2019 Silver Hart Access Road Stream Crossing Assessments

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EXECUTIVE SUMMARY

EDI conducted fish and fish habitat assessments along the Silver Hart access road in late August 2019 to support and inform planning and permitting for the upgrading of select stream crossings. The streams along the road flow into upper Rancheria and Meister River drainages which are known to contain lake trout, bull trout, Arctic grayling, mountain whitefish, longnose sucker, white sucker, burbot, lake chub, and slimy sculpin.

- Fish were captured in the streams at the crossings at Site 2, Site 5, and Site 9.
- No fish were captured in the remaining crossings investigated; Site 0, Site 2B, Site 3, and Site 10 – of these; Site 0 and Site 2B were determined to be non fish-bearing. Site 3 and Site 10 defaulted to fish-bearing status given the available habitat and accessibility to nearby fish-bearing waters.

Crossings over demonstrated or defaulted fish-bearing streams should be designed to ensure fish passage is maintained. Upgrade works on all streams should be planned and completed in a manner that uses best practices to minimize impacts to water quality.

ACKNOWLEDGEMENTS

Thanks to Kevin Brewer for project direction and organizing lodging during fieldwork. The project was completed within the First Nation Traditional Territory of the Teslin Tlingit Council, and the Kaska Dena Council (Ross River Dena Council and Liard First Nation).

AUTHORSHIP

This report was prepared by EDI Environmental Dynamics Inc. Staff who contributed to this project include:

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Pat Tobler, R.P.Bio. CPESC, Regional Director, Territories ..... Senior Review

Jonathan Lowey and Matt Power completed fieldwork for this project.

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1 INTRODUCITON

EDI Environmental Dynamics Inc. was retained by CMC Metals Ltd. to conduct assessments of specified stream crossings along the Silver Hart access road that are planned to be upgraded in the near future. The Silver Hart mine is a Silver, Lead, Zinc property located in the South-Central, Rancheria district of the Yukon (Map 1. The L). The mine is located approximately 115 km west of the community of Watson Lake, Yukon, and is accessed via a 43 km long access road adjacent to the Alaska Highway at KM 1116, which was built in 1985-86 (Yukon Government 2019a). Once poised for production, the project was cancelled due to falling commodity prices. Several stream crossings have deteriorated significantly, including washed out culverts and bridges, which are currently being forded by local traffic. With renewed interest and exploration activity at the Silver Hart property, the access road and crossings require upgrades to handle the increased traffic.

The first 32.2 KM of the access road lies within the headwaters of the Rancheria River watershed, a tributary of the Liard River. The Rancheria River in this area flows south through several lakes including the Northwind lakes and Daughney lake (Map 1). The last 10.8 KM of the road lies in the Meister River watershed and follows the north shore of Roy and Edgar Lakes before climbing a series of switchbacks to the mine site. Edgar Lake, McCory Creek, and Oake Creek drain to the east into the Meister River, a different tributary of Liard River. All the crossings assessed during this project are located in the Rancheria River watershed.

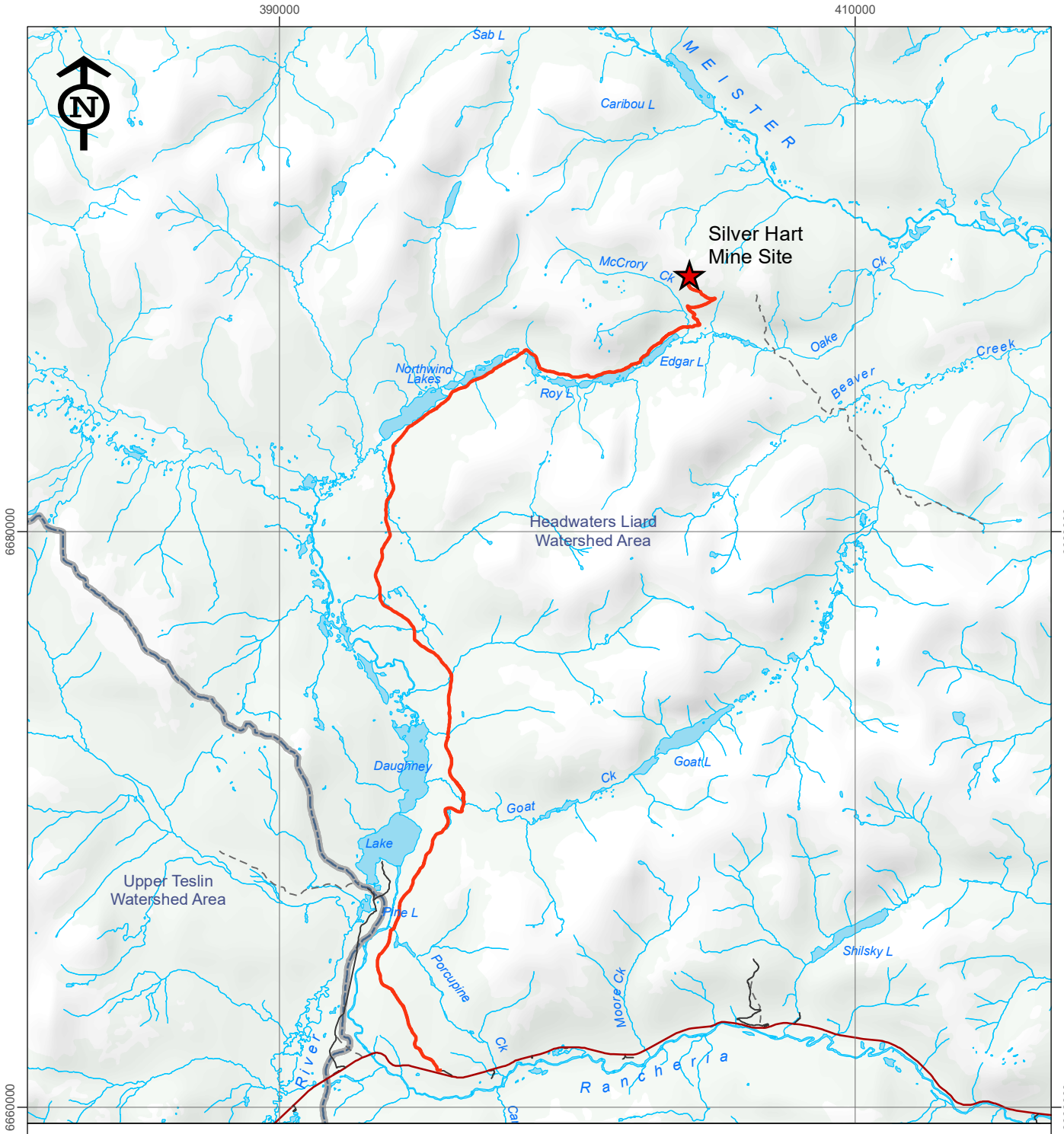
Previous fisheries fieldwork in the area has focused on the creeks and lakes immediately downstream of the proposed mine site, namely in the Meiser River, Oake Creek, and in Edgar Lake. While a number of species were captured in these waterways including lake trout (*Salvelinus namaychush*), bull trout (*Salvelinus confluentus*), Arctic grayling (*Thymallus arcticus*), mountain whitefish (*Prosopium williamsoni*), longnose sucker (*Catostomus catostomus*), burbot (*Lota lota*), and slimy sculpin (*Cottus cognatus*) (CMC Metals Ltd. 2010), little information is available regarding the presence or abundance of fish species in the creeks and streams crossed by the access road. No fish were previously captured in McCory Creek, which flows into Edgar Lake and is the only access road creek crossing where previous fisheries investigations have occurred (CMC Metals Ltd. 2010). Bull trout, lake whitefish, white sucker (*Catostomus commersonii*), and lake chub (*Couesius plumbeus*) are known to occur in the Rancheria River (Yukon Government 2019b). No aquatic species at risk are known to occur in the area (Fisheries and Oceans Canada 2019).

