# Rockfall Milepoint 49 Monitoring Plan for Check Dams on Mt. Hood Highway (US 26)

## (M.P. 49.10 to M.P. 49.23)

**GeoSyntec Consultants and Oregon State University**

**Report to:**
**Oregon Department of Transportation**
**Project SPR - 335**
**Water Quality Facility Investigation**

**Response to Task 4: Stormwater Monitoring Plans**

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# Introduction and Organization

Section 1

## 1.1 Introduction

This Stormwater BMP Monitoring Plan details the approach to be used for monitoring roadside ditch sediment traps located on Highway 26 in the Mt. Hood National Forest. These sediment traps were designed and installed by ODOT for the capture of sediment and adsorbed pollutants associated with winter sand applications conducted by the highway maintenance division.

## 1.2 Monitoring Plan Organization

The plan covers event targeting, sample collection methods, analytical procedures, data analysis and reporting, and heath and safety. The monitoring plan is organized as follows:

| | |
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| Section 1 | Introduction and monitoring plan organization |
| Section 2 | Goals and objectives of the monitoring effort |
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| Section 7 | Safety measures and sample collection procedures |
| Section 8 | Quality assurance and quality control |
| Section 9 | Data management and reporting |

The body of the report includes general descriptions of each of the above sections as well as site-specific monitoring procedures. Provided in the appendices are standard operating procedures for monitoring stormwater and sediment, procedures for setting control points and a sediment and water level staff gauge, and a site visit schedule and field checklist. Also included in the appendices is guidance on collected systematic random sediment samples.

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| Appendix A | Standard Operating Procedures (SOPs) for water quality and sediment monitoring |
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| Appendix C | Systematic random sampling for surficial sediment monitoring |

# Goals and Objectives of the Monitoring Effort

Section

2

The goal of sediment trap monitoring is to estimate the effectiveness of check dams installed in roadside drainage ditches at removing particulates and adsorbed pollutants from stormwater and snowmelt runoff from the western Mt. Hood portion of Highway 26. This is a base level monitoring effort to (1) estimate the quantity and grain size distribution of fine sediment (< 1 mm) captured and bypassed by the check dams, and to (2) assess the concentrations of a selected suite of highway pollutants adsorbed to the captured sediment.

# Site Conditions and BMP Characteristics

Section 3

## 3.1 Study Site Location

Several sediment traps have been installed adjacent to U.S. Highway 26 in Clackamas County, Oregon. This portion of Highway 26 crosses the Cascade mountain range near the base of Mt. Hood. Rockfall Milepoint 49, the site chosen for monitoring, is located in the Mt. Hood National Forest between the towns of Rhododendron and Government Camp between milepost 49.10 and milepost 49.23, at an elevation of approximately 2700 feet. Figure 1 depicts the approximate location of the study site.

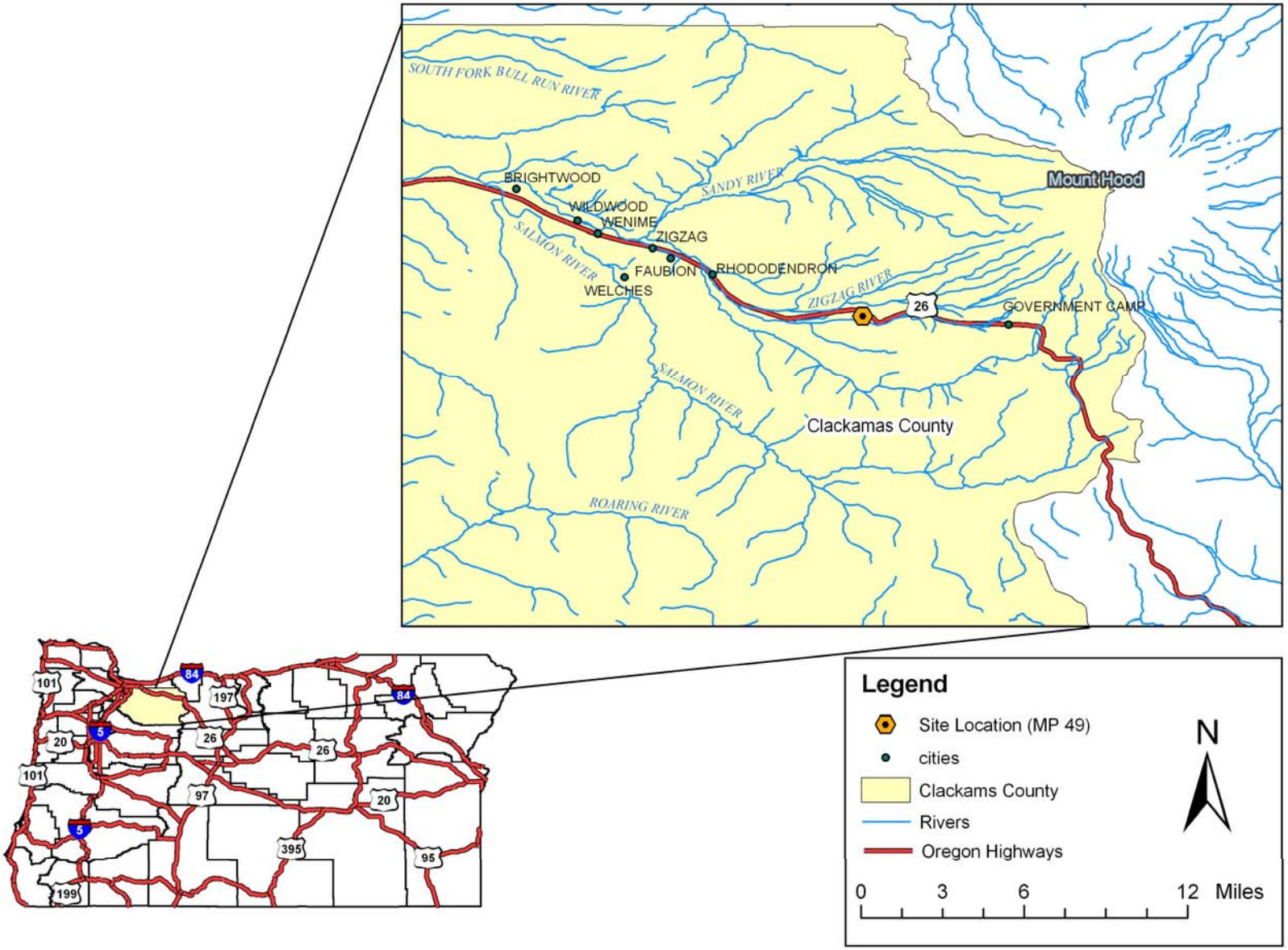


**Figure 1. Vicinity map of the Rockfall Milepoint 49 monitoring site.**

## 3.2 Hydrology and Hydraulics

The study site receives stormwater and snowmelt runoff from adjacent and up-gradient sections of Highway 26, which has two eastbound lanes and one westbound lane at the study location. Sediment and associated pollutants are transported by overland flow into a roadside ditch containing several check dams that retard the flow, allowing for settling of particulates (see Section 3.4 BMP Characteristics). Due to the elevation at the site, both rainfall and snowfall are common throughout the winter months. Rainwater likely contributes more to the transport of sediment than snowmelt runoff due to higher impact and runoff velocities. However, rainfall and vehicle traffic will accelerate the rate at which snow melts, increasing runoff rates and the potential for mobilization of particulates. Springs emerging from the west hill slope also contribute a significant amount of flow to the roadside ditch during the wet season.

