WHALE TAIL PIT

Fish Habitat Offsetting Plan

Prepared by:
C. Portt and Associates
&
Agnico Eagle Mines Limited – Meadowbank Division

Final:
Version 1
March, 2018

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

EXECUTIVE SUMMARY

Agnico Eagle Mines Limited: Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit, a satellite deposit on the Amaruq property, in continuation of mine operations and milling of the Meadowbank Mine. The Amaruq Exploration property is a 408 square kilometre (km^2) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq region of Nunavut.

Baseline fisheries investigations were conducted in Mammoth Lake, Whale Tail Lake, and tributary streams and lakes in 2014, 2015, and 2016. Individuals of six fish species were captured in the primary study area. These were comprised of four large-bodied species (Lake Trout, *Salvelinus namaycush;* Arctic Char, *Salvelinus alpinus*; Round Whitefish, *Prosopium cylindraceum*; Burbot, *Lota lota*) and two small-bodied species (Slimy Sculpin, *Cottus cognatus*; Ninespine Stickleback, *Pungitius pungitius*).

The goal of this document is to characterize fish habitat in areas that will be directly affected by Whale Tail Pit mining operations under baseline conditions and predicted conditions during the operations and post-closure scenarios, and to describe habitat creation and enhancement along with complementary measures that will be used to offsetlosses to fish habitat. This document presents an approach to offsetting for the Whale Tail Pit that achieves a 1.66:1 ratio of habitat gains to habitat losses.

The habitat evaluation procedure (HEP) used to quantify habitat losses and offsets for Whale Tail Pit is based on the procedure used for the 2012 No Net Loss Plan (NNLP) for the Meadowbank Mine, and incorporates changes introduced between 2014 and 2016 based on DFO review of plans for Vault Lake, Phaser Lake, and the conceptual and draft offsetting plans for Whale Tail Pit (June, 2016; June, 2017)).

Changes to baseline fish habitat will occur during the operations and post-closure phases of Whale Tail Pit. During the operations phase there will be habitat losses due to dewatering or isolation of portions of Whale Tail Lake and some of its tributary lakes and connecting watercourses. Much smaller habitat losses will also occur in Mammoth Lake during operations as a result of diking and dewatering and in Nemo Lake due to the construction of a freshwater intake jetty. Habitat gains will occur from flooding of terrestrial areas south of the Whale Tail Dike. Overall, there is a 48.6 ha increase in the area of fish habitat and a 42.7 unit increase in the number of habitat units (HUs) during operations relative to baseline conditions. However, since flooding of terrestrial zones is only planned to occur over a 4-7 year period prior to drawdown, fish habitat availability during the operations phase is conservatively not considered a habitat offset, and calculations were performed for reference only. In the final net change calculation, only differences between baseline and post-closure conditions are compared.

Post-closure, in the absence of offsetting, most of the area affected during operations will revert to baseline conditions. The dikes will be breached, dewatered areas will be reflooded and isolated areas will be reconnected. The largest change between baseline and post-closure conditions is the creation of Whale Tail Pit. For the purposes of offsetting calculations, and at the request of DFO, it has been assumed that the flooded pit and pit cap will have no fish habitat value. Therefore, although the excavation of the pit into terrestrial areas will increase the surface area of Whale Tail Lake by 27.4 ha after flooding, the number of habitat units present will decrease. There also remains a small decrease in the area and number of habitat units in Nemo and Mammoth Lakes. Following closure, without offsetting, there would be a net decrease of 14.45 HUs compared to baseline conditions.

As offsetting for these losses, it is proposed to construct a sill in the connecting channel between Whale Tail Lake and Mammoth Lake to raise the elevation of Whale Tail Lake by 1 m which will flood a band around the perimeter of Whale Tail Lake. This increase would convert land to aquatic habitat and modify much of the existing habitat by increasing its depth. It is also proposed to construct 8.77 ha of shoals in the portion of Whale Tail Lake that is dewatered during operations, and to scarify the roads within that area prior to reflooding, converting them from mixed to coarse habitat. The net result of all habitat creation and enhancement measures is an increase of 21.26 ha and 15.03 HUs relative to the post-closure condition with no offsetting. This results in an offsetting to losses ratio of approximately 1:1 (losses = 14.45 HUs, gains = 15.03 HUs).

