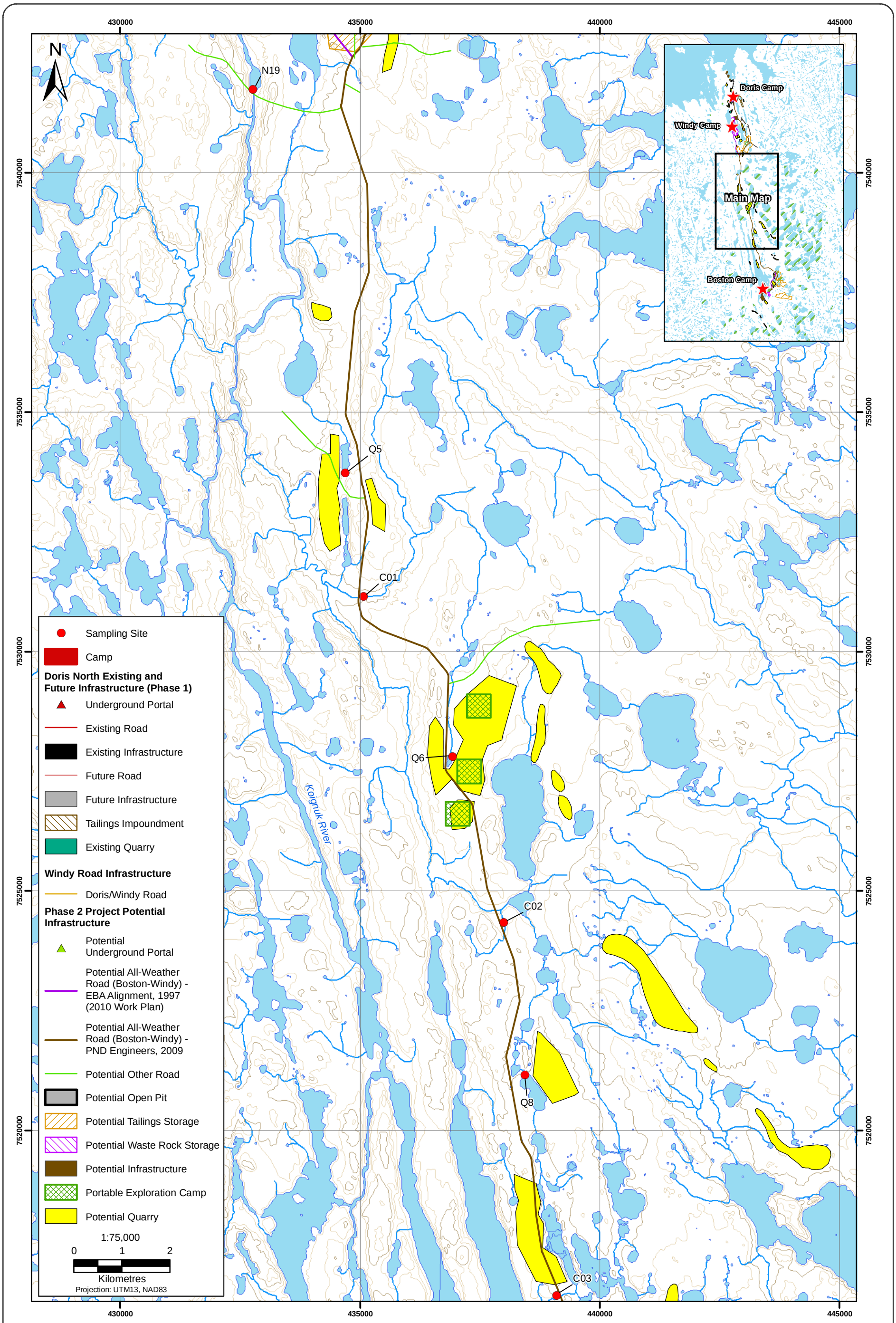

Figure 2.1-2b

NEWMONT NORTH AMERICA

Stream and Pond Fish Habitat and Fish Community Assessment Locations, Hope Bay Belt Central, 2010

Figure 2.1-2b

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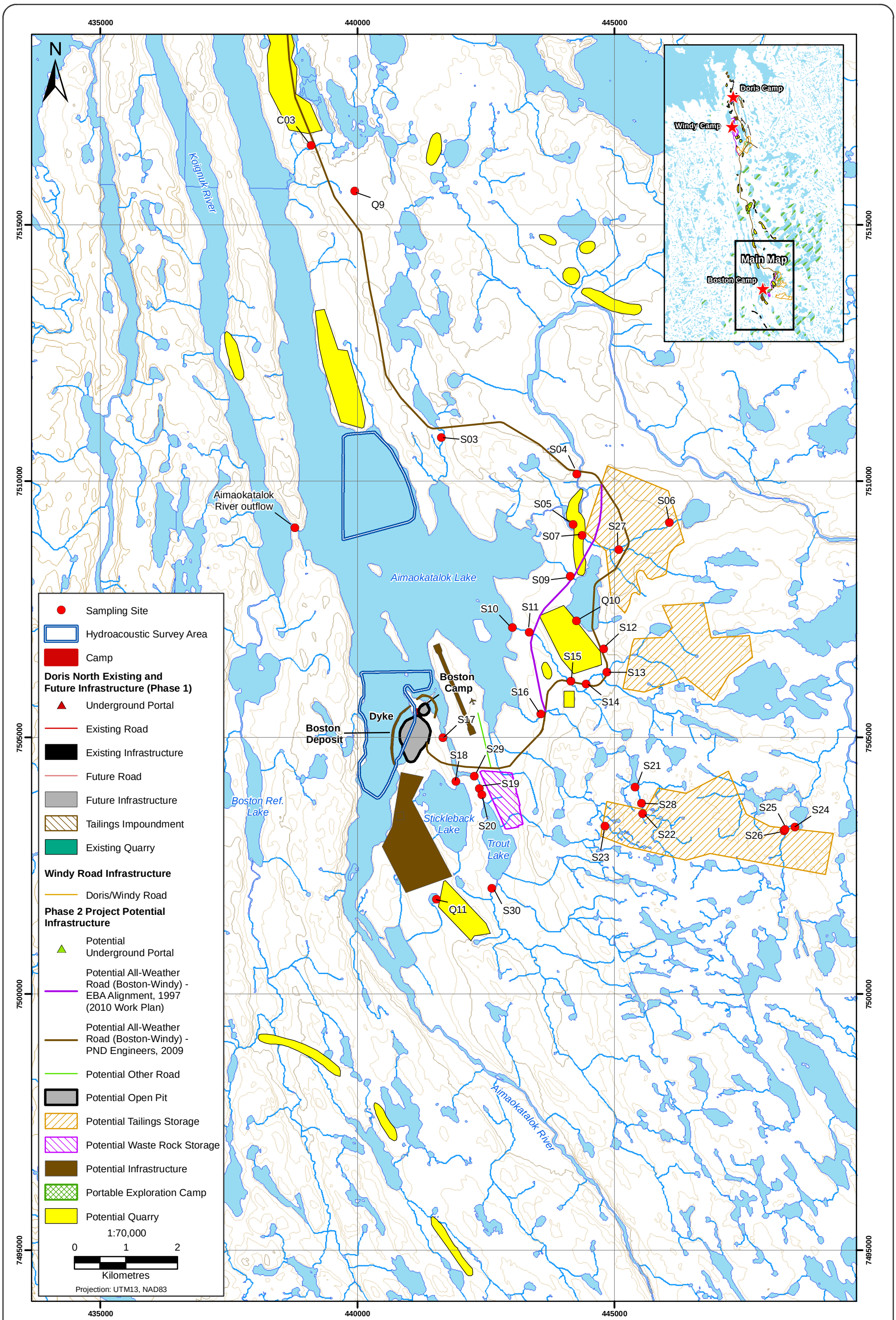


