



Seepage Investigation of Annie Creek, September 17 and 18, 2008, and Water Rights Assessment

Crater Lake National Park, Oregon

Natural Resource Technical Report NPS/NRSS/WRD/NRTR—2012/572



ON THE COVER

Annie Creek, upstream of its confluence with the East Fork,
Crater Lake National Park
Photograph by: James Harte, NPS

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Contents

	Page
Figures.....	v
Tables.....	v
Executive Summary	vii
Acknowledgments.....	ix
Introduction.....	1
The Futile Call Argument	4
Previous Investigations	4
Pre-1902 Annie Creek Water Rights	5
Study Area Description.....	9
Cross Section Descriptions	9
Methods.....	11
Uncertainties in Discharge Measurements	13
Results and Discussion	15
Conclusions.....	17
Recommendations.....	19
Literature Cited	21
Appendix A.....	23
Appendix B	45

Figures

	Page
Figure 1. Summary of discharge measurements for September 17 and 18, 2008, Annie Creek Seepage Investigation, Crater Lake National Park, Oregon.....	3
Figure 2. Summary of OWRD water rights information for Annie Creek, Oregon. Water rights are grouped by Point of Diversion with Priority Dates and associated diversion rates (cfs). The CRLA boundary is shown as a dashed line in the upper left corner of the map.	6
Figure 3. Pre-1902 Annie Creek water rights (cfs) showing (1) the rate per Priority Date, (2) the cumulative rate for all Priority Dates, (3) the rate reduced by half after July 20 each year, and (4) the Annie Creek flow equalled or exceeded 95% of the time, computed at U.S. Forest Service Gauge Station 61420301, for the period of record October 1, 1992, through September 30, 1999 (modified from Gorman 2010).	7

Tables

	Page
Table 1. Summary of discharge measurements for September 17 and 18, 2008, Annie Creek Seepage Investigation, Crater Lake National Park, Oregon.....	2

Executive Summary

On October 1, 1999, the National Park Service (NPS) submitted claims in the *Klamath Basin General Stream Adjudication* for water rights within Crater Lake National Park (CRLA), including Claim Number 602 for Annie Creek. Annie Spring, located at the head of Annie Creek in CRLA, provides almost all of the water for operations at CRLA. On March 26, 2002, the State of Oregon issued a Proposed Order recommending approval of Claim Number 602, a federal reserved water right, with a priority date of May 22, 1902.

A priority date of May 22, 1902, leaves CRLA 27th on the priority list for Annie Creek water rights and subject to a call when there is not enough water flowing in Annie Creek to satisfy the rights of the 26 senior water right owners. Based on historic Annie Creek streamflow records, the risk of a call is estimated to be three in five years. If a call was placed on CRLA, it could require a partial or complete closure of the park.

Since 2002 CRLA has implemented two programs and explored other options in an effort to acquire additional water to augment its pending 1902 water right on Annie Creek. To date, the two implemented programs have been unsuccessful, and of the explored options only the futile call argument was determined to warrant further action. The futile call doctrine provides that a senior appropriator may prevent a junior appropriator from diverting water only when doing so will be of some benefit to the senior. The NPS position is that the park's Annie Creek water right of 0.34 cubic feet per second (cfs) is such a small percentage of the water flowing in Annie Creek at the park boundary (60 cfs at the time of this seepage investigation) that a difference in discharge cannot be measured in Annie Creek whether the park is diverting its full entitlement or not.

In support of a futile call argument, a seepage investigation of Annie Creek in CRLA was conducted on September 17 and 18, 2008, to quantify base flow and determine if a difference in discharge could be measured at the park boundary when the park is diverting at full capacity (0.33 cfs) and not diverting at Annie Spring.

The results of the seepage investigation indicate, for the period September 17 and 18, 2008, at the cross section *Annie Creek above the Park Boundary*, the measured discharge was about 60 cfs when the Annie Spring pumps were turned off and about 61 cfs when the pumps were running at full capacity. The apparent increase in discharge in Annie Creek (rather than the expected decrease) when the Annie Spring diversion pumps were running at full capacity demonstrates the difficulty in measuring small changes in discharge in natural stream systems and gives credibility to the futile call argument.

The NPS Water Resources Division (WRD) recommends presenting the results described in this report to the Oregon Water Resources Department (OWRD) and discussing the futile call argument.

Acknowledgments

Thanks to Craig Ackerman, Mac Brock, Brian Coulter, Jim Phelan, Randy Smith, and Lauren Jones of Crater Lake National Park who coordinated Annie Spring diversion pump/park water system logistics and provided housing, field support, and climate data. Thanks to Peter A. Fahmy, U.S. Department of the Interior, Office of the Solicitor, and Eric Lord, NPS Water Resources Division, Water Rights Branch, for their comments to the Draft Report. Thanks to Kyle Gorman, Jonathan La Marche, and the late Vern Church of the Oregon Water Resources Department who were responsible for discharge measurements at two cross sections, and a special thanks to Kyle and Jonathan for their comments to the Draft Report. Thanks to Marshall Gannett and Lorri Courts of the USGS Oregon Water Science Center; Walt Lucas of the Winema National Forest; and Cort Pryor of Graham Matthews and Associates, Arcata, California, who provided groundwater and surface water information and surface water discharge records.

Introduction

Crater Lake National Park (CRLA) is located in the headwaters of the Klamath River Basin. Annie Spring is located at the head of Annie Creek in CRLA and is the sole source of water for operations at CRLA, except for Lost Spring which services a small 17-unit campground on Lost Creek.

On October 1, 1999, the National Park Service (NPS), through the Department of Justice (DOJ), submitted claims in the *Klamath Basin General Stream Adjudication* for water rights within CRLA, including Claim Number 602 for Annie Creek. On March 26, 2002, the State of Oregon issued a Proposed Order recommending approval of Claim Number 602, a federal reserved water right, for 0.34 cubic feet per second (cfs), 62.8 acre-feet, of water for domestic and administrative uses plus 1.0 cfs for fire protection, with a priority date of May 22, 1902.

A priority date of May 22, 1902, leaves CRLA 27th on the priority list (a junior) for Annie Creek water rights and subject to a call when there is not enough water flowing in Annie Creek to satisfy the rights of the 26 senior water right owners (OWRD 2009a). In a call, a senior petitions the Oregon Water Resources Department (OWRD) to require a junior cease diverting water, or replace water lost to senior users, until the rights of the seniors are satisfied. Based on historic Annie Creek streamflow records the risk of a call is estimated to be three in five years. If a call was placed on CRLA, it could require a partial or complete closure of the park.

Since 2002 CRLA has implemented two programs in an effort to acquire additional water to augment its pending 1902 water right on Annie Creek:

- 2003/2004—negotiated with Jacox Ranches for the purchase of senior 1883 water rights (WestWater Research 2004), and
- August, 2006—drilled a test hole to 400 feet in the South Yard that did not encounter a sufficient quantity of water to warrant development.

In addition, the park and the NPS Water Resources Division (WRD) have explored other options including

- haul water from an outside source,
- construct a water well on U.S. Forest Service land,
- construct additional water storage in the park (currently 535,000 gallons),
- develop springs in the Rogue River Basin and convey the water via buried pipeline to the Annie Spring diversion,
- construct a water well in the Administration Yard,
- divert water from Crater Lake, and
- present a futile call argument to the OWRD.

For economic, regulatory, or physical reasons only the futile call argument was determined to warrant further action. In support of a futile call argument, a seepage investigation of Annie Creek in CRLA was conducted by staff from CRLA, the OWRD, and the NPS WRD on September 17 and 18, 2008, to determine base discharge and to determine if a difference in discharge could be measured at the park boundary, using industry standard equipment, when the park is not diverting and when the park is diverting at full capacity, 0.33 cfs, at Annie Spring.

The results of the seepage investigation indicate, for the period September 17 and 18, 2008, at the cross section *Annie Creek above the Park Boundary*, the measured discharge was about 60 cfs when the Annie Spring pumps were turned off and about 61 cfs when the pumps were running at full capacity (table 1 and figure 1). This report is a summary of the September 17 and 18, 2008, seepage investigation. In addition to the value of the discharge data presented, the report includes a history of events leading up to the seepage investigation, a summary of pre-1902 Annie Creek water rights, and recommendations for further action. The report may also serve as a field guide for future seepage investigations on Annie Creek, within CRLA.

Table 1. Summary of discharge measurements for September 17 and 18, 2008, Annie Creek Seepage Investigation, Crater Lake National Park, Oregon

Cross section	Measurement by	Equipment used	Discharge (cfs) Sept. 17, 2008 (with 0.00 cfs diversion at Annie Spring)	Discharge (cfs) Sept. 18, 2008 (with 0.33 cfs diversion at Annie Spring)
Annie Spring Weir	Randy Smith, Crater Lake NP	Staff gauge and rating table	1.7 – 2.4	1.4 – 2.0
Annie Creek below Middle Fork	Jim Harte, NPS WRD	Pygmy meter	30	29
Annie Creek below East Fork	Jonathan La Marche, OWRD	SonTek FlowTracker™	47	48
Annie Creek above Park Boundary	Vern Church, OWRD	Pygmy meter	60	61

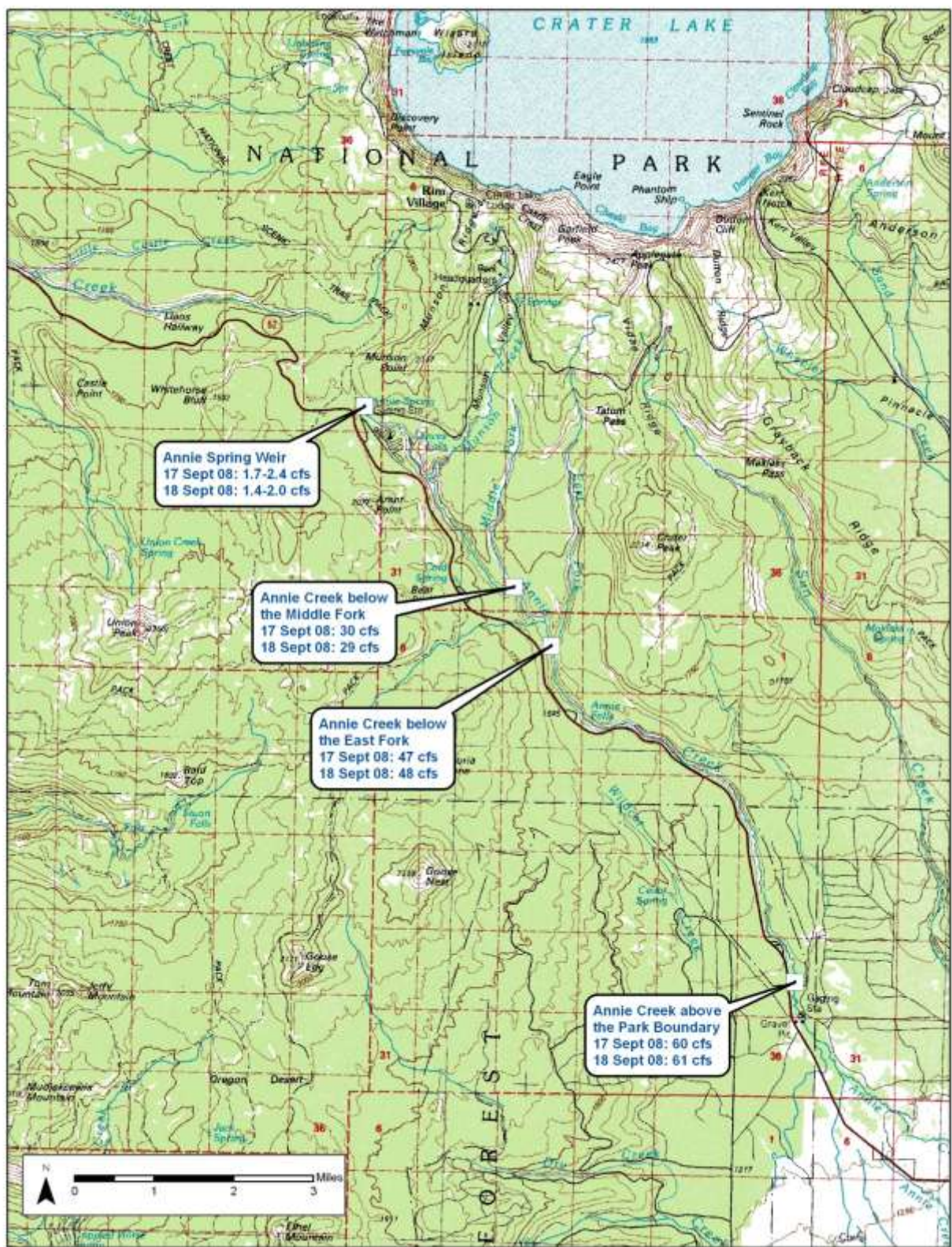


Figure 1. Summary of discharge measurements for September 17 and 18, 2008, Annie Creek Seepage Investigation, Crater Lake National Park, Oregon

The Futile Call Argument

The futile call doctrine provides that a senior appropriator may prevent a junior appropriator from diverting water only when doing so will be of some benefit to the senior. For example, if water is allowed to flow past the junior's point of diversion, but the stream is dry at the senior's point of diversion, shutting off (calling) the junior will not cause the water to reach the senior. Thus, the senior's endeavor of calling the junior is futile (*Michael Fort v. State of Washington, Department of Ecology* 2006).

The State of Oregon Administrative Rules 690-250-0020 (OWRD 2009b) state, in-part,

- (1) “A call for distribution of surface water is futile when a junior appropriator has been denied the use of water and, in the judgment of the watermaster, an inadequate amount of water, or no water, reaches the senior appropriator or minimum flow point or reach or instream water right”; and
- (2) “Upon the judgment that water will not reach its destination, or that an inadequate amount of water will reach its destination, the watermaster may disregard the call of the senior downstream appropriator.”

In the case of CRLA’s Annie Creek water right, the maximum diversion rate of 0.33 cfs at Annie Spring is such a small percentage of the total flow in Annie Creek above the park boundary (measured to be about 60 cfs on September 17, 2008, and 61 cfs on September 18, 2008) that a difference in discharge when the park diverts and when the park does not divert cannot be measured at the park boundary. Since there would be no apparent benefit to the senior in preventing the park from diverting up to its full entitlement the senior's “call” on the park would be futile.

Previous Investigations

Discharge measured at Annie Spring was 1,220 gpm (2.7 cfs) on September 20, 1908, (Hampton 1967) and 1.48 cfs in September 1968 (Frank and Harris 1969).

The U. S. Geological Survey (USGS) maintains a historical record of discharge for USGS Station 11503000, Annie Spring Near Crater Lake, OR, for the period June 1977 through September 2004 (USGS 2009). The gauge, located on Annie Creek about one-tenth-mile downstream of Annie Spring below the highway bridge, was decommissioned by J. G. House on December 14, 2004, due to lack of funding.

The NPS WRD and staff from CRLA measured stage and discharge intermittently on Annie Creek at a cross section “just upstream of the park boundary” between July 1989 and November 1993 (Albright 1994). The U.S. Forest Service, with private consultant Graham Matthews and Associates, operated a continuous surface water gauge on Annie Creek at the same location, measuring stage and computing discharge for Water Years 1993 through 2006 (U.S. Forest Service 2008 and Pryor 2008).

On June 27, 2001, the NPS WRD and U.S. Forest Service, Winema National Forest, measured discharge on Annie Creek downstream of the confluence with the Middle Fork (26 cfs) and downstream of the confluence with the East Fork (46 cfs) (NPS 2001).

Pre-1902 Annie Creek Water Rights

The State of Oregon has issued a Proposed Order recommending approval of Claim Number 602 for CRLA with a priority date of May 22, 1902. The OWRD water rights database includes 26 Annie Creek water right certificates with Points of Diversion (POD) downstream of CRLA and Priority Dates earlier than May 22, 1902. The pre-1902 OWRD Annie Creek water rights information is displayed in figure 2. The 26 certificates are grouped by POD location, and the Priority Dates and associated diversion rates (cfs) are displayed for each group (Groups 1 through 10). Detailed tabular water rights data for each group are displayed in Appendix A.

Inspection of each group and POD (figure 2) shows the park is not vulnerable to a call for regulation of its Annie Creek water right from all ten groups. Groups 1, 2, 3, 6, 7, 8, and 9 could make a call on the park. Groups 4 and 5 could not make a call on the park as their PODs are on Sun Creek, upstream of its confluence with Annie Creek. Group 10 will likely never make a call on the park as the POD is on the Wood River, downstream of its confluence with Annie Creek, and the greater percentage of the discharge in the Wood River originates from springs near the head of the Wood River (Gorman and La Marche 2010).

