Quality Assurance Project Plan for Targeted Stormwater Management
Program Effectiveness Monitoring

Prepared in Compliance with Section S8.E of Pierce County, Washington’s Phase I Municipal Stormwater Permit

Prepared By:

Pierce County Public Works & Utilities Surface Water Management

February 2011
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Name_____________________________________________________________________

Pierce County Public Works & Utilities Surface Water Management
Quality Assurance Project Plan for Targeted Stormwater Management Program Effectiveness Monitoring
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<th>Name</th>
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Quality Assurance Plan

This Quality Assurance Plan (or QAPP) describes the quality assurance procedures for targeted stormwater management program effectiveness monitoring by Pierce County, as required by Section S8.E of the Phase I Municipal Stormwater Permit (WAR04-4503). This permit was issued by the Washington Department of Ecology (WDOE) on January 17, 2007, effective February 16, 2007, under the National Pollutant Discharge Elimination System (NPDES). This Plan was developed under guidance from the Department of Ecology, Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology 2004).

This Plan is organized into the following sections:

- Goals and objectives of stormwater management effectiveness monitoring program
- Type, quality, and quantity of data needed to meet program objectives
- Sampling procedures needed to acquire data needed
- Quality assurance procedures to ensure the Plan is implemented as prescribed
- Assessment procedures to determine if the data conform to the specified criteria and will satisfy the program objectives, and the analysis and format for presentation of the results

SECTION A. GOALS AND OBJECTIVES OF THE PROGRAM

This section includes background information, a program description, and program organization and schedule.

3. BACKGROUND

The Washington State Department of Ecology (Ecology) issued the current NPDES Municipal Stormwater Phase I Permit on January 17, 2007, effective February 16, 2007. The Phase I Permit applies to Pierce, King, Snohomish, and Clark counties and to the cities of Tacoma and Seattle. This includes unincorporated portions of counties whose populations exceed 100,000 in the 1990 census, including Pierce County.

In accordance with the Phase I Permit, each permittee is directed to develop and implement stormwater management programs to reduce the discharge of pollutants to the maximum extent practicable. An element of these programs is a monitoring program to assess program effectiveness.

In general, the required monitoring program shall include the following components:

1. Stormwater characterization monitoring (S8.D)
2. Targeted stormwater management program effectiveness monitoring (S8.E)


A separate QAPP is developed for each component of the monitoring program; this QAPP provides details on the targeted stormwater management program effectiveness monitoring (S8.E) component only. Hereafter, this will be referred to as the SWMP effectiveness monitoring program.

3.1 Permit overview and monitoring requirements

The SWMP effectiveness monitoring program will involve two studies. The first study, Study #1, involves the monitoring of salmon carcass placement conducted by Pierce County SWM and its partners and its impact on the benthic invertebrate community in the stream as measured by BIBI scores. The second study, referenced as Study #2, involves assessing the change in chloride concentrations in receiving water as a result of sodium chloride application as part of routine snow and ice control program as conducted by Pierce County Roads Maintenance Operations Department.

According to Section S8.E.1, the targeted SWMP effectiveness monitoring must be designed to answer each of the following questions:

What is the effectiveness of a targeted action?

What is the effectiveness of achieving a target outcome?

3.2 The Problem

Project Description

Study #1: Pierce County has an active salmon recovery program. Pierce County SWM functions as the Salmon Recovery Lead Entity under the State’s Salmon Recovery Act for WRIA 10 and 12 and participates on technical and policy committees for lead entities in WRIAs 11 and 15. The program includes salmon carcass placement projects, conducted by local recovery partners designed to provide food and increased nutrients for juvenile salmon. In addition, Pierce County has established monitoring program for benthic invertebrate communities using the Benthic Index of Biological Integrity (BIBI). This monitoring provides a measure for determining water and aquatic habitat quality. To better understand the relationship between salmon carcasses placement projects and BIBI scores, Pierce County will conduct a controlled study to
assess BIBI before and after salmon carcass placement in several stream reaches, to help determine if there is a relationship between BIBI scores and salmon carcass placement projects.

More than 95% of the biomass of a salmon is accumulated in the ocean environment. When salmon return to freshwater to spawn and die their carcasses provide an important source of marine-derived nutrients to aquatic and terrestrial environments. Salmon carcasses are eaten by juvenile salmon and aquatic invertebrates. And stream side vegetation has been found to take up marine-derived nitrogen. The nutrient subsidy of the freshwater environment can result in increased biomass and productivity of benthic invertebrates, juvenile salmonids, and riparian vegetation.

Frozen salmon carcasses will be obtained from local hatcheries and trucked to the study sites. The carcasses will be distributed manually in water during the winter months (mainly January and February). BIBI study sites will be located upstream and downstream of the carcass placement sites.

Study #2 - Pierce County is investigating the use of sodium chloride (salt) for roadway snow and ice control and its possible effects on adjacent waterbodies. Pierce County will concurrently assess the corrosion effects salt may have on vehicles and roadway infrastructure. Monthly grab sampling will occur in three streams receiving stormwater. Stormwater influenced streams are locations proximate to roadways where salt is applied. Water will be sampled for the full suite of enhanced Water Quality Index (WQI) parameters including chlorides monthly.

Pierce County Road Operations applies salt to roadways in a brine mixture to bare pavement via a spreader on the back of the truck. Once the brine mixture is applied, it is extremely difficult to separate from receiving waters and can adversely affect water quality. Salt is very soluble in water and can form solutions using the moisture in the air when temperatures are above -21 degrees Celsius. When salt is in a solution, it will split into sodium and chloride as charged ions. Sodium ions are positively charged and can become bound to soil particles while chloride is negatively charged and is less likely to become bound to particles. Chloride will typically travel farther from the roadway than sodium and can potentially enter ground and surface waters.

Snow and ice activities are thought to be a significant source of the total chloride loading to fresh waters. Peak chloride levels usually occur in the springtime during runoff. Although most chloride is exported out of the system, some may accumulate over time and trigger water quality exceedances. Studies have found evidence of an increasing chloride trend both in surface and ground waters where chloride levels have seen increases of 240% to 350% over several decades. Godwin, K. S., Hafner, S. D. and Buff, M. F., 2003. Long-term trends in sodium

Effectiveness of targeted action

Study #1 - The targeted action is to determine if a relationship can be established between BIBI scores and the benefits of re-establishing ocean nutrients from active salmon carcass placement in streams. The healthy benthic organisms, measured by the effectiveness of this action will be evaluated by comparing results from a pre and post carcass placement BIBI. It is assumed that a higher BIBI score correlates with benefits of nutrients returned to streams from decaying salmon carcasses.

