APPENDIX G
FINAL WORKPLAN, SEDIMENT YIELD MODELING TO ESTABLISH POLLUTANT CREDITS FOR SEDIMENT DELIVERY TO THE ST. MARIES RIVER

FINAL WORKPLAN

SEDIMENT YIELD MODELING TO ESTABLISH POLLUTANT CREDITS FOR SEDIMENT DELIVERY TO THE ST. MARIES RIVER

EMERALD CREEK GARNET, LTD
BENEWAH AND SHOSHONE COUNTIES, IDAHO

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WGI HEAVY MINERALS INCORPORATED

TITLE PAGE

Project:	Workplan for Hydrologic-Sedimentation Modeling in Support of TMDL compliance
Document Title:	*Sediment Yield Modeling To Establish Pollutant Credits for Sediment Delivery to the St. Maries River*
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1.0 INTRODUCTION

1.1 Background

An Environmental Impact Statement (EIS) has been prepared to evaluate reasonable alternatives associated with a proposal by Emerald Creek Garnet, Ltd. (ECG) to mine 327.5 acres of garnet reserves in and near the St. Maries River floodplain south of Fernwood, Idaho, in Benewah and Shoshone Counties. Of the 327.5 acres, 133 are wetlands and other waters of the United States (U.S.) subject to regulation under §404 of the Clean Water Act (CWA). The U.S. Army Corps of Engineers has chosen a preferred alternative under which mining would be permitted for 12 months of the year using wet and dry panel mining techniques (See Chapter 2 of the EIS).

An overview of the proposed action, describing all mining operations, application of Best Management Practices, and mitigation is described in Section 2.2 of the EIS and presented in detail in Section 2.0 of Volume II Appendix A. There is potential for storm water runoff from proposed mining areas to discharge to the St. Maries River or its tributaries. These discharges will require an NPDES permit from EPA Region 10. Prior to operation, ECG will develop and implement stormwater pollution prevention plans and will seek coverage under two NPDES general permits issued by EPA Region 10:

- Discharges from temporary haul roads, from overburden stockpiles, and from the outer edges of berms would be authorized under EPA's Construction General Permit (permit number IDR100000). Permit coverage will be required from the time of initial disturbance until final reclamation.

- Discharges from the run-on diversion ditches that surround the mining panels would be authorized under EPA's NPDES Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activities (known as MSGP-2000), Sector J (Mineral Mining and Dressing). Permit coverage will be required before mining operations begin.

The designated uses for the St. Maries River are for c*old water aquatic life, primary contact recreation, drinking water supply and special resource water*. Water bodies may be designated as a *special resource* for a variety of reasons listed under IDPA 58.01.02.056.01, such as the water is of unique ecological significance or the water possesses outstanding recreational or aesthetic qualities as well as others. In general, discharges of pollutants to water bodies designated as a *special resource water* can not degrade the ambient water quality (IDAPA 58.01.02.400.01.b).

The St. Maries River, including nearly all of the stream segments in its watershed, is listed as water quality limited under §303(d) of the CWA for not meeting designated uses identified by the State of Idaho under the Idaho Administrative Code (IDAPA 58.01.02).
Sediment is uniformly listed as the pollutant of concern, while nutrients, temperature, dissolved oxygen depletion, and bacteria are also listed as pollutants of concern for some segments. The segments of the St. Maries River where ECG has proposed to mine garnets were listed for sediment and temperature in the State of Idaho 1998 303(d) list (IDEQ 1999).

The CWA and the State of Idaho require that Total Maximum Daily Loads (TMDL) be developed for water bodies listed as being water quality limited. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality.

The Idaho Department of Environmental Quality (IDEQ) prioritizes the development of TMDLs depending on the severity of pollution and the uses of the water body (40 CFR 130.7(b) (4) and IDAPA 58.01.02.054.03). Idaho's schedule for TMDL development has resulted from litigation brought by the Idaho Conservation League and The Lands Council against the Environmental Protection Agency (EPA), which has Federal authority over the CWA. A TMDL developed for the St. Maries River basin in July 2003 concluded that the primary sources of sediment to the St. Maries River are the result of silviculture activities, forest roads, agricultural land activities and stream bank erosion (IDEQ 2003a). The TMDL further concludes that sediment contributions from point sources (i.e., municipal and industrial discharges) are "negligible" compared to nonpoint sources throughout the watershed. Concerning temperature, the TMDL concluded that increased water temperatures are caused by reduced canopy cover (shading) of streams throughout the watershed. The TMDL defines necessary load reductions in sediment yield (tons/year) and increased canopy/shading goals that would be required for the river to meet its designated uses.

Before the Corps of Engineers can issue the §404 permit, IDEQ must certify, that the discharge will comply with applicable provisions of the CWA and state Water Quality Standards. Because a TMDL has been completed, IDEQ's §401 certification will need to ensure that the discharge of pollutants will be conducted in a manner consistent with the TMDL (IDPA 58.01.02.054.04).

To obtain §401 certification, be in compliance with the TMDL, and acquire NPDES storm water permits, ECG will be required to implement watershed improvement projects that will result in sediment load reductions (i.e., credits) that are greater than the amount of sediment that will be generated throughout the life of the mining project. In general, sediment reductions (i.e. credits) from these projects must be achieved prior to or in conjunction with the construction and mining activities that may result in sediment discharges. Guidance for conducting studies and implementing water quality trading policies are provided by the *Pollutant Trading Guidance* (IDEQ 2003b) and *Water Quality Trading Policy* (EPA 2003).

1.2 Description of Workplan

A quantification of the amount of sediment that will be generated and delivered to the St. Maries River through out the life of the project and a quantification of the amount of sediment yield that will be reduced by an implemented watershed improvement project(s) will be required to meet the requirements discussed above.

Mitigation actions to offset potential impacts to water temperature in the St. Maries River are described in the EIS. The TMDL identified the lack of shading as the primary cause of elevated water temperatures. The mining action will not generally cause increases in stream temperatures because mining will always occur with a minimum 30 foot buffer zone from the river or tributary streams and will not impact stream side vegetation such as willow, alder, or trees next to the bank.

As discussed in the TMDL for the St. Maries River, any attempt to model sediment output provides relative, rather than exact, sediment yields. The methods described in this workplan attempt to account for all significant sources of sediment that could provide inputs to the St. Maries River. The methods used provide relatively high degrees of conservatism in that they generally over estimate the actual sediment production from a source. Conservatism in sediment modeling was further discussed in the TMDL (IDEQ 2003a). The model used to develop the TMDL was considered to be 231% conservative in its estimation of total sediment yield. This over estimate of sediment yield was used as an allocation to the Margin of Safety in the TMDL (IDEQ 2003b).

