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Technical Memorandum

Prepared for: Brown and Caldwell

Project Title: Stibnite Gold Project

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Technical Memorandum

Subject: Evaluation of Upper EFSFSR Fish Passage Barriers

Date: December 2021

To: Midas Gold Idaho, Inc. (currently known as Perpetua Resources Idaho, Inc.)

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Errata: In this technical memorandum, changes have been made to adjust the accuracy of eight barrier location coordinates (latitude and longitude) within Attachment A. Figures that display those locations have been updated to reflect the revised coordinates.

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Section 1: Introduction and Purpose

Midas Gold Idaho, Inc. has proposed to redevelop portions of the Stibnite Mining District (District), as outlined in the Stibnite Gold Project (SGP or Project) Plan of Restoration and Operations (PRO or Plan), in the upper East Fork South Fork Salmon River (EFSFSR) (Midas Gold 2016). The SGP will include cleanup of legacy impacts from past mining activity, including restoration of anadromous fish passage at the Yellow Pine pit (YPP). Much of this restoration will occur in the early phases of the Project, or as mining activities are completed in each area.

As a part of that commitment to restore fish passage, Midas Gold Idaho, Inc. requested the development of this technical memorandum (TM) to provide a watershed perspective on potential fish passage barriers within the upper EFSFSR watershed. Salmonid species that occur in all or portions of the upper EFSFSR include spring/summer Chinook salmon (*Oncorhynchus tshawytscha),* steelhead *(O. mykiss),* westslope cutthroat trout (*O. clarki lewisi*), and bull trout (*Salvelinus confluentus*) (Kuzis 1997; Nelson 2009; MWH 2017) [1].

The distribution and occurrence of different species and migratory life forms have changed because of legacy mining impacts and the excavation of the YPP. Because of those impacts, Chinook salmon and steelhead no longer occur naturally upstream of the high-gradient cascade barrier just upstream of the YPP. However, resident bull trout and westslope cutthroat trout still occur upstream of this barrier but are isolated from populations downstream.

Designated critical habitat (DCH) for Chinook salmon was established in 1993 in the Federal Register (58 FR 68543) and defines the specific geographic areas and essential habitat elements. Critical habitat for Chinook salmon includes all river reaches presently or historically accessible and adjacent riparian zones (i.e., 300 feet on either side of the normal high-water line), except reaches above impassable natural falls. Virtually every perennial stream except those reaches above known, natural passage barriers (e.g., falls, high gradients) is DCH for Chinook salmon. DCH for steelhead is limited in the upper EFSFSR to about 1,000 feet upstream from the confluence of Sugar Creek (70 FR 52630).

The objectives of this TM are to:

1. Establish the recognized value of fish passage barrier removal as part of the restoration and conservation of migratory and anadromous salmonids and associated resident fish species.
2. Provide generally accepted definitions of fish passage barrier terms, including artificial versus natural barriers, and complete and partial barriers.
3. Identify and map the locations of known and potential natural and artificial fish barriers within the main Project area in the upper EFSFSR.
4. Identify and map the inferred upstream extent of fish based on occupancy model (Isaak et al. 2017) and intrinsic habitat potential (Cooney and Holzer 2006) stream size, flow, and gradient criteria.

[1] Mountain whitefish (*Prosopium williamsoni*) are salmonids that also occur in the upper EFSFSR (BC 2019).

Section 2: Recognized Value of Fish Passage Barrier Removal

To address the first objective, these main points are offered, First, the importance of properly functioning migration corridors free of obstruction or impediments is recognized in the physical and biological features necessary for the conservation of Endangered Species Act (ESA)-listed spring/summer Chinook salmon, steelhead, and bull trout (75 FR 63898; 70 FR 52630). Second, the National Marine Fisheries Service (NMFS) (2017a) presented regional strategies in recovery planning to help address tributary habitat-related factors limiting the recovery of Snake River spring/summer Chinook salmon and steelhead populations. One of those strategies is to restore passage and connectivity to habitats blocked or impaired by artificial barriers and to maintain properly functioning passage and connectivity. Similarly, the United States Fish and Wildlife Service (USFWS) (2015) indicated that lack of fish passage and impaired connectivity continue to impact bull trout and contribute to their decline, isolation, and habitat fragmentation. Lastly, in reviews of restoring fish passage, it is recognized that passage restoration is one of the most effective restoration actions and can increase fish distribution and abundance (Hillman et al. 2016; Roni et al. 2008; Roni et al. 2014). Fish can respond rapidly to fish passage barrier removal which can open up miles of spawning and rearing habitat and the effects of barrier removal restoration actions are usually long term or even permanent (Hillman et al. 2016; Roni et al. 2008). Regional efforts to remove barriers to fish passage and to restore watershed connectivity have been the focus of many restoration activities (Maier 2014; NMFS 2014). For example, from 2007 to 2009, NMFS (2014) presented that 696 miles of improved access to fish habitat resulted from tributary habitat programs within the Upper Columbia River, Snake River, and Mid-Columbia River Chinook salmon evolutionary significant units (ESUs) and steelhead distinct population segments (DPSs).

Section 3: Defining Fish Passage Barriers and Upstream Extent

Fish passage terms used in this document are defined in Table 1. The terms include complete and partial barriers to fish passage, and no passage barrier (Robison et al. 1999; Taylor and Love 2003). A complete passage barrier is a natural or artificial stream condition that is impassable to all fish at all times of the year. Complete passage barriers exclude fish entirely or from portions of a watershed and may isolate fish populations upstream of the barrier. A partial passage barrier is a 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.

The terms natural or artificial describe whether the potential barrier was formed because of natural processes (natural barrier) or if the barrier is linked to human-caused disturbances that can modify water quality, stream channel or hydraulic conditions (artificial barrier).

Table 1. Different passage terms defined for potential barriers to fish passage (Robison et al. 1999; Taylor and Love 2003).

Term	Definition
Complete Barrier	A complete passage barrier is a 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 conditions.
Partial Barrier	A partial passage barrier is a 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	No impediment to fish passage to fish or a given species of concern.

3.1 Literature Review and Road-Stream Crossings

To identify potential fish passage barriers, we reviewed the available literature that describes barriers within the upper EFSFSR. In addition, the Payette National Forest (PNF) provided information on road-stream crossings within the area of interest. To evaluate potential fish passage barriers in the upper EFSFSR watershed, we assembled information from several sources including: biological assessments (Faurot and Burns 2007; Nelson 2009; Wagoner and Burns 2001), watershed analysis (Kuzis 1997), a multi-year aquatic resources sampling program conducted in the EFSFSR during 2012-2019 (Stantec 2018; 2019), stream functional assessments (HDR 2016; Rio ASE, Pers. Comm, R. Richardson), recovery plans (NMFS 2017b; NMFS 2017c), and personal communications with professionals familiar with the area.

Data from the available literature and unpublished resources were placed within a GIS database and plotted on a stream layer of the upper EFSFSR watershed. Location coordinates for barriers referenced within this TM are presented in Attachment A-1. Potential barriers associated with anthropogenic disturbances such as mining, or stream-road crossings were considered artificial barriers. Some potential passage barriers appeared to be influenced by anthropogenic disturbance, but the dominant landscape features were natural. This situation occurred in Blowout Creek and in the EFSFSR upstream of its confluence with Meadow Creek. Potential barriers in non-fish bearing streams in the existing condition were noted, but a fish passage barrier assumes some level of potential fish use and restriction of that use associated with the barrier; this condition occurred in Hennessy Creek, Midnight Creek, and Garnet Creek.

