EA 1352

RESTORATION PLAN

AN INTERIOR EXAMPLE

Submitted to:

Forest Renewal BC

February 2000

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Submitted to:

Forest Renewal BC
727 Fisgard St.
Victoria, BC
V8W 9R1

by

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February 2000

EXECUTIVE SUMMARY

The Valley River is a community watershed that also supports two regionally significant species, bull trout, a blue listed species, and rainbow trout. Valley River has, therefore, been designated a Key Watershed by the Ministry of Environment, Lands and Parks (MELP) and the Ministry of Forests (MoF). This Restoration Plan describes in detail the work plans for two high priority subbasins, Turtle Creek and Mink Creek, that are recommended for restoration.

Investment in the Turtle and Mink subbasins will provide long-term economic benefits that will be evident in improved water quality, fish stocks and watershed health. These improvements will be a result of reduced sediment transport to streams from roads and slopes, re-establishment of hillslope drainage systems, instream habitat restoration, and riparian zone restoration.

Improvements in water quality through a reduction in sediment loads will significantly reduce water treatment costs for the Town of Lucre by $15,000 annually, and postpone reservoir dredging by an estimated 15 years. Restoration of road and hillslope drainage systems will also improve the productivity of degraded forest sites, while riparian treatments will improve channel stability, provide a long-term large woody debris source, and increase the quality of wildlife habitat along river corridors.

The juvenile abundances of the target species, rainbow and bull trout, are expected to increase by about 30% after implementation of the restoration works. This estimate is based on published evaluations of restoration projects, although evaluations on bull trout habitat restoration are very limited. Reduced sediment transport to the critical habitat reaches will further increase the long-term efficacy of instream treatments, improve egg incubation success for both target species, and contribute to greater juvenile and adult production.

A total of $661,000 is estimated to implement the proposed Restoration Plan, which includes $26,000 for the preparation of restoration prescriptions, $590,000 for the implementation of restoration treatments, and $45,000 for Routine Effectiveness Evaluations. Restoration activities in the two subbasins are anticipated to include 3.5 km of road deactivation, 17 km of riparian treatments, stabilization of 3 gullies, and salmonid rearing habitat improvements on 8.5 km of instream habitat.

WRP expenditures will fall into two distinct phases: Major Works, and Evaluation and Maintenance. In the Major Works phase, restoration prescriptions and treatments on all high priority components will be implemented. This phase will be concluded when quality assurance sign-offs have been provided by qualified professionals on all high priority works identified in this Restoration Plan.

The second phase, Evaluation and Maintenance, will continue beyond the Major Works phase, and will encompass the implementation of Routine Effectiveness Evaluations on both

subbasins, as well as maintenance and additional treatments. Additional treatments, if needed, will be described in an amendment to the Restoration Plan. The Evaluation and Maintenance phase will be concluded when a brief status report states that watershed health is acceptable and no maintenance or additional restoration treatments are required.

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1.0 INTRODUCTION

The Restoration Plan (RP) for Valley River summarizes the assessment information that was used to prioritize and select subbasins where restoration work would proceed. The Plan describes in detail the work plans for two high priority subbasins, Turtle Creek and Mink Creek. For each high priority subbasin, the RP:

- identifies the factors limiting water quality;
- identifies the critical limiting factors affecting fish;
- identifies the components targeted for restoration;
- describes the subbasin, component and site level restoration objectives;
- identifies the proposed restoration activities and sites;
- provides a schedule of works and budget estimate; and
- describes an evaluation plan.

2.0 RATIONALE FOR SELECTION AS KEY WATERSHED

The Valley River is community watershed and has been designated a 'very high' value. In addition, the watershed also supports two regionally significant species, bull trout, a blue listed species, and rainbow trout. Because both species are regionally significant, the Valley River watershed has a 'very high' fisheries value ranking (39 out of a possible score of 40). Valley River has, therefore, been designated a Key Watershed by the Ministry of Environment, Lands and Parks (MELP) and the Ministry of Forests (MoF).

The chances of restoration success are rated high by both ministries. All of the subbasins in Valley River, with the exception of the Gold Creek basin, had over 15% of their watershed areas cut by 1988. Even though the hillslopes, roads and stream channels have been impacted as a result of logging, there are still significant areas of good quality habitat within the basin. It is believed that restoration activities can significantly improve conditions or prevent further damages that will benefit both the quality of the drinking water and the habitat of the target species. Valley River has been classified as a Category I Watershed, and a Target Watershed for restoration.

3.0 DESCRIPTION OF WATERSHED

Valley River is a 4^{th} order interior watershed with a drainage area of 294 km^2 (Figure 1). The Valley River watershed is comprised of four sub-basins: Lower Valley, Mink, Turtle, and Gold. The entire watershed is above the 800 m elevation contour and exceeding the 1500 m contour at the upper elevations of most sub-basins. The Valley mainstem flows for approximately 35 km in a northwest direction from the Town of Lucre to its mouth.

The slope throughout the Valley River mainstem is low, at less than 1%. No barriers to fish migration were observed although some large log jams were observed in the lower study

area (Level 1 FHAP 1999). The tributaries are of low slope in the lower sections and become steeper approaching 6% at their upper ends.

The subbasins of the Valley watershed are coupled to the hillslopes in the headwater zone, but immediately below headwater slopes, are partially or completely decoupled across floodplains. Channel aggradation is common, and the greatest source of sediments is from the mobilization of glaciolacustrine sediments resulting from gullying or slope failures. The terrain is described by rounded summits and rolling terrain due to glacial processes in the Pleistocene. The main valleys are incised with steep valley walls. The surficial material in river valleys originates from glacial deposits due to a combination of ice-damming, glacio-fluvial deposits and incision by streams. Glaciolacustrine deposits of silt, clay, deltaic sands and gravels have accumulated in the lower reaches of tributaries. Large woody debris (LWD) is particularly important in this type of stream channel for primary habitat development.

Degraded freshwater habitat is believed responsible for much of the decline in bull trout and rainbow trout populations in Valley River. Impacts from logging have degraded stream habitat in the mainstem and its tributaries, particularly affecting rearing habitats for both bull trout and rainbow trout. Timber harvest activities impacting fish habitat have related to: logging to the edge of the streambanks, and logging and road construction on unstable terrain leading to slope failures and instream sedimentation. Fish habitat impacts have included: loss of pool habitat, in-filling of boulder and cobble riffles, decrease in quality of spawning substrate, and loss of LWD cover in pools. Because rainbow and bull trout heavily use small tributaries for spawning and rearing, and mainstem pool habitat for holding and rearing, these species have received the greatest impact from harvesting.

Approximately 28% of the lower and 13% of the upper Valley watershed has been harvested (Overview Channel and Hillslope Assessment 1998). In several cases, logging has occurred from the stream banks to the top of watersheds as slopes are moderate throughout. In some areas adequate buffers have been left along the stream banks and in other areas logging has occurred to the stream bank.