Pierce County would like to better understand the effects, if any, that carcass placement recovery efforts have on water quality and aquatic habitat. Salmon carcass placement projects attempt to mimic the natural nutrient enhancement that occurs during a late fall or winter run of salmon. The salmon carcasses provide an important source of food for juvenile salmon, which feed upon the carcasses directly. In addition, the carcasses provide a source of nutrition for benthic invertebrates, which themselves serve as an important food source for juvenile salmon.

We will test the hypothesis that carcass placement results in changes to the benthic invertebrate community that are beneficial to salmon populations and are associated with stream biological health. Results of the study will help guide the development and implementation of similar carcass placement projects in other streams in Pierce County.

Permit requirement S8.E.3.d. requires Pierce County to develop a monitoring program that contains...“Expected modifications to management actions depending on the outcome of hypotheses testing.” Study #1 is to determine if a relationship can be established between BIBI scores and the benefits of re-establishing ocean nutrients from active salmon carcass placement in streams. As indicated above, we will test the hypothesis that carcass placement results in changes to the benthic invertebrate community that are beneficial to salmon populations and are associated with stream biological health. The metric of this test is an expected increase in BIBI scores in areas where carcass placement is occurring as compared to baseline scores without such carcass placement.

Department of Ecology comments received on this study suggest that Pierce County identify which maintenance and operations standard operating procedures required under the following Permit requirement would be modified based on this study:
“S5.C.9.b.vi. Within 12 months of the effective date of this permit, establish practices to reduce stormwater impacts associated with runoff from parking lots, streets, roads, and highways owned or operated by the Permittee; and road maintenance activities conducted by the Permittee. Implementation of practices shall begin no later than 18 months after the effective date of this permit, and continue on an ongoing basis throughout the term of the permit. The following activities shall be addressed:

(1) Pipe cleaning
(2) Cleaning of culverts that convey stormwater in ditch systems
(3) Ditch maintenance
(4) Street cleaning
(5) Road repair and resurfacing, including pavement grinding
(6) Snow and ice control
(7) Utility installation
(8) Maintaining roadside areas, including vegetation management.
(9) Dust control
(10) Pavement striping maintenance

It is not possible to speculate whether any of the above procedures may be modified as a result of this study for the following reasons: (a) BIBI measures overall stream health based on biology and not specific contributors; (b) sites selected for BIBI and carcass placement include sites in proximity to, and not in proximity to, County MS4 structures subject to NPDES permit maintenance and operations requirements; and (c) watershed and stream health is influenced by many factors, many of which are not within the domain of the limited parameters of the NPDES Municipal Stormwater Permit.

Thus, the **expected modifications to management actions depending on the outcome of hypotheses testing** (as required by S8.E.3.d.) in this study is to increase Pierce County’s involvement in fish carcass placement in streams monitored for BIBI should an increase in BIBI scores so support, and to guide the development and implementation of similar carcass placement projects in other streams in Pierce County.
In the event that the results of this Study #1 indicate any procedure required by S5.C.9.b.vi. need be modified, Pierce County would determine the feasibility and process needed to achieve that modification.

Study #2 - The targeted action is to monitor what effects, if any, its snow and ice program is having on water quality. This will be accomplished by taking grab water samples.

To date, most studies in Washington have found no evidence of increasing chloride in freshwaters. WSDOT performed a comprehensive study in 2001 which found that snow and ice activities on SR 507 had no measurable physical, chemical, or biological impacts to water quality at an adjacent stream. Conversely, studies in the eastern portion of the US and Canada have concluded that snow and ice activities in these areas are negatively affecting both surface and ground water. The state of Maine uses 21 tons of a salt per lane mile while other states in the Snowbelt regions of the U.S. use as much as 35 tons per mile. Pierce County typically applies about 1-2 tons per lane mile on County-maintained roads.

The targeted outcome of this study is to produce data to assess the impacts of current snow and ice activities. Activities may be modified depending on what is learned from the data. Monitoring will be used as a tool to assess the effects of snow and ice activities to water quality. For this study, monitoring is defined as “the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective”.

Effectiveness of targeted outcome for this study is the implementation of the Standard Operating Procedures for the Regional Road Maintenance Endangered Species Act Program Guidelines (Appendix B) and to verify if the salt to sand ratio for snow and ice activities needs to adjusted.

3.3 Study area

Pierce County has the largest populations of unincorporated residents (385,000) in Washington State. It is the second most populous county in Washington, with nearly 800,000 residents. The county has a total area of 1,806 square miles, and is notable for being home to Mount Rainier, the tallest mountain in the Cascade Range and over 150 miles of shoreline on Puget Sound. Land use can be described as suburban within the developed areas and rural residential outside of the developed parts of the Urban Growth Area. See Figure 1.

Study #1 - Currently, salmon carcass placement projects occur in the Nisqually Watershed (WRIA 11) Nisqually River main stem, the Mashel River, the Puyallup River mainstem, and several tributaries to the Puyallup River in the Puyallup, White River (WRIA 10). Unfortunately,
BIBI sampling is problematic in the large river mainstems. So, the study locations must include tributaries where BIBI sampling can occur along with salmon carcass placement. The Mashel River has several sites where such a study is feasible. The area of study will be conducted on the Little Mashel up stream of fish carcass placement at Box Car Canyon and downstream of the fish carcass placement on the Little Mashel at Smallwood Park. In addition, the study will be replicated on one of several tributaries to the Puyallup River. This area of study will be conducted on Kapowsin Creek downstream of the fish carcass placement at the mouth of the creek before the creek enters the Carbon River and upstream of the carcass placement. See Figure 3 & 4 for site location.

Study #2 - The monitoring locations are in close proximity to where snow and ice application occur. Streams that will have monthly grab samples are Kapowsin, Squally and Fennel Creek (WRIA 10) See figure #2. See Figure 2 for site location.

### 3.4 Monitoring challenges

Study #1 - A study of the relationship between salmon carcass placement projects and BIBI sampling faces several challenges. One challenge is locating stream reaches that have the proper conditions including access for sampling BIBI upstream and downstream of the planned placement projects and coordinating with our salmon recovery partners Nisqually Tribe, others to ensure that carcass placement projects take placed as planned.

