Guidelines for Planning Watershed Restoration Projects

by

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The formatting in this document may vary slightly from the printed version.

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Preface

This circular provides a suggested format for planning projects funded under the Watershed Restoration Program component of Forest Renewal BC's "Land-based Programs". Refer to Forest Renewal BC's "1996/97 Handbook for Land-based Programs" for a detailed discussion of how to apply for restoration funding. The activities that this circular recommends would generally follow the approval in principle by Forest Renewal BC of a preliminary proposal, although some of the overview activities outlined in this circular would be useful for developing your preliminary proposal.

Proponents should note that the procedures discussed in this circular are recommendations rather than fixed requirements. The procedures and outputs would only become mandatory if they are written into the contract for the project between the proponent and the ministry that administers the work on behalf of Forest Renewal BC.

The information given in this circular is correct as of October 1995. Nevertheless, proponents should consult regional Forest Renewal BC staff to ensure that they have up-to-date information regarding eligibility, application and implementation requirements. As Forest Renewal BC's policies evolve to meet the needs of its clients, changes to the contents of this circular may be required; **ensure that you have the most current version of this circular**.

Proponents are strongly advised to consult regional FRBC staff and district and regional WRP staff **before** commencing detailed project planning and development.

Introduction

Background

There is an urgent need to renew the forest resources upon which an environmentally sustainable British Columbia economy depends. Past land management practices have lessened the productive capacity of both forest lands and, especially, fish producing waters. The Watershed Restoration Program (WRP) is a provincial initiative under Forest Renewal BC to restore the productive capacity of forest, fisheries and aquatic resources that have been adversely impacted by past forest harvest practices, and thus to aid in providing long-term employment opportunities in resource-dependent communities. The Watershed Restoration Program hastens the recovery of degraded environmental resources in logged watersheds by identifying the need for, designing, and implementing projects to re-establish conditions more similar to those found in unimpacted watersheds, or mitigates impacts where rehabilitation is not feasible. This circular outlines planning and assessment processes that will enable appropriate and successful rehabilitation or restoration projects to be developed and implemented.

The Watershed Restoration Program is one component of British Columbia's Forest Renewal Plan. The cornerstone of the Forest Renewal Plan is the comprehensive renewal of our forests through improved reforestation and tending and through the restoration, rehabilitation and protection of our environmental resources. Other initiatives, such as the Forest Practices Code, will help maintain healthy and productive forest ecosystems and protect environmental resources. Forest Renewal BC (FRBC), the crown corporation that was established to implement the Forest Renewal Plan, funds the Watershed Restoration Program. The WRP is administered by the Ministry of Environment, Lands and Parks (MoELP) and the Ministry of Forests (MoF) on behalf of FRBC.

Program Goals

The major goals of the Watershed Restoration Program are:

- to protect, restore and maintain fisheries, aquatic and forest resources that have been adversely impacted by past forest harvesting practices,
- to provide community-based employment, training and stewardship opportunities, and
- to provide a mechanism to bridge historical forest harvesting practices and the new standards established by the Forest Practices Code

The WRP will achieve these goals by providing the infrastructure to train and employ workers to restore fisheries and forest resources, and by implementing assessments, prescriptions, and rehabilitation measures in logging-impacted watersheds in partnership with the forest industry, government agencies, First Nations, and community-based groups. The WRP will also implement demonstration watershed restoration projects for training, education and scientific purposes. The activities of the WRP will foster opportunities for community stewardship of local resources and promote the concept of an environmentally sustainable economy.

An important goal of the WRP is to encourage working partnerships among local groups to ensure that the whole range of logging-related resource impacts are identified and rehabilitated in a systematic, coordinated manner at the watershed level. Restoration activities funded under the Watershed Restoration Program should adopt a process-oriented approach that:

- reduces the generation and delivery of sediments from hillslopes to stream channels,
- re-establishes natural drainage patterns and water quality,
- replaces lost channel-structuring elements within streams to increase the amount and quality of fish habitat, and
- restores habitat within selected terrestrial, riparian and stream ecosystems towards pre-logging conditions.

The intent of the restoration work should be to return the processes that cause the adverse impacts to their natural levels rather than simply treating the symptoms of the impacts. By altering the rates of processes that control the physical and biological structure of watersheds, the program hopes to re-establish more productive, normally functioning ecosystems in the future.

Organizational Roles (Who Does What)

Forest Renewal BC establishes policy, defines broad strategic objectives and eligibility criteria for the Watershed Restoration Program and assists proponents to develop proposals for funding. The Watershed Restoration Program coordinates the development and implementation of operational projects to restore logging-impacted watersheds. Government and non-government project proponents such as the forest industry, licensees, First Nations, community organizations and stewardship groups design and implement restoration projects that are funded by Forest Renewal BC through the Watershed Restoration Program. The BC Ministry of Environment, Lands and Parks and the BC Ministry of Forests jointly administer the operational program on behalf of FRBC and establish the technical standards and procedures for the watershed restoration work that is undertaken by project proponents. Restoration proposals that are submitted to FRBC regional offices by government, industry, First Nations,

and public groups are evaluated against program objectives by regional review and advisory committees that rank proposals for inclusion in regional investment plans, based on regional priorities. The regional investment plans then go to Forest Renewal BC's board for funding approval. The Canada Department of Fisheries and Oceans (DFO) is also cooperatively involved in implementing the operational program.

Sources of Information About the WRP

Forest Renewal BC publishes a "Handbook for Land-based Programs" that outlines the goals, eligibility criteria and application procedures for its programs, including the Watershed Restoration Program. The handbook (Forest Renewal BC 1996) is available from Forest Renewal BC regional offices throughout the province, or from:

Forest Renewal BC
9th floor, 727 Fisgard Street
Victoria, B.C., V8V 1X4
phone: (604) 387-2500

If you have questions about the goals or administration of the WRP, you should contact your regional FRBC office, the Forest Sector Initiatives Manager in your regional Ministry of Forests office, or the WRP Coordinator in your regional Ministry of Environment, Lands and Parks office; see Appendix A for addresses. If you have technical questions about watershed restoration, you should contact the WRP Coordinators in your regional Ministry of Environment, Lands and Parks or Ministry of Forests offices or WRP technical staff (both MoELP and MoF) located in your district Ministry of Forests offices. See the blue pages of your local telephone directory under "Province of British Columbia" for the locations of district and regional offices. You should direct questions about upslope components of watershed restoration projects (roads, hillslopes, gullies, site rehabilitation, riparian areas) to MoF staff and questions about streamside and aquatic components (riparian areas, stream channel, water quality, fish habitat and fish) to MoELP staff.

About This Circular

What Is the Purpose of This Circular?

The purpose of this circular is to assist local groups (forest licensees, First Nations, community groups, stewardship organizations) to develop and implement integrated, effective, cost-efficient projects at the watershed scale to rehabilitate or restore natural resources that have been adversely

impacted by past forestry practices. The circular provides a standard framework for identifying the needs and opportunities for restoration through systematic resource assessments, and for prescribing and implementing effective activities to improve forest, aquatic and fishery resources. You should use this circular in conjunction with the series of Watershed Restoration Technical Circulars (Appendix B) that describe detailed procedures for conducting assessments and for designing appropriate restoration projects.

Who Should Use This Circular?

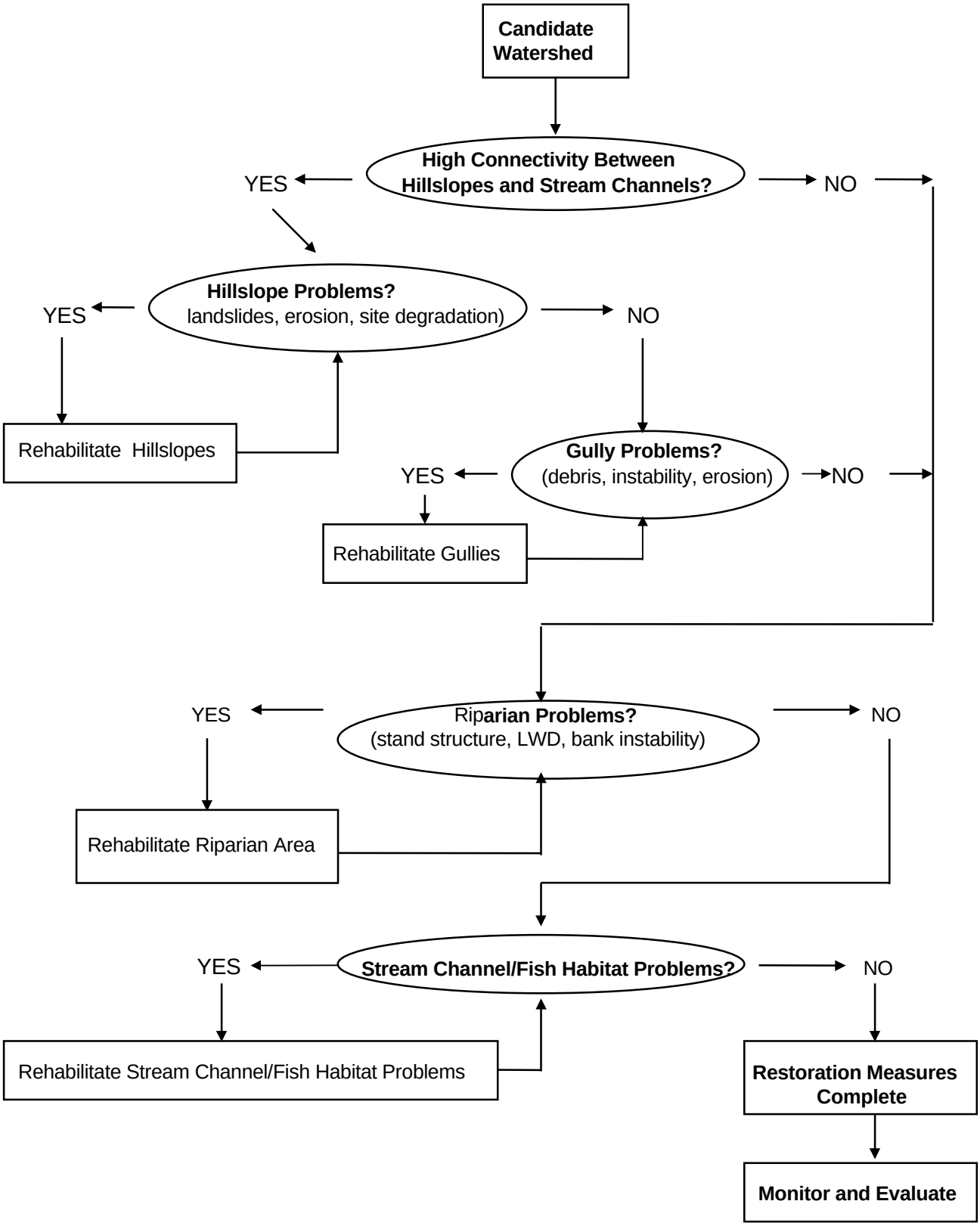
Organizations that apply for funding from Forest Renewal BC under the Watershed Restoration Program should use this circular to plan their activities and to help develop their detailed proposal following approval in principle. Where several groups are cooperatively developing an integrated restoration proposal for a watershed, the project coordinator should use the circular to ensure the effective integration of component projects. District and regional WRP staff can also use the circular to ensure that proposals meet minimum planning standards.

Why Should You Use This Circular?

