Thompson Divide Supplemental Water Quality Study 2013

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Prepared for:

THOMPSON DIVIDE COALITION
OUR HOME. OUR WATERSHED. OUR LIVELIHOOD.

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Separate Data File

Compilations of all laboratory and field data are presented in a separate data file available by contacting Thompson Divide Coalition. The file includes complete data from all stations plus summary statistics for all data at each sampling location.

Executive Summary

This report describes the second phase (2013) of a study to define baseline water quality and flow conditions for both surface waters and springs, collected prior to the onset of any significant oil and gas development in portions of Pitkin and Garfield counties. Sampling efforts focused on the Fourmile Creek and Thompson Creek Watersheds. The first phase of this study was titled Thompson Divide Baseline Water Quality Report (Moran R., 2011).

Water quality sampling and flow measurement were conducted at four surface water and four ground water sites selected to be representative of potential impacts from proposed oil and gas drilling and development activities. The first phase activities were conducted between late September 2009 and late August 2010; the second phase was conducted between late February and early October 2013. These dates were specifically chosen to represent the range of normal, seasonal hydrologic conditions.

The list of chemical constituents reported in 2013 was reduced from those determined during 2009-10 to reduce costs. Nevertheless, it included the constituents and measurements most useful for extending the timeframe of the baseline data and for making basic hydrologic interpretations.

This second phase of the study demonstrates that *surface waters* at the monitored sites continue to be cold (median = 2.6°C), highly oxygenated (median D.O. Saturation = 78%), largely sediment-free (visual observations), with low concentrations of dissolved chemical constituents (median lab TDS = 110 mg/L). Measurements of field specific conductance (S.C., median = 175 µS) confirmed that dissolved concentrations of chemical constituents were low in all waters. This was also confirmed by the lab determinations of selected anions (i.e. ammonia, nitrate, sulfate), which were present at concentrations below reporting limits or at low concentrations. These chemical constituents were selected because they are often indicators of industrial, agricultural or human waste contamination.

No determinations of minor, trace elements, or organic compounds were included in this 2013 effort, but data for these constituents were included in the first phase, 2009-10 report (Moran R, 2011).

Ground water data show these waters to be cold (median temperature = 8.2°C) and sediment-free (visual observations), with low concentrations of dissolved chemical constituents (median TDS = 240 mg/L; median S.C. = 418 µS), and moderately oxygenated (median D.O. saturation = 55%). No regulated water contaminants were detected at unacceptable concentrations in any samples.

These baseline water quality results continue to be consistent with the conclusions presented in the studies of bottom-dwelling organisms and sediment by Miller (2010). Samples collected for the present study and the Miller (2010) study were collected at the same locations. This report together with Miller (2010) indicate that the baseline waters are healthy, uncontaminated and support significant populations of benthic aquatic organisms.

Additionally, sections of the creeks sampled in this study are considered of such high quality that the Colorado State Water Quality Control Commission recently designated 3 reaches of Thompson Creek as “Outstanding Waters”.

Statistical summaries of the 2013 water quality data and Phase One 2009-2010 water quality data are presented in Appendix 1.0. A comparison of these two statistical data bases is also presented in Appendix 1.0. Compilations of all laboratory and field data are presented in a separate data file available by contacting Thompson Divide Coalition.

1.0 Introduction

Purpose and Scope

This study presents the second phase of a study to define baseline water quality and flow conditions for both surface and ground waters, collected prior to the onset of any significant oil and gas development in portions of Pitkin and Garfield counties. Sampling efforts focused on the Fourmile Creek and Thompson Creek Watersheds. The first phase of this study was titled Thompson Divide Baseline Water Quality Report (Moran R., 2011). Together, these pre-development data are referred to as "baseline" water quality data. Such data are exceptionally important for identifying and defining any impacts to water quality as a result of future industrial activities. The focus of this study, however, has been predominantly on natural gas exploration and development activities, which have become significant environmental factors within the region. This baseline data set will act as a water quality "yardstick" against which future changes in water quality can be measured. To a lesser extent, they will be useful in recognizing changes to local spring discharges.

Natural gas drilling and development activities have expanded significantly in the Piceance Basin in recent decades The Thompson Divide region, an area in which the Thompson Divide Coalition and Roaring Fork Conservancy (RFC) have a mandate to protect water quality and habitat characteristics, is located on the eastern edge of the basin and has been partially leased for mineral development.

Historically, adequate, reliable baseline water quality data have not been collected by State, county or other public agencies, prior to initiation of such drilling or other potentially-contaminating activities. In many areas of western Colorado, and much of the rest of the United States, the role of monitoring water quality and quantity has been ceded to the industry, in this case the drilling companies themselves, and their contractors. Such industry generated monitoring data are often incomplete, inadequately collected and analyzed, and are often not readily available to the public.

Without reliable baseline (pre-exploration and pre-operational) data, the public lacks strong technical and legally-defensible bases on which to argue that degradation of water quality has or has not occurred. The present report is an attempt to correct that situation.

It is my (Dr. Robert Moran's) opinion that some degradation of water quality is inevitable if oil and gas exploration and development becomes a reality within the Fourmile Creek and Thompson Creek Watersheds. This opinion is based on more than 42 years of experience in applied Water Quality, Geochemistry and Hydrogeology, much of it related to all forms of energy and natural resource development.

This study involved collection of surface and ground water quality samples from sites in both Pitkin and Garfield Counties. Monitoring locations, together with gas exploration lease boundaries, are shown on Figure 1. Sampling efforts focused on the Fourmile Creek and Thompson Creek Watersheds.

The overall water quality sampling and analytical program was originally designed by Dr. Robert Moran (hydrogeologist/geochemist), Dr. John Huntington (environmental chemist), Mr. Thomas Glibota (resource and environmental geologist), and Mr. Chad Rudow (biologist), in conjunction with members of Roaring Fork Conservancy and Thompson Divide Coalition.

All field activities (water quality sampling, flow measurement, measurement of field parameters) were conducted by Mr. Chad Rudow of Roaring Fork Conservancy, with oversight in the field by Dr. Moran. The sampling team utilized professionally-recognized procedures (see descriptions below) and operated with the assistance and direction of the independent consultant, Dr. Moran.

Water quality sampling and flow measurement were conducted at *four surface water and four ground water sites* selected to be representative of baseline water quality conditions and suitable for detecting potential impacts from proposed oil and gas drilling and development activities. These baseline data are also useful to indicate changes to natural water quality resulting from changes in other activities (i.e. increased agriculture, industrial, municipal, etc.) in addition to those of oil and gas drilling and production. *Monitoring locations are shown on Figure 1.*

Surface Water Sites

Surface water sampling sites are identified by the creek initials. Figure 1 (next page) shows the surface water sample site locations as circles. Site IDs, names, and general location descriptions are as follows:

ID	Name	Site Description
FC	Fourmile Creek	upstream of Sunlight Ski area
NTC	North Thompson Creek	upstream of reclaimed North Thompson Creek Mine
MTC	Middle Thompson Creek	upstream of Willow Park
SMTC	South Middle Thompson Creek	upstream of confluence with Middle Thompson Creek

Ground Water Sites

Ground water sampling sites consist of seeps and springs. Ground water sampling sites are identified by site name initials. Figure 1 (next page) shows the ground water sample site locations as triangles. Site IDs, names, and general location descriptions are as follows:

ID	Name	Site Description
SHS	Sunlight Homestead Spring	near Sunlight Ski area
YCS	Yank Creek Spring	near Yank Creek
SMTSP	South Branch Middle Thompson Spring	near South Branch of Middle Thompson Creek
WCWPS	Wolf Creek Well Pad Spring	near the headwaters of Middle Thompson Creek

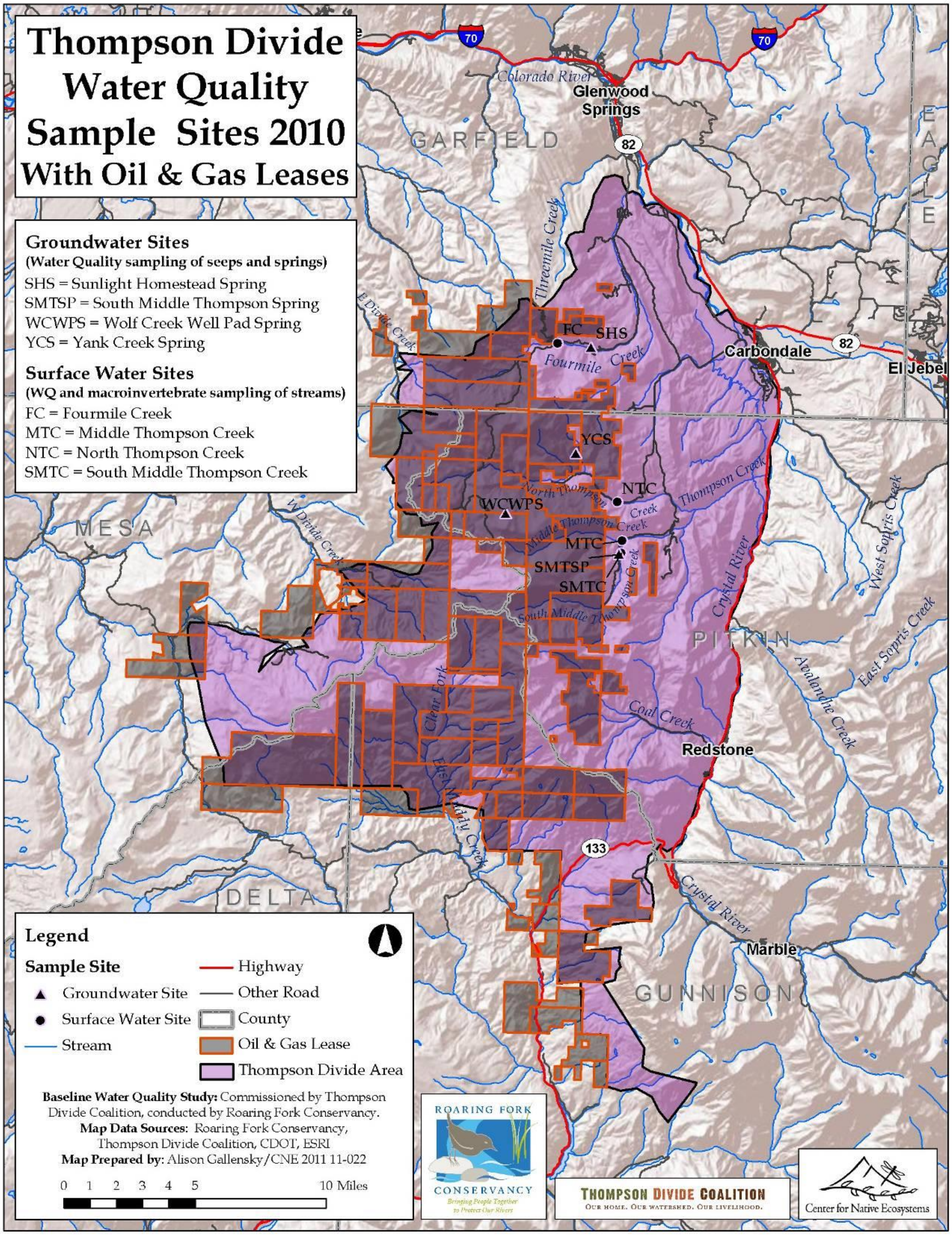
Samples were collected between February and October 2013, with dates representing the normal range of hydrologic conditions. Sampling activities occurred during the following time periods:

- Late February, 2013 - winter low flows

- Early April, 2013 - first flush of meltwaters
- Late May to early June, 2013 - spring runoff (high flows)
- Late September to early-mid October, 2013 - fall base flows

In a few instances, winter samples at groundwater sites were not collected due to a lack of winter flows and/or access. In all cases documentary photos were taken at all monitoring sites and can be obtained by contacting Thompson Divide Coalition. An overview of these data is presented in Appendix 1.0 using summary statistics, while compilations of all laboratory and field data are available by contacting Thompson Divide Coalition.

