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MEMORANDUM

TO: Chris Rodden, Manager, Compliance and Licensing, Evolugen
FROM: Harlan Wright, Dip.Tech., and Aaron Burkell, B.Sc., Dip.Tech.
Ecofish Research Ltd.
DATE: December 18, 2023
FILE: 1085-46

RE: Summary of Fisheries Monitoring Completed on the Kokish River in 2023 for the Kokish River Hydroelectric Project

This memorandum summarizes fisheries work carried out by Ecofish Research Ltd. (Ecofish) in 2023 for the Kokish River Hydroelectric Project (the Project), which is operated by Evolugen. Fisheries monitoring was required by the Project's Operational Environmental Monitoring Plan (OEMP) (Lewis *et al.* 2014) for two years prior to completion of project construction (2012 and 2013), and for years 1, 2, 3, 5 and 10 post construction (2014-2023). Fisheries data collected from 2012 to 2018 were summarized in six previous memos (Wright and Faulkner 2013; Wright 2014, 2015; Wright and Thornton 2016; Wright and Lewis 2017; Wright and Thornton 2018) and presented in further detail in annual OEMP reports. Fisheries monitoring was not required in 2019, 2020, 2021, or 2022; therefore, memos produced in these years (Wright and Dinn 2019, 2020, 2021, 2022) contained information only pertaining to annual flow compliance.

An OEMP summary report was submitted to regulators in Fall 2019 which contained monitoring results from 2012-2018. No further monitoring is required under the OEMP for groundwater quality, water temperature, stream morphology, stream water quality, or invertebrate drift monitoring components post 2018. Monitoring will continue for flow, including instream flow compliance and ramping rate compliance.

This memo summarizes results for the Year 10 (2023) adult fish migration and abundance monitoring component in the Kokish River (Section 1) as well as monitoring activities for other required components addressed in Year 10 (i.e., juvenile abundance, headpond habitat suitability and abundance, and flow compliance) in Sections 2 through 4. More detailed results will be presented in the annual OEMP Year 10 report.

1. ADULT FISH MIGRATION AND ABUNDANCE

Snorkel surveys were conducted in 2023 along three sections of the Kokish River during the summer and fall fish migration periods. Additional surveys will occur in February to April 2024 for winter steelhead and will be included along with summer/fall fish migration snorkel data in the annual OEMP



Year 10 report. Snorkel survey section start and end points for summer and winter surveys are presented in Table 1 and Map 1. The relative abundance of adult salmonids observed during the snorkel surveys is provided in Table 2, while a scatterplot of the relative abundance by fish species within each survey section is provided in Figure 1 through Figure 7.

To assess summer steelhead and Pacific salmon species migration, 11 surveys were conducted in Sections 1 and 3 between June 14 and October 6, 2023. In addition, three full river surveys (i.e., Sections 1, 2 and 3) were conducted from August 2 to 4, 2023, August 27 to 29, 2023, and October 6 to 7, 2023. During the October full river survey, crews were only able to swim Section 1 and 3 due to high flows. The final survey on October 23, 2023, targeted Chum Salmon and late-run Coho salmon in Section 1 (Table 2).

Peak snorkel counts in 2023 (Year 10 of OEMP) were compared with results from the most recent monitoring data collected in 2018 (Year 5 of OEMP). Winter steelhead snorkels are scheduled from February to April 2024. The completion of the surveys will be the final fisheries requirement of the OEMP.

The peak count of summer steelhead was recorded during the full river survey carried out between August 27 and 29, 2023 when a combined total of 44 fish were observed in Sections 1, 2, and 3 (Figure 1). Of those 44 fish, 16 were observed above the Project intake (above river km 11.4). Most of the steelhead observed upstream of the intake ($n = 14$) were observed in the “Cool pool” at the confluence of the east fork of the Kokish river, and two additional steelhead were observed in the headpond reach immediately upstream of the intake. The peak total count for 2023 is lower than observed in 2018 when 80 summer steelhead were observed (Wright and Thornton 2018) but fairly similar to 2016 when a peak count of 54 summer steelhead was observed (Wright and Thornton 2016).

Surveys from June through August 2023 targeted early run Coho Salmon, which are known to migrate further upstream than the fall run (Lough and Hay 2009). Between August 27 and 29, 2023, a total of 116 Coho Salmon were observed (Figure 2), none of which were observed upstream of the 11.3 km falls (just below the Project intake). For the later fall run, the peak count for Coho Salmon was observed between October 15 to 16, 2023, when a combined total of 356 adults were observed in Sections 1 and 3 (Figure 2). These peak counts are higher than those recorded in 2018 (early run: 96, fall run: 356; Wright and Thornton 2018).