The two nearest rain gages are located in the towns of Brightwood to the west and Government Camp to the east. The station information and summary rainfall statistics of these two gages are shown in the tables below. Note that for these summary statistics storm events have been defined as having a total rainfall volume greater than 0.1 inch (the minimum rainfall amount typically associated with runoff) and an inter-event time of 6 hours or greater.

**Table 1. Rainfall characteristics at Government Camp, OR.**

| **Government Camp, OR Rain Gage 3402** | | | | | |
|---|---|---|---|---|---|
| Elevation: 3979.0' above s/l<br>Lat/Lon: 45°18'N / 121°45'W<br>Data Source: National Climatic Data Center<br>Rain Record Used: Oct. 1948 – Sept 1999 | | | | | |
| Storm Events | Units | Min | Max | Average | Coef. of Var. |
| Average Intensity | in/hr | 0.001 | 0.4 | 0.05 | 0.8 |
| Depth | in | 0.11 | 8.9 | 0.6 | 0.8 |
| Average Duration | hrs | 0 | 133 | 14.0 | 1.0 |
| Annual No. of Events | | 35 | 114 | 69 | 0.2 |
| Annual Rainfall Depth | in | 15.6 | 62.7 | 38.7 | 0.3 |

**Table 2. Rainfall characteristics at Brightwood, OR.**

| **Brightwood, OR Rain Gage 1033** | | | | | |
|---|---|---|---|---|---|
| Elevation: 977.8' above s/l<br>Lat/Lon: 45°23'N / 122°03'W<br>Data Source: National Climatic Data Center<br>Rain Record Used: Oct. 1971 – Sept 2000 | | | | | |
| | Units | Min | Max | Average | Coef. of Var. |
| Average Intensity | in/hr | 0.017 | 1.4 | 0.07 | 0.7 |
| Depth | in | 0.11 | 8.6 | 0.7 | 1.1 |
| Average Duration | hrs | 0 | 110 | 11.3 | 0.9 |
| Annual No. of Events | | 33 | 125 | 91 | 0.3 |
| Annual Rainfall Depth | in | 23.4 | 91.0 | 65.4 | 0.3 |

## 3.3 Receiving Waters

The study site is located in the Zig Zag River watershed, which is essentially bisected by Highway 26. After flowing through a culvert beneath the highway, water discharging from the Rockfall sediment traps drains directly to Camp Creek, which enters the Zig Zag River approximately 3.5 miles downstream from the study site. At the study site discharge point, Camp Creek has a moderately steep gradient that gradually lessens downstream and then flattens for one mile into an unstable channel in an area of volcanic mudflow deposits before it becomes lower in gradient prior to reaching the Zigzag River.[1] The primary water quality concerns identified for Camp Creek include turbidity and sediment associated with highway sanding and road surface erosion.[2]

The Zig Zag River is tributary to the Sandy River, which discharges to the Columbia River east of the City of Troutdale. The Sandy River is protected as a scenic waterway from Dodge Park to Dabney Park, and is an active spawning grounds for several species of steelhead and salmon, including state endangered Coho and federally threatened winter steelhead and spring Chinook. The lower Sandy River is listed on the Oregon 303(d) list as impaired for high temperature and low dissolved oxygen during the summer. However, moderately high levels of total phosphates and biochemical oxygen demand (BOD) also occasionally impact water quality in the Sandy River during high flows.[1] These occasional impacts indicate the introduction of inorganic and organic materials to the water by runoff from fields, ditches, and storm drains.

## 3.4 BMP Characteristics

The Rockfall sediment traps are located on the westbound roadside of Highway 26 near milepost 49. The sediment traps are a series of check dams located within a rock-lined swale adjacent to the highway along the base of a steep rock face. The width of the swale varies between 2.7 and 6.2 meters and side slopes vary between 1V:6H to 1V:1.5H. The check dams consist of cobble-sized (25-250 mm) rocks and are typically designed with 1V:2H approach slopes and 1V:1.5H downstream slopes. There are 28 check dams along the length of the 275-meter swale. Figure 2 shows the approximate dimensions of a typical swale section. Figure 3 is a picture of the lower 4 check dams and Figure 4 is a picture taken at the same location as Figure 3 looking up-gradient. Both photos were taken at the end of March 2003. During the time of the photos, 15 of the 28 check dams contained flowing water with two locations where the flow went completely subsurface.

[1] Sandy River Basin Watershed Council (1999). "Phase 1 Watershed Assessment for the Sandy River Basin." [Online Available] http://www.columbia-center.org/SRBWC/Info/P1asesmt.doc

[2] U.S. Forest Service, Region 6, Mt. Hood National Forest (1995). "Zigzag Watershed Analysis, Mt. Hood National Forest." [Online Available] http://www.fs.fed.us/r6/mthood/sitemap/publications.shtml

