2nd 34

Silver Creek Water Quality Monitoring Protocol

by
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Purpose of Research Projects

In 1998 The Nature Conservancy (TNC) launched an ambitious five year program known as the "Freshwater Initiative" (FWI). The goal of this program is to "dramatically increase freshwater conservation in the United States, Latin America, and the Caribbean." Accordingly, it seeks to substantially improve the organization's ability to conserve freshwater by providing expertise and support for ecoregional planning teams and sharing information about the results of testing new conservations strategies. To accomplish these objectives, FWI identified 31 locations for implantation, of which 10 were selected as important demonstration sites. FWI then subdivided these sites into two broad categories, those being threatened by hydrologic alterations and those facing degraded water quality.

To focus on the most critical freshwater sites TNC developed a nationally standardized aquatic community classification system and encouraged TNC staff to employ a variety of techniques to address these issues. Near the top of the list was the encouragement to "...establish a rigorous monitoring program to measure and evaluate the impact of these efforts." Thus an integral part of FWI's Mission Statement became "we will use scientific data and methods to identify the most critical waters deserving conservation attention." [1]

In response to this challenge, The Nature Conservancy of Idaho nominated the Silver Creek Preserve as a demonstration site by promising to "...set up a monitoring program" to be implemented by October of 1999."[2] In addition, the Idaho TNC pledged:

> to maintain and enhance Silver Creek's aquatic and riparian systems by preserving water quality and quantity, restoring and preserving natural habitats and rare species, and increasing the extent of protected land. This objective will be accomplished: (1) evaluating potential recharge sites; (2) acquiring or somehow securing recharge water to directly improve Silver Creek's flows; and (3) implementing long-term monitoring of the hydrologic system.

This commitment was echoed in June of 2000 when the Preserve manager stated "A critical missing piece is a coherent, resource-efficient, long term monitoring program."[3]

To achieve the goals pledged, a *Site Conservation Plan* (Plan) was crafted identifying four conservation targets for Silver Creek: (1) the high-desert cold springs

aquatic community; (2) riverine shrublands and marshes; (3) groundwater-fed shrub lands and meadows; and (4) its avian community. With respect to each of these four targets the Plan enumerated specific stresses, their sources, and rankings. In the case of the primary conservation target---the high-desert, cold-springs aquatic community---the Plan lists seven "stressors" posing threatening hydrologic alteration. Two of these threats (lowered water tables, reduced surface water flows) deal primarily with issues of water quantity and have been addressed elsewhere.[4]

A third threat (altered channel structure) is being addressed by a two pronged strategy. One of these prongs has been to train staff in using the inter-agency method known as *Proper Functioning Condition.*[5] This technique was developed and adopted by four major United States agencies and establishes as way to use 17 indicators to evaluate the stream channel of a lentic water body. After attending workshops on this method, Davidson and Brown then classified Silver Creek as "functioning properly but at risk." Agency mentors then did a site visitation and concurred in this diagnosis. Moreover, this baseline classification system allows subsequent assessments of channel viability to determine if channel degradation is taking place. Additionally, it is part of the long range plan to assess this aspect of stream integrity using aerial photography and remote sensing.[6]

Over the remaining stressors two are biotic concerns (increased sedimentation, degraded water quality) and two are abiotic (altered community structure/composition, altered /absent riparian vegetation). The water monitoring protocol to be discussed in subsequent pages is centered upon these four stresses to the primary conservation target.

The Research Question

Monitoring programs can have any number of goals. In some cases they can be to verify compliance, identify sensitive areas, check BMP effectiveness, evaluate models, define problems, perhaps even be part of basic research? With respect to the task at hand, there are two primary objectives: (1) establish a set of uniform water quality baseline measurements and (2) its corollary, the evaluation of trends associated with changes in land use practices in Silver Creek's headwaters. Keywords are "baseline" and "trends." Said differently, to gauge baseline and trend data calls for the specification of the level of

analysis as the **water column** and the unit of analysis as the **primary conservation** target.

Research Hypotheses

The first area of monitoring will investigate degraded water quality as a potential stressor. Probing this issue calls for an emphasis on abiotic measurements.

Research Issue 1 – Degraded water quality.

Numerous factors of water quality are known to touch upon aquatic organisms. Foremost among these are variables affecting spawning and welfare such as nutrients, oxygen, temperature, turbidity, pH, acid buffering capacity, and conductivity. Some of these elements are considered more important for lotic than lentic bodies and the same is true for free stone streams versus spring fed creeks. Based upon the prevailing economic, staffing, and hydrologic conditions at Silver Creek, the following postulations were selected to probe the issue of degraded water.

H_{O1}: there will be no significant increase in Nitrogen (as Nitrate) between measurements taken during the baseline period and subsequent time periods.

H_{O2}: there will be no significant increase in stream temperature between measurements taken during the baseline period and subsequent time periods

H_{O3}: there will be no significant increase in dissolved oxygen between measurements taken during the baseline period and subsequent time periods.