A peak count of 231 Chum Salmon was observed in Section 1 on October 23, 2023 (Figure 3), which is higher than the peak count of 120 individuals observed on November 10, 2018 (Wright and Thornton 2018). During the peak count of Chum Salmon in 2023, a total of 25 were observed upstream of the Powerhouse, 21 holding in the Project tailrace area, and an additional 185 downstream of the tailrace area.



Sockeye Salmon were observed in low abundance, with a peak count of 8 individuals observed in Section 1 on August 29, September 7, and September 16, 2023 (Figure 4). This count is lower than the peak count of 17 observed in 2018 (Wright and Thornton 2018).

Pink Salmon were the most abundant adult salmon species observed, with a peak count of 819 observed in Section 1 on September 16, 2023. This is substantially higher than the peak count of 12 observed in 2018 (Wright and Thornton 2018).

A peak count of 65 Chinook Salmon was observed on October 6 and 7, 2023 (Figure 6). During these surveys, 64 were observed in Section 1 and a single Chinook Salmon was observed in Section 3. This peak count is higher than previous monitoring years, with the second highest count being 22 in 2008 during baseline fisheries studies by Lough and Hay (2009). In 2018, a peak count of three Chinook Salmon were observed (Wright and Thornton 2018).

Peak counts of resident and anadromous trout and char species in all sections combined were: 12 Rainbow Trout during a full river swim conducted June 16, 2023; 23 Cutthroat Trout on September 7, 2023; and 79 Dolly Varden observed during the full river swim between August 27 to 29, 2023. The peak count of Rainbow Trout was lower than 2018 when 41 fish were observed. Peak counts of Cutthroat Trout and Dolly Varden were higher in 2023 when compared to 2018. In 2018, peak counts of 16 Cutthroat and 24 Dolly Varden were observed (Wright and Thornton 2018).

In addition to the snorkel surveys, underwater video monitoring was conducted at the fishway located at the Project intake. An underwater camera was installed at the upstream exit of the fishway. Video footage may be reviewed and data used to augment the snorkel survey results to confirm successful passage of steelhead and Coho Salmon.

Table 1. Snorkel survey locations for adult fish migration and abundance monitoring in the Kokish River.

Location	Start Point (km)	End Point (km)	Description
Section 1	4.4	0.0	Bottom of Lower Canyon to Estuary
Section 2	8.5	4.4	Lower Canyon
Section 3	12.0	8.5	Outlet of Ida Lake to Top of Lower Canyon



Table 2. Adult salmonids observed during summer/fall 2023 snorkel surveys in the Kokish River.

Survey Date	Section	Fish Observed ¹										
		CH	CM	CO	CT	DV	PK	RB	RB/CT	SK	ST	UNK
14-Jun	1	0	0	0	4	0	0	3	0	0	0	0
16-Jun	3	0	0	0	0	0	0	12	0	0	1	0
21-Jun	1	0	0	0	12	1	0	5	0	0	0	0
22-Jun	3	0	0	0	2	0	0	4	0	0	1	0
29-Jun	3	0	0	2	0	0	0	2	0	0	1	0
30-Jun	1	0	0	1	10	0	0	0	0	0	4	0
06-Jul	3	0	0	2	0	0	0	2	0	0	1	0
07-Jul	1	0	0	3	11	1	0	1	0	0	2	0
13-Jul	1	0	0	0	6	3	0	7	0	0	3	0
14-Jul	3	0	0	11	0	0	0	6	0	0	2	0
20-Jul	1	0	0	1	4	7	0	2	0	0	9	0
21-Jul	3	0	0	10	1	0	0	0	0	0	5	0
27-Jul	1	0	0	8	8	3	0	6	0	0	0	0
28-Jul	3	0	0	9	0	0	0	2	0	0	6	2
02-04 Aug	3	0	0	6	0	0	0	2	0	0	22	1
	2	0	0	13	0	0	0	1	0	0	6	0
	1	0	0	13	6	13	1	4	0	0	0	0
10-Aug	3	0	0	17	0	1	0	3	0	0	15	1
11-Aug	1	0	0	10	7	10	20	2	0	2	1	0
17-Aug	3	0	0	36	0	0	0	0	0	0	14	0
18-Aug	1	0	0	12	2	12	97	0	0	2	3	0
27-29 Aug	3	0	0	38	0	3	0	2	0	0	25	1
	2	0	0	30	0	4	0	0	0	0	7	0
	1	7	0	48	9	72	343	0	1	8	12	0
07-Sep	1	2	0	77	23	48	539	3	0	8	2	0
08-Sep	3	0	0	68	1	0	0	0	0	0	20	0
15-Sep	3	0	0	71	1	0	0	2	0	0	22	0
16-Sep	1	6	0	285	7	55	819	3	0	8	2	0
06-Oct	3	1	0	32	1	0	0	0	0	0	4	0
07-Oct	1	64	4	121	4	18	243	4	0	0	0	0
23-Oct	1	2	231	127	3	1	4	1	0	0	0	0

¹ CH = Chinook Salmon; CM = Chum Salmon; CO = Coho Salmon; CT = Cutthroat Trout; DV = Dolly Varden; PK = Pink Salmon; RB = Rainbow Trout; RB/CT = Rainbow Trout/Cutthroat Hybrid; SK = Sockeye Salmon; ST = steelhead; UNK = Unknown

Figure 3. Number of adult Chum Salmon observed during summer/fall snorkel surveys in the Kokish River during 2023.