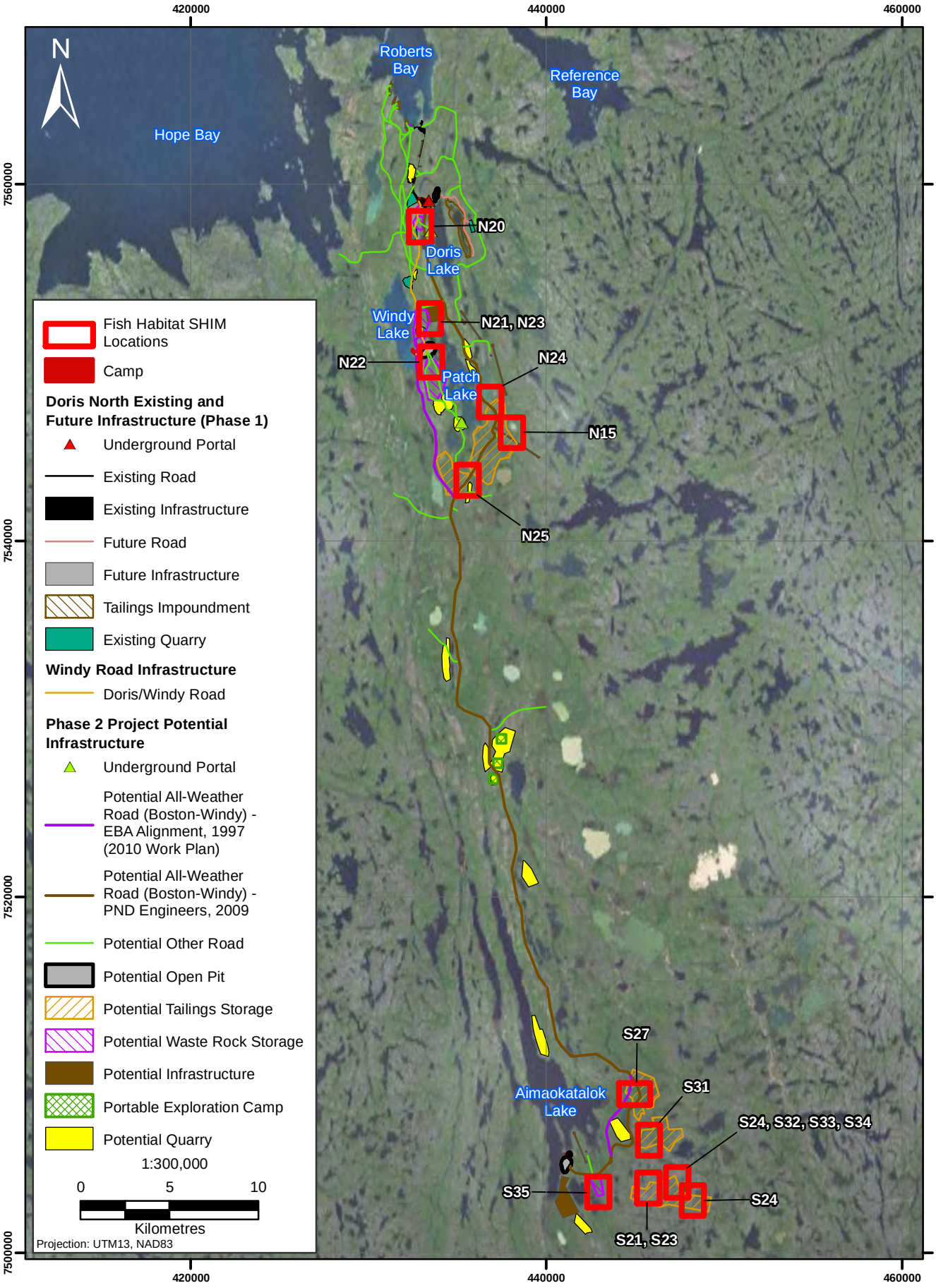
Figure 2.1-2c

NEWMONT NORTH AMERICA

Stream and Pond Fish Habitat and Fish Community Assessment Locations, Hope Bay Belt South, 2010

Figure2.1-2c

Rescan™ Engineers & Scientists



Locations of Streams Assessed by SHIM, Hope Bay Belt Project, 2010

Figure 2.1-3

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Table 2.1-3. Stream and River Fish Habitat Assessment Locations, Hope Bay Project, 2010

Site ID	Location	Time of Sampling	Upstream		Downstream	
			Easting	Northing	Easting	Northing
Northern Belt						
Koignuk River 1	Koignuk River	June	431017	7596355	-	-
Koignuk River 2	Koignuk River	June	429600	7554912	-	-
Little Roberts Creek	Roberts Bay Inflow	August	433800	7563622	433602	7563731
Ref B outflow	-	June and August	427134	7530417	427237	7530576
Ref D outflow	-	June	448133	7562868	448147	7563077
N01	-	August	433759	7564295	-	-
N02	East of Roberts Bay	June and August	434742	7564105	434947	7564094
N04	Glenn Lake Outflow	June and August	431027	7563215	431179	7563338
N05	Glenn Lake Outflow #2	June and August	430911	7563244	430829	7563189
N06	NE of Aimaokatalok Lake	June only	435059	7562919	434889	7562856
N07	Doris Lake Outflow	June and August	434569	7561367	434584	7561481
N08	Windy Outflow to Glenn Lake	June only	430925	7556570	-	-
N09	Doris Southeast Inflow	June only	435355	7555256		
N10	Patch 14 crossings 1 and 2	August	433324	7550444	434766	7547121
N11	P.O. Lake Inflow	June only	437196	7549851	437166	7500015
N12	-	June only	434809	7547676	434800	7547552
N13	Boston Area	August	434791	7547278	434756	7547137
N14	Wolverine Lake Outflow	June only	434778	7547181	434751	7547064
N16	P.O. Lake Outflow	June only	437779	7546438	437734	7546621
N17	P.O. Lake Inflow	June only	435460	7545606	435587	7545729
N18	Doris Area	June only	438352	7545523	-	-
N19	Koignuk River	June and August	432760	7541603	432760	7541749
Central Belt						
C01	Doris Area	June only	434893	7531138	435071	7531149
C02	NE of Aimaokatalok Lake	June only	437887	7524620	437990	7524343
C03	Boston Area	June only	439235	7516589	439098	7516550
Southern Belt						
Aimaokatalok Lake outflow	Boston Area	June	438777	7509090	-	-
Aimaokatalok River	Boston Area	June	450398	7486717	-	-
Aimaokatalok River Reference Site	Boston Area	August	450384	7486596	450363	7486701
S03	Boston Area	June only	441648	7510935	441631	7510845
S04	Boston Area	June and August	444282	7510291	444267	7510137
S05	Boston Area	August	444194	7509155	-	-
S06	Boston Area	June only	446248	7509300	446066	7509194
S07	-	June only	444481	7508846	444370	7508938
S09	Boston Area	June only	444210	7508103	444138	7508146

(continued)

Table 2.1-3. Stream and River Fish Habitat Assessment Locations, Hope Bay Project, 2010 (completed)

Site ID	Location	Time of Sampling	Upstream		Downstream	
			Easting	Northing	Easting	Northing
S10	Aimaokatalok inflow	August	443159	7507107	443017	7507143
S11	Boston PND road crossing	June and August	443521	7506971	443343	7507053
S12	Boston Area	June only	444790	7506730	-	-
S13	Boston Area	June only	444850	7506280	-	-
S14	Boston Area	June only	444450	7506040	-	-
S15	Boston Area	June only	444150	7506100	-	-
S16	Boston Camp	June only	443703	7505541	443566	7505458
S17	Stickleback Lake Outflow	August only	441655	7504997	-	-
S18	Stickleback Lake Outflow	June only	441932	7504231	441910	7504149
S19	Boston new campsite	June only	442447	7503727	442369	7504008
S20	Boston camp south	August	442368	7503979	442414	7503890
S21	Boston tailings pond 1	June only	445530	7503770	445402	7504033
S22	Boston tailings stream 2	August	445550	7503515	-	-
S23	Boston tailings stream 1	August	444818	7503270	-	-
S24	Boston tailings pond 1	June only	448331	7503236	448516	7503256
S25	Boston tailings stream 3	August	448294	7503124	448320	7503213
S26	Boston tailings pond 1	June only	448231	7502992	448302	7503185
S27	Boston Road	June only	445080	7508661	-	-
S28	Boston Area	June only	445530	7503720	-	-
S29	Boston new camp	June only	442367	7504100	442266	7504250
S30	Inlet to waste rock pond	June only	442602	7501876	442612	7502060

Table 2.1-4. Classification System for Streams, Hope Bay Belt Project, 2010

Stream Class	Channel Width (m)	Fish-Bearing Status
S1 - Large River	> 100	Fish
S1	> 20	Fish
S2	20 to 5	Fish
S3	5 to 1.5	Fish
S4	< 1.5	Fish
S5	> 3.0	No Fish
S6	< 3.0	No Fish

2.2 FISH COMMUNITY

2.2.1 Aimaokatalok Lake Hydroacoustic and Video Surveys

2.2.1.1 General

Mobile hydroacoustic surveys were conducted in August 2010 to compare fish density and distribution patterns in the Ore Deposit and Reference areas in Aimaokatalok Lake. Survey methods generally

followed protocols for the sampling of fish populations with hydroacoustics described in Thorne (1983), Brandt (1996), Simmonds and MacLennan (2005) and Beauchamp et al. (2009).

2.2.1.2 Data Collection

In most situations, night is the preferred time for hydroacoustic sampling to determine fish abundance (Thorne 1983); however, only a daytime and dusk sampling were possible due to safety concerns and the short duration of darkness at the time of the survey. The Ore Deposit site was surveyed during dusk (2100 to 0000 hours) on August 4 and during the day on August 6 (1000 to 1300 hours), 2010. The Reference site was surveyed during the day only (1300 to 1700) on August 6, 2010.

Hydroacoustic sampling was conducted from a 4.9 m-long power boat travelling approximately 1.1 to 1.8 m/s along the same transect lines used for substrate surveys. Not all transects in the Ore Deposit area were sampled on each survey because of time restrictions. The echo sounding system consisted of the same dual-transducer BioSonics DT-X split-beam echo sounder, and Garmin model 18 differential GPS. Full beam angles of the transducers (at the half power point) were 6.7° (down-looking) and 6.8° (side-looking). Other system specifications are shown in Table 2.1-1. The sounder was controlled by a laptop computer that displayed electronic echograms for monitoring system performance during data collection. Hydroacoustic data merged with geographic coordinates from the GPS were logged to the computer hard drive for processing at a later date.

The transducers were mounted on a metal pole that was attached to the boat's port side (Plate 2.1-1), with one transducer aimed downward (down-looking) and the other aimed sideways (side-looking) perpendicular to the boat's direction of travel, tilted slightly downward. The down-looking transducer was aimed 1° to 3° sternward to aid in the identification of bubbles. The side-looking transducer was tilted 5° down from horizontal to reduce echoes from the lake surface as described by Yule (2000). The side-looking transducer was necessary to obtain an adequate sampling volume in the many shallow parts of the lakes and to minimize boat avoidance by fish, as recommended by Kubecka et al. (1994) and Kubecka and Wittingerova (1998). During sampling, pings (sound transmissions) alternated between transducers, giving a rate per transducer of 5.5 pings per second. Because the lakes were relatively shallow (i.e., less than 30 m), all data were collected using a low transmit power setting (-10.3 dB) to avoid saturation of the bottom signal, which was used for substrate identification. Also, a pulse width of 0.4 milliseconds and a data collection threshold of -80 dB were used for all sampling. Other settings used for data collection are shown in Table 2.1-1.