Water right rates on Annie Creek are reduced by half after July 20 each year. For example, a water right with an associated diversion rate of 3.0 cfs prior to July 20 would be reduced to 1.5 cfs after July 20, through the remainder of the year (figure 3). The 95% exceedance discharge for Annie Creek measured at the U.S. Forest Service Gauge Station 61420301, for the period of record October 1, 1992, through September 30, 1999, is superimposed on the cumulative water right rates shown in figure 3. The 95% exceedance discharge is defined as the discharge in Annie Creek that is equaled or exceeded 95% of the time. In theory, since the 95% exceedance discharge is greater than the cumulative water right rate after July 20, the probability of the park's water right being called out after July 20 is decreased significantly. Therefore, the greatest potential for a call is from the time the park opens in May or June until July 20 each year. On this basis, it is during this period, especially the July 4 holiday, the park needs to consider strategies for conserving and/or augmenting its water supply (Gorman and La Marche 2010).

A comparison of the total water right diversion rates listed in figures 2 and 3 reveals a difference between water right totals listed in the OWRD database and totals listed with the local watermaster's office. Reconciling the differences is beyond the scope of this report. In the event the differences become an issue for CRLA, they will need to be reconciled at that time.

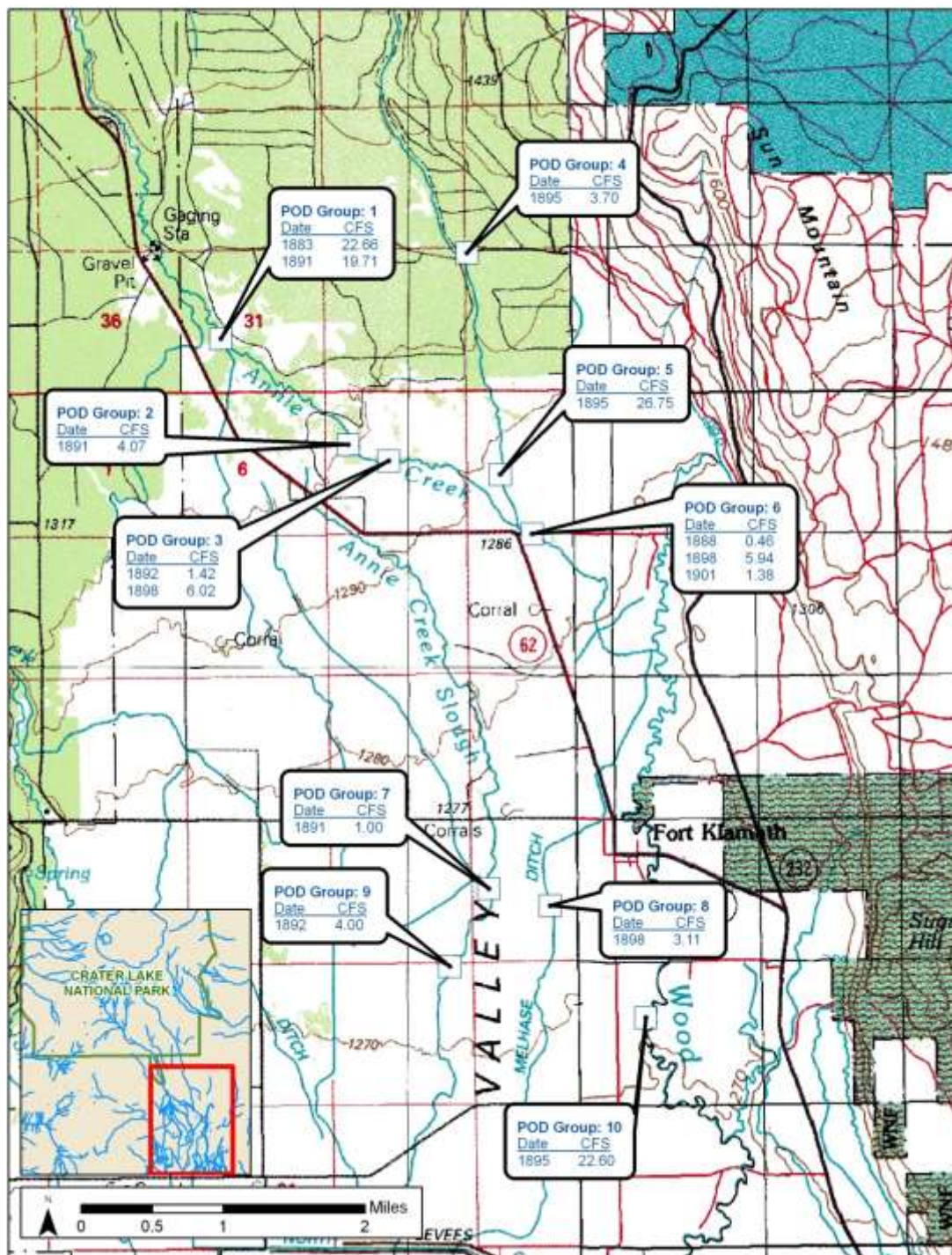


Figure 2. Summary of OWRD water rights information for Annie Creek, Oregon. Water rights are grouped by Point of Diversion with Priority Dates and associated diversion rates (cfs). The CRLA boundary is shown as a dashed line in the upper left corner of the map.

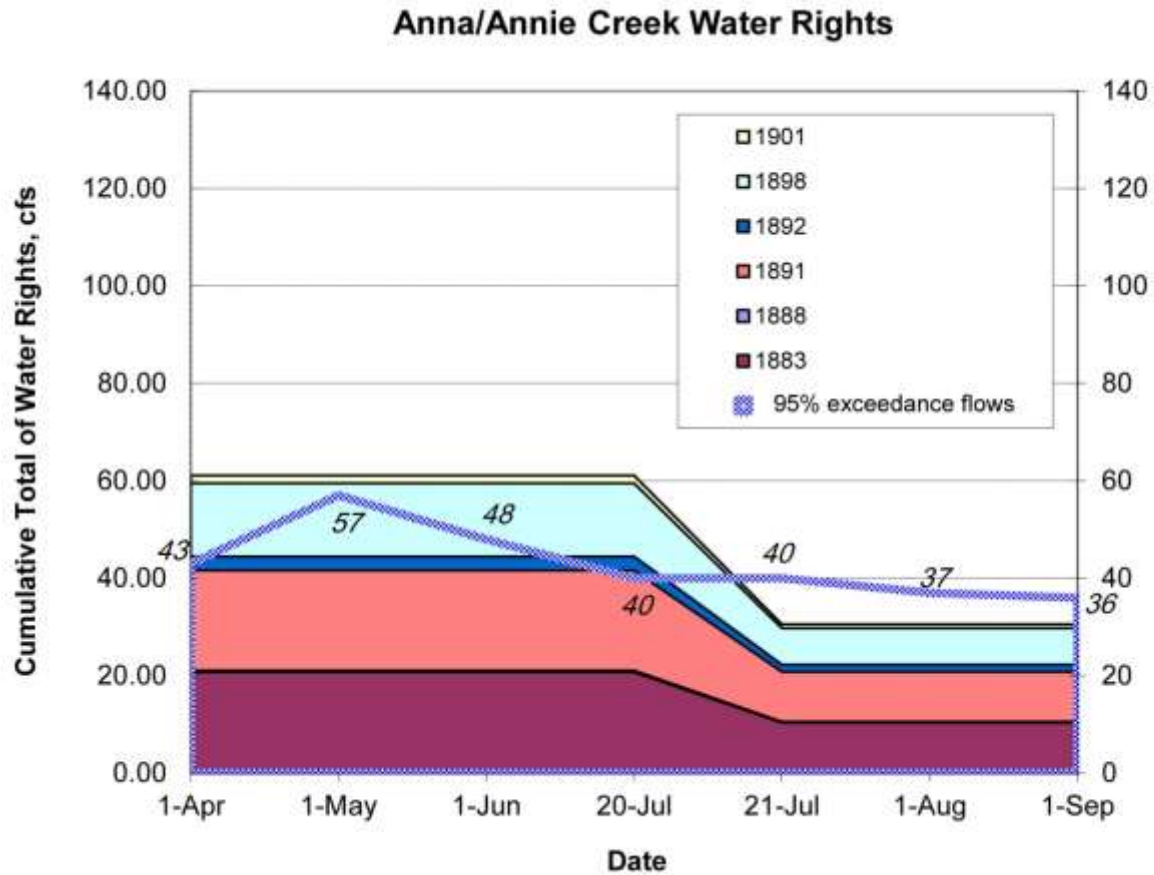


Figure 3. Pre-1902 Annie Creek water rights (cfs) showing (1) the rate per Priority Date, (2) the cumulative rate for all Priority Dates, (3) the rate reduced by half after July 20 each year, and (4) the Annie Creek flow equalled or exceeded 95% of the time, computed at U.S. Forest Service Gauge Station 61420301, for the period of record October 1, 1992, through September 30, 1999 (modified from Gorman 2010).

Study Area Description

Crater Lake National Park is located in the headwaters of the Klamath River Basin. Annie Spring is located at the head of Annie Creek, on the south-facing slope of Mount Mazama, at an elevation of about 6,000 feet amsl. From Annie Spring, Annie Creek flows southeast for approximately 11.5 miles through a steep-walled canyon cut through Mount Mazama ash flow deposits, to the south park boundary, at an elevation of about 4,360 feet amsl. Annie Creek joins the Wood River near Fort Klamath, Oregon.

Average annual precipitation at CRLA from 1919 through 2007 was 65.16 inches. December and January have the highest average monthly precipitation and July and August have the lowest average monthly precipitation. The Annie Creek flow system is a snowmelt-dominated system that receives over 500 inches of average annual snowfall (Western Regional Climate Center 2008).

Large quantities of snowmelt-fed groundwater discharge from the porous soils directly into Annie Creek and its tributaries. Peak discharge at Annie Spring, 1977 through 2004, occurred during June and July, and the least discharge occurred during February and March (USGS 2009). Peak discharge at the park boundary, 1996 through 2006, occurred during May and June, and the least discharge occurred during March, September, October, and November (U.S. Forest Service 2008).

Cross Section Descriptions

Cross section photographs for *Annie Spring Weir*, *Annie Creek below the East Fork*, and *Annie Creek above the Park Boundary* are located in Appendix B. No photographs were taken for *Annie Creek below the Middle Fork*.

Annie Spring Weir, USGS Gauging Station 11503000, Annie Spring Near Crater Lake, OR

Location: latitude 42° 52' 18" N, longitude 122° 10' 04" W, under the Rim Drive bridge approximately one-tenth-mile downstream of Annie Spring.

Datum elevation: 5,982.65 feet mean NGVD 1929.

The *Annie Spring Weir* is a 90° V-notch weir consisting of a steel plate with a "V-notch" cut out of the plate. The bottom elevation of the V-notch is relative to an elevation of 2.0 feet on the staff plate (outside gauge) mounted on the one-foot diameter corrugated metal pipe stilling well located upstream of the weir plate on the left bank. The steel weir plate is mounted in the stream channel perpendicular to the banks and acts as a control.

The USGS maintained the gauge until it was decommissioned on December 14, 2004. Stage and discharge data are available from the USGS for the period October 1977 through September 2004 (USGS 2009). The last documented stage/discharge rating for the gauge is USGS Rating ID 12.1. The USGS rates the accuracy of the records from this station as FAIR to POOR.

On September 16, 17, and 18, 2008, flow estimated to be less than 0.1 cfs was seeping around the weir plate where the weir plate meets the left bank. On a previous visit (June 2001) flow estimated to be greater than 0.5 cfs was bypassing the weir plate at the same location near the left bank. Discharge given in USGS Rating ID 12.1 is greater for a given head than the discharge given in the standard 90° V-notch weir discharge table. USGS Rating ID 12.1 likely adjusts for flaws in gauge construction (see photos in Appendix B) and flow bypassing the weir plate, and may be influenced by the quality of the discharge measurements used to compute the rating. Due to the shallow depth and channel configuration it is difficult to make good discharge measurements upstream of the weir.

Annie Creek below the Middle Fork

Location: latitude 42° 50' 22" N, longitude 122° 07' 44" W

The cross section is located approximately 950 feet downstream of the confluence of Annie Creek and the Middle Fork and is accessed by parking in the south end of the Lodgepole Picnic Area loop and walking due east to a ridge with a steep drop-off to the east and following the descending ridgeline southeast to Annie Creek. The channel bottom is uniform to moderately rough gravel/cobble, and the banks are grasses with dense root systems. Discharge measurements made on September 17 and 18, 2008, are rated GOOD and FAIR respectively.

Annie Creek below the East Fork

Location: latitude 42° 49' 46" N, longitude 122° 07' 15" W

The cross section is located approximately 200 feet downstream of the confluence of Annie Creek and the East Fork and is accessed by parking at the north end of a pullover on the east side of State Highway 62, about one mile south of the Lodgepole Picnic Area loop, and walking due east down a steep hillside directly above the confluence. The channel bottom is uniform, moderately rough, gravel/small cobbles, and the banks are sandy with grasses/forbs. There is considerable downfall across Annie Creek upstream of the cross section, but flow at the cross section was generally unaffected. Discharge measurements made on September 17 and 18, 2008, are rated GOOD.

Annie Creek above the Park Boundary

Location: latitude 42° 46' 11" N, longitude 122° 03' 32" W

The cross section is located at the site of a decommissioned stage gauge operated by the U.S. Forest Service with a private consultant from 1993 through 2006. The cross section is accessed by parking at a small unmarked pull-off just north of the south park boundary sign on the east side of State Highway 62 and walking due east to Annie Creek. The cross section location is marked by the abandoned shelter and plumbing from the decommissioned gauge located on the left bank. The channel bottom is gravel, and the banks are grasses/forbs. Discharge measurements made on September 17 and 18, 2008, are rated GOOD.

Methods

U. S. Geological Survey discharge measurement protocol was used during the seepage investigation. The primary reference used was *Techniques for Water Resources Investigations of the United States Geological Survey*, Book 3, Chapter A8, “Discharge Measurements at Gaging Stations,” by Thomas J. Buchanan and William P. Somers, 1976. Standard NPS Discharge Measurement Notes forms were used to record all data.

There were four participants in the seepage investigation. On September 17 and 18, 2008, at 10:00 am PST, the participants made simultaneous discharge measurements at four cross sections along an 11.5-mile reach of Annie Creek in CRLA. From upstream to downstream the cross sections are (1) *Annie Spring Weir*, (2) *Annie Creek below the Middle Fork*, (3) *Annie Creek below the East Fork*, and (4) *Annie Creek above the Park Boundary* (table 1). Diversion pumps at Annie Spring were shut off on September 12 and 13, 2008, prior to making the September 17, 2008, discharge measurements. On September 17, 2008, at 12:00 pm PST, the Annie Spring diversion pumps were turned on to their maximum pumping rate of 150 gallons per minute (gpm), approximately 0.33 cfs, and discharge measurements were made 22 hours later at 10:00 am on September 18, 2008. The average flow velocity measured at all cross sections, except the *Annie Spring Weir*, on September 17 and 18, 2008, was about 2.3 feet per second. In theory, at a flow velocity of 2.3 feet per second, it would take a particle of water about 7.3 hours to travel the 11.5-mile length of the measured reach from *Annie Spring Weir* to the park boundary. It was expected that 22 hours would be sufficient time for discharge in the 11.5-mile measured reach of Annie Creek to stabilize following the increase in diversion rate from 0.00 to 0.33 cfs at Annie Spring.

Discharge measurements were made at the *Annie Spring Weir* by noting the water surface elevation on the staff gauge (outside gauge) mounted on the outside of the stilling well in the pool upstream of the weir. The bottom elevation of the V-notch in the weir plate is relative to an elevation of 2.0 feet on the outside gauge; therefore, the “head” is computed as the outside gauge reading minus 2.0 feet. For example, for the September 17, 2008, outside gauge reading of 2.85 feet, the head was computed as $2.85 - 2.0 \text{ feet} = 0.85 \text{ feet}$. Referring to a standard 90° V-notch weir discharge table (BOR 1997), a head of 0.85 feet equates to a discharge of about 1.7 cfs. The USGS computed discharge ratings specifically for the *Annie Spring Weir* by measuring discharge upstream of the weir and noting the water surface elevation (stage) at the outside gauge for each discharge measurement. With enough discharge measurements made at a range of stages, a stage/discharge relationship can be computed for the weir. The last rating used by the USGS at the *Annie Spring Weir* was Rating ID 12.1. That rating equates a head of 0.85 feet to a discharge of about 2.4 cfs. The discharge from the USGS Rating ID 12.1 may be higher than the discharge from the standard 90° V-notch weir discharge table, for a given head, for a number of reasons, including (1) the USGS rating may account for flow bypassing the weir, and (2) the weir installation itself may not be to specification (the weir plate bows downstream, the V-notch edges are rough, and the upstream face of the weir plate is not smooth). Since USGS Rating ID 12.1 was last used in 2004, the true discharge may lie somewhere between that given in the standard 90° V-notch weir discharge table and USGS Rating ID 12.1.