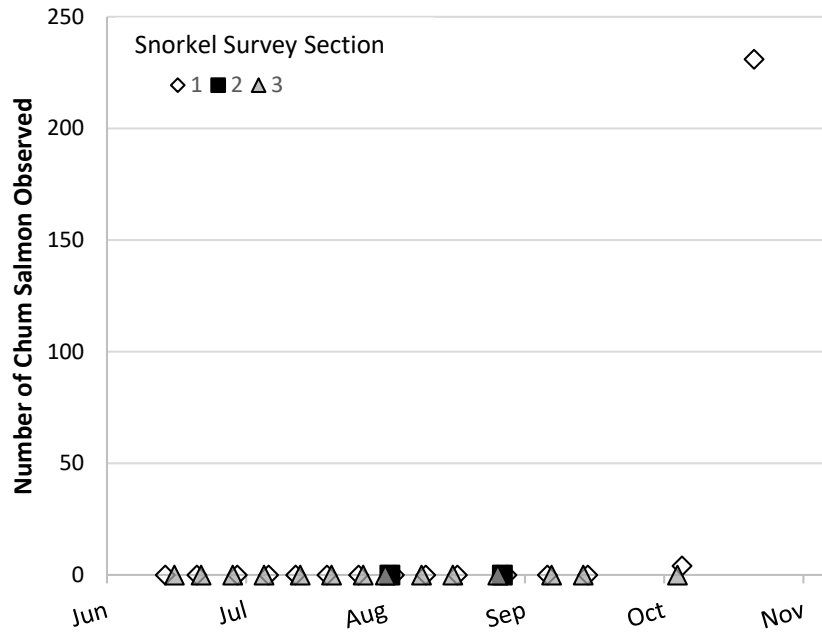


Figure 4. Number of adult Sockeye Salmon observed during summer/fall snorkel surveys in the Kokish River during 2023.

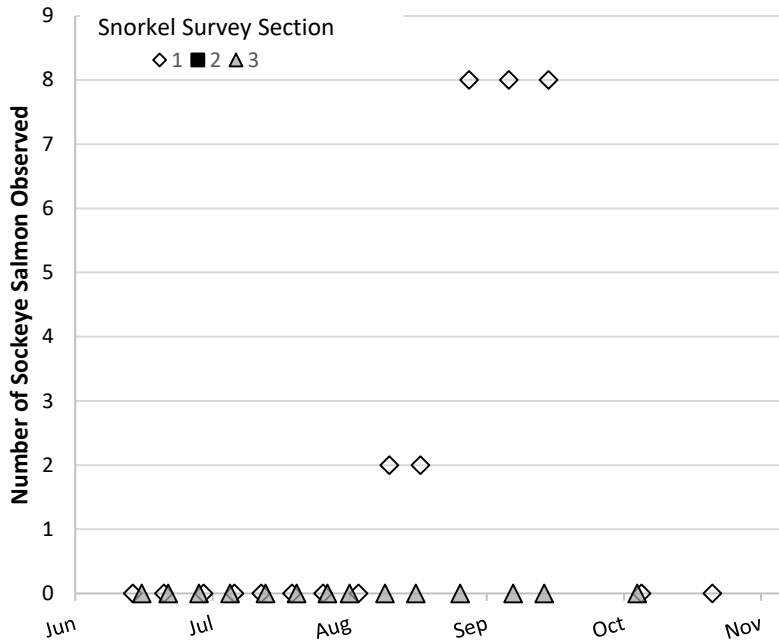
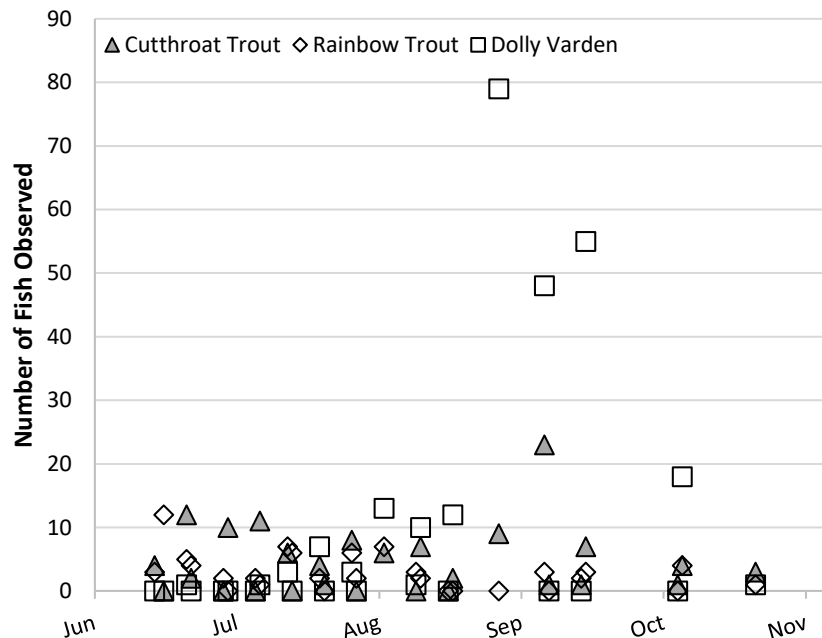


