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Technical Tip

Environmental Mitigation Prescriptions

James D. Hogarth and P. Mark Hawley

A site-by-site assessment of previously prescribed road deactivation and slope stabilization measures was undertaken on northern Vancouver Island in the spring of 1996. The purpose of this assessment was to prescribe appropriate environmental mitigation measures that would enable road deactivation and slope stabilization works to proceed, where possible, outside the fisheries timing window.

Preliminary standard prescriptions for access and deactivation were developed prior to the field assessment work. These incorporated stream classifications and various mitigative measures and environmental controls into separate access and deactivation prescriptions. Field assessments consisted of stream classification by a fisheries specialist in conjunction with an Erosion and Sediment Delivery (ESD) risk assessment by a geotechnical engineer. It is important to note that an ESD risk assessment should be conducted by an individual with an understanding of erosion processes, slope stability, and road deactivation and slope stabilization activities. Based on the results of the stream classification and the ESD risk, site specific Environmental Mitigation Prescriptions (EMPs) were prepared utilizing the standard prescriptions as a guide. Modification of the preliminary standard prescriptions during the field program was necessary to reflect the results of the field assessment.

Environmental Mitigation Prescriptions consist of site specific prescriptions for mitigative measures, environmental monitoring and timing of work with respect to peak flows. They are to be employed during the implementation of prescribed road deactivation and slope stabilization measures, including activities associated with redeveloping access to old roads. While applicable predominantly at stream crossings, EMP's may be applied to any site.

To determine the appropriate EMP for a site, the Erosion and Sediment Delivery (ESD) risk is first estimated based on three basic parameters:

i) **Connectivity:** The proximity and connection of the stream crossing or site to a fish-bearing stream or fisheries sensitive habitat.

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EROSION/SEDIMENT DELIVERY (ESD) POTENTIAL	
CONNECTIVITY[1]	
NC	No connection to fish-bearing stream or fisheries sensitive habitat. Gap in the channel system (e.g. flat or fan with no channel, non-fish bearing lake or wetland, ditch or cross ditch with no direct or indirect connection to an existing channel).
IC	Indirect connection to a fish-bearing stream or fisheries sensitive habitat. Channel has a gradient of less than 5% for greater than 100m before reaching a fish-bearing stream or fisheries sensitive habitat.
DC	Direct connection to a fish-bearing stream or fisheries sensitive habitat; or channel discharges into a non-fish bearing stream that discharges into a fish-bearing stream or fisheries sensitive habitat within 100m, or the channel gradient remains greater than 5% until it reaches a fish-bearing stream or fisheries sensitive habitat.
WATER TRANSPORT POTENTIAL[2]	
L	Low water transport potential. Water Power Index <8; Upstream catchment <9 ha; Scattered, unsorted woody debris only, with no log jams; Sediment wedges/bed load sand sized or finer.
M	Moderate water transport potential. Water Power Index 8 to 11; Upstream catchment area ≥ 9 ha; Small woody debris jams; Sediment wedges/bed load up to cobble sized.
H	High water transport potential. Water Power Index >11; Upstream catchment area ≥ 9 ha; Large woody debris jams or evidence of debris flows or channel cleaning due to flooding; Sediment wedges/bed load up to boulder sized.
SEDIMENT SOURCE POTENTIAL	
L	Low potential as a source of sediment. Shallow cross ditches and culverts (<1m deep); coarse road bed materials (<10% fine fraction) being excavated or trafficked. Coarse bed load (<10% fine fraction) in channel being trafficked.
M	Moderate potential as a source of sediment. Moderately deep cross ditches and culverts (1-3m deep), well graded road bed material (10 to 20% fine fraction) being excavated or trafficked. Graded bed load (10 to 20% fine fraction) in channel.
H	High potential as a source of sediment; Deep cross ditches and culverts (>3m deep), fine grained road bed material (>20% fine fraction) material being excavated or trafficked. Fine-grained bed load (>20% fine fraction) in channel.

Notes:
1. Connectivity definition based on descriptions in the Gully Assessment Procedures Guidebook, February, 2001.
2. Water Power Index and Water Transport Potential are as defined in the Gully Assessment Procedures Guidebook, December 1995.

Figure 1. Definitions of the parameters utilized to determine Erosion and Sediment Delivery Risk.

ii) **Water Transport Potential:** The potential of the stream to carry sediment to a fish-bearing stream or fisheries sensitive habitat.

iii) **Sediment Source Potential:** The availability of deleterious sediment (i.e., silt and fine sand) at the stream crossing or site that may be introduced into a stream by access or deactivation activities.

Each of these parameters is discussed in Figure 1. Where practical, the methodology contained in existing publications under the Forest Practices Code of B.C. was used, or modified as appropriate, to define the various levels for each parameter.

