Golder Associates Inc.
1200 W. Ironwood Drive, Suite 102
Coeur d'Alene, Idaho 83814
Telephone: (208) 676-9933
Fax: (208) 676-8602
www.golder.com

FINAL REPORT ON

GOLD CREEK AND CHLORIDE GULCH STREAM CHANNEL ASSESSMENT

Submitted to:

Avista Corporation
P.O. Box 1469, # 1 Dam Road
Noxon, MT 59853

Submitted by:

Golder Associates Inc.
1200 W. Ironwood Drive, Suite 102
Coeur d'Alene, Idaho 83814

Bryony Stasney, L.HG.
Senior Project Hydrogeologist

Robert Anderson, L.HG.
Principal Hydrogeologist

Distribution:

2	Copies -	Joe DosSantos, Avista Corporation
2	Copies -	Chris Downs, Idaho Department of Fish and Game
1	Copy -	Geoff Harvey, Idaho Department of Environmental Quality
1	Copy -	Kevin Davis, United States Forest Service
2	Copies -	Golder Associates Inc.

February 28, 2006 053-1545.004

EXECUTIVE SUMMARY

This project was initiated to determine if sediment removal and stream channel restoration along Gold Creek from the Conjecture Mine to West Gold Creek and along Chloride Gulch below the Lakeview Mine will restore perennial streamflow. Restoration of perennial flow along the project streams was considered for this assessment primarily because of the importance of lower Gold Creek to bull trout (*Salvelinus confluentus*) recovery. Gold Creek is the second most important bull trout spawning tributary within the Lake Pend Oreille subbasin (Panhandle Bull Trout Technical Advisory Team Report, 2002). Bull trout are listed as threatened under the Federal Endangered Species Act, as sensitive species by the United States Forest Service (USFS) Region 1 and as species of concern by the State of Idaho.

The stakeholders involved in oversight of this project are: Avista Corporation (Avista); Idaho Department of Fish and Game (IDFG); Idaho Department of Environmental Quality (IDEQ); and, the United States Forest Service (USFS).

The project study area (Figure 1) is located on the south side of Lake Pend Oreille, in northern Idaho, and includes the Gold Creek watershed and its sub-watersheds (including Kick Bush Gulch, West Gold Creek and Chloride Gulch). Gold Creek flows in a generally northerly direction from its headwaters for about seven miles and discharges into Lake Pend Oreille at the town of Lakeview. The Conjecture Mine is located in the upper Gold Creek watershed, about four miles upstream of Lake Pend Oreille and about 1.5 miles upstream of the Chloride Gulch confluence (Figure 1). Chloride Gulch flows in a generally northeasterly direction and discharges into Gold Creek. The Lakeview Mine is located within the upper Chloride Gulch watershed, about two miles upstream of the Gold Creek confluence (Figure 1).

This project involved: compiling historical information on fires, land use (mining, timber harvest, settlement) and streamflow; describing the historic and current conditions of the project area stream channels; researching and reporting on the local geology and hydrogeology of the project area; and, conducting streamflow and spring measurements.

Based on the data compilation and interpretation presented in this report, it appears that the intermittent nature of the project streams (i.e. Chloride Gulch and Gold Creek above West Gold Creek) is a natural occurrence that results primarily from the project area hydrogeology. Relatively permeable glacial deposits occur within the project stream valleys at elevations below about 2,800 ft amsl. Surface water runoff from the upper watershed infiltrates into permeable glacial deposits and flows as groundwater within the glacial deposits. Well logs and spring locations indicate that the groundwater flows in a north-northeasterly direction within the glacial sediments of the Chloride Gulch and upper Gold Creek valleys and discharges into lower Gold Creek as a series of springs. The springs occur primarily on the eastern bank of Gold Creek below West Gold Creek and above Kick Bush Gulch. In September 2005, the total flow of the springs on the eastern bank of Gold Creek below West Gold Creek was measured at 2.53 cfs (i.e., 35 % of the 7.27 cfs flow in Gold Creek measured below the springs). The temperature of the springs ranged between 6.7 to 7.9 degrees Centigrade. The temperature of Gold Creek above the springs (at the West Gold Creek confluence) was measured at 10.7 degrees Centigrade. The temperature of Gold Creek below the springs (at the powerline crossing below Kick Bush Gulch) was measured at 7.9 degrees Centigrade. The springs and additional ungaged groundwater discharge to Gold Creek below West Gold (estimated at about 3.41 cfs) therefore results in a significant increase in the flow of Gold Creek and causes a significant decrease in the temperature of the surface water flow.

Based on available well logs, the groundwater table within the glacial sediments in the vicinity of the project streams is between 50 to 100 feet below ground surface. Although it is likely that up to 5 feet of sediment may have aggraded along sections of the project streams due to mining activities removal of excess sediment and restoration of the channels to a stable, natural geometry will not restore perennial flow since over 50 feet and up to 100 feet of sediment would need to be removed to restore perennial flow.

It is clear that the lower Gold Creek springs are critical to the continued spawning and occurrence of bull trout in lower Gold Creek (i.e. Gold Creek below the confluence with West Gold Creek) since they deliver a significant flow of cold water to lower Gold Creek. This study therefore recommends that the project stakeholders consider the following to protect the water quality and flow of the Lower Gold Creek springs:

1. Acquisition of the two private land parcels located on the west side of lower Gold Creek north of Kick Bush Gulch (i.e. parcels 53N01W100900 and 53N01W101100) for bull trout habitat protection. The land parcel located on the east side of lower Gold Creek north of Kick Bush Gulch (i.e. parcel 53N01W100601) is owned by Avista.
2. Acquisition of the four private land parcels (i.e. parcels 53N01W102250, 53N01W107200, 53N01W107280 and 53N01W107690) located south of Kick Bush Gulch (for protection of spring flows) with the northern most of these parcels (53N01W102250) as the priority for acquisition since it is closest to the springs.
3. Installation of groundwater monitoring wells to monitor groundwater levels.
4. Careful monitoring of groundwater supply development and groundwater levels within the glacial deposits of the upper Gold Creek watershed (i.e. the Gold Creek watershed above Kick Bush Gulch), and in particular in the area immediately upgradient of the springs.
5. No significant land management activities (e.g. timber harvest, road building) within at least 500 feet of the springs.
6. Development of site specific BMPs for land management activities (e.g. timber harvest, road building) within 1,000 feet of the springs.
7. Management of the Kick Bush Slide area to minimize sediment input to Kick Bush Gulch and Gold Creek, including consideration of an alternate alignment for USFS Road 278.
8. Sediment control BMPs for mine reclamation or road building / maintenance activities in the watershed near streams to minimize sediment loading.
9. Removal and stabilization of the tailings and waste rock material in and adjacent to the Gold Creek stream channel at the Conjecture Mine site.
10. Revisit and update the approved sediment TMDL for Gold Creek to consider the natural hydrogeology of upper Gold Creek as the primary control on the intermittency of Gold Creek above the West Gold Creek confluence.
11. Inclusion of spring protection in TMDL implementation.

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1.0 INTRODUCTION

The purpose of this report is to document work conducted by Golder Associates Inc. (Golder) to evaluate stream flow patterns and restoration potential of Gold Creek and Chloride Gulch and to present the conclusions and recommendations of this work. This report and the work it documents fulfils Contract No. R-27215 between Avista Corporation (Avista) and Golder. The stakeholders involved in oversight of this project are:

- Avista - Joe DosSantos;
- Idaho Department of Fish and Game (IDFG) – Chris Downs;
- Idaho Department of Environmental Quality (IDEQ) – Geoff Harvey; and,
- US Forest Service (USFS) – Kevin Davis.

The project was initiated to determine if sediment removal and stream channel restoration along Gold Creek (from the Conjecture Mine to West Gold Creek) and along Chloride Gulch (below the Lakeview Mine) will restore perennial streamflow. The locations of these project streams are shown on the site map (Figure 1).

1.1 Project Purpose

Restoration of perennial flow along the project streams (Figure 1) was considered by the stakeholder group for this assessment primarily because of the importance of lower Gold Creek to bull trout (*Salvelinus confluentus*) recovery. Bull trout are listed as: threatened under the Endangered Species Act; as sensitive species by USFS Region 1; and, as species of concern by the state of Idaho. Gold Creek is the second most important bull trout spawning tributary within the Lake Pend Oreille subbasin (Panhandle Bull Trout Technical Advisory Team Report, 2002). Bull trout spawn primarily in lower Gold Creek, from the confluence with West Gold to Lake Pend Oreille (USFS, 1997) and are known to utilize the lowest reach of the West Gold Creek and North Gold Creek for about 0.74 miles upstream of Lake Pend Oreille (USFS, 1997). If perennial flow can be restored within stable channel geometry in Gold Creek upstream of the West Gold confluence, additional habitat could be provided for bull trout. Stable channel geometry and instream habitat complexity are important for persistence of bull trout over time (Panhandle Bull Trout Technical Advisory Team Report, 2002). In addition, stream temperature below 15 degrees Centigrade is an important characteristic of suitable bull trout habitat. Bull trout have repeatedly been associated with the coldest stream reaches within basins (Panhandle Bull Trout Technical Advisory Team Report, 2002).

1.2 Project Area

The project study area (Figure 1) is located on the south side of Lake Pend Oreille, and includes the Gold Creek watershed and its sub-watersheds (including Kick Bush Gulch, West Gold Creek and Chloride Gulch). Gold Creek flows in a generally northerly direction from its headwaters for about seven miles and discharges into Lake Pend Oreille at the town of Lakeview. The Conjecture Mine is located in the upper Gold Creek watershed, about 4 miles upstream of Lake Pend Oreille and about 1.5 miles upstream of the Chloride Gulch confluence (Figure 1). Chloride Gulch flows in a generally northeasterly direction, discharging into Gold Creek. The Lakeview Mine is located within the upper Chloride Gulch watershed, about two miles upstream of the Gold Creek confluence (Figure 1). North Gold Creek drains the area to the north and east of Gold Creek, and flows in a generally westerly

direction into Lake Pend Oreille, at the Town of Lakeview (Figure 1). The project area is accessed via USFS roads 2707 and 278.

1.3 Regulatory Framework

Under authority of the Clean Water Act, the Environmental Protection Agency (EPA) and the States must develop plans and objectives that will restore and maintain the chemical, physical, and biological integrity of stream segments of concern. Gold Creek is currently a listed 303(d) water quality limited segment from the headwaters to Lake Pend Oreille. The pollutants of concern are sediment and heavy metals. Currently there is an approved sediment Total Maximum Daily Load (TMDL) (approved by EPA in 2001) and its implementation plan is pending from IDEQ. Metals pollution in Gold Creek will be addressed during the next 303(d) listing cycle (IDEQ, 2001). Under the current status, there should be no net increase in sediment in Gold Creek. The approved sediment TMDL requires a sediment load reduction of 2,255.3 tons per yr (IDEQ, 2001). The load reduction was calculated by estimating: 1) a background load to the stream of 250.5 tons per year assuming the watershed is entirely forested; 2) current sediment export to the stream of 2,505.8 tons per year from past mining, roads and stream bank erosion; and, 3) subtracting the background load from the current sediment export to the stream (IDEQ, 2001). The Gold Creek TMDL also notes that the Gold Creek stream temperature is kept artificially low, "only because the stream has been buried by excess bedload and mining related stream alterations". The TMDL (IDEQ, 2001) states that a temperature TMDL should be considered since removal of the mining waste from the stream will restore surface flow and may result in higher surface water temperatures (IDEQ, 2001).

The USFS will develop an implementation plan for its portion of the TMDLs in Gold Creek in cooperation with IDEQ and the Idaho Department of Lands (IDL) and other interested parties. Currently the USFS has agreements with the Idaho state agencies to implement Best Management Practices (BMPs) for all management activities in the Gold Creek watershed.

Under the Endangered Species Act (ESA), bull trout are listed as threatened. Section 4 of the ESA provides for designation of critical habitat for listed species, where critical habitat includes geographic areas "on which are found those physical and biological features essential to the conservation of the species and which may require special management considerations or protection". Section 6 of the ESA encourages States to develop and maintain conservation programs for resident listed species. Section 7 of the ESA includes direction that Federal agencies in consultation with the US Fish and Wildlife, will not authorize, fund or conduct actions that are likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their critical habitat.

Gold Creek from Lake Pend Oreille to West Gold Creek and West Gold Creek for 2.3 km above the Gold Creek confluence were proposed for critical habitat designation by the US Fish and Wildlife Service (USFWS) in 2003. The current rule (approved on September 26, 2005) designates as critical habitat only those reaches of Gold Creek and West Gold Creek within the 2003 proposed designation that also occur on private property. The reaches of Gold Creek from Lake Pend Oreille to West Gold Creek and West Gold Creek for 2.3 km above the Gold Creek that occur on USFS land were removed from the critical habitat designation because these reaches are protected by the USFS Inland Native Fish Standards and, since the USFS is a federal agency, Section 7 of the ESA already requires the USFS to consult with the USFWS regarding management activities on USFS land that have the potential to impact listed species.

1.4 Project Phases

This project was completed as a series of sequential phases:

- Phase I – Initial site visit and confirmation of project goal;
- Phase II – Information review and presentation of findings;
- Phase III – Stream flow and spring monitoring; and,
- Phase IV – Reporting.

