Appendix D
Water Monitoring
Buckhorn Access Project

Buckhorn Road Impact Monitoring
(Toroda Creek road generated turbidity levels from Marias Creek)

Background: Road related activities, construction and reconstruction activities, maintenance, and road prism overland flow, have been identified as a major source of stream sedimentation considering all forest management activities. Roads closest to streams or have stream crossings of roads are the most likely to contribute to elevated levels of stream sedimentation. Water turbidity is an indicator of stream sedimentation and can be measured in water samples easily. Turbidity has a state water quality criterion of 5 NTUs (see Buckhorn Water Resource report). Stream sediment is likely to be transported from Marias Creek to Toroda Creek during some periods following road work in Marias Creek.

Problem: Approximately 2.8 miles of constructed and reconstructed road lies along Marias Creek in the RHCA (within 300 feet of the stream or closer) and has several stream crossings of Marias Creek or tributaries to Marias Creek. Road generated stream sedimentation from Marias Creek will eventually get to Toroda Creek. Water turbidity in Toroda Creek must also meet turbidity state water quality criterion, as a result of the road work in Marias Creek.

Objective: Determine if water turbidity levels in Toroda Creek meets WA state water quality criterion during the construction and reconstruction of the Marias Creek Road for up to five years following the road work for the Plan of Operations and Road Use Permit.

Past Work: No known past turbidity information is available in Toroda Creek at the confluence with Marias Creek.

Collected Data: Water samples will be processed to determine turbidity values in NTUs.

Turbidity information will be determined for each sample the first year of monitoring. During the second and third years of monitoring, samples will be analyzed for turbidity once every seven days, unless visual observation of the collected samples or precipitation events of .25 inches or more in a 24-hour period occurs at the site or at a nearby weather station, such as Republic, Tonasket or Omak. Samples immediately proceeding, during and immediately following the precipitation will be processed to determine turbidity. Timing will apply to both stations in Toroda Creek (monitoring locations above).

Sampling Locations: The “above” sampling location will be in Toroda Creek in Section 2 or 11, Township 39 North, Range 31 East, W.M. (just above the confluence of Toroda Creek and Marias Creek). The “below” sampling location will be located on Toroda Creek in Section 2, Township 39 North, Range 31 East or Section 36, Township 40 North, Range 31 East, W.M. or other suitable locations (just below the confluence of Toroda Creek and Marias Creek after a complete mixing occurs).

Sampling Procedure: Collect daily water samples with an automatic water sampler. Samples will be individual samples (not composite samples in a single collection container).

Sampling Frequency: Samples will be collected daily during daytime in mid afternoon.

Sampling would begin when the construction and reconstruction of the Marias Creek Road begins.

Data Analysis: Collected information will be analyzed used a student t test to determine if there is a significant difference at the .05 probability level of the in Toroda Creek turbidity levels above and below the confluence with Marias Creek.

Quality Control: Sample collection methods will follow the WA DOE procedures currently used to collect background water samples in Marias Creek.

Responsibility for Monitoring: The Project Proponent will be responsible for setting up the monitoring equipment, keeping it in operating condition and collecting the samples on a regular basis.

Report Completion, Location and Responsibility: Collected information will be sent to the Forest Service monthly. Information will be provided in an EXCEL spreadsheet, and will contain date of sample collection and turbidity.

Costs: The costs will be borne by the Project Proponent and will include the cost of the continuous water collection and stage recording equipment, site visits to collect the samples or maintain the equipment and determining the turbidity values for the collected water samples. Costs are expected to be the highest the first year, because of the equipment purchases and processing of all water samples for turbidity. Costs are expected to be much lower the second through fifth years because there will likely be no equipment purchases and substantially fewer water samples processed for turbidity.

Trigger: If the turbidity state water quality criterion is exceeded, field examination will be started as soon as practicable to determine where the source of increased turbidity is located. Actions to repair the source of the sediment creating the turbidity will begin as soon as possible (through FS permit administration enforcement procedures).

Buckhorn Road Impact Monitoring
(Marias Creek road generated magnesium levels)

Background: Road use and maintenance activities may contribute to elevated magnesium,. Roads closest to streams or having stream crossings are the most likely to contribute to elevated levels of magnesium and sodium. Magnesium not have state water quality criteria. There is no drinking water criterion for magnesium.

Problem: Approximately 2.8 miles of constructed and reconstructed road lies along Marias Creek in the RHCA (within 300 feet of the stream or closer) and there are several stream crossings of Marias Creek or tributaries to Marias Creek. Road maintenance includes application of magnesium chloride for dust abatement during the summer and sand and salt applications during the winter for traction aid on snowy and icy roads. Magnesium is soluble and are likely to eventually be transported to Marias Creek.

Objective: Determine the trend of magnesium levels in Marias Creek during the next five years of the Plan of Operations and Commercial Road Use Permit.