Proponents of projects that are submitted for funding under the WRP should use this Technical Circular to ensure that their proposals consider all important aspects of watershed restoration, that they have planned their proposed activities in an efficient manner, that their procedures and methods are technically sound, and that any data that may be collected by their projects will be compatible with Provincial data standards.

Watershed restoration deals with the results of complex, interconnected processes that often cannot be partitioned into independent subcomponents when devising effective corrective actions. Proponents must recognize the linkages existing among the various physical and biological subcomponents of watersheds when planning restoration activities. Your restoration activities must be integrated if their implementation is to succeed! Watersheds are functional units in the landscape: the downslope movement of water, sediments and wood from hillslopes to floodplains to riparian areas to stream channels imposes a hierarchical structure on potential restoration activities that must be recognized in the development of restoration plans. The preferred implementation sequence depends on the connectivity of the upslope and downslope areas. Subcomponents such as stream channels often cannot be successfully treated in isolation from the upslope processes to which they are connected. Projects must, therefore, be planned at the whole watershed scale and should generally proceed sequentially from hillslopes to riparian areas to the stream channel (Figure 1). There are, of

Figure 1. Overview of Watershed Restoration Implementation Sequence



course, exceptions: e.g., offchannel and fisheries mitigation activities can often be implemented simultaneously with hillslope activities, as can rehabilitation activities in lake-headed streams that are buffered from sediment impacts by the retention capacity of the lake.

Definitions

There are several frequently used terms in this circular whose meaning needs definition:

condition assessment - an objective procedure to characterize the present state of a natural resource in a watershed and to diagnose resource impairment that can be remedied by restoration activities.

fisheries sensitive zones - side and back channels, ponds, swamps and other wetlands, seasonally flooded depressions, lake littoral zones and estuaries that are seasonally occupied by over-wintering anadromous fishes (refer to the Forest Practices Code)

floodplain - the low-lying, topographically flat area adjacent to a stream channel which is regularly flooded by stream water on a periodic basis and which shows evidence of the action of flowing water, such as active or inactive flood channels, recent fluvial soils, rafted debris, or tree scarring.

forest resources - the new Forest Practices Code of British Columbia Act defines forest resources as "resources and values associated with forests and range including, without limitation, timber, water, wildlife, fisheries, recreation, botanical forest products, forage, and biological diversity".

gully - a long, linear depression incised into steep hillslopes, where the overall gradient is at least 25%, with a channel confined in a V-notch ravine with banks higher than 3 m and sideslopes steeper than 40 percent, and an overall length greater than 100 m.

mass wasting - landslide processes, including debris falls, debris slides, debris avalanches, debris flows, debris torrents, rockfalls, rockslides, slumps and earthflows, and the small scale slumping, collapse and ravelling of road cuts and fills.

mitigation - activities undertaken to compensate for the impairment of natural resources where restoration or rehabilitation is not feasible. Mitigation may not replace like-with-like and need not occur in the damaged watershed.

rehabilitation - returning to a state of health and useful activity. In this circular, rehabilitation means producing conditions more favourable to

particular groups of organisms, especially the economically valuable or aesthetically desired components of the native flora and fauna, without necessarily returning the system to its undisturbed condition.

restoration - bringing back to a former or original condition (e.g., the pre-logging state). In this circular the term "restoration" is meant to include rehabilitation.

riparian area - the land adjacent to the normal high water line in a stream or lake whose soils and vegetation are influenced by the presence of the ponded or channelized water. Riparian management areas are administratively defined strips of land adjacent to certain stream channels; consult the Forest Practices Code and regulations for their definition.

stakeholders - local groups that have a legitimate interest in the management of a watershed and its forest resources, especially those groups with a legally recognized interest.

stream - a watercourse formed when water flows between continuous, definable banks. The flow in the channel may be perennial or intermittent.

stream order - stream order is a scale-dependent property of drainage networks that describes the position and approximate size of a stream segment in the network. First order streams are headwater streams that have no tributaries. A second order stream is formed where two first order streams join, a third order stream is formed where two second order streams join, etc. Note that the confluence of a second order stream with a first order stream remains a second order stream. The WRP designates stream order using 1:50,000 scale National Topographic Series maps.

stream reach - a homogeneous segment of a drainage network, characterized by uniform channel pattern, gradient, substrate, discharge and channel confinement.

watershed - an area of land (the catchment or drainage basin), bounded peripherally by a topographic height of land, that delivers water along a stream channel to a common outlet. Watersheds are the natural landscape units from which hierarchical drainage networks are formed.

Planning a Watershed Restoration Project

Overview of the Project Development Process

Two levels of planning occur in the development of any project (Everest et al. 1991). *Program planning* defines the broad objectives and priorities of

the work. *Project planning* deals with the development and implementation of site-specific activities to attain the program objectives. The preceding sections have outlined the program-level objectives and priorities of the Watershed Restoration Program.

The general sequence of tasks in restoration project planning and development for a specific watershed include (Anonymous 1994a):

- choosing a location (watershed) that meets program objectives and priorities,
- identifying the nature and causes of forestry-related resource impairment,
- identifying restoration strategies,
- defining project scope and specific objectives for restoration,
- setting priorities for restoration objectives,
- prescribing appropriate restoration treatments,
- estimating costs, constraints and scheduling,
- assembling the necessary manpower and resources,
- implementation,
- maintenance, and
- monitoring and evaluation.

Here we consider project-level planning at the watershed level. Figure 2 is a flowchart for project planning and implementation. The key issues for initial planning are identifying the nature and causes of damage to forest and fisheries resources in the watershed, and assessing the potential for effective, cost-efficient restoration work.

Getting Started

Before you begin project planning, you should obtain the current version of the FRBC handbook from your local Forest Renewal BC office and ensure that your proposed activities will meet the objectives and eligibility criteria of the WRP. You should also discuss your proposed activities with regional MoELP and MoF staff to ensure that the work is compatible with regional management objectives and priorities. Your project will be reviewed against program objectives and priorities at several points along the project development sequence as additional information about the project becomes available.

Basic Eligibility Criteria

To be eligible for funding under the WRP, proposals must meet several basic criteria:

- "Forest Renewal BC investments must be incremental to obligations on industry or government, whether those obligations are derived from statute, policy or common practice." (FRBC 1996),
- projects must be on Crown land,
- projects must restore, protect or maintain fishery, aquatic or forestry resources adversely impacted by past forest harvesting practices, and
- projects must be compatible with the basic WRP objective to rehabilitate the entire watershed.

Eligibility criteria may change, so you must refer to the current FRBC handbook for the current criteria.

Eligible Activities

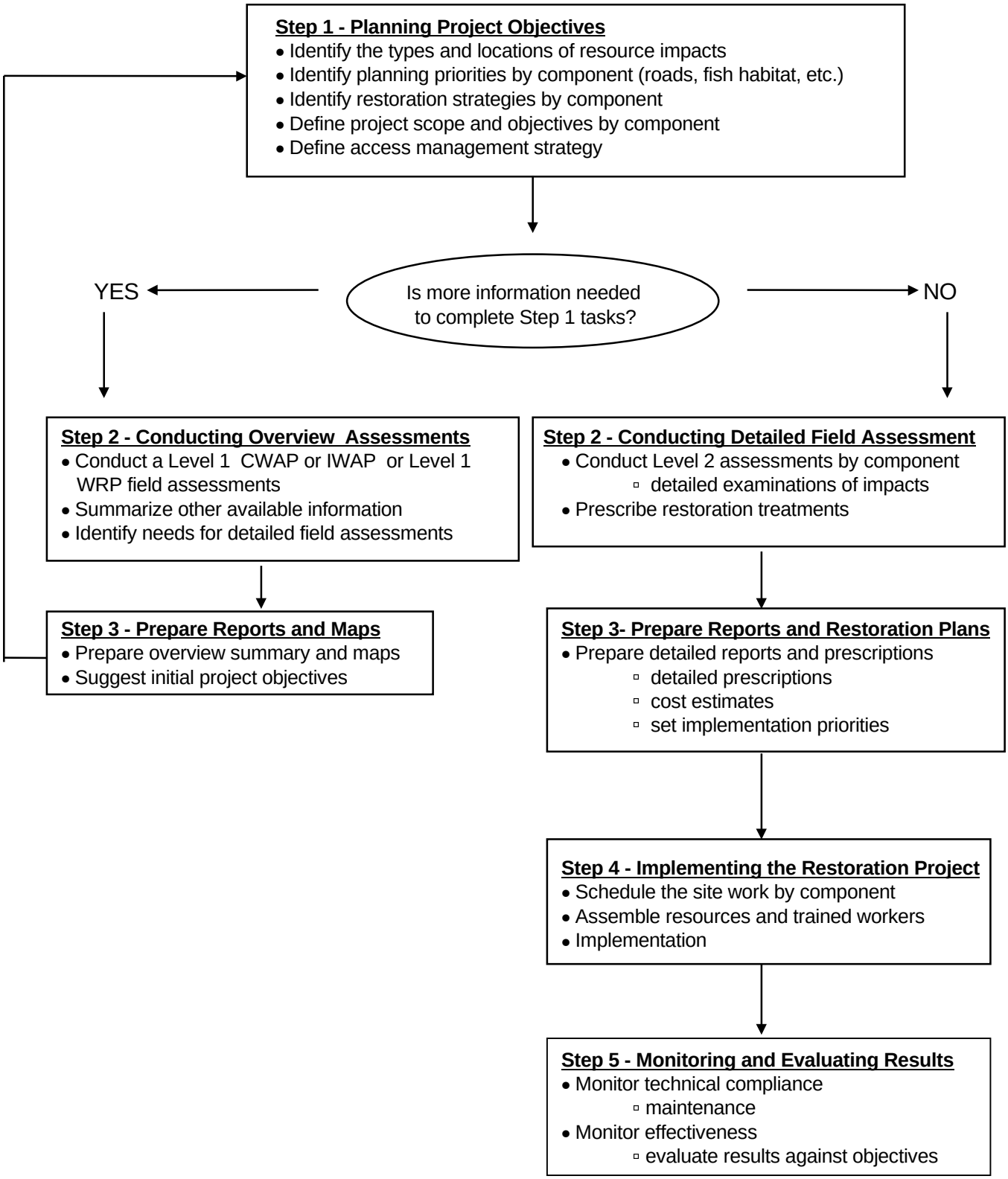
At present, the following activities are eligible for funding under the WRP, subject to the above basic criteria:

- condition assessments on logged watersheds,
- the preparation of detailed restoration prescriptions and plans,
- repairing resource roads to mitigate existing damage to riparian areas or aquatic resources, or where a high risk of future damage is evident (see the FRBC handbook for details),
- deactivating or rehabilitating semi-permanent and permanent roads,
- the rehabilitation of hillslopes, gullies, riparian areas, and stream channels for erosion and sediment control, and
- the restoration of fish and aquatic habitat adversely affected by forest harvesting activities.

Which Watershed?

The objectives, priorities and eligibility criteria of the WRP define, in a general way, the watersheds in which restoration activities may be developed. Additional information about the watershed, its forest resource values, and the nature and extent of logging-related impacts in the watershed are used to identify specific watersheds that should be restored. Note that regional WRP staff have identified regional priorities for restoration; consult your regional WRP Coordinators before commencing work to identify watersheds for restoration projects.

Figure 2. Flowchart of Watershed Restoration Project Planning and Implementation Steps (modified from Moore 1994)



If you are considering a specific watershed as a potential site for restoration activities, you will generally have information which suggests that forest harvesting has damaged fishery, forestry or aquatic resources in the watershed, that these impacts are potentially correctable with current restoration methods, and that the potential benefits of the restoration work warrant the costs of restoration. All these questions must be considered by you, the proponent, before commencing the development of restoration plans and by the program administrators in making a decision whether to fund the work.

