Exercising the Highway 26 Check-dam Monitoring Plan 2003-2004

Informal Summary Report

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Introduction

As part of an Oregon Department of Transportation (ODOT) State Planning and Research (SPR) project entitled "Water Quality Facility Investigation" the "Rockfall Milepoint 49 Monitoring Plan for Check-dams on Mt. Hood Highway (US 26) (M.P. 49.10 to M.P. 49.23)" authored by Geosyntec was implemented from July 2003 to August 2004. This report summarizes the data collected by this implementation and observations regarding the plan itself. The actual laboratory analysis reports and other data are included as appendices. The objective of this report is to both document the water quality facility observations as well as provide feedback regarding the monitoring plan itself.

The report is organized according to the six data collecting activities that were implemented. The ordering of these activities is chronological according to their first implementation.

The first site visit served to document the physical condition of the facility. The soil sampling collected sediment samples from the facility for laboratory analysis of grain size and Copper (Cu), Zinc (Zn), Lead (Pb), and Cadmium (Cd) abundance. The water sampling collected water samples from the facility for laboratory analysis of total suspended solids. The water was also analyzed for Magnesium (Mg) and Chlorine (Cl) at the request of a Technical Advisory Committee member. The sanding material sampling collected material from the ODOT maintenance facility stock pile that was used for winter road maintenance along this portion of US 26. This sample was analyzed similar to the sediment samples. The native rock at the site was also sampled for laboratory analysis of Cu, Zn, Pb, and Cd abundance, even though not specified in the monitoring plan. The final site visits documented the ending physical condition of the facility.

First Visit

The first site visit, as defined in the plan, called for the establishment of a numbering scheme and sampling areas. Staff gauges were also to be installed.

The actual first site visit took place on July 31, 2003. During this visit no formal data collection took place but some photos were taken and the features of the site were observed contemplating the implementation of the monitoring plan. It was observed that there was a paucity of sediment in the basins behind most of the check-dams.

The first official site visit took place on September 29, 2003. At this time the check-dams were assigned sequential numbers 1 through 28 beginning at the most upstream check-dam. No type of permanent marker was placed at most of the check-dams on the premise that it was easy to count from the beginning. In retrospect this was a mistake. Some sort of marker, visible and legible in photographs, should have been placed at each check-dam. A small sign with a combination of colored quadrants and a written number would probably maximize legibility (see Figure 1.).

Three colors in this scheme would allow for 81 sites or features and four colors would allow for 256.

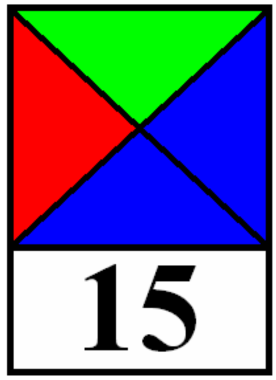

Figure 1. Concept for markers for site features to be studied.

Check-dams numbers 2, 15, 24, and 27 were selected for the installation of the staff gauges and control points. This is smaller than the 6-8 indicated in the monitoring plan. Only four were selected because in the first 21 check-dams only numbers 2 and 15 had remotely enough sediment in them to try and sample. The staff gauges were very difficult to place in the rocky basins of check-dams numbers 2 and 15.

The field observations check list provided in the monitoring plan asked for some data that were not field observations (freezing level, number of days since last rainfall, number of days since last highway sanding activity). Since a thermometer hadn't been listed on the field equipment list, one was not available to make that observation. The yes/no questions such as "is there snow at the site?" and "is there vegetation growing in any of the check-dams?" do not illicit information that is very useful. "How much snow?" and "what percentage ground coverage?" are questions that are begged by the simple yes/no questions. Regarding the vegetation, the question is how much vegetation constitutes "vegetation growing." Does a single sprig of grass qualify? Does one sprig per square foot qualify? In Oregon even the poorest ground doesn't stay completely devoid of vegetation for very long.

In summary what was to be done was very clear in the plan. The problems centered on how easily accomplished the tasks were as applied to this particular set of facilities and on having the correct equipment and information to accomplish them.