DFO has indicated support for complementary measures to provide 60% of the required offsetting. Following discussions of suitable research topics with DFO, Agnico Eagle has worked with researchers to develop proposals for a suite of research activities to benefit local stakeholders and contribute to the understanding of aquatic systems. These complementary measures are valued at 60% of constructed offsets (9.02 HUs), providing a total offsetting ratio of 14.45 HUs lost to 24.05 HUs gained (1:1.66).

SECTION 1 • INTRODUCTION

Agnico Eagle Mines Limited: Meadowbank Division (Agnico Eagle) is proposing to develop Whale Tail Pit, a satellite deposit on the Amaruq property, in continuation of mine operations and milling of the Meadowbank Mine. The Amaruq Exploration property is a 408 square kilometre (km^2) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq region of Nunavut (Figure 1-1).

1.1 GOAL

The goal of this document is to characterize fish habitat in areas that will be directly altered by Whale Tail Pit mining operations. Changes to fish habitat between baseline conditions and predicted conditions during the operations and post-closure scenarios are compared.

Options being considered to offset residual serious harm to fish that would occur as a result of mining activities at Whale Tail Pit were introduced in the Conceptual Fish Habitat Offsetting Plan (Agnico Eagle, 2016). In subsequent meetings to discuss offsetting for the project, DFO indicated that, given the need for knowledge regarding how fish populations and communities in the north respond to habitat changes, it would be acceptable for 60% of offsetting to consist of complementary measures. Those complementary measures would focus on funding scientific research that will improve the understanding of how aquatic systems in the far north respond to perturbations from human activities and/or the development of technologies to reduce impacts from human activities. The amount of research funding provided would be based on the predicted cost of achieving the desired offsets using typical offsetting methods that involve habitat alteration.

The approach used here to quantify harm and offsetting (previously termed compensation) builds upon methods developed for the Meadowbank mine site from 2012 through 2016. This offsetting approach was introduced in the 2012 Meadowbank no-net-loss plan (NNLP) after researching techniques and projects implemented at other northern mines, holding workshops and site visits with the local Hunter's and Trapper's Organization, Kivalliq Inuit Association and the DFO Habitat and Science & Research Departments, and reviewing the literature for information on effectiveness of compensation. Offsetting concepts specific to Whale Tail Pit were discussed with community groups during TK workshops initially held in Baker Lake in February 2016; follow-up workshops were held during the authorization phase of the project.