Thus, you should consider the current state of the watershed, the potential resource benefits from restoration activities, and the likelihood of success when choosing a watershed in which to propose restoration work. The FRBC handbook (p. 52) identifies the minimal information on the status of natural resources in the watershed to be considered in project evaluation. You should consider:

- the percentage of the watershed that has been harvested,
- the percentage of the floodplain that has been harvested,
- the number of logging-related and road-related landslides in the watershed,
- the percentage of the watershed comprised of highly erodible soils,
- fish species present and trends in fish abundance,
- the approximate value of the fishery resources, and
- any previous restoration work done in the watershed.

Also consider potential long-term benefits from projects, such as:

- the area (ha) of disturbed mineral soil or roads returned to productive forest,
- the linear extent (km) of fish habitat restored, and
- the estimated increment in adult fish numbers generated by fish habitat restoration.

Proponents are often only interested in restoring a particular watershed. For instance, a watershed may lie within a company's forest tenure area, or a watershed may be the drinking water source for a community, or a watershed may have special historical or cultural significance for a First Nation. Nevertheless, proponents should recall that all work conducted under the auspices of the WRP must meet its objectives and eligibility criteria. Because funds are limited, only those projects that provide the greatest benefits can be funded. Proponents should carefully consider the objectives of the WRP and regional management priorities when choosing watersheds in which to develop restoration plans. The potential for significant benefits to natural resources is given a large weighting in judging projects. Regional and district WRP staff can provide information about regional priorities for watershed restoration.

Project Scope

Whole watersheds, and not their subcomponents, are the units for which restoration plans should be developed.

Your plans for watershed restoration should attempt to identify and, where possible, correct the whole set of logging-derived resource problems in the watershed rather than arbitrarily focusing on an isolated component such as roads or fish habitat. Watersheds are hierarchically organized functional units in the landscape. They are shaped by the physical and biological processes that control the downslope movement of water, soil and organic matter. The problems that sometimes arise from poorly planned timber-harvest practices result from changes to the rates of the interconnected processes that structure the watershed. Successful rehabilitation or restoration requires that the logging-induced changes to these processes and the linkages among them be recognized in planning and implementing the restoration work. Partial analyses and partial solutions are unlikely to be of lasting benefit. The assessment and planning procedures that are presented in Watershed Restoration Technical Circulars No. 2-9 (Appendix B) will assist you in systematically examining all the major perturbations that may have occurred.

The assessment procedures in WRP Technical Circulars No. 2-9 emphasize the potential impacts of forest harvest on aquatic resources. To assess the cumulative effects of forest harvest, you will usually first complete the appropriate watershed assessment procedure (WAP) or a similar overview assessment. You would then examine the state of roads, hillslopes, gullies, riparian areas, stream channels or fish habitat, as appropriate, to identify specific problems that may be treated through restoration projects.

The appropriate spatial scale for applying the assessment and restoration procedures from Technical Circulars No. 2-9 is, approximately, third order watersheds on 1:50,000 National Topographic series (NTS) maps. Watersheds of this size are logistically tractable for integrated restoration projects. Because lower order watersheds are nested hierarchically within higher order watersheds, large watersheds can usually be subdivided into sub-basins of a size that is appropriate for our assessment procedures. In coastal areas with high precipitation, use smaller (i.e., third order) watersheds, while in drier interior locations, you can use larger watersheds.

For overview assessments, where you are trying to obtain basic information about the watershed, it may be more efficient to work with contiguous sets of third order sub-basins that are grouped into larger watershed units. For example, if aerial photography is necessary, it will usually be more cost-efficient to set up flight lines that encompass all the third order sub-basins within a larger watershed rather than flying each sub-basin independently as it is individually considered for restoration purposes.

Stakeholders and Partnerships

Numerous groups within your community may have an interest in a particular watershed, typically because they use the watershed for some recognized purpose such as recreation or resource extraction. Such groups may include, for instance, the forest tenure holders, forest worker groups, permitted water users, First Nations, resource stewardship groups, recreational groups, licensed outfitters or guides, and the various government agencies responsible for the management of Crown resources. These local groups are the stakeholders in the watershed, who have a legitimate interest in the management of the watershed and its forest resources.

An important goal of watershed restoration is to foster local stewardship of resources by stakeholder groups, by encouraging cooperatively developed restoration projects that unite industry and the community in an activity that benefits both. Identifying the stakeholders and establishing partnerships among them is an important part of restoration project planning. Because watershed restoration affects many stakeholders, it is essential that the major stakeholders be part of the process that plans and implements restoration activities. The evaluation of requests for funding under the WRP explicitly considers the extent and the nature of partnerships established by the proposal. The forest tenure holders and other legally established stakeholders should certainly be consulted early in the planning process.

Establishing working partnerships among stakeholders is a good way for groups planning restoration projects to broaden their expertise. Different stakeholders often have special skills and training that make them particularly useful in planning specific components of the overall restoration plan. Because watershed restoration deals with many different problems, the involvement of diverse stakeholder groups is a good way to ensure that well-integrated proposals are developed to deal with the complete set of problems that exist in the watershed.

There are several ways in which stakeholders can work together in developing a watershed restoration project. One way is for the different groups to form an umbrella organization to which all contribute their separate expertise. Either a lead proponent or a coordinating group would then develop and submit a single proposal to the WRP on behalf of all. Frequently the forest tenure holder, who is able to satisfy the planning and forest management provisions of the Forest Practices Code, will act as the lead proponent in planning and managing the project for the group of partners. The different groups may be jointly or separately involved in implementing the various aspects of the joint proposal.

Because funding for restoration projects takes the form of a contract between the proponent and either MoELP or MoF, there needs to be a

clearly identifiable, legally responsible lead agency or individual who takes responsibility for the contractual agreement. Cooperating stakeholders may wish to consider forming a legally registered society or company to provide the administrative framework to sign contracts and conduct business without risking personal liability for the contracted work. Alternatively, a suitable lead proponent (e.g., the forest tenure holder) could administer the contract, with the other partners as subcontractors who are responsible for portions of the overall project.

Alternatively, cooperating stakeholder groups could each submit separate proposals for specific components of the overall plan for the watershed. If this is done, you will need to link the separate proposals so that the ministry staff who evaluate the projects are aware that the separate proposals form part of an integrated project rather than simply a collection of uncoordinated or unrelated projects.

Assessing the Need for Restoration Activities

The nature and quality of the available information about the status of forest resources in the watershed determine the next step in project development. Before you can identify and rank restoration objectives, or develop and schedule useful restoration prescriptions, you must identify all significant, potentially treatable logging-derived resource impacts in the watershed. The condition assessment procedures that are described in WRP Technical Circulars No. 2-9 provide objective methods to characterize the state of the watershed and to diagnose opportunities for the effective restoration of logging-degraded environmental resources.

Impacts of Forest Harvest on Aquatic Resources

In order to assess the need for restoration, you must have a basic understanding of the impacts of poor forest harvest practices on biophysical resources. Numerous studies document the impacts of forest harvest activities on fishery and other aquatic resources. Good recent summaries include:

- Hartman, G.F. and J.C. Scrivener. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Canadian Bulletin of Fisheries and Aquatic Sciences 223, Ottawa, Ontario.

- Koski, K.V. 1992. Restoring stream habitats affected by logging activities. pp. 343-403 *In* G.W. Thayer [ed.] Restoring the nation's marine environment. Maryland Sea Grant College, University of Maryland, College Park.

- Meehan, W.R. 1991. [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Bethesda, Maryland.

- Slaney, P.A. 1995. The Watershed Restoration Program of British Columbia: an opportunity and a challenge. pp. 117-133 *In* W.T. Dushenko, H.E. Poll and K. Johnston [eds.] Environmental impact assessment and remediation: towards 2000. Canadian Society of Environmental Biologists, Toronto.

The adverse impacts of forest harvest practices on fishery and aquatic resources arise primarily through:

- ***increases in the rate of sediment generation and delivery to the stream network***, which reduces the productivity of the aquatic ecosystem through deleterious changes to the physical structure of the stream channel as well as through direct physiological effects on the biota. Fine sediment, which often originates from road running surfaces, is particularly damaging. In coastal B.C., mass wasting in logged areas or from poorly sited or poorly maintained road networks is also a common sediment source. In interior B.C., surface erosion after the exposure of fine-textured mineral soils is an important sediment source. The interception and concentration of natural drainage by road networks often exacerbates the erosion and delivery of fine sediments to the stream channel. The geomorphic impacts of increased sediment delivery to the stream channel depends on the ability of the channel to transport and store the material. Where sediment sources are directly connected to the stream channel, large changes to stream channel structure may occur.

- ***altered patterns of discharge,*** from changes to the hydrologic regime (altered patterns of rainfall interception and storage, snowmelt, or evapo-transpiration following tree removal) and from flow concentration by road networks, which alter the timing and amounts of water delivered to the stream channel.

- ***removal of the natural riparian vegetation and its replacement by vegetation with very different stand characteristics, both of which may impair the functional role of the riparian zone in establishing physical and biological conditions within the stream ecosystem.*** Ecological functions of the riparian vegetation that may be affected include:
  - the regulation of stream temperature by controlling the direct input of solar insolation,
  - the regulation of instream primary production by controlling the amount and quality of photosynthetically active radiation reaching the stream,
  - the regulation of instream biological production by determining the inputs of allochthonous organic carbon (leaves, detritus, terrestrial insects, large woody debris, dissolved organic carbon) to the channel,

- partial control of the physical structure of the stream channel by determining the input and characteristics of large woody debris that acts as roughness elements to control sediment storage and transport as well as cover and local flow characteristics which determine the amounts and quality of fish habitat,
- the maintenance of bank stability,
- determining microclimate along the stream,
- buffering the stream from contaminants or pollutants by intercepting surface flow and altering subsurface flow.

The characteristics of the riparian vegetation strongly influence the diversity and productivity of the aquatic biota. Changes from the typical seral stages for the site often alter the ecological functioning of the riparian zone in ways that produce undesirable changes to the composition and abundance of the pre-logging fauna, e.g., by decreasing the abundance of economically valuable salmonid fishes. Changes to riparian function such as decreased LWD generation may take 40-50 years post-harvest to be fully expressed (Scrivener and Brown 1993) and 75-150 years subsequently to recover (Koski 1992).

You should consult the references (above) and experienced professionals for further information on the adverse impacts of forest harvest on aquatic resources. Note that mass wasting or extensive surface erosion may also reduce timber production on the upland areas and impair other forest resource values that are not considered here.

Condition Assessment Procedures

Planning a program of watershed restoration activities in an area of past harvesting is a complex task that can be made more manageable by dividing the task into discrete subcomponents. The WRP condition assessments subdivide the task into components for roads, gullies, site rehabilitation, riparian areas, stream channels, and fish habitat.

The condition assessments are simply tools to identify effective restoration prescriptions that will benefit logging-impacted forest resources in the watershed. If you have little information about the potential for successful resource restoration in the watershed, you would conduct an overview watershed assessment (such as a level 1 CWAP or IWAP, see Appendix B) to identify the general nature and locations of the cumulative impacts of forest harvest activities in the watershed. You would then do overview field ("level 1") assessments of components such as roads or fish habitat to confirm the nature and specific locations of logging impacts. In some cases, the level 1 field assessments provide sufficient information to define project priorities and to plan restoration projects. Where necessary, you would conduct more detailed, site-specific ("level 2") assessments to provide the detailed information needed to plan appropriate restoration

prescriptions. Coordinate the various assessment procedures to maximize the information that is collected from field surveys, especially where access to the watershed is difficult or where a seasonal work window is of short duration. Aim to complete both the level 1 assessments and any necessary level 2 assessments in the same field season.

