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Technical Memorandum

Prepared for: Midas Gold Idaho, Inc. (Midas Gold)

Project Title: Stibnite Gold Project

Technical Memorandum

Subject: Errata to the Stream Functional Assessment Report: Stibnite Gold Project (February 2019)

Date: July 9, 2019

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Section 1: Introduction

Stream function is defined as the processes that create and support a stream ecosystem as defined by the National Research Council (2002), Fischenich (2006), Sandin and Solimini (2009), and Nadeau et al. (2018b). According to the recently released Oregon Stream Functional Assessment Method ([SFAM] Nadeau et al. 2018b), “Direct measurement of function requires that data be collected and evaluated over longer time frames and larger spatial scales than are within the practical scope of individual permitted actions.” Rather than measuring function directly, the Oregon SFAM (Nadeau et al. 2018b) and other existing functional assessments (Harman and Jones 2016, Johnson et al. 2016) measure stream attributes (i.e., conditions) that indicate function resulting in an assessment that is “functionally based.” To accomplish this, the measured conditions are quantified individually, then combined mathematically, producing a functional score. In some instances (Oregon SFAM), the functional score has been tested against and calibrated to closely match best professional judgement (i.e., expert opinion) by adjusting the mathematical formula used to combine the quantified condition measurements (Nadeau et al. 2018b).

In support of the Stibnite Gold Project (SGP) permitting effort, a Stream Functional Assessment (SFA) and associated SFA Ledger (Version 2/28/19) were developed to evaluate baseline and proposed stream function (Rio Applied Science and Engineering [ASE] 2019a). Early versions of the SFA included evaluations of the Proposed Action. Subsequent versions of the SFA Ledger have now been produced to evaluate all four proposed alternatives as part of the SGP Environmental Impact Statement (EIS).

The SFA methodology was adapted from Watershed Condition Indicator (WCI) scoring as summarized in the U.S. Forest Service (USFS) Forest Land and Resource Management Plan (LRMP) for the Payette National Forest (USFS 2003), specifically its Appendix B, which has been attached to this document for reference (Attachment A). WCI elements were developed as a nationally consistent, science-based approach to represent different physical, chemical, or biological conditions that inform functional value (i.e., functioning appropriately, functioning at risk, or functioning at unacceptable risk) relative to “potential natural condition” (Potyondy and Geier 2011). The SFA quantifies each WCI element (i.e., condition) and combines these scores mathematically to produce a Functional Index related to quality and Functional Units related to both quality and quantity. The evaluation criteria and the mathematical formula used to produce the functional scores has been evaluated by regulatory agencies and has been modified numerous times to address agency concerns and refine the SFA results (as summarized in previous SFA reports as well as this document). The SFA therefore is a functional-based model used to estimate stream function for the SGP incorporating both quantitative data and interdisciplinary/inter-agency expert opinion.

Following submittal of the February 28, 2019, version of the SFA Ledger, multiple meetings were held with the agencies to discuss development and initial results. During these meetings, several questions and concerns were raised by the agencies regarding the SFA element scoring criteria. Many of these questions and concerns were addressed as part of the April 15, 2019, SFA Ledger Workshop, but several concerns remained. The purpose of this technical memorandum is three-fold, as follows.

1. Provide additional justification/rationale and summarize changes to the scoring criteria and mathematical formulae used in the SFA Ledger to address the remaining agency concerns regarding SFA scoring methodology and application.
2. Describe how the SFA Ledger has been adapted to evaluate the four EIS alternatives.
3. Serve as an errata to the February 2019 Final Stream Functional Assessment Report (Rio ASE 2019a), and describe the associated changes that have been incorporated into a revised version of the SFA Ledger (Version 7/8/19), from which four separate copies have been produced, one for each of the four

ESA alternatives. All previous versions of the SFA Ledger are considered obsolete, including the 6/12/19, 5/16/19, and 2/28/19 versions.

Summary of Agency Concerns

During the April 15, 2019, SFA Workshop, the agencies expressed concerns regarding the following SFA scoring methodologies (including summary of agency concern):

- Standardized scoring metrics (not all elements are appropriate for all reaches)
- Scoring for diversions and lined channels (insufficient impact and/or excessive benefit in SFA)

Additionally, the agencies accepted the proposed SFA element scoring criteria for 10 of the 17 SFA elements. Those not accepted consist of the following (including summary of agency concern):

- Physical Barriers (reach ratings for activities not occurring within reach)
- Large Woody Debris (LWD; scoring for LWD recruitment)
- Pool Frequency (scoring threshold determination/justification)
- Pool Quality (scoring threshold determination/justification)
- Off-Channel Habitat (scoring for reaches that don’t typically have off-channel habitat)
- Riparian Conservation Area (RCA) and Disturbance History (clarify definition, measurement, and scoring)

Provided below is a discussion with supporting documentation to address these remaining concerns of the agencies and other changes to the SFA Report and/or associated SFA Ledger since its publication in February 2019.

Section 2: SFA Summary

Several changes/edits have been made to the SFA Ledger as discussed in the following sections. These changes have resulted in modifications to tables originally documented in the SFA Report (Rio ASE 2019a). Revised tables, with their original table numbers, are provided below.

Table 3-2. Summary of SFA Indicators, Elements, and Scoring Criteria

Indicator	Element	Rating	FA	FR	UR	
Water Quality	Temperature (°C)	Rearing	≤12	>12 - ≤15	>15	
		Spawning	≤12	>9 - ≤10	>10	
	Fine Sediment (%)	Granitic Basin	<12%	12% - 18%	>18%	
		Non-Granitic Basin	< 3%	3% - 6%	>6%	
	Chemical Contaminants (# Exceeding Threshold)			0	1	>1
Access	Physical Barriers Located Downstream		No	Partial	Yes	
Habitat Elements	Embeddedness (Free Matrix %)	Granitic Basin	≥ 27%	27% - 17%	<17	
		Non-Granitic Basin	≥ 54%	54% - 43%	<43%	
	Large Woody Debris	Pieces Per Mile	> 20	>20 or <20	<20	
		Recruitment Potential	Yes	No or Yes	No	
	Pool Frequency (% of optimal)			> 75 th %	75 th % - 25 th %	<25 th %
	Pool Quality (# pools/mile >1m deep residual depth)			>14.1	6.7 - 14.1	<6.7
	Off-Channel Habitat with Cover (# of Features)			Many (>2)	Some (1-2)	None (0)
Channel Conditions	Width/Depth Ratio		≤ 10	10< ≥20	>20	
	Streambank Condition (Stability)	Pfankuch 1975 Method	< 39	39 -77	>77	
		Qualitative	CS or US	CU	UU	



Table 3-2. Summary of SFA Indicators, Elements, and Scoring Criteria

Indicator	Element	Rating	FA	FR	UR
Indicator and Dynamics	Floodplain Connectivity	Entrenchment Ratio	> 2.2	2.2 - 1.4	<1.4
		Qualitative	Slightly	Moderately	Entrenched
Flow and Hydrology	Change in Flow	Peak or Base Discharge	< 10%	10% - 20%	>20%
		Timing	< 10%	10% - 20%	>20%
	Change in Drainage Network (% Increase)	< 15%	15% - 25%	>25%	
Watershed Conditions	Road Density and Location (Combine either top 2 or bottom 2 rows)	Road Density (Feet/Mile)	< 0.7	0.7 - 1.7	>1.7
		Density in RCA	0.0	≤1.7	>1.7
		Road Density (Feet/Mile)	< 0.7	<.07	≥0.7
		Density in RCA	0.0	≤1.7	>1.7
	Riparian Conservation Areas (% Intact)	> 80%	70% - 80%	<70%	
	Disturbance History (Combine all three rows)	% Disturbed	≤ 15%	≤15%	>15%
		In Landslide Areas	No	Yes OR No	Yes
In RCA		No	Yes OR No	Yes	
Fish Use	Occupancy Potential*	Intrinsic Potential (CH & ST)	High	Medium	Low (Negligible=0.25)
		Occupancy Model (BT & WCT)	100-90%	90-33%	33-0%
	Critical Habitat**	Yes		No	
	Presence/ Absence**	Yes		No	

BT = Bull Trout
 CH = Chinook Salmon
 CS = Covered and Stable
 CU = Covered and Unstable
 FA = Functioning Appropriately
 FR = Functioning at Risk
 Neg. = Negligible
 ST = Steelhead Trout
 UR = Unacceptable Risk
 US = Uncovered and Stable
 UU = Uncovered and Unstable
 WCT = Westslope Cutthroat Trout

* Occupancy Potential has not been estimated by the USFS and is not yet entered into the SFA Ledger as of the date of this report.
 ** Critical Habitat and Presence/Absence fish use elements are used as data filters and are populated with scores.

Table 3-3. Summary of SFA Ledger Spreadsheet Parts (Tabs)

Tab	Description
INTRODUCTION	Sheet provides a summary of tabs associated with the ledger and acts as a table of contents and cover letter for the ledger when printed.
USER INTERFACE	Sheet provides a summary of required inputs and variables the user can manipulate to assess various scenarios throughout the mine life.
SFA RRESULTS SUMMARY	Results are summarized in a number of concise tables and graphs evaluating the variation in stream Functional Units throughout the life of the mine.
RUN SCENARIO SUMMARY	A scenario generated by an agency/individual is summarized and time stamped here for inclusion in export memos.
WCI SCORING SUMMARY	Sheet contains a summary of WCI scores for each reach through baseline, interim, restored and fully restored
WCI SCORING CRITERIA	Sheet summarizes WCI scoring criteria to determine if reaches are functioning good, fair or poor.
DATA REACH RAW	Sheet includes the raw data for the reference reach data (for all years) that gets input into the baseline data. This data is copied from the Great Ecology Baseline Stream Data spreadsheet, Process SFA Data tab.
DATA REACH RAW SUMMARIZED	Sheet includes the raw data for the reference reach data that gets input into the baseline data



Table 3-3. Summary of SFA Ledger Spreadsheet Parts (Tabs)

Tab	Description
TEMPERATURE MODEL DATA OUTPUT	Sheet includes temperature results based on the SPLNT model for summer and fall. Latest output from the SPLNT model was from 7/1/2019.
SITE WIDE WATER CHEMISTRY MODEL DATA RESULTS	Sheet includes water chemistry results from the Site Wide Water Chemistry (SWWC) Model. This compares the same contaminants from the model and field samples to remain consistent between the model and baseline data. The latest output from the SWWC Model is from 07/03/2019.
PASSAGE-HUMAN	Sheet includes passage barrier identifications for each mine year based on if and when passage is allowed through the tunnel, when impacts occur and when restoration actions are complete for only human caused barriers.
PASSAGE-ALL	Sheet includes passage barrier identifications for each mine year based on if and when passage is allowed through the tunnel, when impacts occur and when restoration actions are complete for both human and natural barriers.
FLOW DATA	Sheet includes variation in base flow conditions for each mine year and beyond being evaluated. This information is based on the MODFLOW model results presented in response to RFAI 88/88A and in the spreadsheet entitled "IP Model Baseflow SFA Summary 011719.xlsm" from Rio ASE.
WATERSHED	Sheet includes information on watershed WCI elements and when those watershed scale elements are in each phase of the proposed project (baseline, interim, restored, and fully restored)
OCCUPANCY DATA	Sheet includes final results from the bull trout and cutthroat occupancy models developed by the USFS and their third-party consultants (AECOM and Ecosystem Sciences). The latest output from the occupancy models are not included at this time.
IP DATA	Sheet includes final results from the Chinook Salmon and steelhead intrinsic potential models developed by the USFS and their third-party consultants (AECOM and Ecosystem Sciences). The latest output from the intrinsic potential models are not included at this time.
BASELINE RAW DATA	Sheet includes the raw WCI element data for baseline conditions.
INTERIM RAW DATA	Sheet includes the raw WCI element data for each reach's interim conditions.
RESTORED RAW DATA	Sheet includes the raw WCI element data for each reach's restored conditions.
FULLY RESTORED RAW DATA	Sheet includes the raw data for fully restored conditions.
EOY RAW	Each Sheet (29 Total) includes the raw data for each end of mine year. This material is pulled from the Hydrologic Model Data Output, Temperature Model Data Output, Site Wide Water Chemistry Model Data Output, Passage Assumptions, Occupancy Model Data Output, Intrinsic Potential Model Data Output, Baseline Raw Data, Interim Raw Data, Restored Raw Data, and Post Restored Raw Data sheets within this overall spreadsheet.
EOY SFA	Each Sheet (29 Total) applies the WCI scoring criteria to the raw data for each end of mine year. This material is pulled from the EOY Raw -4 through FR Sheets.
CMP OUTPUT TABLES	Sheet contains output tables for the Conceptual Mitigation Plan summarizing impacts, and restoration efforts and their stream length and associated stream functional assessment units.
LIST	Sheet contains a number of dropdown list options used through the analysis; this sheet does not print.

Table 3-4. Summary of Available User Inputs (Filters) Applied to the SFA Ledger

User Inputs (Filters)	Notes
Allow Passage Through Tunnel <ul style="list-style-type: none"> If Yes, EOY Passage Allowed 	Allowing fish passage upstream of existing Yellow Pine pit via tunnel. This input changes the Physical Barriers WCI element score from "Yes" barriers to "No" barriers for the interim mine phase for reaches upstream of the Yellow Pine pit (up to another barrier or partial barrier) until the mine year in which passage is restored through Yellow Pine pit. <ul style="list-style-type: none"> If yes, the user must identify the end of mine year (EOY) in which passage is allowed
Evaluate Barrier Types	Select if you want to evaluate only human-caused barriers or if you want to evaluate both human-caused and natural barriers. The default function is to only evaluate human-caused barriers.



Table 3-4. Summary of Available User Inputs (Filters) Applied to the SFA Ledger

User Inputs (Filters)	Notes
Species of Interest	Bull trout and cutthroat or Chinook salmon and/or steelhead, or all species. Scoring for temperature is slightly different between these species' groups. Those net scores can be evaluated individually or averaged together using this SFA feature. This input also informs the species of interest for Critical Habitat Potential, Occupancy Models, and fish Presence/Absence inputs (below) The Functional Index and Functional Units will only be displayed and summarized for the selected species of interest.
Minimum Number of Elements Required to Score	Minimum number of elements required to calculate score, otherwise uses default WCI score identified below. It is assumed a minimum threshold of data must be available in order to achieve a representative score for a given reach. Selecting the number of elements to define this threshold will ensure only those reaches with sufficient data are scored based on those data, otherwise the default score is given to that reach.
Default WCI Score	Assign the default WCI score for application where there are no data or too little data to apply actual WCI scores per reach. Default score options are 1, 2, 3, or the length weighted average WCI element score for all scorable reaches. If a 1, 2, or 3 default score is given to a reach, that score is given across all phases such that length becomes the only metric for temporal evaluation of that reach. If the length weighted average WCI element score is used, it will utilize the average baseline score until a specific reach is in the interim phase at which point it will use the average WCI element score for each year from then on to show annual variability.
Weight Perennial Streams vs Non-Perennial Stream <ul style="list-style-type: none"> • If Yes, Select Weight for Perennial 	Select if you want to apply a weighting factor to differentiate between perennial and non-perennial channels <ul style="list-style-type: none"> • Input a weighting factor to apply to perennial streams; assumes non-perennial stream weight = 1
Weight Streams Based on Stream Order	Select if you want to weight streams based on their stream order. Stream order is a surrogate for width applied to the calculation of Functional Units to derive a quasi-weighted usable area (length x width x function). Stream Order + 1 is used in the computation to prevent multiplication by zero for the case of zero-order streams.
Weight WCI elements <ul style="list-style-type: none"> • If Yes, Use Survivorship Weights 	Select if you want to individually weight elements (Yes) or have them all equal (No). Weighting with a score of zero effectively turns off that element, enabling the user to perform sensitivity analyses on one or more elements at a time. <ul style="list-style-type: none"> • Option to assign weights based on survivorship (pre-determined weighting) reported in the SFA Ledger with rationale based on each elements potential to impact survivorship. • To exclude fish use elements weighting must be turned on and those elements turned to zero.
Weight Fish Species	Select if weights will be applied to each species when scores for those species are combined when developing the reach Functional Index
Use Occupancy Models as on/off control	If selected No, occupancy will act as an additional WCI element integrated with the other elements as part of the weighted average when calculating the Functional Index per reach. If selected Yes, the Functional Unit for each reach will be multiplied by a value between 0-100% based on the modeled suitability of that reach. If selected Yes, and the user does not want to use it as a WCI element and a filter the user must weight this element with a weight of zero.
Use Critical Habitat as on/off control	If selected No, Critical Habitat will act as an additional WCI element integrated with the other elements as part of the weighted average when calculating the Functional Index per reach. If selected Yes, only areas with Critical Habitat will be evaluated for the species identified by the user in the "Species of Interest" input. The Critical Habitat regulatory delineation of streams and will not change from baseline to fully restored. If selected Yes, and the user does not want to use it as a WCI element and a filter the user must weight this element with a weight of zero.
Use Presence/Absence as on/off control	If selected No, Presence/Absence will act as an additional WCI element integrated with the other elements as part of the weighted average when calculating the Functional Index per reach. If selected Yes, only areas with fish present will be evaluated for the species identified

Table 3-4. Summary of Available User Inputs (Filters) Applied to the SFA Ledger

User Inputs (Filters)	Notes
	by the user in the “Species of Interest” input. If selected Yes, and the user does not want to use it as a WCI element and a filter the user must weight this element with a weight of zero.
Analyze Jurisdictional Waters Only	If selected Yes, the SFA Ledger will only provide Functional Unit scores for reaches designated as jurisdictional waters of the US. (Note: all streams have not been given a jurisdictional rating yet and this filter although currently functional is not accurate)
WCI Average Significant Digits	Rounds WCI scoring criteria to either a whole number or allows decimals where multiple criteria are averaged (currently only temperature criteria utilizes this option)

Table 3-5. Summary of SFA Results Scenario Evaluated for CMP

User Inputs (Filters)	Scenario Selected for CMP
Allow Passage Through Tunnel • If Yes, EOY Passage Allowed	Yes • Allow passage through the tunnel in mine end of year -1
Evaluate Barrier Types	Human-caused barriers only
Species of Interest	All Species (Bull Trout, Westslope Cutthroat Trout, Chinook Salmon, and Steelhead)
Minimum Number of Elements Required to Score	5 elements, which requires approximately 30% of the elements have data to be analyzed
Default WCI Score	Average WCI element score based on length weighted average of scorable reaches (Baseline average is 1.959).
Weight Perennial Streams vs Non-Perennial Stream • If Yes, Select Weight for Perennial	• No, Perennial and Non-perennial are weighted the same
Weight Streams Based on Stream Order	Yes
Weight WCI elements • If Yes, Use Survivorship Weights	Yes • No, do not use survivorship weights • Equal weighting on all elements (1), with the exception of a weighting of zero (0) for the three fish factor elements.
Weight Fish Species	No, weight fish species equal
Use Occupancy Models as on/off control	No
Use Critical Habitat as on/off control	No
Use Presence/Absence as on/off control	No
Analyze Jurisdictional Waters Only	No (This should be Yes in the future once a full determination of jurisdictional waters has been completed)
WCI Average Significant Digits	1, Rounds WCI average scores to the tenth or one decimal place

Section 3: Standardized Scoring Metrics

Table 1. Standard Scoring Metrics Summary

Agency Concern	The agencies have questioned the applicability of scoring several elements based on the relative appropriateness of a given element within a given reach.
Solution	No change to the SFA Ledger; provide additional justification/support; change nomenclature to reduce potential confusion.
Justification	Precedents from other existing and accepted SFA methods strongly support the use of standard/absolute evaluation criteria and performance thresholds.

Any tool designed to measure losses and gains, especially in the context of project-specific analysis, needs to use, to the greatest extent possible, a standardized index scale for all streams and stream reaches to compare existing versus proposed conditions and/or functions. Quantification of conditions, which combine to inform functions, facilitates the assessment of impacts (debits) and benefits (credits) associated with permitted actions as well as mitigation requirements (U.S. Environmental Protection Agency 2012).

As discussed in Section 1, the SFA was modified from the USFS WCI. The WCI approach defines watershed condition relative to “potential natural condition” (Potyondy and Geier 2011). WCIs were developed to determine if conditions are in line with expectations; hence, they are relative measures, not absolute. Additionally, the WCI scoring nomenclature includes the terms “appropriately” and “risk” when referring to functional conditions, which imply a relative evaluation—functioning appropriately or at risk relative to expectation and/or geomorphic conditions. Without standardized scoring of each condition in the SGP SFA Ledger, it would not be possible to accurately compare existing versus proposed conditions in a manner compatible with the requirements of the 2008 Final Compensatory Mitigation Rule. Tools that have been developed along these lines—the Oregon SFAM (Nadeau et al. 2018b), FACStream 1.0 in Colorado (Johnson et al. 2016), and the Stream Quantification Tool in North Carolina (Harmon and Jones 2016)—are designed with an emphasis on evaluating absolute rather than relative measures. This conclusion was emphasized in the Oregon SFAM where peer review “corroborated the identified critical need for standard performance indices and standardized thresholds to support meaningful SFAM outputs” (Nadeau et al. 2018b).

To reduce potential confusion surrounding the nomenclature as it pertains to standardized (versus relative) scoring, we changed the scoring nomenclature as follows for all SFA elements to more closely follow the nomenclature used in the Oregon SFAM (Nadeau et al. 2018b), as shown in Table 2 below.

Table 2. SFA Scoring Nomenclature

Previous Nomenclature	New Nomenclature	SFA Score
Functioning Appropriately (FA)	High Function (Good)	3
Functioning at Risk (FR)	Moderate Function (Fair)	2
Functioning at Unacceptable Risk (UR)	Low Function (Poor)	1

Section 4: Scoring for Diversions

Table 3. Scoring for Diversions Summary

Agency Concern	SFA scoring methodology for proposed diversions does not sufficiently take into consideration the magnitude of anticipated impacts.
Solution	Score the five specific habitat indicator elements (substrate embeddedness, LWD, pool frequency, pool quality, off-channel habitat) with a value of 0 as opposed to 1, 2, or 3 for perennial stream diversions.
Justification	Proposed diversions are not intended to provide functional habitat, suggesting less than a “Low” function score is warranted.

Several temporary stream channel diversions are proposed during the interim phase of the SGP. Most of these diversions are not intended to provide habitat or habitat function. Although some habitat may form and be utilized by aquatic organisms at times within the diversions, as is the case with the existing diversion of Meadow Creek around the Spent Ore Disposal Area, the diversions would be designed to resist habitat formation (i.e., pools and off-channel habitat) and maintained such that most other habitat elements that formed would be removed for safety and hydraulic efficiency (i.e., LWD and gravel deposition). It is difficult to quantify what limited habitat function may be afforded by the proposed diversions, and it is difficult to justify the function of that habitat given our interpretation of the intent of the five specific habitat indicator elements (substrate embeddedness, LWD, pool frequency, pool quality, off-channel habitat). For these reasons, we believe it is warranted to deviate from the standard SFA scoring of 1, 2, and 3 for perennial diversions that are not intended to provide habitat to include an additional score of zero (0). We recognize that by and large the lowest WCI score of “Low Function” (score = 1) implies limited (not zero) function; therefore, when there is potentially zero function, the score should be conservatively reduced to zero for the five habitat elements. The SFA, therefore, conservatively assumes zero function for all five habitat elements within interim perennial diversions that are not intended to provide habitat including the following:

- Meadow Creek diversion around the tailings storage facility (TSF) and Hangar Flats development rock storage facility (DRSF)
- East Fork South Fork Salmon River through the tunnel fishway
- Fiddle Creek around the Fiddle DRSF
- West End Creek around the West End pit and DRSF
- Midnight Creek where it is diverted into the EFSFSR tunnel fishway

SFA Ledger scoring (per Rio ASE 2019a) is generally applied to each phase of the project for every element in a reach for which baseline data are available. In other words, if 12 elements have baseline data in a given reach, only those 12 elements will be evaluated for future phases (interim, restored, and fully restored). The remaining elements without data are not factored into the calculation and, therefore, do not affect the score. In the case of applying a zero score for all habitat elements within a diversion, the SFA Ledger (Version 7/8/19) applies a score of zero during the interim project phase for all diversions of perennial reaches summarized above regardless of whether or not a reach has baseline data for a given habitat element. This conservative approach ensures diversions will receive no potential benefit (i.e., credit) for habitat elements within the SFA in the event there are baseline data gaps.

Section 5: Scoring for Lined Channels

Table 4. Scoring for Lined Channels Summary

Agency Concern	SFA reaches restored over the top of an impermeable liner appear to receive higher than expected scores considering association with underlying impacts including the tailings storage facility (TSF) and development rock storage facilities (DRSFs)
Solution	In addition to unrestored historical disturbance areas, also include TSF, DRSF, mine pit highwall, and pit lakes as “disturbed” within the “Fully Restored” phase of SFA related to Watershed disturbance and Riparian Conservation Area (RCA) disturbance
Justification	Although the streams and floodplains will be restored, their association with human features such as an impermeable liner and underlying TSF/DRSF justify the classification of such areas as “disturbed” into perpetuity

Several of the proposed restoration reaches include the use of an impermeable stream liner to prevent excessive seepage loss and undesired contact with underlying materials (Rio ASE 2018 and Rio ASE 2019b). The stream liner is proposed to be buried at depth and covered with alluvium fill upon which the stream and floodplain would be constructed. Agency-hypothesized impacts associated with lining stream channels as proposed are centered primarily around reduced groundwater interaction and associated effects related to alterations in temperature, baseflow, and interaction with potential contaminants. These elements have been evaluated in detail for proposed conditions using calibrated models (Brown and Caldwell [BC] 2018a,c; BC 2019; SRK Consulting [SRK] 2018), the results of which have been incorporated into the SFA Ledger.

A summary of those SFA elements affected by the stream liner consist of the following and the associated results are included in the SFA Ledger (Version 7/8/19):

- **Temperature.** The reduced connection to groundwater is expected to affect stream temperature as shown by the detailed Stream and Pit Lake Network Temperature (SPLNT) modeling (BC 2018a and 2019).
- **Chemical Contaminants.** The proposed stream liner would separate the restored stream corridor from underlying materials affecting potential interaction with chemical contaminants as modeled by SRK (2018).
- **Change in Peak/Baseflow.** Reduced connection to groundwater is expected to impact stream baseflows as shown by detailed hydrologic modeling summarized in the response to Request for Additional Information (RAI) 88/88a (BC 2018b,c).

Most SFA elements are not expected to be impacted by use of stream liner as proposed, including the following:

- **Fine Sediment and Substrate Embeddedness.** Small anticipated changes to baseflow are not expected to have a measurable effect on the generation or transport of sediment in lined reaches. As sediment transport is proportional to discharge, most sediment transport would occur at higher flows (Barry et al. 2008). Neither the channel nor floodplain will be confined laterally or vertically by the stream liner as proposed allowing a natural flux of sediment into and out of the designed reach.
- **Physical Barriers.** The liner will not generate a physical barrier to fish passage and is intended to ensure sufficient baseflow remains within lined reaches (as has been modeled and described in the response to RAI-88/88a: BC 2018b,c) to maintain adequate flows for fish passage within those reaches where steep gradients do not otherwise create a barrier.
- **LWD.** Wood is proposed to be placed during restoration to meet LWD requirements for the short term. See specific discussion regarding LWD Recruitment later in this technical memorandum (Section 6.6).
- **Pool Frequency and Pool Quality.** The depth of liner is defined in part by the maximum calculated scour depth of the proposed channel (Rio ASE 2019b), such that the liner would be positioned below the

calculated maximum scour depth plus any additional armor layer; therefore, pools would form where geomorphically appropriate within the placed alluvium above the liner.

- **Off-Channel Habitat and Floodplain Connectivity.** Neither the channel nor the floodplain will be excessively confined laterally or vertically by the stream liner as proposed. The Stream Design Report (Rio ASE 2019b) provides explanation for the proposed geomorphically appropriate floodplain width and associated meander belt width for each lined reach.
- **Width/Depth Ratio.** The channel geometry (Rio ASE 2019b), including width/depth ratio, for restored channels is a derivative of the bankfull discharge, gradient, confinement, grain sizes, and in-stream structure, none of which would be impacted by a stream liner as proposed.
- **Streambank Condition.** The liner is proposed to be buried well beneath the entire channel and floodplain and, therefore, would not interact with the stream bank. The stream liner is not expected to interfere with the development and growth of riparian vegetation that would populate the stream bank (see Rio ASE 2019b, Tetra Tech 2019, and the LWD recruitment discussion later in this technical memorandum [Section 6.6]).
- **Drainage Network Increase.** The stream liner does not affect the location, length, or sinuosity of the restored streams as proposed (Rio ASE 2019b).
- **Road Density.** The stream liner is not associated with roads.

Two elements may be affected by the liner, and the SFA Ledger scoring has been changed accordingly.

- **RCA Disturbance and Watershed Disturbance History.** Unrestored historical disturbance areas (based on historical disturbance GIS polygon) remain part of the “Fully Restored” disturbance footprint. Additionally, while it could be argued that the restoration of the streams and floodplains atop the TSF/DRSFs would eliminate the “disturbance” as defined by these elements, it could also be argued that human alteration of the landscape (despite the restoration) represents a disturbance. To be conservative, we believe it is justifiable to include the entire TSF and DRSF areas as well as the pit lakes and associated highwalls (mining excavations) as part of the disturbance footprint during the “Fully Restored” project phase within the SFA Ledger. In this way, streams restored over a liner now receive fewer Functional Units than the previous version of the ledger at the fully restored phase. Previous versions of the SFA Ledger (including Version 2/28/19) had considered these areas “restored” and, therefore, no longer disturbed.

Section 6: SFA Elements

Changes to the scoring elements in the SFA Ledger are outlined in the sections below.

6.1 Temperature

Table 5. Temperature Summary

Agency Concern	Define what scenario (Proposed Action or other alternative) is modeled and provide more explanation regarding temperature modeling assumptions/methods.
Solution	Improved explanation
Justification	Based on SPLNT modeling (BC 2019)

Previous versions of the SFA Ledger (2/28/19) included temperature modeling results that incorporated modifications to the Proposed Action (including piping of baseflow through diversions around the TSF during mining operations). The revised (7/8/19) version of the SFA Ledger represents the Proposed Action (for all reaches and elements, including temperature) as appropriate for each EIS alternative.

The revised (7/8/19) version of the SFA Ledger utilizes both the summer 7-day average maximum temperature as well as the fall 7-day average maximum temperature results from the SPLNT model (BC 2019). The summer maximum temperatures are used to assess potential rearing conditions for all aquatic species of interest (rearing temperature preferences differ for each species) while the fall maximum temperatures are used to assess potential spawning conditions for both bull trout and Chinook salmon (spawning temperature preferences differ for each species). Where multiple life stages are assessed, the various life stage (rearing or spawning) element scores are combined using a weighted average, where the weights are based on user-selected preference (life-stage preference). Those species-specific scores are then combined using a weighted average where the weights are based on user-selected preference (species preference).

6.2 Fine Sediment

Table 6. Fine Sediment Summary

Agency Concern	Improved rationale for scoring criteria divisions
Solution	Improved explanation
Justification	Based on USFS LRMP Appendix B

The SFA Report (Rio ASE 2019a) did not clearly specify the rationale used for dividing the scoring criteria for the fine sediment element. The SFA used the USFS LRMP Appendix B (USFS 2003) to define scoring criteria for fine sediment. The LRMP Appendix B identifies <12 percent fines as “Functioning Appropriately” for both “steelhead, chinook” and for “areas of spawning and incubation,” which is mirrored in the SFA (i.e., “High” function). The LRMP Appendix B identifies “Functioning at Risk” for “steelhead, chinook” as 12–20 percent surface fines and for “areas of spawning and incubation” as 12–17 percent surface fines. The SFA averages these two results (12–18.5 percent) and rounds down to the nearest whole number to be conservative (12–18 percent) for “Moderate” function. Likewise, 18 percent surface fines has also been used in the SFA as the threshold between “Moderate” and “Low” function following the same rationale.

6.3 Chemical Contaminants

Table 7. Chemical Contaminants Summary

Agency Concern	The scoring criteria need to more closely reflect the USFS LRMP guidelines.
Solution	Revise the SFA Ledger such that the number of chemical constituents exceeded = 0 for “High” function, = 1 for “Moderate” function, and = 2 or more for “Low” function.
Justification	Refined understanding of the USFS LRMP Appendix B scoring criteria for Chemical Contaminants

The previous version of the SFA Ledger (2/28/19) interpreted the USFS LRMP Appendix B (USFS 2003) incorrectly, such that “low levels of chemical contamination” was believed to be equivalent to a low number of chemical constituents exceeding contamination thresholds (i.e., a value greater than zero). Through discussion with the agencies, it was made clear that “low levels of chemical contamination” refers more generally to potential contamination such that no chemical constituents are exceeding contamination thresholds resulting in low levels of contamination. It is implied that if one or more chemical constituents are exceeding contamination thresholds, there would be a level of contamination other than “Low” for at least one constituent. To accommodate this refined understanding, the SFA Ledger (Version 7/8/19) has been revised as summarized in Table 8 below.

Table 8. Revised Chemical Contaminants Scoring Criteria

High Function (Good = 3)	Moderate Function (Fair = 2)	Low Function (Poor = 1)
0 chemical constituents exceed thresholds 1 or more times	1 chemical constituent exceeds thresholds 1 or more times	2 or more chemical constituents exceed thresholds 1 or more times

Additionally, the agencies provided a summary of revised thresholds for specific chemical contaminants where previous determinations had been made regarding jeopardy to anadromous species and/or adverse modification to designated critical habitat (Sandow 2019). A summary of these revised thresholds and comparison to those thresholds used to evaluate chemical contaminants for the SFA are summarized below.

- Arsenic: Revised criteria = 10 ug/L is the same as currently applied in the SFA
- Cyanide: Most stringent revised criteria = 5.2 ug/L is the same as currently applied in the SFA
- Copper: Recent acceptance of biological ligand model (BLM). Using the BLM with baseline data from the EFSFSR yields a minimum value of about 2 ug/L. The two draft NPDES permits for other mines in Idaho each contain a BLM-based value of 1 ug/L as a daily maximum and 0.4 ug/L as a monthly average. The SFA currently uses 0.4 ug/L as a conservative threshold to be consistent with recent NPDES permits. Additional clarification from Idaho Department of Environmental Quality and the U.S. Environmental Protection Agency may be incorporated at a future date if current thresholds are not considered appropriate.
- Mercury: Revised criteria of 10 ng/L versus the original SFA criteria of 12 ng/L.
- Selenium: Revised criteria of 3.1 ug/L is the same as currently applied in the SFA Ledger.

6.4 Physical Barriers

Table 9. Physical Barriers Summary

Agency Concern	<ol style="list-style-type: none"> 1. There is insufficient description and justification of existing barriers. 2. SFA should not include natural barriers. 3. SFA scoring for barrier impacts should not include reaches beyond the reach in which the barrier occurs.
Solution	<ol style="list-style-type: none"> 1. Greater description and justification of existing barriers provided in this memo 2. Removal of natural barriers from the SFA 3. Apply barrier impacts to all upstream fish-bearing reaches as opposed to all upstream reaches
Justification	<ol style="list-style-type: none"> 1. N/A 2. Precedents established from other accepted evaluation methodologies that generally do not include natural barriers 3. Literature and professional judgment suggest physical barriers should only apply to reaches that fish can/could occupy

Following submittal of the February 28, 2019, version of the SFA Ledger, the agencies requested three items with respect to physical barriers, as shown in Table 9. Regarding Items 1 and 3, additional information about the evaluation of specific barriers within the SGP area and a summary of pertinent literature supporting the functions and values associated with barriers beyond the reach in which they occur has been provided in a separate technical memorandum (BioAnalysts 2019).

Regarding Item 2, we modified how physical barriers are applied within the SFA Ledger. In the February 28, 2019, version of the SFA Ledger, barriers were defined as both human-caused or natural and were evaluated as complete (Low; score of 1), partial (Moderate; score of 2), or none (High; score of 3). The score associated with a given barrier was then applied to all upstream reaches. For the purpose of the SFA, we refined the definition of passage barriers as follows (from BioAnalysts 2019).

- **Complete Barrier** (SFA score = 1): Natural or artificial stream condition that is impassable to fish. Complete passage barriers exclude fish entirely or from portions of a watershed and may isolate fish populations upstream of the barrier. Stream flows do not change hydraulic conditions sufficiently to create passable condition.
- **Partial Barrier** (SFA score = 2): Natural or artificial stream condition that may be impassable to some fish. A partial barrier may exclude only certain fish species or life stages at certain times of the year. Stream flows may change hydraulic conditions sufficiently to create passable conditions by some species.
- **No Barrier** (SFA score = 3): No impediment to fish passage.
- **Human-caused:** Obstruction to fish passage within a given reach that is primarily the result of human features and/or human-caused impacts. We have changed the SFA Ledger to allow the flexibility of each user (i.e., each agency) to consider passage resulting from just human-caused barriers or both human-caused and natural barriers.
 - All the existing streams within the SGP area have been at least partially impacted by humans due to roads in the watershed, historical land use, fire management, water diversion, power generation, physical alteration, etc. Every barrier identified within the SGP area has been classified as primarily “natural” or primarily “human-caused” based on the primary cause of the barrier. A detailed summary of each fish passage barrier classified within the SGP is provided in BioAnalysts’ technical memorandum (2019) to support the final scoring.

We also modified the upstream extent to which a given barrier score is applied such that the revised SFA Ledger (Version 7/8/19) scores a reach with the appropriate value for a barrier in that reach, then extends that barrier score upstream to the next barrier or to the upstream extent of fish use, whichever occurs first. Upstream extent of fish use is defined by the upstream extent of the Ecosystem Sciences’ Occupancy Model (in progress) as 0.2 cubic feet per second summer flow or greater than 15 percent average slope for all upstream reaches.

6.5 Substrate Embeddedness

Table 10. Substrate Embeddedness Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

6.6 Large Woody Debris (LWD)

Table 11. Large Woody Debris Summary

Agency Concern	“Restored” and “Fully Restored” phases may over-predict LWD recruitment potential.
Solution	Evaluate and revise planting plan to meet minimum tree density requirements identified in USFS LWD recruitment guidelines to provide for short- and long-term recruitment at the “Fully Restored” project phase.
Justification	Provide supporting documentation regarding proposal to plant trees on lined channel/floodplain reaches; follow USFS guidelines for performance requirements to achieve required recruitment potential adjacent restored stream corridors.

SFA scoring criteria for LWD includes both frequency (pieces per mile of stream) and recruitment potential, derived directly from the USFS LRMP Appendix B (USFS 2003) and its associated references to past biological opinions and EISs. Recruitment of LWD is directly linked to riparian or adjacent upslope and/or upstream forest conditions (USFS 2006). The evaluation of future (proposed condition) LWD recruitment,

therefore, depends on the proposed planting prescription and expected density of trees within the near-stream riparian floodplain at such future time as trees would be expected to reach a size class for which they would contribute to LWD recruitment to the streams.

The SGP stream design (Rio ASE 2019b) and conceptual mitigation plan (Tetra Tech 2019) identify Engelmann spruce as the primary tree species utilized within the near-stream riparian floodplain, which would be classified as potential vegetation group nine (PVG 9—Hydric subalpine fir) (Nalder 2019). The USFS estimates 71–110 years for Engelmann spruce to mature to a “medium” size class, defined as greater than or equal to 12-inch diameter at breast height (USFS 2006). Additionally, the USFS recommends 40 medium-size-class trees per acre are needed to provide 20 calculated recruitable trees within areas classified as PVG-9 (USFS 2006). The USFS (2003) identifies 20 pieces of LWD per mile of stream as the threshold for functioning appropriately, which has been carried over to the SFA as the threshold for “High” function.

The SGP stream design (Rio ASE 2019b) prescribes Engelmann spruce container plantings on 8-foot centers within Zone 4 (above bankfull water surface elevation). The SGP wetland designs (Tetra Tech 2019) identify most of the proposed floodplain wetland area as palustrine emergent (PEM) for which the proposed planting plan does not prescribe Engelmann spruce or other tree plantings. Only a relatively small area of the proposed near-bank floodplain includes palustrine forested (PFO) wetland type for which the proposed planting plan does prescribe Engelmann spruce and lodgepole pine.

To clarify this inconsistency between the stream and wetland designs, Midas Gold will revise the wetland planting plan for those near-bank floodplain areas (within 100 feet of the stream) to include enough PFO wetlands to equal or exceed the tree density recommendations of the USFS (2006). This revision would ensure sufficient short- and long-term woody recruitment potential at the “Fully Restored” project phase on all restored streams with prescribed floodplain wetlands, but excluding the steep, rock-lined channels down the face of the Hangar Flats, Fiddle, and West End DRSFs and the steep reach of Hennessy Creek where it cascades into the backfilled Yellow Pine pit DRSF.

Some concern has also been raised by the agencies that planting trees may not be appropriate or that planted trees may not survive in riparian areas associated with stream liners. As described in the stream design (Rio ASE 2019b), the impermeable stream liners are anticipated to be covered by 2.3- to 16-feet of alluvial fill material and soil (depending on the stream size and gradient [see response to RFAI-87, i.e., Rio ASE 2018]), into which the proposed trees would be planted and subsequently grow. Research has shown that the risk of damage to subsurface impermeable liners as a result of tree root penetration is relatively low given adequate depth of cover over the liner (as proposed), and tree rooting depth will adjust to match site-specific soil conditions. See Attachment B of this technical memorandum for more specific details and references regarding tree rooting depth and risk of damage from tree roots to buried liners.

6.7 Pool Frequency

Table 12. Pool Frequency Summary

Agency Concern	Arbitrary divisions between functional scores (1, 2, or 3)
Solution	Revise and justify divisions in SFA Ledger using a large data set of undisturbed and minimally disturbed reference streams
Justification	Statistical analysis and precedent from existing/ accepted SFA methods

The February 28, 2019, version of the SFA Ledger utilized pool frequency criteria developed from Appendix B of the USFS LRMP (2003), which was derived from the following sources:

- Overton et al. (1995) for bull trout including data from the Upper Salmon River basin in Idaho
- USFS (1994) for Chinook salmon and steelhead including data from Oregon, Washington, Idaho, and Alaska

As requested by the agencies, we have reviewed these source documents and have several concerns. Some of the Overton et al. (1995) data have very large standard deviations, such that one standard deviation from the average would result in negative values, and some sample sizes are so small they may not provide an accurate representation of the pool frequency (e.g., only two observations for the 0- to 5-foot wetted width classification). Likewise, we have concerns with the USFS (1994) data, as follows.

- There is no statistical information reported with the summary conclusions in this report, so the standard error, standard deviation, or average condition are unknown and cannot be calculated.
- The data only represent the frequency of pools greater than 1-meter residual depth rather than all pools.
- The data were derived only from Rosgen Type-C, low-gradient channels, which do not adequately represent many of the conditions present or proposed within the SGP area.

As stated in Appendix B of the LRMP (USFS 2003), the data tables derived from Overton et al. (1995) and USFS (1994) are to be used only if more relevant site-specific data are not available. We reviewed the literature for additional relevant classifications, and finding limited relevant literature, we then searched for more robust raw data sources. As has been shown in other established SFA methods (Nadeau et al. 2018b), the statistical evaluation of a large dataset can be used as an effective and appropriate means of establishing divisions between functional ratings. The Integrated Status and Effectiveness Monitoring Program (ISEMP) was created to support the Federal Columbia River Power System Biological Opinion. In 2011, ISEMP initiated the Columbia Habitat Monitoring Program (CHaMP) to further develop standardized fish and habitat monitoring. Data were collected for several years from 630 CHaMP sites spanning 26 watersheds in Oregon, Washington, and Idaho selected to represent a broad spectrum of habitat conditions. The CHaMP data include pool frequency along with many other stream criteria enabling refined queries based on the amount of human disturbance and the site locale as summarized in Attachment C of this technical memorandum.

The large CHaMP dataset and the ability to query specific sites based on robust stream classification information supports the selection of a dataset that is most representative of natural/reference conditions for streams similar to those at the SGP. Given the potential concerns with the Overton et al. (1995) and USFS (1994) data sources summarized above, and the availability of more relevant/robust data (CHaMP), we have used the CHaMP dataset for “undisturbed” and “low disturbance” sites for analysis of total pool frequency in the SFA. Based on methods established from other functional assessments (Nadeau et al. 2018b), we revised the SFA (Version 7/8/19) such that the divisions between High, Moderate, and Low function use the 25th and 75th percentiles of the pool spacing data for each wetted width category (Table 13). Additional details regarding pool frequency data analysis are provided in Attachment C of this technical memorandum.