Transects were spaced approximately 200 m apart, approximately perpendicular to the long axis of the lake, using a systematic sampling design according to Cochran (1977). The number of transects was 13 in the Ore Deposit area and 10 in the Reference area. Transects covered all available habitats and depth ranges including shallow bays and flats, although it was expected that data from the shallowest areas would not be usable for fish abundance estimates. In the field, crews sampled to a minimum bottom depth of approximately 1 m and to within a few metres of shore where possible.

2.2.1.3 Data Processing and Analysis

Hydroacoustic data files were processed using Myriax Echoview software (version 4.9) to estimate fish density (e.g., fish/m^3 and fish/ha) and measure target strength (TS, the hydroacoustic size of fish). Side-looking data were processed according to standard split-beam trace counting and TS methods (Thorne 1983; Brandt 1996; Simmonds and McLennnan 2005). The side-looking transducer represented the upper 5 m of the water column, so, considering the transducer deployment depth (0.4 m), beam angle (6.8°) and downward tilt (5°), data from 10 to 30 m within the transducer were processed. For the down-looking transducer, data from the 2 to 30 m range were processed, but results from less than 5 m were not used for the population estimate. Down-looking data were processed by echo

integration (Thorne 1983) because fish were mainly on the bottom and seldom discernible as individuals. Target strength of available single targets was measured by the split-beam method.

Fish tracks were recognized on side-looking echograms by their shape, cohesiveness and TS. At least two echoes with a TS greater or equal to -60 dB was required for acceptance as a fish track. Additionally, only echoes within the main portion of the acoustic beam (6.8°) were accepted. Other fish processing and tracking settings are listed in Table 2.1-1. Bubbles were not seen during any of the surveys, so no correction for their presence was necessary.

The accuracy of hydroacoustic measurements was verified by BioSonics and field calibration tests. The echo sounder was calibrated by BioSonics prior to the study, and in-situ TS measurements of a standard sphere were made during the survey. Results of field tests were 0.5 dB greater than the expected value (-39.5 dB) for the down-looking transducer and 1.6 dB less than the expected value for the side-looking transducer. Corrections for these deviations were applied during processing in Echoview.

Five-metre depth intervals (e.g., 0 to 5 m, 5.1 to 10 m, etc.) were used for fish density data analysis. Fish densities were summarized as fish per cubic meter (fish/m^3) for description of vertical distributions, and as fish per hectare (fish/ha) in 50 m-long segments of transects to describe horizontal distributions. From side looking data (trace counts) fish/m^3 was calculated for each spatial cell of interest as the total number of fish counted divided by the volume sampled according to the wedge model (Keiser and Mulligan 1984). From down-looking data (echo integration), fish/m^3 was computed for each cell using mean volume backscattering strength (Sv) and mean backscattering cross section per fish (Sbs) according to standard echo integration methods (Simmonds and Maclennan 2005). Because few measurements of Sbs were obtained from acoustics, it was estimated for each area and depth interval from the mean size of fish in the gillnet catch using Love's (1977) ± 45° equation.

For estimates of mean fish density in the study areas, each transect provided one replicate of each 5 m depth interval that it included (shallow transects did not contain all intervals). Estimates of mean fish/m^3 and its standard deviation were computed by depth interval for comparison of vertical distribution patterns between study areas. Mean areal fish density (fish/ha) and its standard deviation was calculated for comparison of overall fish density between areas.

Because acoustics cannot differentiate fish species, gillnet catch data from the study areas was used to estimate species composition. The relative abundance of each species (i.e., species CPUE) was used as an estimate of its relative abundance for apportioning the acoustic fish density estimate. This method was only effective for fish large enough to be captured in the mesh sizes used and it assumes equal selectivity for all sizes and species of fish present in Aimaokatalok Lake.

2.2.2 Field Sample Collection and Processing

The fish communities of five lakes (Aimaokatalok Lake, Reference Lake B, Reference Lake D, Stickleback Lake and Trout Lake), two large river sites (Koignuk River and Aimaokatalok River), 57 stream sites and six ponds were sampled in July and August 2010. Figure 2.2-1 shows the location of the five lakes sampled for fish community. Fish communities were sampled at the same stream, pond and river sites as fish habitat (see Figures 2.1-2a to 2.1-2c, Table 2.1-3). These sites were sampled using a combination of sinking and floating gillnets (Plate 2.2-1), seine nets, minnow traps and backpack electrofishing (Plate 2.2-2). Gillnets and minnow traps were set in lakes that could accommodate a boat, while minnow traps and electrofishing were used at the lake inflows and outflows, or along the shoreline areas. For sites where the fish community was known (from past studies), the fish community studies were conducted for one of three purposes: 1) to estimate relative fish abundance and species-specific population sizes in Aimaokatalok Lake; 2) to collect tissue metals samples from Reference Lake D, Aimaokatalok Lake and from streams located downstream of potential tailings impoundment areas; or 3) to collect general fish community data (i.e., community composition and fish biological data) for baseline reporting.

Plate 2.2-1. Gillnetting at Aimaokatalok Lake, Hope Bay Belt Project, 2010.

Plate 2.2-2. Backpack electrofishing gear used to assess the fish communities in streams, Hope Bay Belt Project, 2010.

PROJECT #1009-006-02 GIS # HB-06-130 November 16 2011

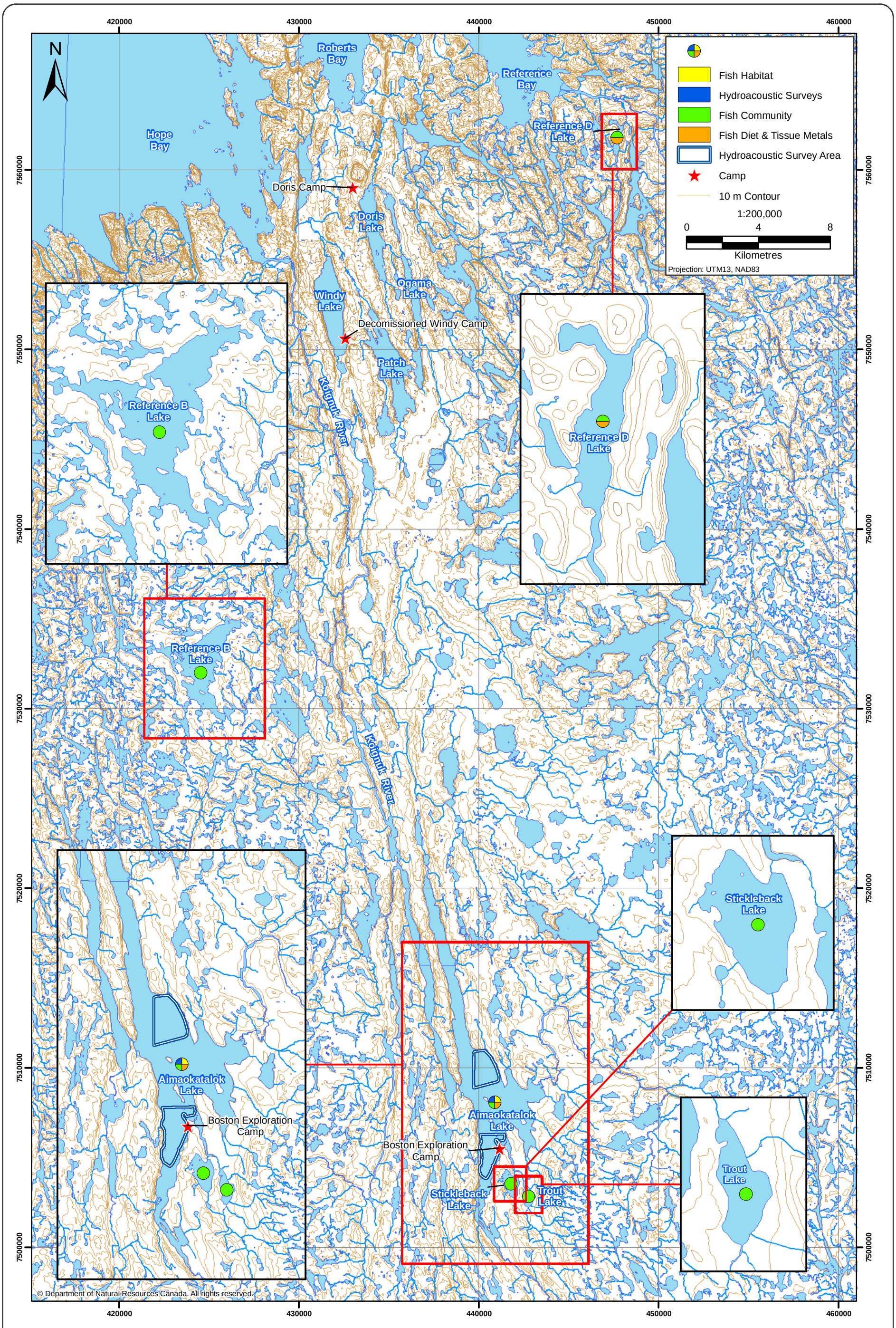

Figure 2.2-1

NEWMONT NORTH AMERICA

Hope Bay Fisheries Lake Sampling Sites

Figure 2.2-1

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Site layout options considered in 2010 included the planned Phase 2 Project infrastructure footprint areas that were not covered previously, a single all-weather road option between the Boston and Doris/Madrid areas, a road option from the jetty to a potential deep water port site in Roberts Bay, and two reference areas.