Soil Sampling

The soil sampling was to be done at the end of the wet season/beginning of the dry season and at the end of the dry season/beginning of the wet season. Soil samples were collected on September 29, 2003, April 26, 2004 and again on August 25, 2004. As mentioned previously, sediment volume available in the upper check-dams was very small. The random sampling approach couldn't really be applied even in the more sediment rich basins of check-dams number 24 and 27 because the sediment was confined to a very small area of the basin. By the final visit on August 25, 2004 the sediment supply had essential been exhausted. It was difficult to gather enough material in the standing water to form an adequately large sample. The grain size plots clearly show an increasing tendency to pick up large chunks when sampling the sediment.

Finding a source for a 24 ounce Teflon coated scoop proved difficult. Teflon coating also proved insufficiently durable for the rocky conditions present at the site. If avoiding contamination of the samples with metal from the scoop was the goal, disposable plastic scoops would have been a much better recommendation.

When the first arrangements for the soil samples were being made with the laboratory they raised a question regarding the reporting limits. It turned out that the table of reporting limits in the monitoring plan contained values for an aqueous sample not a soil sample.

Analyte →	**Total Cu**			**Total Zn**			**Total Pb**			**Total Cd**		
Site ↓	9/26/03	4/26/04	8/25/04	9/26/03	4/26/04	8/25/04	9/26/03	4/26/04	8/25/04	9/26/03	4/26/04	8/25/04
Check-dam 3	20.9	9.5	16.9	77.5	25.7	41.4	24.9	6.87	9.33	ND	ND	ND
Check-dam 15	94.5	70.3	108	217	189	272	98.4	96	113	ND	ND	ND
Check-dam 24	40.1	18.1	71.1	89.1	46.1	194	37.6	25.2	73.4	ND	ND	ND
Check-dam 27	34.9	12.6	58.9	104	23.4	91.3	45.5	11	33.5	ND	ND	ND

Table 1. Copper, Zinc, Lead and Cadmium abundance in the check-dam sediment samples.

Generally the problem was that the details of the sampling approach in the plan were not appropriate for the conditions encountered along Highway 26. There was just not enough sediment.

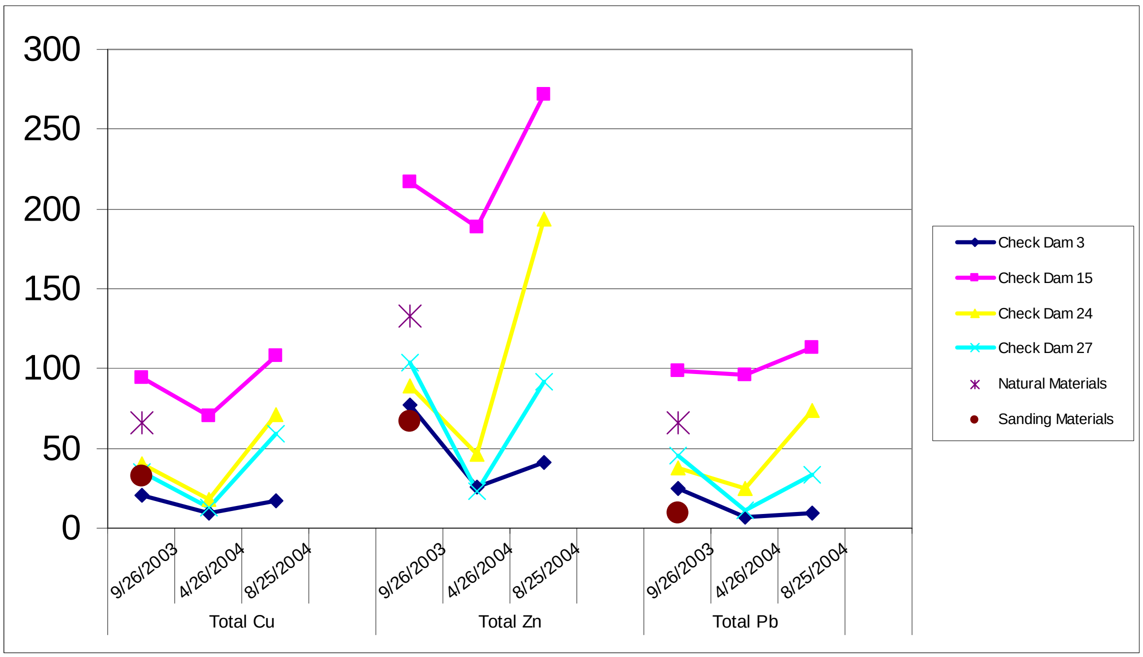

Figure 2. Graph of copper, Zinc, and Lead abundance through time in the check-dam sediment samples.