You should normally use the assessment procedures from Technical Circulars No. 2-9, although there are other procedures available. The reasons for using a common set of procedures are to ensure that all proponents use accurate diagnostic procedures, that proponents collect survey information in a manner that is appropriate for subsequent analyses, and that (costly) survey information is compatible with provincial data standards; all work funded by Forest Renewal BC must be done using methods approved by the provincial Resource Inventory Committee. Proponents should note that some interim procedures described in WRP Technical Circulars No. 2-9 are gradually being replaced by corresponding Forest Practices Code guidebooks. You should contact the WRP coordinator in your district or regional MoELP or MoF office to ensure that you are using the most recent update of the relevant procedure.

Where recent aerial photography exists at a suitable scale (about 1:15,000 or larger), air photo interpretation can efficiently provide supplementary overview information to identify and prioritize potential problems with roads, terrain stability, erosion and site degradation, riparian buffers and stream channels. Use air photos that are less than two years old, and complement the analysis by direct observations to ensure that more recent problems are not ignored. In some cases (e.g., where access to the watershed is very costly), it may be cost-effective to take new aerial photographs. Compare the costs of obtaining equivalent information from field surveys before undertaking aerial photography. Photos of the stream channel and riparian areas need to be about 1:5,000 to be useful for quantitative assessments, but you can photograph upslope areas at smaller scales (1:15,000). Other aerial imagery (conventional video, digital video) may usefully provide non-quantitative overview information.

Where up-to-date resource information is readily available in digital formats suitable for analyses using Geographic Information Systems (GIS), overview summaries in the form of map overlays are an acceptable alternative to the tabular diagnoses specified in the interim condition assessment procedures. Use 1:20,000 terrain resources information management digital topographical maps (TRIM maps) as base maps for GIS analyses. Consult with WRP staff regarding the use of and suitable formats for GIS.

The output from overview and level 1 field assessments should be a set of planning priorities, restoration strategies, initial project objectives and specific recommendations for necessary level 2 assessments. In some cases, the level 1 field assessments may also allow you to develop detailed

restoration plans. The output from level 2 assessments should be detailed site-specific restoration prescriptions. Level 2 assessments also produce new resource inventory information that proponents or contractors may be required to supply in specified formats.

Information Sources for an Overview Assessment

You will generally want an overview of the cumulative impacts of forest harvest on natural resources in the watershed. The results of the overview will define planning priorities, restoration strategies and any need for more detailed assessments prior to identifying effective restoration prescriptions. You should start by assembling and summarizing the information that is currently available on the state of forest resources in the watershed.

There are numerous potential sources of current resource information, including:

maps:

- National Topographic Series (NTS) or BC Geographic System (BCGS) topographical maps
- terrain resources information management digital topographical maps (TRIM maps)
- soil maps
- terrain stability maps
- forest cover maps
- access management plan maps
- forest district tenure maps
- aquatic biophysical inventory maps

aerial photographs:

- current aerial photographs
- historic aerial photographs

planning documents:

- forest development plans
- access management plans
- land use planning documents

inventory summaries (fish):

- stream information summary system (SISS)
- fisheries information summary system (FISS)
- DFO salmon escapement database system (SEDS)
- aquatic biophysical inventory maps

reports:

- MoELP/MoF/DFO specialist reports and studies
- Water Survey of Canada streamflow records

Appendix C gives sources for some of these materials. Often the forest tenure holder(s) will have much of the available resource information. Also consult your district Ministry of Forest staff and your regional BC Fisheries Branch staff for unpublished information on forest or fisheries resources.

Step 1 - Planning Project Objectives

Watershed, Component, and Site Level Project Planning

Watershed restoration project planning encompasses a nested hierarchy of objectives and the activities to achieve these objectives, which become successively more specific and detailed as you proceed from the watershed level to the site level. The planning process identifies goals, and proposes and prioritizes a linked series of subordinate objectives and actions to attain the higher order objective. A watershed restoration plan normally comprises several component projects dealing with roads, hillslopes and gullies, riparian areas, stream channels, and fish habitat and fish. Each of the component projects will have numerous site-specific projects that vary in nature and specific objectives while conforming to the overall objectives of the larger project of which they are a part.

Watershed level planning identifies and prioritizes the general objectives for the entire set of activities that are undertaken, and suggests the most appropriate strategy for attaining these broad objectives. These general objectives derive from diagnoses of the nature and causes of forest harvest impacts on resources in the watershed, based on overview level assessments, and from the desired future conditions for the watershed. For example, the results of a CWAP and level 1 field assessments might suggest that fine sediments transported to the stream channel from improperly ditched upslope logging roads has reduced the quality of limited spawning gravel and overwintering pools used by bull trout, whose abundance has decreased following forest harvest. At the watershed level, one possible restoration objective might be "to restore the production of bull trout to their pre-logging levels", with sub-objectives "to improve the quantity and quality of spawning gravel" and "to increase the number of deep, overwintering pools". Another watershed level objective might be "to restore natural drainage".

Component project planning identifies and prioritizes a more specific set of objectives and activities that will achieve a watershed level objective. Component objectives and tasks are generally organized into major themes that relate to a physical process whose rate has been altered by forest harvest practices. The set of WRP Technical Circulars suggests a set of components about which you can organize restoration activities:

- roads,
- hillslope and site rehabilitation,
- gullies,
- riparian areas,
- stream channels,
- fish habitat and fish.

Road, hillslope and gully components usually treat increased rates of sediment delivery to the stream network, while riparian, stream channel and fish habitat components treat altered channel structuring processes or biological productivity in the aquatic ecosystem.

The condition assessments guide the component planning by indicating the processes that cause the current conditions, which knowledge suggests possible component objectives and corrective actions to attain the watershed scale objective. The realization of a single watershed level objective may involve several subordinate objectives at the component level. For example, the objective "to restore the production of bull trout to their pre-logging levels by (a) improving the quality of spawning gravel and (b) increasing the number of deep overwintering pools" may require road, hillslope and fish habitat subprojects with subordinate objectives of "reducing the generation of fine sediments from road running surfaces and ditches", "reducing the direct delivery of sediment to the stream channel", and "introducing large woody debris to the stream channel to scour deep pools and trap coarse gravel", respectively.

The objectives of each component project must be directly related to one of the higher order (i.e., watershed level) restoration objectives. The component project objectives define the steps needed to achieve the watershed level objective.

Similarly, the implementation of each of the component objectives normally requires a set of *site-specific objectives* and actions that you should explicitly identify in planning the overall project. For example, the road component objective of "reducing the generation of fine sediments from road running surfaces and ditches" may have a series of sub-objectives such as "deactivate abandoned roads to reduce the amount of running surface", "reconstruct road segments to reduce surface erosion", "reditch and seed to reduce surface erosion", etc., each of which may require different work to be done at many specific locations in the watershed. The prescriptions for site works must identify a specific objective to be met at the site as well as the methods and standards to achieve the objective. For example, the objective to "reconstruct road segments" may specify that: ditches be cleaned and seeded between km 10.4 and 11.5 of the R104 branch road; that larger cross-drain culverts be installed at km 11.8, 18.9 and 25.3; that the road running surface be crowned between km 5.2 and

6.0, etc. Implementing these prescriptions requires that you specify a further series of lower level objectives and actions for each site. Other components would require that similar series of site-specific objectives be specified.

In this example the hierarchy of objectives and actions would be:

watershed level objective #1*: to restore the production of bull trout to their pre-logging levels by:*

(a) improving the quality of spawning gravel, and
(b) increasing the number of deep overwintering pools

road component objective #1.1**:** *to reduce the generation of fine sediments from road running surfaces and ditches*

sub-objective #1.1.1**:** *reconstruct road segments to reduce surface erosion*

site objective #1.1.1.1: *crown the road running surface between km 5.2 and 6.0 along the R104 branch road*

site objective #1.1.1.2: *install larger cross drain culverts at km 11.8, 18.9 and 25.3 along R104*

sub-objective #1.1.2**:** *re-establish natural drainage patterns to reduce erosion of the road running surface*

site objective #1.1.2.1: *clean and re-seed ditches between km 10.4 and 11.5 along the R104 branch road*

stream component objective #1.1**:** *to increase the amount of high-quality spawning gravel*

sub-objective #1.1.1**:** *introduce stable, LWD elements to trap coarse gravel between stream kilometres 8.4 and 13.6*

site objective #1.1.1.1: *place log v-weirs in long riffles at stream kilometre 9.10, 9.15, and 9.20*

stream component objective #1.2**:** *to increase the number of deep pools with cover in stream areas used by bull trout for overwintering*

sub-objective #1.2.1**:** *introduce stable, LWD complexes in overwintering areas to scour deep pools*

site objective #1.2.1.1: *anchor 1m-diameter rootwads on meander bend at stream kilometre 5.2*

Specifying a hierarchical series of objectives and actions may seem onerous and unnecessary: the higher level objectives of site prescriptions often appear obvious. It may seem simpler to identify the need for a site-specific corrective action such as "install a larger cross-drain culvert at km 11.8" and to implement it. However, organizing your goals into a hierarchical sequence serves several useful purposes:

- it ensures that all the work that is undertaken is consistent with and directed towards the highest priority objectives for the watershed,
- it clarifies the linkages between different component activities, thus facilitating the coordination and scheduling of component projects, and
- it provides definite measures of performance that can be used to track the progress of the projects.

The individual Technical Circulars provide more information on planning projects for particular components such as roads or fish habitat.

Identifying Planning Priorities

Sequentially consider the following factors to establish planning priorities for restoration projects:

- the risk to the environment or public safety posed by the problem,
- the potential for benefits to fisheries and forest resources from the restoration activity,
- the prior activities required for successful restoration.

Table 1 gives suggested criteria to establish initial planning priorities for restoration projects; the various assessment procedures also provide criteria that are applicable to specific components (e.g., Moore 1994). Assign the highest priority to component projects that remove significant immediate risks to public safety or health within the Crown provincial forest, where these risks are the direct result of past logging practices. Also give a high priority to projects that remove significant future risks to public safety.

Risk assessment includes both the magnitude of adverse impacts and the likelihood of their occurrence. In assessing risks to public safety, consider methods other than restoration for managing the risk, (e.g., by restricting access). Note that not all risks to public safety are eligible for WRP funding. Numerous other agencies and programs have specific responsibilities for public safety (e.g., dyking for flood protection), and should be consulted when the perceived risks lie within their mandates.

Table 1. Suggested criteria to establish overview priorities for watershed restoration projects (consult WRP staff).

Priority	Criteria
Higher	Present conditions pose a significant risk to: • human safety or health (see note below).
	Conditions in the near future will pose a significant risk to: • human safety or health. (see note below).
	Present conditions pose a significant risk to: • unimpaired natural resources with significant economic value to local communities (e.g., high fishery or timber values), • community water supplies, • domestic dwellings, industrial development, public utilities, etc. (see note below)
	Present conditions pose a significant risk to: • sensitive natural resources (threatened or endangered species), • areas of high public interest or concern, • moderately to heavily licensed domestic water use.
	Planned restoration activities have a high potential for significant benefit to natural resources with a high economic value to local communities.
	Planned restoration activities have a high potential for significant benefit to natural resources of special significance (rare, endangered, or of public concern).
	Planned restoration activities have moderate potential for significant benefit to locally or regionally important natural resources.
	Project success does not depend on the prior successful restoration of other forest or aquatic resources.
Lower	Project success depends on the prior successful restoration of other forest or aquatic resources.