Discharge measurements were made at *Annie Creek below the Middle Fork* and *Annie Creek above the Park Boundary* using pygmy current meters with digital counters that compute velocity and discharge and top-setting wading rods. A spin test was required for each pygmy meter before and after each discharge measurement with a minimum criterion of 45 seconds. A temporary staff gauge was installed at the *Annie Creek below the Middle Fork* cross section, and the permanently installed staff gauge at the decommissioned U.S. Forest Service gauge was used at the *Annie Creek above the Park Boundary* cross section. The gauge height was noted before and after each discharge measurement, and water and air temperatures were noted before each discharge measurement. Start and end times (24 hrs) were recorded for each discharge measurement. Channel bottom and flow conditions were noted for each cross section. Discharge was computed in the field using the velocity-area method and recomputed in the office using the HMST v2.6 One-Point Velocity Discharge Measurement Checker software package (Loving 2002). Qualitative ratings (EXCELLENT, GOOD, FAIR, POOR) were assigned to each discharge measurement by the person making the measurement.

Discharge measurements were made at *Annie Creek below the East Fork* using a SonTek FlowTracker™ with datalogger. The FlowTracker™ performs quality control diagnostics and produces a Quality Control Report for each measurement (Appendix B). A temporary staff gauge was installed at the cross section, and the gauge height was noted before and after each discharge measurement. Air and water temperatures and channel bottom and flow conditions were noted before each discharge measurement. Start and end times (24 hrs) were recorded for each discharge measurement. Discharge was computed in the field using the SonTek FlowTracker™ software and recomputed in the office using the HMST v2.6 One-Point Velocity Discharge Measurement Checker software package (Loving 2002). A qualitative rating (EXCELLENT, GOOD, FAIR, POOR) was assigned to each discharge measurement by the person making the measurement.

Uncertainties in Discharge Measurements

All discharge measurements are subject to uncertainty. The measurement uncertainty can be thought of as a quantitative measure of the dispersion of the measured discharge about the “true” discharge (Turnipseed and Sauer 2010). The total uncertainty may arise from several sources, including

- measurement of the cross-sectional area,
- measurement of the water-velocity profile,
- deviation from assumptions used in computational procedures, and
- random or systematic errors.

Many studies have been made to define uncertainties in measuring the various components of a discharge measurement, and then to combine these uncertainties into an overall estimate of the discharge error (Sauer and Meyer 1992). These studies have been used to confirm a quasi-quantitative method used to evaluate the accuracy of each discharge measurement. This method is based on a qualitative evaluation of factors such as cross-section uniformity, velocity uniformity, stream bed conditions, and other factors that might, in the opinion of the streamgauger, affect the accuracy of the measurement. The streamgauger then assigns one of the following accuracy ratings to the measurement:

- EXCELLENT (within 2% of the “true” discharge)
- GOOD (within 5%)
- FAIR (within 8%)
- POOR (greater than 8%)

Quantitative error studies have shown this to be a reasonable rating system.

As a general rule, the accuracy of most discharge measurements will be about 5%, or qualitatively a GOOD measurement (Turnipseed and Sauer 2010). A discharge measurement rated as GOOD could be as much as 5% higher or lower than the “true” discharge. For example, on September 17, 2008, the discharge at cross section *Annie Creek above the Park Boundary* was measured to be 60 cfs, and the measurement was given a qualitative rating of GOOD. Under this rating system the true discharge could range from 57 cfs to 63 cfs. On September 18, 2008, the discharge at cross section *Annie Creek above the Park Boundary* was measured to be 61 cfs, and the measurement was given a qualitative rating of GOOD. Under the rating system the true discharge could range from 58 cfs to 64 cfs. This example illustrates the difficulty in detecting small differences in discharge, with a reasonable degree of accuracy, using industry-standard equipment in natural stream channels, even if the streamgauger has made a GOOD discharge measurement.

Procedures for quantifying discharge measurement errors may be found in Dickinson 1967, Pelletier 1988, and Sauer and Meyer 1992.

Results and Discussion

On September 17, 2008, discharge was measured at the *Annie Spring Weir*, *Annie Creek below the Middle Fork*, *Annie Creek below the East Fork*, and *Annie Creek above the Park Boundary* while the pumps at the Annie Spring diversion were off. On September 18, 2008, discharge was measured at the same locations while the pumps at the Annie Spring diversion were running at full capacity (150 gpm, 0.33 cfs). Discharge measurements were made simultaneously at 10:00 am PST on both days. Summary results are listed in table 1 and displayed on figure 1. NPS Discharge Measurement Notes forms, SonTek Discharge Measurement Summaries, and HMST v2.6 One-Point Velocity Discharge Measurement Checker printouts for each cross section are located in Appendix B.

On September 17, 2008, discharge between *Annie Spring Weir* and *Annie Creek above the Park Boundary* increased from about 2.4 cfs at the *Annie Spring Weir*, to about 30 cfs at *Annie Creek below the Middle Fork*, to about 47 cfs at *Annie Creek below the East Fork*, to about 60 cfs at *Annie Creek above the Park Boundary*, an increase of about 58 cfs over the 11.5-mile reach. No known surface water diversions, or non-natural surface water inputs, occurred along the measured reach prior to, or during, the September 17, 2008, discharge measurements.

On September 18, 2008, discharge between *Annie Spring Weir* and *Annie Creek above the Park Boundary* increased from about 2.0 cfs at the *Annie Spring Weir*, to about 29 cfs at *Annie Creek below the Middle Fork*, to about 48 cfs at *Annie Creek below the East Fork*, to about 61 cfs at *Annie Creek above the Park Boundary*, an increase of about 59 cfs over the 11.5-mile reach. The 0.33 cfs diversion at Annie Spring was the only known surface water diversion occurring along the measured reach during the September 18, 2008, discharge measurements. There were no known non-natural surface water inputs into Annie Creek prior to, or during, the September 18, 2008, discharge measurements.

The difference in discharge measured at the *Annie Spring Weir* under no-diversion and full-diversion conditions was about -0.3 to -0.4 cfs. The difference in discharge measured at *Annie Creek above the Park Boundary* under no-diversion and full-diversion conditions was about $+1.0$ cfs. In theory, a decrease in discharge would have been expected at *Annie Creek above the Park Boundary* on September 18, 2008.

Precipitation is measured daily at a gauge located in the CRLA Administration Area. The precipitation total for August 2008 was 1.92 inches with 1.42 inches recorded between August 18 and 21 and 0.02 inches recorded after August 21, 2008. No precipitation was recorded between September 1 and 21, 2008 (NPS 2008). Average Total Precipitation for August and September, for the period of record 10/01/1919 to 12/31/2007 at CRLA, is 0.94 inches and 2.11 inches respectively (Western Regional Climate Center 2008). Although the four-day rainfall total for August 18 through 21 was 150% of the average total monthly precipitation, the climate record suggests the discharge measured on Annie Creek on September 17 and 18, 2008, was not influenced by recent precipitation.

No problems were reported while making the discharge measurements on either September 17 or 18, 2008.

Conclusions

At the *Annie Creek above the Park Boundary* cross section, greater discharge was measured on September 18, 2008, with the Annie Spring diversion pumps running at full capacity (0.33 cfs), than was measured on September 17, 2008, with the Annie Spring diversion pumps turned off.

The percent difference between discharge measured on September 17 and 18, 2008, at *Annie Creek above the Park Boundary* was +1.7%, an apparent increase in discharge. The fact that the measured discharge increased (rather than decreased), while the Annie Spring diversion pumps were running at full capacity, demonstrates the difficulty in detecting (and measuring) small changes in discharge (0.33 cfs) over long distances (11.5 miles) in natural stream systems. The similar increase in discharge measured at *Annie Creek below the East Fork* on September 18, 2008, gives us confidence in the measurement made at *Annie Creek above the Park Boundary*. No precipitation was recorded at the park immediately preceding or during the seepage investigation; therefore, the apparent increase in discharge on September 18, 2008, may have been due to some other natural process or was a product of the inherent difficulties with accuracy and precision associated with making discharge measurements by hand. The percent difference of +1.7% would fall well within the standard error for the GOOD USGS qualitative rating for a discharge measurement.

The results of this single seepage investigation, performed with a discharge of about 60 cfs in *Annie Creek above the Park Boundary*, suggest the validity of a futile call argument. If the discharge in *Annie Creek above the Park Boundary* was much less, like the 36 cfs recorded at *Annie Creek above the Park Boundary* on September 23 and 24, 2001 (U.S. Forest Service 2008), the percentage of the total flow represented by the park's full diversion capacity of 0.33 cfs would be higher, but still less than 1% of the total flow and difficult to measure.

At the time of the seepage investigation, the OWRD was reluctant to hear the park's argument for a futile call. In the view of the OWRD, the fact that senior water right owners know the park is diverting water at Annie Spring, even though a resulting decrease in discharge could not be measured at the park boundary, is enough evidence for the watermaster to place a call on the park during periods when there is not enough water in Annie Creek to satisfy the rights of the senior water right owners. In fact, the principal of conservation of mass would dictate that a decline in flow exists, regardless of whether it can be measured. Still, it would be worthwhile to present the results of this seepage investigation to the OWRD and revisit the futile call argument.

Recommendations

1. Pursue the futile call argument with the OWRD, referencing the results of this seepage investigation. If CRLA chooses to pursue the futile call argument, additional seepage investigations should be performed.
2. Purchase/lease 1883/1886 Priority Date water rights sufficient to augment the park's water supply during a call.
3. Purchase land with 1883/1886 Priority Date water rights sufficient to augment the park's water supply during a call.

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Appendix A

Oregon Water Resources Department Water Rights Information for pre-1902 Annie Creek Water Rights for Groups 1 through 10 (figure 2).

Table A.1. Oregon Water Resources Department water rights information for Group 1, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1089 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53435	COPELAND	12/31/1883	3
Cert: 1089 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53435	COPELAND	12/31/1883	1.5
Cert: 1089 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53435	COPELAND	12/31/1883	0
Cert: 1089 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53435	COPELAND	12/31/1883	0
Cert: 1089 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53435	COPELAND	12/31/1883	0.005
Cert: 1089 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53435	COPELAND	12/31/1883	0.1

Table A.1. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1092 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53438	DENTON	12/31/1883	1
Cert: 1092 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53438	DENTON	12/31/1883	0.5
Cert: 1092 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53438	DENTON	12/31/1883	0
Cert: 1092 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53438	DENTON	12/31/1883	0
Cert: 1092 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53438	DENTON	12/31/1883	0.005
Cert: 1092 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53438	DENTON	12/31/1883	0.1

Table A.1. (continued).

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1105 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53451	NICHOLSON	12/31/1883	3
Cert: 1105 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53451	NICHOLSON	12/31/1883	0
Cert: 1105 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53451	NICHOLSON	12/31/1883	0
Cert: 1105 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53451	NICHOLSON	12/31/1883	0.005
Cert: 1105 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53451	NICHOLSON	12/31/1883	0.1
Cert: 1105 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53451	NICHOLSON	12/31/1883	6

Table A.1. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1107 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	12/31/1891	3.25
Cert: 1107 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	12/31/1891	0.005
Cert: 1107 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	12/31/1891	0.1
Cert: 1107 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	12/31/1891	6.5
Cert: 1107 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	12/31/1891	0
Cert: 1107 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	12/31/1891	0

Table A.1. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1113 OR * IR	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=53459	WEED	12/31/1891	2.38
Cert: 1113 OR * IR	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=53459	WEED	12/31/1891	1.19
Cert: 1113 OR * LV	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=53459	WEED	12/31/1891	0
Cert: 1113 OR * DO	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=53459	WEED	12/31/1891	0
Cert: 1113 OR * DO	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=53459	WEED	12/31/1891	0.005
Cert: 1113 OR * LV	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=53459	WEED	12/31/1891	0.1

Table A.1. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 10915 OR * IR	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=63304		12/31/1891	2.375
Cert: 10915 OR * IR	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=63304		12/31/1891	3.8
Cert: 10917 OR * IR	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=63306	MILLER	11/30/1883	2.4153
Cert: 10917 OR * LV	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=63306	MILLER	11/30/1883	0.1
Cert: 10917 OR * LV	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=63306	MILLER	11/30/1883	0
Cert: 10917 OR * IR	http://apps2.wrd.state .or.us/apps/wr/wrinfo /wr_proofing_details. aspx?snp_id=63306	MILLER	11/30/1883	4.8306

Table A.2. Oregon Water Resources Department water rights information for Group 2, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 76151 RR * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=128501	DENTON	12/31/1891	0.895
Cert: 76310 CF * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=128627		12/31/1891	3.172

Table A.3. Oregon Water Resources Department water rights information for Group 3, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1107 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	4/30/1898	1.97
Cert: 1107 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	4/30/1898	0
Cert: 1107 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	4/30/1898	0
Cert: 1107 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	4/30/1898	0.005
Cert: 1107 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	4/30/1898	0.1
Cert: 1107 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53453	PELTON	4/30/1898	3.94
Cert: 68357 RR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=120691	GORDEN	12/31/1892	1.42

Table A.4. Oregon Water Resources Department water rights information for Group 4, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 10903 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63292	HESSIG	12/31/1895	1.197
Cert: 10903 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63292	HESSIG	12/31/1895	0
Cert: 10903 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63292	HESSIG	12/31/1895	0
Cert: 10903 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63292	HESSIG	12/31/1895	0.005
Cert: 10903 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63292	HESSIG	12/31/1895	0.1
Cert: 10903 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63292	HESSIG	12/31/1895	2.394

Table A.5. Oregon Water Resources Department water rights information for Group 5, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 10897 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63286	CARDWELL	12/31/1895	2.15
Cert: 10897 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63286	CARDWELL	12/31/1895	0
Cert: 10897 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63286	CARDWELL	12/31/1895	0
Cert: 10897 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63286	CARDWELL	12/31/1895	0.005
Cert: 10897 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63286	CARDWELL	12/31/1895	0.1
Cert: 10897 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63286	CARDWELL	12/31/1895	4.306

Table A.5. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 10902 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63291	DIXON	12/31/1895	0
Cert: 10902 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63291	DIXON	12/31/1895	5.349
Cert: 10902 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63291	DIXON	12/31/1895	0.1
Cert: 10902 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63291	DIXON	12/31/1895	0.005
Cert: 10902 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63291	DIXON	12/31/1895	0
Cert: 10902 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63291	DIXON	12/31/1895	10.698

Table A.5. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 10906 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63295	LEEVEE	12/31/1895	1.312
Cert: 10906 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63295	LEEVEE	12/31/1895	0
Cert: 10906 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63295	LEEVEE	12/31/1895	0
Cert: 10906 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63295	LEEVEE	12/31/1895	0.005
Cert: 10906 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63295	LEEVEE	12/31/1895	0.1
Cert: 10906 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63295	LEEVEE	12/31/1895	2.624

Table A.6. Oregon Water Resources Department water rights information for Group 6, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1087 OR * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53433	CARDWELL	12/31/1901	0.25
Cert: 1087 OR * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53433	CARDWELL	12/31/1901	0.5
Cert: 1097 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53443	HILL	11/30/1898	1.6
Cert: 1097 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53443	HILL	11/30/1898	0.8
Cert: 1097 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53443	HILL	11/30/1898	0
Cert: 1097 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53443	HILL	11/30/1898	0
Cert: 1097 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53443	HILL	11/30/1898	0.005
Cert: 1097 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53443	HILL	11/30/1898	0.1

Table A.6. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1099 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	12/31/1898	0.005
Cert: 1099 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	12/31/1898	0.1
Cert: 1099 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	12/31/1898	0.25
Cert: 1099 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	12/31/1898	0.125
Cert: 1099 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	12/31/1898	0
Cert: 1099 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	12/31/1898	0
Cert: 1099 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	11/30/1898	0.1
Cert: 1099 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	11/30/1898	0.005

Table A.6. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1099 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	11/30/1898	0.83
Cert: 1099 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	11/30/1898	0.415
Cert: 1099 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	11/30/1898	0
Cert: 1099 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53445	LOOSLEY	11/30/1898	0
Cert: 1103 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53449	MOSHIER	11/30/1898	0.5
Cert: 1103 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53449	MOSHIER	11/30/1898	0
Cert: 1103 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53449	MOSHIER	11/30/1898	0
Cert: 1103 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53449	MOSHIER	11/30/1898	0.005

