DEPARTMENT OF
ECOLOGY
State of Washington

Innovative Temperature Total Maximum Daily Load Pilot Study

Quality Assurance Project Plan

March 2009

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Quality Assurance Project Plan

Innovative Temperature Total Maximum Daily Load Pilot Study

March 2009

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WQP – Water Quality Program
EAP – Environmental Assessment Program
SCS – Statewide Coordination Section
WOS – Western Operations Section

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Purpose of This Document

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives.

This study will produce two temperature Total Maximum Daily Load (TMDL)[1] reports that will be posted to the Internet. These reports will be for (1) Salmon Creek in Clark County, and (2) Squalicum and Padden Creeks in Whatcom County.

The study will also produce a guidance document to assist Ecology staff in calculating near-stream shade targets for temperature TMDL studies.

Temperature TMDLs are significant because high stream temperatures are a major environmental stressor to Washington's cold-water fish.

Ecology's current practice of conducting site-specific temperature modeling for each temperature TMDL is time-consuming and expensive. The result of this work is nearly always to recommend full system-potential shade.

The approach described in this document will allow temperature TMDLs to be developed much faster and at a lower cost. The goal is to put TMDL implementation measures in place more quickly than under the traditional TMDL approach.

[1] TMDLs are water cleanup plans. These TMDLs are also called Water Quality Improvement Reports.

Temperature Criteria and Beneficial Uses

Fresh waters

Temperature affects the physiology and behavior of fish and other aquatic life. Temperature may be the most influential factor limiting the distribution and health of aquatic life and can be greatly influenced by human activities.

Temperature levels fluctuate over the day and night in response to changes in climatic conditions and river flows. Since the health of aquatic species is tied predominantly to the pattern of maximum temperatures, the criteria are expressed as the highest 7-day average of the daily maximum temperatures (7-DADMax) occurring in a waterbody.

In the Washington State water quality standards, aquatic life use categories are described using key species (salmon versus warm-water species) and life-stage conditions (spawning versus rearing) [WAC 173-201A-200; 2003 edition].

(1) To protect the designated aquatic life uses of "Char Spawning and Rearing," the highest 7-DADMax temperature must not exceed 12°C (53.6°F) more than once every ten years on average.

(2) To protect the designated aquatic life uses of "Core Summer Salmonid Habitat," the highest 7-DADMax temperature must not exceed 16°C (60.8°F) more than once every ten years on average.

(3) To protect the designated aquatic life uses of "Salmonid, Spawning, Rearing, and Migration, and Salmonid Rearing and Migration Only," the highest 7-DADMax temperature must not exceed 17.5°C (63.5°F) more than once every ten years on average.

(4) To protect the designated aquatic life uses of "Non-anadromous Interior Redband Trout," the highest 7-DADMax temperature must not exceed 18°C (64.4°F) more than once every ten years on average.

(5) To protect the designated aquatic life uses of "Indigenous Warm Water Species," the highest 7-DADMax temperature must not exceed 20°C (68°F) more than once every ten years on average.

Washington State uses the criteria described above to ensure that where a waterbody is naturally capable of providing full support for its designated aquatic life uses, that condition will be maintained. The standards recognize, however, that not all waters are naturally capable of staying below the fully protective temperature criteria. When a waterbody is naturally warmer than the above-described criteria, the state provides a small allowance for additional warming due to human activities. In this case, the combined effects of all human activities must not cause more than a 0.3°C (0.54°F) increase above the naturally higher (inferior) temperature condition.

Whether or not the waterbody is naturally high in temperature is determined using a model. The model roughly approximates natural conditions, and is appropriate for determining the implementation of the temperature criteria. This model results in what is called the "system thermal potential" or "system potential" of the waterbody.

Special consideration is also required to protect spawning and incubation of salmonid species. Where Ecology determines the temperature criteria established for a waterbody would likely not result in protective spawning and incubation temperatures, the following criteria apply: A) Maximum 7-DADMax temperatures of 9°C (48.2°F) at the initiation of spawning and at fry emergence for char; and B) Maximum 7-DADMax temperatures of 13°C (55.4°F) at the initiation of spawning for salmon and at fry emergence for salmon and trout.

Global climate change

Changes in climate are expected to affect both water quantity and quality in the Pacific Northwest (Casola et al., 2005). Summer streamflows depend on the snowpack stored during the wet season. Studies of the region's hydrology indicate a declining tendency in snow water storage coupled with earlier spring snowmelt and earlier peak spring streamflows (Hamlet et al., 2005). Factors affecting these changes include climate influences at both annual and decadal scales, and air temperature increases. Increases in air temperatures result in more precipitation falling as rain rather than snow and earlier melting of the winter snowpack.

Ten climate change models were used to predict the average rate of climatic warming in the Pacific Northwest (Mote et al., 2005). The average warming rate is expected to be in the range of 0.1-0.6°C (0.2-1.0°F) per decade, with a best estimate of 0.3°C (0.5°F) (Mote et al., 2005). Eight of the ten models predicted proportionately higher summer temperatures, with three indicating summer temperature increases at least two times higher than winter increases. Summer streamflows are also predicted to decrease as a consequence of global climate change (Hamlet and Lettenmaier, 1999).

The expected changes coming to our region's climate highlight the importance of protecting and restoring the mechanisms that help keep stream temperatures cool. Stream temperature improvements obtained by growing mature riparian vegetation corridors along streambanks, reducing channel widths, and enhancing summer baseflows may all help offset the changes expected from global climate change – keeping conditions from getting worse. It will take considerable time, however, to reverse those human actions that contribute to excess stream warming. The sooner such restoration actions begin and the more complete they are, the more effective we will be in offsetting some of the detrimental effects on our stream resources.

These efforts may not cause streams to meet the Washington State numeric temperature criteria everywhere or in all years. However, they will maximize the extent and frequency of healthy temperature conditions, creating long-term and crucial benefits for fish and other aquatic species. As global climate change progresses, the thermal regime of the stream will change due to reduced summer streamflows and increased air temperatures.

The state is writing *temperature TMDLs* to meet Washington State's water quality standards based on current and historic patterns of climate. Changes in stream temperature associated with global climate change may require further modifications to the human-source allocations at some time in the future. However, the best way to preserve our aquatic resources and to minimize future disturbance to human industry would be to begin now to protect as much of the thermal health of our streams as possible.

Study Objectives

This proposal for an efficient, low-cost temperature TMDL approach relies on shade curves to define the shade needed for meeting water quality standards. This proposal defines the process for setting wasteload allocations for point sources.