H_{O4}: there will be no significant increase in total phosphorus between measurements taken during the baseline period and subsequent time periods.

H_{O5}: there will be no significant increase in stream pH between measurements taken during the baseline period and subsequent time periods

H_{O6}: there will be no significant increase in stream turbidity between measurements taken during the baseline period and subsequent time periods

H_{O7}: there will be no significant increase in Biochemical Oxygen Demand between measurements taken during the baseline period and subsequent time periods

H_{O8}: there will be no significant increase in conductivity between measurements taken during the baseline period and subsequent time periods

To clarify these terms, "significant increase" will be a statistical p value of less than 0.05 using standard statistical practices (least squares regression, comparison of annual means, cumulative distribution curves, Q-Q root, times series analysis using autocorrelations, and seasonal Kendall test) to either reject, or fail to reject the null theses. Data are to be collected at 1 location (a transect located 200 meters below the confluence of Loving Creek) more frequently (bi-weekly) during the agricultural season (April – October) and monthly during the non-agricultural season. If findings indicate, additional transects (Stalker Creek above the confluence of Grove Creek and Silver Creek above the confluence of Loving Creek) will be added. Given the limitations of fiscal and human resources, no transects are to be established on private property in the tributaries.

Sampling techniques involved a combination of *in situ* measurements (i.e. temperature, dissolved oxygen), bench chemistry (i.e. conductivity, turbidity, pH) and outsourcing to Alchem laboratories (i.e. BOD).[7]

Flow measurements are also to be taken at three locations and porcelain staff gages will be positioned and calibrated using USGS protocols for creating rating curves.

The "baseline year:" will be the 12 month period beginning June 1, 2001 and ending May 31, 2002 and "subsequent time periods" shall be a period of no less than five years.

Research Issue 2 – Increased Sedimentation

Sedimentation of any lake or stream is a constant concern. Natural sedimentation always takes place and can ultimately result in the eutrophocation of water bodies. Enhanced sedimentation, however, can be stimulated by a variety of land use changes affecting stream bank erosion and, in turn, water column organisms. To evaluate the effect of sediment load in Silver Creek two null hypotheses are conjectured:

H_{09}: there will be no significant increase in suspended load sediment between measurements taken during the baseline period and subsequent time periods

H_{10}: there will be no significant increase in bed load sediment between measurements taken during the baseline period and subsequent time periods

To evaluate these null theses, sediment sampling shall be accomplished using a depth integrated sampler (DH-48) with a wading rod at three transects (see above). In addition, a Style A porcelain gage will be placed in "Lake Kilpatrick" to assess sediment

accrual. Lastly, aerial photography can also be used to study the sediment contributions of various farming practices in the tributaries. All methods, terms, and time periods are described above.

Research Issues 3 and 4 – Altered Community Structure/Altered Riparian Vegetation

Issues 3 and 4 are more concerned with living organisms. These biotic categories introduce a level of complexity an order higher than measuring physical characteristics as stream temperature or perhaps pH. Earlier studies tended to focus on specific species and later upon their diversity or abundance. This design, however, accepts as its point of departure, the tenet that multiple metric indices are superior to indicator species or taxon list approaches. But to probe the integrity of biological communities---defined as "...assemblages of species that recur in similar ecological settings...and distinct assemblages of species that recur under similar habitat conditions and ecological processes"---calls for a level of sophistication and resources not easily acquired at Silver Creek. As a result of fiscal and professional constraints, an alternate path has been explored. Moreover, the USGS takes an extensive water chemistry and biological inventory on a tri-annual basis just two stream miles below the Preserve. In discussions with the US Geological Society and Idaho Fish and Game it has been possible to have them make an identical and simultaneous multi-metric study in June of 2001 when they make their own study. By comparing results taken from two transects relatively close together it is hoped we can assess their comparability. Should the results be comparable, then the Preserve can rely on the USGS results in subsequent years. If this strategy proves viable then economies of time, resources, and dollars will be saved to obtain valid results.

We are just now in the process of completing these arrangements and similar null theses will be stipulated for longitudinal study.[8]

Sampling Transects, Parameters, Frequency

There shall be three sampling transects:

- T1 is an AM site located West of the Assistant Manger's house about 200 meters below the confluence of Loving Creek and Silver Creek site;

- T2 is a PM site near the Visitor's Center on Silver Creek at a point above the confluence of Loving Creek and below the confluence of Grove Creek;
- T3 is an AM site on Stalker Creek just north of the Manager's house and the TNC offices above the confluence of Grove Creek but below the confluence of Mud and Chaney Creeks.