Table A.6. (continued)

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1103 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53449	MOSHIER	11/30/1898	0.1
Cert: 1103 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53449	MOSHIER	11/30/1898	1
Cert: 1112 OR * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53458	STREETER	12/31/1901	0.63
Cert: 10905 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63294	LEEVEE	12/31/1888	0.462

Table A.7. Oregon Water Resources Department water rights information for Group 7, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 76154 RR * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=128504	SANDERSON	12/31/1891	1

Table A.8. Oregon Water Resources Department water rights information for Group 8, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1104 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53450	NICHOLSON	4/30/1898	1
Cert: 1104 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53450	NICHOLSON	4/30/1898	0
Cert: 1104 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53450	NICHOLSON	4/30/1898	0
Cert: 1104 OR * DO	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53450	NICHOLSON	4/30/1898	0.005
Cert: 1104 OR * LV	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53450	NICHOLSON	4/30/1898	0.1
Cert: 1104 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53450	NICHOLSON	4/30/1898	2

Table A.9. Oregon Water Resources Department water rights information for Group 9, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 1100 OR * I*	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=53446	MCDONOUGH	12/31/1892	4

Table A.10. Oregon Water Resources Department water rights information for Group 10, figure 2

Certificate	Information Source	Name	Priority Date	Rate (cfs)
Cert: 10908 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63297	LOOSLEY	12/31/1895	0.25
Cert: 10908 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63297	LOOSLEY	12/31/1895	0.4
Cert: 10911 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63300	LOOSLEY	12/31/1895	5.16
Cert: 10911 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63300	LOOSLEY	12/31/1895	8.26
43 Cert: 10914 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63303	LOOSLEY	12/31/1895	5.252
Cert: 10914 OR * IR	http://apps2.wrd.state.or.us/apps/wr/wrinfo/wr_proofing_details.aspx?snp_id=63303	LOOSLEY	12/31/1895	3.28

Appendix B

Cross Section Photographs, NPS Discharge Measurement Notes Forms, SonTek Discharge Measurement Summaries, and HMST v2.6 Printouts



Cross Section: Annie Spring Weir
USGS Gaging Station 11503000, Annie Spring near Crater Lake, Oregon
Annie Spring Weir located below Rim Drive bridge.
View from upstream to downstream.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Spring Weir
USGS Gaging Station 11503000, Annie Spring near Crater Lake, Oregon
Annie Spring Weir located below Rim Drive bridge.
View from left bank to right bank.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Spring Weir
USGS Gaging Station 11503000, Annie Spring near Crater Lake, Oregon
Annie Spring Weir located below Rim Drive bridge.
View from left bank to right bank.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Spring Weir
USGS Gaging Station 11503000, Annie Spring near Crater Lake, Oregon
Annie Spring Weir located below Rim Drive bridge.
View from downstream to upstream.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek below the East Fork

Annie Creek about 200 feet downstream of the confluence with the East Fork.
Cross section at downstream pink flagging. View from right bank to left bank.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek below the East Fork
Annie Creek about 200 feet downstream of the confluence with the East Fork.
View of temporary staff gage at left bank.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek below the East Fork

Annie Creek about 200 feet downstream of the confluence with the East Fork.
View downstream from cross section.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek below the East Fork

Annie Creek about 200 feet downstream of the confluence with the East Fork.
View from left bank to right bank. Cross section at pink flagging.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek above the Park boundary
Annie Creek at the site of the former US Forest Service stream gage.
View upstream from upstream of cross section.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek above the Park boundary
Annie Creek at the site of the former US Forest Service stream gage.
View from left bank to right bank. Cross section at pink flagging.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek above the Park boundary

Annie Creek at the site of the former US Forest Service stream gage (shelter visible behind downfall).
View from right bank to left bank. Cross section at pink flagging.

Annie Creek, Klamath County, OR.
September 16, 2008



Cross Section: Annie Creek above the Park boundary
Annie Creek at the site of the former US Forest Service stream gage.
View downstream from upstream of cross section. Shelter and antenna visible on left bank.

Annie Creek, Klamath County, OR.
September 16, 2008

Observation/Comments: _____

(Aug. 2007)

UNITED STATES
DOI-NPS-WRD
WATER RIGHTS BRANCH

DISCHARGE MEASUREMENT NOTES

Meas. No. _____

Date 9-17-08

Station Number _____ Comp. by _____ Checked by _____

Park CRATER LAKE Station Name ANWIE SPRINGS (BRIDGE)

Personnel: Meter STAFF GAUGE Notes R. SMITH

Weather CLEAR

Measurement Type (circle one) Wading, Cable, Bridge, Boat, Ice, Upslr., Dnslr., _____ ft. mi. of gage

Measurement Time/G.H.: Local/Standard (24hr) Start: _____ G.H. _____ Stop: _____ G.H. _____

Meter Type _____ S/N _____ Spin Before Meas. _____ After _____ (sec)

Meter Rating _____ Levels Obtained: Yes/No _____ Datum Changed: Yes/No _____

High Water Mark _____ Gage Height of Zero Flow _____ ft.

Crest Stage Checked: Yes/No _____ Stick Reading _____ ft.

GAGE READINGS		
TIME (local 24 hr)	INSIDE (gate gage)	OUTSIDE (staff gage - G.H.)
1600		2.85
1118		2.83
1200		2.85
Weighted M.G.H.		
G.H. correction		
Correct M.G.H.		

Air _____ °C °F @ _____

Water _____ °C °F @ _____

Cond. _____ @ _____

pH _____ @ _____

Sensor: _____

Bubbler: _____

Type _____

Bbl rate _____ per min.

Intake/Orifice cleaned: Yes/No _____

Transducer: _____

Type _____

PSIG 2.5, 5, 10, 15, 30

Other: _____

Desiccant changed: Yes/No _____

Flow: Width _____ Area _____ Ave. Vel. _____ G.H. _____ Disch. _____

Method _____ Method coeff. _____ Hor. Angle coeff. _____ Susp. Type _____ Susp. Coeff. _____

Meter _____ ft. above bottom of weight No. Secs. _____ G.H. changes _____ ft. in _____ hrs.

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%); based on the following cond:

Flow _____

Cross Section _____

Control _____

Meas. Plots _____ % diff. from _____ rating _____

Photos Taken: Yes/No _____

WRB REVIEW NOTES FIELD CARD FOR USE OF VERTICAL AXIS METER

Velocity limits of current meters

Meters	Velocity (ft./sec.)
Pygmy	0.25-3.00
AA	0.25-8.00

Spin tests limits

Meters	Normal	Minimum
Pygmy	1.5	45 sec
Ice, vane	4.0	2.0
Type-AA	4.0	2.0

Meter operation.

Water Depth (feet)	Meter use	Method
2.5 or deeper	Type-AA	0.2 and 0.8
1.5-2.5	Type-AA	0.8
1.5 or deeper	Pygmy	0.2 and 0.8
0.30-1.5	Pygmy	0.6

- A measurement cross section should have 25-30 measurement stations.
- No more than 10% of the total flow should be in a single measurement cell.
- Each measurement should be at least 40 seconds duration, and end on a complete revolution of the meter bucket wheel.
- A two point, two and eight tenths, velocity method should be used with an AA in depths over 2.5 feet.
- The AA meter should be used in depths 1.5 feet or greater. It should not be used less than 0.5 feet from any boundary such as the bed or bank of a channel.
- The pygmy meter should be used in depths between 0.3 and 1.5 feet. It should not be used at less than 0.3 feet from any boundary such as the bed or bank of a channel.
- Complete discharge calculations on the appropriate form before leaving a site.

DESCRIPTIONS FOR MEASUREMENT NOTE SHEETS

FLOW

- Steady or Varied
 - Describe change in GH during measurement
- Uniform or Non-Uniform
 - How is flow distributed in the cross section?
- Laminar or Turbulent
 - Does the flow pulsate? Does flow have some vertical component?
- Suspended Material
 - Do leaves or algae in water affect meter performance?

CROSS-SECTION

- Uniform or Non-Uniform
 - Is cross-section profile even or uneven?
- Smooth, moderately rough, rough, very rough
 - Describes irregularity of bed
- Channel bed material
 - Mud, sand, pebbles, cobbles, boulders?
 - Upstream bed material - may create turbulent flow

CONTROL

- Describe control type
 - Natural riffle
 - Length?
 - Bed material?
 - Stable or subject to change?
 - channel
 - Is flow contained in channel, in the bank vegetation, or over bank flow?
 - channel constriction
 - are banks stable?
 - Bank composition?
 - Weir
 - type and condition
- Where
 - How many feet downstream of gage?
- Conditions
 - Clear & unobstructed, affected by moss or algae, affected by leaves or other debris, noticeable changes?

HMST v2.9 One-Point Velocity Discharge Measurement Checker With EDIs

By Brian Loving, Hydrologist, US Geological Survey

Station Name:	Annie Creek below Middle Fork				Print Header				
Station Number:		WIDTH	15.200	# of Sections	32	* Standard error computed using OFR 92-144 Method			
Date:	09/17/08	AREA	13.163	Sections > 5%	4				
Measurement #:		VELOCITY	2.289	Sections > 10%	0				
Meter Type:	Pygmy	TOTAL DISCHARGE		30.124	*Standard Error				
Rating # (1 or 2)	2					Clear Sheet			
# of EDI Verticals	5	Measurement sheet Q is OK if between 29.82 and 30.42				Rod			
EDI Sample #						Stable (uneven, gravel-boulders)			
Location to Sample	1	2	3	4	5	6	7	8	9
	3.4	5.3	7.4	9.6	12.5				

NOTE: BEW in column L below refers to Beginning Edge of Water

Correction Coefficient	Distance	Width	Depth	Revolutions	Seconds	Velocity At Point	Mean Velocity	Adjusted Velocity	Area	Discharge	Distance From BEW	% of Total Q So Far
	0	0.25	0.46			0.174	0.174	0.174	0.115	0.020	0.25	0%
	0.5	0.50	0.46			0.516	0.516	0.516	0.230	0.119	0.75	0%
	1	0.50	0.49			0.674	0.674	0.674	0.245	0.214	1.25	1%
	1.5	0.50	0.53			1.072	1.072	1.072	0.265	0.284	1.75	2%
	2	0.50	0.59			1.549	1.549	1.549	0.295	0.457	2.25	4%
	2.5	0.50	0.68			1.938	1.938	1.938	0.340	0.659	2.75	6%
	3	0.50	0.81			2.330	2.330	2.330	0.405	0.944	3.25	9%
	3.5	0.50	0.82			3.017	3.017	3.017	0.410	1.237	3.75	13%
	4	0.50	1			2.986	2.986	2.986	0.500	1.493	4.25	18%
	4.5	0.50	0.91			4.089	4.089	4.089	0.455	1.860	4.75	24%
	5	0.50	0.8			4.069	4.069	4.069	0.400	1.628	5.25	30%
	5.5	0.50	0.9			3.504	3.504	3.504	0.450	1.577	5.75	35%
	6	0.50	0.72			3.648	3.648	3.648	0.360	1.313	6.25	39%
	6.5	0.50	0.89			2.936	2.936	2.936	0.445	1.307	6.75	44%
0.98	7	0.50	0.85			3.463	3.463	3.394	0.425	1.442	7.25	48%
0.99	7.5	0.50	0.85			3.505	3.505	3.470	0.425	1.475	7.75	53%
0.99	8	0.50	0.9			3.600	3.600	3.564	0.450	1.604	8.25	59%
0.99	8.5	0.50	0.98			2.492	2.492	2.467	0.490	1.209	8.75	63%
0.99	9	0.50	1			2.953	2.953	2.923	0.500	1.462	9.25	67%
0.99	9.5	0.50	1			2.200	2.200	2.178	0.500	1.089	9.75	71%
0.99	10	0.50	1.05			2.521	2.521	2.496	0.525	1.310	10.25	75%
0.99	10.5	0.50	1			2.696	2.696	2.669	0.500	1.335	10.75	80%
0.99	11	0.50	0.91			2.468	2.468	2.443	0.455	1.112	11.25	83%
0.99	11.5	0.50	1.03			1.454	1.454	1.439	0.515	0.741	11.75	86%
0.99	12	0.50	0.98			1.516	1.516	1.501	0.490	0.735	12.25	88%
0.99	12.5	0.50	0.89			2.024	2.024	2.004	0.445	0.892	12.75	91%
	13	0.50	1.09			1.485	1.485	1.485	0.545	0.809	13.25	94%
	13.5	0.50	1.1			1.114	1.114	1.114	0.550	0.613	13.75	96%
	14	0.50	0.9			1.080	1.080	1.080	0.450	0.486	14.25	98%
	14.5	0.50	0.98			0.941	0.941	0.941	0.490	0.461	14.75	99%
	15	0.35	1.1			0.618	0.618	0.618	0.385	0.238	15.1	100%
	15.2	0.10	1.08			0.000	0.000	0.000	0.108	0.000	15.2	100%

1) 19-second spin Test Following measurements. I let the H₂SO₄ meter ground out against the left bank while going up to measure velocity at the last vertical (left bank). Soil/Root mass likely fell from the bank into the bucket wheel, resulting in a bad spin test after the measurements. The measurements made previous to the left bank (all other verticals were likely good).

Meters	Velocity (ft./sec.)
Pyomy	0.25-3.00
ΔΔ	0.25-3.00

Meters	Normal	Minimum
Pygmy	1.5	48 sec
Ice, vane	4.0	2.0
Tuna, AA	4.0	2.0

Water Depth (feet)	Motor use	Method
2.5 or deeper	Type-AA	0.2 and 0.8
1.5-2.5	Type-AA	0.6
1.5 or deeper	Pygmy	0.2 and 0.8
0.30-1.5	Pvariv	0.6

- A measurement cross section should have 25-30 measurement stations.
- No more than 10% of the total flow should be in a single measurement cell.
- Each measurement should be at least 40 seconds duration, and end on a complete revolution of the meter bucket wheel.
- A two point, two and eight tenths, velocity method should be used with an AA in depths over 2.5 feet.
- The AA meter should be used in depths 1.5 feet or greater. It should not be used less than 0.5 feet from any boundary such as the bed or bank of a channel.
- The pygmy meter should be used in depths between 0.3 and 1.5 feet. It should not be used at less than 0.3 feet from any boundary such as the bed or bank of a channel.
- Complete discharge calculations on the appropriate form before leaving a site.

FLOW

- **Steady or Varied**
 - Describe change in GH during measurement
- **Uniform or Non-Uniform**
 - How is flow distributed in the cross section?
- **Laminar or Turbulent**
 - Does the flow pulsate? Does flow have some vertical component?
- **Suspended Material**
 - Do leaves or algae in water affect meter performance?

CROSS-SECTION

- Uniform or Non-Uniform
 - Is cross-section profile even or uneven?
- Smooth, Moderately rough, rough, very rough
 - Describes Irregularity of bed
- Channel bed material
 - Mud, sand, pebbles, cobbles, boulders?
 - Upstream bed material – may create turbulent flow

CONTROL

- Describe control type
 - Natural riffle
 - Length?
 - Bed material?
 - Stable or subject to change?
 - channel
 - is flow contained in channel, in the bank vegetation, or over bank flow?
 - channel constriction
 - are banks stable?
 - Bank composition?
 - Weir
 - type and condition
- Where
 - How many feet downstream of gage?
- Conditions
 - Clear & unobstructed, affected by moss or algae, affected by leaves or other debris, noticeable changes?