Table 13. Revised Pool Frequency (pools/mile) Scoring Criteria for Various Channel Wetted Widths

Wetted Width (feet)			High Function (Good = 3)	Moderate Function (Fair = 2)	Low Function (Poor = 1)	
0	-	5	> 235	138 - 235	<	138
5	-	10	> 113	52 - 113	<	52
10	-	15	> 79	31 - 79	<	31
15	-	20	> 50	25 - 50	<	25
20	-	25	> 48	22 - 48	<	22
25	-	40	> 37	11 - 37	<	11
40	-	50	> 15	9 - 15	<	9
50	-	100	> 14	4 - 14	<	4

Note: Analysis of pool frequency data from (CHaMP)

6.8 Pool Quality

Table 14. Pool Quality Summary

Agency Concern	<ol style="list-style-type: none"> 1. Arbitrary divisions between function scores (1, 2, or 3) 2. Concern for applicability of evaluating pool quality in small streams.
Solution	<ol style="list-style-type: none"> 1. Revise and justify divisions using a large dataset of undisturbed and minimally disturbed reference streams 2. No change to the SFA Ledger regarding applicability of evaluating pool quality in small streams; provide additional justification/support
Justification	<ol style="list-style-type: none"> 1. Statistical analysis and precedent from existing/accepted SFA methods 2. Precedents from existing/accepted SFA methods strongly support the use of standard evaluation criteria and performance thresholds.

Pool quality criteria developed by the USFS (2003) were qualitative—the criteria were many, few, or none. Within the SFA Ledger (Version 2/28/19), Rio ASE quantified these values as a percentage of the optimal pool frequency, but the divisions between quantified ratings were based on professional judgement with little additional justification. As has been shown in other established SFA methods (Nadeau et al. 2018b), the statistical evaluation of a large dataset can be used as an effective and appropriate means of establishing divisions between functional ratings.

Rio ASE reviewed a summary of the U.S. Fisheries Bureau studies completed in the 1940s to evaluate pools with residual depths greater than 1 meter (McIntosh et al. 1994). We were able to determine that from the pools evaluated by the U.S. Fisheries Bureau, there were an average of 10.4 deep pools (greater than 1 meter deep) per mile. Following the method for establishing index thresholds from large datasets (Nadeau et al. 2018b), the threshold for “Low” functioning was determined using the 25th percentile, and the threshold for “High” functioning was determined using the 75th percentile value (Table 15).

Table 15. Revised Pool Quality Frequency (deep pools/mile) Scoring Criteria

High Function (Good = 3)	Moderate Function (Fair = 2)	Low Function (Poor = 1)
> 14.1	6.7 - 14.1	< 6.7

Note: Analysis of data summarized in Attachment C of this technical memorandum

As discussed at the beginning of this technical memorandum, all stream reaches, regardless of size, have been evaluated for pool quality where there are data to support the evaluation (see discussion above).

Additional details regarding pool quality data analysis is provided in Attachment C of this technical memorandum.

6.9 Off-Channel Habitat

Table 16. Off-Channel Habitat Summary

Agency Concern	Applicability of scoring off-channel habitat within reaches where off-channel habitat would not be expected or considered geomorphically appropriate
Solution	No change to the SFA Ledger; provide additional justification/support
Justification	Precedent from existing/accepted SFA methods strongly supports the use of standard evaluation criteria and performance thresholds.

During SFA workshops and meetings held following submittal of the SFA Ledger (Version 2/28/19), several agency representatives suggested off-channel habitat should not be evaluated if off-channel features (such as side channels) were not appropriate for the watershed and/or associated geomorphic character. As discussed in Section 3 of this technical memorandum, all stream reaches, regardless of their geomorphic character, are evaluated for off-channel habitat function where there are data to support the evaluation.

6.10 Width-to-Depth Ratio

Table 17. Width-to-Depth Ratio Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

6.11 Streambank Condition

Table 18. Streambank Condition Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

6.12 Floodplain Connectivity

Table 19. Floodplain Connectivity Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

6.13 Change in Peak/Base Flows

Table 20. Substrate Embeddedness Summary

Agency Concern	Provide more clarification regarding changes to baseflow in lined channel segments predicted from groundwater modeling
Solution	More clarification provided
Justification	Groundwater modeling (BC 2018b,c)

Baseflow hydrology modeling conservatively assumes no groundwater interaction within stream reaches built over a non-permeable liner (i.e., no gains from or losses to groundwater) (BC 2018b,c). In other words, the discharge estimated from groundwater modeling results immediately upstream of a lined reach is continued downstream over the top of a lined reach until a confluence with another channel or until the end of the lined reach (BC 2018b,c). Further clarification regarding the assumption of no loss to groundwater, while including likely hyporheic exchange within lined channels, was provided in the Stream Design Report Appendix H, comment response #31 (Rio ASE 2019b):

The stream liner will create a perched aquifer with a groundwater elevation estimated to be similar to the water surface elevation in the stream based on simple Darcy's Law calculations of anticipated groundwater transmissivity relative to the volume of flow in the stream. Perched groundwater would occur above the liner that would interact/exchange with surface water. This interaction would be contained above the liner and therefore would not interact/exchange with water in contact with tailings or development rock outside of the liner extents or below the liner.

The SFA, therefore, uses the baseflow modeling results (BC 2018b,c) to evaluate changes to baseflow values for all reaches (including those with a proposed stream liner) for all phases of the SGP.

Scoring criteria divisions (High, Moderate, Low) were based on a literature review and precedents from other SFAs (Johnson et al. 2016).

6.14 Change in Drainage Network

Table 21. Change in Drainage Network Summary

Agency Concern	Poor rationale supporting selected scoring criteria divisions
Solution	Provide additional rationale/justification
Justification	Based on professional judgement and current scientific understanding

Scoring criteria divisions (High, Moderate, Low) were based on professional judgement considering the lack of available scientific literature and the current scientific understanding that changes in drainage density are considered detrimental (negative) if perennial stream length decreased or if the length of human-related drainage ditches increased.

6.15 Road Density and Location

Table 22. Road Density and Location Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

6.16 RCA and Watershed Disturbance History

Table 23. RCA and Watershed Disturbance Summary

Agency Concern	Unclear methodology
Solution	Refine methodology and provide improved explanation: <ul style="list-style-type: none"> • Refine timing of disturbance from reach-based to watershed-based. • Define disturbance as including only human-caused; remove equivalent clear-cut area from definition. • Include unrestored historical disturbance areas, TSF, DRSF, mine pit highwall, and pit lakes as “disturbed” within the “Fully Restored” phase of SFA.
Justification	<ul style="list-style-type: none"> • Disturbances are evaluated on a sub-watershed-scale and therefore regardless of the timing for various reaches, the RCA and Watershed Disturbance scores should begin and end at the same time for all reaches within the same sub-watershed. • The intent of the SFA is to evaluate the change in stream function from the project over time; therefore, only project-related disturbances should be evaluated. Natural disturbances are not expected to change as a result of the project and are difficult to predict in the future. • Reaches associated with human features such as TSF, DRSF, mine highwall, and pit lake justify the classification of such areas as “disturbed.”

Rio ASE identified a discrepancy in the SFA timing as applied to the WCI (including RCA and Watershed Disturbance) that has been corrected in the 7/8/19 version of the SFA Ledger. The 2/28/19 version applied a score for each WCI element based on the timing of the impact or restoration per reach. We believe it is more appropriate to apply the score based on the timing of the impact or restoration for all reaches within the evaluated sub-watershed according to the earliest timing of the impact and after all restoration has been completed. This is a more conservative approach and will synchronize the timing of the impact and restoration scores for these elements within specified sub-watersheds as reported in the SFA.

The agencies also identified lack of clarity regarding how the disturbance areas were mapped and, therefore, quantified per project phase. This apparently originated from language in the SFA Report (Rio ASE 2019a) defining disturbance as pertaining to human actions and defining disturbance using the equivalent clear-cut area (ECA) as recommended in USFS LRMP Appendix B (2003). The ECA is a measure of area lacking tall trees that may result from many natural causes including fire, rock outcrop, open water, and different natural vegetation cover types (e.g., grass or scrub/shrub).

The intent of the SFA is to evaluate the change in stream function related to the proposed SGP and should not include potential natural disturbances, which in addition to being natural, are difficult to predict and quantify into the future. For this reason, the revised (7/8/19) SFA Ledger defines disturbance as being directly related to human actions and eliminates the use of ECA terminology. Additionally, the revised SFA Ledger (Version 7/8/19) classifies all unrestored historical disturbances (based on historical disturbance GIS polygon), the TSF, all DRSFs, the remaining mining pit highwalls, and pit lakes as “disturbed” even after restoration, given that these are human-constructed features and despite restoration of the streams and wetlands on their surfaces, the features are not natural and, therefore, should conservatively be considered “disturbed.” See Attachment D for maps illustrating the disturbance area per phase.

Previous (2/28/19 Version) Assessment Approach

- Baseline = Entire historical disturbance footprint = disturbed
- Interim = Entire proposed SGP footprint (maximum disturbance polygon) and roads = disturbed
- Restored = Same as Interim because vegetation has not yet grown back; therefore, the entire footprint is still directly related to human actions
- Fully Restored = Only remaining roads = disturbed



Revised (7/8/19 Version) Assessment Approach

- Same as previous approach but changed Fully Restored phase to reflect that unrestored historical disturbances, the entire TSF and DRSF areas, as well as the pit lakes and associated highwalls (mining excavations) would remain “disturbed” as well as any roads that are proposed to remain; all else is considered no longer disturbed.

Scoring criteria divisions for RCA and Watershed Disturbance History were based on the USFS LRMP Appendix B (USFS 2003).

Tables B4 through B9 below replace the tables in Appendix B of the SFA Report (Rio ASE 2019a). The quantity and magnitude of watershed-scale change is comparable between each alternative. Based on a sensitivity analysis, none of the values changes sufficiently between alternatives to change the SFA score; therefore, only the revised Alternative 1 values are provided for context.

Table B4. Total Drainage Network Length per Sub-Watershed

Total Drainage Network Length (%)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
EFSFSR/Meadow Creek Confluence	-0.9%	-51.7%	-0.3%	-0.3%
EFSFSR/Sugar Creek Confluence	1.8%	-62.8%	3.5%	3.5%
West End/Sugar Creek Confluence	0.0%	-159.3%	-8.4%	-8.4%

Notes:

EFSFSR = East Fork South Fork Salmon River

Percentage (%) is relative to estimated pre-disturbance (pristine) conditions.

Table B5. Road Density per Sub-Watershed

Road Density (miles/mile ²)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Burntlog Creek	1.23	1.21	1.27	1.27
Curtis Creek	1.62	1.75	1.80	1.80
Ditch Creek-Johnson Creek	0.81	1.01	1.03	1.03
Fourmile Creek-SF Salmon River	0.15	0.15	0.15	0.15
Goat Creek-SF Salmon River	0.39	0.38	0.38	0.38
Headwaters EFSFSR	1.91	2.37	0.52	0.52
Headwaters Johnson Creek	1.03	1.02	1.03	1.03
Lunch Creek-Johnson Creek	1.36	1.34	1.45	1.45
No Mans Creek-EFSFSR	0.45	0.46	0.40	0.40
Porcupine Creek-Johnson Creek	0.70	0.80	0.86	0.86
Profile Creek	0.18	0.17	0.17	0.17
Riordan Creek	0.49	0.80	0.51	0.51
Sheep Creek-Johnson Creek	0.77	0.76	0.76	0.76
Six-bit Creek-SF Salmon River	2.10	2.09	2.10	2.10
Sugar Creek	1.07	1.27	0.03	0.03
Tamarack Creek	0.00	0.00	0.00	0.00
Trapper Creek-Johnson Creek	0.97	1.26	1.19	1.19



Table B5. Road Density per Sub-Watershed

Road Density (miles/mile ²)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Upper Big Creek	1.72	1.96	1.98	1.98
Warm Lake Creek	1.18	1.30	1.37	1.37

Table B6. Roads Within Riparian Conservation Areas per Sub-Watershed

Roads Within RCA (miles/mile ²)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Burntlog Creek	2.22	2.18	2.30	2.30
Curtis Creek	2.70	2.88	2.98	2.98
Ditch Creek-Johnson Creek	1.95	2.37	2.37	2.37
Fourmile Creek-SF Salmon River	0.55	0.55	0.55	0.55
Goat Creek-SF Salmon River	0.77	0.76	0.76	0.76
Headwaters EFSFSR	3.08	3.72	0.91	0.91
Headwaters Johnson Creek	1.81	1.79	1.81	1.81
Lunch Creek-Johnson Creek	2.27	2.25	2.33	2.33
No Mans Creek-EFSFSR	2.04	2.03	1.98	1.98
Porcupine Creek-Johnson Creek	2.17	2.31	2.48	2.48
Profile Creek	1.07	1.06	1.06	1.06
Riordan Creek	0.32	0.52	0.34	0.34
Sheep Creek-Johnson Creek	1.59	1.56	1.57	1.57
Six-bit Creek-SF Salmon River	1.62	1.59	1.63	1.63
Sugar Creek	1.85	2.31	0.10	0.10
Tamarack Creek	0.01	0.01	0.00	0.00
Trapper Creek-Johnson Creek	1.40	1.62	1.60	1.60
Upper Big Creek	2.83	3.10	3.07	3.07
Warm Lake Creek	1.98	2.15	2.32	2.32

Table B7. Riparian Conservation Areas Disturbed per Sub-Watershed

Riparian Conservation Area (% Disturbed)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Burntlog Creek	1.3%	1.7%	1.7%	1.7%
Curtis Creek	1.5%	2.6%	2.6%	2.0%
Ditch Creek-Johnson Creek	1.1%	3.1%	3.1%	1.6%
Fourmile Creek-SF Salmon River	0.2%	0.2%	0.2%	0.2%
Goat Creek-SF Salmon River	0.4%	0.4%	0.4%	0.4%
Headwaters EFSFSR	9.7%	29.4%	29.4%	21.6%
Headwaters Johnson Creek	1.0%	1.1%	1.1%	1.1%



Table B7. Riparian Conservation Areas Disturbed per Sub-Watershed

Riparian Conservation Area (% Disturbed)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Lunch Creek-Johnson Creek	1.3%	1.3%	1.3%	1.5%
No Mans Creek-EFSFSR	1.0%	1.2%	1.2%	1.2%
Porcupine Creek-Johnson Creek	1.2%	2.1%	2.1%	1.7%
Profile Creek	0.6%	0.6%	0.6%	0.6%
Riordan Creek	0.4%	1.0%	1.0%	0.4%
Sheep Creek-Johnson Creek	0.9%	0.9%	0.9%	0.9%
Six-bit Creek-SF Salmon River	0.9%	1.0%	1.0%	1.0%
Sugar Creek	1.5%	6.0%	6.0%	6.0%
Tamarack Creek	0.0%	0.0%	0.0%	0.0%
Trapper Creek-Johnson Creek	1.0%	1.4%	1.4%	1.3%
Upper Big Creek	1.6%	2.5%	2.5%	2.0%
Warm Lake Creek	1.1%	2.3%	2.3%	1.4%

Table B8. Disturbance History per Sub-Watershed

Disturbance History ECA (%)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Burntlog Creek	0.7%	1.1%	1.1%	0.9%
Curtis Creek	0.9%	1.4%	1.4%	1.1%
Ditch Creek-Johnson Creek	0.5%	1.1%	1.1%	0.6%
Fourmile Creek-SF Salmon River	0.1%	0.1%	0.1%	0.1%
Goat Creek-SF Salmon River	0.2%	0.2%	0.2%	0.2%
Headwaters EFSFSR	3.7%	14.2%	14.2%	9.8%
Headwaters Johnson Creek	0.6%	0.6%	0.6%	0.6%
Lunch Creek-Johnson Creek	0.8%	0.8%	0.8%	0.9%
No Mans Creek-EFSFSR	0.2%	0.3%	0.3%	0.3%
Porcupine Creek-Johnson Creek	0.4%	0.8%	0.8%	0.6%
Profile Creek	0.1%	0.1%	0.1%	0.1%
Riordan Creek	0.6%	1.2%	1.2%	0.6%
Sheep Creek-Johnson Creek	0.4%	0.4%	0.4%	0.4%
Six-bit Creek-SF Salmon River	1.2%	1.3%	1.3%	1.2%
Sugar Creek	1.5%	4.5%	4.5%	4.2%
Tamarack Creek	0.0%	0.0%	0.0%	0.0%
Trapper Creek-Johnson Creek	0.8%	1.3%	1.3%	1.0%
Upper Big Creek	1.0%	1.6%	1.6%	1.2%
Warm Lake Creek	0.7%	1.2%	1.2%	0.8%

Table B9. Disturbance Within Riparian Conservation Areas per Sub-Watershed

Riparian Conservation Area (% Disturbed)				
Sub-Watershed	Baseline	Interim	Restored	Fully Restored
Burntlog Creek	Yes	Yes	Yes	Yes
Curtis Creek	Yes	Yes	Yes	Yes
Ditch Creek-Johnson Creek	Yes	Yes	Yes	Yes
Fourmile Creek-SF Salmon River	Yes	Yes	Yes	Yes
Goat Creek-SF Salmon River	Yes	Yes	Yes	Yes
Headwaters EFSFSR	Yes	Yes	Yes	Yes
Headwaters Johnson Creek	Yes	Yes	Yes	Yes
Lunch Creek-Johnson Creek	Yes	Yes	Yes	Yes
No Mans Creek-EFSFSR	Yes	Yes	Yes	Yes
Porcupine Creek-Johnson Creek	Yes	Yes	Yes	Yes
Profile Creek	Yes	Yes	Yes	Yes
Riordan Creek	No	No	No	No
Sheep Creek-Johnson Creek	Yes	Yes	Yes	Yes
Six-bit Creek-SF Salmon River	No	No	No	No
Sugar Creek	Yes	Yes	Yes	Yes
Tamarack Creek	Yes	Yes	Yes	Yes
Trapper Creek-Johnson Creek	Yes	Yes	Yes	Yes
Upper Big Creek	Yes	Yes	Yes	Yes
Warm Lake Creek	Yes	Yes	Yes	Yes

6.17 Occupancy Potential

Table 24. Occupancy Potential Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

Occupancy potential includes intrinsic potential for Chinook salmon and steelhead and occupancy modeling for bull trout and westslope cutthroat trout. These models are currently in development (by USFS’s 3rd party consultant) and, therefore, represent a data gap in the SFA Ledger. A placeholder has been incorporated into the SFA Ledger to accommodate these data once available. The SFA Ledger is fully functional without these data, but certain data/results, filtering, and species-specific evaluations may not be possible until these data are entered into the SFA Ledger. Once available, we believe the ability to filter data/results based on species-specific occupancy potential will address agency concerns voiced in SFA meetings on March 19, April 15, and May 23, 2019, regarding the applicability of some elements relative to potential fish use (i.e., passage and habitat). For example, concern was raised regarding the amount of SFA credit applied to the Physical Barriers element given that much of the stream length made accessible by providing passage at Yellow Pine pit would not be used by Chinook salmon. Applying the intrinsic potential filter would refine the results such that only those reaches that Chinook salmon are likely to occupy would be scored, enabling a

more focused review specific to Chinook salmon. Applying occupancy potential filters is one means by which these concerns can be addressed (as with the other filters listed below—Critical Habitat and existing Fish Presence/Absence).

6.18 Critical Habitat

Table 25. Critical Habitat Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

6.19 Fish Presence/Absence

Table 26. Fish Presence/Absence Summary

Agency Concern	No specific concerns
Solution	N/A
Justification	N/A

Section 7: Alternatives Analysis

Early versions of the SFA Ledger included evaluations of the Proposed Action as described in the Plan of Restoration and Operations ([PRO] Midas Gold 2016). Subsequent versions of the SFA Ledger have now been produced to evaluate all four proposed alternatives as part of the SGP EIS. Summarized below is a brief description of each alternative and the changes made to the SFA Ledger to accommodate them.

Alternative 1 (PRO): This alternative includes the actions proposed in the PRO (Midas Gold 2016). All previous iterations of the SFA Ledger have included increasingly refined assessments of this alternative. No changes to the Alternative 1 (PRO) version of the SFA Ledger have been made to accommodate this alternative beyond those changes reported in the previous sections of this document that pertain to all versions of the SFA Ledger including the addition of many new SFA stream reaches to ensure the same spatial area has been evaluated for every alternative (i.e., apples-to-apples comparison).

Alternative 2 (Modified PRO): This alternative includes those actions proposed in the PRO with the following principal modifications pertaining to streams:

- Interim phase diversions around the TSF and DRSFs were modified to include piping of baseflow to reduce temperature impacts (see SPLNT model results [BC 2019]).
- Interim phase Hennessy Creek diversion was modified to flow on the surface north of the proposed EFSFSR bypass channel entering the EFSFSR near the south portal of the tunnel rather than passing into the tunnel directly via a series of boreholes.
- The West End DRSF was removed from this alternative and the associated Interim phase diversion around the feature was adjusted to divert flow around the proposed West End pit.
- A 5.28-mile segment of the Burntlog Route (Riordan Creek Segment; Segment 8a) would be rerouted shortening the Burntlog Route by approximately one mile. Additional stream crossings associated with the 8a route were added to the ledger and the crossings associated with the original route were removed.

Alternative 3 (EFSFSR TSF): This alternative includes a relocation of the proposed TSF from the Meadow Creek valley to the upper EFSFSR valley (upstream of the confluence with Meadow Creek). Resulting from

this alternative, many additional reaches were added to the SFA Ledger to account for the proposed impact area shifting from Meadow Creek to the upper EFSFSR. None of the new SFA reaches included stream segments that had not been previously evaluated as part of the Intrinsic Potential and Occupancy Modeling exercise completed by the USFS 3rd party consultant. In addition to the relocated TSF, the proposed Burntlog Access Route and worker housing facility were relocated from the upper EFSFSR valley to the upper Blowout Creek valley to accommodate the location of the EFSFSR TSF. Upper Blowout Creek would be diverted around the worker housing facility during mine operations then restored to its baseline condition after mining. The design principals associated with the interim stream channel diversions and restored stream channels for the EFSFSR TSF are consistent with those described in the Stream Design Report (Rio ASE 2019b) for Alternatives 1 and 2. SFA elements evaluated for stream reaches located downstream of the EFSFSR and Meadow Creek confluence remain unchanged from the PRO (Alternative 1).

Alternative 4 (Johnson Creek and Stibnite Access Route): This alternative includes a change to the proposed access route from the Burntlog Route located relatively high in the watershed to use of Johnson Creek and Stibnite Roads that are located relatively low in the watershed (adjacent Johnson Creek and the EFSFSR respectively). There is no change to the Proposed Action within the mine site proper (generally considered upstream of the EFSFSR and Sugar Creek confluence). It should be noted that while the proposed Johnson Creek and Stibnite access route may pose greater risk of potential stream contamination due to the increased proximity of the road to perennial streams, the SFA must assume all appropriate best management practices and sediment control measures are adhered to for both access routes. In other words, the SFA evaluates the stream function associated with the Proposed Action but does not account for possible risk. Additional stream crossings associated with the Johnson Creek and Stibnite access route were added to the ledger.

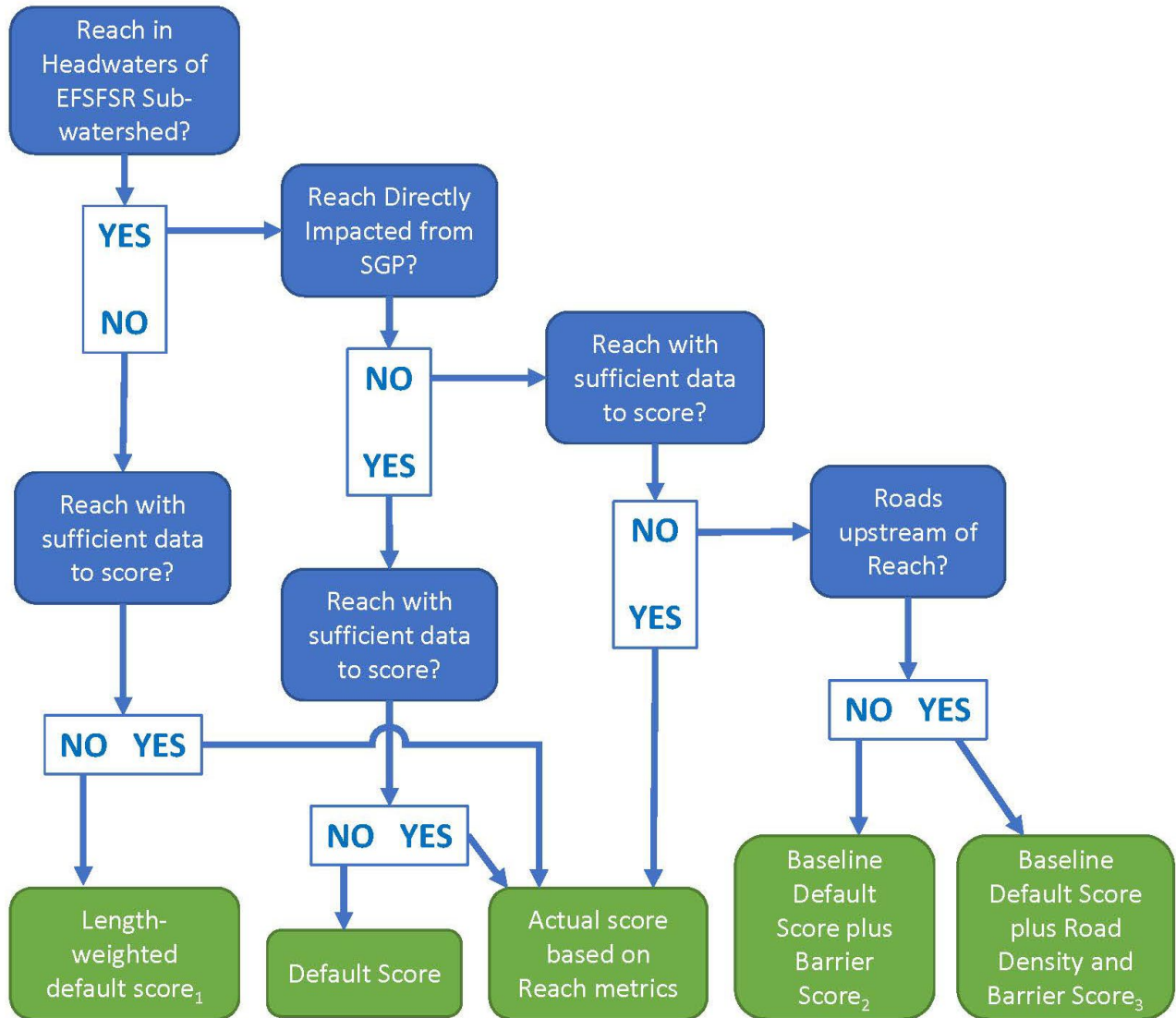
Section 8: Discovery During the EIS Alternatives Analysis

As described above in Section 7, many additional reaches were added to the baseline SFA streams to accommodate the full spatial extent of all four alternatives. Each alternative SFA Ledger includes the same baseline stream reaches and associated SFA element scores; therefore, the Functional Index and associated Functional Units for each baseline reach are the same for all four alternatives, establishing the baseline for comparison between phases within one alternative and/or between different alternatives (i.e., apples-to-apples comparison). The additional reaches affectively raise the baseline score (Functional Index and Functional Units) compared with earlier versions of the SFA Ledger that had fewer reaches.

In addition to adding several new reaches to spatially encompass all four alternatives ensuring the baseline conditions and Functional Units are the same for all four alternatives, discovery during the EIS alternatives evaluation (i.e., development of alternative SFA Ledgers) resulted in a revision to the application of default scores for reaches lacking sufficient data to receive a score of their own and for reaches that are not directly impacted by the project for a given alternative.

The new reaches added to the SFA to accommodate alternatives analysis typically would be impacted only in some alternatives but not others (e.g., upper Blowout Creek Reach BC0.02 would only be impacted [by the proposed worker housing facility] in Alternative 3). These new reaches are generally high in the watershed and often are non-perennial or otherwise lack baseline data for many of the WCI elements. As the SFA Ledger was previously programmed, these new reaches lacking sufficient baseline data would have received a default score for each phase of the project. The recommended default score is derived from the average Functional Index of the overall project and therefore reflects impacts and benefits associated with the overall project over time. It would be inappropriate to increase and/or decrease the Functional Index and associated Functional Units for unimpacted reaches in accordance with the impacts and/or benefits associated with the overall project.

The SFA Ledger was therefore modified with two new tabs identifying which reaches are impacted by which alternatives. There is a Watersheds tab that summarizes watershed scale impacts and the year watershed disturbances begin and the year they are restored. An Impacts tab was added to signify if a reach was directly impacted by the proposed project. If reaches are not directly impacted, they can be indirectly impacted by fish passage and upstream road density. Additionally, the application of default scoring was modified in the SFA Ledger as illustrated in Figure 1.



- Notes:
 1) See Equation 2
 2) See Equation 3
 3) See Equation 4

Figure 1. Refined Application of SFA Reach Default Scoring

The application of default scoring was modified to apply the most appropriate default score to those reaches that lack sufficient data to generate a score of their own in the SFA Ledger. The order of operations to determine the scoring approach per reach is summarized in Figure 1 and further defined below.

- **Headwaters of EFSFSR Sub-Watershed** – Reaches within the vicinity of the proposed mine site proper are considered generally representative of the conditions associated with the mine site. The area associated with the proposed mine site proper has been defined conservatively as the entire headwaters of the EFSFSR HUC-6 sub-watershed.
- **Direct Impacts from SGP** – Used in conjunction with the proximity to the mine site proper (i.e., headwaters of the EFSFSR sub-watershed) to determine if the Default score should be applied when there is not sufficient data to score a given reach. Summarized in new tab “Impacts,” which states if a reach is directly impacted by the alternative and if that reach is located downstream of proposed roads (for that alternative). Based on these classifications, the default score at baseline either remains the same (not impacted and do roads upstream) or gets adjusted as described below.
- **Sufficient Data to Score** – The User Interface tab of the SFA Ledger allows the user to define the number of SFA elements that must have data for a given reach in order to calculate a reach-specific Functional Index score. Those reaches that have data for at least as many elements as defined by the user as the minimum number required to score therefore have sufficient information from which to calculate a reach-specific Functional Index rather than using a default score.
- **Roads Upstream** – Used to determine if the Road Density SFA element should be applied to the default score based on the presence of SGP proposed roads upstream of the reach in question therefore potentially indirectly impacting that reach.
- **Default Score** – Where there is insufficient data to score a given reach in the SFA, the Ledger must use a default score for all phases in order to report a Functional Index. The default score (value between 1 and 3) must be entered by the user or the user can select to use an average score (recommended). The average default score is calculated from all stream reaches that have reported a score for the baseline condition. The average score then varies up or down by year to be applied accordingly to each reach with insufficient data to score based on its particular “interim” and “restored” phase timing. It is assumed that the condition of those reaches lacking data would reflect the average conditions of the overall project for that given year. This default score is therefore applied to each phase for those reaches otherwise lacking sufficient data to generate a reach-specific score.
- **Length-Weighted Default Score** – This score was broken into two categories: access roads and impacts associated with transmission lines. The length-weighted default score is used to adjust the baseline score for impacts outside of the upper EFSFSR subwatershed when there is insufficient data to score a reach. This score uses the default score for baseline conditions. Once a reach is impacted, the score is adjusted for impacts associated with roads and transmission lines.
 - For roads, it is assumed that existing lengths of culverts exhibit no change in their function and only the impacted reaches where culverts or ditches do not currently exist are affected. It is assumed for these reach lengths that the following WCI elements are directly affected by the placement of a culvert: fine sediment, embeddedness, LWD, pool frequency, pool quality, off-channel habitat, streambank condition and floodplain connectivity. It is assumed these eight WCI elements (if used in the analysis) receive a scoring of low function. This results in the following formula (Equation 2) to calculate the adjusted functional index during interim conditions for all the length associated with a road reach.

$$FI_{impacted} = \frac{\sum W_{i-non-impacted} * E_{baseline\ ave} + \sum W_{i-impacted} * E_{Impacted}}{\sum_i^n W_i} / E_{max} \quad \text{EQ-1}$$



$$FI_{interim} = \frac{L_{existing} * FI_{baseline\ ave} + L_{impacted} * FI_{impacted}}{L_{existing} + L_{impacted}} \quad \text{EQ-2}$$

Where:

$FI_{impacted}$ = Functional Index applied to impacted lengths within a given reach

$W_{i-non-impacted}$ = Weight of WCI element i associated with assumed non-impacted WCI elements (if being used in the analysis)

$E_{baseline\ ave}$ = The baseline average element score, can be calculated as the baseline average Functional Index multiplied by the maximum element score

$W_{i-impacted}$ = Weight of WCI element i associated with assumed impacted WCI elements (if being used in the analysis)

$E_{impacted}$ = Assumes impacted WCI elements score at a poor condition or a quantitative score of 1

W_i = Weight of WCI element i

E_{max} = Maximum element score possible (good or quantitative score of 3)

$FI_{interim}$ = Functional Index during the interim condition

$L_{existing}$ = Length of existing culvert or road crossing (estimated by number of existing crossings multiplied by existing average road width) within a road reach

$FI_{baseline\ ave}$ = Average Functional Index score for baseline conditions

$L_{impacted}$ = reach length directly impacted by proposed actions and is equal to the total reach length minus the length of existing culvert or road crossings within the reach

$FI_{impacted}$ = The reduced or impacted Functional Index for road crossings where 8 elements (if all elements score would go to a scoring of poor

- For transmission lines, it is assumed the following WCI elements are directly affected by the transmission lines: LWD, pool frequency, and pool quality. It is assumed these three WCI elements (if used in the analysis) receive a scoring of low function during the interim condition up to the fully restored condition. This results in utilizing Equation 1 above to calculate the adjusted Functional Index during interim conditions for transmission line reaches.
- **Baseline Default Score** – Calculated from the average baseline score (Functional Index) from all stream reaches that have reported a score for the baseline condition. Unlike the default score that varies by mine year, the baseline default score remains constant (equal to the baseline score) for all phases of the project. The baseline default score is applied to stream reaches within the headwaters of the EFSFSR sub-watershed that would not be directly impacted by the proposed SGP and have insufficient data to generate a reach-specific score. These reaches are located exclusively upstream of the project impact area.
- **Baseline Default Score plus Barrier Score** – Fish passage barriers is the only SFA element that has indirect impacts affecting upstream reaches (i.e., fish passage barriers block migratory fish access to upstream reaches). All baseline default scores therefore also include reach-specific barrier data that overwrites the baseline default score for this particular element based on the timing (mine year) of any proposed change to barrier status that would affect the given reach. The formula to calculate the functional index for any given mine year in a non-impacted reach is seen below (Equation 3).

$$FI_{yr} = \frac{\sum W_{i-non-impacted} * E_{baseline\ ave} + W_{passage} * E_{passage}}{\sum_i^n W_i} / E_{max} \quad \text{EQ-3}$$

Where:



FI_{yr} = Functional Index for end of mine year “x”

W_{passage} = Weight of WCI element associated with fish passage

E_{passage} = The passage element score associated with end of mine year “x”

- Baseline Default Score plus Road Density and Barrier Score** – In addition to fish passage barriers indirectly impacting reaches upstream of the proposed SGP impact area, there are proposed access roads located upstream of otherwise unimpacted reaches that may result in indirect impacts to those reaches. To account for these potential indirect impacts to otherwise unimpacted reaches using the baseline default score, the SFA Ledger has identified which reaches have proposed access roads upstream of the reach and within the same drainage basin. The SFA Ledger conservatively assumes there will be an indirect impact to this reach associated with road density; therefore, along with the baseline default barrier score, the baseline default road density score is also overwritten to include the reach-specific timing and magnitude of this indirect impact for a given reach. The formula to calculate the functional index for any given mine year in a non-impacted reach, with access roads located upstream within the watershed is seen below (Equation 4).

$$FI_{yr} = \frac{\sum W_{i-\text{non-impacted}} * E_{\text{baseline ave}} + W_{\text{passage}} * E_{\text{passage}} + W_{\text{road density}} * E_{\text{road density}}}{\sum_i^n W_i} / E_{\text{max}} \quad \text{EQ-4}$$

Where:

$W_{\text{road density}}$ = Weight of WCI element associated with road density

$E_{\text{road density}}$ = The road density element score associated with end of mine year “x”

Section 9: SFA Element Weighting

The SFA Ledger includes an objective and scientifically supported evaluation of the function of various elements as informed by conditions represented by the specific elements identified above. The SFA Ledger also provides the user opportunity to weight different elements higher/lower to support the user’s (agency’s) values. If a user believes certain elements are of more or less value than others, and the user can provide rationale and/or justification for this determination, the user can elect to weight those elements accordingly. This functionality enables users to evaluate the sensitivity of various elements and the ability to customize the SFA Ledger to meet their specific needs. For example, agencies have expressed concern regarding the applicability of some elements versus others and/or the potential dilution of value associated with the score of one element among many for a given reach. These concerns can be overcome using strategic and justified weighting.

Section 10: Data Sources

Data sources for each element are summarized in the SFA Report Appendix A (Rio ASE 2019a). The agencies requested additional information regarding why some of those reported data were not used in the SFA. Specific raw data pertaining to several elements (fine sediment, substrate embeddedness, LWD, pool frequency, and pool quality) did not always align with results reported in the final baseline SFA report (HDR 2016). It is unclear why there may have been discrepancies between raw/draft data and the final reported values in previous reports. Data may differ due to variance associated with grouping and averaging over different spatial scales and/or due to removal of suspect data points via quality control protocols following data analysis. Also, as noted in Appendix A of the SFA Report (Rio ASE 2019a), methods for measuring data changed over time for some elements (i.e., LWD and Pools), resulting in discrepancies. In all cases, the final

published data (HDR 2016) were interpreted to represent the most accurate summary of results, thereby superseding any draft or raw data wherever discrepancies were identified.

Many of the raw data sources for Pool Quality included information regarding pools but lacked associated stream length, thereby precluding calculation of the frequency of quality pools. The use of these partial data was classified as “TBD” in the SFA Report, Appendix A, Table 20 (Rio ASE 2019a). Due to insufficient information from these sources, the SFA Ledger (Versions 2/28/19 and 7/8/19) excluded these data. As noted below (Section 9), pool frequency and pool quality will be measured in a spatially continuous manner for Lower Meadow Creek and the East Fork South Fork Salmon River from Meadow Creek to Sugar Creek during proposed summer 2019 field efforts.

Section 11: Data Gaps

Numerical models (such as the SFA Ledger) are dependent on the data used to populate them, whereby more data provide more refined results. With a small volume of data, each data element in the model has a relatively significant influence on the model outputs. With larger volumes of data, the relative significance of each data element is diluted resulting in less overall influence on the model outputs. This incremental reduction in influence represents a diminishing return, suggesting it is impractical and (from a modeling perspective) inappropriate to fill every data gap in a model.

There are data gaps in the SFA Ledger, but most of the perennial stream length represented in the SFA Ledger has been populated with data. The SFA Ledger outputs are, therefore, believed to be broadly representative of the various project phases evaluated, and use of the SFA Ledger should not necessarily be postponed while waiting for a handful of data gaps to be filled. That said, there are a number of data gaps that will be filled in the near-term to validate/refine existing data estimates (as is the case for LWD, pools, and off-channel habitat) to facilitate specific SFA functionality (as is the case for occupancy modeling and approved jurisdictional determinations of streams in the project area), and to expand the spatial extent of the SFA. Data gaps that are planned to be populated in the near-term consist of the following:

- Data that will facilitate specific SFA functionality by enabling refined data/results filtering
 - Occupancy modeling results (Intrinsic Potential and Occupancy Potential models)
 - Development of an approved jurisdictional determination for streams impacted by the project
- Data that will validate and/or refine the existing data estimates
 - Spatially continuous measurements of LWD, pool frequency/quality, and off-channel habitat baseline data will be collected in summer 2019 and applied to a subsequent version of the SFA Ledger. Current data were derived from one monitoring site (MWH-059; HDR 2016) and from detailed aerial photo analysis.
- Data that will expand the spatial extent of the SFA
 - The National Hydrography Dataset (NHD) of streams has been added to the SFA stream layer to temporarily fill the prior data gap of missing perennial streams west of Warm Lake and to add resolution to those mapped streams along the proposed transmission line corridor. Where NHD streams overlap the more refined stream layer from prior field mapping (HDR and Tetra Tech) and LiDAR delineation (Ecosystem Sciences) exercises, the NHD data were ignored. Additional field mapping, verification, and jurisdictional determination of streams will be conducted in the future, which may result in further resolution of the stream layer (and therefore reaches) used in the SFA.

As described in the SFA Report (Rio ASE 2019a), data gaps associated with non-perennial streams will not be filled.

Section 12: SFA Results

Following are three figures for each of the four evaluated alternatives summarizing the following results:

1. User inputs
2. Model run scenario summary and tabular results
3. Graphical results summarized by stream length, Functional Index, and Functional Units

STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 1: PROPOSED ACTION (PRO) STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



SFA LEDGER
VERSION - 7/8/2019

USER INSTRUCTIONS FOR THIS PAGE

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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/6/19 3:20 PM

GIVENS

		Notes
Evaluation Period Begins at End of Year (EOY):	-4	Evaluation begins at EOY -4 (baseline conditions one year before pre-production work)
Final Year of Mine Operations and Restoration:	24	Mine operations and restoration extend through EOY 24 (end of restoration)
Year Evaluated Following Full Closure:	Fully Restored	Stream Functional Assessment is also evaluated at an approximated Fully Restored condition
Functioning Good (FG)	3	Value given to each element that is functioning good.
Functioning Fair (FF)	2	Value given to each element that is functioning fair.
Functioning Low (FL)	1	Value given to each element that is functioning low.

INPUTS

1 GENERAL INPUTS

		Notes
Allow Passage Through Tunnel (Yes/No):	Yes	Allowing fish passage upstream of existing Yellow Pine via tunnel.
If Yes, EOY Passage is Allowed:	-1	If passage is allowed upstream, identify the EOY passage is allowed.
Evaluate Barrier Types:	Human	Either human-caused barriers or both human-caused and natural barriers evaluated.
Species of Interest:	All Species	Either bull trout and cutthroat (BT and CT) or Chinook Salmon and steelhead (CH and ST), or CH, ST, BT, CT or an average of all species (All Species)
Minimum Number of Elements Required to Score:	5	Minimum number of indicators required to utilize indicators, otherwise uses default WCI score identified below.
Default WCI Score:	Average	Default WCI score where there is no data or too little data to apply true WCI scores per reach.
	2.049 ; 2.091	Baseline Average (BT/CT ; CH/ST)

2 WEIGHTING OPTIONS

		Notes
Weight Perennial Streams vs Non-Perennial Streams (Yes/No):	No	Select if you want to apply a weighting factor to differentiate between perennial and Non-Perennial channels.
If Yes, Select Weight for Perennial:	NA	Input a weighting factor to apply to perennial streams.
Weight Streams Based on Stream Order (Yes/No):	Yes	Select if you want to weight streams based on their stream order (SO) (Non-Perennial streams have a SO of 0 so weight is SO+1).
Weight Watershed Condition Indicators (Yes/No):	Yes	Select if you want to individually weight WCI or have them all equal.
If Yes, Use Survivorship Weights:	No	These WCI weighting factors assign weights based on fish survivorship.

	Water Quality			Habitat Access	Habitat Elements					Channel Conditions and Dynamics			Flow and Hydrology		Watershed Conditions			Fish Factors		
	Temperature	Fine Sediment	Chemical Contaminants	Physical Barriers	Substrate Embeddedness	Large Woody Debris	Pool Frequency	Pool Quality	Off-Channel Habitat	Width/Depth Ratio	Streambank Condition	Floodplain Connectivity	Change in Peak/Base Flows	Drainage Network	Road Density and Location	Riparian Conservation Areas	Disturbance History	Occupancy Model/Intrinsic Potential	Critical Habitat	Presence/Absence
Weighting Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0

Weight Fish Life Stage for Temp Evaluation (Yes/No): No Select if you want to weight life stage or have them all equal.

	Bull Trout and Cutthroat		Chinook Salmon/ Steelhead	
	Rearing	Spawning	Rearing	Spawning
Weighting Factor	NA	NA	NA	NA



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 1: PROPOSED ACTION (PRO) STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



SFA LEDGER
VERSION - 7/8/2019

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MODEL RUN SCENARIO SUMMARY

Scenario Requested By: Agency Name Scenario Requested On: Date
Scenario Generated By: Rio Applied Science and Engineering Scenario Generated On: 7/6/19 3:20 PM

Weight Fish Species (Yes/No): No Select if weights will be applied to each species when they are combined.

	Bull trout and Cutthroat	Chinook Salmon/ Steelhead
Weighting Factor	NA	NA

Use Occupancy Models as Weighting No If selected No, this element will act as an element, if selected Yes FU will be weighted by a value from 0-1 based on occupancy suitability
 Use Critical Habitat as a on/off control No If selected No, Critical Habitat will act as an element, if selected Yes only areas with Critical Habitat will be evaluated
 Use Presence/ Absence as an on/off control No If selected No, Presence/ Absence will act as an element, if selected Yes only areas with fish Present will be evaluated
 Analyze Jurisdictional Waters Only No If selected No, both jurisdictional and non-jurisdictional reaches will be analyzed, if selected Yes only designated jurisdictional reaches will be analyzed

3 WATERSHED CONDITION INDICATORS RESULTS SCORING CRITERIA

WCI Average Significant Digits¹: 1 **Notes** Rounds WCI Scoring Criteria to either a whole number or allows decimals where multiple criteria are utilized.