Specific objectives

- Apply the innovative temperature TMDL approach to two watersheds that have local support.
- Create instructions for determining system-potential vegetation and effective-shade curves.
- Provide training to Ecology TMDL staff.

Grant requirements

Complete all tasks approved as deliverables to Environmental Protection Agency (EPA) Grant # X7-96072501-0.

Tasks submitted to EPA for grant approval April 2008

1. *Select two pilot basins.* Basin selection will be based on TMDL project requests received from Ecology regional office staff during the FY09 project scoping process. The FY09 project scoping process is designed to select the highest-priority areas for new work based on environmental need and the readiness of local entities to proceed.

2. *Write a project plan for this project.* A Quality Assurance Project Plan (QAPP) will be written that lays out the project objectives, methods, staff roles, external advisory committee role, schedule, and deliverables.

3. *Conduct technical analyses for both pilot basins.*

4. *Write the Water Quality Improvement Reports (TMDLs)* for the two basins, including recommendations for effectiveness monitoring.

5. *Write guidance and conduct training* for Washington State TMDL staff on how to determine site-specific vegetation.

Scope of Work

Task 1. Select two pilot basins.

The Salmon Creek watershed in Clark County (Figure 1) and Squalicum and Padden Creeks in Whatcom County (Figure 2) were selected as the pilot basins. These two basins were selected as the highest priority watersheds submitted by Ecology regional staff during the FY09 scoping. These also met criteria for anticipated success because of local support for implementation using this expedited TMDL process.

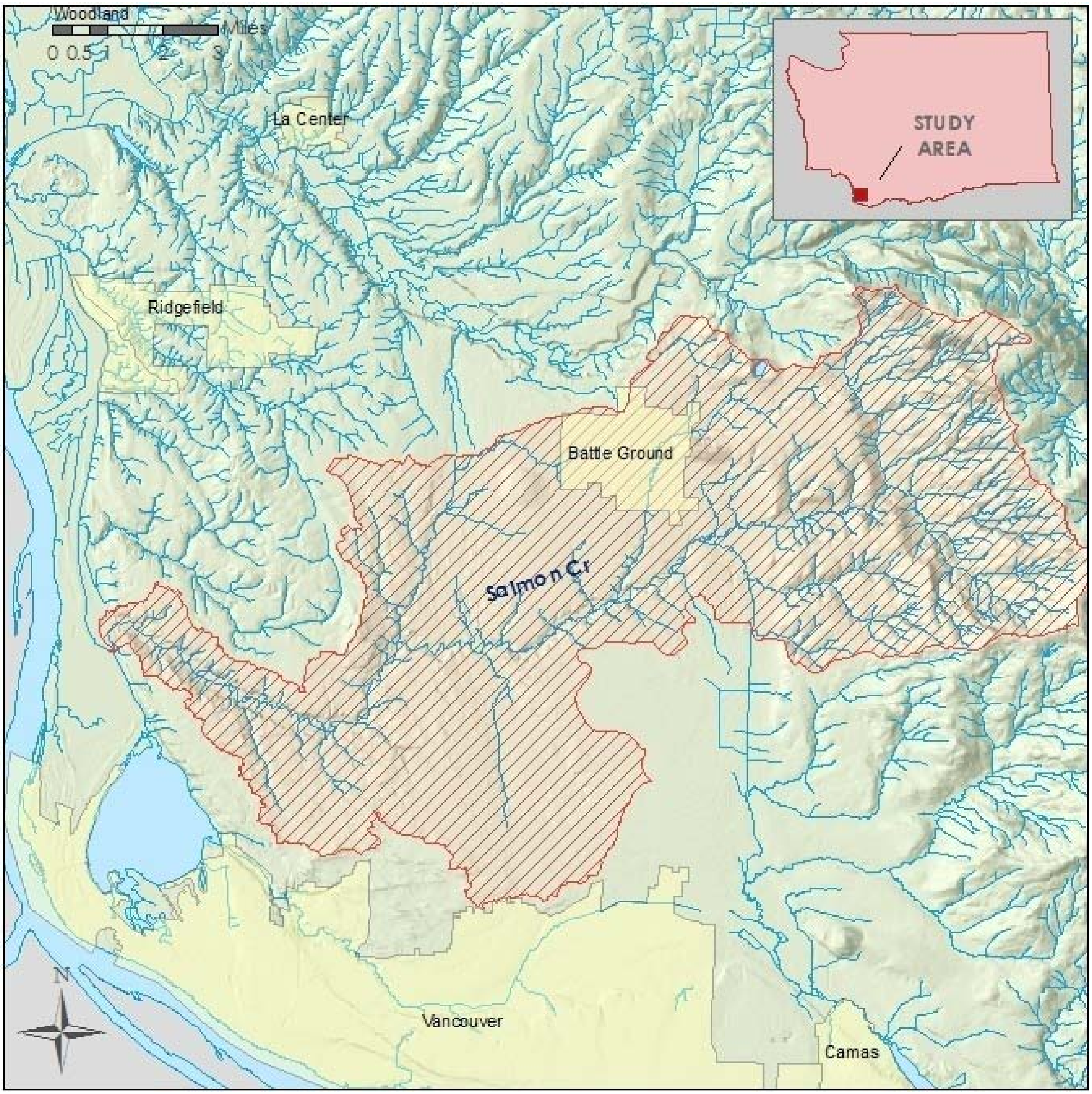

Figure 1. Location of the Salmon Creek study area.

Figure 2. Location of the Squalicum and Padden Creeks study area.

Task 2. Write a project plan for this project.

This document is the project plan.

Task 3. Conduct technical analyses for both basins.

The technical analysis will consist of:

- Evaluating existing available temperature data.
- Generating effective-shade, load-allocation curves that are based on system-potential vegetation.
- Exploring stormwater permitting in Salmon Creek.
- Optional analysis that may be required for a proposed Battle Ground Wastewater Treatment Plant (WWTP) discharge to Salmon Creek.

Salmon Creek

Sufficient temperature and stream flow data are available on which to base this TMDL.

The following text (in italics) comes from Ecology's Southwest Regional Office (SWRO) project request to Ecology's Environmental Assessment Program:

Ecology completed a TMDL for fecal coliform and turbidity in the Salmon Creek watershed in 1995. Based on data collected between 1998 and 2002, Salmon Creek is currently listed as impaired for temperature, dissolved oxygen (DO), and pH. Clark County initiated an intensive, long term monitoring program on Salmon Creek and its tributaries in 2002, and collects monthly temperature, turbidity, pH, dissolved oxygen, conductivity and fecal coliform data at 8 sites. Their data indicate that while temperature impairments are widespread, dissolved oxygen and pH violations are rare.