A systematic evaluation of road-stream crossings was conducted by the PNF during the summers of 2002 through 2004 (Adams and Zurstadt 2005). The PNF compiled the information into a road-stream crossing database (PNF 2005). Road-stream crossings are presented for the upper EFSFSR upstream from the confluence of Sugar Creek. The method used by the PNF to assess road-stream crossings (i.e., culverts) was a modification of the *National Inventory and Assessment Procedure for Identifying Barriers to Aquatic Organism Passage at Road-Stream Crossings* (Clarkin et al. 2003). A more recent version of the assessment procedure is available online (Clarkin et al. 2005).

3.2 Potential Barrier Status

Defining potential fish passage barriers can be difficult because there are a number of criteria that can be used to define them. Other than road-stream crossings involving culverts, potential barriers presented within the upper EFSFSR watershed were largely indicated by channel gradient, and at one location based on a combination of stream flow and gradient.

Gradient barriers to anadromy and resident fish are presented in Table 2. Washington Department of Fish and Wildlife (WDFW 2019) and Cooney and Holzer (2006) present similar criteria for accessible habitat defined by a stream slope of 20 percent or greater for a distance of 525 to 656 feet. The Coastal Conservancy (2004) considered stream gradients over shorter distances with and without pools. Passage criteria based on channel gradients with pools is characterized as greater than 20 percent for 30 feet or more for adult salmon and steelhead and a stream gradient of 20 percent for 20 feet for resident trout[2]. The channel gradient criteria without pools is greater than 12 percent for greater than 30 feet for adult anadromous salmonids and greater than 12 percent for greater than 20 feet for resident trout.

[2] Coastal Conservancy reported these criteria soon after Oregon had changed administrative rules to evaluating passage barriers on a case-by-case basis. The Oregon Department of Fish and Wildlife (ODFW) fish passage coordinator thought the criteria cite in the report were useful. but in Oregon, strict criteria were replaced recognizing that each situation is unique and species specific (G. Apke, Personal Comm., May 28, 2019).

As presented in the Coastal Conservancy (2004), the Oregon Department of Forestry rules characterize gradient barriers as natural falls and chutes of greater than 8 vertical feet for adult salmon and steelhead, and greater than 4 vertical feet for resident trout. Any falls greater than 2 vertical feet must have a jump pool that is 1.25 times deeper than the jump height (Powers and Orsborn 1985). The criteria presented provide general guidance when reviewing the literature or statements made on barrier status (Table 2).

Table 2. Criteria for barriers to anadromy and resident trout based on gradient for accessible habitat and summer stream flow (Coastal Conservancy 2004; WDFW 2019; Cooney and Holzer 2006; Isaak et al. 2017).

Description	Criteria	Species	Source
Channel gradient with pools	>20% for 30-ft.	Adult salmon and steelhead	Oregon Department of Forestry as cited in Coastal Conservancy 2004
	20% for 20-ft.	Resident trout	
Channel gradient without pools	>12% for >30-ft.	Adult salmon and steelhead	
	>12% for 20-ft.	Resident trout	
Natural Point Barrier (waterfall or chute)	>8-ft.	Adult salmon and steelhead	
	>4-ft.	Resident trout	
Natural Point Barrier (waterfall or chute)	>12-ft.	Not indicated (presume all species)	WDFW 2019
Gradient	≥20% for ≥160 meters	Not indicated (presume all species)	
Gradient	20% for 200 meters	Chinook salmon and steelhead	Cooney and Holzer 2006
Gradient or summer steam flow	≥ 15% or <0.2 cfs	Bull trout and Westslope Cutthroat Trout	Isaak et al. 2017

Notes:

cfs = cubic feet per second

ft. = feet

3.3 Fish Presence

The PNF and Ecosystem Sciences applied the criteria of the intrinsic habitat potential (Cooney and Holzer 2006) and occupancy model (Isaak et al. 2017) fish distributions within the upper EFSFSR to help delineate potential fish use and to describe habitats available for spring/summer Chinook salmon, steelhead, bull trout, and cutthroat trout (Figures 1 through3).

Potential presence for fish has been inferred to occur in stream reaches where summer stream flow is greater than or equal to 0.2 cubic feet per second (cfs) and in stream reaches that are located downstream from channel gradients of greater than or equal to 15 percent average slope for all upstream reaches (Figure 1) (Isaak et al. 2017). Endpoints were established to reflect the upstream extent of fish use (Attachment A-2). Fish passage barriers points were overlain with upstream limits of intrinsic habitat potential for spring/summer Chinook salmon and steelhead as well as potential fish use (Chinook salmon, steelhead, bull trout, and westslope cutthroat trout) for the entire upper EFSFSR watershed.

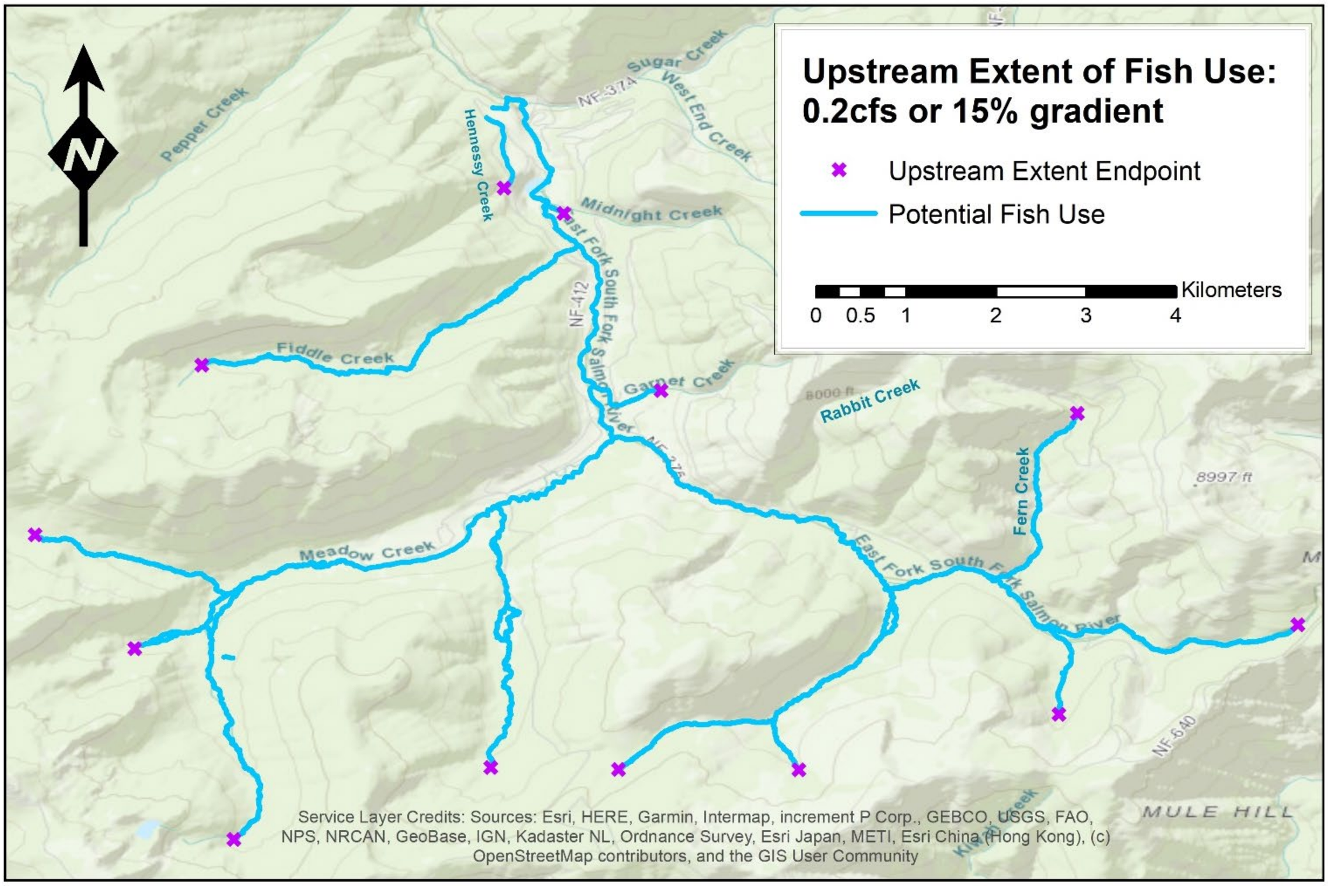

Figure 1. Upstream extent of potential fish use based on the criteria of Isaak et al 2017; <0.2 cfs or >15 percent stream gradient) as developed by Ecosystem Sciences and PNF for the upper EFSFSR watershed.