1.4.1 Phase I- Initial Site Visit and Project Goal

The kick-off project meeting and site visit were conducted on June 16, 2005 and documented in a technical memorandum dated July 7, 2005. A copy of this memorandum is included in Appendix A. The purpose of the site visit was to view important aspects of the project in the field; confirm the project goal; and, confirm the scope for the next phase of project work. At the site visit, the stakeholder group agreed that the project goal was to answer the question:

> ***"Is it feasible to restore perennial flow within Gold Creek and Chloride Gulch by removing sediment and restoring the channel to a stable, natural geometry?"***

1.4.2 Phase II - Information Review and Presentation of Findings

Following the site visit, Golder completed the following work tasks between July and August 2005:

- Walked project and potential reference streams, noting wet and dry reaches;
- Identified reference reaches for: 1) Gold Creek (above West Gold); and, 2) Chloride Gulch;
- Reviewed the following information:
  - Stream surveys provided by the USFS and IDEQ;
  - Aerial photographs at the USFS office in Sandpoint;
  - Geologic and hydrogeologic information including available well logs;
  - Previous studies and reports provided by the stakeholders; and,
  - Project area topography and stream profiles using the USGS Lakeview ID quadrangle map (1:24,000 scale with 40 foot contour intervals).

The primary objectives of this phase of work were to: (1) propose reference reaches for project streams; (2) determine the extent to which natural hydrogeologic conditions contribute to dry stream reaches; and, (3) based on the results, revisit the project goal and scope the next phase of work.

Golder presented the findings of the information review at a stakeholder meeting on September 1, 2005 and submitted a draft memorandum entitled, "Gold Creek Watershed Assessment – Phase 1 Information Review and Next Step". Following the presentation, the stakeholder group reviewed and provided comment on the draft memorandum. It was agreed at the September 1, 2005 meeting that

the information included in the draft memorandum along with stakeholder comments would be incorporated into this report.

1.4.3 Phase III - Stream Flow and Spring Monitoring

The stakeholder group also agreed at the September 1, 2005 meeting that the next phase of work would include the following:

1. Stream flow and temperature measurements at the following locations:
    - Gold Creek below Kick Bush Gulch, near Avista powerline crossing;
    - Kick Bush Gulch above confluence with Gold Creek;
    - Gold Creek above confluence with West Gold Creek;
    - West Gold Creek above confluence with Gold Creek;
    - Chloride Gulch below the Lakeview Mine; and,
    - Gold Creek below the Conjecture Mine.
2. Identification of springs along Gold Creek between the West Gold Creek confluence and the Avista powerline crossing, including Global Positioning Satellite (GPS) locations.
3. Collection of spring flow rates and water temperature where possible.
4. Development of a simplified water balance to assess if stream flow and spring flow data support the hypothesis that the intermittent nature of project streams (i.e. Chloride Gulch, and Gold Creek above West Gold Creek) results from natural hydrogeologic conditions.
5. Development of a Geographical Information Systems (GIS) coverage showing land ownership information (by parcel) in the vicinity of identified groundwater springs.

Golder conducted the stream flow and spring monitoring between September 17 and 18, 2005. The results of the surveys and the additional tasks are included in this report.

1.5 Report Organization

The main text of this report is divided into seven sections that present technical information as follows. Supporting information is included in the figures and appendices that follow the main text.

Section 1 provides an introduction to the project including a description of the project purpose, study area, phases of work and information reviewed to support this project.

Section 2 summaries information provided by stakeholders and reviewed by Golder for this project.

Section 3 presents and describes topographic profiles for the project streams and potential reference reaches, describes stream survey information collected by the USFS for the project streams (i.e. Gold Creek and Chloride Gulch) and, identifies the most suitable reference reach for the project streams.

Section 4 compiles historic and recent information on the locations of dry and flowing reaches within the project and potential reference streams (i.e., Gold Creek, Chloride Gulch, Kick Bush Gulch, North Gold Creek and West Gold Creek) and documents stream flow and spring measurements made in September 2005 by Golder for this study.

Section 5 presents information on regional and local hydrogeology.

Section 6 presents the conclusions of the study and makes recommendations.

Section 7 lists reports, publications and information sources cited in the report.

Supporting tables are included in the main report text. Supporting figures and appendices follow the main text.

2.0 INFORMATION REVIEW

This section lists the information reviewed for this project and provides a summary of project area information on fires, mining, road building, settlement, timber harvest, power line construction, mine reclamation and land use. Stream characteristics, hydrology and hydrogeology are described in subsequent sections of this report. Where available, references for the information are cited in Section 7 of this report.

2.1 Information Sources

The following information was reviewed for this project:

- United States Geologic Survey (USGS) geologic mapping;
- USGS 1:24,000 scale topography (hard copy and electronic);
- Gold Creek Cumulative Watershed Effects Assessment (IDL, December 1999);
- West Fork Gold Creek Cumulative Watershed Effects Assessment (IDL, December 1999);
- Information provided by IDEQ, including:
    - Beneficial Use Reconnaissance Program (BURP) data collected between 1994 and 2003 for Gold Creek, Chloride Gulch, West Gold Creek, Kick Bush Gulch and North Gold Creek;
    - Clark Fork / Pend Oreille Sub-Basin Assessment and Total Daily Maximum Loads (TMDLs) (March, 2001); and,
    - Gold Creek Watershed Restoration Implementation Plan (March 2003 Discussion Draft).
- Information provided by the USFS, including:
    - Aerial photographs;
    - 2002 stream surveys for Gold Creek, Chloride Gulch, Kick Bush Gulch and West Gold Creek;
    - Historic information, including General Land Office (GLO) notes from the 1908 and 1910 section surveys and historic data on fires, road building, settlement, logging and mining);
    - Excerpts from various watershed assessment reports, including the Gold Creek Ecosystem Analysis, Watershed Scale (EAWS) and the Panhandle Bull Trout Technical Advisory Team Report; and,
    - Water yield and sediment load balance and yield modeling (WATSED) for Gold Creek and West Gold Creek.
- Land ownership information from the Bonner County Assessor's Office.

2.2 Land Ownership and Use

The majority of land in the Gold Creek watershed (well in excess of 90%) is owned by the USFS (IDEQ, 2003 Discussion Draft) with about 43 acres privately owned. The main land use activities in the watershed are timber harvest, outdoor recreation (e.g., hunting) and road maintenance.

2.3 Fires

The General Lands Office (GLO) includes survey notes for Township 53 N, Range 1 W made in July through September 1891 by Frederick Mills and made by later surveyors between 1908 and 1910. The second survey (1908 to 1910) was conducted because a large forest fire destroyed most of the original surveyed section corners. The most likely date for this fire is 1896, although there may have been earlier and later fires in addition.

The December 1908 GLO description of Township 53 N, Range 1 W notes:

> *"All of this township is well adapted to grazing, since there is very little timber and an abundance of grass. There are mining operations going on within this township [the Old Weber Mine within the upper Gold Creek watershed and the Conjecture Mine on Gold Creek about one mile downstream of the Weber Mine]. There are abandoned prospects in nearly every part of the township. The entire area burned over many years ago and there is very little live timber standing"*.

It is also known that the large fire of 1896 destroyed all the buildings at the Weber Mine (located in the headwaters of Gold Creek, about one mile upstream of the Conjecture Mine).

Soil erosion following the fires of this time is documented. Gumaer and Decamp (1916 and 1917) note that the "problem of soil erosion is being effectively met by a thorough system of fire protection and the burned-over areas are now coming back under watershed cover. The new forest cover is holding the soil in place and doing its part in the retarding and dissemination of the run-off of snow water."

The following summarizes this and addition information on fires in the project area (Gold Creek, Chloride Gulch and North Gold and West Gold watersheds):

- 1850s - large lethal and mixed severity fires.
- 1896 -very large stand replacement fire. Project area left in early successional stage of stand development with grasses, brush and small trees dominating the landscape. Some riparian areas, such as West Gold Creek through Sections 16 and 17, may not have been burned.
- 1926-1934 – about 25% of the project area reburned with stand replacement and mixed severity fires.
- Since 1934 no major fire activity has occurred.

2.4 Mining

The following information summarizes the mining activities in the Gold Creek watershed (including Gold Creek and Chloride Gulch and their tributaries). Very little mining occurred within the North Gold watershed (including North Gold Creek, Branch North Gold Creek and their tributaries). No mining has occurred in the West Gold Creek watershed (USFS, 2000).

- 1881: Mineral claims were recorded for limestone deposits near the mouths of Gold Creek and North Gold Creek.

- 1883-1884: A small prospecting boom occurred in the Lakeview area. Trails and cabins were built and some hand-mining and prospecting was done.

- 1888: The Weber and Keep Cool Mines in the upper Gold Creek watershed and the Lakeview Mine in Chloride Gulch attracted miners and business ventures. Mining camps on Gold Creek near the Weber Mine and on Chloride Gulch near the Lakeview Mine appeared. Chloride Gulch had a mining camp of 3,000 people. The town of Lakeview developed as a supply point. By 1908, activity at Lakeview had diminished.

- 1894: The Conjecture Mine was discovered. The mine was most productive in 1913 and 1956.

- 1896: The Weber Mine was destroyed by a forest fire.

- 1923: The mill at the Idaho Lakeview Mine was built and probably marks the start of the waste rock dump in Chloride Gulch. The mill working inconsistently in the 1940s, 1950s and 1970s.

- 1925: The Lakeview Mine was the largest producer in the district.

- 1949: Open pit mining operations began at the Weber and Keep Cool Mines and continued to the early 1980s.

- 1950s: Major work at the Conjecture Mine occurred.

- 1960s: Duval Corporation partially dewatered the Conjecture shaft to depth of 4,000 feet (Maxim, 2001; Kun, 1974).

- 1980s: When silver prices dropped, mining activities ceased.

- 1995: Royal Silver Mines Inc. took over the lease of the Conjecture Mine and announced a plan to explore for additional ore if funds became available. Shoshone Silver currently owns the lease to the mine.

- 2003 / 2004: USFS completed removal and restoration projects on Chloride Gulch below the Lakeview Mine (see Section 2.9.1 of this report for additional detail).

- 2005: EPA completed a time-critical removal action of mine waste at the Lakeview Mine site (see Section 2.9.2 of this report for additional detail).

The Gold Creek Watershed Restoration Implementation Plan Discussion Draft (IDEQ, 2003) notes that mining activities and logging roads have caused 70% and 30% respectively of the sediment source loading to the watershed (in excess of the natural sedimentation rate). The largest sediment contributors are noted as the Conjecture Mine on Gold Creek and the Lakeview Mine on Chloride Gulch. It is noted that steam restoration in the Gold Creek watershed will be futile until removal and stabilization of mine waste sediment and metals sources are completed (IDEQ, 2003).

2.5 Settlement

Records suggest that the earliest homesteading started in the project area around the start of the 20th Century (about 1900). At the peak of private ownership in 1916 to 1917, 924 acres in the Gold Creek watershed was held by homestead patent, most along the creek and adjacent flat bench land (Gumaer and Decamp, 1916-1917; USFS, 1997). One resident stated that cattle were raised before 1932 in the Gold Creek watershed and were driven out along the West Gold Creek trail (USFS, 1997). Grazing permits were also issues by the USFS for sheep grazing in 1921, 1938 and 1945 (USFS, 1997). The December 1910 GLO survey also notes settlers within the Gold Creek watershed at the following locations: 10-15 acres under cultivation within Section 15 (Gold Creek and lower Chloride Gulch); and, miners and settlers in Sections 10 and 11 (Kick Bush Gulch), 22, 26 and 28 (Chloride Gulch).

2.6 Road Building

The following summarizes historic information provided by the USFS on road building:

- Prior to 1932, trails and wagon roads connected Lakeview to mining prospects and homesteads;
- In 1932 the USFS built the first road (USFS Road 2707) into Lakeview;
- In 1953 the powerline was installed and nearby roads were upgraded to access the line; and,
- In 1982, USFS Road 278 was built to connect USFS Road 332 with USFS Road 2707 and to provide additional access to Lakeview.

The Gold Creek Watershed restoration Implementation Plan Discussion Draft (IDEQ, 2003) notes that mining and logging roads have resulted in 70% and 30% respectively of the sediment source loading to the watershed in excess of the natural sedimentation rate.

In Kick Bush Gulch, below the USFS Road 278 crossing, exaggerated sediment delivery from a chronic road failure is occurring (USFS, 1997). The slope sloughs yearly on to the road and is bladed downslope, over the edge of the road. Rains wash the sediment into Kick Bush Gulch where it is transported downstream into Gold Creek.

The Kick Bush slide was repaired by the USFS in 2002 using a variety of funding sources including Avista, Trout Unlimited and USFS funding. The unstable slope gradient was reduced and stabilized by excavating material, constructing two benches and installing a gabion wall at the toe of the slope. The surface of the resulting 3-stepped slope was stabilized using a geo-timber grid that was constructed to minimize surface erosion from the site. Native vegetation was planted within the grid cells to provide soil stabilization and retention and long term rooting stabilization.

2.7 Timber Harvest

The Gold Creek watershed is primarily managed for timber production. The following summarizes historic information provided by the USFS on timber sales:

- There were seven small timber sales to local residents in the Gold Creek watershed noted by the Marshall Ranger Station that operated in the 1920s and 1930s. There was very little merchantable timber to sell at this time, probably as a result of large fires.

