Merritt Forest District

Interior Watershed Assessment Procedure

Final Report

Prepared for

Southern Interior Region, Ministry of Environment
Merritt Forest District, Ministry of Forests
Province of British Columbia

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Executive Summary

A Level 1 Interior Watershed Assessment Procedure (IWAP) analysis was performed on the entirety of the Merritt Forest District by Middle Fork GIS in consultation with the British Columbia Ministry of Environment, Southern Interior Region, and Ministry of Forests, Merritt Forest District,, in the winter of 1996-97.

The Merritt District IWAP was carried out under the methodology of the IWAP Level 1 Guidebook of the British Columbia Forest Practices Code, and utilizing the ARC/INFO geographic information system (GIS). ARC/INFO themes supplied by MoE and MoF were used in an automated analysis methodology, developed by MFGIS for the Ministry of Environment as part of this project.

The District was examined at four levels of analysis. The primary analysis examined the entire District in 59 individual IWAP basins, including 40 fifth order basins, 16 units consisting of sections of mainstem streams of orders 6 and above, and three lower order basins. The 59 IWAP basins contained a total of 218 subbasin and residual analysis units. Additional IWAP analyses were performed on 12 sixth order basins with 40 associated sub-basins; 10 Community Watersheds with 11 associated sub-basins; and 8 third and fourth order basins with 3 associated sub-basins.

Following the IWAP Guidebook normalization, hazard indexing, and recommendation guidelines, 32 of 59 basins, and 123 of 218 subbasin areas meet the criteria for level 2 IWAP analysis. In particular, it was found that the majority of basins (52 of 59) and subbasins (179 of 218) exceed the threshold criteria for surface erosion impacts, approximately half (28 of 59 basins, 103 of 218 subbasins) exceed the threshold criteria for riparian buffer impacts, and about thirty percent (18 of 59 and 61 of 218) exceed the peak flow impact threshold. Conversely, none of the basis and only one of the 218 subbasins exceeded the mass wasting impact threshold. Source data were deemed insufficient to provide meaningful results and recommendations for the mass wasting criteria.

Results were consistent with the findings of previous IWAPs, which point towards the need to refine at least some of the conversion table values. Therefore, a rigid adherence to the recommendations mandated by the IWAP Guidebook would be an improper use of the data. Instead, prioritization of basins for further review should be based upon a number of criteria, of which the IWAP recommendations can play an important role.

All source and resultant GIS coverages, database tables, and the ARC/INFO IWAP methodology are provided, with documentation, for future in-house review

and analysis.

Contents

Intended Audience

This document is intended for all interested parties working within the Merritt Forest District and for all users who will employ the ARC/INFO IWAP model. Additionally, its methods and results may be of use for those responsible for maintinaing and enhancing the IWAP procedure.

Related Documents

The *Interior Watershed Assessment Procedure Guidebook (IWAP) Level 1 Analysis* (Ministry of Forests, September 1995) is the document which provides the motivations, methodologies, assumptions, and interpretations that together constitute the IWAP tool. The *Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook* (Ministry of Forests, June 1995) defines the methodologies under which erodible soil and unstable slope areas were determined. These Guidebooks were written under the authority of the Forest Practices Code of British Columbia in support of its regulations.

The *Technical Guide to the ARC/INFO Interior Watershed Assessment Procedure (ARC/IWAP)* (MFGIS, 1997) documents the methodologies employed by the ARC/IWAP model, including assumptions inherent in ARC/IWAP, preparation of data for input to the model, and the complete text of all AML programs. The *ARC/IWAP Technical Guide* provides the methodology under which the Merritt District IWAP was carried out.

The detailed set of Merritt District IWAP results are bound under separate cover.

Acknowledgements

This project was carried out with the assistance of John DiGregoria, Shuksan Environmental Services, methodology interpretation and development, and document authoring; and Tom Gaines, methodology interpretation and development.

Introduction

An Interior Watershed Assessment Procedure (IWAP) Level 1 analysis was conducted on the Merritt Forest District, which encompasses the majority of the Nicola and Similkameen River basins of southern British Columbia (figure 1). The area of analysis included the entirety of the approximately 1.1 million hectare District. The project was performed in the winter of 1996-97, reflecting conditions current to the date of preparation of the data sources used in the analysis[1].

The IWAP was conducted using the ARC/INFO geographic information system (GIS), and employing the ARC/INFO IWAP model (ARC/IWAP) developed by Middle Fork GIS concurrently with the Merritt analysis. The Merritt District IWAP represents the prototype implementation of the ARC/IWAP.

The District was examined at four scales of analysis. The primary analysis examined the entire District in 59 individual IWAP basins, including 40 fifth order basins, 16 units consisting of sections of mainstem streams of orders 6 and above, and three lower order basins[2]. The 59 IWAP basins contained a total of 218 subbasin and residual analysis units. Additional IWAP analyses were performed on 12 sixth order basins with 40 associated sub-basins; 10 Community Watersheds with 11 associated sub-basins; and 8 third and fourth order basins with 3 associated sub-basins. The complete set of IWAP parameters and results were prepared for each basin, and for each subbasin, for each of the four analyses.

District-wide locational maps of each of the IWAP basins are presented on the following pages:

Each basin and its associated subbasins are presented as a single-page locator map in the separately bound volume *Basin Locator Maps.*

1 The primary data subject to temporal variation is the forest cover layer. Refer to the *Source Data* section for dates of forest cover update.

2 These areas drain directly to the Thompson River: Pimanius and Inkikuh Creeks, and face areas immediately above the river. IWAP result output for these basins are combined with the 3rd and 4th order basins, Volumes VIII and IX.

Methodology

The Merritt Forest District Level 1 IWAP was carried out using the ARC/INFO Geographic Information System (GIS), utilizing an ARC/INFO Macro Language interpretation of the 1995 IWAP Guidebook, developed by Middle Fork GIS concurrently with the Merritt District IWAP analysis. The ARC/INFO IWAP methodology (ARC/IWAP) was designed to provide an objective, faithful, easy-to-use, and repeatable interpretation of the IWAP procedure.

The ARC/IWAP methodology is described in detail in the companion document *Technical Guide to the ARC/INFO Interior Watershed Assessment Procedure*. Specific conditions encountered in performing the Merritt District IWAP are discussed in the Source Data and Discussion sections of this document. Where portions of the IWAP procedure subjectively interpreted, the assumptions made by ARC/IWAP are documented as such in the ARC/IWAP Technical Guide.

Source Data

The Merritt District IWAP was carried out utilizing GIS data provided by the Ministries of Environment and Forests; no original data collection efforts were performed under this project. However, most data required pre-processing prior to their use in the ARC/IWAP procedure.

Unless otherwise identified, data adhere to the standards of the *IWAP Guidebook*. Data preparation followed the specifications of the *Technical Guide to ARC/IWAP*, with exceptions and special cases described herein.

All GIS themes were prepared as single, District-wide coverages, and all analyses utilized the same data layers. Data used were identical across all analyses[3]. All data and analyses employed the MoE standard projection[4].

Roads

Road feature location data were obtained from the 1996 version of the MoF Forest cover (FC1) dataset. Visual comparison of the location and completeness of these road data against the older MoF roads dataset and against the TRIM roads dataset indicates that in general, this road coverage is the most complete of the three. It appears to have been updated to include roads from TRIM which were not present on the prior version of the MoF FC1 data.

Road feature attributes included only road class data (e.g. asphalt, gravel), but lacked use class (e.g. active, abandoned). Thus, the assumption was that all roads in the coverage were in active use, and all road features were used in the IWAP analyses.

Streams

Stream features were extracted from the TRIM TWTR coverages and processed using the *SmarTWTR* program (MFGIS, 1996). Lengths of polygon river features (those with both left and right banks identified) were defined as the length of the centerline through the polygon. Consultation with MoE fisheries staff (Chan, 1996) resulted in the selection of the following set of TWTR features for use in the analyses:

FCODE	Description
GA05200130	Tributary

3 Except that hypsometric threshold (H_{60}) lines vary depending upon choice of basin boundary. This variation in turn affects the values of the peak flow and road density above H_{60} indicators.

4 Projection ALBERS; Units METERS; Datum NAD83 CNT; Spheroid GRS1980; Parameters 50 0 0 /* 1st standard parallel; 58 30 0 /* 2nd standard parallel; -126 0 0 /* central meridian; 45 0 0 /* latitude of projection's origin; 1,000,000/* false easting (meters); 0 /* false northing (meters)

GA10450000 Falls
GA23500000 Rapids_Double
GA24850000 River_Stream_Definite
GA24850110 Brained Chanel
GA24850120 River_Stream_Disappearing
GA24850130 River_Stream_Dry1
GA24850140 River_Stream_Indefinite
GA24850150 River_Stream_Intermittent

1 Not considered in determination of fish-bearing streams

Forest Cover

Ministry of Forests forest cover data utilized were from a set of tiles compiled in late 1996. The table below lists, on a tile-by-tile bases, the dates of most recent update of the forest cover FIP database, *not the date of last activity (i.e. cutting) within the tile*. These dates represent an update period between August, 1994 and December, 1995. Activities which took place subsequent to each tile's data revision process are not represented in the Merritt District IWAP datasets and results.

mapsheet	update						
082E041	94/08/23	092H048	95/12/14	092H086	95/01/20	092I019	95/02/28
082E051	94/08/23	092H049	95/12/14	092H087	95/01/20	092I020	95/02/28
082L001	95/05/17	092H050	95/12/14	092H088	95/01/20	092I024	95/02/28
082L011	95/05/17	092H055	95/06/26	092H089	95/01/20	092I025	95/11/06
082L021	94/09/01	092H056	95/12/14	092H090	95/05/16	092I026	95/11/06
082L031	94/09/01	092H057	95/12/14	092H094	94/09/01	092I027	95/11/06
092H007	95/11/02	092H058	95/12/14	092H095	95/01/20	092I028	95/11/06
092H008	95/10/26	092H059	95/12/14	092H096	95/01/20	092I029	95/11/06
092H018	95/10/03	092H060	95/12/14	092H097	95/01/20	092I030	95/11/06
092H019	94/09/01	092H065	95/12/14	092H098	95/02/13	092I034	95/11/06
092H020	94/09/01	092H066	95/12/14	092H099	95/01/20	092I035	95/11/06
092H026	95/12/14	092H067	95/12/14	092H100	95/05/16	092I036	95/11/06
092H027	95/10/03	092H068	95/12/14	092I004	95/02/28	092I037	95/11/06
092H028	95/10/03	092H069	95/12/14	092I005	95/02/28	092I038	95/11/06
092H029	95/10/03	092H070	95/12/14	092I006	95/02/28	092I039	95/11/06
092H030	95/10/03	092H074	95/10/16	092I007	95/02/28	092I040	95/11/06
092H035	95/10/16	092H075	95/12/14	092I008	95/03/14	092I044	95/11/06
092H036	95/10/03	092H076	95/01/20	092I009	95/02/28	092I045	95/11/06
092H037	95/12/14	092H077	95/02/20	092I010	95/02/28	092I046	95/11/06
092H038	95/12/14	092H078	95/01/20	092I014	95/02/28	092I047	95/11/06
092H039	95/12/14	092H079	95/01/20	092I015	95/02/28	092I048	94/11/16
092H040	95/12/14	092H080	95/05/16	092I016	95/02/28	092I054	94/11/16
092H046	95/12/14	092H084	95/10/16	092I017	95/02/28	092I055	94/11/16
092H047	95/12/14	092H085	95/01/20	092I018	95/02/28	082E031	94/08/23

The number of identified logging activities, by year, for the 1990's are shown below:

1990	408
1991	478
1992	398
1993	234
1994	68

1995 1
1996 0

Thus, the IWAP reflects essentially none of the activities which occurred in the years 1995 and 1996, and only partially the activities of 1994.