The laboratory report for the September 29, 2003 samples is found in Appendix A. The laboratory report for the April 26, 2004 is found in Appendix E. The laboratory report for the August 25, 2004 samples is found in Appendix H.

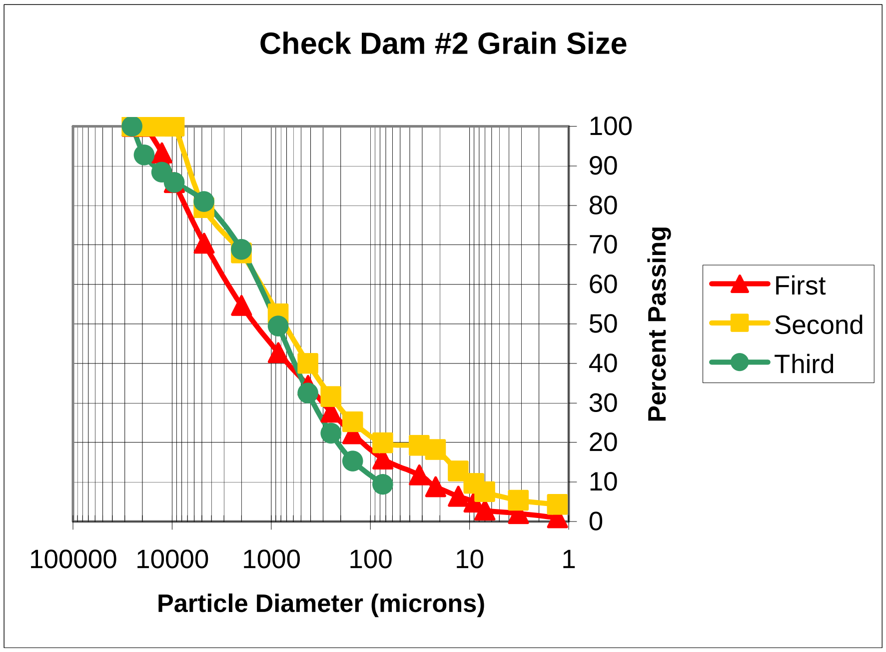

Figure 3. Graph of grain-size distribution for samples taken from check-dam #2.

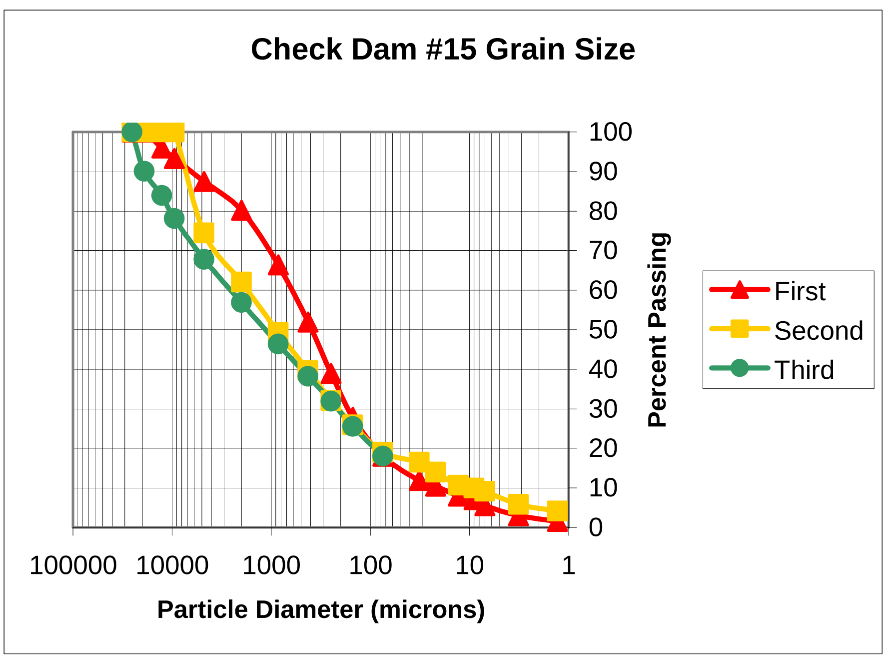

Figure 4. Graph of grain-size distribution for samples taken from check-dam #15.