A quantification of the amount of sediment that will be generated and delivered to the St. Maries River throughout the life of the project and a quantification of the amount of sediment yield that will be reduced by implemented watershed improvement project(s) will be required to meet the requirements discussed above. As discussed in the TMDL for the St. Maries River, any attempt to model sediment output provides relative, rather than exact, sediment yields. The methods described in this workplan attempt to account for all significant sources of sediment that could provide inputs to the St. Maries River. The methods used provide relatively high degrees of conservatism in that they generally overestimate the actual sediment production from a source. Conservatism in sediment modeling was further discussed in the TMDL (IDEQ 2003a). The model used to develop the TMDL was considered to be 231% conservative in its estimation of total sediment yield. This overestimate of sediment yield was used as an allocation to the Margin of Safety in the TMDL (IDEQ 2003a).

This workplan describes an approach to estimate sediment yield and sediment delivery to the St. Maries River that would result from actions taken throughout the 20-year life of the mining project. This includes estimates of sediment yield that would occur from reclaimed and restored areas until these areas would be considered to be reasonably mature. Reclamation performance standards for all wetland and upland habitats have been established and are described in detail in Volume II Appendix H of the EIS. For the purposes of this workplan, the term “mature” refers to the reclaimed community’s ability to prevent raindrop impact, retard or prevent rill and inter-rill erosion, and filter soil and sediment transport across the surface. These physical aspects of the reclaimed community should be considered stable and reasonably unchanging. This concept is discussed further in Section 3.8.

The workplan also describes an approach for estimating sediment yield reductions (i.e. offsets or credits) that would be expected by implementation of watershed improvement projects. The types of projects that would be considered, identified, and implemented are described in this workplan, but the exact number and type of projects will be dependent on the quantitative estimates for sediment yield that would be made when the workplan is implemented. The use of Best Management Practices (BMPs) to minimize erosion from site activities will not be considered toward pollution reduction credit.

SAIC evaluated a number of numeric models for estimating sediment erosion, including: SEDIMONT II, SEDCAD, HEC-RAS, HEC-5 and WEPP). We determined that no single model would be sufficient to simulate the complex process that will affect sediment yield from the mining operation. We determined that using two models could be used to subjectively simulate the major components of the proposed operation. The Water Erosion Prediction Project

(WEPP), developed primarily by the U.S. Department of Agriculture Agricultural Research Service (Flannigan and Nearing, 1995), will be used to simulate sediment yield transport resulting from all mining components, including roads and reclaimed areas. The U.S. Army Corps of Engineers' HEC-RAS (River Analysis System) software (USACE, 2001) will be used to evaluate encroachment of overbank floods on sediment berms, which are one of the BMPs proposed to prevent the transport of sediments from the mining operation to the river. A background summary description of these models and their capabilities is provided in Section 2.0 of this workplan.

Section 3.0 describes the approaches and assumptions that will be used to estimate sediment yield from the mining project. Section 4.0 provides approaches and assumptions that will be used to estimate sediment yield from potential sediment reduction/mitigation offset projects. Finally, section 5 presents references cited in the text.

2.0 OVERVIEW OF MODELS PROPOSED FOR ANALYSIS

2.1 Overview of the WEPP Erosion Prediction Project[1]

The USDA - Water Erosion Prediction Project (WEPP) model represents an erosion prediction technology based on fundamentals of stochastic weather generation, infiltration theory, hydrology, soil physics, plant science, hydraulics, and erosion mechanics. WEPP provides best available technologies for estimating soil erosion on and sediment delivery from hillslope profiles and small watersheds. The model simulates the detachment and transport of sediment by the following processes:

- detachment and transport by raindrop impact on inter-rill areas
- detachment, transport, and deposition by overland flow in rill channels;
- detachment, transport, and deposition by concentrated flow in channels;
- deposition in impoundments;
- deposition resulting from BMPs such as straw bales and silt fencing;
- erosion off roads.

The continuous simulation model also includes components that mimic climate, surface and subsurface hydrology, winter processes, irrigation, plant growth and residue decomposition. The WEPP computer program calculates spatial and temporal distributions of soil loss, as well as sediment delivery and sediment particle distribution characteristics. Figure 2-1 depicts a simple example of how WEPP can be applied to erosion and sediment transport elements in a small watershed.

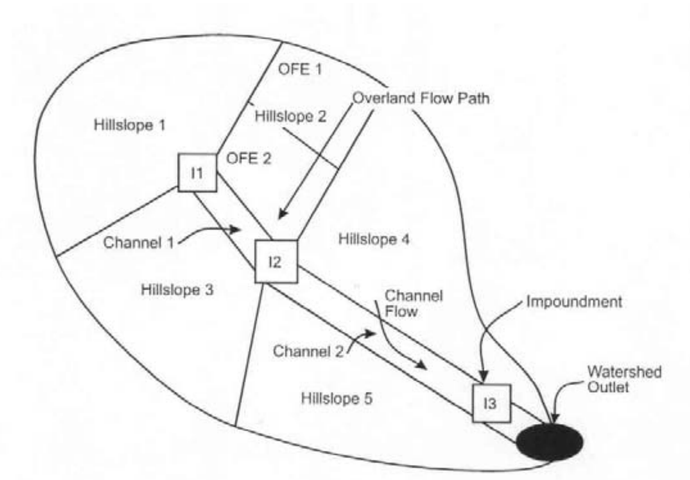

Figure 2-1. Watershed schematic of a small watershed showing how WEPP can be applied to evaluate sediment yield off of five hillslopes, routing through two channels and three surface impoundments to a defined watershed outlet.

[1] Adapted from Flannigan and Nearing (1995).

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WEPP consists of two primary modules: a hillslope profile model and a watershed model. Processes considered in hillslope profile model applications include rill and inter-rill erosion, sediment transport and deposition, infiltration, soil consolidation, residue and canopy effects on soil detachment and infiltration, surface sealing, rill hydraulics, surface runoff, plant growth, residue decomposition, percolation, evaporation, transpiration, snow melt, frozen soil effects on infiltration and erodibility, climate, tillage effects on soil properties, effects of soil random roughness, and contour effects including potential overtopping of contour ridges. The model accommodates the spatial and temporal variability in topography, surface roughness, soil properties, crops, and land use conditions on hillslopes.