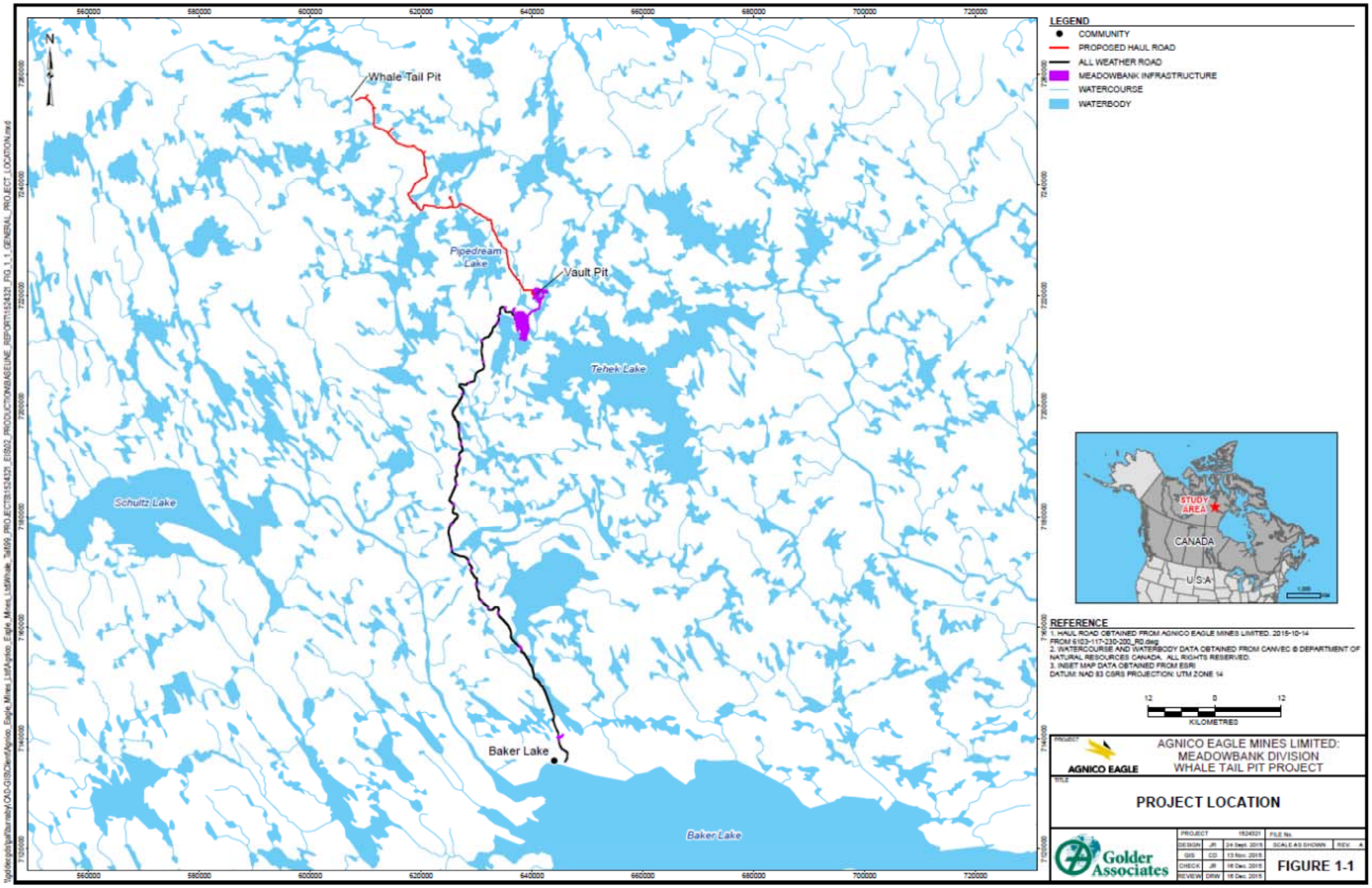

Figure 1-1. Location of the proposed Whale Tail Pit Study Area.

1.2 HYDROLOGIC SETTING

The hydrologic setting of Whale Tail Pit is shown in Figure 1-2. Lakes were assigned alpha-numeric codes to facilitate discussion, with the letter designating the subwatershed and, within each branch, the number increasing in an upstream direction. Lake A17 is referred to as Whale Tail Lake. Lake A16 is referred to as Mammoth Lake and lake C38, in the subwatershed immediately north of the Whale Tail Pit, is referred to as Nemo Lake.

The primary study area is in the headwaters of subwatershed A. All flow from the primary study area ultimately reaches lake DS1, but there are two pathways of flow downstream from Lake A12. The primary flow path, which conveys the majority of the flow, passes through lakes A11, A10, A9, A8 and A7, and then into Lake A32 before continuing through Lakes A6, A5, A4, A3, A2, A1 and into DS1. The secondary flow path is from Lake A12 to Lake A77 and then to Lake A76. Lake A76 has two outlets; with about half the outflow of the lake flowing to the east through Lake A41 to rejoin the primary flow path at Lake A10, while the other half flows west through Lakes A75, A74, A73, A72, A71, A70, A69 and into Lake DS1.