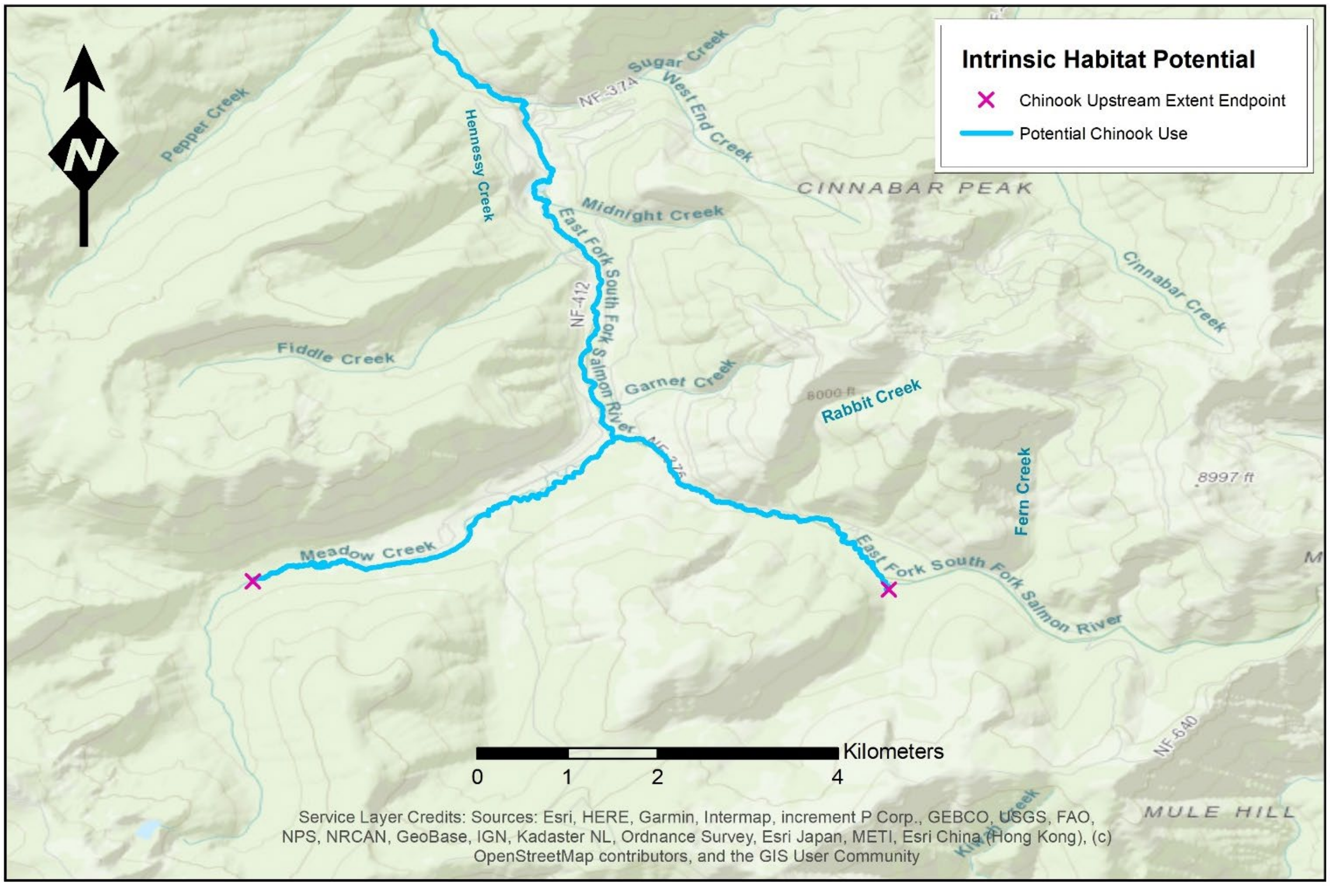

Figure 2. Streams identified with Chinook salmon intrinsic habitat potential based on the criteria of Cooney and Holzer (2006) as developed by Ecosystem Sciences and PNF for the upper EFSFSR watershed.