The WEPP watershed module is a process-based, continuous simulation model built as an extension of the WEPP hillslope model. The model was developed to predict erosion effects from agricultural management practices and to accommodate spatial and temporal variability in topography, soil properties, and land use conditions within small watersheds. The watershed model is capable of: I) identifying zones of sediment deposition and detachment within constructed channels (e.g., grassed waterways or terraces) or concentrated flow (ephemeral) gullies; 2) accounting for the effects *of* backwater on sediment detachment, transport, and deposition within channels; and 3) representing spatial and temporal variability in erosion and deposition processes as a result of applied BMPs. It is intended for use on small watersheds (up to 640 acres) in which the sediment yield at an outlet is significantly influenced by hillslope and channel processes. The watershed model includes a component for simulating sediment retention in typical impoundments or hydrologic structures including culverts, filter fences, straw bales, drop and emergency spillways, and perforated risers.

2.2 Overview of HEC-RAS

HEC-RAS is a computer program developed at the U.S. Army Corps of Engineers' Hydrologic Engineering Center (HEC). The software allows the user to perform one-dimensional, gradually varied, steady flow analysis. The steady flow component is capable of modeling subcritical, supercritical, and mixed flow regime water surface profiles. The effects of various obstructions --such as bridges, culverts, weirs, and structures in the floodplain--may be considered in the computations. The program can be applied to floodplain management and flood insurance studies to evaluate floodway encroachments. Special features include multiple plan analyses, multiple profile computations, and multiple bridge and/or culvert-opening analysis.

The latest version of the HEC-RAS program computes water surface profiles using the standard step method, but the program has also built in the conservation of linear momentum relationship that allows for mixed flow computations where a hydraulic jump may form. The bridge routine incorporates low flow computations using an energy balance, momentum balance, Yarnell's equation, and the contracted opening method used in the USGS WSPRO[2] program. The high flow options include an energy balance and a pressure weir flow computation. A number of different culvert shapes are handled by the program, and the procedures follow Federal Highways Administration guidelines for culvert hydraulics.

[2] WSPRO computes water-surface profiles for subcritical, critical, or supercritical flow as long as the flow can be reasonably classified as one-dimensional, gradually-varied, steady flow.

HEC-RAS has the ability to model multiple bridges and/or culvert openings at any individual river crossing. Types of openings can consist of bridges, culvert groups, and conveyance areas (open channel flow computations).

3.0 SEDIMENT YIELD ESTIMATES FROM MINING OPERATIONS

2.1 Summary of Mining and Reclamation Operations

This workplan and assumptions for sediment modeling were developed for Alternative 3 as described in the EIS, which will be the Corps' preferred action alternative in the final EIS. Mining and reclamation activities that would occur under this alternative are described in detail in Volume I Sections 2.2 and 2.5 and in Volume II Appendix A of the EIS. Under this alternative, mining would be permitted for 12 months of the year using wet and dry panel mining techniques[3] in 327.5 acres of the areas proposed for mining, including 133.0 acres of jurisdictional wetland. Mining would be conducted during all times of the year, with one to three mining units being mined per year. The mining and post reclamation period would be 27 years. Areas would not be disturbed until immediately before mining, and mined areas would be reclaimed as soon as mining was completed in the area. Active mining would occur on approximately 15 to 25 acres per year, depending on the number of mining units.

Mining would occur in six main mining areas, with each mining area being divided into several mining units. Three mining areas occur in upland pastures north of State Highway 3 and three mining areas occur in floodplain areas south of State Highway 3 (See figure 2-3 of the EIS). A conceptual sequence of the mining and reclamation of mining units, within the mining areas of C and E of Figure 2-3, are depicted in Figures A-6 and A-7 of Volume II, Appendix A of the EIS. Active mining is estimated to require 14 to 16 years to mine all the areas depicted in Figure 2-3.

To initiate mining garnet, the top soil of an annual mining unit is stripped off and some is used to construct sediment berms around the area. Berms are set back a minimum of 22.5 feet from the St. Maries River or a tributary creek. As can be seen in Figure A-6 of Volume II, Appendix A, some mining units occur several hundred feet from the river. In these cases, the sediment berms are also constructed several hundred feet from the river. Remaining topsoil is stored within the mining unit after construction of the sediment berms. The sediment berms are seeded and reinforced with silt fencing or straw bales, as needed. Additional features are constructed to minimize erosion and provide storm water controls, including:

- **Interceptor Channels** to collect storm runoff from upland areas and route it around the mining unit.
- **Sediment Basins** constructed at the downstream end of all interceptor channels before discharging over a spillway to a minimum 30 foot of grass filter. These are sized to contain the runoff that would result from a 25-year, 24-hour storm event.
- **Straw Bails and Silt Fencing** used as required to reinforce or prevent sediment from entering specific areas or bodies of waters.

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[3] See the EIS for full descriptions of "wet" and "dry" panels. In both types of mining, the topsoil and overburden is removed and stockpiled – in part as sediment berms -- for use in reclamation. Dry panel methods are used in confined areas, and garnet-bearing material is excavated from the dry panel and removed to a wet panel for concentration. Wet panel methods are used in most areas, and the area being mined is kept flooded while garnet-bearing material is removed and concentrated, with water being recycled back into the panel.

The garnet-bearing gravels will be extracted using combinations of wet and dry panel mining and using different types of dredge equipment. Excavated material will then be taken to an on-site concentration facility, with all water returned to the wet panel. Washed rock from the concentration facility will be replaced in the mining unit.

Reclamation activities for each annual mining unit will be undertaken during the drier summer and fall months after annual high spring flows in the river have receded. Reclamation activities are undertaken in one season in the mining areas north of State Highway 3 being reclaimed to pasture. Pasture reclamation is completed the first summer season after mining by removing BMP's respreading topsoil, seeding a pasture seed mix, and irrigating as needed to establish vegetation.

Floodplain reclamation in the mining areas south of State Highway 3 will require two seasons for completion. During the first summer season, BMPs are removed, topsoil is respread, the unit is seeded with upland and wetland seed mixes, and the area is irrigated as required. Woody vegetation is planted and oxbow wetlands are reconstructed during the second summer season.

3.2 Potential Sources of Sediment

There are several principal potential sources of sediment that can be generated from the proposed action could be delivered to the St. Maries River:

- Stormwater from the outside slopes of berms;
- Overflow of storm water runoff captured in interception ditches and by the sediment detention basins;
- Direct erosion of berms from St. Maries River or tributary overbank flows;
- Stormwater runoff from constructed haul roads;
- Overtopping of berm due to extreme storm event and the outflow of sediment-laden water normally contained behind the berm;
- Stormwater runoff from reclaimed areas or from newly constructed wetlands

Approaches to modeling sediment yield and delivery to the St. Maries River from each of these sources is discussed in Sections 3.3 through 3.9 below. Each section provides both a description of the WEPP and/or HEC-RAS model component used, the mining features modeled and any assumptions that will be used in modeling. In general, modeling will be conducted on an annual, year-by-year, basis based on mining and reclamation sequences. A start date of July 1, 2004 will be assumed for the purposes of vegetation height and cover and to initiate the weather generation routines in WEPP. Mining and reclamation sequences for succeeding years will be based on this initial year. Sediment yield that results from each source and for each year will be summed to provide both annual and total sediment yield that would result through the life of the project.