Notes:
1. WCI Average Significant Digits are applicable to temperature where percent of time temperature falls into each category is applied to FA, FR, UR and then averaged to one functional index value per life stage and then averaged to one species. The significant digits also affect the rounding of this final average WCI score to a whole number or a fraction of a number. Also where one criteria is averaged over multiple reaches, the average of these reaches can be shown as a whole number or a fraction of a number.

4 STREAM TYPE EVALUATED

Stream Type Evaluated: Both Perennial and Non-Perennial

RESULTS

Stream Functional Assessment Summary for the Stibnite Gold Project

	End of Mine Year																											
	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Stream Length (ft)	247558	247695	247201	231864	231779	236953	236953	236953	236953	236953	236871	232555	232555	232555	238053	238142	238142	237020	237020	243005	243005	243005	243005	243005	242589	242589	242589	242589
Functional Index	0.69	0.67	0.65	0.67	0.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.68	0.69	0.69	0.69	0.69	0.71	0.72	0.72	0.72
Stream Functional Units	408781	395852	375730	372740	373919	373072	372492	372684	372810	372931	370776	372109	374548	374059	373926	387817	384888	384911	384441	384581	407566	411198	411370	413274	429613	432334	432824	433326
Stream Length % Variation from Baseline	0%	0%	0%	-6%	-6%	-4%	-4%	-4%	-4%	-4%	-4%	-4%	-6%	-6%	-6%	-4%	-4%	-4%	-4%	-4%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Functional Index % Variation from Baseline	0%	-2%	-5%	-4%	-3%	-4%	-4%	-4%	-4%	-4%	-5%	-4%	-4%	-4%	-4%	-3%	-3%	-3%	-3%	-3%	-1%	-1%	-1%	0%	3%	4%	4%	4%
Stream Functional Units % Variation from Baseline	0%	-3%	-8%	-9%	-9%	-9%	-9%	-9%	-9%	-9%	-9%	-9%	-8%	-8%	-9%	-5%	-6%	-6%	-6%	-6%	0%	1%	1%	1%	5%	6%	6%	6%
Stream Functional Units from Baseline	0	-12929	-33052	-36042	-34863	-35709	-36290	-36098	-35972	-35850	-38006	-36672	-34233	-34722	-34855	-20964	-23893	-23870	-24341	-24201	-1216	2417	2589	4493	20832	23553	24043	24545
Cumulative Variation in Functional Units	0	-12929	-45981	-82022	-116885	-152594	-188883	-224981	-260952	-296802	-334808	-371480	-405713	-440435	-475290	-496254	-520147	-544017	-568357	-592558	-593773	-591356	-588768	-584275	-563443	-539891	-515848	-491303



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 1: PROPOSED ACTION (PRO) STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



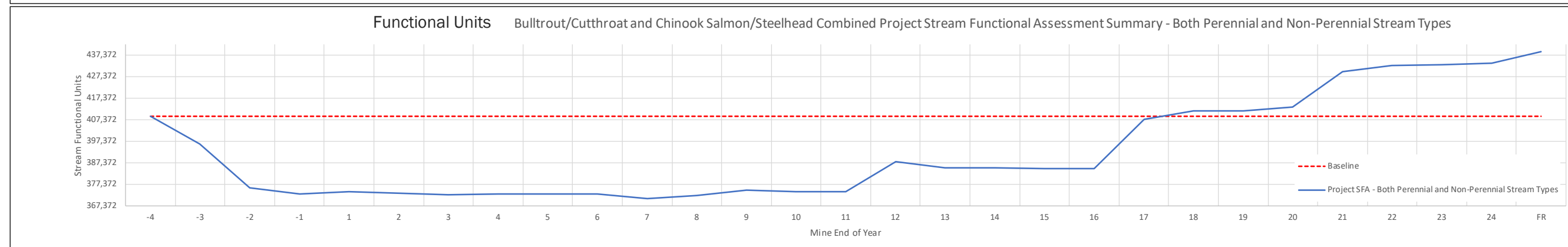
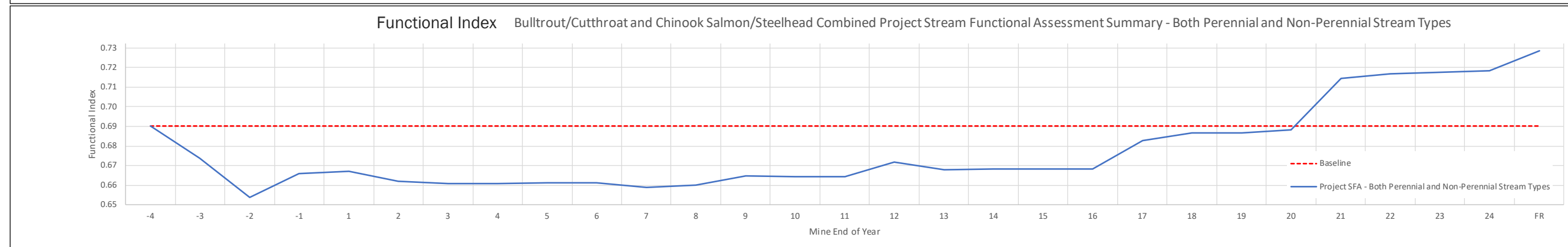
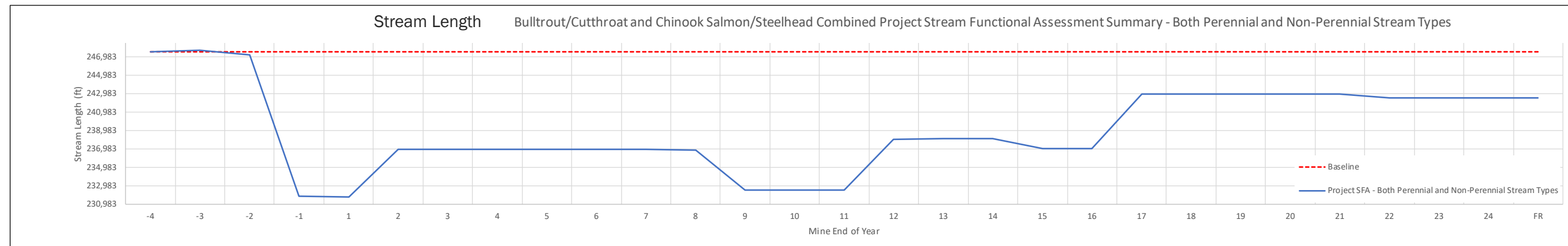
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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/6/19 3:20 PM



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 2: MODIFIED PROP. ACTION (MOD-PRO) STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



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VERSION - 7/8/2019

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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/6/19 3:24 PM

GIVENS

		Notes
Evaluation Period Begins at End of Year (EOY):	-4	Evaluation begins at EOY -4 (baseline conditions one year before pre-production work)
Final Year of Mine Operations and Restoration:	24	Mine operations and restoration extend through EOY 24 (end of restoration)
Year Evaluated Following Full Closure:	Fully Restored	Stream Functional Assessment is also evaluated at an approximated Fully Restored condition
Functioning Good (FG)	3	Value given to each element that is functioning good.
Functioning Fair (FF)	2	Value given to each element that is functioning fair.
Functioning Low (FL)	1	Value given to each element that is functioning low.

INPUTS

1 GENERAL INPUTS

		Notes
Allow Passage Through Tunnel (Yes/No):	Yes	Allowing fish passage upstream of existing Yellow Pine via tunnel.
If Yes, EOY Passage is Allowed:	-1	If passage is allowed upstream, identify the EOY passage is allowed.
Evaluate Barrier Types:	Human	Either human-caused barriers or both human-caused and natural barriers evaluated.
Species of Interest:	All Species	Either bull trout and cutthroat (BT and CT) or Chinook Salmon and steelhead (CH and ST), or CH, ST, BT, CT or an average of all species (All Species)
Minimum Number of Elements Required to Score:	5	Minimum number of indicators required to utilize indicators, otherwise uses default WCI score identified below.
Default WCI Score:	Average	Default WCI score where there is no data or too little data to apply true WCI scores per reach.
	2.049 ; 2.091	Baseline Average (BT/CT ; CH/ST)

2 WEIGHTING OPTIONS

		Notes
Weight Perennial Streams vs Non-Perennial Streams (Yes/No):	No	Select if you want to apply a weighting factor to differentiate between perennial and Non-Perennial channels.
If Yes, Select Weight for Perennial:	NA	Input a weighting factor to apply to perennial streams.
Weight Streams Based on Stream Order (Yes/No):	Yes	Select if you want to weight streams based on their stream order (SO) (Non-Perennial streams have a SO of 0 so weight is SO+1).
Weight Watershed Condition Indicators (Yes/No):	Yes	Select if you want to individually weight WCI or have them all equal.
If Yes, Use Survivorship Weights:	No	These WCI weighting factors assign weights based on fish survivorship.

	Water Quality			Habitat Access	Habitat Elements					Channel Conditions and Dynamics			Flow and Hydrology		Watershed Conditions			Fish Factors		
	Temperature	Fine Sediment	Chemical Contaminants	Physical Barriers	Substrate Embeddedness	Large Woody Debris	Pool Frequency	Pool Quality	Off-Channel Habitat	Width/Depth Ratio	Streambank Condition	Floodplain Connectivity	Change in Peak/Base Flows	Drainage Network	Road Density and Location	Riparian Conservation Areas	Disturbance History	Occupancy Model/Intrinsic Potential	Critical Habitat	Presence/Absence
Weighting Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0

Weight Fish Life Stage for Temp Evaluation (Yes/No): No Select if you want to weight life stage or have them all equal.

	Bull Trout and Cutthroat		Chinook Salmon/ Steelhead	
	Rearing	Spawning	Rearing	Spawning
Weighting Factor	NA	NA	NA	NA



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 2: MODIFIED PROP. ACTION (MOD-PRO) STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
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MODEL RUN SCENARIO SUMMARY

Scenario Requested By: Agency Name Scenario Requested On: Date
Scenario Generated By: Rio Applied Science and Engineering Scenario Generated On: 7/6/19 3:24 PM

Weight Fish Species (Yes/No): No Select if weights will be applied to each species when they are combined.

	Bull trout and Cutthroat	Chinook Salmon/ Steelhead
Weighting Factor	NA	NA

Use Occupancy Models as Weighting No If selected No, this element will act as an element, if selected Yes FU will be weighted by a value from 0-1 based on occupancy suitability
 Use Critical Habitat as a on/off control No If selected No, Critical Habitat will act as an element, if selected Yes only areas with Critical Habitat will be evaluated
 Use Presence/ Absence as an on/off control No If selected No, Presence/ Absence will act as an element, if selected Yes only areas with fish Present will be evaluated
 Analyze Jurisdictional Waters Only No If selected No, both jurisdictional and non-jurisdictional reaches will be analyzed, if selected Yes only designated jurisdictional reaches will be analyzed

3 WATERSHED CONDITION INDICATORS RESULTS SCORING CRITERIA

Notes

WCI Average Significant Digits¹: 1 Rounds WCI Scoring Criteria to either a whole number or allows decimals where multiple criteria are utilized.

Notes:
1. WCI Average Significant Digits are applicable to temperature where percent of time temperature falls into each category is applied to FA, FR, UR and then averaged to one functional index value per life stage and then averaged to one species. The significant digits also affect the rounding of this final average WCI score to a whole number or a fraction of a number. Also where one criteria is averaged over multiple reaches, the average of these reaches can be shown as a whole number or a fraction of a number.

4 STREAM TYPE EVALUATED

Stream Type Evaluated: Both Perennial and Non-Perennial

RESULTS

Stream Functional Assessment Summary for the Stibnite Gold Project

	End of Mine Year																												
	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	FR
Stream Length (ft)	247558	247695	247201	235305	235220	240394	240394	240394	240394	240394	240394	240394	236078	236078	236078	238738	238728	238728	237607	237607	243858	243858	243858	243858	243858	243472	243472	243472	243472
Functional Index	0.69	0.68	0.66	0.67	0.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.69	0.69	0.69	0.69	0.71	0.71	0.71	0.71	0.72
Stream Functional Units	408781	399230	377853	377211	377303	376326	375983	375869	376003	376119	374576	375100	377641	377775	377815	389140	389744	389841	388675	388531	412017	412342	412277	412664	429148	429848	430034	430519	436465
Stream Length % Variation from Baseline	0%	0%	0%	-5%	-5%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-5%	-5%	-5%	-4%	-4%	-4%	-4%	-4%	-1%	-1%	-1%	-1%	-1%	-2%	-2%	-2%	-2%
Functional Index % Variation from Baseline	0%	-2%	-5%	-4%	-3%	-4%	-4%	-4%	-4%	-4%	-5%	-5%	-4%	-4%	-4%	-2%	-2%	-2%	-2%	-2%	-1%	0%	0%	0%	3%	3%	3%	4%	5%
Stream Functional Units % Variation from Baseline	0%	-2%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-5%	-5%	-5%	-5%	-5%	1%	1%	1%	1%	5%	5%	5%	5%	7%
Stream Functional Units from Baseline	0	-9552	-30928	-31570	-31478	-32456	-32799	-32913	-32779	-32662	-34206	-33682	-31141	-31007	-30966	-19641	-19037	-18940	-20106	-20250	3236	3561	3496	3883	20367	21067	21253	21738	27684
Cumulative Variation in Functional Units	0	-9552	-40480	-72050	-103528	-135983	-168782	-201694	-234473	-267135	-301340	-335022	-366162	-397169	-428135	-447776	-466813	-485753	-505859	-526109	-522873	-519312	-515816	-511933	-491566	-470500	-449247	-427509	



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 2: MODIFIED PROP. ACTION (MOD-PRO) STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



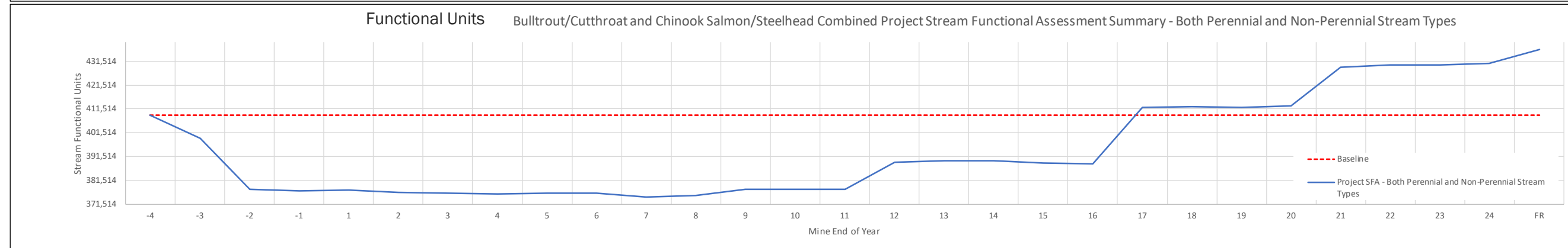
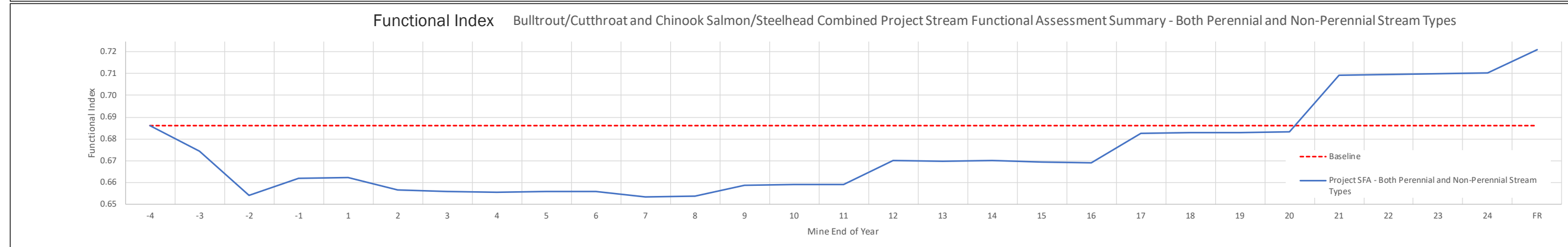
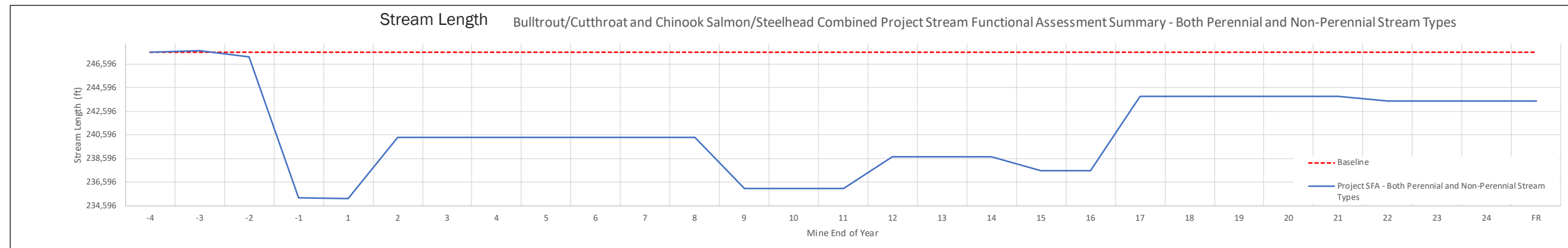
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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/6/19 3:24 PM



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 3: ALTERNATIVE EFSFSR TSF LOCATION STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



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VERSION - 7/8/2019

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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/5/19 2:07 PM

GIVENS

		Notes
Evaluation Period Begins at End of Year (EOY):	-4	Evaluation begins at EOY -4 (baseline conditions one year before pre-production work)
Final Year of Mine Operations and Restoration:	24	Mine operations and restoration extend through EOY 24 (end of restoration)
Year Evaluated Following Full Closure:	Fully Restored	Stream Functional Assessment is also evaluated at an approximated Fully Restored condition
Functioning Good (FG)	3	Value given to each element that is functioning good.
Functioning Fair (FF)	2	Value given to each element that is functioning fair.
Functioning Low (FL)	1	Value given to each element that is functioning low.

INPUTS

1 GENERAL INPUTS

		Notes
Allow Passage Through Tunnel (Yes/No):	Yes	Allowing fish passage upstream of existing Yellow Pine via tunnel.
If Yes, EOY Passage is Allowed:	-1	If passage is allowed upstream, identify the EOY passage is allowed.
Evaluate Barrier Types:	Human	Either human-caused barriers or both human-caused and natural barriers evaluated.
Species of Interest:	All Species	Either bull trout and cutthroat (BT and CT) or Chinook Salmon and steelhead (CH and ST), or CH, ST, BT, CT or an average of all species (All Species)
Minimum Number of Elements Required to Score:	5	Minimum number of indicators required to utilize indicators, otherwise uses default WCI score identified below.
Default WCI Score:	Average 2.049 ; 2.091	Default WCI score where there is no data or too little data to apply true WCI scores per reach. Baseline Average (BT/CT ; CH/ST)

2 WEIGHTING OPTIONS

		Notes
Weight Perennial Streams vs Non-Perennial Streams (Yes/No):	No	Select if you want to apply a weighting factor to differentiate between perennial and Non-Perennial channels.
If Yes, Select Weight for Perennial:	NA	Input a weighting factor to apply to perennial streams.
Weight Streams Based on Stream Order (Yes/No):	Yes	Select if you want to weight streams based on their stream order (SO) (Non-Perennial streams have a SO of 0 so weight is SO+1).
Weight Watershed Condition Indicators (Yes/No):	Yes	Select if you want to individually weight WCI or have them all equal.
If Yes, Use Survivorship Weights:	No	These WCI weighting factors assign weights based on fish survivorship.

	Water Quality			Habitat Access	Habitat Elements					Channel Conditions and Dynamics			Flow and Hydrology		Watershed Conditions			Fish Factors		
	Temperature	Fine Sediment	Chemical Contaminants	Physical Barriers	Substrate Embeddedness	Large Woody Debris	Pool Frequency	Pool Quality	Off-Channel Habitat	Width/Depth Ratio	Streambank Condition	Floodplain Connectivity	Change in Peak/Base Flows	Drainage Network	Road Density and Location	Riparian Conservation Areas	Disturbance History	Occupancy Model/ Intrinsic Potential	Critical Habitat	Presence/ Absence
Weighting Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0

Weight Fish Life Stage for Temp Evaluation (Yes/No): No Select if you want to weight life stage or have them all equal.

	Bull Trout and Cutthroat		Chinook Salmon/ Steelhead	
	Rearing	Spawning	Rearing	Spawning
Weighting Factor	NA	NA	NA	NA



STIBNITE GOLD PROJECT MITIGATION PROGRAM

ALTERNATIVE 3: ALTERNATIVE EFSFSR TSF LOCATION STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
 Prepared by Rio Applied Science and Engineering
 Version Date: 7/8/2019



SFA LEDGER
VERSION - 7/8/2019

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MODEL RUN SCENARIO SUMMARY

Scenario Requested By: Agency Name Scenario Requested On: Date
 Scenario Generated By: Rio Applied Science and Engineering Scenario Generated On: 7/9/19 1:02 PM

Weight Fish Species (Yes/No): No Select if weights will be applied to each species when they are combined.

	Bull trout and Cutthroat	Chinook Salmon/ Steelhead
Weighting Factor	NA	NA

Use Occupancy Models as Weighting No If selected No, this element will act as an element, if selected Yes FU will be weighted by a value from 0-1 based on occupancy suitability
 Use Critical Habitat as a on/off control No If selected No, Critical Habitat will act as an element, if selected Yes only areas with Critical Habitat will be evaluated
 Use Presence/ Absence as an on/off control No If selected No, Presence/ Absence will act as an element, if selected Yes only areas with fish Present will be evaluated
 Analyze Jurisdictional Waters Only No If selected No, both jurisdictional and non-jurisdictional reaches will be analyzed, if selected Yes only designated jurisdictional reaches will be analyzed

3 WATERSHED CONDITION INDICATORS RESULTS SCORING CRITERIA

WCI Average Significant Digits¹: 1 **Notes** Rounds WCI Scoring Criteria to either a whole number or allows decimals where multiple criteria are utilized.

Notes:
 1. WCI Average Significant Digits are applicable to temperature where percent of time temperature falls into each category is applied to FA, FR, UR and then averaged to one functional index value per life stage and then averaged to one species. The significant digits also affect the rounding of this final average WCI score to a whole number or a fraction of a number. Also where one criteria is averaged over multiple reaches, the average of these reaches can be shown as a whole number or a fraction of a number.

4 STREAM TYPE EVALUATED

Stream Type Evaluated: Both Perennial and Non-Perennial

RESULTS

Stream Functional Assessment Summary for the Stibnite Gold Project

	End of Mine Year																												
	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	FR
Stream Length (ft)	247558	249100	255808	240470	240385	245560	245560	245560	245560	245560	245477	241161	241161	241161	246659	246748	246748	245627	245627	234084	234084	234084	234084	234084	233668	233668	233025	233025	
Functional Index	0.69	0.67	0.63	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.62	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.65	0.65	0.65	0.65	0.68	0.68	0.68	0.68	0.69	
Stream Functional Units	408781	391682	375233	364451	365211	364600	363216	363088	363437	362711	362394	362959	365123	364462	364323	378725	375301	375451	374420	375852	380135	381859	381799	381689	399399	402328	403066	402418	408271
Stream Length % Variation from Baseline	0%	1%	3%	-3%	-3%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-3%	-3%	-3%	0%	0%	0%	-1%	-1%	-5%	-5%	-5%	-5%	-5%	-6%	-6%	-6%	-6%
Functional Index % Variation from Baseline	0%	-3%	-8%	-9%	-9%	-9%	-10%	-10%	-10%	-10%	-10%	-10%	-9%	-9%	-9%	-8%	-9%	-9%	-9%	-9%	-6%	-6%	-6%	-6%	-2%	-1%	-1%	-1%	0%
Stream Functional Units % Variation from Baseline	0%	-4%	-8%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-7%	-8%	-8%	-8%	-8%	-7%	-7%	-7%	-7%	-2%	-2%	-1%	-2%	0%
Stream Functional Units from Baseline	0	-17099	-33548	-44330	-43571	-44182	-45565	-45693	-45344	-46070	-46388	-45822	-43659	-44320	-44459	-30056	-33481	-33331	-34361	-32929	-28646	-26923	-26983	-27092	-9382	-6454	-5716	-6363	-511
Cumulative Variation in Functional Units	0	-17099	-50647	-94977	-138548	-182729	-228294	-273987	-319331	-365401	-411789	-457611	-501269	-545589	-590047	-620103	-653584	-686914	-721275	-754204	-782850	-809773	-836755	-863847	-873229	-879683	-885398	-891761	



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 3: ALTERNATIVE EFSFSR TSF LOCATION STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



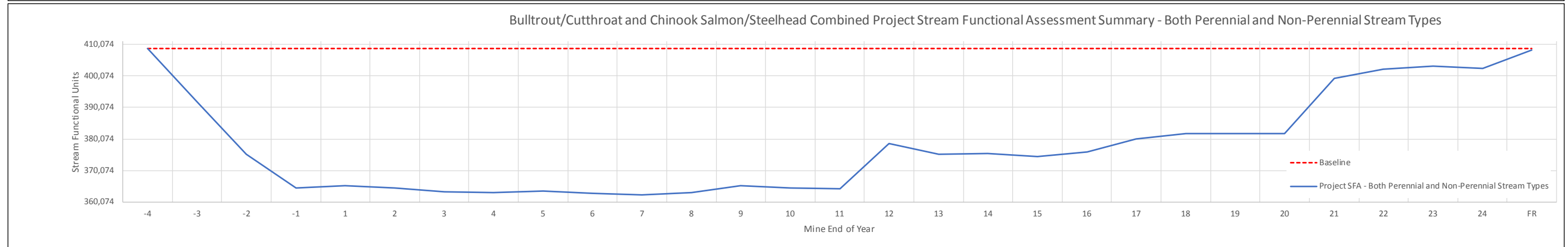
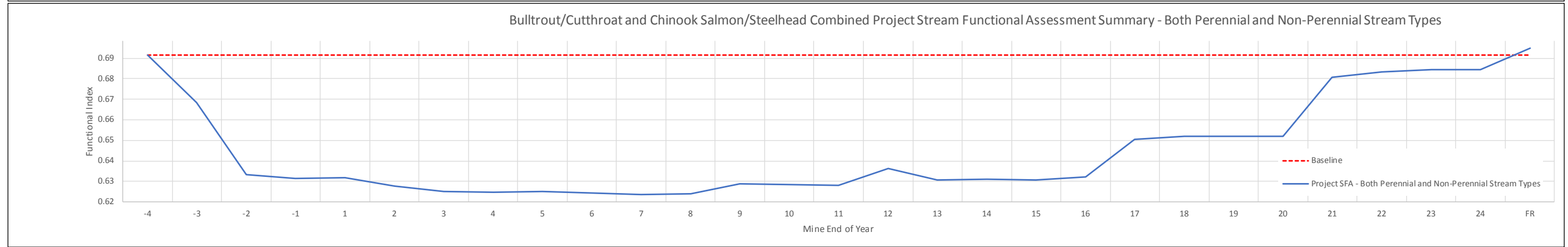
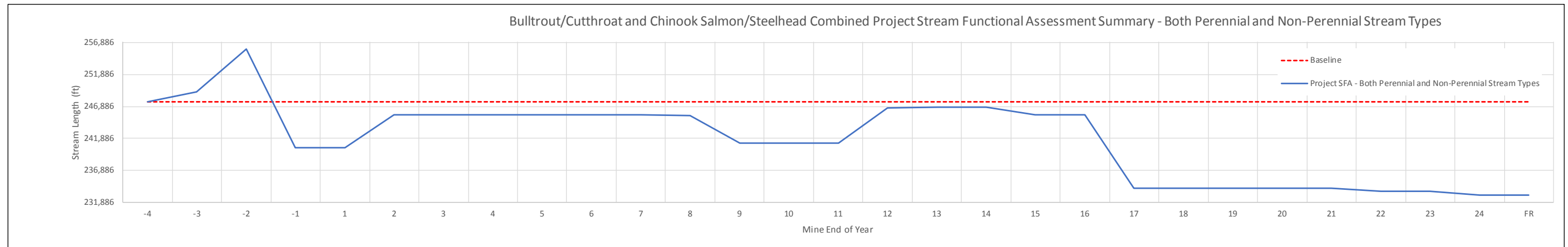
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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/9/19 1:02 PM



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 4: STIBNITE ACCESS ROUTE STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/5/19 2:09 PM

GIVENS

		Notes
Evaluation Period Begins at End of Year (EOY):	-4	Evaluation begins at EOY -4 (baseline conditions one year before pre-production work)
Final Year of Mine Operations and Restoration:	24	Mine operations and restoration extend through EOY 24 (end of restoration)
Year Evaluated Following Full Closure:	Fully Restored	Stream Functional Assessment is also evaluated at an approximated Fully Restored condition
Functioning Good (FG)	3	Value given to each element that is functioning good.
Functioning Fair (FF)	2	Value given to each element that is functioning fair.
Functioning Low (FL)	1	Value given to each element that is functioning low.

INPUTS

1 GENERAL INPUTS

		Notes
Allow Passage Through Tunnel (Yes/No):	Yes	Allowing fish passage upstream of existing Yellow Pine via tunnel.
If Yes, EOY Passage is Allowed:	-1	If passage is allowed upstream, identify the EOY passage is allowed.
Evaluate Barrier Types:	Human	Either human-caused barriers or both human-caused and natural barriers evaluated.
Species of Interest:	All Species	Either bull trout and cutthroat (BT and CT) or Chinook Salmon and steelhead (CH and ST), or CH, ST, BT, CT or an average of all species (All Species)
Minimum Number of Elements Required to Score:	5	Minimum number of indicators required to utilize indicators, otherwise uses default WCI score identified below.
Default WCI Score:	Average	Default WCI score where there is no data or too little data to apply true WCI scores per reach.
	2.049 ; 2.091	Baseline Average (BT/CT ; CH/ST)

2 WEIGHTING OPTIONS

		Notes
Weight Perennial Streams vs Non-Perennial Streams (Yes/No):	No	Select if you want to apply a weighting factor to differentiate between perennial and Non-Perennial channels.
If Yes, Select Weight for Perennial:	NA	Input a weighting factor to apply to perennial streams.
Weight Streams Based on Stream Order (Yes/No):	Yes	Select if you want to weight streams based on their stream order (SO) (Non-Perennial streams have a SO of 0 so weight is SO+1).
Weight Watershed Condition Indicators (Yes/No):	Yes	Select if you want to individually weight WCI or have them all equal.
If Yes, Use Survivorship Weights:	No	These WCI weighting factors assign weights based on fish survivorship.

	Water Quality			Habitat Access	Habitat Elements					Channel Conditions and Dynamics			Flow and Hydrology		Watershed Conditions			Fish Factors		
	Temperature	Fine Sediment	Chemical Contaminants	Physical Barriers	Substrate Embeddedness	Large Woody Debris	Pool Frequency	Pool Quality	Off-Channel Habitat	Width/Depth Ratio	Streambank Condition	Floodplain Connectivity	Change in Peak/Base Flows	Drainage Network	Road Density and Location	Riparian Conservation Areas	Disturbance History	Occupancy Model/Intrinsic Potential	Critical Habitat	Presence/Absence
Weighting Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0

Weight Fish Life Stage for Temp Evaluation (Yes/No): **No** Select if you want to weight life stage or have them all equal.

	Bull Trout and Cutthroat		Chinook Salmon/ Steelhead	
	Rearing	Spawning	Rearing	Spawning
Weighting Factor	NA	NA	NA	NA



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 4: STIBNITE ACCESS ROUTE STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



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MODEL RUN SCENARIO SUMMARY

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Scenario Generated By: Rio Applied Science and Engineering Scenario Generated On: 7/5/19 2:09 PM

Weight Fish Species (Yes/No): No Select if weights will be applied to each species when they are combined.

	Bull trout and Cutthroat	Chinook Salmon/ Steelhead
Weighting Factor	NA	NA

Use Occupancy Models as Weighting No If selected No, this element will act as an element, if selected Yes FU will be weighted by a value from 0-1 based on occupancy suitability
 Use Critical Habitat as a on/off control No If selected No, Critical Habitat will act as an element, if selected Yes only areas with Critical Habitat will be evaluated
 Use Presence/ Absence as an on/off control No If selected No, Presence/ Absence will act as an element, if selected Yes only areas with fish Present will be evaluated
 Analyze Jurisdictional Waters Only No If selected No, both jurisdictional and non-jurisdictional reaches will be analyzed, if selected Yes only designated jurisdictional reaches will be analyzed

3 WATERSHED CONDITION INDICATORS RESULTS SCORING CRITERIA

Notes

WCI Average Significant Digits¹: 1 Rounds WCI Scoring Criteria to either a whole number or allows decimals where multiple criteria are utilized.

Notes:
1. WCI Average Significant Digits are applicable to temperature where percent of time temperature falls into each category is applied to FA, FR, UR and then averaged to one functional index value per life stage and then averaged to one species. The significant digits also affect the rounding of this final average WCI score to a whole number or a fraction of a number. Also where one criteria is averaged over multiple reaches, the average of these reaches can be shown as a whole number or a fraction of a number.

4 STREAM TYPE EVALUATED

Stream Type Evaluated: Both Perennial and Non-Perennial

RESULTS

Stream Functional Assessment Summary for the Stibnite Gold Project

	End of Mine Year																												
	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	FR
Stream Length (ft)	247558	247695	247201	231864	231779	236953	236953	236953	236953	236953	236953	236871	232555	232555	232555	238053	238142	238142	237020	237020	243272	243272	243272	243272	243272	242856	242856	242856	242856
Functional Index	0.69	0.67	0.65	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.66	0.66	0.67	0.67	0.67	0.68	0.67	0.67	0.67	0.67	0.69	0.69	0.69	0.69	0.71	0.72	0.72	0.72	0.73
Stream Functional Units	408781	395905	376371	374637	375812	374968	374390	374584	374707	374827	372678	374010	376443	375951	375820	389707	386781	386804	386334	386473	410156	413789	413946	415968	430442	433109	433643	434218	439582
Stream Length % Variation from Baseline	0%	0%	0%	-6%	-6%	-4%	-4%	-4%	-4%	-4%	-4%	-4%	-6%	-6%	-6%	-4%	-4%	-4%	-4%	-4%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Functional Index % Variation from Baseline	0%	-2%	-5%	-3%	-3%	-3%	-4%	-3%	-3%	-3%	-4%	-4%	-3%	-3%	-3%	-2%	-2%	-2%	-2%	-2%	0%	0%	0%	0%	3%	4%	4%	4%	5%
Stream Functional Units % Variation from Baseline	0%	-3%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-8%	-9%	-9%	-8%	-8%	-8%	-5%	-5%	-5%	-5%	-5%	0%	1%	1%	2%	5%	6%	6%	6%	8%
Stream Functional Units from Baseline	0	-12876	-32411	-34145	-32970	-33813	-34392	-34198	-34075	-33954	-36104	-34771	-32338	-32830	-32961	-19074	-22000	-21977	-22448	-22309	1375	5008	5165	7187	21661	24328	24862	25437	30801
Cumulative Variation in Functional Units	0	-12876	-45287	-79431	-112401	-146214	-180605	-214803	-248877	-282831	-318935	-353706	-386044	-418874	-451835	-470909	-492909	-514886	-537333	-559642	-558267	-553259	-548095	-540908	-519247	-494919	-470057	-444620	



STIBNITE GOLD PROJECT MITIGATION PROGRAM ALTERNATIVE 4: STIBNITE ACCESS ROUTE STREAM FUNCTIONAL ASSESSMENT LEDGER - RUN SCENARIO SUMMARY

Prepared for Midas Gold Idaho, Inc.
Prepared by Rio Applied Science and Engineering
Version Date: 7/8/2019



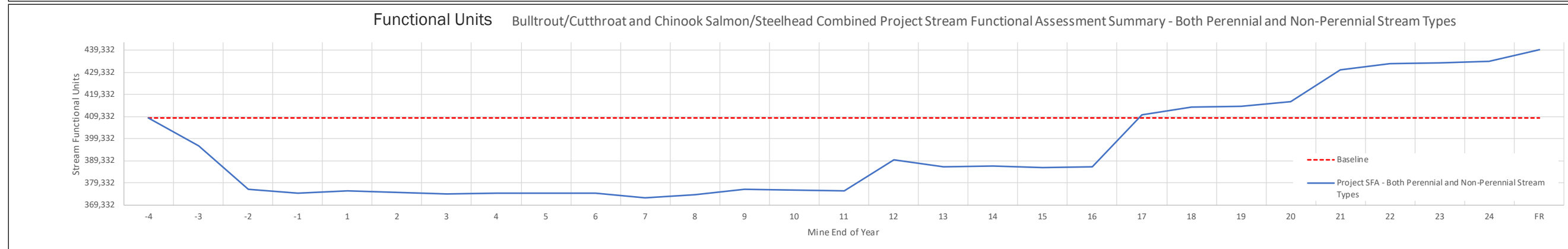
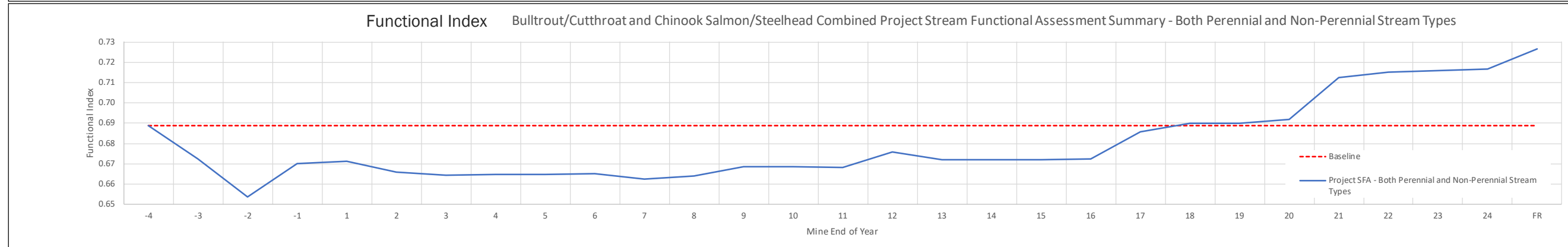
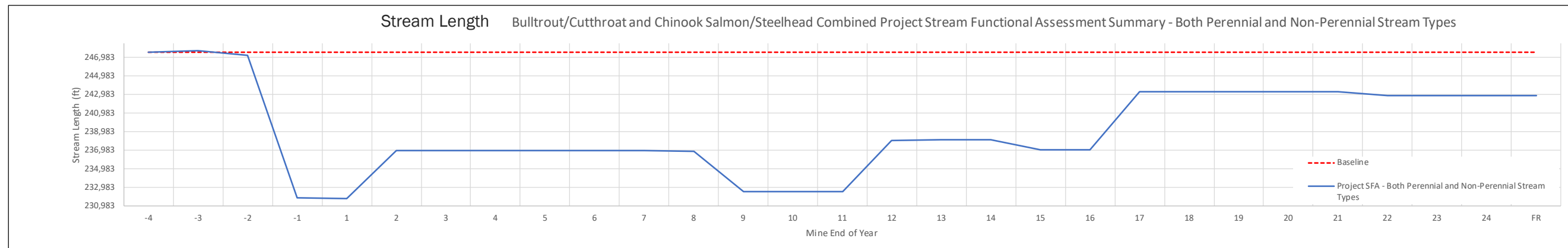
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MODEL RUN SCENARIO SUMMARY

Scenario Requested By:	Agency Name	Scenario Requested On:	Date
Scenario Generated By:	Rio Applied Science and Engineering	Scenario Generated On:	7/5/19 2:09 PM



Section 13: SFA Scoring Rationale Changes

Several changes have been made to the scoring rationale (Appendix B of the Final SFA Report – Rio ASE 2019a). Most changes reflect the addition of new reaches and new versions of the SFA Ledger to accommodate all four alternatives considered in the EIS. A summary of SFA scoring rationale changes is provided below for each alternative.

13.1 Alternative 1

Following is a list of additions and corrections to SFA Appendix B (Rio ASE 2019a):

- New reaches were added to the SFA Ledger to accommodate alternatives. These reaches would be generally unimpacted by Alternative 1 and received default scores as summarized above (Section 8). The added reaches include the following:
 - Upper Blowout Creek (added for Alt 3): BC0.01 and BC0.02
 - Burntlog Route (added for Alt 1, 2, and 3 to separate road crossings of streams in Alt 1, and Alt 2 from streams without road crossings in Alt 3): BL1.1, BL2.1, BL2.2, and BL2.3
 - Burntlog Route (added for Alt 2): new stream segments to BL3 and BL4 to accommodate the 8a alternative.
 - Blowout Creek Road (added for Alt 3): BR1
 - Upper EFSFSR (added for Alt 3): EF0.22, EF0.23, EF0.24, EF0.25
 - Johnson Creek Road (added for Alt 4): JC1
 - Public Access Route (added for Alt 3): PA1
 - Stibnite Road (added for Alt 4): ST1
 - Transmission Line (added for all alternatives – filling previous data gap): TR3
- Baseline LWD recruitment potential for Reach EF2.1 changed from “No” to “Yes” based on aerial photo interpretation that most of the reach is located within a forested area. The LWD recruitment potential does not change as a result of the project in the SFA Ledger for any of the Enhancement Reaches (including Reach EF2.1) during all phases of the project.
- Baseline LWD recruitment potential for Reach MC2 changed from “Yes” to “No” based on aerial photo interpretation that the reach is located within a meadow without large trees within a recruitable distance from the stream.
- Interim Floodplain Connectivity for reaches EF3.2 and EF3.3 (located within the proposed tunnel fishway) changed from an entrenchment ratio of 3.0 to 1.0 based on refined fishway designs and improved understanding of the fishway operations.
- Restored Pool Frequency increased from 21 to 57 pools per mile for Reach MC2 and from 42 to 53 pools per mile for Reach MC4.1 to correct erroneous values from the prior version of SFA Ledger. The refined values reflect the proposed stream design assuming a pool would form at each major meander bend, most of which would also be associated with LWD.
- Fully Restored LWD Recruitment potential for Reach EF3.1 changed from “No” to “Yes” to reflect planting plan for the restored EFSFSR floodplain atop the backfilled Yellow Pine pit. See Section 6.6 for more information.

13.2 Alternative 2

Following is a list of additional and/or changed scoring rationale associated with Alternative 2 (Modified PRO). All rationale are assumed to be the same as Alternative 1 unless stated otherwise below.

- The same SFA stream reaches were evaluated in Alternative 2 as in Alternative 1.
- Temperature, flow, and chemical contaminants modeling results along with changes to passage barriers, were all updated to reflect the proposed conditions in Alternative 2.
- Interim phase diversions around the TSF and DRSFs were modified to include piping of baseflow to reduce temperature impacts (See SPLNT model results [BC 2019]); includes Reaches FC0, FC1, FC2, MC0.7, MC0.8, MC0.9, MC1.1, MC1.4, MC1.5, MC2, MC3, MC4.1, WE2, and WE3.
- Hennessy Creek Reach HC0.1 was modified to flow on the surface north of the proposed EFSFSR bypass channel entering the EFSFSR near the south portal of the tunnel rather than passing into the tunnel directly via a series of boreholes. All habitat elements for this reach were changed to a score of zero for the Interim project phase as discussed above in Section 4.
- West End Reach WE1 is no longer impacted by the project and there are no proposed roads upstream of the reach. This information is tracked on the “Impacts” tab of the SFA Ledger.
- Additional stream crossings were added to Reaches BL3 and BL4 accommodate the 8a alternative Burntlog Route. There are no data for the stream crossings within this area. The SFA Ledger uses the default score to evaluate these new reaches.

13.3 Alternative 3

Following is a list of additional and/or changed scoring rationale associated with Alternative 3 (EFSFSR TSF). All rationale are assumed to be the same as Alternative 1 unless stated otherwise below.

- The same SFA stream reaches were evaluated in Alternative 3 as in Alternative 1.
- All reaches of Blowout Creek and reach BR1 (Blowout Creek access route) were changed on the “Impacts” tab of the SFA Ledger to indicate proposed roads upstream of each reach, and Reach BC0.02 was changed to indicate it would be directly impacted by the alternative. These changes were made to accommodate the access route and worker housing facility where they would be moved from the upper EFSFSR to the Blowout Creek drainage to accommodate the EFSFSR TSF.
- The following reaches were changed on the “Impacts” tab of the SFA Ledger from no direct impact and no roads upstream to impacted with roads upstream to accommodate the EFSFSR TSF: EF0.01, EF0.03, EF0.04, EF0.06, EF2.0, EF2.2, EF2.4, EF2.5, and PA1.
- The following reaches were changed on the “Impacts” tab of the SFA Ledger from no impact with roads upstream to impacted with roads upstream to accommodate the EFSFSR TSF: EF0.07, EF0.10, EF0.11, EF0.12, EF0.13, EF0.14, EF0.15, EF01.7, EF0.18, and EF0.19.
- The following reaches were changed on the “Impacts” tab of the SFA Ledger from impacted with roads upstream to no impact with no roads upstream to accommodate moving the TSF from Meadow Creek to the EFSFSR: MC0.7, MC0.8, MC0.9, MC1.1, MC1.2, MC1.3, MC1.31, MC1.4, MC1.5, MC2, MC3, MC3.1, MC4.1.
- Reach BC0.02 would be modified to flow in a surface diversion around the proposed Blowout Creek worker housing facility. All habitat elements for these perennial reach segments were changed in the SFA Ledger to a score of zero for the Interim project phase as discussed above in Section 4.
- Perennial stream reaches of the EFSFSR and tributaries would be modified to flow in a surface diversion around the proposed EFSFSR TSF. All habitat elements for these perennial reaches were changed to a score of zero for the Interim project phase as discussed above in Section 4. The stream reaches

changed include: EF0.01, EF0.03, EF0.04, EF0.06, EF0.07, EF0.07, EF0.10, EF0.11, EF0.12, EF0.13, EF0.14, EF0.15, EF0.17, EF0.19, EF0.20, EF0.22, EF0.24, and EF0.25.