Cutblock Areas

Cutblocks in the Merritt Forest District were defined for the purpose of determining logged stream banks as any forest cover polygons with a history of logging (as indicated in the Forest Cover FIP History table (MoF, 1996)), regardless of date of activity or percent of partial cut.

Logged Streams

Logged streambanks are determined through the spatial overlay of cutblock unit and stream coverages. According to the IWAP Guidebook, "*A section of stream 'logged right to the edge' is identified on a forest cover map by locating cutblocks that are immediately adjacent to or straddle a stream*" (MoF, 1995b).

This definition is problematic on two counts. First, it fails to specify either a partial cut threshold or the temporal context in which the logging of stream banks should be examined. From the standpoint of assessing riparian impact, it may be reasonable to consider any historic logging within riparian areas. However, IWAP analyses relying upon forest cover maps or GIS layers will identify only those areas logged subsequent to the initiation of the forest cover database, and ignore all activities in the decades prior to that time.

The second issue is one of map scale, accuracy, and resolution. A distance of twenty meters represents one millimeter on a 1:20,000 TRIM layer or forest cover map sheet. Thus, when the IWAP Guidebook states that "*if a cutblock is mapped as being immediately adjacent to the stream or straddling the stream, then no riparian buffers were left*", it fails to consider that the scale of mapping will in general not allow the distinction of a legitimate riparian buffer on the order of 10 - 20 meters from a stream logged with no buffer. While IWAPs performed on a single basin or a small number of basins can rely upon aerial photographs to supplement logged streambank knowledge, such review was beyond the scope of this District-wide analysis.

The determination of logged streambanks within the Merritt District IWAP was affected by both of these issues. In order to partially overcome these problems, all cutblock units were buffered by a distance of 10 meters before intersection with the streams coverage. This action was based upon the assumption that 20 meters was the approximate spatial resolution of the source forest cover and stream themes. By selecting a 10 meter buffer, it was hoped the streams with legitimate buffers which were erroneously classified as cut streambanks, and

those with logged banks but incorrectly considered to have riparian buffers would tend to cancel one-another out.

Hydrologic Recovery

Hydrologic recovery of disturbed areas was determined according to the criteria established under the IWAP Guidebook, as interpreted by the ARC/IWAP model implementation. Forest cover units identified at the polygon level as **non-productive forest** areas in general follow the instructions given for open range land areas (one instance of the non-productive forest category). ARC/IWAP expands this category from open range areas to include most non-productive descriptors, including all natural conditions such as water features, alpine and alpine forest areas, natural meadows, and non-productive brush and forest lands. The ARC/IWAP methodology interpreted the instructions on page 67 of the IWAP Guidebook to imply these areas are **excluded** from the total land area for the purpose of calculating equivalent clearcut area (ECA). However, this interpretation is not universally accepted, and is not implemented in the IWAP spreadsheet (Teti, 1997). The effect of the exclusion of range areas from total basin area will be to increase the peak flow index values relative to the portion of the basin covered by these areas.

Non-productive forest polygons identified as human-disturbed (urban, gravel pits, and non-natural clearings) are given recovery values of zero and included in ECA calculations. At the layer level the forest cover FIP manual defines **non-forest** areas as "*land that is not currently forested but which is capable of supporting commercial forest*" (MoF, 1996) Therefore, ARC/IWAP and the Merritt District IWAP **includes** these areas in ECA calculations as zero-percent recovery areas.

Ownership

Ownership data were obtained from the ownership layer of the December, 1996 MoF forest cover (FC1) compilation. Percent private and crown ownership are presented on IWAP form 8. Where the sum of private and Crown ownership and crown ownership total less than 100 percent, the balance represents First Nation reserves.

Review of the source GIS data indicated a reasonable degree of completeness of coverage across areas of private ownership. Consequently, all analyses are based upon the **inclusion** of private land areas.

Operability

The forest cover operability layer was found to contain no-data identifiers for approximately one-third of the land area of the district. Consequently, operability values were not considered in the Merritt District IWAP.

Landslides

Landslide features (Terratech, 1994) were received from the Ministry as an ARC/INFO point coverage representing landslide locations. No aerial photography or other original review work was carried out under the Merritt District IWAP. Within the Merritt District, only 44 landslides were identified.

Elevation Surface

The elevation surface grid utilized in the IWAP analyses was derived from the TRIM TDEM spot elevations using the ARC/INFO Topogrid tool (ESRI, 1996) and the connected stream network coverage created with the SmarTWTR tool (MFGIS, 1996). Cell size of the grid was 20 meters.

Hillslope

Values of topographic hillslope in percent were derived from the elevation surface grid using the GRID *hillslope* function and stored in GRID format.

Slopes Over Sixty Percent

Hillslope areas exceeding of sixty percent gradient were extracted from the hillslope grid using a simple conditional query of the form *slope60=con(hillslope ge 60,1,0)*.

Watershed Boundaries

Watershed basin boundaries were determined using ARC/INFO's watershed delineation tools, and subject to extensive manual and ARCEDIT post-processing and validation. The source elevation surface was a 20 meter resolution lattice derived from TRIM TDEM elevation points using the ARC/INFO Topogrid tool. Basin orders were defined from a TRIM TWTR derived stream network coverage and based upon the Strahler ordering system. In general, these streams represent approximately one order more detail than the corresponding B.C. Watershed Atlas data. That is, a stream (an hence its watershed) identified in the Watershed Atlas as a fourth order basin is of order 5 in the more detailed TRIM-derived product.

In most cases, the Merritt District boundary follows major watershed divides, with discrepancies due to resolution. Where the District Boundary coverage was seen to imply correspondence with watershed basin divides, the basin divides were used as the extent of IWAP analysis. Major exceptions are:

- Pimainus and Inkikuh Creeks, two tributaries to the Thompson River , are within the northwest corner the District, as are face areas draining directly to the Thompson in the vicinity of these creeks.
- Areas in the Guichon Creek basin including and upstream from the Meadow Creek basin are outside the District.
- Moore Creek above and including Frogmore Creek is outside the District.
- Stump Lake and tributaries are outside the District.

- Salmon River tributaries Munro Creek, Goodwin Creeks, Nash Creek below Sawmill Lake, and areas contributing to Salmon Lake are within the District, the remainder of the Salmon River is outside the District.
- The Nicola River headwaters are outside of the District.
- The Pasayten River upstream from (ie south of) the international border is outside the District.
- The Similkameen River headwaters in Manning Park are outside the Merritt Forest District.

In each of these cases, lack of complete data coverage precluded performing IWAP analyses on the entire basins. Instead, IWAP results represent those areas within the District.

Hypsometric Threshold (H60) Lines

Hypsometric threshold (H60) lines were determined for each basin which was the subject of an IWAP analysis. The hypsometric line was determined as defined in the *IWAP Guidebook* and the *ARC/IWAP Technical Guide*. The hypsometric threshold of an IWAP basin was determined from the entire contributing area above the basin outlet rather than the area within the IWAP analysis boundary. For example, the section of the Tulameen River below Otter Creek and excluding Granite Creek formed an IWAP analysis area. The hypsometric threshold for this IWAP was defined as the hypsometric threshold for the entire Tulameen River. Where the headwaters of a basin were outside of the District Boundary, the entire basin was utilized in determination of the H60 line, so as to represent the true hypsometric threshold elevation. For example, the H60 line of the Pasayten River basin is based upon the entire watershed, including that portion located in Washington State.

Fish Bearing Streams and Lakes

Known fish presence information was obtained from the British Columbia Watershed Atlas and related fish event tables current through November, 1996. Additionally, a set of plots produced by the Ministry of Environment using the standard AML routine *plotfdz.aml* were manually enhanced by Ministry fisheries biologists and provided to MFGIS. Both the digital event table data and the manual enhancements were utilized in the transfer of known fish presence locations from the WSA to the TRIM base.

Inferred fish presence was defined to include those stream segments[5] whose gradient is under 20 percent, and which are connected to known fish-bearing segments without an intervening stream segment in accedence of 20 percent gradient. For bull trout only, the gradient threshold is 30 percent. However, the Watershed Atlas fish event tables records indicated only two bull trout

5 Stream segments as defined here represent GIS processing units and *do not correspond to stream reaches as determined through field survey*.

records within the District, one associated with Midday Creek and another at an unspecified locale within the Thompson River. The 30 percent criteria was applied only to the Midday Creek system and not to the Thompson River as a whole. Consequently, streams subject to the 30 percent criteria provided a minor contribution to the final results.

The determination of stream gradients was carried out in a manner consistent with the methodology described in the ARC/IWAP technical guide. However, gradient determination was problematic and imprecise due to the 20 meter resolution of the elevation lattice. At this resolution, the location stream channels and their banks may fall within the same grid cell. Where streams are contained within incised channels, elevations assigned to the stream may in fact represent locations on stream banks high above the stream. In such cases, calculated gradient values would be greater than the true stream gradient, and fish blockages would be inferred where in fact none exist. This was found to be the frequent case for areas within the Merritt District.

Two strategies were used to correct these problems. The first involved re-coding short segments on the order of 50 meters and under from high- to low-gradient, (over 20 percent to under 20 percent) when those segments were bounded on both sides by much longer segments of low gradient. The second involved the manual correction (in ARCEDIT) of gradient values for stream segments located valley bottoms, based upon the assumption that these areas are of gradient much less than 20 percent. Neither strategy is part of the automated ARC/IWAP process.

Inferred fish bearing lakes were determined through intersection with the stream network coverage, which includes centerlines through water polygons. Inferred fish presence attributes on the network centerline arcs were migrated to the intersecting lake polygon.