Figure 7. Number of adult Cutthroat Trout, Rainbow Trout and Dolly Varden observed during summer/fall snorkel surveys in the Kokish River during 2023.



2. JUVENILE FISH ABUNDANCE

Juvenile fish abundance sampling was conducted between August and September 2023 to support Year 10 monitoring requirements of the OEMP. The fish monitoring focused on assessing the standing stock of juvenile steelhead and Coho Salmon within the diversion reach of the Kokish River. Sampling was also undertaken in the Tsulton River, where control reaches had been selected and monitored during the baseline monitoring program and Years 1, 2, 3, and 5 of the OEMP (Lewis *et al.* 2014). Electrofishing was used as the primary method for capturing and enumerating fry (age 0+) while snorkel surveys were used as the primary method for observing, capturing, and enumerating parr (age 1+, 2+ and 3+). A high-level summary of the 2023 survey efforts for this component are provided in the subsections below.

2.1. Juvenile Electrofishing

Electrofishing was conducted at 15 sites in the Kokish River (impact) and 11 sites in the Tsulton River (control) which are presented in Map 2 and Map 3. Site locations and dates sampling was conducted on the Kokish and Tsulton Rivers are presented in Table 3 and Table 4, respectively.

In the Kokish River, single pass electrofishing was conducted in ‘open’ sites (i.e., without the use of stop nets). At a sub-sample of electrofishing sites, a mark-recapture experiment was conducted to



estimate average capture efficiency for the electrofishing program. The calculated capture efficiency is used during data analysis to transform raw results (# of fish captured) into estimates of fish abundance, density, and biomass at all sampling sites. The Tsulton River was sampled using closed site multi-pass removal electrofishing (rather than open site mark-recapture) because this river is smaller than the Kokish River and it is feasible to close-off entire habitat units with nets. Further analysis on these components is underway and this information will be presented in the Year 10 OEMP report, which is due June 2024.

Table 3. Juvenile salmonid electrofishing sites on the Kokish River during 2023.

Site	Sampling Date	Mesohabitat Type	River km (from mouth)	UTM (Zone 9 U, NAD 83)	
				Easting	Northing
KOK-DVEF01	20-Aug-23	Riffle	10.5	654943	5593241
KOK-DVEF04	22-Aug-23	Riffle	2.3	650648	5598396
KOK-DVEF05	22-Aug-23	Glide	2.5	650798	5598241
KOK-DVEF06	22-Aug-23	Riffle	2.7	650827	5598055
KOK-DVEF07	22-Aug-23	Riffle	2.8	650843	5597872
KOK-DVEF09	21-Aug-23	Cascade	6.9	652750	5595020
KOK-DVEF10	21-Aug-23	Cascade	7.0	652823	5594945
KOK-DVEF11	23-Aug-23	Run	7.1	652789	5595018
KOK-DVEF12	21-Aug-23	Riffle	7.8	653299	5594486
KOK-DVEF13	21-Aug-23	Riffle	7.8	653321	5594447
KOK-DVEF14	21-Aug-23	Cascade	7.9	653399	5594398
KOK-DVEF15	20-Aug-23	Riffle	11.0	655029	5592757
KOK-DVEF16	20-Aug-23	Riffle	10.6	654963	5593000
KOK-DVEF17	23-Aug-23	Cascade	7.2	653042	5594900
KOK-DVEF18	21-Aug-23	Run	7.3	653111	5594847

Table 4. Juvenile salmonid electrofishing sites on the Tsulton River during 2023.