Placer mining for gold has been ongoing since 1861 in Gold Creek with most activity occurring in the upper portion of the sub-basin. The main mining impacts that occurred historically and are evident today include: hydraulic mining of the stream channel, mobile substrate accumulation (fine and coarse sediments), man-made channels diverting flow from the stream, and direct alteration of the stream channel.

4.0 PRIORITY SUBBASINS

Three of the four subbasins in Valley River are Category I Watersheds. Gold Creek is a Category IIB Watershed with logging in the lower reaches and placer mining in the middle and upper reaches. Restoration work in Gold Creek is not recommended because the impacts relate primarily to placer mining in the upper reaches, and no coordinated restoration plan is in place. There are no outstanding obligations on the part of the forest tenure holder in any of the subbasins.

The Overview (Stage 1) Assessments of Valley River examined hillslope (roads, landslides, gullies), riparian, channel and fish habitat condition in each of the four subbasins (Overview Channel and Hillslope Assessment 1998; Overview FHAP 1998). Overview summaries of channel and hillslope conditions for the four subbasins are presented in Tables 1 to 4 and Figure 2.

Turtle Subbasin is the community water source for the Town of Lucre and is considered the highest priority for restoration. The level of disturbance for the watershed components is low-moderate except for roads which are rated high (Tables 1 and 5). There is a high risk of impact to water quality from sediments generated from roads and gullies. Improper drainage, inadequate vegetative cover proximal to the road, and excessive cut- and fill-slope erosion are mostly responsible for road-related sediment inputs to Turtle Creek. There is a high likelihood of benefits from treatment of roads and gullies, and both components are recommended for restoration (Table 6). Even though a significant portion of the riparian zone has been logged, the streambanks are relatively stable and little sediment is being generated from bank erosion.

Mink Subbasin is the second priority for restoration. Mink Creek has the highest potential for the target species and is presently the most populated with rainbow trout and bull trout juveniles. Both target species, bull and rainbow trout, are heavily dependent on this subbasin for providing suitable rearing and spawning habitats. This subbasin has low to high levels of existing disturbance for each watershed component (Tables 2 and 5). In particular, there is a high incidence of riparian disturbance with a high risk to fish habitat. The likelihood of restoration success benefitting bull trout and rainbow trout habitat is rated high for restoration of instream habitat and riparian (long term) components in this subbasin. Instream habitat and riparian components are recommended for restoration (Table 6).

Lower Valley River is not recommended for restoration at this time (Table 6). There is a low risk to fish habitat for each of the watershed components (Tables 3 and 5). The benefits of restoration to the targeted species habitats would be rated low for all components in this subbasin. Habitat within the Lower Valley River is generally in good condition and, consequently, the benefits of instream restoration are considered low. Riparian logging has not occurred in this subbasin. Level of disturbance in the channel is considered low, and it has not overwidened significantly from historic conditions.

Restoration of the two high priority subbasins will require the implementation of primary and secondary watershed components to restore water quality in Turtle Creek, and to protect and restore critical limiting habitats for bull trout and rainbow trout in Mink Creek. The restoration objectives for each of the priority watershed components in Turtle Creek and Mink Creek are described below.

5.1 Turtle Subbasin

5.1.1 Basin Condition

Channel and hillslope conditions for Turtle Subbasin are described in Table 1. This is a Type B watershed with the stream channel coupled to the hillslopes in the headwaters, but uncoupled further downstream. Some early cutblocks, 1958 to 1972, occur in the middle Turtle Creek sub-basin. Landslide, channel, riparian and gully conditions are fair while road conditions are poor (Erosion and Mass Wasting Assessment 1999; Riparian Assessment 1999; Overview Channel and Hillslope Assessment 1998). There are numerous gullies and landslides associated with the roads (Figure 2). Three gullies are actively delivering sediment to the channel downstream of the lake. The channel is aggraded as a result of sediments delivered from hillslopes. Fish habitat is also fair in the mainstem of Turtle Creek (Overview FHAP 1998; Level 1 FHAP 1999).

5.1.2 Water Quality

The quality of the community water supply for Lucre is being impacted by primarily glaciolacustrine sediments delivered from roads (and skid trails) and gullies. In particular, turbidity levels are greater than the values recommended for drinking water in the British Columbia Approved Water Quality Guidelines (Anonymous 1998). Prior to logging in the subbasin, water quality was good and turbidity levels met the Water Quality Guidelines. High sediment loads are also causing the water supply reservoir to rapidly in-fill, and if not reduced, will necessitate dredging within the next five years.

5.1.3 Limiting Fish Habitat

The mainstem of the Turtle Subbasin has an abundant supply and quality of spawning gravels (Level 1 FHAP 1999). The abundance of LWD in the mainstem is considered fair, and there is adequate future recruitment of LWD as only a portion of the riparian has been logged. Deep pool habitat downstream of the lake is considered fair, having been impacted by sediments generated primarily from landslides and gullies. Also, boulder and cobble habitats have been in-filled by sedimentation, reducing cover for rainbow trout parr in riffles. Degraded summer rearing and adult holding habitats are considered to be limiting rainbow and bull trout production in Turtle Creek. A reduction in both boulder cover and water depths in pools will continue to occur unless hillslope sediment sources are stabilized.

5.1.4 Access Management

The Ministry of Forests has stipulated that two wheel drive road access must be maintained in Reaches 11and 12 because of ongoing silvicultural operations (Access Management Plan 1998). There is also a desire by Ministry of Environment, Lands and Parks to limit the access of recreational hunters to moose habitat on the west side of Reach 9.

5.1.5 Restoration Objectives

There are two Subbasin Level Objectives for restoration in Turtle Creek. The objectives are:

- to reduce sediment delivery from the hillslopes to the mainstem of Turtle Creek; and
- to improve water quality in the community water supply for the Town of Lucre.

The primary watershed components for restoration in the Turtle Subbasin are roads (Tables 5 and 6). There are 35 km of road in this subbasin of which 3.5 km are considered high priority for deactivation and 7.9 km are medium priority (Erosion and Mass-Wasting Assessment 1999; Access Management Plan 1999). In addition, many of the skid trails have surface erosion caused by the concentration of drainage and, in many cases, this sediment is entering the creek directly. The Component Level Objectives for road deactivation works in Turtle Subbasin are:

- reduce the volume of sediment generated from roads and trails;
- restore hillslope drainage networks; and
- reduce the intensity of water erosion on exposed mineral soils.

Site Level Objectives for road deactivation works, as they apply to high priority sites, are:

- increase the number of crossings and cross-ditches;
- reduce the erodibility of exposed soil surfaces on roads, trails, and cut- and fill-slopes; and
- stabilize existing and potential road-related failures that have direct linkages to the mainstem channel.