Study #2 - Salt application varies with the severity of the snow season, so drawing any conclusions based on one year of monitoring would be unsound. Ideally monitoring should occur over long time frames so that trends can be observed and analyzed before any response actions are undertaken. Timing of snow and ice control application and subsequent runoff of chlorides is likely to be highly episodic and sampling at few random monitoring events could present a challenge to detect exceedences unless they were more chronic.

### 4. PROGRAM DESCRIPTION

This section presents the goals and objectives of the program; information requirements; specific target parameters to be monitored; the data required to meet the program objectives; the study area boundaries; and practical constraints that will need to be addressed.

#### 4.1 Goal and objectives

Study #1 - The goal of the salmon carcass placement study is to determine what effects, if any, carcass placement has on benthic invertebrate communities. The objectives of the study include:
Identify appropriate study sites within tributaries that currently have both BIBI monitoring and salmon carcass placement;

Develop an appropriate experimental design that identifies treatment and control stream reaches;

Collect BIBI samples the summer before and the summer after a winter salmon carcass placement.

Analyze BIBI data using an appropriate statistical method to determine before and after treatment effects

Report study findings in one public outreach forum

Study #2 - The goal of this study is to determine if the current application rate used by Pierce County Roads Operations use of sodium chloride for roadway snow and ice control potentially causes elevated chloride in adjacent waterbodies and corrosion to vehicles and right-of-way infrastructure. The objectives of the study include:

Determine whether there are measurable chloride concentrations in the sampled waterbodies;

If so, determine if chloride concentration exceeds state water quality guidelines

Report study findings in one public outreach forum

4.2 Information requirements

The information necessary to meet these objectives includes the following:

Study #1. Extent and mass of salmon carcass placement in monitored reaches

Study #2. Application rate and loading in monitored reaches

4.3 Data collection

Study #1 - Benthic invertebrate data will be collected using a standard method currently employed by Pierce County. Salmon carcass placement data will include location of placement and quantity by weight. *Biological monitoring and Assessment: Using Multimetric Indexes Effectively* (Karr and Chu 1997). See Appendix A for BIBI SOP

Study #2 - Data on chlorides will be obtained from two sources: grab samples taken at regular intervals in waterbodies adjacent to roadways where snow and ice activities are occurring. Site will be randomly sampled each month and will be collected and designated sampling locations. See figure 2.
4.4 Target population

The target population of the targeted action component of the monitoring program is two-fold: first, impact of Pierce County’s snow and ice activities and second the impact of fish carcass placement in stream with active BIBI sampling.

4.5 Study area boundary

The study area is Pierce County. Kapowsin, Squally, and the upper reach of Fennel Creek will study the effects of Chloride applications. While the Little Mashel and Kapowsin Creek will show either increase or decrease of BIBI scores of five index score points. See figures 2, 3, & 4.

4.6 Practical constraints

Study #1 – Carcass placement is conducted opportunistically by salmon recovery partners. In other words often the site access problems and the enthusiasm of volunteers can result in a wide variety of placement success with many carcasses thrown in some streams and few in others. Sufficient excess fish biomass must be available and volunteers to conduct placement activities in any given year. A statistically significant change in BIBI (5 points) may be difficult to detect because of natural or anthropogenic interference from a wide variety of causes.

Study #2 - There are currently no comprehensive data describing chloride use within Pierce County. As a result, the necessary context for inferring the patterns of use within the target streams will depend upon the chloride occurrence patterns that are observed during the first year of monitoring data. This study is occurring over a short time frame with a limited number of sampling stations. A huge constraint is the reliability of snow fall in Western Washington.

5. ORGANIZATION AND SCHEDULE

This section describes the components of the program team and schedule, including any special training that will be required as well as the process of revising this document when appropriate.

5.1 Roles and responsibilities

Below is a table that defines the major aspects of the program and the corresponding responsible personnel.
Table 1. Program Roles and Responsibilities

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<th>Position</th>
<th>Role and Responsibility</th>
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<tr>
<td>Department of Ecology Permit Coordinator</td>
<td>Review of Plan and program deliverables from Pierce County to Ecology</td>
</tr>
<tr>
<td>Program representative for Pierce County</td>
<td>Overall management of the County’s NPDES Faze I compliance activities. Monitor and assess the quality of work. Comply with corrective action requirements.</td>
</tr>
<tr>
<td>Principle investigator (PI)</td>
<td>Develop, implement, and maintain this QAPP. Verify the QAPP is followed and the program is producing data of known and acceptable quality. Ensure adequate training and supervision of all data collection and outreach activities. Initiate corrective action as appropriate. Analyze data and prepare reports.</td>
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<tr>
<td>Data manager</td>
<td>Conduct field work. Acquire monitoring station, grab sample and BIBI data. Responsible for QA/QC.</td>
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5.2 Schedule

The following table indicates the estimated implementation schedule of the components of the program.

Table 2. Anticipated Program Schedule

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<th>Activity</th>
<th>Anticipated Date of Initiation</th>
<th>Anticipated Date of Completion</th>
<th>Deliverable</th>
<th>Deliverable Due Date</th>
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<td>Install water quality monitoring stations</td>
<td>August 2010</td>
<td>August 2010</td>
<td>Water quality data</td>
<td>Ongoing status reports</td>
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<tr>
<td>County’s 2010 Annual Reporting</td>
<td>Fall 2010</td>
<td>March 2011</td>
<td>Report</td>
<td>March 2011</td>
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### 5.3 Special training needs

Project staff will require the following training and experience:

- Assessment data analysis software and techniques
- BIBI sampling techniques
- Knowledge of sampling equipment operation and sample handling
- Targeted education techniques

### 5.4 Revisions

Per section S8.C. (2) Of the Phase I Municipal Stormwater Permit (WAR04-4503), this plan does not require WDOE review and approval prior to monitoring. Subsequent revisions to the Plan will be submitted to Ecology only if substantial changes are proposed. As necessary, any internal revisions will be documented in a Plan Addendum and will be distributed to WDOE and all program personnel. Multiple Addendums will be compiled and distributed quarterly, if appropriate.
SECTION B. TYPE, QUALITY, AND QUANTITY OF DATA NEEDED

This section defines the quality of data required to meet the study goals and objectives, and the sampling process design, which determines the type and quantity of data to be collected. The quality of data required to meet the study goals and objectives for the targeted outcome component of the program are described in the QAPP Pierce County Phase 1 Municipal Stormwater NPDES Permit – Section S8.D – Stormwater Characterization (November 2009) on file with Pierce County Surface Water Management.