Note: *Ensure that such projects do not duplicate the functions of existing programs to protect public safety or property, that the risk lies within the Crown provincial forest, and that the risk arises from past logging practices.*

The relative importance of the other criteria (Table 1) depends on trade-offs between risks and benefits that must be assessed on a case-by-case basis to establish priorities for restoration activities in the watershed. In general, actions that will maintain or improve important forest or aquatic resources should receive a high priority. The original value of a resource and its present rate of deterioration are important factors in deciding whether its restoration warrants a higher or lower priority. The likelihood of success is also an important factor in establishing priorities; problems that can be corrected by well established methods receive a higher priority. Note that some types of restoration projects may require the prior or simultaneous restoration of other resources in order to be successful. In general, you will

need to remedy upslope problems (roads, gullies, landslides, erosion) that deliver sediment to the stream network before stream channel restoration will be successful, although you may need to simultaneously undertake fish habitat restoration or enhancement to maintain fishery values until the habitat fully recovers. Finally, consider the estimated benefits and costs of the work.

You will modify this initial set of planning priorities as more information accumulates throughout the assessment phase of project development.

Identifying Restoration Strategies

Identify an appropriate "restoration" strategy for high-priority resource problems. There are several strategies available:

- **Strategy 1: Restoration**

Restore the resource to its original state or to a successional state that will more quickly return to the original state than would the current state. It is an appropriate strategy when logging impacts are limited. Restoration presupposes that the original state of the resource is the desired future condition. It also assumes that the end-point state is well-defined, that the task is technically feasible, that the appropriate resources are available, and that the expected benefits justify the cost. In many cases restoration will be impossible or impractical. Information on the original state of the watershed can come from pre-harvest inventories and air photos, from comparisons with nearby unperturbed watersheds that are topographically similar to the target watershed, or from established standards.

- **Strategy 2: Rehabilitation**

Rehabilitation is the most useful strategy for many biological resources, where the altered physical habitat conditions necessary for ecosystem restoration may be attainable only after unacceptably long times. Rehabilitation usually focuses on economically valuable species, but may also produce more favourable conditions for many non-target species. Thus, it may restore ecosystem function rather than form. Because of its more limited scope, rehabilitation is usually technically simpler and less costly than restoration.

- **Strategy 3: Mitigation**

Mitigation may be a useful strategy where opportunities for the direct restoration or rehabilitation of an impaired biological resource in a damaged watershed are technically limited, excessively costly, or likely to be ineffectual, but opportunities for significant benefits to the impaired resource or similar resources exist elsewhere nearby.

- **Strategy 4: Do nothing**

To do nothing may be the best strategy if the resource is little damaged and likely will recover quickly without intervention, or where the resource is so badly damaged that either no effective intervention is possible or nothing can be done at an acceptable monetary or environmental cost and no opportunities for mitigation exist within the target watershed.

Figure 3 gives a flowchart to identify an appropriate restoration strategy. When evaluating the "feasibility" of a strategy, consider:

- *technical feasibility* - are there established methods to achieve the strategic goal which are applicable in this case? are the necessary technical resources available?
- *benefits and costs* - will the action significantly benefit the resource? are the costs acceptable, given the likely benefits? would another strategy impose much lower costs for similar benefits?
- *risk* - is there significant risk of failure, or uncertainty about results?
- *management implications* - how does the strategy affect other resource users? does the strategy meet regional resource management priorities?

Defining Project Scope and Objectives

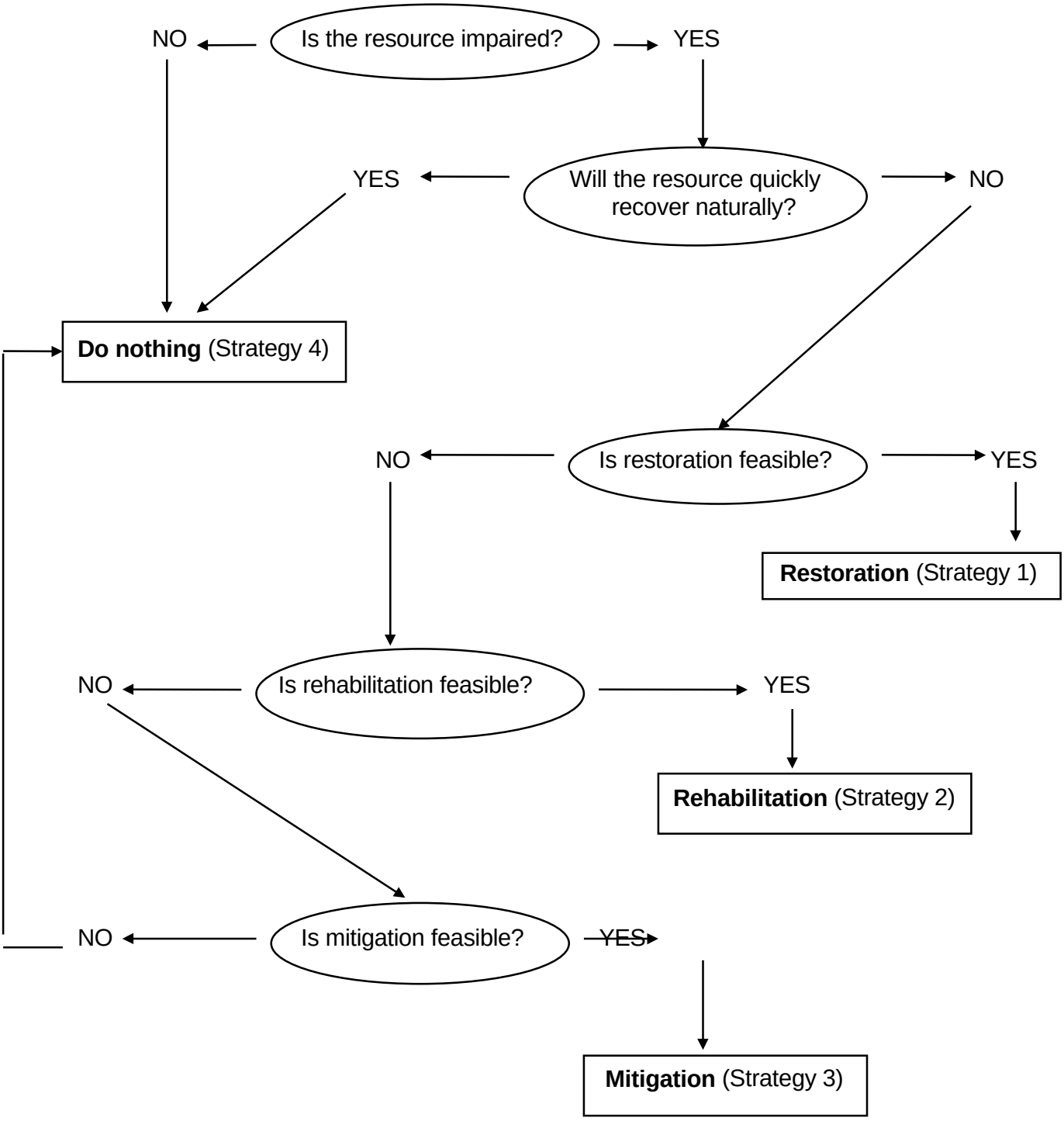
You should clearly define the project scope and frame a clear statement of project objectives before proceeding to level 2 field assessments and the development of detailed restoration plans. This is important information to the personnel who conduct the detailed assessments because it focuses their efforts on particular issues and guides their selection of appropriate restoration prescriptions (Moore 1994). Explicit statements of project scope and objectives help ensure that project activities are consistent with higher order project objectives. Formal statements of project scope and objectives also help to clarify the relationships between component projects, and thus facilitate their integration into the overall plan for the watershed.

Project scope defines what is encompassed by the project. It includes:

- the topics and activities to be considered (or excluded),
- the spatial bounds of the project,
- the time frame for the project, and
- its links to other project components.

You should specify as clearly as possible what is and what is not part of the project. For example, a level 2 fish habitat assessment might only consider anadromous salmonids, or be restricted to mainstem stream reaches whose

Figure 3. Flowchart for Identifying an Appropriate Restoration Strategy



average gradient is less than 10%, or to the time period between 15 July and 30 August. A level 2 road assessment might state that "silvicultural site treatments are not part of the field work" or "prescriptions for gullies and landslide tracks are included in the scope of the field work" (Moore 1994).

A statement of project objectives should include:

- the concerns that initiated the project. For example: road related slope stability problems; or, non-vegetated riparian buffer zones; or, infilling of salmon spawning gravel with fine sediments.
- the intent (goals) of the project, and
- its relationship to the overall goals of the restoration plan for the watershed.

State the project scope and project objectives as precisely as possible. As more detailed information becomes available from the condition assessments, refine the statements of project scope and objectives, moving progressively from the general (e.g., "to reduce the risk of slope failures and surface soil erosion that could have an impact on high value fisheries", Moore 1994) to the specific (e.g., "to pull back oversteepened fill slopes between km 10.5 and 11.2 on the R104 road, re-contour the slope to its angle of repose and hydro-seed the slope, to reduce the risk of slope failures that would directly enter Fish Creek near known spawning sites").

Access Management

Access management is a critical part of overall project planning. Failure to maintain adequate access for workers and equipment will preclude many types of restoration activities in affected areas of the watershed. In order to plan access requirements, you must identify the complete set of activities and locations where restoration projects will occur, and the duration over which access to specific areas must be maintained. Moore (1994) discusses the identification of access needs. Include any requirements for recreational access. Once you have identified your access needs, consult with district MoF engineering staff. Compare your needs with the MoF Access Management Plan for the watershed, if one exists. You should also discuss your access requirements with licensees who maintain roads in the watershed. If your needs are not incorporated into the formal Access Management Plan, you may be unable to undertake some restoration projects.

Step 2 - Conducting Field Assessments

The condition assessment procedures that have been developed for the WRP provide standard methods to acquire and interpret the information

needed to identify opportunities for effective restoration treatments. Refer to Appendix B for a list of the available procedures. The individual Technical Circulars give detailed descriptions of the procedures.

There are two levels of WRP field assessment:

- **level 1 field assessment:** A level 1 assessment is an overview field examination of the status of a particular component, designed to indicate the nature and locations of impacts on that component, to suggest preliminary prescriptions, and to identify any needs for more detailed, site-specific information. In some cases, the level 1 field assessment is sufficient to plan detailed restoration prescriptions.

- **level 2 field assessment:** A level 2 assessment is a more detailed field examination to permit the detailed prescription of appropriate corrective treatments.

Normally you would start a formal analysis of the need for restoration treatments by conducting a level 1 watershed assessment, using either the Forest Practice Code's coastal watershed assessment procedure (CWAP) or the interior watershed assessment procedure (IWAP). The WAP provides an objective, repeatable, quantifiable procedure for characterizing the state of six key watershed variables: mass wasting, surface erosion, headwater hydrology, stream flows, riparian areas, and stream channel conditions. The level 1 WAP identifies the general nature and magnitude of cumulative impacts of forest harvest on aquatic resources. It will indicate areas of concern that may be dealt with through restoration projects.

If you do not complete a WAP, you should review existing file data to summarize information similarly to a WAP.