Figure 1.0 Thompson Divide Sampling Area Map



2.0 Methods

Sampling and Handling Methods

Detailed sampling, sample handling, and methods for making field measurements were originally developed by the independent consultants [Moran, Glibota and Huntington] and have been discussed in detail in the Roaring Fork Conservancy, Thompson Divide Field Sampling Plan (FSP). Appropriate sections from that document are presented in Appendix 2.0.

All samples were collected with strict adherence to the protocols outlined in the Field Sampling Plan (FSP) developed using the following guidance documents:

- [USGS] United States Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at: http://pubs.water.usgs.gov/twri9A.
- [CDPHE] Colorado Department of Public Health and Environment (US). Standard Operating Procedures for the Collection of Water Samples Colorado: Water Quality Control Division. Environmental Data Unit. (Oct. 2008).
- [CDPHE] Colorado Department of Public Health and Environment (US). Standard Operating Procedures for the Planning of and Field Procedures for Conducting Monitoring. Colorado: Water Quality Control Division. Environmental Data Unit. (Apr. 2007 Revision 04).

Detailed procedures are described in the updated 2013 Field Sampling Plan (FSP) (Roaring Fork Conservancy, 2013) and in Appendix 2.0 of this report.

Field Measurements

The following field measurements were recorded at each field site.

- Stream Discharge
- Dissolved Oxygen (D.O.)
- Specific Conductance (S.C.)
- Oxidation Reduction Potential (Redox)
- pH
- Temperature

Stream (and ground water) discharge rates were measured to allow future calculation of the mass, sometimes called “loads”, of the chemical constituents carried by the streams and springs at any one time. [For example: discharge rate x chemical constituent concentration = load]. Such data will allow the public to note trends (changes) in both water flow rates and chemical loads through time. Stream discharge was calculated using the procedures listed in the FSP (see Appendix 2.0.) including use of a SonTek FlowTracker Acoustic Doppler Velocimeter. All other field measurements were taken with a YSI Professional Plus Field Meter. Water Quality (WQ) field meter detection limits and specifications are presented in the FSP.

Laboratory Methods: Water Quality Constituents

This 2013 round of sampling incorporates a subset of water quality analytes from the first round. This subset includes several anions that act as useful "tracers" of contamination and are key indicators of the broader sampling conducted in the first round. The following analytes were collected by RFC and analyzed by ALS Laboratory Group, Fort Collins, CO. The anions included in this study were determined via ion chromatography.

The chemical constituents determined for each sample and the laboratory analytical methods (US EPA method designations) employed are listed below. Analytical reporting limits for these constituents are presented in Appendix 3.0.

General Chemistry

• Ammonia as N	Method 4500-NH3
• Nitrogen, Nitrate	Method 300.0
• Sulfate	Method 300.0
• Total Dissolved Solids	Method 160.1

Three other analytes were collected during 2013 sampling. Alkalinity, Hardness, and pH were collected and analyzed by Roaring Fork Conservancy staff, using RFC lab equipment, following Colorado River Watch protocols-*Colorado River Watch Water Quality Sampling Manual*. For a complete citation refer to FSP Section 4.0.

General Chemistry

• Alkalinity as $CaCO_3$	Method Acid/base titration with sulfuric acid (H_2SO_4) as titrant
• Hardness as CaCO3	Method Acid/base titration with EDTA (ethylene diamine tetra acetic acid) as titrant
• pH	Method Calibrated Beckman pH meter

Quality Analysis / Quality Control Procedures

In order to ensure the quality of the data collected, a Quality Assurance/Quality Control (QA/QC) Plan was designed to establish the policies, organization, objectives and specific QA/QC activities for the associated Thompson Divide Field Sampling Plan (FSP).

In addition ALS Laboratory subjected all samples to its internal precision and accuracy checks. Details concerning these ALS QA/QC procedures and results, together with chain-of-custody documents, are available for public review at the offices of Thompson Divide Coalition and Roaring Fork Conservancy. Finally, the analytical data were screened by the independent consultant, Dr. Moran, using numerous checks for internal consistency to locate potential errors (sampling, analytical, reporting).

All such QA/QC data indicated that these study data were of excellent quality for determining the water quality baseline.

3.0 Results

Compilations of all laboratory and field data are presented in the separate data file available by contacting Thompson Divide Coalition. This separate file contains all data for each monitoring location and sampling date as well as summary statistics.

An overview of these data is presented in Appendix 1.0 as summary statistics.
This appendix presents summary statistics for:

- *all surface and ground water stations from this 2013 round of sampling;*
- *all surface and ground water stations from the original 2009-2010 round of sampling;*
- *a comparison of the 2009-2010 and 2013 summary statistics.*

These statistical summaries present the number of samples or measurements (n), the minimum and maximum concentrations measured, the average (mean) concentration, and the median concentration, which is the middle value in the range between the minimum and the maximum. The *median* value is often a better indicator of a characteristic than the average where population sizes are relatively small. Hence median values are discussed below when characterizing these waters.

Discussion

Study data demonstrate that *surface waters* at the monitored sites had the following general characteristics (based on *median* concentrations presented in Appendix 1.0): waters are cold (median temperature = 2.6°C); highly oxygenated (median = 78% saturation), which is adequate to support healthy cold-water fish populations; largely sediment-free, even during spring runoff periods; slightly alkaline (median total alkalinity = 83 mg/L), with a median field pH of 7.8. Consistently, all surface waters had low concentrations of dissolved contents [median total dissolved solids (Lab TDS) = 110 mg/L], and median S.C. = 175 µS.

In general, these surface waters can be characterized as calcium-bicarbonate-rich waters, common for uncontaminated waters with this type of geology. Most major chemical constituents were present at concentrations *below reporting limits* or at low concentrations. In summary, these surface waters show no indication of detectable contamination due to human activities.[1]

Ground water data show these ground waters to be generally cold, sediment-free, oxygenated, and free of any form of detectable contamination. No water quality constituents having regulatory standards or criteria were detected at unacceptable concentrations in any samples.

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[1] These studies emphasized chemical water quality, not microbiological characteristics. Thus, samples were not collected to evaluate concentrations of bacteria and / or parasites (i.e. *Giardia)*, or the suitability of these waters for human consumption.

All study ground waters had near-neutral or slightly alkaline pHs (median field pH = 7.4), moderately oxygenated (median D.O. saturation = 55%), with low to moderate concentrations of dissolved minerals (median Lab TDS = 240 mg/L), which is supported by the median conductivity being = 418 µS. Thus, the study area ground waters had slightly lower pHs and slightly higher TDS concentrations than the study surface waters—as was the trend in the phase 1 (2009-2010) data.

These baseline water quality results are consistent with the conclusions presented in the studies of benthic macroinvertebrate organisms and sediments by Miller (2010). Samples collected for this study and the Miller (2010) study were collected at the same locations. This report together with Miller (2010) indicate that the baseline waters are healthy, uncontaminated and support significant populations of benthic aquatic organisms.

Additionally, sections of these creeks are considered of such high quality that the Colorado State Water Quality Control Commission recently designated three reaches of Thompson Creek as “Outstanding Waters”. The three reaches on North, Middle, and the South Branch of Middle Thompson Creek, coincide with areas in this study, further corroborating the results found here.

Additional Interpretive Comments

Elevated concentrations of ammonia, nitrate, and sulfate (Together with sulfide, chloride, and orthophosphate, dissolved and total organic carbon collected during the phase 1 sampling) are often indicators of industrial, agricultural or human waste contamination. All of the study surface and ground waters *contained very low concentrations* of these chemical constituents.

Evidence for contamination from oil and gas drilling and development activities is often indicated by rising concentrations of the chemical constituents described above (and in the phase 1 report), frequently associated with increasing concentrations of various organic compounds often associated with hydrocarbons and often in gaseous form. Increases in the concentrations of numerous metals and metal-like elements may also indicate contamination from oil and gas drilling and development, especially elements that are commonly mobile at alkaline pHs such as arsenic, molybdenum, selenium, chromium, nickel, uranium, other natural radioactive elements, etc. (Collins, 1975; Hem, 1985).

Normal Data Error/Limitations

All environmental data contain a range of expected error. Such routine error is due to a combination of the variability in sampling and sample handling procedures, laboratory procedures, and reporting errors. Such errors are always present in similar studies. Hence it is important to attempt to gather data on the extent of the error (i.e. replicate precision data) so that investigators may know how to reasonably use the data when making interpretations. The data presented in this report comply with accepted quality checks and are clearly suitable to define the water quality baseline. Nevertheless, readers should be cautioned not to assume that because, for example, the nitrate concentration at a site changes from 4.5 to 5.5 mg/L between two successive sample episodes, that a true increase has occurred. Such an increase may actually be the result of the errors mentioned above. Real changes would need to be verified by collection of additional data over time, to reveal the actual trends. All such data should be added to the existing data base and evaluated statistically---as has been done in this report.

The statistical summaries presented (Appendix 1.0) allow the reader to evaluate trends in a population of data rather than looking at only individual data points.

Standards and Criteria

Table 1.0 (next page) is a summary of the most important federal (US EPA) and Colorado water quality standards and guidelines. They are by no means all-inclusive. This information is presented merely to allow the reader a general picture of how the site baseline water quality compares to these “yardsticks”. Standards are considered to be legally-enforceable while criteria are generally treated as technical “recommendations”.

Because the site surface waters are used for multiple purposes, including cold-water fisheries, agriculture, potential water supplies, etc., Table 1.0 includes both the federal drinking water standards, and the U.S. and Colorado aquatic life criteria and standards. Readers should be cautioned that the regulatory guidance documents for the Colorado Aquatic Life Standards differ for each drainage basin within Colorado, and are complicated, and often confusing. It should be understood that the Colorado Aquatic Life standards are partly the result of technical toxicity information, which have then been altered / revised by complicated regulatory negotiations with the larger industries and stakeholders in each drainage basin.

Table 1.0 US EPA & Colorado Water Quality Standards & Criteria

Parameter	Units	US EPA	US EPA	US EPA Aquatic Life Criteria[1]		Colorado Aquatic Life Standards[2]	
		Drinking Water MCL[3]	Secondary Drinking Water[3]	Acute	Chronic	Acute	Chronic
INORGANICS							
pH	Units	---	6.5 to 8.5	---	6.5 to 9	---	6.5 to 9
TDS	mg/l	---	500	250	250	---	---
Phosphorous	mg/l	---	---	---	---	---	---
Sodium	mg/l	---	30 to 60	---	---	---	---
Chloride	mg/l	---	250	860	230	250	250
Chlorine	mg/l	4	---	0.019	0.011	0.019	0.011
Sulfate	mg/l	250	250	---	---	250	250
Sulfide	mg/l	---	---	---	0.002	0.002	0.002
Nitrate (as N)	mg/l	10	---	---	---	10	10
Nitrite (as N)	mg/l	1	---	---	---	0.05	0.05
Total N	mg/l	10	---	---	---	---	---
Ammonia (as N)	mg/l	----	30	2.9 to 5.0	0.26 to 1.8	0.002 to 0.325	0.032 to 0.049
Fluoride	mg/l	4.0	2.0	---	---	---	---
METALS							
Aluminum	mg/l	---	0.05 to 0.2	0.75	0.087	---	---
Antimony	mg/l	0.006	---	---	---	---	---
Arsenic	mg/l	0.01	---	0.34	0.15	0.34	0.02 (total rec)
Barium	mg/l	2	---	---	---	---	---
Beryllium	mg/l	0.004	---	---	---	---	---
Boron	mg/l	---	---	---	---	0.75	0.75
Cadmium	mg/l	0.005	---	0.002	0.00025	0.0024	0.00037
Chromium III	mg/l	---	---	0.57	0.074	0.050	0.064 (total rec)
Chromium VI	mg/l	---	---	0.016	0.011	0.016	0.011
Chromium (tot)	mg/l	0.1	---	---	---	---	---
Cobalt	mg/l	---	---	---	---	---	---
Copper	mg/l	1.3	1.0	0.013	0.009	0.0113	0.0077
Iron (tot)	mg/l	---	0.3	---	1	0.30	0.30
Lead	mg/l	0.015	---	0.065	0.0025	0.053	0.0021
Manganese	mg/l	---	0.05	---	---	0.05	0.05
Mercury	mg/l	0.002	---	0.0014	0.00077	0.01(Total)	0.01(Total)
Molybdenum	mg/l	---	---	---	---	---	---
Nickel	mg/l	---	---	0.47	0.052	0.403	0.045
Selenium	mg/l	0.05	---	---	0.005	0.0184	0.0046
Silver	mg/l	---	0.1	0.0032	---	0.0015	0.00023
Thallium	mg/l	0.002	---	---	---	---	---
Tin		---	---	---	---	---	---
Uranium	mg/l	0.03	---	---	---	0.030	0.030
Zinc	mg/l	---	5	0.12	0.12	0.14	0.10
Alpha, Gross	picoCi/L	15	---	---	---	---	---

1 US EPA National Recommended Water Quality Criteria, 2009 http://www.epa.gov/OST/criteria/wqctable (EPA, 2009). US EPA Freshwater criteria for metals are expressed in terms of the dissolved metal in the water column with the exception of selenium that is expressed in terms of total recoverable metal in the water column.