The secondary watershed component for restoration in Turtle Subbasin is gullies. The 5 km of road recommended for deactivation have had numerous road-related failures owing to inadequate drainage structures. There are presently several gullies that have significant volumes of sediment from previous road wash-outs. These gullies have direct linkages to the mainstem of Turtle Creek. The gully component has a high likelihood of benefit to water quality if restored. The Component Level Objective for gullies is:

- reduce the volume of sediment generated from gullies that originated from road wash-outs.

The Site Level Objective is:

- reduce the volume of road-prism material occupying gully crossings.

Restoration of the roads and gullies will also have a high benefit on fish habitat by reducing sedimentation in rainbow and bull trout rearing and holding habitats. No additional fish habitat restoration works are recommended. For the other watershed components, i.e., landslides, riparian and channel, no restoration work is recommended. No landslides are at risk of contributing sediment to the channel. There is also a low benefit to water quality from restoration of the channel component because existing channel disturbance relates primarily to sediments derived from gullies and road failures rather than the streambanks.

5.2 Mink Subbasin

5.2.1 Basin Condition

Channel and hillslope conditions for Mink Subbasin are described in Table 2. This is a Type B watershed with the stream channel uncoupled from the hillslopes. Riparian condition is poor while hillslope conditions are good (Erosion and Mass Wasting Assessment 1999; Riparian Assessment 1999). Channel condition is considered fair with all of the disturbance attributed to accelerated bank erosion after riparian logging. Fish habitat is considered of fair quality with extensive pool in-filling and a low frequency of LWD (Level 1 FHAP 1999).

5.2.2 Limiting Fish Habitat

The mainstem (Reaches 14-18) of the Mink Subbasin has an abundant supply and quality of spawning gravels for both species of trout (Level 1 FHAP 1999). Pool cover is considered fair with less than 6 % wood cover, but there is no future recruitment as the riparian zones have been heavily logged on both banks (Figure 4). Currently, the riparian is dominated by mature aspen. The abundance of riffles has provided good rearing habitat for rainbow trout fry and parr at moderate flows. The few deep pools that do occur have been created by multiple-log structures. The lack of deep pools and loss of LWD cover in the pools has reduced the quantity and quality of late summer rearing habitat for rainbow and bull trout juveniles, and holding habitat for adult rainbow trout.

5.2.3 Access Management

Recreational rainbow trout anglers have requested that the mainline on the south side of Reaches 14 to 17 be maintained (Access Management Plan 1999). The Ministry of Forests has stipulated that two wheel drive road access must be maintained on specific spur roads and the mainline because of ongoing silvicultural operations about 2.5 km north of Reach 18.

5.2.4 Restoration Objectives

The Subbasin Level Objectives for Mink Creek are:

- improve rearing and holding habitat for bull trout and rainbow trout; and
- restore a functional, conifer-dominated riparian forest.

The primary watershed component for restoration in Mink Subbasin is instream fish habitat (Table 6). The quality of summer rearing habitat for juvenile trout and holding habitat for adult rainbow trout are the main concerns. The Component Level Objectives for the instream habitats are:

- increase the frequency of deep pools;
- increase residual pool depths; and
- increase cover in the tributaries and mainstem.

Site Level Objectives for the instream habitats are:

- increase LWD frequency;
- increase the percent of LWD cover in pools; and
- increase scour in existing pools.

The secondary watershed component for restoration in Mink Subbasin is riparian (Table 6). Long-term stability of the tributaries and mainstem channels have been compromised by the removal of riparian vegetation from both streambanks. Recruitment of LWD to the tributaries and mainstem channels is expected to be limited over the next 75-100 years. Re-establishment of a conifer dominated riparian forest will, in the long term, lead to improved bank stability and channel geometry, and improved rearing habitats for bull trout and rainbow trout by providing a LWD recruitment source. Also, LWD from the restored riparian area will strongly influence channel morphology (and fish habitat) in these streams where the average bankfull widths are less than 12 m. The Component Level Objectives for riparian restoration in Mink Subbasin are:

- increase potential for stream bank stability;
- establish optimum conifer density to provide an adequate size and number of LWD for future instream habitat; and
- accelerate conifer growth rate in the riparian reserve zone.

Site Level Objectives for riparian restoration are:

- increase soil cohesion on stream banks; and
- reduce growth competition to conifers from deciduous species.

For the other watershed components, i.e., landslides, gullies, roads and channel, no restoration work is recommended. Landslides, roads and gullies have a low level of disturbance and a low risk to targeted fish habitat. There is a moderate risk to fish habitat from the channel component as a consequence of bank erosion and subsequent pool in-filling. However, channel restoration benefits are considered low because it is believed that the streambanks cannot be treated cost-effectively to have a significant fish habitat benefit, and riparian treatments will have the greatest benefit to long term bank stability.

6.0 IMPLEMENTATION PLAN

6.1 Turtle Creek

6.1.1 Work Site Priorities

Figure 3 shows the proposed sites, segments or reaches where prescriptions for each priority component are recommended. All medium and high priority locations will be prescribed, but restoration works will only be implemented at high priority locations at this time. Activities anticipated for road restoration include: drainage control and road deactivation of roads at high risk of landsliding into the streams; removing blocked culverts and installing fords; installing cross-ditches and water-bars; and seed grass or plant deciduous shrubs on exposed soil surfaces. Roads will be re-vegetated after deactivation to reduce surface erosion. For the gullies which are persistently releasing sediments to the mainstem, restoration activities will include: removing fill and sub-grade material in gully crossings; and stabilizing by seeding grass, and/or installing biotechnical works.

It is anticipated that restoration work will involve:

- about 3.5 km of road deactivation;
- restoration of three gullies.

6.1.2 Time Frame of Works

Prescription plans for the roads and gullies will be undertaken during the summer of 2000. Restoration works will begin with road deactivation in 2001, starting on the north side of the mainstem and lake. Gully restoration will occur concurrently with road deactivation. If bio-engineering techniques are employed, gully stabilization will occur during the willow dormancy period, typically late fall to early spring. It is anticipated that road deactivation and gully stabilization will be completed in one year.

6.1.3 Milestone and Restoration Completion Benchmarks

Restoration prescriptions, works scheduling and the anticipated construction budget will be prepared and managed by the multi-year agreement (MYA) holder. Activity summary reports will be submitted each February to District and/or Regional Agency WRP specialists. The reports will summarize pending and completed restoration work, Effectiveness Evaluation findings, recommended maintenance, and detailed expenditure statements.