UNITED STATES
DOI-NPS-WRD
WATER RIGHTS BRANCH

Meas. No. 1

Date 9/18/08
Station Number _____ Comp. by _____ Checked by _____
Park CRLA Station Name ANNIE CREEK bel cont. w/ Middle Fork
Personnel: Meter J. Harte Notes J. Harte
Weather Clear
Measurement Type (circle one) Wading: Cable, Bridge, Boat, Ice; Upstr., Crst. _____ ft., mi. of gage
Measurement Time/G.H.: Local / Standard (24hr) Start: 1000 G.H. .43 Stop: 1055 G.H. .43
Meter Type Papson S/N 18308230 Spin Before Meas. 4.5 sec. After 19 sec. (sec)
Meter Rating _____ Levels Obtained: Yes/No _____ Datum Changed: Yes/No _____
High Water Mark _____ Gage Height of Zero Flow _____ ft.
Crest Stage Checked: Yes/No _____ Stick Reading _____ ft.
Air 13.8°C @ 1100 hrs
Water 4.6°C @ 1100 hrs

[illegible]

Air 70 °C °F @ 0945
 Water 3.5 °C °F @ 0947
 Cond. _____ @ _____
 pH _____ @ _____
 Sensor: _____
 Bubbler: _____
 Type _____
 Bbl rate _____ per min.
 Intake/Orifice cleaned: Yes/No _____
 Transducer: _____
 Type _____
 PSIG 2.5, 5, 10, 15, 30 _____
 Other: _____
 Desiccant changed: Yes/No _____

Flow: Width 15.2 Ft Area _____ Ave. Vel. _____ G.H. _____ Disch. 29.4
Method _____ Method coeff. _____ Hor. Angle coeff. _____ Susp. Type _____ Susp. Coeff. _____
Meter _____ ft. above bottom of weight No. Secs. _____ G.H. changes _____ ft. in _____ hrs
Measurement rated: excellent (2%) good (5%), fair (8%), poor (over 8%); based on the following cond:
Flow SMALL-ANGLE FLOW LINE AT SOME VERTICALS
Cross Section uniform gravel/cobble @ bank undercut 6.5 Ft
@ bank vertical w/ some root mat
Control _____
Meas. Plots _____ % diff. from _____ rating _____
Photos Taken: Yes/No _____

HMST v2.9 One-Point Velocity Discharge Measurement Checker With EDIs

By Brian Loving, Hydrologist, US Geological Survey

Station Name:	Annie Creek below Middle Fork				Print Header	
Station Number:	WIDTH	15.200	# of Sections	32	* Standard error computed using OFR 92-144 Method Clear Sheet Rod Stable (uneven, gravel-boulders)	
Date:	09/18/08	AREA	13.201	Sections > 5%		5
Measurement #:		VELOCITY	2.227	Sections > 10%		0
Meter Type:	Pygmy	TOTAL DISCHARGE		29.402		*Standard Error
Rating # (1 or 2)	2					
# of EDI Verticals	5	Measurement sheet Q is OK if between 29.11 and 29.70				
EDI Sample #	1	2	3	4	5	6
Location to Sample	3.3	5.3	7.4	9.5	12.3	

NOTE: BEW in column L below refers to Beginning Edge of Water

Correction Coefficient	Distance	Width	Depth	Revolutions	Seconds	Velocity At Point	Mean Velocity	Adjusted Velocity	Area	Discharge	Distance From BEW	% of Total Q So Far
	0	0.25	0.41			0.077	0.077	0.077	0.103	0.008	0.25	0%
	0.5	0.50	0.46			0.402	0.402	0.402	0.230	0.092	0.75	0%
0.99	1	0.50	0.55			0.707	0.707	0.700	0.275	0.192	1.25	1%
0.99	1.5	0.50	0.58			1.211	1.211	1.199	0.290	0.348	1.75	2%
0.99	2	0.50	0.6			1.780	1.780	1.762	0.300	0.529	2.25	4%
	2.5	0.50	0.69			1.875	1.875	1.875	0.345	0.647	2.75	6%
	3	0.50	0.8			2.192	2.192	2.192	0.400	0.877	3.25	9%
	3.5	0.50	0.9			2.946	2.946	2.946	0.450	1.326	3.75	14%
	4	0.50	1			2.779	2.779	2.779	0.500	1.390	4.25	18%
	4.5	0.50	0.98			3.743	3.743	3.743	0.490	1.834	4.75	25%
	5	0.50	0.75			3.815	3.815	3.815	0.375	1.431	5.25	29%
	5.5	0.50	0.88			3.384	3.384	3.384	0.440	1.489	5.75	35%
0.99	6	0.50	0.73			3.441	3.441	3.407	0.365	1.243	6.25	39%
0.99	6.5	0.50	0.88			2.840	2.840	2.812	0.440	1.237	6.75	43%
0.99	7	0.50	0.8			3.609	3.609	3.573	0.400	1.429	7.25	48%
0.99	7.5	0.50	0.93			3.489	3.489	3.454	0.465	1.606	7.75	53%
0.99	8	0.50	0.9			3.360	3.360	3.326	0.450	1.497	8.25	58%
0.99	8.5	0.50	0.98			3.169	3.169	3.137	0.490	1.537	8.75	64%
0.99	9	0.50	0.98			2.600	2.600	2.574	0.490	1.261	9.25	68%
0.99	9.5	0.50	1.03			2.361	2.361	2.337	0.515	1.204	9.75	72%
0.99	10	0.50	1.05			2.474	2.474	2.449	0.525	1.286	10.25	76%
0.99	10.5	0.50	1.08			2.528	2.528	2.503	0.540	1.351	10.75	81%
	11	0.50	0.9			2.187	2.187	2.187	0.450	0.984	11.25	84%
	11.5	0.50	0.9			1.521	1.521	1.521	0.450	0.684	11.75	87%
	12	0.50	0.98			1.875	1.875	1.875	0.490	0.919	12.25	90%
	12.5	0.50	0.87			1.780	1.780	1.780	0.435	0.774	12.75	92%
	13	0.50	1.01			1.544	1.544	1.544	0.505	0.780	13.25	95%
	13.5	0.50	1.09			0.975	0.975	0.975	0.545	0.531	13.75	97%
	14	0.50	0.91			0.994	0.994	0.994	0.455	0.452	14.25	98%
	14.5	0.50	1			0.681	0.681	0.681	0.500	0.341	14.75	100%
	15	0.35	1.1			0.318	0.318	0.318	0.385	0.122	15.1	100%
	15.2	0.10	1.08			0.000	0.000	0.000	0.108	0.000	15.2	100%

Velocity limits of current meters

Motors	Velocity (ft./sec.)
Pygmy	0.25-3.00
AA	0.25-8.00

Spin tests limits

Meters	Normal	Minimum
Pygmy	1.5	45 sec
Ice, vane	4.0	2.0
Type-AA	4.0	2.0

Meter operation.

Water Depth (feet)	Meier use	Method
2.5 or deeper	Type-AA	0.2 and 0.8
1.5-2.5	Type-AA	0.6
1.5 or deeper	Pygmy	0.2 and 0.8
0.30-1.5	Pygmy	0.6

- A measurement cross section should have 25-30 measurement stations.
- No more than 10% of the total flow should be in a single measurement cell.
- Each measurement should be at least 40 seconds duration, and end on a complete revolution of the meter bucket wheel.
- A two point, two and eight tenths, velocity method should be used with an AA in depths over 2.5 feet.
- The AA meter should be used in depths 1.5 feet or greater. It should not be used less than 0.5 feet from any boundary such as the bed or bank of a channel.
- The pygmy meter should be used in depths between 0.3 and 1.5 feet. It should not be used at less than 0.3 feet from any boundary such as the bed or bank of a channel.
- Complete discharge calculations on the appropriate form before leaving a site.

FLOW

- Steady or Varied
 - Describe change in GH during measurement
- Uniform or Non-Uniform
 - How is flow distributed in the cross section?
- Laminar or Turbulent
 - Does the flow pulsate? Does flow have some vertical component?
- Suspended Material
 - Do leaves or algae in water affect meter performance?

CROSS-SECTION

- Uniform or Non-Uniform
 - Is cross-section profile even or uneven?
- Smooth, moderately rough, rough, very rough
 - Describes irregularity of bed
- Channel bed material
 - Mud, sand, pebbles, cobbles, boulders?
 - Upstream bed material – may create turbulent flow

CONTROL

- Describe control type
 - Natural riffle
 - Length?
 - Bed material?
 - Stable or subject to change?
 - channel
 - Is flow contained in channel, in the bank vegetation, or over bank flow?
 - channel constriction
 - are banks stable?
 - Bank composition?
 - Weir
 - type and condition
- Where
 - How many feet downstream of gage?
- Conditions
 - Clear & unobstructed, affected by moss or algae, affected by leaves or other debris, noticeable changes?

UNITED STATES
DOI-NPS-WRD
WATER RIGHTS BRANCH

Meas. No.

Station Number _____ Comp. by JL Checked by _____

Park Crater Lake Station Name Amara Cr blue E. Fk confluence

Personnel: Mater J. LaMarche Notes NA 10/11/1960

Weather Sunny / cool

Measurement Type (circle one) Wading, Cable, Bridge, Boat, Ice; Upstr., Dnstr. 4 ft., mi. of gage _____

Measurement Time/G.H.: Local /Standard (24hr) Start: 10:30 G.H. .36 Stop: 11:30 G.H. .36

Meter Type Se-Tek S/N P1009 Spin Before Meas. — After — (s)

Meter Rating FLUORIDE Levels Obtained: Yes/No Datum Changed: Yes/No

High Water Mark _____ Gage Height of Zero Flow _____

Crest Stage Checked: Yes/No Stick Reading _____ ft.

GAGE READINGS		
TIME (local-24 hr)	INSIDE (data logger)	OUTSIDE (raft gage - GH)
9:22 DST		0.36 ±
10:30 DST		0.36 ±
11:30 DST		0.36 ±
Weighted M.G.H.		
G.H. correction		
Correct M.G.H.		

1. at 46.3 °C/E@ 11:30

Water _____ °C °F @ _____

Cond. _____ @ _____
Alt. _____ @ _____

Sensor:

Bubblers:

Type _____

Intake/Orifice cleaned: Yes/No

Transducer:

Type _____
2010 25 5 10 15 20

Other: _____

Descript changed: Yes/No

1000

Flow: Width 23.1 Area 20.39 Ave. Vel. 2.30 G.H. 4.36 Disch. 46.89

Method	Method coeff	Hor Angle coeff	Susp Type	Susp Coeff
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32

Weight _____ N. Approx. percent of weight H₂O: _____ and % unchanged _____ % in _____

[illegible]

Core Section = Fairly uniform in length and width

Control	100 mg	50 mg	25 mg	10 mg	5 mg	2 mg	1 mg	0.5 mg	0.25 mg	0.125 mg	0.0625 mg	0.03125 mg	0.015625 mg	0.0078125 mg	0.00390625 mg	0.001953125 mg	0.0009765625 mg	0.00048828125 mg	0.000244140625 mg	0.0001220703125 mg	0.00006103515625 mg	0.000030517578125 mg	0.0000152587890625 mg	0.00000762939453125 mg	0.000003814697265625 mg	0.0000019073486328125 mg	0.00000095367431640625 mg	0.000000476837158203125 mg	0.0000002384185791015625 mg	0.00000011920928955078125 mg	0.000000059604644775390625 mg	0.0000000298023223876953125 mg	0.00000001490116119384765625 mg	0.000000007450580596923828125 mg	0.0000000037252902984619140625 mg	0.00000000186264514923095703125 mg	0.000000000931322574615478515625 mg	0.0000000004656612873077392578125 mg	0.00000000023283064365386962890625 mg	0.000000000116415321826934814453125 mg	0.0000000000582076609134674072265625 mg	0.00000000002910383045673370361328125 mg	0.000000000014551915228366851806640625 mg	0.0000000000072759576141834259033203125 mg	0.00000000000363797880709171295166015625 mg	0.000000000001818989403545856475830078125 mg	0.0000000000009094947017729282379150390625 mg	0.00000000000045474735088646411895751953125 mg	0.000000000000227373675443232059478759765625 mg	0.0000000000001136868377216160297393798828125 mg	0.00000000000005684341886080801486968994140625 mg	0.000000000000028421709430404007434844970703125 mg	0.0000000000000142108547152020037174224853515625 mg	0.00000000000000710542735760100185871124267578125 mg	0.000000000000003552713678800500929355621337890625 mg	0.0000000000000017763568394002504646778106689453125 mg	0.00000000000000088817841970012523233890533447265625 mg	0.000000000000000444089209850062616169452667236328125 mg	0.0000000000000002220446049250313080847263336181640625 mg	0.00000000000000011102230246251565404236316680908203125 mg	0.000000000000000055511151231257827021181583404541015625 mg	0.0000000000000000277555756156289135105907917022705078125 mg	0.00000000000000001387778780781445675529539585113525390625 mg	0.000000000000000006938893903907228377647697925567626953125 mg	0.0000000000000000034694469519536141888238489627838134765625 mg	0.00000000000000000173472347597680709441192448139190673828125 mg	0.000000000000000000867361737988403547205962240695953369140625 mg	0.0000000000000000004336808689942017736029811203479766845703125 mg	0.00000000000000000021684043449710088680149056017398834228515625 mg	0.000000000000000000108420217248550443400745280086994171142578125 mg	0.0000000000000000000542101086242752217003726400434970855712890625 mg	0.00000000000000000002710505431213761085018632002174854278564453125 mg	0.000000000000000000013552527156068805425093160010874271392822265625 mg	0.0000000000000000000067762635780344027125465800054371356964111328125 mg	0.00000000000000000000338813178901720135627329000271856784820556640625 mg	0.000000000000000000001694065894508600678136645001359283924102783203125 mg	0.0000000000000000000008470329472543003390683225006796419620513916015625 mg	0.00000000000000000000042351647362715016953416125033982098102569580078125 mg	0.000000000000000000000211758236813575084767080625169910490512847900390625 mg	0.0000000000000000000001058791184067875423835403125849552452564239501953125 mg	0.00000000000000000000005293955920339377119177015629222762262821197509765625 mg	0.000000000000000000000026469779601696885595885078146113811314105987548828125 mg	0.0000000000000000000000132348898008484427979425390730569056570529937744140625 mg	0.00000000000000000000000661744490042422139897126953652845282852649688720703125 mg	0.000000000000000000000003308722450212110699485634768264226414263248443603515625 mg	0.0000000000000000000000016543612251060553497428173841321132071316242218017578125 mg	0.00000000000000000000000082718061255302767487140869206605660356581211090087890625 mg	0.0000000000000000000000004135903062765138374357043460
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Line: Photo Of: *SB* ending

Photo Taken: Visible

Discharge Measurement Summary

Date Generated: Wed Oct 1 2008

File Information

File Name Misc_2008-09-17.WAD
Start Date and Time 2008/09/17 09:29:17

Site Details

Site Name
Operator(s) JL

System Information

Sensor Type FlowTracker
Serial # P1009
CPU Firmware Version 3.4
Software Ver 2.20

Units (English Units)

Distance ft
Velocity ft/s
Area ft^2
Discharge cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	0.9%
Velocity	0.7%	2.2%
Width	0.1%	0.1%
Method	1.4%	-
# Stations	1.6%	-
Overall	2.4%	2.6%

Summary

Averaging Int. 40 # Stations 33
Start Edge REW Total Width 23.100
Mean SNR 34.5 dB Total Area 20.392
Mean Temp 41.26 °F Mean Depth 0.883
Disch. Equation Mid-Section Mean Velocity 2.2994
Total Discharge 46.8896