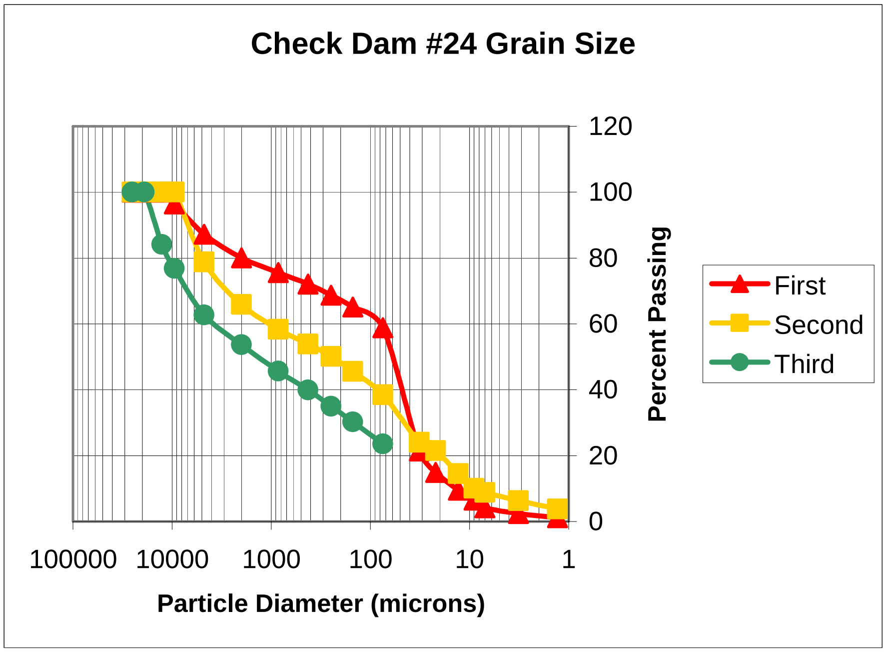

Figure 5. Graph of grain-size distribution for samples taken from check-dam #24.

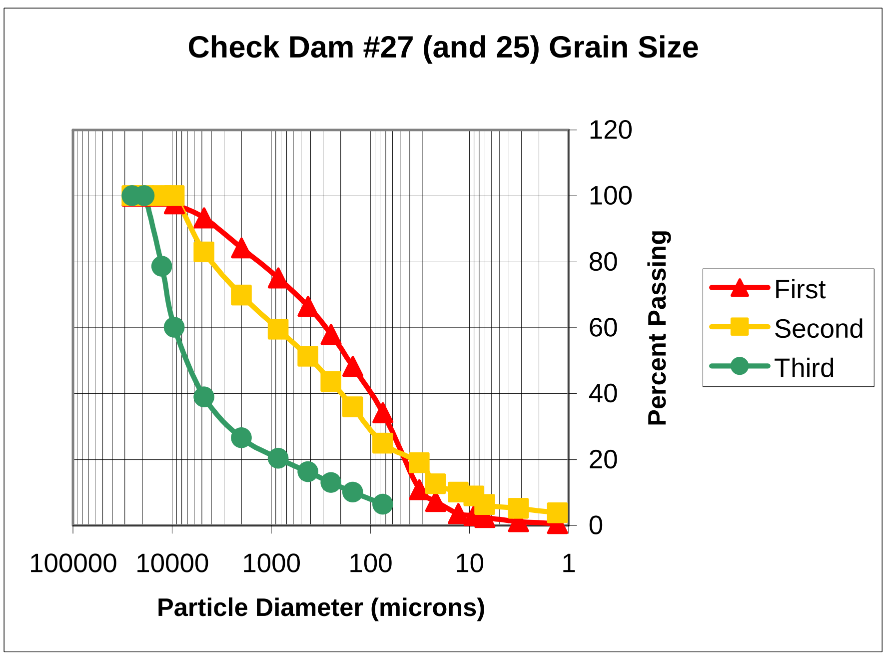

Figure 6. Graph of grain-size distribution for samples taken from check-dams #27 and #25.