WRP expenditures in the Turtle Creek Subbasin will fall into two distinct phases: Major Works, and Evaluation and Maintenance. In the Major Works phase, restoration prescriptions and treatments on all high priority works will be implemented. This phase will be concluded when quality assurance sign-offs have been provided by qualified professionals on all high priority works identified in this Restoration Plan.

The second phase, Evaluation and Maintenance, will continue beyond the Major Works phase and will encompass the implementation of Effectiveness Evaluations, as well as maintenance and additional treatments, if appropriate. The MYA holder will be responsible for the implementation of Effectiveness Evaluations and maintenance on the treated high priority sites.

Five years after completion of all high priority works, a brief status report on watershed health will be provided by qualified professionals doing the Routine Evaluations. The report will provide an interdisciplinary evaluation on the state of recovery of the subbasin and on the effectiveness of restoration treatments at meeting the stated restoration objectives. Specifically, this report will:

- summarize Routine Evaluation findings;
- describe the present status and extent of recovery of the watershed components (e.g., sediment sources; levels of risk on roads, landslides and gullies; hillslope, riparian, channel and habitat condition);
- describe the state of recovery of watershed processes;
- provide the rationale if further restoration work on recently identified high priority sites or on moderate priority sites is required; and
- identify the specific sites requiring maintenance or treatment.

If further restoration treatments are recommended, an amendment to the Restoration Plan would be prepared by the MYA holder that incorporates status report findings and recommendations. The amended RP would be submitted to the WRC for approval. A status report would again be prepared five years after completion of the recommended restoration treatments. The Evaluation and Maintenance phase will be concluded when the status report states that:

- Routine Effectiveness Evaluations of road and gully components indicate that restoration works are meeting or exceeding the restoration objectives;
- Levels of risk on roads, landslides, and gullies are acceptable;
- Analysis of chemical parameters at the intake of the community water supply indicates that water quality meets the British Columbia Approved Water Quality Guidelines (Anonymous 1998) for drinking water. In particular, the value for maximum induced turbidity should be less than1 NTU; and
- No maintenance or additional treatments are recommended.

6.1.4 Effectiveness Evaluation Plan

Routine Evaluations are recommended for Turtle Creek. The main objectives of the Routine Evaluations will be to:

- assess the present configuration and condition of restoration treatments (i.e., are the works still in place);
- through the assessment of a number of key variables, assess whether or not the treatments have been effective in addressing the restoration objectives (i.e., are the works functioning as intended); and
- determine if remedial work is needed.

Although further refinement will occur after prescriptions have been completed, the effectiveness evaluation questions anticipated for each watershed component are:

Roads

1) Has deactivation of roads at risk reduced the incidence of road-related failures?
2) Has revegetation of skid trails and deactivated roads reduced surface erosion?
3) Has installing cross-ditches and water-bars reduced the concentration of drainage?

Gullies

1) Has cleaning and seeding gullies reduced sediment delivery to the mainstem?
2) Has bioengineering reduced the frequency of gully failures?

The variables that will be evaluated are:

- incidence of landslides, failures or surface erosion from deactivated roads and trails using rating categories;
- percent vegetative cover on rehabilitated gullies, skid trails, cut- and fill-slopes, and deactivated roads using ordinal rating categories;
- evaluation of present stability of rehabilitated gullies using rating categories;
- functional condition of water management structures (crossings, cross-ditches, fords, etc.) using rating categories; and
- suspended sediment and turbidity concentrations of raw water at the intake to community water supply.

The proposed sampling frequency and methodology are:

Roads: annual aerial review of all works to determine if post-deactivation road-related landslides have occurred; to examine vegetative cover; and to determine if surface flow is still contained in intended channels and structures.

Gullies: annual aerial and/or ground review of gullies to determine stability and percent of vegetative cover.

Water Quality: continuous sampling using an Optical Back Scatter (OBS) meter, and supplemented with intermittent pump sampling during flood peaks. All sampling to be conducted by the Town of Lucre.

Sampling on roads and gullies may be terminated when residual risk is deemed acceptable. All evaluation data, interim and final reports will be submitted annually to district and/or regional agency WRP specialists. This will provide an opportunity for adjustments to be made in the evaluation objectives, selection of variables or sampling methodologies.

6.1.5 Budget

Estimated costs for the preparation of restoration prescriptions, implementation of restoration works and Routine Effectiveness Evaluations are provided in Table 7. The budget estimate assumes that the consultant(s) develops prescription plans for roads and gullies concurrently and costs associated with effectiveness evaluations represent the total to complete the Routine Evaluations as specified.

6.2 Mink Creek

6.2.1 Work Site Priorities

Figure 4 shows the proposed sites, segments or reaches where prescriptions for each priority component are recommended. All medium and high priority locations will be prescribed, but restoration works will only be implemented at high priority locations at this time. Restoration works will include LWD structures that will increase cover in mainstem pools, and increase pool depths hydraulicly through scour. High priority riparian treatments are paired with high priority instream fish habitat works. Similarly, medium and low priority riparian treatments are paired with adjacent fish habitat works that are considered medium or low priority, respectively.

It is anticipated that restoration work will involve:

- instream habitat treatments on about 8.5 km of the mainstem and tributaries; and
- riparian treatments on 17 km of streambanks.

6.2.2 Time Frame of Works

Prescription plans for riparian and instream habitat treatments will be undertaken in the summer of 2000. We anticipate beginning on instream habitat work in 2002, after restoration works are completed in Turtle Creek. These works will be located adjacent to high priority riparian segments in Reaches 14 to 17. It is anticipated that habitat restoration will extend over three years. The instream work will be implemented during the recommended timing window, from July 15 to August 15 (Chilibeck1992).

Riparian treatments will be undertaken between the late fall and early spring. They will begin in the high priority mainstem segments of Reach 17 during the late fall of 2001, and the high priority tributary segments in 2002. It is anticipated that riparian treatments will be completed by the spring of 2003. Riparian treatments of the medium and low priority segments are not recommended at this time.

6.2.3 Milestone and Restoration Completion Benchmarks

Restoration prescriptions, works scheduling and anticipated construction budget will be prepared and managed by the MYA holder. Activity summary reports will be submitted each February to district and/or regional agency WRP specialists. The reports will summarize pending and completed restoration work, Effectiveness Evaluation findings, recommended maintenance, and detailed expenditure statements.

WRP expenditures in the Mink Creek Subbasin will fall into two distinct phases: Major Works, and Evaluation and Maintenance. In the Major Works phase, restoration prescriptions and treatments on all high priority works will be implemented. This phase will be concluded when quality assurance sign-offs have been provided by qualified professionals on all high priority works identified in this Restoration Plan.

The second phase, Evaluation and Maintenance, will continue beyond the Major Works phase and will encompass the implementation of Effectiveness Evaluations, as well as maintenance and additional treatments, if appropriate. The MYA holder will be responsible for the implementation of Effectiveness Evaluations and maintenance on the treated high priority sites.