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	09:29	0.70	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	09:30	1.50	0.6	0.630	0.6	0.252	0.5719	1.00	0.5719	0.567	0.3242	0.7
2	09:31	2.50	0.6	0.710	0.6	0.284	1.1883	1.00	1.1883	0.710	0.8437	1.8
3	09:33	3.50	0.6	0.650	0.6	0.260	2.3701	1.00	2.3701	0.650	1.5404	3.3
4	09:36	4.50	0.6	0.710	0.6	0.284	2.2014	1.00	2.2014	0.710	1.5630	3.3
5	09:38	5.50	0.6	0.890	0.6	0.356	2.7497	1.00	2.7497	0.801	2.2026	4.7
6	09:40	6.30	0.6	0.710	0.6	0.284	2.8117	1.00	2.8117	0.532	1.4972	3.2
7	09:41	7.00	0.6	0.800	0.6	0.320	2.4816	1.00	2.4816	0.480	1.1911	2.5
8	09:42	7.50	0.6	0.880	0.6	0.352	2.4341	1.00	2.4341	0.440	1.0709	2.3
9	09:47	8.00	0.6	0.900	0.6	0.360	2.6949	1.00	2.6949	0.450	1.2126	2.6
10	09:49	8.50	0.6	1.020	0.6	0.408	2.0863	1.00	2.0863	0.510	1.0640	2.3
11	09:50	9.00	0.6	1.100	0.6	0.440	2.9012	1.00	2.9012	0.550	1.5958	3.4
12	09:55	9.50	0.6	1.200	0.6	0.480	2.6775	1.00	2.6775	0.600	1.6067	3.4
13	09:57	10.00	0.6	1.250	0.6	0.500	2.5640	1.00	2.5640	0.625	1.6025	3.4
14	10:01	10.50	0.6	1.250	0.6	0.500	1.7205	1.00	1.7205	0.625	1.0753	2.3
15	10:03	11.00	0.6	1.230	0.6	0.492	2.6480	1.00	2.6480	0.615	1.6285	3.5
16	10:04	11.50	0.6	1.220	0.6	0.488	2.7723	1.00	2.7723	0.610	1.6913	3.6
17	10:05	12.00	0.6	1.200	0.6	0.480	2.6158	1.00	2.6158	0.600	1.5697	3.3
18	10:07	12.50	0.6	1.200	0.6	0.480	2.5515	1.00	2.5515	0.600	1.5311	3.3
19	10:08	13.00	0.6	1.200	0.6	0.480	2.4131	1.00	2.4131	0.600	1.4480	3.1
20	10:09	13.50	0.6	1.180	0.6	0.472	2.3192	1.00	2.3192	0.590	1.3685	2.9
21	10:11	14.00	0.6	1.000	0.6	0.400	2.3665	1.00	2.3665	0.500	1.1832	2.5
22	10:13	14.50	0.6	0.900	0.6	0.360	2.4108	1.00	2.4108	0.540	1.3019	2.8
23	10:14	15.20	0.6	0.850	0.6	0.340	2.6529	1.00	2.6529	0.638	1.6913	3.6
24	10:16	16.00	0.6	0.800	0.6	0.320	2.8255	1.00	2.8255	0.720	2.0338	4.3
25	10:18	17.00	0.6	0.800	0.6	0.320	2.7936	1.00	2.7936	0.800	2.2345	4.8
26	10:19	18.00	0.6	0.900	0.6	0.360	2.7208	1.00	2.7208	0.900	2.4485	5.2
27	10:20	19.00	0.6	0.900	0.6	0.360	2.0584	1.00	2.0584	0.900	1.8524	4.0
28	10:22	20.00	0.6	0.900	0.6	0.360	2.0085	1.00	2.0085	0.900	1.8075	3.9
29	10:23	21.00	0.6	0.920	0.6	0.368	1.8435	1.00	1.8435	0.920	1.6959	3.6
30	10:25	22.00	0.6	0.900	0.6	0.360	2.0197	1.00	2.0197	0.900	1.8176	3.9
31	10:26	23.00	0.6	0.900	0.6	0.360	1.4767	1.00	1.4767	0.810	1.1960	2.6
32	10:26	23.80	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

Discharge Measurement Summary

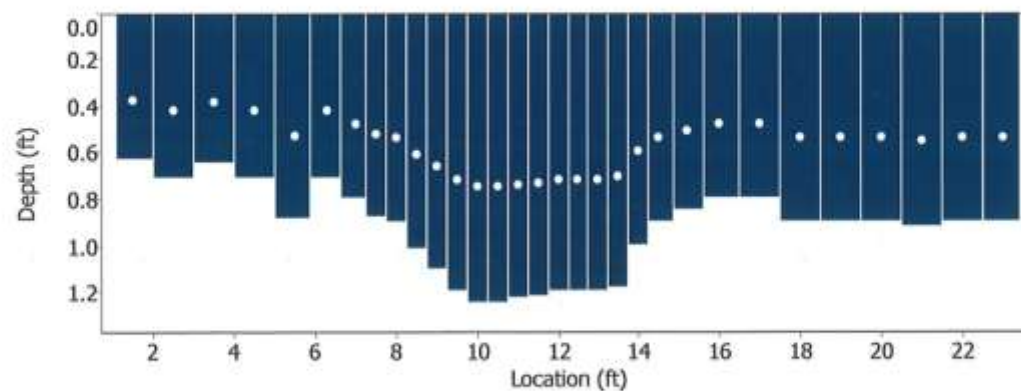
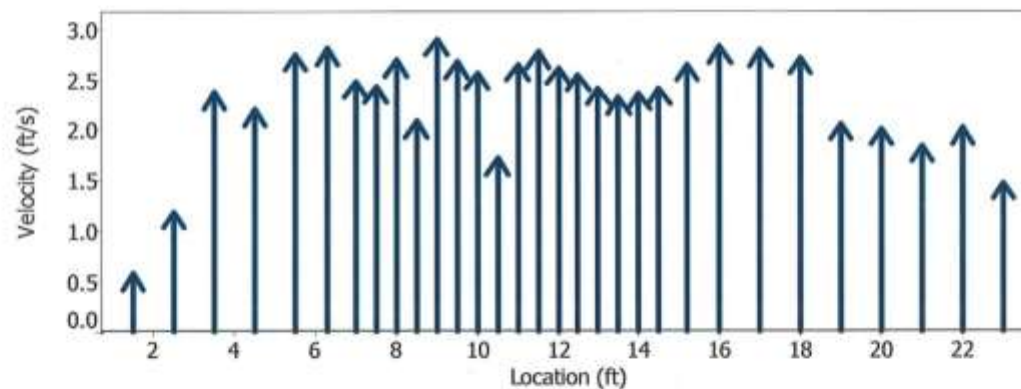
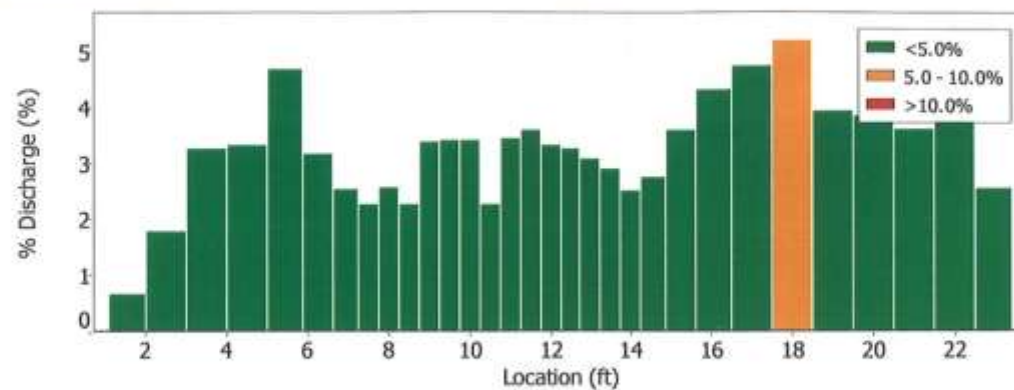
Date Generated: Wed Oct 1 2008

File Information

File Name Misc_2008-09-17.WAD
Start Date and Time 2008/09/17 09:29:17

Site Details

Site Name
Operator(s) JL



Discharge Measurement Summary

Date Generated: Wed Oct 1 2008

File Information

File Name Misc_2008-09-17.WAD
Start Date and Time 2008/09/17 09:29:17

Site Details

Site Name
Operator(s) JL

Quality Control

St	Loc	%Dep	Message
1	1.50	0.6	High SNR variation during measurement: 6.0,3.0
		0.6	Boundary QC is Fair; possible boundary interference
2	2.50	0.6	High angle: 28
7	7.00	0.6	High standard error: 0.146
8	7.50	0.6	High standard error: 0.128
10	8.50	0.6	High standard error: 0.115
12	9.50	0.6	High number of spikes: 5
14	10.50	0.6	High standard error: 0.146
22	14.50	0.6	High number of spikes: 5
28	20.00	0.6	High standard error: 0.115

HMST v2.9 One-Point Velocity Discharge Measurement Checker With EDIs

By Brian Loving, Hydrologist, US Geological Survey

Station Name:	Annie Creek below the East Fork			
Station Number:	WIDTH	23.100	# of Sections	33
Date:	09/17/08	AREA	20.393	Sections > 5%
Measurement #:	Pygmy	VELOCITY	2.299	Sections > 10%
Meter Type:	2	TOTAL DISCHARGE		46.890
Rating # (1 or 2)	5	Measurement sheet Q is OK if between 46.42 and 47.36		
# of EDI Verticals	1	2	3	4
EDI Sample #	5.2	9.2	12.3	16.1
Location to Sample:	20.5	6	7	8

Print Header

Print Full Sheet

Clear Sheet

* Standard error computed using OFR 92-144 Method

Rod

Stable (uneven, gravel-boulders)

NOTE: BEW in column L below refers to Beginning Edge of Water

Correction Coefficient	Distance	Width	Depth	Revolutions	Seconds	Velocity At Point	Mean Velocity	Adjusted Velocity	Area	Discharge	Distance From BEW	% of Total Q So Far
	0.7	0.40	0			0.000	0.000	0.000	0.000	0.000	0.4	0%
	1.5	0.90	0.63			0.572	0.572	0.572	0.567	0.324	1.3	1%
	2.5	1.00	0.71			1.188	1.188	1.188	0.710	0.843	2.3	2%
	3.5	1.00	0.86			2.370	2.370	2.370	0.850	1.541	3.3	6%
	4.5	1.00	0.71			2.201	2.201	2.201	0.710	1.563	4.3	9%
	5.5	0.90	0.89			2.750	2.750	2.750	0.801	2.203	5.2	14%
	6.3	0.75	0.71			2.812	2.812	2.812	0.533	1.497	5.95	17%
	7	0.60	0.8			2.482	2.482	2.482	0.480	1.191	6.55	20%
	7.5	0.50	0.88			2.434	2.434	2.434	0.440	1.071	7.05	22%
	8	0.50	0.9			2.695	2.695	2.695	0.450	1.213	7.55	24%
	8.5	0.50	1.02			2.086	2.086	2.086	0.510	1.064	8.05	27%
	9	0.50	1.1			2.901	2.901	2.901	0.550	1.596	8.55	30%
	9.5	0.50	1.2			2.678	2.678	2.678	0.600	1.607	9.05	34%
	10	0.50	1.25			2.564	2.564	2.564	0.625	1.603	9.55	37%
	10.5	0.50	1.25			1.721	1.721	1.721	0.825	1.075	10.05	39%
	11	0.50	1.23			2.548	2.548	2.548	0.615	1.629	10.55	43%
	11.5	0.50	1.22			2.772	2.772	2.772	0.610	1.691	11.05	46%
	12	0.50	1.2			2.616	2.616	2.616	0.600	1.569	11.55	50%
	12.5	0.50	1.2			2.552	2.552	2.552	0.600	1.531	12.05	53%
	13	0.50	1.2			2.413	2.413	2.413	0.600	1.448	12.55	56%
	13.5	0.50	1.18			2.319	2.319	2.319	0.590	1.368	13.05	59%
	14	0.50	1			2.367	2.367	2.367	0.500	1.183	13.55	61%
	14.5	0.50	0.9			2.411	2.411	2.411	0.540	1.302	14.15	64%
	15.2	0.75	0.85			2.653	2.653	2.653	0.636	1.691	14.9	68%
	16	0.90	0.8			2.826	2.826	2.826	0.720	2.034	15.8	72%
	17	1.00	0.8			2.794	2.794	2.794	0.800	2.235	16.8	77%
	18	1.00	0.9			2.721	2.721	2.721	0.900	2.449	17.8	82%
	19	1.00	0.9			2.058	2.058	2.058	0.900	1.853	18.8	86%
	20	1.00	0.9			2.009	2.009	2.009	0.900	1.808	19.8	90%
	21	1.00	0.92			1.844	1.844	1.844	0.920	1.696	20.8	94%
	22	1.00	0.9			2.020	2.020	2.020	0.900	1.818	21.8	97%
	23	0.90	0.9			1.477	1.477	1.477	0.810	1.196	22.7	100%
	23.8	0.40	0			0.000	0.000	0.000	0.000	0.000	23.1	100%

Observation/Comments: _____

WRB REVIEW NOTES FIELD CARD FOR USE OF VERTICAL AXIS METER

Velocity limits of current meters

Meters	Velocity (ft./sec.)
Pygmy	0.25-3.00
AA	0.25-8.00

Spin tests limits

Meters	Normal	Minimum
Pygmy	1.5	45 sec
Ice, vane	4.0	2.0
Type-AA	4.0	2.0

Meter operation

Water Depth (feet)	Meter use	Method
2.5 or deeper	Type-AA	0.2 and 0.8
1.5-2.5	Type-AA	0.6
1.5 or deeper	Pygmy	0.2 and 0.8
0.30-1.5	Pygmy	0.6

- A measurement cross section should have 25-30 measurement stations.
- No more than 10% of the total flow should be in a single measurement cell.
- Each measurement should be at least 40 seconds duration, and end on a complete revolution of the meter bucket wheel.
- A two point, two and eight tenths, velocity method should be used with an AA in depths over 2.5 feet.
- The AA meter should be used in depths 1.5 feet or greater. It should not be used less than 0.5 feet from any boundary such as the bed or bank of a channel.
- The pygmy meter should be used in depths between 0.3 and 1.5 feet. It should not be used at less than 0.3 feet from any boundary such as the bed or bank of a channel.
- Complete discharge calculations on the appropriate form before leaving a site.

DESCRIPTIONS FOR MEASUREMENT NOTE SHEETS

FLOW

- Steady or Varied
 - Describe change in GH during measurement
- Uniform or Non-Uniform
 - How is flow distributed in the cross section?
- Laminar or Turbulent
 - Does the flow pulsate? Does flow have some vertical component?
- Suspended Material
 - Do leaves or algae in water affect meter performance?

CROSS-SECTION

- Uniform or Non-Uniform
 - Is cross-section profile even or uneven?
- Smooth, moderately rough, rough, very rough
 - Describes irregularity of bed
- Channel bed material
 - Mud, sand, pebbles, cobbles, boulders?
 - Upstream bed material - may create turbulent flow

CONTROL

- Describe control type
 - Natural riffle
 - Length?
 - Bed material?
 - Stable or subject to change?
 - channel
 - is flow contained in channel, in the bank vegetation, or over bank flow?
 - channel constriction
 - are banks stable?
 - Bank composition?
 - Weir
 - type and condition
- Where
 - How many feet downstream of gage?
- Conditions
 - Clear & unobstructed, affected by moss or algae, affected by leaves or other debris, noticeable changes?

(Aug. 2007)

UNITED STATES
DOI-NPS-WRD
WATER RIGHTS BRANCH

DISCHARGE MEASUREMENT NOTES

Meas. No. _____

Date 9/10/08

Station Number _____ Comp. by _____ Checked by _____

Park Crater Lake Station Name Annie Cr blw EFR Confluence WR
FT Klamath, OR

Personnel: Meter J LaMaruka Notes IL

Weather Sunny / Cool

Measurement Type (circle one) Yading Cable, Bridge, Boat, Ice Upstr, Dnst. 3 ft., ml. of gage

Measurement Time/G.H.: Local /Standard (24hr) Start: 10:00 G.H. 0.36± Stop: 10:54 G.H. 0.36±

Meter Type Son Tek S/N _____ Spin Before Meas. _____ After _____ (sec)

Meter Rating Flow Tractor Levels Obtained: Yes/No _____ Datum Changed: Yes/No _____

High Water Mark _____ Gage Height of Zero Flow _____ ft.

Crest Stage Checked: Yes/No _____ Stick Reading _____ ft.

GAGE READINGS		
TIME (local 24 hr)	INSIDE (data logger)	OUTSIDE (staff gage- GH)
<u>9:30</u>		<u>0.36 I</u>
<u>10:00</u>	<u>START</u>	<u>0.36±</u>
<u>10:54</u>	<u>Finish</u>	<u>0.36±</u>
Weighted M.G.H.		
G.H. correction		
Correct M.G.H.		

Air _____ °C °F @ _____

Water 38.8 °C °F @ 10:54

Cond. _____ @ _____

pH _____ @ _____

Sensor: _____

Bubbler: _____

Type: _____

Bbl rate _____ per min.

Intake/Orifice cleaned: Yes/No _____

Transducer: _____

Type: _____

PSIG 2.5, 5, 10, 15, 30

Other: _____

Desiccant changed: Yes/No _____

Flow: Width 23.6 Area 20.81 Ave. Vel. 2.29 G.H. 0.36± Disch. 47.61

Method 0.6 Method coeff. _____ Hor. Angle coeff. NOTED Susp. Type _____ Susp. Coeff. _____

Meter _____ ft. above bottom of weight No. Secs. 33 G.H. changes 0 ft. in 1 hrs.