- Additional small timber sales occurred in the 1960s (Green Mountain and upper North Gold) and early 1970s (Bernard).

- During the late 1970s, the West Gold / Chloride timber sale and New Lakeview Road were contracted. Private land along North Gold and Branch North Gold was also logged at this time.

- Several timber sales occurred in the 1980s.

- Since the year 2000, there have been two timber sales going through National Environmental Protection Act (NEPA) permitting: one within the West Gold watershed; and, the second within the Chloride Gulch watershed. Priority for the Chloride Gulch sale has dropped. The West Gold sale is currently being revised by the USFS and will be scoped for additional public review (Kevin Davis, USFS email communication 120605).

2.8 Power Line Construction

Bonneville Power Administration and Avista transmission lines span Gold Creek in the lower reach below Kick Bush Gulch (Figure 4A). The lines cross Gold Creek at this location and then run parallel to West Gold Creek (Figure 4A and Figure 2D). Timber and vegetation were cleared in a 250 foot corridor for line construction in the early 1950s. Loss of woody debris recruitment may affect these portions of the streams and shade is diminished (IDEQ, 2001).

2.9 Mine Remediation and Pilot Scale Removals

2.9.1 Pilot Scale Removals and Stream Bank Restoration along Chloride Gulch

In 1994, the USFS installed wooden "V" notch structures (see photo 13 in Appendix B) along about one mile of streambed in Chloride Gulch about ¼ mile above the confluence between Chloride Gulch and Gold Creek (in Sections 15 and 22, Township 53 N, Range W, Boise Meridian). The purpose of this action was to: control downcutting of the channel; restore natural channel gradients; and, reduce bedload sediment transport. In the Chloride Gulch Stream Survey Report (USFS, 2002), it is noted that about ¾ of the original wooden "V" notch structures are still present and that the structures are causing fairly large plunge pools and are helping to stabilize the stream banks.

In 2004, the USFS completed pilot scale removals of tailings material from the floodplain of Chloride Gulch about ¼ mile upstream of the confluence between Chloride Gulch and Gold Creek. The purpose of this restoration action was to remove sediment impacted by heavy metals from the floodplain. Removed sediments were transported to the nearby USFS Road 278 repository that is currently being used to store mine waste from the Lakeview Mine.

The USFS hired a contractor to design the specifications for a stream bank restoration project on 300 feet of Chloride Gulch directly below the Lakeview Mine tailings removal site. All tailings were removed from the floodplain. Native soils were replaced and the floodplain was built up to specified elevations. The streambank restoration project was implemented in the summer of 2003 and consisted of reconfiguring the channel with respect to slope, sinuosity, profile, and in-channel features, such as pools. Stream banks were fortified using encapsulated soil terraces and planted with native shrubs. The stream banks were more heavily planted with larger shrubs, willow and cottonwood, using a stinger to plant cuttings below the summer water table. Native grasses were planted over much of the area to reduce erosion and revegetate the floodplain and to discourage invasive plant species.

2.9.2 Remediation at the Conjecture and Lakeview Mines

The Gold Creek Watershed Restoration Implementation Plan Discussion Draft (IDEQ, 2003) notes that the largest sediment and metal load contributors in the Gold Creek watershed are the Conjecture Mine and Lakeview Mine. As a result, the report recommends that tailings removals and waste rock stabilization projects at these two sites have the highest priority (IDEQ, 2003 Discussion Draft).

The EPA time-critical removal action of mine waste at the Lakeview site was completed in the second week of November, 2005. The removal was initially thought to be about 20,000 cubic yards of waste rock. Excavation demonstrated that the material was a layering of waste rock over a deeper deposit of tailings (jig and flotation). About 50,000 cubic yards of material was removed to the Lakeview Repository, located on a bench above Chloride Gulch. The repository is about 0.5 miles upstream of the Gold Creek confluence on land managed by the USFS. A temporary cap with a geosynthetic clay liner and closure of the repository was completed by EPA in November, 2005. EPA was able to reshape the Chloride Gulch channel in the vicinity of the removal. However, removals in the channel between this EPA removal action and the 2003 Forest Service removal (see Section 2.8.1 above) were not implemented. Some removal of “hot spots” was completed around the existing Idaho Lakeview Mill site. The Forest Service intends to reshape and close the repository with a final capping during the 2006 construction season. The Forest Services consultant, Maxim Technologies Inc., installed two monitoring wells near the repository. One estimated to be up gradient of the facility and one down gradient (noted as Well IDs 9 and 10 on Figure 7). Neither well reached the water table. The Forest Service is committed to installing additional well(s) that will reach groundwater during the 2006 construction season.

There are currently no specific plans for remediation at the Conjecture Mine site, which is in private ownership and is leased by Shoshone Silver. However the Gold Creek Watershed Restoration Implementation Plan (IDEQ, 2003 Discussion Draft) includes concepts for removal actions and waste rock stabilization at the Conjecture Mine.

3.0 STUDY AND REFERENCE STREAMS

This section presents and describes topographic profiles for the project streams and potential reference reaches, describes stream survey information collected by the USFS for the project streams (i.e. Gold Creek and Chloride Gulch) and, identifies North Gold Creek as the most suitable reference reach for the project streams.

3.1 Project Stream Reaches

The stream reaches assessed in relation to the project goal are:

- Gold Creek from the Conjecture Mine to the confluence with West Gold Creek; and,
- Chloride Gulch from the Lakeview Mine to the confluence with Gold Creek.

The locations of these reaches are illustrated on Figure 1. These stream reaches were selected for study by the stakeholder group because it was felt that human related impacts to these stream reaches (e.g., from headwater mining, fires, logging and clearing for settlement) may have resulted in sufficient deposition of sediment in the channels to cause surface water flows to infiltrate into the channel sediments during low flow months.

3.2 Potential Reference Reaches

For this project, reference reaches are considered stream reaches that have similar characteristics to those of the project stream reaches (i.e. Chloride Gulch below the Lakeview Mine and Gold Creek below the Conjecture Mine to the West Gold confluence). Characteristics that make a stream reach eligible to be a reference reach include watersheds of similar size, topography and geology (Rosgen, 1996). Potential reference reaches for consideration were identified initially by the stakeholder group as:

- Kick Bush Gulch (for Chloride Gulch);
- West Gold Creek (for Gold Creek); and,
- North Gold Creek (for Gold Creek).

The final reference reach(es) selected are documented in Section 3.5. Sections 3.3 and 3.4 below provide information on the project stream and potential reference reaches that support selection of the reference reach in Section 3.5.

3.3 Stream Profiles

This section summarizes the topographic information for the project streams and potential reference reaches. Stream profiles were developed starting at an elevation of 3,600 feet above mean sea level (amsl) for Gold Creek, Chloride Gulch, Kick Bush Gulch, West Gold Creek and North Gold Creek. The locations of the profiles are illustrated on Figure 2. The profiles are presented on Figures 2A through 2E. For these streams, there is a general pattern of a steep upper reach, a relatively low gradient mid-elevation reach and a moderately steep lower reach.

Project area elevations between 3,000 and 4,500 feet amsl are within the rain-on-snow zone where the snow pack generally accumulates all season long but is constantly near isothermal (i.e. 0 degrees Centigrade). When the freezing level rises above 4,500 feet amsl, rain falling below the freezing

level can result in rapid snow pack melting and flash-flooding. About 69% of the Gold Creek watershed is within the rain-on-snow zone. Therefore, the dominant current channel forming and sediment transport events are associated with rain-on-snow events and spring run-off. (USFS, 2001).

3.3.1 Gold Creek

The longitudinal profile for Gold Creek from approximately elevation 3,600 feet amsl to Lake Pend Oreille is shown on Figure 2A. The profile indicates three distinct reaches:

- An upper reach from elevation 3,600 to 2,750 feet amsl with an average gradient of 6.9%;
- A mid reach from elevation 2,750 to 2,400 feet amsl with an average gradient of 2.9%; and,
- A lower reach from elevation 2,400 to 2,080 feet amsl with an average gradient of 3.6%.

3.3.2 Chloride Gulch

The longitudinal profile for Chloride Gulch from approximately elevation 3,600 feet amsl to its confluence with Gold Creek is shown on Figure 2B. The profile indicates three distinct reaches:

- An upper reach above the Lakeview Mine from elevation 3,600 to 3,000 feet amsl with an average gradient of 25%.
- A mid reach from elevation 3,000 to 2,800 feet amsl with an average gradient of 5%.
- A lower reach from elevation 2,800 to 2,580 feet amsl with an average gradient of 2.4%.

3.3.3 Kick Bush Gulch

The longitudinal profile for Kick Bush Gulch from approximately elevation 3,600 feet amsl to its confluence with Gold Creek is shown on Figure 2C. The profile indicates three distinct reaches:

- An upper reach from elevation 3,600 to 2,800 feet amsl with an average gradient of 8.9%.
- A mid reach from elevation 2,800 to 2,560 feet amsl with an average gradient of 4.5%.
- A lower reach from elevation 2,560 to 2,220 feet amsl with an average gradient of 10.8%.

3.3.4 West Gold Creek

The longitudinal profile for West Gold Creek from approximately elevation 3,600 feet amsl to its confluence with Gold Creek is shown on Figure 2D. The profile indicates three distinct reaches with similar gradient characteristics:

- An upper reach from elevation 3,600 to 3,000 feet amsl with an average gradient of 5.0%.
- A mid reach from elevation 3,000 to 2,675 feet amsl with an average gradient of 3.0%.
- A lower reach from elevation 2,675 to 2,400 feet amsl with an average gradient of 6.3%.

3.3.5 North Gold Creek

The longitudinal profile for North Gold Creek from approximately elevation 3,600 feet amsl to its confluence with Lake Pend Oreille is shown on Figure 2E. The profile indicates four distinct reaches:

- An upper reach from elevation 3,600 to 3,200 feet amsl with an average gradient of 6.2%.
- A mid reach from elevation 3,200 to 2,650 feet amsl with an average gradient of 4.2%.
- A mid reach from elevation 2,650 to 2,550 feet amsl with an average gradient of 1.3%.
- A lower reach from elevation 2,550 to 2,062 feet amsl with an average gradient of 6.1%.

3.4 Project Stream Surveys

This section describes the results of stream surveys completed by the USFS Sandpoint Ranger District for Gold Creek in 2003 (USFS, 2003) and for Chloride Gulch in 2002 (USFS, 2002). The surveys used a Rosgen channel type classification methodology (Rosgen, 1996).

3.4.1 Gold Creek

Rosgen channel type classification taken from the USFS 2003 survey of Gold Creek (USFS, 2003) from the Conjecture Mine to the West Gold confluence is presented on the stream profile in Figure 2A and is summarized below:

- Reach 5 – upstream of the Conjecture Mine for 1,215 meters (3,986 ft) - **Channel Type F4b**. "Moderate entrenchment and high flows may be the primary causes of bank instability. In addition, USFS Road 1017 runs parallel to the stream, influencing hydraulics and sediment delivery" (USFS, 2003).
- Reach 6 –Conjecture Mine. "Not surveyed due to its extremely unnatural state" (USFS, 2003)
- Reach 7 – from downstream end of Conjecture Mine waste dump for 400 meters (1,312 feet) – **Channel Type B4a**. "The channel has a steeper grade that helps flush out sediment" (USFS, 2003).
- Reach 8 – 850 meters (2,854 feet) downstream of end Reach 7 – **Channel Type F4b**. "Stream channel grade lessens and sediment settles out. Sediment is moved during high flows. Streambed goes dry within this reach" (USFS, 2003).
- Reach 9 – 2,400 meters (7,874 feet) downstream of end Reach 8 – **Channel Type B4**. "Entire reach was dry. During spring runoff the flow appears to be a well functioning B4 channel type. Banks are stable with boulders and large woody debris as stabilizers" (USFS, 2003).
- Reach 10 – 130 meters (427 feet) downstream of end Reach 9 – **Channel Type F4b.** "Channel was dry at the time of the survey. Large woody debris aggregate has built up to a significant size and the water has cut down into the streambed " (USFS, 2003).

- Reach 11 – 520 meters (1,706 feet) downstream of end Reach 10 to the West Gold Confluence – **Channel Type B4.** "Water is starting to appear in pools. Channel similar to Reach 9" (USFS, 2003).

- Reach 12 – 890 meters (2,920 feet) downstream of the West Gold Confluence – **Channel Type B2a.** "The substrate is predominately boulder and bedrock with numerous waterfalls and cascades, none of which appear to be fish barriers" (USFS, 2003).

- Reach 13 – 920 meters (3,019 feet) downstream of Reach 12 – **Channel Type B3.** "Channel banks are stable and substrate is moving through at a constant rate. This reach has highest quality fish habitat. There are 10 springs present in the middle of the reach emanating from stream right bank" (USFS, 2003).

- Reach 14 – starts just above the power line ford crossing and is 330 meters longs (1,083 feet) – **Channel Type B4c.** "This reach may have been created because of the road crossing that has widened out the channel and deposited sediment below. This reach appears stable" (USFS, 2003).

- Reach 15 – is 920 meters longs (3,019 feet) and extends to Lake Pend Oreille – **Channel Type F4.** "Sediment appears to have been deposited many years ago and the channel has since been down cut. Fish habitat is good with large pools" (USFS, 2003).