6. QUALITY OBJECTIVES

This section discusses the issues of data quality objectives (DQOs) and measurement quality objectives (MQOs) for the monitoring program. The standard approach for defining these kinds of objective in a typical water-quality monitoring program includes collection of quality control (QC) samples to provide estimates of bias, precision, and accuracy of the measurements, based on the characteristic sources of error. These include the potential for contamination in the field or laboratory process, variability due to inappropriate sampling procedures, and bias due to matrix effects. In assessments of human knowledge and behavior, however, the associated sources of potential error are quite different.

The Quality Assurance component of this program has been developed specifically to reduce, to the extent practicable, these sources of error in the assessments. Specific attention will be placed on reducing “sampling error” rather than specific components of error. This requires ongoing discussion about tradeoffs between acceptable versus unacceptable errors, as well as the costs and resources needed to reduce these possible errors. This action requires knowledge of both the strategies to reduce errors and the costs of the resources involved.

To the extent practicable, the quality of assessment results will be evaluated with standard survey measures of conformability, dependability, transferability, and credibility. Conformability is a measure of reliability, and will be based primarily on the use of audit trails that describe the approach to data collection and all decisions about how to collect and interpret the data. Dependability refers to the relative stability of the data, and will be evaluated by questions designed to evaluate the internal consistency of responses. Transferability provides a measure of the potential for generalizing results for one population to other populations, specifically between the test and control streams. For this program, credibility will be enhanced by the explicit consideration of multiple lines of evidence that may be available to support study findings.
7. SAMPLING PROCESS DESIGN

This section describes the sampling process design.

7.1 General assessment approach

The basic components of sampling include the following—Study #2 - Monthly Chloride grab samples taken at Kapowsin, Squally, and Upper Fennel Creek on a random selected date. Study #1- BIBI collection taken in summer and spring months before and after fish carcass; the program will rely on random sampling methods to selected streams for both the pre- and post-outreach components of the study. A key component of sampling design that must be considered is the sampling frame that is used to define the targeted sampling.

7.2 General approach to outreach campaign

Pierce County will present the results of this program effectiveness monitoring in at least one public workshop in summer of 2012. Particular focus will be given to describing and encouraging steps that can be taken to reduce stormwater pollution and mitigate impacts to benthic organisms. Educational materials could include—

- Fact sheets or Power Point presentation for general public and specific audiences
- Alternative information sources, such as web sites
- Description of snow and ice control activities and fish carcass placement
- Event participation with educational displays at outreach functions
- Overall watershed health and results of watershed report card
- Change if any, to stormwater management program as a result of study

7.3 Development of assessment mechanism and outreach campaign

The goal of the assessment mechanism is to describe attitudes and behavior related to the use of Pierce County’s snow and ice activities and fish carcass placement in targeted streams. The goal of the outreach campaign is to communicate potential impacts of these activities on watershed health and changes if any to reduce these impacts. To appropriately target and focus the assessment and outreach campaigns, their development will be based on data collected by the basic stormwater characterization program at targeted stream monitoring locations. Patterns of Chloride runoff that are observed during the first year of the monitoring program will provide important information about the patterns of Chloride use within the target streams. Also patterns of active fish carcass placement that are observed during BIBI index scoring will be compared to previous BIBI monitoring events.
SECTION C. SAMPLING AND MEASUREMENT PROCEDURES

These procedures will be based, on standard sampling techniques. However, it is not anticipated that sufficient resources will be available for a large-scale and statistically significant sample approach. The details of the assessment mechanism will be provided as they are developed in status reports and the annual Stormwater reports required by the stormwater permit.

Sampling and measurement procedures for the targeted outcome component of this program are described in Pierce County’s QAPP prepared for stormwater characterization under S8.D.

Study #1 BIBI Sample Collection will be conducted as follows. The protocol described below is from Biological monitoring and Assessment: Using Multimetric Indexes Effectively (Karr and Chu 1997).

Three total replicates will be taken from each sample location using the following methodology:

Site selection procedure: Sample sites need to representative of the larger study area. Physiographic characteristics like vegetation, soils, geology, land use, gradient, riparian characteristics, and substrate need to be considered to assure that sample sites are representative of the larger population. Professional judgment will be used to determine specific sites.

After a stream reach is selected, find a riffle long enough to accommodate three replicate samples. Ideal sampling locations consist of rocks 5 to 10 cm in diameter sitting on top of pebbles. Substrates dominated by rocks larger than 50 cm in diameter should be avoided.

Sample sites should not be directly downstream from, culverts, bridges, roads, landslides, or waterfalls, unless these are the conditions that the monitoring program is evaluating. It is desirable to sample at least 50 yards upstream of a bridge or culvert and 100 yards downstream of a bridge or culvert.

1. Sample within the main flow of the stream. Sample at water depths of preferably 10-40 cm. Depth, flow, and substrate type should be similar for the three replicate samples collected in the riffle. Begin sampling downstream and proceed upstream for the three replicates.

2. Place Surber sampler on the selected spot with the opening of the nylon net facing upstream. Brace the frame and hold it firmly on the stream bottom.
3. Lift the larger rocks resting within the frame and brush off crawling or loosely attached organisms so that they drift into the net. After “cleaning” the rocks, inspect for invertebrates and discard from sampling area.

4. Once the larger rocks are removed, disturb the substrate vigorously with a trowel or a large spike for 60 seconds. This disturbance should extend to a depth of about 10 cm to loosen organisms in the interstitial spaces, washing them into the net.

5. Lift Surber out of the water and tilt the net up and out of the water while keeping the open end upstream. This helps to wash the organisms into the receptacle. Drop a pierce of weighted flagging tape to mark the location of the first replicate sample. Do not step on remaining sample areas while walking to stream bank.

6. On the stream bank, empty the contents of Surber into the appropriate container which has been labeled for that particular replicate and has been preserved with ethanol (95 percent). Residual water in the sample will dilute the ethanol to about 70 percent.

7. Inspect all the larger rocks and place any macro-invertebrates found into the proper replicate container. Rinse the wash bin and pour any floating organic matter into a 500-um soil sieve then transfer into the sample jar.