3.3 Outside Slope of Berms

Description of Conceptual Model

The WEPP hillslope profile module will be used to estimate the erosion, transport and deposition of detached sediments from stormwater runoff occurring on berms constructed around each annual mining unit. Processes considered in the hillslope profile model include rill and inter-rill erosion, sediment transport and deposition, infiltration, soil consolidation, residue and canopy effects on soil detachment and infiltration, surface sealing, rill hydraulics, surface runoff, plant growth, residue decomposition, percolation, evaporation, transpiration, snow melt, frozen soil effects and erodibility, and climate. Figure 3-1 provides a simple depiction of the processes that will be modeled to determine sediment transport and delivery from these features. In general rainfall detaches soil particles in inter-rill areas, transports it to rill areas and off the berm. Overland runoff transports detached sediments to the grass/vegetated buffer area where sediments are deposited or continue in overland flow to the St. Maries River, adjacent tributary, or one of the road ditches that discharge to the river. The amount of sediment detached and transported for a given storm event is dependent on the type, density, and cover of the vegetation; deposition from preceding storm events; and soil characteristics, and distance to the river.

Model Inputs and Assumptions

- Modeled storms will be based on the climate generator module in WEPP using available climatic data bases for northern Idaho. Modeling will occur from the assumed start date for construction of each mining unit until berms are regraded and the area reseeded.

- Soil characteristics and particle size distributions to determine “erodibility” will be based on actual site samples.

- Species, height, basal and aerial cover of vegetation both on the berm and across the vegetated buffer will be based on site observations location of mining unit.

- Exact height of berms will be determined from additional water surface profile modeling for the St. Maries and adjacent tributaries using HEC-RAS. Berm height slope and configuration will be based on this additional modeling and will be sized to reasonably minimize the potential for the overtopping by an out of bank flood event during the assumed active mining period of 20 years while not creating a large erosive feature.[4] Final berm heights sufficient to prevent overtopping into the mining unit from the 25-year flood event will be modeled, as will berm heights sufficient to control 50-year and 100-year flood events will be considered.

[4] The assumed active mining period and post reclamation period is 27 years, 20 of years active mining and 7 additional years until reclamation performance standards have been met on all areas.

- Specific mining units and a sequence for mining these units has only been planned for Mining Areas C and E, as depicted in Figures A-6 and A-7 of Volume II, Appendix A of the EIS. The following assumptions will be used for the purposes of sediment modeling and transport from berms in the other mining areas.

  - Mining units will average 8 acres in size;
  - For mining areas south of Highway 3, one half of the mining will be set 300 feet from the river (i.e., the amount of vegetation buffer zone will be 300 feet), and one half of the mining units will be set next to the river with a 22.5 foot vegetation buffer.
  - Mining sequences will always be designed so that mine units that occur 300 foot from the river will be mined prior to units that occur next to the river. This will mean that runoff from mining unit berms set farther from the river will always have 300 feet of undisturbed vegetation as a buffer.
  - For mining areas north of Highway 3, all mining units will be assumed to be set 22.5 feet away from the adjacent tributary or from the Highway road drainage ditch.

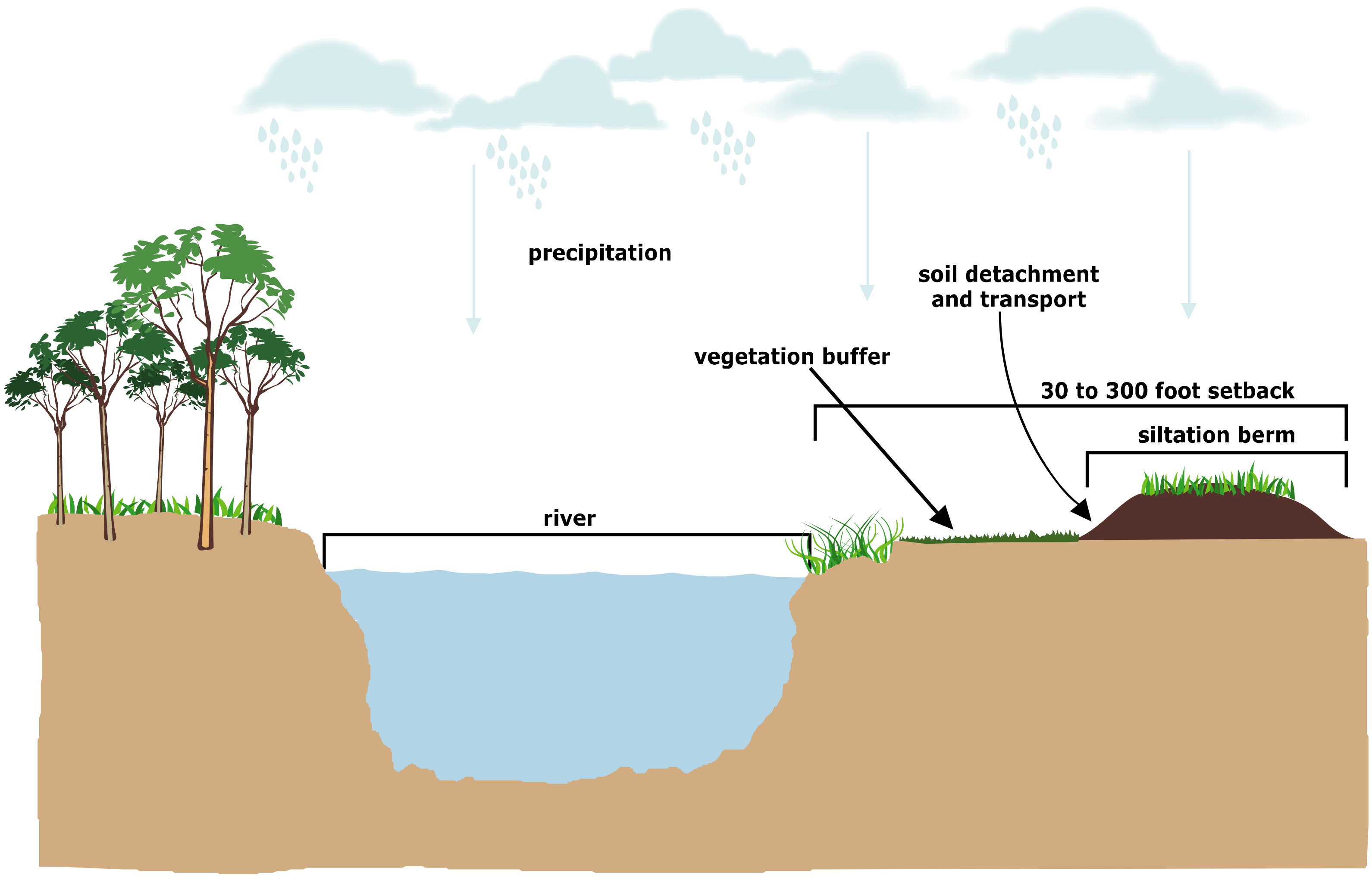


Figure 3-1. Depiction of modeled features for erosion from sediment berms.

