July 2009
Surface Water Quality Assessment Caldera Section of the Henry's Fork of the Snake River

Upper Henry's Fork Sub basin
Hydrologic Unit – 17040202
Freemont County, Idaho

A Marine Ventures Foundation Technical Report

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Introduction

While reestablishing historic trout populations on the Henry's Fork is a primary objective of the Caldera Project and our work, indirectly, over the past year, the Marine Ventures Foundation understands that the entire ecosystem, not just trout, must be researched, evaluated and understood in order to achieve this goal. Focusing research effort on fish is a logical approach and a necessary component of understanding trout population dynamics, but without information concerning their habitat, the physical processes which affect it and the organisms they share it with, these data will not effectively address the problems at hand. Additional research focused upon key components of the river's ecosystem, such as macrophytes (rooted aquatic plants), waterfowl, Island Park reservoir management and water quality, is critical if we are to understand and effectively manage trout populations as part of the entire ecosystem. [Marine Ventures Foundation, 2009]

As stated above, one of the many facets of Marine Ventures interest in the Caldera Project, as it relates to the entire river system, is water quality. While numerous reports have been published over the years in the area, there has been no consistent water quality assessments conducted on the Henry's Fork from Island Park Dam south through Harriman State Park to where it exits the caldera. There, where based on geology, topography, population density, agricultural interests, runoff and other common issues associated with a year round working population, one would expect significant water quality changes within the river system.

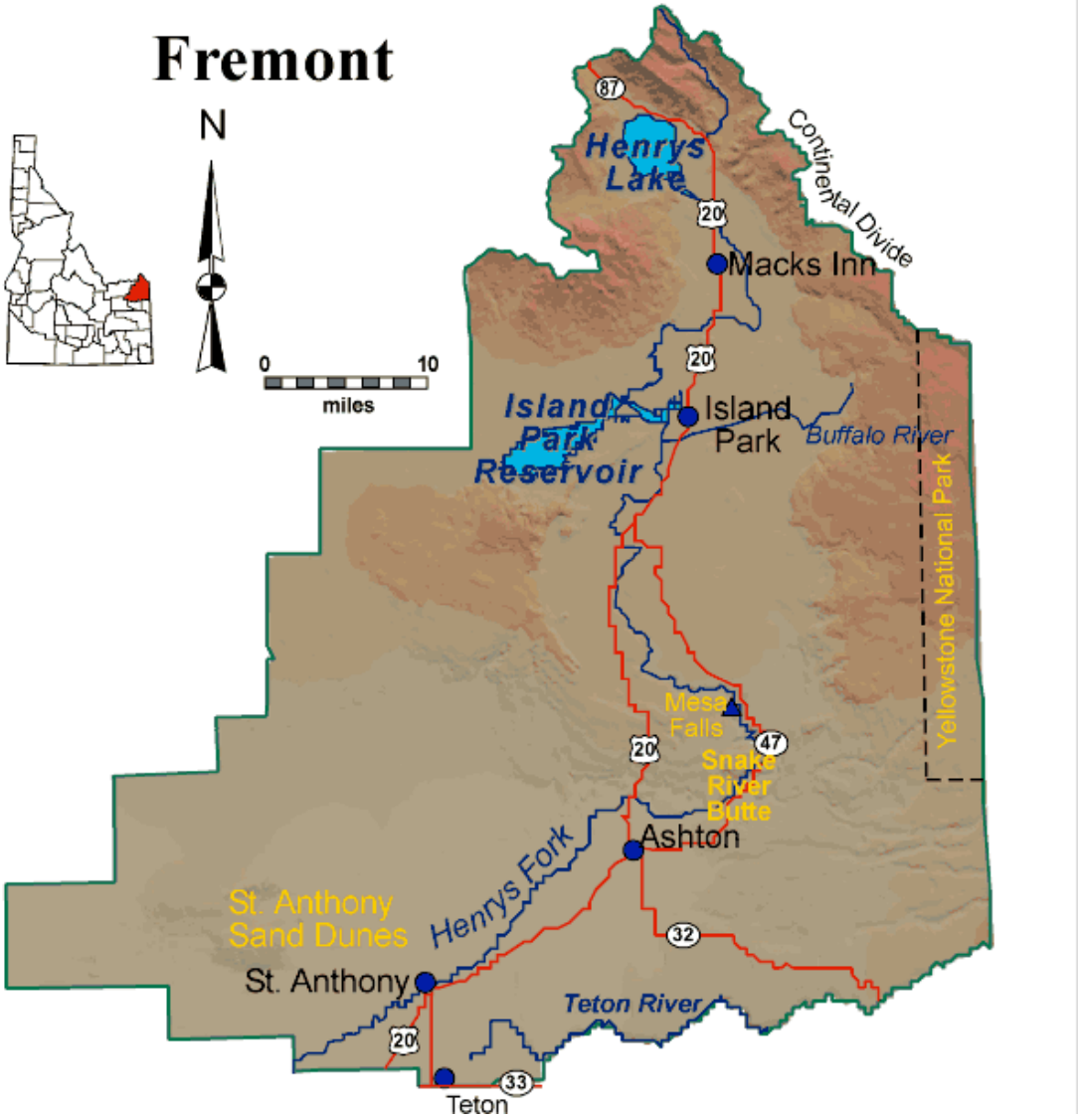
It was not Marine Ventures Foundation intent to conduct a comprehensive, long term surface water sampling project or duplicate previous assessments, but rather to establish a baseline of conditions for the Henry's Fork ecosystem and lay the foundation for continuation of the assessment by the appropriate state agency or other community stakeholders or interested parties.