Water quality sampling at these locations during the Baseline Year will vary based upon whether or not the measurements are taken time of year (irrigation, shoulder, and winter seasons), time of day (AM/PM), and type of equipment used (i.e. data loggers, hand-held instruments). Data should be recorded on the appropriate ***Field Recording Sheet*** designed specifically for each transect and then immediately transferred to the appropriate ***Data Entry Sheet***. The "seasons" are specified as:

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Mondays for all 3 transects.
2. Shoulder Season (Oct 1 to Dec 1) 1st & 3rd Mondays for Transect 1 only
3. Winter Season (December 1 to February 1) 1st Monday Transect 1
4. Shoulder Season (February March 1 to April 15) 1st & 3rd Mondays Transect 1

Transect 1 and 3 are morning (AM) sites while Transect 2 is an afternoon (PM) site.

MEASUREMENTS FOR BASELINE YEAR – By Season

Temperature - Onset "Stowaway" submersible Data Loggers shall be placed at two locations (Transect 2 and Transect 3) and secured where possible with an anti-theft cable. Response time should be set at two minute intervals. Measurements can be set in both C and F. The Hydrolab from DEQ will be emplaced at Transect 1. In addition, thermometer readings (F) should be taken for both ambient air and water every time stream measurements are made. Be sure to take air temperature readings in the shade prior to water temperature measurements. If, for any reason, water temperatures are recorded prior to air temperatures then the thermometer must be wiped dry and placed in the shade for at least 5 minutes.

Sreamflow (Q) and Staff Gauge Readings – Stream flow and staff gauge measurements are to be recorded for Transects 1 and 3 in morning and for Transect 2 in the late afternoon. The baseline year will collect Q information permitting the creation of a rating curve. It is necessary in creating a rating curve to have measurements across a full range observations and this is why readings must be done through an entire year.

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Mondays for all 3 transects.
2. Shoulder Season (Oct 1 to Dec 1) 1st & 3rd Mondays for Transect 1 only

3. Winter Season (December 1 to February 1) 1st Monday Transect 1
4. Shoulder Season (February March 1 to April 15) 1st & 3rd Mondays Transect 1

Dissolved Oxygen (DO) – Dissolved Oxygen readings are to be taken by the Hydrolab at Transect 1 on a continuous basis. Care must be taken to check probe calibration frequently (perhaps every two weeks). Indications of the Hydrolab losing its calibration can be seen in a pattern of increasing swings between daytime and nighttime DO levels. The YSI hand held DO meter can also be used to verify DO levels. Dissolved Oxygen levels at transects 2 and 3 can be taken with the YSI meter either as bench chemistry or *in situ*. Be aware that DO levels can change from the stream to the bench as a function of time and air exposure so bench chemistry should be performed as quickly as possible to obtain accurate results. I would suggest that a combined program of checking both *in situ* and bench chemistry could be used initially to empirically evaluate differences.

NOTE: While this protocol specifies a regular period for the collection of DO for the purposes of analysis, this stipulation should be meant to foreclose other "as needed" measurements. It may well be during peak summer/low flow episodes, the taking of early AM measurements of DO might be required on an almost daily basis.

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Mondays for all 3 transects.
2. Shoulder Season (Oct 1 to Dec 1) 1st Monday, Transect 1
3. Winter Season (December 1 to February 1) 1st Monday, Transect 1
4. Shoulder Season (February March 1 to April 15) 1st Monday, Transect 1

Depositional Sediment – Depositional sediment sampling involves the emplacement of a Style A staff gauge in the sediment bed near the Assistant manager's house. Readings can then be taken through an underwater viewing box to record the increase in deposition over time. Readings may be taken on a monthly basis.

Suspended Sediments - Suspended sediments sampling can be done with the DH-48 Depth Integrated Sampler using the 0.25" nozzles. The results of sampling are sent to a lab and can be interpreted two ways. Particle Size analysis reports the number of sediments in a percent who are finer (in millimeters) than the size indicated. Concentration of sediments reported as the ratio of the weight of the sediment to the weight of the water sediment and the weight of the water sediment sample. The answer is reported as PPM (mg/L) and defined as the dry weight of the sediment divided by the weight of the water sediment mixture multiplied by one million. Since the selection of sample site, transit times, verticals, calibration to a single vertical, and the creation of conversion coefficients are too complicated to be discussed here and will be explained in the field.

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Monday, all 3 transects.
2. Shoulder Season (Oct 1 to Dec 1) 1st Monday, Transect 1
3. Winter Season (December 1 to February 1) 1st Monday, Transect 1
4. Shoulder Season (February March 1 to April 15) weekly, all three transects

Provisions for bed load sampling are not complete at this time.

Conductivity, pH, and Turbidity - These two measurements are similar and can either be taken *in situ* or measured by grab samples and done as bench chemistry. Chances are the Hydrolab will collect one or perhaps both of these parameters since it should have the new shuttered turbidity capacity. These elements need not be collected as often.

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Monday, Transect 1.
2. Shoulder Season (Oct 1 to Dec 1) 1st Monday, Transect 1
3. Winter Season (December 1 to February 1) 1st Monday, Transect 1
4. Shoulder Season (February March 1 to April 15) 1st and 3rd Mondays all transects

Biochemical Oxygen Demand, Nitrate, Total Phosphorous – These parameters must be sent to the laboratory for analysis.

