Selenium Area Wide Investigation
Southeast Idaho Phosphate Mining Resource Area

Water Quality Sampling for Metals -
Blackfoot River and Tributaries (HUC 17040207) and
Selected Bear River Tributaries (HUC 16010201)

18 – 21 May 2004

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

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24 March 2005

SUMMARY

During May 2004 Idaho Department of Environmental Quality personnel conducted surface water sampling operations in cooperation with U.S. Forest Service personnel. Twenty-two (22) sites located on 13 streams were sampled. Discharge was measured at 19 sites. Samples were shipped under chain of custody to ACZ Laboratories (Steamboat Springs, Colorado) for analysis. Of 11 metals analyzed for, 8 were present in samples at concentrations greater than the minimum detection limit. Three sites sampled on East Mill Creek and Spring Creek at its mouth contained selenium at concentrations $\geq$ the acute aquatic life criteria (CMC). Selenium concentrations at Blackfoot River near Slug Creek and Georgetown Creek were $\geq$ to the chronic aquatic life criteria (CCC).

INTRODUCTION

As part of the Selenium Area Wide Investigation Total Maximum Daily Load (TMDL) baseline monitoring task, sampling of total selenium and ten dissolved metals in stream surface waters was conducted. This monitoring information will be used to continue to assess impacts to water quality from phosphate mining operations and aid in prioritizing and implementing remedial activities in affected watersheds.

METHODS

Study Sites

Twenty four sites in the Blackfoot and Bear River drainages were sampled 18-21 May 2004 (Figure 1), using 3 teams of personnel. Sampling personnel consisted of Idaho Department of Environmental Quality (DEQ) and U.S. Forest Service employees. Field teams followed USGS and Federal Interagency Sedimentation Project sampling protocols described by TtEMI (2001, 2002, and 2003). Water samples were collected using a depth-integrated sampler (Model US DH-95). A bridge-board winch platform was used at several sites where wading was not possible. Samples were placed in polyethylene containers, preserved with sulfuric or nitric acid as necessary, and stored at 4 °C on ice in a cooler or a refrigerator. Samples were collected in accordance with DEQ 4-day averaging protocol at 18 sites and 6 sites were sampled on a discrete date. In contrast to previous years when discrete samples were analyzed, 3 samples collected per site over a 4-day period were composited at DEQ and shipped under chain of custody and within holding times, overnight to ACZ Laboratory, Steamboat Springs, Colorado. A YSI multiparameter monitoring system (model 6920 sonde, model 650 MDS display) was used to acquire in-situ readings of dissolved oxygen, temperature, turbidity, conductivity, and pH concurrent with water sampling. Readings were taken at 3 locations perpendicular to the stream flow (middle, left third, right third). Discharge was measured using a portable electromagnetic flow meter (Marsh-McBirney model 2000) in conjunction with a top setting wading rod or a bridge board sampling weight. At sites with very low flow, discharge was determined by the time required to fill a 10-L bucket. For purposes of determining loads, mean discharge of 2 measurements taken over the 3-d sampling period was calculated.

RESULTS

Discharge Measurements
Discharge measurements are provided in Table 1. Discharge at individual sites ranged from 0 – 94 cubic feet per second (cfs). Discharge at most sites decreased over the sampling period. Measurements on Rasmussen, Montpelier (at KOA), and Spring (at mouth) creeks indicated increases in flow over the study period.

Physicochemical Measurements
In-situ measurements of physicochemical parameters were recorded at all sites (Table 2). Water temperature ranged from 5.64-13.61° C. Specific conductivity @ 25° C ranged from 327 to 857 $\mu s/cm^2$. All dissolved oxygen measurements were > 8 mg/L. pH ranged from 7.67 to 8.59. Turbidity was < 5 NTU at all sites except East Mill lower (11.9), East Mill middle (9.2), and Blackfoot River at China Hat (12.3).

Chemical Constituents
Calcium ranged from 48 – 138 (mean = 171) mg/L. Magnesium ranged from 10 - 38 (mean = 17) mg/L. Bicarbonate ranged from 139 – 273 (mean = 190) mg/L. Total organic carbon averaged 3.4 (range = 2 – 10) mg/L. Mean water hardness was 246 (range = 164 – 488) mg/L $CaCO_3$. Nutrient concentrations ranged from a nitrate + nitrite mean of 0.272 (range = <0.02 – 1.26) and phosphorus mean of 0.07 (range = <0.01 – 0.17) mg/L. Total alkalinity ranged from 145 – 273 (mean = 194) mg/L.