Purpose

The purpose of this report is to present the results of a baseline surface water quality sampling event conducted in July 2009 on a section of the Henry's Fork of the Snake River located in Freemont County, Idaho by the Marine Ventures Foundation. The sampling sites were primarily located in or adjacent to the Harriman State Park in Island Park, Idaho. The surface water sampling was conducted during Marine Ventures Foundation baseline assessment work on portions of the Henry's Fork which also included high definition balloon aerial photography, low definition aerial flyovers, macrophyte studies and general observations.

Background Information

"The Upper Henry's Fork sub basin, located in northeastern Idaho, is the origin of the Henry's Fork of the Snake River. The sub basin encompasses 1,068 square miles, including 30 square miles in Wyoming and 60 square miles in Yellowstone National Park (USEPA 1998; Whitehead 1978). The northern extent of the sub basin is bounded by the continental divide, which also delineates the boundary



between Idaho and Montana.

The natural sub basin boundary, which is marked topographically by the Yellowstone Plateau, meanders east and west of the Idaho-Wyoming state line. The western and southern extent of the sub basin does not coincide with any

political boundaries but is instead marked by the northeastern extent of the Snake River Plain geologic formation.

The sub basin is located within the Greater Yellowstone Ecosystem and possesses many of the unique geological, scenic, recreational, and wildlife attributes for which Yellowstone National Park is valued. The majority of the sub basin is managed by the U.S. Forest Service (USFS), and the economy of the region has historically been based on livestock grazing and timber production, with cultivated agriculture limited to the most southern edge of the sub basin. Irrigated agricultural lands outside of the sub basin are supplied with water stored in two sub basin reservoirs: Henry's Lake and Island Park. A large and growing population of rural summer residents are concentrated in the Henry's Lake and Island Park regions, but most permanent residents live at the southern-most end of the sub basin at Ashton.

The quality of surface waters within the sub basin is generally good, with almost half of the water derived from springs in nearly pristine condition. The northern portion of the sub basin is geologically rich in phosphorus, and the highly enriched waters of Henry's Lake support a trophy trout fishery. The Henry's Fork fishery has had an international reputation among fly fishers, and anglers drawn to the area are increasingly important to the local economy." [Upper Henry's Fork Sub basin Assessment, 1998, IDEQ]