1.3 WATER ELEVATIONS AND LAKE SHORELINES

The shorelines used to determine baseline habitat areas in the Conceptual Fish Habitat Offsetting Plan (Agnico Eagle, 2016) were from CanVec mapping. Comparison of these shorelines to satellite imagery from July 21, 2011, indicated that the water levels represented by the CanVec shorelines were lower than those shown in the imagery. Water elevations were estimated by overlaying the digital elevation model for the study area and the July 21, 2011, satellite imagery for three lakes where actual water level data were available for 2015 and 2016 and the estimated elevations were compared to the field data[1]. The results (Table 1-1) were shared with DFO (meeting held in Winnipeg, March 23, 2017) and it was agreed that the water elevations and shorelines used to calculate habitat areas in the final offsetting plan would be determined using DEM and the July 21, 2011, imagery. Those elevations are provided in Appendix A.

[1] The following determination of shoreline elevations was provided in response to DFO IR 4 and 7. Agnico Eagle (January, 2017). DFO IR 4 – Freshwater Environment – Habitat Alteration; DFO IR 7 – Monitoring, Mitigation and Management Plans – Conceptual Offsetting Plan. January 20th, 2017 submission RE: NIRB File No 16MN056 Application No: 124683/NWB File No. 2AM WTP ----: Information Requests Received from Parties Regarding Agnico Eagles Mines Ltd's "Whale Tail Pit" Project.