Metals concentrations varied among sites (Table 3). Zinc and cadmium were not present above laboratory detection limits (0.01 - 0.0002 mg/L) in any samples. Chromium ranged from <0.0002 – 0.0013 (mean = 0.00042) mg/L. Copper ranged from 0.0005 – 0.0016 (mean = 0.0011), lead ranged from 0.0001 – 0.0005 (mean = 0.0003) mg/L. Nickel ranged from <0.0004 – 0.0092 (mean = 0.0027) mg/L. Selenium ranged from <0.001 – 0.78 (mean = 0.0992) mg/L. Silver ranged from <0.0001 – 0.0004 (mean = 0.0002) mg/L. Vanadium ranged from 0.0004 – 0.0028 (mean = 0.00092) mg/L.

Equipment blanks collected during field sampling were non-detect for all constituents analyzed for except copper (0.002mg/L, MDL=0.001 mg/L) in both samples, nitrate/nitrite (0.03 mg/L, MDL=0.02 mg/L) in one, and total phosphorus (0.01 mg/L, MDL=0.01 mg/L) in the second. Duplicate samples were all within 20 percent for all constituents except total organic carbon (33 and 50 percent).

DISCUSSION

Discharge
Discharge was generally < that determined in 2003 (Figure 2). Discharge at Blackfoot River (USGS gage 13063000; Figures 3a and 3b) was similar to that in 2003 during the

study; however, summer base flows were greater in 2004 than 2003. During this study, change in discharge ranged from 0-29%. Since samples were composited prior to analyses, any relationship among analyte concentrations and discharge could not be investigated.

Chemical Constituents
State of Idaho criteria for metals criteria consists of acute (CMC) and chronic (CCC) concentration limits. Criteria for several metals (cadmium, chromium, copper, lead, silver, and zinc) also are hardness-dependent. Acute and chronic criteria concentrations were calculated for each of these metals using hardness values in the analytical report (Table 3). Selenium concentrations in samples from three sites on East Mill Creek and Spring Creek at its mouth were $\geq$ the CMC for aquatic life (Figure 4). Concentrations of all hardness-dependent metals analyzed for (cadmium, chromium, copper, lead, silver, and zinc) were less than the detection limit, or were 1-2 orders of magnitude < the CCC at all sites. No criteria except for human consumption of drinking water (0.26 mg/L) are available for vanadium.

Laboratory Data Quality
Detections of copper, nitrate/nitrite, and total phosphorus in equipment blanks were at or slightly above method detection limits; however all were < practical quantitation limits. Except for total organic carbon (TOC), analyte concentrations in duplicate samples were all within 20% relative difference, even at concentrations near the minimum detection limits. For sample results greater than or equal to five times the practical quantitation limit (PQL), the acceptance criteria is typically ± 20 percent relative percent difference. TOC varied 33 and 50% among duplicate samples. However, TOC concentrations in samples were low and ranged from 2-10 mg/L, with a minimum detection limit of 1 mg/L and a practical quantitation limit of 5 mg/L. Three of four duplicate sample TOC concentrations were < the PQL, therefore, differences in duplicates were likely due to low concentrations in the samples.

RECOMMENDATIONS

Sampling should continue at most sites investigated in this study. An earlier report indicated selenium concentrations correlate with annual snowfall (TtEMI 2004). Given that since 1998, precipitation in the region has been less than average, sampling needs to continue to document changes in metals concentration during above average versus below average precipitation years; however, some sites have sufficient data from low precipitation years. Several locations had selenium concentrations < minimum detection limit; however, retaining the Lanes Creek site will provide a basis for comparison with other sites, especially on Blackfoot River. Sites recommended to be excluded from sampling next year are Spring Creek spring sites, Rasmussen, Slug (below Goodheart Creek), and Montpelier creeks. Additional sites recommended for sampling are Crow, Deer, and Sage creeks in the Salt River drainage. Given that most metals were not detected or were present at several orders of magnitude < their detection limits in this sampling event, the analyte list should be revised to include only total suspended solids, total organic carbon, hardness as CaCO3, nitrate + nitrite as nitrogen (dissolved), total

phosphorus, total alkalinity, selenium, cadmium, zinc, and nickel. If funding permits, selenium sample analyses should be further differentiated into selenate and selenite components.

LITERATURE CITED

Tetra Tech EM Inc. (TtEMI). 2001. Final Sampling and Analysis Plan—Baseline Water Quality Assessment Selenium Project. Prepared for the IDEQ. May 2001.

TtEMI. 2002. Final 2001 TMDL Baseline Monitoring Report. Prepared for the IDEQ. April 2002.

TtEMI. 2003. 2003 TMDL Baseline Monitoring Sampling and Analysis Plan Addendum. Prepared for the IDEQ. May 2003.

TtEMI. 2004. Supplement to 2001 Total Maximum Daily Load Baseline Monitoring Report Prepared for the IDEQ. January 2004.