Stakeholders are aggressively implementing activities identified in the 2005 Salmon Creek DIP(Detailed Implementation Plan). Those activities include riparian planting, shoreline stabilization, livestock owner education, and other actions that should improve water quality parameters beyond fecal coliform and turbidity.

Salmon Creek seems like an ideal location to conduct an innovative TMDL for temperature for the following reasons: (1) there are no industrial point sources in the watershed (although stormwater will need to be addressed because Clark County has a Phase 1 NPDES Municipal Stormwater Permit), (2) the DO and pH violations appear to be restricted to a couple of locations and violations will likely diminish as other water quality parameters improve, and (3) stakeholders have proven they are interested in improving the watershed as they are already implementing actions that will likely be required to achieve compliance with temperature, DO and pH water quality standards.

Clark County collects monthly temperature and streamflow data. The county collected continuous temperature data at several locations in the watershed in 2003.

Figure 3 shows locations of continuous temperature monitors in 2003, and Figure 4 shows temperature results at those locations. The complete report (Schnabel, 2004) for the 2003 data collection and analysis can be found at: www.co.clark.wa.us/water-resources/documents/Monitoring/2003%20Salmon%20Creek%20watershed%20stream%20temperature.pdf.

A complete listing of Clark County water quality monitoring activities and Quality Assurance Project Plans (QAPPs) can be found on their web site: www.co.clark.wa.us/water-resources/documents-monitoring.html.
Clark County has maintained five stream-flow gages in the Salmon Creek watershed since 2003.

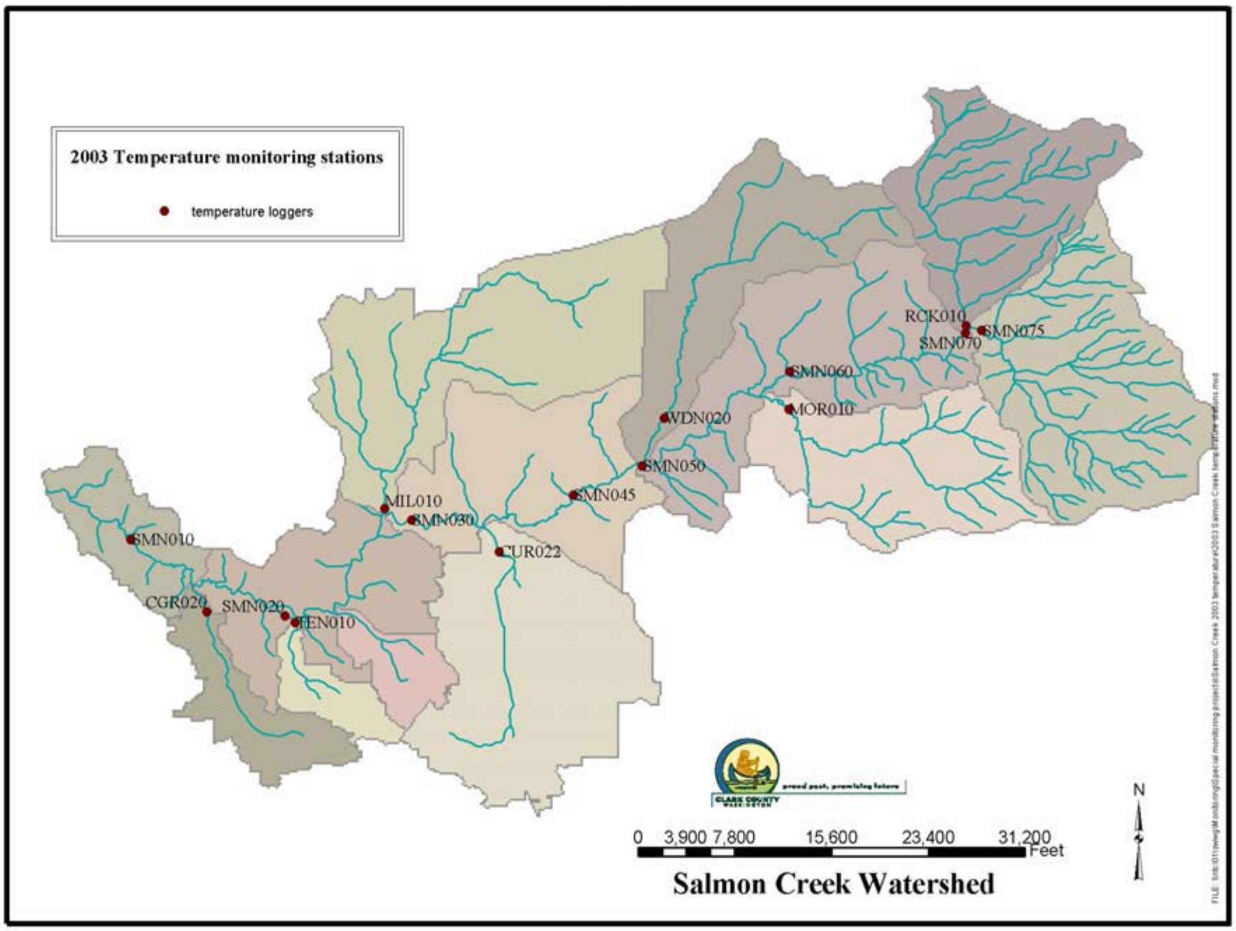

Figure 3. Salmon Creek watershed temperature monitoring stations, 2003. (Schnabel, 2004).