Five years after completion of all high priority works, a brief status report on watershed health will be provided by qualified professionals doing the Routine Evaluations. The report will provide an interdisciplinary evaluation on the state of recovery of the subbasin, and on the effectiveness of restoration treatments at meeting the stated restoration objectives. Specifically, this report will:

- summarize Routine Evaluation findings;
- describe the present status and extent of recovery of the watershed components (e.g., sediment sources; levels of risk on roads, landslides and gullies; hillslope, riparian, channel and habitat condition);
- describe the state of recovery of watershed processes;
- provide the rationale if further restoration work on recently identified high priority sites or on moderate priority sites is required; and
- identify the specific sites requiring maintenance or treatment.

If further restoration treatments are recommended, an amendment to the Restoration Plan would be prepared by the MYA holder that incorporates status report findings and recommendations. The amended RP would be submitted to the WRC for approval. A status report would again be prepared five years after completion of the recommended restoration treatments. The Evaluation and Maintenance phase will be concluded when the status report states that:

- Routine Effectiveness Evaluations of riparian and fish habitat components indicate that restoration works are meeting or exceeding the restoration objectives;
- Levels of risk on roads, landslides, and gullies are acceptable;
- Comparison of fish habitat conditions after restoration to FHAP diagnostic quality values (Table 5 in Johnston and Slaney 1996) are within the fair and good levels (reach basis); and
- No maintenance or additional treatments are recommended.

6.2.4 Effectiveness Evaluation Plan

Routine Evaluations are recommended for Mink Creek. The main objectives of the Routine Evaluations will be to:

- assess the present configuration and condition of restoration treatments (i.e., are the works still in place);

- through the assessment of a number of key variables, assess whether or not the treatments have been effective in addressing the restoration objectives (i.e., are the works functioning as intended); and
- determine if remedial work is needed.

Although further refinement will occur after prescriptions have been completed, the effectiveness evaluation questions anticipated for each watershed component are:

Instream Habitat

1) Have LWD structures increased residual pool depth?
2) Has the cover in pools used by bull trout and rainbow trout increased?
3) Has the frequency of pools increased?

Riparian

1) Has brushing permitted conifer growth to outpace competing brush species?

The variables that will be evaluated are:

- growth of conifers and brush species;
- residual pool depth;
- pool frequency;
- functional LWD frequency;
- percent cover;
- presence/absence of bull trout and rainbow trout; and
- instream structure stability and condition using rating categories.

The proposed sampling frequency and methodology are:

Instream Habitat: walk through review of all installations after first and third year to determine habitat complexity and functional stability and condition, following Routine Monitoring Protocol (Koning et al. 1998); measure residual pool depths; presence/absence of bull trout and rainbow trout using Gee traps or through visual observation; sampling every five years thereafter or after a 1 in 10 year flood event.

Riparian Areas: annual inspection to determine growth of conifers and brush species. Once a stand reaches free-to-grow, inspection will be every five years.

All evaluation data, interim and final reports will be submitted annually to district and/or regional agency WRP specialists. Reports will also be submitted annually to the WRC so that adjustments can be made, if necessary, in the evaluation objectives, selection of variables or sampling methodologies.

We suggest that the evaluation on riparian areas also be considered for an Intensive Evaluation. Riparian treatments are still experimental and require further refinement before being applied on a broader basis. This would be a longer term study, and include more frequent sampling, permanent sample plots, and quantitative variables. A separate proposal will be submitted for this evaluation if the RP is approved.

6.2.5 Budget

Estimated costs for the preparation of restoration prescriptions, implementation of restoration works and Routine Effectiveness Evaluations are provided in Table 8. The budget estimate assumes that costs associated with Effectiveness Evaluations represent the total to complete the Routine Evaluation as specified.

7.0 RATIONALE FOR INVESTMENT

Investment in the Turtle and Mink subbasins will provide long-term economic benefits that will be evident in improved water quality, fish stocks and watershed health. These improvements will be a result of reduced sediment transport to streams from roads and slopes, re-establishment of hillslope drainage systems, instream habitat restoration, and riparian zone restoration.

Improvements in water quality through a reduction in sediment loads will significantly reduce water treatment costs for the Town of Lucre by $15,000 annually, and postpone reservoir dredging by an estimated 15 years. Restoration of road and hillslope drainage systems will also improve the productivity of degraded forest sites, while riparian treatments will improve channel stability, provide a long-term large woody debris source, and increase the quality of wildlife habitat along river corridors.

The juvenile abundances of the target species, rainbow and bull trout, are expected to increase by about 30% after implementation of the restoration works. This estimate is based on published evaluations of restoration projects, although evaluations on bull trout habitat restoration are very limited (Koning and Keeley 1997). Reduced sediment transport to the critical habitat reaches will further increase the long-term efficacy of instream treatments, improve egg incubation success for both target species, and contribute to greater juvenile production.

A total of $661,000 is estimated to implement the proposed Restoration Plan, which includes $26,000 for the preparation of restoration prescriptions, $590,000 for the

implementation of restoration treatments, and $45,000 for Routine Effectiveness Evaluations. Restoration activities in the two subbasins are anticipated to include 3.5 km of road deactivation, 17 km of riparian treatments, stabilization of 3 gullies, and salmonid rearing habitat improvements on 8.5 km of instream habitat.

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TABLES

Table 1. Channel and hillslope conditions for Turtle Creek.

Subbasin	Turtle Creek
Drainage Area (km^2)	50
Tenure	98 % TFL; 2% Municipal
Area Logged (%)	15.4
Equivalent Clearcut Area (%)	10
Channel (lower reach)	
Type (CAP)	Riffle-pool
Width (m)	8.5-10
Gradient (%)	1-2
Watershed Type	In the downstream portion, the stream channel is uncoupled from the hillslopes. Floodplains are well developed.
Channel Condition	Fair. The mainstem channel appears to be aggraded as a result of forestry-related landslides. Some logging of the riparian zone has occurred but bank erosion is minimal. Bank stability is considered moderate. Sediment wedges, and LWD jams were evident in the mainstem reaches.
Riparian Condition	Fair. Only a portion of the mainstem has been logged to the water's edge. LWD recruitment to the stream channel from the riparian zone is considered fair. Mature spruce and cottonwood are predominant.
Road Condition	Poor. 5 km of road were rated as having a moderate to high risk of failure. Of this 5 km, 3 km were moderate risk and 2 km were high risk. Improper drainage control appears to be the main cause of road instability. Also, some of the high risk roads were constructed on unconsolidated sediments (glaciolacustrine).
Hillslope Condition	Fair. Three gullies located primarily in the lower reaches of the mainstem and associated with existing roads are actively transporting sediment to the mainstem. No landslides or gullies have been rehabilitated.