Table 1. Discharge measurements for Blackfoot River selenium sampling locations, 17-22 May 2004.

Location	Date	Flow (cfs)	Mean Flow (cfs)	Field personnel	Notes
Blackfoot at Trail Cr. Road	17-May	93.83		GM/DV	measured from bridge
Blackfoot at Trail Cr. Road	20-May	71.19	82.51	GM/DV	measured downstream of bridge
Blackfoot at Slug	17-May	86.33		GM/DV	
Blackfoot at Slug	20-May	82.24	84.29	GM/DV	
Blackfoot above Narrows	18-May	91.65		GM/DV	
Blackfoot above Narrows	21-May	85.55	88.60	GM/DV	
Blackfoot upper bridge	18-May	86.72		GM/DV	
Blackfoot upper bridge	21-May	82.22	84.47	GM/DV	
Spring Creek - Mouth	18-May	11.07		GM/DV	
Spring Creek - Mouth	21-May	12.72	11.90	GM/DV	
Lanes Creek above Diamond confluence	18-May	51.39		GM/DV	
Lanes Creek above Diamond confluence	21-May	44.76	48.07	GM/DV	
East Mill Creek - lower	18-May	0.55		GM/DV	measured at north channel only
East Mill Middle	18-May	1.28		GM/DV	
East Mill Creek - Upper	21-May	0.16		GM/DV	
Spring Creek - S spring	18-May	1.80		GM/DV	
Spring Creek - N spring	18-May	0.90		GM/DV	
Georgetown Cr. Below Mill	17-May	5.73		LVE/WF	
Georgetown Cr. Below Mill	20-May	5.37	5.55	LVE/WF	
Rasmussen Cr	17-May	0.37		LVE/WF	
Rasmussen Cr	20-May	0.48	0.42	LVE/WF	
Angus Upper	17-May	0.10		LVE/WF	
Angus Upper	20-May	0.08	0.09	LVE/WF	
Montpelier Cr. @ KOA	18-May	7.92		LVE/WF	
Montpelier Cr. @ KOA	21-May	8.30	8.11	LVE/WF	
Montpelier Creek u/s Mine	18-May	6.70		LVE/WF	
Montpelier Cr d/s Home	18-May	6.53		LVE/WF	
Montpelier Cr d/s Home	21-May	6.21	6.37	LVE/WF	
State Land Cr	17-May	0.07		LVE/WF	
State Land Cr	20-May	0.07	0.07	LVE/WF	
Goodheart Cr	18-May	0.00		LVE/WF	
Goodheart Cr	21-May	0.00	0.00	LVE/WF	

Table 2. Mean physical water parameters during selenium water sampling.

SITE	Blackfoot River - ChinaHat	Blackfoot River Monsanto	Blackfoot Trail	Blackfoot Slug	Blackfoot Narrows	Blackfoot Upper Bridge	Lanes Creek	Spring Creek Mouth	Spring Creek South	North Spring Creek	E Mill Lower
T(°C)	13.04	13.19	12.85	13.48	11.60	11.19	13.21	11.71	6.74	6.62	8.92
SPC	411	355	354	347	354	356	357	354	342	348	413
pH	7.84	8.43	8.44	8.52	8.42	8.38	8.51	8.36	7.68	7.70	8.50
DO %	86.0%	83.5%	92.1%	107.2%	108.8%	107.1%	112.8%	110.7%	82.3%	85.1%	91.5%
DO mg/L	9.03	8.75	9.72	11.20	11.84	11.75	11.81	11.91	10.01	10.44	10.58
Turbidity	12.3	4.0	3.9	3.5	3.4	3.7	3.2	0.7	0.0	-0.3	11.9

SITE	E Mill Middle	East Mill Upper	Goodheart Creek (view of Champ Mine)	Stateland Creek	Montpelier Creek below Waterloo Mine @ KOA	Georgetown Creek	Rasmussen Creek above culvert	Montpelier Creek below Home Canyon	Slug Creek @ Slug Cr Road	Angus Creek - Upper	Montpelier Creek above Mining
T(°C)	7.53	6.03	12.85	14.24	9.96	5.64	13.61	9.49	13.53	13.19	10.81
SPC	423	671	857	329	552	370	327	462	390	835	444
pH	8.42	7.71	7.67	8.29	8.26	8.43	8.59	8.33	8.35	8.28	8.53
DO %	94.9%	85.9%	112.1%	81.4%	90.4%	84.8%	90.5%	88.7%	107.4%	92.5%	93.4%
DO mg/L	11.33	10.68	11.82	8.33	10.18	10.64	9.41	10.13	11.17	9.68	10.33
Turbidity	9.2	2.0	0.5	2.3	4.0	1.0	3.9	3.4	1.9	2.6	3.4