- For the Interim diversion stream reaches listed in the previous bullet, the Streambank Condition for those reaches with baseline data was changed from matching the baseline condition (Covered/Stable) to the condition of the proposed diversion channel (Uncovered/Stable).
- All Interim and Restored conditions were changed to match baseline conditions for Meadow Creek Reaches above the proposed Hangar Flats pit lake including Reaches: MC0.7, MC0.8, MC0.9, MC1.1, MC1.2, MC1.3, MC1.31, and MC1.4.
- Restored reaches atop the proposed EFSFSR TSF were changed to match conditions reported in Alternative 1 for comparable reaches restored atop the Meadow Creek TSF. Only those stream reaches with data were revised; the default score was used to populate scores for reaches lacking sufficient data to score. Temperature, Chemical Contaminants, Change in Peak/Baseflow, and watershed-scale elements (Drainage Network, Road Density, RCA % Intact, Disturbance History) were updated for all reaches based on modeling results and GIS analysis. Comparable stream reaches included the following:
 - Restored Stream Order 1: EF0.01, EF0.02, EF0.03, EF0.05, EF0.08, EF0.09, EF0.16, EF0.19, EF0.20, EF0.21, EF0.22, EF0.23, EF0.24, EF0.25 = average conditions reported for MC1.1 and MC1.2. Note: none of these EFSFSR reaches had sufficient data to score; all received the default score.
 - Restored Stream Order 2: EF0.04, EF0.06, EF0.10, EF0.11 = average conditions reported for MC1.3, MC1.31, MC1.4. Note: Reach EF0.11 was the only reach with sufficient data to score; the others received the default score.
 - Restored Stream Order 3: EF0.07, EF0.12, EF0.14, EF0.15, EF0.17, EF0.18 = MC1.5. Note: All but EF0.18 had data and received updated scores; EF0.18 received the default score.
 - Boulder Chute down face of DRSF: EF0.15, EF0.17 = MC3

13.4 Alternative 4

Following is a list of additional and/or changed scoring rationale associated with Alternative 4 (Johnson Creek and Stibnite Road access route). All rationale are assumed to be the same as Alternative 1 unless stated otherwise below.

- No changes to scoring rationale were made.

Section 14: Additional Appendix

Much of the rationale for the WCI elements and scoring as applied to the SGP SFA was derived from the USFS LRMP Appendix B (USFS 2003). At the request of the agencies, this document has now been appended to the SFA Report to facilitate review and utilization of the SFA – Included with this Technical Memorandum/Errata as Attachment A.

References

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Attachment A: USFS LRMP Appendix B



**SOUTHWEST IDAHO ECOGROUP MATRIX OF PATHWAYS AND WATERSHED
CONDITION INDICATORS - "THE MATRIX"****Overview Of The Matrix**

The revised Forest Plan management direction (goals, objectives, standards, and guidelines) found in Chapter III of this document replaces direction in the Forest's Land and Resource Management Plan, as amended by Pacfish/Infish, and the 1995 and 1998 Biological Opinions (BOs) for listed fish species. Appendix B was created and tied to direction in Chapter III of this Plan, and it incorporates components of Pacfish/Infish, the 1995 and 1998 Opinions, the Endangered Species Act (ESA), and the Clean Water Act (CWA) important to the Forests long-term Aquatic Conservation Strategy (ACS).

Specifically, Appendix B combines the separate matrices [NMFS (NOAA Fisheries), 8/96; FWS 2/98] identified for use in the 1995 and 1998 BOs. In order to combine the two original matrices, modifications were made to provide consistency and efficiency in application. Within Forest Plan documents, Appendix B may be referred to as Appendix B, the Southwest Idaho Ecogroup Matrix of Pathways and Watershed Condition Indicators, or the "Matrix". The Matrix is the second component of the ACS.

Information and process guidance provided in this Appendix comprise a decision support tool that has been developed to assist land managers in assessing how well management actions designed to implement the Forest Plan move toward related resource goals. Specifically, the Matrix and related Watershed Condition Indicators (WCIs) discussed in this appendix will assist in:

1. Identifying how management actions may potentially influence the condition and trend of soil, water, riparian, and aquatic resources, including native and desired non-native fish.
2. Making ESA Determinations of Effects to Listed Fish Species important to assessing ESA compliance.
3. Identifying how management actions may potentially influence beneficial uses associated with native and desired non-native fish habitat and the importance of that influence to assessing CWA compliance.

The Matrix has been designed for application during project-specific NEPA assessments to assist in project design and analysis. A hierarchical sequence is followed to ascertain which fish species and/or beneficial uses the Matrix is focused on, ensuring the most imperiled fish species or most limiting designated beneficial use is considered first. Project-level analyses are generally conducted at the watershed or subwatershed scale (5th or 6th field hydrologic units or HUs), which are the typical scales at which aquatic and water resource cumulative effects analyses are completed in a project NEPA analysis. Analyses may also be conducted at the subbasin scale (4th field HU) depending on the geographic extent and scope of the proposed action(s), and the scale at which cumulative effects need to be addressed in any project-specific NEPA analysis. The ID team and the appropriate line officer (District Ranger or Forest Supervisor) for each project (i.e., management action) determine the analysis scale(s). Where the action may influence listed fish species directly, indirectly or cumulatively, the line officer should determine the appropriate scale of analysis in conference with the Level 1 streamlining team.

As stated above, Appendix B is referenced within specific Forest-wide objectives, standards, and guidelines related to Forest Plan goals found in two resource sections: (1) Threatened, Endangered, Proposed and Candidate (TEPC) Species, and (2) Soil, Water, Riparian and Aquatic (SWRA) Resources.

Additional objectives, standards, and guideline are included in specific Management Area direction, but are not referenced here.

The direction statements for TEPC Species and SWRA Resources directly or indirectly relate to multiple goals, objectives, standards and guidelines under many resource sections in Chapter III. For example, an action that proposes to revise an allotment management plan would need to comply with all applicable Forest-wide standards and guidelines in Chapter III. For instance, standards such as Rangeland Resources 1 (“Livestock trailing, driving, bedding, watering, and other handling efforts shall be limited to those acres and times that maintain or allow for restoration of beneficial uses and native and desired non-native fish habitat”) and SWRA Resources 1 (“Management actions shall be designed in a manner that maintains or restores water quality to fully support beneficial uses and native and desired non-native fish species and their habitat”) would need to be met before the action could proceed. To assist in determining whether this action will maintain or allow for restoration of beneficial uses and native and desired non-native fish habitat, and meet both standards, the land manager would use the Matrix at the appropriate scale in Appendix B.

Forest-wide Standards SWRA 1 and SWRA 4, along with other protections, are intended to improve aquatic and riparian functions and processes over the life of the Plan. The Matrix can be an important tool in tracking how management actions, over time, are trending “functioning at unacceptable risk” (FUR) and “functioning at risk” (FR) indicators toward a “functioning appropriately” (FA) condition, or are maintaining already FA indicators at multiple scales. How quickly WCIs obtain a FA condition depends on the baseline, the kinds of management actions that are implemented and their effects over time, and the types of natural disturbances that occur.

Not every project, even in a degraded baseline, will be restorative. Some management actions will be proposed in a watershed with a FUR baseline that will result in a temporary or possibly short-term “degrade” in the Matrix. These management actions are appropriate as long as they do not retard the attainment of riparian processes and functions, have measurable long-term ecological benefits, and do not have substantially measurable short-term effects to important subwatersheds or to the overall watershed (5th field HU) scale. If riparian and watershed processes are to be restored over time within watersheds that have a FR or FUR baseline, it is critical that management actions individually and collectively do not further degrade or retard attainment of WCIs. It is also critical that management actions in ACS priority subwatersheds provide some degree of restoration to WCIs at the appropriate temporal and spatial scales if desired conditions are to be achieved. For example, if after ten years management actions in an ACS priority subwatershed have only maintained FUR or FR WCIs, then restoration would not be realized and the intent of the long-term ACS would not be realized.

The Matrix is designed to be applied over a range of analysis scales and account for a variety of environmental conditions. It provides flexibility and allowances for addressing localized information and/or project-specific variability. A certain degree of professional judgment is required and is an essential element for effectively interpreting and applying evaluation results.

It is expected that improvements to the Matrix will occur in the future and periodically result in refinement and updates to the WCI range of values and processes found in this appendix. Improvements may include, but are not limited to, changes to the parameters or indicator values within the various WCIs, additions or deletions of WCIs, or replacement of this Matrix with a different process that meets the same intent through more efficient and effective means.

Description Of The Matrix

Introduction

There are four components/tables in the Matrix (see Figure B-1). Tables B-1, B-2, and B-3 should be used when evaluating actions that would affect SWRA resources, regardless of whether listed fish species would also be affected. Table B-4 should only be used when ESA-listed fish species may be affected.

- Table B-1: Pathways for WCIs, “Reference Conditions”
- Table B-2: Environmental Baseline, “Current Conditions”
- Table B-3: Effects of Management Actions
- Table B-4: Dichotomous Key for Making ESA Determinations of Effect and Documentation of Expected Incidental Take for Listed Fish Species.

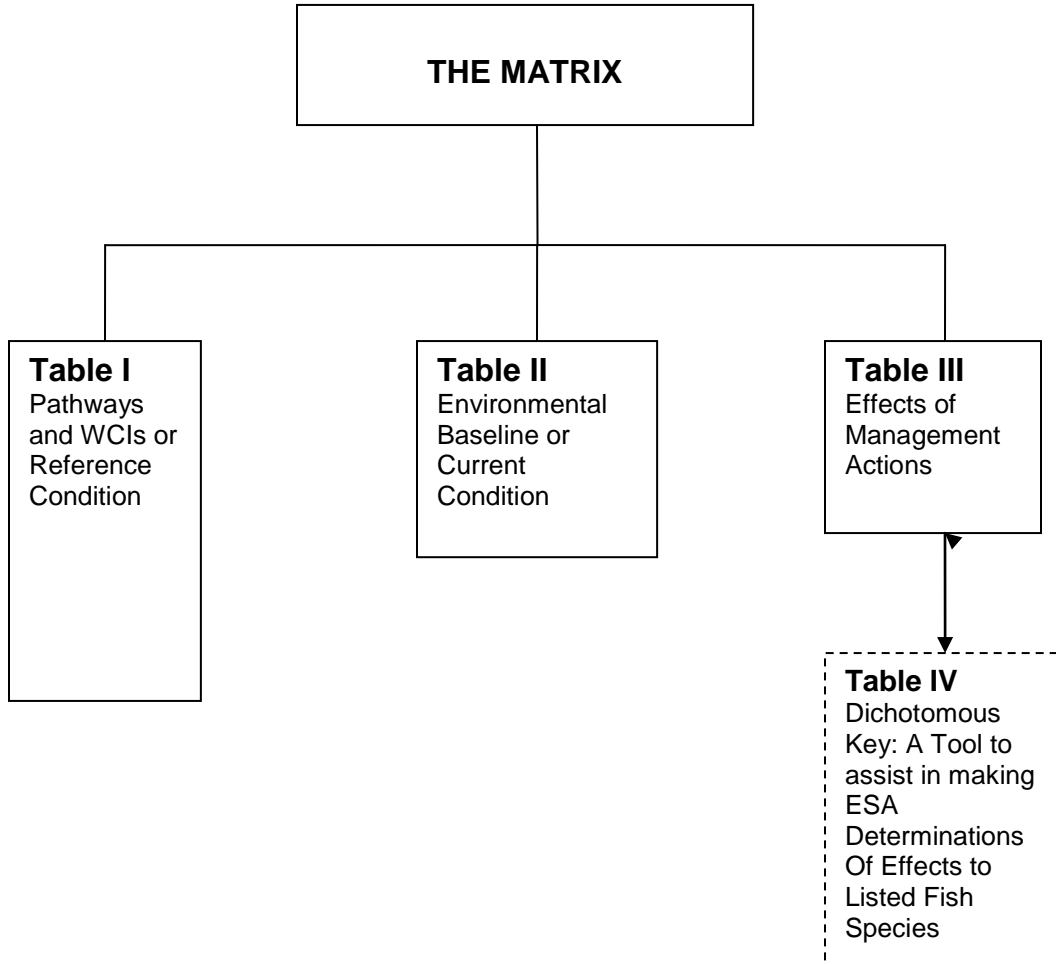
Tables B-1, B-2, and B-3 are divided into 8 overall pathways (major rows). Each of these rows represents a significant pathway by which actions can have potential effects on native and desired non-native fish species, their habitats, and associated beneficial uses. Pathways are further broken down into WCIs. WCIs are described in terms of functionality (Appropriate, At Risk, At Unacceptable Risk). The Functioning Appropriately column represents the desired condition to strive toward for each particular WCI. These WCIs improve upon and update the Riparian Management Objectives identified in Pacfish and Infish. The process outlined later in this Appendix will help land managers determine what the relevant WCIs are that should be considered where proposed management actions are expected to affect beneficial uses, and anadromous, inland native, or desired non-native fish or their habitat.

The evaluation of WCIs provides a consistent and logical line of reasoning to recognize when, where and why adverse, beneficial or no effects may occur to related resources. WCIs are not independent from other components of the aquatic conservation strategy but provide a starting point to describe the current and desired condition for upland watershed condition, water quality, and aquatic habitat. Evaluation procedures consider the suite of WCIs that are likely to be affected by proposed management actions, not just effects to any individual WCI. WCIs are not always sensitive to immediate effects and may instead exhibit response to cumulative effects within subwatersheds over time. In some cases, adverse effects to one WCI in the temporary or short term may be acceptable in order to improve another WCI in the short and/or long term. The duration of an adverse impact that may be allowed in the temporary or short term in order to improve another WCI and provide for long-term benefits will depend on site-specific conditions and resources of concern. Results from the evaluation of WCIs affected by a proposed action can be used to help modify the design of the actions, including mitigating adverse impacts, and developing strategies for restoration of degraded conditions.

The Dichotomous Key included as Table B-4 of this Matrix is used to assist in making ESA effects determinations where effects to listed fish species are likely to occur. It is important to note that use of Table B-4 of this Matrix will not, in itself, result in effects determinations for listed fish species from management actions. The purpose of the Key is to provide indicators as to what the effect is likely to be relative to results from evaluations in Tables B-1, B-2, and B-3. Information obtained from this Matrix should be used in biological assessments to support ESA determinations relative to the potential site-specific effects of the proposed activities evaluated.

Figure B-1. Southwest Idaho Ecogroup Matrix of Pathways and Watershed Condition Indicators

Pathways For Watershed Condition Indicators (WCIs), Environmental Baseline, Effects Of Management Actions, and Dichotomous Key: A Tool To Assist In Making ESA Determinations Of Effects To Listed Fish Species



Appropriate Matrix Scale

The Matrix can be used at several (multi) scales. Riparian functions and ecological processes represented by the Matrix operate at multiple scales, including site, subwatershed, watershed, and subbasin. Similarly, the effects of land management activities on these functions and processes can occur at multiple scales, depending on the scope and magnitude of the action, and the baseline, sensitivity, and watershed recovery trajectory of the affected resources. Assessment of management action effects should address the spatial and temporal scales that are relevant to the proposed action and to the WCIs that would be affected.

The project (i.e., management action) scale will generally be the smallest scale that the Matrix is used. Typically the project scale is equivalent to the 7th or 6th field HU. However, smaller scales (e.g., site) may be appropriate in some cases. If a site is determined to be the appropriate scale to assess, the user should be aware that some indicators (e.g., refugia, disturbance history, road density, etc.) may not be appropriate or relevant and should not be evaluated. If little information is available at the site scale, it may be acceptable to use, and note appropriately, information collected at the 7th or 6th field HU scale as a surrogate for the baseline condition portion of the Matrix. Impacts of the action should be assessed at the actual site scale. Ultimately, the ID team and appropriate line officer for each project should determine the analysis scale(s). Where the action may influence listed fish species directly, indirectly or cumulatively, the line officer should determine the appropriate scale of analysis in conference with the Level 1 streamlining team.

The Matrix may often be prepared at two or more spatial and temporal scales. When an indicator is likely to be degraded (temporary, short term or long term) by the impacts of an action or actions, a second Matrix at the next larger scale should be prepared to evaluate the impacts of the actions to the larger WCIs. Typically this analysis would be completed at the watershed (5th field HU) scale. The larger-scale matrix may also be relevant when assessing the aggregate effects of several actions with “degrade” checkmarks within a watershed during batched and programmatic consultations. Not all indicators or their values may be appropriate at a 4th field scale. For example, pool frequency is a good indicator at the project or subwatershed scale. But at the subbasin scale it may be more appropriate to stratify pool frequency by geomorphic landtypes, or aggregate the total number by local populations to look for landscape patterns. Completion of a 4th field HU (subbasin) Matrix will be uncommon, but, when needed, the user should work with either the Level 1 team or the Continuous Assessment Planning Team (CAP) to develop appropriate indicators and values.

Table B-1: Pathways and WCIs “Reference Conditions”

Table B-1 of the Matrix is similar to “Step 4: Description of Reference Conditions” section for soil, water, riparian and aquatic resources described in *Version 2.2 of the Federal Guide for Ecosystem Analysis at the Watershed Scale* (Regional Interagency Executive Committee 1995). The eight pathways described in this table represent a suite of ecological indicators identified as WCIs. The reference condition values of ecological indicators, or WCIs, found in Table B-1 are diagnostic tools to assist in comparing and evaluating current SWRA watershed conditions to be described in Table B-1I. The WCI values provided in Table B-1 were largely taken from the original matrices tied to the 1998 BOs for steelhead and bull trout. These values are considered the default values that should be used, unless better subwatershed or project-specific information is available to update these values (refer to the “How to Modify this Matrix” section in this appendix).

The WCIs are generally arranged from a finer to a broader scale. For example, under the pathway “Habitat Elements,” the WCIs refer to information from the channel unit level (substrate); to the stream reach level (large woody debris, pool frequency and quality/large pools), to the valley segment (off-channel habitat), and finally the complete watershed (refugia). Definitions for the WCIs are found at the end of this appendix.

Units of measure specific to each WCI are provided, followed by functionality definitions for each WCI that are represented as ranges within their respective units of measurement. There are three functional condition levels identified for each WCI: (1) “functioning appropriately, or FA,” (2) “functioning at risk, or FR,” and (3) “functioning at unacceptable risk, or FUR.”

The quantitative and qualitative default WCI values provided are not intended to be absolute values that precisely define desired conditions or to define data standards. The values and descriptions are a diagnostic tool to promote discussions and evaluations of the environmental functional relationships specific to the watershed being considered for management actions. WCIs are criteria to assist in

evaluating progress towards an attainment of SWRA goals. They do not replace state and federal water quality standards under the Clean Water Act or state laws, nor do they make determination of effects for proposed management actions under ESA. However, WCIs do address several important objectives of the Clean Water Act by determining whether designated beneficial uses are attainable and to what degree these uses are supported (Bauer and Ralph 1999). WCIs complement existing laws and standards by providing measurable criteria for water quality and aquatic habitat.

If local data relating to a specific WCI are not available for comparison and verification, then proposed management actions should be designed to minimize adverse impacts to the WCI based on the default value provided in Table B-1. If local data are available to help define a more site- or watershed-specific WCI value, follow procedures in the “How to Modify the Matrix” section to document the basis for the change. Likewise, if a default WCI value is not functionally attainable given the inherent characteristics of the watershed being considered, follow procedures outlined in the “How to Modify the Matrix” section to document the basis for varying from the default WCI value provided.

Table B-2: Environmental Baseline “Current Conditions”

Table B-2 of the Matrix is similar to “Step 3: Description of Current Conditions” section for soil, water, riparian and aquatic resources described in *Version 2.2 of the Federal Guide for Ecosystem Analysis at the Watershed Scale* (Regional Interagency Executive Committee 1995). Completion of Table B-2 also provides the supporting documentation and rationale for the evaluations and determinations of the environmental baseline condition included in a watershed or project- specific NEPA analysis. The environmental baseline, or current condition, can be assessed at multiple spatial scales; typically at the project scale representing a 7th or 6th field HU. The baseline can be recorded at larger scales (e.g., 5th or 4th field HUs) to address cumulative effects of a proposed management action or actions. When evaluating the baseline condition, all landownerships should be included at the relevant spatial scale for which the Matrix is completed.

The current condition of each WCI is represented as falling within its respective functionality class as described in Table I, including any refinements to the default values for that class. Thus, this evaluation documents whether a WCI is “functioning appropriately”, “functioning at risk” or “functioning at unacceptable risk”. The units of measure for WCIs are generally reported in one of two ways: (1) quantitative metrics that have associated numeric values (for example, “large woody debris: > 20 pieces per mile”); or (2) qualitative descriptions based on field reviews, professional judgment, etc., (e.g., “physical barriers: man-made barriers present”). Different approaches are needed because numeric data are not always readily available for every WCI, or there are no reliable numeric values. In such cases, a qualitative description of overall functionality may be the only appropriate method to describe the value. Ideally, the baseline condition determination is based on site measurements, but if data are not available another form of measurement and/or professional judgment must be applied. It is not anticipated that new field surveys would be required for every project. The level of information collected should be commensurate with the scope and scale of project being proposed. Those projects that have a greater chance of causing negative effects in subwatersheds with no to little baseline information should conduct the appropriate level of field surveys to support the decision.

When documenting the baseline condition in the Matrix the rationale for that condition must be supported with a quantitative and/or narrative description. Biologists are encouraged to reference this rationale by citing existing documentation, such as NEPA analyses, whenever possible. When professional judgment is required to document the existing condition, a “PJ” for professional judgment should be included next to the indicator in the baseline column in Table B-2. For example, if pool frequency is believed to be “functioning at risk”, a FR – PJ should be noted. Other data sources should also be noted according to the following criteria: WA - Watershed Analysis; NEPA – CE, EA or EIS; SR – Surveys; M – Monitoring; FR – Field Reviews; O – Other.

The suite of relevant WCIs, considered together, encompasses the environmental baseline or current condition for the subwatershed and associated aquatic resources. The user must realize not every indicator may be relevant to every area assessed. For example, indicators specific only to bull trout (e.g., life history, genetic characteristics, etc.) would not be completed if bull trout were currently or historically absent in the assessment area. In these situations a “not applicable” should be recorded under the desired and existing condition columns.

In most cases, the “Functioning Appropriately” values in Table B-1 will be displayed in the desired condition column in Table B-2. However, as described in the “*How to Modify the Matrix*” section, WCIs can be refined to better reflect conditions that are functionally attainable in a specific subwatershed or stream reach based on local geology, land and channel form, climate, and potential vegetation. If WCI values are modified, then the referenced value or its range should be included in the desired condition column with a footnote listing what process was used.

Table B-3: Effects of Management Actions

Table B-3 of the Matrix is the assessment of potential impacts of the action. The Matrix provides a synthesis of the collective effects of a proposed or ongoing action(s) on WCIs. This information and evaluation will assist the land manager in determining if native and desired non-native fish habitat important to fish populations will be sustained, and if water and aquatic resource beneficial uses identified by the State will continue to be supported.

The effects of management actions described in Table B-3 are represented as a change in the functionality of the WCI(s) that would likely result from proposed or ongoing management actions. Effects are identified on the basis of the amount of restoration or degradation for each WCI. Table B-3: Effects of Management Actions is designed to be used in conjunction with both Table I: Pathways and WCIs, and Table II: Environmental Baseline. Together they document the effects on a WCI in terms of being “restored”, “maintained”, “degraded”, or “not applicable”. A positive, negative, or “no” trend is then noted for three time periods (temporary, short term, and long term) for that particular WCI. A brief narrative or reference to an existing NEPA document is included in the Matrix. As with baseline conditions, each action impact in the Matrix must be supported with a quantitative and/or narrative description. Users must remember that the Matrix is merely a tool to summarize the NEPA analysis. A thorough description of how an action affects WCIs, at different spatial and temporal scales, in NEPA analysis is critical. All terms are defined in the Glossary of this appendix.

The suite of WCIs must be considered together, both those affected by a proposal and those not affected, in order to fully describe the condition and trend of the subwatershed and associated aquatic resources and designated beneficial uses that would result from implementation of a proposed management action or continuation of ongoing actions. Completion of Table B-3 provides supporting documentation and rationale for the evaluations and determinations of effects included in biological assessments and/or project-specific NEPA analyses. When Table B-3 is completed to support findings in a biological assessment or project-specific NEPA analysis, it should be appropriately referenced within the body of the document.

In some cases it may be appropriate to note both short-term impacts and long-term benefits in the Matrix at the project or subwatershed scales. When this is needed, a “degrade” and “restore” would be recorded in the Effects column, and the appropriate temporal scale would be indicated.

Table B-4: Description of Dichotomous Key for Making ESA Determinations of Effect and Documentation of Expected Incidental Take for Listed Fish Species

The Dichotomous Key for Making Determinations of Effect is the fourth component of the Matrix. It is specifically designed to aid in the determination of effects relative to proposed management actions that **require** a Section 7 consultation or conference, or a permit under Section 10 of the ESA. Evaluations

that use the Dichotomous Key draw from information generated in Tables B-1, B-2, and B-3, including any modifications to WCIs completed through procedures that incorporate better subwatershed or site-specific data that are available. The findings from evaluations using the Dichotomous Key are used to help make related ESA determinations of effect.

Table B-4 was not designed to be used to aid in the determination of effects for proposed management actions that **do not require** a Section 7 consultation or conference of the ESA.

How And When To Use The Matrix

The Matrix has been developed to help design, and estimate the effects of, management actions to WCIs used as indicators of soil, hydrologic, water quality, riparian and aquatic resource conditions within the subwatershed, as well as to ESA-listed fish species where applicable. A Matrix can be completed for one action or a set of actions specific to a particular spatial and temporal scale. To determine when the Matrix should be used and which tables should be completed, use the following criteria:

1. Management actions will have no effect on listed species and WCIs will be maintained.
2. Management actions **WILL** result in quantifiably measurable, or clearly defined qualitative, negative effects (temporary, short term, or long term) on WCIs, and the proposed management action **does not require** a Section 7 consultation or conference of the ESA. **COMPLETE MATRIX TABLES B-1, B-2, and B-3 only.**
3. Management actions **WILL** result in small effects, beneficial effects, or quantifiably measurable, or clearly defined qualitative, negative effects (temporary, short term, or long term) on WCIs and the proposed management actions **require** a Section 7 consultation or conference of the ESA. **COMPLETE ALL MATRIX TABLES.**

If it is determined that all or some of the tables in the Matrix should be completed, use the following criteria to determine which aquatic species or water quality beneficial use evaluations the Matrix user should focus on:

1. If the watershed has ESA-listed fish species, sensitive fish species, and non-listed fish species, the Matrix for the ESA-listed species should be completed.
2. If the watershed has sensitive fish species and non-listed fish species, but no ESA-listed species, use the Matrix for sensitive species, with modified parameters (or criteria) for the WCIs appropriate for those species.
3. If there are only non-listed and non-sensitive fish species in the watershed, use the Matrix for native, or desired non-native fish species, with modified parameters (or criteria) for the WCIs appropriate for those species and associated beneficial uses.
4. If there is a TMDL or 303(d) listed water quality limited water body, and the management action may have impacts on the WCI value(s) for which it was listed, and only non-listed and non-sensitive aquatic species are present, use the Matrix for native or desired non-native fish species, with modified parameters (or criteria) for the WCIs appropriate for those species and associated beneficial uses.

Table B-2 linkage to Table B-1

For each project area, determine the environmental baseline by describing the conditions for the WCIs listed under the pathways that may be affected by the management action against the reference condition for the WCI described in Table I. This will result in each WCI in Table II being classified as either: “Functioning Appropriately” (FA), “Functioning at Risk” (FR), or “Functioning at Unacceptable Risk” (FUR). It is preferred that the WCI values used to determine FA, FR and FUR be based on local data collected over time that either validates the default value or refines the value to better reflect local conditions following procedures as described in the “*How to Modify the Matrix*” section, below. If local data are lacking, consider the biophysical characteristics of the subwatershed when determining functionality categories, and use local databases and/or related literature to discern the most appropriate WCI values for the Matrix.

Table B-3 linkage to Table B-2

Use Table B-3 to evaluate the expected effects of management actions (or groups of actions) on the WCIs by comparing the expected effects on the WCIs against the environmental baseline in Table B-2. Where conditions are FR or FUR, actions that affect WCIs that are not fully functioning will not retard attainment of WCIs unless to meet the exceptions in SWRA Standard 4. For example, management actions that have temporary or short-term effects can still be consistent with Forest-wide TEPC and SWRA objectives, standards, and guidelines if they do not retard the attainment of riparian processes and functions, have significant long-term benefits, and do not have significant short-term effects to important subwatersheds or to the overall watershed scale. Actions that have long-term impacts to important subwatershed and/or watershed-scale processes would likely prevent the attainment of WCIs and be inconsistent with Forest Plan direction. Where conditions are FA, the action(s) should be designed to maintain those conditions in the short and long term.

It is important to understand that all effects are not the same just because they may occur within the same temporary, short-term, or long-term time period. The duration or repetition of an effect within that time period can vary greatly, as can the intensity, location, or type of effect. The Matrix allows Forest personnel the flexibility to determine these differences during project-level analysis and provides a means to display if the temporary, short-term, or long-term effect has a positive, negative, or no trend. If WCIs within a pathway are not evaluated in Table B-2 or B-3, documentation describing why they were not evaluated should be included in the project record.

Table B-4 linkage to Tables B-2 and B-3

Use evaluations in Tables B-2 and B-3 to answer the questions in the dichotomous key contained in Table B-4. Written documentation of rationale and logic substantiating answers to questions generated through interdisciplinary and Section 7 consultation or conference discussions should be included in the project record and used to support determinations reached in biological assessments and NEPA documents.

Examples Describing the Use of the Matrix

The following are some brief examples to assist in describing the intended use of the Matrix.

Example 1 - Thinning and prescribed fire are proposed as vegetation treatments over a large portion of a 6th field HU. Current large woody debris (LWD) frequency is 10 pieces per mile, below the FA value of >20. Assuming the values for a FA call are appropriate for the geoclimatic setting, the proposed activity should be designed in such a way that desired conditions would be reached and lead to attainment of Functioning Appropriately conditions over the long term. At the stream reach level, site-specific project design features to promote FA conditions might include increased RCA widths, adjustment of the treatment unit boundaries, or changes in how the specific treatment tool (prescribed fire ignitions or mechanical thinning) is implemented.

Example 2 - The action is to replace a damaged culvert in a 6th field HU with a FR baseline. Currently, surface fines are between 12 and 20 percent, and embeddedness is between 20 and 30 percent. This action will cause temporary degradation to turbidity and embeddedness indicators downstream, but impacts will not go beyond the 6th field HU. The action will also restore the fish passage indicator, and will maintain all remaining indicators. This action will be appropriate because it does not retard the attainment of riparian processes and functions, has measurable long-term ecological benefits by providing fish passage, and does not have substantially measurable short-term effects.

Example 3 - Existing fine sediment levels in bull trout spawning gravels (≤ 6.0 mm) are approaching the desired condition of ≤ 12 percent, and the local bull trout population is small and isolated. A temporary increase in sediment from one individual project could yield significant adverse effects to bull trout that could be significant in both short- and long-term effects on the isolated local population. Also, temporary inputs of sediment could have short- and long-term consequences if channel morphology and stream gradient are associated with infrequent flushing. Low-gradient stream channels might retain sediment for decades.

The question to be answered is whether or not temporary effects from any proposed action will sustain the local isolated population of bull trout and associated beneficial uses. For instance, proposed restoration activities may be appropriate for short-term or long-term recovery, but the timing may not be right if existing stream habitat conditions would be degraded. If the isolated bull trout population would be at risk from temporary effects, it may be prudent to delay project implementation until stream conditions improve, or implement management actions incrementally, using more restrictive BMPs. The over-riding objective is to avoid or minimize temporary jeopardy risks to the bull trout population while striving to recover the habitat that will allow for increasing the bull trout population in the short and long term.

Example 4 - A new placer mine, timber sale, and road restoration project are planned over several 6th field HUs in the same 5th field watershed. The placer mine occurs in a 6th field HU where most indicators are FA. The timber sale and road projects occur in HUs where many baseline indicators are FUR or FR. Even though the placer mine will have short- and long-term adverse effects to pool quality and streambank indicators, it is allowed to proceed due to the 1872 mining law. The other two projects are designed to restore WCIs in the long term, but will cause degradation in the temporary and short term to sediment and peak flows at the 6th field scale.

Cumulative effects from these actions are expected to occur in a low-gradient reach downstream of each project. A second Matrix is prepared to see if cumulative effects will degrade WCIs at the watershed scale and over what timeframe. If cumulative effects are determined not to degrade or retard indicator functions, the actions can proceed. If cumulative effects degrade indicators at the subwatershed scale, then projects are modified to reduce effects or delayed until baseline conditions improve to be consistent with the Forest Plan.

How To Modify The Matrix

When a WCI value identified in the Matrix is not physically or biologically appropriate, given the inherent characteristics (geoclimatic setting) of the subwatershed, the WCI should be modified. WCIs should be refined to better reflect conditions that are functionally attainable in a specific watershed or stream reach based on local geology, land and channel form, climate, historic and potentially recoverable fish species habitat, and potential vegetation. Modification of interim default WCIs may be completed through a variety of methods such as mid-level analysis, Forest-wide monitoring results, and collection and evaluation of watershed and/or stream reach specific data.

Ideally, when modifying WCIs, suitable reference conditions should be used to adopt more functionally attainable indicator values. Reference conditions should be as representative as possible of historical values prior to significant management disturbance. However, since pristine subwatersheds are uncommon, there will need to be agreement on what constitutes an acceptable site to determine suitable reference conditions. Reference conditions may be established using a combination of methods including surveys, historical data, and inferences made from literature, professional judgment, and local landscape conditions. Regardless of what methods are used, written documentation of the methods and procedures, quality and source of data, and rationale supporting the modifications should be included in record documentation for the project or mid-level analysis. In watersheds with ESA-listed fish species, modification of WCIs will be coordinated with NMFS and/or USFWS through Section 7 consultations.

The Matrix Tables

(Note: Parameters were taken from the 8/96 NMFS and 2/98 FWS Matrices)

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Bull Trout Local Population Characteristics within Core Areas			
Local Population Size	Mean total local population size or local habitat capacity more than several thousand individuals. Adults in local population > 500. All life stages are represented within the local population.	Adults in local populations < 500 but > 50. ¹	Adults in local population < 50.
Growth and Survival	Local population has the resilience to recover from temporary or short-term disturbances (e.g., catastrophic events, etc.) or local population declines within 1 to 2 generations (5-10 years). The local population is characterized as increasing or stable. At least 10 years of data support this estimate. ²	When disturbed, the local population will not recover to pre-disturbance conditions within 1 generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The local population is reduced in size, but the reduction does not represent a long-term trend. At least 10 years of data support this characterization. If less data are available and a trend cannot be confirmed, a local population will be considered at risk until enough data is available to accurately determine its trend.	The local population is characterized as in rapid decline or is maintaining at alarmingly low numbers. Under current management, the local population condition will not improve with 2 generations. This is supported by a minimum of 5 years of data.
Life History Diversity and Isolation	The migratory form is present and the local populations are in close proximity to each other. Migratory corridors and rearing habitat (lake or larger river) are in good to excellent condition for the species. Neighboring local populations are large with high likelihood of producing surplus individuals or straying adults that will mix with other local populations.	The migratory form is present but the local population is isolated or fragmented.	The migratory form is absent and the local population is isolated to the local stream or a small watershed not likely to support more than 2,000 fish.

¹ Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S.D.A. Forest Service, Intermountain Research Station, Boise ID.

² Rieman, B.E. and D.L. Meyers. 1997. Use of redd counts to detect trends in bull trout (*Salvelinus confluentus*) populations. Conservation Biology 11(4): 1015-1018.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Bull Trout Local Population Characteristics within Core Areas (continued)			
Persistence and Genetic Integrity	Connectivity is high among multiple (5 or more) local populations with at least several thousand fish each. Each of the relevant local populations has a low risk of extinction. The probability of hybridization or displacement by competitive species is low to nonexistent.	Connectivity among multiple local populations does occur, but habitats are more fragmented. Only 1 or 2 local populations represent most of the fish production. The probability of hybridization or displacement by competitive species is imminent, although few documented cases have occurred.	Little or no connectivity remains for re-founding local populations in low numbers, in decline, or nearing extinction. Only a single local population, or several local populations that are very small or that otherwise are at high risk remain. Competitive species readily displace bull trout. The probability of hybridization is high and documented cases have occurred.
Water Quality			
Temperature (steelhead, chinook)	7-day average maximum. Spawning, rearing and migration: 50-57°F (10-13.9°C) ³	Spawning: 57-60 °F (13.9-15.5°C) Migration and rearing: 57-64°F (13.9-17.7°C) ⁴	Spawning: >60 °F (>15.5°C) Migration and rearing: >64°F (>17.7°C)
Temperature (bull trout)	7-day average maximum temperature in a reach during the following life history stages: ⁵ Incubation: 2-5°C or 35.6-41.0°F Rearing: 4-12°C or 39.2-53.6°F Spawning: 4-9°C or 39.2-48.2°F Also temperatures do not exceed 15°C or 59.0°F in areas used by adults during migration (no thermal barriers)	7-day average maximum temperature in a reach during the following life history stages: ⁵ Incubation: <2°C or 6°C or <35.6° or 42.8°F. Rearing: <4°C or 13-15°C or <39.2°F or 55.4-59.0°F Spawning: <4°C or 10°C or 39.2°F or 50.0°F. Also temperatures in areas used by adults during migration sometimes exceed 15°C or 59.0°F.	7-day average maximum temperature in a reach during the following life history stages: ⁵ Incubation: <1°C or >6°C or <33.8°F or > 42.8°F. Rearing: >15°C or > 59.0°F Spawning: <4°C or >10°C 39.2°F or > 50.0°F Also temperatures in areas used by adults during migration regularly exceed 15°C or 59.0°F (thermal barriers present)

³ Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138. Meehan, W.R., ed.

⁴ Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

⁵ Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other coldwater species in Oregon, W.C. Mackay, M.K. Brewen, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings, held in Calgary, Alberta, May 5-7, 1994

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Water Quality (continued)			
Temperature (other fish species: i.e., redband, rainbow, wood river sculpin, etc.)	Use 7-day average maximum temperature. Species-specific criteria should be developed.		
Sediment/Turbidity (steelhead, chinook)	Low turbidity is indicated by < 12% surface fines (< 0.85 mm) ⁶	Moderate turbidity is indicated by 12-20% surface fines (< 0.85 mm) ⁴	High turbidity is indicated by > 20% surface fines (< 0.85 mm) ⁴
Sediment/Turbidity (in areas of spawning and incubation; rearing areas will be addressed under substrate) (bull trout)	< 12% fines (< 0.85 mm) in gravel. ⁶ Surface fines (≤ 6 mm) \leq 12% ^{7, 8}	12-17% fines (<0.85mm) in gravel. ⁶ Surface fines (≤ 6 mm) are 12-20%.	>17% fines (< 0.85mm) in gravel; ⁶ Surface fines (< 6mm) or depth fines (< 6mm) in > 20% in spawning habitat
Sediment/Turbidity (other fish species: i.e., red band, rainbow, wood river sculpin, etc)	Species-specific criteria should be developed.		
Chemical Contamination/Nutrients	Low levels of chemical contamination from agricultural, industrial, and other sources; no excess nutrients, no 303(d) water quality limited water bodies. ⁹	Moderate levels of chemical contamination from agricultural, industrial, and other sources; some excess nutrients, one 303(d) water quality limited water body. ⁹	High levels of chemical contamination from agricultural, industrial, and other sources; high excess nutrients, >1 303(d) water quality limited water bodies. ⁹

⁶ Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

⁷ Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitewell, and K.A. Duncan. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-322.

⁸ Overton, C.K., S.P. Wollrab, B.C. Roberts, and M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-346.

⁹ A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2). 1994.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat Access			
Physical Barriers (address subsurface flows impeding fish passage under the pathway "Flow/Hydrology)	Any man-made barriers present in watershed allow upstream and downstream fish passage at all flows.	Any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows.	Any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows.
Substrate Embeddedness (Bull trout rearing areas. Spawning and incubation areas are addressed under the Sediment/Turbidity WCI)	Dominant substrate is gravel or cobble (interstitial spaces clear), or embeddedness is < 20%. ^{6, 10, 11}	Gravel and cobble is subdominant, or if dominant, embeddedness is 20-30%. ^{6, 10}	Bedrock, sand, silt, or small gravel dominant, or if gravel and cobble dominant, embeddedness is > 30%. ^{4, 10}
Large Woody Debris (Consider variations based on local biophysical elements, i.e., vegetation habitat type/community type, ecological processes, stream channel width and type, landform, etc., appropriate to the site.)	> 20 pieces per mile, > 12 inches in diameter, > 35 feet length; ^{4, 12} and adequate sources of large woody debris for both long and short-term recruitment in RCAs.	Currently meets standards for functioning appropriately, but lacks potential sources of short or long-term large woody debris recruitment from RCAs to maintain that desired condition.	Does not meet standards for functioning appropriately and lacks potential large woody debris for short and/or long-term recruitment.

¹⁰ Biological Opinion on Implementation of Interim Strategies for Managing Anadromous fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service. Northwest Region, January 23, 1995.

¹¹ Shepard, B.B., K.L. Pratt, and P.J. Graham. 1984. Life histories of westslope cutthroat and bull trout in the Upper Flathead River Basin, MT. Environmental Protection agency Rep. Contract No. R008224-01-5.

¹² Interior Columbia Basin Ecosystem Management Project Draft Environmental Impact Statement and Appendices.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk																																						
Habitat Access (continued)																																									
Pool Frequency and Quality: consider variations based on local biophysical elements i.e., vegetation habitat type/community type, ecological processes, stream channel width and type, landform etc., appropriate to the site.	<p>Pools have good cover and cool water, and only minor reduction of pool volume by fine sediment. Large woody debris recruitment standards for functioning appropriately (above) are met and pool frequency in a reach closely approximates:^{7, 13}</p> <p>Steelhead and chinook: Channel</p> <table border="1"> <thead> <tr> <th>Width (ft.)</th> <th>No. Pools/Mile</th> </tr> </thead> <tbody> <tr><td>0-5</td><td>184</td></tr> <tr><td>5-10</td><td>96</td></tr> <tr><td>10-15</td><td>70</td></tr> <tr><td>15-20</td><td>56</td></tr> <tr><td>20-25</td><td>47</td></tr> <tr><td>25-50</td><td>26</td></tr> <tr><td>50-75</td><td>23</td></tr> <tr><td>75-100</td><td>18</td></tr> </tbody> </table> <p>Bull Trout: Wetted</p> <table border="1"> <thead> <tr> <th>Width (ft.)</th> <th>No. Pools/Mile</th> </tr> </thead> <tbody> <tr><td>0-5</td><td>39</td></tr> <tr><td>5-10</td><td>60</td></tr> <tr><td>0-15</td><td>48</td></tr> <tr><td>15-20</td><td>39</td></tr> <tr><td>20-30</td><td>23</td></tr> <tr><td>30-35</td><td>18</td></tr> <tr><td>35-40</td><td>10</td></tr> <tr><td>40-65</td><td>9</td></tr> <tr><td>65-100</td><td>4</td></tr> </tbody> </table> <p>Can use the formula: pools/mile =</p> $\frac{5280}{\text{wetted channel width}} = \# \text{ pools/mi}$ <p># channel widths per pool</p>	Width (ft.)	No. Pools/Mile	0-5	184	5-10	96	10-15	70	15-20	56	20-25	47	25-50	26	50-75	23	75-100	18	Width (ft.)	No. Pools/Mile	0-5	39	5-10	60	0-15	48	15-20	39	20-30	23	30-35	18	35-40	10	40-65	9	65-100	4	<p>Pool frequency is similar to values in "functioning appropriately", but pools have inadequate cover/temperature,⁶ and/or there has been a moderate reduction of pool volume by fine sediment. Large woody debris recruitment is inadequate to maintain pools over time.</p>	<p>Pool frequency is considerably lower than values desired for "functioning appropriately"; also cover/temperature is inadequate,⁶ and there has been a major reduction of pool volume by fine sediment.</p>
Width (ft.)	No. Pools/Mile																																								
0-5	184																																								
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¹³ USDA Forest Service. 1994. Section 7 Fish Habitat Monitoring Protocol for the Upper Columbia River Basin.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat Access (continued)			
Large Pools/Pool Quality (All Fish Species) In adult holding, juvenile rearing, and over wintering reaches where streams are 3.0 meters in wetted width at base flow.	Each reach has many large pools > 3.28 feet (1 meter deep). ⁶ Pools have good cover and cool water, and only minor reduction of pool volume by fine sediment.	Reaches have few large pools > 3.28 feet (>1 meter) present ⁶ or inadequate cover/temperature. Moderate reduction of pool volume by fine sediment.	Reaches have no deep pools > 3.28 feet (> 1 meter) ⁶ and inadequate cover/temperature. There is a major reduction of pool volume by fine sediment.
Off-channel Habitat (Appropriate to the watershed and associated stream system; is the stream capable of using its floodplain similar to an unmanaged stream system?)	Watershed has many ponds, oxbows, backwaters, and other off-channel areas with cover; side channels are low energy areas. ⁶	Watershed has some ponds, oxbows, backwaters, and other off-channel areas with cover; but side channels are generally high-energy areas. ⁶	Watershed has few or no ponds, oxbows, backwaters, or other off-channel areas. ⁶
Refugia (steelhead, chinook) (see glossary for definition of steelhead and chinook refugia)	Habitat refugia exist and are adequately buffered (e.g., by intact riparian conservation areas); existing refugia are sufficient in size, number, and connectivity to maintain viable populations or sub-populations. ¹⁴	Habitat refugia exist but are not adequately buffered (e.g., by intact riparian conservation areas); existing refugia are insufficient in size, number, and connectivity to maintain viable populations or sub-populations. ¹⁴	Adequate habitat refugia do not exist. ¹⁴
Refugia (bull trout) (see glossary for definition of bull trout refugia)	Habitats capable of supporting strong and significant local populations are protected and are well distributed and connected for all life stages and forms of the species. ^{14, 15}	Habitats capable of supporting strong and significant local populations are insufficient in size, number, and connectivity to maintain all life stages and forms of the species. ^{14, 15}	Adequate habitat refugia do not exist. ¹⁴

¹⁴ Frissell, C.A., W.J. Liss, and David Bayles. 1993. An Integrated Biophysical Strategy for Ecological Restoration of Large Watersheds. Proceedings from the Symposium on Changing Roles in water Resources Management and Policy, June 27-30, 1993 (American Water Resources Association), p. 449-456.