3.4.2 Chloride Gulch

Rosgen channel type classification taken from the USFS 2002 survey of Chloride Gulch (USFS, 2002b) from the Lakeview Mine to the Gold Creek confluence is presented on the stream profile in Figure 2B and is summarized below:

- Reach 1 – located above the Lakeview Mine - **Channel Type A4a+. "**The channel side slopes are steep (up to 27%) and there is landslide debris in the stream within the upper portion of the reach. Where mine waste has been deposited into the stream channel, the stream goes subsurface and there is a tremendous amount of small gravel in the channel" (USFS, 2002b).

- Reach 2 – downstream of Lakeview mine – **Channel Type F4b.** "The channel cuts into waste rock deposited in stream banks. Would likely be a B type channel under natural conditions" (USFS, 2002b).

- Reach 3 – **Channel Type B4c**. "Stream channel widens and valley opens. Lots of large woody debris and cutthroat present" (USFS, 2002b).

- Reach 4 – **Channel Type C4b**. "Major rehabilitation work completed in 1994" (USFS, 2002b).

- Reach 5 – **Channel Type F4b**. "Stream went dry at 1,345 feet along reach. Would likely be a B type channel under natural conditions" (USFS, 2002b).

- Reach 6 – **Channel Type B4c**. This reach is dry. Man-made structures exist in the stream channel that have created plunge pools when water flows" (USFS, 2002b).

- Reach 7 – **Channel Type C4.** "This reach is dry from the 278 road crossing to the confluence with Gold Creek. This reach is more sinuous with a wider valley bottom and steeper banks" (USFS, 2002b).

3.5 Selected Reference Reach

In order to select the most appropriate reference reach(es), the following information was compared for the project area streams and potential reference reaches: longitudinal profile; geology; and, human activities in the watersheds (e.g., mining, logging and clearing for settlement). Fires were not considered a differentiating factor since the entire project area has experienced a similar fire history. Based on the results of these comparisons (described below), North Gold Creek is considered the most suitable reference reach for the project streams (i.e. both Chloride Gulch and Gold Creek above West Gold Creek). As a result, North Gold Creek is considered to be the most probable "natural channel" comparable for the project streams under the present hydrology and sediment regime.

3.5.1 Longitudinal Profile and Watershed Size

The longitudinal profiles for North Gold Creek (Figure 2E), Gold Creek (Figure 2A) and Chloride Gulch (Figure 2B) show similar characteristics with an upper relatively steep reach, and a middle relatively low gradient reach. Kick Bush Gulch is a much steeper gradient stream than Chloride Gulch (see Figures 2B and 2C) and has a smaller watershed area. Therefore Kick Bush Gulch is not considered an appropriate reference reach for Chloride Gulch. North Gold Creek is a fourth order watershed that covers about 10,500 acres (16.4 square miles), comparable to the Gold Creek watershed, which is also a fourth order watershed and covers about 14,100 acres (22.0 square miles) (USFS, 1997).

3.5.2 Geology

Review of geologic mapping (Figure 5) completed by the United State Geologic Survey (USGS) indicates the following:

- North Gold Creek has similar geology to that of Gold Creek and Chloride Gulch with the upper steep reach underlain by bedrock and a middle relatively flat reach underlain by unconsolidated glacial deposits. North Gold Creek, Gold Creek and Chloride Gulch are all intermittent along the mid elevation reach where the stream channels occur above the unconsolidated glacial deposits (see Section 4 of this report for more details).

- West Gold Creek is underlain primarily by bedrock and is therefore not considered an appropriate reference reach for either Gold Creek or Chloride Gulch.

A more detailed discussion of the project area geology is included in Section 5 of this report.

3.5.3 Human Activity

In comparison to Chloride Gulch and Gold Creek, there has been relatively little human disturbance within the North Gold watershed other than some homesteading and timber harvesting.

4.0 HYDROLOGY

This section of the report compiles historic and recent information on the locations of dry and flowing reaches within the project and potential reference streams (i.e., Gold Creek, Chloride Gulch, Kick Bush Gulch, North Gold Creek and West Gold Creek) and documents stream flow measurements made in September 2005 by Golder for this study.

4.1 Dry and Flowing Stream Reaches

A number of information sources on project area stream flows were reviewed and compiled to improve understanding of the locations of dry and flowing reaches for project area streams. The following information sources were reviewed and the results compiled on to Figure 3:

- Historic General Lands Office (GLO) section survey notes (1908 and 1910);
- Idaho Department of Environmental Quality (IDEQ) Beneficial Use Reconnaissance Project (BURP) information (1994 through 2003);
- USFS stream survey information (unpublished) and information extracted from previous reports provided by the USFS for this project;
- Site walkovers (Golder, June through September 2005); and
- Stream flow measurements (Golder, September 17 and 18, 2005).

A summary of this information is provided in the sections below.

4.1.1 Gold Creek

As illustrated on Figure 3, the compilation of information sources indicates that Gold Creek is (and has been historically) typically flowing along its upper reach; typically dry along its mid-section reach; and, typically flowing below the West Gold Confluence. The following sub-sections describe the information used to develop this observation. It should be noted that the existence of a defined channel along the typically dry reaches indicates that during high flows (e.g., spring melt or rain-on-snow events) significant water flows within this channel.

4.1.1.1 Historic General Lands Office (GLO) Section Survey Notes (1908 and 1910)

The following summarize GLO survey notes made between 1908 and 1910 for Gold Creek within Township 53 North, Range 1 West from upstream to downstream. The assumed locations for the survey notes are shown on Figure 3 as solid circles on the streams (blue for flowing and yellow for dry). Where the notes do not mention that the stream is dry, it is assumed that the stream is flowing.

- Heading west along sections 26 and 35: Upper east branch of Gold Creek is 3.3 ft wide; Gold Creek is 9.9 ft wide (March 1910).
- Heading west along sections 23 and 26: Gold Creek is 11.88 ft wide (November 1908).
- Heading west along sections 14 and 23: Gold Creek exists as 2 ft wide (November 1908).
- Heading north along sections 22 and 23: Gold Creek exists as 9.9 ft wide (November 1908).

- Heading west along sections 15 and 22: Gold Creek is dry; Chloride Gulch is dry (November 1908).
- Heading west along sections 10 and 15: Dry bed of Gold Creek (November 1908).
- Heading west along sections 3 and 10: Gold Creek exists as 82.2 ft wide (November 1908).

4.1.1.2 Idaho DEQ Beneficial Use Reconnaissance Project (BURP)

The Idaho Department of Environmental Quality BURP files include two survey locations for Gold Creek (shown on Figure 3 as crosses, blue where noted as flowing and yellow where noted as dry):

Date: 7/7/1994

- Location: NW1/4 of the NE1/4 of the NE1/4 of Section 10, T53N R1W. Gold Creek downstream of West Gold Creek and Kick Bush Gulch.
- Stream gradient: 3.0%.
- Flow conditions: 15.06 cfs.
- Valley type: v-shaped.
- Sinuosity: moderate.
- Particle sizes range from silt/clay (0-1mm) to small boulders (256-512mm) with mostly pebbles.
- Other: Substrate consists of granites, limestone, shale; outcrops along reach include limestone, shale, schist.

Date: 7/22/2003

- Location: NW1/4 of the SE1/4 of the SE1/4 of Section 15 T53N R1W. Gold Creek at USFS Road 278 upstream of Chloride Gulch.
- Stream bed was dry at this location on July 22, 2003.

4.1.1.3 USFS References

The USFS characterization of the Gold Creek watershed (USFS, 1997; USFS, 2001; USFS, 2003) notes that Gold Creek above West Gold goes dry for most of the summer and that the channel dimensions are not within dynamic equilibrium and not within expected normal ranges. In upper Gold Creek it is estimated that 50,000 cubic yards of tailings has been deposited into the channel below the Conjecture Mine and that an additional 110,000 cubic yards of tailings remains at the mine site. Based on discussions with nearby residents, the deposition of the 50,000 cubic yards of tailings from the Conjecture Mine site likely occurred in a single rain on snow event (Geoff Harvey, IDEQ email communication January 12, 2006). However, there is no information available on the thicknesses of the tailings material within the Gold Creek channel below the Conjecture Mine. Based on an observed sediment thickness of about 3 feet in the USFS Rd 278 culvert (Photo 5, Appendix B), it is estimated that about 11,000 cubic yards (cy) of tailings may occur in the Gold Creek channel from the Conjecture Mine to where the gradient flattens (a reach length of about 8,000 feet with a bank full width of about 13 feet). Below this upper reach, there is no field information available to support estimates of tailings thicknesses in the Gold Creek channel. However, Cedar stumps

(estimated to be over 100 years old) were observed in the Gold Creek channel (Photo 6, Appendix B) within the middle, low gradient reach. The fact that these stumps are not buried with sediment indicates that there may be little, if any, tailings deposition within this middle reach. In addition, metals detected in sediments (above background levels) at the Gold Creek delta into Lake Pend Oreille (Chris Downs, email communication 091305) suggests that some portion of the tailings material has been transported through the Gold Creek system.

Below West Gold, Gold Creek is noted to be perennial and in equilibrium with year-round flows (USFS, 2001). The bedrock controlled nature of lower Gold Creek (below West Gold Creek) is noted as making lower Gold Creek more resilient to natural and human-caused disturbances.

The USFS survey of Gold Creek during the summer of 2003 includes the following information on dry and flowing reaches. The approximate locations of the survey reach breaks are shown on the stream profile in Figure 2A.

- Reach 5 – upstream of the Conjecture Mine for 1,215 meters (3,986 ft) - Channel Type F4b. **Flowing.**

- Reach 6 –Conjecture Mine. Not surveyed due to its extremely unnatural state. **Flowing**

- Reach 7 – from downstream end of Conjecture Mine waste dump for 400 meters (1312 feet) **–** Channel Type B4a. **Flowing**

- Reach 8 – 850 meters (2,854 feet) downstream of end Reach 7 – Channel Type F4b. Stream channel grade lessens and sediment settles out. Sediment is moved during high flows. **Streambed goes dry within this reach.**

- Reach 9 – 2,400 meters (7,874 feet) downstream of end Reach 8 – Channel Type B4. **Entire reach was dry.** During spring runoff the flow appears to be a well functioning B4 channel type. Banks are stable with boulders and large woody debris as stabilizers.

- Reach 10 – 130 meters (427 feet) downstream of end Reach 9 – Channel Type F4b**. Channel was dry at the time of the survey.**

- Reach 11 – 520 meters (1,706 feet) downstream of end Reach 10 to the West Gold Confluence – Channel Type B4. **Water is starting to appear in pools.** Channel similar to Reach 9.

- Reach 12 – 890 meters (2,920 feet) downstream of the West Gold Confluence – Channel Type B2a. The substrate is predominately boulder and bedrock with numerous waterfalls and cascades, none of which appear to be fish barriers. **Flowing.**

- Reach 13 – 920 meters (3,019 feet) downstream of Reach 12 – Channel Type B3. Channel banks are stable and substrate is moving through at a constant rate. This reach has highest quality fish habitat. There are 10 springs present in the middle of the reach emanating from stream right bank. **Flowing.**

- Reach 14 – starts just above the power line ford crossing and is 330 meters longs (1,083 feet) – Channel Type B4c. This reach may have been created because of the road crossing that has widened out the channel and deposited sediment below. This reach appears stable. **Flowing.**

- Reach 15 – is 920 meters longs (3,019 feet) and extends to Lake Pend Oreille – Channel Type F4. Sediment appears to have been deposited many years ago and the channel has since been down cut. Fish habitat is good with large pools. **Flowing.**

4.1.1.4 Site Observations (June through September, 2005)

Golder personnel walked Gold Creek from the Conjecture Mine (Photo 1, Appendix B) to the confluence with West Gold Creek (Photo 7, Appendix B) between July 14 and 18, 2005 and from West Gold Creek to the powerline crossing below Kick Bush Gulch (Photo 8, Appendix B) between September 17 and 18, 2005. The following summarize the observations. Pictures supporting these observations are included in Appendix B.

- Gold Creek is flowing from the Conjecture Mine to approximately 0.2 miles southeast of the USFS Road 278 culvert (the NE corner of Section 22 of T53N R1W). Flow was estimated visually below the Conjecture Mine at about 2 cubic feet per second (cfs) on June 16, 2005 (Photo 2, Appendix B) and was measured at 0.28 cfs on September 18, 2005 (Photo 3, Appendix B).

- Gold Creek is dry from approximately 0.2 miles southeast of the USFS Road 278 culvert (Photo 4, Appendix B) until approximately 0.2 miles upstream of its confluence with West Gold Creek (about a 1.5 mile reach). Where the water surfaces, there are several pools and the water flow is very low.

- At the USFS Rd 278 culvert (72-inch diameter elliptical culvert) the sediment is approximately three feet above the bottom of the culvert (Photo 5, Appendix B). This indicates that about 3 feet of sediment has aggraded in this location since the culvert was installed in the early 1970s (Kevin Davis (USFS) email communication 121905).

- Gold Creek was noted on June 26, 2005 as dry for about 0.5 miles upstream and downstream of Chloride Gulch (Photo 15, Appendix B). Large cedar stumps of considerable age (100+ years) were noted in the stream channel (Photo 6, Appendix B). It does not appear that these stumps have been inundated with sediment.