Table 3. Results of surface water quality sampling from 18-21 May 2004 in the southeastern Idaho phosphate mining district. (All results in mg/L)

	Calcium, dissolved	Chromium, dissolved	Copper, dissolved	Lead, dissolved	Magnesium, dissolved	Nickel, dissolved	Selenium, total	Silver, dissolved	Vanadium, dissolved	Bicarbonate as CaCO3	Carbon, total organic (TOC)	Carbonate as CaCO3	Hardness as CaCO3	Nitrate/Nitrite as N, dissolve	Phosphorus, total	Residue, Non-Filterable (TSS)	Total Alkalinity
Up Angus (	129	0.0002	< 0.001	0.0002	38.3	0.0018	0.005	< 0.0001	0.0008	185	2	< 2	480	0.05	0.06	< 5	185
Montpelier	64.1	0.0003	< 0.001	0.0004	18.9	< 0.0004	< 0.001	< 0.0001	0.001	179	3	8	238	0.03	0.02	< 5	187
Slug Cr bel	58.2	0.0002	< 0.001	0.0005	15.5	0.0005	< 0.001	< 0.0001	0.0009	191	5	4	209	< 0.02	0.02	< 5	195
Blackfoot @	57.4	< 0.0002	< 0.001	< 0.0002	11.2	< 0.0004	0.005	0.0004	0.0009	171	3	7	190	< 0.02	0.05	< 5	179
Stateland (	48.2	0.0003	0.001	0.0004	10.7	0.0013	0.003	< 0.0001	0.0028	147	3	< 2	164	< 0.02	0.1	< 5	147
Blackfoot-U	60	0.0002	< 0.001	0.0003	11.6	< 0.0004	0.003	< 0.0001	0.0008	197	4	4	198	< 0.02	0.05	< 5	201
Spring Cr (	54.9	0.0005	< 0.001	< 0.0002	12	0.0005	< 0.001	< 0.0001	0.0004	185	2	< 2	187	0.16	0.03	< 5	185
Spring Cr (	53.3	0.0004	< 0.001	< 0.0002	14.3	< 0.0004	< 0.001	< 0.0001	0.0004	192	2	< 2	192	0.11	< 0.01	< 5	192
Montpelier	66.3	< 0.0002	< 0.001	0.0004	20.1	< 0.0004	< 0.001	< 0.0001	0.0008	217	2	< 2	248	0.02	0.04	< 5	217
Georgetow	62.1	0.0003	< 0.001	< 0.0002	13.4	< 0.0004	0.015	0.0002	0.0008	205	2	4	210	< 0.02	0.13	< 5	208
Blackfoot F	66.8	< 0.0002	< 0.001	< 0.0002	14.5	0.0004	0.002	< 0.0001	0.001	222	4	< 2	227	< 0.02	0.09	< 5	222
Blackfoot @	59.4	< 0.0002	< 0.001	< 0.0002	11.7	0.0006	0.002	< 0.0001	0.001	186	4	3	197	< 0.02	0.06	< 5	189
Lanes Cr	60.9	< 0.0002	< 0.001	< 0.0002	10.8	< 0.0004	< 0.001	< 0.0001	0.001	186	3	10	197	< 0.02	0.05	< 5	195
Blackfoot-N	58.8	< 0.0002	< 0.001	< 0.0002	11.4	< 0.0004	0.002	< 0.0001	0.0008	185	3	6	194	< 0.02	0.05	< 5	191
Blackfoot-N	59.1	< 0.0002	< 0.001	< 0.0002	11.5	0.0005	0.002	< 0.0001	0.0008	189	6	5	195	< 0.02	0.06	< 5	194
Blackfoot -	60	< 0.0002	< 0.001	< 0.0002	11.9	< 0.0004	0.002	< 0.0001	0.0009	183	5	5	199	< 0.02	0.05	< 5	188
Spring Cr-N	59.1	< 0.0002	< 0.001	< 0.0002	11.9	< 0.0004	0.02	< 0.0001	0.0006	182	2	4	197	< 0.02	0.04	< 5	186
Rasmusse	54.5	< 0.0002	< 0.001	0.0003	9.9	< 0.0004	< 0.001	< 0.0001	0.0011	139	3	6	177	< 0.02	0.07	< 5	145
Goodheart	138	0.0002	< 0.001	0.0002	34.9	0.0092	0.002	< 0.0001	0.0008	273	10	< 2	488	< 0.02	0.04	< 5	273
Angus Cr (	128	0.0003	0.0016	0.0002	37.3	0.0068	0.003	< 0.0001	0.00088	193	4	< 2	473	0.05	0.06	< 5	193
Montpelier	77.8	0.0002	0.0007	0.0002	23.4	0.0035	0.001	< 0.0001	0.00092	191	2	3	291	0.04	0.03	< 5	194
E. Mill (Upp	104	0.0013	0.0012	0.0001	27.1	0.0049	0.78	< 0.0001	0.00099	204	3	< 2	371	1.26	0.11	8	204
E. Mill (mid	66.8	0.0006	0.0005	< 0.0002	15.9	0.003	0.31	< 0.0001	0.00073	187	2	2	232	0.39	0.17	14	189
E. Mill (Low	67.3	0.0005	< 0.001	0.0003	15.2	< 0.0004	0.25	0.0001	0.0009	189	3	6	231	0.32	0.15	18	196
E. Mill (Lwr	65.3	0.0006	< 0.001	< 0.0002	14.7	< 0.0004	0.28	< 0.0001	0.0009	185	2	7	224	0.33	0.16	24	192
Equipment	< 0.2	< 0.0002	0.002	< 0.0002	< 0.2	< 0.0004	< 0.001	< 0.0001	< 0.0001	< 2	< 1	< 2	< 1	< 0.02	0.01	< 5	< 2
Equipment	< 0.2	< 0.0002	0.002	< 0.0002	< 0.2	< 0.0004	< 0.001	< 0.0001	< 0.0001	< 2	< 1	< 2	< 1	0.03	< 0.01	< 5	< 2

