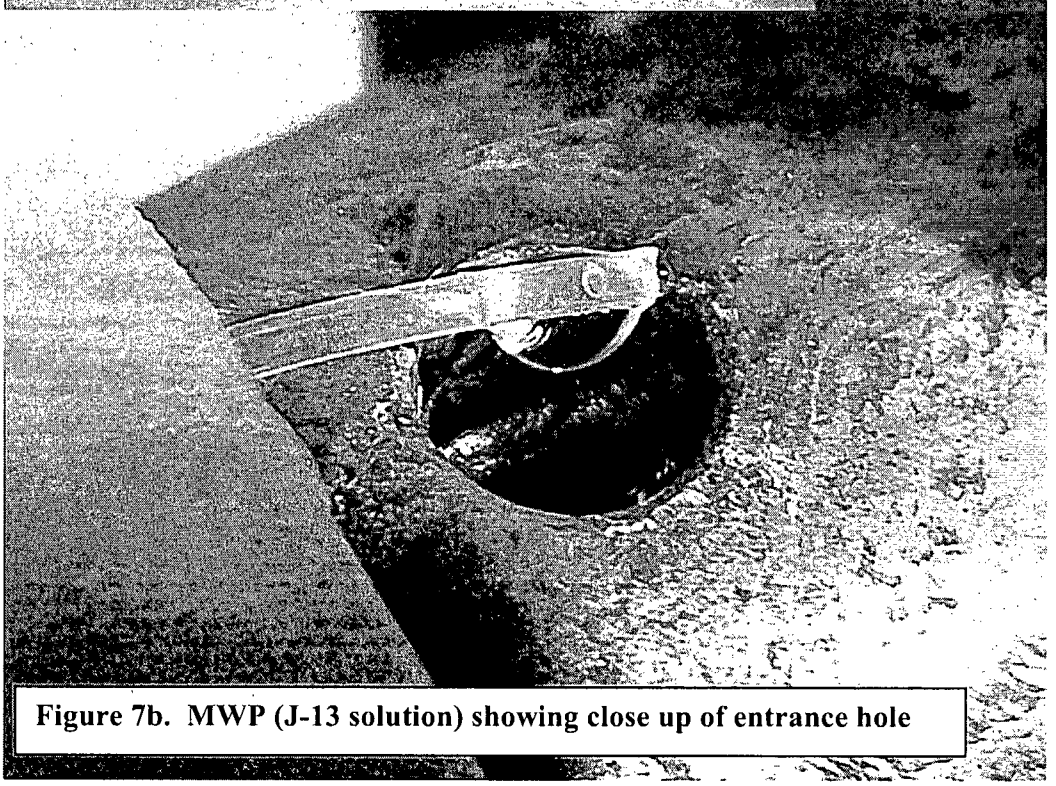


Figure 7b. MWP (J-13 solution) showing close up of entrance hole

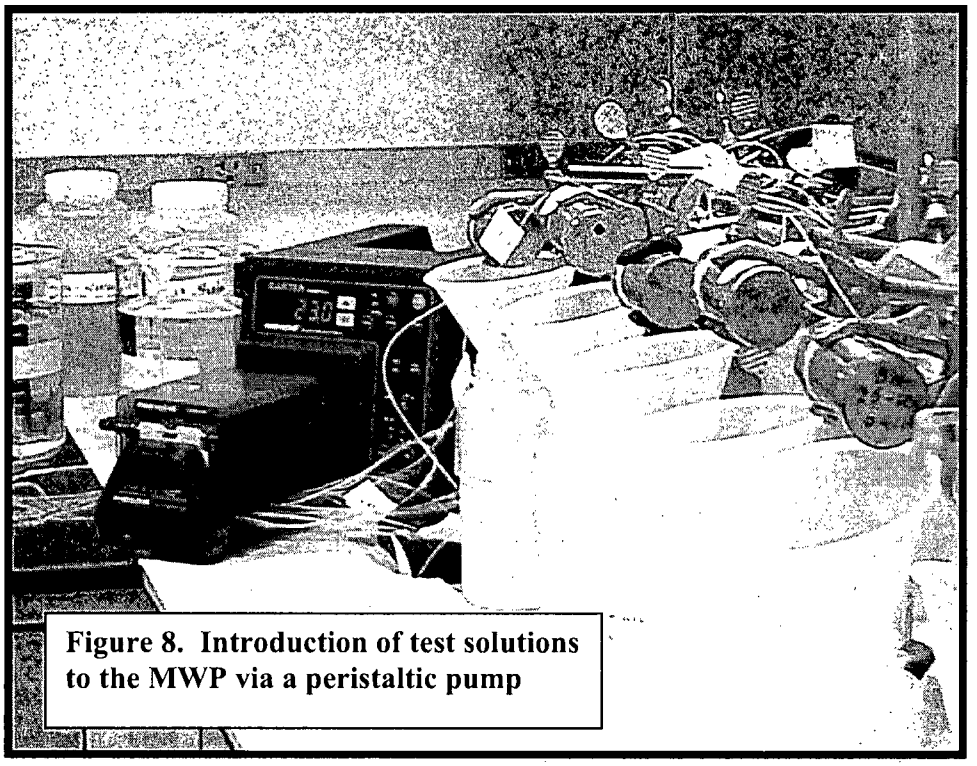


Figure 8. Introduction of test solutions to the MWP via a peristaltic pump

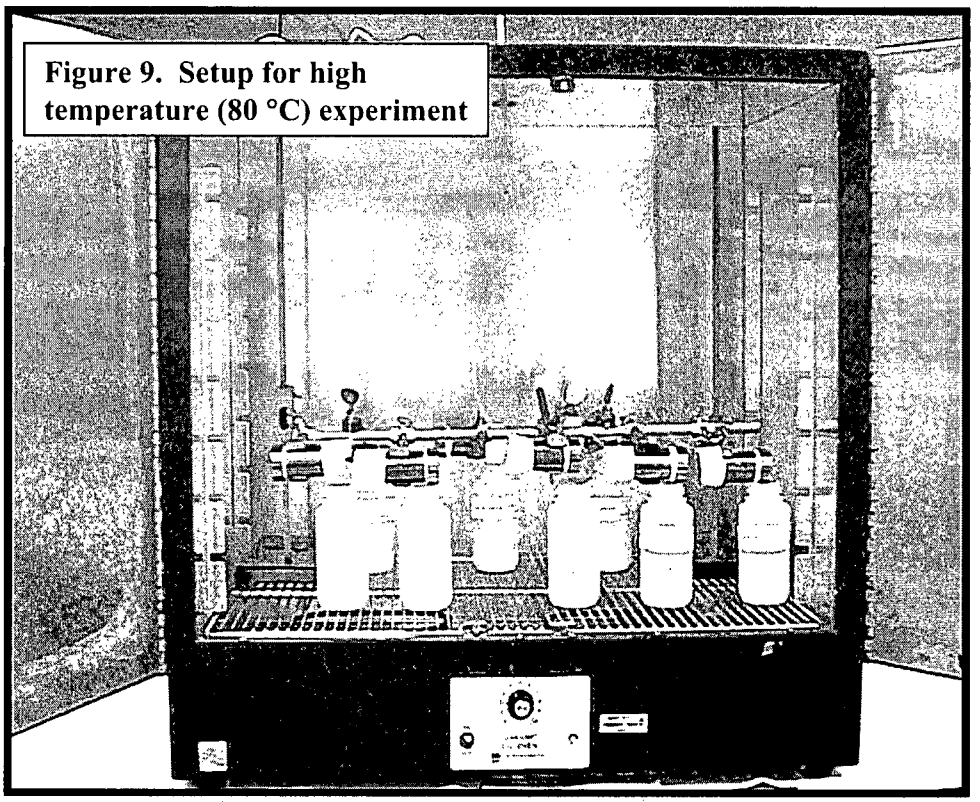


Figure 9. Setup for high temperature (80 °C) experiment

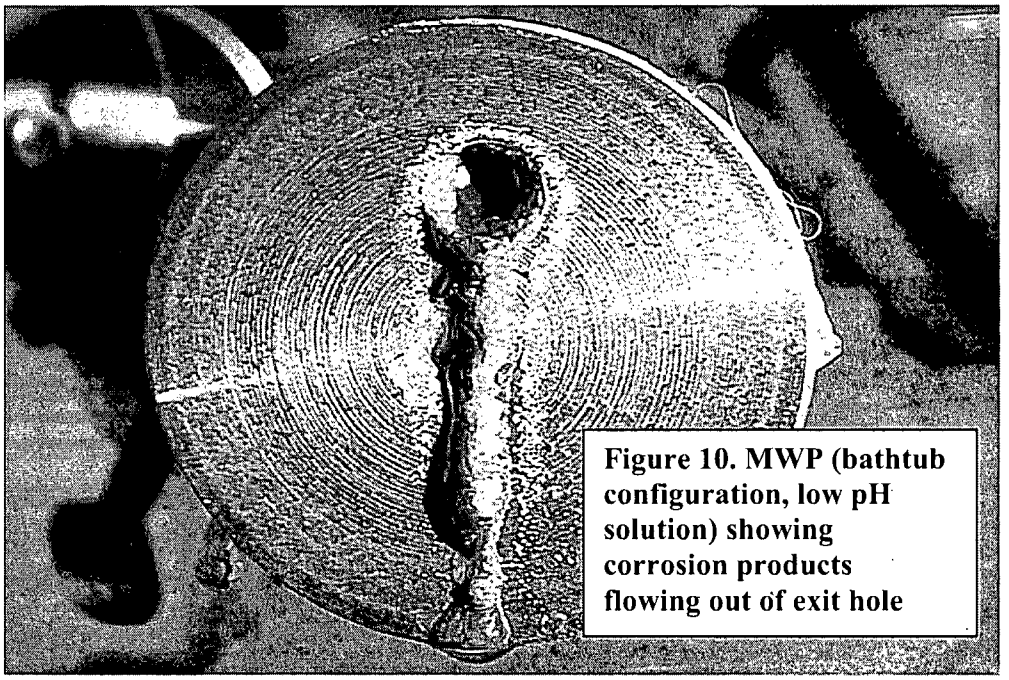


Figure 10. MWP (bathtub configuration, low pH solution) showing corrosion products flowing out of exit hole

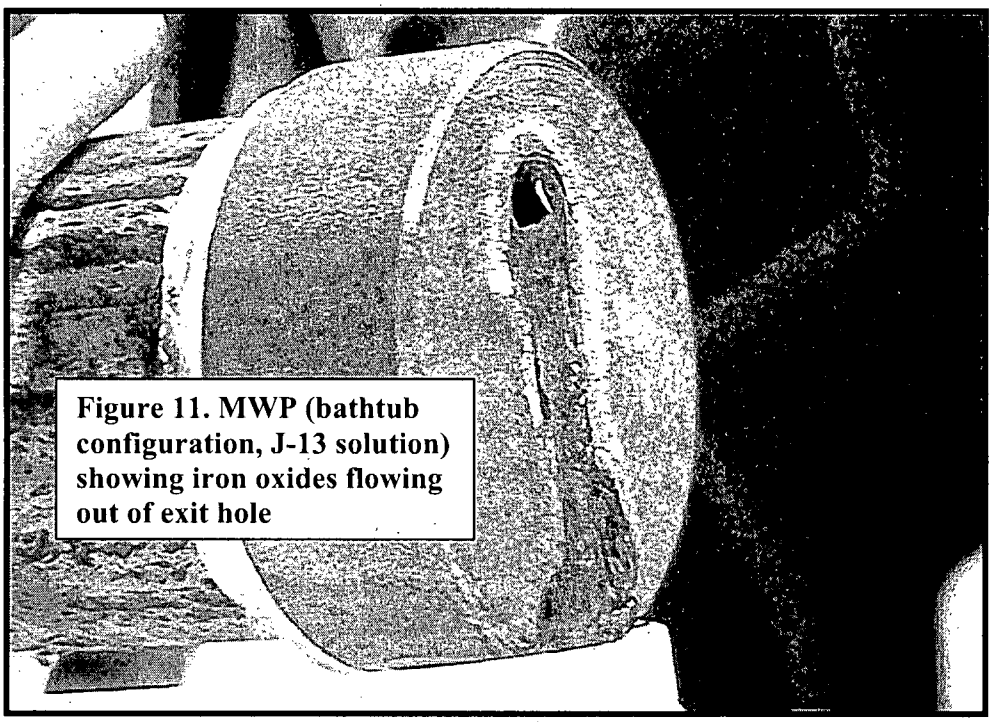


Figure 11. MWP (bathtub configuration, J-13 solution) showing iron oxides flowing out of exit hole

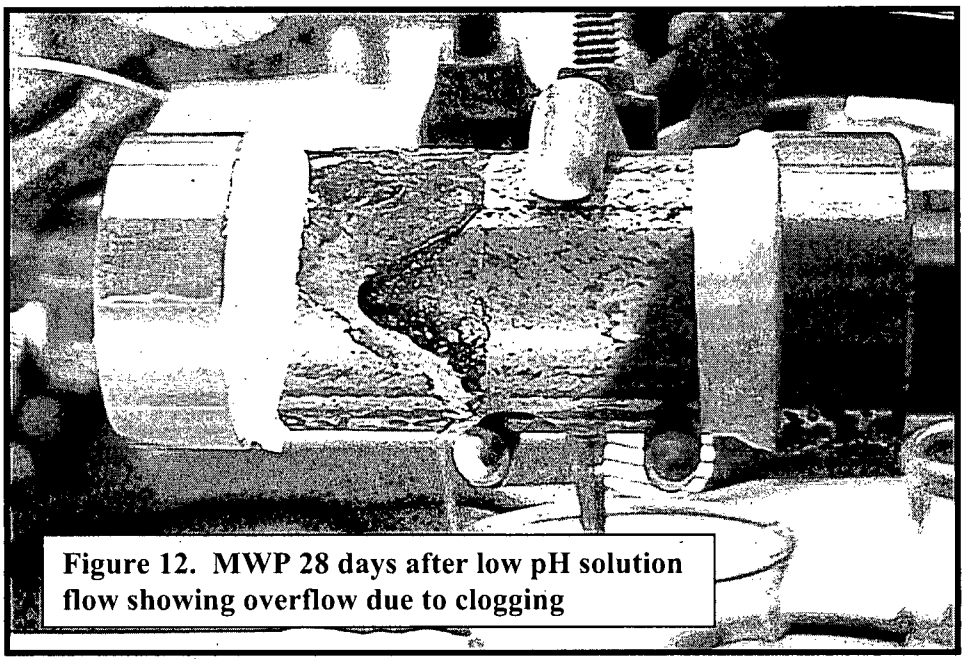


Figure 12. MWP 28 days after low pH solution flow showing overflow due to clogging