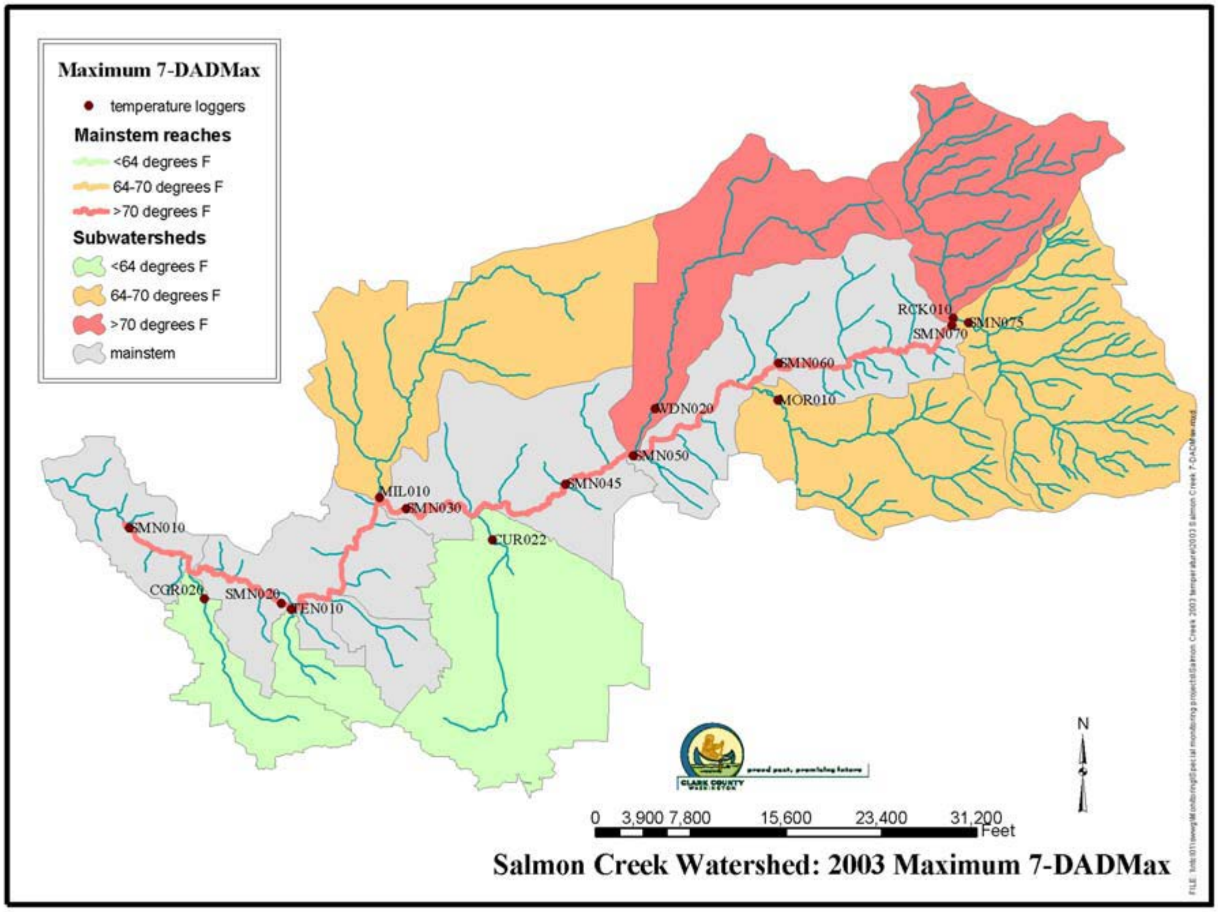

Figure 4. Maximum 7-DADMax temperature for Salmon Creek mainstem and subwatershed stations, June 27 – September 9, 2003 (Schnabel, 2004).

Point source and stormwater issues: The city of Battle Ground processes its wastewater at the Salmon Creek WWTP and then pipes it 7,462 feet to the outfall at the Columbia River (Ecology, 2005). The city is exploring the possibility of a winter-time discharge to Salmon Creek. Many of the discharge options are documented in the *City of Battle Ground Wastewater Feasibility Study* (Kennedy/Jenks, 2004).

Figure 5 shows water temperatures measured near the site of the proposed Salmon Creek discharge from October 2007 through September 2008. Stream temperatures are low compared to the numeric criteria during November 1- March 31. The water quality standard may allow discharge under the temperature TMDL during those months. All portions of WAC 173-201A and guidelines under Hicks (2007) would need to be met. Effects of discharge to Salmon Creek for other parameters such as dissolved oxygen will not be evaluated under the innovative temperature TMDL.

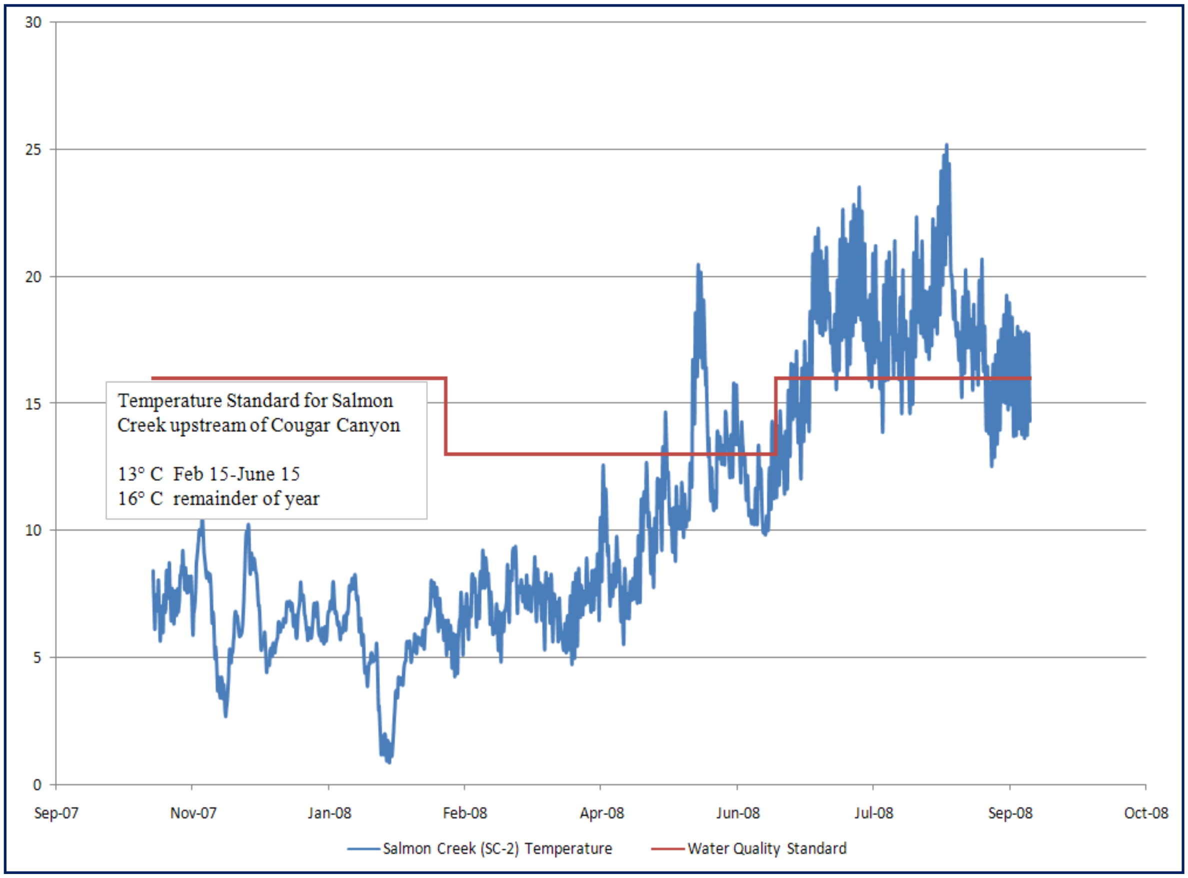

Figure 5. Salmon Creek stream temperatures near site of proposed Battle Ground discharge (based on Kennedy/Jenks data, unpublished).