Past Work: Recently collected water samples from Marias Creek shows magnesium averages 13 ppm, varying from 7-17 ppm.

Collected Data: Water samples will be processed to determine values in ppm. Collection and testing will meet the same standards as presently used for water monitoring at other locations.

Sampling Locations: The "above" sampling location will be in Marias Creek in Section 31, Township 40 North, Range 31 East, W.M., above Forest Road 3550 (just above the upper crossing of Marias Creek, SW-2). A second sample location will be in Marias Creek in Section 4, Township 39 North, Range 31 East, W.M. just prior to Bat Canyon Creek entering Marias Creek. The "lower" sampling location will be located in Marias Creek in Section 2, Township 39 North, Range 31 East, W.M., near where Marias Creek crosses the Forest boundary but above the area where Marias Creek flows sub-surface most of the year.

Sampling Procedure: Water samples will be collected manually at the selected locations following procedures established by the WA DOE for collecting and analyzing background water quality samples in Marias Creek.

Sampling Frequency and duration: Samples will be collected every three months during the year when the stream is flowing for a period of at least 5 years.

Sampling would begin two months prior to the construction and reconstruction of the Marias Creek Road.

Data Analysis: Collected information will be analyzed by plotting the collected data in a time series in an EXCEL spreadsheet for each sample location. An analysis of covariance will be performed on the slope of each regression line slope to determine if the slopes are the same or different at the .1 probability level. Analysis of the data will be done by the Forest Service.

Quality Control: Sample collection methods will follow the WA DOE procedures currently used to collect background water samples in Marias Creek.

Responsibility for Monitoring: The Proponent will be responsible for conducting all monitoring.

Report Completion, Location, and Responsibility: The Proponent will be responsible for providing collected data in a EXCEL spreadsheet containing the sample concentration of magnesium and the date the sample was collected. A final report will be submitted in five years, with informal written interim reports annually.

Costs: All costs will be borne by the Proponent.

Trigger: If the trend to higher magnesium levels in the affected section of Marias Creek exceeds the trend of the salts above the road in the RHCA field examination will be begin as soon as practicable to determine where the source of increased salts are located. Actions to change the application of the salts will begin as soon as possible (through FS permit administration enforcement procedures).

Buckhorn Road Turbidity Monitoring
(Marias Creek road generated turbidity)

Background: Road related activities, construction and reconstruction activities, maintenance, and road prism overland flow, have been identified as a major source of stream sedimentation considering all forest management activities. Roads closest to streams or have stream crossings of roads are the most likely to contribute to elevated levels of stream sedimentation. Water turbidity is an indicator of stream sedimentation and can be measured in water samples easily. Turbidity has a state water quality criterion of 5 NTUs above background if background is less than 50 NTUs. Otherwise, less than 10% increase if background is grater than 50 NTUs. (see Buckhorn Water Resource report).

Problem: Approximately 2.8 miles of constructed and reconstructed road lies along Marias Creek in the RHCA (within 300 feet of the stream or closer) and has several stream crossings of Marias Creek or tributaries to Marias Creek. The first three years following construction or reconstruction have the greatest potential to increase turbidity levels the most, with the first year following road work generating 80-90% of the accelerated sediment and having the most impact on turbidity levels in Marias Creek.

Objective: Determine if WA State Water quality criterion for turbidity are met in Marias Creek during and three years following road reconstruction and construction beginning in June 2006 as allowed in the Plan of Operations and Road Use Permit.

Past Work: No past turbidity work has been done in Marias Creek.

Collected Data: Water samples will be processed to determine turbidity values in NTUs. Discharge at the upper and lower sampling sites will also be collected to determine when streams flows increased in relation to precipitation events.

Sampling Locations: The “above” sampling location will be in Marias Creek in Section 31, Township 40 North, Range 31 East, W.M., above Forest Road 3550 (just above the upper crossing of Marias Creek). A second sample location will be in Marias Creek in Section 4, Township 39 North, Range 31 East, W.M. just prior to Bat Canyon Creek entering Marias Creek. The “lower” sampling location will be located in Marias Creek in Section 2, Township 39 North, Range 31 East, W.M., near where Marias Creek crosses the Forest boundary but above the area where Marias Creek flows sub-surface most of the year).

Sampling Procedure: Collect daily water samples with an automatic water sampler. Samples will be individual samples (not composite samples in a single collection container). Discharge will collected with a portable water stage recorder at the above and below site. Stream discharge data would be collected each time the automatic water samplers were emptied and refilled with empty bottles. A rating curve would be developed at each location to estimate discharge.

Sampling Frequency: Samples will be collected daily during daytime in mid afternoon throughout the period when the automatic samplers do not require heating to keep the samplers operating. Sampling will occur for at least five years.

Sampling would begin one month prior to the construction and reconstruction of the Marias Creek Road.