3.4 Interception Ditches and Sediment Basins

Description of Conceptual Model

The WEPP watershed module will be used to estimate sediment yield that would result from the capture and transport of upland stormwater runoff in interception channels and sediment basins. Three components will be modeled by the watershed model: hilllslope erosion, transport, and deposition processes; in-channel transport, erosion, and deposition; and impoundment settling and outflow hydrographs including sediment concentrations. Figure 3-2 provides a simple depiction of the processes that will be modeled to determine sediment transport and delivery from these features. Storm runoff from upland areas will be captured by interception ditches where additional erosion and sediment deposition can occur, and then transported to sediment basins where a majority of sediments settle out. For larger storm events, sediment basins overflow to a minimum 30 foot grass/vegetated buffer area where sediments are further deposited or continue to runoff with the overland flow. The amount of sediment detached and transported for a given storm event depends on the size of the storm event; the type, density, and cover of the vegetation; deposition from preceding storm events; length of vegetation buffer; and soil characteristics.

Model Inputs and Assumptions

- Modeled storms will be based on the climate generator module in WEPP using available climatic data bases for northern Idaho. Modeling will occur from the assumed starting date for construction of each mining unit until berms are regraded and the area reseeded.

- Soil characteristics and particle size distributions to determine “erodibility” will be based on actual site samples.

- Species, height, basal and aerial cover of vegetation both on upland areas and across the vegetated buffer will be based on site observations location of the mining unit.

- Interception channels will only be used for mining units that occur in pasture areas occurring in mining areas north of State Highway 3. Interception channels will not be required in mining areas south of State Highway 3 because the highway drainage captures and transports runoff from upland areas.

- Sediment detention basins and interception channels will be sized to convey and detain the runoff that would occur from a 25-year storm event.

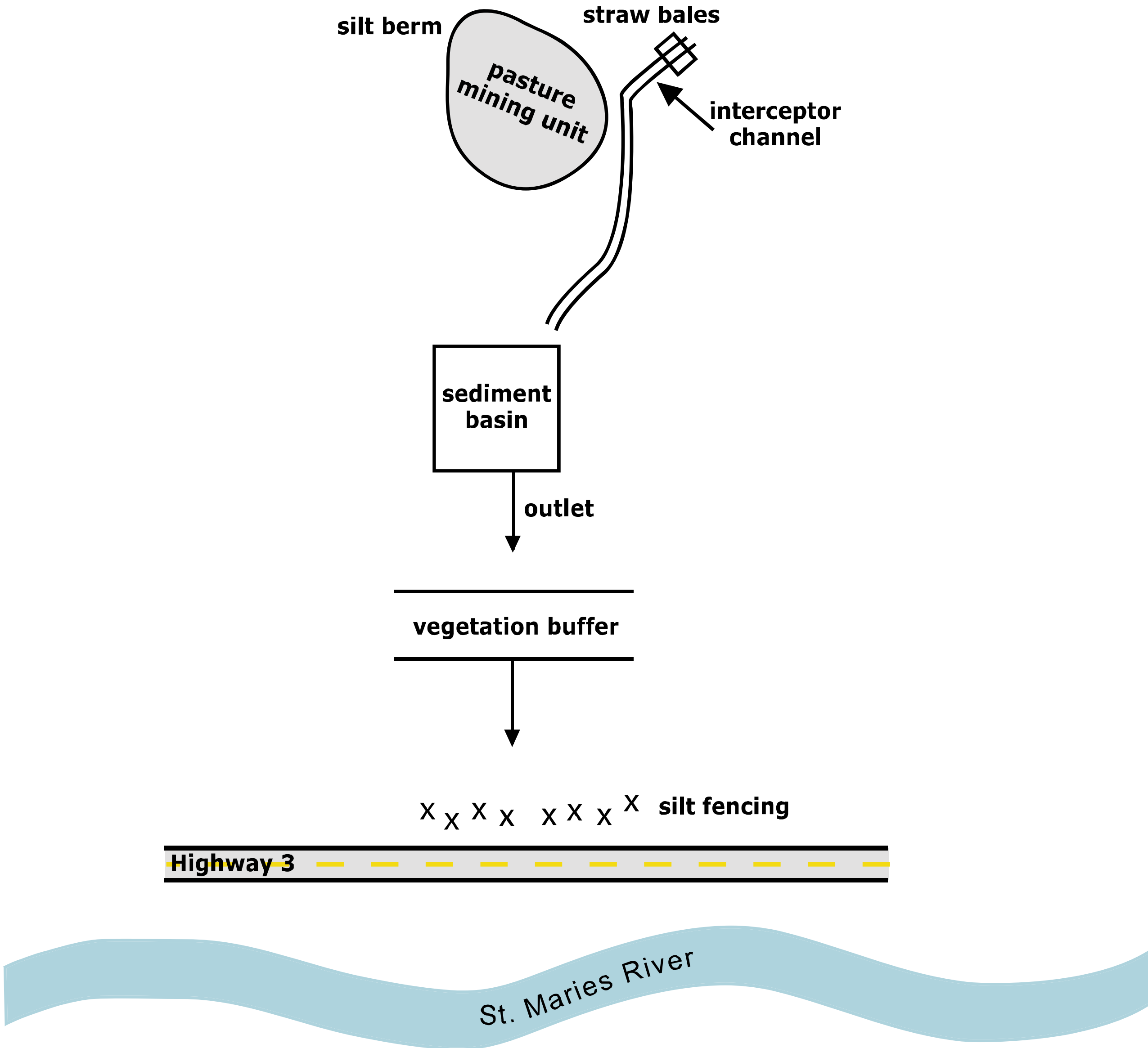


Figure 3-2. Depiction of modeled features for mining areas that occur north of Highway 3.