To date, most temperature TMDLs have dealt with existing discharges (instead of new discharges) during the critical warm summer season and thus have set wasteload allocations using the language:

When a waterbody is naturally warmer than the numeric criteria, the state provides a small allowance for additional warming due to human activities. The combined effects of all human activities must not cause more than a 0.3°C (0.54°F) increase above the naturally higher (inferior) temperature condition at the edge of the mixing zone.

Under the innovative temperature TMDL format, an existing discharge would need to be able to meet the water quality standard as defined with the following mass balance equation (referred to as the "default equation" (page 7) in the document *Implementing Washington State Temperature Standards through TMDLs and NPDES Permits*, Hicks, 2007).

February 15 – June 15

$T_{NPDES} = [\mathbf{13.0}^{o}C - 0.3^{o}C] + [\text{chronic dilution factor}] * 0.3^{o}C$

June 16-February 14

$T_{NPDES} = [\mathbf{16.0}^{o}C - 0.3^{o}C] + [\text{chronic dilution factor}] * 0.3^{o}C$

where: T_{NPDES} is the maximum effluent temperature allowable under the NPDES permit, and **13.0** and **16.0** are the are the seasonal numeric standards for the receiving water.

As a note, effluent discharges from point sources are also regulated under permit to meet:

1. Incremental warming restrictions established in the standards when the threshold criteria are being met (background cooler than the criteria).
2. Restrictions to avoid instantaneous lethality to fish and other aquatic life.

The purpose of these restrictions is to ensure that sources prevent unreasonable warming of the background receiving water from an effluent discharge that may impact the aquatic life uses or impact the general temperature regime of the watershed. The water quality standards at WAC 173-201A-200(1)(c) (i) – (vii) contain these restrictions and other notes on implementation of the temperature threshold criteria.

Numeric temperature allocations for stormwater have, to date, not been set in a temperature TMDL. The process for doing this is unknown at this time.

Data collected on stormwater will be evaluated to see if there is a logical way to incorporate this into the TMDL:

- Clark County is performing a multi-year stormwater needs assessment for Salmon Creek sub-basins that includes GIS mapping of all the municipal stormwater outfalls (about 2000) in the Salmon Creek watershed.
- The Clark County Clean Water Program will provide all monitoring data and associated metadata.

Squalicum/Padden Creeks

The *Whatcom Creek Draft Temperature TMDL* is nearly complete and will be used as a basis for the Squalicum/Padden analysis. Extensive data collection, analysis, and temperature modeling is complete for Whatcom Creek. The draft report includes identification of system-potential vegetation for the Bellingham area. The Whatcom Creek report will be expanded to include Squalicum and Padden Creeks.

A network of continuous temperature data loggers was installed in the Whatcom Creek watershed by the City of Bellingham to monitor stream temperatures during the summer of 2002. The locations of stream temperature sensors along Whatcom Creek and its tributaries are showed in Figure 6.

Table 1 reports the highest daily and highest 7-DADMax temperatures measured at these locations.

Figure 6. Stream temperature sensor locations in Whatcom Creek during the 2002 monitoring period.

Table 1. Summary of the highest daily maximum water temperatures in Whatcom Creek, 2002.

ID Number	Station	Description	River KM	Highest 7-day-average daily maximum water temperature during 2002 (deg C)	Highest daily maximum water temperature during 2002 (deg C)
521498	Hanna Creek	Hanna Creek at mouth	At mouth	24.1	28.9
531540	"Control Dam"	Whatcom Creek at headwaters	6.7	24.6	25.3
531532	State Street	Whatcom Creek at State Street	1.5	23.6	24.5
521497	Dupont Street	Whatcom Creek at Dupont Street	0.4	23.5	24.4
531535	James Street	Whatcom Creek at James Street	2.1	23.7	24
483462	Racine Street	Whatcom Creek at Racine Street	3.3	22.9	23.6
531531	Valencia Street	Whatcom Creek at Valencia Street	3.8	22.7	23
483460	"Water Plant"	Whatcom Creek at the Water Plant	5.3	22.9	23
483461	Fever Creek	Fever Creek at mouth	At mouth	20.9	21.3
512712	Lincoln Creek	Lincoln Creek at mouth	At mouth	19.7	20.4
531538	Cemetery Creek	Cemetery Creek at mouth	At mouth	18.6	19.3

The following text (in italics) comes from the Water Quality Program, Bellingham Field Office (WQ-BFO) project request to Ecology's Environmental Assessment Program:

Squalicum and Padden Creeks are the remaining streams running through the city of Bellingham. Riparian vegetation is subject to loss if critical areas are not identified. The creeks are used by Chinook and other salmonids. The City of Bellingham is finishing up its shoreline master program and will begin identifying priorities soon. Identifying riparian vegetation needs is a critical step. Implementation of the Whatcom Creek Temperature TMDL can be concurrent. Urban streams in Bellingham Bay are critical rearing habitat for Coho Salmon. The City of Bellingham has a culture of neighborhood adoption of streams and volunteer support. The city collected the data for the Whatcom Creek TMDL and is supportive of protecting streams for aquatic life. The Shoreline Master Program identifies preservation of natural riparian corridors where available. This will provide city planning staff with additional tools to protect critical habitat in the plan review stage.

One of the largest independent drainages in Whatcom County, the Squalicum Creek watershed, includes most of northern Bellingham, beginning at Squalicum and Toad Lakes and stretching west to Bellingham Bay. This 24-square- mile (15,097 acres) watershed encompasses Baker Creek, which joins Squalicum near Meridian Street and is the largest of the tributaries, as well as Spring and McCormick Creeks.
http://whatcomsalmon.wsu.edu/background/watershed_archive/archive-squalicum.html

Squalicum Creek and its tributaries still provide habitat for several salmonid species including coho, chum, sea-run steelhead, and cutthroat trout.