Table 2. Channel and hillslope conditions for Mink Creek.

Subbasin	Mink Creek
Drainage Area (km^2)	41
Tenure	100 % TFL
Area Logged (%)	23.5
Equivalent Clearcut Area (%)	8
Channel (lower reach)	
Type (CAP)	Riffle-pool
Width (m)	8-11
Gradient (%)	1-2
Watershed Type	Stream channels are coupled to hillslopes but in the downstream portion, the stream channel is uncoupled from the hillslopes.
Channel Condition	Fair. In general, the mainstem channel appears stable with a consistent and appropriate bankfull width, and no evidence of extensive bars. The channel bed is comprised of gravel substrate with little fines. In several locations, logging to the water's edge has de-stabilized the streambanks, and caused some bank erosion. Bank stability however is considered moderate. LWD occurs sparsely in the channel.
Riparian Condition	Poor. The mainstem and tributaries have been logged to the water's edge and the riparian areas are now primarily aspen. LWD recruitment to the stream channel from the riparian zone is considered poor. Some mature spruce are present.
Road Condition	Good. All road segments are at a low risk of failure. None of the road segments have been rehabilitated.
Hillslope Condition	Good. No landslides or gullies are actively transporting sediment to the creek channel. No landslides or gullies have been rehabilitated.

Table 3. Channel and hillslope conditions for Lower Valley River.

Subbasin	Lower Valley River
Drainage Area (km^2)	294
Tenure	100 % TFL
Area Logged (%)	28
Equivalent Clearcut Area (%)	17
Channel (lower reach)	
Type (CAP)	Riffle-pool
Width (m)	10-15
Gradient (%)	0.8-1
Watershed Type	Stream channels are coupled to hillslopes but in the downstream portion, the stream channel is uncoupled from the hillslopes.
Channel Condition	Good. The mainstem channel is meandering and appears to be relatively unchanged in comparison to the historic channel prior to logging. There is little evidence of aggradation from hillslope mass wasting in channel. Bank stability is considered good. LWD occurs frequently and typically in small debris jams at meander bends.
Riparian Condition	Good. No riparian logging has occurred. The vegetation on both banks is old growth forest. LWD recruitment to the stream channel from the riparian zone is considered good.
Road Condition	Fair. About 2 km of road were rated as having a moderate risk of failure. None of the roads are impacting the stream channel. Improper drainage control appears to be the main cause of road instability. Also, some of the moderate risk roads were constructed on unconsolidated sediments (glaciolacustrine). None of the road segments have been rehabilitated.
Hillslope Condition	Good. No landslides were evident. Only one gully associated with a previous road washout is transporting a small amount of sediment. This gully is uncoupled to the stream channel. No landslides or gullies have been rehabilitated.

Table 4. Channel and hillslope conditions for Gold Creek.

Subbasin	Gold Creek
Drainage Area (km^2)	53
Tenure	30% TFL; 70% Crown
Area Logged (%)	3.1
Equivalent Clearcut Area (%)	2
Channel (lower reach)	
Type (CAP)	Riffle-pool
Width (m)	7.5-12
Gradient (%)	1
Watershed Type	Stream channels are coupled to hillslopes but in the downstream portion, the stream channel is uncoupled from the hillslopes.
Channel Condition	Fair. In the lower reaches the creek meanders along a flat floodplain. Placer mining in the middle and upper reaches has caused channel aggradation, particularly evident in the lower reaches. Bank stability is considered fair. LWD occurs frequently and is the dominant cover element.
Riparian Condition	Good. The riparian areas have not been logged. LWD recruitment to the stream channel from the riparian zone is considered good.
Road Condition	Roads were constructed within the subbasin to access mining sites upstream. Roads are in good condition through the TFL, but in fair condition and associated with slides and gullies in the upper portion of the basin.
Hillslope Condition	No landslides or gullies are impacting on the stream channel in the lower reaches. In upper reaches hillslope condition is fair with four landslides and four gullies actively delivering sediment to the channel. No landslides or gullies have been rehabilitated.

Table 5. Evaluation of the likelihood of restoration activities benefitting fish habitat for all subbasins in Valley River watershed.

				Watershed Components					
Subwatershed Example	Target Species	Limiting Fish Habitat/Restoration Priority	Watershed Condition and Restoration Benefits	Landslides	Gullies	Roads	Riparian	Channel	Instream Fish Habitat
Turtle Creek		Community Water Supply	Level of Existing or Potential Disturbance	Moderate	Moderate	High	Moderate	Moderate	N/A
			Impact or Risk to Water Quality	Low	High	High	Low	Moderate	N/A
			Likelihood of Benefits to Water Quality from Restoration of Component	Low	High	High	Low	Low	N/A
Turtle Creek	Rainbow/ Bull Trout	Summer rearing; Adult holding	Impact or Risk to Fish Habitat	Low	High	High	Low	Moderate	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	High	High	Low	Low	Low
Mink Creek	Rainbow/ Bull Trout	Summer rearing; Adult holding	Level of Existing or Potential Disturbance	Low	Low	Low	High	Moderate	Moderate
			Impact or Risk to Fish Habitat	Low	Low	Low	High	Moderate	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	Low	Low	High (Long Term)	Low	High
Lower Valley River	Rainbow/ Bull Trout	None	Level of Existing or Potential Disturbance	Low	Low	Moderate	Low	Low	Low
			Impact or Risk to Fish Habitat	Low	Low	Low	Low	Low	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	Low	Low	Low	Low	Low
Gold Creek	Rainbow Trout	Summer rearing; Adult holding	Level of Existing or Potential Disturbance	Moderate	Moderate	Moderate	Low	Moderate	Low
			Impact or Risk to Fish Habitat	Moderate	Moderate	Moderate	Low	Moderate	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	High	High	Low	Low	Low

Table 6. Prioritization of subbasins and components for restoration in Valley River watershed.

			Likelihood of Restoration Success			Component for Restoration	
Watershed	Subbasin	Priority	Low	Moderate	High	Primary	Secondary
Valley	Turtle	1			*	Roads	Gullies
	Mink	2			*	Instream	Riparian
	Lower Valley	-	*			None	
	Gold	Cat. IIB			*	Roads	Gullies

Table 7. Cost estimate for restoration project in Turtle Creek.