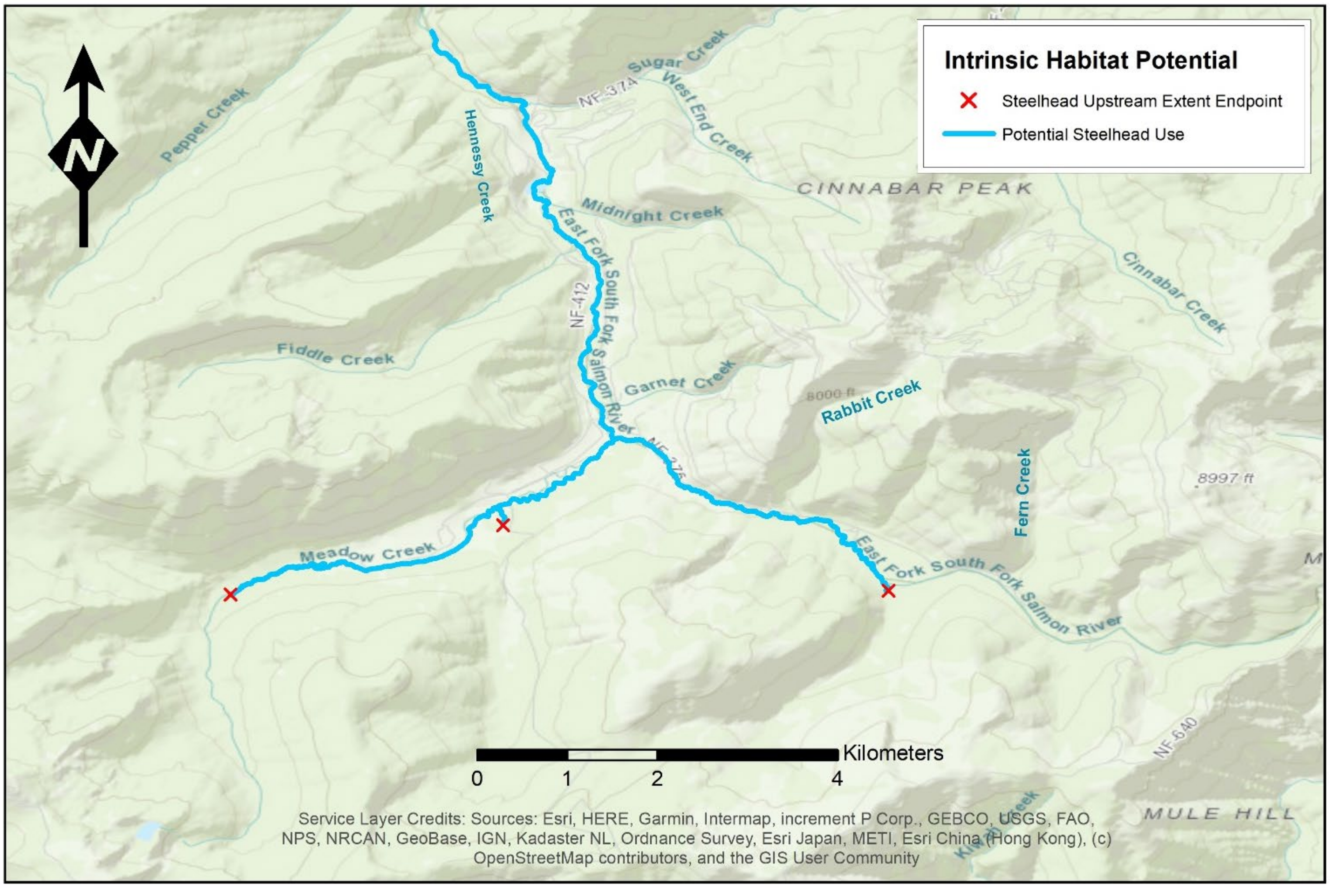

Figure 3. Streams identified with steelhead intrinsic habitat potential based on the criteria of Cooney and Holzer (2006) as developed by Ecosystem Sciences and PNF for the upper EFSFSR watershed.

Section 4: Existing Fish Passage Barriers

There has been no previous formal evaluation of natural and artificial fish passage barriers in the upper EFSFSR beyond the analysis of existing road crossings. This evaluation relies heavily on the information reported in stream surveys and assessments conducted within the area of interest. In this section, potential fish passage barriers are identified and supporting information sources are referenced.

4.1 Barriers in Fish Bearing Streams

4.1.1 East Fork South Fork Salmon River

Possibly the most important artificial barrier that limits fish passage in the upper EFSFSR watershed is the high-gradient (greater than 20 percent) boulder cascade directly upstream of the YPP (Kuzis 1997; Faurot and Burns 2007; NMFS 2017b) (Figures 4 through 6; Table 3). Because of its position at the downstream end of the upper EFSFSR, the cascade at the YPP represents a significant impediment to ESA-listed spring/summer Chinook salmon, steelhead, and bull trout.

As noted in the ESA Recovery Plan for Idaho Snake River spring/summer Chinook salmon and Snake River Basin steelhead (NMFS 2017b):

> *"Bradley Pit is a manufactured upstream barrier to adult summer Chinook salmon migration created by excavation of the river channel for gold mining. The high stream gradients at the upstream end of excavation of the river channel create the barrier. Since hatchery supplementation began, some adult summer Chinook salmon have been returning to spawn in the East Fork South Fork Salmon River but are limited from passing upstream further than Bradley Pit."*

NMFS (2017c) suggested that the cascade upstream of the YPP could be a barrier to steelhead, but that steelhead passage there may be flow dependent. There is currently no evidence that steelhead have recolonized the EFSFSR upstream since this barrier was formed by mining. In recent fish surveys and environmental DNA (eDNA) samples there has been no indication that native steelhead *O. mykiss* occur naturally upstream of the barrier (MWH 2017).

There are other locations within the upper EFSFSR watershed that potentially inhibit salmonid passage. About 1.7 miles upstream from the YPP high-gradient cascade is a concrete box culvert located where the NF 412 road crosses the EFSFSR (Figures 4 through 6; Table 3). The PNF classified this structure as a partial barrier (PNF 2005). The box culvert is a concrete structure about 67 feet long by 15 feet wide and has a gradient of 6 percent (PNF 2005). The box culvert is divided lengthwise with baffles to form a fish ladder on the left and a smooth concrete channel on the right. Fish passage on the right bank side would be difficult, especially during low-flow conditions which are likely to occur during adult spring/summer Chinook salmon and bull trout migrations[3]. Flow enters the fish ladder and cascades through nine alternating, diagonal, and open-top baffles.

[3] At the time that the box culvert was observed (July 11, 2018) daily mean stream flow was about 27 cfs at United States Geological Survey (USGS) gaging station 13311000 (EFSFSR at Stibnite) and 32 cfs at USGS 13311250 (EFSFSR above Sugar Creek) gaging station further downstream. Depth on the right bank side of the culvert was 0.4 feet and maximum depth was about 1.0 foot in the fish ladder.

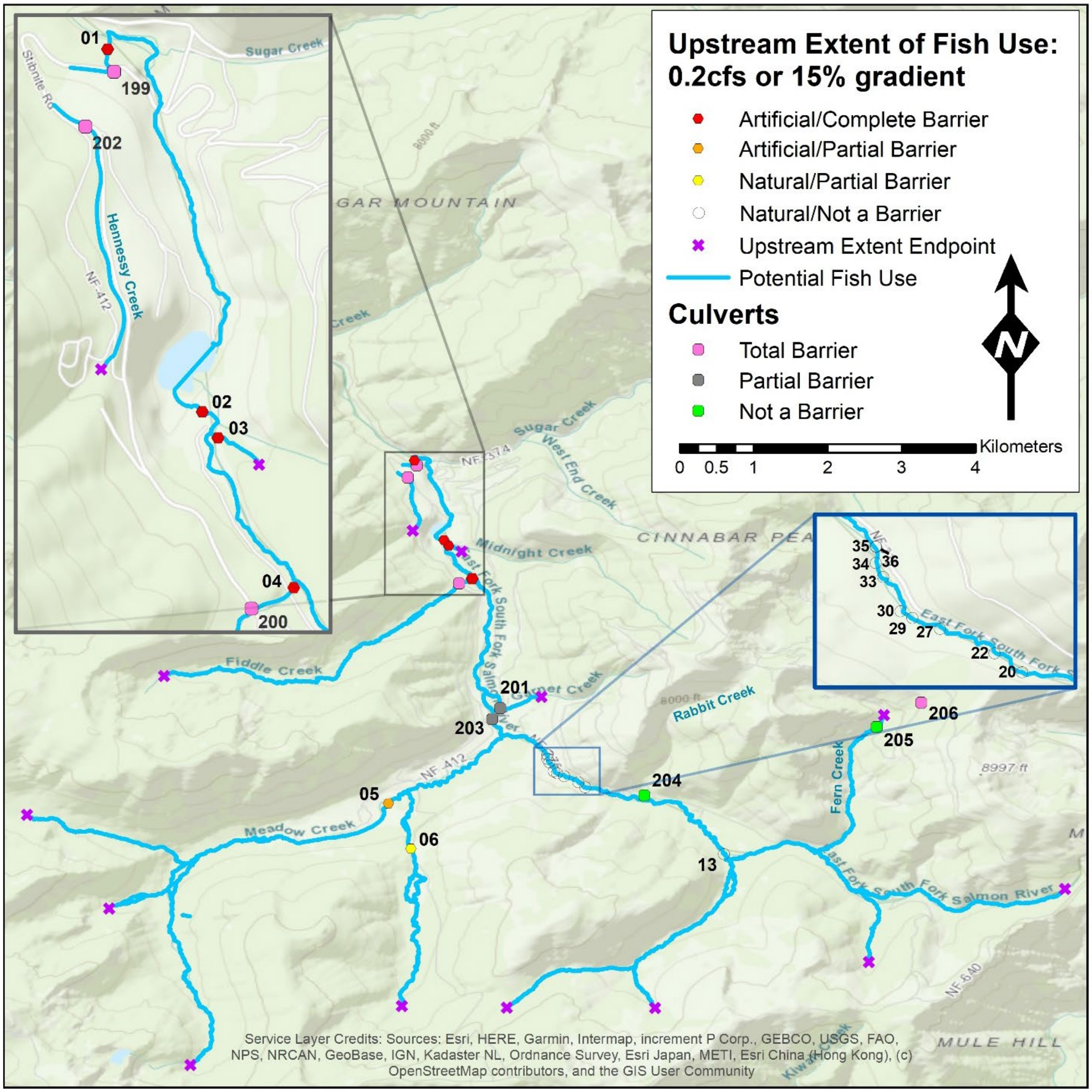

Figure 4. Artificial and natural barriers plotted on areas potentially used by fish based on the criteria of Isaak et al 2017; <0.2 cfs or >15 percent stream gradient) as developed by Ecosystem Sciences and PNF for the upper EFSFSR watershed. Natural partial barriers displayed on the EFSFSR (inset box) upstream from the confluence of Meadow Creek were later determined to be passable.