2 Colorado Aquatic Life Standards based on Roaring Fork Stream Segments 1 and 3a and Thompson Creek Segment 10, Colorado Department of Public Health and Environment Water Quality Control Commission 5 CCR 1002-33 Classifications and Numeric Standards for Upper Colorado River Basin and North Platte River (Planning Region 12). These segments are classified for Aquatic Cold Life 1, Recreation E, Water Supply and Agriculture. (CDPHE, 2011).

3 US EPA 2009 Edition of the Drinking Water Standards and Health Advisories, EPA 822-R-09-011, Office of Water, U.S. Environmental Protection Agency Washington, DC, fall 2009, Date of update: October, 2009. (EPA, 2009).

Calculated values based on mean hardness value of 83.9 mg/l. [Derived from reported lab calcium and magnesium concentrations in the following equation: Hardness (total) = 2.5 Ca conc. + 4.1 Mg conc. (Freeze & Cherry, 1979)].

Metals are stated as dissolved concentrations unless specified as total recoverable (total rec) or total.

4.0 Recommendations

It is recommended that Thompson Divide Coalition (TDC) or some allied group continue to make field measurements of the field parameters previously collected [as a minimum: temperature, specific conductance (S.C.), and pH]. These measurements ideally would be made monthly, or at least quarterly, at all of the presently monitored locations. TDC should also consider the utility of adding additional monitoring locations to the south in Figure 1 towards Coal Creek, etc.

The present baseline data allow calculation of the numeric relationships between field S.C. and laboratory TDS. Continued collection of these measurements would allow the estimation of future TDS concentrations, to note changing data trends and have an on-going picture of the general site water quality at relatively little additional cost.

It may also be beneficial to collect periodic samples for laboratory analysis of selected constituents. These should be analyzed at a laboratory utilizing techniques capable of reporting the constituents to below drinking water standards and/or aquatic life criteria reporting levels.

It is also recommended that TDC or allied groups attempt to obtain any other regional water quality and flow data collected by other State, federal or local groups and integrate them into the present baseline database. This would include integration of other on-going water quality data presently being generated by Roaring Fork Conservancy's Water Quality program.

5.0 Summary

The ground and surface waters sampled during this baseline study, both phases 1 and 2, indicate that these waters are presently uncontaminated by any human activities. Furthermore, the baseline data presented in this report provide an excellent "yardstick" against which any future changes in water quality may be compared.

6.0 References

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Appendices

Appendix 1.0 Laboratory and Field Data Statistical Summaries

Table A1.1 Water Quality Statistical Summaries (2013)

Thompson Divide WQ Statistical Summaries (2013)

Surface Water Sites (FC, MTC, NTC, SMTC)

Parameter	Units	n	< values	minimum	maximum	average	median
General Field Data							
Discharge (field)	ft^3/sec	10	0	1.2	43.5		
pH (field)	pH	16	0	7.5	8.2	7.9	7.8
pH (lab)	pH	16	0	7.6	8.3	8.1	8.1
Specific Conductance (field)	µS/cm	16	0	61	345	183	175
Dissolved Oxygen (field)	mg/L	16	0	8.9	11.4	10.3	10.3
Dissolved Oxygen % Saturation (field)	%	16	0	66	83	76	78
Total Dissolved Solids (field)	mg/L	16	0	40	224	119	114
Total Dissolved Solids (lab)	mg/L	16	0	50	200	117	110
Water Temperature (field)	° C	16	0	0.0	7.5	3.0	2.6
Oxidation-Reduction Potential (field)	mV	16	0	20	125	76	73
Major Anions							
Ammonia as N	mg/L	16	16	**0.1**	**0.1**	**0.1**	**0.1**
Nitrate as N	mg/L	16	12	**0.2**	0.3	**0.2**	**0.2**
Sulfate	mg/L	16	0	2.1	8.7	5.0	5.0
Others							
Alkalinity, Total	mg/L	16	0	26	192	89	83
Hardness	mg/L	16	0	22	182	85	76

Ground Water Sites (SHS, SMTSp, WCWPS, YCS)

Parameter	Units	n	< values	minimum	maximum	average	median
General Field Data							
Discharge (field)	gal/min	8	0	0.28	9.54		
pH (field)	pH	10	0	7.1	8.2	7.6	7.4
pH (lab)	pH	10	0	7.0	7.7	7.5	7.6
Specific Conductance (field)	µS/cm	10	0	73	587	360	418
Dissolved Oxygen (field)	mg/L	9	0	5.5	9.4	7.1	6.4
Dissolved Oxygen % Saturation (field)	%	9	0	47	79	58	55
Total Dissolved Solids (field)	mg/L	10	0	47	382	234	271
Total Dissolved Solids (lab)	mg/L	10	0	71	350	213	240
Water Temperature (field)	° C	10	0	2.7	11.5	7.7	8.2
Oxidation-Reduction Potential (field)	mV	9	0	19	130	58	42
Major Anions							
Ammonia as N	mg/L	10	10	**0.1**	**0.1**	**0.1**	**0.1**
Nitrate as N	mg/L	10	6	**0.2**	0.3	**0.2**	**0.2**
Sulfate	mg/L	10	0	3	34	11.3	9.4
Others							
Alkalinity, Total	mg/L	10	0	16	338	186	220
Hardness	mg/L	10	0	20	318	184	223

Footnotes

- The column heading "n" refers to the number of total measurements/lab determinations.
- The column heading "< values " refers to the number of "less than" values where the result was below laboratory reporting limits. (i.e <20).
- All **bolded** statistics represent "less than" (<) values and are based on the numeric value of the qualified result (i.e. <20 was converted to 20).

Table A1.2 Water Quality Statistical Summaries (2009-2010)

Thompson Divide WQ Statistical Summaries (2009-2010)

(For explanations see footnotes below)

Surface Water Sites (FC, MTC, NTC, SMTC)

Parameter	Units	n	# of < values	minimum	maximum	average	median
General Field Data							
Discharge (field)	ft^3/sec	16		1.4	152.5		
pH (field)	pH	19	0	7.8	8.7	8.4	8.4
pH (lab)	pH	20	0	7.6	8.4	8.1	8.1
Specific Conductance (field)	µS/cm	20	0	57	355	199	195
Specific Conductance (lab)	µS/cm	16	0	45	341	180	189
Dissolved Oxygen (field)	mg/L	20	0	7.9	11.0	9.5	9.6
Dissolved Oxygen % Saturation (field)	%	20	0	56	80	75	77
Total Dissolved Solids (field)	mg/L	19	0	37	231	130	127
Total Dissolved Solids (lab)	mg/L	16	0	66	200	118	115
Total Suspended Solids (lab)	mg/L	16	14	**20**	23	20	**20**
Water Temperature (field)	° C	20	0	0.1	12.4	5.7	6.1
Oxidation-Reduction Potential (field)	mV	17	0	113	324	185	174
Major Cations							
Calcium T	mg/L	16	0	7.3	100.0	32.2	26.5
Calcium D	mg/L	16	0	7.0	57.0	28.2	26.0
Magnesium T	mg/L	16	0	1.4	13	5.3	4.3
Magnesium D	mg/L	16	0	1.3	8.8	4.8	4.2
Potassium T	mg/L	16	11	**1**	2.3	1.2	**1**
Potassium D	mg/L	16	12	**1**	2.3	1.1	**1**
Sodium T	mg/L	16	0	1.4	13	6.2	7.4
Sodium D	mg/L	16	0	1.3	8.7	5.9	7.5
Major Anions							
Ammonia as N	mg/L	16	16	**0.1**	**0.1**	**0.1**	**0.1**
Bicarbonate	mg/L	16	0	22	190	102	100
Carbonate	mg/L	16	16	**5**	**20**	**14**	**15**
Chloride	mg/L	16	0	0.3	0.99	0.63	0.53
Fluoride	mg/L	16	4	**0.1**	0.16	0.13	0.12
Nitrate as N	mg/L	16	15	**0.2**	0.2	**0.2**	**0.2**
Nitrite as N	mg/L	16	16	**0.1**	**0.1**	**0.1**	**0.1**
Sulfate	mg/L	16	0	1.9	8.1	4.7	5.7
Other Non-metals and nutrients							
Alkalinity	mg/L	20	0	22	200	105	100
Carbon, Dissolved Organic	mg/L	16	0	1.4	8.9	3.5	2.1
Hardness	mg/L	4	0	72	180	109	92
Orthophosphate as P	mg/L	16	16	**0.5**	**0.5**	**0.5**	**0.5**
Sulfide, Total	mg/L	16	16	**2**	**2**	**2**	**2**
Metals and Metalloids							
Aluminum T	mg/L	16	10	**0.1**	1.1	0.35	**0.1**
Aluminum D	mg/L	16	12	**0.1**	0.45	0.16	**0.1**
Antimony T	mg/L	16	16	**0.0003**	**0.0003**	**0.0003**	**0.0003**
Antimony D	mg/L	16	16	**0.0003**	**0.0003**	**0.0003**	**0.0003**
Arsenic T	mg/L	16	16	**0.002**	**0.002**	**0.002**	**0.002**
Arsenic D	mg/L	16	16	**0.002**	**0.002**	**0.002**	**0.002**
Barium T	mg/L	16	11	**0.1**	0.74	0.17	**0.1**
Barium D	mg/L	16	13	**0.1**	0.27	0.13	**0.1**
Beryllium T	mg/L	16	16	**0.005**	**0.005**	**0.005**	**0.005**

