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Quality Assurance Project Plan

Black Creek Temperature Monitoring

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303 (d) listing

Waterbody	T	R	S	Listing ID	WBID	Parameter
Black Creek	18N	07W	17	7735	1236520470101	Temperature

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Quality Assurance Project Plan

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June 2010

Approved by:

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Abstract

Black Creek is in central Grays Harbor County, in the Washington State Department of Ecology's (Ecology) Water Resource Inventory Area (WRIA) 22. Black Creek is a tributary to the Wynoochee River, which is a major tributary to the Chehalis River. Black Creek is on the 303(d) list for temperature and has been since 1998. The category 5 listing is the result of data collected in 1990 by Ecology where water temperatures were found to exceed 18°C, the previous Class A standard. In 2006, the City of Montesano conducted a follow-up study. The data from that study showed that the downstream site would have met the water quality standard if it were still 18°C. However, the current water quality standard for temperature in Black Creek is 16°C and the segment exceeded the standard. This 2010 study will monitor current water temperatures to determine if temperatures in Black Creek meet the Core Summer Salmonid Habitat water quality standard of 16°C.

Each study conducted by Ecology must have an approved Quality Assurance Project Plan (QAPP). The QAPP describes the objectives of the study and the procedures to be followed to achieve those objectives. After completion of the study, a final report describing the study results will be posted to the Internet.

Background

Black Creek is in central Grays Harbor County, Washington, in Ecology's WRIA 22. Black Creek is a tributary to the Wynoochee River, which is a major tributary to the Chehalis River. The Black Creek watershed encompasses about 16,000 acres. This is a headwaters area with most of the watershed privately owned forest with some rural development (Schillinger, 2006).

During 1988 and 1989 commercial timber harvesting occurred on one side of the Black Creek headwaters (Rashin and Graber, 1992). At that time, the north side of the stream was clear-cut with reforestation less than five years old. Only a narrow zone of riparian over-story vegetation remained. Some portions of the riparian management zone (RMZ) were completely devoid of vegetation (Rashin and Graber, 1992). Rashin concluded that the RMZ was not adequate to protect water quality. Thermograph measurements in 1990 identified creek temperatures exceeding state water quality standard of 18°C. As a result, this reach of Black Creek was considered impaired and was placed on Ecology's 303(d) list of impaired waterbodies.

In 2006 the City of Montesano did follow-up monitoring to characterize summer water temperatures in the Black Creek headwaters after vegetation and canopy cover had had the chance to recover (Schillinger, 2006) No final report of results was written.