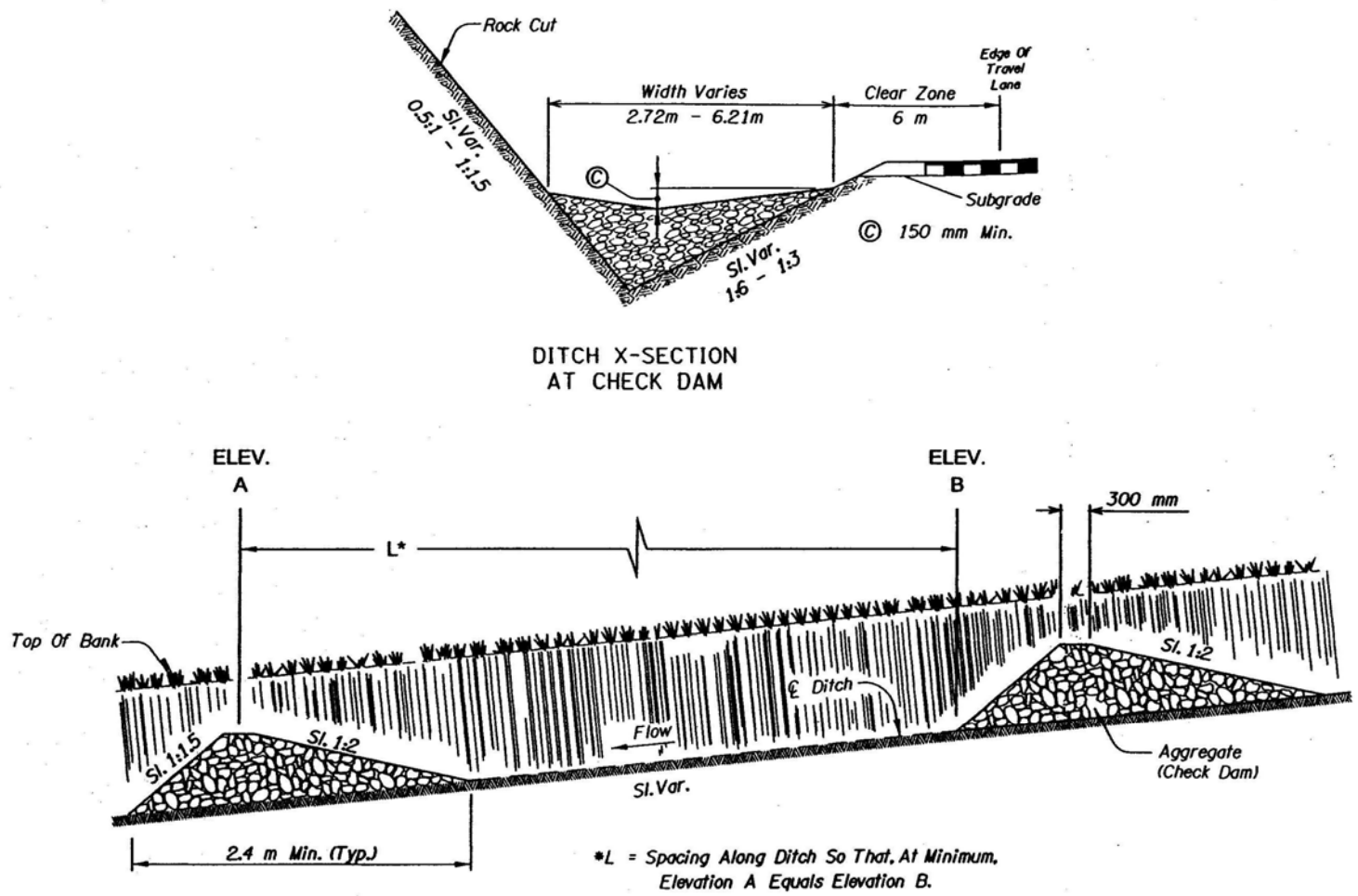


**Figure 2. Check dam at Rockfall Milepoint 49.**

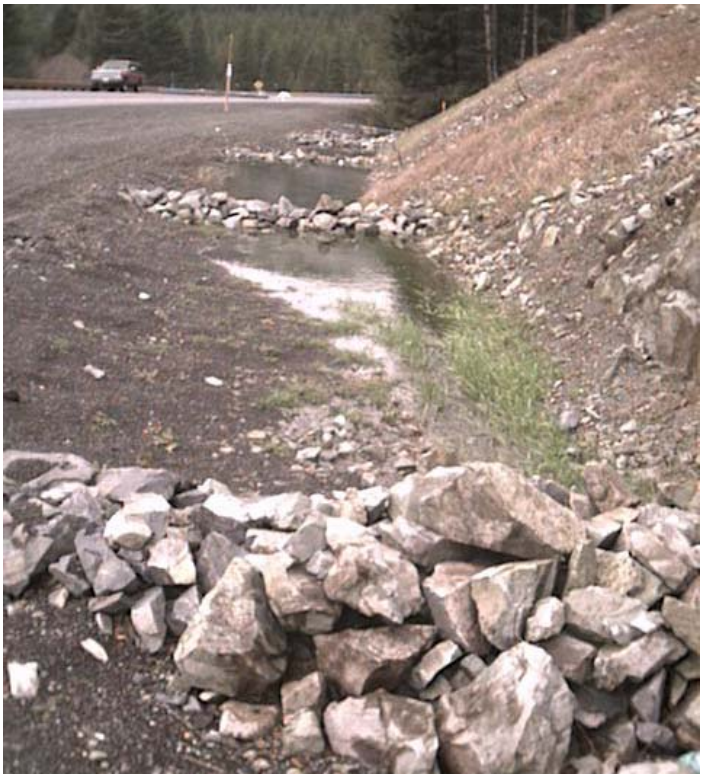

**Figure 3. Lower 4 Check dams at Rockfall Milepoint 49. Picture taken 3/22/2003.**

**Figure 4. Check dams at Rockfall Milepoint 49. Picture taken 3/22/2003.**

# Monitoring Methodology and Sampling Locations

Section 4

As opposed to typical stormwater monitoring where event mean concentrations of stormwater runoff are generally targeted, this monitoring effort focuses on monitoring and sampling of settled sediment before and after the wet season. Performance evaluations will be primarily based on visual observations and analyses of bed material samples. However, the collection of periodic time-weighted grab samples for analysis of suspended sediment is also included in this monitoring plan. Visual observations will include documenting and photographing the hydrologic and geomorphic changes at the site, such as the number of check dams containing water, activity of tributary springs, aggradation or scour of sediment, and growth of vegetation. Material deposited in front of the check dams will be collected and analyzed for grain size distribution and adsorbed contaminants. The following paragraphs describe site procedures for visual observations, instructions for setting up the sediment sampling sites and collecting the samples, and methods for periodic water quality grab samples.

## 4.1 Visual Observations

The site should be visited 3 times during the wet season (October 15 – April 15) and twice during the dry season (April 16 – October 14) to take photographs and make visual observations. On the first site visit, staff gauges and control stakes should be installed on the upstream side of several of the check dams to monitor gross sediment accumulation rates and water depth in the sediment traps. Refer to Appendix B for instructions on installing staff gauges and control stakes. A site visit schedule and field activities checklist are also provided in Appendix B.

## 4.2 Surficial Sediment Sampling

Sediment deposited upstream of the sediment traps should be sampled biannually, with samples taken during the last site visit of the dry season and during the last site visit of the wet season. Not all of the sediment traps need be sampled to collect representative data. However, since there are subsurface flows toward the middle of the ditch, sampling will be focused on the upper and lower sections of the sediment traps.

Sediment samples should be taken on the upstream side of the sediment traps at locations that are representative of deposited sediments. Sampling areas should be chosen using professional judgment and assessment of visual observations (i.e., should choose to sample sediment traps that show deposition of sediment). For the purposes of this monitoring plan, a sampling length and width define a sampling area, with the length equal to the downstream third of the ditch area between two sediment traps and the width equal to the width of ponded or previously ponded water on the upstream side of the sediment trap (e.g., if the distance between two sediment traps is 30 feet and the width of

ponding is 10 feet, the sampling area would be 10 feet by 10 feet, or 100 square feet). Each sampling area should be divided into an approximate grid of 2 to 3 foot cells. A sample should be taken in the center of the subarea that corresponds to a selected random number. Three subareas should be sampled for each check dam monitored using this systematic random sampling method. The procedure for taking random samples as well as a table of uniformally distributed random numbers is presented in Appendix C. General procedures for taking sediment samples are discussed in Section 7.

## 4.3 Suspended Sediment Grab Samples

In addition to surficial sediment sampling, time-weighted composite grab samples for analysis of total suspended sediment should be taken 1 to 3 times per year during storm events. Suspended sediment concentrations will be used to assess the ability of the sediment traps at removing fine particulates.

Grab samples for suspended sediment should be taken in three locations if possible: at the inlet to the sediment trap roadside ditch, at an intermediate sediment trap, and at the outlet of the sediment trap roadside ditch. Discussed below are the methods and criteria that should be used for targeting storm events for TSS sampling. The procedure for taking samples is discussed in Section 7.

### 4.3.1 Event Targeting

Each year of monitoring, one to three events should be targeted for total suspended sediment sampling. The quantitative probability forecast information should be examined regularly during the rainy season. A target event should have a 70% probability of producing 0.5 inches of rainfall in a 24 hour period and 80% probability of producing 0.2 inches per hour during two consecutive 3-hour periods.

### 4.3.2 Weather Forecasting

The Sampling Event Coordinator (see Section 6: The Sampling Team) will use four resources to monitor storm activity.

Oregon Climate Service (http://www.ocs.orst.edu/)
National Weather Service (http://www.wrh.noaa.gov/Portland/)
Extended Range Weather Forecasting Company (http://www.erfweather.com)
NW News Channel 8 (http://www.kgw.com/weather)

Weather monitoring should occur throughout the wet season, or until the desired number of events have been sampled.