1. Once a month sampling at Transect 1 for all seasons.

SUMMARY

This "Protocol" is not meant to be definitive and should be interpreted as a tentative first step toward the institution of a long range, systematic, program of water quality monitoring. Surely, some parameters will be substituted along the way as will changes be made to the overall frequency and duration of sampling. The best strategy remains a flexible one suited to time and resources available.

The Appendices contain copies of the various documents designed for the initial stages of this monitoring agenda.

APPENDICES

Field Recording Sheet for Transect 1

Recorded By_____ Date_____Air Temp_____
Water Temp_____ Gauge Height_____
Bench Chemistry:
DO_____ pH_____ Turbid_____ Conductance_____

Sediment Sampled? (yes/no); BOD Sampled? (yes/no)
Nitrate Sample Taken (yes/no); Phosphorous Sampled? (yes no)
Date Samples Mailed to Lab_____

Tag Line	***Distance(ft)***	***Depth (ft)***	***Velocity 60%***	***Averaged Velocity 20/80%***
0	LEW = 2	0.00		
1	5			
2	7			
3	9			
4	11			
5	13			
6	15			
7	17			
8	19			
9	21			
10	23			
11	25			
12	27			
13	29			
14	31			
15	33			
16	35			
17	37			
18	39			
19	41			
20	43			
21	45			
22	47			
23	49			
24	51			
25	53			
26	55			
27	57			
28	59			
29	61			
30	63			
0	REW=65	0.00		

Field Recording Sheet for Transect 2

Recorded By_____ Date_____Air Temp_____
Water Temp_____ Gauge Height_____
Bench Chemistry:
DO_____ pH_____ Turbid_____ Conductance_____

Sediment Sampled? (yes/no); BOD Sampled? (yes/no)
Nitrate Sample Taken (yes/no); Phosphorous Sampled? (yes no)
Date Samples Mailed to Lab_____

Tag Line	***Distance(ft)***	***Depth (ft)***	***Velocity 60%***	***Averaged Velocity 20/80%***
0	LEW=1.25	0.00		
1	5			
2	7			
3	9			
4	11			
5	13			
6	15			
7	17			
8	19			
9	21			
10	23			
11	25			
12	27			
13	29			
14	31			
15	33			
16	35			
17	37			
18	39			
19	41			
20	43			
21	45			
22	47			
23	49			
24	51			
25	53			
26	55			
27	57			
28	59			
29	61			
30	63			
31	65			
0	REW=66.3	0.00		

Field Recording Sheet for Transect 3

Recorded By_____ Date_____Air Temp_____
Water Temp_____ Gauge Height_____
Bench Chemistry:
DO_____ pH_____ Turbid_____ Conductance_____

Sediment Sampled? (yes/no); BOD Sampled? (yes/no)
Nitrate Sample Taken (yes/no); Phosphorous Sampled? (yes no)
Date Samples Mailed to Lab_____

Tag Line	***Distance(ft)***	***Depth (ft)***	***Velocity 60%***	***Averaged Velocity 20/80%***
0	LEW=4.4	0.00		
1	5			
2	7			
3	9			
4	11			
5	13			
6	15			
7	17			
8	19			
9	21			
10	23			
11	25			
12	27			
13	29			
14	31			
15	33			
16	35			
17	37			
18	39			
	REW=41.25			

Data Entry Sheet; Transect 1
Main Stem Silver Creek Below Loving Creek

Recorded by:	Date	DO
Air Temp:	Water Temp:	Turbidity
Sed Sample (yes/no)	pH	Conduct.
Gauge Height:	Nitrate	Total P

	Distance LEW=2.0	Depth (ft)	Velocity (fps)*	Width (ft)	Area (ft/2)	Flow (Q) cfs
1	5	0	0	4	0	0
2	7	0	0	2	0	0
3	9	0	0	2	0	0
4	11	0	0	2	0	0
5	13	0	0	2	0	0
6	14	0	0	2	0	0
7	17	0	0	2	0	0
8	19	0	0	2	0	0
9	21	0	0	2	0	0
10	23	0	0	2	0	0
11	25	0	0	2	0	0
12	27	0	0	2	0	0
13	29	0	0	2	0	0
14	31	0	0	2	0	0
15	33	0	0	2	0	0
16	35	0	0	2	0	0
17	37	0	0	2	0	0
18	39	0	0	2	0	0
19	41	0	0	2	0	0
20	43	0	0	2	0	0
21	45	0	0	2	0	0
22	47	0	0	2	0	0
23	49	0	0	2	0	0
24	51	0	0	2	0	0
25	53	0	0	2	0	0
26	55	0	0	2	0	0
27	57	0	0	2	0	0
28	59	0	0	2	0	0
29	61	0	0	2	0	0
30	63	0	0	3	0	0
	REW=65				**Q =**	0

Note: only a single velocity figure should be entered; average any 20/80 value and enter