Water Sampling

Water samples were collected on November 17, 2003, March 25, 2004, and April 14, 2004. Only on November 17, 2003 was water present behind check-dam 15 in sufficient quantity to collect a sample.

Quite a number of problems were encountered when trying to do the water sampling. The first was that the laboratory considered the request for gallon jars to be quite unusual and had to special order them. It was not clear why the monitoring plan requested such large volumes of water to be collected.

Early in the Fall no forecasts were meeting the criteria for sampling. A few storms came close to actually producing the required precipitation amounts and durations but none was forecast to do such. Finally it was concluded that only the probability of precipitation should be used, not the forecast 24-hour total. Forecasts and precipitation amounts were saved manually on normal work days for the first part of the winter. In February a program was written which would download and save the forecast and precipitation data automatically every day. A summary of the Precipitation and Forecast data are found in Appendix J.

The November 17, 2003 sampling was the first storm after this conclusion was reached. It was also forecast to give between a 0.5 inches and 1 inch or precipitation. It was also the last rain storm for over four months. The volume of water actually collected was half the amount requested in the plan (~ 1gallon). This decision was based on both the volume of water available at check-dams numbers 2 and 15 and the fact that 6 one gallon jars were not available at the time of the first sampling visit. This same volume was also collected for the subsequent samples.

During the period Oct. 15, 2003 to April 15, 2004 there were 21 days that ultimately produced ≥ 0.50 inches of precipitation and had a forecast of ≥ 70% probability of precipitation on the day before. Eighteen days had ≥ 0.50 inches of precipitation and had a forecast of ≥ 70% probability of precipitation on the same day. Some of those 18 days were not forecast at ≥ 70% probability of precipitation on the day before. There were a total of 9 days that generated ≥ 0.50 inches of precipitation and had a forecast of ≥ 70% probability of precipitation on the same day and the site wasn't snowed in. The first three of these nine days were forecast at <0.50 inches and were before that criteria was being ignored. Of the remaining 6 candidate days 3 were sampled. Of the 3 which weren't sampled, for two of them the precipitation came as snow even though the site wasn't snowed in. The final candidate came the day after a day that was sampled and thus was skipped.

The Total Suspended Sediment samples were turned over to the laboratory but when the results were shared with the Technical Advisory Committee a question about the reporting limit was raised. In fact the tests had been done with a reporting limit of 10 mg/liter. The plan calls for a reporting limit of 1 mg/liter. It is believed that the desired reporting limits were shared with the lab at the beginning of the project. The chain of custody form turned in with the samples simply requested a "Total Suspended Solids" test (TSS), using the terminology of the monitoring plan. Unfortunately the laboratory uses a different terminology for a test with a reporting limit of 1 mg/liter, namely "LLTSS" or "Lower Limit Total Suspended Solids". It isn't known how standard this terminology is but, at least for ODOT's current contracted laboratory, this is the terminology that makes the desired test clear. In general the lesson learned was to include all the details of desired testing parameters on the chain of custody form, even though the form doesn't elicit these details. Based on the clarity of the water and the results of subsequent LLTSS tests it is quite likely that the "Not Detected" result would have been obtained for all these first samples even using the LLTSS test.

From mid November to late March all precipitation at the site came in the form of snow. Several trips were made to the site during storms in the November through March time period, but there was either insufficient running water or the site was inaccessible due to snow being piled on the shoulder of the road. Snow level forecasts were essentially useless during the winter of 2003-2004. Trips made during sunny weather during this period made it apparent that water flowed through the facility at other times. It is surmised that the flow was from snow melt following the end of the storms. It was not clear if melt water would have been desirable to sample but the timing of the flows at the site was impossible to predict from weather forecasts and the Government Camp road camera. The monitoring plan doesn't mention snow at all.