## 4.4 Highway Sanding Materials Samples

In addition to onsite sampling, annual samples of the materials used for winter sanding applications should be taken to help provide the baseline grain-size distribution and monitored contaminant concentrations. Samples should be collected from a sand stockpile, preferably one nearest the site, using ODOT's standard sampling method for aggregate sampling from stockpiles.

# Analytical Parameters

Section 5

Surficial sediment samples, as well as the highway sanding materials, should be analyzed for particle size distribution and total cadmium, copper, lead, and zinc. The three samples from each sample area should be composited in a laboratory before beginning analysis. Since fine-grained sediments usually contain greater concentrations of metals than coarse-grained sediments, effort should be made to minimize the loss of fines during the handling and processing of samples. The composited wet sediment samples should be pre-sieved in the laboratory using a 2-mm non-metallic sieve and de-ionized water, or water obtained from the site if water was present and collected during sampling. American Society for Testing and Materials (ASTM) Standard D2217 can be followed to prepare the wet sediment samples for particle size distribution determination. Split the material passing the 2-mm sieve into approximate quarters. Using ASTM, EPA, or other standard methods, two sub-samples should be prepared for analysis of total metals (cadmium, copper, lead, and zinc) and two sub-samples should be prepared for analysis of particle size distribution.

Water quality grab samples should only be analyzed for total suspended sediment concentration, unless additional parameters are warranted at a later date. A suggested list of analytical parameters and test methods is shown in Table 3.

**Table 3. Analytical parameters suggested for monitoring at Rockfall Mile Point 49.**

| Parameter | Method | Reporting Limit | |
|---|---|---|---|
| Wet Preparation of Sediment Sample for Particle Size Distribution | ASTM D2217 | NA | |
| Particle Size Analysis | ASTM D422, D1140 | NA | |
| Total Suspended Solids | EPA 160.2 | 1 | mg/l |
| Total Cadmium | EPA 200.8/7000 | 0.1 | µg/l |
| Total Copper | EPA 200.8/7000 | 1 | µg/l |
| Total Lead | EPA 200.8/7000 | 0.5 | µg/l |
| Total Zinc | EPA 200.8/7000 | 5 | µg/l |

# The Sampling Team

Section 6

The Sampling Team refers to all personnel who are involved in logistical support, sample collection, traffic control, and safety during the monitoring event. There may be backup personnel to cover for employees that have other obligations when a monitoring event is scheduled, but at a minimum the Sampling Team should include:

- Sampling Event Coordinator (1 person, can be remote)
- Monitoring Team (2-4 persons)

## 1.1 Sampling Event Coordinator

[INSERT NAME AND TITLE OF SAMPLING EVENT COORDINATOR] will be the Sampling Event Coordinator for monitoring. The Sampling Event Coordinator (Coordinator) is responsible for initializing the monitoring program, reviewing field data and visual observations, and modifying the monitoring program if necessary. The Coordinator is also responsible for tracking weather patterns and selecting storm events for TSS grab samples. The Coordinator should notify the Monitoring Team 72-hours in advance of a potential monitoring event. The Coordinator should select water quality sampling events based on weather conditions and a prediction of the quantity of water available for sampling. Past field observations and storm forecasts can be used to predict whether adequate water will be available for sampling.

## 1.2 Monitoring Team

The Monitoring Team consists of [INSERT NAMES AND TITLES OF TEAM MEMEBERS]. They are responsible for ensuring that all required equipment is ready for field operation. They are also responsible for performing the entire field monitoring activities and most of the monitoring preparation. Any member of the Monitoring Team may recommend canceling monitoring if health or safety of the team could be imperiled due to site conditions or extreme weather. The Monitoring Team's other duties include contacting the analytical lab to arrange for delivery of sample bottles and drop-off of the samples at the lab once monitoring is completed.

# Safety Measures and Sampling Procedures

Section 7

As mentioned above, three levels of monitoring are incorporated into this monitoring plan: 1) field observations, 2) surficial sediment sampling, and 3) suspended sediment grab samples. There are general procedures for safety, cleanliness, documentation, and transport that apply to each of these. Additionally, there are more specific procedures that must be followed if the Sampling Event Coordinator decides to modify this plan for additional monitoring. Stormwater monitoring generally takes place under difficult operating conditions, which can increase safety risks or sample collection problems for the sampling team. There also exists the potential for sample contamination during collection, processing, and transport. Adherence to the procedures outlined in this section and the Standard Operating Procedures (SOPs) can help to minimize these risks and problems as well as reduce the likelihood of errors in sampling results. Topics covered in this section include:

- Personal Safety
- Sampling Equipment and Bottles\
- Field Observations and Measurements
- Clean Sampling Techniques
- Surficial Sediment Sampling
- Total Suspended Sediment Sampling
- Transport and Chain of Custody

## 7.1 Personal Safety

The Health and Safety Plan approved by [INSERT NAME AND TITLE OF ACTIVE HEALTH AND SAFETY OFFICER] should be reviewed by the all field personnel before the sampling operations covered in this monitoring plan begin. Personal safety should be of primary concern while conducting all monitoring activities. All persons visiting the site should be aware of the hazards associated with environmental monitoring and should freely voice any concerns if potential hazards become apparent. The Occupational Safety and Health Administration (OSHA) provides regulations and guidance on occupational safety, many of which are directly applicable to the types of activities involved in sediment and stormwater monitoring. It is the direct responsibility of each person involved in the monitoring program to read the Health and Safety Plan and adhere to its requirements.

## 7.2 Field Observations and Measurements

Initial site visits are important for the field crew to become familiar with the site and to individually assess potential hazards at the site. During the first site visit, the field crew

should identify which sediment traps will be monitored and install staff gauges in each of those sediment traps. Staff gauges should be installed in the deepest point of the sediment trap, and the reading at this point should be recorded as the datum, or reference point for all subsequent readings. Appendix B provides the procedures to be followed during the first site visit including installation of staff gauges and other control points.

The performance of the sediment traps is likely dependent on a number of environmental factors. Therefore, routine site visits are important to document the seasonal geomorphologic and hydrologic characteristics of the sediment traps. Photographs should be taken during each site visit and filed with the daily field notes. A field observations checklist is included in Appendix B.

## 7.3 Clean Sampling Techniques

Clean sample collection techniques should be followed to minimize the potential for contamination of sediment and water quality samples. Care must be taken during all sampling operations to avoid contamination of the samples by human, atmospheric, equipment, or other potential sources of contamination. The monitoring team should practice the "clean hands/dirty hands" technique to avoid sample contamination, as well as take the following precautions:

- Minimize interaction between samples and containers and implements,
- Minimize interaction between samples and external environment,
- Treat sample containers with the same precautions as samples,
- Wash sample containers and implements with appropriate cleaners,
- Run an appropriate analytical blank to which to refer every sample collected, and
- Whenever possible, collect samples upstream, and upwind of sampling personnel and equipment

## 7.4 Surficial Sediment Sampling

Sampling of sediments captured by the sediment traps should be conducted before and after the wet season as to reduce the likelihood of a significant amount of water at the site. Deep and rapidly moving water may drastically affect the results of the analyses of the sediment samples and therefore is not recommended during significant rainfall-runoff events. The following paragraphs describe the equipment and procedures for sampling surficial bottom sediments.