Parameter	**Units**	**n**	**# of < values**	**minimum**	**maximum**	**average**	**median**
Beryllium D	mg/L	16	16	**0.005**	**0.005**	**0.005**	**0.005**
Boron T	mg/L	16	16	**0.1**	**0.1**	**0.1**	**0.1**
Boron D	mg/L	16	16	**0.1**	**0.1**	**0.1**	**0.1**
Cadmium T	mg/L	16	16	**0.0003**	**0.0003**	**0.0003**	**0.0003**
Cadmium D	mg/L	16	16	**0.0003**	**0.0003**	**0.0003**	**0.0003**
Chromium T	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Chromium D	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Cobalt T	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Cobalt D	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Copper T	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Copper D	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Iron T	mg/L	16	5	**0.1**	1.00	0.39	0.20
Iron D	mg/L	16	11	**0.1**	0.32	0.15	**0.1**
Lead T	mg/L	16	13	**0.0005**	0.00072	0.00052	**0.0005**
Lead D	mg/L	16	15	**0.0005**	0.00074	0.00052	**0.0005**
Manganese T	mg/L	16	7	**0.01**	0.039	0.019	0.016
Manganese D	mg/L	16	12	**0.01**	0.021	0.013	**0.01**
Mercury T	mg/L	16	16	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Mercury D	mg/L	16	16	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Molybdenum T	mg/L	16	16	**0.001**	**0.001**	**0.001**	**0.001**
Molybdenum D	mg/L	16	16	**0.001**	**0.001**	**0.001**	**0.001**
Nickel T	mg/L	16	16	**0.02**	**0.02**	**0.02**	**0.02**
Nickel D	mg/L	16	16	**0.02**	**0.02**	**0.02**	**0.02**
Selenium T	mg/L	16	16	**0.001**	**0.001**	**0.001**	**0.001**
Selenium D	mg/L	16	16	**0.001**	**0.001**	**0.001**	**0.001**
Silver T	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Silver D	mg/L	16	16	**0.01**	**0.01**	**0.01**	**0.01**
Thallium T	mg/L	16	16	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Thallium D	mg/L	16	16	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Tin T	mg/L	16	16	**0.05**	**0.05**	**0.05**	**0.05**
Tin D	mg/L	16	16	**0.05**	**0.05**	**0.05**	**0.05**
Uranium T	mg/L	16	2	**0.0001**	0.00340	0.00057	0.00030
Uranium D	mg/L	16	2	**0.0001**	0.00095	0.00038	0.00028
Zinc T	mg/L	16	16	**0.020**	**0.020**	**0.020**	**0.020**
Zinc D	mg/L	16	15	**0.02**	0.026	0.020	**0.02**
Radiation							
Gross Alpha	pCi/L	16	16	**-0.39**	**1.70**	**0.55**	**0.58**
Gross Beta	pCi/L	16	16	**-0.6**	**2.8**	**1.4**	**1.6**
Organics (dissoved gases)							
Ethane	µg/L	16	16	**2**	**2**	**2**	**2**
Ethene	µg/L	16	16	**1**	**1**	**1**	**1**
Methane	µg/L	16	13	**1**	2.5	1.2	**1**
Organics (SVOCs)							
1-METHYLNAPHTHALENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2,3,4,6-TETRACHLOROPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2,4,5-TRICHLOROPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2,4,6-TRICHLOROPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2,4-DICHLOROPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2,4-DIMETHYLPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2,4-DINITROPHENOL	µg/L	16	16	**19**	**20**	**20**	**20**
2-CHLOROPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2-METHYLNAPHTHALENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**

Parameter	Units	n	# of < values	minimum	maximum	average	median
2-METHYLPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
2-NITROPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
3+4-METHYLPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
4,6-DINITRO-2-METHYLPHENOL	µg/L	16	16	**19**	**20**	**20**	**20**
4-CHLORO-3-METHYLPHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
4-NITROPHENOL	µg/L	16	16	**19**	**20**	**20**	**20**
ACENAPHTHENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
ACENAPHTHYLENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
ANTHRACENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
BENZO(A)ANTHRACENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
BENZO(A)PYRENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
BENZO(B)FLUORANTHENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
BENZO(G,H,I)PERYLENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
BENZO(K)FLUORANTHENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
CHRYSENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
DIBENZO(A,H)ANTHRACENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
FLUORANTHENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
FLUORENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
INDENO(1,2,3-CD)PYRENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
NAPHTHALENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
PENTACHLOROPHENOL	µg/L	16	16	**19**	**20**	**20**	**20**
PHENANTHRENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
PHENOL	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
PYRENE	µg/L	16	16	**9.5**	**10**	**9.8**	**9.8**
SVOC Tentatively Identified Compounds	µg/L	None detected for all samples					
Organics (VOCs)							
1,1,1,2-TETRACHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1,1-TRICHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1,2,2-TETRACHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1,2-TRICHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1-DICHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1-DICHLOROETHENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,1-DICHLOROPROPENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2,3-TRICHLOROBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2,3-TRICHLOROPROPANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2,4-TRICHLOROBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2,4-TRIMETHYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2-DIBROMO-3-CHLOROPROPANE	µg/L	16	16	**2**	**2**	**2**	**2**
1,2-DIBROMOETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2-DICHLOROBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2-DICHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,2-DICHLOROPROPANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,3,5-TRIMETHYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,3-DICHLOROBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1,3-DICHLOROPROPANE	µg/L	16	16	**1**	**1**	**1**	**1**
1,4-DICHLOROBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
1-CHLOROHEXANE	µg/L	16	16	**1**	**1**	**1**	**1**
2,2-DICHLOROPROPANE	µg/L	16	16	**1**	**1**	**1**	**1**
2-BUTANONE	µg/L	16	16	**10**	**10**	**10**	**10**
2-CHLOROTOLUENE	µg/L	16	16	**1**	**1**	**1**	**1**
2-HEXANONE	µg/L	16	16	**10**	**10**	**10**	**10**

Parameter	Units	n	# of < values	minimum	maximum	average	median
4-CHLOROTOLUENE	µg/L	16	16	**1**	**1**	**1**	**1**
4-METHYL-2-PENTANONE	µg/L	16	16	**10**	**10**	**10**	**10**
ACETONE	µg/L	16	16	**3.8**	**10**	**9.2**	**10**
BENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
BROMOBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
BROMOCHLOROMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
BROMODICHLOROMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
BROMOFORM	µg/L	16	16	**1**	**1**	**1**	**1**
BROMOMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
CARBON DISULFIDE	µg/L	16	16	**1**	**1**	**1**	**1**
CARBON TETRACHLORIDE	µg/L	16	16	**1**	**1**	**1**	**1**
CHLOROBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
CHLOROETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
CHLOROFORM	µg/L	16	16	**1**	**1**	**1**	**1**
CHLOROMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
CIS-1,2-DICHLOROETHENE	µg/L	16	16	**1**	**1**	**1**	**1**
CIS-1,3-DICHLOROPROPENE	µg/L	16	16	**1**	**1**	**1**	**1**
DIBROMOCHLOROMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
DIBROMOMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
DICHLORODIFLUOROMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
ETHYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
HEXACHLOROBUTADIENE	µg/L	16	16	**1**	**1**	**1**	**1**
IODOMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
ISOPROPYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
M+P-XYLENE	µg/L	16	16	**1**	**1**	**1**	**1**
METHYL TERTIARY BUTYL ETHER	µg/L	16	16	**1**	**1**	**1**	**1**
METHYLENE CHLORIDE	µg/L	16	16	**1**	**1**	**1**	**1**
NAPHTHALENE	µg/L	16	16	**1**	**1**	**1**	**1**
N-BUTYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
N-PROPYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
O-XYLENE	µg/L	16	16	**1**	**1**	**1**	**1**
P-ISOPROPYLTOLUENE	µg/L	16	16	**1**	**1**	**1**	**1**
SEC-BUTYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
STYRENE	µg/L	16	16	**1**	**1**	**1**	**1**
TERT-BUTYLBENZENE	µg/L	16	16	**1**	**1**	**1**	**1**
TETRACHLOROETHENE	µg/L	16	16	**1**	**1**	**1**	**1**
TOLUENE	µg/L	16	16	**0.34**	**1**	**0.96**	**1**
TRANS-1,2-DICHLOROETHENE	µg/L	16	16	**1**	**1**	**1**	**1**
TRANS-1,3-DICHLOROPROPENE	µg/L	16	16	**1**	**1**	**1**	**1**
TRICHLOROETHENE	µg/L	16	16	**1**	**1**	**1**	**1**
TRICHLOROFLUOROMETHANE	µg/L	16	16	**1**	**1**	**1**	**1**
VINYL ACETATE	µg/L	16	16	**2**	**2**	**2**	**2**
VINYL CHLORIDE	µg/L	16	16	**1**	**1**	**1**	**1**
VOC Tentatively Identified Compounds	µg/L	None detected for all samples					

Footnotes

- Parameters with a T denote Total Recoverable concentrations, those with a D denote Dissolved concentrations.
- The column heading "n" refers to the number of total measurements/lab determinations.
- All **bolded** statistics represent "less than" (<) values and are based on the numeric value of the qualified result (i.e. <20 was converted to 20).
- Gross alpha and beta detection limits depend partly on radiation back-calculations of net activity and can therefore result in positive or negative values. All **bolded** numbers represent "less than" values as noted above.

Thompson Divide WQ Statistical Summaries (2009-2010)

(For explanations see footnotes below)

Ground Water Sites (SHS, SMTSp, WCWPS, YCS)

Parameter	Units	n	# of < values	minimum	maximum	average	median
General Field Data							
Discharge (field)	gal/min	13		0.04	4.28		
pH (field)	pH	16	0	7.0	8.1	7.6	7.6
pH (lab)	pH	16	0	6.8	7.9	7.5	7.4
Specific Conductance (field)	µS/cm	16	0	61	620	363	392
Specific Conductance (lab)	µS/cm	12	0	53	567	379	428
Dissolved Oxygen (field)	mg/L	16	0	3.0	8.7	6.5	6.1
Dissolved Oxygen % Saturation (field)	%	15	0	26	68	51	50
Total Dissolved Solids (field)	mg/L	15	0	40	403	240	263
Total Dissolved Solids (lab)	mg/L	12	0	61	320	222	240
Total Suspended Solids (lab)	mg/L	12	12	**20**	**20**	**20**	**20**
Water Temperature (field)	° C	16	0	0.9	10.0	6.3	6.8
Oxidation-Reduction Potential (field)	mV	15	0	63	225	138	129
Major Cations							
Calcium T	mg/L	12	0	7.2	100	55.3	59
Calcium D	mg/L	12	0	7.5	100	60.4	59
Magnesium T	mg/L	12	1	**1**	19	11.0	12
Magnesium D	mg/L	12	1	**1**	19	11.4	12
Potassium T	mg/L	12	6	**1**	1.7	1.2	1.1
Potassium D	mg/L	12	5	**1**	1.6	1.1	1.1
Sodium T	mg/L	12	0	3.0	14	7.8	7.2
Sodium D	mg/L	12	0	3.1	14	8.3	7.3
Major Anions							
Ammonia as N	mg/L	12	12	**0.1**	**0.1**	**0.1**	**0.1**
Bicarbonate	mg/L	12	0	27	320	209	225
Carbonate	mg/L	12	12	**5**	**20**	**17**	**20**
Chloride	mg/L	12	0	0.4	2.2	1.3	1.4
Fluoride	mg/L	12	2	**0.1**	0.22	0.15	0.15
Nitrate as N	mg/L	12	10	**0.2**	0.3	0.2	**0.2**
Nitrite as N	mg/L	12	12	**0.1**	**0.1**	**0.1**	**0.1**
Sulfate	mg/L	12	0	2	15	7.5	5.0
Other Non-metals and nutrients							
Alkalinity	mg/L	16	0	27	320	202	221
Carbon, Dissolved Organic	mg/L	12	5	**1**	8.9	2.2	1.3
Hardness	mg/L	4	0	42	228	138	140
Orthophosphate as P	mg/L	12	12	**0.5**	**0.5**	**0.5**	**0.5**
Sulfide, Total	mg/L	12	12	**2**	**2**	**2**	**2**
Metals and Metalloids							
Aluminum T	mg/L	12	10	**0.1**	0.19	0.11	**0.1**
Aluminum D	mg/L	12	11	**0.1**	0.15	0.10	**0.1**
Antimony T	mg/L	12	11	**0.0003**	0.00071	0.00033	**0.0003**
Antimony D	mg/L	12	10	**0.0003**	0.00130	0.00039	**0.0003**
Arsenic T	mg/L	12	12	**0.002**	**0.002**	**0.002**	**0.002**
Arsenic D	mg/L	12	12	**0.002**	**0.002**	**0.002**	**0.002**
Barium T	mg/L	12	3	**0.1**	0.78	0.28	0.13
Barium D	mg/L	12	2	**0.1**	0.77	0.33	0.13
Beryllium T	mg/L	12	12	**0.005**	**0.005**	**0.005**	**0.005**