If additional information is needed to complete Step 1 of the planning process, you would proceed to a level 1 field assessment for those components where you require more information. After your initial identification and ranking of overall project objectives, you would conduct level 2 assessments for components where further information is needed to develop restoration prescriptions.

Level 1 Field Assessments

The activities carried out in a level 1 field assessment depend on what information you need to complete Step 1 tasks for those components where the WAP has indicated significant cumulative impacts. The level 1 field assessments have several important functions:

- to identify or verify the nature, extent and severity of impacts of past forest harvest on particular forest resources,

- to provide sufficient information to identify and prioritize initial project scope, objectives, and restoration strategies,
- to suggest restoration options,
- to identify specific needs for level 2 assessments, and
- to prepare initial budgets and schedules for restoration projects.

Most WRP level 1 procedures involve a combination of aerial imagery analysis, aerial reconnaissance and limited, semi-quantitative field inspections to confirm the nature and locations of impacts. Ensure that the various inspections coordinate field work and exchange relevant survey information. Where possible, you should combine the field inspections for several components.

Use the field data sheets or inspection forms from the appropriate assessment procedure to ensure that you collect sufficient information to document problems; refer to the Technical Circulars.

Level 2 Field Assessments

The level 1 field assessments often provide sufficient information to prepare restoration prescriptions. You will conduct level 2 field assessments where you require additional site-specific information to prepare detailed restoration prescriptions.

The main functions of level 2 assessments are:

- to provide the detailed site information needed to confirm initial restoration options and priorities, and
- to prepare appropriate restoration prescriptions.

Level 2 field assessments often require detailed on-site inspections and measurements, but are usually limited in scope. To increase the utility of level 2 field assessments, you should:

- review initial statements of project scope and objectives to direct the field assessments to high priority sites,
- schedule the field inspections to maximize your ability to obtain the information needed to propose useful corrective treatments,
- ensure that those doing the assessments have the training, experience and a sufficient understanding of the project scope and objectives to accurately document and correctly interpret present conditions and to recommend suitable prescriptions for restoration.

Refer to the Technical Circulars for descriptions of level 2 assessment procedures.

You will use the level 2 field assessment data to revise the initial statements of project scope, objectives and priorities. Use the general criteria in Table 1 and specific criteria from the various assessment procedures to establish revised planning priorities. You will use these priorities later to schedule projects.

The prescription phase of project planning involves identifying and evaluating particular problems, and determining a "best" course of action to address them (Moore 1994). Recommended prescriptions must be consistent with the higher level objectives of the restoration project and with regional management plans for the area. Generally the Technical Circulars will suggest recommended methods for standard problems. You should discuss novel restoration methods with district WRP staff and with appropriate regional WRP technical experts before prescribing them.

Refer to the various Technical Circulars for appropriate formats to prepare and present restoration prescriptions. Establishing suitable restoration prescriptions involves both formal analyses and professional judgement, and is often best done on-site. Try to write clear and detailed prescriptions that can be used as technical specifications for the on-site work. Clear, detailed prescriptions also facilitate accurate budget estimates for your funding submissions. Photographs, sketches and drawings are useful aids to formulating clear prescriptions. Try to avoid costly engineering drawings unless they are essential.

It is important to locate work sites accurately. If possible, use Global Positioning Systems to obtain UTM coordinates for the site. Record the distance to the site from some well defined location (e.g., along a road) and accurately indicate the site on large scale maps (e.g., 1:5,000 or 1:20,000 as appropriate). You may want to lay out the work site with flagging tape, painted marks, or boundary stakes at the same time that you develop the prescription. Having an accurate location will be important for post-implementation monitoring when the problem that initiated the restoration work may no longer be visible to mark the site.

Make sure that your prescriptions conform to current standards for the activities (e.g., with Forest Practices Code regulations).

Who Should Do the Assessments?

Overview assessment procedures such as the (FPC) level 1 Coastal Watershed Assessment or the various WRP level 1 field assessments are designed to be done by experienced technicians. Level 2 procedures generally can be completed by experienced technicians working, if necessary, under the supervision of a licensed professional.

The assessment procedures are not a substitute for training and experience: consult specialists for particularly complex situations. Any assessment that involves public safety must be done by an experienced licensed professional with the appropriate background. Some geotechnical assessments must, by regulation, be done by members of certain professional bodies (registered professional engineers or geoscientists).

Step 3 - Preparing Reports and Restoration Plans

Refer to the Technical Circulars for suggested reporting formats for the various condition assessment procedures. Use the following outlines as a guide to reporting requirements. Note that, beginning in 1996, proponents may be asked to provide summary assessment data in specified electronic file formats; consult regional WRP staff to obtain a template for any required information. After the publication of the FPC WAP guidebooks (July 1995), you may be asked to provide WAP summaries in the electronic format specified on the diskette that is available for automating the WAP computations.

As much as possible, integrate the results of the various component assessments into a single report that indicates clearly the links among the component projects. For example, to derive effective prescriptions for fish habitat restoration from the fish habitat assessment procedure may require information on the risk of upslope impacts on the stream channel that was obtained as part of the road and gully assessments.

Overview Assessment Report

The overview assessment report should summarize basic information about the location, physical characteristics, resource values and perceived problems in the watershed. Overview summaries in the form of GIS map overlays (Arc/Info format) are suitable for reporting distribution data. Existing file information may provide much of the data for the overview report. If a WAP has not been done, use file data and limited air photo interpretation to provide information similar to that from a WAP. Where level 1 field assessments are done to complete Step 1 of the planning process, combine the results from the field assessments in one report with the overview information.

The text of the report should describe the methods and sources used to complete the assessment, summarize the results, provide conclusions drawn from the data, and make recommendations for level 1 or level 2 field assessments or other work. Any data or analyses necessary to support the conclusions and recommendations should be presented as appendices to the report.

Watershed location and tenure information should include:

- gazetteered name of the watershed, plus any local names
- NTS 1:50,000 or BCGS 1:20,000 map sheets for the watershed (specify map source); include a 1:50,000 map showing the watershed boundaries as an appendix to the report
- hierarchical watershed code (obtained from MoELP regional staff)
- UTM of stream mouth (using NAD 1983 geo-referencing standard)
- stream order at 1:50,000 NTS map scale
- named sub-basins (tributaries)
- MoF region and district
- nearest community, distance (km) and type of access
- licensee(s) and other significant stakeholders
- forest tenure (TFL, etc.)
- C.O.R.E. area designation
- percent private lands.

Try to include the following physical characteristic information:

- ecoregion
- biogeoclimatic zone(s) and subzones
- bedrock geology classification (see IWAP appendix M)
- dominant soil groups
- hydrological zone
- watershed area (ha)
- valley flat area (ha), where valley flat has a gradient less than 7% and is adjacent to the stream network (from 1:50,000 NTS maps)
- steepland area (ha), where steepland has a gradient greater than 60%
- mean annual discharge ($m^3 \bullet s^{-1}$), if known, and gauging station reference
- mean bankfull channel width (m) at the stream mouth
- locations and areas (ha) of lakes or impoundments along the stream
- mean daily July air temperature (°C).

Where available, give the following information on forest and aquatic resources:

- percent watershed logged and logging history (approximate dates of logging, harvest methods and reforestation)
- percent valley flat logged
- percent unstable terrain or slopes with gradients greater than 60% logged
- FPC fish stream classifications or distribution of salmon and sportfish
- historic trends in abundance and distribution of salmon or sportfish

- occurrence of rare, threatened, endangered or regionally significant fish or wildlife
- water use (community watershed, domestic water supply) and historic trends in water quality
- other (non-forestry) industrial uses of the watershed
- recreational use
- special public concerns
- non-WRP resource rehabilitation work
- ongoing resource monitoring programs.

If you have done a level 1 CWAP or IWAP, then the overview assessment of cumulative impacts should include:

- the "watershed report card" and recommendations from the WAP
- forms 1-9 from the WAP (as appendices)
- the perceived impacts of forest harvest on fish and fish habitat, and supporting data
- perceived impacts on forest site productivity and supporting data
- perceived impacts on water quality and supporting data.

Where the overview assessment is derived from GIS, the supporting data for perceived impacts can be map overlays showing the locations of direct impacts such as landslides, surface erosion, altered stream channel morphology, or degraded fish habitat and the initial priorities for restoration.

If you have not completed a level 1 WAP, your overview assessment should attempt to provide information similar to a WAP. Air photo interpretation (1:15,000 scale or larger) is often an efficient source for overview-level information, although driving the road network may allow you to obtain equivalent overview information in some cases. Try to obtain the following information, by sub-basin if appropriate:

roads:

- road density ($km \cdot ha^{-1}$), by type (mainline, branch, spur, logging trail) if possible
- road density ($km \cdot ha^{-1}$) on unstable slopes or erodible soils
- number and area (ha) of landslides originating from roads
- number of landslides, originating from roads, that directly enter the stream channel
- mainline road density ($km \cdot ha^{-1}$) within 100 m of a stream
- density of crossings ($number \cdot km^{-1}$ of stream) on headwater streams

hillslopes and gullies:

- number and area (ha) of open slope landslides that originate on clearcuts

- number of open slope landslides that originate on clearcuts and reach stream channels
- area (ha) of exposed mineral soil on open slopes (excluding landslides)
- number and area (ha) of landslides that originate in gullies
- number of landslides that originate in gullies and reach stream channels

floodplain and riparian area:

- proportion ($ha \bullet ha^{-1}$) of floodplain logged
- proportion of floodplain that is not satisfactorily restocked (NSR)
- proportion ($km \bullet km^{-1}$) of riparian length logged on at least one bank, by FPC stream class
- proportion of logged riparian length that is NSR

stream channels:

- length of stream (km) with actively eroding bank
- length of stream (km) with multiple channels
- length of stream (km) with elevated mid-channel bars
- number of log jams per length of stream ($number \bullet km^{-1}$)
- proportion of large woody debris (LWD) pieces oriented parallel to the channel banks
- proportion of channel in riffles ($km \bullet km^{-1}$), by stream reach

fish habitat and fish:

- the fish species assemblage for the watershed,
- FPC fish stream classifications
- potential barriers to fish migration (juveniles and adults)
- LWD pieces per length of stream ($number \bullet km^{-1}$), by stream reach
- pool frequency (number of $pools \bullet bankfull\ channel\ width^{-1}$) in low gradient (stream gradient less than 2%) reaches
- percent canopy closure, by stream reach
- occurrence of off-channel habitat (sidechannels, ponds, oxbows).

The overview assessment report should also provide a large scale (1:50,000) map showing the topography of the watershed and, where possible:

- the road network,
- areas of unstable terrain or erodible soils,
- logged riparian areas,
- fish stream classifications,
- areas of impacted stream channel.

Level 1 Field Assessment Report

The level 1 field assessment report should provide the outlines of an integrated restoration plan for the watershed. It should verify the nature, locations and severity of impacts to particular forest resources, recommend restoration strategies, identify project objectives and project scope, and give initial priorities for restoration work. The focus of the report is not only to identify the type and locations of impacts but also to provide an accurate evaluation of the opportunities for restoration activities.

The Technical Circulars that describe the level 1 field assessment procedures specify the information that you should report. Integrate the results of the separate assessment procedures into a single report for the watershed, although it may be convenient to retain the different assessments as separate sections.