Gillnetting was used to estimate fish abundance and populations, and to determine fish distribution (vertical and horizontal) in Aimaokatalok Lake to document information that would be required to develop a compensation plan for the resulting loss of fish habitat.

Five lakes (Aimaokatalok, Stickleback, Trout, Reference B and Reference D) were sampled for fish community and tissue metals in the Project area in 2010. Figure 2.2-1 shows the locations of the five lakes within the Hope Bay Belt. Figures 2.2-2 to 2.2-7 show the location of gillnets and minnow traps in these lakes. Appendix 2.2-1 presents the set and retrieval times and UTM coordinates for gillnets and minnow traps.

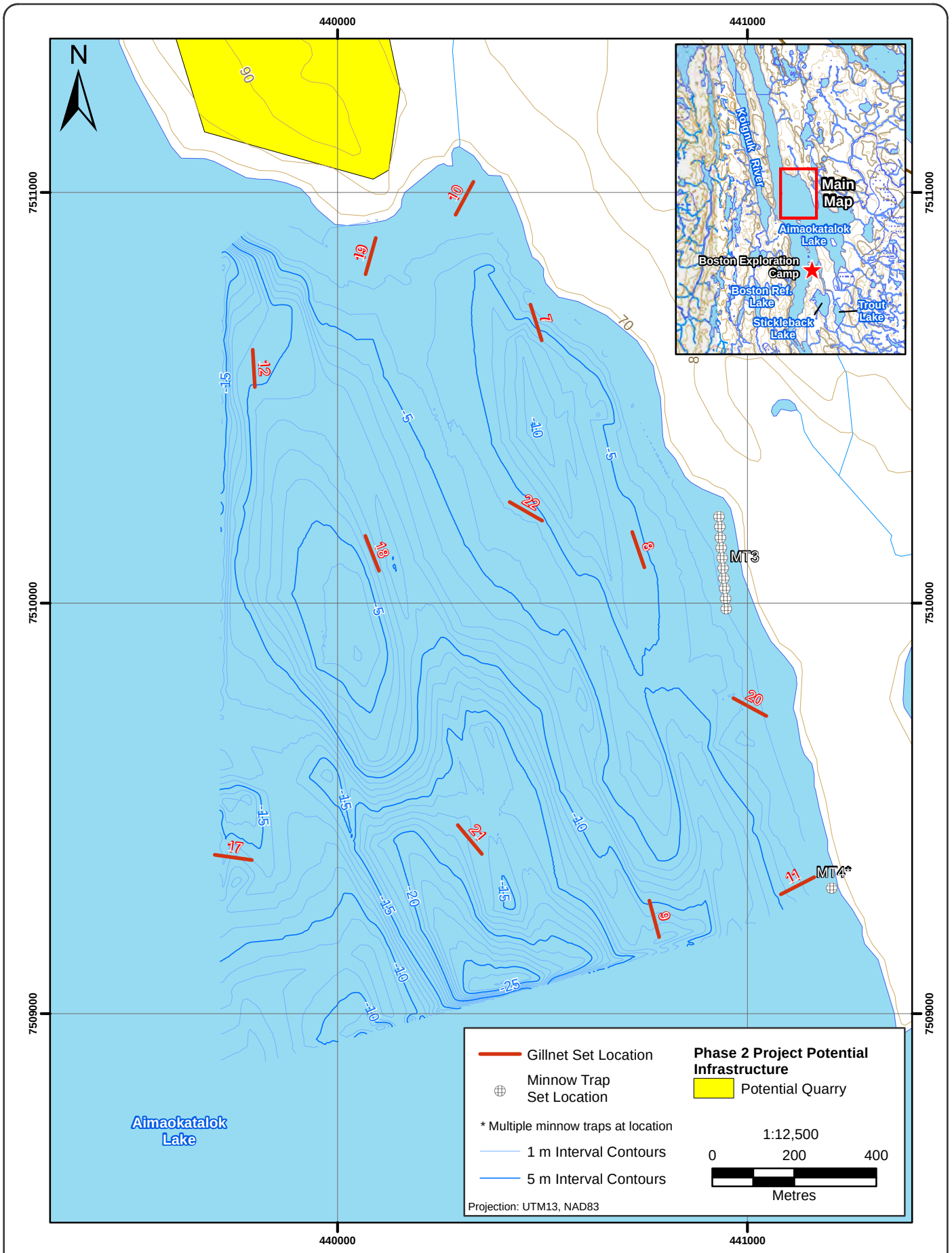
The lakes were sampled using monofilament index gillnet gangs. Resources Information Standards Committee (RISC) gillnet gangs consisted of six panels, ranging from 25 to 89 mm stretched mesh. Each RISC gillnet gang was tied in the following order: Panel 1 – 25 mm; Panel 2 – 76 mm; Panel 3 – 51 mm; Panel 4 – 89 mm; Panel 5 – 38 mm; and Panel 6 – 64 mm. Each panel measured 15.2 m long by 2.4 m deep for an area of 36.48 m^2 and a total area of 218.88 m^2 per gang. All gillnets included a lead line at the bottom and a floating line at the top of the net. Sinking nets were designed to fish at the bottom of the lake, while floating nets were designed to fish at the lake surface.

Data (geographic coordinates, depths, catch-per-unit-effort or CPUE) for individual RISC gillnets set at Aimaokatalok, Stickleback, Trout, and Reference B and D lakes were examined graphically to show general trends in fish distribution patterns. Maps using a graduated colour scale were produced to represent areas of relatively high (red) to low (purple) CPUE. Gillnet CPUE patterns were compared with estimates of absolute fish abundance (fish/m^3 or fish/ha) generated from hydroacoustic surveys.

Minnow traps consisted of two wire mesh cylinders that were locked together using a clip attached to a rope and marker buoy. Mesh size of minnow traps was 1/8 inch (3.175 mm). Each minnow trap was baited with a small amount of dry crab bait. Minnow traps were then placed on the streambed or along the shore of lakes or ponds so that the trap was resting on the substrate.

Captured fish were identified to species, measured for fork length to the nearest 1 mm, weighed to the nearest 0.1 g and sampled for various structures (scales, fin rays and otoliths) used to determine the age of the fish. Otoliths were only collected from incidental mortalities or from fish lethally sampled for tissues (e.g., muscle and liver). Scales were collected with a knife below the posterior margin of the dorsal fin on the left side of the fish. Two to three rays of the left pelvic fin were collected with scissors or pliers (Plate 2.2-3). Aging structures were placed in envelopes (Plate 2.2-4) labelled with the site, date, species and sample number.

All aging analysis of scales, fin rays and otoliths was performed by John Tost of North Shore Environmental Services, Thunder Bay, Ontario. Age was estimated by counting the number of annuli (or yearly rings) in each structure. Scales were attached to plastic fiches and annuli were counted with a microfiche reader. The fin rays were air-dried and then mounted in a 50:50 epoxy medium. Microsections were cut using a Beuler Isomet diamond saw and mounted on slides and annuli were counted with a compound microscope. Otoliths were air-dried, cracked and passed over a flame to increase the visibility of annuli. Otoliths were then mounted in Plasticine and immersed in oil for better inspection using a compound microscope. When more than one structure was used for aging, the one with the highest confidence in the annuli count was used.



Gillnet and Minnow Trap Set Locations in Aimaokatalok Lake (Reference Area), Hope Bay Belt Project, 2010