Parameter	**Units**	**n**	**# of < values**	**minimum**	**maximum**	**average**	**median**
Beryllium D	mg/L	12	12	**0.005**	**0.005**	**0.005**	**0.005**
Boron T	mg/L	12	11	**0.1**	0.63	0.14	**0.1**
Boron D	mg/L	12	12	**0.1**	**0.1**	**0.1**	**0.1**
Cadmium T	mg/L	12	12	**0.0003**	**0.0003**	**0.0003**	**0.0003**
Cadmium D	mg/L	12	12	**0.0003**	**0.0003**	**0.0003**	**0.0003**
Chromium T	mg/L	12	12	**0.01**	**0.01**	**0.01**	**0.01**
Chromium D	mg/L	12	12	**0.01**	**0.01**	**0.01**	**0.01**
Cobalt T	mg/L	12	12	**0.01**	**0.01**	**0.01**	**0.01**
Cobalt D	mg/L	12	12	**0.01**	**0.01**	**0.01**	**0.01**
Copper T	mg/L	12	11	**0.01**	0.011	0.010	**0.01**
Copper D	mg/L	12	12	**0.010**	**0.010**	**0.010**	**0.010**
Iron T	mg/L	12	10	**0.1**	0.19	0.11	**0.1**
Iron D	mg/L	12	10	**0.1**	0.44	0.13	**0.1**
Lead T	mg/L	12	12	**0.0005**	**0.0005**	**0.0005**	**0.0005**
Lead D	mg/L	12	12	**0.0005**	**0.0005**	**0.0005**	**0.0005**
Manganese T	mg/L	12	10	**0.01**	0.020	0.011	**0.01**
Manganese D	mg/L	12	11	**0.01**	0.033	0.012	**0.01**
Mercury T	mg/L	12	12	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Mercury D	mg/L	12	12	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Molybdenum T	mg/L	12	12	**0.001**	**0.001**	**0.001**	**0.001**
Molybdenum D	mg/L	12	12	**0.001**	**0.001**	**0.001**	**0.001**
Nickel T	mg/L	12	12	**0.02**	**0.02**	**0.02**	**0.02**
Nickel D	mg/L	12	12	**0.02**	**0.02**	**0.02**	**0.02**
Selenium T	mg/L	12	10	**0.001**	0.0024	0.0012	**0.001**
Selenium D	mg/L	12	10	**0.001**	0.0024	0.0011	**0.001**
Silver T	mg/L	12	12	**0.01**	**0.01**	**0.01**	**0.01**
Silver D	mg/L	12	12	**0.01**	**0.01**	**0.01**	**0.01**
Thallium T	mg/L	12	12	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Thallium D	mg/L	12	12	**0.0002**	**0.0002**	**0.0002**	**0.0002**
Tin T	mg/L	12	12	**0.05**	**0.05**	**0.05**	**0.05**
Tin D	mg/L	12	12	**0.05**	**0.05**	**0.05**	**0.05**
Uranium T	mg/L	12	2	**0.0001**	0.0034	0.00134	0.00110
Uranium D	mg/L	12	2	**0.0001**	0.0034	0.00156	0.00110
Zinc T	mg/L	12	10	**0.02**	0.11	0.029	**0.02**
Zinc D	mg/L	12	11	**0.02**	0.03	0.021	**0.02**
Radiation							
Gross Alpha	pCi/L	12	11	**-0.54**	2.7	**1.16**	**1.24**
Gross Beta	pCi/L	12	12	**0.8**	**3.0**	**1.68**	**1.30**
Organics (dissoved gases)							
Ethane	µg/L	12	12	**2**	**2**	**2**	**2**
Ethene	µg/L	12	12	**1**	**1**	**1**	**1**
Methane	µg/L	12	10	**1**	7.1	1.7	**1**
Organics (SVOCs)							
1-METHYLNAPHTHALENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2,3,4,6-TETRACHLOROPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2,4,5-TRICHLOROPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2,4,6-TRICHLOROPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2,4-DICHLOROPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2,4-DIMETHYLPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2,4-DINITROPHENOL	µg/L	12	12	**19**	**20**	**19**	**19**
2-CHLOROPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2-METHYLNAPHTHALENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**

Parameter	Units	n	# of < values	minimum	maximum	average	median
2-METHYLPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
2-NITROPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
3+4-METHYLPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
4,6-DINITRO-2-METHYLPHENOL	µg/L	12	12	**19**	**20**	**19**	**19**
4-CHLORO-3-METHYLPHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
4-NITROPHENOL	µg/L	12	12	**19**	**20**	**19**	**19**
ACENAPHTHENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
ACENAPHTHYLENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
ANTHRACENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
BENZO(A)ANTHRACENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
BENZO(A)PYRENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
BENZO(B)FLUORANTHENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
BENZO(G,H,I)PERYLENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
BENZO(K)FLUORANTHENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
CHRYSENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
DIBENZO(A,H)ANTHRACENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
FLUORANTHENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
FLUORENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
INDENO(1,2,3-CD)PYRENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
NAPHTHALENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
PENTACHLOROPHENOL	µg/L	12	12	**19**	**20**	**19**	**19**
PHENANTHRENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
PHENOL	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
PYRENE	µg/L	12	12	**9.5**	**10**	**9.7**	**9.6**
SVOC Tentatively Identified Compounds	µg/L	None detected for all samples					
Organics (VOCs)							
1,1,1,2-TETRACHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1,1-TRICHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1,2,2-TETRACHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1,2-TRICHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1-DICHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1-DICHLOROETHENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,1-DICHLOROPROPENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2,3-TRICHLOROBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2,3-TRICHLOROPROPANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2,4-TRICHLOROBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2,4-TRIMETHYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2-DIBROMO-3-CHLOROPROPANE	µg/L	12	12	**2**	**2**	**2**	**2**
1,2-DIBROMOETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2-DICHLOROBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2-DICHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,2-DICHLOROPROPANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,3,5-TRIMETHYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,3-DICHLOROBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1,3-DICHLOROPROPANE	µg/L	12	12	**1**	**1**	**1**	**1**
1,4-DICHLOROBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
1-CHLOROHEXANE	µg/L	12	12	**1**	**1**	**1**	**1**
2,2-DICHLOROPROPANE	µg/L	12	12	**1**	**1**	**1**	**1**
2-BUTANONE	µg/L	12	12	**10**	**10**	**10**	**10**
2-CHLOROTOLUENE	µg/L	12	12	**1**	**1**	**1**	**1**
2-HEXANONE	µg/L	12	12	**10**	**10**	**10**	**10**

Parameter	Units	n	# of < values	minimum	maximum	average	median
4-CHLOROTOLUENE	µg/L	12	12	**1**	**1**	**1**	**1**
4-METHYL-2-PENTANONE	µg/L	12	12	**10**	**10**	**10**	**10**
ACETONE	µg/L	12	12	**10**	**10**	**10**	**10**
BENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
BROMOBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
BROMOCHLOROMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
BROMODICHLOROMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
BROMOFORM	µg/L	12	12	**1**	**1**	**1**	**1**
BROMOMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
CARBON DISULFIDE	µg/L	12	12	**1**	**1**	**1**	**1**
CARBON TETRACHLORIDE	µg/L	12	12	**1**	**1**	**1**	**1**
CHLOROBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
CHLOROETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
CHLOROFORM	µg/L	12	12	**1**	**1**	**1**	**1**
CHLOROMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
CIS-1,2-DICHLOROETHENE	µg/L	12	12	**1**	**1**	**1**	**1**
CIS-1,3-DICHLOROPROPENE	µg/L	12	12	**1**	**1**	**1**	**1**
DIBROMOCHLOROMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
DIBROMOMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
DICHLORODIFLUOROMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
ETHYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
HEXACHLOROBUTADIENE	µg/L	12	12	**1**	**1**	**1**	**1**
IODOMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
ISOPROPYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
M+P-XYLENE	µg/L	12	12	**1**	**1**	**1**	**1**
METHYL TERTIARY BUTYL ETHER	µg/L	12	12	**1**	**1**	**1**	**1**
METHYLENE CHLORIDE	µg/L	12	12	**1**	**1**	**1**	**1**
NAPHTHALENE	µg/L	12	12	**1**	**1**	**1**	**1**
N-BUTYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
N-PROPYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
O-XYLENE	µg/L	12	12	**1**	**1**	**1**	**1**
P-ISOPROPYLTOLUENE	µg/L	12	12	**1**	**1**	**1**	**1**
SEC-BUTYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
STYRENE	µg/L	12	12	**1**	**1**	**1**	**1**
TERT-BUTYLBENZENE	µg/L	12	12	**1**	**1**	**1**	**1**
TETRACHLOROETHENE	µg/L	12	12	**1**	**1**	**1**	**1**
TOLUENE	µg/L	12	12	**0.35**	**1**	**0.95**	**1**
TRANS-1,2-DICHLOROETHENE	µg/L	12	12	**1**	**1**	**1**	**1**
TRANS-1,3-DICHLOROPROPENE	µg/L	12	12	**1**	**1**	**1**	**1**
TRICHLOROETHENE	µg/L	12	12	**1**	**1**	**1**	**1**
TRICHLOROFLUOROMETHANE	µg/L	12	12	**1**	**1**	**1**	**1**
VINYL ACETATE	µg/L	12	12	**2**	**2**	**2**	**2**
VINYL CHLORIDE	µg/L	12	12	**1**	**1**	**1**	**1**
VOC Tentatively Identified Compounds	µg/L	None detected for all samples					

Footnotes

- Parameters with a T denote Total Recoverable concentrations, those with a D denote Dissolved concentrations.
- The column heading "n" refers to the number of total measurements/lab determinations.
- All **bolded** statistics represent "less than" (<) values and are based on the numeric value of the qualified result (i.e. <20 was converted to 20).
- Gross alpha and beta detection limits depend partly on radiation back-calculations of net activity and can therefore result in positive or negative values. All **bolded** numbers represent "less than" values as noted above.

Table A1.3 Water Quality Statistical Comparisons (2009-2013)

Thompson Divide WQ Statistical Comparisons (2009-2013)

Surface Water Sites (FC, MTC, NTC, SMTC)

		2009-2010 Statistics						2013 Statistics					
Parameter	**Units**	**n**	**< values**	**minimum**	**maximum**	**average**	**median**	**n**	**< values**	**minimum**	**maximum**	**average**	**median**
General Field Data													
Discharge (field)	ft^3/sec	16	0	1.4	152.5			10	0	1.2	43.5		
pH (field)	pH	19	0	7.8	8.7	8.4	8.4	16	0	7.5	8.2	7.9	7.8
pH (lab)	pH	20	0	7.6	8.4	8.1	8.1	16	0	7.6	8.3	8.1	8.1
Specific Conductance (field)	µS/cm	20	0	57	355	199	195	16	0	61	345	183	175
Dissolved Oxygen (field)	mg/L	20	0	7.9	11.0	9.5	9.6	16	0	8.9	11.4	10.3	10.3
Dissolved Oxygen % Saturation (field)	%	20	0	56	80	75	77	16	0	66	83	76	78
Total Dissolved Solids (field)	mg/L	19	0	37	231	130	127	16	0	40	224	119	114
Total Dissolved Solids (lab)	mg/L	16	0	66	200	118	115	16	0	50	200	117	110
Water Temperature (field)	° C	20	0	0.1	12.4	5.7	6.1	16	0	0.0	7.5	3.0	2.6
Oxidation-Reduction Potential (field)	mV	17	0	113	324	185	174	16	0	20	125	76	73
Major Anions													
Ammonia as N	mg/L	16	16	**0.1**	**0.1**	**0.1**	**0.1**	16	16	**0.1**	**0.1**	**0.1**	**0.1**
Nitrate as N	mg/L	16	15	**0.2**	0.2	**0.2**	**0.2**	16	12	**0.2**	0.3	**0.2**	**0.2**
Sulfate	mg/L	16	0	1.9	8.1	4.7	5.7	16	0	2.1	8.7	5.0	5.0
Others													
Alkalinity, Total	mg/L	20	0	22	200	105	100	16	0	26	192	89	83
Hardness	mg/L	4	0	72	180	109	92	16	0	22	182	85	76

Footnotes

- The column heading "n" refers to the number of total measurements/lab determinations.
- The column heading "< values " refers to the total number of "less than" values where the result was below laboratory reporting limits. (i.e <20).
- All **bolded** statistics represent "less than" (<) values and are based on the numeric value of the qualified result (i.e. <20 was converted to 20).