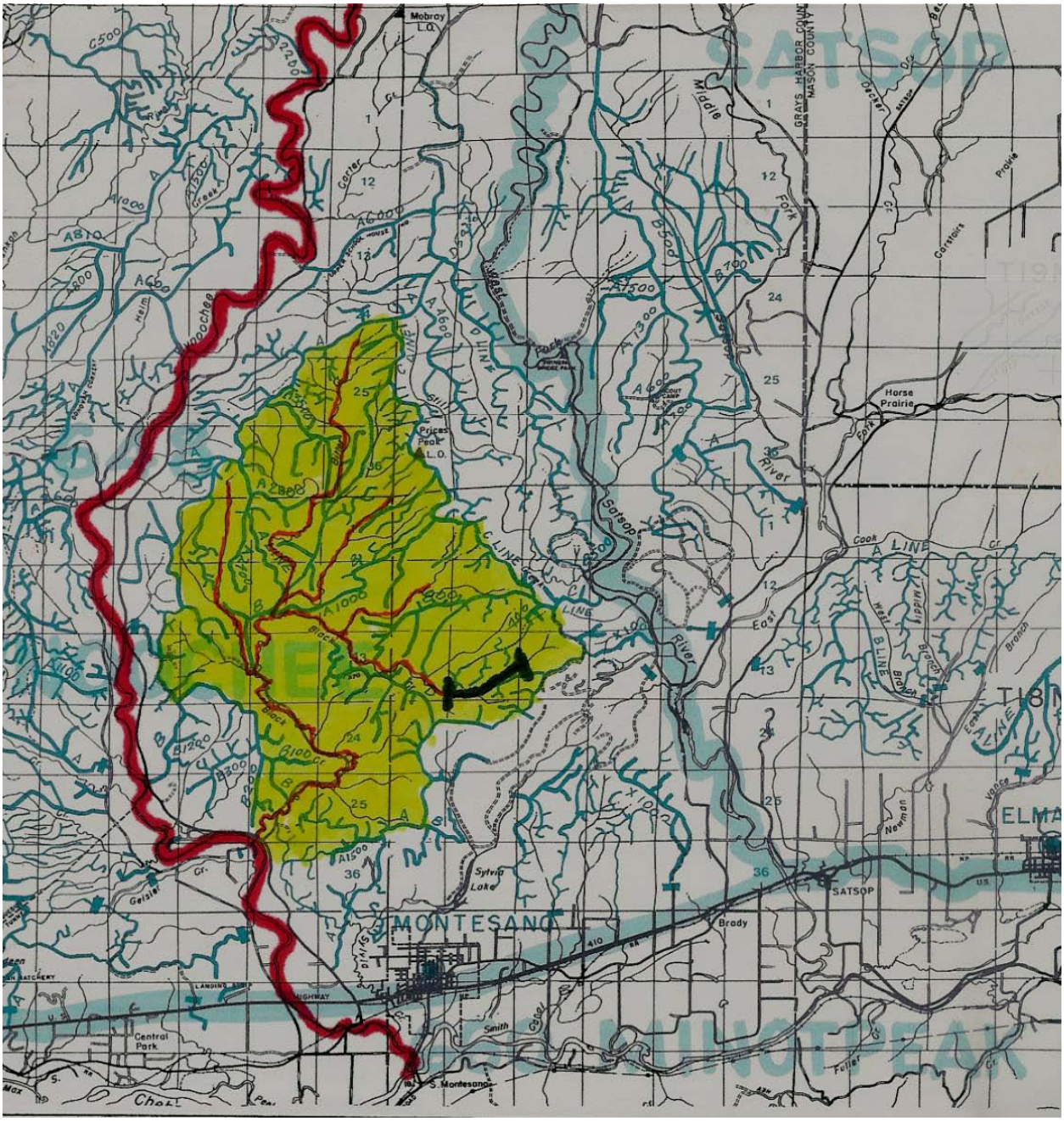

Figure 1. Black Creek Watershed and 1998 303d Listing Segment. *The listing segment on Black Creek is shown by the short thick black line within the watershed boundary. The longer thick red line highlights the Wynoochee River. (map from Schillinger, 2006).*

Project Description

This study will monitor current water temperatures to determine if temperatures in Black Creek meet the Core Summer Salmonid Habitat water quality standard of 16°C (Ecology, 2006).

Objectives

The objectives for this Black Creek study are:

1. Characterize water temperatures during the summer from July through September 2010.
2. Compare water temperature with Core Summer Salmonid Habitat water quality standards to determine if water quality standards are being met.

Beneficial uses

The Aquatic Life Temperature Criterion for Black Creek is Core Summer Salmonid Habitat. That is, the 7-day average of the daily maximum (7DADMAX) temperature can't exceed 16°C (Ecology 2006, Chapter 173-201A-030 WAC). The criteria are intended to define the level of protection necessary to protect beneficial uses. The primary beneficial uses of Black Creek are:

- Recreation: fishing and swimming
- Fish habitat: Fall Chinook (Oncorhynchus tshawytscha), coho (O. kisutch), winter steelhead (O. mykiss) and Cutthroat trout (O. Clarkii)
- Wildlife habitat: riparian areas provide habitat for many species of wildlife

Water temperature is a critical concern for water quality because most aquatic species are cold-blooded and therefore are strongly influenced by the temperature of water they have to live in (Schuett-Hames et al., 1999). Temperature is a major concern in Black Creek due to its use by salmonids. Elevated temperature resulting from various land use activities, such as stream adjacent timber harvest, limits the availability of adequate habitat.