There were no data supplied or generated under this project indicating specific knowledge of fish absence. Consequently, proper interpretation of fish presence information for the Merritt Forest District IWAP must be based upon the understanding that **ABSENCE OF KNOWLEDGE OF FISH PRESENCE DOES NOT IMPLY KNOWLEDGE OF FISH ABSENCE.**

Soil

Soils survey data for areas within the Merritt Forest District, mapped at the scale of 1:100,000 were available for the 92I letter block and the eastern half of the 92H letter block. The 92H and 92I soils data were from different sources and contain differing database structures. The 92I soils mapping and database was developed according to the BCSNF protocol and the 92I soils mapping and database was developed according to the CAPAMP protocol (Ministry of

Environment, 1987).

92H soils data were received in two source coverages corresponding with the Tulameen and Princeton one degree by one-half degree map sheets. The database schema were identical between tiles. 92I soils data were received in 16 source coverages corresponding with the 1:50,000 map sheet tiles. The database schema were identical between tiles.

Pre-processing of soils data were identical in both cases. The source tiles were merged into single coverages for each letter block. Lines were first edge matched, and then a *mapjoin* operation was performed to combine the tiles. Each letter-block coverage was then cleaned up through the execution of an *eliminate* operation. Polygons of identical soils types which straddled the boundaries of individual source tiles were dissolved into single polygons.[6]

Each original soil mapping unit contained one, two, or three individual soil series. Soil series were identified by percent composition of the mapping unit, but not differentiated by location within the unit.

Erodible Soils and Unstable Slopes

Areas of erodible soils and unstable slopes were determined from soil, slope, and biogeoclimatic ecosystem units using the methodology described in the *Technical Guide to ARC/IWAP*. The methodology followed the procedure defined in the British Columbia Forest Practices Guidebook Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes (MoF 1995a). Proper interpretation of the unstable slope and erodible soils themes must follow review and understanding this Guidebook. Specifically, these definitions are for disturbed conditions. The erodible soils layer is defined for areas of exposed mineral soils (ie. after removal of the surface organic layers), and the unstable slopes layer is defined for areas subject to cut- or fill-slope failure (implying disturbance for the purpose of road construction). These definitions are appropriate for the IWAP analysis, because both themes are used in conjunction with the roads theme to identify hazard areas under disturbed conditions.

It would, however, be improper to use these themes as definitions of erodible soils and unstable slopes over the entire landscape, as they are not intended to represent hazard areas under undisturbed conditions. Improper use of these data would tend to **overestimate** areas, especially of erodible soils. Thus, the values on IWAP form 9 should be reviewed accordingly.

Soils for areas in the Merritt Forest District located within the 82E and 82L letter blocks, as well as the western half of the 92H letter block were not yet

6 For the case of the 92I data, this required the dropping of the items MAPSHEET and POLYGONNUM from the PAT.

available at the time of the IWAP analysis. For these areas, hillslope areas exceeding sixty percent gradient were utilized to represent both erodible soils and unstable slopes.

District-wide erodible soils and unstable slopes coverages were created by merging all source themes using a MAPJOIN operation. Final coverages were generalized to a minimum mapping unit of one-half hectare.

Because the original soil polygons each consisted of one, two or three soil series identified by percent contribution to the polygon, the final erodible and unstable coverages are identified by the fraction of each polygon which is in the erodible or unstable class. In the IWAP analyses, these fractions are utilized to proportionally determine such indicators as roads on erodible soils. Thus, one kilometer of road on a polygon containing 30 percent erodible soils would yield 300 meters of road length on erodible soil. This treatment is consistent with the methodology in Appendix 6 of the IWAP Guidebook.

Range use close to streams
No data were provided. All values are coded 'UNK' (unknown) on IWAP form 7.

Mining close to streams
No data were provided. All values are coded 'UNK' (unknown) on IWAP form 7.

ATV use close to streams
No data were provided. All values are coded 'UNK' (unknown) on IWAP form 7.

Stream temperature concerns
No data were provided. All values are coded 'UNK' (unknown) on IWAP form 9.

Dominant bedrock geology
No data were provided. All values are coded 'UNK' (unknown) on IWAP form 9.

Hydrological zone
No data were provided. All values are coded 'UNK' (unknown) on IWAP form 9.

Glaciers
The TRIM TWTR coverage contains no features indicating the presence of glaciers or icefields within the Merritt District.

Results

The Merritt Forest District Level 1 Watershed Analysis examined the entirety of the approximately 1.1 million hectare District. The project was performed in the winter of 1996-97, reflecting conditions current to the date of preparation of the data sources used in the analysis[7]. The District was examined at four scales of analysis. The primary analysis examined the entire District in 59 individual IWAP basins, including 40 fifth order basins, 16 units consisting of sections of mainstem streams of orders 6 and above, and three lower order basins[8]. The 59 IWAP basins contained a total of 218 subbasin and residual analysis units. Additional IWAP analyses were performed on 12 sixth order basins with 40 associated sub-basins; 10 Community Watersheds with 11 associated sub-basins; and 8 third and fourth order basins with 3 associated sub-basins. The complete set of IWAP parameters and results were prepared for each basin and for each subbasin, for each analysis.

The numeric results of the Merritt District IWAP are presented in detail in Volumes II - IX of this report. Results are presented both as IWAP forms 1-11, and in the format of the IWAP.XLS spreadsheet[9]. These volumes are presented under separate cover, as follows:

Volume II: Fifth Order Basins, IWAP.XLS Format
- A: Nicola River Basins
- B: Similkameen River Basins

Volume III: Fifth Order Basins, IWAP Forms 1-11
- A: Nicola River Basins
- B: Similkameen River Basins

Volume IV: Sixth Order Basins, IWAP.XLS Format
Volume V: Sixth Order Basins, IWAP Forms 1-11
Volume VI: Community Watersheds, IWAP.XLS Format
Volume VII: Community Watersheds, IWAP Forms 1-11
Volume VIII: Miscellaneous 3rd and 4th Order Basins, IWAP.XLS Format
Volume IX: Miscellaneous 3rd and 4th Order Basins, IWAP Forms 1-11

Volumes IIA, IIB, IIIA, and IIIB are each bound independently. Volumes IV and V are bound together, and Volumes VI-IX are combined under a single binding.

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7 The primary data subject to temporal variation of the forest cover layer. Refer to the *Source Data* section for dates of forest cover update.

8 These areas drain directly to the Thompson River: Pimanius and Inkikuh Creeks, and face areas immediately above the river. IWAP result output for these basins are combined with the 3rd and 4th order basins, Volumes VIII and IX.

9The latter were prepared entirely within the ARC/IWAP model, and thus differ slightly in appearance from the spreadsheet printouts.

The results, in the form if the IWAP Hazard Indexes, are summarized in tabular format in the following pages:

Summary count of basins and subbasins with hazard values over 0.5
Fifth order basins qualifying for Level 2 Analysis
Fifth order subbasins qualifying for Level 2 Analysis (3 pages)
Sixth order basins and subbasins qualifying for Level 2 Analysis
Community watershed basins and subbasins qualifying for Level 2 Analysis
Miscellaneous 3rd and 4th order basins qualifying for Level 2 Analysis
Fifth order basin and subbasin Hazard Index values (5 pages)

Additionally, results are presented under separate cover for the primary (fifth order) analysis as a set of District-wide color plates, which graphically display both Hazard Index values and raw indicator scores both for basins and for subbasins. All data used to prepare the IWAP Forms 1-11 and the IWAP.XLS-format output are provided on floppy diskette in the universally-readable DBF database exchange format. These data are documented in Appendix A.

All spatial and tabular data have been provided to the Ministry of Environment, Southern Interior Region, and are documented in Appendix B.

MERRITT FOREST DISTRICT IWAP- HAZARD INDEXES OVER 0.5

Level 5 Basins

BASINS - 56 records

individual totals		*combinations*	
PF	18	-none-	
SE	52		
RB	28	4	SE only
MW	0		
		20	PF-SE
32 basins meet criteria for level 2 analysis			
		4	SE-RB
		14	PF-SE-RB
		14	

SUBBASINS - 218 records

individual totals		*combinations*	
PF	61	-none-	
SE	181		
RB	103	32	
MW	1	PF only	2
		SE	only
123 subbasins meet criteria for level 2 analysis		62	
		RB only	2
		PF-SE	
		18	
		SE-RB	
		60	
		PF-SE-RB	
		40	
		PF-SE-RB-MW	1

Level 6 Basins

BASINS - 12 records

individual totals		*combinations*	
PF	4	SE	only
SE	12		
RB	6	4	
MW	0	PF-SE	
8 basins meet the criteria for level 2 analysis		2	
		SE-RB	
		4	
		PF-SE-RB	
		2	

SUBBASINS - 40 records

individual totals		*combinations*	
PF		-none-	3
		SE only	12
14		PF-SE	4
SE		SE-RB	11
		PF-SE-RB	10
37			
RB			
21			
MW	0		
25 subbasins meet the criteria for level 2 analysis			

Community Watersheds

BASINS - 10 records

individual totals		*combinations*	
PF	7	SE	only
SE	10		
RB	6	3	
MW	1	PF-SE-RB	
7 basins meet the criteria for level 2 analysis		6	
		PF-SE-MW	
		1	

SUBBASINS - 11 records[10]

individual totals		
PF		0
		8 subbasins meet the criteria for level 2 analysis
6		
SE		
9		
RB		
7		
MW		

10 Of the community watersheds, only Dillard and Trout creeks had associated subbasins

combinations		PF-SE	SE-RB	PF-SE-RB	5
-none-	2				
SE only	1	1	2		

Miscellaneous third and fourth order basins

Basins - 8 records			SUBBASINS - 3 records[11]		
individual totals		*combinations*	*individual totals*	*combinations*	
PF	3	SE	PF	SE only	1
SE	8			PF-SE-RB	2
RB	5	3	2		
MW	0	SE-RB	SE		
5 basins meet criteria for level 2 analysis		2	3		
		PF-SE-RB	RB		
		3	2		
			2 subbasins meet criteria for level 2 analysis		

PF - Peak Flow; SE - Surface Erosion; RB - Riparian Buffer; MW - Mass Wasting

11Only Whistle Creek had associated subbasins

Merritt Forest District IWAP Results
Basins Qualifying for Level 2 Analysis
(Fifth Order Basins)

Indexes Exceeding 0.5: PF-SE-RB

Allison Creek above Summers Creek
Clapperton Creek
Granite Creek
Guichon Creek
Hayes Creek above Siwash Creek
Lawless Creek
Midday Creek
Range Creek
Smith Creek
Spearing and Mcphail Creeks
Summers Creek
Voght Creek
Whipsaw Creek
Wolfe Creek