Another issue which emerged was personnel proximity to the site. Salem is roughly 2 hours distant from the Highway 26 site depending on traffic and weather conditions. This meant that the timing of site visits with respect to precipitation was crude. Logistically 2 hours travel each way proved difficult and is likely the maximum that should be contemplated. A maximum of 1 hour travel each way would be a more optimal arrangement.

On the first water sampling visit it was also apparent that rock fall hazard was probably an issue worth explicitly mentioning in the monitoring plan to increase safety awareness. Obviously, other than the wearing of a hard hat, mitigation of the hazard is very problematic.

During this period it was noted that the staff gauges weren't strong enough to deal with the snow being thrown off the road by the snow plows. The check-dam number 15 staff gauge was reset once including excavating rock rubble to a fair depth. By the end of December, snow knocked down all the staff gauges. Either they couldn't be embedded deep enough (numbers 2 and 15) , the sediments were too soft to provide sufficient support (number 24), or the staff gauge broke (number 27). The only solution would have been to excavate a hole into which to pour a concrete pad in which to set the staff gauges. Even then the strength of the gauges themselves would probably be an issue. The gauge would need to be mounted on a very stout piece of wood. The resulting basin would be very different in character from the other basins raising questions about the data that would be collected. This is particularly true given the role of subsurface flow at this site.

Beginning with March 25, 2004 some of the precipitation began to come as rain once again. For this storm and the one on April 14, 2004 standing water was not present behind check-dam number 15.

The laboratory report for the samples collected on November 17, 2003 is found in Appendix B. The laboratory report for the samples collected on March 25, 2004 is found in Appendix C. The laboratory report for the samples collected on April 14, 2004 is found in Appendix D. The water was also analyzed for Mg and Cl at the request of a member of the TAC

Analyte →	Total Suspended Solids (mg/liter)			Magnesium (mg/liter)			Chloride (mg/liter)		
Site ↓	11/17/03	3/25/04	4/14/04	11/17/03	3/25/04	4/14/04	11/17/03	3/25/04	4/14/04
Check-dam 2	ND	37.3	6	2.78	14.1	24.6	18	48.1	99.9
Check-dam 15	ND	No Sample	No Sample	2.81	No Sample	No Sample	17.9	No Sample	No Sample
Check-dam 24	ND	ND	3	3.06	3.88	3.86	18.6	18.2	17.9

Table 2. Total suspended solids, Magnesium, and Chloride in water samples taken from pools behind check-dams #2, #15, and #24.

Sanding Material Sampling

The sanding material sampling was done on November 19, 2003. No problems were encountered, but this might be due to the very brief nature of the section of the plan that dealt with this task. The laboratory report for this sample is found in Appendix F

Analyte	Abundance (mg/kg dry)
Total Copper	32.9
Total Zinc	67.1
Total Lead	9.78
Total Cadmium	No Detect
Total Magnesium	5150
Total Chloride	No Detect

Table 3. Copper, Zinc, Cadmium, Magnesium, and Chloride abundance in sample of sanding material.

Native Material Sampling

When the first sediment sample analyses came back it raised the question of how the abundance of metals compared with the native rock material. Values for a number of Mt. Hood lavas were found for Cu and Zn. The Cu abundance ranged from 14.1 ppm to 69.4 ppm with an average value of 36.5 ppm. The Zn abundance ranged from 62.5 ppm to 109 ppm with an average value of 75.5 ppm. The range of values for samples from locations above Government Camp was as great as for all of Mt. Hood (Cribb and Barton, 1997). It was decided to analyze the natural material at the site for the same metals specified in the monitoring plan because the natural values are in the range of the values for the sediment samples collected. Cu was measured at 32.9 ppm, Zn at 67.1 ppm, Pb at 9.78 ppm, and Cd was not detected. Cu and Zn agreed very nicely with the published values for Mt. Hood lavas. The values for Cu and Zn in the basin sediments basically coincide with the natural materials found on Mt. Hood. This, taken with the absence of Pb data for other than the single sample taken of natural material at the monitoring site, would seem to indicate that more needs to be done with the natural abundance of Pb before interpreting the values observed in the check-dam samples. The laboratory report for this sample is found in Appendix G.

Analyte	**Abundance (mg/kg dry)**
Total Copper	66.4
Total Zinc	133
Total Lead	66.4
Total Cadmium	ND
Total Magnesium	5330
Total Chloride	No Detect

Table 4. Copper, Zinc, Lead, Cadmium, Magnesium and Chloride abundance in sample of natural material at site.