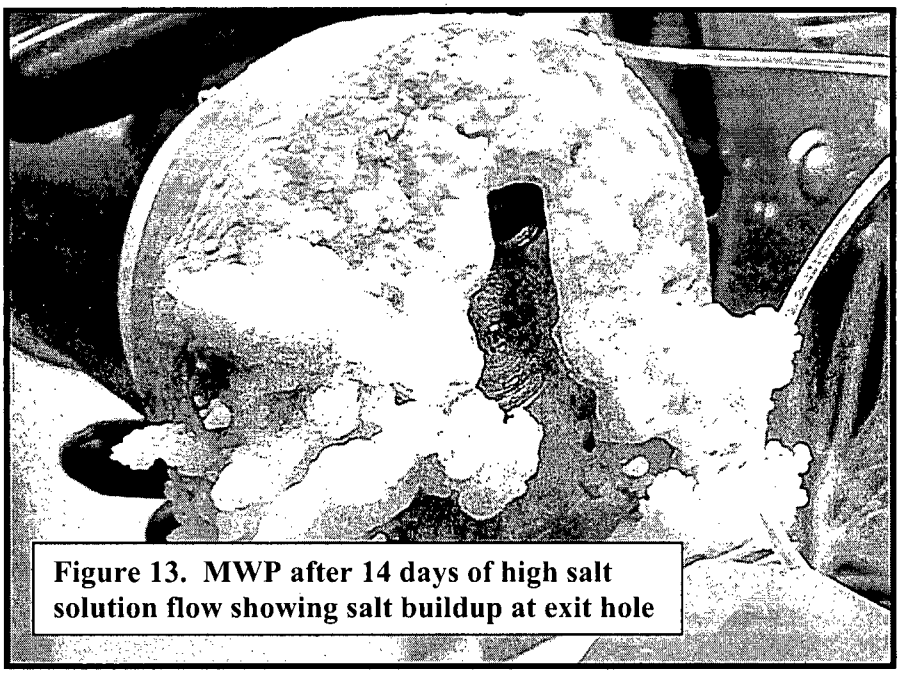


Figure 13. MWP after 14 days of high salt solution flow showing salt buildup at exit hole

Figure 14. MWP after 14 days of high salt-high nitrate solution flow showing salt buildup and iron oxides at exit hole

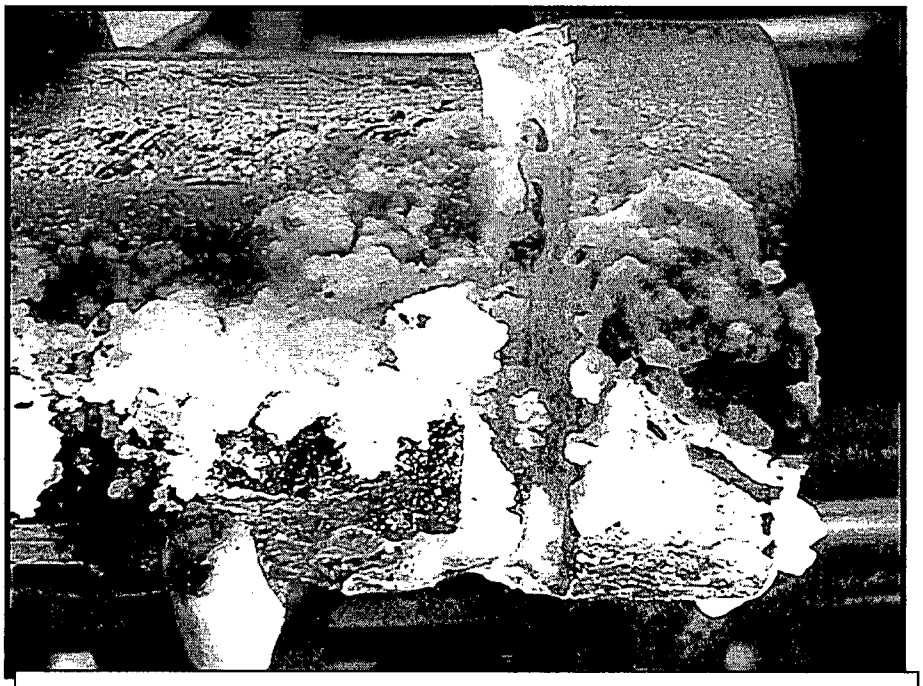


Figure 15. MWP after 14 days of high salt – high nitrate solution showing corrosion pattern on bottom of package

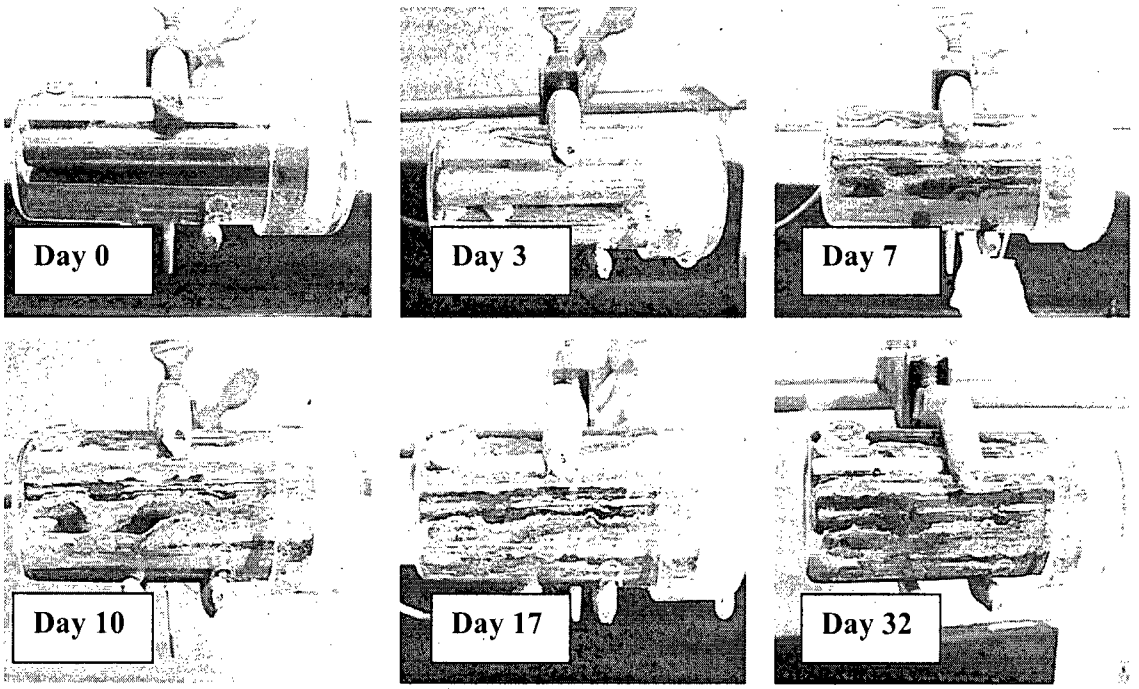


Figure 16. Time-Lapse Photos Showing Corrosion Process in Glass MWP Without Iron Shot using J-13 water (side view)

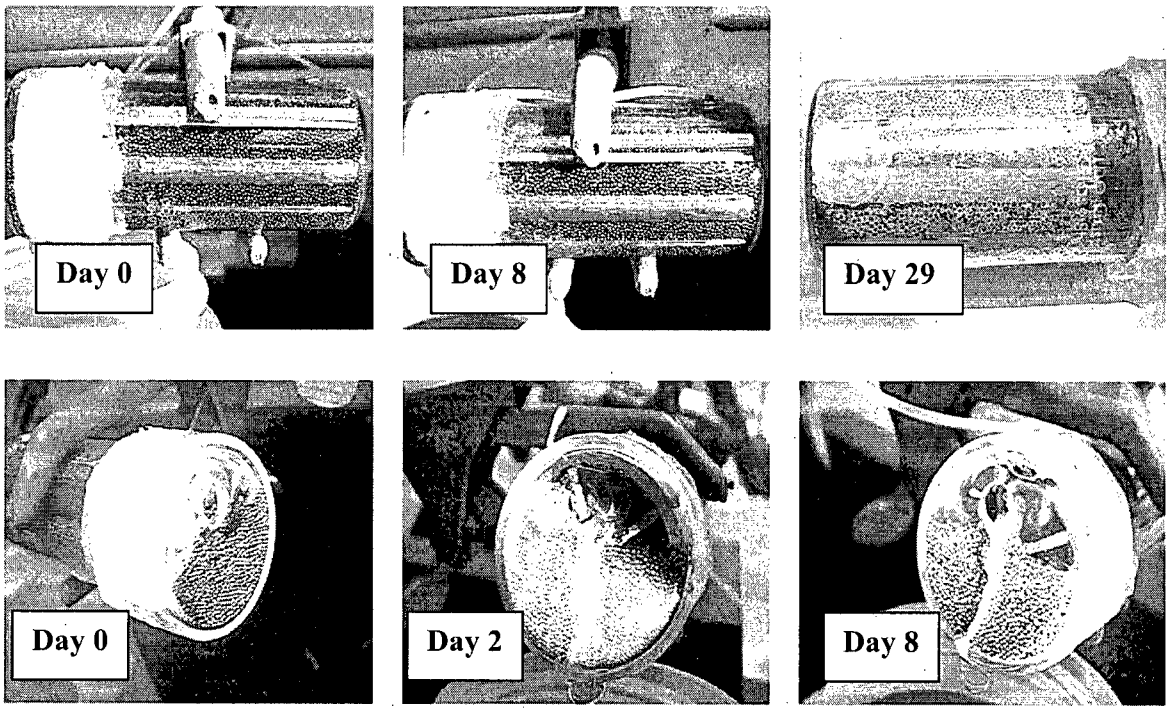


Figure 17. Time-Lapse Photos Showing Corrosion Process in Glass MWP for J-13 solution (with iron shot)

4.2 Quantification of Transported Materials

To quantify the transport of soilds (corroded iron) from MWP, no differentiation was made between solids with average diameters smaller than 0.1 μm and "dissolved" components in the effluent. Tables 6 (EXP I) and 8 (EXP II) are summaries of average concentration of solids in different effluents of MWP by particle size. In experiments where J-13 well water was used as inflow, on average 99% by mass of the transported solids in the MWP effluent were particles with average diameters greater than 0.1μm. The remaining 1% of corrosion products in the effleuent were "dissolved" products (Figure 18). In the case of high nitrate-high salt inflow, more than 97% of transported solids exiting the MWP were particles with average sizes greater than 0.1μm (Fig 20). In contrast, the low pH solution had only 11.5% of the solid particles in the outflow with average sizes greater than 0.1μm and 88.5% were smaller than 0.1μm or dissolved (Figure 20). There is a great contrast in mass/filter size distribution between the low pH and the other two types of inflow solutions (control and high salts). The excess concentration of H^+ in low pH solution could retard formation of $FeOH^+$ which contributes to formation of $Fe(OH)_2$ and green rust complexes.

Tables 6 and 8 also shows the average mass of solids in the outflow of the MWP under different types of inflow. Total average for all inflow conditions is 20.7 mg/L(EXP I) and 44.8 mg/L (EXP II) . In the control samples the average mass from MWP with iron shot was higher, possibly due to larger internal surface area. The average mass flow of control samples was 16.5 mg/L. The two high salt inflows produced average mass flows of about 20.2 mg/L (EXP I) and 37.8 mg/L (EXP II). The amount of solids were produced from low pH inflow averaging about 26.0 mg/L (EXP I) and 27.2 (EXP II).