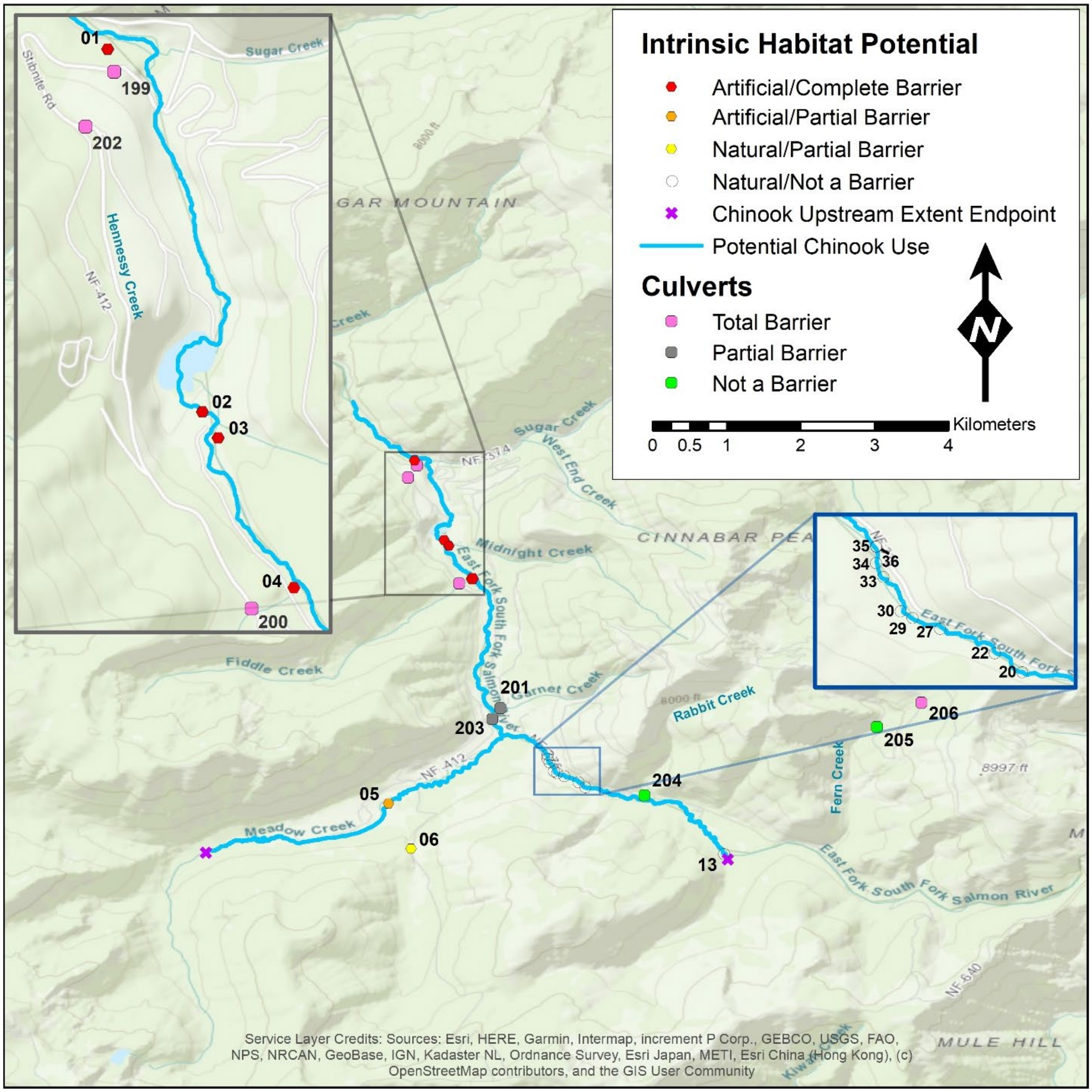

Figure 5. Natural and artificial barriers plotted on Chinook salmon intrinsic habitat potential based on the criteria of Cooney and Holzer (2006) as developed by Ecosystem Sciences and PNF for the upper EFSFSR watershed. Natural partial barriers displayed on the EFSFSR (inset box) upstream from the confluence of Meadow Creek were later determined to be passable.