- The Gold Creek channel at the West Gold confluence is bedrock and increases in elevation upstream from the confluence with West Gold about 8 feet vertical over a 20 foot horizontal distance (Photo 7, Appendix B). Flow from Gold Creek above the confluence was noted as a trickle on June 26, 2005 (estimated visually at about 0.1 cfs) and was measured at 0.01 cfs on September 17, 2005. The flow of water from West Gold Creek into Gold Creek was estimated visually at about 5 cfs on June 26, 2005 and was measured as 0.92 cfs on September 17, 2005.

- Gold Creek was noted as flowing from the West Gold confluence to its discharge into Lake Pend Oreille between September 17 and 18, 2005 (Photo 8, Appendix B).

4.1.2 Chloride Gulch

As illustrated on Figure 3, the compilation of information sources indicates that Chloride Gulch is typically flowing along its upper reach and is typically dry along its lower reach to its confluence with Gold Creek. The following sub-sections describe the information used to develop this observation. As for Gold Creek above, it should be noted that the existence of a defined channel along the

typically dry reach indicates that during high flows (e.g., spring melt or rain-on-snow events) significant water flows within this channel.

4.1.2.1 Historic General Lands Office (GLO) Section Survey Notes (1908 and 1910)

The following summarize GLO survey notes made between 1908 and 1910 for Chloride Gulch (from upstream to downstream) within Township 53 North, Range 1 West. The assumed locations for the notes are shown on Figure 3 as solid circles on the streams (blue for flowing and yellow for dry). Where the notes do not mention that the stream is dry, it is assumed that the stream is flowing.

- Heading west along sections 21 and 28: Chloride Gulch is 6.6 ft wide (November 1908).
- Heading north along sections 21 and 22: East Fork of the Middle Fork of Gold Creek (assumed to be Chloride Gulch) is about 5.28 ft wide (November 1908).
- Heading west along sections 15 and 22: Gold Creek is dry; Chloride Gulch is dry (November 1908).

4.1.2.2 Idaho DEQ Beneficial Use Reconnaissance Project (BURP)

Idaho DEQ's BURP files indicate one survey location for Chloride Gulch (shown on Figure 3 as a yellow cross).

Date: 7/20/1998

- Location: NE1/4 of the NE1/4 of the NW1/4 of Section 22, T53N R1W. Chloride Gulch just upstream of USFS Road 298 and about 1/3 mile upstream of Gold Creek.
- Stream bed was dry at this location on July 20, 1998.

4.1.2.3 USFS References

The USFS characterization of the Gold Creek watershed notes that Chloride Gulch is intermittent and that channel dimensions are not within dynamic equilibrium and not within expected normal ranges (USFS, 1997; USFS, 2001). Mine waste placed in the channel at the Lakeview Mine is noted as a primary sediment source. The dominant channel type is a B4c, with intermittent F4b and C4b channel types. The waste rock is deposited during high flow events and then down cutting occurs, resulting in an F type channel. Under natural conditions the channel would likely be B type (USFS, 1997; USFS, 2001). A stream survey was completed for Chloride Gulch by the USFS in July 2002. The survey team noted that Chloride Gulch was dry for about 4,200 feet upstream of the Gold Creek confluence. The following summarize the survey findings (USFS, 2002). The approximate locations of the reach breaks are shown on the Chloride Gulch stream profile in Figure 2B.

- Reach 1 – located above the Lakeview Mine - Channel Type A4a+. The channel side slopes are steep (up to 27%) and there is landslide debris in the stream within the upper portion of the reach. Where mine waste has been deposited into the stream channel, the stream goes subsurface and there is a tremendous amount of small gravel in the channel. **Flowing.**
- Reach 2 – downstream of Lakeview mine – Channel Type F4b. The channel cuts into waste rock deposited in stream banks. Would likely be a B type channel under natural conditions. **Flowing.**

- Reach 3 – Channel Type B4c. Stream channel widens and valley opens. Lots of large woody debris and cutthroat present. **Flowing.**

- Reach 4 – Channel Type C4b. Major rehabilitation work completed in 1994. **Flowing.**

- Reach 5 – Channel Type F4b. **Stream went dry at 1,345 feet along reach.** Would likely be a B type channel under natural conditions.

- Reach 6 – Channel Type B4c. **This reach is dry.** Man-made structures exist in the stream channel that have created plunge pools when water flows.

- Reach 7 – Channel Type C4. **This reach is dry from the 278 road crossing to the confluence with Gold Creek.** This reach is more sinuous with a wider valley bottom and steeper banks.

4.1.2.4 Site Observations (June through September, 2005)

Golder personnel walked Chloride Gulch from the Lakeview Mine to the Gold Creek confluence on June 26, 2005. The following summarize the observations. Pictures supporting these observations are included in Appendix B.

- Chloride Gulch just below the Lakeview Mine was noted visually flowing at about 1 cfs on June 16, 2006 (Photo 11, Appendix B). Flow about 1 mile downstream of this location was measured at 0.02 cfs on September 18, 2005.

- The Chloride Gulch channel became dry about 0.5 miles below the second Lakeview Mine road crossing (Figure 3 and Photo 12, Appendix B).

- Chloride Gulch was noted as dry from about 0.5 miles below the second Lakeview Mine road crossing to the confluence with Gold Creek on June 26, 2005 (Photo 15, Appendix B).

- A small spring or tributary to Chloride Gulch was noted on June 26, 2005 about 0.25 miles upstream of the USFS pilot bed load removals on Chloride Gulch. A small amount of water was noted in Chloride Gulch for about 50 feet downstream of this source. Below this, the channel was dry. Photo 13 (Appendix B) illustrates Chloride Gulch at the USFS pilot removals.

- On June 26, 2005, in the dry reach of Chloride Gulch, large cedar stumps of considerable age (100+ years) were noted in the stream channel (Photo 14, Appendix B). It does not appear that these stumps have been inundated with sediment.

4.1.3 Kick Bush Gulch

As illustrated on Figure 3, the compilation of information sources indicates that Kick Bush Gulch at lower flow months of the year is typically dry along its mid elevation reach and flowing along its lower reach to its confluence with Gold Creek. The following sections describe the information used to develop this observation. As for other project area streams it is assumed that Kick Bush flows along its length when flows are sufficiently high (e.g., during spring melt and flowing rain-on-snow events).

4.1.3.1 Historic General Lands Office (GLO) Section Survey Notes (1908 and 1910)

The following summarize GLO survey notes made between 1908 and 1910 for Kick Bush Gulch within Township 53 North, Range 1 West. The assumed locations for the notes are shown on Figure 3 as solid circles on the streams (blue for flowing and yellow for dry). Where the notes do not mention that the stream is dry, it is assumed that the stream is flowing.

- Heading west along sections 11 and 14: Dry stream bed of Kick Bush Creek (March 1910).
- Heading north along sections 10 and 11: Kick Bush Creek exists as 7.92 ft wide (November 1908).

4.1.3.2 Idaho DEQ Beneficial Use Reconnaissance Project (BURP)

Idaho DEQ's BURP files include one survey location for Cheer Creek, a tributary to Kick Bush Gulch. This location is shown on Figure 3 as a blue cross.

Date: 7/23/2003

- Location: NW1/4 of the SE1/4 of the NW1/4 of Section 11, T53NR1W. Cheer Creek just upstream of its confluence with Kick Bush Gulch.
- Stream gradient: 3.0%.
- Flow conditions: 0.04 cfs.
- Sinuosity: low.
- Particle sizes range from silt/clay (0-1mm) to large cobbles (128.1-256mm) with mostly pebbles.
- Other: Dense vegetation and trees down throughout reach; many log jams: trails run across streams; amphibians were observed; no fish were electrofished.

4.1.3.3 USFS References

The USFS characterization of the Gold Creek watershed (USFS, 1997; USFS, 2001) notes that Kick Bush Gulch is likely not out of the range of natural variability and that very scant in-channel woody debris resulting from historic fires is the main cause of headwater downcutting. The USFS 2002 survey of Kick Bush notes that the watershed has not experienced any mining activity and that the forest and riparian areas along the stream are in good condition. Above Cheer Creek, Kick Bush Gulch is noted as intermittent (USFS, 2002). The USFS 278 road culvert was surveyed in June 2002 and was found to be in poor condition. The Kick Bush slide, located at the USFS 278 road near the culvert, has resulted in deposition of gravel and fines in the channel. Above the slide, the dominant channel sediment is cobble sized.

4.1.3.4 Site Observations (June through September, 2005)

The following summarize the observations made by Golder personnel between June and September, 2005.

- Kick Bush Gulch was noted as flowing (flow estimated visually at about 1 cfs) on June 16, 2005 at the USFS Road 278 crossing.

- Kick Bush Gulch was noted as flowing (flow measured at 0.31 cfs) just above its confluence with Gold Creek on September 17, 2005 (Photo 10, Appendix B).

4.1.4 West Gold Creek

As illustrated on Figure 3, the compilation of information sources indicates that West Gold Creek flows year round. The following sub-sections describe the information used to develop this observation.

4.1.4.1 Historic General Lands Office (GLO) Section Survey Notes (1908 and 1910)

The following summarize GLO survey notes made between 1908 and 1910 for West Gold Creek within Township 53 North, Range 1 West. The assumed locations for the notes are shown on Figure 3 as solid circles on the streams (blue for flowing and yellow for dry). Where the notes do not mention that the stream is dry, it is assumed that the stream is flowing.

- Heading north along sections 29 and 30: Tributary of West Gold Creek is 3.3 ft wide (November 1908).

- Heading west along sections 17 and 20: Tributary of West Gold Creek is 3.3 ft wide; West Gold Creek is 9.9 ft wide (November 1908).

- Heading north along sections 16 and 17: West Gold Creek is 11.8 ft wide (November, 1908).

- Heading north along sections 9 and 10: West Gold Creek is 11.8 ft wide (November, 1908).

4.1.4.2 Idaho DEQ Beneficial Use Reconnaissance Project (BURP)

Idaho DEQ's BURP files include three survey locations for West Gold Creek (shown on Figure 3 as crosses, blue if noted as flowing and yellow if noted as dry):

Date: 7/8/1994

- Location: NE1/4 of the SE1/4 of the SE1/4 of Section 9, T53N R1W. West Gold Creek upstream of USFS Road 278 and about 1/2 mile upstream of confluence with Gold Creek.
- Flow conditions: 1.98 cfs.
- Stream gradient: 3.2%.
- Other: amphibians and fish observed.

Date: 7/20/1998

- Location: SW1/4 of the NW1/4 of the SW1/4 of Section 10, T53N R1W. West Gold Creek downstream of USFS Road 278 and about 1/3 mile upstream of confluence with Gold Creek.
- Stream gradient: 3%.
- Flow conditions: 2.25 cfs.
- Valley type: v-shaped.
- Sinuosity: moderate.

- Particle sizes range from silt/clay (0-1mm) to small boulders (256-512mm) with mostly small cobbles.
- Other: several small tributaries entering reach.

Date: 8/18/1998

- Location: NE1/4 of the NW1/4 of the NW1/4 of Section 20, T53N R1W. Upper West Gold Creek about 2.5 miles upstream of confluence with Gold Creek.
- Stream gradient: 2.5%.
- Flow conditions: 1.14 cfs.
- Valley type: v-shaped.
- Sinuosity: low.
- Particle sizes range from silt/clay (0-1mm) to large boulders (>1024 mm) with mostly pebbles.

4.1.4.3 USFS References

The USFS characterization of the Gold Creek watershed (USFS, 1997; USFS, 2001) notes that West Gold Creek flows year round. The bedrock controlled nature of West Gold Creek is noted as making West Gold more resilient to natural and human-caused disturbances although timber harvest units in the headwaters have caused localized downcutting where buffers do not protect streams (USFS, 1997; USFS, 2001). The predominant Rosgen channel type in West Gold is B3/B4.

4.1.4.4 Site Observations (June through September, 2005)

The following summarize the observations made by Golder personnel between June and September, 2005.

- Golder personnel viewed West Gold Creek at USFS Road 2707 on June 16, 2005. Flow was estimated visually at about 2 cfs within a bedrock channel (Photo 9, Appendix B).
- Golder personnel accessed the West Gold – Gold Creek confluence on June 26, 2005 and September 17, 2005. The flow of water from West Gold Creek into Gold Creek within a bedrock channel was estimated visually at about 5 cfs on June 16, 2005 and was measured at 0.92 cfs on September 17, 2005.

4.1.5 North Gold Creek

As illustrated on Figure 3, the compilation of information sources indicates that North Gold Creek: (1) flows year round into Lake Pend Oreille; (2) is dry during low flow months within its mid low gradient reach; and, (3) has flowing and dry reaches downstream and above Branch North Gold. The following sub-sections describe the information used to develop this observation.

4.1.5.1 Historic General Lands Office (GLO) Section Survey Notes (1908 and 1910)

The following summarize GLO survey notes taken between 1908 and 1910 for North Gold Creek within Township 53 North, Range 1 West. The assumed locations for the notes are shown on Figure 3 as solid circles on the streams (blue for flowing and yellow for dry). Where the notes do not mention that the stream is dry, it is assumed that the stream is flowing.

- Heading north along sections 1 and 2: Dry creek bed of North Gold Creek exists as 158.4 ft wide (November 1908).