3.5 Direct Erosion of Berms from Overbank River Flows

Description of Conceptual Model

Water surface profile modeling using HEC-RAS was performed for the EIS to evaluate the encroachment of overbank flood events in the St. Maries River on mining units and the sediment berms. Results of this modeling showed that an eighteen inch berm would prevent all over the bank flows up to and including the 5-year flood event from overtopping into the mining unit (see Appendix E of the EIS). These data further suggest that a 10-year flood event would be required to significantly overtop the berms and flood the mining unit.

Additional HEC-RAS modeling will be conducted on the St. Maries River and tributaries to further evaluate effects of overbank flows and to design additional protection from possible inundation of the sediment berms and mining units by increasing berm heights. The additional modeling will be used to provide a berm design height sufficient to prevent reasonably large flood events from overtopping the berms. Previous results suggest that these berm heights ranging from 3.5 to 4.0 feet in height could prevent a 25-year flood event.

Erosion and sediment models are not available to adequately or realistically simulate the erosion or deposition effects of overbank water on the grassed sediment berms. Because of this, the erosion and sediment yield that would result from an event encroaching on the berms will have to be based a series of assumptions, past field observations, flood recurrence interval (probability of flooding), and best scientific judgment.

The method will be applied as follows:

- The probability of overbank flows for 2-year, 5-year, 10-year, and 25-year flood events occurring within the 20 year active mining period will be calculated using a Bernoullli stochastic process described by Barfield *et al.* (1981).

- A direct volume method for erosion, as discussed in the *Erosion and Sediment Yield: Channel Evaluation Workshop (1983)* will be adapted to estimate the volume of sediments eroded from the encroached berms during an overbank event. This method was used to estimate erosion that could occur from unstable stream banks in the TMDL (IDEQ 2003a).

- The probability of occurrence for a specific flood event will be multiplied by the estimate of the amount of erosion that would occur from flood encroachment on the berms. For example, the probability of a 25-year event occurring in a 20 year period will be multiplied by the estimated amount of erosion that would occur from a 25-year flood event encroaching on the berms.

Model Inputs and Assumptions

- Sediment berms will be assumed to be moderately stabilized from placement, compaction, and reseeding/vegetation (i.e., they will not be assumed to be loose, easily erodible soil).
- Soil characteristics and particle size distributions to determine “erodibility” will be based on actual site samples.

- The occurrence of events with less probability than a 25-year event will not be considered (e.g., 50-year, 100-year, etc.). Events of this magnitude would be considered catastrophic and not practical for estimating erosion for the purpose of calculating offset credits.

- Berm heights will be based on the additional water surface profile modeling.

3.6 Runoff from Constructed Haul Roads

Description of Conceptual Model

Storm water runoff from constructed haul roads and sediment transport through road culverts installed to provide drainage will be modeled using WEPP-ROAD. WEPP-Road is one in a series of the U.S.D.A. Forest Service's Internet-based computer programs based on the WEPP model:
(http://forest.moscowfsl.wsu.edu/fswepp/docs/wepproaddoc.html, March 2004)

Erosion from road surfaces to road conveyance ditches, the transport of sediments, and deposition of sediments across grass buffer zones will be simulated.

Model Inputs and Assumptions

- Roadbed materials (rock and gravel types) will be based on actual material used by ECG to build roads.

- Species, height, basal and aerial cover of vegetation across the vegetated buffer will be based on site observations location of mining unit.

- Deposition effects from catchment basins and other BMPs such as silt fencing and straw bales will be considered in the model.

3.7 Overtopping of Berms and Berm Failure

Description of Conceptual Model

As discussed in Section 3.5, additional HEC-RAS modeling will be conducted on the St. Maries River and tributaries to further evaluate effects of overbank flows and to design additional protection from possible inundation of the sediment berms and mining units by increasing berm heights. The additional modeling will be used to select a final berm design height, which is likely to be sufficient to prevent at least a 25-year flood event from overtopping the berms and flooding the mining unit; berm heights sufficient to control larger flood events also will be considered.

The occurrence of events with less probability than a 25-year event (e.g., such as a 50- or 100-year event) will not be considered for the purposes of calculating pollutant credits. The probability of flood events with occurrence intervals above the 25-year level occurring within a single 20 year mining period is low. Events of this magnitude would be considered single event related and not considered practical for estimating erosion in compliance with the TMDL and for the calculation of credits (see assumptions below).

Assumptions

- The occurrence of flood events with a lower probability of occurrence than the 25-year event would cause releases of sediment to the St. Maries River from mining operations. However, this size event would have a low probability of occurrence, would be single-event in nature and thus result in short term impacts, and not necessarily significant to other nonpoint source erosion processes in the watershed.

- Flows in the river from large-scale, basin-wide flood events of magnitudes greater than the 25-year event would be highly concentrated with suspended sediments prior to reaching the mine site. Under these conditions, the river would have very little available or additional transport capacity (i.e., the river's ability to carry a sediment load under a given flow) and little energy would be available to entrain additional sediments. Additionally, overbank floodwaters would have very low velocities and might actually be expected to deposit sediments, especially under receding conditions.

- Observations from the 1996 flood event, which was estimated to be approximately a 200-year event, showed that berms on Carpenter Creek did not fail or significantly erode. Significant erosion and undermining of a berm did occur in 1995 at ECG when a berm was undermined by flood waters. However, mining practices and BMPs were significantly improved since that time (in part, in response to the problems in 1995). Mining practices at that time allowed development of very large wet panels – in excess of 100,000 square feet. Flooding of the wet panel during a large scale precipitation event caused flood waters within the mining unit to undermine a berm. Current mining practices and BMPs were implemented after that event to prevent this type of flooding. Current practices dictate that the maximum size of wet panels which will remain open in a mining unit is 80 by 300 feet rather than the much larger size used in 1995. This minimizes the panel's size with respect to the entire mining unit area and therefore minimizes flooding effects inside the area. In addition, ECG has significantly improved berm construction, including compacting berms and carefully picking out woody and other debris during berm construction.