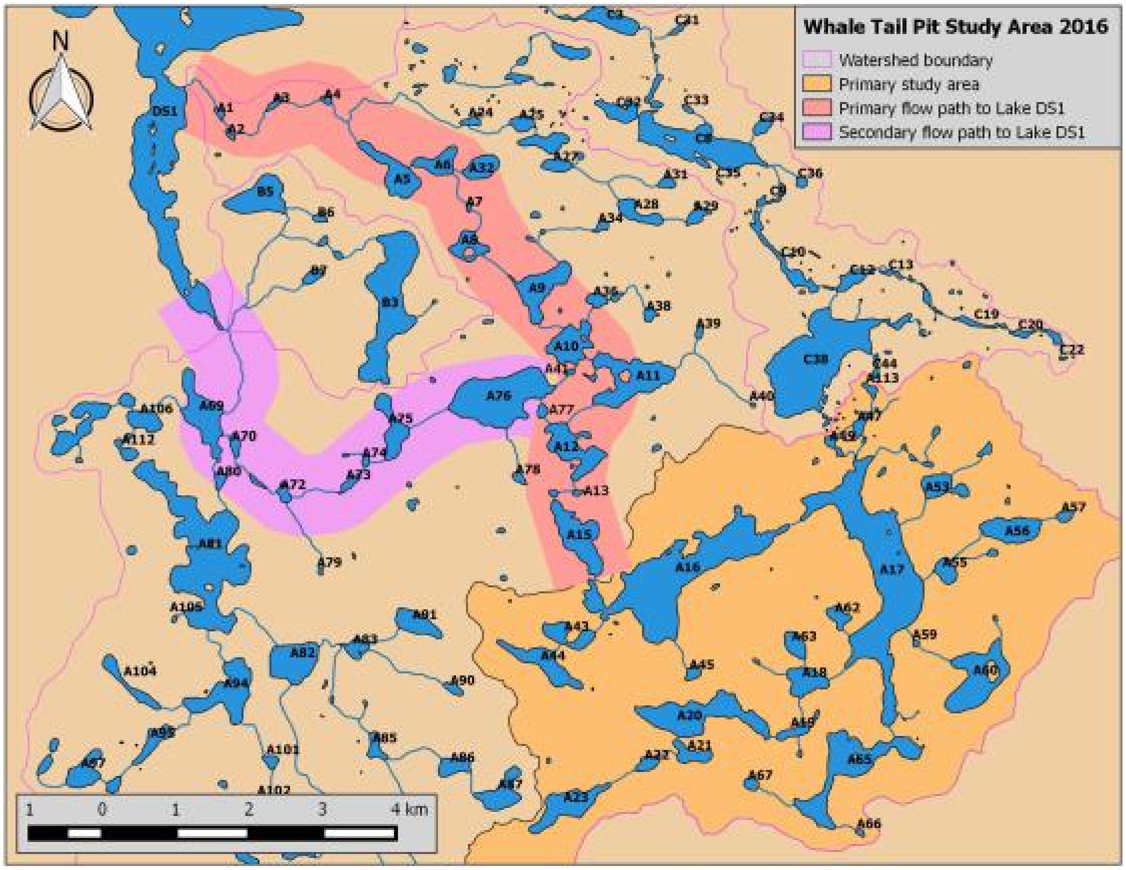

Figure 1-2. Hydrologic setting and lake identification codes. Mammoth Lake is A16. Whale Tail Lake is A17. Nemo Lake is C38.

Table 1-1. Water elevation estimated from the July 21, 2011, imagery, the minimum, maximum and range of water elevations recorded in the field in 2015 and 2016, the difference between the minimum and maximum water elevations recorded in the field and the water elevation estimated from the July 21, 2011, imagery, and the number of days each year that the recorded water elevation was higher than the water elevation estimated from the July 21, 2011, imagery, for 2015 and 2016.

Parameter	**Whale Tail Lake (A17)**		**Lake A18**		**Nemo Lake (C38)**	
Water elevation estimated from July 21, 2011 imagery (masl)	153.02		154.05		156.00	
Year	2015	2016	2015	2016	2015	2016
Maximum water elevation (masl)	153.31	153.11	154.20	154.10	155.98	156.04
Minimum water elevation (masl)	152.46	152.59	153.80	153.78	155.65	155.70
Range (m)	0.85	0.53	0.40	0.32	0.33	0.34
Difference between estimated water elevation and the recorded maximum (m)	0.29	0.09	0.15	0.05	-0.02	0.04
Difference between estimated water elevation and the recorded minimum (m)	-0.56	-0.43	-0.25	-0.27	-0.35	-0.30
# of days water elevation was higher than the water elevation estimated from shoreline elevation	10	5	11	5	0	11

1.4 WHALE TAIL STUDY AREA FISH COMMUNITY

Baseline fisheries investigations conducted in Mammoth Lake, Whale Tail Lake, and tributary streams and lakes in 2014, 2015 and 2016 are described in C. Portt and Associates (2018). The results are summarized here.

A total of six fish species are present in the primary study area, comprised of four large-bodied species (Lake Trout, *Salvelinus namaycush;* Arctic Char, *Salvelinus alpinus*; Round Whitefish, *Prosopium cylindraceum*; and Burbot, *Lota lota*) and two small-bodied species (Slimy Sculpin, *Cottus cognatus*; and Ninespine Stickleback, *Pungitius pungitius*).

Arctic Grayling occur further downstream in the watershed but upstream migration barriers prevent them from moving into the primary study area. The major barriers are a steep set of rapids on the primary flow path and a long section where there is only sub-surface, interstitial flow, even during spring freshet, on the secondary flow path. In addition to those primary barriers, there are connecting channels between a number of other lakes along these flow paths where there is only interstitial flow except during spring freshet. The absence of Arctic Grayling in the primary study area is consistent with the paucity of suitable spawning habitat and absence of riverine adult habitat in the tributaries to Mammoth and Whale Tail Lake.

Lake Trout was the most abundant species in gill net catches and the most widely distributed among the lakes, followed by Round Whitefish and Arctic Char (Table 1-2). Few Burbot were captured. Gill netting catch per unit effort was low for all species. In Mammoth, Whale Tail and Nemo Lakes combined, average catch per unit effort in gill nets, calculated as the number of individuals captured per hour of soak time using a standard Agnico Eagle gill net was 0.5, 0.1 and 0.01 for Lake Trout, Round Whitefish and Arctic Char, respectively. Lake Trout was the most frequently observed large-bodied species on underwater video recorded in Whale Tail Lake.