Caldera Geology

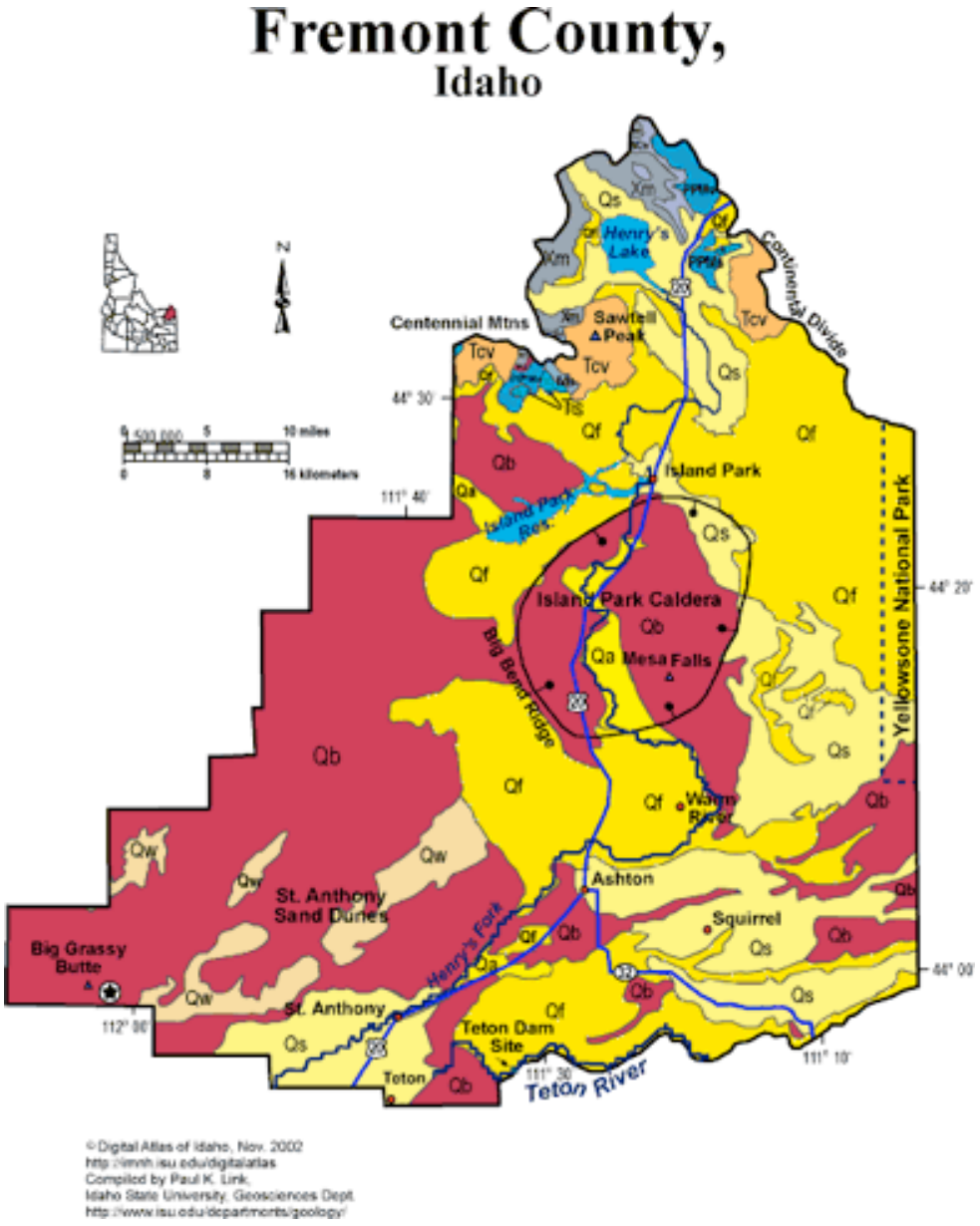
Fremont County occupies the northeast corner of the Snake River Plain and includes the western fringe of Yellowstone National Park. It is mainly underlain by volcanic rocks associated with the Snake River Plain and Yellowstone hot spot system. Quaternary sediments overlie these volcanic rocks and allow irrigated farming.

The Island Park area forms the central part of Fremont County, and consists of the subsided Island Park Caldera, which erupted about 1.2 million years ago to form the Mesa Falls tuff, and then subsided since its underpinnings were withdrawn. As one drives north on the Ashton grade, one ascends the wall of the caldera.

The Centennial Mountains, on the north edge of Fremont County, on the border with Montana, form the Continental Divide. These mountains contain Paleoproterozoic gneiss basement, overlain by Cambrian through Triassic sedimentary rocks. These Paleozoic rocks are similar to those of the Teton Mountains, and much thinner than those of the Beaverhead Range to the west.