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%); based on the following cond:

Flow Fairly uniform, turbulent, steady

Cross Section UNIFORM, MODERATELY ROUGH, GRAVEL/SMALL COBBLES

Control Riffle, 100' long

Meas. Plots _____ % diff. from _____ rating _____

Photos Taken: Yes/No _____

River at--												
Angle co-efficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY		Adjusted for hor. angle or -----	Area	Discharge	
							At point	Mean in vertical				
	0.2	—	—	0.6			REW @ 10:00					.80
	1.0	0.8	0.88				1.61					.85
	2.0	1.0	0.72				1.79					
	3.0	1.1	0.95				1.98					.90
	4.0	0.9	0.90				2.11					
	5.0	1.0	0.90				2.53					.92
	6.0	1.0	0.90				3.02					.94
	7.0	1.0	0.81				3.28					
	8.0	1.0	1.80				2.90					.96
	8.8	0.8	0.90				2.39					.97
	9.5	0.7	0.92				2.53					.98
	10.0	0.5	1.00				2.02					.99
	10.5	0.5	1.00				2.47					
	11.0		1.18				2.34					
0	11.5		1.18				2.36					1.00
	12.0		1.23				2.52					
	12.5		1.18				2.79					
	13.0		1.20				2.85					.99
	13.5		1.28				2.63					.98
	14.0		1.28				2.37					.97
	14.5		1.25				2.44					.96
	15.0		1.05				2.55					
	15.5		1.10				2.62					.94
	16.0		1.00				2.25					.92
	16.5		0.85				2.99					.90
	17.0	1.0	0.90				1.93					
	18.0	1.0	0.78				2.94					
	19.0	1.0	0.81				2.35					.85
	20	1.0	0.70				1.83					
	21	1.0	0.75				1.40					
	22	1.0	0.71				0.88					.80
	23	1.0	0.65				0.46					
	23.8	0.8					LEW @ 10:54					

Discharge Measurement Summary

Date Generated: Wed Oct 1 2008

File Information

File Name Misc_2008-09-18.WAD
Start Date and Time 2008/09/18 09:00:24

Site Details

Site Name
Operator(s) JL

System Information

Sensor Type FlowTracker
Serial # P1009
CPU Firmware Version 3.4
Software Ver 2.20

Units (English Units)

Distance ft
Velocity ft/s
Area ft^2
Discharge cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	1.2%
Velocity	0.6%	2.3%
Width	0.1%	0.1%
Method	1.4%	-
# Stations	1.6%	-
Overall	2.4%	2.8%

Summary

Averaging Int. 40 # Stations 33
Start Edge REW Total Width 23.600
Mean SNR 33.2 dB Total Area 20.810
Mean Temp 38.83 °F Mean Depth 0.882
Disch. Equation Mid-Section Mean Velocity 2.2880
Total Discharge 47.6129

Measurement Results

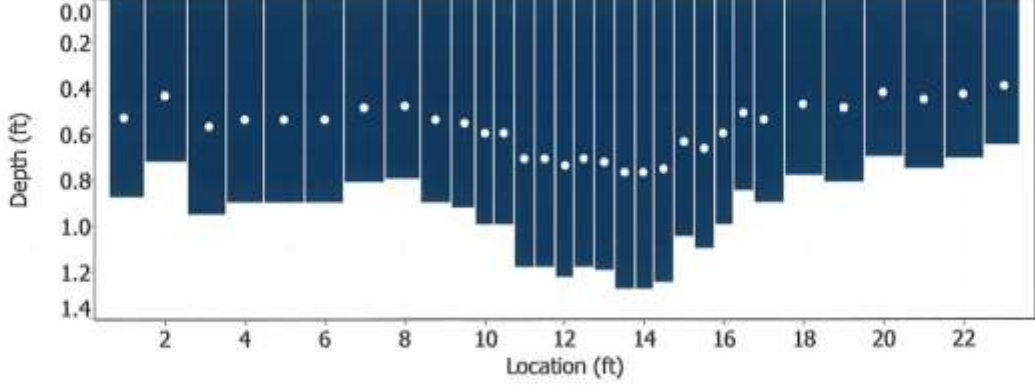
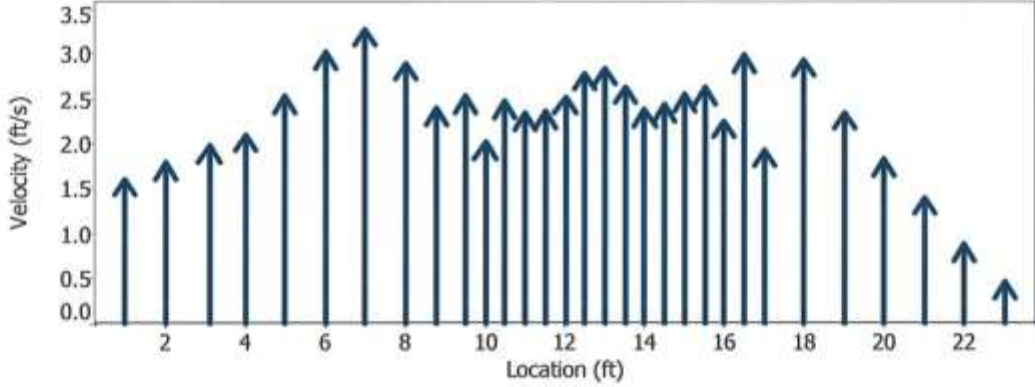
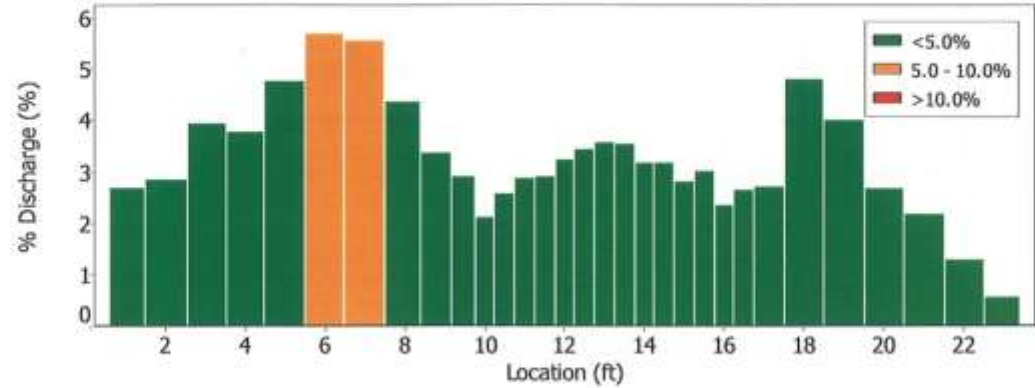
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	09:00	0.20	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	09:00	1.00	0.6	0.880	0.6	0.352	1.6106	1.00	1.6106	0.792	1.2754	2.7
2	09:03	2.00	0.6	0.720	0.6	0.288	1.7923	1.00	1.7923	0.756	1.3553	2.8
3	09:05	3.10	0.6	0.950	0.6	0.380	1.9757	1.00	1.9757	0.950	1.8772	3.9
4	09:07	4.00	0.6	0.900	0.6	0.360	2.1073	1.00	2.1073	0.855	1.8015	3.8
5	09:08	5.00	0.6	0.900	0.6	0.360	2.5285	1.00	2.5285	0.900	2.2755	4.8
6	09:09	6.00	0.6	0.900	0.6	0.360	3.0203	1.00	3.0203	0.900	2.7181	5.7
7	09:11	7.00	0.6	0.810	0.6	0.324	3.2792	1.00	3.2792	0.810	2.6563	5.6
8	09:12	8.00	0.6	0.800	0.6	0.320	2.8973	1.00	2.8973	0.720	2.0856	4.4
9	09:15	8.80	0.6	0.900	0.6	0.360	2.3924	1.00	2.3924	0.675	1.6147	3.4
10	09:16	9.50	0.6	0.920	0.6	0.368	2.5322	1.00	2.5322	0.552	1.3978	2.9
11	09:18	10.00	0.6	1.000	0.6	0.400	2.0167	1.00	2.0167	0.500	1.0084	2.1
12	09:20	10.50	0.6	1.000	0.6	0.400	2.4724	1.00	2.4724	0.500	1.2362	2.6
13	09:21	11.00	0.6	1.180	0.6	0.472	2.3363	1.00	2.3363	0.590	1.3785	2.9
14	09:22	11.50	0.6	1.180	0.6	0.472	2.3635	1.00	2.3635	0.590	1.3946	2.9
15	09:24	12.00	0.6	1.230	0.6	0.492	2.5210	1.00	2.5210	0.615	1.5504	3.3
16	09:26	12.50	0.6	1.180	0.6	0.472	2.7900	1.00	2.7900	0.590	1.6463	3.5
17	09:27	13.00	0.6	1.200	0.6	0.480	2.8468	1.00	2.8468	0.600	1.7083	3.6
18	09:28	13.50	0.6	1.280	0.6	0.512	2.6345	1.00	2.6345	0.640	1.6859	3.5
19	09:30	14.00	0.6	1.280	0.6	0.512	2.3743	1.00	2.3743	0.640	1.5194	3.2
20	09:32	14.50	0.6	1.250	0.6	0.500	2.4373	1.00	2.4373	0.625	1.5233	3.2
21	09:33	15.00	0.6	1.050	0.6	0.420	2.5502	1.00	2.5502	0.525	1.3387	2.8
22	09:35	15.50	0.6	1.100	0.6	0.440	2.6227	1.00	2.6227	0.550	1.4426	3.0
23	09:37	16.00	0.6	1.000	0.6	0.400	2.2503	1.00	2.2503	0.500	1.1252	2.4
24	09:38	16.50	0.6	0.850	0.6	0.340	2.9865	1.00	2.9865	0.425	1.2694	2.7
25	09:40	17.00	0.6	0.900	0.6	0.360	1.9295	1.00	1.9295	0.675	1.3023	2.7
26	09:43	18.00	0.6	0.780	0.6	0.312	2.9393	1.00	2.9393	0.780	2.2922	4.8
27	09:44	19.00	0.6	0.810	0.6	0.324	2.3540	1.00	2.3540	0.810	1.9068	4.0
28	09:45	20.00	0.6	0.700	0.6	0.280	1.8287	1.00	1.8287	0.700	1.2804	2.7
29	09:46	21.00	0.6	0.750	0.6	0.300	1.4039	1.00	1.4039	0.750	1.0529	2.2
30	09:48	22.00	0.6	0.710	0.6	0.284	0.8809	1.00	0.8809	0.710	0.6254	1.3
31	09:50	23.00	0.6	0.650	0.6	0.260	0.4587	1.00	0.4587	0.585	0.2683	0.6
32	09:50	23.80	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

Discharge Measurement Summary

Date Generated: Wed Oct 1 2008

File Information		Site Details	
File Name	Misc_2008-09-18.WAD	Site Name	
Start Date and Time	2008/09/18 09:00:24	Operator(s)	JL



Discharge Measurement Summary

Date Generated: Wed Oct 1 2008

File Information

File Name Misc_2008-09-18.WAD
Start Date and Time 2008/09/18 09:00:24

Site Details

Site Name
Operator(s) JL

Quality Control

St	Loc	%Dep	Message
14	11.50	0.6	High number of spikes: 5
20	14.50	0.6	High standard error: 0.123
25	17.00	0.6	High standard error: 0.113
27	19.00	0.6	High angle: 25
28	20.00	0.6	High angle: 28
29	21.00	0.6	High angle: 29
31	23.00	0.6	High angle: 25

HMST v2.9 One-Point Velocity Discharge Measurement Checker With EDIs

By Brian Loving, Hydrologist, US Geological Survey

Station Name:	Annie Creek below the East Fork				Print Header
Station Number:		WIDTH	23.600	# of Sections	33
Date:	09/18/08	AREA	20.810	Sections > 5%	2
Measurement #:		VELOCITY	2.288	Sections > 10%	0
Meter Type:	Pymy	TOTAL DISCHARGE		*Standard Error	
Rating # (1 or 2)	2				
# of EDI Verticals	5	Measurement sheet Q is OK if between 47.14 and 48.09			
EDI Sample #	1	2	3	4	5
Location to Sample	3.7	7.6	11.7	14.6	18.7

* Standard error computed using OFR 92-144 Method

Clear Sheet

Stable (uneven, gravel-boulders)

Rod

NOTE: BEW in column L below refers to Beginning Edge of Water

Correction Coefficient	Distance	Width	Depth	Revolutions	Seconds	Velocity At Point	Mean Velocity	Adjusted Velocity	Area	Discharge	Distance From BEW	% of Total Q So Far
	0.2	0.40	0			0.000	0.000	0.000	0.000	0.000	0.4	0%
	1	0.90	0.88			1.611	1.611	1.611	0.792	1.276	1.3	3%
	2	1.05	0.72			1.792	1.792	1.792	0.756	1.355	2.35	8%
	3.1	1.00	0.95			1.978	1.978	1.978	0.950	1.877	3.35	9%
	4	0.95	0.9			2.107	2.107	2.107	0.855	1.802	4.3	13%
	5	1.00	0.9			2.529	2.529	2.529	0.900	2.276	5.3	18%
	6	1.00	0.9			3.020	3.020	3.020	0.900	2.718	6.3	24%
	7	1.00	0.81			3.279	3.279	3.279	0.810	2.656	7.3	29%
	8	0.90	0.8			2.897	2.897	2.897	0.720	2.086	8.2	34%
	8.8	0.75	0.9			2.392	2.392	2.392	0.675	1.615	8.95	37%
	9.5	0.60	0.92			2.532	2.532	2.532	0.552	1.398	9.55	40%
	10	0.50	1			2.017	2.017	2.017	0.500	1.008	10.05	42%
	10.5	0.50	1			2.472	2.472	2.472	0.500	1.236	10.55	45%
	11	0.50	1.18			2.336	2.336	2.336	0.590	1.378	11.05	48%
	11.5	0.50	1.18			2.364	2.364	2.364	0.590	1.394	11.55	51%
	12	0.50	1.23			2.521	2.521	2.521	0.615	1.550	12.05	54%
	12.5	0.50	1.18			2.790	2.790	2.790	0.590	1.646	12.55	57%
	13	0.50	1.2			2.847	2.847	2.847	0.600	1.708	13.05	61%
	13.5	0.50	1.28			2.635	2.635	2.635	0.640	1.686	13.55	64%
	14	0.50	1.28			2.374	2.374	2.374	0.640	1.520	14.05	68%
	14.5	0.50	1.25			2.437	2.437	2.437	0.625	1.523	14.55	71%
	15	0.50	1.05			2.550	2.550	2.550	0.525	1.339	15.05	74%
	15.5	0.50	1.1			2.623	2.623	2.623	0.550	1.442	15.55	77%
	16	0.50	1			2.250	2.250	2.250	0.500	1.125	16.05	79%
	16.5	0.50	0.85			2.987	2.987	2.987	0.425	1.269	16.55	82%
	17	0.75	0.9			1.930	1.930	1.930	0.675	1.302	17.3	84%
	18	1.00	0.78			2.939	2.939	2.939	0.780	2.293	18.3	89%
	19	1.00	0.81			2.354	2.354	2.354	0.810	1.907	19.3	93%
	20	1.00	0.7			1.829	1.829	1.829	0.700	1.280	20.3	96%
	21	1.00	0.75			1.404	1.404	1.404	0.750	1.053	21.3	98%
	22	1.00	0.71			0.881	0.881	0.881	0.710	0.625	22.3	99%
	23	0.90	0.65			0.459	0.459	0.459	0.585	0.268	23.2	100%
	23.8	0.40	0			0.000	0.000	0.000	0.000	0.000	23.6	100%

River at--

Angle coefficient	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY		Adjusted for hor. angle or -----	Area	Discharge	
							At point	Mean in vertical				
	50		0.0	0.0	13	43.6	0.34					.80
	60		0.3	0.3	13	43.5	0.31					.85
	70		0.4	0.4	30	40.2	0.74					
	80		0.4	0.4	31	40.0	0.76					
	90		0.52	0.5	58	40.0	1.42					.90
	100		0.6	0.6	65	40.3	1.58					.92
	110		0.73	0.75	73	40.6	1.750					.94
	120		0.85	0.85	79	40.4	1.90					.96
	130		1.0	1.0	88	40.4	2.123					.97
	140		1.1	1.1	90	40.3	2.17					.98
	150		1.2	1.2	98	40.6	2.349					.99
	15.5		1.1	1.1	105	40.3	2.533					.99
	160		1.2	1.2	110	40.2	2.605					
	16.5		1.3	1.2	104	40.3	2.51					
0	170		1.2	1.2	112	40.2	2.70					1.00
	17.5		1.2	1.2	115	40.0	2.70					
	180		1.3	1.2	114	40.1	2.74					
	18.5		1.3	1.3	114	40.3	2.74					.99
	190		1.3	1.3	178	40.2	2.95					.98
	19.5		1.4	1.4	116	40.2	2.80					.97
	200		1.4	1.4	111	40.2	2.68					.96
	20.5		1.3	1.3	103	40.3	2.48					.94
	210		1.3	1.3	103	40.5	2.54					.92
	21.5		1.6	1.6	110	40.5	2.666					.90
	220		1.6	1.6	112	40	2.73					.88
	22.5		1.6	1.6	114	40.2	2.75					.85
	230		1.6	1.6	112	40	2.73					
	23.5		1.3	1.3	118	40.3	2.84					.80
	240		1.4	1.4	116	40.1	2.89					
	24.5		1.4	1.4	114	40.1	2.76					
	250		1.25	1.25	106	40.1	2.57					.80
	25.5		1.2	1.2	108	40.2	2.61					