The text of the report should describe the methods used in the field assessments, the areas examined, and the results of the assessments. Map overlays are particularly useful in identifying areas of the watershed where impacts are evident. The level 1 report should suggest restoration strategies and should provide an initial classification of impacts as low, medium or high priorities for restoration (using the criteria of Table 1). Tabulate significant problems, identify project objectives and preferred restoration strategies, and provide work sequence priorities by area (e.g., by sub-basin). Try to provide preliminary estimates of time and costs, based on the restoration strategies and priorities that you have identified. Make specific recommendations for level 2 assessments. Provide the data (field notes, data forms, maps) and analyses to support your interpretations as appendices to the report.

The level 1 field assessment report develops initial statements of project scope and objectives for the components of the integrated watershed-level restoration plan. The major elements of the plan and likely approaches to restoration derive from the level 1 field assessment results. In some cases, level 2 assessment results will be needed to flesh out the initial plan into specific prescriptions and implementation schedules, but the level 1 assessments define the problem. In some cases, a level 1 field assessment may provide sufficient information to proceed with restoration prescriptions.

Level 2 Field Assessment Reports

The level 2 field assessment reports should summarize and evaluate the site-specific technical data collected by the field surveys, to identify and prioritize effective restoration prescriptions.

The Technical Circulars define the specific reporting requirements for the different level 2 field assessments. At a minimum, the text of the report should describe the objectives of the field assessments, the areas examined, the methods used, the results of the assessments, and the recommended actions. Be precise about objectives, locations and methods. Use overlays to map necessary restoration activities by priority class. Provide the data (field notes, data forms, maps) and analyses to support your interpretations as appendices to the report.

The overview and level 1 field assessments provide initial statements of project objectives and scope that level 2 assessments confirm and refine. Use the results of the level 2 assessments to clarify the objectives and scope of restoration activities at specific locations. Describe the purpose of any proposed restoration work and the specific concerns to be addressed at each site. Review the priority of the work using the criteria in Table 1. Using the WRP Technical Circulars or other appropriate technical standards, identify and recommend effective restoration prescriptions to attain the desired site objectives.

Where several corrective actions are possible, provide a rationale for the recommended prescription. You must ensure that the recommended prescriptions are consistent with the objectives of the restoration project and with regional management objectives. Predict the likely resource benefits of the work, using published biostandards or other standard estimates. Identify any constraints, such as a requirement for antecedent work, that may influence the effectiveness of prescriptions. Identify any likely impacts on non-target resources. Provide a cost estimate for the work, using standard costs for the activities. If appropriate, consider the non-resource benefits of the prescription, such as employment.

Summarize the necessary restoration work (on a site-by-site basis) in a concise overview table, indicating:

- the exact location of the site (e.g., road number or name and distance; stream name and distance; UTM coordinates)
- the boundaries of the work site
- the nature of the problem
- the objectives of the work
- the recommended prescription(s)
- its work sequence priority
- special concerns (e.g., safety, environmental protection, timing)
- the estimated cost of the work
- the expected benefits of the work.

Restoration Prescriptions

You will normally develop detailed restoration prescriptions for the higher priority problem sites identified in the level 1 and 2 assessments. Consult your regional WRP Coordinators to determine whether or not to prepare detailed prescriptions for lower priority sites. In most cases you will develop the prescription in the field, on site, either as you do the assessment or subsequently after the nature of the problem has been clearly established. Emulate natural conditions as much as possible.

The prescriptions should supply the information that is required to implement the necessary restorative work correctly and efficiently. A prescription must provide:

- a clear statement of the specific objectives of the work (from the level 1 or level 2 field assessment, above),
- the exact location and spatial bounds of the work site,
- a clear and accurate specification of the activities to be undertaken, with appropriate technical specifications and standards,
- all necessary site maps, drawings, or blueprints,
- the manpower, equipment and materials needed to complete the work, by activity and time period,
- requirements for trained personnel,
- timing windows and the implementation schedule,
- access requirements,
- detailed costing for the work,
- appropriate job safety and environmental plans,
- requirements for site supervision
- special concerns or site constraints that might affect the work,
- possible impacts of the work on other stakeholders or resources,
- the regulatory or agency approvals needed prior to implementation,
- inspection and maintenance schedules.

Note that you will require a lead time of at least 60 days to obtain regulatory approvals. If seasonal work windows constrain the implementation of your project, ensure that the process is started early enough to receive the approvals before the work must be done.

The prescription should have two primary goals:

- accuracy of implementation, and
- efficient use of resources of time, money, labour and materials.

Accuracy of implementation can be increased by writing clear instructions, by using trained, experienced workers, and by adequate on-site supervision.

Organize the prescription into a logical sequence of discrete steps, and provide clear, detailed instructions for the required activities at each step. Checklists are often useful aids to accurate implementation. Identify the need for on-site supervision by technical personnel.

The appropriate WRP Technical Circular or other technical standard for the work (e.g., FPC guidebooks, MoF engineering manual) may provide detailed descriptions of specific types of activities which can be incorporated into the site prescription. Some routine activities may require less detailed site prescriptions if implemented by an experienced work crew, but note that even "cookbook" prescriptions can rarely be implemented without site-specific modifications that should be identified in advance. Registered licensed professionals must review and sign certain types of prescriptions; ensure this is done where it is required. Clearly identify the needs for site supervision, especially where unusual problems may be encountered.

Use the detailed site-specific restoration prescriptions to revise the initial cost estimates for the projects. Set up an electronic spreadsheet that identifies tasks; estimates labour (by job type), materials and equipment time; and uses standard day rates and material costs to provide more precise estimates of project costs.

Step 4 - Implementing the Project

A watershed restoration project will usually include several component projects (e.g., road restoration, forest site rehabilitation, fish habitat improvements) whose implementation must be coordinated. Coordination among subcomponent projects is especially important where one project may directly affect another (e.g., by altering access to portions of the watershed) or where several projects share a common need for costly resources (e.g., machine time).

Efficient project coordination and scheduling requires that the complete set of restoration activities be known. Even in cases where subcomponent projects will be staged in time (Figure 1), you must know the high priority project objectives and work sites for all the subcomponents to plan an efficient implementation schedule. Attempting to implement one component before you have identified the objectives and needs of other major components (e.g., deactivating roads before access requirements for riparian reforestation are known) may preclude certain highly desirable restoration projects.

Organizing the planning objectives in a hierarchical sequence shows the interconnections among component activities and facilitates the staging of site activities. Work often falls into a natural time sequence because activity

A must logically precede activity B. Access constraints may also structure project implementation; work sequences often progress from the farthest point on a road network, or certain projects can only be done while access to an area is maintained.

Planning for project implementation involves "selecting personnel, equipment, contractors, materials and the timing of project construction" (Everest et al. 1991, p. 71). Choosing personnel and contractors is a critical function that will directly influence project success. Try to obtain highly motivated, experienced people who understand the objectives of the work. Explain the objectives to field personnel - such knowledge is essential to the numerous decisions that they must make while implementing the site works.

Implementation Schedules

In scheduling site works, consider (Moore 1994):

- work sequence priorities established during project planning,
- timing windows or other seasonal constraints,
- availability of equipment, materials, trained labour or funds,
- access, and
- necessary prior activities.

Develop a multi-stage implementation schedule for the overall watershed restoration project that lists the complete set of planned site activities, their locations, work sequence priorities, special equipment needs (e.g., machine time) and timelines in a concise table. Organizing the site works by geographic location (sub-basin, major road) and planning subcomponent (roads, hillslopes, forest site rehabilitation, etc.) will reveal dependencies among site projects that need to be considered in scheduling the work to make efficient use of resources.

Site Supervision

The successful translation of plans into site works requires close cooperation and clear and frequent communication among planners, administrators and contractors to achieve project objectives (Everest et al. 1991). Where possible, the person who designed the project should work closely with the contractor to implement the work. Review the work with field personnel "to ensure that the operator understands why and how certain activities are carried out. This will help the equipment operator make final adjustments in the recommended work based on actual site conditions encountered" (Moore 1994, p. 40).

Clearly identify the site supervisor, his authority and his responsibilities. The site supervisor must ensure that the work meets the required technical

specifications. He should prepare and sign a final inspection report upon completion of the work. The site supervisor should document any changes from the original site plans or specifications, any significant difference between estimated and actual budgets, and any unforeseen problems with the work.

Keep detailed records of the location, design, materials used and costs of individual projects. A minimal record sheet is given in Anonymous (1994b). These records are used for tracking maintenance costs and monitoring the effectiveness of particular types of projects.

Job Safety Plan

Develop a job safety plan for projects. Activities associated with restoration can be dangerous and often take place at sites that are remote from medical facilities. Identify potential hazards to worker safety through a formal job safety analysis and take steps to minimize risk to workers' safety. Workers must be trained to recognize and reduce potential risks. All work must conform to Workers Compensation Board regulations for job safety. Certified first aid attendants and supplies may be required on site, and all crew members must be trained to a "survival first aid" level.

Regulatory Approvals

In order to carry out your watershed restoration projects you may need approvals from a number of government agencies who have statutory responsibilities for land and water resource management. Early in the project planning stage, contact your regional WRP Coordinators to find out what approvals you will need from the various regulatory agencies. The WRP Coordinators can streamline the approval process and help you to satisfy the requirements of the various agencies. Note that you will require a lead time of at least 60 days to obtain regulatory approvals. If seasonal work windows constrain the implementation of your project, ensure that the process is started early enough to guarantee that you have the approvals when the work must be done.

Fisheries Act

The BC Ministry of the Environment, Lands and Parks and the Canada Department of Fisheries and Oceans both administer the Fisheries Act of Canada, which prohibits the harmful alteration of fish habitat, the deposition of substances deleterious to fish, and the obstruction of fish. The Fisheries Act also regulates the capture, holding, retention, transfer and breeding of fish. You must review your proposed projects with regional fisheries and habitat protection biologists to develop an environmental plan that eliminates or reduces the harmful effects of

activities associated with altering fish habitat. You must obtain formal approval from both MoELP and DFO regional habitat protection biologists before proceeding with your plans and you must use necessary safeguards during the work. Habitat protection technicians or conservation officers may inspect your projects for compliance.

Water Act

The BC Water Management Branch licenses and regulates water use under the Water Act of British Columbia. It must approve activities in and around streams such as modifications to the channel, the construction of flood channels or flood control structures, water storage and diversion, and the withdrawal of water from streams. Activities that affect the volume of streamflow, the shape of the channel, or water quality require approval from the Water Management Branch before the work starts.

Bylaws

Some municipalities have bylaws under the Municipal Act of British Columbia that restrict alterations to or work "in and around" watercourses. Activities in and around streams may require approval by the municipal engineering department or other municipal authorities.

Navigable Waters

The Navigable Waters Protection Act of Canada regulates any activity within navigable waters; approvals may be required from the Canadian Coast Guard. Provided that instream habitat structures are restricted to the margins of the stream, approvals are usually granted. The Harbour Commissions Act of Canada may require local Harbour Commissions approval of projects within port boundaries.

Forest Practices Code and other Approvals Involving Lands

Watershed restoration projects that involve the use of provincial Crown lands (e.g., to construct temporary access trails) may require approval by the agency that administers the land. Depending on its classification, Crown land may be administered by the BC Ministry of Forests (provincial forests, including Timber Licence, Tree Farm Licence and Pulp Licence areas), BC Parks Branch (provincial parks) or the Land Administration section of MoELP (other Crown lands). You must obtain the permission of the legal owner to cross private land. The Land Title Office can clarify questions of land ownership within the watershed.

The new Forest Practices Code (FPC) regulates most activities in Provincial forests and certain other lands. Your regional WRP Coordinators can advise you on Code requirements that might affect your projects. You should also discuss your proposed activities with the forest tenure holder, whose obligations under the Code might be affected by your activities. Consult the local MoF District Manager to obtain approvals required under the FPC.