Site	Sampling Date	Mesohabitat Type	River km (from mouth)	UTM (Zone 9 U, NAD 83)	
				Easting	Northing
TSL-EF02	9-Sep-23	Riffle	3.2	648562	5597086
TSL-EF03	10-Sep-23	Glide	3.5	648321	5596860
TSL-EF06	7-Sep-23	Run	2.1	648988	5597944
TSL-EF07	6-Sep-23	Glide	2.7	648745	5597470
TSL-EF08	8-Sep-23	Glide	2.3	648910	5597792
TSL-EF09	7-Sep-23	Glide	2.0	649053	5598044
TSL-EF10	7-Sep-23	Glide	1.9	649140	5598041
TSL-EF11	9-Sep-23	Glide	3.0	648603	5597193
TSL-EF17	9-Sep-23	Glide	2.8	648701	5597389
TSL-EF22	8-Sep-23	Glide	2.5	648817	5597597
TSL-EF23	10-Sep-23	Glide	3.4	648384	5596976

2.2. Juvenile Snorkel Surveys

Snorkel surveys were completed to enumerate age 1+, 2+, and 3+ steelhead in the Kokish and Tsulton rivers. Surveys included a total of 18 sites in the Kokish River and 14 sites in the Tsulton River (Map 2 and Map 3). Site locations and dates sampling was conducted on the Kokish and Tsulton Rivers are presented in Table 5 and Table 6. A mark-recapture program was undertaken to estimate the observer efficiency during index snorkel surveys. In a subsample of sites on both streams, fish were marked with visible hook tags the night prior to each survey, and ‘re-sighted’ the following day to establish an observer efficiency. Observer efficiency is used during data analysis to transform raw results (# of fish observed) into estimates of fish abundance, density, and biomass at all snorkel sites. Additional snorkel effort was also conducted during the mark-resight surveys to enumerate tagged fish that may have migrated outside of the marking sites which is subsequently accounted for when calculating observer efficiency.

Table 5. Juvenile salmonid snorkel sites in the Kokish River during 2023.

Site	Sampling Date	Mesohabitat Type	River km (from mouth)	UTM (Zone 9 U, NAD 83)	
				Easting	Northing
KOK-DVSN01	21-Aug-23	Glide	8.0	653450	5594422
KOK-DVSN02	21-Aug-23	Cascade	8.1	653564	5594521
KOK-DVSN03	22-Aug-23	Glide	10.3	654797	5593407
KOK-DVSN04	22-Aug-23	Riffle	10.2	654757	5593454
KOK-DVSN05	21-Aug-23	Glide	7.1	652897	5594887
KOK-DVSN06	21-Aug-23	Cascade	7.0	652868	5594908
KOK-DVSN07	21-Aug-23	Run	7.4	653129	5594778
KOK-DVSN08	22-Aug-23	Riffle	2.4	650733	5598339
KOK-DVSN09	22-Aug-23	Glide	2.3	650687	5598387
KOK-DVSN10	22-Aug-23	Glide	2.1	650605	5598546
KOK-DVSN11	20-Aug-23	Pool	10.4	654930	5593311
KOK-DVSN12	22-Aug-23	Glide	10.1	654704	5593566
KOK-DVSN13	21-Aug-23	Pool	6.6	652555	5595168
KOK-DVSN14	21-Aug-23	Cascade	6.6	652572	5595155
KOK-DVSN15	20-Aug-23	Pool	10.7	654910	5593065
KOK-DVSN16	20-Aug-23	Riffle	10.6	654963	5593000
KOK-DVSN17	23-Aug-23	Cascade	7.2	653042	5594900
KOK-DVSN18	21-Aug-23	Run	7.3	653111	5594847

Table 6. Juvenile salmonid snorkel sites in the Tsulton River during 2023.

Site	Sampling Date	Mesohabitat Type	River km (from mouth)	UTM (Zone 9 U, NAD 83)	
				Easting	Northing
TSL-SN06	06-Sep-23	Pool	3.1	648620	5597143
TSL-SN07	06-Sep-23	Glide	2.7	648745	5597470
TSL-SN11	06-Sep-23	Glide	3.3	648419	5597004
TSL-SN15	06-Sep-23	Pool	2.7	648774	5597452
TSL-SN16	06-Sep-23	Pool	2.8	648730	5597399
TSL-SN18	06-Sep-23	Glide	3.1	648497	5597251
TSL-SN19	06-Sep-23	Glide	2.5	648855	5597619
TSL-SN20	09-Sep-23	Glide	2.4	648922	5597732
TSL-SN21	09-Sep-23	Pool	2.4	648886	5597684
TSL-SN22	06-Sep-23	Glide	2.5	648817	5597597
TSL-SN23	06-Sep-23	Glide	2.5	648790	5597595
TSL-SN24	06-Sep-23	Glide	2.9	648658	5597339
TSL-SN25	09-Sep-23	Pool	2.1	649015	5597991
TSL-SN26	06-Sep-23	Glide	3.3	648497	5597037