Thompson Divide WQ Statistical Comparisons (2009-2013)

Ground Water Sites (SHS, SMTSp, WCWPS, YCS)

		2009-2010 Statistics						2013 Statistics					
Parameter	**Units**	**n**	**< values**	**minimum**	**maximum**	**average**	**median**	**n**	**< values**	**minimum**	**maximum**	**average**	**median**
General Field Data													
Discharge (field)	gal/min	13		0.04	4.28			8		0.28	9.54		
pH (field)	pH	16	0	7.0	8.1	7.6	7.6	10	0	7.1	8.2	7.6	7.4
pH (lab)	pH	16	0	6.8	7.9	7.5	7.4	10	0	7.0	7.7	7.5	7.6
Specific Conductance (field)	µS/cm	16	0	61	620	363	392	10	0	73	587	360	418
Dissolved Oxygen (field)	mg/L	16	0	3.0	8.7	6.5	6.1	9	0	5.5	9.4	7.1	6.4
Dissolved Oxygen % Saturation (field)	%	15	0	26	68	51	50	9	0	47	79	58	55
Total Dissolved Solids (field)	mg/L	15	0	40	403	240	263	10	0	47	382	234	271
Total Dissolved Solids (lab)	mg/L	12	0	61	320	222	240	10	0	71	350	213	240
Water Temperature (field)	° C	16	0	0.9	10.0	6.3	6.8	10	0	2.7	11.5	7.7	8.2
Oxidation-Reduction Potential (field)	mV	15	0	63	225	138	129	9	0	19	130	58	42
Major Anions													
Ammonia as N	mg/L	12	12	**0.1**	**0.1**	**0.1**	**0.1**	10	10	**0.1**	**0.1**	**0.1**	**0.1**
Nitrate as N	mg/L	12	10	**0.2**	0.3	0.2	**0.2**	10	6	**0.2**	0.3	**0.2**	**0.2**
Sulfate	mg/L	12	0	2	15	7.5	5.0	10	0	3	34	11.3	9.4
Others													
Alkalinity, Total	mg/L	16	0	27	320	202	221	10	0	16	338	186	220
Hardness	mg/L	4	0	42	228	138	140	10	0	20	318	184	223

Footnotes

- The column heading "n" refers to the number of total measurements/lab determinations.
- The column heading "< values " refers to the total number of "less than" values where the result was below laboratory reporting limits. (i.e <20).
- All **bolded** statistics represent "less than" (<) values and are based on the numeric value of the qualified concentration (i.e. <20 was converted to 20).

Appendix 2.0 Field Sampling and Measurement Procedures

[Excerpted from Roaring Fork Conservancy updated 2013 Field Sampling Plan (FSP)]

Surface Water Sampling

A 100-foot reach representative of the characteristics of the stream was selected. Whenever possible, the area was upstream from any road or bridge crossing to minimize its effect on stream quality, velocity, depth, and overall habitat quality. The following procedures were employed at each sample site prior to and during sampling:

- Review and understand the protocols for collecting and processing samples before field work begins.
- Complete the chemical/physical field data sheets to document site description, weather conditions, and land use.
- Record a description of site conditions and any anomalies at the time of sampling. Be aware of and record potential sources of contamination at each field site.
- Use hand-held Global Positioning System (GPS) for latitude and longitude determination taken at the exact sampling location within the reach.
- Use camera to thoroughly document sample location from multiple angles and surrounding area including landmarks.
- Use flagging and stakes to thoroughly mark site for easy identification during subsequent sampling (especially in winter).
- Wear appropriate equipment:
  - Avoid hand contact with contaminating surfaces (such as equipment, coins, food) while sampling.
  - Gloved as well as ungloved hands must not contact the water sample.
- Use equipment constructed of materials that are relatively inert with respect to the analytes of interest.
- Use only equipment that has been cleaned according to prescribed procedures.
- Field rinse equipment, but only as directed.
- Collect a sufficient number of quality-control samples.
- Use correct sample-handling procedures:
  - Minimize the number of sample-handling steps.
  - Follow a prescribed order for collecting samples.

Field sampling activities were conducted in a prescribed order to minimize disturbance of sediment, foliage, detritus, etc. on the bed and banks of the stream which could potentially affect the samples measure. Procedures started with the most delicate constituents and finished with measurements which were least affected by disturbance. The prescribed order was as follows:

1. Collect all water quality samples.
   a. Collect samples in bottles containing preservative, including QC samples when applicable.
   b. Collect samples in bottles without preservative, including QC samples when applicable.

    c. Collect samples requiring field filtration using appropriate equipment and including QC samples when applicable.
2. Conduct field measurements requiring multi-parameter probe.
3. Conduct flow measurements.
4. Conduct any photography, GPS measurements, etc. that requires wading in the stream.

Surface Water Sampling Procedures

Surface water sample collection was conducted according to the Colorado Department of Public Health and Environment Water Quality Control Division Standard Operating Procedures for the Collection of Water Samples. Sections 3.0 General Sample Procedures and 4.0 Sample Collection (10/2008). For a complete citation refer to FSP Section 2.0.

- Stream samples were collected as "grab" samples. A grab sample is collected by filling each sample bottle directly in the stream. Alternatively, an appropriate collection container may be used to collect sample water and immediately transfer to sample bottles. The grab sample should be collected from the main channel thalweg[2], just below the water surface, incorporating the top half of the water column.
- To minimize sample contamination, the area around the sample site should be disturbed as little as possible until sampling is complete.
    - The area upstream of the sample site shall not be disturbed by any of the sample team prior to collecting samples.
    - Samples will always be collected upstream of where the sampler is standing.
    - When rinsing collection equipment, bottles will always be filled upstream and dumped downstream of where the sampler is standing.
- Samples collected include preserved (acid preserved), and neutral (unpreserved) samples in both plastic (high density polyethylene) and glass containers. Sample collection procedures for each bottle type are as follows:
    - Preserved (glass and polyethylene bottles)
        1. Rinse pre-cleaned collection container with sample source water three times before collecting sample.
        2. Fill with grab sample.
        3. Carefully pour sample water into appropriate sample bottles as they contain acid for preserving the sample and should be handled with care. Do not rinse and do not over-fill container as this will affect the preservative. Leave approximately ½ inch headspace to allow for mixing and expansion.
    - Neutral (glass and polyethylene bottles)
        1. Rinse with sample source water three times before collecting sample.

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[2] The thalweg of a stream is a line drawn to join the lowest points along the entire length of the streambed in its downward slope, defining its deepest channel. It thus marks the natural direction of a watercourse and is almost always the line of fastest flow in any stream. Due to the above definition the thalweg often denotes the best mixed section of a stream for sampling purposes.

   2. Fill with grab sample.
   3. Alternatively, neutral sample containers can be filled from collection container following procedures listed for preserved containers.
- Samples were collected into appropriate bottles (FSP Section 2.6.1). Immediately after a sample is collected it will be sealed, labeled, logged onto a chain of custody form and placed into an ice filled cooler until shipped to ALS Laboratory Group located in Fort Collins, CO for analysis. Due to short holding times (FSP Appendix 4) on some of the constituents, samples will be shipped the same day they are collected.

Measurement of Surface Water Field Parameters

Stream discharge measurements were taken at each surface water site. The 2013 round of water quality sampling implemented the use of a SonTek FlowTracker Acoustic Doppler Velocimeter to measure stream discharge (flow). Flow measurements were taken in accordance with the protocols in the following guidance documents: SonTek/YSI Incorporated-*FlowTracker Handheld ADV Technical Manual* and USGS-*OSW Technical Memos* and *SonTek/YSI FlowTracker Policy memos*. For a complete citation refer to FSP Section 4.0. Appendix 1 contains water quality SonTek FlowTracker detection limits and specifications. Measurement and calculation of stream discharge using a FlowTracker included the following protocols:

- A FlowTracker "BeamCheck" should be performed, recorded, and archived prior to each week of use.
- Prior to each discharge measurement, perform an automated field "BeamCheck" labeled "QC Test".
- Measurement site selection -- the measurement section should be within a straight reach, where streamlines are parallel. The streambed should be relatively uniform and free of numerous boulders, debris, and heavy aquatic growth. The flow should be relatively uniform and free of eddies, slack water, and excessive turbulence.
- Avoid measurement sections with abrupt changes in bed topography. These changes can result because of such things as large rocks or cobbles in the measuring section. Avoid placing the FlowTracker sample volume within 2 inches from any solid boundary.
- Velocity sample time – under normal measurement conditions, each point velocity measurement should be sampled for a minimum of 40 seconds.
- Location of velocity observations in each vertical – The six-tenths-depth (0.6) method should be used in depths 1.5 ft. or less. For depths greater than 1.5 ft., the two-point (0.2/0.8) method should be used. If the velocity measurement at the 0.8 depth could be corrupted by the sample volume being located on or near a boundary, then a six-tenths method should be used. If a non-standard velocity profile is found while making a two-point velocity measurement, a three-point method (0.2 depth, 0.6 depth, and 0.8 depth) should be used.
- Monitor the FlowTracker SNR readings during the measurement for readings that are less than 4 dB.

- Pay close attention to the flow angle reported by the FlowTracker. The wading rod (with FlowTracker attached) always should be held perpendicular to the tagline, and the tagline should be set up perpendicular to the flow in the cross section to be measured.

All other field Parameters were collected and measured using a YSI Professional Plus multiparameter field meter and according to the following guidance documents: YSI Incorporated-*YSI Professional Plus Calibration Tips* and Y*SI Professional Plus User Manual* and the United States Geological Survey-*National field manual for the collection of water quality data. Chapter A6.8 Use of Multiparameter Instruments for Routine Field Measurements*. For a complete citations refer to FSP Section 4.0.

The following steps were followed during the measurement of field parameters:
- Conduct appropriate calibration of field meters and parameters.
- Allow time for the readings on the display to stabilize within the appropriate criteria.
- Record all required and targeted field measurements on the appropriate field forms, laboratory analytical request forms, project log books, chain-of-custody logs, etc.

Field Measurements for surface water sites were measured in situ and included the following procedures:
- Wait for the sensors to reach thermal equilibrium with the water temperature at each location.
- At each location, allow the field-measurement values on the instrument display to stabilize within the established criterion before recording final field measurements.
- Measure in the main channel thalweg (the line of fastest flow in the stream channel and often the deepest), just below the water surface.

Ground Water Sampling

Ground water sampling consisted of collecting water from seeps and/or springs as they emerge from the ground. An effort was made to collect samples as near the point of emergence as possible while still in an area with enough flow to collect water while minimizing sediment disturbance. The following procedures were adhered to at each sample site prior to and during sampling:
- Review and understand the protocols for collecting and processing samples before field work begins.
- Complete the physical/chemical field sheet to document site description, weather conditions, and land use.
- Record a description of site conditions and any anomalies at the time of sampling. Be aware of and record potential sources of contamination at each field site.
- Use hand-held Global Positioning System (GPS) for latitude and longitude determination taken at the exact sampling location within the reach.
- Use camera to thoroughly document sample location from multiple angles and surrounding area including landmarks.

- Use flagging and stakes to thoroughly mark site (especially springs) for easy identification during subsequent sampling (especially in winter).
- Wear appropriate equipment:
    - Avoid hand contact with contaminating surfaces (such as equipment, coins, food) while sampling.
    - Gloved as well as ungloved hands must not contact the water sample.
- Use equipment constructed of materials that are relatively inert with respect to the analytes of interest.
- Use only equipment that has been cleaned according to prescribed procedures (FSP Section 2.7.1).
- Field rinse equipment, but only as directed.
- Collect a sufficient number of quality-control samples.
- Use correct sample-handling procedures:
    - Minimize the number of sample-handling steps.
    - Follow a prescribed order for collecting samples.