The purpose of this project was to investigate specific stream crossings highlighted by CMC Metals Ltd. as requiring upgrades (Table 1), and to determine fish species presence and community composition while also collecting stream measurements to guide recommendations related to planned future work upgrading these crossings.

Table 1. Silver Hart Access Road stream crossing site name concordance table for the assessed crossings.

Site Name	Distance up the Silver Hart Access Rd. (km's)	Previous YESAB Name[1]	Previous CMC Metals Ltd. Name[1]	Proposed Crossing Type
Site 0	1.5	-	-	Culvert
Site 2	12.2	Site 2	405	Bridge
Site 2B	13.5	-	-	Culvert
Site 3	14.8	Site 3	407	Culvert(s)
Site 5	17.0	Site5	412	Bridge
Site 9	24.5	Site 9	420	Large culvert or Bridge
Site 10	30.2	Site 10	426	Culvert

[1]As per (YESAB 2018) report.



Legend

- Silver Hart Access Road
- Alaska Highway
- Secondary Road
- Resource Road
- Watershed Boundary

Map 1. Overview of Silver Hart Access Road Crossing Locations

Data Sources
1:50,000 CanVec topographic data from Government of Canada, Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. Geogratis website (http://geogratis.cgdi.gc.ca).

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Disclaimer
EDI Environmental Dynamics Inc. has made every effort to ensure this map is free of errors. Data has been derived from a variety of digital sources and, as such, EDI does not warrant the accuracy, completeness, or reliability of this map or its data.