Historic data review

RMZ management was evaluated in July 1990 by Ecology in cooperation with the Cooperative Monitoring, Evaluation, & Research Committee (Rashin and Graber, 1992). Temperature conditions in this RMZ were monitored. The 18°C temperature criterion was exceeded at the downstream location for 7 of the 12 days (58%). The RMZ at this site in 1990 was determined to be ineffective at maintaining stream temperature within water quality standards. The upper site was not considered a background reference site because part of the area had been clearcut.

In 2006, the City of Montesano conducted a follow-up study to the 1990 Ecology study (Schillinger, 2006). The objective was to determine if regrowth of the RMZ resulted in reduction of water temperatures. A final report was not written (Schillinger, personal communication, email April 2, 2010).

Ecology reviewed the data from 2006, summarized in Tables 1 and 2. Ecology's review found that the creek segment exceeded the old 18°C criteria during the entire study period. However, the downstream site did meet the18°C temperature criteria when looking at the data during July 18-31, 2006—the time period similar to the 1990 study.

Table 1. Percent Temperature Exceedance from the Previous Water Quality Standard of 18° C.

June 6, 2006 - September 15, 2006 (n=96)	
Upstream	Downstream
exceedance >18°C	exceedance >18°C
92%	22%
July 18, 2006 - July 31, 2006 (n=14)	
exceedance >18°C	exceedance >18°C
Upstream	Downstream
64%	0

n=number of samples

However, when reviewing the 2006 data in relation to the current standard of 16°C the stream segment did not meet water quality standards (Table 2).

Table 2. Percent Temperature Exceedance from the Current Water Quality Standard of 16° C.

June 6, 2006 - September 15, 2006 (n=96)	
Upstream	Downstream
exceedance >16°C	exceedance >16°C
100%	35%
July 18, 2006 - July 31, 2006 (n=14)	
exceedance >16°C	exceedance >16°C
Upstream	Downstream
93%	57%

n=number of samples

Organization and Schedule

Table 3 describes the responsibilities of project staff and Table 4 describes the schedule for project completion.

Table 3. Organization of Project Staff and Responsibilities

Staff	Title	Responsibilities
David Rountry Southwest Region Water Quality Program Phone: 360-407-6276	Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP. Field assistance. Reviews and approves draft and final report.
Betsy Dickes Southwest Region Water Quality Program Phone: 360-407-6296	Project Manager & Principal Investigator	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts quality assurance review of data. Analyzes and interprets data, and enters data into EIM. Writes the draft and final report.
Variable Ecology Staff	Field Assistant	Helps collect samples and records field information.
Craig Graber Southwest Region Water Quality Program Phone: 360-407-6299	Technical Assistant	Provides internal review of the QAPP and approves the final QAPP. Reviews draft and final report. Provides assistance with data logger installation.
Kim McKee Southwest Region Water Quality Program Phone: 360-407-6407	Unit Supervisor	Provides internal review of the QAPP, approves the budget, tracks progress, and approves the final QAPP. Reviews and approves draft and final report.
Garin Schrieve Southwest Region Water Quality Program Phone: 360-407-6271	Southwest Region Manager	Reviews the project scope and budget, reviews the draft QAPP, and approves the final QAPP. Reviews and approves draft and final report.
Mike Herold, Headquarters Water Quality Program Phone: 360-407-6434	Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.
Shawna Beers Southwest Region Water Quality Program Phone: 360-407-6270	Secretary Lead	Formats draft QAPP and report.
Kelsey Highfill Headquarters Water Quality Program Phone: 360-407-6722	Communication Consultant	Formats final QAPP and report. Uploads documents onto the Ecology website.

EIM – Environmental Information Management system
QAPP – Quality Assurance Project Plan

Table 4. Proposed Schedule for Completing Field Work and Reports.