Indexes Exceeding 0.5: RB-SE

Allison Creek below Summers Creek
Coldwater River below Voght Creek excluding Midday Creek
McCullogh Creek
Nicola Lake
Nicola R ds of Guichon Creek order 4 and under
Nicola River above Chapperon Creek
Nicola River between Guichon Creek and Nicola Lake
Otter Creek above McCullogh Creek
Otter Creek below McCullogh Creek excluding Mcphail and Spearing Creek
Similkameen River above Whipsaw Creek excluding Pasayten River & Copper Creek
Skuhun Creek below Skuhost Creek
Spahamin Creek
Spius Creek below Maka Creek excluding Prospect Creek
Tulameen River below Otter Creek excluding Granite Creek

Indexes Exceeding 0.5: PF-SE

Maka Creek
Pasayten River
Skuhost Creek
Skuhun Creek above Skuhost Creek

Merritt Forest District IWAP Results
Subbasins Qualifying for Level 2 Analysis
(Fifth Order Basins)

Indexes exceeding 0.5: PF-SE-RB-MW

Basin Name	Subbasin Name (map identifier)
Lawless Creek	Holm Creek (82)

Indexes exceeding 0.5: PF-SE-RB

Basin Name	Subbasin Name (map identifier)
Allison Creek	unnamed trib to Allison Creek above Dry Lake (79)
Allison Creek	Allison Cr above Dry L excl. unnamed basin #79 (78)
Clapperton Creek	Residual (26)
Coldwater River	Godey Creek (182)
Granite Creek	Granite Creek above Arrastra Creek (88)
Guichon Creek	Hector Creek (214)
Guichon Creek	Meadow Creek Face Units (217)
Hayes Creek	Trehearne Creek (172)
Hayes Creek	Chain, Link, Osprey Lakes above Shinish Creek (67)
Hayes Creek	Shinish Creek (68)
Hayes Creek above Siwash Creek	Residual (66)
Lawless Creek	Residual (80)
Lower Stump Lake Creek	Peter Hope Lake and upstream (15)
Maka Creek	Residual (44)
McNulty Creek	Alaric Creek (98)
McNulty Creek	unnamed e. bank s. of Alaric borders Bull, Isintok (100)
McNulty Creek	unnamed first tributary above Hedley confluence (102)
Midday Creek	Midday Creek above unnamed basin #43 (42)
Midday Creek	unnamed (43)
Nicola River	Stumbles Creek (207)
Otter Creek	Manning Creek (155)
Otter Creek	Guliford Creek (62)
Pasayten River	Peeve Creek (129)
Range Creek	unnamed west tributary (24)
Similkameen River	Whistle Creek (179)
Similkameen River	unnamed east bank south of Sunday Cr (150)
Similkameen River	Placer Creek (152)
Siwash Creek	Galena Creek (70)
Smith Creek	Smith headwaters (105)
Spearing and Mcphail Creeks	McPhail Creek (65)
Spius Creek above Maka Creek	unnamed first trib upstream of Maka Creek (48)
Spius Creek above Maka Creek	unnamed southern tributary (51)
Summers Creek	Dillard Creek (74)
Summers Creek	Rampart Creek (76)
Tulameen River	Asp Creek (164)
Voght Creek	Howarth Creek (55)
Voght Creek	Voght Creek (54)
Whipsaw Creek	Whipsaw Creek headwaters (109)
Whipsaw Creek	Lamont Creek (108)
Wolfe Creek	Willis Creek (121)

Merritt Forest District IWAP Results
Subbasins Qualifying for Level 2 Analysis
(Fifth Order Basins)
Page 2

Indexes exceeding 0.5: SE-RB

Basin Name	Subbasin Name (map identifier)
Allison Creek	Belfort Creek (175)
Chapperon Creek	Frank Ward Creek (147)
Clapperton Creek	Shuta Creek (30)
Coldwater River below Vogh Cr excluding Midday Cr	Residual (181)
Coldwater River above Vogh Creek	Residual (142)
Gordon Creek	Residual (20)
Granite Creek	Arrastra Creek (89)
Guichon Creek	Rey Creek (210)
Guichon Creek	Residual (208)
Guichon Creek	Steffans Creek (213)
Hayes Creek	Grant Creek (169)
Hayes Creek	Christian Creek (173)
Hayes Creek below Siwash Cr excluding Red Cr	Residual (167)
Lawless Creek	Lawless Creek upstream from Holm Creek (81)
McCullogh Creek	Angstadt Creek (59)
McCullogh Creek	Davis Lake and above (58)
McCullogh Creek	unnamed eastern tributary (57)
McCullogh Creek	Residual (56)
Moore Creek	Residual (17)
Nicola Lake	Residual (191)
Nicola River	Howse Creek (197)
Nicola River	Lauder Creek (196)
Nicola River	Mellin Creek (133)
Nicola River - Nicola Lake to Chapperon Cr	unnamed (201)
Nicola River - Nicola Lake to Chapperon Cr	unnamed to Douglas L w of Nicola R (199)
Nicola River - Nicola Lake to Chapperon Cr	unnamed across from Chaperon Creek (198)
Nicola River - Nicola Lake to Chapperon Cr	unnamed (200)
Nicola River between Guichon Creek and Nicola Lake	Residual (188)
Nicola River between Guichon Creek and Nicola Lake	Jesse Creek (189)
Nicola R ds of Guichon Cr order 4 and under	Residual (203)
Nicola R ds of Guichon Cr order 4 and under	Skeikut Creek (204)
Otter Creek above McCullogh Creek	Above and incl Bates Creek (61)
Otter Creek above McCullogh Creek	Residual (60)
Otter Creek below McCullogh Cr excluding Mcphail and Spearing Cr	Residual (153)
Otter Creek below McCullogh Cr excluding Mcphail and Spearing Cr	Elliot Creek (156)
Pasayten River	Pasayten River - Peeve Cr to border (131)
Pasayten River	Calcite Creek (127)
Prospect Creek	Residual (36)
Quilchena Creek	Pothole Creek (139)
Quilchena Creek	unnamed immediately n of Teenamilsts Creek (136)
Salmon River Below Nash Creek	Index Creek (4)
Shakan Creek	Residual (11)
Similkameen River Merritt District Bdry to Tulameen- order4 & under	Soukup Creek (178)
Similkameen River above Whipsaw Cr excl. Pasayten R & Copper Cr	Residual (148)
Siwash Creek	Residual (69)
Skuhun Creek below Skuhost Cr	Papsilqua Creek (187)
Smith Creek	Residual (103)
Spahamin Creek	Spahomin Creek above Douglas Cr. below Pennask L (32)
Spearing and Mcphail Creeks	Residual (63)
Spearing and Mcphail Creeks	Above McPhail Creek (64)
Spius Creek below Maka Creek excluding Prospect Cr	Robert/James/Richardson Creeks (184)
Spius Creek below Maka Creek excluding Prospect Cr	Residual (183)
Summers Creek	Missezula (75)
Summers Creek	Residual (73)
Tulameen River between Otter Cr and Vuich Cr excluding Lawless Cr	Residual (157)
Tulameen River below Otter Cr excluding Granite Creek	Residual (162)
Voght Creek	Residual (53)
Vuich Creek	Sutter Creek (92)

Merritt Forest District IWAP Results
Subbasins Qualifying for Level 2 Analysis
(Fifth Order Basins)
Page 3

Indexes exceeding 0.5: PF-SE

Basin Name	Subbasin Name (map identifier)
Chapperon Creek	Residual (145)
Clapperton Creek	unnamed above Helmer Lake w of Clapperton Cr (28)
Clapperton Creek	Clapperton Creek above Helmer Lake (27)
Guichon Creek	Broom Creek (211)
Guichon Creek	Tyner Creek (212)
Guichon Creek	Dupuis Creek (215)
Midday Creek	Residual (41)
Moore Creek	Frogmoore Creek (18)
Nicola River - Nicola Lake to Chapperon Cr	unnamed First trib to Nicola R above Nicola L (193)
Nicola River - Nicola Lake to Chapperon Cr	Residual (192)
Quilchena Creek	Quilchena Creek above Wasley Creek (140)
Red Creek	Red Creek headwaters (84)
Skuhost Creek	Skuhost Creek East Fork (9)
Skuhun Creek above Skuhost Creek	Chataway Creek (7)
Skuhun Creek above Skuhost Creek	Skuhun Creek (6)
Smith Creek	Smith headwaters (west) (106)
Tulameen River	Champion Creek (159)
Tulameen River	Cook Creek (163)

Indexes exceeding 0.5: PF

Basin Name	Subbasin Name (map identifier)
Copper Creek	unnamed (118)
Range Creek	residual (23)

Indexes exceeding 0.5: RB

Basin Name	Subbasin Name (map identifier)
Nicola River above Chapperon Creek	Beak Creek (134)
Similkameen River above Whipsaw Creek	Belgie Creek (151)

Merritt Forest District IWAP Results
Basins Qualifying for Level 2 Analysis
(Sixth Order Basins)

Indexes Exceeding 0.5: PF-SE-RB
Allison Creek
Guichon Creek

Indexes Exceeding 0.5: SE-RB
Coldwater River
Nicola River above Nicola Lake
Otter Creek
Similkameen River above Tulameen River

Indexes Exceeding 0.5: PF-SE
Salmon River below Nash Cr- Mer. Dist
Skuhun Creek

Indexes Exceeding 0.5: SE (not alone sufficient to require Level 2 IWAP)
Hayes Creek
Hedley Creek
Spius Creek
Tulameen River above Otter Creek

Subbasins Qualifying for Level 2 Analysis

Indexes exceeding 0.5: PF-SE-RB
Allison Creek above Summers Creek
Guichon Creek (Merritt District)
Hayes Creek above Siwash Creek
Lawless Creek
Pasayten River (British Columbia)
Range Creek
Spearing and Mcphail Creeks
Summers Creek
Voght Creek
Whipsaw Creek

Indexes exceeding 0.5: SE-RB
Allison Creek below Summers Creek
Coldwater River below Voght Cr excluding Midday Creek
McCullogh Creek
Midday Creek
Nicola River above Chapperon Creek
Otter Creek below McCullogh Creek excluding Spearing Creek
Otter Creek above McCullogh Creek
Similkameen River above Whipsaw Creek excluding. Pasayten River & Copper Creek
Skuhun Creek below Skuhost Creek
Spahamin Creek
Spius Creek below Maka Creek excluding Prospect Creek

Indexes exceeding 0.5: PF-SE
Salmon River below Nash Creek
Skuhost Creek
Skuhun Creek above Skuhost Creek
Maka Creek

Merritt Forest District IWAP Results
Basins Qualifying for Level 2 Analysis
(Community Watersheds)

Indexes Exceeding 0.5: PF-SE-MW
William Creek

Indexes Exceeding 0.5: PF-SE-RB
Brook Creek
Dillard Creek
Hacket Creek
Kwinshatin Creek
Skuagam Creek
Trout Creek above Camp Creek