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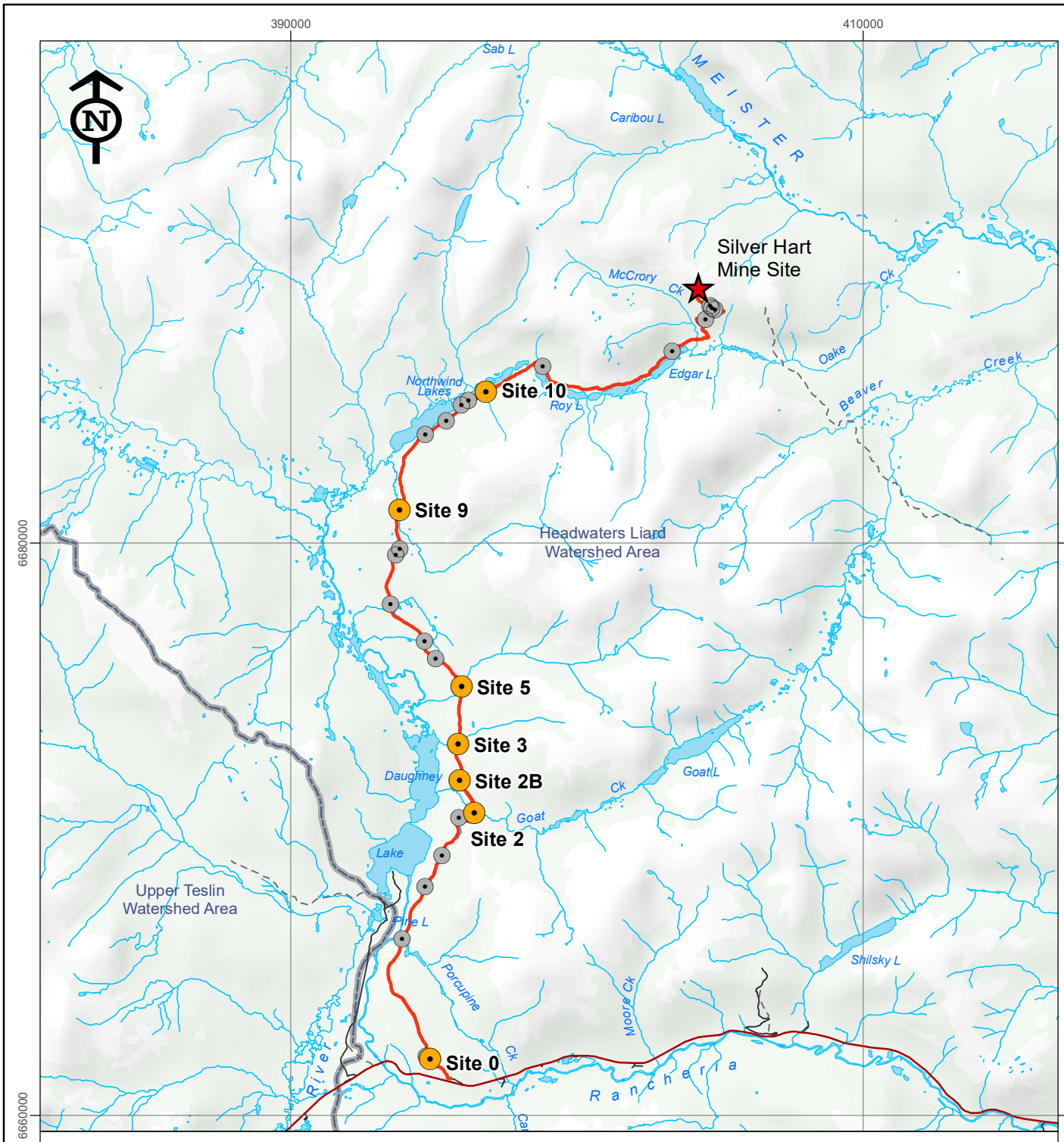
2 METHODS

An EDI biologist and technologist conducted fish and fish habitat investigations of seven stream crossings along the Silver Hart access road from August 27 - 30, 2019 (Map 2). Stream crossing investigations included the collection of measurements and notes on stream morphology, fish habitat characteristics, and fish sampling.

Sampling for fish presence and community composition was conducted using a combination of minnow trapping and electrofishing. Minnow traps were set overnight for between 15 - 23 hours (19.6 hrs on average) in areas of calm water close to the crossings. Minnow traps were baited with sterilized salmon roe and set in an average water depth of 0.35 metres. Electrofishing was conducted using a Smith-Root Ltd. model LR-24 electrofisher for a minimum of 300 seconds (309s - 791s) at each site depending on habitat availability and complexity. Please see Appendix A for a list of the electrofisher settings used at each site. Capture data was converted to Catch Per Unit Effort (CPUE) as the number of fish captured per day (24 hrs) for minnow trapping, and the number of fish captured per minute (60 seconds) for electrofishing.

Stream assessments followed the B.C. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures Guide (BC Fisheries Information Branch 2001). Measurements of stream characteristics were taken using either a folding meter stick or flexible measuring tape. Sites were photographed, and descriptions of fish habitat quality and potential (overwintering, spawning, and rearing) were recorded.

In-situ water quality parameters were collected at each stream crossing investigation site using a YSI Pro Plus multimeter. Measurements of water temperature, pH, Dissolved Oxygen, and Oxidation Reduction Potential (ORP) were collected at each site. Turbidity (recorded as Nephelometric Turbidity Units, NTU's) was also collected at each site using an Oakton T-100 turbidity meter.



Legend

- Crossing - Stream Assessment Completed
- Crossing - No Stream Assesment
- Silver Hart Access Road
- Alaska Highway
- Secondary Road
- Resource Road
- Watershed Boundary

Map 2. Silver Hart Access Road Assessed Crossings

Data Sources
1:50,000 CanVec topographic data from Government of Canada, Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. Geogratis website (http://geogratis.cgdi.gc.ca).

Digital Elevation Model provided by Geomatics Yukon - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

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3 RESULTS

Fish were captured at three of the seven assessed crossings; Site 2, Site 5, and Site 9. More fish were captured by electrofishing than minnow trapping, which only captured two slimy sculpin at Site 2. In total 2 Arctic grayling, 13 bull trout, and 17 slimy sculpin were captured during fish sampling (Table 2). No fish were captured or observed during sampling at four of the investigated crossings (Site 0, Site 2B, Site 3, and Site 10).

Table 2. Fish sampling results including catch per unit effort (CPUE) and length by species at assessed Silver Hart access road crossings.

Site	Numb. - Species	Electrofishing CPUE fish/min.	Minnow Trapping CPUE fish/24hr	Fork Lengths (mm)
Site 0	0 - NFC	0.00	0	-
Site 2	1 - GR	0.12	0	120
	1 - BT	0.12	0	92
	12 - CCG	1.24	2.09	95, 92, 83, 80, 80, 77, 76, 74, 70, 61, 53, 48
Site 2B	0 - NFC	0.00	0	-
Site 3	0 - NFC	0.00	0	-
Site 5	1 - GR	0.12	0	140
	12 - BT	1.44	0	118, 110, 83, 81, 81, 77, 73, 45, 44, 41, 41, 37
Site 9	5 - CCG	0.43	0	72, 70, 57, 45, 35
Site 10	0 - NFC	0.00	0	-

GR = Arctic grayling, BT = bull trout, CCG = slimy sculpin, NFC = No Fish Caught

In situ water quality parameters were within acceptable ranges for fish at all sites sampled. Site 0 had the highest water temperature and SPC, and the lowest levels of dissolved oxygen (Table 3). Site 10 had the lowest water temperature (5.9°C), and Site 3 had the highest turbidity (1.90 NTU) which is still quite low. All sites had a neutral pH between 7 and 8 (Table 3).