- Heading north along sections 2 and 3: North Gold Creek exists as 13.2 ft wide. (November 1908).

4.1.5.2 Idaho DEQ Beneficial Use Reconnaissance Project (BURP)

Idaho DEQ's BURP files include two survey locations for North Gold Creek and one for Branch North Gold Creek. The survey locations are shown on Figure 3 as crosses, blue is the stream is noted as flowing and yellow is the stream is noted as dry.

Date: 7/6/1994

- Location: SE1/4 of the SW1/4 of the NE1/4 of Section 3 T53N R1W. North Gold Creek at Lakeview, about 1/3 mile upstream of Lake Pend Oreille.

- Stream gradient: 2.4%.

- Flow conditions: 10.4 cfs.

- Valley type: v-shaped.

- Sinuosity: moderate.

- Particle sizes range from silt/clay (0-1mm) to small boulders (256-512mm) with mostly pebbles and cobbles.

- Other: No bull trout found while electrofishing. All westslope cutthroat trout (*Oncorhynchus clarki lewisi*).

Date: 7/1/1997

- Location: SE1/4 of the SE1/4 of the NW1/4 of Section 1 T53N R1W. North Gold Creek just below Branch North Gold and USFS Road 278.

- Stream gradient: 2.0%.

- Flow conditions: 14.78 cfs.

- Valley type: v-shaped.

- Sinuosity: moderate.

- Particle sizes range from silt/clay (0-1mm) to large cobbles (128.1-256mm) with mostly pebbles and cobbles.

- Other: salmonids observed.

Date: 7/7/1997

- Location: SE1/4 of the SW1/4 of the NE1/4 of Section 1, T53N R1E. Branch North Gold Creek about ¼ mile upstream of confluence with North Gold Creek.

- Stream gradient: 4.0%.

- Flow conditions: 5.36 cfs.

- Valley type: U-shaped.

- Sinuosity: moderate.

- Particle sizes range from sand (1.1-2.5mm) to small boulders (256.1-512mm) with mostly sand and pebbles.

- Other: reach is braided in sections; no amphibians or fish observed.

4.1.5.3 USFS References

The USFS characterization of the North Gold watershed (USFS, 1997; USFS, 2001) notes that North Gold Creek and Branch North Gold Creek are likely not out of the range of natural variability and that large historic fires have resulted in increased sediment deposition to the streams. North Gold Creek is noted as having several intermittent channel sections throughout its length (USFS, 1997). The first section occurs about ¼ mile below the USFS 278 road crossing of North Gold and stays dry for about ½ mile downstream. The next intermittent section is above Branch North Gold. The USFS believes that intermittent flow in these reaches is in part from loss of woody debris caused by historical fires, homesteading in the area (resulting in clearing of riparian vegetation) and partly because of downward flow of water from the stream into the subsurface and into highly fractured bedrock (personal communication with Jerry Niehoff, 1996).

4.1.5.4 Site Observations (June through September, 2005)

Golder personnel observed the mouth of North Gold Creek at Lake Pend Oreille and walked about 2 miles of North Gold Creek from the eastern boundary of Section 6, T53N, R1W to about 0.5 miles downstream of the Branch North Gold Creek confluence between July 14 and 18, 2005. The following summarize the observations. Notation of the wet and dry reaches is presented on Figure 3.

- On July 15, 2005, throughout Section 6, T53N, R1W and to the Branch North Gold Creek confluence North Gold Creek alternates between flowing (below 1 cfs) and dry conditions (Photo 16, Appendix B).

- Branch North Gold was noted as flowing on July 14, 2005 for about one mile above its confluence with North Gold Creek with flow visually estimated at between 3 to 4 cfs (Photo 17, Appendix B).

- North Gold Creek was noted on July 14, 2005 as flowing below Branch North Gold with flow visually estimated at between 3 to 4 cfs.

- North Gold Creek was noted on July 14, 2005 as flowing into Lake Pend Oreille with flow visually estimated at between 6 to 8 cfs (Photo 18, Appendix B).

4.2 September 2005 Stream and Spring Flows

Stream flow and spring flow measurements were made within the Gold Creek watershed to better understand the relationship between dry and flowing project stream reaches and to develop simplified water balances.

4.2.1 Stream Flow Measurements

Stream flow measurements were taken using standard USGS protocols (Rantz, S.E., and others, 1982a; Rantz, S.E., and others, 1982b) with a Swoffer flow meter Model 3000-12. Additional data collected at each of the six sites included weather conditions, bank-full width, wetted width, water temperature, and GPS location whenever possible. General observations, including bull trout sightings, were also noted in the field. There were two locations where stream flow and / or channel morphology did not allow for the use of standard stream flow measurement protocols: 1) Gold Creek above the confluence with West Gold Creek; and, 2) the unnamed tributary to Chloride Gulch. In these two instances, the same methodology used to obtain the groundwater spring flow measurements was used to provide a measurement of stream flow. The methodology used to measure springs is outlined in Section 4.2.2.

Stream flow measurements were taken at seven locations over a two day period on September 17 and 18, 2005 (Figure 4A). Stream flow data is summarized in the bulleted list below and on Table 1. Stream discharge measurements are included in Appendix C.

1. Gold Creek just upstream of the powerline crossing was measured at approximately 7.27 cubic feet per second (cfs) on September 17, 2005 (Photo 8, Appendix B).
2. Kick Bush Gulch just above the confluence with Gold Creek was measured at approximately 0.31 cfs on September 17, 2005 (Photo 10, Appendix B).
3. West Gold Creek just above the confluence with Gold Creek was measured at approximately 0.92 cfs on September 17, 2005.
4. Gold Creek above the confluence with West Gold Creek was measured at approximately 0.01 cfs on September 17, 2005 using the same technique as for spring flow measurements (Photo 7, Appendix B).
5. Gold Creek below the Conjecture Mine was measured at approximately 0.28 cfs on September 18, 2005 (Photo 3, Appendix B).
6. An unnamed tributary to Chloride Gulch was measured at approximately 0.07 cfs on September 18, 2005.
7. Chloride Gulch was measured at approximately 0.02 cfs on September 18, 2005 using the same technique as for spring flow measurements.

TABLE 1

Stream Flow Data Summary

Location	Station ID Number	Temperature °C	Flow (cfs)	Flow (gpm)
Gold Creek below Kick Bush gulch at powerline	1	7.9	7.27	3,261
Kick Bush Gulch above confluence with Gold Creek	2	8.0	0.31	137
West Gold Creek above confluence with Gold Creek	3	10.7	0.92	411
Gold Creek above confluence with West Gold Creek	4	11.0	0.01	5
Gold Creek below Conjecture Mine	5	10.3	0.28	127
Unnamed tributary to Chloride Gulch below Lakeview Mine	6	10.3	0.07	30
Chloride Gulch below Lakeview Mine	7	10.5	0.02	10

Note: The locations of the stream flow measurement sites are shown on Figure 4A and are denoted by Station ID Number.

4.2.2 Spring Flow Measurements

Unlike surface water flow measurements, groundwater springs cannot be measured using standard flow equipment as they often occur as small seeps, overland flow, or tiny channels along stream banks. In some cases along Gold Creek, groundwater springs emanate directly from vertical banks along the channel. In order to obtain a flow measurement, a 2-1/2 gallon bucket was used with markers at every 1/4 gallon and 1 liter. At each groundwater spring, the bucket was placed in such a manner as to obtain all of the flow with the exception of minimal side seepage. If the spring flow was too high and or difficult to accurately obtain at the confluence with the stream, the field scientist followed the spring to a suitable location for obtaining a more accurate flow data. Given the bucket capacity (2-1/2 gallons), flow measurements of up to 150 gallons per minute were possible at each collection site. Flow was collected for a specified period of time using a digital stopwatch accurate to $1/100^{th}$ of a second. A minimum of two duplicate flow measurements were recorded at each site and the reported flow value was averaged.

Field observations located a total of fourteen (14) groundwater springs entering Gold Creek below the confluence with West Gold Creek and above the powerline crossing (below Kick Bush Gulch). Three (3) of these springs were noted on the west bank of Gold Creek and the remaining eleven (11) on the east bank of Gold Creek. The locations of the springs are shown on Figure 4A and in detail on Figure 5. Only six of the fourteen springs could be located with GPS because the canopy cover was too dense at the remaining locations to obtain readings. To improve the accuracy of locating these springs in the field, distances to springs without GPS readings from springs with recorded GPS locations were measured whenever possible with a 150 foot tape. Table 2 below summarizes the information recorded for the springs. The springs are numbered from north to south on Figure 5 with identification (ID) numbers that correspond to the ID numbers presented on Table 2.

Although 14 spring sources were documented, a total of forty (40) groundwater spring flow measurements were taken as many of the springs entered Gold Creek in a series of tiny channels

along heavily vegetated banks making a single flow measurement impossible. The total input from measured groundwater springs to Gold Creek was approximately 2.62 cubic feet per second (cfs) or 1,171 gallons per minute (gpm). The three spring emanating from the west bank had a combined flow of about 35 gpm or 0.08 cfs (4+3+28 gpm). The eleven springs emanating from the east bank had a combined flow of about 1,136 gpm or 2.53 cfs. Based on this information, spring flows to Gold Creek between the West Gold Confluence and the powerline crossing (below Kick Bush Gulch) account for at least 36 percent of the total flow of Gold Creek measured at the powerline.

The temperature of the springs (Table 2) emanating from the east side of Gold Creek ranged between 6.7 and 7.9 degrees Celsius. The temperature of the three springs emanating from the west side of Gold Creek ranged between 7.9 and 10.3 degrees Celsius. It is apparent that the relatively low temperature spring flows from the east side of Gold Creek cause a significant decrease in the temperature of the surface water in Gold Creek from 10.7 degrees Celsius at the West Gold Creek confluence to 7.9 degrees Celsius at the powerline crossing. Continuous temperature measurements made by IDEQ record an average temperature of 8 degrees Celsius in Gold Creek below West Gold Creek between 6/21-9/27/1997 (IDEQ, 1999).

TABLE 2

Gold Creek Spring Data Summary

Spring ID Number	Flow (cfs)	Flow (gpm)	Temperature °C	Lat / Long	Comments
1	0.01	4	7.9	47.961944000 / -116.446389000	Spring on West bank. Four bull trout observed in Gold Creek
2	0.01	3	10.3	47.959527383 / -116.444892983	Seeping bedrock wall on West bank.
3	0.01	3	7.9	47.958889000 / -116.444722000	
4	0.56	246	6.7	47.9585664831 / -116.444703694	
5	0.09	40	6.8	47.958483945 / -116.444874489	Series of seeps, over about 150 feet
6	0.06	28	8.5	47.958333000 / -116.445556000	Spring on West bank.
7	0.23	103	6.9	47.958155198 / -116.445325112	
8	0.04	16	6.9	47.9580530191 / -116.445374300	
9	0.05	24	6.9	47.9579505952 / -116.445463932	
10	0.17	75	7.2	47.957778000 / -116.445278000	
11	0.20	90	7.2	47.9573932002 / -116.445537344	
12	0.47	210	7.0	47.9572154569 / -116.445727080	
13	0.13	60	7.0	47.9570520315 / -116.445795667	Gold Creek temperature 10.9 °C. Seven bull tout observed in Gold Creek.
14	0.60	270	7.2	47.9564573501 / -116.446144221	West Gold Creek temperature 10.7 °C
Total Flow:	**2.62**	**1,171**			

Notes:

1. The locations of the springs are shown on Figures 4 and 7.
2. Latitude / longitude projection is Washington State Plane, North Zone, NAD 83 (feet).

4.3 Simplified Water Balance

Considering both the stream flow and spring flow measurements made on September 17 and 18, 2005 (Figure 4A), a simplified water balance (Table 3) was developed for the Gold Creek watershed above the powerline crossing (located below Kick Bush Gulch). The water balance concept is illustrated on Figure 4B.

The simplified water balance for September 17/18 2005 (Table 3 and Figure 4B) indicates that surface water inflows to Gold Creek from West Gold Creek and Kick Bush Gulch, plus spring discharges between West Gold Creek and the powerline on Gold Creek (a combined total of 3.86 cfs) is less than the outflow from Gold Creek at the powerline below Kick Bush Gulch (measured at

7.27 cfs. This suggests that about 3.41 cfs (i.e., 7.27-.3.86 cfs) of water enters the lower section of Gold Creek as groundwater upwelling and / or small springs and seeps that are not easily identified in the field. The additional discharge to lower Gold Creek originates as recharge to the upper portion of the watershed.

Assuming that the ungaged discharge to lower Gold Creek (3.41 cfs) plus the spring flows gaged on the east bank of Gold Creek below West Gold Creek (2.53 cfs) represents the total infiltration recharge over the Gold Creek watershed, the water balance indicates that about 5.94 cfs (i.e. 3.41 + 2.53 cfs) of water infiltrates to the groundwater over the Gold Creek watershed (above the lower Gold Creek powerline). The Gold Creek watershed above the powerline covers about 14,000 acres, so this infiltration rate is equivalent to about 3.69 inches per year (or 0.31 feet per year). Since this is a reasonable infiltration rate for the project area, there is a degree of confidence that this simplified water balance adequately represents this system. Groundwater infiltration is therefore a significant component of the hydrology of Gold Creek, and is not constrained to the channel of the creek.