### 7.4.1 Sediment Sampling Equipment

All equipment that will be in direct or indirect contact with samples must be thoroughly washed with phosphate-free soap and rinsed with de-ionized water prior to taking to field. The following should be taken to the field during each sampling event:

- Field notebook
- Chain-of-custody records
- Sample jar labels
- Calculator

- Tape measure
- 24-ounce Teflon-lined scoop
- 32-ounce wide-mouth glass jars with Teflon-lined lids (one for each sampling area)
- Large cooler with ice ($4^{o}C$)
- De-ionized water
- Powderless, disposable nitrile gloves

### 7.4.2 Sediment Sampling Procedures

When sampling surface sediments (0-6 inches in depth) with a scoop from beneath a shallow aqueous layer (0-12 inches in depth) utmost care must be exercised to minimize the loss of fines. After a random subarea has been selected for sampling, the clean sampling techniques in SOP A-4 should be followed in addition to the following procedure when collecting sediments with a scoop:

1. Put on sterile nitrile gloves
2. Remove lid of sample bottle
3. Place lid top down on a clean surface (out of the rain if raining) or hold in hand while taking sample, do not allow inside of lid to contact any objects.
4. With a decontaminated Teflon-lined scoop, penetrate the surface sediment at approximately a 45-degree angle at the sampling location to 4-6 inches or to the total depth of deposited sediment, which ever is less, and gently retrieve the sample. If water is present, stay downstream of the sample location and scoop upstream. If there is a significant loss of material as the sample is retrieved, choose a new location, following the random selection procedure described in general above and in detail in Appendix C, and resample. Each sample should be between 12 and 16 ounces.
5. Transfer the sample to a glass jar designated and labeled for the sample area. A decontaminated spatula may be needed to transfer the sample.
6. Replace lid and place in the cooler with ice.
7. Repeat steps 3 through 7 until at least three samples have been obtained from each sample area.
8. Proceed to next sample area and repeat procedure.

If water is present at the site, a 2-3 gallon sample should be collected in a clean vessel, taking care not to collect any suspended or disturbed materials. This water will be used to wet sieve the collected sediment samples for determination of particle size distribution.

## 7.5 Suspended Sediment Sampling

Grab samples should be taken while there is sufficient water to facilitate sampling without disturbing bottom sediments or capturing bed load materials. Consequently, the conditions at the site may be considerably more hazardous than during surficial sediment sampling. The Sampling Team should be fully aware of the potential hazards at the site and should make safety the highest priority. The equipment and sampling procedures for taking grab samples for suspended sediment analysis are detailed below.

### 7.5.1 Grab Sample Equipment

As with the surficial sediment sampling, all equipment that will be in direct or indirect contact with samples must be thoroughly washed with phosphate-free soap and rinsed with de-ionized water prior to taking to field. The following should be taken to the field during each grab sampling event:

- Intermediate sampling vessel (i.e., glass jar or plastic bucket)
- 6, 1-gallon glass jars with lids (provided by lab)
- 3, 32-ounce wide-mouth glass jar with Teflon-lined lids
- Calculator
- Watch or stopwatch
- Large cooler with ice (4$^{o}$C)
- De-ionized water
- Powderless, disposable nitrile gloves
- Field notebook
- Chain-of-custody records
- Sample jar labels

### 7.5.2 Time-Paced Composite Sampling

Time-paced composite samples will be collected for total suspended solids (TSS). Time-paced composite samples will be collected every 30 to 60 minutes as decided by the Sampling Event Coordinator depending on the predicted event conditions. Ideally, 7 to 13 samples should be collected within 6 hours time to fill the two (2) 1-gallon sample jars (7,571 mL total). The expected rainfall intensity and duration, number of team members present and other conditions are factors in determining the sampling interval and volumes. Whichever interval is chosen, it is important to record the sample times and volumes on the field data sheet. The team may decide to increase the volumes per interval or decrease the interval duration if it looks like the rain event will not last 6 hours. Again, this should be recorded on the field data sheet. The following is a guideline for volumes per interval based on a 6-hour event:

**Table 8.1. Volume and time interval guideline for time-weighted composite sample collection.**

| Interval | Volume per Interval |
|---|---|
| 30 minutes | 582 mL: |
| 45 minutes | 841 mL |
| 60 minutes | 1,082 mL |

Composite grab samples should be collected using an appropriate intermediate container such as a glass jar or plastic bucket. Adhering to clean sampling techniques in SOP-A3, the following grab sample technique should be followed:

1. Decide on the sampling interval and associated volume. Adjust throughout event if conditions dictate.
2. Put on sterile nitrile gloves.
3. Rinse intermediate sample bottle with source water by filling and emptying three times.
4. Beginning near the outlet of the check dams, fill the sample vessel at mid-depth of deepest part of channel with bottle opening facing upstream and neck higher than the bottom at all times. If sampling in shallow depths, submerse lip of container in flowing stream, taking care not to disturb bottom sediments and avoid collection of bed load material. A sample volume equal to or greater than the aliquot volume should be collected all at once if possible. However, multiple dips with an intermediate container may be necessary for shallow depths. An extra single grab sample should be collected during the first sample collection period after the first composite sample is taken for analysis of first flush concentrations.
5. Slowly pour the chosen aliquot amount into the first 1-gallon sample jar. Pour the extra first flush sample into the 32-ounce glass jar.
6. Replace lid on jars, fill out labels and field data sheet, and place both in cooler with ice.
7. Repeat procedure every chosen interval for 6 hours or until the two (2) 1-gallon sample jars are full.
8. Repeat procedure at each of the three sampling locations moving upstream.

## 7.6 Sample Packing and Shipping

Monitoring personnel will deliver the samples to the laboratory. Sample bottles will be placed in coolers or some other package that is rigid enough to provide protection of the samples and has insulative properties to keep samples cold. During packing, the sample from one monitoring location should not be separated into separate shipping containers unless bottles of one size need to be shipped together because of container size. If samples from a location are separated a copy of the field-sampling sheet pertaining to the bottles will be enclosed in each shipping container. Prior to shipping all sample bottles will be recorded on the packing lists, which will include the shipping date and the method of transporting the samples.

## 7.7 Chain of Custody

After samples have been obtained and the collection procedures properly documented, a written record of the chain of custody of each sample will be made. This record ensures that samples have not been tampered with or inadvertently compromised in any way, and it also tracks the requested analyses for the analytical laboratory. “Chain of Custody” (COC) refers to the documented account of changes in possession that occur for samples. The Chain of Custody record tracks the sampling path from origin through laboratory analysis. Information necessary in the chain of custody includes:

- Names of the persons collecting the sample(s)
- Date and time of sample collection
- Location of sample collection

- Names and signatures of all persons handling the samples in the field and in the laboratory
- Laboratory analysis requested and control information (e.g., duplicate or spiked samples etc.) and any special instructions (e.g., time sensitive analyses)

To ensure that all necessary information is documented a COC form will accompany each sample or set of samples. COC forms should be printed on multipart carbonless paper so that all personnel handling the samples may obtain a copy. A COC record should accompany all sample shipments and the sample originator should retain a copy of the forms. When transferring custody of samples the transferee should sign and record the date and time of each transfer. Each person who takes custody should complete the appropriate portion of the chain of custody documentation.

# Quality Assurance and Quality Control

Section

8

Quality assurance (QA) and quality control (QC) are fundamental components of any monitoring program and are essential for the collection of quality data. Data quality can be determined using measurements of precision and accuracy, as well as evaluating the representativeness, completeness, and comparability of the data collection techniques and results. The level of data quality determination depends on the data quality objectives and budgetary constraints of the monitoring program.