Table 3. In-situ surface water quality parameters collected at assessed crossings during August 2019 fieldwork.

Site	Temp (°C)	pH	DO (%)	DO (mg/L)	SPC (µs/cm)	ORP	Turbidity (NTU)
Site 0	10.6	7.22	66.8	7.44	132.7	320.8	0.60
Site 2	9.6	7.67	83.2	9.44	47.8	309.1	0.37
Site 2B	8.3	7.60	83.7	9.87	53.6	309.7	0.27
Site 3	9.5	7.29	80.3	9.26	34.6	-	1.90
Site 5	7.8	7.54	87.2	10.39	32.0	312.5	0.54
Site 9	7.6	7.57	87.7	10.46	41.4	316.3	0.50
Site 10	5.6	7.60	89.0	11.70	43.7	-	0.06

Site specific findings and recommendations are described in the sections below.

3.1 SITE 0

Site 0 is located approximately 1.5 km up the Silver Hart access road (Photo 1); no drainage is mapped in this location on CanVec, 1:50,000 mapping. This site is characterized by a wetland and small pond upstream of the road (Photo 2), and a small, low gradient, poorly defined channel downstream of the road. The creek is not connected to any waterbodies upstream of the pond and emerges from a large fen complex 100 m upstream (northeast) (Photo 3 and Photo 4) before pooling upstream of the road. Water flows directly over the road and into a narrow channel with an average bankfull width of 0.35 metres. The drainage was assessed for 260 m downstream of the crossing and frequently flows underground in sections with no stream channel (Photo 5 and Photo 6).

Fish sampling at the crossing included electrofishing and minnow trapping in the ponded water upstream of the road. Fish sampling was not completed in the creek downstream of the road due to the difficulty of sampling and shallow nature of the creek. Electrofishing was conducted for 440 seconds and 150 m of linear habitat. Three minnow traps were set for 15.75 hrs each (47.25 hrs total). No fish were captured or observed during sampling.

Photo 1. Water flowing over the road at Site 0 from the pond on the left (east) to the creek on the right (west).

Photo 2. The wetland and pond at Site 0 immediately upstream (northeast) of the road.

The pond upstream of the road has an average depth of approximately 1.0 m and is approximately 0.3 ha in size. Because of the pond's small size, limited depth and low flow, the pond likely either freezes to bed or becomes anoxic during winter. Large amounts of organic material were observed in the pond, which would contribute to anoxic winter conditions. Due to the lack of connectivity between the creek at this crossing and watercourses either upstream or downstream, the results of fish sampling, and the lack of potential overwintering habitat this drainage has been determined to be non-fish bearing. Future work to install a culvert at this crossing should be designed in a manner to help maintain downstream water quality (i.e. complete work in the dry by pumping water over the road during culvert installation).

Photo 3. The terminal fen up gradient from road and pond at Site 0.

Photo 4. Detailed view of the upstream terminal fen, where the stream starts flowing on the surface.

Photo 5. Poorly defined channel at Site 0 approximately 10 m downstream of the road.

Photo 6. An example of where the creek flows underground at Site 0 where there is no visible stream channel.

3.2 SITE 2 (GOAT CREEK)

Site 2 is located on Goat Creek approximately 12.2 km up the Silver Hart access road (Photo 7); there are a number of lakes upstream of this crossing including Goat Lake (Map 2). The site is characterized by a mostly intact bridge that has one corner slumping slightly due to erosion (Photo 8). At this crossing Goat Creek is of moderate size, with an average bankfull width of 6.91 metres and abundant instream cover provided by boulders, undercut banks, and deep pools. Moderate habitat complexity exists near the crossing including numerous pools, riffles, runs, cascades, and some off-channel habitat.

Photo 7. Downstream view of the bridge at the Site 2 crossing from Goat Creek.

Photo 8. View of the bridge at Site 2 looking south. Note the slight slumping of the north side of the bridge on the left side of the photo.

Fish sampling at the crossing included electrofishing and minnow trapping. Electrofishing was conducted for 482 seconds and a linear distance of 152 m. Three minnow traps were set for 23.0 hrs each (69.0 hrs total). Two slimy sculpin were captured in minnow traps, and 10 slimy sculpin, 1 Arctic grayling, and 1 bull trout were captured via electrofishing.

Goat Creek contains limited spawning potential at the crossing location as the bed material is comprised primarily of cobbles and boulders, and limited amounts of small gravels. Overwintering habitat potential is moderate as the stream has substantial flow, but few large, deep pools were identified near the crossing. However, the presence of slimy sculpin suggests overwintering habitat exists nearby as sculpin are a species with high site fidelity and may migrate only a few hundred metres a year (Gray et al. 2004). Rearing habitat potential is good as indicated by moderate habitat complexity, abundant cover, and numerous fish captured at the site. Future work to lift the slumped end of the bridge should implement the following suggested mitigation measures to protect fish and fish habitat at the crossing.