Table 6: Average Concentration of Solids in the Effluent (EXPI)

MWP NUMBER	AVERAGE FLOW RATE mL / Day	SOLIDS ON .45 µm (mg)	SOLIDS ON .22 µm (mg)	SOLIDS ON .1 µm (mg)	TOTAL SOLIDS (mg)	No. of Days (Days)	Mass Flow of Filtered Solids[1] (mg/L)
BN-25-C-001A	26.73	9.1000	1.7000	0.6000	11.4000	28	15.2313
BN-25-C-001B	25.60	12.6000	2.0000	0.8000	15.4000	28	21.4819
BI-25-C-002A	32.55	5.0000	1.7000	0.5000	7.2000	28	7.9004
BI-25-C-002B	31.82	6.2000	1.4000	0.8000	8.4000	28	9.4294
FN-25-C-003A	33.80	22.9000	1.4000	0.7000	25.0000	28	26.4156
FN-25-C-003B	30.64	19.9000	1.7000	1.0000	22.6000	28	26.3394
FI-25-C-004A	32.81	10.1000	1.3000	0.8000	12.2000	28	13.2819
FI-25-C-004B	26.67	6.4000	1.5000	1.2000	9.1000	28	12.1853
Average							16.5+/- 7.7
BN-25-HS-005A	36.62	8.1000	1.3000	1.0000	10.4000	24	11.8321
BN-25-HS-005B	25.24	8.6000	2.8000	2.6000	14.0000	24	23.1076
BI-25-HS-006A	30.05	6.0000	1.6000	3.3000	10.9000	24	15.1127
BI-25-HS-006B	31.56	7.5000	1.9000	4.2000	13.6000	24	17.9557
FN-25-HS-007A	30.11	6.9000	17.9000	7.2000	32.0000	24	44.2794
FN-25-HS-007B	26.65	7.8000	2.4000	2.9000	13.1000	24	20.4800
FI-25-HS-008A	37.80	5.1000	2.1000	5.6000	12.8000	24	14.1091
FI-25-HS-008B	37.91	3.9000	1.7000	1.9000	7.5000	24	8.2431
Average							19.4+/-9.1
BN-25-LPH-009A	34.07	19.3000	10.0000	11.5000	40.8000	24	49.8900
BN-25-LPH-009B	33.82	8.0000	3.0000	3.3000	14.3000	24	17.6155
BI-25-LPH-010A	34.24	9.0000	5.2000	4.0000	18.2000	24	22.1475
BI-25-LPH-010B	34.65	10.8000	9.1000	9.5000	29.4000	24	35.3536
FN-25-LPH-011A	37.30	9.8000	3.0000	1.9000	14.7000	24	16.4222
FN-25-LPH-011B	37.87	15.2000	1.5000	5.7000	22.4000	24	24.6435
FI-25-LPH-012A	27.87	9.5000	0.9000	1.8000	12.2000	24	18.2377
FI-25-LPH-012B	32.91	15.0000	1.6000	1.8000	18.4000	24	23.2926
Average							26.0+/-6.5
BN-25-HS-HN-013A	34.52	9.4000	3.7000	3.9000	17.0000	24	20.5185
BN-25-HS-HN-013B	31.09	11.3000	1.4000	2.4000	15.1000	24	20.2355
BI-25-HS-HN-014A	26.93	10.4000	1.3000	2.2000	13.9000	24	21.5054
BI-25-HS-HN-014B	34.27	9.8000	0.8000	1.5000	12.1000	24	14.7095
FN-25-HS-HN-015A	33.78	19.3000	2.0000	1.6000	22.9000	24	28.2485
FN-25-HS-HN-015B	29.16	15.8000	1.0000	2.6000	19.4000	24	27.7221
FI-25-HS-HN-016A	36.94	16.2000	1.4000	2.0000	19.6000	24	22.1107
FI-25-HS-HN-016B	32.70	6.5000	1.6000	1.8000	9.9000	24	12.6146
Average							21.0+/-4.9
Total Average							20.7+/- 3.4

NOTES: Explanation of abbreviations is listed in the "Key for Select Abbreviation" Section

1. Mass Flow (mg/L) = Total Solids/((Ave. Flow Rate)(No. of Days)(1000 mL/L)); Data Source: DID# 034JC.002

Table 7 is a summary of iron inventory by converting mass of solids corrosion products to iron. Goethite (FeOOH) was considered as a typical corrosion product and the amount of solids collected on different filter sizes was assumed to goethite, which was converted to equivalent mass of iron (molar ratio of Fe^0 to FeOOH is 1:1). Figures 18 and 19 shows percent distribution and inventory (mass distribution) of iron as a function of particle size in the effluent.

Table 7. Total Iron Inventory in the MWP outflow (mg) for Experiment I [1,2,3]

MWP	Iron Mass on 0.45 μm Filters	Iron Mass on 0.22μm Filters	Iron Mass on 0.10 μm Filters	Mass of Dissolved Iron[3]	Total
BN-25-C-001A	5.7	1.1	0.4	0.2	7.3
BI-25-C-002A	3.1	0.9	0.3	0.05	4.4
FN-25-C-003A	14.4	1.1	0.4	0.1	16.0
FI-25-C-004A	6.4	0.8	0.5	0.03	7.7
BN-25-HS-005A	5.1	0.8	0.6	7.2	13.8
BI-25-HS-006A	3.8	1.0	2.1	14.5	21.3
FN-25-HS-007A	4.3	11.3	4.5	15.5	35.7
FI-25-HS-008A	3.2	1.3	3.5	14.6	22.7
BN-25-LPH-009A	12.2	6.3	7.2	91.1	116.8
BI-25-LPH-010A	5.7	3.3	2.5	90.2	101.6
FN-25-LPH-011A	6.2	1.9	1.2	115	124.2
FI-25-LPH-012A	6.0	0.6	1.1	25.8	33.4
BN-25-HS-HN-013A	5.9	2.3	2.5	1.8	12.6
BI-25-HS-HN-014A	6.5	0.8	1.4	0.9	9.7
FN-25-HS-HN-015A	12.2	1.3	1.0	1.3	15.7
FI-25-HS-HN-016A	10.2	0.9	1.3	1.3	13.7

NOTES: Explanation of abbreviations is listed in the "Key for Select Abbreviation" Section

1.Duration of the experiments was 24 days and the average volume of effluent was 569 mL.

2.Assuming goethite (FeO(OH)) as the most commonly identified corrosion product and converting it to equivalent iron.

3.Data calculated as follows: the average iron concentration in μg/g (ppm) obtained from ICP-MS analysis (UCCSN Data ID #034JC.006) was multiplied by the weight of solution (g) (UCCSN Data ID #034JC.007) and by a factor of 1000 to give mass (mg). For example, for BN-25-LPH-009A the average concentration found by ICP-MS was 111.7 μg/g. Multiplying this value by the weight of solution (816 g) and dividing by 1000 gives the mass of 91.1 mg.

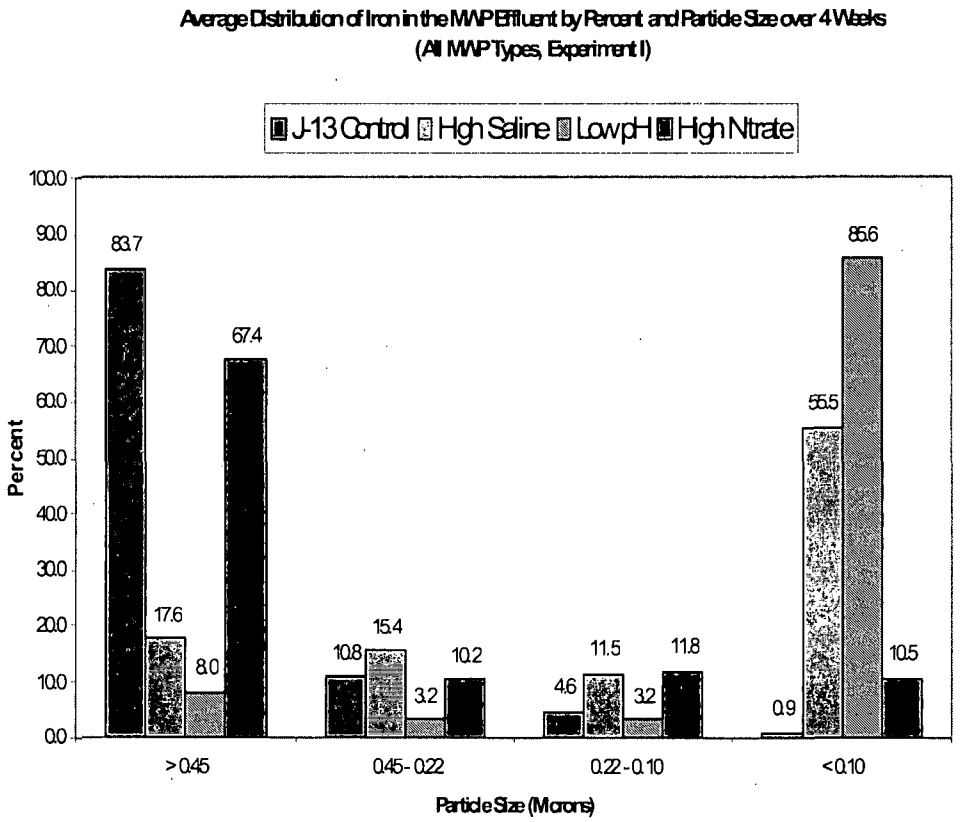


Fig. 18. Average Distribution of Iron in the MWP Effluent by Percent and Particle Size Over 4 Weeks (All MWP Types, EXP I). The graph was generated from UCCSN Data #034JC.002 and #034JC.007 as follows: total mass of solids from the A runs (from worksheet "solids by filter size") were multiplied by the percent mass of iron (0.629) in geothite (FeO(OH)) and by 1000 to change the units to mg of iron.

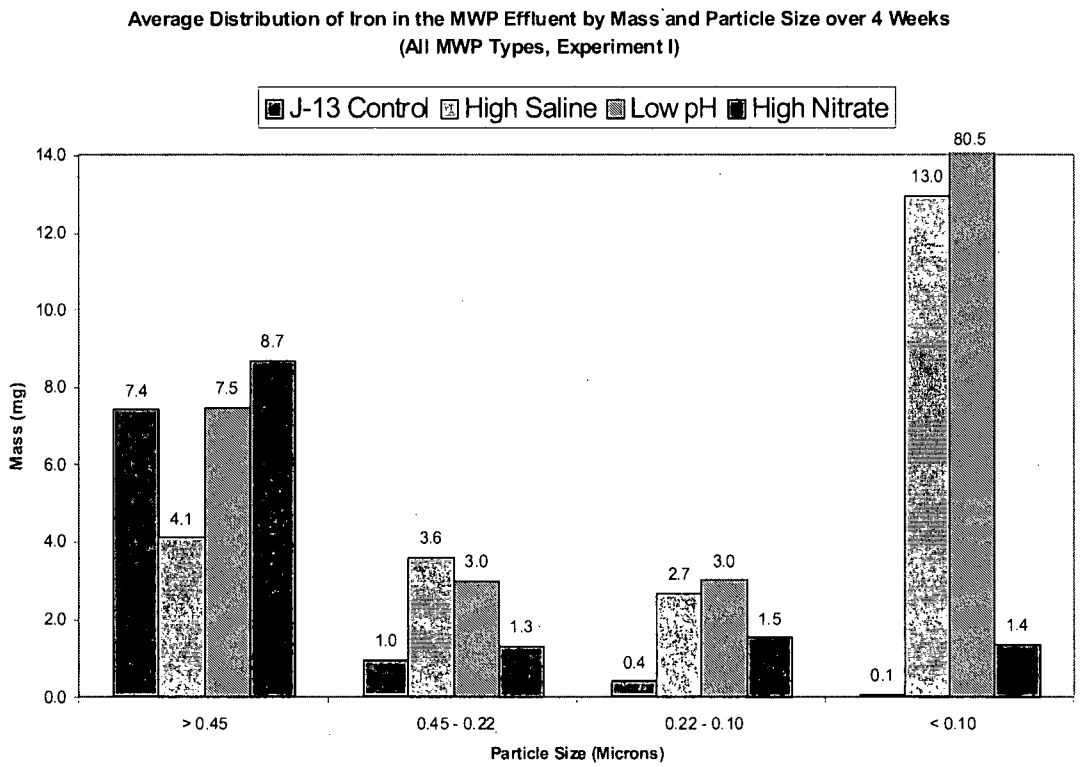


Fig. 19. Average Distribution of Iron in the MWP Effluent by Mass and Particle size over 4 weeks (All MWP Types, EXP I). See legend in Fig. 18 for calculation details.

Tables 8 and 9 contain data on the average mass of solids and iron inventory performed in experiment II (EXP II). Experiment II was conducted to assure that procedures used for washing filters in high salinity and low pH experiments were sufficient to produce accurate data. Data in these tables show higher amount of solids on the filters for high salt solutions (regardless of the presence of nitrate) but very little difference on low pH results between the two experiments. Figures 20 and 21 show the average concentration of solids and inventory of iron in the effluents of different experiments repeated for EXP II.

Table 8 : Average Concentration of Solids in the Effluent (EXPII)[1]

MWP NUMBER	AVERAGE FLOW RATE (mL/Day)	SOLIDS 0N 0.45 µm (mg)	SOLIDS 0N 0.22 µm (mg)	SOLIDS 0N 0.10 µm (mg))	TOTAL SOLIDS (mg)	No. of Days (Days)	Mass Flow of Filtered Solids[1] (mg/L)
BN-25-HS-037A	27.47	13.6000	5.4000	6.5000	25.5000	28	33.1480
BN-25-HS-037B	22.36	7.6000	6.9000	5.3000	19.8000	28	31.6252
FN-25-HS-039A	23.8	12.4000	3.8000	7.3000	23.5000	28	35.2590
FN-25-HS-039B	24.93	9.5000	4.0000	2.7000	16.2000	28	23.2124
Average							30.8125
BN-25-LPH-041A	23.79	9.1000	3.4000	3.1000	15.6000	28	23.4157
BN-25-LPH-041B	25.82	13.0000	5.4000	10.6000	29.0000	28	40.1093
FN-25-LPH-043A	21.76	9.3000	3.5000	1.7000	14.5000	28	23.8007
FN-25-LPH-043B	18.76	7.7000	2.8000	0.8000	11.3000	28	21.5114
Average							27.2075
BN-25-HS-HN-045A	23.44	16.5000	6.3000	4.0000	26.8000	28	40.8371
BN-25-HS-HN-045B	28.12	12.2000	3.1000	4.2000	19.5000	28	24.7705
FN-25-HS-HN-047A	25.04	31.5000	8.0000	5.0000	44.5000	28	63.4810
FN-25-HS-HN-047B	20.62	22.8000	3.6000	2.6000	29.0000	28	50.2384
Average							44.8325

NOTES: Explanation of abbreviations is listed in the "Key for Select Abbreviation" Section

[1] Mass Flow (mg/L) = Total Solids/((Ave. Flow Rate)* (No. of Days)(1000 mL/L)); Data Source: DID#, 034JC.004.

Table 9. Total Iron Inventory in the MWP outflow (mg) for Experiment II [1,2,3]

MWP	Iron Mass on 0.45 μm Filters	Iron Mass on 0.22μm Filters	Iron Mass on 0.10 μm Filters	Mass of Dissolved Iron[3]	Total
BN-25-HS-037A	8.6	3.4	4.1	7.8	23.9
BN-25-HS-037B	4.8	4.3	3.3	6.2	18.6
FN-25-HS-039A	7.8	2.4	4.6	3.6	18.4
FN-25-HS-039B	6.0	2.5	1.7	3.9	14.1
BN-25-LPH-041A	5.7	2.1	2.0	86.7	96.5
BN-25-LPH-041B	8.2	3.4	6.7	89.1	107.4
FN-25-LPH-043A	5.9	2.2	1.1	82.0	91.1
FN-25-LPH-043B	4.8	1.8	0.5	82.0	89.1
BN-25-HS-HN-045A	10.4	4.0	2.5	0.5	17.4
BN-25-HS-HN-045B	7.7	2.0	2.6	0.6	12.9
FN-25-HS-HN-047A	19.8	5.0	3.1	0.5	28.5
FN-25-HS-HN-047B	14.4	2.3	1.6	0.4	18.7

NOTES: Explanation of abbreviations is listed in the "Key for Select Abbreviation" Section

1.Duration of the experiments was 28 days and the average volume of effluent was 569 mL.