The caldera is underlain by two primary rock formations denoted as Qf and Qb on the geologic map of Freemont County. Qf, the primary rock formation encountered along the river when fishing or walking the Harriman Ranch section

of the river, is Pleistocene age (0.01 to 1.8 million years ago) and is comprised of silicic volcanic rocks of the Yellowstone Group. Qb, which almost surrounds these silicic volcanic rocks inside the caldera, is a Pleistocene age basaltic lava and is also quite prevalent to the southwest of the caldera. [Digital Atlas of Idaho, Nov. 2002]



Caldera Hydrology

Unlike rivers whose primary source of water is mountain streams, the main source of the Henry's Fork is a series of year round springs where large amounts of groundwater come to the surface. While snowmelt-fed rivers are known for high flows in the spring season, the spring-fed Henry's Fork maintained a

relatively constant flow year-round. The construction of the Island Park Dam in 1938 changed the flow pattern of the river. Due to the storage of irrigation water, the Henry's Fork frequently has less water in it during the winter months when water is being stored and higher peak flows in the summer when water is being released for agricultural use downstream. Although no active geysers are found in the area, warm water from geothermal forces keep many spring-fed streams open year round. [Henry's Fork River Access, Henry's Fork Foundation, 1998]

Sampling

Unlike the Keller and Associates, *Freemont County, Idaho, 2008 Water Sampling Report*, the Marine Ventures Foundation study concentrated on the waters below the Island Park Reservoir Dam. The sampling locations selected for this assessment were a compilation of locations sampled by Goodman, *1994 Assessment of Water Quality on the Henrys Fork of the Snake River*, suggestions from the Henry's Fork Foundation, Marine Ventures professional opinion and cost. Locations were chosen based on that input and year round sampling accessibility. Three sites on the main river were selected along with three feeder streams to the Henry's Fork within the Caldera. The sampling sites and locations were:

Sample Site	Latitude	Longitude
Island Park Dam	N 44° 24' 58.7"	W 111° 23' 43.1"
Blue Springs Creek	N 44° 22' 6.7"	W 111° 24' 3.0"
Last Chance	N 44° 21' 38.3"	W 111° 24' 23.8"
Thurmon Creek	N 44° 19' 38.6"	W 111° 27' 50.0"
Osborne Cattle Bridge	N 44° 19' 18.7"	W 111° 26' 56.9"
Fish Creek.	N 44° 18' 24.5"	W 111° 26' 00.0"

The surface water quality sampling parameters were based on input from the Goodman report, personal experience and the laboratory methods. Surface water quality samples from the six sampling locations selected were sent to Magic Valley Labs in Twin Falls, Idaho. Surface water quality samples were analyzed for:

Constituent	Method
Total Phosphorous	EPA Method 365.1
Nitrate	EPA Method 300.0
Nitrite	EPA Method 300.0
Total Inorganic Nitrogen	Calculation
Ammonia	EPA Method 350.1
Hardness	EPA Method 130.2
Turbidity	EPA Method 180.1
Total Kjeldahl Nitrogen	EPA Method PA1-DK03
Total Coliform	Standard Method 9223-B

In addition to the surface water samples analyzed by the lab, Marine Ventures also collected field data for dissolved oxygen, pH, salinity, total dissolved solids, conductivity, water temperature, air temperature, elevation and latitude and longitude. Stream flow velocity parameters were also collected where applicable in the main river section. Flows were too low in the feeder creeks for accurate flow measurements.

The primary field data was collected using Extech Instruments ExStik DO600 Dissolved Oxygen Meter and a ExStik EC500 pH/Conductivity/TDS/Salinity/ Temperature Meter. A Garmin Colorado 400T handheld GPS was used to obtain the elevation, latitude and longitude of the sampling locations. A Kestrel 3000 Pocket Weather Meter was used to record ambient air temperature and a Brunton ADC (Atmospheric Data Center) was used to record stream velocity.

Samples were collected as close to mid-stream and mid-depth as practical with the exception of the sample from Island Park Dam. Deep and fast flowing water prevented sampling in mid stream. The surface water samples collected from the three feeder creeks, Blue Springs, Thurmon and Fish Creeks, were collected at standard sampling locations used by the Henry's Fork Foundation staff. Each of these locations is approximately 100 meters upstream from each creeks confluence with the main river and is marked by a set of steel fence posts.