Precision is the measure of agreement among duplicate samples. For this monitoring plan, field duplicate samples should be collected at a rate of 10% of the total number of samples collected during each site visit. Duplicate samples should be fictitiously labeled and as such and included with the set of original samples. The analytical laboratory should also perform duplicate analyses according to the laboratory's QC/QA program.

Accuracy is the measure of how close the results are to a true or expected value. The analytical laboratory should evaluate the accuracy of its sample extraction and/or analytical procedures using spike samples. Acceptable spike recoveries must fall within statistically derived laboratory "control limits."

Representativeness is based on the selection of sampling sites and the use of professional judgment when collecting samples. Given the use of professional judgment, the recommended sampling methods contained in this monitoring plan should result in the collection of representative samples.

Completeness is based on a comparison of the amount of valid data originally planned for collection versus the amount actually collected. Completeness should be assessed during periodic data summary and analysis reports.

Comparability expresses the confidence with which one data set can be compared to another. Data are comparable if collection techniques, measurement procedures, methods, and reporting are equivalent for the samples within a sample set. Comparable data will be collected if comparable sampling, analysis, QA/QC and reporting procedures are implemented throughout the monitoring program.

# Data Management and Reporting

Section 9

Results will be reported by the laboratory as hard copy and as electronic files. Hard copy data will be entered into an electronic format, and checked at least once by a different person. Electronic submittal of results will be discussed with the analytical lab in advance of delivery and its format arranged. A separate record will be generated for each sample analysis.

In addition the key information such as; station ID, sample date and time, name of sampler, name of constituent, all results, units, detection limits, EPA methods used, name of the laboratory, and any field notes will be entered into a site water quality database. Additional information, such as compositing of multiple samples, or the use of grab or automatic samples, will also be included.

When reporting the laboratory results for each stormwater sample the following information will be provided:

- Sample site
- Sample date and time
- Sample number (or identification)
- Sampling technician(s)
- Detection Limit and Reliability Limit of analytical procedure(s)
- Sample Results with clearly specified units

# Standard Operating Procedures for Monitoring (SOPs)

Appendix

A

## SOP A-1 General Equipment and Procedures Checklist

**Table A.1: Stormwater monitoring field equipment checklist**

| Documentation | Safety |
|---|---|
| Signed Health and Safety Plan<br>Stormwater Monitoring Plan<br>Monitoring Plan Check Lists and Field Notebooks<br>Field Data Sheet<br>Equipment Manuals (if applicable)<br>Chain of Custody Forms/Bottle Labels/Permanent markers/pen/pencils | Traffic cones<br>Traffic control signs<br>Cell phone (or two way radios)<br>Gloves (protective leather and nitrile)<br>Hard hat (1 per person)<br>Goggles (1 set per person)<br>Safety vest (1 per person)<br>Raingear<br>First Aid kit |
| **Sampling Equipment** | **Miscellaneous** |
| 24-ounce Teflon-coated scoop<br>32-ounce wide-mouth glass jars with Teflon-lined lids<br>Intermediate sampling vessel for TSS composites<br>2 – 1-gallon glass jars w/ lids (provided by lab)<br>1-gallon plastic bags<br>Cooler with ice (4$^{o}$C) (one for water quality samples and one for sediment samples)<br>Watch or stopwatch<br>Distilled water | Calculator<br>Tape measure<br>Plastic buckets<br>Stakes and flagging<br>Rubber mallet<br>Duct tape<br>Digital camera<br>Paper towels |

## SOP A-2 Weather Tracking and Monitoring Preparation

The Sampling Event Coordinator will review the National Weather Service, Portland forecasts (http://www.wrh.noaa.gov/portland/) and track potential rainfall events for total suspended sediment sampling.

If an event being tracked has a 70% or greater probability of generating 0.5 inch of rainfall within a 24 hour period and 80% probability of producing 0.2 inches per hour

during two consecutive 3-hour periods, the Sampling Event Coordinator will inform the Monitoring Team 72 hours before its predicted arrival and the Team will be placed in a "Prepare Mode."

Monitoring Team "Prepare Mode"

- Order bottles from lab and alert lab of possible monitoring activities (may want to keep a supply on hand during monitoring season)
- Assemble field equipment
- Arrange team members schedule for field activities
- Arrange vehicle for monitoring activities
- For 1st event of each season, check and flag all sample locations and assess site conditions, report any potential problems to Sampling Event Coordinator

The Sampling Event Coordinator will continue to monitor weather patterns and if the forecast still predicts a target magnitude event at 48 hours before its arrival, the Monitoring Team will be placed in a "Stand-By Mode."

Monitoring Team "Stand-By Mode"

- Identify Monitoring Team and arrange schedules for field activities
- Check bottle inventory against station check list
- Initiate chain of custody procedure
- Confirm team members schedules for field activities
- Arrange for vehicle to conduct monitoring activities

At 24 hours before the event is predicted to arrive if there is still a 70% probability that the storm will generate 0.5 inch of rainfall within 24 hours and 80% probability of producing 0.2 inches per hour during two consecutive 3-hour periods, the Sampling Event Coordinator will issue a monitoring "Alert."

Monitoring Team "Alert Mode"

- Label bottles
- Check field boxes for supplies
- Ensure a sufficient amount of ice for sampling and sample transport

At 12 hours before a target event is scheduled to arrive, a Go/No-Go decision on monitoring will be made by the Sampling Event Coordinator.

## SOP A-3 Bottle Organization

- Bottles of proper size and material and sufficient quantity should be prepared by the analytical lab and delivered to the Monitoring Team at least 48 hours prior to the sampling event (see sample bottle order form).
- An 80-quart Rubbermaid Environmental Cooler should be prepared to include the required bottles for sampling at each site as well as bottles for blanks and duplicates as required by the QA/QC plan.

- All sample bottles should have labels with as much information as possible filled out when bottles are dry. A second label or corresponding Sample ID No. should be placed on the sample bottle lid.
- Powder free nitrile gloves should be worn whenever handling clean bottles.

## SOP A-4 Clean Sampling Techniques

Sample collection personnel should adhere to the following rules while collecting stormwater samples to reduce potential contamination.

### General

- No Smoking
- Do not park vehicles in immediate sample collection area; do not sample near a running vehicle.
- Always wear clean powder-free nitrile gloves when handling composite bottles, lids, sterile grab sample bottles, tubing, or strainers.
- Never touch the inside surface of a sample bottle or lid with any material (including a gloved hand) other than the sample water or sediment.
- Never allow any object or material to fall into or contact the collected sample water or sediment.
- Avoid allowing rainwater to drip from rain gear or other surfaces into sample bottles.
- Do not eat or drink during sample collection.
- Do not breathe, sneeze, or cough in the direction of an open sample bottle.