2. Assuming goethite (FeO(OH)) as the most commonly identified corrosion product and converting it to equivalent iron.. In the case of dissolved iron mass was converted to equivalent moles of goethite.

3.Data from ICP-MS Analysis (see note in Table 7 for calculation details).

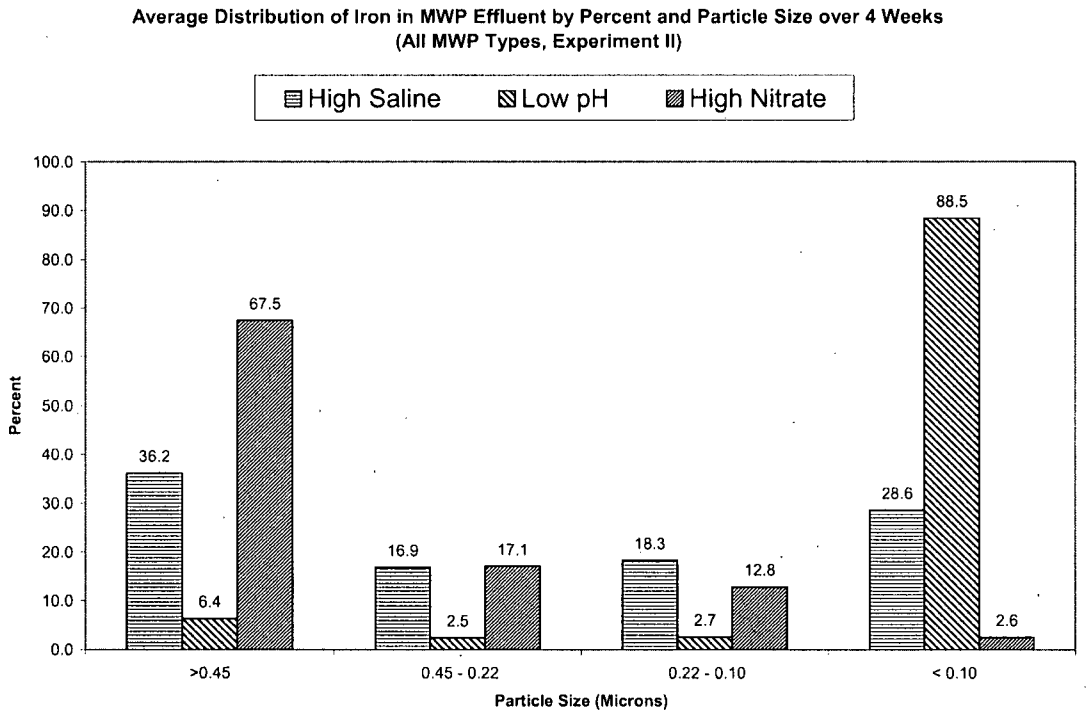


Fig. 20. Average Distribution of Iron in the MWP Effluent by Percent and Particle Size Over 4 Weeks (All MWP Types, EXPII). See legend in Fig. 18 for calculation details.

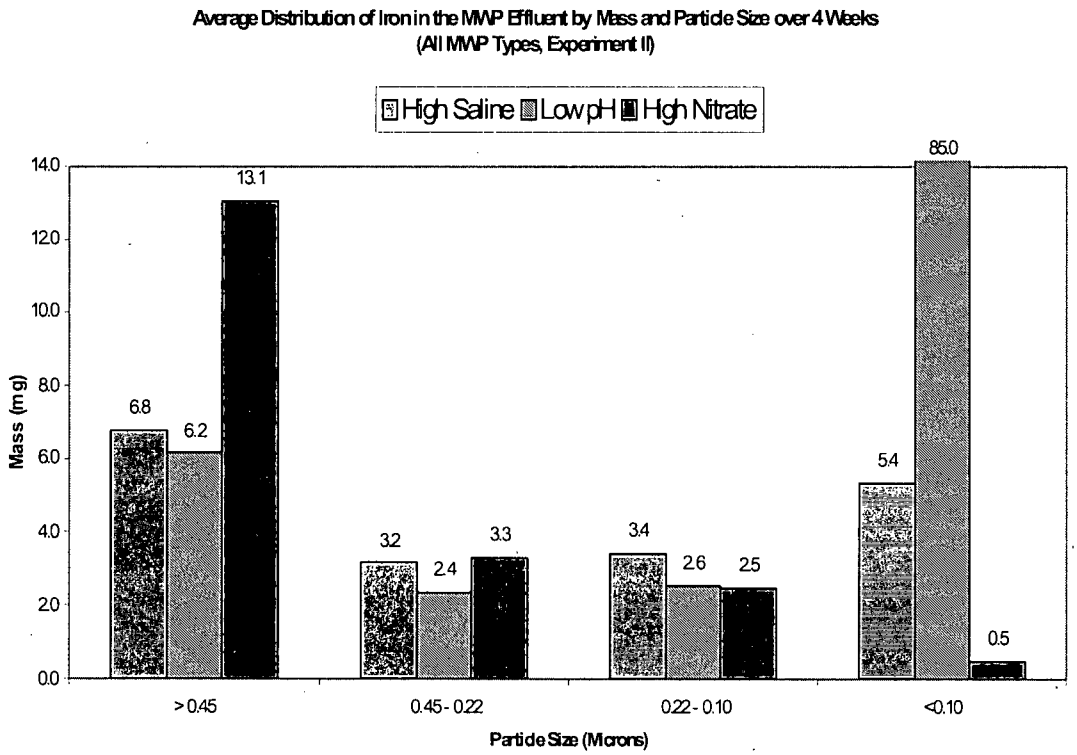


Fig. 21. Average Distribution of Iron in the MWP Effluent by Mass and Particle size over 4 weeks (All MWP Types, EXP II). See legend in Fig. 18 for calculation details.

4.3 Characterization of Transported Minerals

Selected filters were forwarded to the Nevada Bureau of Mines and Geology at the University of Nevada Reno for X-ray Diffraction (XRD) analysis to identify mineral components. The most important difference in the formation of these minerals is the availability of oxygen to iron, the effective concentration (activity) of water, and the kinetics of nucleation. The ratio of oxygen to iron in hematite and goethite is 1.50 where as in magnetite it is 1.33. Higher activity of water, e.g. with low concentrations of dissolved solutes, favors goethite over hematite. However, the thermodynamic stabilities of these two minerals, in the presence of pure water, are so close that which mineral actually begins to form typically depends on the nature of the substrates upon which they begin to grow. Once started, that mineral will generally persist, even though it may not be the most stable.

Table 10: XRD results of solids collected on filters. Data source: DID#, 034JC.003.

FN-25-HS-HN-015A	A poorly crystalline material containing magnetite ($FeFe_2O_4$).
FI-25-LPH-012B	A poorly crystalline material containing lepidiocrocite (FeO(OH)).
BI-25-HS-HN-014A	A poorly crystalline material containing magnetite ($FeFe_2O_4$).
BN-25-C-HS-001B	A poorly crystalline material containing iron oxide ($FeFe_2O_4$). This is similar to BI-25-LPH-HS-014A, but the highest intensity peak at ~34.5° 2θ is slightly offset from the coresponding magnetite peak
BI-25-C-002A:	A poorly crystalline material containing magnetite ($FeFe_2O_4$) and goethite (FeO(OH)).
FI-25-C-004A	Contains goethite (FeO(OH)), lepidiocrocite (FeO(OH)), and maghemite-C (Fe_2O_3).
FN-25-LPH-011A	Contains goethite (FeO(OH)), lepidiocrocite (FeO(OH)), magnetite ($FeFe_2O_4$) and possible sodium sulfate hydrate ($Na_2S_2O_6 \cdot 2H_2O$).
FN-25-HS-007A	Contains goethite (FeO(OH)) and lepidiocrocite (FeO(OH)).
BI-25-HS-HN-014A	Contains goethite (FeO(OH)) and kogarkoite (Na_3FSO_4).
BN-25-HS-005B	Contains goethite (FeO(OH)) and iron oxide hydrate ($Fe_2O_3 \cdot H_2O$).
BN-25-C-001B	Contains goethite (FeO(OH)), lepidiocrocite (FeO(OH)), magnetite ($FeFe_2O_4$) and possible magnesium chloride hydroxide hydrate ($Mg_3(OH)_5Cl \cdot 4H_2O$).
BN-25-HS-HN-013B	Contains goethite (FeO(OH)). At 20.66° and 29.87° 2θ are two unidentifiable peaks
BN-25-LPH-009B	Contains goethite (FeO(OH)) and magnetite ($FeFe_2O_4$). This sample was collected from liquid that drained from the continer. This liquid was air dried before sampling
BI-25-LPH-010A	Contains maghemite-C (Fe_2O_3) and possible magnesium chloride hydroxide hydrate ($Mg_3(OH)_5Cl \cdot 4H_2O$).

Particle Size Distribution: Particle sizes of the filtered solids were estimated by inspecting select filters with a scanning electron microscope (Joel JSM-5600, Joel Inc., Peabody, MA). This visual inspection revealed a range of particles sizes and what appear to be conglomerates of particles (Figs. 22 and 23). A scan of the X-rays produced from the sample when excited by the electron beam confirmed that we were interpreting the image correctly. For example, when analyzing what appear to be iron oxide particles, the EDS spectra contained peaks at ~6.41 and 7.05 keV which are energies associated with iron atoms. Conversely, the spectra for the background material contained no iron peaks but a carbon (Teflon) peak at ~0.22 keV. From the various SEM images, we conclude that individual particles generally range from about 0.2 - 0.8 microns in diameter and that larger conglomerates up to several microns in diameter are also present. Interestingly, despite having first passed through both 0.45 and 0.22 μm filters, most of the particles on the 0.1 μm filters appear to be larger than 0.22 μm in diameter. It is possible that the vacuum assisted filtration forced larger particles through the filters or that what appear to be individual particles are actually conglomerates, perhaps forming post-filtration.

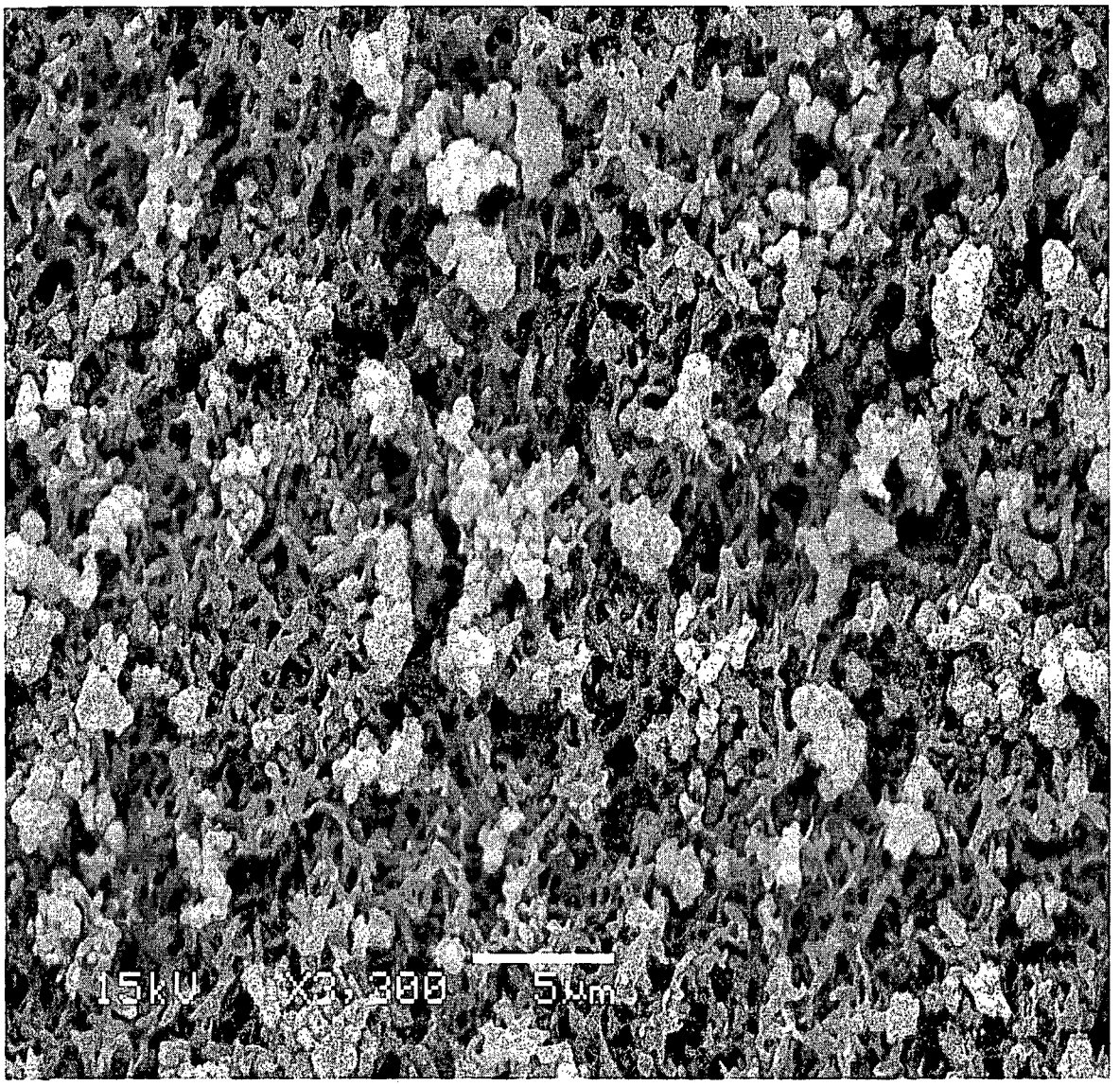


Figure 22: 300 times SEM Image magnification of filtered solids on 0.45 um filter size. Non-Q, for corroborative use only.