The Padden Creek watershed drains about 3,830 acres in the south end of Bellingham and includes the sub-basins of Lake Padden and Connelly Creek. The Padden Creek watershed elevation ranges from sea level to 985 feet. The upper watershed consists of several unnamed tributaries that flow through forested parks into Lake Padden. The lower portion is drained by Padden Creek as it meanders 2.9 miles from Lake Padden to Bellingham Bay, through residential development and city parks. The lower watershed includes moderate density residential use, forested parks, a golf course, a commercial garden, and a retail area.

The Urban Streams Monitoring Program was developed to obtain baseline water quality data for streams in the city of Bellingham. Data are used to detect changes in these streams. The program is conducted by the Public Works Operations Division. The city has carried out monthly water quality monitoring of streams since 1990. Currently monitoring takes place at 18 sites, on 11 streams: Whatcom, Hanna, Cemetery, Lincoln, Fever, Padden, Connelly, Chuckanut, Squalicum, Baker, and Silver Creeks.

Figure 7 shows that the locations of stream restoration projects are concentrated in Squalicum, Padden, and Whatcom Creeks. Because of progress and local involvement in this area, the study area is a good candidate for an innovative TMDL.

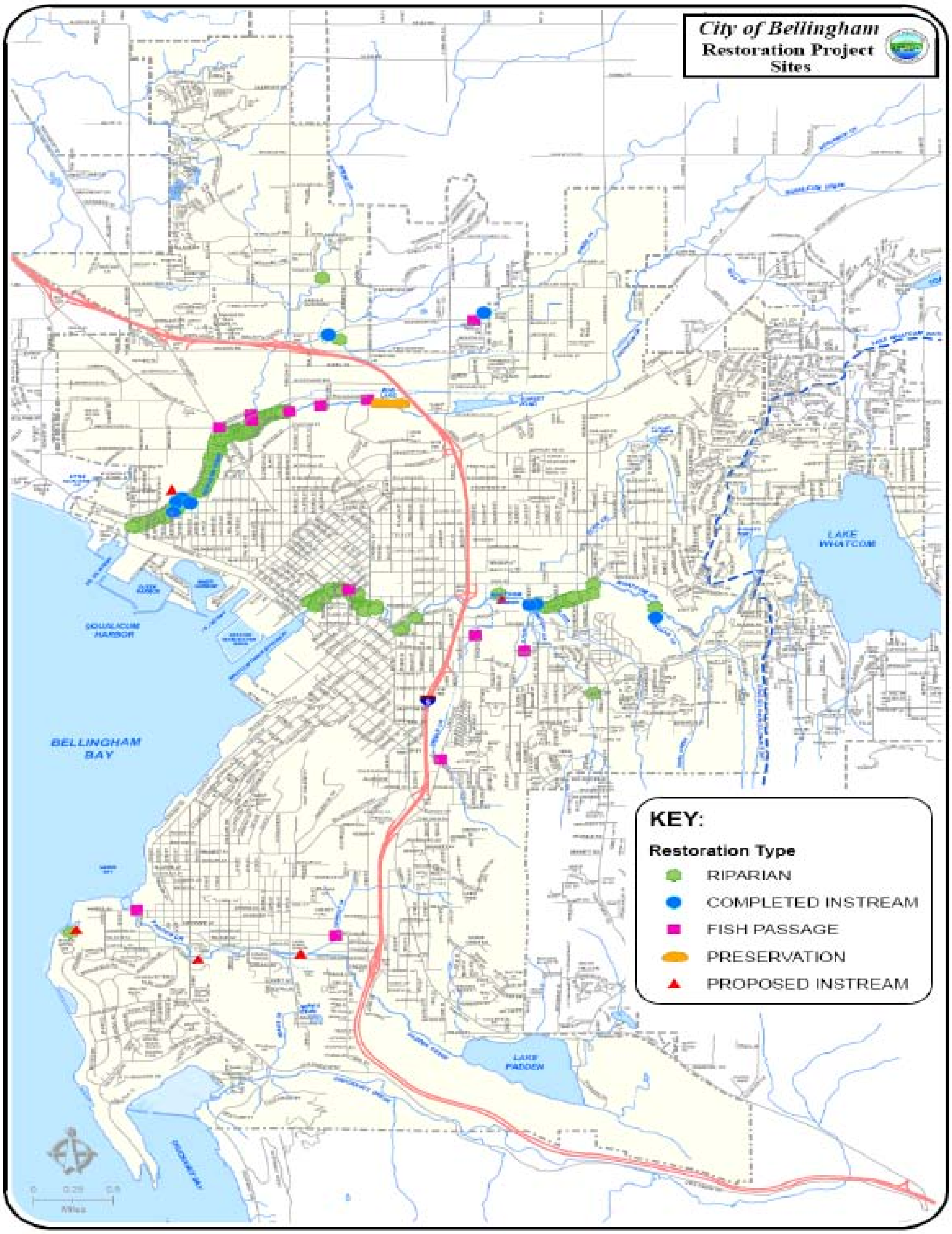

Figure 2.0-5. Location and types of stream restoration projects within the City of Bellingham.

Figure 7. City of Bellingham stream restoration projects (Bellingham, 2006).

Task 4. Write the Water Quality Improvement Reports (TMDLs) for the two basins.

Water Quality Improvement Reports (WQIRs) based on innovative TMDLs should include the following. Under this pilot project, Ecology staff will collaborate on the report, with general assignments as listed below.

TMDL Report submittal to EPA

- Loading capacity calculated by Environmental Assessment Program (EAP) staff. Load and wasteload allocations and implementation section written by regional Water Quality Program (WQP) TMDL leads.
- WQIR text should include a short basin background information section and a discussion of beneficial uses and applicable criteria (authored by regional WQP staff).
- For public participation, EPA requires a 30-day public notice period. Ecology usually chooses to do more. Regional WQP staff are responsible for public involvement.

Load allocations will be based on shade curves. See Figure 8 and Table 2.