Seep and Spring Sampling Procedures

Seep and spring sample collection were conducted according the following procedures:

- Samples are collected as "grab" samples. The grab sample is collected by filling each sample bottle directly from the spring, as near to the point of emergence as possible, while still in an area with enough flow to collect water while minimizing sediment disturbance. Alternatively, an appropriate collection container may be used to collect sample water and immediately transfer to sample bottles.
- To minimize sample contamination, the area around the sample site should be disturbed as little as possible until sampling is complete.
    - The area around the point of emergence shall not be disturbed by any of the sample team prior to collecting samples.
    - Samples will always be collected from points of the spring where sediment disturbance will be minimal.
    - When rinsing collection equipment, bottles will always be dumped away and downhill from the sample area.
- Samples collected include preserved (acid preserved), and neutral (unpreserved) samples in both plastic (high density polyethylene) and glass containers. Sample collection procedures for each bottle type are as follows:
    - Preserved (glass and polyethylene bottles)
        1. Rinse pre-cleaned collection container with sample source water three times before collecting sample.
        2. Fill with grab sample.
        3. Carefully pour sample water into appropriate sample bottles as they contain acid for preserving the sample and should be handled with care. Do not rinse and do not over-fill container as this will affect the preservative. Leave approximately ½ inch headspace to allow for mixing and expansion.
    - Neutral (glass and polyethylene bottles)

    1. Rinse with sample source water three times before collecting sample.
    2. Fill with grab sample.
    3. Alternatively, neutral sample containers can be filled from collection container following procedures listed for preserved containers.
- The samples were collected into appropriate bottles (FSP Section 2.6.1). Immediately after a sample was collected it was sealed, labeled, logged onto a chain of custody form and placed into an ice filled cooler until shipped to ALS Laboratory Group located in Fort Collins, Colorado for analysis. Due to short holding times (FSP Appendix 4) on some of the constituents, samples were shipped the same day they were collected.

Measurement of Ground Water Field Parameters

Spring discharge measurements were made at each site. Multiple measurements were taken to do error analysis and calculate the degree of uncertainty in those estimates. Measurement and calculation of stream discharge included the following procedures:

- After all samples and other field measurements have been taken, select section of the spring where all the flow goes over a small pour-over.
- Document this section with photographs.
- Insert measuring container and begin timing. Measure the exact amount the container filled in a given period of time and document.
- Perform this at least six times to get an average discharge and conduct error analysis.
- Convert results to gallons/minute.

All other field Parameters were collected and measured using a YSI Professional Plus multiparameter field meter and according to the following guidance documents: YSI Incorporated-*YSI Professional Plus Calibration Tips* and Y*SI Professional Plus User Manual* and the United States Geological Survey-*National field manual for the collection of water quality data. Chapter A6.8 Use of Multiparameter Instruments for Routine Field Measurements*. For a complete citations refer to FSP Section 4.0.

The following steps were followed during the measurement of field parameters:

- Conduct appropriate calibration of field meters and parameters.
- Allow time for the readings on the display to stabilize within the appropriate criteria.
- Record all required and targeted field measurements on the appropriate field forms, laboratory analytical request forms, project log books, chain-of-custody logs, etc.

Field measurements for ground water sites were measured in situ if depth and flow allowed. In these circumstances, the following steps were used:

- Wait for the sensors to reach thermal equilibrium with the water temperature at each location.
- At each location, allow the field-measurement values on the instrument display to stabilize within the established criterion before recording final field measurements.
- Measure the spring as near to the point of emergence as possible while still in an area with enough flow to minimize sediment disturbance.

Alternately, if depth and flow were too low to permit submersion of the probes without sediment disturbance, the following steps were used:

- Field rinse an appropriate sample collection container with spring water.
- Collect a grab sample by filling the collection container directly from the spring as near to the point of emergence as possible while still in an area with enough flow to minimize sediment disturbance.
- Immediately place the probe into the container to conduct measurements. Container will need to be swirled during DO measurement to ensure accurate readings.
- Wait for the sensors to reach thermal equilibrium with the water temperature but record temperature as soon as stabilized to minimize sample warming.
- Allow the field-measurement values on the instrument display to stabilize within the established criterion before recording final field measurements.

Sample Handling, Identification, and Test Methods
Sample Containers and Preservation

Containers

Water Quality (WQ) samples were placed in clean containers provided by ALS Laboratory Group. ALS Laboratory Group, Fort Collins provides EPA certified Level 3 clean (I-Chem 300 ™, Eagle Pitcher Level 1, or equivalent) sample bottles for sample collection. The Sample Receiving Department maintains certificates of cleanliness that are provided by the vendor for all sample bottles. These certificates are provided to the client upon request. The 2013 round of water quality sampling utilized a smaller subset of samples, thus a smaller sample container list, see Table 3 (below). ALS Laboratory Group will provide sampling containers for Nitrate, Sulfate, TDS, and Ammonia. RFC will provide sample containers for Alkalinity, Hardness and pH.

Table A3.0 Sampling Containers and Preservatives

Analytes	# of containers per sample	Container Type	Preservative
Nitrate, Sulfate, TDS	1	1L polyethylene	none
Ammonia as N	1	250mL polyethylene	H_2SO_4
Alkalinity, Hardness, pH	1	500mL polyethylene	none

Sample Preservatives

WQ samples were preserved with chemical additives, as required by the analytical method. Correct preservatives were provided in the sample container by the laboratory. Table 3 (above) lists containers and associated preservatives.

Temperature Control

WQ samples were stored in coolers with ice. Samples were placed in the coolers as soon as possible after sample collection and remained in the coolers during transport from the field and until shipment to the lab for analysis. Prior to shipment coolers may be re-packed with new ice to ensure proper temperature levels of 4° C or less (FSP Appendix 3).

Sample Identification/Labels

All samples were identified by sticker-labels affixed to the container. The information was recorded in waterproof ink. The information recorded on the labels included:

- Sample identification
- Initials of sampler
- Sample location
- Analysis to be conducted
- Date and time of collection
- Preservatives, if any
- Client

Sample Packing and Shipping

Water-Quality Samples were shipped to ALS Laboratory Group in Ft Collins, Colorado via FedEx. ALS provided shipping labels for next day delivery. Samples were shipped in coolers provided by ALS using absorbent and packaging material also provided by ALS. Alkalinity, Hardness and pH samples were stored on ice in coolers and delivered directly to the RFC lab in Basalt, CO the same day as collection

The following procedures were used to assure the integrity of sample containers during shipping:

- Double check tightening of all container lids.
- Careful packing of sample containers in coolers to prevent breakage (e.g., use of packing materials).
- Use of bags and absorbent materials to prevent cross contamination and/or water damage to labels in case of leaks.
- Placement of each sample container in an upright position to help assure containment.
- Double bagging of ice to minimize potential for water damage to labels and/or seepage into containers.

Chain of Custody

Once sample labels were placed on sample containers, the containers were documented on a chain-of-custody form. The chain-of-custody forms accompanied the samples to the laboratory. The form was sealed in a plastic bag and taped to the inside lid of the sample cooler.

The applicable laboratories will provide the blank chain-of-custody forms with carbon copies and will return the forms with the analytical results. A blank copy of the chain-of-custody form is provided in FSP Appendix 4.

Field Equipment

A YSI Professional Plus WQ Field Meter was used to collect field measurement data. The following probes were used in connection with the meter:

- Dissolved Oxygen probe
- Electrical Conductivity probe
- Oxidation Reduction Potential probe
- pH probe
- Temperature probe

In 2013, a SonTek/YSI FlowTracker Acoustic Doppler Velocimeter was used to measure/calculate stream discharge of surface waters.

Equipment manuals for these meters were provided with the equipment in the field including calibration procedures, operation procedures, and maintenance procedures. Water quality field meter detection limits and specifications are presented in the FSP.

Sampling Equipment Decontamination

Any equipment in contact with sample water, such as field meter probes, was thoroughly decontaminated before each use. Decontamination was performed on site, in an area located away from the sampling activities.

Decontamination of field sampling equipment was performed in the following steps prior to sampling:

- Wash/scrub with distilled water and Liquinox (non-phosphate soap). (Field meter probes will skip this step).
- Distilled water rinse.
- Deionized water rinse (2-3 times).
- Sample water rinse (at next site).

Sampling-Derived Waste Management

The following general guidelines were followed for management of sampling-derived waste:

<u>Water</u>

Due to the baseline nature of this sample plan, all wastewater is expected to have very low levels of contamination. For this reason, wastewater generated through surface and groundwater sampling procedures will be discharged onto the ground in non-erosive areas.

<u>Solid Waste</u>

Disposable sampling supplies and personal protective equipment will be placed in plastic bags and transported from the field to a waste container for proper disposal.

Documentation

Field documentation will include field book notes, field sampling forms, and chain-of-custody forms. For examples of Field Forms refer to FSP Appendix 3. The field book and forms will document the following:

- Project identification
- Dates and time
- Sample locations, maps and related information
- Sample site information and conditions
- Potential anomalies and contaminants affecting sample
- Weather conditions at time of sampling
- Names of personnel involved
- Activities performed and order in which they are performed
- Field measurement data
- Samples collected
- Equipment type, calibration and maintenance
- Chain-of-Custody

Reporting

Laboratory results for chemical analyses as well as data collected from the field sampling activities will be logged according to the above plan. Results and data will be provided to the Water Quality consultants (listed in Section 1.0 Introduction) for review. Consultants will compile the data, provide data validation, and then interpret the results. Using the results, consultants will produce a final report that provides baseline results and key findings specific to the overall Sampling and Analysis Plan goals.

Appendix 3.0 Laboratory Test Methods and Reporting Limits

ALS Laboratory Group located in Fort Collins, Colorado analyzed all water quality samples. Lab water quality parameters and their associated reporting limits are presented below.