- As possible, work should be planned and completed so that instream work is avoided.
- Erosion and sediment control measures should be installed as needed to prevent sediment from entering the stream channel.
- If instream work is required, work should be completed between June 15th and Sept. 1st, the freshwater fish timing window identified by DFO.

It is understood that the ford will continue to be used at the crossing for heavy equipment (Photo 9) as the bridge is too narrow to accommodate some vehicles. The streambed and stream bank materials are stable at the crossing and not easily erodible, with few fines present. The streambed is dominated by cobbles, and fast water velocities at and downstream of the ford limit spawning habitat potential. In addition, the entrance and exit to the ford crossing are stable and at a low angle. If the number of ford crossings is kept small and the riparian vegetation at the crossing is maintained the impact to water quality and fish should be minimal.

Photo 9. Upstream view at Site 2 from the bridge showing the location of the ford.

3.3 SITE 2B

Site 2B is located on an unmapped drainage (CanVec 1:50,000) approximately 13.5 km up the Silver Hart access road. The site is a small creek that connects to the road and flows for 100 m in the ditch before flowing over the road (Photo 10). The creek is consistently narrow and confined, with an average bankfull width of 0.5 m, and contains very little habitat complexity. The creek bed is primarily comprised of cobbles and gravels (Photo 11), and varies in gradient from five to fifteen percent in the forest before connecting to the ditch (Photo 12).

Photo 10. Water flowing over the access road at Site 2B.

Photo 11. Upstream view of the stream 200 m upstream of the road crossing.

Photo 12. The creek flows in the ditch for 100 m upstream of the crossing.

Fish sampling near the crossing was limited to electrofishing as the water was not deep enough set minnow traps. Electrofishing was conducted for 537 seconds over 107 m of linear habitat. No fish were captured or observed during sampling.

The creek at site 2B is primarily comprised of shallow riffles and contains poor habitat quality and complexity. Few areas of slack water are present where rearing fish might rest and recover. Downstream of the road the stream disappears underground with no signs of a channel that would allow for fish passage. At the road crossing, the creek has low volume with no deep pools and likely freezes to bed in the winter. Because the creek is not connected to any water bodies downstream of the road (i.e. flows underground with no stream channel; Photo 13 and Photo 14), contains limited usable habitat, and does not provide overwintering habitat it was determined that this stream is non-fish bearing. Future work to install a culvert at this crossing should be designed in a manner to help maintain downstream water quality (e.g. complete work in the dry by pumping water over the road during culvert installation).

Photo 13. Downstream of the crossing the volume of water in the creek decreases and flows underground.

Photo 14. Downstream of the crossing where the drainage flows underground with limited evidence of surface flow.

3.4 SITE 3

Site 3 is located approximately 14.8 km up the Silver Hart access road (Photo 15). The site is characterized by a stream with numerous beaver dams upstream and downstream of the crossing (Photo 16 and Photo 17). One beaver dam was identified upstream of the crossing, and two were identified downstream during the assessment. The stream near the crossing has an average bankfull width of 2.53 m. The streambed is comprised of cobbles and gravels covered in a thick mat of algae. Approximately 60 m downstream of the crossing is a pond (Photo 18) created by a large beaver dam that is currently an impediment to upstream fish movement (barrier 1.2 m - 1.6 m in height). Upstream of the crossing the stream flows in a well-defined channel, whereas downstream of the crossing the stream flows into the pond in multiple braided channels through willow and sedge tussocks.

Photo 15. The crossing at Site 3 (photo provided by Kevin Brewer).

Photo 16. Beaver dam approximately 40 m upstream of the crossing.

Photo 17. Small beaver dam approximately 35 m downstream of the crossing.

Fish sampling at the crossing included electrofishing and minnow trapping. Electrofishing was conducted for 791 seconds and a linear distance of 93 m. Three minnow traps were set for 21.7 hrs each (65.1 hrs total). No fish were captured or observed during sampling.

The beaver dams investigated during this crossing assessment may temporarily limit the upstream movement of fish; however, these are dynamic systems and dams deteriorate over time. Dams may degrade due to high water events such as flooding and spring freshet; or winter processes such as ice scour and overflow. The pond located downstream, and additional ponds upstream of the crossing, provide potential overwintering and rearing habitat. Because the stream at this crossing is located less than one kilometer upstream of the Rancheria River, contains rearing and overwintering habitat, and has no permanent barriers to fish passage, the stream at this crossing should be considered fish-bearing.

Future work to install a culvert at this location should implement the following suggested mitigation measures to protect potential fish and fish habitat at the crossing.

- Culvert needs to be sized so it does not constrict the stream channel (>2.5 m diameter) and embedded to ensure fish passage.
- Divert water during construction to install the culvert in the dry.
- Limit disturbing surrounding riparian vegetation to maintain bank stability.
- Install appropriate erosion and sediment control measures.
- Complete work between June 15th and Sept. 1st, the freshwater fish timing window identified by DFO.

Photo 18. The pond created by an old, large beaver dam downstream of the crossing looking west.

3.5 SITE 5

Site 5 is located approximately 17.0 km up the Silver Hart access road (Photo 19). The site is of moderate size, with an average bankfull width of 4.61 metres. The bridge at this crossing has been washed out and transported a short distance downstream (Photo 20). Currently, this crossing is forded by local traffic.

Photo 19. The current ford stream crossing at Site 5.

The stream at this crossing contains moderate habitat complexity with some areas of moderate slope (12.5% gradient) comprised of small cascades and steep riffles (Photo 21). This is a relatively high energy system at higher water levels as is evident by the washed-out bridge, and a streambed comprised of boulders and cobbles. Instream cover is primarily provided by boulders in addition to overhanging vegetation, undercut banks, and some pools.