The following data was collected during the Marine Ventures Foundation surface water assessment of the Henry's Fork of the Snake River:

Table 1

Surface Water Field Data Information
Henry's Fork of the Snake River
Caldera Project

	Is Park Dam	Blue Springs Creek	Last Chance Creek	Thurmon	Osborne Bridge	Fish Creek
Date	7/23/2009	7/23/2009	7/23/2009	7/23/2009	7/23/2009	7/23/2009
Time	1215	1142	1243	1320	1345	1415
DO%	58.4	86.4	82.4	110	108.2	118
DO mg/l	4.56	6.37	5.92	8.88	7.3	10.2
pH	7.95	7.92	8.55	9.51	8.92	8.8
Salinity ppm	83.1	84	58.1	56.3	65.1	39.3
TDS mg/l	117.3	117.1	85.4	81.8	91.6	56.8
Cond us/cm	172	171.7	123.1	118.1	132.5	81.9
H2O Temp C	19.4	17.1	19.2	24.5	22.1	24.5
Air Temp C	31.1	29.5	29.7	31.1	30.8	31.4
Elevation	7743	7670	7671	7647	7645	6654
Flow ft/sec	2.5NA		2.4NA		4.3NA	
Date	7/26/2009	7/26/2009	7/26/2009	7/26/2009	7/26/2009	7/26/2009
Time	1222	1250	1315	1338	1417	1440
DO%	62.1	114	100	101.5	140	123
DO mg/l	5.8	11.2	9.08	8.66	12.59	10.3
pH	7.65	7.89	8.4	9.5	8.99	8.9
Salinity ppm	67.6	66	64	62.6	70.1	42
TDS ppm	97.5	94.5	84	87.9	91.6	58.5
Cond us/cm	140.1	142	118	126.3	141.3	84.6
H2O Temp C	18	16.9	18.4	23.7	21.2	23.8
Air Temp C	24.4	29.1	23.0NA		25.7	27.4
Elevation	7743	7670	7671	7647	7645	6654

The following data was collected with a 2nd but identical meter

Date	7/26/2009	7/26/2009	7/26/2009	7/26/2009	7/26/2009	7/26/2009
Time	1222	1250	1315	1338	1417	1440
DO%	67	122	110	112	154	133
DO mg/l	6.34	11.4	10.4	9.55	13.7	10.95
pH	7.52	7.9	8.5	9.5	9.1	8.6
Salinity ppm	70.8	71.6	64.1	61.4	70.5	44.5
TDS ppm	101	102.2	91.2	87.2	101.7	63.7
Cond us/cm	146.7	147.9	130	125.4	144.5	92
H2O Temp C	18.3	16.9	18.7	24.2	20.9	24.1
Air Temp C	24.4	29.1	23.0NA		25.7	27.4
Elevation	7743	7670	7671	7647	7645	6654

Below is a summary of the laboratory analyses. Please refer to the appendices for the complete laboratory certificates of analysis and chain of custody.

Table 2

Surface Water Laboratory Analyses
Henry's Fork of the Snake River
Caldera Project

	Is Park Dam	Blue Springs Creek	Last Chance	Thurmon Creek	Osborn Bridge	Fish Creek
Date	7/23/2009	7/23/2009	7/23/2009	7/23/2009	7/23/2009	7/23/2009
Time	1215	1142	1243	1320	1345	1415
Tot Phosphorus	0.06	<0.05	<0.05	0.14	0.06	0.07
Nitrate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Nitrite	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tot Inorg Nitrogen	<0.30	<0.30	0.19	0.14	0.1	0.09
Ammonia	<0.05	<0.05	0.19	0.14	0.1	0.09
Hardness	67	59.1	55.2	51.2	55.2	39.4
Turbidity	<1	<1	<1	<1	<1	1
TKN	0.16	0.12	0.25	0.89	0.22	0.42
Total Coliform	1120	816	1120	1203	613	272

Note: All results expressed in mg/l (ppm) except coliform. Coliform expressed in MPN/ 100ml

Conclusions

Based on a comparison of surface water sample results from the three sites on the main river from the 1994 Goodman assessment and the 2009 Marine Ventures Foundation assessment, it appears that surface water quality fluctuation issues exist in some areas. Dissolved oxygen, phosphorus, ammonia and hardness had the most noticeable variations. Dissolved oxygen levels were lower, while phosphorus, ammonia and hardness tended to be higher in the Marine Ventures assessment.

Total Coliform is a commonly-used bacteria indicator of sanitary quality of foods and water. They are abundant in the feces of warm-blooded animals, but can also be found in the aquatic environment, within the soil and on vegetation, and their presence is used to indicate other pathogenic organisms of fecal origin may be present.