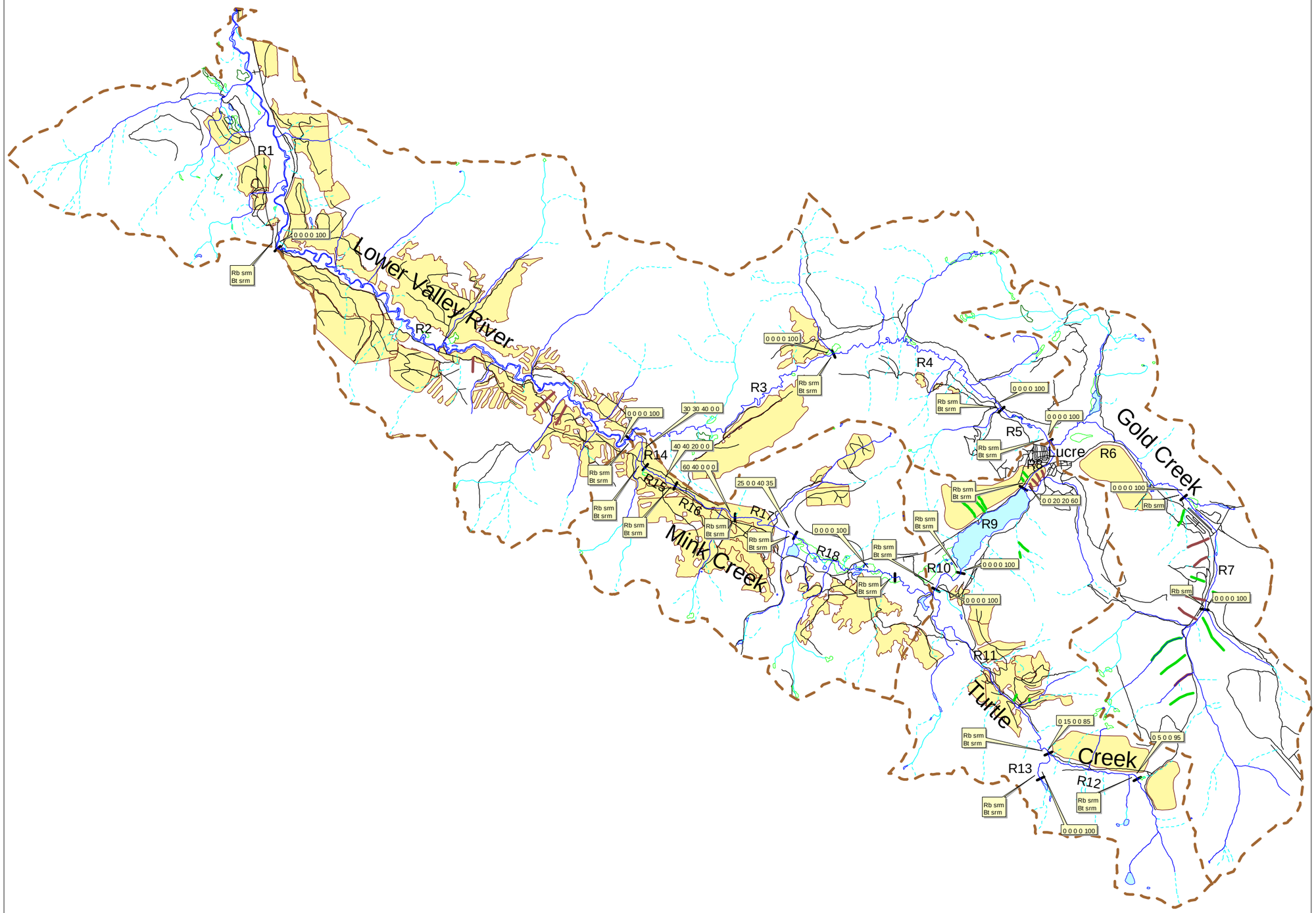
Description		Estimated Cost
Prescription Plans		
1	Roads	$5,000.00
2	Gullies	$3,000.00
Sub-total Prescription Plans		**$8,000.00**
Restoration Works		
1	Roads	$175,000.00
2	Gullies	$20,000.00
Sub-total Restoration Works		**$195,000.00**
Effectiveness Evaluations		
1	Roads	$10,000.00
2	Gullies	$5,000.00
3	Water Quality	$10,000.00
Sub-total Effectiveness Evaluations		**$25,000.00**
Total Cost		**$228,000.00**

Table 8. Cost estimate for restoration project in Mink Creek.

Description		Estimated Cost
Prescription Plans		
1	Instream Habitat	$10,000.00
2	Riparian	$8,000.00
Sub-total Prescription Plans		**$18,000.00**
Restoration Works		
1	Instream Habitat	$255,000.00
2	Riparian	$140,000.00
Sub-total Restoration Works		**$395,000.00**
Effectiveness Evaluations		
1	Instream Habitat	$10,000.00
2	Riparian	$10,000.00
Sub-total Effectiveness Evaluations		**$20,000.00**
Total Cost		**$433,000.00**

FIGURES

Figure 1. Index Map of the Valley River watershed.



LEGEND

- Stream - resident
- Stream - unknown
- Intermittent Stream
- Marsh
- Swamp
- Lake
- Roads
- Watershed Boundary
- Reach Break
- Slide Failure
- Gully Failure
- Logged

Rb srm
Bt srm

Fish Distribution and Habitat Use
Species: Rb Rainbow Trout, Bt Bull Trout
Habitat: s spawning, r rearing, m migration

0 15 25 0 60

Riparian Vegetation Type (RVT) Classification
Percent Composition: RVT 1 2 3 4 5

N

1:100000

1 0 1 2 Kilometers

Figure 2.
Map of Valley River showing subbasin condition from Overview/Stage 1 Assessments.