Photo 20. The washed-out bridge at Site 5 just downstream of the ford crossing.

Photo 21. Example of stream habitat downstream of the crossing at Site 5.

Fish sampling at the site included electrofishing and minnow trapping. Electrofishing was conducted for 500 seconds and a linear distance of 65 m. Three minnow traps were set for 19.7 hrs each (59.1 hrs total). One Arctic grayling and 12 bull trout were captured by electrofishing. No fish were captured in minnow traps.

Because of the high energy nature of the stream and the limited amount of gravels present in the streambed the potential for spawning habitat is limited. Similarly, overwintering potential is moderate to poor in the area of the crossing as few deep pools were identified. Summer rearing habitat at the crossing is good, with an abundance of cover and habitat complexity.

Future work to lift and re-install the currently washed out bridge at this crossing should implement the following suggested mitigation measures to protect fish and fish habitat at the crossing.

- Complete work to armour the streambanks in the dry, or in isolation from the stream flow.
- If instream work is required, it should be completed between June 15th and Sept. 1st, the freshwater timing window identified by DFO

Photo 22. Arctic graying captured electrofishing at Site 5.

Photo 23. Bull trout captured electrofishing at the Site 5.

3.6 SITE 9

Site 9 is located at approximately KM 24.5 of the Silver Hart access road (Photo 24). The site crosses a low gradient stream (1.5%) of moderate size, with an average bankfull width of 6.53 metres. Currently, the crossing is forded by local traffic, with a low gradient approach from the south, and a steeper approach from the north. The streambed material is comprised primarily of cobbles and gravels, with some boulders present throughout. Moderate instream cover is provided by overhanging vegetation, and to a lesser extent undercut banks, deep pools, and instream vegetation. Good habitat complexity exists with well-defined riffles, pools, and glides evenly distributed throughout the regularly meandering stream (Photo 25 and Photo 26)

Photo 24. The crossing at Site 9 looking north.

Fish sampling at the crossing included electrofishing and minnow trapping. Electrofishing was conducted for 700 seconds and a linear distance of 163 metres. Three minnow traps were set for 18.0 hrs each (54.0 hrs total). Five slimy sculpin were captured via electrofishing at the site. No fish were captured in minnow traps.

The stream contains moderate spawning and overwintering habitat potential, and good rearing habitat. No barriers to movement were identified during fieldwork. While only slimy sculpin were captured at the crossing, other species likely use this stream for rearing or to migrate between different habitat. Future work to install a crossing structure should implement the following suggested mitigation measures to protect fish and fish habitat at the crossing.

- The crossing structure should be sized to accommodate the bankfull width of the stream and not reduce the width of the stream at the crossing (here approximately 6.5 metres).
- If a bridge is installed, construction of bridge footings or supports should occur isolated from the streamflow.
- Any instream work should be scheduled to be completed between June 15th and Sept. 1st, to coincide with the freshwater fish timing windows identified by DFO.

Photo 25. Downstream view of instream habitat immediately downstream of the crossing at Site 9.

Photo 26. Downstream view of stream habitat approximately 100 m downstream of the crossing at Site 9.

A bridge was previously installed at the crossing but has since been washed 50 m downstream (Photo 27). There was some mention of the possibility of re-using this structure at the crossing. If this option is pursued some mitigation measures to protect fish and fish habitat specific to the excavation of the bridge should be implemented. These include all of the measures mentioned above, in addition to the following.

- Complete the work during low flows and within the instream work windows (June 15th and Sept. 1st).
- Have a qualified environmental monitor (EM) on-site during extraction to refine a removal plan, monitor instream turbidity, and implement an access plan that minimizes disturbance to the stream and riparian vegetation.

Photo 27. The washed-out bridge 50 m downstream of the crossing and partially buried by fluvial material.

3.7 SITE 10

Site 10 is located approximately 30.2 km up the Silver Hart access road (Photo 28). The site is characterized by a steep, fast creek that flows over the road in a wide, shallow alluvial fan (Photo 29). The creek near this crossing is relatively small and steep, with an average bankfull width of 3.22 m, and a gradient that ranges from 10-14 % (Photo 30). Downstream of the road the creek is confined to a well-defined channel. However, there is evidence that when the creek floods the banks become overtopped as fluvial material can be seen deposited throughout the surrounding forest downstream of the crossing. Approximately 50 m downstream of the crossing the creek flowed subsurface for 30 m before re-surfacing and flowing into the lake (Photo 31). While this section of the creek was dry at the time of the survey, there was evidence of surface flow at this location and as such should not be considered a permanent barrier to fish passage.

Photo 28. View of the ford crossing at Site 10, with the creek flowing over the road.

Photo 29. Upstream view of the creek flowing onto the road at Site 10.

Photo 30. A view of the creek at Site 10 looking upstream a short distance up from the road.

Photo 31. View of the lower portion of the dry section of the channel (top of the photo) as the creek re-emerged as surface flow immediately upstream of the lake.

Fish sampling at the crossing involved electrofishing only as the water was not deep enough to set minnow traps. Electrofishing was conducted for 309 seconds and a linear distance of 72 metres. No fish were captured or observed at the site during sampling.

The creek at this crossing contains poor spawning and overwintering potential due to the creeks shallow, steep flow and limited habitat complexity. The creek also likely freezes to bed in the winter. However, there is moderate rearing habitat at and upstream of the crossing and given the proximity to the fish-bearing lake (90 m downstream) this area could be used by fish on a seasonal basis. Bull trout which are present in the Rancheria River system, are known to utilize similar steep, high energy, cold water habitat for summer rearing. This stream should be considered fish-bearing.