3.8 Runoff from Reclaimed Areas and Newly Constructed Wetlands

Description of Conceptual Model

The WEPP hillslope profile module will be used to estimate the erosion, transport, and deposition of detached sediments from stormwater runoff from reclaimed areas and newly constructed wetlands. Processes considered in the hillslope profile model include rill and inter-rill erosion, sediment transport and deposition, infiltration, soil consolidation, residue and canopy effects on soil detachment and infiltration, surface sealing, rill hydraulics, surface runoff, plant growth, residue decomposition, percolation, evaporation, transpiration, snow melt, frozen soil effects and erodibility, and climate. Figure 3-1 provides a simple depiction of the processes that will be modeled to determine sediment transport and delivery from these features. In general, rainfall detaches soil particles in inter-rill areas which are then transported to rill areas and off of the sediment berm. Overland runoff transports detached sediments to the 30 foot grass/vegetated buffer area where sediments are deposited or continue to runoff with overland flow to the St. Maries River, adjacent tributary, or stormwater channel. The amount of sediment detached and transported for a given storm event is dependent on the type, density, and cover of the vegetation; deposition from preceding storm events; and soil characteristics. The density and cover of vegetation will vary each year after reclamation and model simulations will be conducted for seven years (see assumptions below).

Model Inputs and Assumptions

- Modeled storms will be based on the climate generator module in WEPP using available climatic data bases for northern Idaho. Modeling will occur from the assumed starting date for reclamation and reseeding of each mining unit.

- Soil characteristics and particle size distributions to determine "erodibility" will be based on actual site samples.

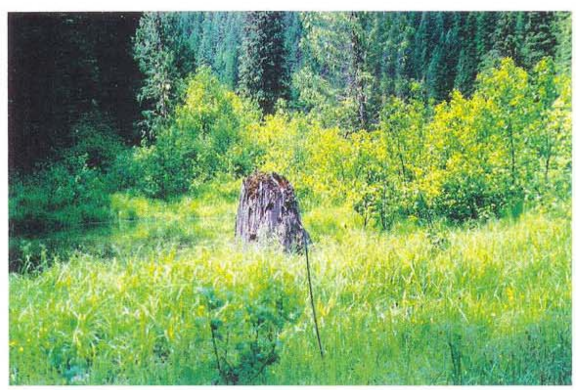
- Reclaimed and restored wetland areas would conservatively be considered as "reasonably mature" after seven years. The seven-year value is based on results from vegetation monitoring conducted to evaluate reclamation success that suggest that a mature cover of vegetation exists in 4 to 5 years; the additional 2 years are to add conservatism. These data are provided in the *Riparian Reclamation Summary Report in* Volume II Appendix L of the EIS. For purposes of this workplan, the term "mature" refers to the reclaimed community's ability to prevent raindrop impact, retard or prevent rill and interrill erosion, and filter soil and sediment transport across the surface. These physical aspects of the reclaimed community should be considered stable and reasonably unchanging in seven years based on the results of Appendix L, which shows that vegetative aerial cover ranged from 85% to 120% in seven years based on the specific reclaimed community studies. Figures 3-3 and 3-4 show successive annual photos from reclaimed wetland and upland communities, respectively.

Data Plot 2 - 1996

Data Plot 2 - 1997

Data Plot 2 - 1999

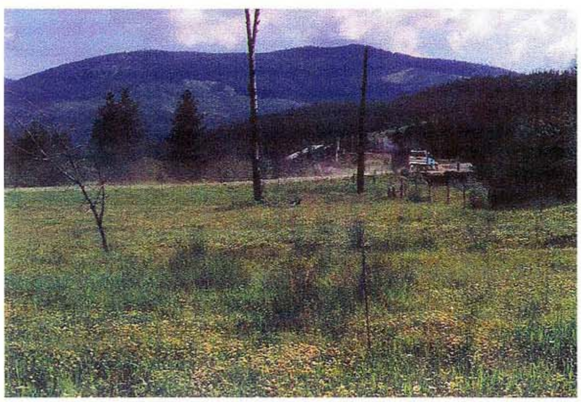
Data Plot 2 - 2001



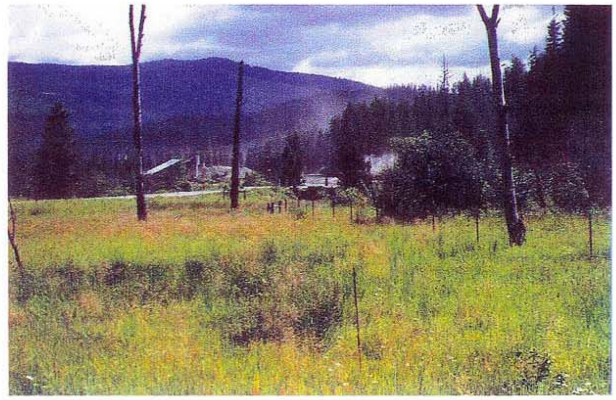
Data Plot 2 - 2002

Figure 3-3. Reclamation success on a pasture type mining unit. The total canopy cover exceeded 120% in 2002.

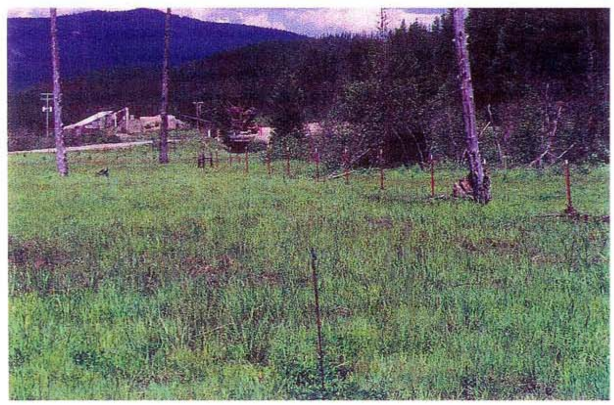
Data Plot 1 - 1996



Data Plot 1 - 1998



Data Plot 1 - 1999



Data Plot 1 - 2001

Data Plot 1 - 2002

Figure 3-4. Reclamation success on a pasture type mining unit. The total canopy cover exceeded 85% in 2002.

4.0 SEDIMENT YIELD FOR MITIGATION OFFSET PROJECTS

4.1 Quantification of Sediment Offsets/Credits

To obtain §401 Certification, be in compliance with the TMDL, and acquire NPDES storm water permits, ECG will be required to implement approved watershed improvement projects that will result in sediment load reductions (i.e., credits) that are greater than the amount of sediment that will be generated throughout the life of the mining project. The amount and size of mitigation projects that will be implemented will be dependent on the results of modeling to determine sediment yields that would result from the mining operations (Section 3.0).

Mitigation projects would be implemented to obtain sediment offsets on a 1:1 basis for the following reasons:

- Mitigation projects would be considered effective in perpetuity and would be effective long after the proposed mining project is implemented. This would greatly assist in meeting the objectives of the TMDL to meet established sediment goals within 50 years. For example, reclaiming disturbed areas in the watershed that otherwise would not be reclaimed would provide long term improvements in erosion reduction and sediment delivery to the river.