Indexes Exceeding 0.5: SE (not alone sufficient to require Level 2 IWAP)
Anderson Creek
Bell Creek
Lee Creek

Subbasins Qualifying for Level 2 Analysis

Indexes Exceeding 0.5: PF-SE-RB

Basin Name	Subbasin Name
Dillard Creek	Dillard Creek above Vinson Creek
Trout Creek above Camp Creek	Empress Creek
Trout Creek above Camp Creek	North Trout Creek
Trout Creek above Camp Creek	Trout Cr. above North Trout Cr excl Crescent Cr.
Trout Creek above Camp Creek	Crescent Creek

Indexes Exceeding 0.5: SE-RB

Basin Name	Subbasin Name
Dillard Creek	Residual
Trout Creek above Camp Creek	Residual

Indexes Exceeding 0.5: PF-SE

Basin Name	Subbasin Name
Trout Creek above Camp Creek	Kathleen Creek

Indexes Exceeding 0.5: SE (not alone sufficient to require Level 2 IWAP)

Basin Name	Subbasin Name
Dillard Creek	Vinson Creek

Basins Qualifying for Level 2 Analysis
(Miscellaneous third and fourth order basins)

Indexes Exceeding 0.5: PF-SE-RB
McPhail Creek
Whistle Creek
Wolfe Creek above Willis Creek

Indexes Exceeding 0.5: SE-RB
Spearing Creek above McPhail Creek
Willis Creek

Indexes Exceeding 0.5: SE (not alone sufficient to require level 2 IWAP)
Champion Creek
Inkikuh Creek

Pimainus Creek

NICOLA RIVER BASINS

	PF	SE	RB	MW	
L2					
Skuhost Creek	**0.54**	**1.00**	**0.17**	**0.01**	**YES**
Skuhost Creek East Fork	0.63	1.00	0.24	0.00	YES
unnamed west tributary	0.23	1.00	0.00	0.02	NO
Residual	0.21	0.98	0.29	0.00	NO
Skuhun Creek above Skuhost Creek	**0.61**	**1.00**	**0.12**	**0.00**	**YES**
Chataway Creek	0.70	1.00	0.14	0.00	YES
Skuhun Creek	0.60	1.00	0.14	0.00	YES
Residual	0.17	0.91	0.03	0.00	NO
Skuhun Creek below Skuhost Cr	**0.15**	**0.82**	**0.54**	**0.00**	**YES**
Papsilqua Creek	0.15	0.89	0.68	0.00	YES
Residual	0.14	0.77	0.49	0.01	NO
Shakan Creek	**0.08**	**0.27**	**0.12**	**0.03**	**NO**
Shakan Creek above Silk Creek	0.08	0.20	0.05	0.03	NO
Silk Creek	0.02	0.05	0.00	0.00	NO
Residual	0.20	0.94	0.74	0.07	YES
Gordon Creek	**0.41**	**1.00**	**0.48**	**0.00**	**NO**
Abbot Creek	0.45	1.00	0.23	0.00	NO
Gordon Creek above Abbot Creek	0.45	1.00	0.25	0.00	NO
Residual	0.22	1.00	1.00	0.01	YES
Nuaitch Creek	**0.19**	**0.63**	**0.15**	**0.03**	**NO**
unnamed	0.18	0.28	0.00	0.00	NO
unnamed	0.28	0.00	0.00	0.00	NO
Residual	0.22	0.88	0.24	0.04	NO
Spius Creek below Maka Creek excluding Prospect Cr	**0.22**	**1.00**	**0.72**	**0.05**	**YES**
Robert/James/Richardson Creeks	0.17	0.95	0.71	0.00	YES
Wolden Creek	0.16	0.27	0.05	0.00	NO
Residual	0.24	1.00	0.80	0.06	YES
Prospect Creek	**0.26**	**0.66**	**0.33**	**0.07**	**NO**
Prospect Creek headwaters north	0.05	0.25	0.00	0.00	NO
Prospect Creek headwaters west	0.11	0.26	0.11	0.00	NO
Teepee Creek	0.26	0.97	0.47	0.20	NO
unnamed across from Pole Gulch	0.23	0.35	0.20	0.11	NO
Residual	0.38	0.98	0.63	0.07	YES

Maka Creek		**0.52**	**0.88**	**0.38**	**0.03**
YES					
	Maka Creek headwaters	0.25	0.41	0.05	0.04
NO					
	Murray Lake Creek	0.35	0.69	0.42	0.06
NO					
	Residual	0.79	1.00	0.55	0.02
YES					
Nicola R ds of Guichon Cr order 4 and under		**0.32**	**1.00**	**0.53**	**0.03**
YES					
	Manning Creek	0.40	1.00	0.30	0.01
NO					
	Skeikut Creek	0.11	0.73	0.61	0.00
YES					
	Stumbles Creek	0.61	1.00	0.70	0.03
YES					
	unnamed s of Hendy Creek across fr Poison Creek	0.01	0.04	0.00	0.00
NO					
	Residual	0.30	1.00	0.53	0.03
YES					
Spius Creek above Maka Creek		**0.42**	**1.00**	**0.37**	**0.01**
NO					
	Spius Creek headwaters - south	0.31	0.56	0.00	0.03
NO					
	unnamed first trib upstream of Maka Creek	0.75	1.00	0.88	0.01
YES					
	unnamed north headwaters	0.13	0.17	0.00	0.00
NO					
	unnamed southern tributary	0.57	1.00	0.89	0.00
YES					
	unnamed west headwaters	0.26	0.06	0.00	0.00
NO					
	Residual	0.28	0.89	0.17	0.00
NO					

PF - Peak Flow; SE - Surface Erosion; RB - Riparian Buffer; MW - Mass Wasting; L2 - Level 2 IWAP

		PF	SE	RB	MW
L2 **Guichon Creek (Merritt District)**		**0.52**	**1.00**	**0.74**	
0.01 **YES**					
	Broom Creek	0.60	1.00	0.10	0.02
YES					
	Cougar Creek	0.34	1.00	0.18	0.02
NO					
	Dupuis Creek	0.67	1.00	0.15	0.00
YES					
	Hector Creek	0.58	1.00	1.00	0.00
YES					
	Meadow Creek Face Units	0.65	1.00	0.57	0.00
YES					
	Quenville Creek	0.38	0.74	0.25	0.01
NO					
	Rey Creek	0.47	0.94	0.68	0.00
YES					
	Steffans Creek	0.37	1.00	0.60	0.01
YES					
	Tyner Creek	0.58	1.00	0.15	0.01
YES					
	Residual	0.41	1.00	1.00	0.02
YES					
Nicola River between Guichon Creek and Nicola Lake		**0.40**	**1.00**	**0.79**	**0.01**
YES					
	Hamilton Creek	0.30	1.00	0.36	0.00
NO					
	Jesse Creek	0.42	1.00	1.00	0.00
YES					
	Residual	0.49	1.00	0.71	0.01
YES					
Midday Creek		**0.57**	**1.00**	**0.83**	**0.00**
YES					
	Midday Creek above unnamed basin #43	0.54	1.00	1.00	0.01
YES					
	unnamed	0.50	1.00	1.00	0.00

YES				
Residual	0.86	1.00	0.07	0.00
YES				
Coldwater River below Voght Cr excl. Midday Cr	**0.46**	**1.00**	**0.91**	**0.02**
YES				
Godey Creek	0.56	1.00	1.00	0.00
YES				
Residual	0.43	1.00	0.84	0.03
YES				
Voght Creek	**0.57**	**1.00**	**1.00**	**0.00**
YES				
Howarth Creek	0.72	1.00	1.00	0.00
YES				
Voght Creek	0.59	1.00	1.00	0.01
YES				
Residual	0.29	1.00	1.00	0.00
YES				
Coldwater River above Voght Creek	**0.37**	**0.77**	**0.35**	**0.01**
NO				
Juliet Creek	0.36	0.37	0.22	0.06
NO				
Mine Creek	0.42	0.66	0.12	0.02
NO				
Residual	0.37	1.00	0.63	0.01
YES				
Clapperton Creek	**0.59**	**1.00**	**0.62**	**0.00**
YES				
Clapperton Creek above Helmer Lake	0.65	1.00	0.40	0.00
YES				
Mabel Creek	0.44	1.00	0.30	0.00
NO				
Shuta Creek	0.46	1.00	0.79	0.00
YES				
unnamed above Helmer Lake w of Clapperton Cr	0.72	1.00	0.48	0.00
YES				
Residual	0.57	1.00	0.88	0.00
YES				
Quilchena Creek	**0.40**	**0.69**	**0.35**	**0.00**
NO				
Logans Creek	0.21	0.56	0.49	0.00
NO				
Pothole Creek	0.43	0.57	0.55	0.00
YES				
Quilchena Creek above Wasley Creek	0.58	0.65	0.30	0.00
YES				
unnamed	0.06	0.35	0.33	0.00
NO				
unnamed immediately n of Teenamilsts Creek	0.26	0.99	1.00	0.00
YES				
unnamed upstream of Minnie Lake	0.40	0.93	0.40	0.00
NO				
Residual	0.24	0.71	0.27	0.00
NO				
Nicola Lake	**0.34**	**0.87**	**0.60**	**0.01**
YES				
Moore Creek	**0.39**	**1.00**	**0.49**	**0.00**
NO				
Frogmoore Creek	0.56	1.00	0.17	0.00
YES				
Harold Creek	0.22	0.86	0.19	0.00
NO				
Residual	0.28	1.00	1.00	0.01
YES				
Nicola River - Nicola Lake to Chapperon Cr	**0.35**	**0.97**	**0.49**	**0.00**
NO				
Howse Creek	0.19	0.56	0.69	0.00
YES				
Jack Douglas Creek	0.43	0.99	0.33	0.00
NO				

Louder Creek	0.46	1.00	0.92	0.00	YES
Nuaitch Creek headwaters south	0.33	1.00	0.97	0.00	YES
unnamed	0.23	1.00	1.00	0.00	YES
unnamed First trib to Nicola R above Nicola L	0.59	1.00	0.14	0.00	YES
unnamed across from Chaperon Creek	0.23	0.71	0.80	0.00	YES
unnamed to Douglas L w of Nicola R	0.08	1.00	0.57	0.00	YES
unnamed w of Lauder Creek incl Salt L	0.16	0.37	0.16	0.00	NO
Residual	0.60	0.97	0.13	0.00	YES

PF - Peak Flow; SE - Surface Erosion; RB - Riparian Buffer; MW - Mass Wasting; L2 - Level 2 IWAP