8. Repeat rinsing and pouring into the 500-um soil sieve until all apparent organisms are removed from any containers used during the collection process. Use a magnifying glass as tweezers to remove the last of the macro-invertebrates into the sample jar.

Archive sample: Insert a sample label that contains the name of team, date, location, and sample number and replicate number into the jar. Fill the sample jar to the top with alcohol and seal. Write the location and date on the top of the sample lid.

Collect replicate sample: Return to the location of the first sample, walk upstream and collect another sample of invertebrates. Leave another flagged marker and process the sample as above. Repeat this process once more for a total of three replicate samples from each site location. Each replicate should be labeled (e.g., #1, #2, #3) and archived separately.

Study #2 Grab sampling procedures for Chloride sampling:

1. To collect samples, clamp the bottle onto a properly designed sampling rod or pole (if necessary). If samples can be gathered within arm’s reach, a pole will not be used.

2. To gather water samples from a creek, dip the sample bottle into the flow being careful not to draw in bottom sediments or detritus.
3. Face the sample bottle upstream to avoid contamination

4. Fill bottles and leave as little headspace as possible

5. Once the sample has been filled, quickly cap it and place it in a suitable storage container (i.e. ice chest) for transportation to the laboratory.

Chloride grab samples are taken randomly on a month by month basis. Stormwater chloride grab sample are collected before the stormwater reaches receiving water body. The grab samples are located in an area where there is adequate mixing to assure that the samples represent water from the targeted drainage area. Sampling mid stream in the pipe/channel is a good way to ensure collection of a representative sample. If low flow conditions exist, it may not be possible to collect mid stream in the pipe/channel.

Sample sites will be free flowing and not affected by backwater and or tidal conditions. Chloride samples will be collected in a Polyethylene 250ml non preserved bottle provided by Spectra Laboratories. Once the sample has been collected the bottle will be labeled and sent to a certified lab for analysis. Chloride has a holding time of 28 days, will be analyzed using sample method EPS 325.2 and will be reported in mg/L.

SECTION D. QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

The Quality Assurance and Quality Control component of this program will be focused on reducing the two major types of data errors:

- Errors in the data from falsification by participants
- Errors in the data from inaccurate data entries, data transfers, misinterpretation of responses, and inherent limitations of the assessment techniques

The guidelines presented here are intended to help avoid or minimize errors in the data generated by this program. They are general in nature, and the specifics may vary as the program is developed.

Falsification by assessment participants will be minimized by careful construction of the assessment mechanisms and by training, although it cannot be avoided completely. The most important component of the QA program addresses the second groups of errors by adequate education and training of the investigators and all other personnel involved in the implementation of the assessment mechanisms. This training should be conducted at the start of the program and at intervals during the study, as appropriate. Training should include not only discussions of the assessment mechanisms, but also sessions on how to complete all
necessary forms, enter the data into the designated databases, and basic concepts of research methods. The Principle Investigator must be closely involved with all data collection activities in order to ensure high quality and timely conduct of data entry. Examination of data to identify possible outliers should be done routinely throughout the life of the assessment program.

SECTION E. ASSESSMENT PROCEDURES

12. AUDITS AND REPORTS

This section describes the processes that will ensure that the quality assurance procedures specified by this Plan are being implemented correctly, that the quality of the data is acceptable, and that corrective actions are conducted in a timely manner.

12.1 Audits

Audits are an important tool to verify that the quality assurance procedures described in this Plan are being adequately implemented as necessary. During an audit, the reviewer will check for the following—

- Sufficient documentation of all required activity
- Identification and justification for any activity that is not in the plan
- Correction of any problems that have been identified

Periodic audits will be scheduled by request from the Principle Investigator, Pierce County, or the Department of Ecology. The Principle Investigator will be responsible for initiating audits, selecting the team of reviewers, and overseeing the implementation of the audit.

Audits of the assessment procedures will address the following questions—

- Are all assessment mechanisms conducted as specified?
- Are documentation records complete?
- Are problems identified and resolved appropriately?
- Are data management procedures adequate?

Any nonconformance to established protocols will result in appropriate corrective action. The results of the audit and oversight activities will be reported to the Program Representative from
Pierce County, who has ultimate responsibility for ensuring that the corrective action response is appropriate, complete, and documented.

### 12.2 Reports

Reports that will be generated for this program include assessment files, outreach campaign files, status reports, and the Annual Stormwater Monitoring Report. Additional details regarding documentation of the targeted outcome component of the program are provided in the QAPP prepared for monitoring under S8.D.

**Assessment files:** Sample files are not required by the Phase I Permit, but will be maintained to track the details of each assessment mechanism. They will include all supporting information and documentation of the assessment, including the procedure for selecting the subset for sampling, all supporting information describing the assessment participants, details of the assessment approach, and the results of the assessment. Other supporting documentation may include notes regarding any assessment anomalies or other issues that could impact data analysis and reporting. The Principle Investigator is responsible for maintaining these files.

**Status reports:** Status reports will be prepared and submitted to the Program Representative for Pierce County, either quarterly or as requested. These will include a summary of the successful and valid assessments to date, a summary of the education campaign after it is implemented, a summary of any quality control issues for survey results, and a discussion of all issues that may need to be addressed. The Principle Investigator is responsible for preparing these reports.

**Annual stormwater monitoring report:** The Stormwater Monitoring Report is required to be submitted with the annual report every year (S8.H). Each report will contain all monitoring data collected during the previous water year (October 1 through September 31). As appropriate, the reports will integrate data from earlier years into the analysis of results and will incorporate results from this program as they become available.

Reports will be submitted in both paper and electronic form and will include:

- A summary description of each target streams (test and control), describing location, land use, drainage area, and pertinent demographic characteristics
- The status of implementing the SWMP effectiveness monitoring program, including supporting data from the stormwater characterization component of the program
- A comprehensive report of assessment and outreach results, as appropriate, with an explanation and discussion of the results
• Comparison of concentrations and loads for chlorides and fish carcass nutrient load in the test streams for the periods prior to and following studies
• Discussion of the status and results of the outreach campaign

The data report will explain the program results, present the data, document the overall quality of the data, and discuss any data anomalies. Additionally, the report will describe any planned changes to the current Plan that may be appropriate to address QA issues that have been observed.