Surface water quality is subject to frequent, dramatic changes in bacterial quality as a result of a variety of activities. Discharges of sewage or raw water, treated effluents from processing facilities, storm water runoff, or other non-point source runoff all affect surface waters. The Idaho Water Quality Standard (section 250.01.a.i) uses two classifications for recreational waters for limits on fecal coliform. Primary contact when persons are likely to be fully immersed in water and secondary is used for less than full immersion (e.g., wading in streams).

Primary Contact Recreational Water
• Fecal coliforms not to exceed 500/100 mL at any time.
• Fecal coliforms not to exceed 200/100 mL in more than 10 percent of total samples over 30 days.
Secondary Contact Recreational Water
• Fecal coliforms not to exceed 800/100 mL at any time.
• Fecal coliforms not to exceed 400/100 mL in more than 10 percent of total samples over 30 days.

Marine Ventures did not request a separate fecal or e-coli count for coliform. From discussions with the lab, they indicated that the fecal/e-coli count can be no higher than the total count but generally is half or less of the total coliform. Considering the reported values from this assessment, it is reasonably possible that other forms of the coliform bacteria are present within the sampled areas of the Henry's Fork system and that violations of Idaho Water Quality Standards for secondary contact with fecal coliform in recreational waters is possible. Additional coliform sampling is suggested.

The surface water quality sampling results discussed above would appear to be due to increased pressures from manmade appurtenances and recreational use. Some of the controlling factors, such as precipitation, baseflow into the river and water discharge from Island Park Dam are also intertwined with these results and affect significant variables in the water quality equation.

This surface water quality "snapshot" of the Caldera Section of the Henry's Fork shows promise for the river. The abundance of springs generating a significant portion of the river flow, the short river reach and fairly limited development, considering the area, appear to contribute to the water quality. However, a consistent surface water quality sampling regimen conducted by the appropriate state agency or other concerned stakeholders, combined with what appears to be long term sampling programs going on above the Island Park Dam by Freemont County, will give the river stakeholders a better picture of the general river health, will provide information relative to understanding water quality fluctuations over time and seasons as well possibly locating contaminant point source issues that need to be addressed and or remediated such as leaking septic tanks and sedimentation from both development and agricultural activities.

Recommendations

Purchase a water quality test kit. Set up a standard field data sampling regimen and perform weekly or bi-weekly field testing during the spring, summer and fall as practical. Tabulate and graph this data to help in understanding water quality trends within the river system. The test kit used during this assessment costs less than $500.00 and should provide years of service without having to buy costly titration standards or chemical packets needed for sampling using the spectrophotometer method. In addition, all sampling and data is completed in the field as opposed to carrying various sample containers for later analysis. There is also no need to clean bottles for multiple uses over time which limits the possibility of cross contamination between sampling sites and events.

Perform standard surface water quality measurements through a state certified laboratory on a regular basis (quarterly or semi-annually). Additional research should be done on laboratory methodologies to ensure the quantified results are useful and meet expectations. The analytical cost for this round of sampling was $642.00. Tabulate and graph this data.

Discussions with the laboratory should involve the method detection limits or MDLs. The detection limits should be low enough for the specific water quality measurements collected on the Henry's Fork to report useful values.

Collect water samples for field measurements using a one quart or one liter type open top container. This will help the meter stabilize quicker and the larger volume of water will allow the readings to be accurately recorded before conditions are affected by ambient air conditions. Due to obvious variances in the river flow regime, meter stabilization was slow to non-existent.

A different method of stream flow calculation should be used. While the Brunton ADC meter used to measure stream flow was advertised to be "waterproof" and capable of this measurement task, it was not.

Have the laboratory do a separate count for fecal, e-coli and non-fecal coliform bacteria. There are also some newer testing methodologies becoming available to help distinguish between man made and natural bacteria's that may prove useful. However, cost may be the determining factor for their use.

Use data published by others, such as the Keller Associates report (hopefully Freemont County will continue with some type of regular sampling program), to follow trends upriver that will affect the caldera and ranch sections of the river.

If these and other issues are addressed, the Henry's Fork of the Snake River may once again become one of Americas great trout rivers. Marine Ventures

Foundation understands that people want to do the right thing generally, but often don't know what the right thing is until they are informed about the impact that it has on the pursuit that they enjoy so much.

If you have any questions regarding this information or require any additional information please contact me at blueridgej@aol.com or call 704 482-2111.

Respectfully submitted:
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Henry's Fork sample report 92009rev6.doc