Figure 2.2-2

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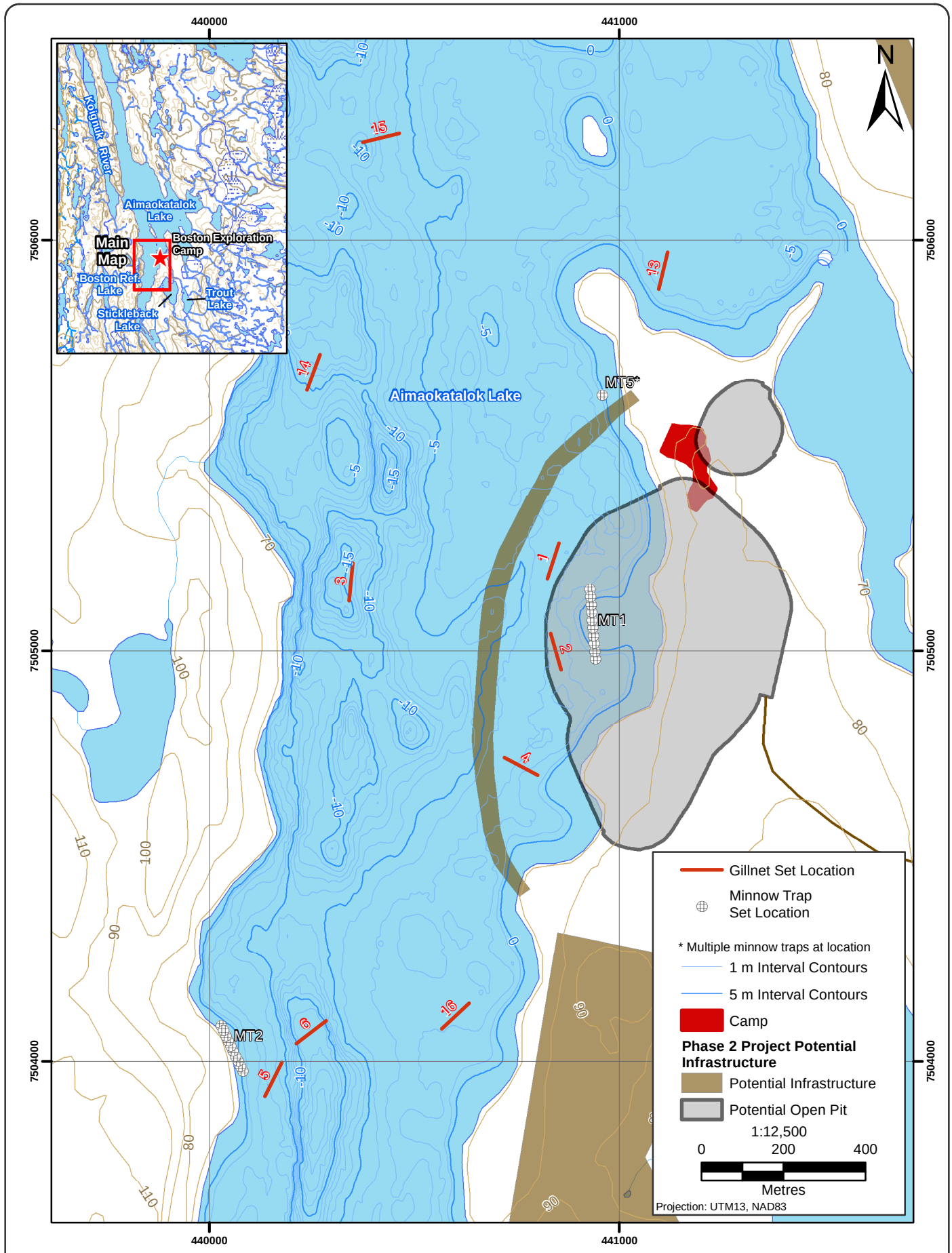

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Gillnet and Minnow Trap Set Locations in Aimaokatalok Lake (Ore Deposit Area), Hope Bay Belt Project, 2010

Figure 2.2-3

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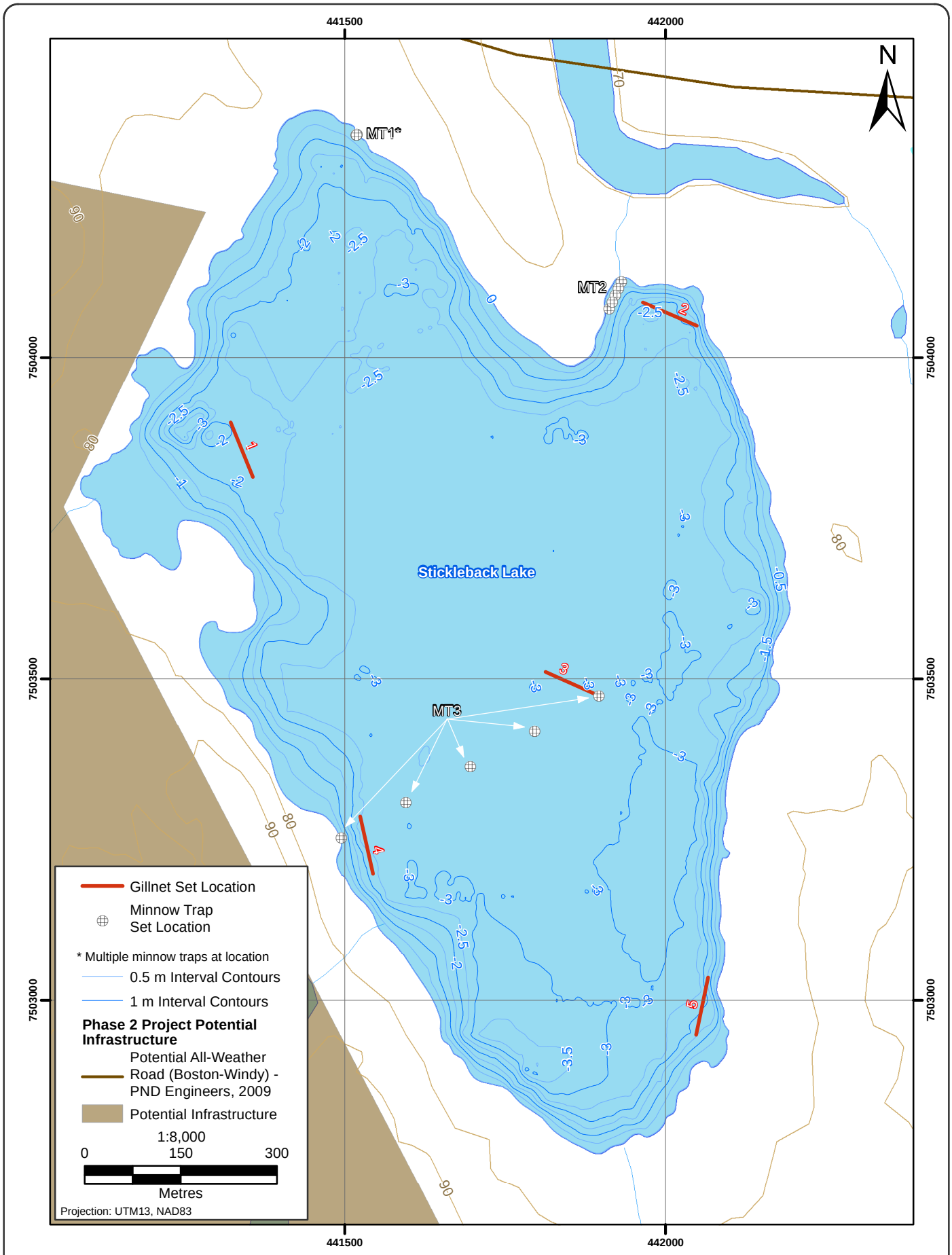

Gillnet and Minnow Trap Set Locations in Stickleback Lake, Hope Bay Belt Project, 2010

Figure 2.2-4

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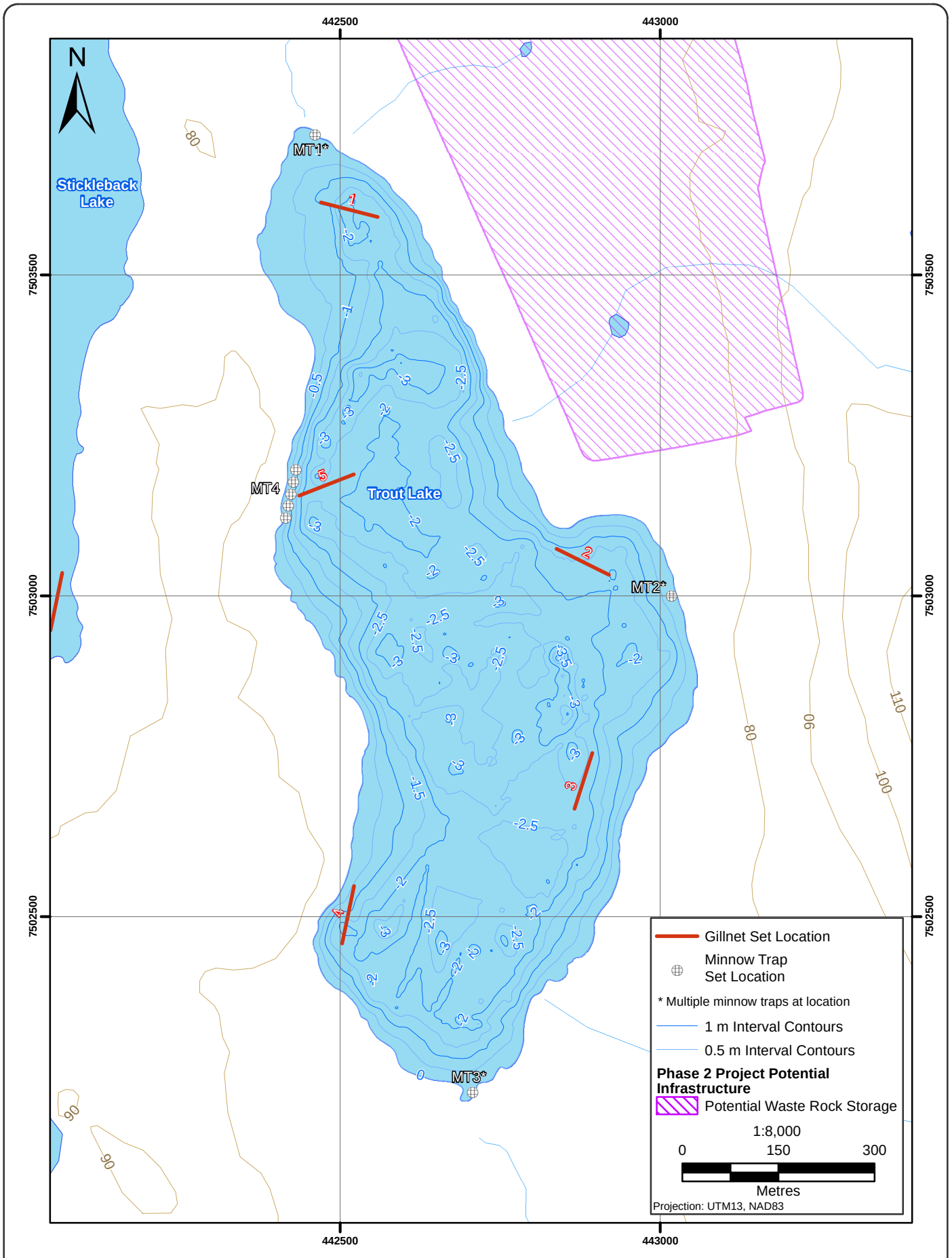