13. DATA REVIEW AND VERIFICATION

This section describes the data review and verification procedures that determine whether the data conform to the criteria required by the program objectives. The most basic criterion is that the sampled participants provide an unbiased sample of the target streams. Comparison of the characteristics of the actual prior water quality analysis with the characteristics of the target streams as a whole will be necessary to verify whether they are similar or not.

Data review is the process of examining the data for errors or omissions. This will be done by prompt examination of all water quality samples collected. The Data Manager is responsible for ensuring that assessment data are reviewed and verified. After each successful assessment event, the Data Manager or designee will review all data for gross error (e.g. incongruous responses or data gaps) to verify the completeness of the data. The Principle Investigator will also check to see that assessment data were collected in accordance with required procedures.

Data review and verification procedures for the targeted outcome component of the program are described in the QAPP prepared for monitoring under S8.D.

13.1 Methods of verification and validation

This section presents a brief overview of the methods that may be used for verifying and validating data, including the input that will be necessary, the specific methods to be used, and the output from the verification process.

Data input: A variety of records will be necessary for data verification and validation. These could include, but are not limited to, the following—

• Field logs
• Assessment forms
Data verification methods: Data verification methods will be documented throughout the course of the process, and may be revised as appropriate to the situation. These methods will include—

- Identification of data gaps or missing data
- Identification of data anomalies
- Evaluation of expected patterns versus observed

Data verification products: Outputs from the data verification process include both the verified data and the verification documentation. Verified data will be submitted to the final quality or usability assessment described in the next section. Verification documentation may be included in status reports and/or the QA/QC section of the Annual Stormwater Monitoring Report. Data verification documentation should also include a discussion of any perceived shortcomings of the data.

14. DATA QUALITY ASSESSMENT

Once data have been reviewed and verified, a final data quality assessment will be conducted. The main goals of this assessment are to determine if the data meet the objectives of the program and can be used to evaluate the effectiveness of the outreach campaign.

Usability assessment is a qualitative process where data are evaluated relative to three levels of data quality—

- Accepted: data meet all requirements
- Qualified: data meet most requirements with only minor deviations
- Rejected: data do not meet critical requirements

The usability assessment includes examination of outliers, and verification that the data are complete and representative of the target populations.

Data quality assessment for the targeted outcome component of the program is described in the QAPP prepared for monitoring under S8.D.

15. DATA ANALYSIS AND PRESENTATION

This section describes the content of the Annual Stormwater Monitoring Report, to include data collected during the previous water year. The following elements will be included—
● Target stream summaries
● Data and QA report
● Evaluation of targeted action
● Comparison of previous BIBI index scores
● Evaluation of targeted outcome comparison of concentrations and loads for chlorides

15.1 Stream summaries
Each stream summary will describe the location, land use, drainage basin area, and hydrology. Additionally, a detailed description of the relevant demographic characteristics will be presented, as appropriate. Finally, the report will document all land use, climate, and demographic changes in the drainage basin for each site that could potentially impact either knowledge and behavior or pollutant loading.

15.2 Data summary
The data summary will describe all procedures for obtaining data, including all assessment mechanisms that were utilized. Summary tables will describe all assessment results and education efforts. Changes in knowledge and behavior, and concentrations and loads, will be reported in as appropriate.

15.3 QA summary
This section will include the following elements—

● Data validation information for each assessment that describes any QA issues and corrective actions, as appropriate
● Summary QA report, including
  ● Overview narrative summarizing all data validation information
  ● General assessment of usability and representativeness of data
  ● Description of any proposed changes to the existing QAPP to deal with observed QA problems
Table T 1. Parameters to be analyzed in stormwater

<table>
<thead>
<tr>
<th>Parameters analyzed in receiving waters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conventional Parameters</strong></td>
</tr>
<tr>
<td>Chloride</td>
</tr>
</tbody>
</table>

*SOURCE: Appendix 9, NPDES Municipal Stormwater Permit*
Figure 1. Base Map of Pierce County with Proposed Monitoring Sites
Figure 2. Map for Snow and Ice Activities for Squally Creek, Fennel Creek & Kapowsin Creek
The map features are approximate and are intended only to provide an indication of said feature. Additional areas that have not been mapped may be present. This is not a survey. Orthophotos and other data may not align. The County assumes no liability for variations ascertained by actual survey.

ALL DATA IS EXPRESSLY PROVIDED 'AS IS' AND 'WITH ALL FAULTS'. The County makes no warranty of fitness for a particular purpose.

**CHLORIDE SAMPLE POINTS**

- **Chloride Sample Collection Sites**
- **SQUALLY CREEK**
- **FENNEL CREEK**
- **KAPOWSIN CREEK**

(Figure 2)
Figure 3. Map for BIBI Sample Collection Little Mashel
The map features are approximate and are intended only to provide an indication of said feature. Additional areas that have not been mapped may be present. This is not a survey. Orthophotos and other data may not align. The County assumes no liability for variations ascertained by actual survey.

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Legend

★ BIBI Sample Sites
★ Fish Carcass Placement
Figure 4. Map for BIBI Sample Collection Kapowsin Creek
The map features are approximate and are intended only to provide an indication of said feature. Additional areas that have not been mapped may be present. This is not a survey. Orthophotos and other data may not align. The County assumes no liability for variations ascertained by actual survey. ALL DATA IS EXPRESSLY PROVIDED ‘AS IS’ AND ‘WITH ALL FAULTS’. The County makes no warranty of fitness for a particular purpose.
Appendix A. BIBI Sampling SOP & Field Sheet
**B-IBI SAMPLING PLAN**
**JUNE 15, 2010 THRU OCTOBER 15, 2011**

**Rationale**
A measure of biotic integrity will be used to quantify the cumulative impacts of development on the ecosystem and quantify the level of degradation relative to a range of watershed conditions within the Puget Sound lowlands. The benthic index of biotic integrity (B-IBI) for Puget Sound lowland streams, which quantifies the overall biotic condition of a stream based on measuring attributes of benthic macroinvertebrates, has been selected because B-IBI scores have been shown to correlate well with levels of urbanization (Fore et al. 1996; Horner et al. 1996). The protocol described below is from *Biological monitoring and Assessment: Using Multimetric Indexes Effectively* (Karr and Chu 1997).

**Data Management**
During the B-IBI sampling, site location data and site selection rationale shall be recorded. Additional information on specific site conditions at the time of sampling shall also be collected. This information can be collected in a field notebook and recorded onto the B-IBI summary sheet later. Summary sheet is attached.