Data Analysis: Collected information will be analyzed used a student t test to determine if there is a significant difference at the .05 probability level of the above station to the stations downstream for turbidity levels.

Turbidity information will be compared to stream discharge information to determine if changes in turbidity are related to changes in stream flow. This will be especially true during years two and three of the sampling.

Turbidity information will be determined for each sample the first year of monitoring. During the second through fifth years of monitoring, samples will be analyzed for turbidity once every seven days, unless visual observation of the collected samples or precipitation events of .25 inches or more in a 24-hour period occurs at the Buckhorn site. Samples immediately proceeding, during and immediately following the precipitation will be processed to determine turbidity. Timing will apply to all stations in Marias Creek (monitoring locations above).

Quality Control: Sample collection methods will follow the WA DOE procedures currently used to collect background water samples in Marias Creek. Sampling equipment will be maintained to the manufacturer's specifications.

Responsibility for Monitoring: The Project Proponent will be responsible for setting up the monitoring equipment, keeping it in operating condition, collecting the samples on a regular basis.

Report Completion, Location and Responsibility: Collected information will be sent to the Forest Service monthly via e-mail or CD. Information will be provided in an EXCEL spreadsheet, and will contain date of sample collection, discharge (measured and from the developed rating table), daily water level stage (down to one-tenth of a foot) and turbidity. The rating table will also be provided to the Forest Service.

Costs: The costs will be borne by the Project Proponent and will include the cost of the continuous water collection and stage recording equipment, site visits to collect the samples or maintain the equipment and determining the turbidity values for the collected water samples. Costs are expected to be the highest the first year, because of the equipment purchases and processing of all water samples for turbidity. Costs are expected to be much lower the second and third years because there will likely be no equipment purchases and substantially fewer water samples processed for turbidity.

Trigger: If the turbidity state water quality criterion is exceeded, field examination will be started as soon as practicable to determine where the source of increased turbidity is located. Actions to repair the source of the turbidity will begin as soon as possible (through FS permit administration enforcement procedures).

Buckhorn Road Erosion Stabilization Monitoring
(Marias Creek Silt Fence Monitoring)

Background: Road related activities, construction and reconstruction activities, maintenance, and road prism overland flow, have been identified as a major source of stream sedimentation considering all forest management activities. Roads closest to streams or have stream crossings of roads are the most likely to contribute to elevated levels of stream sedimentation. It is difficult to get effective total ground cover immediately following road construction and reconstruction, so other methods of containment are being used to prevent or minimize the sediment movement into the stream. Techniques designed to prevent sediment from reaching Marias Creek include placing a silt fence, re-enforced with straw bales at the outlet of each relief culvert which is located inside the RHCA. A rock apron will be placed at the outlet of each culvert to minimize erosion and dissipate sediment. A silt fence will be placed below any road fill located within 100 feet of Marias Creek. Waddles will be placed in the road ditch to dissipate energy and trap sediment.

Problem: Approximately 2.8 miles of constructed and reconstructed road lies along Marias Creek in the RHCA (within 300 feet of the stream or closer) and has several stream crossings of Marias Creek or tributaries to Marias Creek and numerous relief culverts are drained toward the stream. The first three years following construction or reconstruction have the greatest potential for accelerated sediment movement into the stream. Keeping road generated sediment from reaching the stream is the most effective way to protect water quality. The mitigation is effective when in good operating condition. Frequent monitoring, evaluation and maintenance of the structures is required for effective mitigation.

Some road fill locations are located within five feet of the stream. The erosion control structures will be placed closer to the road fill, and the sediment capacity will be reduced. Structures at these locations will need to be monitored more frequently and maintained more quickly than other protection structures.

Longer cut and fill slopes are more difficult to get vegetation re-established. These slopes may need to treated or covered with erosion control materials more that one time to have cover that protects the soils. Fill slopes longer than 30 feet long and cut slopes longer than 35 feet should be monitored more frequently for adequate vegetative cover.

Objective: Determine if the erosion control structures are functioning properly, located in the right location and are in good operating condition (or need maintenance).

Past Work: No past work has been done because there is no construction or reconstruction work completed.

Collected Data: Information collected will be based on visual observation of each relief culvert and sediment control structure, road ditch, fill and cut slope cover, and the entire length of silt fence where the road fill is within 100 feet of the stream. Comparison with water quality monitoring for salts and turbidity may also be used to help evaluate the effectiveness of preventing sediment from reaching the stream.

Sampling Locations: The sampling locations will be the length of road inside the RHCA along Marias Creek, cut slopes over 35 feet long and fill slopes over 30 feet long.

Sampling Procedure: Field surveys will be made visually and a written record will be kept on all findings.