- Sediment yields that occur from reclaimed mining areas will be modeled for 7 years. Studies to evaluate reclamation success; however, suggests that a mature cover of vegetation is established in 4 to 5 years. Seven years will be applied to add conservatism to the total sediment yield that is attributed to the mining operation. In effect two additional years of sediment generated from reclaimed areas will be considered as effects from the mining operation and subject to offset requirements.

- The sediment modeling conducted to estimate sediment yields that would result from mining operations is considered conservative in that the modeling would be considered to overestimate actual sediment yields. The hillslope module in WEPP uses similar calculations as those in the Revised Universal Soil Loss Equation (RUSLE). Studies conducted by the USDA Agricultural Research Service and researches at the National Soil Erosion Research Center (Purdue University) evaluating over 1,500 plot-years of data on actual runoff plots, shows very similar predictive results between WEPP and the RUSLE.[5] Studies cited in the TMDL[6] show that only 25% of the sediment modeled using RUSLE was actually delivered to the stream. The TMDL then used the 75% overestimate in sediment delivery by RUSLE in the MOS. Similar overestimates would be expected using the WEPP hillslope module for calculation of sediment delivery from mining operations.

[5] Laflen, J., D. Flanagan, and B. Engel. Soil Erosion and Sediment Yield Prediction Accuracy Using WEPP. Journal of the American Water Resources Association. Accepted for publication. May 2003 expected publication date.

[6] Bauer, S.B., J. Golden, and S. Petit. 1998. Lake Creek Agricultural Project, Summary of Baseline Water Quality Data. Pocketwater Incorporated, Boise, ID. 138 p.

4.2 Description of Project Types

It is assumed that three types of offset projects will be implemented by ECG:

- Reclamation or enhancement of additional disturbed areas not associated with the proposed mining project. These would not include the mining units that would be reclaimed anyway under the proposed action.
- Offset credits would be calculated for the elimination of, or protection from grazing on the 55 acres of ECG-owned lands that will be protected permanently, which includes both undisturbed riparian corridor and some of the lands reclaimed after mining. Elimination of grazing would increase aerial and basal cover of vegetation and reduce erosion and sediment transport to the River.
- Stabilization of stream banks in the St. Maries River and other tributary streams. Unstable banks are one of the three main sources of sediment identified by the TMDL (IDEQ 2003a).
- Road drainage or road improvement projects on area roads. This would require coordination with the U.S. Forest Service. Unpaved forest roads are one of the three main sources of sediment identified by the TMDL (IDEQ 2003a).

Approaches to modeling the reductions in sediment yield from each of these types of projects are discussed in Sections 4.2.1 through 4.2.3 below. Each section provides a description of the models used, the features evaluated, and any assumptions that will be used in modeling.

4.2.1 Reclaimed Areas

Description of Conceptual Model

The WEPP hillslope profile module will be used to estimate the erosion, transport, and deposition of detached sediments from stormwater runoff from reclaimed areas and newly constructed wetlands. Processes considered in the hillslope profile model include rill and interrill erosion, sediment transport and deposition, infiltration, soil consolidation, residue and canopy effects on soil detachment and infiltration, surface sealing, rill hydraulics, surface runoff, plant growth, residue decomposition, percolation, evaporation, transpiration, snow melt, frozen soil effects and erodibility, and climate. Figure 3-1 provides a simple depiction of the processes that will be modeled to determine sediment transport and delivery from these features. In general rainfall detaches soil particles in inter-rill areas, transported to rill areas and off of the sediment berm. Overland runoff transports detached sediments grass/vegetated buffer area where sediments are deposited or continue to runoff with overland flow to the St. Maries River or adjacent tributary. The amount of sediment detached and transported for a given storm event is dependent on the type, density, and cover of the vegetation; deposition from preceding storm events; and soil characteristics. The density and cover of vegetation will vary each year for seven years after reclamation. Model simulations to calculate offsets will be conducted for seven years, as was done for the mine site reclamation areas (Section 3.8). The offset will be determined as the difference between the sediment yield that would result from reclamation (over a seven year period) and the sediment yield that would result if the site was not reclaimed or enhancements made.

Model Inputs and Assumptions

- Modeled storms will be based on the climate generator module in WEPP using available climatic data bases for northern Idaho. Modeling will occur from the assumed starting date for reclamation and reseeding of each mining unit.

- Soil characteristics and particle size distributions to determine "erodibility" will be based on actual site samples.

- Reclaimed and restored wetland areas would conservatively be considered as "reasonably mature" after seven years. The seven year value is based on results from vegetation monitoring conducted to evaluate reclamation success. These data are provided in the *Riparian Reclamation Summary Report,* in Appendix L of the EIS. For the purposes of this workplan, the term "mature" refers to the reclaimed community's ability to prevent raindrop impact, retard or prevent rill and interrill erosion, and filter soil and sediment transport across the surface. These physical aspects of the reclaimed community should be considered stable and reasonably unchanging in seven years based on the results of Appendix L where vegetative aerial cover ranged from 85% to 120% in seven years based on the specific reclaimed community studies.

4.2.2 Stabilization of Stream Banks

Description of Conceptual Model

The direct volume method for erosion, as discussed in the *Erosion and Sediment Yield Channel Evaluation Workshop (1983),* will be used to estimate the volume of sediments that is currently being eroded from unstable streambanks. This method was used to estimate erosion that could occur from unstable stream banks in the TMDL (IDEQ 2003a). The offset will be determined as the difference between the sediment yield that would result from reclamation (after a seven-year period) and the sediment yield that would result if banks were left as they are.

Model Inputs and Assumptions

- Soil characteristics and particle size distributions to determine "erodibility" will be based on actual site samples.

- Seven years will be used as a timeframe because it is consistent with time frames used for reclaimed areas.

4.2.3 Road Improvement Projects

Description of Conceptual Model

Stormwater runoff from road improvement projects will be estimated and sediment transport from road culverts installed to provide drainage will be modeled using WEPP-ROAD. WEPP-Road is one in a series of the U.S.D.A. Forest Service's Internet-based computer programs based on the WEPP model. The model will be used to simulate erosion from road surfaces to road conveyance ditches, and the transport of sediments, and deposition of sediments across grass buffer zones. The offset will be determined as the difference between the sediment yield that would result from the improvement project (after a seven year period) and the sediment yield that would result if projects were not implemented.

Model Inputs and Assumptions

- Roadbed materials (rock and gravel types) will be based on actual material used by ECG to build roads.
- Species, height, basal and aerial cover of vegetation across the vegetated buffer will be based on site observations location of mining unit.
- Deposition effects from catchment basins and other BMPs such as silt fencing and straw bales will be considered.

5.0 REFERENCES

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