End of Wet Season Visit

By the end of the wet season visit most of the issues had been worked out. Vegetation was present to some degree in all the basins but the range was from very sparse to completely ground covering lush. By late spring three corner stakes, one in check-dam number 24's basin and two in check-dam number 27's basin, were covered with material sloughing off of the adjacent slope and/or vegetation. Mysteriously one of the corner stakes for check-dam number 24's basin was lying neatly on the rocks of the check-dam. The laboratory results for these samples are found in Appendix E.

While the staff gauges didn't survive, analysis of the closeup photographs allows estimates of the sediment deposition to be made. Check-dam #2 appears to have accumulated about 1 cm of sediment. Check-dam #15 shows no accumulation of sediment. Check-dam #24 appeared to have between 1 and 2 centimeters of material accumulated on July 14, 2004 but this included a fairly thick algal mat overlain by pluviated sediment and there was still a standing pool of water.. When the site was revisited in on August 25, 2004 the amount of sediment available to be sampled was less than this. Likely the algae desiccated and decayed during the intervening dry period and the sediment had also desiccated and consolidated. Check-dam #27 underwent a dramatic change in how much vegetation was found in the basin. The change in the vegetation combined with the loss of the staff gauge made estimating the accumulation of sediment very difficult. It appears that most of the vegetation was growing on material that was sloughing into the basin from the steep sides and that little material was being washed down the ditch. There was likely between 1 and 2 cm of accumulated sediment in the center of the basin.

Two major changes occurred to the site over the course of the year during which observations were made. The first major change was the vegetation. After one year all the basins had at least some vegetation growing in them. The range was from sparse in the middle dams to lush and covered in some of the lower dams.

The second major change was mass wasting. Several large rockfalls occurred directly on to basins, most notably numbers 11 and 12. Several others received minor rock falls. The some of the lower check-dam basins received a fair amount of material creeping and sloughing from the adjacent hill slope.

Conclusions

The suspended sediment in water collected from Highway 26 near milepost 49 is being controlled by shoulders and a ditch composed of poorly graded aggregate combined with rubble check-dams. So far this system seems to be effective at preventing water with high TSS values from being discharged into the stream paralleling the highway. The rate of accumulation of sediments, on the surface, behind the check dams is very low.

Analysis of the Cu, Zn, and Pb found in sediments collected behind the check-dams over one complete annual wet-dry cycle would seem to imply that these metals accumulate in the check-dams, to a minor degree, in the dry season and are then flushed out in the wet season. Sampling would need to take place over a number of years to confirm this conclusion. It is also possible that there is a long term upward trend for the concentrations of these metals. It is possible that the dry season accumulation doesn't raise the abundance of these metals above the naturally occurring values but the single sample of natural material doesn't allow for a firm conclusion on this point either.

The sanding materials used during the winter of 2003-2004 actually had less Cu, Zn, and Pb in them than seems to be characteristic of the rocks already at the site (both natural and human placed).

While check-dam #15 seemed to have consistently elevated abundance of these metals, it is entirely possible that those levels were the result of natural variations in the natural materials used to construct the ditch and check-dams.

No Cadmium was detected in any of the samples collected.

References

Cribb, J.W. and Barton, M., (1997), Significance of crustal and source region processes on the evolution of compositionally similar calc-alkaline lavas, Mt. Hood, Oregon, Journal of Volcanology and Geothermal Research, 76 nos3-4, p. 229-249.

Appendix A.

Laboratory Report for First End of Dry Season Sediment Samples

Appendix B.

Laboratory Report for First Water Samples

Appendix C.

Laboratory Report for Second Water Samples

Appendix D.

Laboratory Report for Third Water Samples

Appendix E.

Laboratory Report for End of Wet Season Sediment Samples

Appendix F.

Laboratory Report for Sanding Material Sample

Appendix G.

Laboratory Report for Natural Material Sample

Appendix H.

Laboratory Report for Second end of Dry Season Sediment Samples

Appendix I.

Photos of the Monitoring Site

Appendix J.

Precipitation and Forecast Data