Work to install a culvert at this crossing should include the following suggested mitigation measures to protect nearby fish and fish habitat.

- The creek should be pumped or diverted to install the culvert in the dry.
- The culvert should be appropriately sized for the crossing and not reduce the width of the creek.
- The culvert should be imbedded and installed at a gradient that matches the natural gradient of the creek to maintain natural creek processes.
- Instream works should be completed between June 15th and Sept. 1st, to coincide with the freshwater fish timing window identified by DFO for the region.

4 GENERAL RECOMMENDATIONS

The work to upgrade stream crossings along the Silver Hart access road by installing culverts and bridges has the potential to harm fish and negatively impact fish and fish habitat. Proper project planning and design can mitigate such effects. Project approval (YESAB and DFO process[1]) will require a work plan detailing how work will proceed at different crossings in addition to the specific mitigation measures that will be implemented at each crossing. Several different mitigations measures can be implemented simultaneously to reduce the potential negative impacts of the proposed work on the fish and fish habitat at these crossings. Some general mitigation measures include, but are not limited to:

- Preventing the death of fish by conducting pre-work fish salvages for work occurring in wetted areas or areas to be de-watered as part of isolation during the construction process.
- Planning instream work to coincide with fish timing windows identified by DFO (Table 4) to protect critical life stages.
- Maintain riparian vegetation around crossings as much as possible.
- Isolate worksites that require instream works. Potential methods are described in Appendix B.
- From a fisheries perspective[2], culverts and bridges should not constrict the width of the stream channel at the crossing site. For example, culverts should have a minimum diameter equal to the bankfull width in fish-bearing streams.
- Ensure installed culverts are imbedded and match the natural gradient of the stream at fish-bearing crossings.
- Prevent deleterious substances from entering waterways by ensuring equipment is cleaned of excess grease and oils, and refueling occurs away from any watercourse.
- Have a qualified Environmental Monitor (EM) on-site during construction of instream works to assist with erosion and sediment control planning, fish salvages, and water quality monitoring.
- Follow best practices for working around water and erosion and sediment control. A good resource is Yukon Government's Preferred Practices for Works Affecting Yukon Waters (Yukon Government 2019c).

Table 4. Freshwater Fish timing windows identified for the Liard River Basin, Yukon. The shaded areas are the work windows for each species and the darker shading outlines the time that windows for both species coincide (i.e. when instream work can take place).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arctic Grayling												
Bull Trout												

* work should be scheduled to occur within the fully greyed out area, between June 15th - September 1st.

[1] This work may or may not require an authorization. Once plans are finalized, it is suggested to put the project in for a DFO Request for Review to determine if an authorization is needed.

[2] Hydrologic analysis should also be completed to ensure the appropriate crossing structure size.

5 REFERENCES

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APPENDIX A. ELECTROFISHER SETTINGS

Table 5. Electrofisher settings and time spent electrofishing at each sampling site.

Site	Conductivity (SPC: us/cm)	Voltage (V)	Frequency (Hz)	Duty Cycle (%)	Time on (Seconds)
Site 0	132.7	400	40	20	440
Site 2	47.8	600	40	20	482
Site 2B	53.6	600	40	20	537
Site 3	34.6	500	40	20	791
Site 5	32.0	600	40	20	500
Site 9	41.4	600	40	20	700
Site 10	43.7	700	50	20	309

APPENDIX B. SITE ISOLATION TECHNIQUES - NOTES

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Isolation of Worksites

Worksites should be isolated from flowing water to allow for works to be completed in the dry. This can be accomplished by utilizing a passive diversion (construction of a lined diversion channel) or a dam and pump method. The dam and pump method should only be considered if flows are low and construction can be completed in a short period of time, as the pumps must be monitored at all times to ensure downstream flows are maintained. Site-specific recommendations can be developed during the preparation of an Environmental Management Plan in consultation with construction personnel. The below figures demonstrate the dam and pump and diversion methods in addition to the partial isolation of stream to allow for armouring.