Electrofishing more than 3400 m of lake shoreline and pond habitat resulted in the capture of approximately 250 Ninespine Stickleback, 55 Slimy Sculpin, 2 juvenile Arctic Char and 3 juvenile salmonids, either Arctic Char or Lake Trout, which were not identified to species. Ninespine Stickleback was the most frequently observed small-bodied fish species on underwater video recorded in Whale Tail Lake.

No large-bodied fish were captured in Lake A45 or in Lake A113 and it is thought that none are present. Lake A45 is 2.9 ha in area and has a maximum depth of 4.5 m. There is no surface connection between Lake A45 and any other waterbody. No fish were captured in a 2 hour gill net set in Lake A45 in 2015 or in a 29.2 hour gill net set in 2016 using a standard Agnico index gill net gang comprised of 22.7 m long and 1.8 m deep panels of 126, 102, 76, 51, 38, and 25 mm stretched mesh (total gang length = 136.4 m). Lake A113 is 2.1 ha in area with a maximum depth of less than one metre and there is no defined channel connecting it to other waterbodies or watercourses downstream. There, no fish were captured in 3 panels of gill net (22.7 m long and 1.8 m deep panels of 38 mm, 51 mm and 76 mm mesh) set for 16.6 hours in 2015.

At least one large-bodied fish species was captured in eleven of the larger lakes, in addition to Whale Tail, Mammoth and Nemo and Ninespine Stickleback and Slimy Sculpin were also present in most of those. In three of the smaller waterbodies, only Ninespine Stickleback were captured. There were several isolated or nearly isolated small lakes and ponds in which no fish were captured. Most of these are located north of Whale Tail Lake.

All of the watercourses in the primary study area freeze during the winter. There are two broad categories of watercourses present. One type consists of connecting channels between larger lakes. These are generally wide and shallow with boulder and cobble substrate. Some of these connecting channels never have surface flow. Others have sufficient depth during spring freshet for adult large-bodied fish to pass through them but, as flow subsides, they become shallower and impassible to and unusable by large fish and, eventually, all of the flow is interstitial.

Based on the sampling conducted, there is little movement of large fish through the connecting channels that have sufficient depth to pass large fish during the spring. Hoop nets set in or immediately downstream from connecting channels in 2015 and 2016 during the freshet, when there was sufficient water present for large-bodied fish to move through the channels, did not capture any fish. Low numbers of juvenile Lake Trout and Round Whitefish, as well as Ninespine Stickleback and Slimy Sculpin, were captured by electrofishing in the connecting channels (Table A 2) before flow became totally interstitial.

The other type of watercourses present is small streams, most of which drain smaller catchments. These shallow streams often have multiple channels (i.e. are braided). The mean total wetted width of the Whale Tail Lake tributaries ranged from 0.7 m to 7.6 m and their mean depth ranged from 6 cm to 17 cm. Riffle and run habitat is dominant and there are few pools in these tributaries. Peat is the dominant substrate in most of these watercourses.

Electrofishing effort and catches in small streams in the primary study area during the 2015 and 2016 field seasons are summarized in Table A 3. Effort totalled 35,657 electroseconds and 6,330 m. Portions of the largest of these streams were fished on up to eight occasions. Ninespine Stickleback and Slimy Sculpin were the most widely distributed species in the Whale Tail Lake tributaries. Low numbers of juvenile Arctic Char were captured in five of the tributaries and juvenile Lake Trout were captured in two. Juvenile Burbot were captured in three tributaries and a juvenile Round Whitefish was captured in one.