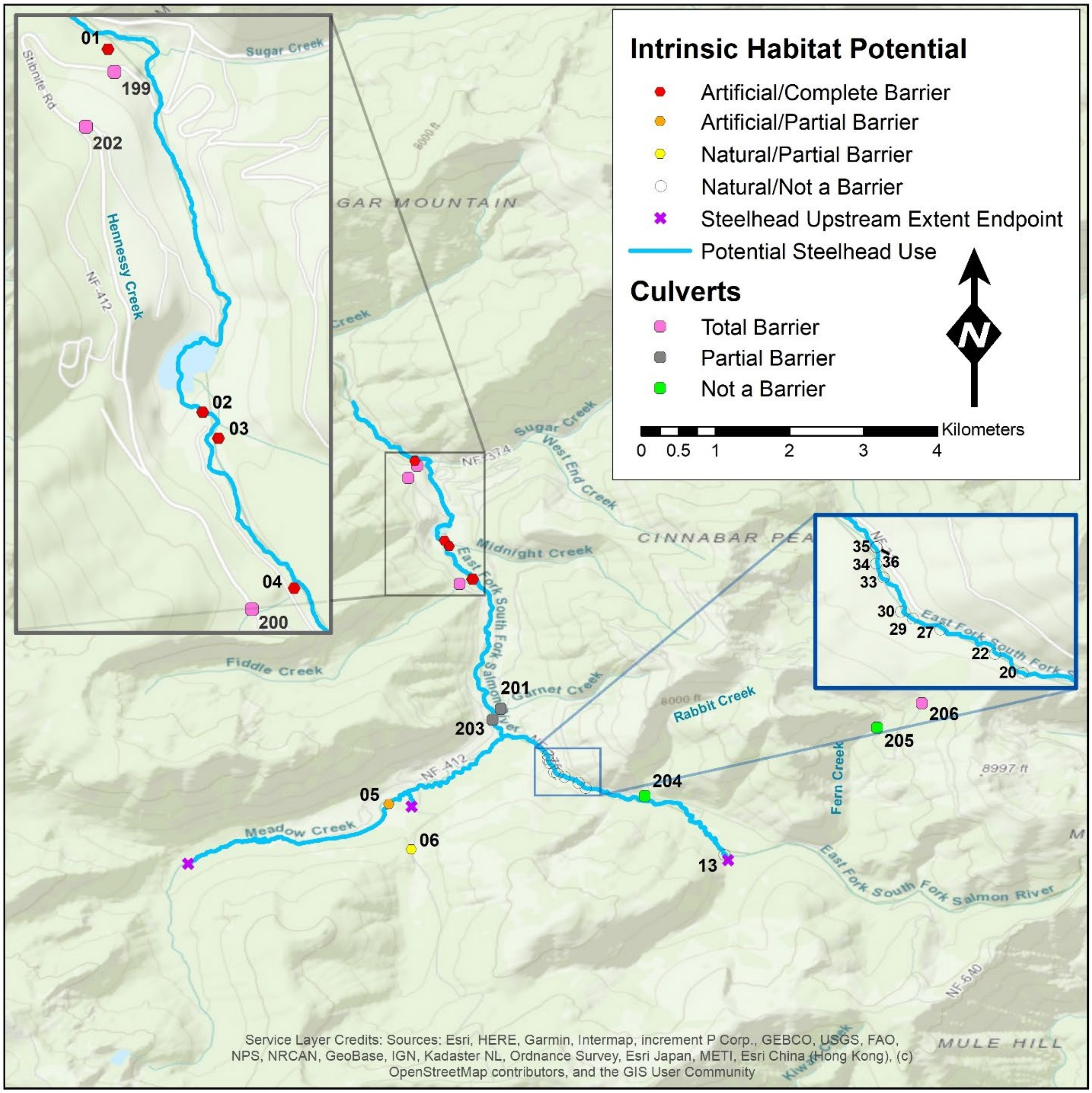

Figure 6. Natural and artificial barriers plotted on steelhead salmon intrinsic habitat potential based on the criteria of Cooney and Holzer (2006) as developed by Ecosystem Sciences and PNF for the upper EFSFSR watershed. Natural partial barriers displayed on the EFSFSR (inset box) upstream from the confluence of Meadow Creek were later determined to be passable.

There are several hydraulic conditions present at the box culvert fish ladder that provide suboptimal conditions for a fishway using the standards of NMFS (2011). First, at the downstream end flow plunges about 0.5 feet which can induce jumping and cause fish injury. The drop has been as much as 3 feet in 2009 and/or 2010 (C. Dail, personal communication, July 16, 2018). Second, depth and spacing within the fish ladder are inadequate for larger migratory species like spring/summer Chinook salmon, steelhead, and larger bull trout. Lastly, there was little to no dissipation of turbulence within pools provided in the fish ladder, hence no area is available for resting.

In a biological assessment, Faurot (2007; pg. 64 Table 10) indicated an option for redevelopment of fish passage above both the YPP barrier and box culvert in response to reasonable and prudent alternatives listed in the Stibnite Mine Biological Opinion. This assessment and statements by others (Wagoner and Burns 2001; Nelson 2009) indicate concerns with the passage conditions present in the box culvert, particularly at low flows.

Just upstream of the box culvert there is an abandoned concrete dam that has been partially demolished, and remnant concrete pieces still remain within the EFSFSR stream channel (Table 3). There has been no indication or mention that the remaining concrete is creating a fish passage barrier. Although the structure is artificial, there does not appear to be any existing hydraulic conditions for which fish could not pass.

Upstream from the confluence of Meadow Creek, a series of hydraulic controls formed by woody debris and large substrate create hydraulic drops that are 2 to 4 feet high (Table 3). These hydraulic drops were identified during a stream enhancement opportunity survey. Most of the hydraulic controls are concentrated in a relatively short segment of the EFSFSR (Figures 4 through 6). In many cases, vertical drops within this range would not present a barrier to adult salmonids if a plunge pool depth is about 1.25 times vertical height (Powers and Orsborn 1985). At these features on EFSFSR, plunge pools generally had little depth from which large salmonids could initiate a jump. Presumably, at high stream flows these locations would provide sufficient flow for adult spring migrants (i.e., steelhead, westslope cutthroat trout) to pass the vertical obstacles. Spring/summer Chinook redds have been documented upstream of the hydraulic controls in 2001 and 2008 (IFWIS 2019). However, in both years, adult spring/summer Chinook salmon were planted upstream in the EFSFSR near Fern Creek (i.e., upstream of the barriers).

These potential barriers on EFSFSR may have been influenced by past ditch and road construction. The degree to which the EFSFSR has been affected by such disturbances is unknown. The dominant natural feature affecting stream confinement at this location is a valley lateral moraine at the confluence of the EFSFSR and Meadow Creek (R. Richardson-, personal comm. May 20, 2019). Therefore, potential passage barriers at this location are considered to be largely a natural condition[4].

[4] On September 4, 2019 representatives from State, Federal, and Tribal entities inspected several locations noted in this TM on the lower EFSFSR. It was the consensus of the group that the locations visited did not represent partial barriers to adult Chinook salmon and bull trout. Therefore, those locations are no longer considered natural partial barriers.

Table 3. Fish passage barriers identified in the literature review and PNF road-stream crossing. (HDR 2016; MWH 2017; Rio ASE 2019a; Adams and Zurstadt 2005; PNF 2005 unpublished data).

Stream (ID)	Location Description	Barrier Type	Barrier Type/Artificial or Natural	Description
Fish Bearing Streams – Not Associated with Road Crossings				
EFSFSR (02)	Upstream of Yellow Pine pit (YPP)	Cascade Gradient (>20%)	Complete Barrier/ Artificial	As described in URS (2000), claims in the area started in the 1923 and 1924 but there was minimal development through 1937. Between 1938 and 1941 production came from the East and West Quarries on either side of the EFSFSR, during which time the EFSFSR was ditched around mine operations. By 1942, exploration on the tungsten ore body showed it was suitable for open-pit mining. In 1943, the Bailey Tunnel was complete and diverted the EFSFSR from near the confluence of Midnight Creek to an outlet on Sugar Creek. Mining operations in YPP ceased in 1952. In 1955, the Bailey Tunnel was abandoned and EFSFSR was allowed to flow into the Yellow Pine open pit creating a small lake (URS 2000). As described by Kuzis (1997), the barrier immediately upstream from YPP is a high-gradient boulder strewn section of stream formed by excavation of the highwall and erosion that resulted from the river flowing back into the excavation.
EFSFSR (No ID)	Remnant Dam just upstream of NF 412 Road	Remnant Concrete	No Barrier/ Artificial	Remnant concrete from dam built in the 1940s and demolished in 2002.
EFSFSR (20-36)	Just upstream from Meadow Creek near NF 375 Road	A series of 9 Wood jams	No Barrier / Natural	A series of hydraulic controls formed by large wood debris and substrate create vertical drops that may be an impediment to salmonids during low flow conditions. This series of debris jams was noted and observed by Mark Miller, BioAnalysts on July 11, 2018. Later, on September 4, 2019 a second field visit with several representatives from different entities determined that the wood jams did not represent a partial barrier.
Fiddle Creek (04)	Near mouth	Average gradient of 37% for 33 ft.	Complete Barrier/ Artificial	At the mouth of Fiddle Creek there is a high-gradient section of stream followed by a culvert. The high stream gradient is a barrier to fish migration (HDR 2016; MWH 2017).
East Fork Meadow Creek (06)	Near mouth	Gradient 8-20%	Partial Barrier/ Natural	The East Fork Meadow Creek transitions from a relatively low gradient stream to a higher gradient cascade downstream from the hanging valley floor (HDR 2016; MWH 2017). An earthen dam was constructed in 1929 and enlarged in 1931 to a reported height of 35 feet, 700 feet long and had a capacity of about 700-acre feet (URS 2000). In 1958, the dam on East Fork Meadow Creek was partially breached by Bradley Mining Company after an inspection by U.S. Forest Service engineers. The breach reduced water depth to 8 feet. In 1965, the dam failed and the surge of flood water scoured the stream channel releasing large volumes of tailings and sediment downstream.
Meadow Creek (05)	At Spent Ore Disposal Area (SODA)	Low stream flow (depth) and 9% Gradient	Partial Barrier/ Artificial	A short section of Meadow Creek at the SODA may be a partial barrier at low flows because of shallow depths and 9 percent gradient (HDR 2016). Spent ore placed on Bradley tailings from 1982-1984, necessitated rerouting of Meadow Creek away from tailings.