Field and laboratory work	Due date	Lead staff
Field work completed	October 2010	Betsy Dickes
Environmental Information System (EIM) database		
EIM user study ID	BEDI0016	
EIM data loaded	July 2011	Betsy Dickes
Final report		
Author lead	Betsy Dickes	
Schedule		
Draft due to supervisor	February 2011	
Draft due to client/peer reviewer	March 2011	
Draft due to external reviewer(s)	April 2011	
Final (all reviews done) due to publications coordinator	June 2011	
Final report due on web	July 2011	

Measurement Quality Objectives

The data quality objectives are described in Table 5.

Table 5. Data Quality Objectives for the Thermographs

Equipment	Accuracy	Resolution
Certified Reference Thermometer HB Instrument Co.	± 0.1 °C	0.1 °C
Field Thermometer Brooklyn Thermometer Co.	± 0.2 °C	0.1 °C
Temperature Logger (Water) Onset Water Temp Prov2 Logger	±0.2°C at 0 to 50°C (± 0.36°F at 32° to 122°F)	0.2 °C
Temperature Logger (Air) Onset Water Temp Prov2 Logger	± 0.4 °C	0.4 °C

The accuracy and instrument bias measurement quality objectives (MQOs) of each temperature logger is verified through both pre- and post-deployment calibration checks following the procedures described in the *Continuous Temperature Sampling Protocols for the Environmental Monitoring and Trends Section* (Ward, 2005) and in the *TFW Stream Temperature Survey Manual* (Schuett-Hames et al, 1999). The procedures require the temperature loggers be tested in controlled water temperature baths that bracket the expected monitoring range (near 0ºC and near 20ºC). The results are then compared to those obtained with a NIST certified reference thermometer.

All temperature loggers that fail to meet the instrument accuracy (Table 5) will be checked a second time. Temperature loggers that fail a second pre-deployment check will not be used.

Temperature loggers that fail a second post-deployment check (this rarely occurs) will have their data adjusted or rejected based on the following:

> If the difference between the pre- and post-deployment calibration check results for a temperature logger is at or below the instrument accuracy, then the instrument bias will be corrected by adding to the raw data the difference between the mean of the pre- and postdeployment calibration check results, and the certified reference thermometer. For example, the temperature logger accuracy is ±0.2°C. The mean pre-deployment calibration check difference is -0.19°C (meets instrument accuracy), and the mean of post-deployment calibration check difference is -0.23°C (fails instrument accuracy). Therefore a correction factor of +0.21°C is needed to correct the data for instrument bias (-19°C + (-0.23°C)/2).

Sampling bias is minimized by following the deployment procedures described in Ward (2005). These procedures specify site selection and deployment methods designed to ensure that the temperature logger results are representation of stream conditions throughout the entire monitoring period and not biased by the effects of solar radiation or low streamflow conditions.

Sampling Design

The study will be set up using the approach by Rashin and Graber (1992) and Schillinger (2006) with an upstream and downstream monitoring location. Table 6 provides the site descriptions. Each site will have a data logger for water temperature and a data logger for air temperature (combined called a thermograph). Continuous temperature data will be collected with Onset® Logger thermographs to determine if water temperatures are meeting water quality standards.

Table 6. Site Location Descriptions.

Site Name	Location	Latitude	Longitude
BLACKCR-UP	Upstream	47°2'43.44''	123°34'26.33''
BLACKCR-DOWN	Downstream	47°2'30.81''	123°35'5.7''

Representativeness

Established protocols will be followed (Bilhimer and Stohr, 2009, Ward, 2005, Schuett-Hames et al, 1999 and Ecology 1993). The continuous temperature data collected may not be considered representative of a watershed or the state as a whole, but will be considered representative of the stream reach being sampled.

Comparability

All measurements and analytical procedures will be documented so that the data can be comparable with samples collected and analyzed in a like manner.

Completeness

The data quality objectives for completeness measure the amount of valid data needed to meet the project objectives. The goals for the collected data will be to determine compliance with current water quality standards. The use of continuous stream temperature data for water quality standards compliance is based on the ability to evaluate the temperature criteria defined by Washington's Water Quality Standards (Chapter 173-201A WAC). The temperature criteria established for protection of aquatic life is measured by the 7-day average of the daily maximum temperatures (7-DADMax). Assessing compliance with this standard requires that the 7-DADMax be calculated using the 7-day period that contains the maximum annual stream temperature.