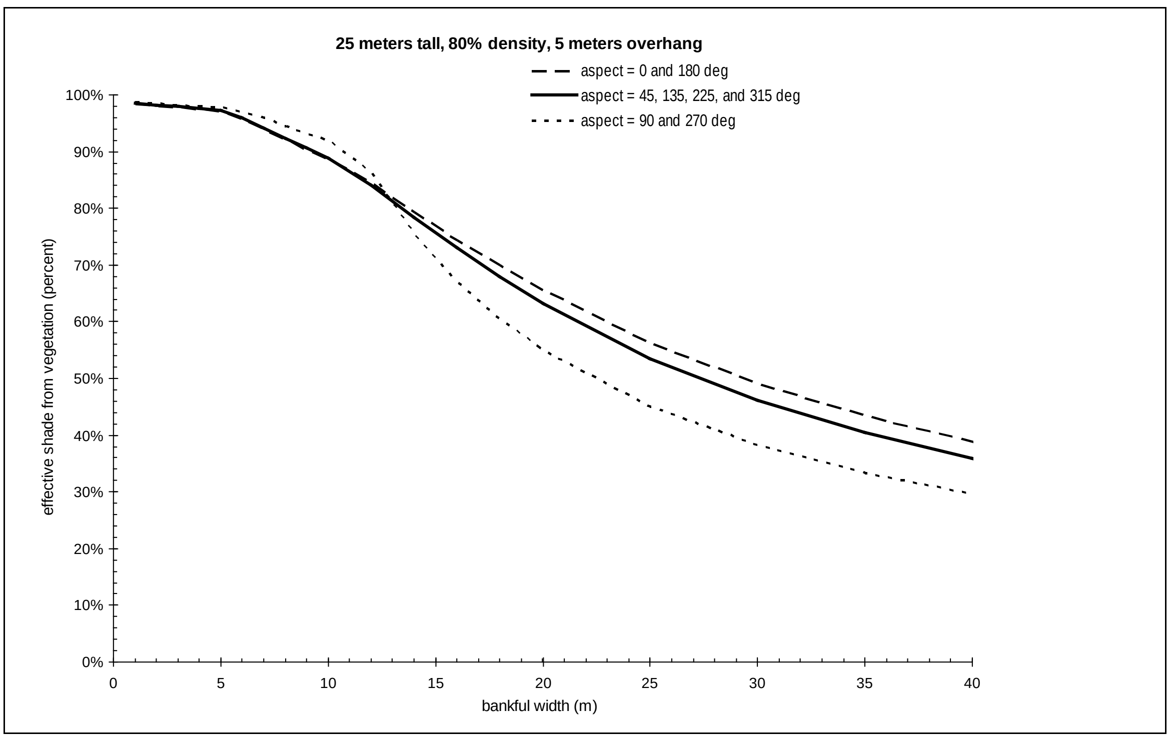

Figure 8. Example shade curve figure: Mixed deciduous/conifer zone.

Table 2. Example load allocation table: Load allocations for effective shade for miscellaneous perennial streams in the mixed conifer-deciduous potential vegetation zone of the Walla Walla River watershed, based on bankfull width and stream aspect.

Bankfull width (meters)	Effective shade from vegetation (percent) at the stream center at various stream aspects (degrees from N)			Daily average global solar shortwave radiation (W/m2) at the stream center at various stream aspects (degrees from N)		
	0 and 180 deg aspect	45, 135, 225, and 315 deg aspect	90 and 270 deg aspect	0 and 180 deg aspect	45, 135, 225, and 315 deg aspect	90 and 270 deg aspect
1	98.4%	98.5%	98.8%	5	5	4
2	98.1%	98.2%	98.5%	6	6	5
3	97.8%	97.9%	98.2%	7	6	5
4	97.5%	97.6%	98.0%	8	7	6
5	97.1%	97.2%	97.7%	9	8	7
6	95.8%	95.9%	97.0%	13	12	9
7	94.0%	94.2%	96.0%	18	18	12
8	92.0%	92.3%	94.6%	24	23	16
9	90.4%	90.6%	93.3%	29	29	20
10	88.7%	88.8%	91.9%	34	34	25
12	84.4%	84.1%	86.3%	47	48	42
14	79.3%	78.4%	75.5%	63	65	74
16	74.4%	73.0%	67.1%	78	82	100
18	70.0%	67.9%	60.4%	91	97	120
20	65.6%	63.2%	55.0%	104	112	136
25	56.3%	53.5%	45.1%	133	141	166
30	49.1%	46.1%	38.4%	154	164	187
35	43.4%	40.4%	33.4%	172	181	202
40	38.9%	35.9%	29.6%	185	194	214

Task 5. Write guidance and conduct training for Washington State TMDL staff on how to determine site-specific vegetation.

- Three or more methods will be documented for determining system-potential vegetation using the following information: soil data, field-collected data for existing trees, **LI**ght **D**istance **A**nd **R**anging (LIDAR) data, and older survey records (e.g., Snoqualmie public land survey).

- Instructions will be written for creating shade curves using Shade.xls software (Ecology, 2003). Shade.xls is the software that has been used to generate effective-shade allocations in Washington State TMDL projects.

- Instructions will be written to run TTools software. This is being done to support staff in using the newly re-written instructions for TTools. Future staff will have sets of instructions that work with LIDAR, DEM, and aerial orthophotos data.

- Training for Ecology staff will be held. Training will cover how to determine system-potential vegetation using the methods developed above.

Modeling and Software Tools

Ecology's Shade model

Ecology's Shade model (Ecology, 2003) will be used to generate effective-shade, load-allocation targets for this project. The Shade model was originally developed by the Oregon Department of Environmental Quality (ODEQ) and enhanced with Shade calculation methods described in Chen (1996) and Chen et al. (1998a and 1998b).

Data required by the Shade model include stream orientation, topographic shade angles, time of year, sun position, latitude, channel width, and riparian vegetation characteristics (height, type, density). The model calculates solar radiation attenuation through the canopy and outputs percent shade for each stream reach by hour of the day for a specific day of the year.

The Shade model has been used to establish effective-shade load allocations in the following EPA-approved TMDL projects in Washington State:

- Willapa River Basin
- Wind River Basin
- Little Klickitat River Basin
- Walla Walla River Basin
- South Prairie Creek
- Stillaguamish River Basin
- Wenatchee River Basin
- Lower Skagit River Tributaries
- Totten/Eld Inlets Tributaries
- Bear-Evans Creek

The Shade model continues to be Ecology's primary method of developing effective-shade load allocations for temperature TMDL projects. The following near-final temperature TMDL projects also use the Shade model:

- Deschutes River Watershed (October 2008, External Review Draft, Volume 1 Technical Findings).
- Upper Naches River Watershed (December 2008, Final, Volume 1 Technical Findings).

TTools ArcGIS extension

TTools is an ArcGIS extension used with digital map data to measure stream channel widths; topographic shade angles to the west, south, and east; stream aspect; and riparian vegetation characteristics. Its primary purpose is to collect information to be used by the Shade model.