Sampling Frequency: If the surveys are done in Marias Creek, they would be completed every three months and immediately following any substantial precipitation event (defined as more than .25 inches in 24 hours at the Buckhorn precipitation station) or where there is obvious evidence of sediment movement from road fills, cut slopes or ditch erosion that would accumulate at the erosion control structures. If the surveys are done in Nicholson Creek, they would be done weekly during the domestic livestock grazing period (to ensure silt fences and any straw bales are in good operating condition), and following a substantial precipitation event.

In Marias Creek, where the road fill is closer than ten feet from the stream, surveys would be done monthly and following precipitation events of .25 inches or more at the Buckhorn precipitation station in a 24 hour period. In Nicholson Creek, surveys following precipitation events of .25 inches at the Buckhorn precipitation station would be done. The weekly surveys would continue in Nicholson Creek.

Sampling would begin when the erosion control structures and protection measures were installed.

Data Analysis: Collected information will determine if and where follow-up work is required (new structures installed or maintenance of existing structures).

Quality Control: Information collection methods will be reviewed and approved by the Forest Service engineer and hydrologist.

Responsibility for Monitoring: The Project Proponent will be responsible for collecting the information on a regular basis.

Report Completion, Location and Responsibility: Collected information will be sent to the Forest Service quarterly. Information will be provided on field sheets.

Costs: The costs will be borne by the Project Proponent and will include work force, transportation and compilation of the field surveys. Costs may be lower in following years as cut slopes, fill slopes and the road ditch stabilize.

Trigger: If the structures and measures are not functioning, require maintenance or are not in the proper location, the project proponent will take action to repair, move or supplement the sediment reduction measures within 7 days of the survey.

Buckhorn Road Impact Monitoring
(Marias Creek road generated chloride levels)

Background: Road maintenance activities may contribute to elevated chloride levels. Roads closest to streams or have stream crossings of roads are the most likely to contribute to elevated levels of chlorides. Chloride levels can be measured in water samples easily. Chloride has a state water quality criterion of 230 parts per million (see Buckhorn Water Resource report).

Problem: Approximately 2.8 miles of constructed and reconstructed road lies along Marias Creek in the RHCA (within 300 feet of the stream or closer) and has several stream crossings of Marias Creek or tributaries to Marias Creek. Road maintenance includes application of magnesium chloride for dust abatement during the summer and sand and salt applications during the winter for traction aid on snowy and icy roads. These chlorides are soluble and are likely to eventually get to Marias Creek.

Objective: Determine if water chloride levels in Marias Creek meets WA state water quality criterion of 230 ppm during the maintenance and use of the Marias Creek Road during the life of the Plan of Operations and Road Use Permit.

Past Work: The measured range in past baseline surface samples for chlorides at SW-2 has been <1 – 9 mg/l with a mean value of 2 (Crown Jewel Mine, 1997).

Collected Data: Water samples will be processed to determine chloride values in ppm. Collection and testing will meet the same criterion as presently used for water monitoring at other locations.

Sampling Locations: The "above" sampling location will be in Marias Creek in Section 31, Township 40 North, Range 31 East, W.M., above Forest Road 3550 (just above the upper crossing of Marias Creek, SW-2). A second sample location will be in Marias Creek in Section 4, Township 39 North, Range 31 East, W.M. just prior to Bat Canyon Creek entering Marias Creek. The "lower" sampling location will be located in Marias Creek in Section 2, Township 39 North, Range 31 East, W.M., near where Marias Creek crosses the Forest boundary but above the area where Marias Creek flows sub-surface most of the year.

Sampling Procedure: Water samples will be collected manually at the selected location following procedures established by the WA DOE for collecting background water quality samples in Marias Creek.

Sampling Frequency:
Samples will be collected every two weeks during the year. Samples will be taken from the turbidity water samples immediately following intense rain storms of more than .4 inches per 24 hours if manual sampling didn't occur during that time. P

Sampling would begin two months prior to the construction and reconstruction of the Marias Creek Road.

Data Analysis: Collected information will be analyzed used a student "t" test to determine if there is a significant difference at the .05 probability level of the Marias Creek chloride levels.

Quality Control: Sample collection methods will follow the WA DOE procedures currently used to collect background water samples in Marias Creek.

Responsibility for Monitoring: The Proponent will be responsible for conducting all monitoring.

Report Completion, Location, and Responsibility: The Proponent will be responsible for submitting collected information. The information of chloride levels in ppm and the date when the sample was collected will be submitted in an EXCEL spreadsheet. Information will be submitted annually.

Costs: All costs will be borne by the Proponent, and would consist of personnel costs and transportation to collect each sample laboratory processing of the sample and preparing the information for submission to the Forest Service.

Trigger: If the chloride state water quality criterion is exceeded, field examination will be started as soon as practicable to determine where the source of increased chloride is located. Actions to adjust the application of the chloride compounds will begin as soon as possible (through FS permit administration enforcement procedures).