LGL Limited, Feb. 00

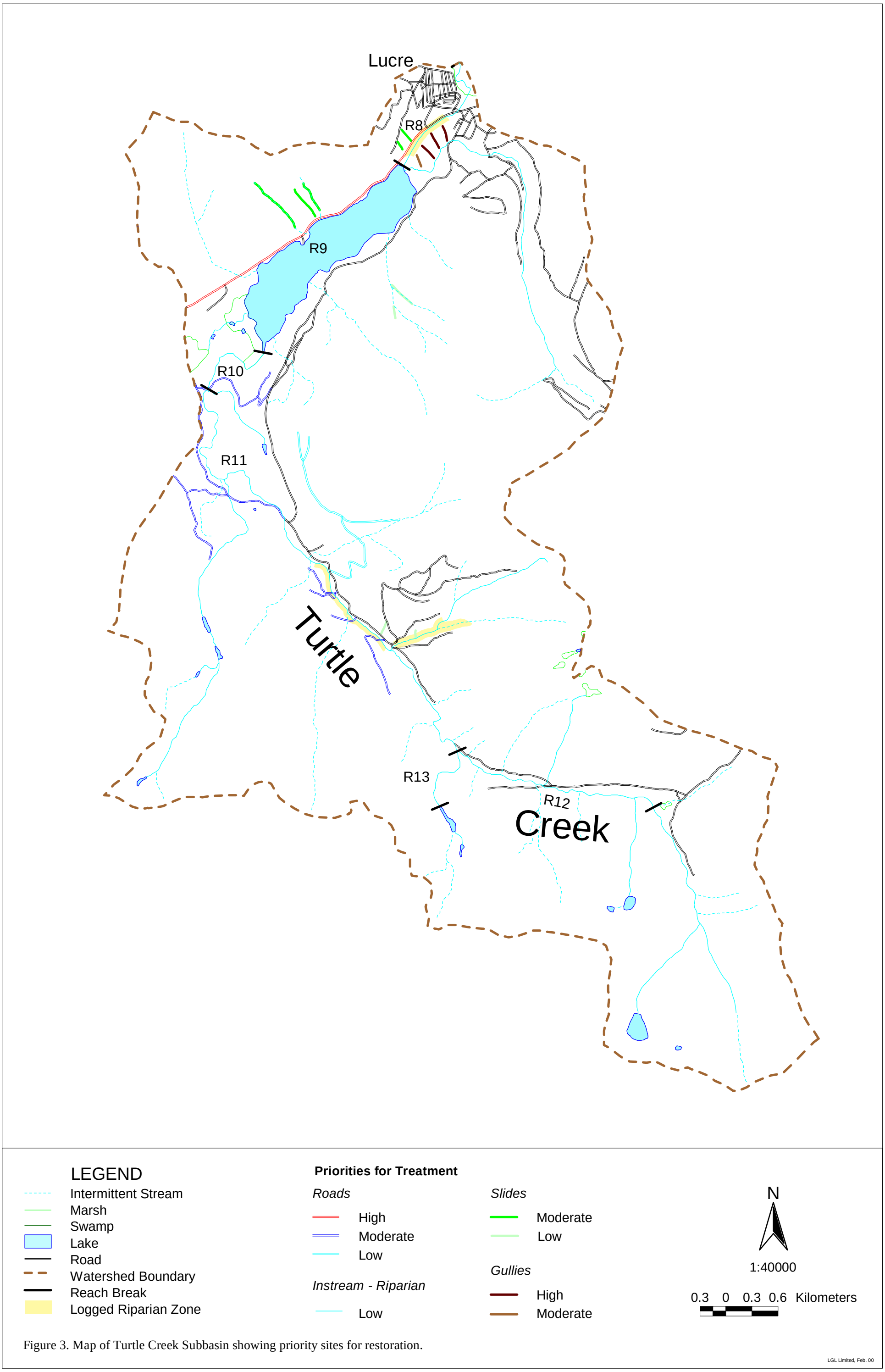
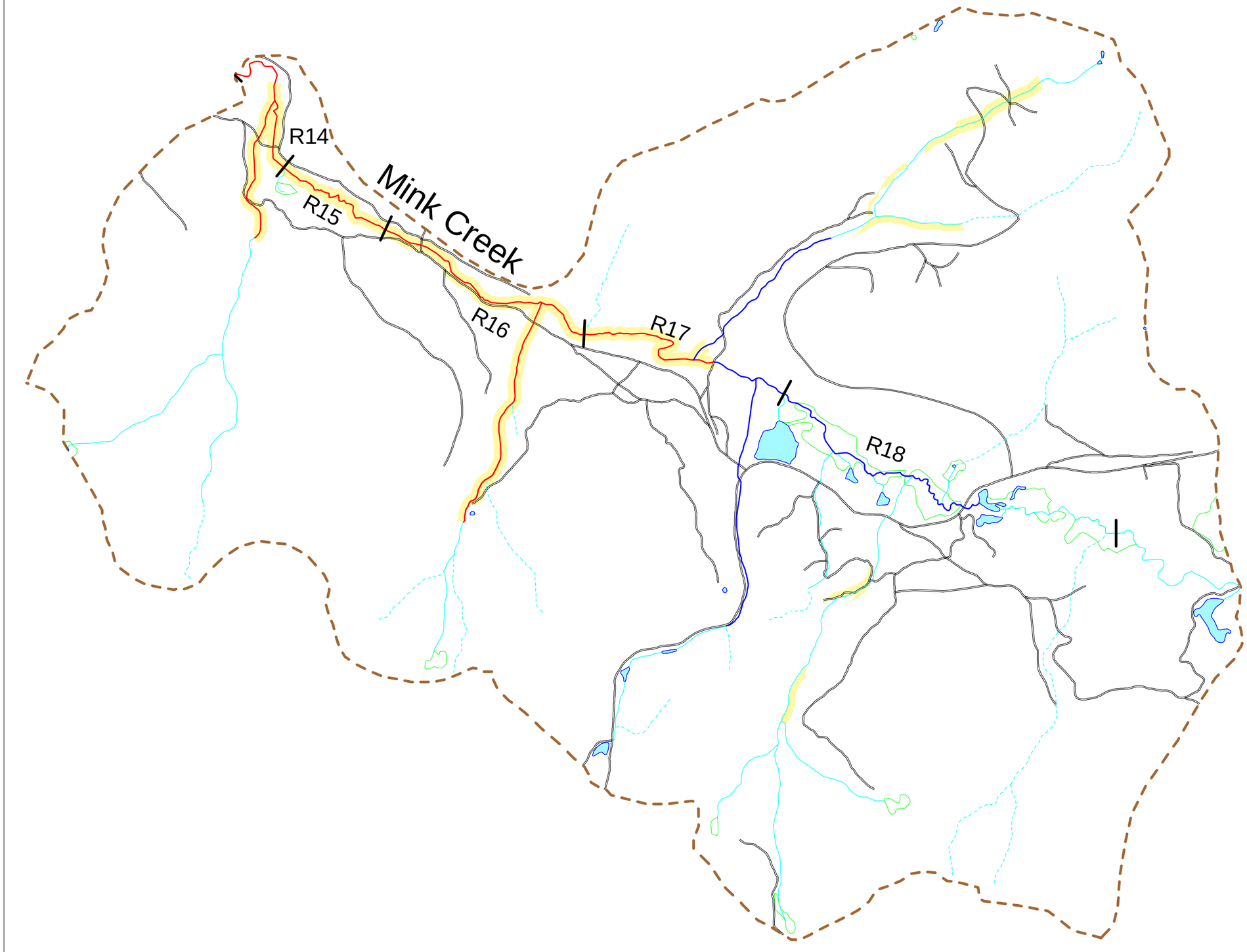


Figure 3. Map of Turtle Creek Subbasin showing priority sites for restoration.



LEGEND

- Intermittent Stream
- Marsh
- Swamp
- Lake
- Road
- Watershed Boundary
- Reach Break
- Logged Riparian Zone

Priorities for Treatment

Instream - Riparian

- High
- Moderate
- Low

N

1:30000

0.4 0 0.4 0.8 Kilometers

Figure 4.
Map of Mink Creek Subbasin showing priority sites for restoration.

LGL Limited, Feb. 00