### Equipment Decontamination Procedures

Non-dedicated sampling equipment will be properly cleaned before sample collection Non-dedicated equipment may include:

- Teflon or fluoropolymer scoops [note- you cannot use stainless steel for trace metals analysis] for sediment samples
- Buckets used to collect manual grab samples

Scoops and buckets used to transfer samples into the sample bottles will be cleaned as follows:

- Clean with tap water and phosphate-free laboratory detergent such as Liquinox®
- Rinse thoroughly with tap water
- Rinse thoroughly with de-ionized water
- Air dry

## SOP A-5 Chain of Custody Records

A chain of custody record (COC) is a legal document designed to track samples and persons who are responsible for them during preparation of the sample container, sample collection, sample delivery, and sample analysis. These form are supplied by the analytical laboratory that is/will be performing the sample analysis. The procedures for filling out these forms are as follows:

### Prior to sampling

After bottles are labeled placed in coolers, fill out general information on COC form including:

- Project Name
- Sample Site ID
- Matrix
- Date
- Sample Numbers (unique to each bottle)
- Type of sample

Place COC in a Ziploc bag and tape to the lid of the cooler

### After sampling is complete

After sampling has been completed, fill out remainder of the COC including:

- Time sampling was initiated
- Number of containers
- Comments or special instructions
- Disposal requirements

Replace in Ziploc bag and tape to lid of cooler

### At laboratory or transfer to another person

Whenever custody of the samples is relinquished:

- Sign and date
- Have new custodian sign and date
- Relay any special instructions
- Take one copy of COC for your records

## SOP A-6 Transporting, Packaging, and Shipping Samples from the Field to the Laboratory

- Clearly mark the analyses to be performed for each sample.
- Fold the chain of custody record form and place in a plastic bag to protect the sheet during transport. Tape COC to the lid of the cooler.
- Pack samples well to prevent breakage or leakage (samples should already be labeled) and provide additional protection for glass sample bottles (e.g., foam or bubble wrapping).
- Sample should be packed in ice or an ice substitute to maintain a sample temperature of 4°C during shipping. Ice (or substitute) should be placed in double wrapped watertight bags to prevent leaking during shipping.
- Using duct tape or packing tape, wrap the cooler twice to seal the opening.
- On the sealing tape, write the date and time the sample container was sealed
- Affix destination, identification, and FRAGILE labels to each shipping container.

# Site Visit Schedule and Field Checklist

Appendix

B

## First Site Visit

During the first visit to the site a numbering scheme should be established for the check dams (e.g., consecutively number going downstream to upstream) and 6-8 check dams should be selected for monitoring with at least two located in the upper portion of the ditch. The choice of check dams should be based on obvious signs of ponding and sedimentation. Once selected, control points should be established for each check dam to be monitored. These control points include the placement of a staff gauge in the deepest part of the channel and four stakes with flagging defining the rectangular extents of the sampling area. The rectangular extents are defined as the downstream third of the distance between two sediment traps by the width of ponded or previously ponded water on the upstream side of the sediment trap. Figure B.1 graphically shows how to define a sampling area for a check dam.

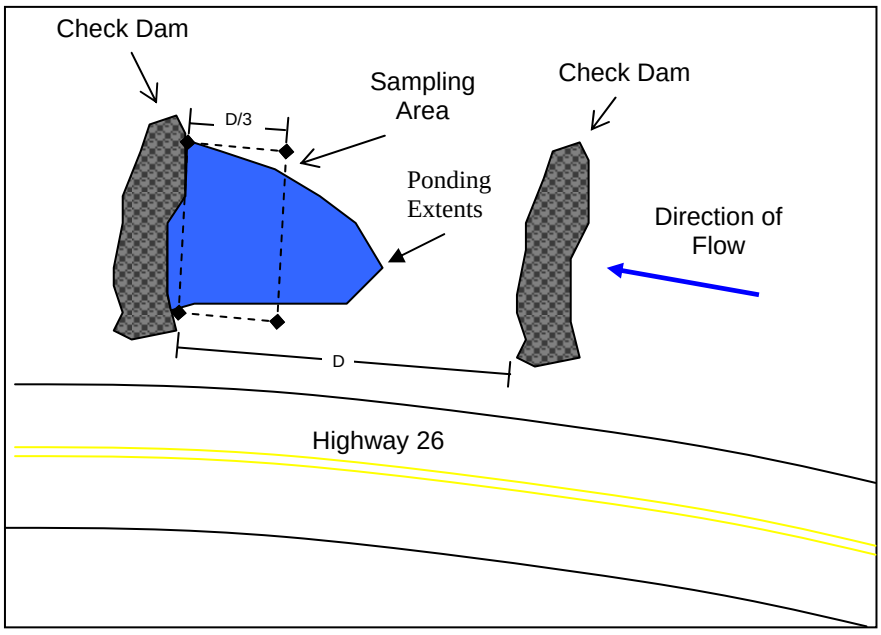


**Figure B.1. Defining a sampling area for check dam sediment monitoring.**

## Site Visit Schedule

As mentioned previously, there are three types of monitoring: visual observations, surficial sediment, and total suspended sediment. Table B.1 shows the recommended site visit frequency for each type of monitoring.

**Table B.1. Site visit schedule for field observations, surficial sediment, and total suspended sediment monitoring.**

| | O | N | D | J | F | M | A | M | J | J | A | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Field Observations | | 1 | | 1 | | 1 | | | 1 | | | 1 |
| Surficial Sediment | | | | | | 1 | | | | | | 1 |
| TSS Grabs | Storm event basis, 1-3 per year | | | | | | | | | | | |

## Field Observations Checklist

Once the check dams have been assigned identification numbers and control points have been established monitoring can begin. The following table is a check list for visual observations monitoring.

| Rockfall Mile Point 49 Check Dams Field Observations Checklist | | | Rockfall Mile Point 49 Check Dams Field Observations Checklist | | | | |
|---|---|---|---|---|---|---|---|
| Date: | Arrival Time: | Departure Time: | Check Dam No. | Sediment Level (in) | Water Level (in) | Pool Extents ($ft^2$) | Notes |
| Names of Field Personnel: | | | 1 | | | | |
| | | | 2 | | | | |
| | | | 3 | | | | |
| | | | 4 | | | | |
| | | | 5 | | | | |
| | | | 6 | | | | |
| Current weather: | | | 7 | | | | |
| Temperature: | | | 8 | | | | |
| Freezing level: | | | 9 | | | | |
| No. days since last rainfall: | | | 10 | | | | |
| No. days since last highway sanding activity: | | | 11 | | | | |
| | | | 12 | | | | |
| Is there snow at the site? | | | 13 | | | | |
| | | | 14 | | | | |
| Is surface water flowing in the ditch upstream of the sediment check dams? | | | 15 | | | | |
| | | | 16 | | | | |
| Is surface water flowing in the ditch downstream of the check dams? | | | 17 | | | | |
| | | | 18 | | | | |
| Is there vegetation growing in any of the check dams? List which ones. | | | 19 | | | | |
| | | | 20 | | | | |
| Other observations? | | | 21 | | | | |
| | | | 22 | | | | |
| <u>Activities</u> | | | 23 | | | | |
| 1) Take photographs of the check dams from top to bottom; note photograph number for cross-referencing | | | 24 | | | | |
| | | | 25 | | | | |
| 2) Take sediment and water level measurements | | | 26 | | | | |
| 3) Approximate the areal extent of each water pool | | | 27 | | | | |
| | | | 28 | | | | |

# Systematic Random Sampling

Appendix

C

Systematic random sampling is a sampling scheme used to ensure the collection of statistically unbiased samples while integrating some knowledge of the characteristics of the parameters being sampled. Surficial sediments should be sampled using the systematic random sampling technique to ensure the samples are representative of distribution of sediment deposited behind the check dams. The method is systematic because only selected areas will be sampled based on the knowledge of the physical process of sedimentation. It is random because the precise location of a sample taken within the sample area is chosen using random numbers. The following describes the process that should be used for taking systematic random sediment samples.

Using the sampling area defined in Section 4.2 and Appendix B the control point located nearest the highway and on the downstream edge should be chosen as the origin as shown in Figure C.1. The width, W, and length, L, should be measured.