Data Entry Sheet; Transect 2
Main Stem at Visitor's Center

Recorded by:	Date	DO
Air Temp:	Water Temp:	Turbidity
Sed Sample (yes/no)	pH	Conduct.
Gauge Height:	Nitrate	Total P

	Distance	Depth (ft)	Velocity (fps)*	Width (ft)	Area (ft/2)	Flow (Q) cfs
	LEW=1.25					
1	5			4.75	0	0
2	7			2	0	0
3	9			2	0	0
4	11			2	0	0
5	13			2	0	0
6	14			2	0	0
7	17			2	0	0
8	19			2	0	0
9	21			2	0	0
10	23			2	0	0
11	25			2	0	0
12	27			2	0	0
13	29			2	0	0
14	31			2	0	0
15	33			2	0	0
16	35			2	0	0
17	37			2	0	0
18	39			2	0	0
19	41			2	0	0
20	43			2	0	0
21	45			2	0	0
22	47			2	0	0
23	49			2	0	0
24	51			2	0	0
25	53			2	0	0
26	55			2	0	0
27	57			2	0	0
28	59			2	0	0
29	61			2	0	0
30	63			2	0	0
31	65			2.3	0	0
	REW=66.3				**Q =**	0

NOTE: enter single velocity; if a 20/80 was taken then enter the average

Data Entry Sheet: Transect 3
Main Stem in Stalker Creek above Grove Creek

Recorded by:	Date	DO
Air Temp:	Water Temp:	Turbidity
Sed Sample (yes/no)	pH	Conduct.
Gauge Height:	Nitrate	Total P

	Distance	Depth (ft)	Velocity (fps)*	Width (ft)	Area (ft/2)	Flow (Q) cfs
	LEW=1.58					
1	5	0	0	4.42	0	0
2	7	0	0	2	0	0
3	9	0	0	2	0	0
4	11	0	0	2	0	0
5	13	0	0	2	0	0
6	15	0	0	2	0	0
7	17	0	0	2	0	0
8	19	0	0	2	0	0
9	21	0	0	2	0	0
10	23	0	0	2	0	0
11	25	0	0	2	0	0
12	27	0	0	2	0	0
13	29	0	0	2	0	0
14	31	0	0	2	0	0
15	33	0	0	2	0	0
16	35	0	0	2	0	0
17	37	0	0	2	0	0
18	39	0	0	2	0	0
19	41	0	0	2.25	0	0
20	REW=41.25					
					Q =	0

Note: Only a single velocity value can be entered; if 20/80 is taken average it and enter

ENDNOTES

3rd of 4

Summary Report on Baseline Data Acquisition

November 22, 2002 Lee Brown, Ph.D.

ABSTRACT

The ***Silver Creek Water Quality Monitoring Protocol*** (April 2001) presented a plan to address the Idaho Nature Conservancy's pledge to implement the "...long-term monitoring of (Silver Creek's) hydrologic system." The primary objectives of this effort were to: (1) establish a dataset of uniform water quality measures; and (2) evaluate trends associated with land use changes in the Silver Creek's headwaters. The protocol stipulated ten null hypotheses to operationalize this study and outlined a programmatic schedule for sampling at three transects. This report summarizes the data collected during the 2001-2002 period.

Silver Creek Water Quality Monitoring Protocol

Substantiation for initiating the Silver Creek water quality monitoring project is provided in the ***Silver Creek Water Quality Monitoring Protocol*** (April 2001) and need not be discussed in great detail here.[1] Originally, Paul Todd wrote the ***Silver Creek Site Conservation Plan*** for the Fresh Water Initiative identifying the Preserve's four conservation targets as well as the 7 key threats posing hydrologic alteration.[2] Four of these stressors involved concerns revolving around altered aquatic community structure, increased sedimentation, degraded water quality and riparian vegetation. To address these issues, the subsequent Preserve manager (Mike Stevens) sought to "...establish a rigorous monitoring program to measure and evaluate the impact of these efforts."

After a period of careful research and discussion of the variables known to affect aquatic organisms, ten null hypotheses were formulated and a plan constructed for gathering data to test these ideas. The terms introduced to operationalize the variables were quantified into standard statistical format.[3]

H_{O1}: there will be no significant increase in Nitrogen (as Nitrate) between measurements taken during the baseline period and subsequent time periods.
H_{O2}: there will be no significant increase in stream temperature between measurements taken during the baseline period and subsequent time periods

H_{O3}: there will be no significant increase in dissolved oxygen between measurements taken during the baseline period and subsequent time periods.
H_{O4}: there will be no significant increase in total phosphorus between measurements taken during the baseline period and subsequent time periods.
H_{O5}: there will be no significant increase in stream pH between measurements taken during the baseline period and subsequent time periods
H_{O6}: there will be no significant increase in stream turbidity between measurements taken during the baseline period and subsequent time periods
H_{O7}: there will be no significant increase in Biochemical Oxygen Demand between measurements taken during the baseline period and subsequent time periods
H_{O8}: there will be no significant increase in conductivity between measurements taken during the baseline period and subsequent time periods
H_{O9}: there will be no significant increase in suspended load sediment between measurements taken during the baseline period and subsequent time periods
H_{10}: there will be no significant increase in bed load sediment between measurements taken during the baseline period and subsequent time periods