One Lake Trout and one Arctic Char were captured in a hoop net set near the mouth of stream A55-A17 for 12 days in late June and early July of 2015. In the latter part of June and early July of 2016, gill nets were set across two of the smaller tributary streams to assess fish movement. A gill net set across stream A53-A17 near its mouth for a total 17 days caught one adult Arctic Char. A gill net set across stream A55-A17 near its mouth for a total of 16 days caught seven adult Arctic Char, five moving upstream and two moving downstream.

Table 1-2. Number of individuals of large-bodied fish species captured by gillnetting and the small-bodied fish species that were captured by electrofishing (X indicates that the species was captured) in the waterbodies that will be directly altered or have access affected during operations at the Whale Tail pit. Nemo Lake was not sampled for small-bodied fish.

Waterbody	Lake Trout	Arctic Char	Round Whitefish	Burbot	Ninespine Stickleback	Slimy Sculpin
A18	0	8	0	0	X	X
A19	0	2	0	1	X	X
A20	11	0	6	0		
A22	2	1	0	0	X	X
A45	0	0	0	0	X	
A47	0	1	0	0	X	
A49	3	0	0	0		X
A53	1	2	0	0	X	
A55	5	0	0	1		X
A62	3	0	0	0	X	
A63	1	0	0	0		X
A65	2	0	2	0	X	X
A113	0	0	0	0	X	
Mammoth Lake	49	0	20	0	X	X
Whale Tail Lake	34	2	5	0	X	X
Nemo Lake	22	0	0	0	ns	ns

SECTION 2 • HABITAT EVALUATION PROCEDURE

The habitat evaluation procedure (HEP) used to quantify habitat losses and offsets for Whale Tail Pit in this report is based on the procedure used for the 2012 NNL assessment for the Meadowbank Mine and incorporates refinements that have been introduced during subsequent work between 2014 and 2016 to develop offsetting measures for Vault and Phaser Lake. Various changes have also been incorporated as a result of DFO review of the conceptual (June 2016) and draft offsetting plans (June 2017) for Whale Tail Pit.

The HEP involves the classification of lake habitat into ten habitat types, based on depth and substrate. For the Whale Tail Pit HEP three additional habitat types have been incorporated to address connecting channels between lakes and small streams, as described in Section 2.1.1. Suitability of each habitat type is ranked between 0 and 1 for each of four life functions (spawning, nursery, foraging, overwintering) for each fish species that is (or is predicted to be) present. The area of each habitat type (in hectares) is multiplied by a habitat suitability index (HSI) and a series of weights (a species weight, a life-function weight and an access weight) and summed in order to derive a value in habitat units (HUs) that describes both the quality and quantity of habitat. These calculations are made for the pre-construction, or baseline, condition and for predicted conditions during the operations and post-closure phases of the project.

Net changes in HUs between phases depend on losses or gains in the area of each habitat types (1 - 13) that are present, and the suitability of each habitat type for each fish species. The HEP model is described in further detail below.

2.1 HEP MODEL

The HEP model used here can be described, for each fish species (spp 1-n) as:

$$\mathbf{HU}_{spp\ 1\text{-}n} = \sum_{HT\ 1\text{-}10} \left(\sum_{sp,nu,fo,ow}(\mathbf{HT}_{1\text{-}10} \times \mathbf{HSI}_{sp,nu,fo,ow} \times \textbf{life function weight} \times \textbf{species weight})\right]) \times \textbf{access factor} \times \textbf{habitat co-factor}$$

Where $HT_{1\text{-}10}$ = area (ha) of habitat types 1 through 10
$HSI_{sp,nu,fo,ow}$ = habitat suitability index for each life function:
sp = spawning use
nu = nursery use
fo = foraging use
ow = overwintering use

2.1.1 Habitat Type Area (HT_{1-13})

The foundation of the HEP is the delineation of areas that provide certain "habitat types" based on depth and substrate (Table 2-1). Habitat types 1 – 9 are lake habitats and were components of the original Meadowbank HEP model. These habitats are delineated by intersecting depth and substrate polygons.