The ESD risk is then calculated based on the matrix given in Figure 2.

ESD RISK MATRIX[1]

Sediment Source Potential	Water Transport Potential	Connectivity	ESD Risk
L	L	NC	L
L	L	IC	L
L	L	DC	L
L	M	NC	L
L	H	NC	L
M	L	NC	L
M	M	NC	L
M	H	NC	L
H	L	NC	L
H	M	NC	L
H	H	NC	L
L	M	IC	M
L	H	IC	M
M	L	IC	M
M	M	IC	M
H	L	IC	M
L	M	DC	H
L	H	DC	H
M	L	DC	H
M	M	DC	H
M	H	IC	H
H	L	DC	H
H	M	IC	H
M	H	DC	VH
H	M	DC	VH
H	H	IC	VH
H	H	DC	VH

Notes:
1. The methodology for assessing ESD potential described above is intended to be used as an interpretive tool by individuals with the appropriate experience and understanding of erosion processes, slope stability and road deactivation/slope stabilization activities. It is a subjective rating scheme and is intended only for assessment of the potential for erosion/sediment delivery at discrete locations. ESD potential ratings should be verified by the Environmental Monitor during implementation of the recommended works and mitigative measures.

Figure 2. Matrix used to calculate the Erosion and Sediment Delivery Risk.

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In developing this risk matrix, connectivity was given a higher weighting than either Sediment Source Potential or Water Transport Potential. Once the ESD risk has been calculated for access and deactivation works and the stream classification known, it is then possible to determine the appropriate EMP category for each site for access and deactivation activities. Standard prescriptions and category codes (i.e., A1, A2, …) for access activities are shown in Figure 3 and prescriptions and category codes (i.e., D1, D2, …) for deactivation activities are shown in Figure 4.

Where a site falls into a category represented by codes A1 to A3 for access and D1 to D3 for deactivation, appropriate environmental mitigation measures for the site are to be determined by the Environmental Monitor during the implementation phase. The higher categories generally deal with larger fish-bearing streams or sites where in-stream works are recommended. As detailed in Figures 3 and 4, suitable, site-specific, EMPs can be developed for sites of this type by a geotechnical engineer in consultation with a fisheries specialist, preferably with appropriate experience in sedimentation mitigation procedures and road deactivation and slope stabilization activities. Once determined, the codes corresponding to the EMP category for access and deactivation are then incorporated into the deactivation prescription spreadsheet (e.g., A2:D3) and shown on the deactivation plan map. Where site specific EMPs were developed, they are also included in the prescription spreadsheet.

Following completion of the Vancouver Island assessments, this system was applied to six watersheds in the Queen Charlotte Islands during the spring and summer of 1996. During the course of this work, further modifications were made to the standard prescriptions to clarify apparent inconsistencies. Except for minor modifications, the standard prescriptions resulting from the Queen Charlotte Islands work are the ones presented in Figures 3 and 4. To date, EMPs have been utilized in a total of eleven study areas in the Queen Charlotte Islands Forest District and the Port McNeill Forest District.