TABLE 3

Simplified Water Balance for Gold Creek (September 17 and 18, 2005)

INFLOWS	**Inflow (cfs)**	**Outflow (cfs)**
Surface Water Runoff		
West Gold above Gold Creek	0.92	
Gold Creek above West Gold	0.01	
Kick Bush Gulch above Gold Creek	0.31	
Total Surface Water Runoff (gaged)	**1.24**	
Springs		
East bank spring flow (between West Gold to Kick Bush)	2.53	
West bank spring flow (between West Gold to Kick Bush)	0.06	
East bank spring flow (between Kick Bush and powerline)	0.02	
Total Spring Flow (gaged)	**2.62**	
TOTAL INFLOWS (gaged)	**3.86**	
OUTFLOWS		
Surface Water Runoff		
Gold Creek at powerline		7.27
TOTAL OUTFLOWS (gaged)		**7.27**
Difference between gaged Inflows and Outflows		
Ungaged infiltration and underflow (7.27 – 3.86 cfs)		**3.41**

4.4 Spring Locations and Property Ownership

The stream and spring survey indicates that at least 36 percent of the flow gaged in Gold Creek at the powerline (below Kick Bush Gulch) is derived from springs that emanate primarily from the east side of Gold Creek along a 1,500 feet reach upstream of Kick Bush Gulch (Figure 5). If it is assumed that the unaccounted for water in Gold Creek at the powerline indicated on Table 3 (i.e., 3.41 cfs) is also groundwater discharge to Gold Creek, as much as 83 percent of the flow in Gold Creek at the powerline results from groundwater discharge between the West Gold confluence and the powerline crossing. As indicated on Table 1, the temperature of West Gold Creek (which provides essentially all the Gold Creek flow below the Gold – West Gold confluence) was noted as 10.7 ^{o}C on September 17, 2005. The temperature of Gold Creek at the powerline (below the groundwater discharge zone) was noted as 7.9 ^{o}C on September 17, 2005. As indicated on Table 2 the temperature of the springs measured on east side of Gold Creek between West Gold and the powerline ranged between 6.7 and 7.9 C on September 17, 2005. It is clear that the springs and additional unmeasured groundwater discharge below the West Gold confluence has the effect of significantly increasing the flow of Gold Creek and lowering the temperature of the water, even during low flow months.

During Golder's September 17 – 18, 2005 survey of the springs, a number of bull trout were observed in Gold Creek between the powerline and the confluence with West Gold Creek. Discussions with the project stakeholders also confirmed that Gold Creek below West Gold provides good bull trout habitat. It is likely that the cold groundwater discharge to Gold Creek along this reach supports the good habitat and is the primary reason why the bull trout utilize this reach. This is supported by information presented in the 2002 Panhandle Bull Trout Technical Advisory Team Report.

In order to determine the property ownership for land in the vicinity of the springs, Golder personnel obtained parcel information from the Bonner County Assessor's office. The property information and the locations of the springs are shown on Figure 5. As indicated on Figure 5, the majority of the springs noted in the field are located on Forest Service Land, upstream of Kick Bush Gulch. One small spring with a flow of about 4 gpm (denoted as spring #1 Figure 5) is located on private land (parcel number 53N01W100900). A second small spring with a flow of about 3 gpm (denoted as spring #2 Figure 5) is located just south of private land (parcel number 53N01W101100). As also indicated on Figure 5, private land parcels are located along USFS Road 278 upgradient of the springs (parcel numbers 53N01W102250, 53N01W107200, 53N01W107280, 53N01W107690, and 53N01W109040). It will be important that groundwater supply development and land use practices on private land and Forest Service land with springs as well as private and Forest Service Land upgradient and adjacent to springs do not impact the quantity and quality of the spring and groundwater discharge to Gold Creek.

5.0 HYDROGEOLOGY

This section includes information on regional and local geology and local hydrogeology. Regional geologic information was obtained primarily from the USGS via the internet. Local hydrogeologic information is based on review of available well logs and interpretation of geologic cross sections developed for this project.

5.1 Regional Geology

Surficial geologic mapping (i.e. mapping of the geologic units exposed at ground surface) for the project area is presented on Figure 6. This mapping was obtained from the USGS via the internet. Additional interim regional mapping (USGS, 2000) and reporting (Kun, 1974) was also reviewed. The geologic history of the region is complex and involves multiple episodes of tectonic uplift and igneous activity followed by erosion and sedimentation caused primarily by glacial and fluvial processes.

The surficial geology of the project area (Figure 6) comprises the following:

- **Bedrock**
    - Precambrian (older than 570 million years) rocks of the Belt Supergroup, denoted by Y on Figure 6; and,
    - Cambrian (505 to 570 million years old) calcareous rocks (limestone, dolomite and marble), denoted by C on Figure 6.
- **Unconsolidated Deposits**
    - Quaternary (younger than 1.6 million years old) sediments denoted by Q on Figure 6 and including glacial, alluvial, colluvial and mass wasting (landslide) deposits.

5.2 Local Geology

The surficial geology of the project area is dominated by bedrock at elevations greater than about 2,800 ft amsl and by glacial sediments that fill the valleys below elevations of about 2,800 ft amsl (Figure 6). Bedrock comprises primarily Precambrian Belt Supergroup rocks and some Cambrian limestone, dolomite and marble (Figure 6). The glacial sediments in the project area (denoted as Qgo on Figure 6) occur in the Gold Creek, Chloride Gulch, Kick Bush Gulch and North Gold Creek valleys (Figure 6 and Kun, 1974). These glacial deposits may be up to several hundred feet thick in the project area and comprise mainly silt, sand, gravel and boulders.

The glacial sediments were likely deposited in two environments: by cirque or valley glaciers at higher elevations; and, within glacial lakes at lower elevations. Valley glaciers would have started as snowfields in amphitheater-like hollows known as cirques and would have extended down-valley as rivers of ice. Lower elevation glacial sediments were likely deposited within lakes that formed along the margins of the large continental glacier that occupied the Lake Pend Oreille basin (Kun, 1974). Melting of the valley glaciers resulted in deposition of a heterogeneous mixture of clay, silt, sand, gravel and boulders. Where the sediments were deposited directly by the melting ice, the glacial deposits are referred to as till and are generally a poorly sorted accumulation of all sediment sizes. Till that is transported and deposited by meltwater streams is known as outwash. Outwash tends to be sorted and stratified. Where the meltwater streams from cirque glaciers were blocked by the

continental glacier that occupied the Lake Pend Oreille basin, lakes would have formed. Meltwater streams would have deposited deltas of stratified sediments into the lakes on the upgradient side of the lakes. In addition, stratified silts would have been deposited aerially within the lakes. Following the retreat of the continental glacier, the lakes drained and the current drainage patterns began to form. Today, most streams in the project area are still attempting to clear glacial debris from their valleys (Harrison et al, 1972).

Observations made at the Gold Creek – West Gold Creek confluence by Golder personnel noted bedrock in the Gold Creek stream channel for a couple of hundred feet upstream of the West Gold confluence to about 1,300 feet below the Kick Bush Gulch confluence. Bedrock was also noted within the West Gold Creek channel for at least a couple of hundred feet upstream of its confluence with Gold Creek. This indicates the USGS regional geologic mapping presented on Figure 6 may not be accurate at a detailed scale since the geology at this location is mapped on the USGS regional map as older glacial sediments (denoted as Qgo on Figure 6) and not as bedrock.

Alluvial deposits that occur within the current stream channels are mainly reworked glacial debris (Kun, 1974). Colluvial and mass wasting (e.g., landslide) deposits occur throughout the project area, including the Kick Bush slide that has a history of failures that have contributed sediment to Gold Creek. Landslides in the area have a number of causes including naturally occurring steep slopes, geologic faults as well as timber harvesting and road building. There are numerous geologic faults in the project area, including a major fault that runs southwest – northeast through Chloride Gulch, Kick Bush Gulch and North Gold Creek.

5.3 Local Hydrogeology

This section presents information on the local hydrogeology based on well logs and on interpretation of field observations.

5.3.1 Well Inventory

In order to improve understanding of the project area hydrogeology, an on-line search was completed to obtain geologic logs for wells on file at the Idaho Department of Water Resources (IDWR). In addition, IDEQ provided two logs for wells drilled by the USFS in October 2005 in the vicinity of the Lakeview repository at the junction of USFS Roads 278 and 1180 within the Chloride Gulch drainage. Table 4 presents the inventory of the well records used for this assessment. Additional logs for wells located in the Lakeview area were found but were not included in the inventory since they did not add further information on the geology and hydrogeology of the project area. The wells are located on Figure 7 based on information provided on the logs. Copies of the well logs are included in Appendix D.

As indicated on Figure 7, there are very few wells located within the project area (i.e. Chloride Gulch below the Lakeview Mine and Gold Creek below the Conjecture Mine and above the confluence with West Gold Creek). Of those found (five in total), three are associated with the Lakeview Resort (now called the Happy Hermit Resort) and are located on the west side of Gold Creek, about 1.4 mile downstream of the Chloride Gulch confluence (Well IDs 1, 2 and 3); and, two occur on the east side of Chloride Gulch, adjacent to the Lakeview repository at the junction of USFS Roads 278 and 1180 (Well IDs 9 and 10).

TABLE 4

Well Inventory

Well ID [1]	Well Depth (ft bgs)	Well Diam. (inches)	Well Owner	T, R, S	1/4-1/4 S	1/4 S	Water Level [2] (ft bgs)	Screened Depth (ft bgs)	Unit Screened / Developed [3]	Depth to Bedrock (ft bgs)
1	140	6	JOHN BERTONI [4]	53N, 1W, 15	SW	NE	105 (8/26/77)	105-125	Qgo	136
2	64	6	JOHN BERTONI	53N, 1W, 15	SW	NE	34 (8/22/75)	25-30, 50-60	Qgo	NE
3	165	6	JOHN BERTONI	53N, 1W, 15	SW	NE	Not noted on log	none	none	130
4	176	8 and 6	BIO ECOLOGY RESEARCH INSTITUTE	53N, 1W, 3	NE	SW	45 to 50 (6/28/78)	74-79, 123-128, 166-176	bedrock	55
5	304	8	JOHN GILLIS	53N, 1W, 3	NE	SW	183 (6/6/90)	240-300	bedrock	15
6	142	8 and 6	BITTEROOT MOUNTAIN LODGE	53N, 1W, 3	SE	NW	5 (5/29/90)	75-135	bedrock	0
7	82	8 and 6	CLIFF GENTRY	53N, 1W, 3	SE	NW	17 (7/24/98)	42-82	bedrock	0
8	45	8 and 6	GORDON NYBERG	53N, 1W, 3	SW	NW	10 (7/24/98)	25-45	bedrock	0
9	75	2	US FOREST SERVICE	53N, 1W, 15	SE	SW	dry (10/11/05)	25-75	Qgo	NE
10	62.5	2	US FOREST SERVICE	53N, 1W, 15	SW	SE	dry (10/12/05)	12.5-62.5	Qgo	NE

Notes: ft bgs – feet below ground surface, T – Township, R – Range, S – Section, ne – not encountered.

1. Well logs are included in Appendix D and are numbered by Well ID. Figure 7 shows well locations by ID.
2. Static water level noted on log at time of drilling (drilling completion date).
3. Estimated / inferred from information available on the well log. See Figure 7 for explanation of unit.
4. This was confirmed by Panhandle Health as the log for the Happy Hermit Resort water supply well.
5. Qgo – Older Glacial Sediments (see Figures 6 and 7).

The logs for the three Happy Hermit wells (Well IDs 1, 2 and 3 in Appendix D) indicate between 130 to 136 feet of glacial deposits (clay, sand, gravels and boulders) overlying shale or decomposed granite. The following notes our conclusions based on review of these well records:

- The static water level noted for Well ID No. 1 (bedrock at 136 feet below ground surface) was 105 feet below ground surface on August 26, 1977. This is the well currently used by the Happy Hermit Resort (confirmed by Mike Nelson, Panhandle Health, 9/7/2005). This log suggests that the saturated thickness of the glacial deposits overlying bedrock is about 31 feet.

- Well ID No 2 (a well also owned by the Happy Hermit) includes two records: (1) for drilling the well in May 1975; and, (2) for deepening the well in August 1975. At the time the well was originally drilled to a depth of 32 feet (May 1975), the static water level was noted at 8 feet below ground surface. When the well was deepened to a depth of 64 feet (August 1975), the static water level was noted at 34 feet below ground surface. Although not confirmed with the current owner, it is likely that this well was deepened because the water level in the well dropped after May causing the well to go dry. The fact that a third well, Well ID No. 1 (and the well currently used) was drilled to a depth of 140 feet in 1977 suggests that the water production / water level in the deepened well may have been insufficient to provide a reliable water supply.

- A third record for a Happy Hermit well was also found (Well ID No. 3). This well was the first drilled, in November 1974, to a total depth of 165 feet and was cased through the glacial deposits (clay and gravel) and into the bedrock (soft shale or decomposed granite) to a depth of 132 feet. No water was noted in this well. It is likely that this well (because it is cased through the glacial deposits) is recording the lack of adequate water for supply within the bedrock between 132 to 165 feet below ground surface.