		PF	SE	RB	MW	L2	Lower
Stump Lake Creek	**0.47**	**1.00**	**0.45**	**0.00**	**NO**		
Peter Hope Lake and upstream		0.58	0.83	0.83	0.00	YES	
unnamed in SE watershed		0.44	0.17	0.00	0.00	NO	
Residual		0.40	1.00	0.38	0.00	NO	
Spahamin Creek		**0.19**	**1.00**	**0.73**	**0.00**	**YES**	
Douglas Creek		0.16	0.62	0.49	0.00	NO	
Spahomin Creek above Douglas Creek below Pennask L		0.25	1.00	0.91	0.00	YES	
Range Creek		**0.60**	**1.00**	**0.61**	**0.00**	**YES**	
Range Creek above unnamed west tributary		0.45	1.00	0.50	0.00	NO	
unnamed west tributary		0.68	1.00	0.83	0.00	YES	
Residual		1.00	0.20	0.00	0.00	YES	
Chapperon Creek		**0.43**	**0.72**	**0.31**	**0.01**	**NO**	
Above Chapperon Lake and inside District		0.18	0.39	0.31	0.02	NO	
Frank Ward Creek		0.46	0.70	0.69	0.00	YES	
Residual		0.83	0.92	0.13	0.00	YES	
Nicola River above Chapperon Creek		**0.17**	**0.61**	**0.55**	**0.00**	**YES**	
Beak Creek - Merritt District		0.08	0.26	0.65	0.00	YES	
Mellin Creek		0.22	0.73	0.63	0.00	YES	
Residual		0.16	0.54	0.48	0.00	NO	
Salmon River Below Nash Creek		**0.36**	**0.86**	**0.45**	**0.00**	**NO**	
Index Creek		0.43	0.91	0.93	0.00	YES	
Rush Creek / Rush Lake		0.28	0.64	0.34	0.00	NO	
Salmon Lake to District Boundary		0.48	0.97	0.50	0.00	NO	

SIMILKAMEEN RIVER BASINS

Paul Creek	**0.19**	**0.73**	**0.21**	**0.01**	**NO**
Paul Creek headwaters	0.31	0.85	0.42	0.01	NO
unnamed southern central	0.03	0.00	0.00	0.00	NO
unnamed tributary	0.32	0.77	0.00	0.00	NO
Residual	0.17	0.85	0.14	0.02	NO
Similkameen River Merritt District Bdry to Tulameen- order4 & under	**0.44**	**0.99**	**0.37**	**0.04**	**NO**
Johns Creek	0.24	0.81	0.20	0.04	NO
Soukup Creek	0.35	0.95	0.59	0.04	YES
Steven Creek	0.25	1.00	0.20	0.02	NO
Whistle Creek	0.72	1.00	0.96	0.03	YES
Residual	0.34	0.91	0.13	0.04	NO
Hedley Creek excluding McNulty Creek	**0.21**	**0.33**	**0.07**	**0.01**	**NO**
Hedley Creek above and incl Broken Creek	0.16	0.25	0.04	0.00	NO
Nickel Plate Creek	0.34	0.44	0.07	0.00	NO
unnamed across fr Broken Creek	0.25	0.32	0.13	0.00	NO
Residual	0.18	0.37	0.08	0.02	NO
McNulty Creek	**0.46**	**0.99**	**0.42**	**0.00**	**NO**
Alaric Creek	0.82	1.00	0.63	0.00	YES
McNulty Creek	0.33	0.68	0.35	0.00	NO
unnamed borders Red Creek	0.07	0.22	0.00	0.00	NO
unnamed east bank south of Alaric borders Bull and Isintok	0.80	1.00	0.84	0.00	YES
unnamed first tributary above Hedley confluence	0.62	1.00	0.82	0.01	YES
Residual	0.25	0.98	0.36	0.00	NO
Smith Creek	**0.62**	**0.86**	**0.52**	**0.02**	**YES**
Smith headwaters	0.94	1.00	0.69	0.00	YES
Smith headwaters (west)	0.62	0.69	0.47	0.00	YES
unnamed nw corner at bend	0.13	0.26	0.06	0.05	NO
Residual	0.33	0.90	0.59	0.04	YES
Wolfe Creek	**0.52**	**1.00**	**0.60**	**0.09**	**YES**
Willis Creek	0.62	0.91	0.71	0.08	YES
Wolfe Creek above Willis Creek	0.45	1.00	0.61	0.19	YES

Residual	0.35	0.94	0.41	0.05	NO

PF - Peak Flow; SE - Surface Erosion; RB - Riparian Buffer; MW - Mass Wasting; L2 - Level 2 IWAP

	PF	SE	RB	MW	L2 Hayes
Creek below Siwash Cr excl. Red Cr 0.30	**1.00**	**0.48**	**0.07**	**NO**	
Christian Creek	0.33	1.00	0.56	0.00	YES
Finnegan Creek	0.09	0.22	0.05	0.12	NO
Grant Creek	0.44	1.00	0.76	0.00	YES
Spukunne Creek	0.36	0.65	0.40	0.00	NO
Trehearne Creek	0.55	1.00	0.66	0.00	YES
unnamed n of Trehearne Creek	0.23	1.00	0.25	0.00	NO
Residual	0.30	1.00	0.54	0.13	YES
Red Creek	**0.27**	**0.65**	**0.10**	**0.00**	**NO**
Red Creek headwaters	0.50	0.78	0.21	0.00	YES
unnamed borders Finnegan Creek	0.09	0.06	0.02	0.00	NO
unnamed tributary in lower Red Creek	0.09	0.06	0.00	0.00	NO
Residual	0.18	0.85	0.07	0.00	NO
Siwash Creek	**0.39**	**0.87**	**0.43**	**0.01**	**NO**
Galena Creek	0.71	0.71	0.55	0.00	YES
Simem Creek	0.29	0.63	0.37	0.00	NO
Siwash Creek	0.27	0.44	0.05	0.00	NO
Residual	0.49	1.00	0.87	0.05	YES
Hayes Creek above Siwash Creek	**0.70**	**1.00**	**0.76**	**0.04**	**YES**
Chain, Link, Osprey Lakes above Shinish Creek	0.50	1.00	0.62	0.08	YES
Shinish Creek	0.75	1.00	0.86	0.08	YES
Residual	0.54	1.00	0.75	0.06	YES
Allison Creek below Summers Creek	**0.49**	**1.00**	**0.53**	**0.04**	**YES**
Belfort Creek	0.45	1.00	0.71	0.00	YES
Residual	0.50	1.00	0.47	0.05	NO
Summers Creek	**0.52**	**1.00**	**0.62**	**0.06**	**YES**
Dillard Creek	0.67	1.00	0.60	0.02	YES
Missezula	0.37	0.81	0.55	0.03	YES
Rampart Creek	0.68	1.00	0.74	0.00	YES
Residual	0.48	1.00	0.63	0.15	YES
Allison Creek above Summers Creek	**0.61**	**1.00**	**0.66**	**0.07**	**YES**
Allison Cr above Dry L excluding unnamed basin #79	0.64	1.00	0.94	0.04	YES
unnamed trib to Allison Creek above Dry Lake	0.73	0.98	0.62	0.03	YES
Residual	0.47	1.00	0.48	0.10	NO
Tulameen River below Otter Cr excl. Granite Creek	**0.47**	**0.95**	**0.76**	**0.06**	**YES**
Asp Creek	0.51	1.00	0.95	0.03	YES
Cook Creek	0.57	0.65	0.42	0.00	YES
Residual	0.43	0.96	0.68	0.09	YES
Granite Creek	**0.62**	**1.00**	**0.52**	**0.13**	**YES**
Arrastra Creek	0.48	1.00	0.65	0.09	YES
Granite Creek above Arrastra Creek	0.75	1.00	0.66	0.13	YES
Residual	0.44	1.00	0.36	0.35	NO
Otter Creek below McCullogh Cr excl. Mcphail and Spearing Cr	**0.47**	**1.00**	**0.87**	**0.08**	**YES**
Elliot Creek	0.44	0.88	1.00	0.00	YES
Manning Creek	0.74	1.00	1.00	0.01	YES
Thynne Creek	0.30	0.70	0.27	0.01	NO
Residual	0.44	1.00	0.99	0.11	YES
Spearing and Mcphail Creeks	**0.52**	**1.00**	**1.00**	**0.02**	**YES**
Above McPhail Creek	0.46	1.00	1.00	0.04	YES
McPhail Creek	0.60	1.00	0.98	0.00	YES
Residual	0.19	1.00	1.00	0.00	YES
McCullogh Creek	**0.36**	**1.00**	**0.92**	**0.04**	**YES**
Angstadt Creek	0.42	1.00	1.00	0.00	YES
Davis Lake and above	0.43	1.00	1.00	0.00	YES
unnamed eastern tributary	0.35	1.00	0.57	0.00	YES
Residual	0.20	0.89	0.58	0.17	YES
Otter Creek above McCullogh Creek	**0.40**	**1.00**	**1.00**	**0.01**	**YES**
Above and incl Bates Creek	0.44	0.93	0.80	0.00	YES
Guliford Creek	0.72	1.00	1.00	0.06	YES
Residual	0.29	0.89	1.00	0.01	YES

PF - Peak Flow; SE - Surface Erosion; RB - Riparian Buffer; MW - Mass Wasting; L2 - Level 2 IWAP

	PF	SE	RB	MW	L2
Tulameen River between Otter Cr and Vuich Cr excl. Lawless Cr	**0.41**	**0.95**	**0.36**	**0.09**	**NO**
Britton Creek above Illal Creek	0.50	0.72	0.34	0.03	NO
Champion Creek	0.56	1.00	0.23	0.19	YES