Stream (ID)	Location Description	Barrier Type	Barrier Type/Artificial or Natural	Description
				Non-Fish Bearing Streams
Hennessy Creek (01)	Near mouth	Average gradient of 37% for greater than 49 ft.	Complete Barrier/ Artificial	Hennessy Creek flows in a constructed ditch alongside Stibnite Road, and then flows under the adjacent rock dump before dropping down a high-gradient section into the EFSFSR (Kuzis 1997; MWH 2017).
Midnight Creek (03)	Near mouth	Average gradient of 90% for about 8 ft.	Complete Barrier/ Artificial	Overall, Midnight Creek is a small, shallow narrow steep stream and does not support fish (HDR 2016; MWH 2017). The high stream segment at 90% gradient for about 8 feet (chute) is the barrier.
				Road-stream Crossings; Fish Bearing Streams
EFSFSR (203)	NF 412 Road Bridge Crossing	Concrete box culvert	Partial Barrier/ Artificial	The box culvert is considered a partial barrier to both adult and juvenile life stages. Chinook salmon, bull trout and Westslope cutthroat trout have been identified in the EFSFSR upstream from YPP (MWH 2017).
Fiddle Creek (200)	Culvert located on abandoned road near [illegible]	Circular concrete culvert	Complete Barrier/ Artificial	Culvert is considered a complete passage barrier to adult and juvenile life stages. Fiddle Creek is small stream that is inhabited by Westslope cutthroat trout (MWH 2017).
Rabbit Creek (204)	Located near the mouth of the stream NF-375 Road	Circular steel culvert	No barrier/ Artificial	Passable to all life stages.
Fern Creek (205)	Located in headwaters of Fern Creek	Circular steel culvert	No Barrier/ Artificial	Passable to all life stages. Bull trout and Westslope cutthroat trout eDNA have been detected in Fern Creek (MWH 2017).
Fern Creek Tributary (206)	Located in headwater of Fern Creek	Circular steel culvert	Complete Barrier/ Artificial	Culvert is considered a complete passage barrier. Small tributary to Fern Creek.
				Road-stream Crossings; non-Fish Bearing Streams
Hennessy Creek (199)	Located near the mouth of the stream	Circular steel culvert	Complete Barrier/ Artificial	Culvert is considered a complete passage barrier. Hennessy Creek is a non-fish bearing stream
Hennessy Creek (202)	Located near the mouth of the stream	Circular culvert	Complete Barrier/ Artificial	Culvert is considered a complete passage barrier. Hennessy Creek is a non-fish bearing stream
Garnet Creek (201)	Near mouth NF-412 Road	Culvert	Partial Barrier/ Artificial	The culvert on Garnet Creek was classified as a partial barrier (HDR 2016) but did not appear in the PNF database; Garnet Creek is a small non-fish bearing stream (MWH 2017)

4.1.2 Fiddle Creek

Fiddle Creek enters the EFSFSR upstream from the YPP on the left bank and is inhabited by westslope cutthroat trout (MWH 2017). There are two road crossings on Fiddle Creek. The first is an abandoned road crossing (possibly with a failed timber bridge or culvert) across the stream near the confluence with the EFSFSR. This crossing has not been classified for fish access (i.e. barrier status is unknown) and no structure is obvious due to downed timber and undergrowth. The second crossing of Fiddle Creek is a culvert on Stibnite Road that has been classified as a complete barrier (MWH 2017). Downstream from the abandoned road crossing there is also a steep section of stream at 37 percent gradient for about 33 feet that has been classified as a complete barrier to fish access (HDR 2016). The section of stream between the roads is likewise steep, timber- and boulder-choked, and overgrown, and is a likely barrier. The two classified barriers on Fiddle Creek are summarized in Table 3 (above).

4.1.3 Meadow Creek and East Fork Meadow Creek

There are two locations in the Meadow Creek watershed that have been identified as barriers to fish passage (Table 3). The first is located on Meadow Creek at the Spent Ore Disposal Area (SODA). Historically, Meadow Creek was re-routed around the SODA and confined within an engineered stream channel. The engineered stream channel at this location has a gradient of 9 percent for 146-feet with a large substrate matrix, through which large salmonids would be unlikely to pass at low flows. This location was considered a partial barrier during low flows by HDR (2016). This partial barrier would likely only affect large adult migrants like spring/summer Chinook salmon and bull trout. Juvenile salmonids and resident fish are small enough to pass through the large substrate at low flows.

In East Fork Meadow Creek, there is a section of high stream gradient that may have been a natural barrier before it was altered by mining activities. As noted in MWH (2017), a dam failure of a reservoir built on the upper East Fork Meadow Creek exacerbated stream conditions creating unstable slopes along the stream. The East Fork Meadow Creek was originally a hanging valley; therefore, high stream gradients are natural for this location and may have limited fish passage prior to the dam or the failure of the dam.

4.1.4 Rabbit Creek and Fern Creek

Rabbit Creek and Fern Creek are tributaries to the EFSFSR upstream from its confluence with Meadow Creek. Recent eDNA results suggest that these streams are fish bearing (eDNA samples 2018, Stantec, unpublished data). Westslope cutthroat trout were indicated as occurring in Fern Creek and bull trout and westslope cutthroat trout were indicated in Rabbit Creek. A single culvert located in a tributary of Fern Creek has been determined to be a complete barrier (PNF 2005). All other road-stream crossings were deemed passable (PNF 2005). Rabbit Creek and Fern Creek do not fall within the extent of intrinsic potential for Chinook salmon and steelhead in the upper EFSFSR (Figure 5 and Figure 6).

4.2 Barriers in Non-Fish Bearing Streams

Recent surveys suggest that Hennessy, Midnight, and Garnet creeks do not currently support fish (MWH 2017). The degree to which their existing fish-bearing status was affected by legacy mining is unknown. However, researchers have noted seasonal use of similar small streams by both juvenile Chinook salmon and steelhead (Bradford et al. 2001; Bramblett et. al 2002; Hillman and Miller 2004). Streams like these could provide seasonal value and benefits particularly near their respective confluences with the EFSFSR should suitable passage conditions exist[5].

Hennessy Creek flows into a constructed ditch alongside Stibnite Road where it then flows under the adjacent waste rock dump before dropping down a very high gradient into the EFSFSR downstream of the confluence of the EFSFSR and Sugar Creek. This high-gradient segment is a complete barrier to fish passage (Table 3). There are two culverts on Hennessy Creek that have both been classified as complete barriers.

Midnight Creek has been diverted and is affected by the excavation of the YPP. The stream has a very high stream gradient over a short distance (90 percent gradient for about 8 feet) near its confluence with the EFSFSR (HDR 2016).

Garnet Creek has also been diverted and enters the EFSFSR downstream from Meadow Creek. Garnet Creek is channelized and has been straightened just before it enters the EFSFSR. A culvert on Garnet Creek was classified as a partial barrier (HDR 2016).

Section 5: Conclusions and Applications

The upper EFSFSR watershed has a number of fish passage barriers that limit watershed connectivity and affect accessibility to stream reaches with physical and biological features important to ESA-listed fish. Existing artificial barriers that are located within Meadow Creek and EFSFSR affect access to DCH for spring/summer Chinook salmon and bull trout.