¹⁵ Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams and others. 1997. Chapter 4: Broad-scale Assessment of aquatic Species and Habitats. In T.M. Quigley and S.J. Arbelbide eds "An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins Volume III." U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management, Gen Tech. Rep PNW-GTR-405.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Channel Conditions and Dynamics			
Average Wetted Width/Maximum Depth Ratio in scour pools in a stream reach. (Consider variation in ranges based on stream channel type).	$\leq 10^{4, 7, 10}$	11-20 ⁷	$> 20^7$
Streambank Condition (Consider variation in ranges based on stream channel type).	>90% of any stream reach has stable banks ^{4, 7} relative to the percent of inherent stable streambanks associated with a similar unmanaged stream system.	80-90% of any stream reach has stable banks relative to the percent of inherent stable streambanks associated with a similar unmanaged stream system.	<80% of any stream reach has stable banks relative to the percent of inherent stable streambanks associated with a similar unmanaged stream system.
Floodplain Connectivity (Consider local landform, stream channel type, climatology, vegetation, etc.)	Within RCAs, floodplains and wetlands are hydrologically linked to the main channel; overbank flows occur and maintain wetland/floodplain functions; and riparian vegetation succession.	Within RCAs, reduced linkage of wetlands and floodplains to the main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland/floodplain function and riparian vegetation succession.	Within RCAs, severe reduction in linkage of wetlands, floodplains and riparian areas to the main channel; overbank flows are drastically reduced relative to historic frequency, as evidenced by substantial reduction of wetland/floodplain function and riparian vegetation succession.
Flow/Hydrology			
Change in Peak/Base Flows	Watershed hydrograph indicates peak flow, base flow, and flow timing characteristics comparable to an undisturbed watershed of a similar size, geomorphology and climatology.	Some evidence of altered peak flow, base flow, and/or flow timing relative to an undisturbed watershed of similar size, geomorphology and climatology.	Pronounced changes in peak flow, base flow, and/or flow timing relative to an undisturbed watershed of similar size, geomorphology and climatology.
Change in Drainage Network	Zero or minimum change in active channel length correlated with human caused disturbance.	Low to moderate change in active channel length correlated with human caused disturbance.	Greater than moderate change in active channel length correlated with human caused disturbance.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Watershed Conditions			
Road Density/Location ¹⁶	Total road density < 0.7 miles/square mile of subwatershed, ¹⁶ no roads within RCAs.	Total road density 0.7-1.7 miles/square mile of subwatershed, ¹⁶ few roads within RCAs.	> 1.7 miles/square mile of subwatershed, ¹⁶ many roads within RCAs.
Disturbance History	< 15% ECA (entire watershed) with no concentration of disturbance in areas with landslide or landslide prone areas, and/or refugia, and/or RCAs.	< 15% ECA (entire watershed) but disturbance concentrated in landslide or landslide prone areas, and/or refugia, and/or RCAs.	> 15% ECA (entire watershed) and disturbance concentrated in landslide or landslide prone areas, and/or refugia, and/or RCAs.
Riparian Conservation Areas	<p>The riparian conservation areas within the subwatershed(s) have historic and occupied refugia for listed, sensitive or native/desired nonnative fish species which are present and provide: adequate shade, large woody debris recruitment, sediment buffering, connectivity, and habitat protection and connectivity to adequately minimize adverse effects from land management activities (>80% intact).</p> <p>All vegetative components are within desired conditions identified in Appendix A of the Forest Plan. RCA functions and processes are intact, providing resiliency from adverse affects associated with land management activities. Conditions fully support habitat for aquatic species.</p>	<p>The riparian conservation areas within the subwatershed(s) contain known historic refugia for listed, sensitive, or native/desired nonnative fish species that are currently absent (but could be re-colonized). Land management activities have resulted in moderate loss to shade, large woody debris recruitment, sediment buffering, connectivity, and habitat protection. (Refugia < 70-80% intact.)</p> <p>Some vegetative components are outside desired conditions in Appendix A of the Forest Plan. RCA functions and processes are still generally intact, providing some resiliency from adverse affects associated with land management activities. Conditions generally support habitat for aquatic species.</p>	<p>Riparian conservation areas as a result of land management have resulted in loss of or substantially fragmented historic refugia, and provide inadequate protection of habitats for listed, sensitive, native or desired non-native fish species (< 70% intact). Historical refugia are currently absent of listed, sensitive, or native/desired non-native fish species.</p> <p>Most vegetative components are outside desired conditions in Appendix A of the Forest Plan. RCA functions and processes are not sufficiently intact, to mitigate adverse affects from land management activities. Conditions may not support habitat for aquatic species</p>

¹⁶ ICBEMP Science Assessment, Supplemental Roads Analysis

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Watershed Conditions (continued)			
Disturbance Regime	Disturbance resulting from land management activities are negligible or temporary. Streamflow regimes are appropriate to the local geomorphology, potential vegetation and climatology resulting in appropriate high quality habitat and watershed complexity that provide refugia and rearing space for all life stages or multiple life-history forms. Ecological processes are within historical ranges. Resiliency of habitat to recover from land management disturbances is high.	As a result of land management activities, scour events, debris torrents, or catastrophic fire are localized events that occur in several minor parts of the watershed. Ecological processes are moderately outside of historical ranges. Resiliency of habitat to recover from land management disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, scour events, debris torrents, or high probability of catastrophic fire exists throughout a major part of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Ecological processes are substantially outside of historical ranges. Resiliency of habitat to recover from land management disturbances is low.
Integration of Pathways (steelhead, chinook)			
	Habitat quality and connectivity among subpopulations is high. Disturbance has not altered channel equilibrium. Fine sediments and other habitat characteristics influencing survival and growth are consistent with the desired conditions for the habitat. The subpopulation has the resilience to recover from short-term disturbance within one to two generations (5-10 years). The subpopulation is fluctuating around an equilibrium or is growing.	Fine sediments, stream temperatures, or the availability of suitable habitats have been altered and will not recover to pre-disturbance conditions within one generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The subpopulation is reduced in size, but the reduction does not represent a long-term trend. The subpopulation is stable or fluctuating in a downward trend.	Cumulative disruption of habitat has resulted in a clear declining trend in the subpopulation size. Under current management, habitat conditions will improve within two generations (5 to 10 years). Subpopulation survival and recruitment responds sharply to normal environmental events.

Table B-1. Pathways and Watershed Condition Indicators (WCIs) - Reference Conditions (continued)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Integration of Pathways (bull trout)			
	<p>Habitat quality and connectivity among local populations is high. The migratory form is present. Disturbance has not altered channel equilibrium. Fine sediments and other habitat characteristics influencing survival and growth are consistent with pristine habitat. The local population has the resilience to recover from short-term disturbance within one to two generations (5 to 10 years). The local population is fluctuating around an equilibrium or is growing.</p>	<p>Fine sediments, stream temperatures, or the availability of suitable habitats have been altered and will not recover to pre-disturbance conditions within one generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The local population is reduced in size, but the reduction does not represent a long-term trend. The local population is stable or fluctuating in a downward trend. Connectivity among the local populations occurs but habitats are more fragmented.</p>	<p>Cumulative disruption of habitat has resulted in a clear declining trend in the subpopulation size. Under current management, habitat conditions will improve within two generations (5 to 10 years). Little or no connectivity remains among local populations. Local population survival and recruitment responds sharply to normal environmental events.</p>
Integration of Pathways (other fish species, i.e., redband, rainbow, wood river sculpin, etc.)			
	Species-specific criteria should be developed.		

Table B-2. Environmental Baseline – Current Conditions

Agency/Unit:		HU Code & Name:	
Fish Species Present:		Spatial Scale of Matrix:	
(Anad. Sp.) Population:		Subpopulation:	
(Bull trout) Core Area:		Local Population:	
Management Action(s):			

Pathways Indicators ^{a, c}	Population and Environmental Baseline		
	Desired Condition	<input checked="" type="checkbox"/> = Data Baseline ^b	Discussion of Baseline – Current Condition
Subpopulation Character			
Subpopulation Size			
Growth and Survival			
Life History Diversity and Isolation			
Persistence and Genetic Integrity			
Water Quality			
Temperature			
Sediment			
Chemical Contaminants/Nutrients			
Habitat Access			
Physical Barriers			
Habitat Elements			
Substrate Embeddedness			
Large Woody Debris			
Pool Frequency			
Pool Quality			
Off-Channel Habitat			
Refugia			

a. Matrix checklist adapted from USFWS and NMFS 1998.

b. FA = Functioning Appropriately, FR = Functioning at Risk, UR = Functioning at Unacceptable Risk, N = Not Applicable

note: “” in baseline discussion indicates actual data were used as the primary source of baseline assessment, otherwise reflects a professional estimate of condition.

c. Evaluated against local criteria where appropriate and available (see IV.C)

Table B-2. Environmental Baseline – Current Conditions (continued)

Pathways Indicators ^{a, c}	Population and Environmental Baseline		
	Desired Condition	☒ = Data Baseline ^b	Discussion of Baseline – Current Condition
Channel Condition and Dynamics			
Width/Depth Ratio			
Stream bank Condition			
Floodplain Connectivity			
Flow/Hydrology			
Change in Peak/Base Flows			
Drainage Network Increase			
Watershed Conditions			
Road Density and Location			
Disturbance History			
Riparian Conservation Areas			
Disturbance Regime			
Integration of Species and Habitat Conditions			

a. Matrix checklist adapted from USFWS and NMFS 1998.

b. FA = Functioning Appropriately, FR = Functioning at Risk, UR = Functioning at Unacceptable Risk, N = Not Applicable

note: “☒” in baseline discussion indicates actual data were used as the primary source of baseline assessment, otherwise reflects a professional estimate of condition.

c. Evaluated against local criteria where appropriate and available (see IV.C)

Table B-3. Effects of Management Actions

Agency/Unit:		HU Code & Name:	
Fish Species Present:		Spatial Scale of Matrix:	
(Anad. Sp.) Population:		Subpopulation:	
(Bull trout) Core Area:		Local Population:	
Management Action(s):			

Pathways Indicators ^{a, d}	Effects of the Management Action(s)				Discussion of Effects
	Effects ^{b, c}	Temporary trend/effect (+/-/none)	Short-term trend/effect (+/-/none)	Long-term trend/effect (+/-/none)	
Subpopulation Character					
Subpopulation Size (bull trout only)					
Growth and Survival (bull trout only)					
Life History Diversity and Isolation (bull trout only)					
Persistence and Genetic Integrity (bull trout only)					
Water Quality					
Temperature					
Sediment					
Chemical Contaminants/ Nutrients					
Habitat Access					
Physical Barriers					
Habitat Elements					
Substrate Embeddedness					
Large Woody Debris					
Pool Frequency					
Pool Quality					
Off-Channel Habitat					
Refugia					

- a. Matrix checklist adapted from USFWS and NMFS1998.
- b. This displays the potential effects of the action on habitats or individuals, and not on the status of the entire local population/ watershed. I = Improve, M = Maintain, D = Degrade, N = No Influence
- c. Effects that "Maintain" or "Improve" indicators are compliant with Pacfish and Infish objectives (see USFWS 1998 for crosswalk).
- d. Evaluated against local criteria where appropriate and available (see IV.C)

Table B-3. Effects of Management Actions (continued)

Pathways Indicators ^{a, d}	Effects of the Management Action(s)				
	Effects ^{b, c}	Temporary trend/effect (+/-/none)	Short-term trend/effect (+/-/none)	Long-term trend/effect (+/-/none)	Discussion of Effects
Channel Condition and Dynamics					
Width/Depth Ratio					
Stream bank Condition					
Floodplain Connectivity					
Flow/Hydrology					
Change in Peak/Base Flows					
Drainage Network Increase					
Watershed Conditions					
Road Density and Location					
Disturbance History					
Riparian Conservation Areas					
Disturbance Regime					
Integration of Species and Habitat Conditions					

- a. Matrix checklist adapted from USFWS and NMFS1998.
- b. This displays the potential effects of the action on habitats or individuals, and not on the status of the entire local population/watershed. R = Restore, M = Maintain, D = Degrade, N = No Influence
- c. Effects that "Maintain" or "Improve" indicators are compliant with Pacfish and Infish objectives (see USFWS 1998 for crosswalk).
- d. Evaluated against local criteria where appropriate and available (see IV.C)

Table B-4. Dichotomous Key For Making ESA Determination Of Effects

(Circle the conclusion at which you arrive)

Name and location of action:

1. Are there any proposed/listed fish species and/or proposed/designated critical habitat in the watershed or downstream from the watershed?

NO No Effect
 YES Go to 2¹

2. Will the proposed action(s) have any effect whatsoever¹ on the species and/or critical habitat?

NO No Effect
 YES Go to 3

3. Does the proposed action(s) have the potential to hinder attainment of relevant properly functioning indicators (from Table II)?

NO Go to 4
 YES Likely to adversely affect²

4. Does the proposed action(s) have the potential to result in “take”² of proposed/listed fish species or adversely affect proposed/designated critical habitat?

- a) There is a negligible (extremely low) probability of take of proposed/listed fish species, or of adversely affecting proposed/designated critical habitat...Not likely to adversely affect
- b) There is more than a negligible probability of take of proposed/listed fish species or of adversely affecting proposed/designated critical habitat...Likely to adversely affect²

¹ “Any effect whatsoever” includes small effects, effects that are unlikely to occur, and beneficial effects (all of which are recognized as “may affect” determinations). A “no effect” determination is only appropriate if the proposed action will literally have no effect whatsoever on the species and/or critical habitat, not a small effect, an effect that is unlikely to occur; or a beneficial effect.

² “Take” – The ESA (Section 3) defines take as “to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect, or attempt to engage in any such conduct”. The USFWS (USFWS, 1994) further defines “harm” as “significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering”, and “harass” as “actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering”. In 1999, NMFS (64 FR 60727) further defined harm to include “spawning” and “rearing” as additional behavioral patterns.

³ Document expected incidental take on next page of this key.

Modification Considerations For Pathways And WCIs

This section is intended to provide a basis for general modification of the WCIs contained in the Matrix and recommendations for data sources or evaluation.

WCIs are an integrated suite of aquatic (including biophysical components), riparian (including riparian-associated vegetation species), and hydrologic (including uplands) condition measures that are intended to be used at the a variety of watershed scales. They assist in determining the current condition of a watershed and should be used to help design appropriate management actions or alter or mitigate proposed and or ongoing actions to move watersheds toward desired conditions. Common sources of information are likely to include Forest Service and other agencies' habitat and population surveys, walk-through surveys, professional judgment, and monitoring and remote sensing data.

The following descriptions are generated to stimulate discussions on Level I teams associated with listed fish species, and Interdisciplinary Teams on evaluations of all the WCIs/Pathways through which riparian functions and ecological processes, aquatic habitat, and fish populations can be altered. These descriptions are not all inclusive, and it is recommended that both field review and literature review be conducted to better understand the inherent variability and interactions of the biophysical resources for any management action within a given watershed.

Use of fairly comprehensive databases such as the "Natural Conditions Dataset" (Overton et al. 1995), may be useful in developing more localized values. Where appropriate, refinement of WCI values can be stratified by several geoclimatic variables, some of which include: geomorphology, landform, stream type and size, climate historic, and potential vegetation.

Pathway: Bull Trout Local Population Characteristics Within Core Areas

WCI-1: Local Population Size. DATA AND ANALYSIS: Determinations of baseline will reflect the known status of the local population as compared against the numeric criteria. Definitions of functionality are derived from Rieman & McIntyre (1993). Determination of baseline "current condition" will reflect the known status of the local population as compared against the numeric criteria.

Utilize primarily professional judgment, or data where available. No criteria for species other than bull trout are needed. Most information sources will reflect only confirmed presence or assumed absence. Where population surveys exist, the data may be sufficient to apply the numeric criteria in Table I, but will unlikely represent the true "population". It may be difficult in some watersheds to separate historic non-use from contemporary non-use, that is, was the species ever present? For the purpose of consistency, the numeric criteria should be applied as written, unless evidence exists to demonstrate historic non-use.

WCI-2: Growth and Survival. DATA AND ANALYSIS: It is unlikely that 5 to 10 years of data exists to support any baseline assessment, as identified in Table I; therefore, analysis should use available data and information to arrive at a professional estimate of the condition. Inferences may be derived from related information such as water temperature or macro-invertebrate data. Unknowns suggest a conservative application of the numeric criteria as written. No criteria for species other than bull trout are needed. Use professional judgment.

The ratio of adults to pre-adults and the extent of the available habitat are used to estimate productivity for growth and survival. Bull trout greater than 6 inches in length are assumed to be adult fish (based on age analyses of resident fish collected on the Forest).

WCI-3: Life History Diversity and Isolation. DATA AND ANALYSIS: Utilize primarily professional judgment, or data where available. Most information sources will reflect only confirmed presence or assumed absence. Known connectivity and past observation of larger migratory bull trout can assist in estimating the current condition. Where neighboring local population surveys exist, the data may be sufficient to apply the matrix standards. Unknowns suggest a conservative application of the numeric criteria as written. No criteria for species other than bull trout are needed.

WCI-4: Persistence and Genetic Integrity. DATA AND ANALYSIS: Utilize primarily professional judgment, or data where available. Most information sources will reflect only confirmed presence or assumed absence. Where neighboring local population surveys exist, the data may be sufficient to apply the Matrix criteria. Unknowns suggest a conservative application of the numeric criteria as written. No criteria for species other than bull trout are needed.

Pathway: Water Quality

WCI-1: Temperature. DATA AND ANALYSIS: Recording thermographs, both within the habitats of concern and during the applicable timeframes (e.g., spawning, rearing, and migration periods), will be required to directly evaluate the Matrix parameters. Spot measurements are typically not sufficient, but could be used to indicate a temperature extreme that warrants further examination. Daily thermograph maximums need not be further processed into 7-day average unless necessary to discriminate between baseline conditions. For spawning temperature criteria, conditions need to meet the criteria throughout the spawning period.

WCI-2: Sediment/Turbidity. DATA AND ANALYSIS: Unless sufficient data/information is available to determine otherwise, no baseline condition will be identified as "functioning appropriately" for any reach within a watershed that is currently included on the 303(d) impaired water body list with sediment identified as the pollutant. If sufficient information is available to dispute the listing, it may be considered "functioning at risk"; otherwise, a 303d listing for sediment will be considered "functioning at unacceptable risk". The values for this indicator may vary greatly and should be refined to better reflect local conditions (geoclimatic setting). Modification of the sediment criteria can utilize the more localized Natural Conditions Dataset (Overton et al. 1995) to incorporate the local geomorphology, landform, stream type and size, potential vegetation type for the stream reach or subwatershed. Surface fines are currently being used as a surrogate for turbidity. If surface fine information is not available, naturally erosive soils and/or stream bank condition indicator may be used in its place. In watersheds with ESA-listed fish species, consult with the Level 1 consultation team before making changes.

WCI-3: Chemical Contamination/Excess Nutrients. DATA AND ANALYSIS: Consider rates of chemical and a nutrient source of contamination only; do not include sediment or temperature (the basis for listing most 303d streams). Where available, utilize appropriate state and federal water quality rules and regulations.

Pathway: Habitat Access

WCI-1: Physical Barriers. DATA AND ANALYSIS: This indicator identifies the known and or potential barriers to fish movement both within a local population and among core areas. This includes but is not limited to dams, culverts, bridges, and fords, as well as barriers associated with thermal or chemical alterations to the water column. Estimation on the amount and extent of fish barriers may be completed using GIS layers of roads (classified and unclassified) and the 1:24,000 streams layer. Natural barriers such as waterfalls, cascades, and elevated stream temperatures from hot springs are important to identify, but should not have an influence on the functionality rating.

Pathway: Habitat Elements

WCI-1: Substrate Embeddedness. DATA AND ANALYSIS: This indicator identifies the extent to which larger particles are embedded or buried by fine sediment. A commonly used procedure for measuring embeddedness is by selecting particles from the streambed and then measuring both the particle height and embedded height perpendicular to the streambed surface. Percent embeddedness is calculated for each particle until at least 100 particles are measured. The values for this indicator may vary greatly and should be refined to better reflect local conditions (geoclimatic setting).

WCI-2: Large Woody Debris. DATA AND ANALYSIS: The indicator considers the number and size of in-channel wood, as well as future recruitment of wood in RCAs. A number of methods can be used to collect in-channel wood data. Most surveys count only those pieces that extend below the waterline at bankfull discharge and exceed some minimum size limit over a specific stream distance. Sometimes spanners or bridged pieces are also included in the count. An adequate source of wood recruitment is generally an estimate of the number of pieces that may fall into the stream in the future. This information is commonly collected through a walk-through survey or intensive riparian survey. Several studies have shown that most (70 to 90 percent) large wood recruited to streams is from trees growing within 65-100 feet of the channel on flat terrain (Murphy and Koski 1989, McDade et al. 1990). Potential wood recruitment should at a minimum be considered within one site potential tree height. This height will vary by potential vegetative group (PVG), and can range from 50 feet in PVG 11 to 120 feet in PVG 1. Analysis should be cognizant of the distribution of terrestrial vegetation habitats within the watershed. For example, stream reaches flowing through broad shrub-dominated meadows lack natural sources of LWD, and would not be expected to meet the numeric criteria. Generally, watersheds or stream reaches with a mosaic of conifer and shrub habitats would be considered at desired conditions unless evidence displays manipulation or disturbance of streamside forests, regardless of LWD numeric levels.

WCI-3: Pool Frequency and Quality. DATA AND ANALYSIS: This indicator is based on the number of pools meeting a minimum size criteria defined by the appropriate methodology by channel width. It also considers the amount of cover in each pool, water temperature, and filling by sediment. Most stream surveys have typically considered this habitat element. "Pocket pools" or other such quantified microhabitat can also be appropriately considered as pools. Where data is lacking, use professional judgment with inference from related mechanisms such as known disturbance within the watershed (e.g., an increase in sediment loads will generally result in a decrease in pool frequency and quality).

WCI-4: Large Pools. DATA AND ANALYSIS: This indicator is based upon the number of pools with maximum depth greater than 3.28 feet. It also considers the amount of cover in each pool, water temperature, and filling by sediment. Most stream surveys have typically considered this habitat element. The values for this indicator may vary greatly and should be refined to better reflect local conditions (geoclimatic setting).

WCI-5: Off-Channel Habitat. DATA AND ANALYSIS: This indicator is based upon the number of side channels, ponds, oxbows, and other backwater areas. Typically this is a measure of either the total number of these habitat types or the total linear distance over a specific reach. Utilize available data and information with professional judgment. Some habitat surveys have quantified conditions in off-channel habitats, and most have at least commented about the existence of such. However, no numeric standard exists.

WCI-6: Refugia. DATA AND ANALYSIS: This is a large-scale indicator based upon the quality, uniqueness, and importance of the 6th or 5th field HU the project being analyzed falls within. Utilize available data and tools, such as aerial photos, with professional judgment. This indicator speaks to the current situation of habitats within the local –population–that is, within the watershed.

Pathways: Channel Conditions and Dynamics

WCI-1: Average Width/Maximum Depth Ratio. DATA AND ANALYSIS: The determination of channel width and channel depth is problematic because both parameters are flow-dependent. Depth tends to increase with flow more rapidly than width, but this relationship may not be constant at any given cross-section. Recent surveys have typically evaluated only wetted channel conditions. Maximum depth identification requires specialized abilities in identifying bankfull features and so has not been consistently collected. Ideally these parameters should be measured at specific discharges and locations. Where no data exists, those familiar with the stream can compare visual observations of it with stream references such as found in the Natural Conditions Dataset (Overton et al. 1995), or Applied River Morphology (Rosgen 1996). The values for this indicator may vary greatly by channel type and should be refined to better reflect local conditions (geoclimatic setting). Utilize available data and information, or professional judgment.

WCI-2: Streambank Condition. DATA AND ANALYSIS: Many stream surveys have evaluated streambank condition (stability), although until recently it was rarely quantified. Where quantified, if summarized by habitat type, this indicator can be evaluated as in the USFWS matrix; that is, what portion of the habitat units have at least 90 percent stable banks. However, if summarized only by reach, simply consider the portion of the total length that is "stable". Engineered revetment should generally not be considered "stable". Where no quantitative data exists, qualitative assessments common in the 1980s such as the Stream Reach Inventory and Channel Stability Evaluation (Pfankuch 1975) can provide considerable inference. Utilize available data and information, or professional judgment.

WCI-2: Floodplain Connectivity. DATA AND ANALYSIS: This indicator is based on whether floodplains and wetlands are hydrologically linked to the main channel. Evidence of channel entrenchment, manipulation, levees, revetment, or alteration should be absent to be considered "functioning appropriately". This indicator is closely related to variations in local geomorphology, landform, stream size and type, climate, and potential vegetation. Utilize primarily professional judgment, or data, information, or photographs if available.

Pathway: Flow/Hydrology

WCI-1: Change in Peak or Base Flows. DATA AND ANALYSIS: This indicator is typically based on field observations and an assessment of management impacts at the 6th or 5th field HU scales. In-channel observations may include channel adjustments such as nick points; scour marks, and eroding banks to dewatered streams. Larger-scale measurements may include past harvest history, road densities and location, and acres burned. Utilize primarily professional judgment, or data and information if available.

WCI-2: Changes in Drainage Network. DATA AND ANALYSIS: This indicator is typically based on field observations and an assessment of management impacts at the 6th or 5th field HU scales. Management activities typically observed are roads with extensive inside ditches and few relief culverts, dewatered or expanded streams below roads, compacted ground within harvest units, and intensive livestock grazing. Utilize primarily professional judgment, or data and information if available.

Pathway: Watershed Conditions

WCI-1: Road Density and Location. DATA AND ANALYSIS: Classified and unclassified road densities and miles within the RCAs can quickly be evaluated, particularly with GIS tools. Utilize available data and information, or professional judgment. Road density default values are from the “Supplemental Roads Analysis of Road Impacts pages 1253-1260 in Volume III of Quigley and Arbelbide, 1997.

WCI-2: Disturbance History. DATA AND ANALYSIS: This indicator is typically based on vegetative recovery from disturbance. The values for this indicator may vary greatly from the default values and should be refined to better reflect local conditions. Local refinements of these indicator values should consider local research data (e.g., Silver Creek Watershed Research Projects, King 1989). It is difficult to predict how much a particular change in ECA will affect watershed function and effect on salmonids; therefore professional judgment will be required.

WCI-3: Riparian Conservation Areas. DATA AND ANALYSIS: Actions and historic disturbance within an RCA can help infer RCA condition and trend. Classified and unclassified roads and number of stream crossings can also be quickly evaluated within a given watershed, particularly with GIS tools. Utilize primarily professional judgment, or data, tabular information, or aerial photographs if available.

WCI-4: Disturbance Regime. DATA AND ANALYSIS: Ecological processes including the disturbance processes that create dynamic soil, water, and hydrologic, riparian and aquatic habitats within watersheds. The results of these processes determine the physical and biological capability within watersheds, including water quality and aquatic habitat. Differences in climate, geomorphology, soils, and potential vegetation (geoclimatic setting) greatly influence the amount and recurrence of disturbance process (disturbance regimes), as well as the ability and rate for a subwatershed to recover (resiliency). The intent of this indicator is to determine the amount of effect that land management activities have or may have on the overall watershed function and resiliency. Utilize primarily professional judgment, based on available data and information when available.

Pathway: Integration of Species and Habitat Conditions

No individual WCIs identified. DATA AND ANALYSIS: This pathway is an integration of the biophysical and aquatic habitat conditions. Individual WCIs represent a starting point to describe the current and desired conditions for water quality and aquatic habitat. This pathway synthesizes the information evaluated for individual indicators to determine the overall functional status of the subwatershed. Utilize professional judgment and reference specific WCIs that have a major influence on the overall condition.

GUIDANCE FOR DELINEATION AND MANAGEMENT OF RIPARIAN CONSERVATION AREAS

Introduction

The third component of the ACS is the delineation of RCAs. Naiman et al. (2000) identifies that recent discoveries about the structure and dynamics of riparian zones have extended the scope of understanding about this portion of the landscape and have important implications for stream and watershed management. The following guidance has been developed to assist interdisciplinary teams in becoming familiar with and consistently applying criteria to: (1) appropriately delineate RCAs; and (2) analyze important considerations in developing appropriate management actions within or affecting RCAs. The objective is to ensure that interdisciplinary teams adequately consider riparian functions and ecological processes in both the delineation of RCAs and determination of appropriate management actions within or affecting RCAs.

The revised Forest Plan direction (goals, objectives, standards, and guidelines) found in Chapter III of this document replaces direction in the 1990 Boise National Forest Land and Resource Management Plan, as amended by Pacfish/Infish, NMFS' 1995 LRMP Biological Opinion (BOs), and the NMFS' and USFWS' 1998 Biological Opinions for steelhead and bull trout. With that replacement, the definitions and delineations of Pacfish/Infish Riparian Habitat Conservation Areas are replaced by the definitions and delineations of RCAs.

Overview Of The RCA Delineation Guidance

Aquatic and riparian systems are easily affected by land management activities on the surrounding hillslopes. RCAs provide both a linkage and transitional habitat between hillslopes and upland terrestrial habitats and the aquatic habitats within stream channels.

In general, there is little controversy over the need to define RCAs in order to maintain riparian functions and ecological processes. The controversy is over the width of the RCA, the extent and type of management activities that can occur within them, and the purposes for those activities. Management activities that occur within, or adjacent to, an RCA are subject to specific goals, objectives, standards and guidelines. Forest plans and the associated management direction regulate two major features of RCAs: (1) their width; and (2) the kind and amount of activity that can take place within or influence them (Spence et al. 1996, Quigley and Arbelbide 1997).

Riparian zones are among the biosphere's most complex ecological systems and also among the most important for maintaining the vitality of the landscape and its rivers (Naiman et al. 2000). Evaluating the effectiveness of RCAs to manage for riparian functions and ecological processes is difficult because of: the complexities of such areas, the extended time over which impacts can occur; and the resiliency and rate of recovery. The RCA should be designed to maintain riparian functions and ecological processes with consideration of multiple scales (stream reach, subwatershed, and watershed scale).

RCA Delineation Criteria For the Boise National Forest

The following are criteria to be used to delineate RCAs for perennial and intermittent streams, ponds, lakes, reservoirs, and wetlands.

I. Forested Streams*

Perennial streams (and intermittent streams providing seasonal rearing and spawning habitat) –

In the absence of local field data, 300-foot slope distance from the ordinary high water mark,

OR

Flood-prone width or two site-potential tree heights, whichever is greatest,

OR

Defined based on a site-specific analysis by a qualified specialist with expertise in the field of riparian function and ecological processes.

II. Forested Streams*

Intermittent streams – In the absence of local field data, 150-foot slope distance from the ordinary high water mark,

OR

Flood-prone width or one site-potential tree height, whichever is greatest,

OR

Defined based on a site-specific analysis by a qualified specialist with expertise in the field of riparian function and ecological processes.

III. Ponds, Lakes, Reservoirs, and Wetlands*

In the absence of local field data, 150-foot slope distance from the ordinary high water mark,

OR

Outer edge of seasonally saturated soils, outer edge of riparian vegetation, or one site-potential tree height, whichever is greatest,

OR

Defined based on a site-specific analysis by a qualified specialist with expertise in the field of riparian function and ecological processes.

IV. Non-Forested Streams*

Perennial and intermittent streams –

The extent of the flood prone width, or riparian vegetation, whichever is greatest,

OR

Defined based on a site-specific analysis by a qualified specialist with expertise in the field of riparian function and ecological processes.

*Note: Sediment delivery distances vary based upon the combination of proposed management actions and the inherent site characteristics. Because sediment delivery distances may exceed the selected option, RCAs may need to be adjusted to avoid or minimize delivery to the associated water body under any option.

Step-Down Process For RCA Delineation

Effective use of the RCA delineation requires a full understanding of the selection criteria options within each of the four Categories.

Delineating an RCA requires two decisions to be made. First, the area needs to be correlated with one of the four Categories (I, II, III, or IV). The second decision is identifying which option, or criteria, within that Category to use.

The decision as to which option or criteria should be chosen should occur through discussions with the interdisciplinary team, resource specialists, and/or the line officer. In general, determining the level of analysis that best suits the needs of the project will be driven by the potential effects of the project, baseline conditions, management direction, and issues associated with the project/area of interest that were identified through scoping, the work of the interdisciplinary team, or the line officer.

Written documentation of the chosen RCA delineation option within a category, and the rationale behind the choice, should be included in record documentation for the project.

The options within a given Category have varying levels of associated analysis that are involved with delineating the RCA. Category IV, Non-forested Streams, differs from the other Categories in that it does not designate a set distance and therefore has two options rather than three.

Option 1

In lieu of field data, selection of the first option provides a conservative boundary--generally in excess of two site-potential tree heights in the case of the 300-foot slope distance, and greater than one site-potential tree height in the case of the 150-foot slope distance--that would be expected to account for most riparian processes including stream shading, LWD recruitment, fine organic litter input, bank stabilization, sediment filtration, wind-throw, riparian microclimate and productivity, and wildlife habitat. Again, selection of this option is expected to provide land managers with the option of delineating an RCA in the absence of field confirmation, with the expectation that the distances would account for most riparian functions and ecological processes in a system.

Option 2

The second criteria option, which is used similarly in Categories I-IV, requires field verification of certain site characteristics and provides a more site-based delineation of an RCA boundary for a specific location. Depending on which Category (I, II, III, or IV) is involved, options include use of flood-prone width, site-potential tree height, or riparian vegetation, whichever is greatest given the category.

Flood-prone width is a relatively easily surveyed geomorphic feature in the field, and it accounts for riparian processes, such as fine organic litter input or bank stabilization, and for various degrees of sediment delivery distances.

Site-potential tree height is spoken to in the literature and correlated with the protection of riparian functions and ecological processes such as stream shading, LWD recruitment, fine organic litter input, bank stabilization, sediment filtration, wind-throw, riparian microclimate and productivity, and wildlife habitat (Spence et al. 1996, Quigley and Arbelbide 1997, FEMAT 1993).

Riparian vegetation is defined through classification of the vegetation associated with the aquatic habitat and its outer extent (see glossary), and it generally influences riparian processes such as fine organic litter input, bank stabilization, sediment filtration, stream shading, and wildlife habitat.

Option 2 requires the use of certain field data to be collected from the project area and analyzed to determine the RCA boundary. It is considered an option requiring potentially less than a site-specific analysis (Option 3), but it is more appropriately tied to the landscape than a default distance might be (Option 1).

Option 3

The third option, which is used in Categories I-IV, is the use of a site-specific analysis to define the RCA. This option requires potentially the most analysis of the three options. When defining the RCA, the specialist conducts an on-site analysis of the riparian functions and ecological processes associated with

the stream, pond, lake, reservoir or wetland, and defines the RCA based on the distance that best encompasses the extent of those functions and processes. The value gained from this effort is a site-specific RCA delineation appropriate to the functions and processes between upland terrestrial habitats and adjacent aquatic habitats for that area. This information potentially provides more opportunities for project design because the existing condition is better known, and therefore effects of actions can be better assessed, and projects can be more responsive to needs of the aquatic ecosystem.

In summary, RCA delineation is set up in a manner that provides flexibility for different levels of analysis that, regardless of the option chosen, will provide for riparian functions and ecological processes. The decision on which option to use must involve considerations of the project in regard to potential effects, baseline conditions, and issues and their relationship to riparian functions and ecological process.

The effectiveness of delineating an accurate RCA provides decision-makers with the information necessary for sound decisions regarding management activities within a watershed. With an understanding of the riparian functions and ecological processes of a system, and the means by which actions may affect them, decision makers are provided an opportunity to design activities to maintain or restore listed fish species, their habitats, and other SWRA resources.

Flood-Prone Width For Use In Identifying RCAs

Rosgen (1996) identifies an acceptable field methodology for determining the flood-prone area width. To measure the width of the flood-prone area, select the elevation that corresponds to twice the maximum bankfull channel depth as determined by the vertical distance between bankfull stage and the thalweg of a riffle. The flood-prone area generally includes the active floodplain and the low terrace (Rosgen 1996). This area can assist to varying degrees in the protection for: stream shading, LWD recruitment, fine organic litter, bank stabilization, sediment filtration, nutrients and other dissolved materials, riparian microclimate and productivity, wildlife habitat, and windthrow.

Flood-prone width, as defined by Rosgen (1996), will vary greatly depending on valley form and channel entrenchment. For example, flood-prone widths would be expected to be narrower in confined, entrenched streams, and wider in broad valley forms with less entrenched streams. Because site-potential tree heights will typically provide a wider RCA in confined, entrenched streams, flood-prone width will not typically be used to define RCAs in these stream types. Similarly, flood-prone width will be more likely to be used in the broad valley forms with low channel entrenchment.

Site-Potential Tree Heights For Use In Identifying RCAs

When planning and implementing vegetation management projects, distances equivalent to one or two site-potential tree heights may be used to determine RCA boundaries, provided a site visit has been completed. Current conditions and dominant potential vegetation group (PVG) for the site/project area must be verified in the field.

Once the dominant PVG has been field-verified, the site-potential tree height criteria in the following table will be used to determine RCA widths in the management units. See the glossary in this appendix for definitions of site-potential tree height, site tree, and seral tree species. For more information about forested vegetation and PVGs, refer to Appendix A of the Forest Plan.

Table B-5. Site Potential Tree Heights by Potential Vegetation Group

Potential Vegetation Group	Age	1 Site Tree Height (feet)	2 Site Tree Heights (feet)
1 - Dry Ponderosa Pine/Xeric Douglas-fir	200	110	220
2 - Warm Dry Douglas-fir/Moist Ponderosa Pine	200	120	240
3 - Cool Moist Douglas-fir	200	120	240
4 - Cool Dry Douglas-fir	200	100	200
5 - Dry Grand Fir	200	110	220
6 - Cool Moist Grand Fir	200	130	260
7 - Cool Dry Subalpine Fir	200	100	200
8 - Cool Moist Subalpine Fir	200	100	200
9 - Hydric Subalpine Fir	200	100	200
10 - Persistent Lodgepole Pine	*	80	160
11 - High Elevation Subalpine Fir	200	70	140

*In PVG 10 individual trees and stands normally do not achieve an average of 200 years. However, mature lodgepole pine site trees can achieve an average height of approximately 80 feet.

Riparian Functions And Ecological Processes: Considerations

The determination of RCA widths must consider the various riparian functions and ecological processes that exert an influence on the adjacent aquatic and terrestrial environment. Integral to the success of proper management, is an understanding of riparian functions and ecological processes, and local knowledge of the site being managed. With field data in hand, design of an appropriate RCA width can focus on conservation of appropriately functioning processes and restoration of damaged processes of concern based on the existing conditions of the site, proposed activities, and issues at hand.

Megahan and Hornbeck (2000) state that a properly designed and managed riparian area can provide a variety of amenities, while protecting riparian functions and ecological processes and diversity of species composition. They further state that a properly designed and managed riparian area includes careful management of forests both within, and outside of the riparian area.

Spence et al. (1996) and Quigley and Arbelbide (1997) identify several important considerations when appropriately delineating and designing management activities within or affecting RCAs. These are as follows:

- a) A stream requires predictable and near-natural energy and nutrient inputs.
- b) Many plant and animal communities rely on streamside or wetland forests and vegetation for migratory or dispersion habitat.
- c) Small streams are generally more affected by hillslope activities than are larger streams.
- d) As adjacent slopes become steeper, the likelihood of disturbance resulting in discernable instream effects increases.
- e) Riparian vegetation 1) provides shade to stream channels; 2) contributes large woody debris; 3) adds small organic matter; 4) stabilizes stream banks; 5) controls sediment inputs from surface erosion; 6) and regulates nutrient and pollutant inputs to streams.

Taking a functional approach to delineating an RCA by looking at “zones of influence” (Spence et al. 1996) allows the qualified specialist to focus on specific riparian functions where a relationship between those functions and RCA widths are known. The ‘zone of influence’ approach provides the qualified specialist a means to distinguish between those riparian functions and ecological processes potentially affected by the proposed actions and those that, regardless of the RCA delineation, the proposed actions will not impair. The functions and processes that would be unaffected by the proposed action, regardless of the RCA delineation, could then be dropped from further discussion. When defining the RCA through site-specific analysis this rationale should be documented.

The riparian functions and processes that may be affected by the proposed action(s) (given the existing conditions and associated issues) should then be addressed through the RCA delineation. In general, the riparian functions and ecological processes that should be considered during delineation of RCAs through site-specific analysis include (taken primarily from Spence et al. 1996):

- Stream Shading
- Large Woody Debris Recruitment
- Fine Organic Litter
- Bank Stabilization
- Sediment Control
- Nutrients and Other Dissolved Materials
- Riparian Microclimate and Productivity
- Wildlife Habitat
- Windthrow
- Importance of Small Streams
- Importance of Hillslope Steepness

The following are brief discussions on some of the riparian functions and ecological processes that are intended to assist the practitioner in a thorough analysis.

Stream Shading (excerpted from Spence et al. 1996)

The ability of riparian forests to provide shade to stream channels is a function of numerous site-specific factors including vegetation composition, stand height, stand density, latitude (which determines solar angle), topography, stream width, and orientation of the stream channel. These factors influence how much incident solar radiation reaches the forest canopy and what fraction passes through to the water surface. The shading influence of an individual tree can be expressed geometrically as a function of tree height, slope, and solar angle. In natural forests, stand density and composition may moderate the shading influence of trees within this zone, with trees closer to the stream channel and understory shrubs providing the majority of stream shade.

More research on riparian influences on shading for all ecosystems east of the Cascades is needed; however, in most instances, RCA widths designed to protect other riparian functions (e.g., LWD recruitment) are likely to be adequate to protect stream shading.

Large Woody Debris Recruitment (excerpted from Spence et al. 1996)

Large wood enters stream channels by a variety of mechanisms, including toppling of dead trees, windthrow, debris avalanches, deep-seated mass soil movements, undercutting of streambanks, and redistribution from upstream. In some systems, wood delivered from upslope areas (via land-sliding) or upstream reaches (via floods or debris torrents) may constitute a significant fraction of the total wood present in a stream reach. When evaluating RCAs, consideration should be given to potential recruitment of wood from upslope areas and non-fish-bearing channel in addition to wood delivered by toppling, windthrow, and bank undercutting.

The potential for a tree or portions of a tree to enter the stream channel by toppling, windthrow, or undercutting is primarily a function of slope distance from the stream channel in relation to tree height and slope angle. Consequently, the zone of influence for large wood recruitment is defined by the particular stand characteristics rather than an absolute distance from the stream channel or floodplain. Other factors, including slope and prevailing wind direction, may influence the proportion of trees that fall in the direction of the stream channel.