Sampling Transects, Parameters, Frequency

Beginning in the summer of 2001 and carrying through the summer of 2002 sampling was inaugurated at three transects:

- T1 is an AM site located West of the Assistant Manger's house about 200 meters below the confluence of Loving Creek and Silver Creek site;
- T2 was to be a PM site near the Visitor's Center on Silver Creek at a point above the confluence of Loving Creek and below the confluence of Grove Creek but ended up being an AM site;
- T3 is an AM site on Stalker Creek just north of the Manager's house and the TNC offices above the confluence of Grove Creek but below the confluence of Mud and Chaney Creeks.

Since sampling results can vary depending upon time of year (irrigation, shoulder, and winter seasons), time of day (AM/PM), and type of equipment (i.e. data loggers, hand-held instruments) it was necessary to build rotational monitoring into the protocol. Seasons were specified as:

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Mondays for all 3 transects.
2. Shoulder Season (Oct 1 to Dec 1) 1st & 3rd Mondays for Transect 1 only
3. Winter Season (December 1 to February 1) 1st Monday Transect 1
4. Shoulder Season (February March 1 to April 15) 1st & 3rd Mondays Transect 1

Data collected were then to be recorded on ***Field Recording Sheets*** designed specifically for each transect and transferred to the appropriate ***Data Entry Sheet.***

Measurements For Baseline Year – By Season

Temperature – Temperature data were collected by "Stowaway" submersible Data Loggers placed at Transects 2 and Transect 3 and secured with anti-theft cables. A borrowed Hydrolab from DEQ was temporarily emplaced at Transect 1 but never functioned correctly. Through a successful grant, Silver Creek was able to obtain its own Minisonde Hydrolab used from mid summer 2002 onward. In addition, thermometer readings were taken for both ambient air and water each time a stream was surveyed for flow.

Streamflow and Staff Gauge – Stream flow and staff gauge measurements were taken for all three transects in order to calibrate a rating curve for staff gauges.

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Mondays for all 3 transects.
2. Shoulder Season (Oct 1 to Dec 1) 1st & 3rd Mondays for Transect 1 only
3. Winter Season (December 1 to February 1) 1st Monday Transect 1
4. Shoulder Season (February March 1 to April 15) 1st & 3rd Mondays Transect 1

Dissolved Oxygen – Dissolved Oxygen (DO) readings were taken by both the Hydrolab and a field meter at all transects during the summer of 2002, data for Transect 1 was also gathered during shoulder and winter seasons.

Depositional Sediment – Depositional sediment sampling was supposed to involve the emplacement of a Style "A" staff gauge in the sediment bed near the Assistant manager's house, but this was delayed until 2003.

Suspended Sediments - Suspended sediment sampling with the DH-48 Depth Integrated Sampler using 0.25" nozzles was completed and results sent to Alchem for both "particle size" and "concentration" of sediments. Sediments were sampled for all three transects during the irrigation season and the second shoulder season when runoff is greatest (February to April 15). Measurements were taken for Transect 1 during winter and early spring shoulder as well. Provisions for bed load sampling were not implemented at this time.

Conductivity, pH, and Turbidity - During the baseline period samples for these three measures where sometimes take *in situ* while at other times they were measured as grab samples for bench chemistry.

1. Irrigation Season (April 15 through Oct 1) 1st and 3rd Monday, Transect 1.
2. Shoulder Season (Oct 1 to Dec 1) 1st Monday, Transect 1
3. Winter Season (December 1 to February 1) 1st Monday, Transect 1
4. Shoulder Season (February March 1 to April 15) 1st and 3rd Mondays all transects

Biochemical Oxygen Demand, Nitrate, Total Phosphorous – Samples for BOD, Nitrate and Total Phosphorous were collected once a month at Transect 1 during all seasons.

Baseline Data

During the "shake down" year most activity went as planned but some difficulties did arise. The Hydrolab installed by the Idaho Department of Environmental Quality at Transect 1 never did work correctly and was ultimately removed. The acquisition of TNC's own Hydrolab helped immensely and is one of the true success stories for this summer although it, too, failed at one point due to a leaky o ring and had to be returned to the factory. At another time the YSI Dissolved Oxygen meter also experienced difficulty. At another point the consultant mistakenly redesignated Transect 2 as an AM site when it was designed to be a PM site.