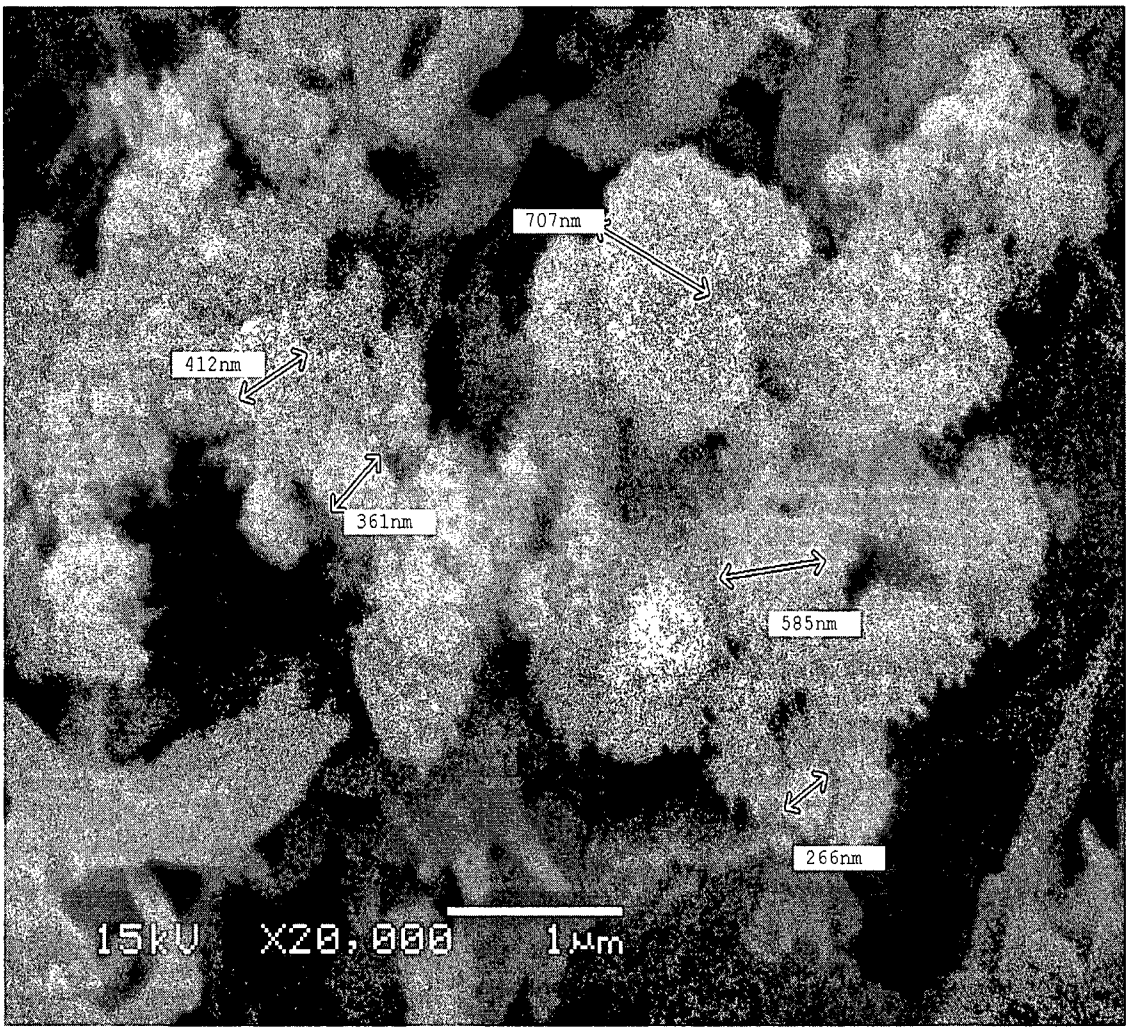


Figure 23: 20,000 times SEM Image magnification of filtered solids on 0.45 um filter size. Non-Q, for corroborative use only.

In summary, through X-Ray Diffraction and Scanning Electron Microscopy studies of the solids in the MWP effluent, we discovered that secondary minerals, such as goethite, lepidocrocite and magnetite were prevalent. Particle analyses revealed that individual particles generally range from about 0.2 to 0.8 μm in diameter are also present.

4.4 pH, conductivity, and dissolved oxygen in MWP effluent

Effluents from the MWP were monitored for changes in pH, conductivity, and dissolved oxygen on a weekly basis. Dissolved oxygen (DO) is an important factor in the corrosion process. In our study, DO ranged between about 2.5 and 5.5 ppm throughout the experiments. The starting (influent) DO concentrations were similar for experiments I and II. The DO values for J-13, low pH, high saline, and high nitrate were 5.3, 4.2, 3.9, and 3.7 ppm, respectively. In general, J-13 had the highest DO, followed by low pH, high nitrate, and high saline (Fig. 24). In experiment I, there appears to be a drop in DO after passing through the MWP for the high salt solutions, however this was not apparent in experiment II. There was a general increase in DO in the effluent for the low pH solution over the course of the experiments (Fig. 25).

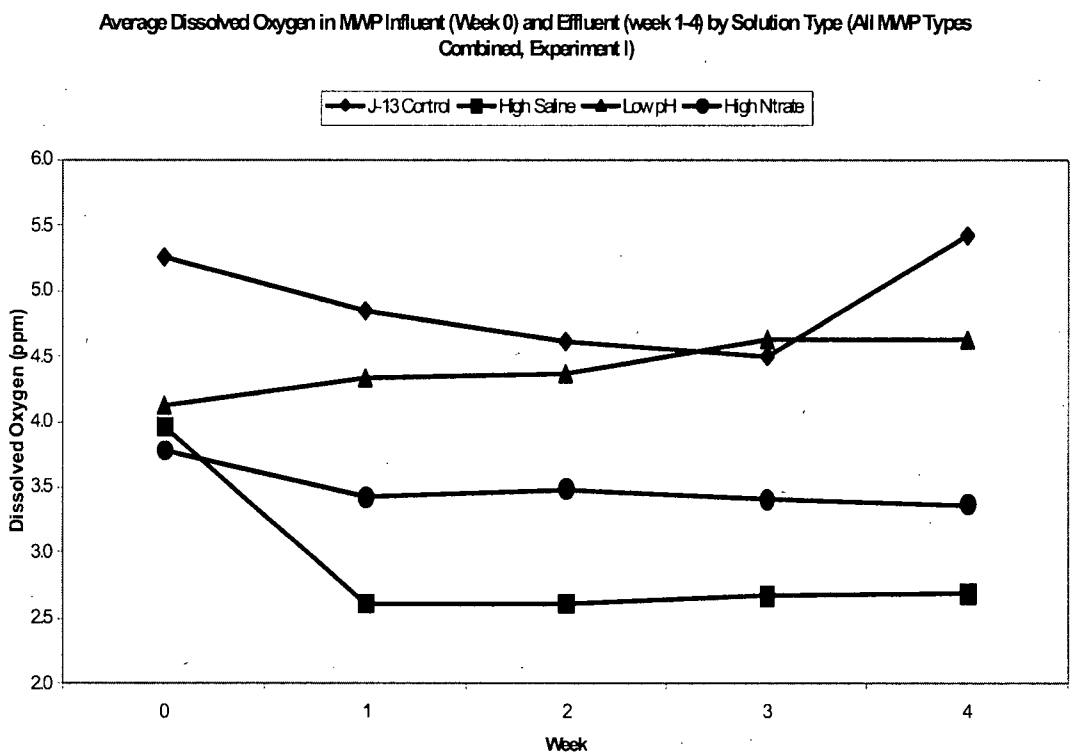


Fig.24. Average Dissolved Oxygen in MWP Inflow (Week 0) and Effluent (Week1-4) By Solution Types (All MWP Types Combined, EXPI). ; Data source: DID#034JC.001 and .034JC.007.

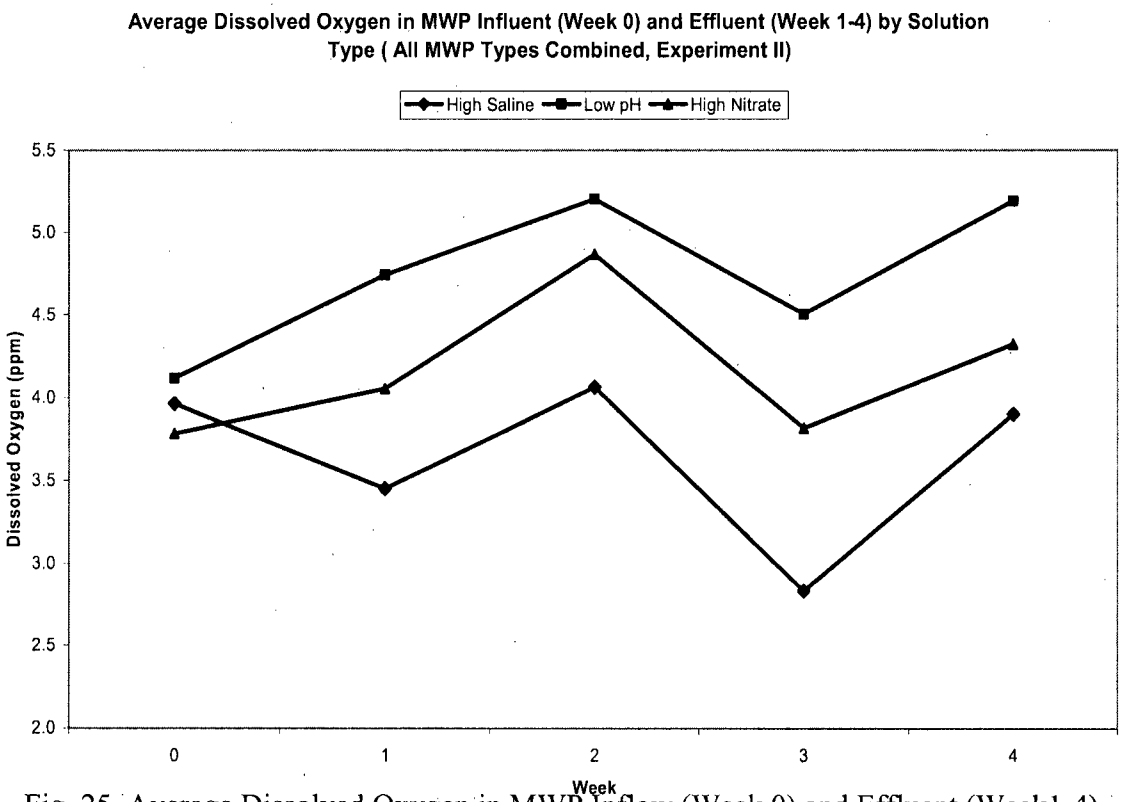


Fig. 25. Average Dissolved Oxygen in MWP Inflow (Week 0) and Effluent (Week1-4) By Solution Types (All MWP Types Combined, EXPII). Data source: DID#034JC.005 and .034JC.007.

For the J-13 groundwater, the average pH for the combined models (bathtub no shot, bathtub with shot, flow-through no shot, and flow-through with shot) rose from about 7.8 at the start of the experiment to about 8.6 by the end of week 2 where it remained relatively constant (Figs. 26 and 27). pH values for the high saline and high nitrate solutions were nearly identical throughout the experiments. The solutions started at a pH of ~9.2, dropped slightly to ~9.0 by week 1, and then gradually increased to about 9.7 by week 4. The trend was the same regardless of MWP type. The low pH solution had a beginning pH of 2.1, rose to ~4.8 by week 1, then decreased to between 3.7 and 4.2. Again, there was little difference between MWP configurations.

Conductivity varied greatly depending on the solution (Figs. 28 and 29). For the J-13 control solution, conductivity varied between 260 and 592 μ-Sm. The Low pH solution had readings of 1366 through 2320 μSm. Both the High Saline and High Nitrate solutions had readings between 70 and 112 mSm.

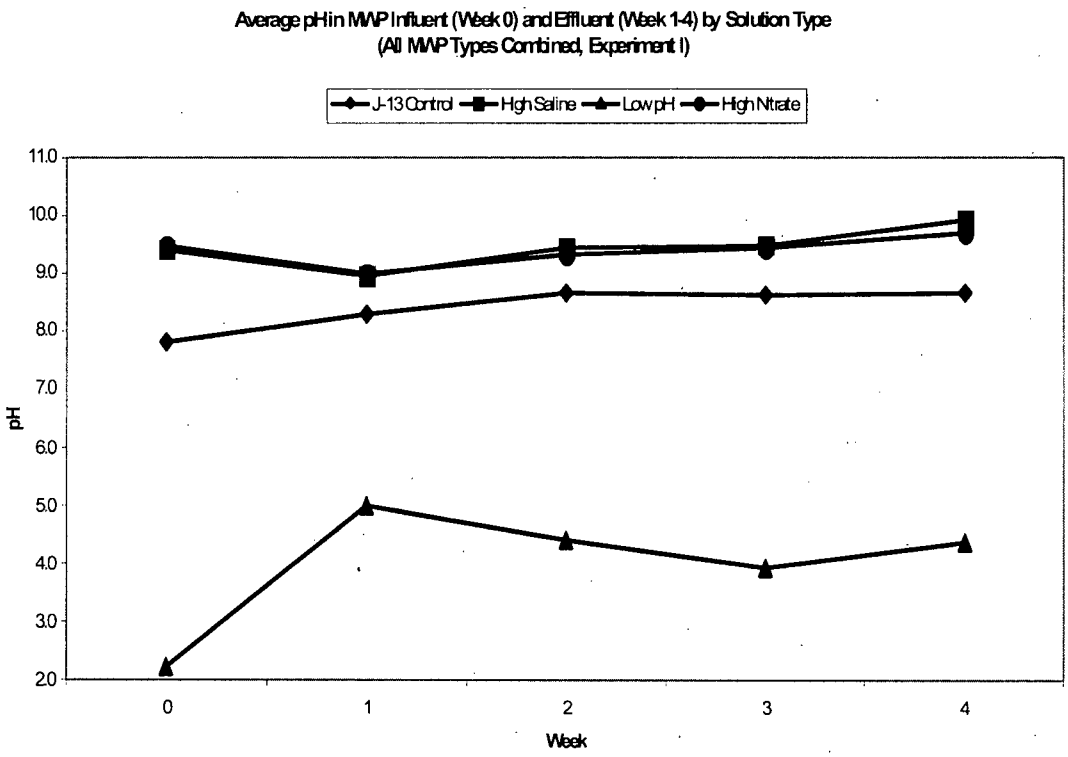


Fig. 26. Average pH in MWP Inflow (Week 0) and Effluent (Week1-4) By Solution Types (All MWP Types Combined, EXP I). Data source: DID#034JC.001 and .034JC.007.