ENVIRONMENTAL MITIGATION PRESCRIPTIONS ACCESS	
A1	Low ESD risk. Classes S5 and S6 streams with a low potential for erosion/sediment delivery to Classes S1 to S4 streams or Fisheries Sensitive Zones (FSZ). Includes existing bridges and culverts that span all classes of streams and appear to be in serviceable condition. No mitigative measures required. Unrestricted access for tracked equipment and rubber-tired vehicles.
A2	Low to moderate ESD risk. Classes S5 and S6 streams with low to moderate potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. Minimize number of times tracked equipment crosses streams. Tracked equipment may require cleaning before crossing stream. Unrestricted access for rubber-tired vehicles.
A3	Moderate ESD risk. Classes S5 and S6 streams with moderate potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. Construct Ford or Squamish culvert using coarse rock with minimal fines. Special measures to mitigate erosion/sedimentation may be required as determined by Environmental Monitor (EM) during construction. EM to inspect ford/culvert construction and approve completed structure before use. Minimize number of times tracked equipment crosses stream. Tracked equipment may require cleaning before crossing stream. Unrestricted access for rubber-tired vehicles.
A4	Moderate to high ESD risk. Classes S3 and S4 streams, and Classes S5 and S6 streams with moderate to high potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. Repair existing structure or construct Squamish culvert (with provision for fish passage, as required), temporary wooden or metal culvert, or bridge as noted. EM to inspect culvert/bridge repair/construction and approve structure before use. If fish are present, they are to be removed and site screened off before commencement of work. Special measures to mitigate erosion/sedimentation during construction as noted. Access restrictions for Squamish culverts as per A3, otherwise unrestricted access for tracked equipment and rubber tired vehicles following approval of structure. Design and mitigative measures for culverts/bridges that span Class S3 or S4 streams determined in consultation with a fisheries specialist, as noted. Culverts >2m equivalent diameter and bridges to be designed, and completed structure approved, by a Professional Engineer (P.Eng.)
A5	High ESD risk. Classes S1 and S2 streams and Classes S3 to S6 streams with a high potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. May require construction of a full span bridge or culvert. Crossing feasibility, design and environmental mitigation requirements determined by a Geotechnical Engineer (P.Eng.) in consultation with a fisheries specialist and other professionals as noted. Full time inspection by EM required during construction of mitigative works, and as required during operations. Completed works to be approved by the Geotechnical Engineer before use. Access restrictions will depend on crossing design and mitigative measures implemented, and are to be determined by the Geotechnical Engineer in consultation with a fisheries specialist.
A6	Very high ESD risk. Any Class S1 to S4 stream with a high fisheries value (as determined by a fisheries specialist) or Class S5 or S6 stream with a high potential for erosion/sediment delivery to a high fisheries value stream or FSZ. No in-stream activity outside of fisheries timing window permitted, unless a full span bridge is installed. Feasibility, crossing design, mitigative measures and restrictions for crossing determined by a Geotechnical Engineer (P. Eng.) in consultation with the fisheries specialist and other professionals, as noted. Fisheries timing window to be determined in consultation with Department of Fisheries and Oceans and B.C. Environment (MELP), as required, prior to commencement of work.

Figure 3. Standard Environmental Mitigation Prescription codes and associated Category Codes for activities related to accessing old roads.

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ENVIRONMENTAL MITIGATION PRESCRIPTIONS DEACTIVATION	
D1	Low ESD risk. Classes S5 and S6 streams with a low potential for erosion/sediment delivery to Classes S1 to S4 streams or Fisheries Sensitive Zones (FSZ). No mitigative measures required.
D2	Low to moderate ESD risk. Classes S5 and S6 streams with a low to moderate potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. Routine erosion/sedimentation control measures may be required as determined by Environmental Monitor (EM) during implementation. Periodic inspections by EM.
D3	Moderate ESD risk. Classes S5 and S6 streams with a moderate to high potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. Special measures to mitigate erosion/sedimentation may be required as determined by EM during implementation. Frequent inspections by EM.
D4A	Moderate to high ESD risk. Streams with moderate to high potential for erosion/sediment delivery to Classes S1 to S4 streams or FSZ. No fish present at site or low fisheries value as determined by a fisheries specialist. Special erosion/sedimentation control measures, including minor diversions, small sedimentation ponds, etc., as noted. Full time supervision by EM.
D4B	Moderate to high ESD risk. Classes S1 to S4 streams with moderate to high potential for erosion/sediment delivery. Fish present at site. Electroshocking/netting of resident fish and screening off site to be conducted by a fisheries specialist prior to commencement of work. Special erosion/ sedimentation control measures, including minor diversions, small sedimentation ponds, etc., determined in consultation with the fisheries specialist, as noted. Full time supervision by EM.
D5	High ESD risk. Classes S5 and S6 streams with a high potential for erosion/sediment delivery to Classes S1 to S4 streams. Feasibility of proposed deactivation works and design of mitigative measures, determined by a Geotechnical Engineer (P.Eng.) in consultation with a fisheries specialist, as noted. Full time inspection by EM. Works to be inspected by the Geotechnical Engineer at critical stages during implementation. Completed works to be inspected and approved by the Geotechnical Engineer.
D6	Very high ESD risk. Any Class S1 to S4 stream with a high fisheries value (as determined by a fisheries specialist) or Class S5 or S6 streams with a high potential for erosion/sediment delivery to a high fisheries value stream. No in-stream activity outside of fisheries timing window permitted. Feasibility of implementing deactivation works and design of possible mitigative measures, determined by a Geotechnical Engineer (P.Eng.) in consultation with a fisheries specialist, as noted. Fisheries timing window to be determined in consultation with Department of Fisheries and Oceans and B.C. Environment (MELP), as required, prior to commencement of work.

Figure 4. Standard Environmental Mitigation Prescription codes and associated Category Codes for activities related to road deactivation.

Some of the benefits of utilizing this system are:

- Consistency of prescriptions from project to project.
- Provides a more detailed work plan to reviewing agencies. This should help speed up approvals.
- A more detailed work plan also means a more accurate cost estimate can be developed before work begins.
- Applications of this system are not limited to road deactivation. It has applications wherever work in or around streams is proposed.

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