The stream water temperature data may have periods with data gaps caused by instrument malfunction or from the probe being exposed to air when flows drop below the deployment location. If these data gaps exist, the continuous air temperature data collected from the station or a nearby one will be used to determine if the data gap occurred during the hottest time of the year. If the data gap spans the hottest time period, then the entire stream temperature data set may not be used for assessing standards compliance. However, if there are other periods of the year that also exceed the 7-DADMax, then the data set may be used for compliance assessment. The assumption is that the highest annual stream temperature will coincide with the highest air temperature.

Sampling and Measurement Procedures

Field sampling and measurement protocols will follow those described in these publications:

1. *Timber-Fish-Wildlife (TFW) Stream Temperature Survey Manual* (Schuett-Hames, et al., 1999).

2. *Continuous Temperature Sampling Protocols for the Environmental Monitoring and Trends Section* (Ward, 2005).

3. *Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams Conducted in a Total Maximum Daily Load (TMDL) Project for Stream Temperature*, (Bilhimer and Stohr, 2009).

4. Field Sampling and Measurement Protocols for the Watershed Assessments Section (Ecology 1993).

Temperature thermographs will be installed in areas of water and air that are representative of the surrounding environment and are shaded from direct sunlight.

To minimize the spread of invasive species field work will proceed from upstream to downstream and waterproof boots will not have felt soles (Ward, 2010). Boots will be washed in hot water and thoroughly dried after each field day. This washing activity will occur in the Ecology Headquarters Chain of Custody room.

Quality Control Procedures

Field sampling variation will be addressed by field checks of the instruments with a calibrated, hand-held thermometer (Ecology, 1993) at the thermograph site upon deployment, retrieval, and mid-season. The Onset® Loggers will be calibrated before deployment and after recovery according to the TFW stream temperature protocols (Schuett-Hames et al.,1999) to document instrument bias and performance at representative temperatures. A National Institute of Standards and Technology (NIST) certified reference thermometer will be used for the calibration. At the completion of the monitoring project the raw data will be adjusted for instrument bias, based on the calibration results, if the bias is greater than +/- 0.2°C (Schuett-Hames et al.,1999).

Data Management Procedures

The raw data will be summarized into the 7-day average of the daily maximum temperature using Excel and an Access database (Microsoft 2007). The data will be used to determine whether the water temperature meets the state water quality criteria for Core Summer Salmonid Habitat.

Audits and Reports

The Project Manager will submit the final technical study report to the client per the project schedule (Table 2). The daily minimum, maximum, and mean values will be entered into EIM after the report has been submitted for final formatting and publishing.

Data Verification and Validation

The project manager is responsible for verifying that field data entries are complete and correct.

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria. Once measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete, with no errors or omissions
- Results for QC samples accompany the sample results
- Established criteria for QC results were met
- Data qualifiers are properly assigned where necessary
- Methods and protocols specified in the QAPP were followed

Data for instream temperature monitoring stations will be verified against the corresponding air temperature station. This will ensure the stream temperature record represents water temperatures and not temperatures recorded while the Onset® Logger was out of the water. The measurement accuracy of the Onset® Loggers will be verified using a NIST certified reference thermometer with instream temperature verification.

Data validation will involve professional judgment and will be used to determine whether data quality objectives have been met. The project manager will examine the complete data package in detail to determine whether the procedures specified in this QAPP were followed.

Data Quality Assessment

The Project Manager will verify that all measurements and data quality objectives have been met for each monitoring station. This determination will be made by examining the data and all of the associated QC information. Data that does not meet the project data quality criteria will be qualified or rejected as appropriate. The Project Manager will produce a station QA report that will include site descriptions, data QA notes, and graphs of all continuous data. Temperature data will be summarized and stored in Ecology's Environmental Information Management system.

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