Fine Organic Litter (excerpted from Spence et al. 1996)

Smaller pieces of organic litter (leaves, needles, branches, tree tops, and other wood) enter the stream primarily by direct leaf or debris fall, although organic material may also enter the stream channel by overland flow of water, mass soil movements, or shifting of stream channels in unconstrained reaches. Little research has been done relating litter contributions to streams as a function of distance from the stream channel; however, it is assumed that most fine organic litter originates within 30 meters, or 0.5 potential tree heights from the channel.

Bank Stabilization (excerpted from Spence et al. 1996)

Roots of riparian vegetation help to bind soil particles together, making streambanks less susceptible to erosion. In addition, riparian vegetation provides hydraulic roughness elements that dissipate stream energy during high or overbank flows, further reducing bank erosion. In most instances, vegetation immediately adjacent to the stream channel is most important in maintaining bank integrity; however, in wide valleys with shifting stream channels, vegetation throughout the floodplain may be important over longer time periods. Although data quantifying the effective zone of influence relative to root strength is scarce, most of the stabilizing influence of riparian root structure is probably provided by trees within 0.5 potential tree heights of the stream channel. Consequently, delineating RCA widths to provide for other riparian functions (e.g., LWD recruitment, shading) are likely to maintain bank stability. In addition, consideration should be given to the composition of riparian species within the area of influence because of differences in the root morphology of conifers, deciduous trees, and shrubs. Specific relationships between root types and bank stabilization have not been documented; however, if the purpose of riparian protection is to restore natural bank characteristics, then retaining natural species composition is a reasonable target for maintaining bank stabilization function of riparian vegetation.

Sediment Control and Importance of Hillslope Steepness (excerpted from Quigley & Arbelbide 1997)

The ability of RCAs to control sediment input from surface erosion depends on several site characteristics including the presence of vegetation or organic litter, slope steepness and slope roughness, soil type, and drainage characteristics. These factors influence the ability of vegetation to trap sediments by determining the infiltration rate of water and the velocity (and hence the erosive energy) of overland flow.

The likelihood of disturbance resulting in discernible instream effects increases as adjacent slopes become steeper. Thus, greater preventive measures to avert negative effects to streams, or restore riparian function and ecological processes on steeper slopes may be required to prevent or reduce instream effects. The designation of RCA widths can easily incorporate the major topographic driver of surface erosion and slope steepness.

Prior research on a variety of wildland and agricultural settings has demonstrated that surface erosion increases with increasing slope steepness, although the increase is not linear. The effect of slope has generally been modeled empirically, and has taken the shape of a power function where the exponent is less than 1, so that slope effects are large for gentle slopes and decline, as slopes get steeper. Megahan and Ketcheson (1996) found that sediment travel distances from road cross drains in the Idaho Batholith are proportional to slope gradient (in percent) raised to the 0.5 power.

Megahan and Ketcheson (1996) and Ketcheson and Megahan (1996) present equations for estimating sediment travel distance below road fills (non-channelized flow) and cross drains (channelized flow) that incorporate sediment volume, obstructions, slope angle, and source area as significant explanatory variables. Slope is a significant predictor of distance, and it is not unreasonable to adjust an RCA width to slope when lacking other intensive site-variable information. At slopes greater than 50 percent, other screening tools that incorporate landslide prone hazards are needed (refer to the Guidelines for Management on Landslide and Landslide Prone Areas in this Appendix).

The strongest single variable affecting sediment travel distance from soil disturbing activities is the volume of material displaced, or delivered to a point on a slope from a culvert, drain, etc. Over 78 percent of the variance in sediment travel distance is explained by volume in the culvert model (channelized flow) of Megahan and Ketcheson (1996).

They suggest that, except on steep slopes, RCAs be designed to protect other riparian functions will generally control sediments to the degree that they can be controlled by riparian vegetation. It is essential, however, that riparian protection be complemented with practices for minimizing sediment contributions from outside the riparian area, particularly those from roads and associated drainage structures, where large quantities of sediment are often produced. In addition, activities within the RCAs that disturb or compact soils, destroy organic litter, remove large down wood, or otherwise reduce the effectiveness of RCAs as sediment filters should be avoided.

Nutrients and Other Dissolved Materials (excerpted from Spence et al. 1996)

Riparian vegetation takes up nutrients and other dissolved materials as they are transported through the riparian zone by surface or near-surface water movement. However, the relationship between RCA width and filtering capacity is less well understood than other riparian functions and ecological processes. Those studies that have been published indicate substantial variability in the effectiveness of RCAs in controlling nutrient inputs. Identifying an appropriate RCA width that can function as a filter for nutrients and other dissolved materials depends on the specific type and intensity of land use, type of vegetation, quantity of organic litter, infiltration rate of soils, slopes, and other site-specific characteristics.

Because of the variability observed in the effectiveness of RCAs in controlling input of nutrients and other dissolved materials, it is difficult to recommend specific criteria for this function. Spence et al. (1996) suggest that for most forestlands, RCAs designed to protect other riparian functions (e.g., LWD recruitment, shading) are probably adequate for controlling nutrient inputs to the degree that such increases can be controlled by RCAs. Exceptions may occur when fertilizer or other chemical applications result in high concentrations of nutrients in surface runoff.

RCA widths for nutrient and pollution control on rangelands should be tailored to specific site conditions, including slope, degree of soil compaction, vegetation characteristics, and intensity of land use. In many instances, RCA widths designed to protect LWD recruitment and shading may be adequate to prevent excessive nutrient or pollution concentrations. However, where land use activity is especially intense, RCAs for protecting nutrient and pollutant inputs may need to be wider than those designed to protect other riparian functions and ecological processes, particularly when land-use activities may exacerbate existing water quality problems.

Riparian Microclimate and Productivity (excerpted from Spence et al. 1996)

Changes in micro-climatic conditions within the riparian zone resulting from removal of adjacent vegetation can influence a variety of riparian functions and ecological processes that may affect the long-term integrity of riparian ecosystems. However, the relationship between RCA width and riparian

microclimate has not been documented in the literature. FEMAT (1993) and Spence et al. (1996) suggest using the generalized curves in FEMAT 1993, relating protection of microclimatic variables relative to distance from stand edges into forests.

Wildlife Habitat (excerpted from Spence et al. 1996)

The importance of riparian areas to many wildlife species is well documented. However, generic recommendations for riparian RCAs to protect wildlife are not justifiable because each species has unique habitat requirements. Some terrestrial and aquatic plant and animal communities rely on the forest and shrubs adjacent to streams and wetlands for all or parts of their life cycles. Animals such as beavers, otters, dippers, and some amphibians are obligate stream and riparian vegetation dependent organisms. Other bird and mammal species and many bat species need the RCAs at crucial life history periods or seasonally for feeding or breeding. Wildlife has a disproportionately high use of riparian areas and streamside forests compared with the overall landscape. RCAs provide habitat needs such as water; cover; food; plant community structure, composition, and diversity; increased humidity; high edge-to-area ratios; and migration routes. When identifying RCAs it is important to also consider the needs of wildlife species.

Windthrow (excerpted from Spence et al. 1996)

Trees within RCAs that are immediately adjacent to clearcuts have a greater tendency to topple during windstorms than trees in undisturbed forests. Extensive blowdown can potentially affect aquatic ecosystems in a number of ways, both positive and negative. In stream systems that lack wood because of past management practices, blowdown may immediately benefit salmonids by providing structure to the channel. Over the long term, however, blowdown of smaller trees may hinder the recruitment of large wood pieces that are key to maintaining channel stability and that provide habitats for vegetation and wildlife within the riparian zone. In addition, soil exposed at the root wads of fallen trees may be transported to the stream channel, increasing sedimentation. Other riparian functions, including shading, bank stabilization, and maintenance of riparian microclimates may also be affected.

Importance of Small Streams

Small streams are more affected by hillslope activities than are larger streams because there are more smaller than larger streams within watersheds (actual area and extent); smaller channels respond more quickly to changes in hydrologic and sediment regimes; and streamside vegetation is a more dominant factor in terms of woody debris inputs and leaf litter and shading. Small perennial and intermittent non-fish-bearing streams are especially important in routing water, sediment, and nutrients to downstream fish habitats.

Channelized flow from intermittent and small streams into fish-bearing streams is a primary source of sediment in mountainous regions. In steep, highly dissected areas, intermittent streams can move large amounts of sediment hundreds of meters, through RCAs, and into fish-bearing streams. In-channel sediment flows are limited primarily by the amount and frequency of flow and by the storage capacity of the channel. Flows in forested, intermittent streams are generally insufficient to move the average-sized wood piece, allowing large wood to accumulate in small channels. These accumulations increase the channel storage capacity and reduce the likelihood of normal flows moving sediment downstream.

Additional Considerations

The publication *Riparian Reserve Evaluation Techniques and Synthesis* (USDA Forest Service 1997) provides an optional toolbox of analysis methods and techniques that addresses the physical and biological elements that are necessary to delineate appropriate widths and appropriate and inappropriate management activities within or that may effect riparian functions and ecological processes. Additional literary references to consider when delineating RCAs are the following:

- 1) Quigley and Arbelbide (1997) An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins, Volume III (PNW-GTR-405, 1997); An Ecosystem Approach to Salmonid Conservation (NMFS TR-4501-96-6057, 1996);
- 2) Naiman et al. (2000) Riparian Ecology and Management in the Pacific Coastal Rain Forest Bioscience November 2000 Vol. 50 No. 11, pages 996-1011
- 3) Megahan and Hornbeck (2000) Lessons Learned in Watershed Management: A Retrospective View USDA Forest Service Proceedings Rocky Mountain Research Station – P – 13. 2000
- 4) Spence et al. (1996) An Ecosystem Approach to Salmonid Conservation December 1996 TR-4501-96-6057
- 5) USDA Forest Service (1997) Riparian Reserve Evaluation Techniques and Synthesis, Supplement to Section II of Ecosystem Analysis at the Watershed Scale: Federal Guide For Watershed Analysis. Version 2.2.

IMPLEMENTATION GUIDE FOR IDENTIFYING AND MANAGING LANDSLIDE AND LANDSLIDE PRONE AREAS

Introduction

This implementation guide describes the basis for Forest-wide landslide-prone (LSP) area management direction and provides a multi-scale step down approach to implementing management actions on LSP areas.

This implementation guide describes the basis for Forest-wide LSP area management direction and provides information for how to implement management actions on LSP areas.

Landslides are a part of a watershed's natural disturbance regime and contribute to proper watershed function and development of aquatic habitat by providing coarse sediment and LWD. The potential for accelerating landslides above some natural level should be minimized (Frissel et al. 1996). This can be accomplished in three ways: (1) Delineating LSP areas with both coarse and fine filters; (2) Developing Forest-wide management direction to properly manage these sensitive areas; and (3) Mitigating management practices based on the relative landslide hazard and associated risk(s).

Identification and development of Forest-wide management direction for LSP areas is a relatively recent requirement for implementing land management actions on the Forest. Development of the Forest-wide management direction incorporated the intent of reducing the threats associated with management actions that might initiate landslides. This Forest-wide direction is similar to the direction identified in recent documents including: Pacfish EA (USDA FS and USDI BLM 1994); INFISH EA (USDA Forest Service 1995); Steelhead Biological Opinion (US Dept of Commerce NMFS 1998); and Bull Trout Biological Opinion (USDI FWS 1998). Chapter III in this Forest Plan has goals, objectives, standards, and guidelines related to identification and management of landslide and LSP areas.

Background

The process for determining LSP areas needs to be consistent, based on the most recent science and literature, applicable from mid-scale to the site or project level, at both broad scale and fine scale, and reproducible over large geographic areas. The use of a physically based model to provide a practical alternative to using riparian buffers for the purpose of protecting potentially unstable ground was identified by Tang and Montgomery (1995). The process needed to be based in a GIS environment in order to be reproducible over large geographic areas. Ground slope and contributing drainage area obtained from Digital Elevation Model (DEM) in the GIS would also be important. Personnel at the Rocky Mountain Research Station (RMRS) in Boise, Idaho recommended several computer models (some of which are GIS based) for determining land slope stability. These models included: LISA, SHALSTAB, and SINMAP. The SINMAP (Stability INDEX MAPPING) model was found to be to best meet the needs identified above after testing with assistance from Boise State University, Utah State University, and RMRS personnel (Dixon et al. 1999). SINMAP is a terrain stability mapping tool that has application in areas that experience shallow translational landsliding, the dominate type of landslide found within the Forest (Megahan et al. 1978, Clayton 1983, Dixon 2001).

SINMAP Model

LSP maps/coverages were developed using the SINMAP model (Pack et al. 1997) and a relatively large database of actual landslides to assist in the calibration of the model. The SINMAP model has accurately delineated the pattern of landsliding in British Columbia (Pack et al. 1997) and meets the intent of the 1998 Steelhead BO that states, "To define landslide prone areas, utilize methods described by Prellwitz et al. (1994), or use at least an equivalent peer reviewed methodology with at least a 90 percent probability of identifying landslide prone slopes." SINMAP is also mentioned as a tool for analyzing shallow landsliding potential in the recent publication, *Roads Analysis: Informing Decisions About Managing The National Forest Transportation System* (USDA Forest Service 1999).

SINMAP is an Arc View extension that implements the computation and mapping of a slope stability index based upon geographic information, primarily digital elevation data. SINMAP has its theoretical basis in the infinite plane slope stability model with wetness obtained from a topographically based steady state model of hydrology. The SINMAP model uses landslide initiation points (identified in the field or through aerial photos) in GIS and three input parameters (T/R; C'; and Phi) to calibrate the model. The term T/R is the ratio of transmissivity to the effective recharge rate of the storm being modeled. T/R may be abstractly thought of as the slope distance required for soil saturation on a straight slope. The term C' is dimensionless cohesion of soil. The term is a combination of root and soil cohesion divided by soil depth. The term Phi is the internal angle of friction of the soil. The SINMAP model uses uniform probability distributions of the input parameters using a lower and upper limit. This approach reflects the uncertainty associated with estimating parameters in terrain stability mapping (Prellwitz et al 1994, Dixon et al. 1999).

DEM methods are used to obtain slope and catchment areas for each individual pixel mapped. Input parameters are allowed to be uncertain following uniform distributions between specified limits. Input parameters are adjusted and calibrated for geographic "calibration regions" based upon landform, soil, vegetation, climatic, and/or geologic data. The calibration involves an interactive visual calibration that adjusts parameters while referring to observed landslides (mapped in GIS). The calibration involves adjustment of parameters so that the stability map "captures" a high proportion of observed landslides in

regions with low stability index, while minimizing the extent of the low stability regions. The SINMAP modeling produces a stability index for each pixel of the DEM analyzed. The pixels are then grouped into four relative hazard classes (stable, low, moderate, and high) based on their calculated stability index.

Step-Down Implementation Process

This guide is not intended to be a decision-making process but will assist in informing land managers in making decisions related to management of LSP areas and potential hazards and risks to other resources. It is to be used in conjunction with the Forest-wide management direction associated with landslide and LSP areas (see Chapter III of the revised Forest Plan). A step-down process for using information at multiple scales to aid in decision-making will be implemented using a coarse filter and fine filter approach to ensure that decisions on management actions will be informed.

The coarse-filter programmatic LSP hazard coverage can be used qualitatively to make relative comparisons between areas, and to identify those that should be targeted for additional fine-filter verification associated with proposed management actions. The SINMAP model and the associated Forest-wide programmatic coarse-scale LSP maps (as well as other appropriate methodologies) are to be used by investigators who have some knowledge and experience concerning landslide behavior and geotechnical properties of soils. The model requires professional judgment and common sense (in the field and office), both in developing input coefficients and interpreting the results. It does not give a unique “right” answer. This is a tool to help understand slope stability processes; to quantify/qualify observations and judgments; and to document and communicate those observations and judgments to land managers. The computer modeling should be used to focus on specific areas of concern for on-the-ground field verification of LSP areas.

SINMAP or other appropriate methodologies do not provide a complete risk analysis; the risk or consequence of potential failures needs to be evaluated by the user. The user may want to assess the potential damage to aquatic habitat and soil productivity, or to roads and structures, or the potential for injury or loss of life resulting from landslides. As an example, two slopes may have the same estimated LSP hazard. However, if an anadromous spawning area or bridge lies below one of the slopes and not the other, the risks associated with the failure of the first slope are much greater than are those associated with the other slope. This guidebook is not intended to serve as a comprehensive risk analysis tool.

Coarse Filter Process and Intended Use

The LSP coarse filter has been completed and the results are in the form of a Forest-wide GIS coverage that has rated each 30-meter topographic cell a relative LSP hazard rating (stable, low, moderate and high) (Dixon et al. 1999). This coarse-filter modeling effort results in a relatively conservative estimate and identifies where additional field verification (fine filter) is warranted for proposed management actions.

This coarse-filter process utilized numerous landslide initiation points and a stratification of the Forest’s land base (approximately 2-3 million acres) using groupings of landtype associations. The relatively rich landslide inventory database on the Forest, combined with 15 groupings of landtype associations to assist in the calibration of the SINMAP model, enabled a relatively accurate identification of LSP areas for the coarse filter.

Additional landslide hazard modeling at finer scales (project or watershed areas) allows for more detailed analysis based on site-specific parameters. Locally based landslide inventories are important for developing site-specific parameters for modeling, as well as criteria for field verification of LSP areas.

Accurate landslide locations in GIS greatly assist in the calibration of the SINMAP model. Inventoried landslide data gathered on the ground--such as ground slope, soil depth, soil texture, vegetation, slope shape, slope position, and contributing area--provide valuable information for both modeling and field verification of LSP areas. The accuracy in identification of LSP areas and their relative hazards will increase as more data is available through fine-filter analysis. When considering the percentage of land area involved in landslides, we must realize that LSP areas may actually occur on a relatively small portion of the landscape. Published landslide inventories indicate values on the order of 0.5 to 15 percent of the area inventoried (Ice 1985). As more fine-filter data (field verification and data from landslide inventories) become available, the certainty in identifying LSP areas should increase.

The following Forest-wide management direction based on the coarse and fine filters applies to both Forest-wide and project-level analysis:

SWRA Standard 12 - Site-specific analysis or field verification of broad-scale landslide-prone models shall be conducted in representative areas that are identified as landslide prone during site/project-scale analysis involving proposed management actions that may alter soil-hydrologic processes. Based on the analysis findings, design management actions to avoid the potential for triggering landslides. Refer to the *Implementation Guide for Management on Landslide and Landslide Prone Areas* located in Appendix B to help determine compliance with this standard.

SWRA Guideline 3 - Where proposed management actions may alter soil-hydrologic processes, representative sample of landslides and landslide-prone areas should be field-verified to identify and interpret controlling and contributing factors of slope stability. Integrate the resulting information with supporting data to provide a final stability assessment and identification of appropriate land management actions in landslide and landslide-prone areas. Refer to the *Implementation Guide for Management on Landslide and Landslide Prone Areas*, located in Appendix B.

SWRA Guideline 4 - General Field Verification Procedures for Landslide and Landslide-Prone Areas: Six major groups of known characteristics should be investigated to supply information adequate to characterize unstable conditions. These are:

- Landform
- Overburden
- Geological Processes on the Hillslope
- Bedrock Lithology and Structure
- Hydrology
- Vegetation

Refer to the *Implementation Guide for Management on Landslide and Landslide Prone Areas*, located in Appendix B.

Fine-Filter Process and Intended Use

Verification through a combination of field work, aerial photograph analysis, and further SINMAP modeling, will reclassify the relative slope stability hazard rating for a given area. This reclassification increases the accuracy/probability of identifying LSP hazards and assists in the development of management practices appropriate for the site, thereby greatly reducing the threats of negative effects to other resources.

The fine-filter process is intended for field verification and reclassification of the coarse filter LSP area coverage. Field evaluation of slope stability is warranted along road corridors, for timber sale areas and associated harvest units, and other site-specific management actions with the likelihood of modifying

landslide processes. Proper management of LSP areas is not based solely on the effects to fish habitat but also effects to long-term soil productivity, water quality, and watershed function, and identifying risks to life and property.

Measures for Avoidance and Prevention of Landslides on LSP Areas

Measures for avoidance and prevention of landslides associated with management actions on LSP areas are improved through fine-filter verification. Recognition and avoidance of high-risk LSP areas are the most effective and cost-efficient methods in implementing management actions. On extreme slopes, abandonment of the area may be the best environmental and economic solution. In most instances within the Forest, the LSP portion of a slope covers only a small area. Megahan et al. (1978) found that, of more than 1,400 landslides inventoried, 90 percent occurred in drainages of four hectares (about 10 acres) or less. Careful field verification can locate the LSP areas. Often they may be easily avoided during road location or deleted from the timber harvest units. Slight changes in the road location or changes in road grade are often adequate to bypass the LSP area. Chapters 3 and 4 of the publication, *A Guide for Management of Landslide-Prone Terrain in the Pacific Northwest* (Chatwin et al. 1994) provide good assistance in both field-identifying landslide prone areas and developing site-specific management practices and mitigation on LSP areas.

In order to avoid or prevent landslides, it is important to understand what disturbances (management-related or natural) have a greater potential to initiate landslides. Road construction is the main destabilizing activity related to forest management actions. Megahan et al. (1978) found that 58 percent of management-related landslides were related solely to roads, while forest vegetation removal accounted for only 9 percent of landslides. Roads in combination with logging or wildfire accounted for 88 percent of all management-related landslides. Gucinski et al. (2001) identified several studies where landslide erosion from roads was one to several orders of magnitude higher than forest vegetation management.

The effects of wildfire may also greatly influence occurrence of landslides. Shaub (2001) found that, of 246 landslides inventoried in the South Fork Payette River watershed near Lowman, Idaho, occurrences of landslides within the burned area of the 1989 Lowman wildfire was 2.5 times greater than in the unburned area. None of these landslides was attributed to past or current management actions. Megahan et al. (1978) postulates that careful land use decisions, considering the amount and nature of disturbance and various site factors, can substantially reduce the occurrence of landslides and the magnitude of their effects.

Fine-filter LSP areas are more accurately identified, allowing for increased accuracy and probability of identifying LSP hazards and assisting in the development of management practices appropriate for the site. Depending on the proposed management action and the associated relative LSP rating, a variety of management practices may be developed. These practices vary based on the type and potential effect of management action and the relative landslide prone hazard in which actions will occur. In general, land managers should consider the following contributing factors when designing and implementing management actions that might initiate or contribute to landslides.

- Altering vegetation can affect landsliding potential. Large blocks of tree mortality caused by wildfire, insects and disease, or logging can decrease evapotranspiration and raise ground water tables (T/R). The increased ground water can add to the slope instability on LSP areas during storm events that may initiate landsliding.
- Rooting strength of vegetation in LSP areas is a major factor adding stability to the slopes. Altering the vegetation by management practices such as timber harvest and controlled burning has the potential to affect rooting strength (C'). Wildfires also alter vegetation (sometimes greatly with

uncharacteristic wildfires), causing tree mortality and affecting rooting strength. Trees provide the greatest amount of rooting strength on forested slopes. Generally the larger trees have a more developed root system and provide more stability to the slopes. Tree species such as ponderosa pine that have a deep tap root provide deeper rooting strength and more stability than similar size species like Douglas-fir that do not have a deep tap root. Burroughs and Thomas (1977) indicates that since a relatively high percentage of mass failures (landslides) occur on areas burned over by wildfires compared with undisturbed forests, that declining root strength following death of trees is an important factor in mass failure of shallow soils on steep slopes in the Idaho Batholith.

- Soil depth influences landslide potential. Deeper soils tend to slide on less steep of a slope than shallow soils. Soil properties affect landslide potential. Rocky soils with angular rock fragments have a higher internal angle of friction than soils with only minor amounts of rock fragments. The soils with a higher internal angle of friction will be more stable than soils with low internal angle of friction on the same slope gradient. Soils with coarse angular sands have a higher internal angle of friction than soils composed of fine sands. For example, oversteepened granitic canyonlands with shallow non-cohesive soils are more susceptible to landslides than maturely dissected mountain slopes with deep loamy skeletal soils.
- The water collection area above a potential landslide prone area has a major influence on landslide potential. Areas where water tends to collect--such as the head of ephemeral draws, bowl shaped areas, and hollows--tend to have high groundwater levels during storm events (T/R) that initiate landslides. Soils at or near saturation tend to have less strength and are more prone to landslides than soils with lower groundwater levels. For example, 3 feet of soil at the head of an ephemeral draw on a 60 percent slope at or near saturation would be much more prone to landslides than 3 feet of soil on a 60 percent slope where the groundwater table is lower.
- Roads have the potential to affect landsliding in several ways. Roads alter the natural ground slope with cuts and fills. Road cuts may destabilize slopes above the cuts by removing material that provided stability to the slope above. Road fills place additional material on slopes that tends to load the slope below the road, increasing the risk of mass failures. Road drainage features such as dips and culverts tend to collect water and concentrate it on slopes below. The additional water can add instability to the slopes. Care should be taken with road drainage so that water is not collected and concentrated on LSP areas below roads.

Other risks should be considered when proposing practices on LSP areas. One major factor is what lies within the path of the landslide that it could potentially affect. Landslides that initiate in the heads of ephemeral draws often trigger channel-scouring debris torrents that can disturb a larger area within a stream channel than the landslide itself. Landslides and their associated debris torrents can and have blocked highways, damaged homes, and other facilities. Deeply scoured channels can take several decades to recover, and are persistent sediment sources due to the raw and oversteepened banks. This sediment may have a lasting effect on water quality and fisheries habitat. Existing and proposed facilities should be located in areas away from the mouths of steep-gradient streams and draws where there is potential for damaging debris torrents initiated by landsliding.

Methods for avoidance and preventing landslides may include but are not limited to:

- Standard Practices – (In Stable and Low Hazard Areas) No special restrictions on management actions are needed as long as the actions are in compliance with other Forest-wide or management area direction.

- Limited Practices – (In Moderate Hazard Areas with Low to Moderate Relative Risk) Management actions are designed with review and guidance of appropriate resource specialists. Limited practices may include but are not limited to: reducing yield or basal area removal of forested vegetation, increased rotation lengths, selective harvest with full suspension yarding, relocating existing or proposed road alignment, improving road drainage design, etc.
- Restricted Practices – (In High Hazard or Moderate Hazard Areas with High Relative Risks) Management actions are severely restricted or eliminated so as to minimize initiation of landslides and effects to other resources.

Chapter 2 in the publication, *A Guide for Management of Landslide-Prone Terrain in the Pacific Northwest* (Chatwin et al. 1994) has a good discussion and field evaluation forms that may serve as a good reference to assist in completing fine-scale field verification.

AQUATIC CONSERVATION STRATEGY

Introduction

The Aquatic Conservation Strategy (ACS) strategy provides direction to maintain and restore characteristics of healthy, functioning watersheds, riparian areas, and associated fish habitats. How these components are applied at the subwatershed and site-specific levels will affect the types and outcomes of management actions and will therefore be an overriding factor that influences potential effects for SWRA resources.

The intent of this section is to examine the eight components of the ACS and the level of protection to demonstrate how they address the threats associated with the factors of decline and provide for recovery and restoration of listed species, their habitat, and SWRA resources. For further detailed description of the eight ACS components refer to Section III.E in the Biological Assessment for the SWIE Revision.

The Forest Plans were developed to provide direction (i.e., goals, objectives, standards and guidelines) for broad classes of management activities and land and water management practices that may affect SWRA resources. Embedded within the ACS, Forest Plans provide policy guidance and requirements. The ACS is a long-term strategy to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within lands administered by this National Forest. It is a refinement and furtherance of approaches outlined in the ICBEMP Implementation Strategy and the USFWS and NMFS 1998 Biological Opinions.

The eight ACS components are identified below. Each component is discussed in detail, including its role in addressing reduction of threats associated with factors of decline and/or its role in a comprehensive recovery and restoration strategy for listed fish species and their habitats. Any of these components has the potential to influence any of the factors of decline or the recovery/restoration strategy.

1. Goals to Maintain and Restore SWRA Resources
2. Watershed Condition Indicators for SWRA Resources
3. Delineation of Riparian Conservation Areas (RCAs)
4. Objectives, Standards, and Guidelines for Management of SWRA Resources, including RCAs
5. Determination of Priority Subwatersheds within Subbasins

6. Multi-Scale Analyses of Subbasins and Subwatersheds
7. Determination of the Appropriate Type of Subwatershed Restoration and Prioritization
8. Monitoring and Adaptive Management Provisions

The ACS provides a scientific basis for protecting aquatic ecosystems; providing for a comprehensive short and long-term recovery of listed fish species; restoration of aquatic habitats and surrounding terrestrial uplands; de-listing of water quality impaired water bodies; and planning for sustainable resource management. In essence, this strategy integrates many of the goals and objectives of both the ESA and the Clean Water Act.

The eight components of the ACS are designed to work in concert to maintain and restore the productivity and resilience of watersheds and their associated aquatic systems. The following discussion reviews each of the eight ACS components and how they reduce threats and or assist in the recovery/restoration of listed fish species, their habitats, and SWRA resources.

ACS Component 1. Goals To Maintain And Restore SWRA Resources

ACS Component 1 serves to reduce the threats associated with the factors of decline and contributes to the comprehensive recovery and restoration strategy for listed fish species and their habitats. The ACS goals, objectives, and management actions are integrated with the other resource and social-economic components of the ecosystem. Ecosystems are healthy and sustainable when their intertwined components and processes are functioning properly, in the context of the desires and needs of society. The ACS components and processes are woven together by the thread of succession/disturbance regimes (e.g., wildfire, landslides, floods, insects and disease) and ecological processes (e.g., flows and cycles of energy, nutrients, and water). Intact succession/disturbance regimes provide for aquatic and terrestrial habitats, intact hydrologic processes, and the continuous and predictable flow of products and land uses. These landscape considerations and their dynamics are the cornerstone of the combined Forest-wide SWRA goals.

The goals to maintain and restore SWRA resources establish a vision of management direction that reduces threats associated with the factors of decline with the expectation that this will promote the characteristics of healthy, functioning watersheds, riparian areas, and associated fish habitats. Because the quality of water and fish habitat in aquatic systems is inseparably related to the integrity of upland and riparian areas within the subwatersheds, the goals encompass both aquatic and terrestrial processes and functions.

The long-term ACS and associated goals to maintain and restore SWRA resources greatly reduce threats and risks of negative effects to listed fish species, resident fish, and water quality conditions in several ways. Primarily, the goals provide the basis for management direction that will be applied to all activities that can affect SWRA and related resources, including listed fish species and their habitats. Other ways that the goals reduce threats and contribute to recovery/restoration include:

- Goals to restore and maintain SWRA resources have been coordinated and integrated with the goals of other resource areas.
- The predicted production of goods and services for key resources has been adjusted to show a more realistic potential for achieving resource goals. For example, RCAs and high landslide prone areas were removed from the suited timber base to indicate that these areas will not be used as a source of predictable timber supply.

- Forest vegetation management goals and their associated management actions (mechanical harvest, fire use and road-related activities) were analyzed using the Cumulative Watershed Effects (Menning et al. 1996) approach for each subbasin to determine their feasibility and compatibility with aquatic resources and water quality beneficial uses.
- Goals identify the destination toward which objectives move baseline conditions during the life of the planning period. There are numerous Forest-wide and Management Area riparian-related goals with associated objectives that spatially and temporally identify restoration prioritization based on the long- and short-term recovery needs of listed fish species and the de-listing of water quality impaired water bodies.
- Goals to restore and maintain SWRA resources were developed with an interdisciplinary team approach to make them understandable, consistent, and capable of being implemented. This approach will further reduce the potential for negative effects from misinterpretation in the planning and implementation of management actions.
- Goals have been developed to achieve the desired conditions described in the TEPC Species and SWRA Resources sections in Chapter III of the Forest Plan, and in the Desired Conditions Common to All Resources section. These desired conditions, in general, envision a landscape that maintains and restores productive and sustainable ecosystems, of which SWRA and TEPC resources are inextricably linked.

ACS Component 2. Watershed Condition Indicators For SWRA Resources

ACS Component 2 serves to reduce the threats associated with the factors of decline and contributes to the comprehensive recovery and restoration strategy for listed fish species and their habitats. WCIs represent diagnostic indicators of the health and trend of watersheds and associated aquatic systems. The WCIs identify various biological and physical components of aquatic systems and associated terrestrial uplands that influence riparian functions and ecological processes. The WCIs are organized into eight Pathways that represent the processes or mechanisms by which management actions can potentially affect watersheds, listed fish species, native and desired non-native fish species and their habitats, and beneficial uses.

The evaluation of WCIs provides a consistent and logical line of reasoning to recognize when, where, and why adverse, beneficial, or no effects may occur to related resources. WCIs are not independent from other components of the ACS but provide a starting point to describe the current and desired conditions for uplands, riparian areas, water quality, and aquatic habitat.

Evaluation procedures consider the suite of WCIs that are likely to be affected by proposed management actions, not just effects to any individual WCI. WCIs are described in terms of how they are functioning (Functioning Appropriately, At Risk, or At Unacceptable Risk), with Functioning Appropriately representing the range of desired conditions to strive toward for each WCI. The WCIs incorporate riparian functions and ecological processes of the entire watershed.

The step-down implementation process is outlined later in this Appendix. This process will assist land managers with making informed decisions by determining the relevant WCIs that should be considered when proposed management actions may affect the habitat of listed fish species; inland native; or desired non-native fish; or water quality beneficial use status.

The Matrix of Pathways and Watershed Condition Indicators is a combined matrix based upon individual USFWS and NMFS Matrices. It assesses potential threats of management actions. The use of this matrix can greatly reduce the risk of negative effects to listed fish species, resident fish and water quality conditions by providing:

- A process to identify how management actions may potentially influence the condition and trend of SWRA resources, including native and desired non-native fish species and their habitats, and beneficial uses;
- A decision framework to assist decision makers in ensuring that management actions will not retard or prevent attainment of properly functioning SWRA desired conditions;
- A tool to assist in making ESA determinations of effects to listed fish species important to assessing ESA compliance;
- A clear and comprehensive set of terms/definitions and Forest-wide standards and guidelines to help prevent degradation of areas that currently surpass the WCIs range of desired conditions, are within the range of, and are currently below the range of WCIs;
- A benchmark by which changes to landscape conditions through management activities can be measured over time;
- Criteria against which attainment or progress toward attainment of multiple goals, standards and guidelines in Chapter III of the Forest Plans can be directly or indirectly measured;
- Criteria for different scales of evaluation, important for assessing effects of project-level management in context of multiple scales.

ACS Component 3. Riparian Conservation Areas – Delineation

ACS Component 3 serves to reduce the threats associated with the factors of decline and contributes to the comprehensive recovery and restoration strategy for listed fish species and their habitats. Aquatic and riparian systems are easily affected by land management activities within RCAs and on the surrounding terrestrial uplands. RCAs contribute to maintaining the integrity of aquatic ecosystems by (1) influencing the delivery of coarse sediment, organic matter and woody debris to streams; (2) providing root strength for channel stability; (3) shading the stream; and (4) protecting water quality. Additional processes and functions provided by RCAs can include wildlife habitat and riparian microclimate and productivity.

Because of the importance of riparian systems on the integrity of aquatic ecosystems that support listed fish habitat, appropriate delineation of RCAs is needed. Recent discoveries about the structure and dynamics of riparian zones have extended the scope of understanding about this portion of the landscape and have important management implications for streams, riparian areas, and adjacent uplands (Spence et al. 1996, Quigley and Arbelbide 1997). The process and methodology for RCA delineation is described in detail earlier in this Appendix.

Implementation of the “Guidance for Delineation and Management of Riparian Conservation Areas” in this Appendix would substantially reduce threats associated with the design and implementation of management actions. This implementation guide provides a consistent and thorough procedure in the delineation of appropriate RCAs across the Forest. The reduction of threats is based on the following:

- The range of options that may be used to delineate an RCA allows land managers to determine the level of analysis that best suits the needs of a project based on potential effects, baseline conditions,

management direction, and issues. Regardless of the option chosen, the RCA delineation provides for consideration of riparian functions and ecological processes.

- The integration of Forest-wide management direction and guidance for delineation of RCAs defines the type and levels of management actions that are suitable within or adjacent to RCAs.
- The effectiveness of delineating an appropriate RCA provides decision-makers with the information necessary for sound decisions regarding management activities within a subwatershed. An understanding of riparian functions and ecological processes, and the means by which actions may affect them, allows decision makers the opportunity to design activities to maintain or restore listed fish species, their habitats, and other SWRA resources.
- RCA delineation makes use of information obtained through multi-scale analysis (ACS Components 6 and 7) to determine the appropriate scale for assessing the different riparian functions and ecological processes that need to be addressed.
- Delineation of RCAs establishes a network of refugia that promotes the conservation of listed fish species while preserving and restoring riparian function and ecological processes;
- RCA delineation will use data collected at mid-, fine-, or project scales to ensure that site-specific riparian function and ecological processes are maintained or restored.

ACS Component 4. Objectives, Standards, And Guidelines For Management Of SWRA Resources, Including RCAs

ACS Component 4 serves to reduce threats associated with the factors of decline and contributes to the comprehensive recovery and restoration strategy for listed fish species, their habitats, and SWRA resources. Management direction within Chapter III in the Forest Plan includes Forest-wide direction, Management Area direction, and Management Prescription Category direction. Together this direction provides the operating sideboards for implementation of management activities designed to further the achievement of the ACS components as well as other resource goals described in the Forest Plan. Specific objectives designed to achieve Forest-wide management goals are also included in this ACS component.

The development of the long-term ACS and associated objectives, standards, and guidelines to maintain and restore SWRA resources primarily reduces threats and the risks of negative effects to listed fish species, resident fish, and water quality conditions by providing protection necessary to conserve listed fish species and water quality, and direction to maintain or restore priority subwatersheds. The reduction in threats and risks of negative effects is accomplished under this ACS component in a variety of ways:

- The development of the objectives, standards and guidelines to restore and maintain SWRA and other related resources was coordinated and integrated with direction for other resource areas to ensure compatibility and consistency in implementation.
- Forest vegetation management direction and associated management actions (mechanical harvest, fire use and road-related activities) were analyzed using a Cumulative Watershed Effects methodology (adapted from Menning et al. 1996) for each subbasin to determine feasibility and compatibility with the values of aquatic resources and water quality beneficial uses.

- Objectives have been designed that will achieve goals both spatially and temporally, address resource concerns and needs, and move existing conditions toward desired conditions over the life of the planning period.
- The development of objectives, standards, and guidelines to restore and maintain SWRA resources was done through coordination between a Level 1 consultation team and an interdisciplinary team to make them clearly understood, and ensure direction could be implemented when integrated with other resource objectives. This integration reduces the likelihood of delays in movement toward achieving goals due to incompatible direction.

ACS Component 5. Priority Subwatersheds Within Subbasins

Note: The results of ACS Component 5 are a result of the multi-scale PFC assessment and analysis in ACS component 6 and its fine-tuning in ACS Component 7. Therefore, it is important to review all three ACS components (5, 6, and 7) to gain a complete understanding of the effects of these components.

ACS Component 5 serves to reduce the threats associated with the factors of decline and contributes to the comprehensive recovery and restoration strategy for listed fish species, their habitats, and SWRA resources. Priority subwatersheds have been identified that provide a pattern of protection and restoration across the Forest for the recovery of threatened and endangered fish species, the de-listing of water quality impaired water bodies, and the restoration and maintenance of SWRA resources. The identification and management of these priority subwatersheds are designed to complement other recovery/restoration plans and build on actions already taking place to recover these species and de-list impaired water bodies.

The process used to identify ACS priority subwatersheds for the ACS is described in Section III(E)(6) of the Biological Assessment for the SWIE Revision. ACS priority subwatersheds have the highest priority for restoration, monitoring, and future multi-scale analysis. In addition, each ACS priority subwatershed is identified in its respective management area direction. The management areas have objectives for the priority and appropriate type of restoration/conservation. Additional management area standards and guidelines further reduce potential impacts associated with other resource management actions. ACS priority subwatersheds reduce threats and contribute to recovery or restoration through the following:

- Management area direction applied to ACS priority subwatersheds reduces site-specific threats to aquatic and watershed values from management actions;
- Management Area direction recognizes the ACS priority subwatersheds as meriting specific management consideration of their aquatic and watershed values during the planning and implementation of management actions.
- Specific management area objectives identify and prioritize the need for restoration or conservation;
- Forest-wide management direction requires that the Watershed and Aquatic Recovery Strategy be updated every 2 years, thus contributing to the effectiveness of the recovery plans for listed fish species and de-listing of water quality impaired water bodies.
- The ACS priority subwatershed designation increases the chance to successfully obtain funding and implement restoration by providing out-year project opportunities and a ready source of needed projects that are part of a mid-scale recovery strategy;

- ACS priority subwatersheds are identified for all subbasins regardless of whether listed fish species occur within them. This allows for appropriate conservation of all resident fisheries and de-listing of water quality impaired water bodies.
- ACS priority subwatersheds are identified for each subbasin and provide a “blue print” of short-term recovery while identifying those subwatersheds important for the long-term recovery of the listed fish species.
- The ACS provides a long-term focus for conservation and restoration of high quality strongholds of listed fish species habitat and restoration prioritization of subwatersheds required for further expansion and re-colonization of fish species to adjacent subwatersheds.

ACS Component 6. Multi-Scale PFC Assessment Of Subbasins And Subwatersheds

ACS Component 6 contributes to the comprehensive recovery and restoration strategy for listed fish species, their habitats, and other SWRA resources. The Forest completed a Properly Functioning Condition (PFC) assessment that provides a multi-scale context between each subbasin and its subwatersheds, and identifies current and potential population status, habitat condition and restoration needs, and management risks and opportunities to meet broad-scale and mid-scale objectives through subsequent site-specific management actions. This assessment assessed the current condition of the SWRA resources based on the integration of soil-hydrologic function, dynamic stream equilibrium, associated aquatic habitat, status of listed and native fish populations, and other resource conditions (vegetation hazard, road transportation system, unroaded and undesignated low road density areas, wildland urban interface areas, etc.) for the subbasins and their respective subwatersheds.

The multi-scale assessment provides a step-down implementation process that forms the basis for a much bigger picture of effects (direct, indirect, cumulative effects at a programmatic scale) on the sustainability and recovery of listed fish species and de-listing of water quality impaired water bodies. The assessment shows how an individual subwatershed contributes to recovery of a species within a subbasin. As such, the ACS presents an interim recovery strategy until formal recovery plans are issued for listed fish species.

The multi-scale assessment served as the groundwork in the development of the comprehensive ACS that was used in the development of management direction to support the goals, objectives and requirements of the ESA, CWA, and other fish and water quality statutes. The Forest Plan also requires the update of the WARS environmental baseline, the foundation for the multi-scale assessment, every two years with available data and new science findings. These updates ensure an appropriate, comprehensive, and current ACS to assist in the recovery of listed fish species and de-listing of water quality impaired water bodies.

At a subwatershed scale or site-specific project scale the potential for a management action to contribute to conditions that will positively or negatively contribute to the broader-scale goals and objectives can be completed by viewing project level effects in context to the multi-scale assessment completed in support of Forest Plan revision and other broader-scale assessments (e.g., NWPC Subbasin Assessments, Final Basinwide Salmon Recovery Strategy, and Final Bull Trout Recovery Plans).

The Multi-scale PFC assessment provides a multi-scale context of each subbasin and its respective subwatersheds' baseline and potential status of population and habitat conditions to develop site-specific management actions to make progress towards attainment of ACS goals. This ACS

component provides the appropriate scales to ACS components 5, 7, and 8, that prioritize, design, and evaluate management actions needed to move towards ACS goals and the conservation of the listed fish species, their habitats and other SWRA resources. Other ways that the multi-scale PFC assessment contributes to recovery or restoration include:

- The subbasins and associated subwatersheds on the Forest have had consistent and comprehensive multi-scale PFC analyses that have resulted in identification of priority subwatersheds, the appropriate type of approach to subwatershed restoration, and the prioritization of subwatershed restoration.
- The results of the multi-scale assessment have been incorporated into many facets of the Forest Plan such as Forest-wide objectives, standards and guides; Management Area specific objectives that recognize the importance and value of priority subwatersheds; and development of specific Management Area objectives for restoration and recovery.
- Identification of unroaded and undesignated low road density areas and their use in determining the condition of geomorphic, water quality and aquatic integrities for each subwatershed and their importance to recovery and restoration goals;
- Forest-wide management direction requires that the Watershed and Aquatic Recovery Strategy be updated every two years, which will contribute to a more effective recovery plan for survival and recovery of listed fish species and de-listing of water quality impaired water bodies.
- Multi-scale analyses are required or recommended in support of management actions as identified in the following Forest-wide management direction: Roads Analysis identified in the FSM 7700 – Transportation Analysis; FSM 2671.45 - Consultation and Conference; FSH 2509.22 - SOIL AND WATER CONSERVATION PRACTICES FSH (R-1/R-4 AMENDMENT NO. 1) PRACTICE: 11.01 - Determination of Cumulative Watershed Effects:
- Regional and Forest Program Managers can use this information and work with District Program managers to bring the larger picture (subbasin-scale layer) of restoration into consideration when planning watershed-scale and site-scale analyses and projects.