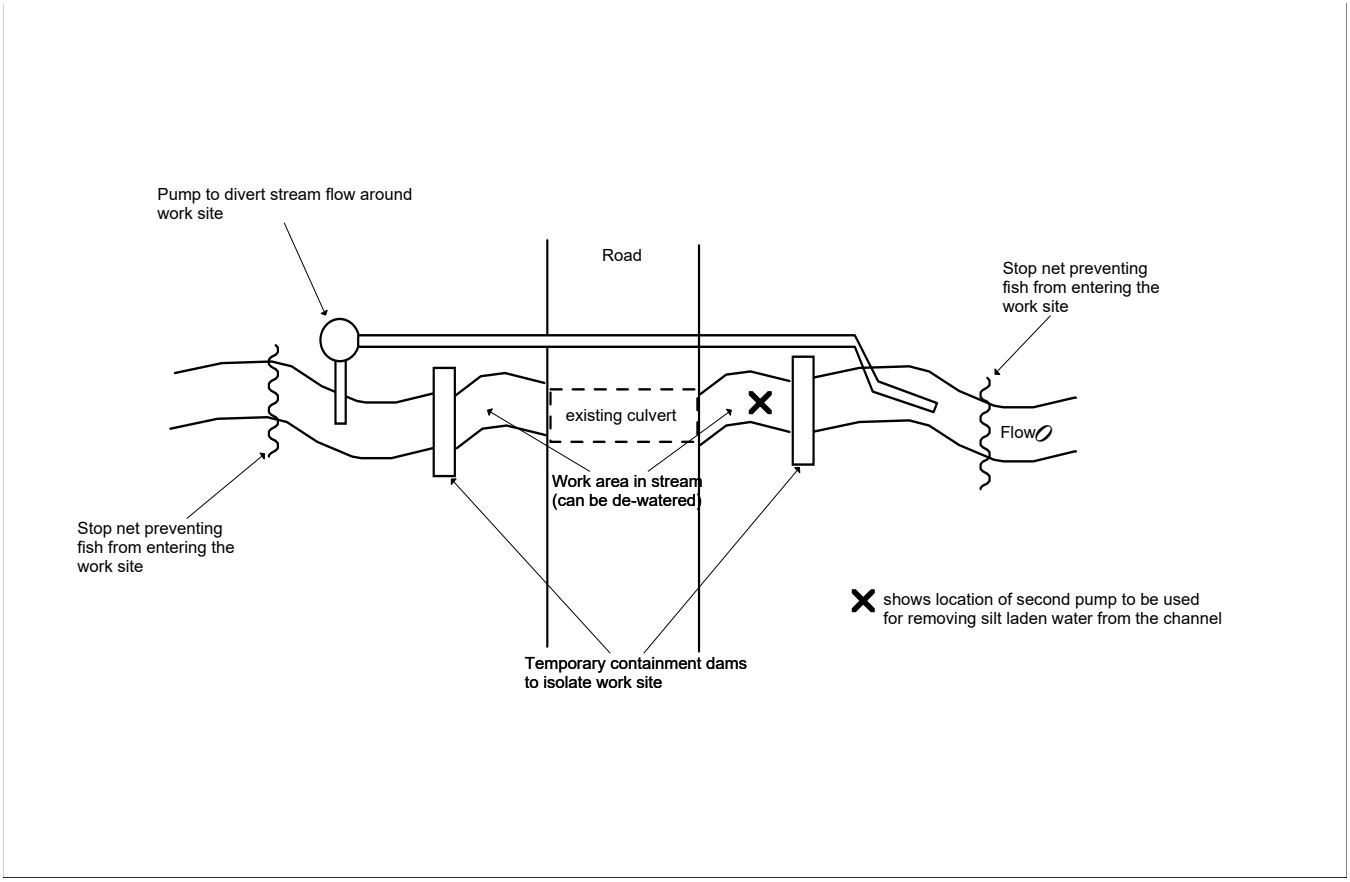

Figure 1. Diagram of the dam and pump around method.

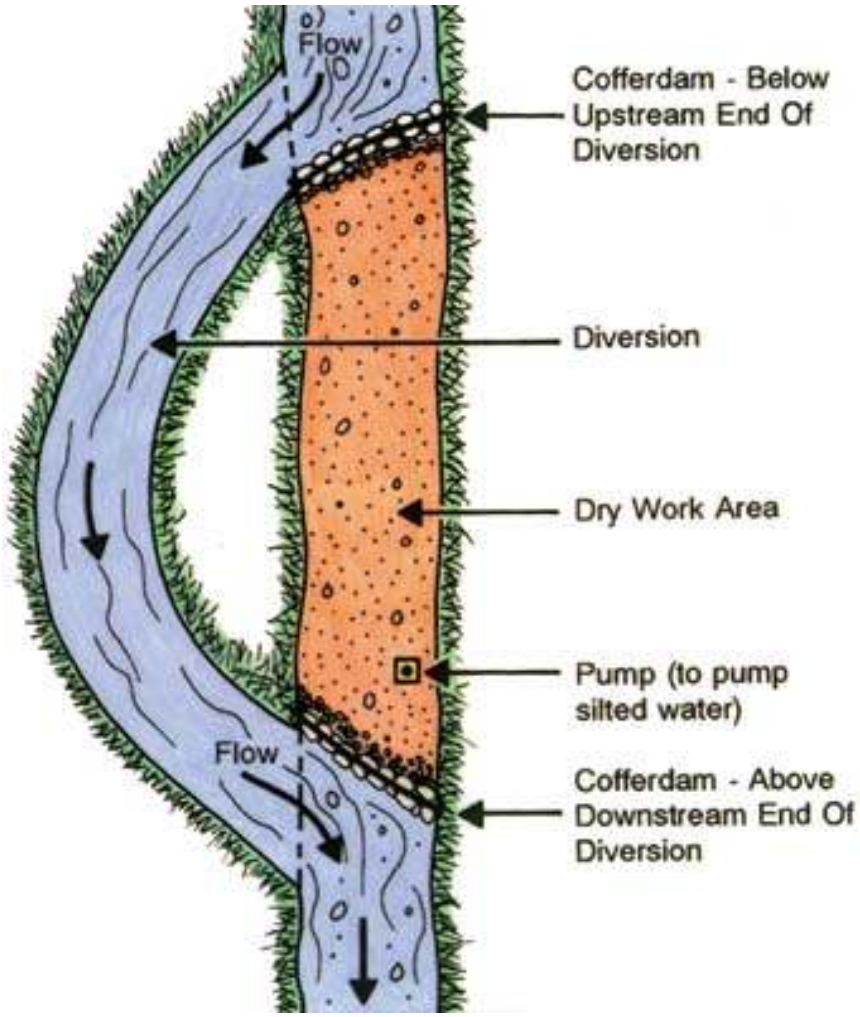

Figure 2. Diagram of the temporary diversion method.

Figure 3. Photo of a method to isolate the stream edge to allow for the installation of armoring or rip rap. A pump is used to contain/remove dirty water from the enclosure.

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