Step 5 - Monitoring and Evaluation

Monitoring and evaluation of watershed restoration projects are required for several different purposes (Kershner et al. 1991):

- **implementation monitoring** (compliance monitoring) determines whether the planned activities and prescriptions were correctly implemented to the required technical standard,

- **effectiveness monitoring** determines "if an objective was actually achieved by the activities" that were undertaken (Kershner et al. 1991, p. 604),

- **validation monitoring** tests hypotheses about our understanding of how or why a system responds to a disturbance or restoration treatment.

Normally you (the project proponent) will only be involved with implementation monitoring and, sometimes, with simple effectiveness monitoring that is coordinated by regional WRP staff.

Implementation Monitoring

In planning projects, routinely provide for implementation monitoring to answer the question "was the job done correctly?". Implementation monitoring may vary greatly in complexity, from simple visual observations to complex measurements to ensure that project specifications were met. Establish an inspection schedule during the project to ensure that the ongoing work conforms to its technical specifications. Often the site supervisor can do these inspections, but you may need external inspectors with particular qualifications for some types of projects. Make sure that the inspections use industry-standard methods and that the results are recorded and signed off.

Some projects may require post-completion inspections and maintenance. If so, establish an appropriate maintenance schedule. Ensure that you record the results and correct any deficiencies. Anonymous (1994b, appendix 8) provides a minimal maintenance record sheet.

Effectiveness Monitoring

Effectiveness monitoring addresses the question "did it work?". It may be done at several levels within a restoration program to assess the effects of individual projects, a particular class of project, or an entire program. Effectiveness monitoring requires a standard methodology to quantify the

response variable and an appropriate statistical design to allow inferences to be drawn about the average effect of the restoration treatment on the response variable(s).

The WRP monitors effectiveness to compare classes of projects or to assess programs at a regional scale. This monitoring is planned and coordinated at the regional or provincial level by WRP staff, although the responsibility for implementing specific simple monitoring protocols may be assigned to proponents as part of your watershed-level programs. WRP staff will provide you with detailed instructions for any effectiveness monitoring that they request of you.

"Experience is invaluable for determining what does and what does not work. A successful watershed restoration program builds on past successes; we also learn from failures. Maintain a database of successes and failures for future reporting" (Moore 1994, p.41).

Approvals for Monitoring

If you need to determine the effect of individual projects within your watershed-level program as part of a regionally coordinated WRP monitoring program, have the regional WRP Coordinator approve the design and implementation of the monitoring. Effectiveness monitoring often requires input from professionals in its design and interpretation.

Validation monitoring is a research function and should be planned and implemented at the regional or provincial level by WRP staff.

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References

Anonymous. 1980. Stream enhancement guide. British Columbia Ministry of Environment and Canada Department of Fisheries and Oceans, Vancouver.

Anonymous. 1994a. Watershed restoration program: program overview and application package. BC Ministry of Environment, Lands and Parks and BC Ministry of Forests, Watershed Restoration Program, Victoria.

Anonymous. 1994b. Fish habitat assessment (interim methods). BC Ministry of Environment, Lands and Parks and BC Ministry of Forests, Watershed Restoration Program, Technical Circular No. 8, Victoria.

Everest, F.H., J.R. Sedell, G.H. Reeves, and M.D. Bryant. 1991. Planning and evaluating habitat projects for anadromous salmonids. pp. 68-77 *In* J. Colt and R.J. White [eds.] Fisheries Bioengineering Symposium, American Fisheries Society Symposium 10, Bethesda, Maryland.

Forest Renewal BC. 1996. Handbook for land-based programs. Enhanced Forestry Program, Watershed Restoration Program, Resource Inventory Program. Forest Renewal BC, Victoria.

Hartman, G.F. and J.C. Scrivener. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Canadian Bulletin of Fisheries and Aquatic Sciences 223, Ottawa, Ontario.

Kershner, J.L., H.L. Forsgren and W.R. Meehan. 1991. Managing salmonid habitats. pp. 599-606 In W.R. Meehan [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Bethesda, Maryland.

Koski, K.V. 1992. Restoring stream habitats affected by logging activities. pp. 343-403 *In* G.W. Thayer [ed.] Restoring the nation's marine environment. Maryland Sea Grant College, University of Maryland, College Park.

Meehan, W.R. 1991. [ed.] Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Bethesda, Maryland.

Moore, G.D. 1994. Resource road rehabilitation handbook: planning and implementation guide (interim methods). BC Ministry of Environment, Lands and Parks and BC Ministry of Forests, Watershed Restoration Program, Technical Circular No. 3, Victoria.

Scrivener, J.C. and T.G. Brown. 1993. Impacts and complexity of forest practices on streams and their salmonid fishes in British Columbia. *In* G. Shooner and S. Asselin [eds.] Le développement du Saumon atlantique au Québec: connaître les règles du jeu pour réussir. Colloque international de la Fédération québecoise pour le saumon atlantique, Québec, décembre 1992. Collection *Salmo salar* n° 1: 201 pp.

Slaney, P.A. 1995. The Watershed Restoration Program of British Columbia: an opportunity and a challenge. pp. 117-133 *In* W.T. Dushenko, H.E. Poll and K. Johnston [eds.] Environmental impact assessment and remediation: towards 2000. Canadian Society of Environmental Biologists, Toronto.

Appendix A. Regional Offices for the WRP

You can obtain information on the *administration* of the Watershed Restoration Program from regional Forest Renewal BC offices or from the Forest Sector Initiatives Manager at your regional Ministry of Forest office. You can obtain information on *technical aspects* of the Watershed Restoration Program from regional WRP Coordinators at your regional Ministry of Environment, Lands and Parks office (riparian habitat, stream channels, water quality, fish habitat and fish) and at your regional Ministry of Forest office (roads, hillslopes, gullies, site rehabilitation, riparian areas):

***Roads, hillslopes, gullies, site rehabilitation and riparian areas**:*

Regional WRP Coordinator
Ministry of Forests
Cariboo Forest Region
540 Borland Street
Williams Lake, B.C.
V2G 1R8

Regional WRP Coordinator
Ministry of Forests
Kamloops Forest Region
515 Columbia Street
Kamloops, B.C.
V2C 2T7

Regional WRP Coordinator
Ministry of Forests
Nelson Forest Region
518 Lake Street
Nelson, B.C.
V1L 4C6

Regional WRP Coordinator
Ministry of Forests
Prince George Forest Region
1011 4th Avenue
Prince George, B.C.
V2L 3H9

Regional WRP Coordinator
Ministry of Forests
Prince Rupert Forest Region
Bag 5000, 3726 Alfred Avenue
Smithers, B.C.
V0J 2N0

Regional WRP Coordinator
Ministry of Forests
Vancouver Forest Region
2100 Labieux Road
Nanaimo, B.C.
V9T 6E9

Riparian habitat, stream channels, water quality, fish habitat and fish:

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Cariboo Region
suite 400, 640 Borland Street
Williams Lake, B.C.
V2G 4T1

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Kamloops Region
1259 Dalhousie Street
Kamloops, B.C.
V2C 5Z5

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Kootenay Region
suite 401, 333 Victoria Street
Nelson, B.C.
V1L 4K3

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Lower Mainland Region
10334 152A Street
Surrey, B.C.
V3R 7P8

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Southern Interior Sub-Region
201 3547 Skaha Lake Road
Penticton, B.C.
V2A 7K2

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Omineca-Peace Region
1011 4th Avenue
Prince George, B.C.
V2L 3H9

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Skeena Region
Bag 5000, 3726 Alfred Avenue
Smithers, B.C.
V0J 2N0

Regional WRP Coordinator
Ministry of Environment, Lands and Parks
Vancouver Island Region
2569 Kenworth Road
Nanaimo, B.C
V9T 4P7

WRP district staff from the Ministry of Environment, Lands and Parks and from the Ministry of Forests are both located at your district Ministry of Forests office to assist you; consult the blue pages of your telephone directory under "Government of British Columbia" for addresses.

Appendix B. WRP Technical Circulars

This series of circulars provides a standard set of techniques to assess opportunities for restoration activities and to plan appropriate restoration prescriptions. The first two circulars provide an overview of the planning process and an assessment process for determining the cumulative effects of forest harvest on forest resources in the watershed. The remaining circulars describe procedures for assessing specific watershed components in more detail and specify activities and standards to assist the rehabilitation of watersheds.

The titles in the series are:

1. Guidelines for Planning Watershed Restoration Projects
2. Watershed Assessment Procedure (Interim Methods) *out of print*
3. Resource Road Rehabilitation Handbook (Interim Methods)
4. Forest Site Rehabilitation for Coastal British Columbia (Interim Methods)
5. Gully Assessment Procedure for British Columbia Forests (Interim Methods) *out of print*
6. Riparian Assessment Procedures (Interim Methods)
7. Stream Channel Assessment (Interim Methods)
8. Fish Habitat Assessment (Interim Methods)
9. Fish Habitat Rehabilitation Procedures

Many WRP interim assessment procedures overlap with procedures that will be required as part of the new Forest Practices Code (FPC). When the Forest Practice Code guidebooks are published, beginning in 1995, they will supersede WRP circulars. In particular, WRP Technical Circular No. 2 - Watershed Assessment Procedure (Interim Methods) has been replaced by two FPC guidebooks:

Coastal Watershed Assessment Procedure
Interior Watershed Assessment Procedure

and WRP Technical Circular No. 5 - Gully Assessment Procedure has been replaced by the following FPC guidebook:

Gully Assessment Procedure Guidebook.

In planning restoration activities, it is important to recognize the linkages among the various physical and biological subcomponents of watersheds and to integrate activities to ensure their successful implementation. Although the circulars treat particular aspects of watershed restoration separately, you should use them together to develop an integrated program that considers activities for the entire watershed.

Copies of the Technical Circulars are available from the WRP Coordinators in your regional MoELP and MoF offices, or from:

Watershed Restoration Program
Ministry of Environment, Lands and Parks
suite 300, 1005 Broad Street
Victoria, B.C.
V8W 2A1.

Appendix C. Sources of Overview Information

You can obtain NTS (1:50,000) and BCGS (1:20,000) topographic maps and digital format TRIM maps (1:20,000) from:

Maps BC
Map and Airphoto Sales
3rd floor, 1802 Douglas Street
Victoria, B.C. V8V 1X4

Note that TRIM digital maps are geo-referenced to North American Datum 1983 UTM standards (NAD83) whereas many NTS maps are referenced to NAD27.

Ministry of Forests staff can obtain TRIM maps from:

Forest Inventory Geographic Information Systems Section
Inventory Branch
Ministry of Forests
722 Johnson Street
Victoria, B.C. V8W 3E7 phone: 387-6745

You can obtain an index of soil maps from Maps BC, at the above address.

You may be able to obtain terrain stability maps, forest cover maps, and access management plan maps from the district MoF office or from the forest tenure holder (licensee).

Maps BC may have historic and current aerial photographs of the watershed. Some forest tenure holders may have additional aerial photographs. Note that flight lines are usually not arranged by watershed; consult Maps BC about how to identify the photo series that you need to cover the watershed.

You can access information on fish distribution, species composition, and fish habitat characteristics from the Stream Information Summary System (SISS) through your regional BC Fisheries Branch office or through:

Inventory Section
BC Fisheries Branch
Ministry of Environment, Lands and Parks
780 Blanshard Street
Victoria, B.C., V8V 1X4