Perhaps the largest disappointment came with difficulties in trying to calibrate staff gauges due to anomalies in the data, which may---or may not---be associated with measurement error. As of this writing, a systematic review of data recording sheets is underway to assess the validity of certain entries. The overall process of staff gauge calibration of staff gauges is complicated due to the subjectivity of each individual sampler in estimating stream "bottom" under varying conditions. As the summer progressed, vegetation growth and its affect on stream flow began giving varying

Table 1. Baseline Data Summarized (Mean) by Transect

	Gage	Flow	Turb	Dis O	Tem W	Tem A	pH	Cond	NO_3	Total P	Precip	BOD	Seds
T1	1.63	86.9	2.35	8.35	11.6	14.4	8.15	35	0.58	0.038	13.35	4.43	15.6
T2	1.72	74.4	2.61	10.1	12.8	17.76	8.27	34	0.51	0.031	13.35	3.21	6.8
T3	1.96	24.95	3.67	7.89	13.9	17.44	7.92	32.9	0.32	0.020	13.35	3.56	8.4

Q results for similar gauge readings.

Results of data acquisition are summarized in Table 1 and provided completely in the appendices. Interpreting these statistics calls for some explanation. Gauge heights, for example, are taken from Style "C" porcelain staff gauges graduated to hundredths and marked at every foot and tenth. Staff gauge measurements are unique to each transect and comparison between readings is meaningless. Flows are a function of the contributions of each tributary contributing upstream of each transect and thus reflect the increasing pattern as one moves from Transect 3 to Transect 1. Turbidity is in "nephelometric turbidity units" or NTUs and reflects the amount of sulfate in the water while "Dissolved Oxygen" is in milligrams per liter of free oxygen for uptake by plants and animals. Temperatures are in Celsius and it is important to recall that Transects 2 and 3 were not monitored during late fall, winter, and early spring periods. The standard measure of acidity/alkalinity is the negative of the logarithm of the hydronium ion concentration ranging from 0 to 14. Conductivity assesses particulate matter in the water and is given in microsiemens per centimeter; unpolluted surface water typically ranges from 30 μS/cm to 400 μS/cm. Nitrogen measured as nitrate and Total Phosphorous are given as milligrams per liter. Biochemical oxygen demand (BOD) is a measure of the biodegradable organic matter in water and stated as milligrams of 0_2 per liter of water; generally, unpolluted stream water will be less than 1.5 mg/L. Lastly, "Seds" are the suspended sediments found in solution within the stream and reported in mg/L that will later be converted into tons per day.

APPENDICES

Appendix 1 – Dataset Summary Transect 1
Appendix 2 – Dataset Summary Transect 2
Appendix 3 – Dataset Summary Transect 3

DATA SUMMARY - TRANSECT 1 (AM Site Below Loving Creek)

Date	Gage	Flow	Turb	Dis O	Temp W	Temp A	pH	Cond	NO3	Total P	BOD	S. Sed	F Sed	Precip	Date
06/08/2001	1.71	86.23	0.28	1.56	14.9	25.3	8.3	0.34						0.13	06/01/2021
06/19/2001	1.7	86.23	1.33	9.97	12.32	14.85	8.4	0.36	0.58	0.01	3			0.89	July
07/03/2001	1.79	88.10	1.13	8.31	14.8	22.4	8.3	0.34	0.48	0.014	4	13	4	0.9	August
07/17/2001	2.5	78.51	4.3	7.85	13.7	17.92	8.4	0.35	0.54	0.026	3	21		0.46	Sept
07/31/2001	1.98	79.97	2.65	7.56	10.7	15	8	0.35	0.57	0.021	3	18	6	0.79	Oct
08/14/2001	1.69	78.64	2.2	6.25	14.3	15.5	8	0.35	0.49	0.047	3			1.52	Nov
08/28/2001	1.61	63.64	1.65	7.7	13.1	12	7.7	0.35	0.47	0.023	3			3.64	Dec
09/11/2001	1.5	80.17	3.24	8.82	10.9	19	8	0.35	0.58	0.032	3	19	7	1.71	Jan
09/25/2001	1.56	82.25	1.24	6.31	11.2	11.5		0.36	0.57	0.018	3	6	1	0.81	Feb
10/15/2001	1.6	76.99	1.6	12.2	8.2	10	8.2	0.35						0.91	Mar
11/05/2001	1.3	76.99	2.5	10.76	6.3	15		0.36	0.94	0.059	8	60	1	1.11	April
03/04/2002	1.1	82.98	3.96	10.79	6.4	-2.2		0.36	0.77	0.037	13	10	6	0.58	May
04/04/2002	1.13	124.07	2.85	11.45	12.7	17		0.37	0.6	0.04	5	4	3		
04/15/2002	1.5	106.90	2.5	8.61	8	2		0.33	0.6	0.022	5	3	1		
05/15/2002	1.45	89.65	3.1	13.8	14	21			0.45	0.017	3	10	9		
06/18/2002	1.92	108.34	3	1.62	13.4	15	8.21	0.35	0.45	0.16	3	8			
07/01/2002	2.23	134.68	2.1			21									
07/16/2002	2.11	99.06	2.5	7.8	15	20			0.5	0.01	4	2.5			
07/30/2002	1.91	93.56		12.84	14.6	31	8.51	0.33	0.43	0.02	4	1			
08/13/2002	1.72	80.45	4.26	5.09	13.89	22	7.9	0.38	0.45	0.019	3	5			
08/27/2002	1.69	69.94	3.2	9.81	12.19	17	8.01	0.34	0.48	0.013	3	2			
09/01/2002	1.67	87.09	3.6	8.71	9.61	13	8.1	0.35	0.43	0.02		4			
09/23/2002	1.73	82.20	1.7	16.3	12.1	2	8.35	0.33	0.43	0.02		4			