3. HEADPOND HABITAT SUITABILITY AND FISH ABUNDANCE

The construction of the Project intake weir at river km 11.4 resulted in the creation of a ~14,000 m² headpond upstream of the weir. The construction of the headpond in the Kokish River has changed the habitat and is expected to alter the mesohabitat composition and habitat suitability (either positively or negatively). This is primarily due to the potential loss of riffle-glide habitat and the creation of slower moving pool habitat. Post-construction habitat and fish abundance surveys were completed in the headpond, upstream of the Project intake during baseline and Years 1, 2, 3 and 5 of the OEMP. This work included snorkel surveys and instream flow study (IFS) transects following similar methods to those used during baseline monitoring in 2012 and Year 1, 2, 3 and 5 of the OEMP (Lewis *et al.* 2014). In 2022 and 2023 the headpond elevation was lowered to re-create riffle-glide habitat and the habitat and fish abundance surveys were repeated following methods from previous years.

Juvenile fish abundance was estimated using snorkel surveys. Crews conducted three upstream snorkel surveys over 3 consecutive days to assess fish abundance and habitat utilization in the headpond under the lowered condition. Eight IFS transects were also sampled during 2023. Data collected at each transect included water depth, water velocity, and substrate composition. A comparative analysis will be conducted as part of the Year 10 OEMP to examine potential changes in juvenile abundance,



density, and distribution, as well as relative abundance and distribution of adult salmonids associated with habitat changes from the headpond.

4. FLOW COMPLIANCE

Stage and flow data are continuously collected to assess Project compliance with the terms and conditions of the conditional water licence (CWL) and to evaluate changes in hydrological conditions due to Project operations (as per the OEMP; Lewis *et al.* 2014). Instream Flow Requirements (IFR), which are detailed in the CWL were set following the Environmental Assessment Process for the Project. Furthermore, ramping rate criteria, which are the rate of stage changes allowable during Project ramp-downs, were established based on general criteria accepted by DFO (e.g., Cathcart 2005) to reduce potential fish stranding for fry at sensitive sites within the diversion and downstream reaches.

Hydrometric stations were established at three locations on the Kokish River to provide real-time, instantaneous stage and flow data for the life of the Project: downstream of the intake, upstream of the powerhouse and downstream of the powerhouse. The uppermost site (UKO-LG01), located downstream of the intake, is the compliance point for monitoring IFR and diversion ramping rates. The station downstream of the powerhouse (KOK-DSL01) is the compliance point for monitoring ramping rates downstream of the powerhouse. The station previously installed upstream of the powerhouse (LKO-LG01) is no longer required for flow compliance monitoring therefore it was decommissioned in June 2018.

In 2023 Ecofish established realtime data feeds from the operational flow monitoring stations at Kokish River through the Project's PLC (programmable logic controller). These data are currently being used for flow compliance monitoring with the intention of removing the UKO-LG01 and KOK-DSL01 stations as they will no longer be required.

Station servicing and discharge measurements were collected at a range of flows during 2023. Updates to the stage-discharge rating curves and sensor offsets were applied based on these results and an annual hydrology report will be produced to detail the status and present stage and discharge data for the flow compliance monitoring stations.



5. SUMMARY

This memorandum summarizes the ongoing fisheries work carried out by Ecofish in 2023 to meet the requirements for Year 10 of the Kokish River Hydroelectric Project OEMP. The study components included assessments of adult fish migration and abundance, juvenile fish abundance, headpond habitat suitability and fish abundance, and flow compliance. Fieldwork scheduled to occur during the winter of 2023/24 includes winter steelhead snorkel surveys, flow compliance monitoring, and maintenance of the hydrometric stations.

Yours truly,

Ecofish Research Ltd.

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Disclaimer:

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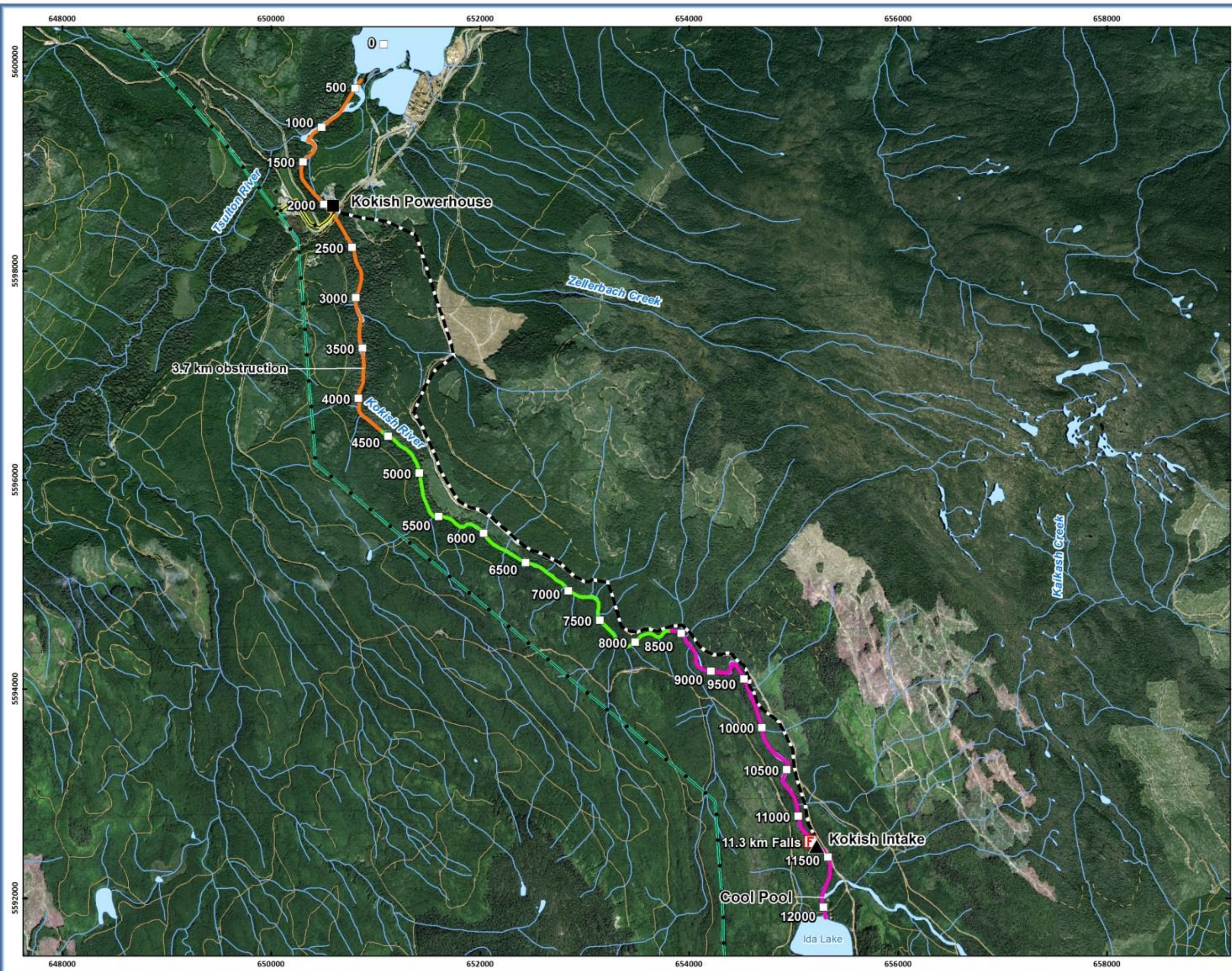


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PROJECT MAPS



KOKISH RIVER HYDROELECTRIC PROJECT
**Kokish River
 Fish Migration
 Snorkel Survey Sections**

- Legend**
- Chainage (500m)
 - F Falls
 - Snorkel Survey Sections**
 - Section 1
 - Section 2
 - Section 3
 - Infrastructure**
 - ▲ Intake
 - Powerhouse
 - Penstock
 - Transmission Line
 - Existing Transmission Line
 - Existing Road
 - Forest Tenure Road



MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

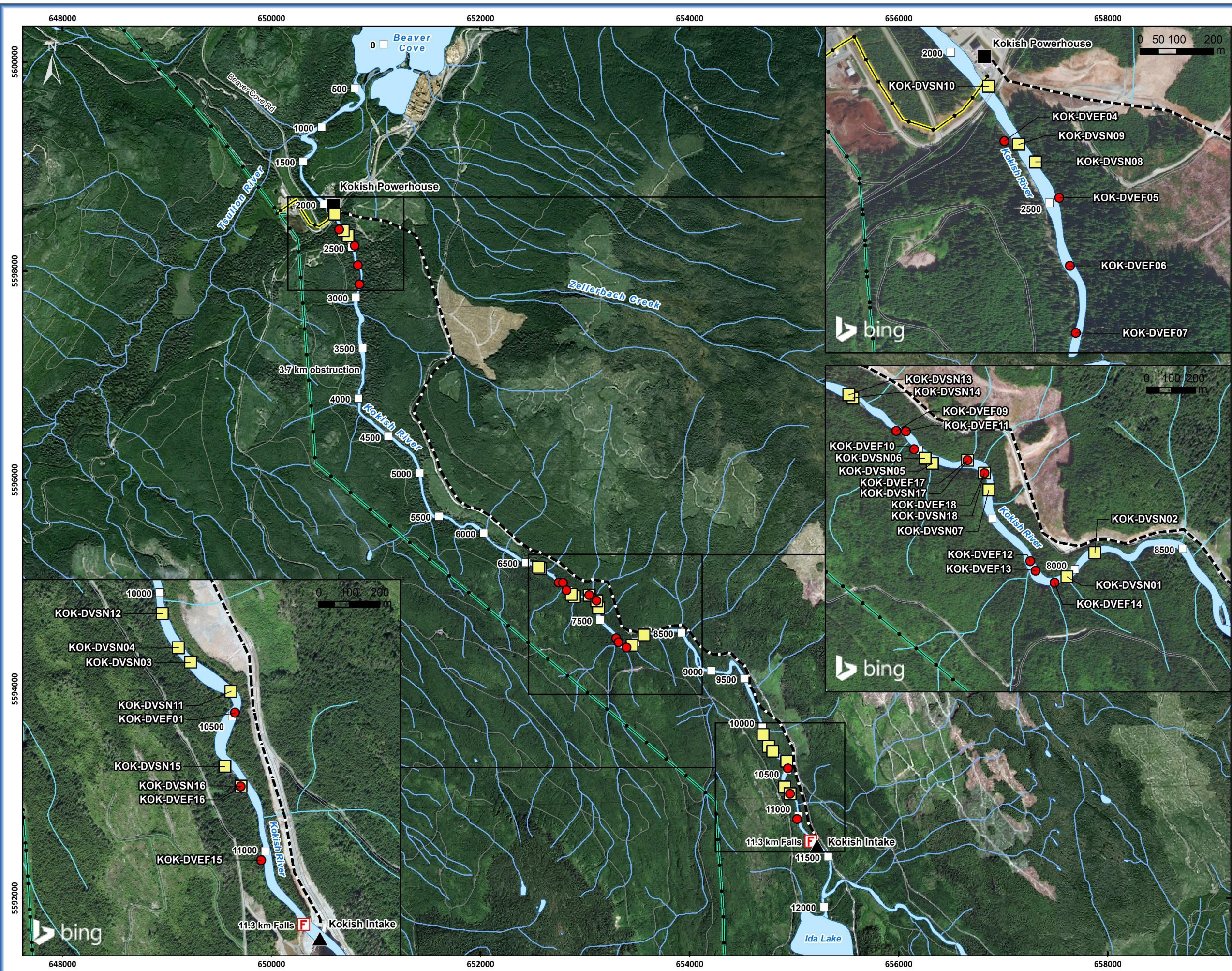


NO.	DATE	REVISION	BY
1	15/03/2016	KOK_SnorkelSurveys_2016Mar15	
2			
3			
4			
5			

Date Saved: 15/03/2016
 Coordinate System: NAD 1983 UTM Zone 9N



Map 1

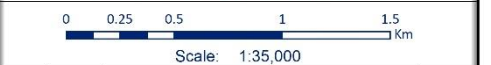


KOKISH RIVER HYDROELECTRIC PROJECT
**Kokish River
 Juvenile Fish Sampling Sites**

- Legend**
- Sample Method**
- Electrofishing Sites
 - Snorkel Sites
 - Chainage (500m)
 - F Falls
- Infrastructure**
- ▲ Intake
 - Powerhouse
 - - - Penstock
 - Transmission Line
 - Existing Transmission Line
 - Existing Road
 - - - Forest Tenure Road



MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES



NO.	DATE	REVISION	BY
1	12/12/2023	1085_KOK_JuvFishSampleSites_6212_20231212	
2			
3			
4			
5			

Date Saved: 12/12/2023
 Coordinate System: NAD 1983 UTM Zone 9N

Map 2

648000 648500 649000 649500 650000 650500

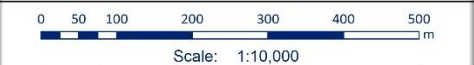


KOKISH RIVER HYDROELECTRIC PROJECT
Tsulton River
Juvenile Fish Sampling Sites

- Legend**
- Sample Method**
- Electrofishing Sites
 - Snorkel Sites
 - Chainage (500m)
 - F Falls
- Infrastructure**
- ▲ Intake
 - Powerhouse
 - - - Penstock
 - Transmission Line
 - Existing Transmission Line
 - Existing Road
 - - - Forest Tenure Road



MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES



NO.	DATE	REVISION	BY
1	12/12/2023	1085_TSL_JuvFishSampleSites_6212_20231212	
2			
3			
4			
5			

Date Saved: 12/12/2023
 Coordinate System: NAD 1983 UTM Zone 9N

648000 648500 649000 649500 650000 650500