Figure 2.2-5

Gillnet and Minnow Trap Set Locations in Trout Lake, Hope Bay Belt Project, 2010

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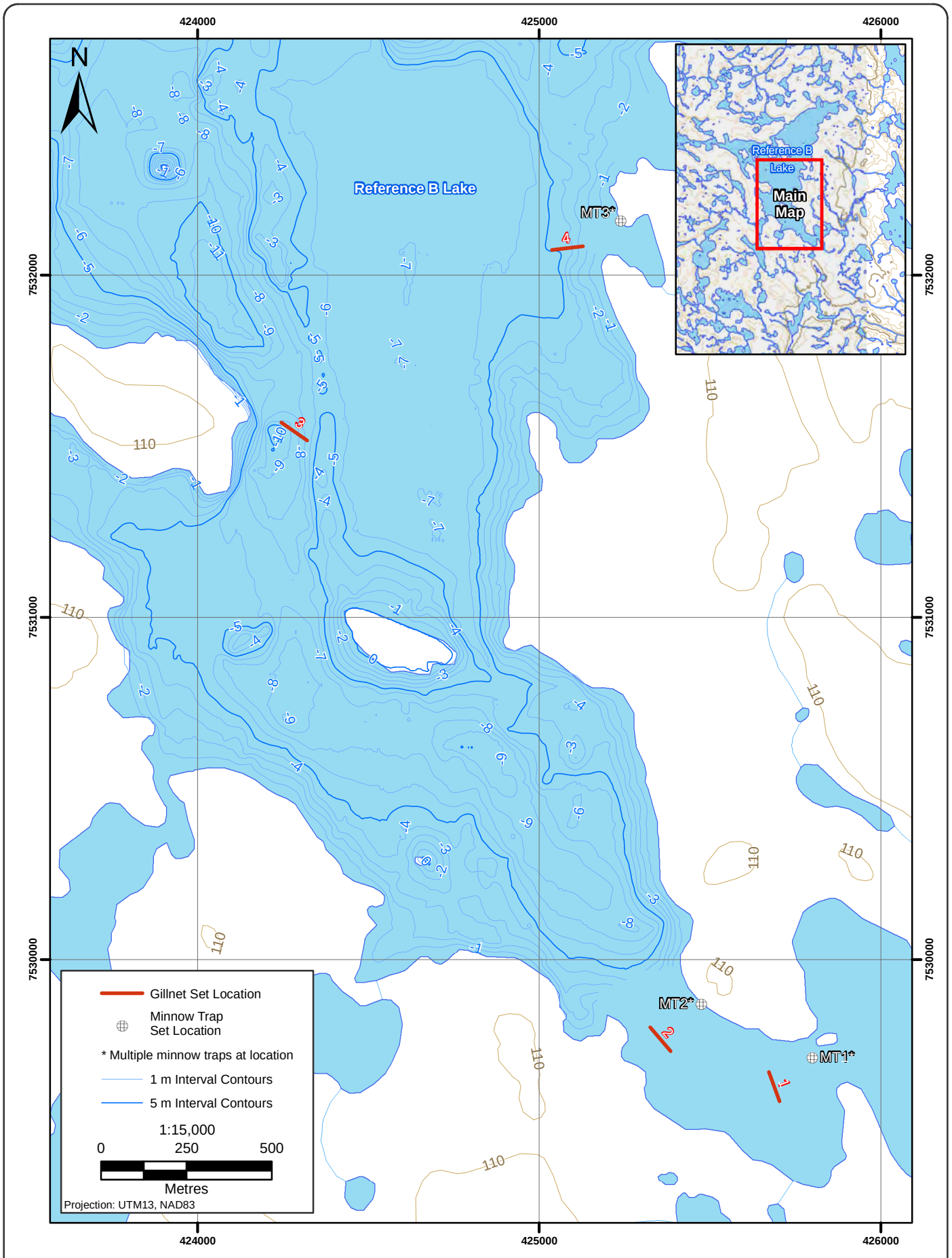

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Gillnet and Minnow Trap Set Locations in Reference B Lake, Hope Bay Belt Project, 2010

Figure 2.2-6

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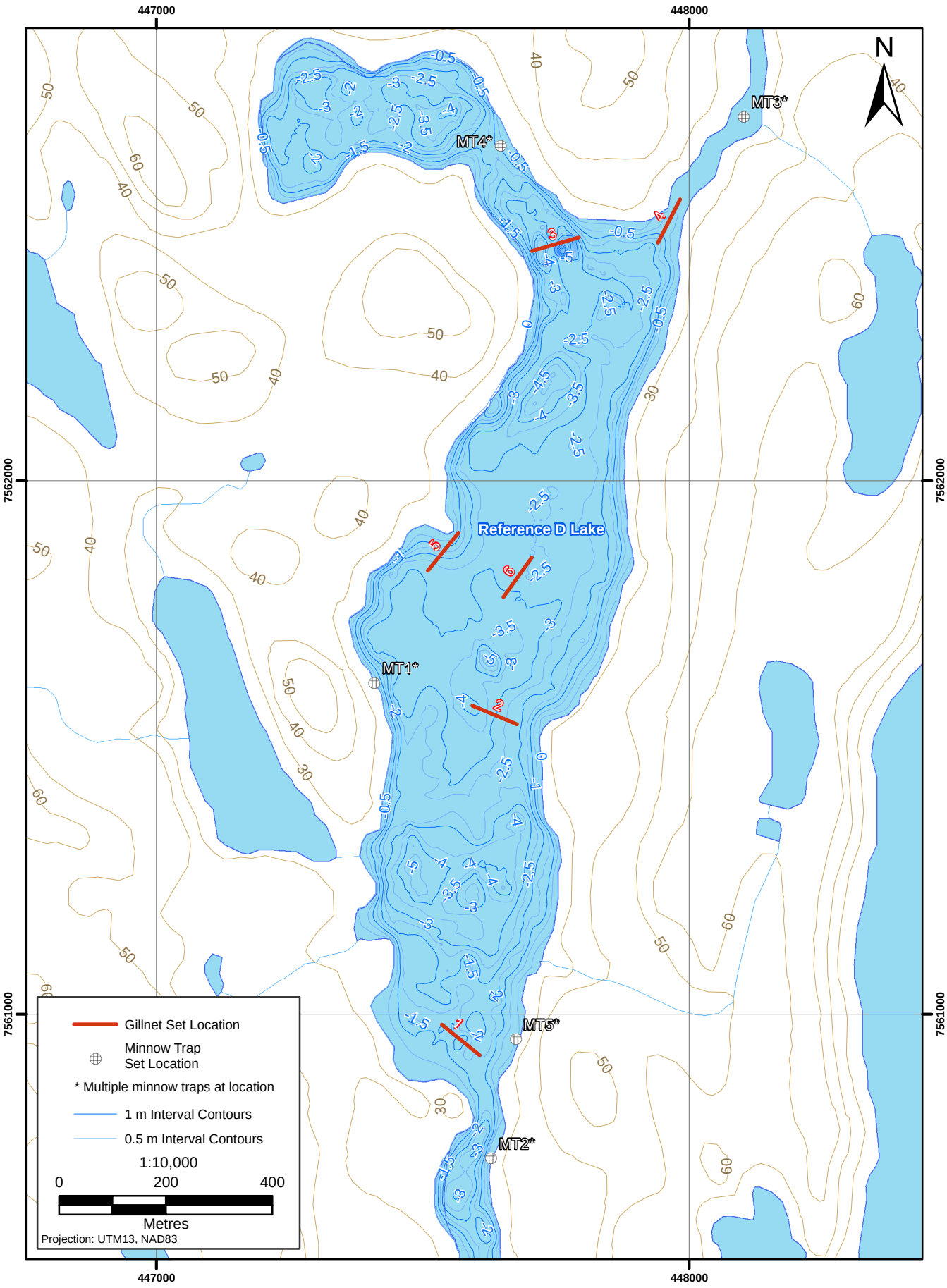

Figure 2.2-7

Gillnet and Minnow Trap Set Locations in Reference D Lake, Hope Bay Belt Project, 2010

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Plate 2.2-3. Field sampling equipment used to collect fish biological data, Hope Bay Belt Project, 2010.