ACS Component 7. Determination Of The Appropriate Type Of Subwatershed Restoration And Prioritization

ACS Component 7 contributes to the comprehensive recovery and restoration strategy for listed fish species and their habitats. Identification of both the appropriate type and prioritization of subwatershed restoration/conservation is integrated into all the ACS components. ACS Component 7 identified the appropriate restoration type and subwatershed restoration prioritization for subwatersheds within their respective subbasins.

Inherent in the classification approach of ACS Component 7 is the identification of active, passive, and conservation restoration opportunities based on the subwatershed's geomorphic integrity (GI), water quality integrity (WQI), aquatic integrity (AI), and vulnerability ratings. Together, these ratings provide the information needed to identify the capacity of the subwatershed to restore itself

naturally to a desired condition. The ratings also indicate the acceptable or needed time period for restoration in order to determine the type of approach (restoration or conservation) to be used. The determination of types and priorities of restoration activities incorporated information on the entire subwatershed, including the current status and recovery needs of listed fish species.

This restoration priority rating, in conjunction with the restoration type and overall priority watershed classification, provides the focus for the long-term ACS recovery of listed fish species and TMDL watersheds. The spatial display of this restoration strategy is the WARS Map, on file in the Forest's GIS library.

Recovery and restoration activities are prioritized based on the presence and sensitivity of listed fish species, impaired water bodies, and the capacity for response of the subwatershed's ecosystem processes. This restoration prioritization approach formulates the template for recovery and restoration by:

- Consistently applying the restoration type (conservation, active, or passive) and prioritization for subwatershed restoration to all subwatersheds within their respective subbasins across the Forest,
- Providing an efficient means to promote restoration activities and recovery of listed fish species and de-listing of water quality impaired water bodies;
- Increasing the chance to successfully obtain funding and implement restoration by providing out-year project opportunities and a source of needed projects that are part of a mid-scale recovery strategy;
- Influencing the placement of MPCs within a Management Area's subwatersheds.

ACS Component 8. Monitoring And Adaptive Management Provisions

ACS Component 8 serves to reduce the threats associated with the factors of decline and contributes to the comprehensive recovery and restoration strategy for listed fish species and their habitats. One of the lessons learned from implementing the original Forest Plan is that it must be dynamic to account for a multitude of issues. The Forest monitoring plan accomplishes five items: (1) it bases the level of monitoring on the commensurate level of management actions; (2) it provides feedback on the effects of activities; (3) it has a mechanism for monitoring accountability and oversight, (4) it evaluates the implementation and effectiveness in the recovery/restoration of listed fish species, their habitats, and other SWRA resources; and (5) it incorporates the monitoring goals identified in the ICBEMP Implementation Strategy and associated MOU.

This plan has a feedback loop that provides management with the information necessary to make appropriate adjustments to individual activities and Forest-wide programs. The feedback loop allows management adjustments as needed to continue moving towards attainment of ACS goals, recovery of listed fish species, restoration of their habitats, and to assist in the delisting of water quality limited waterbodies. If monitoring concludes a specific restoration practice is ineffective or riparian conditions are not being maintained over a number of sites, changes to management practices will be implemented. Those threats that are easily recognized will be dealt with quickly. Monitoring and adaptive management would reduce threats and contribute to recovery or restoration by the following:

- In some cases, low levels of negative effects from either an individual action or aggregate effects from multiple actions may persist until monitoring can alert managers to the need to change management practices or an adjustment in forest plan direction. The adaptive management process will use monitoring results to ensure forest plan direction is effectively reducing threats to listed fish species, their habitats, and other SWRA resources. If not effective, adaptive management will adjust forest plan direction as necessary;
- Adaptive management provides the mechanism to modify management actions in response to monitoring and evaluation results, changes in laws or regulations, or new information. This includes the ability to make appropriate modifications to restoration direction, mitigation measures, budgets, and monitoring approaches;
- The monitoring program will be complementary with ongoing broad- and mid-scale monitoring programs, for example the Pacfish and Infish Interagency Implementation Team monitoring program. This will allow Forest monitoring to be included with basin-level assessments of recovery/restoration activities for listed fish species and their habitats. Monitoring will be conducted at multiple scales to ensure that management actions are consistent with the context of broad and local recovery and restoration goals and objectives;
- Effectiveness, implementation, and validation monitoring over the life of the plan will be key to determining if individually and collectively management actions have maintained or improved SWRA resources. Multiple sites, representing various ecological conditions, across the Forest will be used. A similar approach will also address changes in TEPC species distributions and abundance, and success of restoration and conservation measures in moving subwatersheds toward their desired conditions.
- Accountability and oversight provided by the monitoring plan will allow adjustments needed to ensure the appropriate rate in achieving restoration goals and objectives is being accomplished. This could include, but not be limited to, adjusting budget allocations, shifting restoration prioritizations, or changing management direction or level of activity for a given area.

Definitions Of ESA Effects Thresholds And Examples

The following are definitions of ESA effects or effects determinations, including thresholds and examples.

Adverse Effect - For Forest Plan revision, “adverse effect” is used in the context of the Endangered Species Act relative to effects on Threatened, Endangered, Proposed, and Candidate (TEPC) species. Definitions are from the *Final Endangered Species Consultation Handbook* (USDI FWS and US Dept of Commerce NMFS 1998). They include both “likely to adversely effect” and “not likely to adversely effect”. Both of these definitions are needed to clearly understand the intent of the phrase “adverse effect” when applied to Forest-wide and management area direction involving TEPC species.

The following is a definition specific to anadromous salmonids developed by NMFS, the Forest Service, and the BLM during the Pacfish consultation and is given as example: “Adverse effects include short- or long-term, direct or indirect management-related, impacts of an individual or cumulative nature such as mortality, reduced growth or other adverse physiological changes, harassment of fish, physical disturbance of redds, reduce reproductive success, delayed, or premature migration, or other adverse behavioral changes to listed anadromous salmonids at any life stage. Adverse effects to designated critical habitat include effects to any of the essential features of critical habitat that would diminish the

value of the habitat for the survival and recovery of listed anadromous salmonids” (US Dept of Commerce NMFS 1995).

No Effect - This determination is appropriate only “...if the proposed action will literally have no effect whatsoever on the species and/or critical habitat, not a small effect or an effect that is unlikely to occur” (USDI FWS and US Dept of Commerce NMFS 1998). Furthermore, actions that result in a “beneficial effect” do not qualify as a “no effect” determination. If a “no effect” determination is derived, conference/consultation does not need to proceed, but it is recommended that these determinations be shared within the Level 1 consultation team. Documentation to substantiate this determination must be filed in the project record.

May Affect, Not Likely To Adversely Affect - “The appropriate conclusion when effects on the species or critical habitat are expected to be beneficial, discountable, or insignificant. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur” (USDI FWS and US Dept of Commerce 1998). The term “negligible” has been used in many ESA consultations in the Snake River Basin. This term is considered synonymous with “insignificant” as described above. Consultation/conference is required for this effect determination, but can proceed as informal.

May Affect, Likely To Adversely Affect - The appropriate finding in a biological assessment (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant, or beneficial (see definition of “not likely to adversely affect”). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action is “likely to adversely affect” the listed species. If incidental take is anticipated to occur as a result of the proposed action, an “is likely to adversely affect” determination should be made. A “likely to adversely affect” determination requires the initiation of formal Section 7 consultation.

For the purposes of Section 7, any action that has more than a negligible potential to result in “take” (see definition below) is likely to adversely affect a proposed/listed species. It is not possible for NOAA Fisheries or USFWS to concur on a “not likely to adversely affect” determination if the proposed action will cause take of the listed species. Take can be authorized in the Incidental Take Statement of a Biological Opinion after the anticipated extent and amount of take has been described, and the effects of the take are analyzed with respect to jeopardizing the species or adversely modifying critical habitat. Take, as defined in the ESA, clearly applies to individuals; thus actions that have more than a negligible potential to cause take of individual eggs and/or fish are “likely to adversely affect.”

Likely To Jeopardize The Continued Existence Of - The Code of Federal regulations define jeopardy as “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR §402.02).

Take - To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct [ESA §3(19)]. Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that

create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering (50 CFR § 17.3).

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Attachment B: Geosynthetic Liner Penetration by Woody Vegetation



Technical Memo

To: Dan Kline – Midas Gold Idaho, Inc.

From: Aaron English – Tetra Tech

Date: May 20, 2019

Re: **Geosynthetic Liner Penetration by Woody Vegetation**

This attachment provides an overview of the growth rates and rooting depth of lodgepole pine and Engelmann Spruce and the risk for the root systems of woody vegetation to penetrate geosynthetic liners. Some concern has been raised by the agencies that planting trees may not be appropriate or that planted trees may not survive in riparian areas associated with stream liners. However, research has shown that the risk of damage to subsurface impermeable liners as a result of tree root penetration is relatively low given adequate depth of cover over the liner.

Lodgepole Pine (*Pinus contorta* var. *latifolia*)

Growth Rate

The lodgepole pine grows to a height of 70–90' and an average diameter of 16 inches. It grows at a slow to medium rate, with annual height increases of anywhere from less than 12" to 24" per year. Application of nitrogen fertilizer may enhance growth. Height and diameter growth of lodgepole pine seedlings are higher following inoculation with ectomycorrhizae (Grossnickle, 1982).

Root Depths

Lodgepole pine develop a generally deep root system that is variable in form, depending primarily on soil type (Agee, 1993). A taproot is common, but so is profuse development of vertical sinkers from lateral roots (Koch, 1996). The taproot is dominant during seedling and sapling development, but gradually becomes less important as trees mature and develop lateral root systems. Sinker roots develop near the base of the laterals and provide the major support thereafter (Pfister and Daubenmire, 1975). Maximum rooting depth of lodgepole pine is approximately 11 feet (3.3 m) (Canadell and Ehleringer, 1996). However, growth rates and forms of growth might vary among species/subspecies and ecological setting.

Horton (1958) excavated 40 lodgepole pine in varied soils of Alberta Canada. His work extends over soils having a range of textures, moisture conditions, and fertilities. The adaptability of the lodgepole pine root system is clearly indicated. Three factors are considered predominant in modifying the genetic tendencies of lodgepole pine root systems: soil texture or structure, soil moisture, and soil fertility. These determine whether lateral or vertical root systems will be stunted, normal, or highly developed. Vertical development is particularly sensitive to these variables.

Lodgepole pine rooting habits have been described for Alberta by Horton (1958) and for northeastern Oregon by Bishop (1962). Regarding lateral rooting Horton concluded:

"Most of the lateral roots are in the top few inches of soil. They will seek out areas free of root competition, but on a fully-stocked site the root systems of adjoining trees become interwoven, and natural grafts may occur. In wet and very dry conditions both rooting extent and amount of branching are much less than on the more productive sites. For the first 20 to 25 years, maximum lateral root length was found to be about the same as stem height in the open-grown conditions sampled."

"In general, rooting is extensive at first, attaining maximum areal coverage by 30 years, well before maximum stem height growth is reached; then, nearing maturity, as tree growth requirements increase, rooting becomes much more intensive and complex."

Other studies of lodgepole pine show that trees may develop adventitious roots in response partial stem burial from flooding or other disturbance (Agee, 1988).

In conclusion, lodgepole pine can develop deeper roots (up to 11-feet) depending upon soil type. Vertical root development is most effected by soil texture or structure, soil moisture, and soil fertility. Ensuring sufficient soil depth and soil fertility should allow the use of lodgepole pine in the planting plans and the inevitable natural reestablishment of the species on reclaimed areas.

Engelmann Spruce (*Picea engelmannii*)

Growth Rate

Engelman Spruce grows to a height of 80-130 feet. It is a slow growing tree, with annual height increases of anywhere from 0.25 -0.5 inches a year. A 20 year old tree may only be 4-5-feet in height (Alexander and Sheppard, 1984) Engelmann spruce is a long-lived tree, maturing in about 300 years.

Root Depths

Engelmann spruce is considered to have a shallow root system. Under most growing conditions, roots of the Engelman spruce are in the first 12 to 18 inches of soil. But where spruce grows on deep, porous, well-drained soils, the lateral root system may penetrate to a depth of 8 feet or more (Alexander 1958, 1965).

In conclusion, Engelmann spruce typically have a shallow root system. However, Engelmann spruce can develop a deeper root system (up to 8-feet) if it is growing on deep, porous, well-drained soils. Insuring the tailings cap is designed to maintain moisture in the cap material where the root system of Engelmann spruce can draw from it, will be important to sustaining the typical shallow root system of this species.

Woody Vegetation Penetration of Geotextile Liners

Contrary to popular perception, the main orientation of a tree's root system is not vertical, but horizontal. Whereas the vertical depth of roots is commonly no more than about 3-6.5 feet, and is often less, the horizontal spread can be one to three times the tree height (Dobson and Moffat. 1995). This is especially the case for coniferous tree species in the mountains of central Idaho. Tree roots are highly sensitive to environmental condition and their downward penetration can be restricted by a number of soil factors including compaction, poor aeration and infertility (Dobson and Moffat. 1995). A detailed study of these factors indicates that the materials used for capping landfill sites, such as HDPE (high

density polyethylene) and compacted clays, can provide an effective barrier to downward root growth (Dobson and Moffat. 1995).

In periods of dryness plant roots have an ability to deepen, penetrate even compact soils and potentially penetrate geotextiles used for GCLs (Sarsby and Meggyos, 2008). Roots can penetrate high-density sealing layers and to inhibit roots from penetrating the sealing layer, the cover layer should be carefully planned to reduce deep root growth. The most important factors seem to be nutrient supply in the upper part of the cover layer; hydraulic conductivity; thickness of the sealing layer is of less importance (Stoltz and Greger, 2006). If the cover layer contains sufficient nutrients for the plants, their roots have no need to grow deeper. Stoltz and Greger (2006) also found that the pH of the sealing layer may affect the root penetration; a too low or high pH reduces root growth.

Previous studies suggest that tree roots do not penetrate landfill liners (Gillman, 1989, Dobson and Moffat 1995, Robinson and Handel 1995, Handel et al. 1997, Hutchings et al. 2001). Moffate et al (2008) found that tree roots occasionally penetrated weaker areas of a mineral landfill liner when the soil layer over the cap was less than 3.2 feet. Other studies have indicated that the materials used for capping landfill sites, such as HDPE (high density polyethylene) and compacted clays, can provide an effective barrier to downward root growth (Holl and McStay 2014, Dobson and Moffat. 1995). Trees growing on landfill sites with a rootable soil depth of at least 4.5 feet should be at no greater risk of windthrow than most forest trees on undisturbed sites (Dobson and Moffat. 1995).

The above research on landfills suggests that woody plant roots rarely penetrate intact liners and that woody plant roots have a fairly flexible morphology allowing them to adjust to their immediate microenvironment (Handel et al. 1997) Woody plant roots should not penetrate intact liners as long as a sufficient soil layer over the liner for the type of woody vegetation planned is provided (Holl and McStay 2014).

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Attachment C: SFA Pool Frequency and Quality Analysis



Technical Memorandum



Rio ASE 2449 S. Vista Ave. Suite B, Boise, ID 83705 Telephone: 208-559-4615

TO: MIDAS GOLD IDAHO, INC.
 FROM: RIO ASE
 DATE: MAY 20, 2019
 FILE: 023-090-001-05
 SUBJECT: STIBNITE GOLD PROJECT – SFA POOL FREQUENCY AND QUALITY ANALYSIS

Detailed below is a description of recommended Stibnite Gold Project (SGP) Stream Functional Assessment (SFA) criteria along with supporting justification and rationale for pool frequency and pool quality.

Pool Frequency

ORIGINAL CRITERIA: USFS APPENDIX B (USFS 2003)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk																																		
Habitat Access (continued)																																					
Pool Frequency and Quality: consider variations based on local biophysical elements i.e., vegetation habitat type/community type, ecological processes, stream channel width and type, landform etc., appropriate to the site.	<p>Pools have good cover and cool water, and only minor reduction of pool volume by fine sediment. Large woody debris recruitment standards for functioning appropriately (above) are met and pool frequency in a reach closely approximates:^{7, 13}</p> <p>Steelhead and chinook: Channel Width (ft.) No. Pools/Mile</p> <table border="1"> <tr><td>0-5</td><td>184</td></tr> <tr><td>5-10</td><td>96</td></tr> <tr><td>10-15</td><td>70</td></tr> <tr><td>15-20</td><td>56</td></tr> <tr><td>20-25</td><td>47</td></tr> <tr><td>25-50</td><td>26</td></tr> <tr><td>50-75</td><td>23</td></tr> <tr><td>75-100</td><td>18</td></tr> </table> <p>Bull Trout: Wetted Width (ft.) No. Pools/Mile</p> <table border="1"> <tr><td>0-5</td><td>39</td></tr> <tr><td>5-10</td><td>60</td></tr> <tr><td>0-15</td><td>48</td></tr> <tr><td>15-20</td><td>39</td></tr> <tr><td>20-30</td><td>23</td></tr> <tr><td>30-35</td><td>18</td></tr> <tr><td>35-40</td><td>10</td></tr> <tr><td>40-65</td><td>9</td></tr> <tr><td>65-100</td><td>4</td></tr> </table> <p>Can use the formula: pools/mile =</p> <p>$\frac{5280/\text{wetted channel width}}{\text{# pools/mi}}$ = # channel widths per pool</p>	0-5	184	5-10	96	10-15	70	15-20	56	20-25	47	25-50	26	50-75	23	75-100	18	0-5	39	5-10	60	0-15	48	15-20	39	20-30	23	30-35	18	35-40	10	40-65	9	65-100	4	Pool frequency is similar to values in "functioning appropriately", but pools have inadequate cover/temperature, ⁶ and/or there has been a moderate reduction of pool volume by fine sediment. Large woody debris recruitment is inadequate to maintain pools over time.	Pool frequency is considerably lower than values desired for "functioning appropriately"; also cover/temperature is inadequate, ⁶ and there has been a major reduction of pool volume by fine sediment.
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The USFS Appendix B criteria came from two sources depending on fish species – 1) bull trout or 2) Chinook salmon and steelhead. The bull trout criteria came from Overton et al (1995) and is based on data collected within the Salmon River basin in Idaho, which should include bull trout, Chinook salmon and steelhead habitat. The Chinook salmon and steelhead pool frequency data came from USFS (1994) and includes data from Oregon, Washington, Idaho and Alaska. As stated in the USFS Appendix B document these tables are only to be used if more relevant site-specific data are not available.

CURRENT CRITERIA (SFA LEDGER VERSION 2/28/19)

Rating	FA	FR	UR
Score	3	2	1
Pool Frequency Threshold Criteria	Optimal pool frequency (actual frequency $\geq 100\%$ optimal)	Near Optimal Pool Frequency (frequency $\geq 67\%$ - 100% optimal)	Much less than optimal pool frequency (frequency $< 67\%$ optimal)

The current SFA criteria were modified from the original USFS Appendix B criteria. First, there was a need to quantify the divisions between Functioning Appropriately (FA), Functioning at Risk (FR), and Functioning at Unacceptable Risk (UR) rather than having qualitative divisions such as “considerably lower than,” and “similar to.” The simplest way to quantify these qualitative descriptions was by applying a percentage to the supplied pool frequency criteria, which was completed in order to establish the divisions outlined above. The other change to the USFS criteria was the removal of additional qualitative measures such as: cool water, cover, and large woody debris abundance and future recruitment. We interpreted these additional measures as contributing to pool quality not frequency, and these additional measures were already independently quantified within the SFA Ledger; therefore, the SFA metrics were only divided based on pool frequency.

Issue with Current Criteria:

The issue with the current criteria is that the divisions between FA, FR and UR ($>100\%$ of average, 100%-67%, and $<67\%$) were set arbitrarily and a more scientific/ statistically correct method has been requested to justify the scoring divisions.

Agency and Services Recommended Alterations:

During an SFA workshop (4/15/19) the agencies and services (United States Forest Service, National Marine Fisheries Service, United States Fish and Wildlife Service, United States Environmental Protection Agency, and United States Army Corps of Engineers) recommended applying one standard deviation from the average for each division between FR and UR in the scoring criteria, or other comparably significant statistical division.

PROPOSED CRITERIA:

Attempt to Use Agency and Services Recommended Alterations

Rio ASE reviewed the original pool frequency data referenced in the USFS Appendix B document in an attempt to follow the recommended scoring criteria (using a standard deviation from average) or to better defend the existing divisions in the scoring criteria.

The pool frequency data associated with bull trout was based on the USFS User’s Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho (Overton et al 1995). This report includes the average number of pools per mile, the standard error, and the number of observations for each channel width classification. In an attempt to apply one standard deviation from the average as the division between FR and UR, the

calculated standard deviation for some of the wetted width categories exceeded the average pool frequency resulting in a negative or zero number of pools per mile. In addition, some of the sample sizes were so small that they did not provide an accurate representation of the specific wetted width size class (e.g. there were only two observations for the 0- to 5-foot wetted width classification).

The pool frequency data associated with Chinook salmon and steelhead came from inventory data from the USFS and Bureau of Fisheries in 116 watersheds in Oregon, Washington, Idaho and Alaska (USFS, 1994). There were three major issues associated with these data. 1) While the data presented in this document appeared to represent average pool density, the density was not defined as average, rather as a desired number of pools per mile based on channel wetted width. Associated with that, there was no statistical information available to derive a standard deviation or variation from the average. 2) The dataset did not represent total pool frequency, rather, it only represented the frequency of pools that are greater than 1 meter in residual depth (USFS, 1994). 3) This dataset only represented Rosgen C-type low-gradient channels and did not necessarily represent the range of conditions observed and proposed within the Stibnite Gold Project (SGP) area (USFS, 1994).

Research on Total Pools

Rio ASE evaluated available existing data summarizing undisturbed natural pool frequency and was unable to find published summaries of total pool frequency. There are historic data from some of the original US Fisheries Bureau work that summarized total pool frequency, but these data were not divided into wetted width size classes. In an effort to develop better information, Rio ASE obtained a large dataset consisting of completed Columbia Habitat Monitoring Program (CHaMP) for over 630 sites collected from 2011 through 2014. These data include pool frequency and wetted width among many other stream criteria. We queried the CHaMP data to analyze “All Sites,” “Low and Undisturbed” sites, as well as only sites within the South Fork Salmon River basin (Figure 1 and Table 1).

As another comparison we also took the Salmon River pool frequency data (Overton et al 1995) and recalculated the data as an average number of wetted widths per pool (unitless dimension) for each size class and then combined all wetted width classes based on sample size to calculate the weighted average number of wetted widths per pool. This average number of wetted widths per pool was then converted back to number of pools per mile based on the specified wetted width groupings (Modified Overton Data). This creates a more robust data set (more sample sites) to develop an average unitless parameter scalable to different channel width classes. We compared these data to the various CHaMP data sets and all four of these analyses had similar distributions as seen in Figure 1 below.

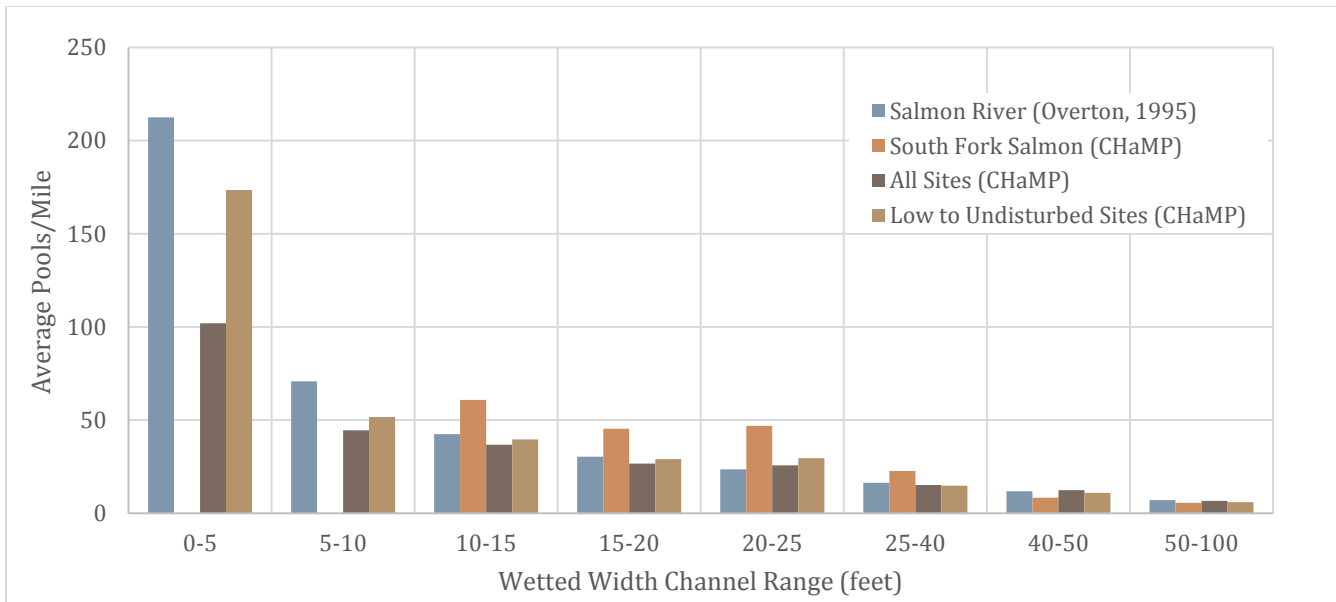


Figure 1. Pool frequency for various CHaMP datasets and USFS dataset (Overton, 1995) separated by various channel wetted width.

As summarized in Figure 1, the modified Overton (1995) and CHaMP data collectively illustrate a similar relationship between pool frequency and stream wetted width. The large CHaMP dataset and the ability to query specific sites based on robust stream classification information, supports the selection of a dataset that is most representative of natural/reference conditions for streams similar to those at the SGP. As summarized in Table 1, **we recommend that the CHaMP dataset for “undisturbed” and “low disturbance” sites be utilized for analysis of total pool frequency.**

Table 1. Summary of evaluated pool datasets and relevance to SGP area streams.

Dataset	SGP Relevance
Salmon River (Overton, 1995)	Includes data from 233 sites within the Salmon River watershed, but channel slope ranges are unknown
CHaMP (South Fork Salmon sites only)	Does not include sites with streams measuring less than 10-foot wetted width
CHaMP (all sites)	Includes many sites that may have been modified by human actions and therefore may not accurately represent natural and/or reference conditions
CHaMP (all “low” and “undisturbed” sites)	Includes 325 sites in the Pacific Northwest region that are minimally disturbed, with a wide range of wetted widths (0-100 feet) and with a wide range of channel slopes (0.0013 ft/ft to 0.0845 ft/ft) that typically fit within the SGP existing and proposed ranges

Statistical Classification

Review of other stream functional assessments completed as regulatory documents in other states suggests that the 25th and 75th percentiles are commonly used to divide between high, medium and low (Nadeau et al 2018). This assumption states that the lowest 25% of all sites are of poor condition and assumed to be functioning at an

unacceptable risk level while the highest 25% of all sites are providing a high level of function are assumed to be functioning appropriately (Nadeau et al 2018). **It is recommended that the divisions between Good, Fair, and Poor use the 25th and 75th percentiles of the pool spacings data for each wetted width category.** The proposed recommendations would result in the scoring criteria for pool frequency identified in Table 2 below for all salmonid species. Pool frequency is driven by geomorphic characteristics such as slope, confinement, sediment size, large woody debris, and vegetative bank stability. These factors are present in a channel regardless of anticipated fish use, and while a specific species may prefer a certain pool frequency, the preference of that species does not drive the geomorphic character of the stream.

Table 2. Recommended pool frequency (pools/mile) scoring criteria for various channel wetted widths.

Wetted Width (feet)	High Function (Good)	Moderate Function (Fair)	Low Function (Poor)
0 - 5	> 235	138 - 235	< 138
5 - 10	> 113	52 - 113	< 52
10 - 15	> 79	31 - 79	< 31
15 - 20	> 50	25 - 50	< 25
20 - 25	> 48	22 - 48	< 22
25 - 40	> 37	11 - 37	< 11
40 - 50	> 15	9 - 15	< 9
50 - 100	> 14	4 - 14	< 4

Pool Quality

ORIGINAL CRITERIA: USFS APPENDIX B (USFS 2003)

Pathways and WCIs	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat Access (continued)			
Large Pools/Pool Quality (All Fish Species) In adult holding, juvenile rearing, and over wintering reaches where streams are 3.0 meters in wetted width at base flow.	Each reach has many large pools > 3.28 feet (1 meter deep). ⁶ Pools have good cover and cool water, and only minor reduction of pool volume by fine sediment.	Reaches have few large pools > 3.28 feet (>1 meter) present ⁶ or inadequate cover/temperature. Moderate reduction of pool volume by fine sediment.	Reaches have no deep pools > 3.28 feet (> 1 meter) ⁶ and inadequate cover/temperature. There is a major reduction of pool volume by fine sediment.

CURRENT CRITERIA:

Rating	FA	FR	UR
Score	3	2	1
Pool Quality Criteria	Reach has >25% of optimal pool frequency >1m deep	Reach has <25% but greater than 0% optimal pool frequency >1m deep	Reach has no deep pools (0% of optimal pool frequency >1m deep)

The current criteria were modified from the original USFS Appendix B criteria. First, all streams were assessed for pool quality regardless of wetted width. This is to maintain a standard/absolute measure between all analyzed reaches. Secondly, there was a need to quantify the breaks between FA, FR, and UR rather than having qualitative breaks such as “many large pools,” and “few large pools.” The other change was the removal of additional qualitative measures such as: cool water, cover, and pool volume reduction by fine sediment. While these additional qualitative measures assist in defining what makes a high-quality pool rather than just a deep pool they are already assessed elsewhere in the SFA – temperature, large woody debris, and fine sediment WCI elements.

Issue with Current Criteria:

There were two issues identified by the agencies and services. The first was the lack of scientific data to defend the quantified divisions in pool quality criteria. The scoring division of 25% was originally based on professional judgment with little literature justification. The second issue was that the original scoring criteria were identified as only applicable for streams over 3.0 meters in wetted width (USFS 2003), which excludes many of the stream reaches in the SGP area.

Agency and Services Recommended Alterations:

It was recommended by the agencies and services that a more scientific rationale be developed for the scoring criteria, or that the existing scoring criteria be better justified. It was also recommended by the agencies and services that streams smaller than 3 meters in wetted width not be evaluated for pool quality due to their inherent inability to scour deep, residual-depth pools.

PROPOSED CRITERIA:

Attempt to Use Agency and Services Recommended Alterations

Scoring all reaches in the same manner using a standardized/absolute metric whether an element can exist in a certain reach or not is paramount to a nonbiased evaluation of changes in conditions within a project area over time as discussed in the body of the parent document to this appendix (Stream Functional Assessment Scoring Concerns Addressed: Stibnite Gold Project Technical Memorandum). Therefore, it is recommended that all streams, regardless of size, should be evaluated for pool quality if there are data to support the evaluation. During background investigations into pool frequency discussed above, it was determined that the original pool frequencies for Chinook salmon and steelhead were based on historic pool data that only included pools with residual depths greater than 1 meter (USFS 1994). Within that dataset were many deep pools associated with channel wetted widths less than 3 meters, which ultimately removes the concern of applying this metric to small streams. Based on this information it is recommended that all stream reaches be analyzed with the same criteria regardless of wetted width size.

Research on Pool Quality

Rio ASE reviewed the US Fisheries Bureau studies that were completed in the 1940's to evaluate pools with residual depths greater than 1 meter (McIntosh 1994). This study summarized data from over 2,000 miles of streams and rivers, but typically only summarized deep pools without relation to channel width. One summarization of the data includes total pools and large pools within the upper Grande Ronde River basin in Oregon. On average, 60% of the total pools observed in 1941 were considered deep pools (> 1-meter residual depth) (McIntosh 1994). We are familiar with this basin and some of the smaller streams currently have zero deep pools, suggesting most of the pools documented were from larger streams. This information along with observations from other watersheds and basic hydraulic scour relationships (relationship between discharge, width, and potential scour depth – see scour calculations in the Stream Design Report section 3.3.6.2, Rio ASE 2019) suggest that small/narrow channels have less ability to develop and sustain deep pools so that the percentage of deep pools in a small/narrow channel should be

less than the percentage of deep pools in a large/wide channel. **We recommend utilizing a standard deep pool density for all streams based on this geomorphic characteristic (rather than excluding small/narrow streams), and that the standard metric represent the average number of deep pools from the US Fisheries Bureau study equal to 10.4 deep pools/mile.** Comparing this average deep pool frequency to average total pool frequency (from low and undisturbed CHaMP sites – Figure 1) a trend results that as a channel becomes wider the percentage of pools qualifying as deep pools increases as seen in Figure 2.

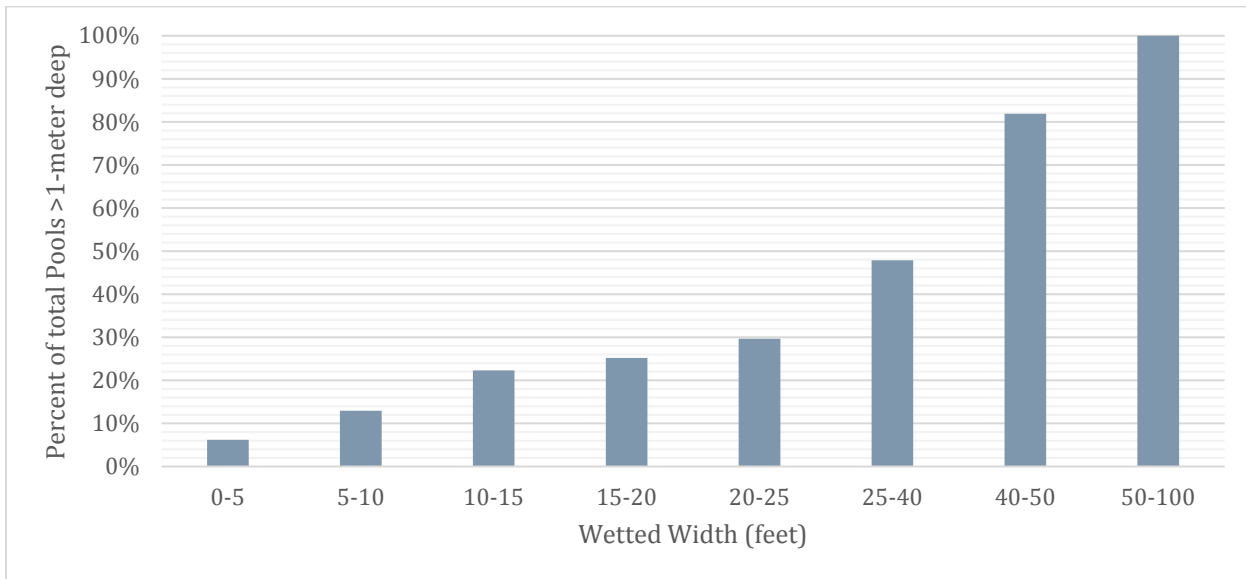


Figure 2. Example of percentage of total pools that are considered deep as derived from US Fisheries Bureau data (McIntosh 1994).

Statistical Classification

Plotting the cumulative distribution of deep pool frequency one can estimate the 25th and 75th percentiles for deep pool frequency. This analysis provides a similar quantifiable division in the scoring criteria as described in the pool frequency section above based on Nadeau et al 2018. The 25th percentile is 4.0 pools per mile while the 75th percentile is 14.6 pools per mile as seen in Table 3.

Table 3. Recommended pool quality frequency (deep pools/mile) scoring criteria.

High Function (Good)	Moderate Function (Fair)	Low Function (Poor)
> 14.6	4.0 - 14.6	< 4.0

References

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 years, 1935 to 1992. U.S. Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR 321.

Nadeau, T-L., C. Trowbridge, D. Hicks, and R. Coulombe. 2018b. A Scientific Rationale in Support of the Stream Function Assessment Method for Oregon (SFAM, Version 1.0) Oregon Dept. of State Lands, Salem, OR, EPA 910-D-18-001, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

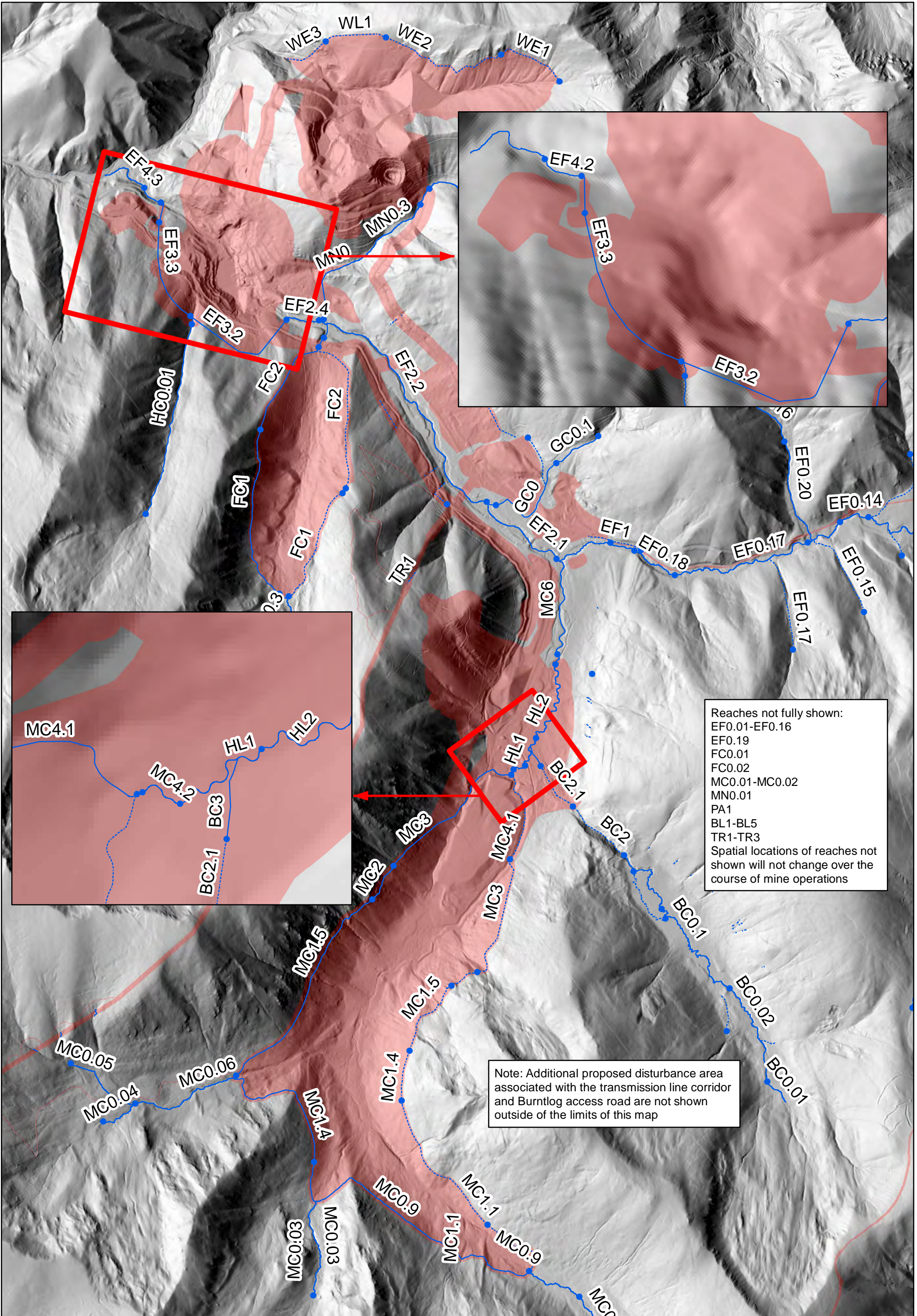
Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitewell, and K.A. Duncan. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Re. INT-GTR-322.

United States Forest Service (USFS). 1994. Section 7 Fish Habitat Monitoring Protocol for the Upper Columbia River Basin.