**Field Equipment**
- 500 micron mesh Surber type sampler
- 500 micron (or smaller) mesh sieve
- Temperature/DO/Conductivity Meter
- Conductivity Standard packets (1413 MicroSiemens)
- pH Standard Packets (4.01 and 7.00)
- Flagged weight to identify sample location
- Ethyl alcohol (80%) diluted to 70% with bottled or filtered water
- Two (2) 1-liter squirt bottles for alcohol
- Garden trowel or large spike to disturb substrate
- White bucket or white wash bin to empty sample from Surber
- Large cup with handle to rinse invertebrates off Surber
- Stop watch
- Forceps (tweezers)
- Plastic spatula
- Waterproof ("Rite-in-the-rain") paper
- Pencil, permanent marker (Sharpie), and grease pencil
- 250 ml screw-top jars (3 per sample site)
- Ziploc bags
- Camera and film
- Site form
- GPS equipment
- Eye Protection
- Eye Wash
- Latex Gloves
- Insect Repellent

**Site Selection procedure**
Sample sites need to be representative of the larger study area. Physiographic characteristics like vegetation, soils, geology, land use, gradient, riparian characteristics, and substrate need to be
considered to assure that sample sites are representative of the larger population. Use professional judgment to determine specific appropriate sites.

After a stream reach is selected, find a riffle long enough to accommodate three replicate samples. Ideal sampling locations consist of rocks 5 to 10 cm in diameter sitting on top of pebbles. Substrates dominated by rocks larger than 50 cm in diameter should be avoided.

Sample sites should not be directly downstream from anomalies such as culverts, bridges, roads, landslides, or waterfalls unless these are the conditions that the monitoring program is evaluating. It is desirable to sample at least 50 yards upstream of a bridge or culvert and 100 yards (more would be better) downstream of a bridge or culvert.

**Invertebrate collection**

Three total replicates will be taken from each sample location using the following methodology:

1. Sample within the main flow of the stream. Sample at water depths of preferably 10 to 40 cm. Depth, flow, and substrate type should be similar for the three replicate samples collected in the riffle. Begin sampling downstream and proceed upstream for the three replicates.
2. Place Surber sampler on the selected spot with the opening of the nylon net facing upstream. Brace the frame and hold it firmly on the stream bottom.
3. Lift the larger rocks resting within the frame and brush off crawling or loosely attached organisms so that they drift into the net. After "cleaning" the rocks, inspect for invertebrates and discard from sampling area.
4. Once the larger rocks are removed, disturb the substrate vigorously with a trowel or large spike for 60 seconds. This disturbance should extend to a depth of about 10 cm to loosen organisms in the interstitial spaces, washing them into the net.
5. Lift Surber out of the water and tilt the net up and out of the water while keeping the open end upstream. This helps to wash the organisms into the receptacle. Drop a piece of weighted flagging tape to mark the location of the first replicate sample. Do not step on remaining sample areas while walking to stream bank.
6. On the stream bank, empty the contents of Surber into the appropriate container which has been labeled for that particular replicate and has been preserved with ethanol (95 percent). Residual water in the sample will dilute the ethanol to about 70 percent.
7. Inspect all the larger rocks and place any macro-invertebrates found into the proper replicate container. Rinse the wash bin and pour any floating organic matter into a 500-μm soil sieve then transfer into the sample jar.
8. Repeat rinsing and pouring into the 500-μm soil sieve until all apparent organisms are removed from any containers used during the collection process. Use a magnifying glass and tweezers to remove the last of the macro-invertebrates into the sample jar.

**Archive sample**

Insert a sample label that contains name of team, date, location, and sample number and replicate number into the jar. Fill the sample jar to the top with alcohol and seal. Write the location and date on top of the sample lid. Place the jar in a Ziploc bag labeled with the same information.

**Collect replicate samples**

Return to the location of the first sample, walk upstream and collect another sample of invertebrates. Leave another flagged marker and process the sample as above. Repeat this process once more for a total of three replicate samples from each site location. Each replicate should be labeled (e.g., #1, #2, #3) and archived separately.
**Photo Documentation**
One team member should take photos during the sampling process. Try and get photos of the team members while they are doing the sampling. Get photos of all three sample points as well as photos of the area around the site. Also point the camera straight up and get some photos of the canopy cover.

Document any information about the photos which will make it easy for stream identification later and add record this data on the last page of the Site description Forms.

**Site Activities**
Before leaving a stream site, the team leader reviews all of the data forms and sample labels for accuracy, completeness, and legibility. A second team member inspects all sample containers and packages them in preparation for transport, storage, or shipment. Refer to Section 3 for details on preparing and shipping samples.

When reviewing field data forms please take the time to ensure that all required data is included. Confirm that the stream identification code, the year, the visit number, and the date of the visit are correct on all forms. On each form, verify that all information has been recorded accurately, the recorded information is legible, and any flags are explained in the comments section. Ensure that written comments are legible and use no "shorthand" or abbreviations. Make sure the header information is completed on all pages of each form. After reviewing each form, initial the upper right corner of each page of the form.

When inspecting samples, ensure that each sample is labeled, all labels are completely filled in and legible, and each label is covered with clear plastic tape. Compare sample label information with the information recorded on the corresponding field data forms (e.g., the Sample Collection Form) to ensure accuracy.

The other team members should return all of the equipment and supplies to the vehicle for transport and clean up the stream site. Pack all equipment and supplies in the vehicle for transport. Keep them organized so they can be inventoried using the equipment and supply checklists presented in Appendix A. Clean up and dispose of all waste material at the stream site. Transport it out of the area if necessary.
### Pierce County 2010 B-IBI Site Description Form

**Date**  
__________/__________/__________ (day/month/year)

**Site Evaluator Name(s)**  
_____________________________________________________________________________________

**Organization**  
_____________________________________________________________________________________

**Site Location**  
Stream____________________________ Watershed__________________________

City____________________________ Location Description (Landmarks / Address) _____________

_____________________________________________________________________________________

**Weather**  
( ) Sunny  ( ) Cloudy  ( ) Partly Cloudy  ( ) Raining  ( ) Foggy

**Longitude**  
__________degrees    __________minutes    __________seconds

**Latitude**  
__________degrees    __________minutes    __________seconds

**Elevation**  
_________________ (Meters)

**Land Uses**  
( ) Agricultural  ( ) Urban/Suburban  ( ) Industrial  ( ) Mining  ( ) Logging
( ) Grazing  ( ) Forest  ( ) Other______________________________________