Cadmium was not detected in any samples at an MDL of 0.0002

Figure 1. Sampling locations for 18-21 May 2004 surface water sampling event.

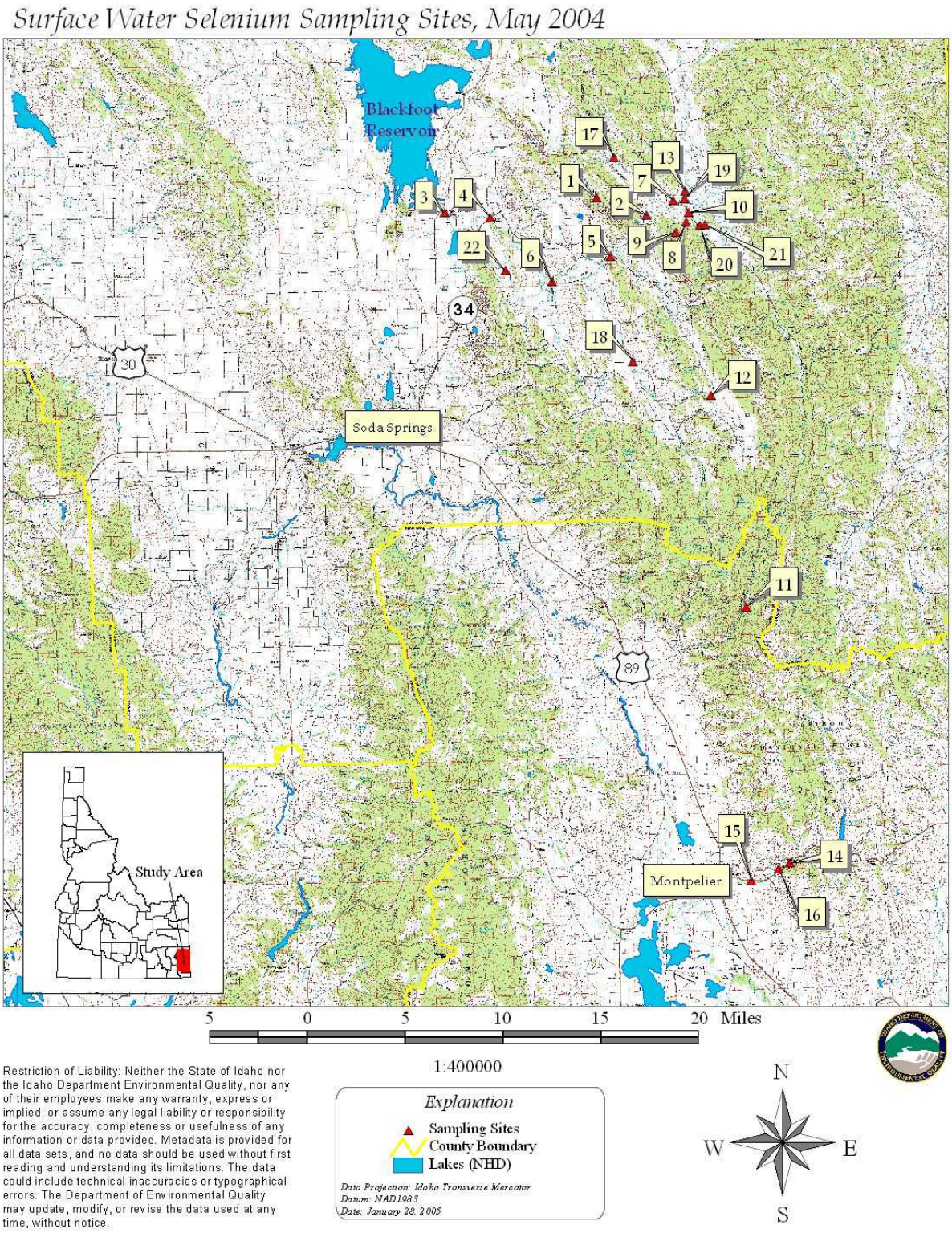

Figure 1 (key). Sampling locations for 18-21 May 2004 surface water sampling event.

Site No.	Sampling Location	Latitude	Longitude
1	Angus Creek (Upper)	42.827583	-111.400389
2	Blackfoot River above Narrows	42.813696	-111.350299
3	Blackfoot River at China Hat	42.820019	-111.553545
4	Blackfoot River at Monsanto	42.815541	-111.507253
5	Blackfoot River at Slug Creek	42.784243	-111.387956
6	Blackfoot River at Trail Creek	42.767308	-111.447211
7	Blackfoot River Upper Bridge	42.824076	-111.323242
8	East Mill Creek (Middle)	42.807934	-111.310923
9	East Mill Creek (Upper)	42.800539	-111.321803
10	East Mill Creek (Lower)	42.814804	-111.308069
11	Georgetown Creek below Mill Site	42.522972	-111.263333
12	Goodheart Creek in view of Champ Mine	42.679389	-111.291889
13	Lanes Creek	42.830729	-111.311123
14	Montpelier Creek (above mining)	42.333000	-111.228139
15	Montpelier Creek at KOA	42.320772	-111.266746
16	Montpelier Creek below Home Canyon	42.328972	-111.238861
17	Rasmussen Creek	42.857332	-111.381155
18	Slug Creek below Goodheart Creek	42.706277	-111.368497
19	Spring Creek	42.825307	-111.311674
20	Spring Creek (North Spring)	42.805130	-111.297228
21	Spring Creek (South Spring)	42.805799	-111.292431
22	State Land Creek	42.776570	-111.493881

Figure 2. Discharge for sample sites, 2003 versus 2004.