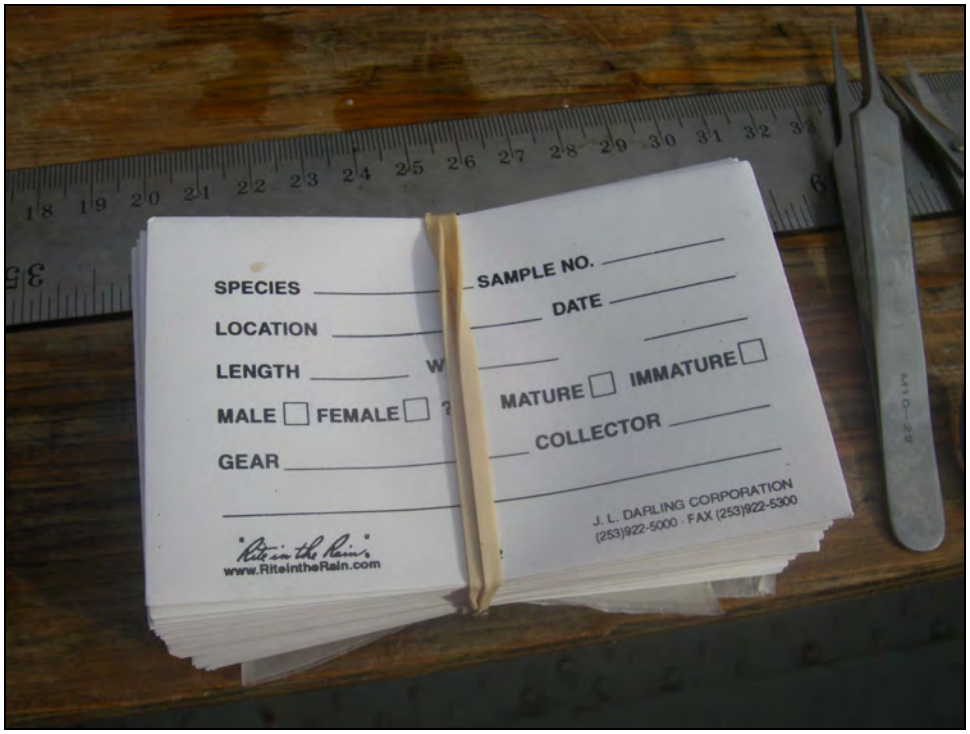


Plate 2.2-4. Envelopes used for the storage of fish aging structures, Hope Bay Belt Project, 2010.

Stomachs were removed from lake trout in Aimaokatalok and Reference D Lakes. In addition, stomachs were removed from whitefish from Aimaokatalok Lake. All samples were preserved in formalin and sent to Applied Technical Services in Victoria for detailed taxonomic analysis of their contents.

Fish tissue samples for metal analyses were collected for lake trout (muscle and liver) and lake whitefish (muscle and liver) from Aimaokatalok Lake and Reference Lake D. Whole body samples of ninespine stickleback were taken from five stream sites located downstream of potential tailings impoundment areas (S21, S22, S23, S25, S28 – see Table 2.1-3).

The overall goal of the tissue metals study was to collect a minimum of 10 fish from each sampling location (where "location" is defined as an individual lake). This sample size was the maximum allowed by Fisheries and Oceans Canada (Fish Collection Licence no. S-10/11-1010-NU) for lethal sampling.

For each fish, after collection of biological data, a 1 to 5 g piece of muscle tissue was taken, stripped of bones and skin, rinsed in clean lake water and placed in an individually labelled Whirl-Pak bag (Plate 2.2-5). Whole livers from each fish were collected and stored in the same manner. The tissue samples were frozen immediately and were kept frozen until they were delivered to ALS Environmental in Vancouver for analysis of metal concentrations.

Plate 2.2-5. Example of a lake trout muscle tissue sample collected for analysis of metals concentrations, Hope Bay Belt Project, 2009.

ALS Environmental analyzed the tissue samples for metals concentrations according to procedures adapted from the United States Environmental Protection Agency (EPA) (US EPA 1995). Samples were divided into two parts: one part for measurement of metal concentrations (on a wet weight basis) and a second part for measurement of percent moisture so that the results could be converted to mg/kg dry weight.

Each sample was homogenized either mechanically or manually prior to digestion at ALS. The hotplate digestion method involved the use of nitric acid followed by repeated additions of hydrogen peroxide. Total concentrations of 25 metals were measured by Inductively Coupled Plasma – Mass Spectroscopy (or ICPMS). The 25 metals and their analytical detection limits are shown in Table 2.2-1. Iron, phosphorus, potassium, sodium and titanium were not measured due to limited sample sizes.

Table 2.2-1. Metals and Detection Limits for Lake Trout Tissue Analysis, Hope Bay Belt Project, 2010

Variable	Detection Limit	Units
Aluminum (Al)	2.0	mg/kg WW
Antimony (Sb)	0.01	mg/kg WW
Arsenic (As)	0.01	mg/kg WW
Barium (Ba)	0.01	mg/kg WW
Beryllium (Be)	0.10	mg/kg WW
Bismuth (Bi)	0.03	mg/kg WW
Cadmium (Cd)	0.005	mg/kg WW
Calcium (Ca)	2.0	mg/kg WW
Chromium (Cr)	0.1	mg/kg WW
Cobalt (Co)	0.02	mg/kg WW
Copper (Cu)	0.01	mg/kg WW
Lead (Pb)	0.02	mg/kg WW
Lithium (Li)	0.1	mg/kg WW
Magnesium (Mg)	1.0	mg/kg WW
Manganese (Mn)	0.01	mg/kg WW
Mercury (Hg)	0.001	mg/kg WW
Molybdenum (Mo)	0.01	mg/kg WW
Nickel (Ni)	0.1	mg/kg WW
Selenium (Se)	0.2	mg/kg WW
Strontium (Sr)	0.01	mg/kg WW
Thallium (Tl)	0.01	mg/kg WW
Tin (Sn)	0.05	mg/kg WW
Uranium (U)	0.002	mg/kg WW
Vanadium (V)	0.1	mg/kg WW
Zinc (Zn)	0.1	mg/kg WW

Mg/kg WW = Milligrams per kilogram wet weight

2.3 QUALITY ASSURANCE / QUALITY CONTROL

For all fish habitat and community surveys, data sheets and electronic hydroacoustic data files were reviewed at the end of each field day to ensure data were complete and collected properly. Field notes were transcribed onto electronic spreadsheets once in the office and all transcriptions were checked visually against the field forms and any errors corrected. The data were also plotted to identify any outliers that may have resulted from transcription errors that occurred in the field.

To assess the accuracy of the fish tissue metal analyses, ALS conducted two measures of quality control: method blanks (or MB) and comparison with reference material (or CRM). A method blank is a test in which no tissue was added. Eleven method blanks were run with 25 metals measured for each

blank, resulting in a total of 275 comparisons between measurements and targets. A total of 18 measurements (or 6.5%) were above the method detection limit (or MDL) and were classified by ALS as "MB-LOR" (Appendix 2.3-1). This result was considered to be of acceptable quality (Amber Springer, ALS Environmental, pers. comm.).

To further assess the accuracy of the metal analyses, samples of a reference material, VA-NRC-TORT2 or lobster hepatopancreas, certified by the National Research Council of Canada, were subjected to the same analytical procedures as the lake trout tissue samples. The measured concentrations of each metal were then compared to the known metal concentrations in the certified material to determine if they fell within the 95% confidence limits expected for each metal. Of the 130 comparisons performed, all 130 fell within the 95% confidence limits around the target (Appendix 2.3-1). These results are considered to be an acceptable range of analytical accuracy (Amber Springer, ALS Environmental, pers. comm.).

To assess the variability of fish tissue metal analysis, and hence the homogeneity of the samples, six of the 98 samples (or ~6% of the total number of samples) were each split into two replicates and the relative percent difference (RPD) between replicate metal concentrations (and percent moisture) was calculated as:

$$RPD = 100((sample - duplicate)/((sample + duplicate)/2))).$$

Since 26 variables were measured for each of the six samples (percent moisture and concentrations of 25 metals), this gave a total of 156 potential RPD (Appendix 2.3-2).

However, 46% of those potential RPD were not calculated because one or both of the values were less than the MDL. In general, analytical variability is much higher near the MDL than is considered acceptable. Therefore, those RPD were classified as "RPD-not available" or RPD-NA (Table 2.3-1).

Table 2.3-1. Tests of Variability of Fish Tissue Metal Concentrations, Hope Bay Belt Project, 2009

Qualifier	Number of Potential RPD	Percent
RPD-NA	66	42
J	3	2
RPD	82	53
DUP-H	5	3
Total	**156**	**100**

RPD = Relative Percent Difference.
RPD-NA = RPD Not Available because one or both values were at or below the MDL.
J = Absolute difference between duplicates. RPD not available because one or both values were less than five times greater than the MDL.
DUP-H = Duplicate results outside of ALS data quality objectives due to sample heterogeneity.

Another 2% of those potential RPD were not calculated because both values were between one and five times higher than the MDL. The *British Columbia Field Sampling Manual* recommends that only RPD calculated from concentrations each of which is greater than five times the MDL should be used for assessing data quality (BCMWLAP 2003). Instead of an RPD, the absolute difference between the values was calculated. These results were qualified by ALS as "J" in Appendix 2.3-2.

The remaining 50 comparisons were considered to be valid RPD. They ranged from 0.06 to 68% with a median of 5%. A total of one RPD exceeded the RPD limits established by ALS (30% for percent moisture and 45% for metals). ALS interpreted these results as showing low variability of analyses (Amber Springer, ALS Environmental, pers. comm.).

2.4 DATA ANALYSIS

The variables used to assess the fish community included: relative species abundance, length, weight, condition, and catch-per-unit-effort (CPUE). Data analysis and interpretation for these variables followed Guy and Brown (2007). Several of these variables required calculation. A description of the calculations undertaken is presented below.

The CPUE statistic is used as an estimate of relative abundance of fish (Hubert and Fabrizio 2007). A key factor that allows comparison of CPUE data is the standardization (type of net, mesh size, etc.) of sampling devices. The same nets, traps and amount of bait were used at all sites allowing comparisons of CPUE data to be made.