TTools was originally developed by the ODEQ (ODEQ, 2001) for use with the older ArcView software. Using a grant from EPA, Ecology upgraded TTools to make it compatible with the newer ArcGIS software.

This software is used for temperature projects that evaluate vegetation using aerial orthophotos or other digital map data.

Currently, there is no TTools documentation for Washington staff. As part of this project, a step- by-step set of instructions will be created to allow more staff to use the software. Instructions will include suggested software settings to standardize analysis for Washington State staff. Currently, the best available documentation is that generated for the older ArcView version for Oregon staff (ODEQ, 2001).

Sources of Secondary Data

Clark County and the City of Bellingham each collected stream temperature data for the purpose of comparing those temperatures to the Washington State water quality standards. Both sets of data were gathered using methods comparable to those used by Ecology for TMDL studies. Data were gathered under Quality Assurance Project Plans (Schnabel, 2003; City of Bellingham, 2001).

Further data may be discovered during the course of this project. Quality of data will be documented in reports where data are used.

Project Organization and Schedule

The following people are involved in this project. All are employees of the Washington State Department of Ecology.

Table 3. Organization of project staff and responsibilities.

Staff (EAP staff unless noted otherwise)	Title	Responsibilities
Steve Hood Water Quality Program Bellingham Office Phone (360) 715-5211	Project Lead for Whatcom, Squalicum, Padden Creek TMDL	Acts as point of contact between EAP staff and interested parties. Coordinates information exchange. Forms technical advisory team and organizes meetings. Reviews the QAPP and technical sections of the TMDL report. Prepares and implements TMDL report for submittal to EPA.
Richard Grout Water Quality Program Bellingham Office Phone (360) 715-5203	Section Supervisor of Whatcom, Squalicum,Padden Creek TMDL Project Lead	Approves TMDL report for submittal to EPA.
Tonnie Cummings Water Quality Program SW Regional Office Phone (360) 690-4664	Project Lead for Salmon Creek TMDL	Acts as point of contact between EAP staff and interested parties. Coordinates information exchange. Forms technical advisory team and organizes meetings. Reviews the QAPP and technical sections of the TMDL report. Prepares and implements TMDL report for submittal to EPA.
Kim McKee Water Quality Program SW Regional Office Phone (360) 407-6407	Unit Supervisor of Salmon Creek TMDL Project Lead	Approves TMDL report for submittal to EPA.
Anita Stohr MIS Statewide Coordination Section Phone (360) 407-6979	Project Manager for Innovative Temperature TMDL	Writes the QAPP, conducts QA review of data, analyzes and interprets data, does technical analysis, and writes the technical sections of the draft report and final TMDL report. Writes technical guidance materials for riparian shade analysis.
Karol Erickson MIS Statewide Coordination Section Phone (360) 407-6694	Unit Supervisor of Project Manager	Reviews and approves the QAPP, staffing plan, technical study budget, and technical sections of the TMDL report.
Will Kendra Statewide Coordination Section (360) 407-6698	Section Manager of Project Manager	Approves the QAPP and technical sections of the TMDL report.
Bob Cusimano Western Operations Section Phone (360) 407-6596	Section Manager for the Study Area	Approves the QAPP and technical sections of the TMDL report.
William R. Kammin (360) 407-6964	Ecology Quality Assurance Officer	Provides technical assistance on QA/QC issues. Reviews the draft QAPP and approves the final QAPP.

EAP – Environmental Assessment Program
QAPP – Quality Assurance Project Plan
MIS – Modeling and Information Unit
QA/QC – Quality Assurance/Quality Control

Table 4. Schedule for draft and final reports.

Final Report: Whatcom, Squalicum, Padden Creek Temperature TMDL	
Report author lead	Anita Stohr and Steve Hood
Schedule:	
Draft EAP technical analysis due to Steve Hood (client) and Karol Erickson (EAP supervisor).	June 2009
Revised EAP technical sections, incorporating the above comments, to Steve Hood.	July 2009
At Steve Hood's discretion: Add Implementation Sections.	
Draft report due to external reviewers and technical peer reviewer (includes at a minimum the EAP technical sections).	September 2009
Additional WQIR review steps to be defined by Steve Hood; must include policy review.	
Final WQIR due to be posted on web.	December 2009
Final Report: Salmon Creek Temperature TMDL	
Report author lead	Anita Stohr and Tonnie Cummings
Schedule:	
Draft EAP technical analysis due to Tonni Cummings (client) and Karol Erickson (EAP supervisor).	October 2009
Revised EAP technical sections, incorporating the above comments, to Tonni Cummings.	December 2009
At Tonni Cumming's discretion: Add Implementation Sections.	
Draft report due to external reviewers and technical peer reviewer (includes at a minimum the EAP technical sections).	February 2010
Additional WQIR review steps to be defined by Tonni Cummings; must include policy review.	
Final WQIR due to be posted on web.	August 2010
Training Instructions for Ecology Staff	
Report author lead	Anita Stohr
Schedule:	
Draft due to supervisor	December 2009
Draft due to clients/peer	January 2010
Draft due to external reviewer	February 2010
Final due	March 2010

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Appendix. Glossary, Acronyms, and Abbreviations

7-DADMax: 7-day average of the daily maximum temperatures. The arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date.

Dilution Factor: The relative proportion of stream (receiving water) to effluent flows occurring at the edge of a mixing zone during critical discharge conditions as authorized in accordance with the state's mixing zone regulations at WAC 173-201A-400. Note: if no dilution factor has been calculated for the WWTP, the maximum dilution ratio of 25% of the 7Q10 flow divided by the end of pipe discharge is often used as an initial estimate. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-400

LIDAR: **LI**ght **D**istance **A**nd **R**anging. A remote sensing system that employs an airborne scanning laser rangefinder to produce accurate elevation data. LiDAR sensors are capable of receiving multiple returns. The first return is when the laser pulse hits the first object on the ground (e.g., a tree canopy), and the last return is received when the pulse continues down to the bare earth.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

System-potential mature riparian vegetation: Vegetation which can grow and reproduce on a site, given climate, elevation, soil properties, plant biology, and hydrologic processes.

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

Acronyms and Abbreviations

DEM	Digital Elevation Model
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FY	Fiscal year
GIS	Geographic Information System
ODEQ	Oregon Department of Environmental Quality
WAC	Washington Administrative Code
WQIR	Water Quality Improvement Report (a TMDL)