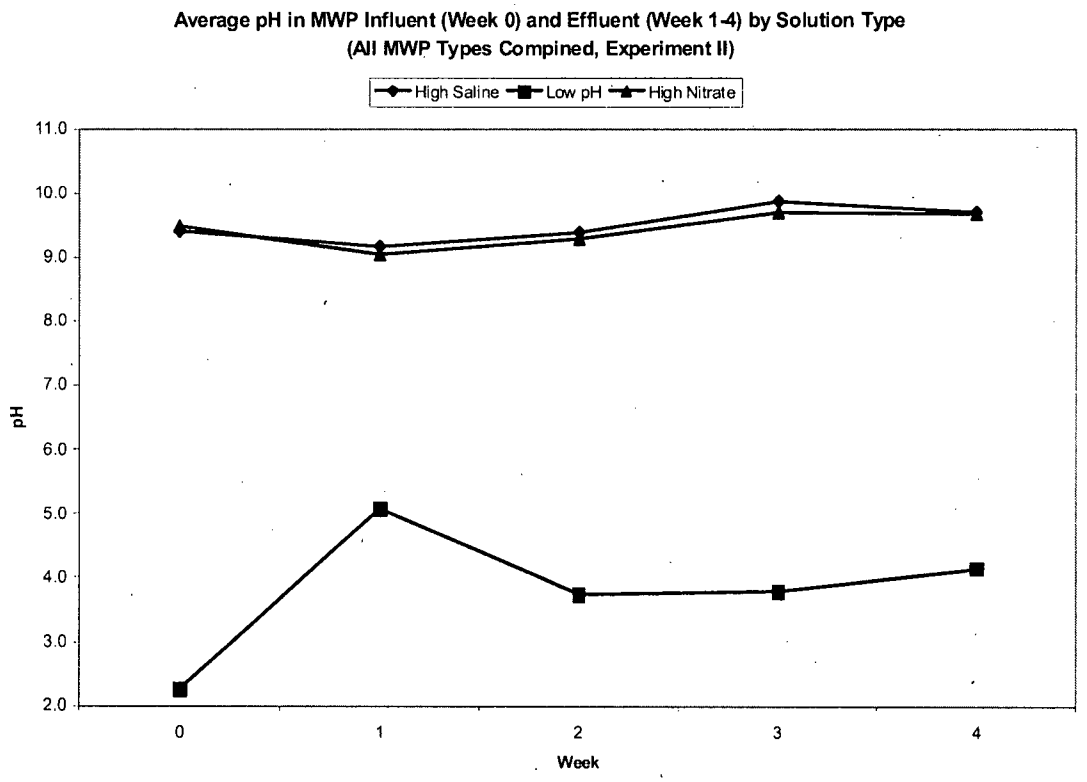


Fig. 27. Average pH in MWP Inflow (Week 0) and Effluent (Week1-4) By Solution Types (All MWP Types Combined, EXP II). Data source: DID#034JC.005 and .034JC.007.

During first week of the experiment TDS of the effluent decreased from original values of about 2500 mg/L to about 750 and remained low for the duration of the experiment. The mass of solids transported out of the MWP was greatest during the first week. Subsequently, the average mass of solids in the effluent dropped steadily until weeks 3 and 4 when there was only about 80% of the mass of the first week. Although the rate of solid transport slowed down, the pH did not go down, perhaps an indicator of a H^+ sink in the MWP. The TDS measurement of the effluent solutions reveals a rapid drop in TDS concentration to about ¼ of the concentration of the first week. The TDS remained contant the rest of the experiment. The hypothesis presented here assumes direct involvement of H^+ in production of solid corrosion products.

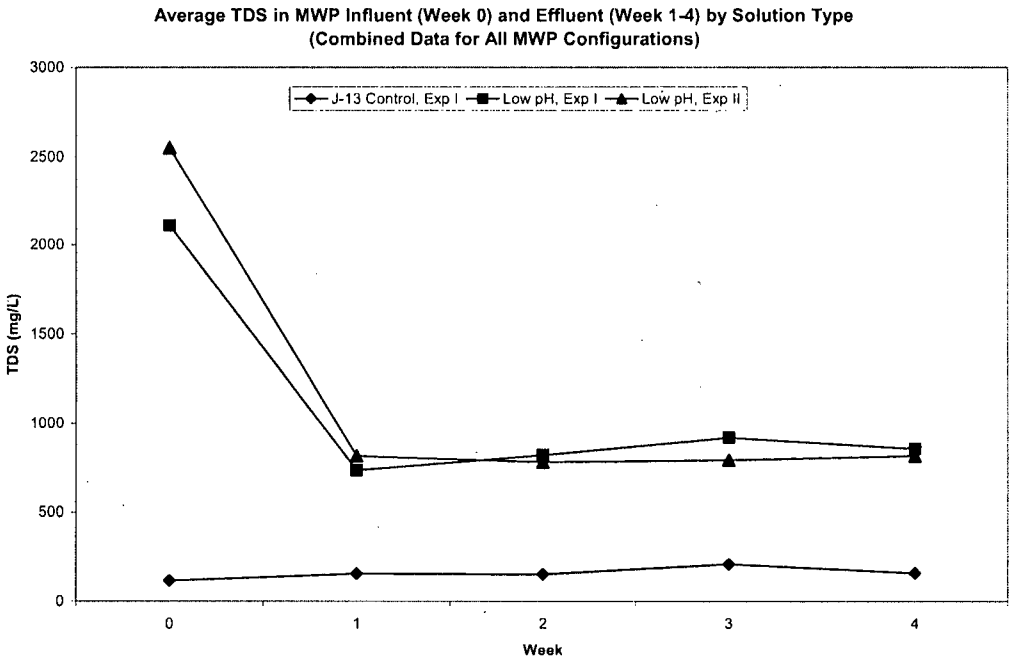


Fig. 28. Average TDS in MWP Inflow (Week 0) and Effluent (Week1-4) By Solution Types (All MWP Types Combined, EXP I and II). Data source: DID#034JC.001, 034JC.005, and .034JC.007.

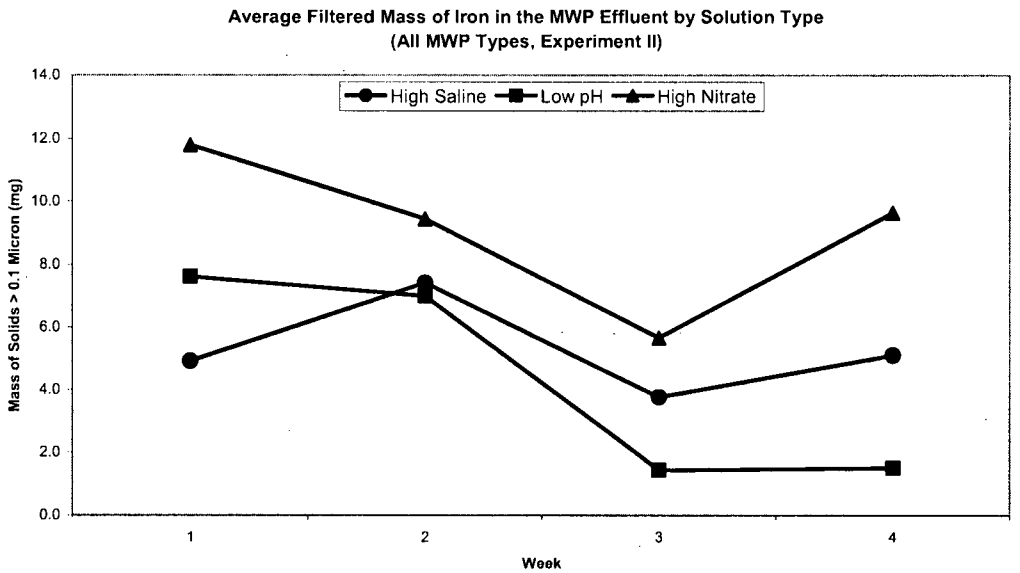


Fig. 29. Average Filtered Mass in MWP Effluent (Week1-4) By Solution Types (All MWP Types Combined, EXPII) DID#034JC.001, 034JC.005, and .034JC.007

4.5 Corrosion Processes in MWP

Corrosion of iron initiated by electrochmical reaction given by Brad and Faulkner (1980)

$Fe \longrightarrow Fe^{2+} + 2e^{-}$ E^0=-0.409V

Iron (III) ions could now form by electrochemical oxidation of dissolved Fe(II)
$Fe^{2+} \longrightarrow Fe^{3+} + e^{-}$ E^0=+0.770V

Cotton and Wilkinson present the overall oxidation of Iron(II) to iron(III) as;

$4Fe^{2+} + O_2 + 4H^+ \text{ ---->} 4Fe^{3+} + 2H_2O$ E^0=+0.460V

Oxidation of Fe(II) to Fe(III) in neutral and natural waters by molecular oxygen could be an ionic reaction between FeOH+ and HO_2^-, however, details of such reactions are uncertain. Other common oxidants in solution like NO_3^- and NO_2^- could oxidize Fe(II) to formation of a brown nitrosyl ion $[FeNO(H_2O)_5]^{2+}$ in the follwing reaction:

$3Fe^{2+} + NO_3^- + 4H^+ \text{ ---->} 3Fe^{3+} + 2H_2O$

Oldfield and Sutton discuss sequential hydrolysis reactions to form $Fe(OH)^+$ and $Fe(OH)_2$.

$Fe^{2+} + H_2O \text{ ---->} Fe(OH)^+ + H^+$

$Fe(OH)_2(s) \text{ ---->} Fe^{2+} + 2OH^-$

Kolar and King reported O_2 oxidation of Fe(II) from biotite

$Fe^{2+}(biotite) \text{ ---}\rightarrow Fe^{2+}(aq)$

$4\ Fe^{2+}(aq) + O_2 + 2H_2O \text{ ---->} 4\ Fe^{3+}(aq) + 4OH^-$ (Highly pH dependent)

$Fe^{3+}(aq) \text{----}\rightarrow Fe^{3+}(s)$

$Fe^{2+}(aq) \text{----}\rightarrow Fe^{2+}(s)$

Iron (II) ion is a strong Lewis base that could react with oxygen to produce superoxide radical ion (O_2^-) and/or its conjugated hydroperoxyl radical (HO_2^-; pKa =4.8) which in turn forms H_2O_2. Rate of H_2O_2 formation in these pathways depend on pH, dissolved metal concentration and oxygen concentrations.

$H^+ + HO_2^{\cdot} + Fe^{2+} \text{ ------>} H_2O_2 + Fe^{3+}$ pH<4.8, k = $1.2 \times 10^6\ M^{-1}s^{-1}$

$HO_2^{\cdot} + Fe^{3+} \text{ ------}\rightarrow O_2 + Fe^{2+} + H^+$ pH<4.8, k < $10^4\ M^{-1}s^{-1}$

$2H^+ + O_2^{\cdot -} + Fe^{2+}$ ------> $H_2O_2 + Fe^{3+}$ pH>4.8, k = 1.2 x 10^7 $M^{-1}s^{-1}$

$O_2^{\cdot -} + Fe^{3+}$ ------→ $O_2 + Fe^{2+}$ pH>4.8, k = 1.5 x 10^8 $M^{-1}s^{-1}$

In natural waters, the reaction of metals and H_2O_2 is responsible for redox cycling of metals. These reactions are even more important at night (absence of UV light from sun for photoreduction reactions). Wilson et al., studied the relative importance of dissolved organic carbon pathways versus pathways involving metal-redox reactions in controlling H_2O_2 concentrations in thermal springs. They concluded that in waters where concentration of dissolved iron concentration exceeds the concentration of dissolved organic carbon, chemical reactions with reduced iron or iron-organic complexes may be important in H_2O_2 formation.

In section 4.3, Table 10 summarizes the XRD analysis of solid materials transported from (and existing inside) the MWP. In general, the dynamic inflow of water resulted in formation of mostly iron oxyhydroxide crystalline materials. It appears formation of crystalline materials is under kinetic rather than thermodynamic control. Figures 16 and 17 show the time-lapse photography of corrosion processes inside of a glass wall MWP. Formation of light brown, green, black and reddish colored corrosion products are evident in this process.

In the following we suggest a mechanism for formation of these products based on the literature search and experimental results at the low temperature regime:

Fe^0 ---------> $Fe^{2+} + 2e^-$ (1)

$Fe^0 + 2\ H_2O$ ---->$Fe^{2+} + H_2 + 2OH^-$ (2)

Fe^{2+} ---->$Fe^{3+} + e^-$ (3)

$Fe^{2+} + H_2O$ ---->$Fe(OH)^+ + H^+$ (4)

$Fe(OH)^+ + OH^-$ --------> $Fe(OH)_{2\ (s)}$ (5)

$Fe(OH)_{2\ (s)}$ --------> $FeO(OH) + H^+ + e^-$ (6)

$Fe^{2+} + Fe^{3+} + Fe(OH)_2\ s$ --------> $[Fe_2^{2+}\ Fe^{3+}\ O_x(OH)_y]^{(7-2x-y)}$ and/or $[Fe^{2+}\ Fe^{3+}\ O_x(OH)_y]^{(5-2x-y)}$ (Green Rust Complexes) (7)

$2[Fe_2^{2+}\ Fe^{3+}\ O_2(OH)_2]^{(1+)} + O_2^-$------>$2\ Fe_3O_{4\ (s)} + 2H_2O$ (8)

5. Conclusion

1) In most cases exit holes were clogged with corrosion products that have higher molar volume than iron. This process will reduce void volume inside the MWP available to incoming water and decreasing the probability of criticality. However, plugged waste packages could have higher probability of bottom failure. An addition of a skirt could divert water from hanging at the bottom of waste packages.
2) Average concentration of solids leaving the MWP was 20.6 mg/L. High salinity of incoming solution increases solid transport out of MWP. Low pH increases transport of total iron (dissolved and solid corrosion products) out of MWP.
3) Most corrosion products are goethite, lepidocrocite, magnetite, and maghemite, and amorphous iron oxyhydroxides. In a dynamic system it appears kinetic control plays a more important role than thermodynamics.