Table A4.0 ALS Reporting Limits

Analyte	Matrix	Anal Meth	LCS Limits	MS Limits	MDL	MDL Exp Date	MDC pCi/L or RL (ppb	Test Type	Surro-gate Limits	DER	RPD
TOTAL DISSOLVED SOLIDS	LIQUID	EPA160.1	85-115	85-115			20000.0	TA			15
TOTAL SUSPENDED SOLIDS	LIQUID	EPA160.2	85-115	85-115			20000	TA			15
pH	LIQUID	EPA150.1					0.1 pH units	TA			
FLUORIDE	LIQUID	EPA300.0	90-110	85-115	33.3	1/11/2009	100	TA			15
AMMONIA	LIQUID	EPA350.1	90-110	75-125	18.6	12/10/2003	100	TA			20
SPECIFIC CONDUCTANCE	LIQUID	EPA120.1					1 umhos/cm	TA			
POTASSIUM	LIQUID	WPA200.7	85-115	70-130	90.3	5/1/2010	1000	TA			20
ALUMINUM	LIQUID	EPA200.7	85-115	70-130	5.66	1/12/2010	200.0	TA			30
BARIUM	LIQUID	EPA200.7	85-115	70-130	0.22	1/12/2010	100.0	TA			30
BERYLLIUM	LIQUID	EPA200.7	85-115	70-130	0.194	1/12/2010	5.0	TA			30
BORON	LIQUID	EPA200.7	85-115	70-130	1.8	1/12/2010	100.0	TA			30
CALCIUM	LIQUID	EPA200.7	85-115	70-130	10.6	1/12/2010	1000.0	TA			30
CHROMIUM	LIQUID	EPA200.7	85-115	70-130	0.429	1/12/2010	10.0	TA			30
COBALT	LIQUID	EPA200.7	85-115	70-130	0.699	1/12/2010	10.0	TA			30
COPPER	LIQUID	EPA200.7	85-115	70-130	0.651	1/12/2010	10.0	TA			30
IRON	LIQUID	EPA200.7	85-115	70-130	3.9	1/12/2010	100.0	TA			30
MAGNESIUM	LIQUID	EPA200.7	85-115	70-130	6.61	1/12/2010	1000.0	TA			30
MANGANESE	LIQUID	EPA200.7	85-115	70-130	0.164	1/12/2010	10.0	TA			30
NICKEL	LIQUID	EPA200.7	85-115	70-130	0.651	1/12/2010	20.0	TA			30
SILVER	LIQUID	EPA200.7	85-115	70-130	0.93	1/12/2010	10.0	TA			30
SODIUM	LIQUID	EPA200.7	85-115	70-130	6.91	1/12/2010	1000.0	TA			30
TIN	LIQUID	EPA200.7	85-115	70-130	2.61	1/12/2010	50.0	TA			30
ZINC	LIQUID	EPA200.7	85-115	70-130	2.59	1/12/2010	20.0	TA			30
ANTIMONY	LIQUID	EPA200.8	85-115	70-130	0.08160943	2/1/2010	0.3	TA			30
ARSENIC	LIQUID	EPA200.8	85-115	70-130	0.04835239	2/1/2010	2	TA			30
CADMIUM	LIQUID	EPA200.8	85-115	70-130	0.01933301	2/1/2010	0.3	TA			30
LEAD	LIQUID	EPA200.8	85-115	70-130	0.02474729	2/1/2010	0.5	TA			30
MOLYBDENUM	LIQUID	EPA200.8	85-115	70-130	0.04519424	2/1/2010	1	TA			30
SELENIUM	LIQUID	EPA200.8	85-115	70-130	0.08216019	2/1/2010	1	TA			30
THALLIUM	LIQUID	EPA200.8	85-115	70-130	0.01212135	2/1/2010	0.2	TA			30
URANIUM	LIQUID	EPA200.8	85-115	70-130	0.00447278	2/1/2010	0.1	TA			30
MERCURY	LIQUID	EPA245.1	85-115	70-130	0.00809	11/29/2009	0.2	TA			20
CHLORIDE	LIQUID	EPA300.0	90-110	85-115	91.4	9/15/2009	200.0	TA			15
NITRATE AS N	LIQUID	EPA300.0	90-110	85-115	25.5	9/15/2009	200.0	TA			15
NITRITE AS N	LIQUID	EPA300.0	90-110	85-115	38	9/15/2009	100.0	TA			15
ORTHOPHOSPHATE AS P	LIQUID	EPA300.0	90-110	85-115	130	9/15/2009	500.0	TA			15
SULFATE	LIQUID	EPA300.0	90-110	85-115	228	9/15/2009	1000.0	TA			15
BICARBONATE AS CACO3	LIQUID	EPA310.1			546	10/3/2003	5000.0	TA			15
CARBONATE AS CACO3	LIQUID	EPA310.1			546	10/3/2003	5000.0	TA			15
SULFIDE	LIQUID	EPA376.1	80-120	80-120	520	3/2/2006	2000.0	TA			20
DISSOLVED ORGANIC CARBON	LIQUID	EPA415.1	85-115	80-120	149	11/21/2009	1000.0	TA			20
GROSS ALPHA	LIQUID	PAI 724	80-120	80-120			3	TA		2.13	
GROSS BETA	LIQUID	PAI 724	80-120	80-120			4	TA		2.13	
ETHANE	LIQUID	RSK175	80-120	70-130	1.02	5/25/2010	2.0	TA			25
ETHENE	LIQUID	RSK175	80-120	70-130	0.867	5/25/2010	1.0	TA			25
METHANE	LIQUID	RSK175	80-120	70-130	0.897	5/25/2010	1.0	TA			25

Table A5.0 ALS Sample Handling Guidelines

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES
Fort Collins, CO

Sample Handling Guidelines

General Inorganic Parameters

		Water			Soil/Sludge		
Parameters	**Method**	**Preservative**	**Container**	**Holding Time**	**Preservative**	**Container**	**Holding Time**
Acidity	E305.1	4°C	250 mL / P	14 Days	Matrix Not Applicable		
Alkalinity (Total, Carbonate, Bicarbonate, Hydroxide)	E310.1, SM2320B	4°C	250 mL / P	14 Days	Matrix Not Applicable		
Ammonia	E350.1, SM4500	4°C, H_2SO_4 to pH <2	125 mL / P	28 Days	4°C	4 oz WMG	28 Days
Anions: Br, Cl, F, SO4 / NO2, NO3, o-PO4	E300.0, SW9056	4°C	125 mL / P	28 Days / 48 Hours	4°C	4 oz WMG	28 D / 48 H from Prep
Chloride	E325.3	4°C	125 mL / P	28 Days	4°C	4 oz WMG	28 Days from Prep
Fluoride	E340.2, SM4500, SW9214	4°C	125 mL / P	28 Days	4°C	4 oz WMG	28 Days from Prep
Nitrite	E354.1	4°C	125 mL / P	48 Hours	4°C	4 oz WMG	48 Hours from Prep
Chromium VI (Hexavalent Cr)	SW7196A(aq, so), SW7196A/3060A (so)	4°C	125 mL / P	24 Hours	4°C	4 oz WMG	24 Hours from Prep
Cyanide (Total)	E335.2, SW9010B, SW9013B, SW9014	4°C, NaOH to pH >12	125 mL / P	14 Days	4°C	4 oz WMG	14 Days
Cyanide (Amenable to Chlorination)	E335.2, SW9010B, SW9013B, SW9014	4°C, NaOH to pH >12	125 mL / P	14 Days	Matrix Not Applicable		
Cyanide (Weak and Dissociable)	SM4500	4°C, NaOH to pH >12	125 mL / P	14 Days	4°C	4 oz WMG	14 Days
Nitrate + Nitrite as N	E353.2	4°C, H_2SO_4 to pH <2	125 mL / P	28 Days	4°C	4 oz WMG	28 Days
Oxyanions (bromate, chlorate, chlorite, iodate)	SW8321	4°C, 1 µL 5% EDA/1 mL sample	40 mL / TLC-Amb G	14 Days	Matrix Not Applicable		
Perchlorate	E314.0, SW9058, SW6850, E331.0, DoD Handbook	4°C, 1/3 headspace	250 mL / P	28 Days	4°C	4 oz WMG	28 Days
Phosphorous, Total	E365.2, SM4500	4°C, H_2SO_4 to pH <2	125 mL / P	28 Days	4°C	4 oz WMG	28 Days
Phosphate, Ortho	E365.2, SM4500	4°C	125 mL / P	48 Hours	4°C	4 oz WMG	48 Hours from Prep
pH	E150.1, SW9040, SW9045	4°C	125 mL / P	4 Days from Receipt	4°C	4 oz WMG	4 Days from Receipt
Solids, Dissolved (TDS)	E160.1	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Solids, Suspended (TSS)	E160.2	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Solids, Total (TS)	E160.3	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Solids, Volatile (TVS)	E160.4	4°C	250 mL / P	7 Days	Matrix Not Applicable		
Specific Conductance	E120.1, SW9050, SM2510B	4°C	125 mL / P	4 Days from Receipt	Matrix Not Applicable		
Sulfide	E376.1 (aq)	4°C, ZnAc, NaOH to pH >9	250 mL / P	7 Days	Matrix Not Applicable		
Total Organic Carbon (TOC)	E415.1 (aq), 9060 (aq), Walkley Black (so)	4°C, H_2SO_4 to pH<2	125 mL / Amb G	28 Days	4°C	4 oz WMG	28 Days
Turbidity	E180.1	4°C	125 mL / P	48 Hours	Matrix Not Applicable		

Metals Parameters

		Water			Soil/Sludge		
Parameters	**Method**	**Preservative**	**Container**	**Holding Time**	**Preservative**	**Container**	**Holding Time**
Metals	E200.7, SW6010B, E200.8, SW6020A	4°C, HNO_3 to pH<2	250 mL / P	6 Months	4°C	4 oz WMG	6 Months
Mercury	E245.1, SW7470 (aq), SW7471 (so)	4°C, HNO_3 to pH<2	250 mL / P	28 Days	4°C	4 oz WMG	28 Days
Hardness	Calculation from Ca & Mg Results	4°C, HNO_3 to pH<2	250 mL / P	6 Months	Matrix Not Applicable		
Sodium Adsorption Ratio (SAR)	Calculation from Ca, Mg, & Na Results	4°C, HNO_3 to pH<2	250 mL / P	6 Months	Matrix Not Applicable		

Organic Parameters

		Water			Soil/Sludge		
Parameters	**Method**	**Preservative**	**Container**	**Holding Time***	**Preservative**	**Container**	**Holding Time***
Chlorinated Herbicides	SW8151A	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
EDB and/or DBCP	SW8011	4°C, HCl to pH<2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
Explosives	SW8330A, SW8330B, SW8332, SW8321	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Glycols (ethylene and propylene)	SW8015D	4°C	3 x 40 mL / V-TLS	7 / 14 Days	4°C	4oz WMG / TLC	14 Days
Lipids	SOP 672	Matrix Not Applicable			Frozen	8oz WMG / TLC	28 Days
Methane, Ethane, Ethene	RSK175	4°C, HCl to pH<2, ZH	3 x 40 mL / V-TLS	14 Days	Matrix Not Applicable		
Moisture	ASTM 2216	Matrix Not Applicable			4°C	4oz WMG / TLC	14 Days
Organochlorine Pesticides	E608, SW8081A	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Organophosphorous Pesticides	SW8141	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
PCBs	E608, SW8082	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Polynuclear Aromatic Hydrocarbons	SW8270D, SW8270D-SIM	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Semivolatile Organics (Base/Neutrals/Acids)	E625, SW8270D , SW8270D-SIM	4°C	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
Total Petroleum Hydrocarbons							
TRPH (C8-C40)	FL-PRO	4°C, H_2SO_4/HCl to pH<2	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4 oz WMG	14 / 40 Days
DRO and/or MO	SW8015M, CAL-LUFT	4°C, H_2SO_4/HCl to pH<2	1000 mL / TLC-Amb G	7 / 40 Days	4°C	4oz WMG / TLC	14 / 40 Days
GRO	SW8015, CAL-LUFT	4°C, H_2SO_4/HCl to pH<2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
Oil and Grease	E1664 (aq), SW9071 (so)	4°C, H_2SO_4/HCl to pH<2	1000 mL / TLC-Amb G	28 Days	4°C	4 oz WMG	28 Days
Volatile Organics	E524.2, E624, SW8260B	4°C, HCl to pH <2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
BTEX and/or MTBE	E524.2, E624, SE8260B	4°C, HCl to pH <2, ZH	3 x 40 mL / V-TLS	14 Days	4°C	4oz WMG / TLC	14 Days
Volatile Organics	5035A/SW8260B	Matrix Not Applicable			4°C	3 ENCORE Samplers	48 H to Analysis or Freezing
Volatile Organics	5035A/SW8260B	Matrix Not Applicable			4°C / sodium bisulfate	1 Tetra Core Sampler	14 Days

*Where two holding times are provided, the first value indicates holding time to extraction, the second value indicates holding time between extraction and analysis.

Appendix 4.0 Quality Assurance/Quality Control Data

In order to ensure the quality of the data collected, a Quality Assurance/Quality Control (QA/QC) Plan, was designed to establish the policies, organization, objectives and specific QA/QC activities for the associated Thompson Divide Field Sampling Plan (FSP). The QAQC Plan addresses such topics as:

- Sample Custody
- Calibration Procedures and Preventative Maintenance
- Analytical Procedures
- Data reduction, validation and reporting
- Internal Quality Control
- Data Assessment Procedures
- Corrective Action Procedures

In addition, all data were evaluated using the following internal checks:

- Field and lab measurements were compared for consistency and changes (within any one sample);
- Trends in data from different sampling dates for all sites were compared for consistency.
- All data were analyzed statistically to summarize simple patterns.

Lastly, all samples were subject to and complied with additional internal ALS Laboratory QA/QC procedures. Details concerning these ALS QA/QC procedures and results, together with chain-of-custody documents, are available for public review at the offices of the Thompson Divide Coalition and Roaring Fork Conservancy.