For gillnets, CPUE was the number of fish caught per 100 m^2 of net per 1 hour.

$$CPUE = number\ of\ fish\ caught\ per\ net \times [100/total\ net\ area\ (m^2)] \times [1/set\ time\ (h)]$$

For minnow traps, CPUE was calculated from the number of fish caught per trap per day.

$$CPUE = number\ of\ fish \times [set\ time\ (h)/24\ h\ (day)]$$

For electrofishing, CPUE was calculated as the number of fish caught per 100 s of electrofishing.

$$CPUE = number\ of\ fish\ caught/100\ s$$

Condition and length-weight regressions are indicators of the relative health of fish within a lake. Condition factor was based on the following formula from Ricker (1975):

$$Condition = weight\ (g) \times 10^5/length^3\ (mm)$$

Weight was multiplied by 10^5 to avoid fractional values, and a length-weight exponent of exactly 3 was assumed to apply to all species of fish. Length-weight relationships (Pope and Kruse 2007) were calculated for fish species captured in significant numbers (e.g., greater than 10). Logarithmic transformations were performed on the data prior to conducting the regression.

$$ln(weight) = ln(a) + b[ln(length)]$$

Weight is in grams, a is a coefficient, b is the slope of the regression, and length is in mm.

Length-age relationships were described with the von Bertalanffy growth model (Isley and Grabowski 2007):

$$L_t = L_\infty(1 - exp\ (-K(t - t_0)))$$

where L_t = length at age (mm), L_∞ = asymptotic length (mm) (i.e., length at infinite age), K = growth rate ($year^{-1}$) and t_0 = age (years) at L = 0 mm. Where length and age data were limited for small and/or young fish, t_0 was fixed at zero to force the x-intercept through the graph origin and create a more realistic model of juvenile growth.

For tissue metals, metals in which 90% of the all concentrations were below the MDL were excluded from analyses. The 90% limit was calculated from muscle and liver tissues together, hence a few of the metals (e.g., arsenic, thallium, and uranium) that were enriched in livers but rare in muscle had greater than 90% of their values for muscle below the MDL. For the included metals, all values below the MDL were assigned values of one-half the MDL in order to use those values in statistical analyses.

Average metal concentrations—with standard error (SE), minimum and maximum—were calculated from that dataset for each type of tissue for each of the two lakes. To compare mean tissue metal concentrations among lakes and tissues, concentrations were ln-transformed to normalize their frequency distributions—a pre-requisite of parametric statistics. Then, mean ln(concentrations) were compared among the five lakes and the two types of tissues with two-way analysis of variance (ANOVA).

All statistics were conducted according to Zar (1984) using SYSTAT (2004). All linear regressions were reported with the appropriate sample size (n), coefficient of determination (r^2, the fraction of variation in the independent parameter that was explained by the dependent parameter) and P value. All r^2 for linear or non-linear regressions were not adjusted for degrees of freedom.

3. Results and Discussion

3. Results and Discussion

3.1 FISH HABITAT

3.1.1 Aimaokatalok Lake Hydroacoustic and Video Surveys

3.1.1.1 Ore Deposit Area

Appendix 3.1-1 presents substrate data collected from hydroacoustics surveys of the ore deposit area. Figure 3.1-1 shows the spatial distribution of substrate in the ore deposit area and Table 3.1-1 shows the frequency distribution of substrate types. The predominant substrate types found at the Ore Deposit area were 'sand and gravel' and 'mud', representing 40% and 39% respectively of the overall bottom area. The subdominant bottom type was 'cobble and large rock', which represented 15% of the overall bottom type. Substrate mapping showed that mud is predominantly located in to the west and south of the ore deposit. Sand and gravel is more commonly distributed in the central and north eastern portion of the area surveyed. Substrates in the immediate ore deposit area and proposed dyke are predominantly 'sand and gravel' and 'cobble and large rock'.

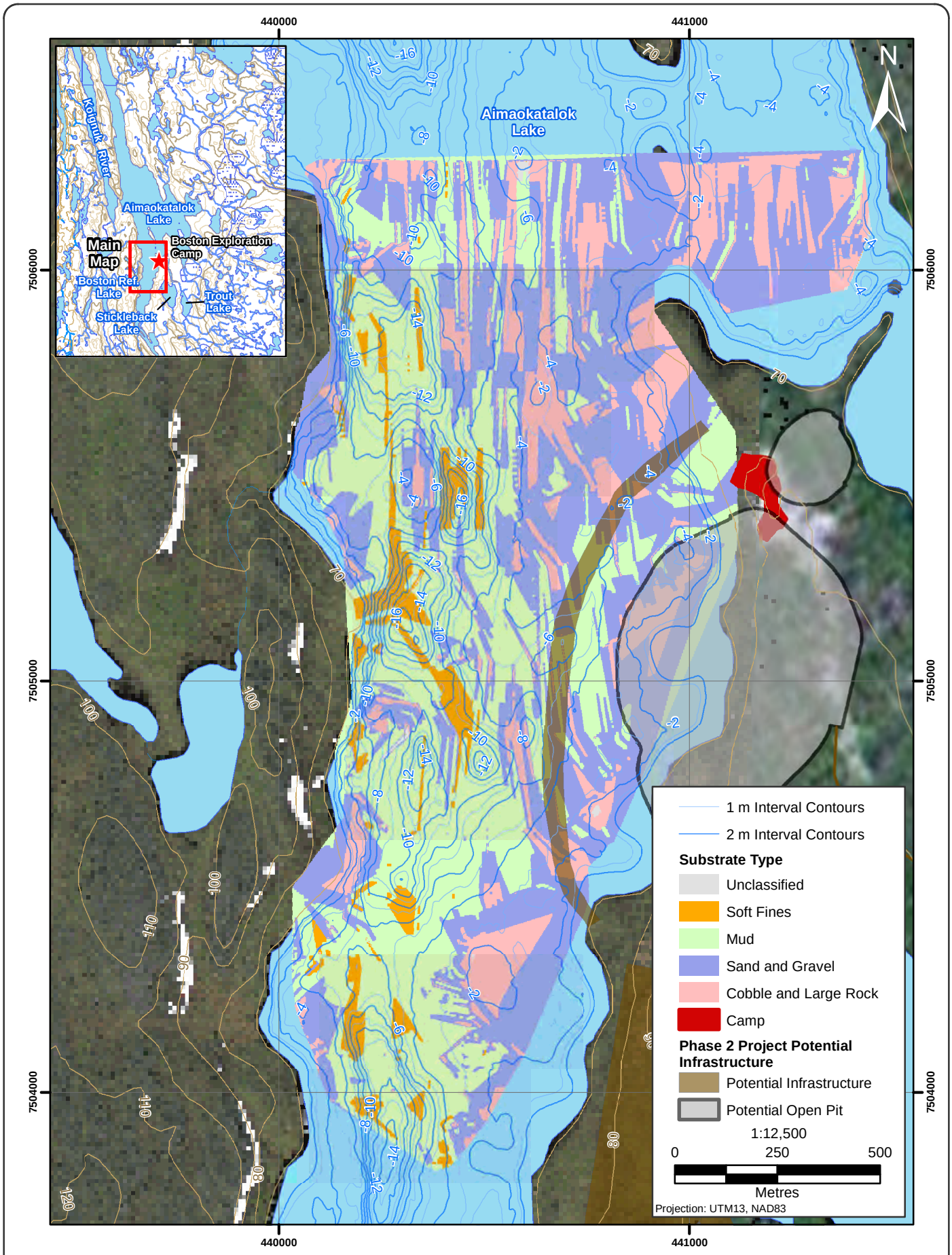
Table 3.1-1. Substrate Composition of Aimaokatalok Lake (Ore Deposit) Derived from Hydroacoustics and Underwater Video, Hope Bay Belt Project, 2010

Location	Substrate Type	Hydroacoustic Substrate Category	Area (ha)	Percent
Potential Ore Deposit and Dyke Area in Aimaokatalok Lake	Unclassified	0	<1	0
	Soft fines	1	10	5
	Mud	2	81	39
	Sand and gravel	3	83	40
	Cobble and large rock	4	31	15
	Total		**205**	**100**

Underwater video footage showed substrates ranging from soft mud (less than 2 mm) to boulders (greater than 256 mm) in the Ore Deposit area. Rocky substrates (e.g., cobble, boulder) typically occurred in depths less than 4 m, along the edge of littoral zones. Transitions between substrate categories were often very rapid. Small particle sizes (soft mud to sand) predominated at most sites sampled. Larger particle sizes (gravel to boulder) predominated at only three sites. Underwater video also showed that gravel, cobble and boulders were often mixed together or occurred in patches. In many cases fine sediment was interspersed with hard substrates. Filamentous algae occurred at many sites at depths less than 7 m, often attached to rocks. Algae were not observed in extensive dense mats as observed in Patch Lake in 2009 (Rescan 2010).

3.1.1.2 Reference Area

Appendix 3.1-2 presents substrate data collected from hydroacoustics surveys of the Aimaokatalok Lake reference area. Figure 3.1-2 shows the spatial distribution of substrate in the reference area and Table 3.1-2 shows the frequency distribution of substrate types. The predominant substrate category found at the reference area area was 'cobble and large rock', representing 42 % of the overall bottom area. The subdominant bottom type was 'sand and gravel', which represented 37 % of the overall bottom type. Mud contributed 20% to the remaining bottom type. Substrate types were randomly distributed in the Reference area. Soft fines were located in small pockets surrounded by mud.



NEWMONT NORTH AMERICA

Substrate Composition of Aimaokatalok Lake (Ore Deposit) Derived from Hydroacoustic and Underwater Video Surveys, Hope Bay Belt Project, 2010

Figure 3.1-1

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