DATA SUMMARY - TRANSECT 2 (PM Site Below Visitors' Center)

Date	Gage	Flow	Turb	Dis O	Temp W	Temp A	pH	Cond	NO3	Total P	BOD	S Sed	F Sed	Precip	Date
06/07/2001	1.59	104.4	0.6	10.6	18.4	29.0	8.4	0.31						0.13	06/01/2021
06/18/2001	1.64	94.2	0.8	10.1	11.9	17.2	8.4	0.31	0.54	0.009	3			0.89	July
07/02/2001	1.75	86.7	1.3	11.0	15.2	29.0	8.4	0.33	0.57	0.041	3	1		0.9	August
07/16/2001	1.88	80.2	3.2	9.4	13.0	20.5		0.34	0.57	0.021	3			0.46	Sept
07/30/2001	1.80	70.5	1.7	9.0	13.9	18.8	8.0	0.32	0.56	0.021	3	7	5	0.79	Oct
08/15/2001	1.75	59.1	1.7	8.4	14.1		8.2	0.32	0.56	0.031	3			1.52	Nov
08/27/2001	1.73	52.2	1.8	9.1	12.9	20.0	7.9	0.34	0.49	0.014	3			3.64	Dec
09/10/2001	1.75	62.8	2.4	9.2	9.4	10.0	8.2	0.36	0.58	0.024	3			1.71	Jan
09/14/2001	1.77	71.4												0.81	Feb
09/24/2001	1.75	72.5	1.2	7.8	10.4	14.0		0.33	0.55	0.016	3	1	1	0.91	Mar
04/16/2002	1.31	63.1	6.3	9.8	6.1	6.0		0.37	0.58	0.022	3	11	1	1.11	April
05/15/2002	1.47	82.1	1.4	10.0	9.4	12.0			0.48	0.017	3	3	2	0.58	May
05/28/2002	1.73	52.7	3.0	10.3	12.4	20.0			0.46	0.042	5	20		Total =	13.45"
06/17/2002	1.92	88.2	3.5	11.5	14.3	22.0	8.4	0.35	0.29	0.007	5	6			
07/02/2002	1.92	88.2	3.5	11.5	14.3	18.0		0.35	0.49	0.019	3	13	7		
07/15/2002	1.83	87.8	5.2	8.4	16.7	22.0		0.35	0.4	0.01	3		1		
07/29/2002	1.75	77.3	2.8	10.3	14.9	17.0	8.4	0.31	0.52	0.013	4				
08/12/2002	1.71	73.2	3.3	9.5	12.1	16.0	8.2	0.35	0.51	0.006	2				
08/26/2002	1.72	64.2	3.4	10.7	12.0	16.0	8.3	0.35	0.5	0.014	2				
09/09/2002	1.72	64.5	3.4	12.1	13.3	17.0	8.4	0.32	0.52	0.013	4	4			
09/23/2002	1.70	67.6	1.7	13.1	10.7	13.0	8.2	0.32	0.5	0.14	3	2			

ENDNOTES

[1] Lee Brown, ***Silver Creek Water Quality Monitoring Protocol*** (April 27, 2001).

[2] Paul Todd, March 15, 1999

[3] To clarify these terms, "significant increase" will be a statistical *p* value of less than 0.05 using standard statistical practices (least squares regression, comparison of annual means, cumulative distribution curves, Q-Q root, times series analysis using autocorrelations, and seasonal Kendall test) to either reject, or fail to reject the null theses. Data are to be collected at 1 location (a transect located 200 meters below the confluence of Loving Creek) more frequently (bi-weekly) during the agricultural season (April – October) and monthly during the non-agricultural season. If findings indicate, additional transects (Stalker Creek above the confluence of Grove Creek and Silver Creek above the confluence of Loving Creek) will be added. Given the limitations of fiscal and human resources, no transects are to be established on private property in the tributaries.

Sampling techniques involved a combination of *in situ* measurements (i.e. temperature, dissolved oxygen), bench chemistry (i.e. conductivity, turbidity, pH) and outsourcing to Alchem laboratories (i.e. BOD).[3]

Flow measurements are also to be taken at three locations and porcelain staff gages will be positioned and calibrated using USGS protocols for creating rating curves.

The "baseline year:" will be the 12 month period beginning June 1, 2001 and ending May 31, 2002 and "subsequent time periods" shall be a period of no less than five years.