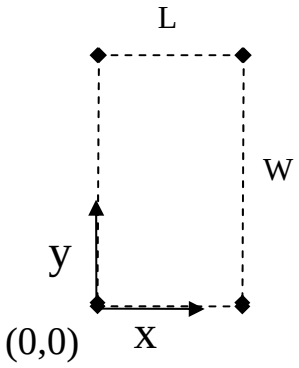


**Figure C.1. Sampling area for surficial sediment sampling.**

Using the selected control points as a reference, a sample should be collected at a point defined by X and Y below:

$X = RN_1 * L$

$Y = RN_2 * W$

Where $RN_i$ is a uniformally distributed random number selected from the 400 values in Table C.1. To select a number from the table choose one of the four quadrants and pick the column that corresponds to the last digit on your vehicle's odometer and the row that corresponds to the second to last digit. Choose a different quadrant for x and y.

**Table C.1. Uniformally-distributed random numbers between 0 and 1.**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.997 | 0.862 | 0.963 | 0.604 | 0.593 | 0.532 | 0.534 | 0.499 | 0.597 | 0.796 | 0 | 0.359 | 0.103 | 0.981 | 0.260 | 0.722 | 0.790 | 0.554 | 0.383 | 0.957 | 0.515 |
| 1 | 0.166 | 0.331 | 0.155 | 0.106 | 0.284 | 0.706 | 0.484 | 0.144 | 0.560 | 0.354 | 1 | 0.169 | 0.708 | 0.839 | 0.780 | 0.293 | 0.999 | 0.500 | 0.551 | 0.565 | 0.852 |
| 2 | 0.523 | 0.797 | 0.307 | 0.168 | 0.760 | 0.345 | 0.979 | 0.662 | 0.726 | 0.091 | 2 | 0.493 | 0.893 | 0.837 | 0.296 | 0.454 | 0.857 | 0.750 | 0.842 | 0.414 | 0.660 |
| 3 | 0.934 | 0.248 | 0.754 | 0.876 | 0.697 | 0.202 | 0.158 | 0.364 | 0.858 | 0.855 | 3 | 0.864 | 0.233 | 0.234 | 0.598 | 0.719 | 0.839 | 0.206 | 0.393 | 0.526 | 0.490 |
| 4 | 0.347 | 0.823 | 0.134 | 0.532 | 0.466 | 0.637 | 0.668 | 0.991 | 0.073 | 0.769 | 4 | 0.032 | 0.618 | 0.239 | 0.110 | 0.733 | 0.471 | 0.500 | 0.346 | 0.479 | 0.584 |
| 5 | 0.652 | 0.754 | 0.892 | 0.696 | 0.418 | 0.312 | 0.433 | 0.069 | 0.655 | 0.034 | 5 | 0.262 | 0.054 | 0.985 | 0.037 | 0.156 | 0.099 | 0.512 | 0.054 | 0.891 | 0.591 |
| 6 | 0.668 | 0.002 | 0.685 | 0.493 | 0.811 | 0.296 | 0.532 | 0.285 | 0.394 | 0.423 | 6 | 0.646 | 0.816 | 0.203 | 0.409 | 0.682 | 0.954 | 0.041 | 0.180 | 0.267 | 0.068 |
| 7 | 0.620 | 0.422 | 0.760 | 0.094 | 0.279 | 0.613 | 0.545 | 0.616 | 0.198 | 0.649 | 7 | 0.653 | 0.801 | 0.144 | 0.709 | 0.362 | 0.573 | 0.176 | 0.990 | 0.449 | 0.643 |
| 8 | 0.465 | 0.974 | 0.111 | 0.714 | 0.898 | 0.924 | 0.969 | 0.313 | 0.702 | 0.124 | 8 | 0.979 | 0.090 | 0.625 | 0.815 | 0.936 | 0.537 | 0.398 | 0.601 | 0.019 | 0.277 |
| 9 | 0.573 | 0.046 | 0.783 | 0.477 | 0.100 | 0.518 | 0.170 | 0.296 | 0.263 | 0.877 | 9 | 0.963 | 0.646 | 0.101 | 0.668 | 0.041 | 0.994 | 0.083 | 0.547 | 0.629 | 0.456 |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 0.280 | 0.209 | 0.492 | 0.339 | 0.694 | 0.074 | 0.004 | 0.331 | 0.959 | 0.503 | 0 | 0.117 | 0.978 | 0.613 | 0.264 | 0.114 | 0.034 | 0.897 | 0.857 | 0.360 | 0.182 |
| 1 | 0.986 | 0.574 | 0.472 | 0.192 | 0.349 | 0.567 | 0.256 | 0.278 | 0.970 | 0.195 | 1 | 0.028 | 0.797 | 0.795 | 0.567 | 0.462 | 0.015 | 0.942 | 0.586 | 0.507 | 0.220 |
| 2 | 0.805 | 0.442 | 0.590 | 0.779 | 0.006 | 0.703 | 0.475 | 0.527 | 0.452 | 0.347 | 2 | 0.858 | 0.596 | 0.914 | 0.627 | 0.883 | 0.958 | 0.085 | 0.582 | 0.213 | 0.679 |
| 3 | 0.463 | 0.293 | 0.869 | 0.121 | 0.969 | 0.562 | 0.620 | 0.641 | 0.587 | 0.338 | 3 | 0.190 | 0.874 | 0.565 | 0.452 | 0.015 | 0.361 | 0.188 | 0.652 | 0.725 | 0.875 |
| 4 | 0.786 | 0.792 | 0.930 | 0.128 | 0.470 | 0.073 | 0.148 | 0.247 | 0.719 | 0.628 | 4 | 0.264 | 0.281 | 0.350 | 0.095 | 0.783 | 0.953 | 0.134 | 0.323 | 0.041 | 0.127 |
| 5 | 0.281 | 0.509 | 0.248 | 0.506 | 0.733 | 0.772 | 0.759 | 0.167 | 0.051 | 0.605 | 5 | 0.809 | 0.312 | 0.200 | 0.339 | 0.461 | 0.856 | 0.032 | 0.192 | 0.332 | 0.403 |
| 6 | 0.792 | 0.942 | 0.287 | 0.467 | 0.123 | 0.804 | 0.827 | 0.464 | 0.285 | 0.226 | 6 | 0.933 | 0.699 | 0.847 | 0.663 | 0.438 | 0.900 | 0.938 | 0.733 | 0.286 | 0.071 |
| 7 | 0.416 | 0.622 | 0.415 | 0.356 | 0.645 | 0.912 | 0.227 | 0.107 | 0.307 | 0.713 | 7 | 0.592 | 0.654 | 0.896 | 0.644 | 0.371 | 0.382 | 0.313 | 0.402 | 0.800 | 0.797 |
| 8 | 0.667 | 0.510 | 0.866 | 0.093 | 0.815 | 0.816 | 0.550 | 0.912 | 0.656 | 0.461 | 8 | 0.990 | 0.706 | 0.397 | 0.291 | 0.978 | 0.351 | 0.217 | 0.896 | 0.578 | 0.903 |
| 9 | 0.012 | 0.869 | 0.904 | 0.004 | 0.396 | 0.317 | 0.234 | 0.515 | 0.795 | 0.566 | 9 | 0.510 | 0.028 | 0.455 | 0.672 | 0.036 | 0.768 | 0.891 | 0.779 | 0.846 | 0.282 |