**Channelized**  
( ) Yes  ( ) No

**Culverts**  
Upstream  ( ) No  ( ) Yes  Approx. distance from sampling site ____________ (Meters)

Downstream  ( ) No  ( ) Yes  Approx. distance from sampling site ____________ (Meters)

**Dams**  
Upstream  ( ) No  ( ) Yes  Approx. distance from sampling site ____________ (Meters)

Downstream  ( ) No  ( ) Yes  Approx. distance from sampling site ____________ (Meters)

**Water Appearance**  
( ) Green  ( ) Orange/Red  ( ) Foam  ( ) Reds  ( ) Blues  ( ) Purples
( ) Blacks  ( ) Milky/White  ( ) Muddy/Cloudy  ( ) Multi-Colored (Oily Sheen)
( ) Other

**Inorganic substrate**  
Silt/Clay/Mud__________%  Sand _________%  Gravel__________%  Cobble__________%

Boulder__________%  Bedrock (Solid rock covers stream bottom)_________%

Percent Inorganic Substrate: _________________ (%)  

**Embeddedness**  
0-10%   11-25%   26-50%   51-90  90+%

**Sediment**  
_______________ (%)  

**Organic substrate**  
( ) Mud/Muck  ( ) Detritus  ( ) Logs/Limbs  ( ) Pulpy Peat  ( ) Fibrous Peat

Percent Organic Substrate: _________________ (%)  

**Bank Slope**  
( ) Steep  ( ) Moderate  ( ) Slight  ( ) Other ________________________
<table>
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<tr>
<th>Bank Stability</th>
<th>Stable</th>
<th>Slightly Eroded</th>
<th>Moderately Eroded</th>
<th>Severely Eroded</th>
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<td>Rock</td>
<td>Dirt</td>
<td>Mud</td>
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<td></td>
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<td></td>
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<td>Stones</td>
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<td></td>
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</tr>
<tr>
<td>Bank Vegetation</td>
<td>Barren</td>
<td>Grasses</td>
<td>Herbaceous</td>
<td>Brush</td>
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<td></td>
<td></td>
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<td>Stream Shading</td>
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<td>Air Temperature</td>
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<tr>
<td>Water Temperature</td>
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<td>(C)</td>
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</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
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<tr>
<td>Conductivity</td>
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<td>(us/cm)</td>
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<tr>
<td>Dissolved Oxygen</td>
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<td>(mg/l)</td>
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<tr>
<td>Surface Oils</td>
<td>None</td>
<td>Some</td>
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<td>Stream Width</td>
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<td>(Meters)</td>
<td>(At sampling site)</td>
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<tr>
<td>Surface Velocity</td>
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<td>(Meters/second)</td>
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<td>Water Depth</td>
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<td>(Meters)</td>
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<tr>
<td>Riffle Length</td>
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<td>(Meters)</td>
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<tr>
<td>Riffle Width</td>
<td></td>
<td>(Meters)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance between replicates within riffle</td>
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<td>(Meters)</td>
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<tr>
<td>Riparian Corridor Width (At sample site)</td>
<td>R. Bank (Meters)</td>
<td>Riparian Type</td>
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<td></td>
<td>L. Bank (Meters)</td>
<td>Riparian Type</td>
<td></td>
</tr>
<tr>
<td>Riparian Corridor Width (Mile Upstream)</td>
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<td>Riparian Type</td>
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<tr>
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<td></td>
<td>L. Bank (Meters)</td>
<td>Riparian Type</td>
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</tr>
<tr>
<td>Additional Notes (Please be as specific as possible in describing any stream attributes):</td>
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</tbody>
</table>
Appendix B. Regional Road Maintenance Endangered Species Act Program Guidelines
Snow and Ice Control
MAINTENANCE ACTIVITY: SNOW AND ICE CONTROL

DEFINITION
Road maintenance crews are responsible for sanding and plowing operations during periods of freezing weather. Snow and ice removal is considered to be work of such importance that it is classified as an emergency operation. Safety for the traveling public and road department personnel shall be given primary consideration at all times. Snow and ice removal reduces vehicle accidents that may adversely impact sensitive areas. Post event cleanup is considered a continuation of the event and removal of sediment from the road surface reduces sediment loading and preserves water quality.

PURPOSE
These activities are performed to provide a safe roadway surface for the traveling public, which in turn protects the environment by reducing accidents and vehicles leaving the roadway.

BMP OUTCOMES
- Provides a reasonably safe roadway surface for traveling public.
- Potentially minimizing pollutants resulting from vehicle accidents such as petroleum hydrocarbons, heavy metals, and road washoff from entering storm drainage/stream system.
- Reduction of salt and other chemicals from entering water bodies.
- Reduces the occurrence of vehicles leaving the road surface and entering sensitive areas.
- Sand clean up reduces sediment loading to sensitive areas.

BMP’S
- Minimize use of salt by reducing sand to salt ratios
- Treat sand cleanup as part of the emergency; remove sand as a priority to remove sediments
- Plow snow in areas that allow vegetation to filter and contain sand
- Prioritize clean up that minimizes impacts to sensitive aquatic habitat areas
- Prioritize clean up areas without sediment collection systems
- Carry Spill Kit used for small spills related to equipment failure. Desired outcome is to control, absorb, or contain spill for clean up and disposal.
  Minimum requirements:
  - Absorbent
  - Pads
  - Shovel
POTENTIAL CONSERVATION OUTCOMES

Habitat Goal:
• Maintain or restore water quality.

Conservation Accomplishments
• Maintain or restore water quality.
• Reduces vehicle accidents:
  • Reduces risk of petroleum and debris entering aquatic habitat.
  • Reduces structural damage to stream system.
  • Reduces vehicles from entering drainage, surface water or habitat
• Reduce sediment transport by cleaning sand from roadway.

Conservation Accomplishments Achieved by:
• Removal of sand from roadway surface reduces sediment contribution to adjacent water bodies and reduces dust and minimizes resulting air quality impacts.
• Reduction in salt and chemical use maintains water quality.
• Improve traction to reduce accidents which reduce pollutants from entering sensitive aquatic habitats.