Illal Creek	0.22	0.52	0.48	0.00	NO
Jim Kelly Creek	0.09	0.54	0.00	0.00	NO
Residual	0.45	1.00	0.62	0.13	YES
Lawless Creek	**0.52**	**1.00**	**0.75**	**0.34**	**YES**
Holm Creek	0.70	1.00	0.81	0.57	YES
Lawless Creek upstream from Holm Creek	0.47	1.00	0.77	0.18	YES
Residual	0.55	1.00	0.90	0.43	YES
Vuich Creek	**0.13**	**0.47**	**0.21**	**0.01**	**NO**
Sutter Creek	0.05	0.63	1.00	0.00	YES
Vuich Creek above Sutter Creek	0.19	0.50	0.00	0.01	NO
Residual	0.05	0.20	0.04	0.00	NO
Tulameen River above Vuich Creek	**0.21**	**0.72**	**0.04**	**0.06**	**NO**
Holding Creek	0.34	1.00	0.00	0.13	NO
Pokunk Creek	0.17	0.58	0.11	0.03	NO
Tulameen River above Holding Creek	0.20	0.85	0.08	0.06	NO
Residual	0.16	0.60	0.00	0.04	NO
Similkameen River - Tulameen River to Granite Cr	**0.33**	**0.94**	**0.38**	**0.22**	**NO**
Bromley Creek	0.34	0.92	0.39	0.06	NO
Residual	0.32	0.95	0.37	0.29	NO
Whipsaw Creek	**0.60**	**1.00**	**0.72**	**0.16**	**YES**
Lamont Creek	0.70	1.00	0.69	0.13	YES
Whipsaw Creek headwaters	0.71	1.00	0.64	0.03	YES
Residual	0.42	1.00	0.77	0.30	YES
Similkameen River above Whipsaw Cr excl. Pasayten R & Copper Cr	**0.33**	**0.99**	**0.67**	**0.12**	**YES**
Belgie Creek	0.07	0.18	1.00	0.04	YES
Placer Creek	0.55	0.93	0.84	0.02	YES
Sunday Creek	0.25	0.91	0.45	0.00	NO
unnamed east bank south of Sunday Cr	0.52	1.00	0.58	0.00	YES
Residual	0.30	1.00	0.79	0.23	YES
Copper Creek	**0.32**	**0.44**	**0.12**	**0.03**	**NO**
Copper Creek headwaters	0.34	0.07	0.02	0.01	NO
unnamed	0.86	0.01	0.00	0.00	YES
unnamed	0.13	1.00	0.44	0.00	NO
unnamed Garrison Creek	0.27	1.00	0.20	0.00	NO
Residual	0.10	0.83	0.22	0.12	NO
Pasayten River (British Columbia)	**0.70**	**1.00**	**0.49**	**0.08**	**YES**
Calcite Creek	0.22	0.62	0.64	0.04	YES
Pasayten River - Peeve Cr to border	0.44	1.00	0.50	0.02	YES
Peeve Creek	1.00	1.00	1.00	0.15	YES
unnamed	0.12	0.75	0.21	0.30	NO
unnamed across from Peeve Creek	0.08	0.20	0.00	0.02	NO
Residual	0.48	1.00	0.29	0.10	NO

PF - Peak Flow; SE - Surface Erosion; RB - Riparian Buffer; MW - Mass Wasting; L2 - Level 2 IWAP

Interpretation

Under the protocols of the IWAP Guidebook, the impacts of past forest activities are reflected in a set of four hazard index values (peak flow, surface erosion, riparian buffer, and mass wasting), produced from the thirteen indicator scores, after their normalization by the IWAP conversion table. These results have been presented in the previous section, and the discussion below follows the interpretation defined by the IWAP protocol.

This interpretation is based on the assumption that the normalization values in the IWAP conversion table result in valid outcomes for each of the four Impact Categories. While the growing number of completed IWAP analyses appears to be pointing towards a necessary refinement in at least some of the conversion table values, such information was not available under the scope of this project. Recommendations for future analyses, based upon the values of the Hazard Indexes, are made under the IWAP protocol, but are not put forward here as absolutes. Instead, it is recommended that land and decision makers use the IWAP results as one criteria among many, in determining the scope of further review.

As a supplement or alternative to the Guidebook interpretation protocol, results of the Merritt District IWAP have been prepared as a set of 12 ranked indicator values, prior to their normalization by the conversion table. The 218 analysis areas produce a large set of values for judging the relative impact among the basins.

The results from the four separate analyses suggest that more than half of all basins and sub-basins meet the Guidebook criteria for Level 2 analysis. The results from the primary analysis (fifth order basins) showed that fifty-seven percent of all fifth order basins and fifty-seven percent of their associated sub-basins failed at least one of the three critical impact categories (peak flows, riparian buffers, and mass wasting). The fourth impact category, soil erosion, is not considered critical since failure of this category does not, by itself, initiate a Level 2 analysis. The results from the three secondary analyses showed that over sixty percent of all basins and associated sub-basins failed at least one of the three critical impact categories.

A review of the final report cards, suggests that the primary problems throughout the Merritt Forest District can be attributed in large measure to road density, and to harvesting within riparian buffers.

Fifth Order Basins

Thirty-two of the fifty-nine basins and one hundred twenty-three of the two hundred eighteen sub-basins meet the Guidebook criteria for a Level 2 analysis. Those areas which failed more than one impact category should have priority when evaluating basins for level 2 analysis (page 24). In particular, fourteen basins were in exceedence of the 0.5 threshold for peak flow, surface erosion, and riparian buffer impacts:

Allison Creek above Summers Creek
Clapperton Creek
Granite Creek

Guichon Creek
Hayes Creek above Siwash Creek
Lawless Creek
Midday Creek
Range Creek
Smith Creek
Spearing and Mcphail Creeks
Summers Creek
Voght Creek
Whipsaw Creek
Wolfe Creek

Peak Flow

The peak flow hazard index resulted in eighteen basins and sixty-one sub-basins with values greater than 0.5. The eighteen basins failed primarily due to road density. Three basins failed due to a high peak flow index while fifteen failed due to a combination of the peak flow index and road density within the basin. The sub-basins failures can be equally contributed to equivalent clearcut areas and road density - twenty-nine failed due to peak flow only and thirty-two failed due to peak flow in combination with road density.

Surface Erosion

A value greater than 0.5 for the surface soil erosion hazard index does not, by itself, initiate a level 2 analysis. If it did, ninety-three percent of all basins and eighty three percent of all sub-basins would meet the criteria for a Level 2 analysis. The high scores for the surface erosion hazard index can be attributed to both road density and erodible soils. The data below show the number of basins and subbasins whose surface erosion hazard index exceeds 0.5, and the criteria upon which the exceedence occurred.

Basin	Sub-basin	Criteria (Indicator number)
37	106	roads on erodible soils < 100 m from a stream (#6)
48	154	the average of density of roads on erodible soils (#4) and density of stream crossings (#7)
52	178	the average of density of roads< 100 m from a stream (#5) and density of stream crossings (#7)
44	152	the average of density of roads , 100 m from a stream (#5) and road density for entire sub-basin (#8)
28	87	the average of density of roads on erodible soils (#4) and road density for entire sub-basin (#8)
43	135	the average of density of roads on erodible soils (#4), density of stream crossings (#7), and road density for entire sub-basin (#8)

Riparian Buffers

The riparian buffer hazard index resulted in twenty-eight basins and one hundred three subbasins with values greater than 0.5. All twenty-eight basin failures were due to the portion of stream logged (Indicator #9). Six of these also failed due to portion of fish-bearing stream logged (Indicator # 10). Ninety-nine of the one hundred three subbasins failed Indicator #9 (portion of stream logged) and thirty two failed indicator # 10 (portion of fish-bearing stream logged). These failures reflect the practice of harvesting to the stream edge with no riparian buffer.

Mass Wasting

The mass wasting hazard index resulted in only one sub-basin meeting the criteria for a Level 2 Analysis. Hazard indicator 11 number of landslides, was based on insufficient data. The *Landslide* coverage consisted of only forty-four point locations for the entire 1.1 million hectares. However, there are many more than forty-four landslides throughout the District (Heller, 1997). Since two of the three options used to determine the mass wasting hazard index require landslide information, the ability of the model to accurately predict areas with potential mass wasting hazards is reduced. Additionally, the district contains few areas in exceedance of sixty percent slope, thus lowering the liklihood of the third option resulting in a value greater than 0.5.

Sixth Order Basins

Eight of the twelve sixth order basins and twenty-five of the forty sub-basins meet the criteria for a level 2 analysis. Those areas which failed more than one impact category should have priority when evaluating basins for level 2 analysis. In particular, Allison Creek and Guichon Creek exceeded the 0.5 threshold for the Peak Flow, Mass Wasting, and Riparian Buffer criteria.

Community Watersheds

Seven of the ten basins and eight of the eleven sub-basins meet the criteria for a level 2 analysis. Those areas which failed more than one impact category should have priority when evaluating basins for level 2 analysis. In particular, William Creek exceeded the 0.5 threshold for the Peak Flow, Surface Erosion, and Mass Wasting criteria, while six watersheds (Brook, Dillard, Hacket, Kwinshatin, Skuagam, and Trout Creeks) were in exceedence of the Peak Flow, Surface Erosion, and Riparian Buffer thresholds.

Miscellaneous Watersheds

Five of eight miscellaneous basins and two of three sub-basins meet the criteria for a level 2 analysis. Those areas which failed more than one impact category should have priority when evaluating basins for level 2 analysis.

Discussion

Limitations in input data

Results of a model application are the direct product of two factors: the model methodology, and the data used in the analysis. Consequently, limitations or errors within the source data will have a fundamental effect on its results. In the Merritt District IWAP, various data sets were seen to have limitations in completeness or maturity (i.e. a history of use which produces a detailed understanding of their pedigree, completeness, representativity, and limitations). The primary data layer with known lack of completeness was the landslide coverage, with only 44 identified features district-wide. Many of the fundamental data sets used in the IWAP were products were derived from preliminary data layers by the contractor, Middle Fork GIS. These are complex data which ideally should show a greater degree of internal development and interpretation by Ministry professional staff and GIS analysts. These critical data sets include:

- Cutblock units
- Equivalent clearcut areas and degree of hydrologic recovery
- Fish-bearing streams
- Logged streambanks
- Erodible soils and unstable slopes

The two data sets most subject to temporal change were the forest cover (for determining logged areas) and roads coverages. Results of the Merritt District IWAP reflect essentially none of the activities which occurred in the years 1995 and 1996, and only partially the activities of 1994.

Subjectivity in the analysis

A primary goal in the development of the ARC/INFO IWAP procedure (and hence, the Merritt District IWAP) was the objectification of as much of the IWAP analysis as possible, so as to provide a faithful and repeatable interpretation of the IWAP framework. That goal has been in large measure met, and most of the Merritt District IWAP was carried out under this objectivity. However, while the IWAP Guidebook presents the methodology under which analyses should be performed, it does not completely specify how the data sets to be used in the IWAP should be prepared. Consequently, various data sources used in the Merritt District IWAP were in some measure subject to subjective determination by the contractor. It is reasonable to consider that other operators could have interpreted the source data differently, which would have consequently produced differing results. The primary areas in which subjective interpretation was necessary included the following:

- Determination of erodible soils and unstable slopes
- Determination of inferred fish-bearing streams
- Interpretation of the Forest Cover FIP databases
- Determination of logged stream banks
- Classifying land use/land cover categories for determination of equivalent clearcut areas.