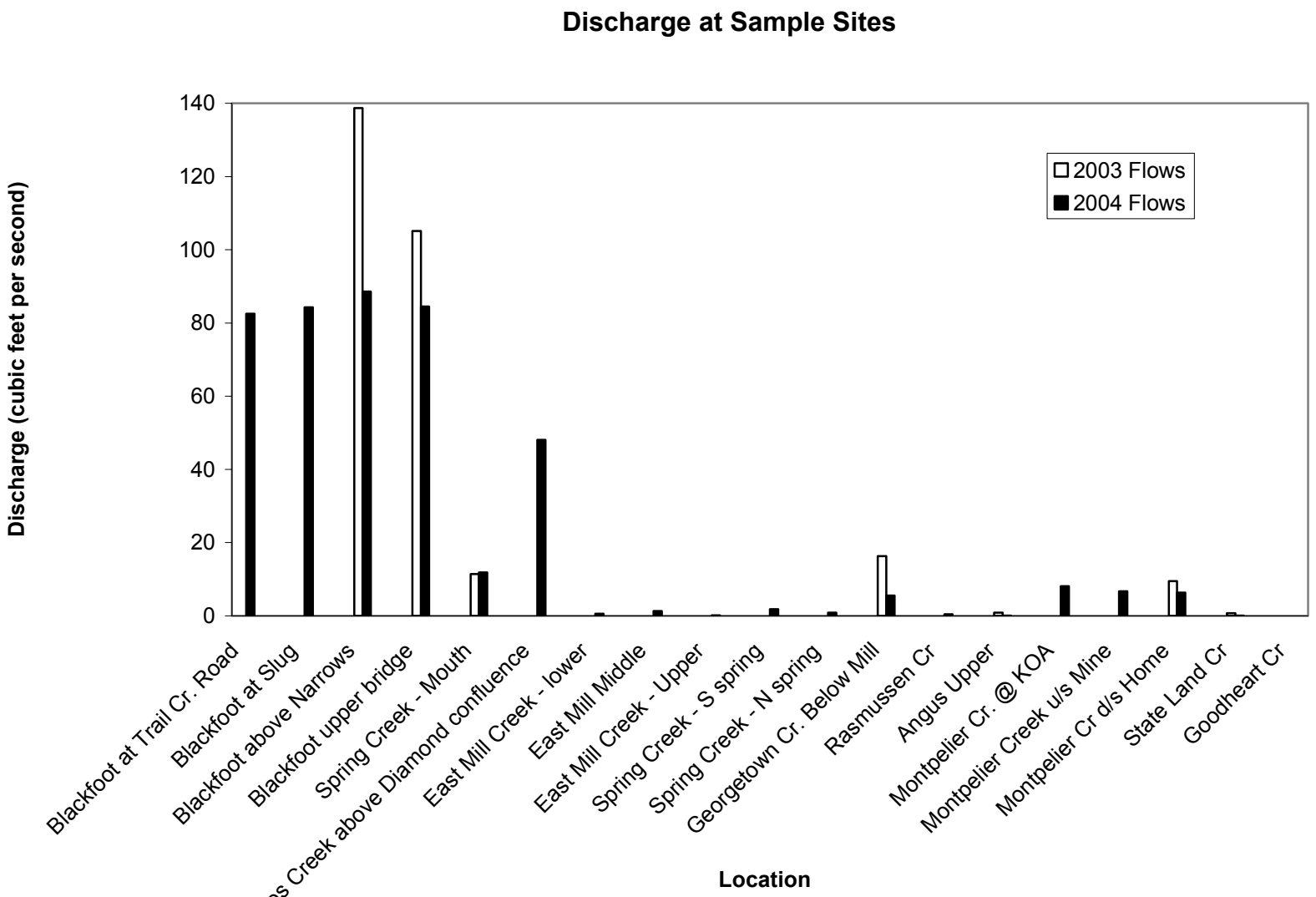

Figure 3a. Blackfoot River flow, 2001-2003.