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For Bathtub, No Iron Shot (BN):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.	
Control	1	5.05	0.0015	2	0.04	
	2	3.10	0.0014	2	0.06	
	3	3.20	0.0007	2	0.03	
	4	2.05	0.0008	2	0.05	
	Total	13.40				13.40
HS	1	5.10	0.0007	2	0.02	
	2	3.70	0.0011	2	0.04	
	3	2.15	0.0015	2	0.10	
	4	1.25	0.0006	2	0.07	
	Total	12.20				12.20
LPH	1	11.35	0.0091	2	0.11	
	2	11.50	0.0092	2	0.11	
	3	3.55	0.0021	2	0.08	
	4	1.15	0.0016	2	0.20	
	Total	27.55				
HS-HN	1	8.65	0.0004	2	0.01	
	2	3.50	0.0008	2	0.03	
	3	0.75	0.0004	2	0.07	
	4	3.15	0.0005	2	0.02	
	Total	16.05				

For Bathtub, Iron Shot (BI):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
Control	1	3.55	0.0002	2	0.01
	2	1.55	0.0008	2	0.07
	3	1.60	0.0003	2	0.03
	4	1.10	0.0001	2	0.02
	Total	7.80			
HS	1	3.15	0.0001	2	0.00
	2	4.45	0.0006	2	0.02
	3	1.05	0.0015	2	0.20
	4	3.60	0.0003	2	0.01
	Total	12.25			
LPH	1	8.30	0.0049	2	0.08
	2	6.55	0.0053	2	0.11
	3	2.65	0.0015	2	0.08
	4	6.30	0.0061	2	0.14
	Total	23.80			
HS-HN	1	7.10	0.0018	2	0.04
	2	2.50	0.0017	2	0.10
	3	1.30	0.0006	2	0.06
	4	2.10	0.0006	2	0.04
	Total	13.00			

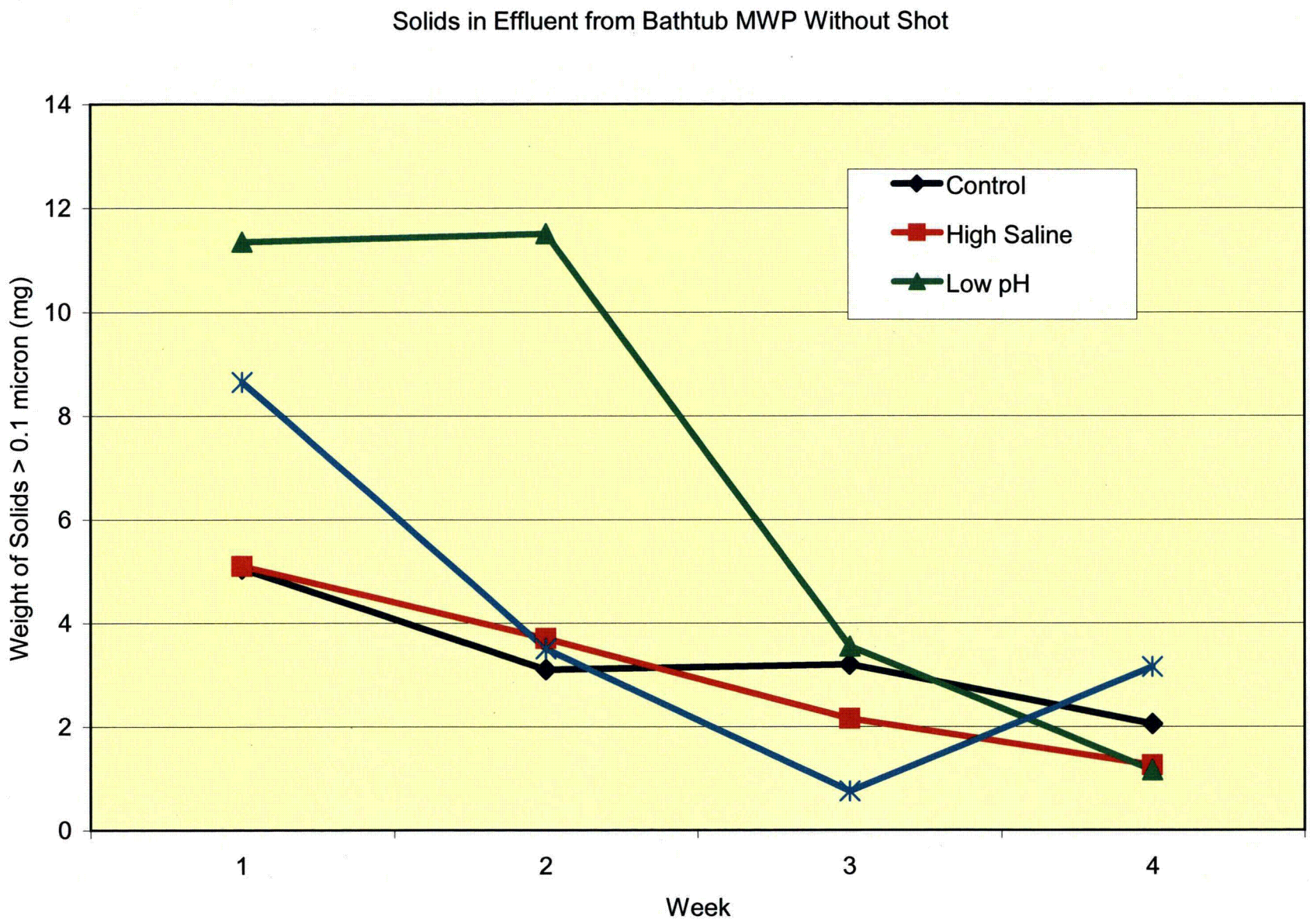
For Flowthru, No Iron Shot (FN):

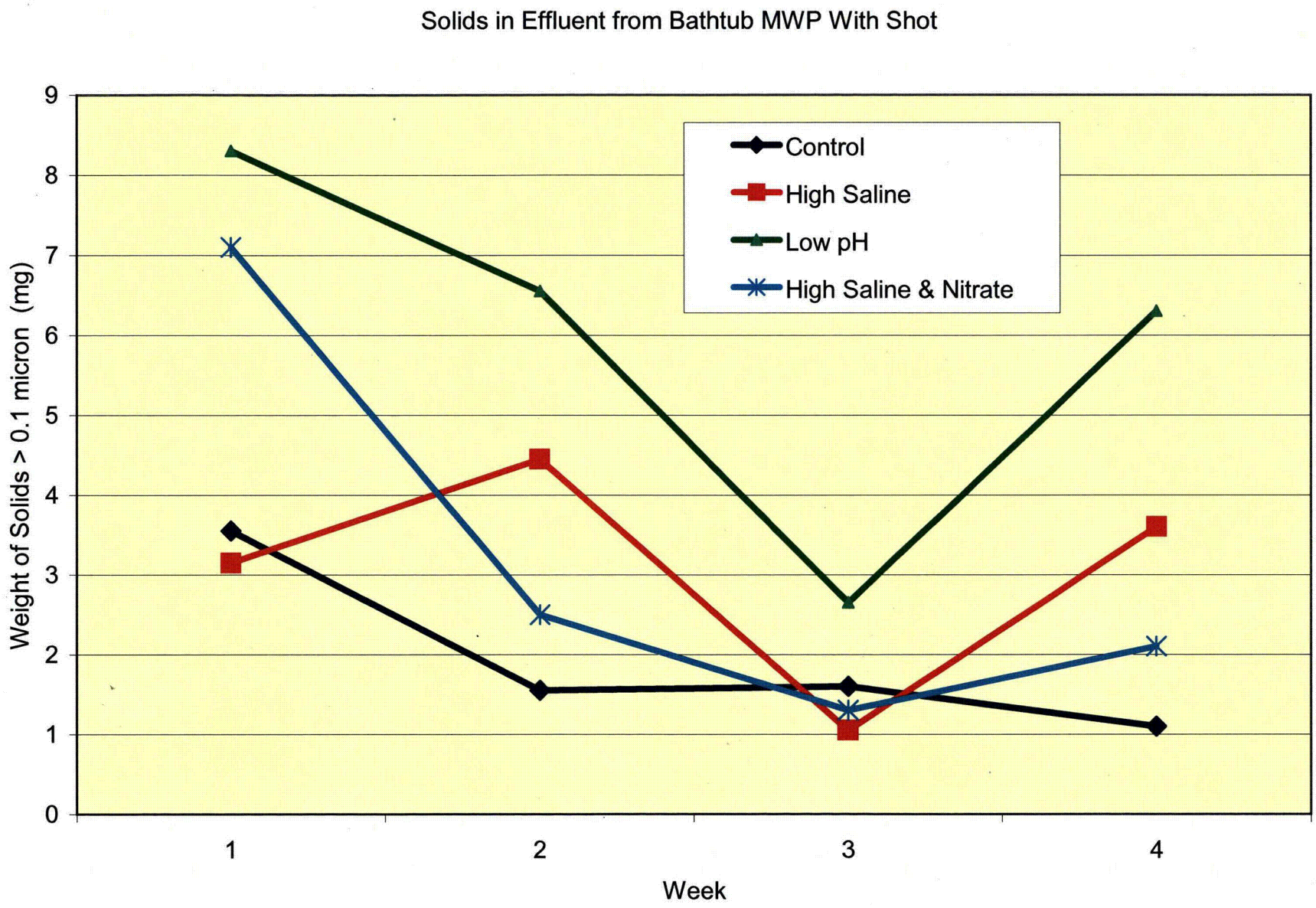
Ave. of total mass (mg) collected for all filter sizes

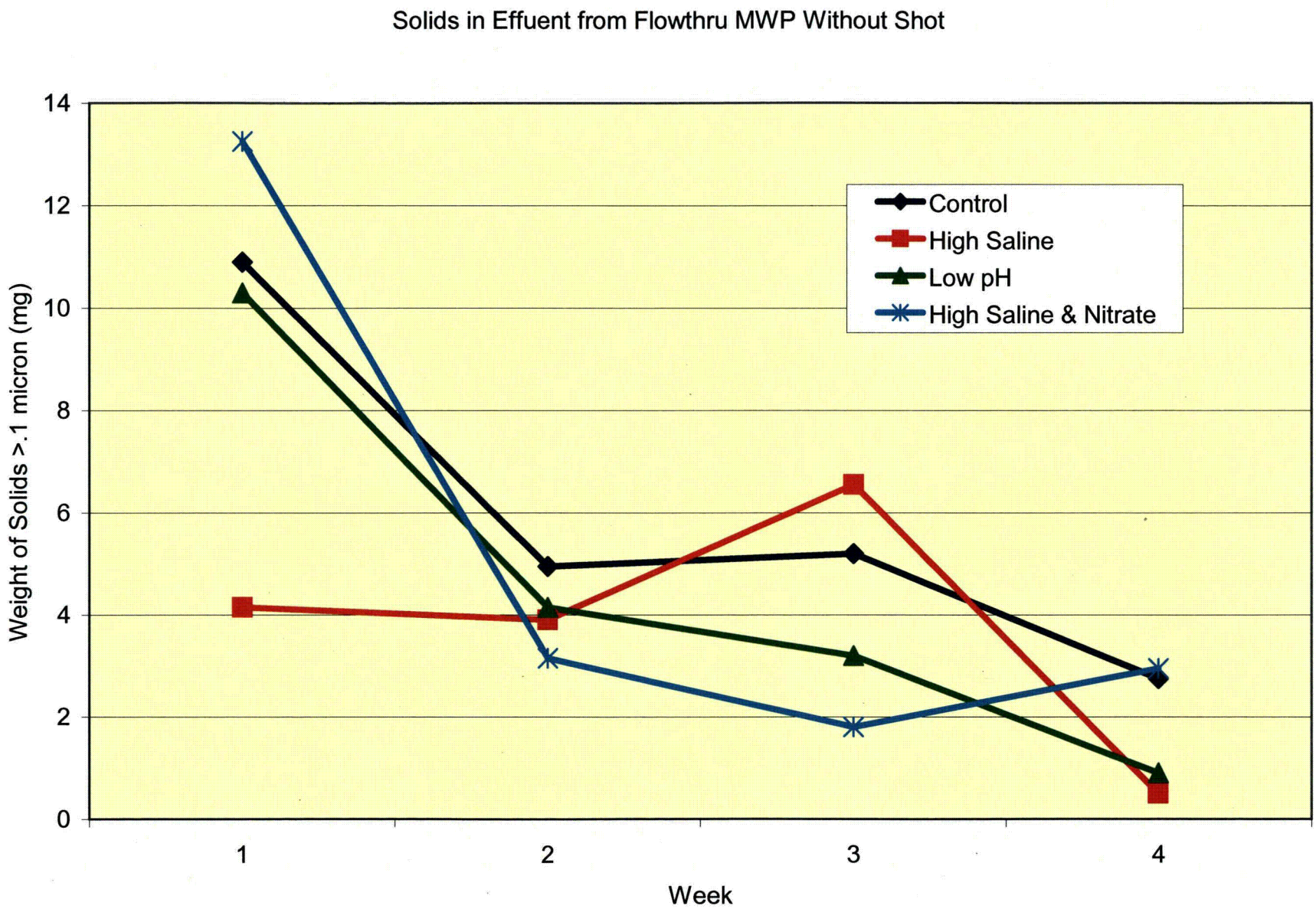
SOLUTION	WEEK	for duplicate experiments	ST. DEV. (g)	n	R.P.D.
Control	1	10.90	0.0045	2	0.06
	2	4.95	0.0013	2	0.04
	3	5.20	0.0006	2	0.02
	4	2.75	0.0009	2	0.05
	Total	23.80			
HS	1	4.15	0.0019	2	0.07
	2	3.90	0.0109	2	0.39
	3	6.55	0.0002	2	0.00
	4	0.50	0.0004	2	0.10
	Total	22.55			
LPH	1	10.30	0.0037	2	0.05
	2	4.15	0.0018	2	0.06
	3	3.20	0.0004	2	0.02
	4	0.90	0.0004	2	0.07
	Total	18.55			
HS-HN	1	13.25	0.0059	2	0.06
	2	3.15	0.0013	2	0.06
	3	1.80	0.0010	2	0.08
	4	2.95	0.0011	2	0.05
	Total	21.15			