Comparing results to other IWAPs

As a result of the incompletely prescribed and partially subjective nature of various components of the IWAP (as described above), comparison of the results of the Merritt District IWAP against those from other IWAPs should be made with caution. Additionally, the analysis of a million plus hectare forest district, should be expected to differ greatly from an IWAP focussed upon a single basin, as it will lack the ability to focus intensely upon the conditions within a single basin. Finally, a completely GIS-based analysis will differ from a paper map and spreadsheet approach. Like the latter, it is inherently dependent upon the degree of completeness in the source data used in the analyses. However, with the paper map approach, the amount of effort grows far more rapidly with the increase in content and complexity of the source data than it does under the GIS approach. Also, under the GIS approach, the correction of errors, updating of data sets, and examination of planned activities or hypothetical scenarios is immensely more simple.

Future Directions

Future developments in both the GIS-based knowledge of the conditions within the District, and in the IWAP methodology itself are both expected and encouraged. For the former, current initiatives are expected to see a greatly enhanced knowledge of soil and terrain conditions, and of fish use information. All forest cover information used in this analysis is at least two years old, and will need to be updated, especially for those basins which have been the focus of recent harvest activity.

GIS in British Columbia is on the cusp of transition between the stages of data development and critical decision-making tool. This project has, for the Merritt Forest District, been a part of that transition, as it participated in the former and contributed to the latter. However, because of its partial basis in the former stage, its results must be viewed accordingly. A second-generation review would clearly provide enhanced knowledge on top of this first analysis.

GIS-based, so-called level 1 watershed analysis is an evolving discipline in general and in British Columbia in particular. Questions about the validity of the normalization values, discussed in this document, are the most visible aspect of the youthfulness of the methodology. However, the assumptions behind the level 1 approach- that there are fundamental indicators of watershed condition, which can be relatively easily determined without reliance upon detailed field review - are sound. Because it examined over a million hectares of the landscape in 218 analysis units, the Merritt District IWAP results may be of benefit in the evolution of the discipline, as land managers will be able to review their detailed knowledge of basins against results of the IWAP, and modify the latter where necessary to better reflect the former.

References Cited

Chan, B., 1996. Personal Communication, Ministry of Environment, Southern Interior Region.

ESRI, 1996. ARC/INFO Documentation, Version 7.0.4.

Heller, F., 1997. Personal Communication. Ministfy of Forests, Merritt Forest District, February, 1997.

Ministry of Environment, 1987. CAPAMP Volume 1: Data Entry and Validation Procedures for Soil, Agriculture Capability, Surficial Geology, and the All Purpose Entity. British Columbia Ministry of Environment and Parks Thematic Mapping Geographic Information Systems, Summer 1987.

Middle Fork GIS, 1996. *SmarTWTR*: A Stream Intelligence Program for TRIM TWTR Data. Report to B.C. Ministry of Environment, Southern Interior Region, October, 1996.

Middle Fork GIS, 1997. Technical Guide to the ARC/INFO Interior Watershed Assessment Procedure (ARC/IWAP). Report to B.C. Ministry of Environment, Southern Interior Region, March, 1997.

Ministry of Forests, 1995a. Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook. Forest Practices Code of British Columbia Act, June, 1995.

Ministry of Forests, 1995b. Interior Watershed Assessment Procedure Guidebook (IWAP). Forest Practices Code of British Columbia Act, September, 1995.

Ministry of Forests, 1996. Forest Inventory Planning Relational Data Dictionary, 2.0.

Terratech Western Profile Consultants, Ltd., 1994. Inventory of Forest Landslide Occurrences in the Kamloops Forest Region. Prepared for B.C. Ministry of Forests, Kamloops Forest Region, March, 1994.

Teti, P., 1997. Personal Communication. Ministry of Forests, Februrary, 1997.

Appendix A: Description of DBF Database Files

The results of the Merritt District IWAP are included on floppy diskette as a set of DBF database tables, which are readable by most current database, spreadsheet, and word-processing programs.

There are two sets of tables - one for the basin level data, and one for the subbasin level data. Names for each are similar, with the string 'sub' appended to the name of the subbasin level tables.

All basin tables share and can be related through the IWAPBASIN item. All subbasin tables share the IWAPBASIN, IWAPSUBBASIN, and UNIQUEBASIN items. The UNIQUEBASIN item identifies uniquely each analysis unit in the IWAP. Values of the IWAPSUBBASIN item which are equal to -1 indicate residual areas.

Contents and descriptions of the basin tables are presented below. Subbasin tables are not displayed, but are identical in form to the basin tables, with the exception of the inclusion of the IWAPSUBBASIN and UNIQUEBASIN items.

Tables are contained in three subdirectories: order5, order6, and commun. Tables in the commun subdirectory contain both community watershed and miscellaneous basin data.

BASINS.DBF

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
BASINNAME	80	C	-	Basin Name
SQ_KM	18	N	6	Basin Area (square kilometers)
MAP_ID	8	N	0	Map Identifier (order 5 only)

IWAP.DBF

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
SQ_KM	18	N	6	
IND1RAW	18	N	6	Values of indicators 1-13 prior to
to				normalization
IND13RAW	18	N	6	
INDEX1	18	N	6	Normalized Indicator Values
to				
INDEX13	18	N	6	
PF_HAZ	18	N	6	Peak Flow Hazard
SE_HAZ	18	N	6	Surface Erosion Hazard
RB_HAZ	18	N	6	Riparian Buffer Hazard
MW_HAZ	18	N	6	Mass Wasting Hazard
LEVEL2_FG	1	N	0	Guidebook Calls for Level2 IWAP (1=yes)

AREA.DBF

Basin area, ownership, erodible soils and unstable slopes area

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
SQ_KM	18	N	6	Basin area (km^2)
AREA_CROWN	18	N	6	Crown land (km^2)
PERC_CROWN	6	N	2	Percent crown ownership
AREA_PRIVA	18	N	6	Private land (km^2)
PERC_PRIVA	6	N	2	Percent private ownership
AREA_NATIV	18	N	6	First Nations ownership (km^2)
PERC_NATIV	6	N	2	Percent First Nations ownership
AREA_UNST	18	N	6	Area of unstable slopes (km^2)
PERC_UNST	6	N	2	Percent of watershed with unstable slopes
AREA_EROD	18	N	6	Area of erodible soils (km^2)
PERC_EROD	6	N	2	Percent of watershed with erodible soils

PKFLOW.DBF

Peak flow data

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
AREA_USE	18	N	6	Basin area for use in ECA calculation
AREA_ABOVE	18	N	6	Area above H60 line (km^2)
AREA_BELOW	18	N	6	Area below H60 line (km^2)
ABOVE_USE	18	N	6	Area above H60 for use in ECA calc (km^2)
ABOVE_IGN	18	N	6	Area above H60 not used in ECA calc (km^2)
BELOW_USE	18	N	6	Area below H60 for use in ECA calc (km^2)
BELOW_IGN	18	N	6	Area below H60 not used in ECA calc (km^2)
ECA_BELOW	18	N	6	ECA below H60 line (km^2)
ECA_ABOVE	18	N	6	ECA above H60 line (km^2)
ECA_BE_FRA	18	N	6	ECA above H60 / total area (km^2 / km^2)
ECA_AB_FRA	18	N	6	ECA above H60 / total area (km^2 / km^2)
ECA_AB_WT	18	N	6	Weighted ECA above H60 (km^2) = 1.5 * ECA_AB_FRA
PF_INDEX	18	N	7	Peak Flow Index

HYPSO.DBF

Basin hypsometric (h60) data. No associated table at the subbasin level

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
PERCENT	3	N	0	Hypsometric threshold percent (ie 60 for the H60 line)
ELEVATION	10	N	0	Elevation of H60 line (meters)

POINT.DBF

IWAP point data

IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
SQ_KM	18	N	6	Basin Area (km^2)
LANDSLIDES	18	N	6	Number of landslides in the basin
LNDSLD_DEN	18	N	6	Density of landslides (#/km^2)
ROADXSTREA	18	N	6	Number of road-stream crossings
RDXSTR_DEN	18	N	6	Density of crossings (#/km^2)

ROADS.DBF

Road data

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
RD_LENGTH	18	N	6	Road length (km)
RD_DENS	18	N	6	Road density (km / km^2)
ABOVE_HLIN	18	N	6	Road length above H60 (km)
HLINE_DENS	18	N	6	Road density above H60 (km / km^2)
STRBUF	18	N	6	Roads within 100 meters of stream (km)
BUF_DENS	18	N	6	Road density w/in 100m of stream (km /km^2)
RD_UNSTABL	18	N	6	Roads on unstable slopes (km)
UNST_DENS	18	N	6	Road density on unstable slopes (km / km^2)
RD_ERODIBL	18	N	6	Roads on erodible soils (km)
EROD_DENS	18	N	6	Road density on erodible soils (km / km^2)
EROD_BUF	18	N	6	Roads on erodible soils w/in 100m of stream (km)
ERODBUFDNS	18	N	6	Road density on erodible soils and w/in 100 m of stream (km / km^2)

STREAM.DBF

stream data

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
STR_LENGTH	18	N	6	Stream length (km)
STR_DENS	18	N	6	Stream density (km / km^2)
STR_FISH	18	N	6	Fish-bearing stream length (km)
FISH_FRAC	18	N	6	Fraction of streams which are fish-bearing (km/km)
STR_LOGGED	18	N	6	Logged stream length (km)
LOG_FRAC	18	N	6	Fraction of streams logged (km/km)
LOG_FISH	18	N	6	Logged fish-bearing stream length (km)
LOGFSHFRAC	18	N	6	Logged fish-bearing stream fraction (km/km)
LOG_GT60	18	N	6	Logged stream length on slopes over 60% (km)
LOG60_DENS	18	N	6	Basin density of logged streams on slopes over 60 percent (km / km^2)

MISC.DBF

Additional information

FIELD	WIDTH	TYPE	N.DEC	
IWAPBASIN	3	N	0	IWAP Basin Unique Identifier
SQ_KM	18	N	6	Basin area (km^2)
TEMPERATUR	3	C	-	Stream Temperature concerns (yes/no/unkown)
HYDROZONE	3	C	-	Hydrological zone
BEDROCK	3	C	-	Bedrock type
GLACIERS	3	C	-	Glaciers in the basin (yes/no)
RANGE	3	C	-	Range use near streams (yes/no/unk)
ATV	3	C	-	ATV use near streams (yes/no/unk)
MINING	3	C	-	Mining near streams (yes/no/unk)

For the fifth order analysis only, two additional tables, rank.dbf and subrank.dbf, are included. These tables present each of the basins ranked by each of the 13 iwap indicator values *prior to their normalization by the IWAP conversion table*.

RANK.DBF

FIELD	WIDTH	TYPE	N.DEC

IWAPBASIN	3	N	0	
RANK1	3	N	0	Rank of this basin for IWAP indicator 1
DECILE1	2	N	0	Decile group (ie 1-10) of this basin for IWAP indicator 1
RANK2	3	N	0	
DECILE2	2	N	0	
(Etcetera)				
RANK13	3	N	0	
DECILE13	2	N	0	