United States Forest Service (USFS). 2003. Land and Resource Management Plan (LRMP) Payette National Forest (PNF). Amended 2010. Accessed online at <https://www.fs.usda.gov/detail/payette/landmanagement/planning/?cid=stelprdb5035589>

Attachment D: SFA Reach Maps per Alternative



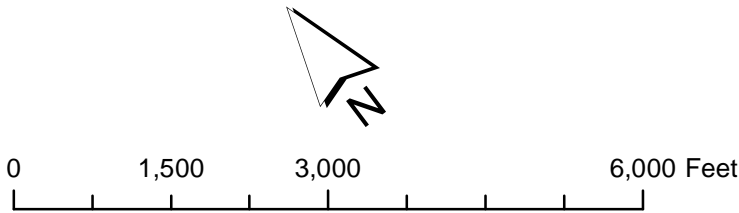


Reaches not fully shown:
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 EF0.19
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 FC0.02
 MC0.01-MC0.02
 MN0.01
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 BL1-BL5
 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

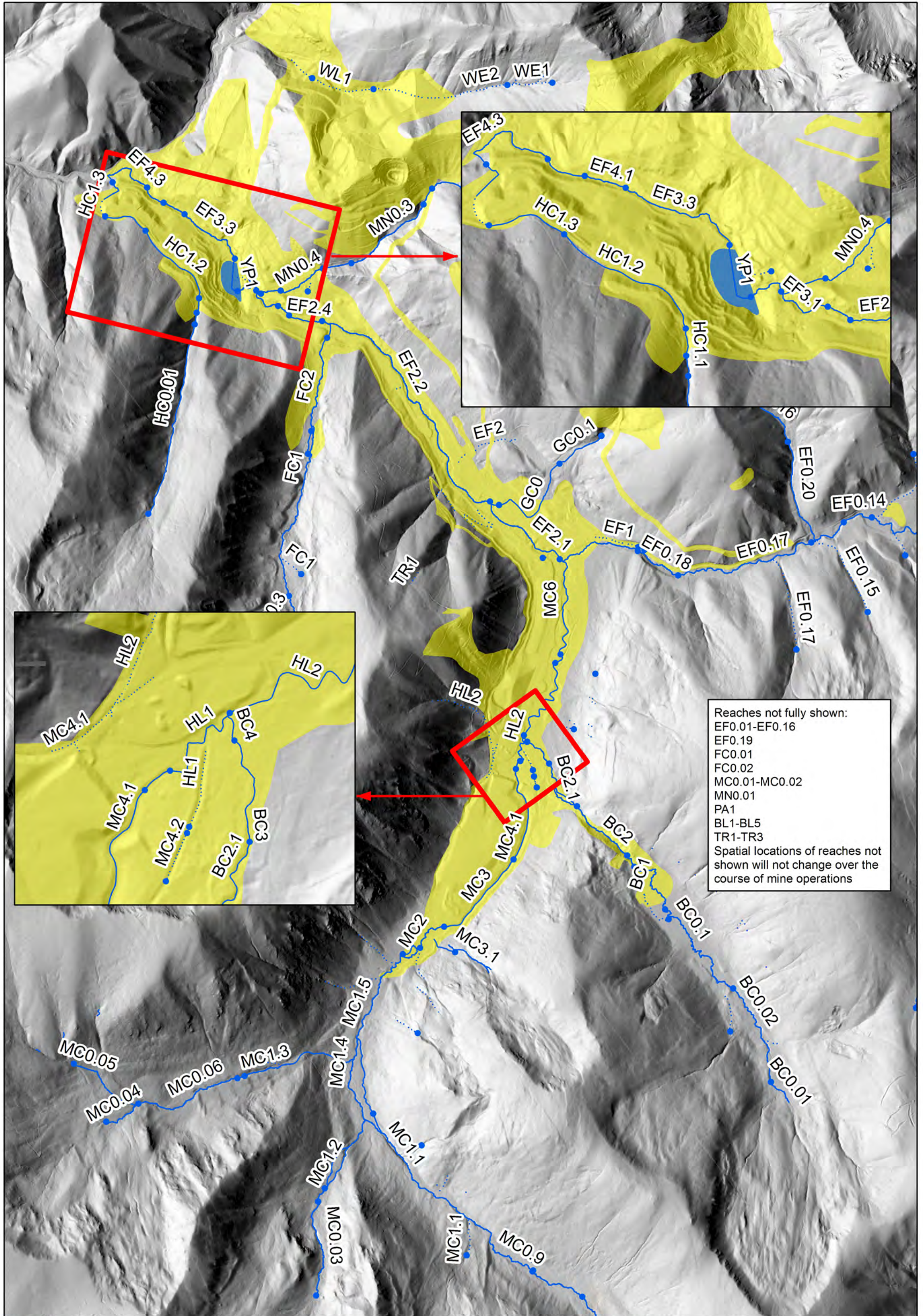
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Proposed Mine Disturbance
- Streams
 - ⋯ Non-perennial
 - Perennial



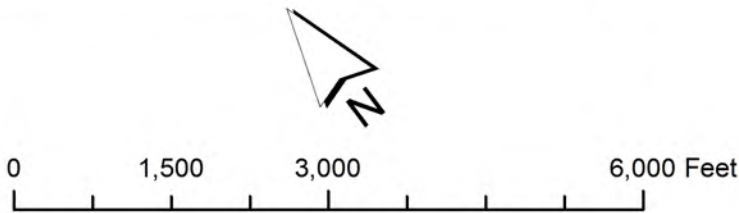
Alternative 1
Interim Conditions



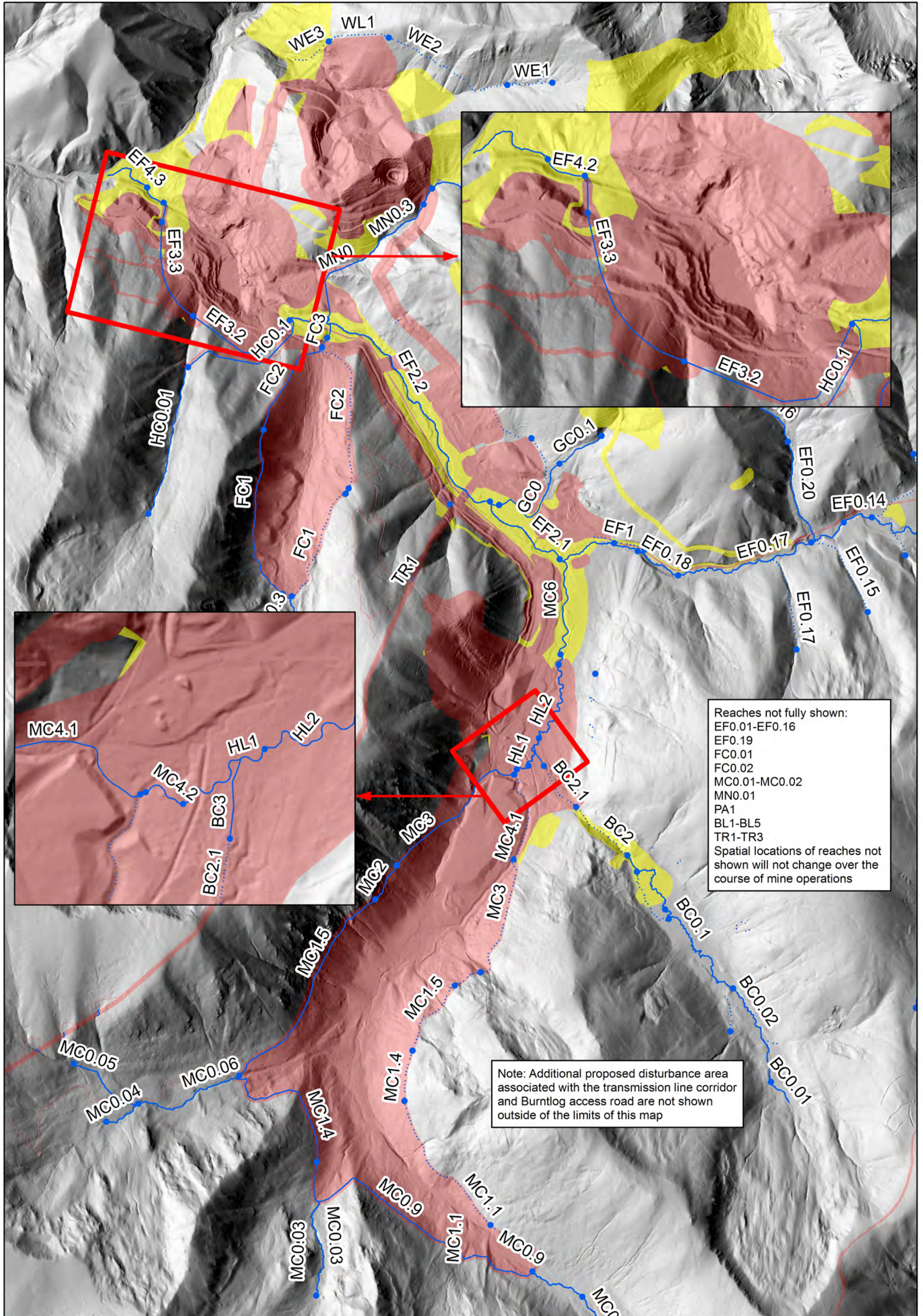
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 PA1
 BL1-BL5
 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

LEGEND

- Pit Lakes
- Historical Disturbance Area
- Streams
 - ⋯ Non-perennial
 - Perennial



Alternative 2
 Baseline Conditions

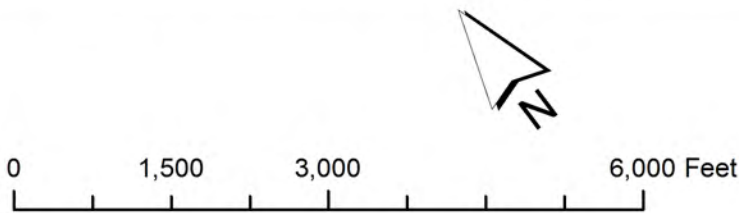


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 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

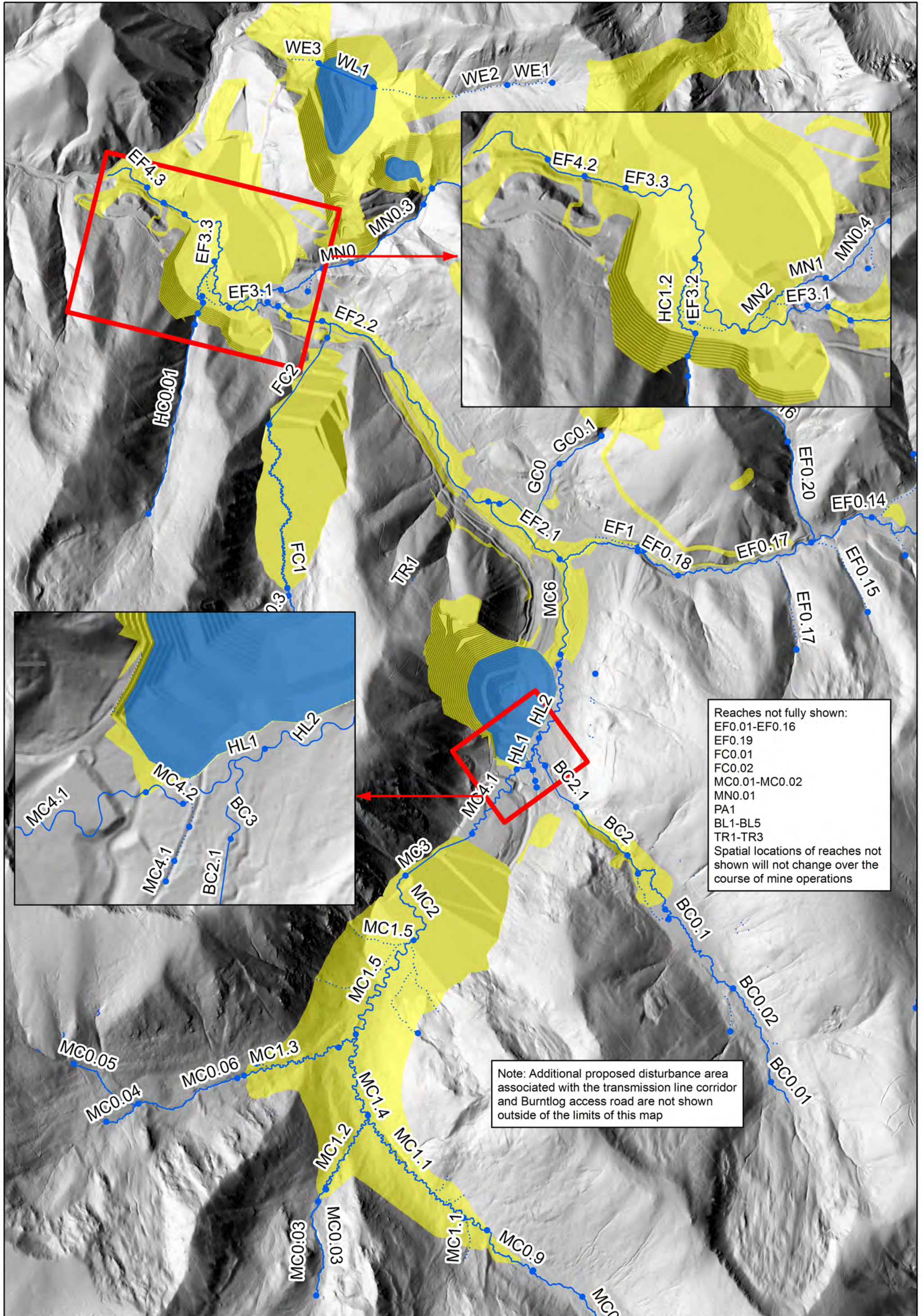
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Proposed Mine Disturbance
- Historical Disturbance Area
- Streams
- Non-perennial
- Perennial



Alternative 2
 Interim Conditions

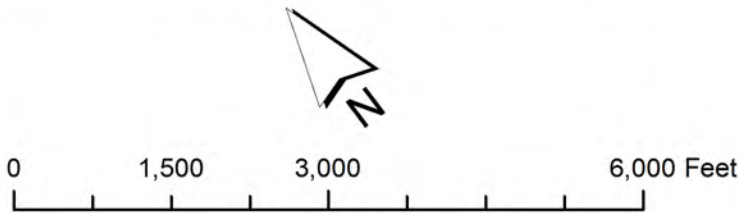


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 BL1-BL5
 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

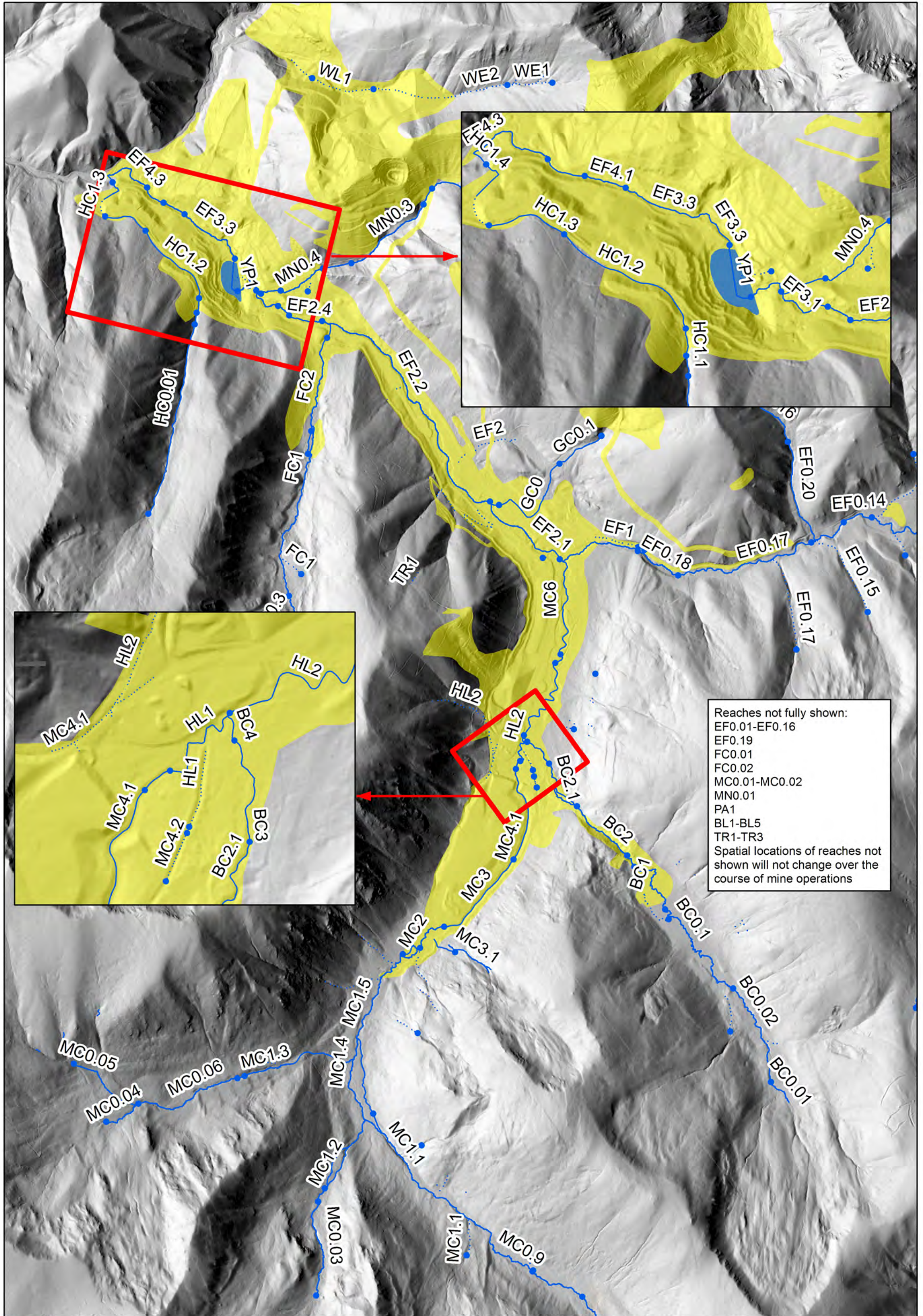
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Remaining Human Features
- Streams
 - Non-perennial
 - Perennial



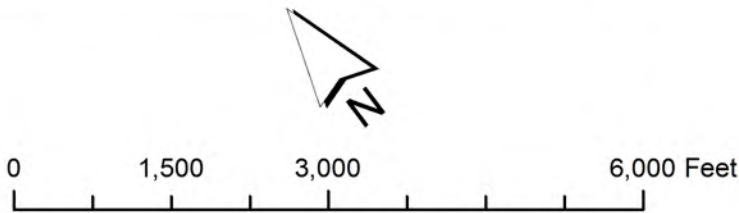
Alternative 2
 Restored Conditions



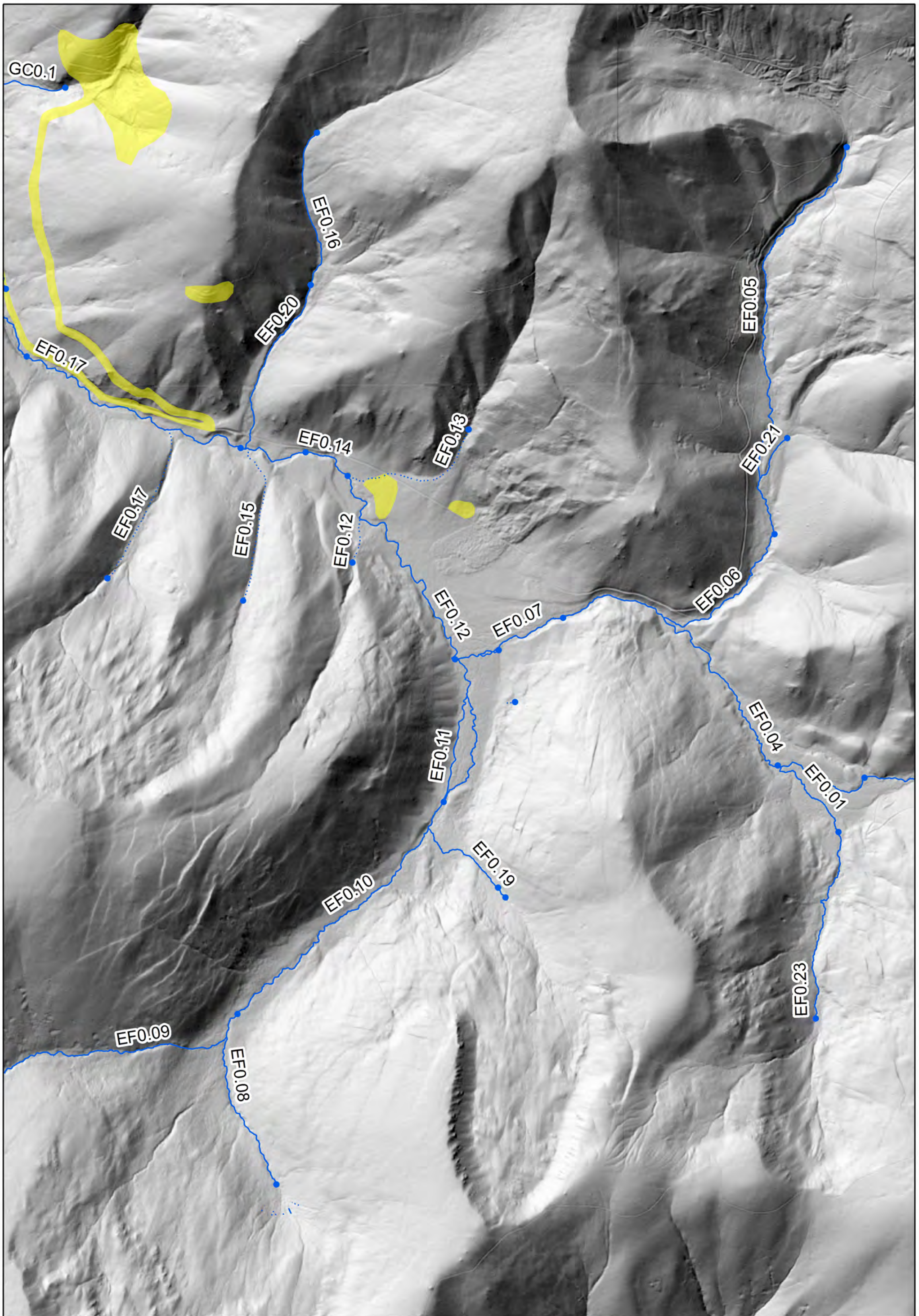
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 MC0.01-MC0.02
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 BL1-BL5
 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

LEGEND

- Pit Lakes
- Historical Disturbance Area
- Streams
 - ⋯ Non-perennial
 - Perennial

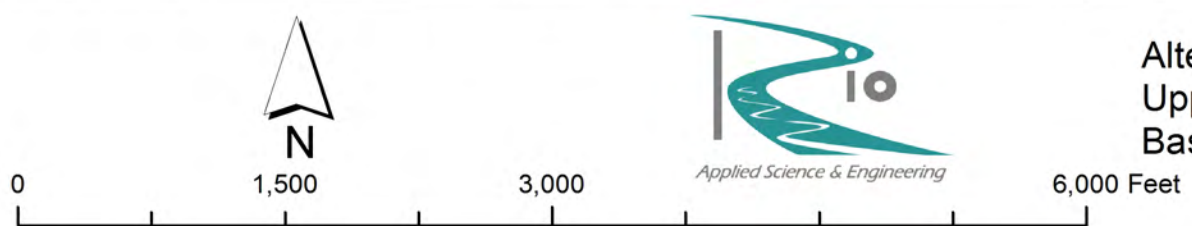


Alternative 3
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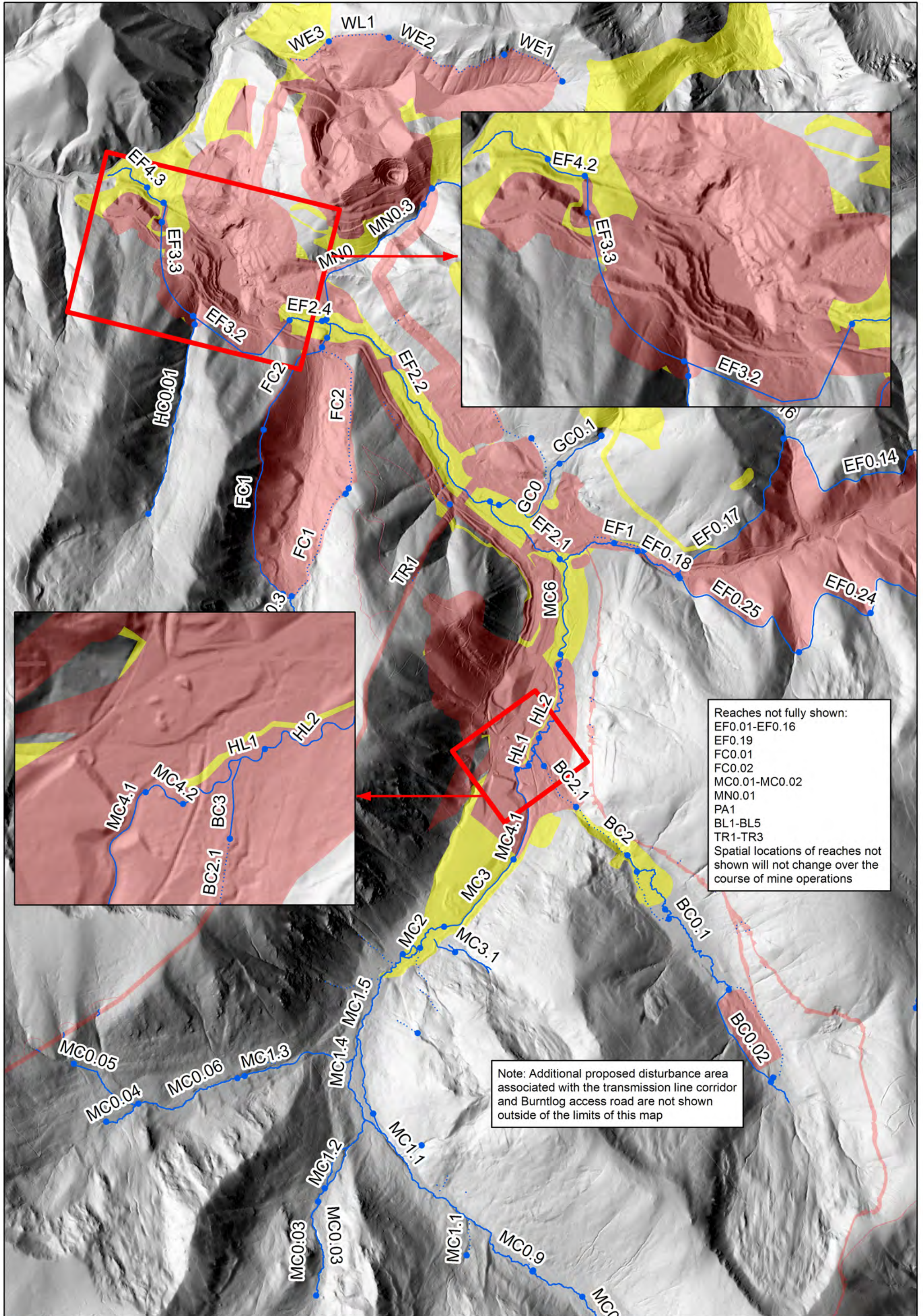


LEGEND

- Pit Lakes
- Historical Disturbance Area
- Streams
- Non-perennial
- Perennial



Alternative 3
Upper EFSFSR
Baseline Conditions

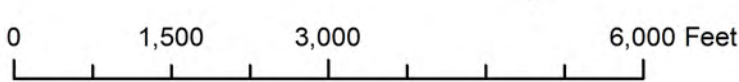


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 Spatial locations of reaches not shown will not change over the course of mine operations

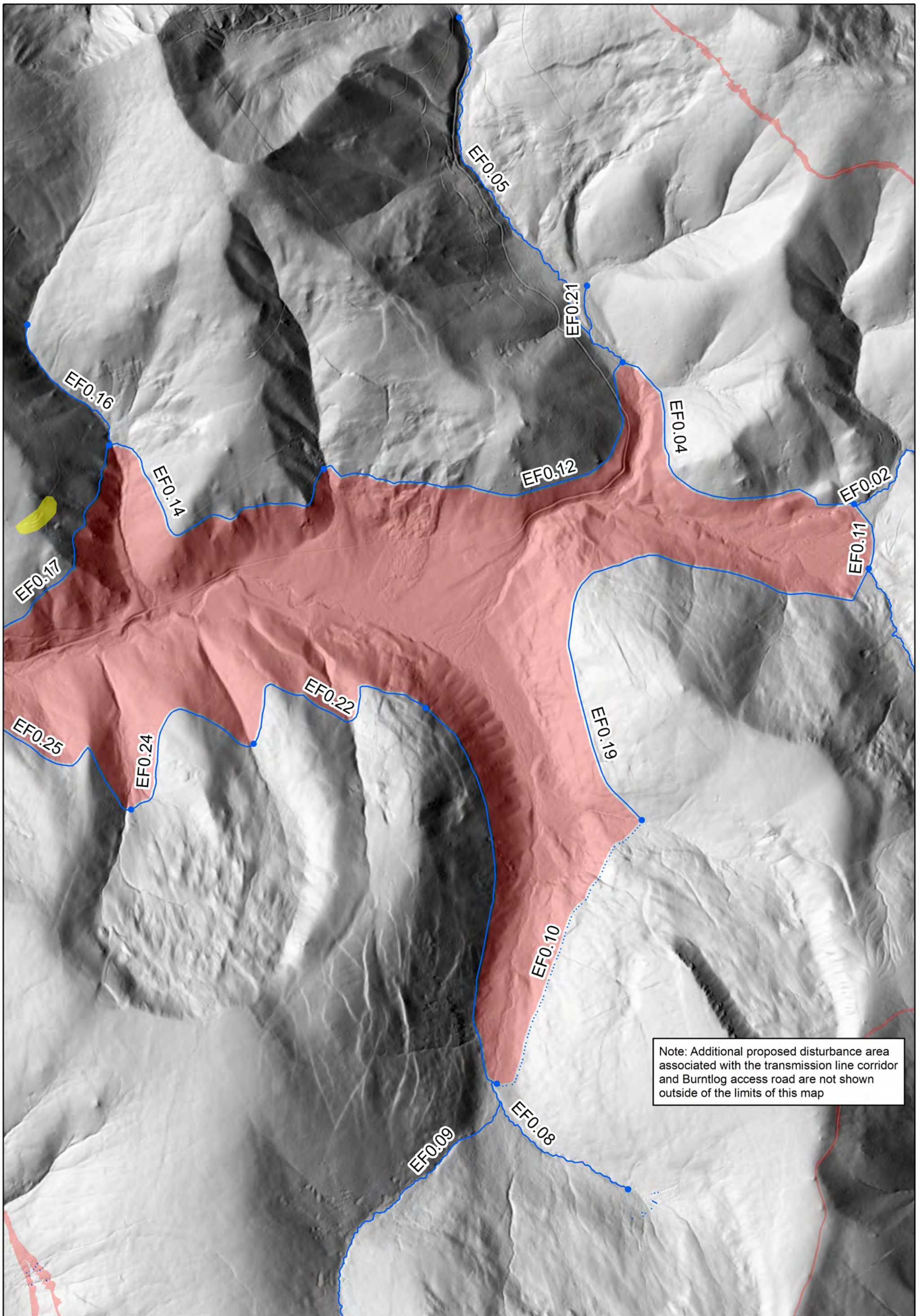
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Proposed Mine Disturbance
- Historical Disturbance Area
- Streams
- ⋯ Non-perennial
- Perennial

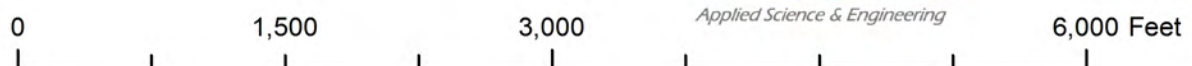


Alternative 3
 Interim Conditions

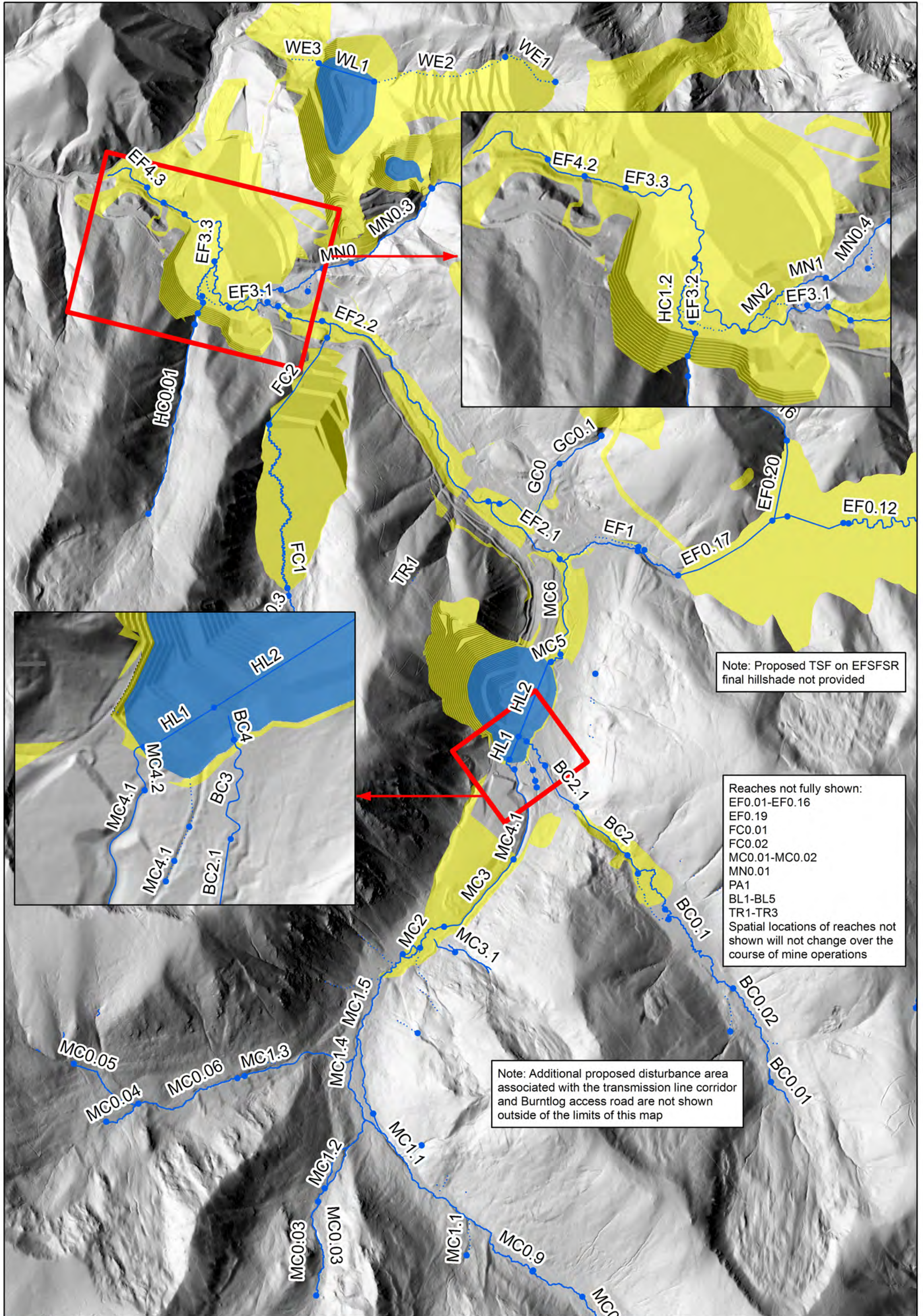


LEGEND

- Pit Lakes
- Proposed Mine Disturbance
- Historical Disturbance Area
- Streams
- ⋯ Non-perennial
- Perennial



Alternative 3
Upper EFSFSR
Interim Conditions



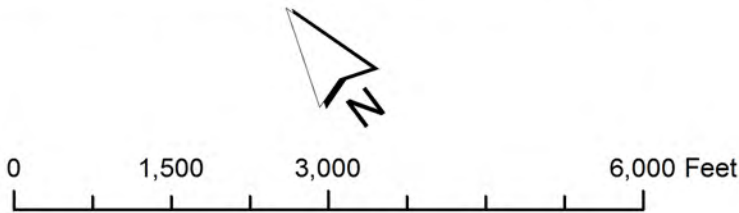
Note: Proposed TSF on EFSFSR final hillshade not provided

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 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

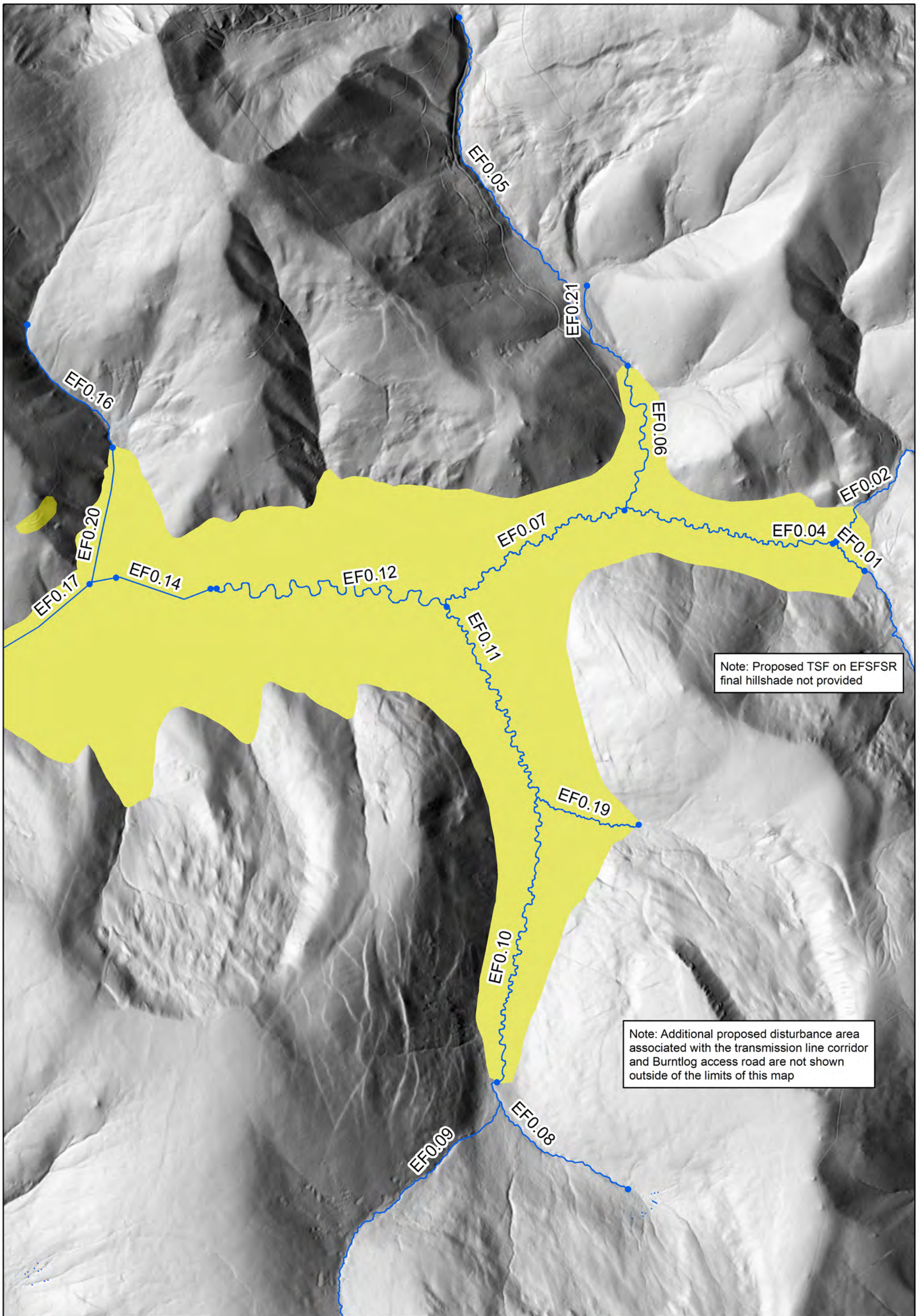
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Remaining Human Features
- Streams
 - - - Non-perennial
 - Perennial



Alternative 3
Restored Conditions

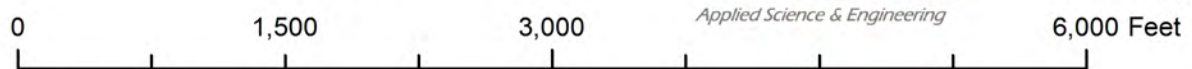


Note: Proposed TSF on EFSFSR final hillshade not provided

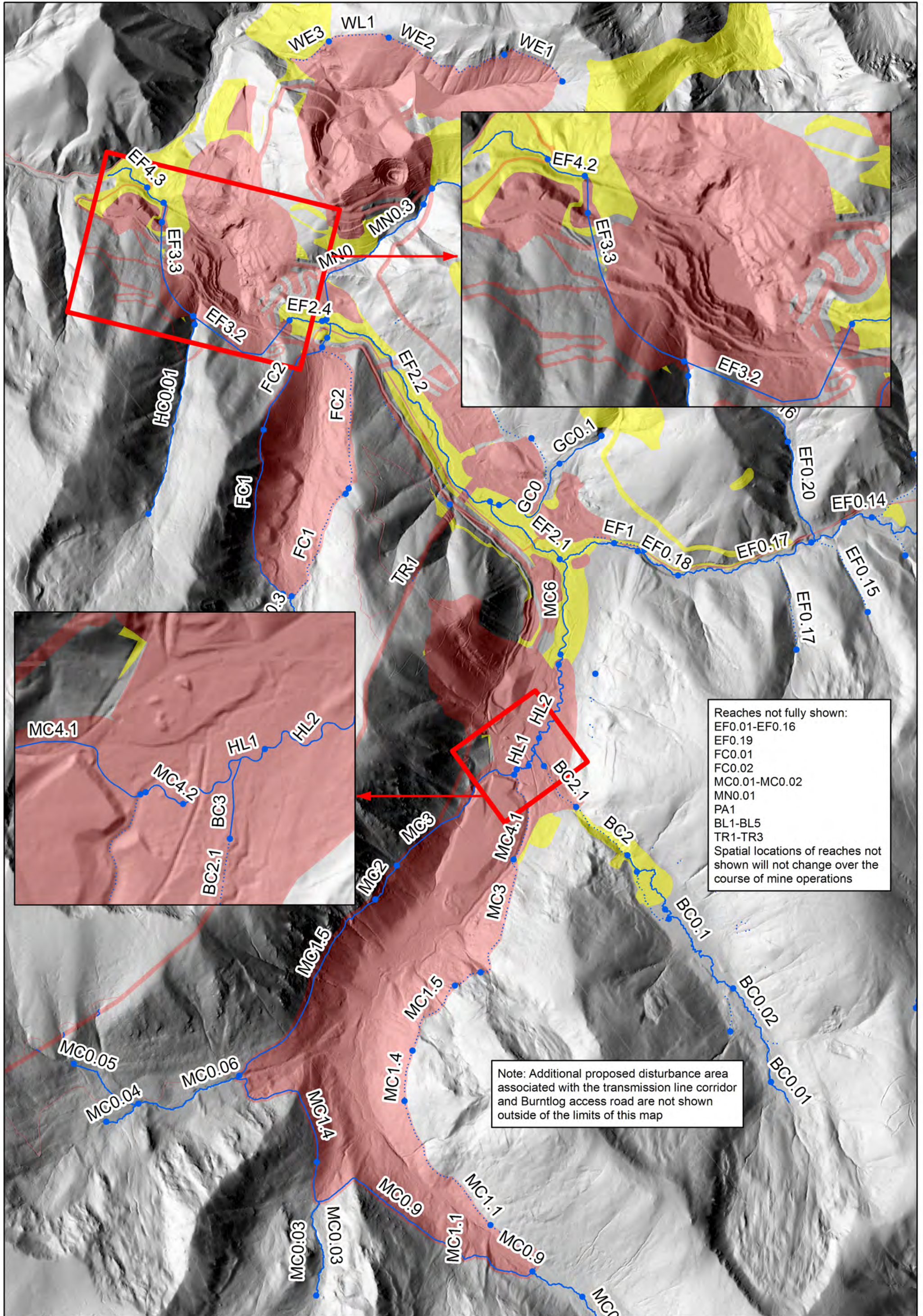
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Remaining Human Features
- Streams**
- Non-perennial
- Perennial



Alternative 3
Upper EFSFSR
Restored Conditions

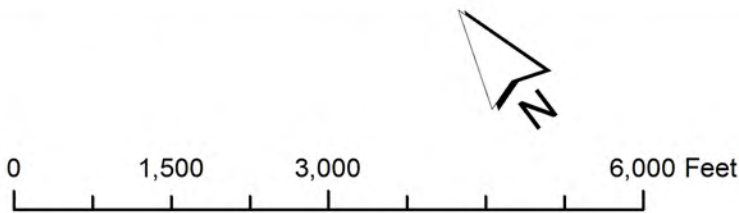


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 BL1-BL5
 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

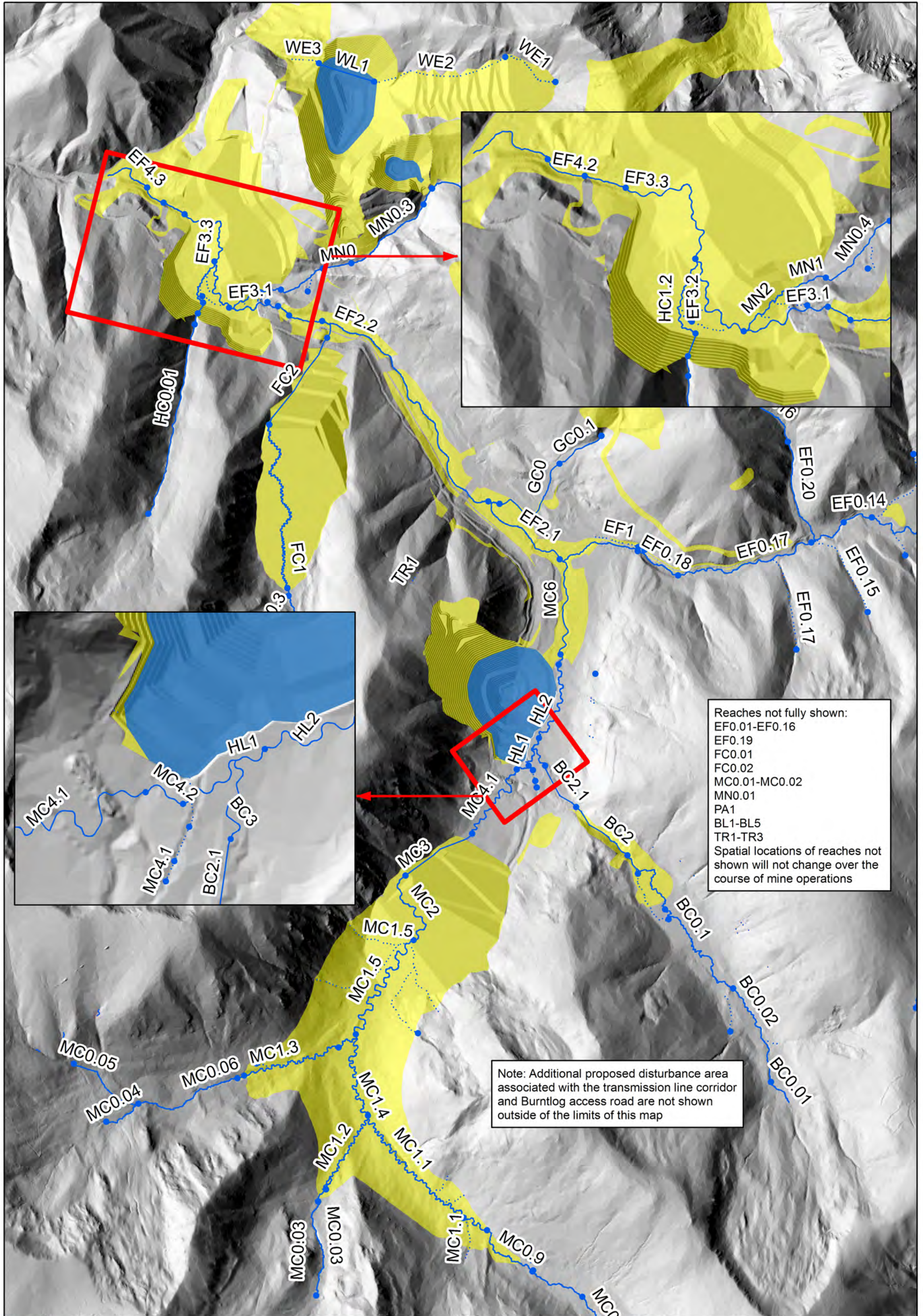
Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Proposed Mine Disturbance
- Historical Disturbance Area
- Streams
 - - - Non-perennial
 - Perennial



Alternative 4
Interim Conditions

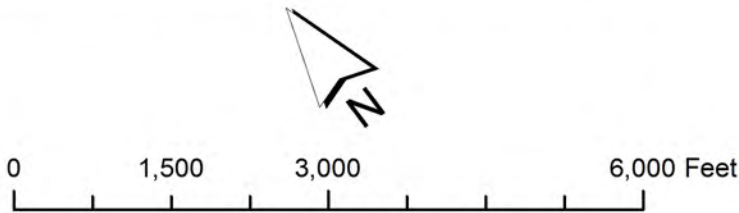


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 MC0.01-MC0.02
 MN0.01
 PA1
 BL1-BL5
 TR1-TR3
 Spatial locations of reaches not shown will not change over the course of mine operations

Note: Additional proposed disturbance area associated with the transmission line corridor and Burntlog access road are not shown outside of the limits of this map

LEGEND

- Pit Lakes
- Remaining Human Features
- Streams
 - Perennial
 - Non-perennial



Alternative 4
 Restored Conditions