.8
.10
.20
.30
.40
.50
.60
.70
.75

[illegible]

HMST v2.9 One-Point Velocity Discharge Measurement Checker With EDIs
By Brian Loving, Hydrologist, US Geological Survey

Station Name:	Annie Creek above Park Boundary			
Station Number:	WIDTH	26.100	# of Sections	43
Date:	09/17/08	AREA	26.240	Sections > 8%
Measurement #:	VELOCITY	2.286	Sections > 10%	0
Meter Type:	Pygmy	*Standard Error		0
Rating # (1 or 2)	2	TOTAL DISCHARGE		59.997
# of EDI Verticals	5	Measurement sheet Q is OK if between 59.40 and 60.60		
EDI Sample #				
Location to Sample	1	2	3	4
	12.8	17.2	20.5	23.4
	27.1	6	7	8
	9			

Point Header
Point Full Sheet
Clear Sheet
Rod
Stable (uneven, gravel-boulders)

* Standard error computed using OFR 92-144 Method

NOTE: BEW in column L below refers to Beginning Edge of Water

Correction Coefficient	Distance	Width	Depth	Revolutions	Seconds	Velocity At Point	Mean Velocity	Adjusted Velocity	Area	Discharge	Distance From BEW	% of Total Q So Far
	5	0.50	0			0.000	0.000	0.000	0.000	0.000	0.5	0%
	6	1.00	0.3			0.310	0.310	0.310	0.300	0.093	1.5	0%
	7	1.00	0.4			0.740	0.740	0.740	0.400	0.296	2.5	1%
	8	1.00	0.4			0.760	0.760	0.760	0.400	0.304	3.5	1%
	9	1.00	0.55			1.420	1.420	1.420	0.550	0.781	4.5	2%
	10	1.00	0.6			1.580	1.580	1.580	0.600	0.948	5.5	4%
	11	1.00	0.75			1.758	1.758	1.758	0.750	1.319	6.5	6%
	12	1.00	0.85			1.900	1.900	1.900	0.850	1.615	7.5	9%
	13	1.00	1			2.123	2.123	2.123	1.000	2.123	8.5	12%
	14	1.00	1.1			2.170	2.170	2.170	1.100	2.387	9.5	16%
	15	0.75	1.2			2.348	2.348	2.348	0.900	2.114	10.25	20%
	15.5	0.50	1.2			2.533	2.533	2.533	0.600	1.520	10.75	23%
	16	0.50	1.2			2.650	2.650	2.650	0.600	1.590	11.25	25%
	16.5	0.50	1.2			2.510	2.510	2.510	0.600	1.506	11.75	28%
	17	0.50	1.2			2.700	2.700	2.700	0.600	1.620	12.25	30%
	17.5	0.50	1.2			2.790	2.790	2.790	0.600	1.674	12.75	33%
	18	0.50	1.2			2.740	2.740	2.740	0.600	1.644	13.25	36%
	18.5	0.50	1.3			2.740	2.740	2.740	0.650	1.781	13.75	39%
	19	0.50	1.3			2.850	2.850	2.850	0.650	1.853	14.25	42%
	19.5	0.50	1.4			2.800	2.800	2.800	0.700	1.960	14.75	45%
	20	0.50	1.4			2.680	2.680	2.680	0.700	1.876	15.25	48%
	20.5	0.50	1.5			2.480	2.480	2.480	0.750	1.860	15.75	51%
	21	0.50	1.5			2.540	2.540	2.540	0.750	1.905	16.25	55%
	21.5	0.50	1.6			2.668	2.668	2.668	0.800	2.133	16.75	58%
	22	0.50	1.6			2.720	2.720	2.720	0.800	2.178	17.25	62%
	22.5	0.50	1.6			2.750	2.750	2.750	0.800	2.200	17.75	65%
	23	0.50	1.6			2.720	2.720	2.720	0.800	2.176	18.25	69%
	23.5	0.50	1.5			2.840	2.840	2.840	0.750	2.130	18.75	73%
	24	0.50	1.45			2.800	2.800	2.800	0.725	2.030	19.25	76%
	24.5	0.50	1.4			2.760	2.760	2.760	0.700	1.932	19.75	79%
	25	0.50	1.25			2.570	2.570	2.570	0.625	1.606	20.25	82%
	25.5	0.50	1.2			2.610	2.610	2.610	0.600	1.566	20.75	85%
	26	0.50	1.1			2.540	2.540	2.540	0.550	1.397	21.25	87%
	26.5	0.50	1.1			2.200	2.200	2.200	0.550	1.210	21.75	89%
	27	0.50	0.98			2.050	2.050	2.050	0.490	1.005	22.25	91%
	27.5	0.50	0.9			2.170	2.170	2.170	0.450	0.977	22.75	92%
	28	0.50	0.9			2.550	2.550	2.550	0.450	1.148	23.25	94%
	28.5	0.50	0.9			2.550	2.550	2.550	0.450	1.148	23.75	96%
	29	0.50	1			2.000	2.000	2.000	0.500	1.000	24.25	98%
	28.5	0.50	1			1.690	1.690	1.690	0.500	0.845	24.75	99%
	30	0.50	1			0.730	0.730	0.730	0.500	0.365	25.25	100%
	30.5	0.55	1			0.340	0.340	0.340	0.550	0.187	25.8	100%
	31.1	0.30	0			0.000	0.000	0.000	0.000	0.000	26.1	100%

Observation/Comments: _____

WRB REVIEW NOTES FIELD CARD FOR USE OF VERTICAL AXIS METER

Velocity limits of current meters

Meters	Velocity (ft./sec.)
Pygmy	0.25-3.00
AA	0.25-8.00

Spin tests limits

Meters	Normal	Minimum
Pygmy	1.5	45 sec
Ice, vane	4.0	2.0
Type-AA	4.5	2.0

Meter operation.

Water Depth (feet)	Meter use	Method
2.5 or deeper	Type-AA	0.2 and 0.8
1.5-2.5	Type-AA	0.6
1.5 or deeper	Pygmy	0.2 and 0.8
0.30-1.5	Pygmy	0.6

- A measurement cross section should have 25-30 measurement stations.
- No more than 10% of the total flow should be in a single measurement cell.
- Each measurement should be at least 40 seconds duration, and end on a complete revolution of the meter bucket wheel.
- A two point, two and eight tenths, velocity method should be used with an AA in depths over 2.5 feet.
- The AA meter should be used in depths 1.5 feet or greater. It should not be used less than 0.5 feet from any boundary such as the bed or bank of a channel.
- The pygmy meter should be used in depths between 0.3 and 1.5 feet. It should not be used at less than 0.3 feet from any boundary such as the bed or bank of a channel.
- Complete discharge calculations on the appropriate form before leaving a site.

DESCRIPTIONS FOR MEASUREMENT NOTE SHEETS

FLOW

- Steady or Varied
 - Describe change in GH during measurement
- Uniform or Non-Uniform
 - How is flow distributed in the cross section?
- Laminar or Turbulent
 - Does the flow pulsate? Does flow have some vertical component?
- Suspended Material
 - Do leaves or algae in water affect meter performance?

CROSS-SECTION

- Uniform or Non-Uniform
 - Is cross-section profile even or uneven?
- Smooth, moderately rough, rough, very rough
 - Describes irregularity of bed
- Channel bed material
 - Mud, sand, pebbles, cobbles, boulders?
 - Upstream bed material - may create turbulent flow

CONTROL

- Describe control type
 - Natural riffle
 - Length?
 - Bed material?
 - Stable or subject to change?
 - channel
 - is flow contained in channel, in the bank vegetation, or over bank flow?
 - channel constriction
 - are banks stable?
 - Bank composition?
 - Weir
 - type and condition
- Where
 - How many feet downstream of gage?
- Conditions
 - Clear & unobstructed, affected by moss or algae, affected by leaves or other debris, noticeable changes?

(Aug. 2007)

UNITED STATES
DOI-NPS-WRD
WATER RIGHTS BRANCH

DISCHARGE MEASUREMENT NOTES

Meas. No. _____

Date 9-18-08

Station Number _____ Comp. by _____ Checked by _____

Park _____ Station Name Border park - Annie Cr

Personnel: Meter Churchill Notes _____

Weather sunny

Measurement Type (circle one) Wading, Cable, Bridge, Boat, Ice; Upstr., Dnst. _____ ft. mi. of gage

Measurement Time/G.H.: Local /Standard (24hr) Start: 1000 G.H. 1.41 Stop: 1100 G.H. 1.41

Meter Type pygmy S/N _____ Spin Before Meas. 45+ After 45+ (sec)

Meter Rating _____ Levels Obtained: Yes/No _____ Datum Changed: Yes/No _____

High Water Mark _____ Gage Height of Zero Flow _____ ft.

Crest Stage Checked: Yes/No _____ Stick Reading _____ ft.

GAGE READINGS

TIME (local/24 hr)	INSIDE (after logger)	OUTSIDE (180° gage-GH)
<u>938</u>		<u>1.41</u>
<u>958</u>		<u>1.41</u>
<u>1100</u>		<u>1.41</u>
<u>Daylight saving time</u>		
Weighted M.G.H.		
G.H. correction		
Correct M.G.H.		

Air 50 °C °F @ 939

Water 40 °C °F @ 940

Cond. _____ @ _____

pH _____ @ _____

Sensor:

Bubbler:

Type _____

Bbl rate _____ per min.

Intake/Orifice cleaned: Yes/No _____

Transducer:

Type _____

PSIG 2.5, 5, 10, 15, 30

Other: _____

Desiccant changed: Yes/No _____

Flow: Width 26.0 Area 26.4 Ave. Vel. 2.31 G.H. 1.41 Disch. 61.1

Method 6 Method coeff. _____ Hor. Angle coeff. _____ Susp. Type _____ Susp. Coeff. _____

Meter _____ ft. above bottom of weight No. Secs. _____ G.H. changes _____ ft. in _____ hrs.

Measurement rated: excellent (2%), good (5%), fair (8%), poor (over 8%); based on the following cond:

Flow even

Cross Section gravel

Control channel

Meas. Plots _____ % diff. from _____ rating _____

Photos Taken: Yes/No _____

Angle of observation	Dist. from initial point	Width	Depth	Observation depth	Revolutions	Time in seconds	VELOCITY		Adjusted for hor. angle or	Area	Discharge
							At point	Mean in vertical			
29	0°		0°	4	N ₆	46.1		LE	W	9.000	
30	0°		0°	17		40.5	0.93				
48	0°		0°	39		40.1	0.96				
60	0°		0°	55		40.1	1.34				
78	0°		0°	65		40.1	1.58				
90	0°		0°	86		40.4	2.07				
10	0°		0°	91		40.3	2.2				
11	1°		1°	104		40.3	2.51				
115	1°		1°	110		40.3	2.65				
120	1°		1°	102		40.3	2.46				
125	1°		1°	106		40.3	2.56				
130	1°		1°	109		40.1	2.64				
135	1°		1°	112		40.1	2.71				
140	1°		1°	111		40.3	2.67				
145	1°		1°	110		40	2.67				
150	1°		1°	105		40	2.55				
155	1°		1°	113		40.3	2.72				
160	1°		1°	117		40.1	2.83				
165	1°		1°	111		40.1	2.69				
170	1°		1°	111		40.1	2.69				
175	1°		1°	104		40.3	2.51				
180	1°		1°	106		40	2.57				
185	1°		1°	107		40	2.60				
190	1°		1°	113		40.5	2.73				
195	1°		1°	117		40.3	2.86				
200	1°		1°	109		40.3	2.63				
205	1°		1°	113		40.1	2.73				
210	1°		1°	110		40.1	2.64				
215	1°		1°	110		40.3	2.65				
220	1°		1°	104		40.1	2.52				
225	1°		1°	104		40.3	2.51				
230	1°		1°	100		40.3	2.43				

[illegible]

HMST v2.9 One-Point Velocity Discharge Measurement Checker With EDIs

By Brian Loving, Hydrologist, US Geological Survey

Station Name:	Annie Creek above Park Boundary				Print Header
Station Number:		WIDTH	26.000	# of Sections	38
Date:	09/18/08	AREA	26.370	Sections > 5%	0
Measurement #:		VELOCITY	2.313	Sections > 10%	0
Meter Type:	Pygmy	TOTAL DISCHARGE		60.987	
Rating # (1 or 2)	2	*Standard Error			
# of EDI Verticals	5	Measurement sheet Q is OK if between 60.38 and 61.60			
EDI Sample #	1	2	3	4	5
Location to Sample	9.6	13.9	17.3	20.1	23.9

* Standard error computed using OFR 92-144 Method

Clear Sheet Rod

Stable (uneven, gravel-boulders)

NOTE: BEW in column L below refers to Beginning Edge of Water

Correction Coefficient	Distance	Width	Depth	Revolutions	Seconds	Velocity At Point	Mean Velocity	Adjusted Velocity	Area	Discharge	Distance From BEW	% of Total Q So Far
	2	0.50	0			0.000	0.000	0.000	0.000	0.000	0.5	0%
	3	1.25	0.3			0.430	0.430	0.430	0.375	0.161	1.75	0%
	4.5	1.50	0.45			0.960	0.960	0.960	0.675	0.648	3.25	1%
	6	1.50	0.55			1.340	1.340	1.340	0.825	1.108	4.75	3%
	7.5	1.50	0.68			1.580	1.580	1.580	1.020	1.612	6.25	6%
	9	1.25	0.9			2.070	2.070	2.070	1.125	2.329	7.5	10%
	10	1.00	0.95			2.200	2.200	2.200	0.950	2.090	8.5	13%
	11	0.75	1.1			2.510	2.510	2.510	0.825	2.071	9.25	16%
	11.5	0.50	1.1			2.650	2.650	2.650	0.550	1.458	9.75	19%
	12	0.50	1.15			2.460	2.460	2.460	0.575	1.415	10.25	21%
	12.5	0.50	1.2			2.560	2.560	2.560	0.600	1.536	10.75	24%
	13	0.50	1.2			2.640	2.640	2.640	0.600	1.584	11.25	26%
	13.5	0.50	1.2			2.710	2.710	2.710	0.600	1.626	11.75	29%
	14	0.50	1.25			2.670	2.670	2.670	0.625	1.669	12.25	32%
	14.5	0.50	1.25			2.670	2.670	2.670	0.625	1.669	12.75	34%
	15	0.50	1.3			2.550	2.550	2.550	0.650	1.656	13.25	37%
	15.5	0.50	1.35			2.720	2.720	2.720	0.675	1.836	13.75	40%
	16	0.50	1.4			2.830	2.830	2.830	0.700	1.981	14.25	43%
	16.5	0.50	1.4			2.690	2.690	2.690	0.700	1.883	14.75	46%
	17	0.50	1.5			2.690	2.690	2.690	0.750	2.018	15.25	50%
	17.5	0.50	1.5			2.510	2.510	2.510	0.750	1.883	15.75	53%
	18	0.50	1.6			2.570	2.570	2.570	0.800	2.056	16.25	56%
	18.5	0.50	1.65			2.600	2.600	2.600	0.825	2.145	16.75	60%
	19	0.50	1.65			2.730	2.730	2.730	0.825	2.252	17.25	63%
	19.5	0.50	1.65			2.860	2.860	2.860	0.825	2.360	17.75	67%
	20	0.50	1.6			2.630	2.630	2.630	0.800	2.104	18.25	71%
	20.5	0.50	1.5			2.730	2.730	2.730	0.750	2.048	18.75	74%
	21	0.50	1.4			2.660	2.660	2.660	0.700	1.862	19.25	77%
	21.5	0.50	1.4			2.650	2.650	2.650	0.700	1.855	19.75	80%
	22	0.50	1.3			2.520	2.520	2.520	0.650	1.638	20.25	83%
	22.5	0.50	1.2			2.510	2.510	2.510	0.600	1.506	20.75	85%
	23	0.50	1.1			2.420	2.420	2.420	0.550	1.331	21.25	88%
	23.5	0.50	0.9			2.490	2.490	2.490	0.450	1.121	21.75	89%
	24	0.75	1			2.030	2.030	2.030	0.750	1.523	22.5	92%
	25	1.00	0.9			2.620	2.620	2.620	0.900	2.358	23.5	96%
	26	1.00	1.05			1.810	1.810	1.810	1.050	1.901	24.5	99%
	27	1.00	1			0.700	0.700	0.700	1.000	0.700	25.5	100%
	28	0.50	0			0.000	0.000	0.000	0.000	0.000	26	100%

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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