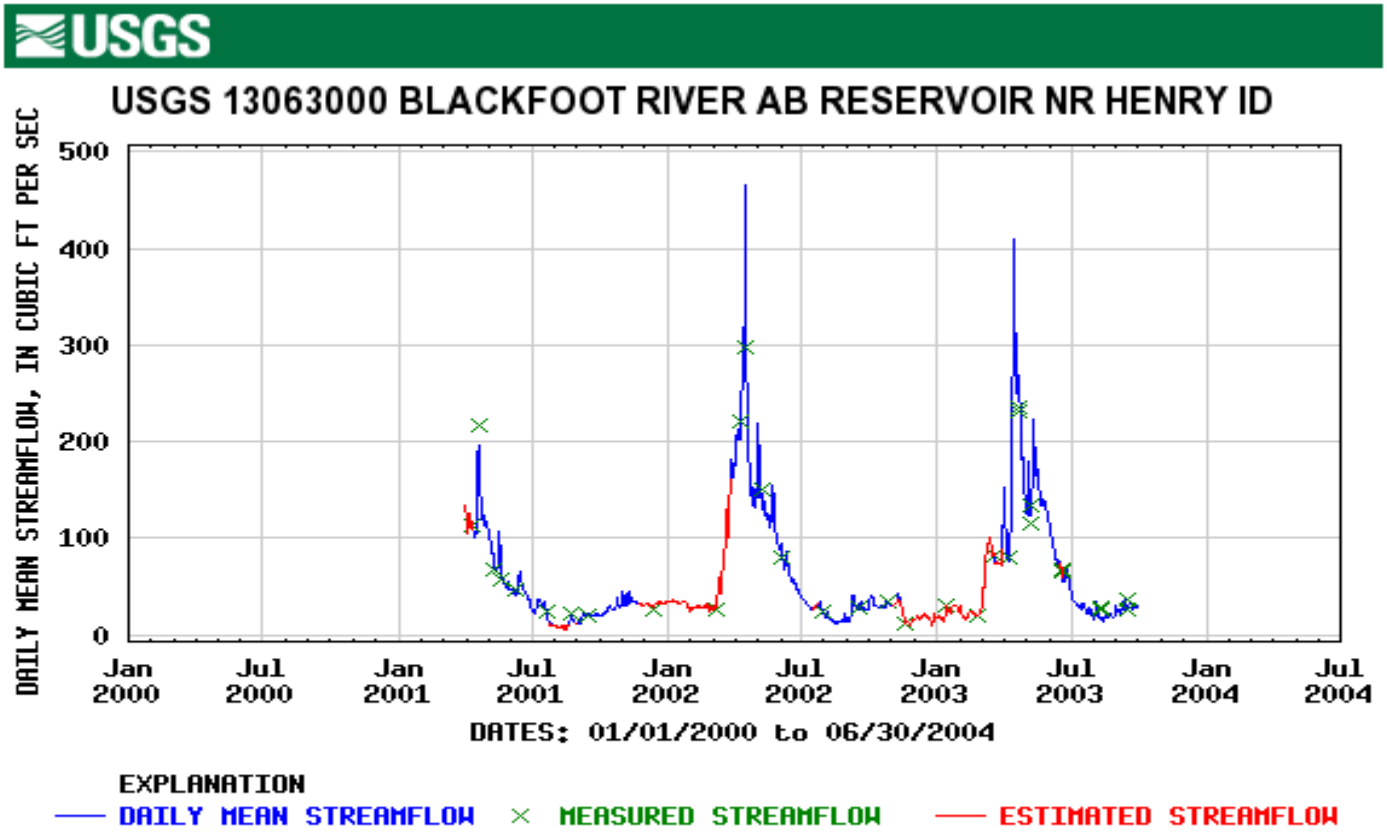

Figure 3b. Blackfoot River flow, 2003-2004.