The logs for the two USFS wells drilled in October 2005 and located on the east side of Chloride Gulch at the junction of USFS Roads 278 and 1180 (Well IDs 9 and 10 on Figure 7 and in Appendix D) indicate that the glacial deposits (noted as clayey silt, silt and gravel) are dry to depths between 62.5 and 75 feet below ground surface. These two wells were drilled using the hollow-stem continuous flight augering method. This involves using a cutter head attached to the leading auger flight which cuts a hole into the ground for the auger flights to follow. Each auger section comprises a hollow pipe with spiral flanges (known commonly as flights) welded to the pipe. As the hole is drilled, cuttings are brought to the top of the hole by the flights which act as a screw conveyor. As the auger drills into the earth, more auger sections are added until the desired depth is reached or penetration is halted by obstructions, hard ground or caving conditions. The boreholes for these wells were not drilled any deeper than 75 feet because the drill rig used (an 8-inch hollow stem auger) was unable to drill deeper due clayey silt binding the auger fights (at 75 feet bgs for Well ID No. 9) and due to an obstruction (e.g., a boulder) or hard ground (at 62.5 feet bgs for Well ID No. 10). The information obtained from these wells indicates that the water level with the glacial deposits occurs at a depth greater than 75 feet below ground surface.

5.3.2 Cross Sections

Using available information (USGS geologic mapping and well logs) along with our understanding of the geologic history of the project area, five conceptual cross sections were developed to illustrate the project area hydrogeology. The locations of the cross sections are shown on Figure 7. The cross sections are presented as Figures 7A, 7B and 7C. The following paragraphs describe each cross section.

5.3.2.1 Cross Section A-A' (Chloride Gulch from the Lakeview Mine to Gold Creek)

Cross Section A-A' (Figure 7A) illustrates how the older glacial deposits (Qgo) are exposed at surface and are likely to overlie bedrock at elevations below 2,800 feet amsl. Based on wells drilled in October 2005 (see Well Logs 9 and 10 located on Figure 7 and included in Appendix D), the thickness of these glacial deposits is greater than 75 feet at the USFS repository site and the static water level was deeper than 75 feet below ground surface in October 2005 (since both wells were noted as dry). Based on this well log information, the glacial deposits comprise silt and gravel with some small cobbles from surface to between 10 and 19 feet below ground surface and primarily silt

with interbedded gravel zones from between 10 and 19 feet below ground surface to between 62.5 and 75 feet below ground surface. Below 42 feet (Well 9) and below 51 feet (Well 10), the silts are noted as clayey. These silts indicate that the glacial deposits may be primarily lacustrine in this location. However, the interbedded gravels indicate deposition of higher energy sediments periodically into the lake deposits. The depth to bedrock and to the water table within the glacial deposits is currently unknown, but is deeper than 75 feet below ground surface at the repository site.

5.3.2.2 Cross Section B-B' (Gold Creek from the Conjecture Mine to Lake Pend Oreille)

Cross Section B-B' (Figure 7B) presents the geology in section along Gold Creek and illustrates how the older glacial deposits (Qgo) are exposed at surface and are likely to overlie bedrock at elevations below 2,800 feet amsl. Based on the Happy Hermit well log (see Well Log 1 located on Figure 7 and included in Appendix D), the glacial deposits above the bedrock in the Gold Creek valley, about 1,000 feet downstream of the Chloride Gulch confluence, are about 136 feet thick. The static water level at the time of well drilling (August, 1977) was noted at 105 feet below ground surface, indicating the glacial deposits have a saturated thickness above the bedrock of about 31 feet. On the log, the glacial deposits are noted as clay with gravel and boulders with some sand, gravel and boulder layers.

At the confluence with West Gold, Gold Creek flows within a bedrock channel. Between Gold Creek and Kick Bush Gulch (where most of the springs are observed), Gold Creek likely flows over a relatively thin veneer of glacial deposits and alluvium and, based on the geologic map (Figure 7), is bounded to the west by bedrock. The springs, that occur primarily on the eastern bank of Gold Creek between West Gold and Kick Bush Gulch (see Figure 5) indicate that the water table within the glacial deposits on the east side of Gold Creek daylights on the eastern valley side above the level of the creek along this reach. This is supported by observations of springs made by Golder for this study in September 2005 (see Section 4.2 and Figure 5).

5.3.2.3 Cross Section C-C' (perpendicular to Gold Creek at the Happy Hermit Resort)

Cross Section C-C' (Figure 7C) presents the geology in section perpendicular to Gold Creek in the vicinity of the Happy Hermit Resort. This cross section illustrates the likely occurrence of the glacial deposits above bedrock in the Gold Creek Valley to a depth of about 136 feet below ground surface and with a saturated thickness of about 31 feet. This section also illustrates the Gold Creek stream channel in relation to the glacial deposits and the groundwater level within these deposits. Based on the topography between the Happy Hermit Resort and Gold Creek, it is likely that the groundwater table in the glacial deposits occurs about 80 feet below the Gold Creek stream channel in this location.

5.3.2.4 Cross Section D-D' (perpendicular to Gold Creek between West Gold Creek and Kick Bush Gulch)

Cross Section D-D' (Figure 7C) presents the geology in section perpendicular to Gold Creek about 2,000 feet downstream of West Gold Creek and about 1,000 feet above Kick Bush Gulch. This cross section illustrates occurrence of bedrock on the west side and glacial deposits on the east of the Gold Creek stream channel. The section also illustrates the location of springs on the east side of Gold Creek, emanating about 40 feet above the stream channel. The springs represent the surface exposure of the groundwater table within the glacial deposits.

5.3.2.5 Cross Section E-E' (South to North from the Happy Hermit Resort to the Gold Creek Springs

Cross Section E-E' (Figure 7C) presents the geology in section across the Gold Creek valley, from the Happy Hermit Resort to the Gold Creek springs located above Kick Bush Gulch. The purpose of this section is to illustrate the occurrence and thickness of the glacial deposits (Qgo) and the groundwater flow within these deposits based on groundwater elevations at the Happy Hermit well (see Well Log 1 located on Figure 7 and included in Appendix D), and the springs. This section in conjunction with Figure 7 indicate that the groundwater flows within the glacial deposits in a north-northeasterly direction, discharging into Gold Creek above Kick Bush Gulch. These relationships suggest that the groundwater flow gradient within the glacial deposits is on the order of 0.05 (i.e. a groundwater table elevation drop of about 240 feet over a horizontal distance of about 4,600 feet). The section also illustrates the location of springs on the east side of Gold Creek, emanating about 40 feet above the stream channel.

5.4 Relationship between Geology and Streamflows

Project area streams with significant deposits of glacial sediments within mid-elevation reaches (i.e., North Gold, Kick Bush Gulch, Gold Creek and Chloride Gulch) become intermittent at or just below the contact between the bedrock and glacial sediments which also coincides with approximately where stream gradients flatten (Figure 6). This suggests that water within the stream channels flows at surface over bedrock and seeps into the relatively permeable glacial sediments. During low flow months, when there is relatively little water flow within the stream channels, this results in the streams going dry or becoming intermittent at or just downgradient of this geologic contact.

Within the upper Gold Creek watershed (that includes Chloride Gulch and Gold Creek above West Gold Creek), review of streamflows, local geology and hydrogeology indicates that the surface water that seeps into the glacial deposits below the upper bedrock contact flows within the glacial deposits in a north-northeasterly direction, discharging as springs and groundwater upwelling into Gold Creek, primarily below the West Gold Creek confluence and above Kick Bush Gulch (see Figure 5).

6.0 CONCLUSION AND RECOMMENDATIONS

This sections presents the conclusion of the study and proposes recommendations.

6.1 Conclusion

This study concludes that it is not feasible to restore perennial flow within Gold Creek (above the West Gold Creek confluence) and Chloride Gulch by removing sediment and restoring the channel to a stable, natural geometry.

The following points support this conclusion.

- General Lands Office (GLO) field notes for section surveys completed in 1908 through 1910 indicate that Gold Creek, Chloride Gulch, Kick Bush Gulch and North Gold Creek are intermittent in reaches (Figure 3). The locations of these intermittent reaches correspond to intermittent reaches observed during walkovers and measurements of the project streams conducted between June and September 2005 by Golder for this study. Since the major mining activity that resulted in the deposition of tailings materials in the stream channels occurred in the years following 1910, it is concluded that the intermittent nature of these streams is not caused by deposition of mining waste. However, sediment deposition within channels downstream of mining activities at the Lakeview and Conjecture Mines do appear to have increased the depth of bedload and may have extended the length of intermittent reaches in an upstream direction. The channel length over which the intermittent reaches may have been extended could not be quantified for this study.

- For all project area streams with significant deposits of glacial sediments within mid-elevation reaches (North Gold, Kick Bush Gulch, Gold Creek and Chloride Gulch), the streams become intermittent at or just below the contact between the bedrock and glacial sediments which also coincides with approximately where stream gradients flatten. This suggests that water within the stream seeps into the unconsolidated glacial sediments. During relatively low flow months, this results in the streams going dry. It is therefore concluded that the geology of the Gold Creek watershed is the primary reason for the intermittency of Gold Creek and Chloride Gulch.

- Based on the results of this study, surface water within the upper Gold Creek watershed infiltrates into the glacial deposits and flows as groundwater in a northeasterly direction, discharging to lower Gold Creek as a series of springs and as upwelling groundwater. For the streams to be perennial, sediment removal within Chloride Gulch and Gold Creek would need to lower the stream channel elevation to below the groundwater table in the glacial deposits. Based on well log information, the groundwater table beneath the Chloride Gulch channel about 0.5 miles upstream of Gold Creek is over 70 feet below ground surface (Figure 7A). Also based on well log information, the groundwater table beneath the Gold Creek channel about 0.5 miles downstream of Chloride Gulch is over 50 feet below ground surface (Figure 7B). Therefore, excavation of the channel to intersect the groundwater table would not meet the project goal of restoring the project stream channels to a stable natural geometry since the channel would need to be potentially excavated to depths greater than 50 feet.

- The September 2005 water balance for the Gold Creek watershed (Section 4.3) indicates that the lower Gold Creek spring flows contribute between 36 percent and 83 percent of the flow gaged in Gold Creek at the powerline crossing (below Kick Bush Gulch).

- Temperature measurements made in September 2005 for this study indicate that the springs lower the surface water temperature in Gold Creek from 10.7 degrees Celsius at the West Gold Creek confluence to 7.9 degrees Celsius at the Gold Creek powerline crossing. Temperature measurements made in September 2005 indicate that the temperature of the springs emanating from the east side of Gold Creek ranged between 6.7 and 7.9 degrees Celsius.
- The springs flowing into lower Gold Creek above Kick Bush Gulch are the primary reason why bull trout continue to successfully spawn in Lower Gold Creek. The springs add to the flow of lower Gold Creek, keep water temperatures low and likely improve water quality by diluting potential toxic effects from upstream mining waste.

6.2 Recommendations

It is clear that the lower Gold Creek springs are critical to the continued spawning and occurrence of bull trout in lower Gold Creek (i.e. Gold Creek below the confluence with West Gold Creek) since they deliver a significant flow of cold water to lower Gold Creek. Impairment of the quality and quantity of these springs could be considered impairment of critical bull trout habitat.

This study therefore recommends that the stakeholders consider the following to protect the water quality and flow of the Lower Gold Creek springs:

1. Acquisition of the two private land parcels located on the west side of lower Gold Creek north of Kick Bush Gulch (i.e. parcels 53N01W100900 and 53N01W101100) for bull trout habitat protection. The land parcel located on the east side of lower Gold Creek north of Kick Bush Gulch (i.e. parcel 53N01W100601) is owned by Avista.
2. Acquisition of the four private land parcels (i.e. parcels 53N01W102250, 53N01W107200, 53N01W107280 and 53N01W107690) located south of Kick Bush Gulch (for protection of spring flows) with the northern most of these parcels (53N01W102250) as the priority for acquisition since it is closest to the springs.
3. Installation of groundwater monitoring wells to monitor groundwater levels.
4. Careful monitoring of groundwater supply development and groundwater levels within the glacial deposits of the upper Gold Creek watershed (i.e. the Gold Creek watershed above Kick Bush Gulch), and in particular in the area immediately upgradient of the springs.
5. No significant land management activities (e.g. timber harvest, road building) within at least 500 feet of the springs.
6. Development of site specific BMPs for any land management activities (e.g. timber harvest, road building) within 1,000 feet of the springs.
7. Management of the Kick Bush Slide area to minimize sediment input to Kick Bush Gulch and Gold Creek including consideration of an alternate alignment for USFS Road 278.
8. Removal and stabilization of the tailings and waste rock material in and adjacent to the Gold Creek stream channel at the Conjecture Mine site.
9. Sediment control BMPs for any mine reclamation or road building / maintenance activities in the watershed near streams to minimize sediment loading.

10. Revisit and revise the approved sediment TMDL for Gold Creek to consider the natural hydrogeology of upper Gold Creek as the primary control on the intermittency of Gold Creek above the West Gold Creek confluence.
11. Inclusion of spring protection in TMDL implementation.

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FIGURES

APPENDICES

APPENDIX A

GOLD CREEK WATERSHED ASSESSMENT – SITE VISIT AND NEXT STEP

APPENDIX B

PROJECT AREA PHOTOGRAPHS

APPENDIX C

STREAM DISCHARGE MEASUREMENTS

APPENDIX D

WELL LOGS