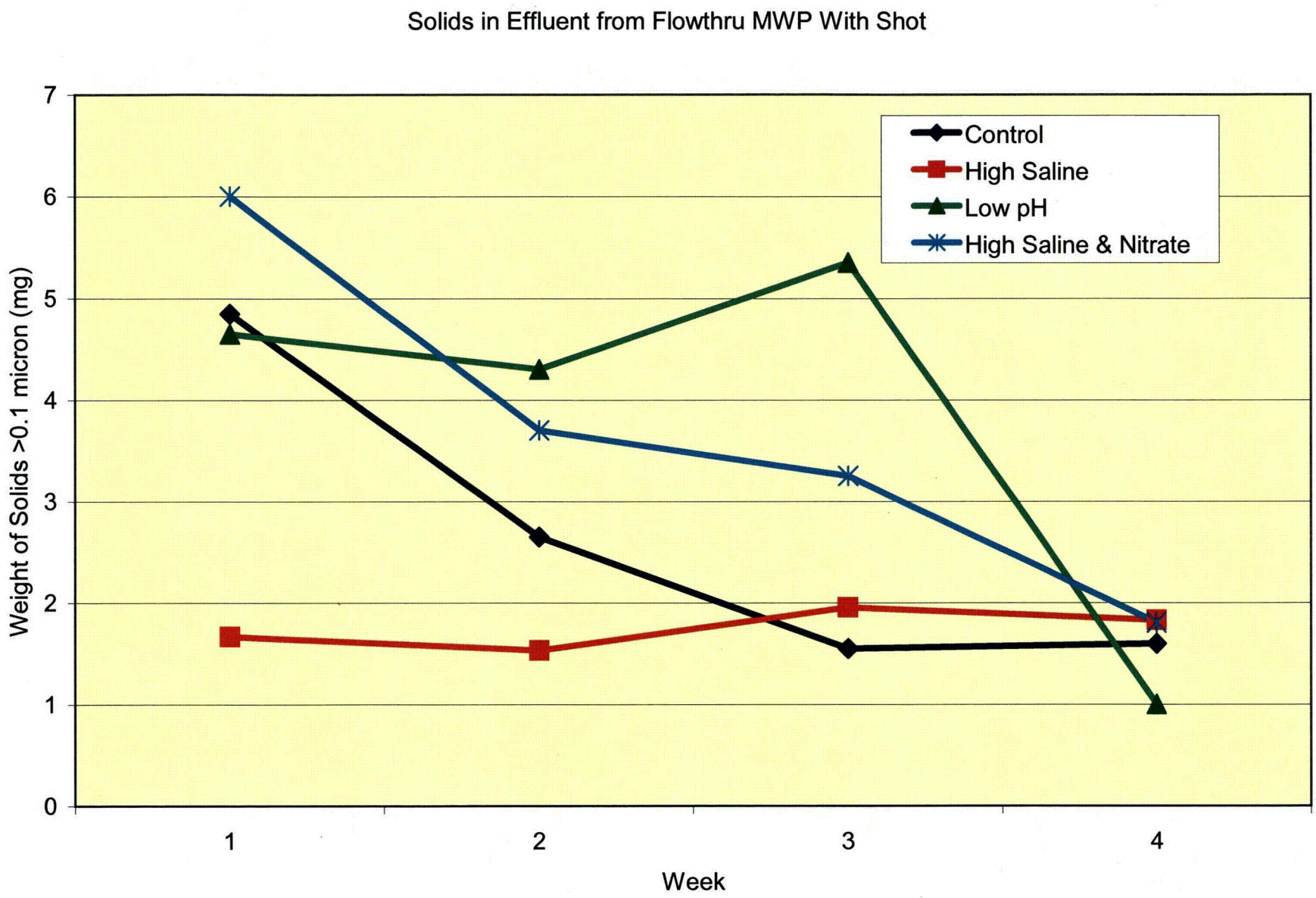
For Flowthru, Iron Shot (FI):

SOLUTION	WEEK	Ave. of total mass (mg) collected for all filter sizes for duplicate experiments	ST. DEV. (g)	n	R.P.D.
Control	1	4.85	0.0025	2	0.07
	2	2.65	0.0016	2	0.09
	3	1.55	0.0009	2	0.08
	4	1.60	0.0004	2	0.04
	Total	10.65			
HS	1	1.67	0.0004	2	0.03
	2	1.53	0.0000	2	0.00
	3	1.95	0.0005	2	0.04
	4	1.83	0.0007	2	0.05
	Total	3.70			
LPH	1	4.65	0.0006	2	0.02
	2	4.30	0.0025	2	0.08
	3	5.35	0.0016	2	0.04
	4	1.00	0.0004	2	0.06
	Total	15.30			
HS-HN	1	6.00	0.0033	2	0.08
	2	3.70	0.0000	2	0.00
	3	3.25	0.0028	2	0.12
	4	1.80	0.0008	2	0.07
	Total	14.75			


Solids in Effluent from Bathtub MWP Without Shot
Weight of Solids > 0.1 micron (mg)
14
12
10
8
6
4
2
0
1
2
3
4
Week
Control
High Saline
Low pH


Solids in Effluent from Bathtub MWP With Shot
Weight of Solids > 0.1 micron (mg)
0
1
2
3
4
5
6
7
8
9
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Solids in Effuent from Flowthru MWP Without Shot
Weight of Solids >.1 micron (mg)
14
12
10
8
6
4
2
0
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate


Solids in Effluent from Flowthru MWP With Shot
Weight of Solids >0.1 micron (mg)
0
1
2
3
4
5
6
7
1
2
3
4
Week
Control
High Saline
Low pH
High Saline & Nitrate

MWP Model

Bathtub w/o Shot

Bathtub w/o Shot — J-13 Control

Week	001A	001B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0040	0.0061	5.0500	0.0015	0.04
2	0.0021	0.0041	3.1000	0.0014	0.06
3	0.0027	0.0037	3.2000	0.0007	0.03
4	0.0026	0.0015	2.0500	0.0008	0.05
Total	0.0114	0.0154	13.4000		

Bathtub w/o Shot — High Saline

	005A	005B	Average(mg)	Std. Dev. (g)	R.P.D.
	0.0056	0.0046	5.1000	0.0007	0.02
	0.0029	0.0045	3.7000	0.0011	0.04
	0.0011	0.0032	2.1500	0.0015	0.10
	0.0008	0.0017	1.2500	0.0006	0.07
	0.0104	0.0140	12.2000		

Bathtub w/o Shot — Low pH

	009A	009B	Average(mg)	Std. Dev. (g)	R.P.D.
	0.0178	0.0049	11.3500	0.0091	0.11
	0.018	0.005	11.5000	0.0092	0.11
	0.005	0.0021	3.5500	0.0021	0.08
	0	0.0023	1.1500	0.0016	0.20
	0.0408	0.0143	27.5500		

Bathtub w/o Shot — LPH-HS

	013A	013B	Average(mg)	Std. Dev. (g)	R.P.D.
	0.0069	0.0084	8.65	0.000	0.01
	0.0041	0.0029	3.50	0.001	0.03
	0.0005	0.0010	0.75	0.000	0.07
	0.0035	0.0028	3.15	0.000	0.02
	0.0170	0.0151	16.05		

MWP Model

Bathtub With Shot

Bathtub With Shot — Control

Week	002A	002B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0034	0.0037	3.5500	0.0002	0.01
2	0.0010	0.0021	1.5500	0.0008	0.07
3	0.0018	0.0014	1.6000	0.0003	0.03
4	0.0010	0.0012	1.1000	0.0001	0.02
Total	0.0072	0.0084	7.8000		

Bathtub With Shot — High Saline

	006A	006B	Average(mg)	Std. Dev. (g)	
	0.0031	0.0032	3.1500	0.0001	0.00
	0.0040	0.0049	4.4500	0.0006	0.02
	0.0000	0.0021	1.0500	0.0015	0.20
	0.0038	0.0034	3.6000	0.0003	0.01
	0.0109	0.0136	12.2500		

Bathtub With Shot — Low pH

	010A	010B	Average(mg)	Std. Dev. (g)	
	0.0118	0.0048	8.3000	0.0049	0.08
	0.0028	0.0103	6.5500	0.0053	0.11
	0.0016	0.0037	2.5500	0.0015	0.08
	0.002	0.0106	6.3000	0.0061	0.14
	0.0182	0.0294	23.8000		

Bathtub With Shot — LPH-HS

	014A	014B	Average(mg)	Std. Dev. (g)	
	0.0084	0.0058	7.10	0.002	0.04
	0.0013	0.0037	2.50	0.002	0.10
	0.0017	0.0009	1.30	0.001	0.06
	0.0025	0.0017	2.10	0.001	0.04
	0.0139	0.0121	13.00		

Flowthru w/o Shot

Flowthru w/o Shot — Control

Week	003A	003B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0141	0.0077	10.9000	0.0045	0.06
2	0.0040	0.0059	4.9500	0.0013	0.04
3	0.0048	0.0056	5.2000	0.0006	0.02
4	0.0021	0.0034	2.7500	0.0009	0.05
Total	0.0250	0.0226	23.8000		

Flowthru w/o Shot — High Saline

	007A	007B	Average(mg)	Std. Dev. (g)	
	0.0055	0.0028	4.1500	0.0019	0.07
	0.0193	0.0039	3.9000	0.0109	0.39
	0.0067	0.0064	6.5500	0.0002	0.00
	0.0005	0.0000	0.5000	0.0004	0.10
	0.0320	0.0131	22.5500		

Flowthru w/o Shot — Low pH

	011A	011B	Average(mg)	Std. Dev. (g)	
	0.0077	0.0129	10.3000	0.0037	0.05
	0.0029	0.0054	4.1500	0.0018	0.06
	0.0029	0.0035	3.2000	0.0004	0.02
	0.0012	0.0006	0.9000	0.0004	0.07
	0.0147	0.0224	18.5500		

Flowthru w/o Shot — LPH-HS

	015A	015B	Average(mg)	Std. Dev. (g)	
	0.0174	0.0091	13.25	0.006	0.06
	0.0022	0.0041	3.15	0.001	0.06
	0.0011	0.0025	1.80	0.001	0.08
	0.0022	0.0037	2.95	0.001	0.05
	0.0229	0.0194	21.15		

Flowthru with Shot

Flowthru with Shot — Control

Week	004A	004B	Average(mg)	Std. Dev. (g)	R.P.D.
1	0.0066	0.0031	4.8500	0.0025	0.07
2	0.0015	0.0038	2.6500	0.0016	0.09
3	0.0022	0.0009	1.5500	0.0009	0.06
4	0.0019	0.0013	1.6000	0.0004	0.04
Total	0.0122	0.0091	10.6500		

Flowthru with Shot — High Saline

	008A	008B	Average(mg)	Std. Dev. (g)	
	0.0014	0.0019	1.6687	0.0004	0.03
	0.0015	0.0016	1.5316	0.0000	0.00
	0.0023	0.0016	1.9548	0.0005	0.04
	0.0023	0.0014	1.8311	0.0007	0.05
	0.0075	0.0037	3.7000		

Flowthru with Shot — Low pH

	012A	012B	Average(mg)	Std. Dev. (g)	
	0.0042	0.0051	4.6500	0.0006	0.02
	0.0025	0.0061	4.3000	0.0025	0.08
	0.0042	0.0065	5.3500	0.0016	0.04
	0.0013	0.0007	1.0000	0.0004	0.06
	0.0122	0.0184	15.3000		

Flowthru with Shot — LPH-HS

	016A	016B	Average(mg)	Std. Dev. (g)	
	0.0083	0.0037	6.00	0.003	0.08
	0.0037	0.0037	3.70	0.000	0.00
	0.0052	0.0013	3.25	0.003	0.12
	0.0024	0.0012	1.80	0.001	0.07
	0.0196	0.0099	14.75		

	Mass Flow mg/L
Control	16.5
High Saline	19.4
Low pH	26.0
High Saline-High Nitrate	21.0

	SOLIDS ON .45 UM (g)	SOLIDS ON .22 UM (g)	SOLIDS ON .10 UM (g)
Control	0.0091	0.0017	0.0006
	0.0126	0.002	0.0008
	0.005	0.0017	0.0005
	0.0062	0.0014	0.0008
	0.0229	0.0014	0.0007
	0.0199	0.0017	0.001
	0.0101	0.0013	0.0008
	0.0064	0.0015	0.0012
High Saline	0.0922	0.0127	0.0064
HS	0.0081	0.0013	0.001
	0.0086	0.0028	0.0026
	0.006	0.0016	0.0033
	0.0075	0.0019	0.0042
	0.0069	0.0179	0.0072
	0.0078	0.0024	0.0029
	0.0051	0.0021	0.0058
	0.0039	0.0017	0.0019
"	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0539	0.0317	0.0287
LPH	0.0193	0.01	0.0115
	0.008	0.003	0.0033
	0.009	0.0052	0.004
	0.0108	0.0091	0.0095
	0.0098	0.003	0.0019
	0.0152	0.0015	0.0057
	0.0095	0.0009	0.0018
	0.015	0.0016	0.0018
	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0966	0.0343	0.0395
HS-HN	0.0094	0.0037	0.0039
	0.0113	0.0014	0.0024
	0.0104	0.0013	0.0022
	0.0098	0.0008	0.0015
	0.0193	0.002	0.0016
	0.0158	0.001	0.0026
	0.0162	0.0014	0.002
	0.0065	0.0016	0.0018
	0.45 micron	0.22 micron	0.10 micron
Sum:	0.0987	0.0132	0.018