The PNF identified eight road-stream crossing locations within the watershed; four were complete barriers, two were partial barriers, and two were not considered barriers.

Eight additional locations classified as artificial barriers were identified in the literature (Kuzis 1997; Faurot and Burns 2007; HDR 2016; NMFS 2017b). Four of the locations were considered complete barriers, three were partial barriers, and one was not considered a barrier. Two locations within the watershed were identified as natural partial barriers to fish passage.

The natural partial barrier on the East Fork Meadow Creek (Blowout Creek) is the result of a stream flowing from a glacial-origin hanging valley downstream to Meadow Creek.

Fish passage barriers are represented by the habitat access element of the watershed condition indicators (WCI). As a watershed condition indicator, habitat access is used to identify and evaluate the known and/or potential man-made barriers to fish movement both within a local population and among core areas (USFS 2003, Appendix B). 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. As noted by United States Forest Service (USFS) (2003), natural barriers are not included in the WCI functional rating but are still important to identify.

Intuitively, it makes sense to apply physical barriers and their functional condition to fish passage only within fish bearing streams. According to the WCI, the presence of man-made barriers within a watershed determine the functional rating of habitat access (Table 4). In a biological assessment, Nelson (2009) evaluated habitat access in the EFSFSR analysis area for spring/summer Chinook salmon, steelhead, bull trout, and Westslope cutthroat trout and noted a rating of “functioning at risk”. Among the physical barriers within the analysis area mentioned by Nelson (2009) were the Glory Hole (YPP) and box culvert. Nelson

[5] Rio ASE 2019b proposed stream enhancements to Midnight, Hennessy, and Garnet creeks.

(2009) applied that functional rating to two fifth level hydrologic units (1706020802-upper EFSFSR; 1706020804-lower EFSFSR).

Table 4. Habitat access pathway and physical barrier indicator for watershed condition indicators (WCI) (from USFS 2003, Table B-1).

Pathway and Indicator	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Habitat Access-Physical Barriers	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.

The USFS (2003) presented guidance that assessment of the effects of management actions should address the spatial and temporal scales that are relevant to the proposed action and to the WCIs that would be affected. As defined in Table 4, a watershed approach is used to determine the overall functional rating and the barriers are described within the context of the watershed. The approach is useful for determining watershed connectivity from a qualitative perspective, however the degree of habitat fragmentation requires a more refined spatial component to fully assess the effects of artificial barriers.

Methods have been developed to help assess and prioritize potential barriers at different spatial scales (ODFW 2019; UCRTT 2019; WDFW 2019; USFS 2016). In Idaho, similar procedures are used to prioritize passage barrier removal projects (M. Edmundson, Aquatic Species Program Manager, Governor's Office of Species Conservation, Personal Comm., May 23, 2019). Common variables within those prioritization strategies include: habitat indicators (potential length and quality of habitat to which access is gained), biological indicators (species status, number of species), and barrier indicators (location, number, and severity of other barriers).

The State of Oregon and the United States Environmental Protection Agency have set an important foundation in developing a stream functional assessment method (SFAM) that includes a fish barrier assessment method (Nadeau et al. 2018a) and the scientific rationale for its development and use (Nadeau et al. 2018b). The Stream Functional Assessment (SFA) method developed for the SGP also includes a fish barrier assessment parameter that includes the types of indicators incorporated into existing barrier assessment and prioritization tools (ODFW 2019; UCRTT 2019; WDFW 2019; USFS 2016). The SFA includes WCI habitat indicators (i.e., substrate embeddedness, large woody debris, pool frequency, pool quality, and off-channel habitat), biological filters (i.e., occupancy potential by fish species), barrier indicator (i.e., barrier status, reach location), and a quantification of linear feet of stream and stream quality blocked or made accessible by each barrier (i.e., total perennial stream length categorized as blocked, partially blocked, or accessible per reach and/or project, per year for the life of the project). The ability of the (SFA) method (Rio ASE 2019a) to incorporate these types of variables facilitates both a qualitative and quantitative assessment of the WCI habitat access pathway.

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Attachment A: Barrier Locations and Fish Endpoints

Attachment A-1. Latitude and longitude coordinates for barriers indicated in Table 3.

Attachment A 2. Fish use endpoint coordinates for the upper EFSFSR watershed. Fish use endpoints are displayed in Figures 1-6.

Attachment A 1. Latitude and longitude coordinates for barriers indicated in Table 3.

Stream (No. ID)	Coordinates		Artificial or Natural	Barrier Status
	Latitude	Longitude		
EFSFSR- YPP High Gradient (02)	44.926020	-115.334827	Artificial	Complete
EFSFSR-Box Culvert (203)	44.904220	-115.328910	Artificial	Partial
EFSFSR (36)	44.899933	-115.322267	Natural	No Barrier
EFSFSR (35)	44.899917	-115.322250	Natural	No Barrier
EFSFSR (34)	44.899400	-115.322267	Natural	No Barrier
EFSFSR (33)	44.898967	-115.322033	Natural	No Barrier
EFSFSR (30)	44.897883	-115.321483	Natural	No Barrier
EFSFSR (29)	44.897667	-115.321100	Natural	No Barrier
EFSFSR (27)	44.897317	-115.320233	Natural	No Barrier
EFSRSR (22)	44.896550	-115.318500	Natural	No Barrier
EFSFSR (20)	44.895950	-115.317633	Natural	No Barrier
Hennessy Creek (01)	44.935700	-115.338395	Artificial	Complete Barrier
Hennessy Creek (199)	44.935160	-115.338380	Artificial	Complete Barrier
Hennessy Creek (202)	44.933630	-115.339170	Artificial	Complete Barrier
Midnight Creek (03)	44.925420	-115.334450	Artificial	Complete Barrier
Fiddle Creek (04)	44.921330	-115.331380	Artificial	Complete Barrier
Fiddle Creek (200)	44.920740	-115.332840	Artificial	Complete Barrier
Garnet Creek (201)	44.905510	-115.327480	Artificial	Partial Barrier
Rabbit Creek (204)	44.893102	-115.309568	Artificial	No Barrier
Fern Creek (205)	44.901436	-115.281290	Artificial	No Barrier
Fern Creek Tributary (206)	44.904375	-115.275884	Artificial	Complete Barrier
Meadow Creek (05)	44.894010	-115.341580	Artificial	Partial Barrier
East Fork Meadow Creek (06)	44.890338	-115.339127	Natural	Partial Barrier

Attachment A 2. Fish use endpoint coordinates for the upper EFSFSR watershed. Fish use endpoints are displayed in Figures 1-6.

Stream (No ID)	Coordinates	
	Latitude	Longitude
Fish Presence Endpoints		
Hennessy Creek	44.927163	-115.338672
Midnight Creek	44.924619	-115.332713
Fiddle Creek	44.909477	-115.368875
Meadow Creek Tributary	44.892574	-115.385538
Meadow Creek Tributary	44.881198	-115.375575
Garnet Creek	44.906958	-115.323002
Meadow Creek	44.862162	-115.365681
East Fork Meadow Creek	44.869362	-115.339969
EFSFSR Tributary	44.869140	-115.327227
EFSFSR Tributary	44.869117	-115.309189
EFSFSR Tributary	48.874671	-115.283224
EFSFSR	44.883573	-115.259370
Fern Creek	44.904710	-115.281393
Chinook Salmon Intrinsic Habitat Potential Endpoints		
EFSFSR	44.887151	-115.363817
Meadow Creek	44.887966	-115.363817
Steelhead Intrinsic Habitat Potential Endpoints		
EFSFSR	44.887151	-115.300351
Meadow Creek	44.886746	-115.365989
East Fork Meadow Creek	44.893665	-115.338821