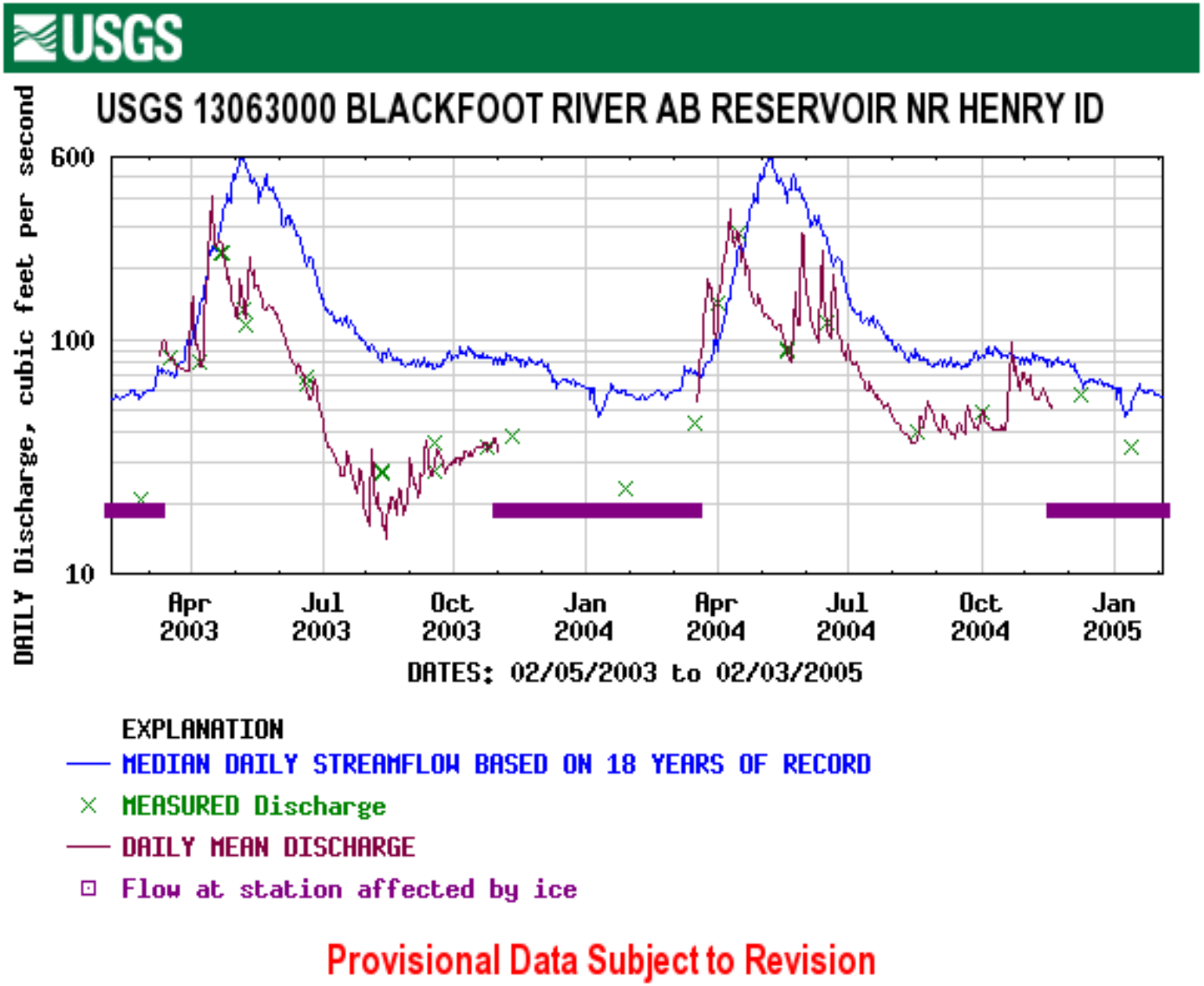

Figure 4. Selenium concentrations for sites sampled May 2004.