Habitat Type 10 was added to the HEP model during the development of the Phaser Lake offsetting plan at the request of DFO to address uncertainty with respect to fish utilization of the deep pit areas. At that time, DFO indicated that the uncertainty arises primarily because there are "no examples of successful re-establishment of self-sustaining fish populations in refilled pits in Canada's North upon which to base end pit lake design" and there is a possibility that the deep areas of flooded pit may become meromictic (i.e. permanently stratified) and therefore be unsuitable for fish (DFO letter to Agnico Eagle dated November 27, 2015). DFO requested that the deep areas of the pit be designated Habitat Type 10 and that zero habitat value be assigned to those deep areas. An earlier conceptual offsetting plan was prepared for Whale Tail using that approach, in which the portion of the pit that is shallower than 22 m was assigned a habitat type based on its depth and it being coarse substrate and the portion deeper that 22 m was assigned Habitat Type 10. After reviewing that conceptual offsetting plan, DFO requested that, at Whale Tail, the entire pit area, regardless of depth and including the pit cap, be designated Habitat Type 10. This has been done for the calculations in this report.

Habitat Type 11 was initially used in the 2012 NNLP for the Meadowbank site to denote pit areas with some level of assigned habitat value. However in this offsetting plan for Whale Tail Pit, the designation HT11 was assigned to the connecting channels that occur between several of the lakes in the Whale Tail Pit study area. These channels are wide and have predominantly boulder and cobble substrates. They have shallow surface flow over most or all of their length during spring freshet and only interstitial flow over most or all of their length later in the open-water season. They freeze during the winter. The edge of the water in the connecting channels was observed in the field to correspond closely to the edge of the tundra vegetation. Therefore, these channels were delineated by digitizing the edge of the tundra vegetation in the July 21, 2011, satellite imagery. The upstream and downstream limits of the connecting channels are defined by the intersection of the upstream and downstream lake elevations with the DEM. When an area that is Type 11 habitat under baseline conditions is flooded during the operations or post-closure phases it becomes the lake habitat type with coarse substrate that corresponds to its new depth.

Habitat types 12 and 13 are also specific to this study and represent small streams with fine and coarse substrate respectively. These streams were characterized from field measurements made using a point-transect method during the period July 5 through July 8, 2016 (C. Portt and Associates, 2018). Many of these small streams have multiple channels and the width of each of the channels was measured at transects across the watercourses and those widths were summed to determine the total wetted width at a transect. To facilitate GIS analysis, the primary flow path of each of these streams was digitized based on the July 21, 2011, satellite imagery and a 'stream polygon' was created by assigning the total wetted width to the digitized flow path at each transect location. This allows the areas of stream habitat to be visualized and calculated during baseline and subsequent stages using standard GIS techniques. The portion of stream habitat that is fine substrate (Habitat Type 12) or coarse substrate (Habitat Type 13) was calculated by multiplying the stream polygon area by the proportion of the points where substrate was fine or coarse based on the field measurements. In the operations and post-closure phases, when Type 12 or 13 habitat was flooded due to increased water levels it was considered converted to lake habitat and the habitat type was assigned based on depth and substrate.

Table 2-1. Physical characteristics of the habitat types used in the Whale Tail Lake HEP. Note that habitat type 10 is applied to all non-backfilled pit areas, independent of depth and substrate characteristics.

Habitat Type	Depth Zone	Substrate
1	0-2 m	Fine
2	0-2 m	Mixed
3	0-2 m	Coarse
4	2-4 m	Fine
5	2-4 m	Mixed
6	2-4 m	Coarse
7	>4 m	Fine
8	>4 m	Mixed
9	>4 m	Coarse
10	Pit and pit cap*	Pit and pit cap*
11	connecting channels	Coarse
12	small streams	Fine
13	small streams	Coarse
* Depth and substrate in pit and pit cap areas are not relevant to suitability, which is assigned 0 value (see Section 2.1.2).		

In order to calculate the extents of each habitat type, bathymetry for each of the lakes was merged with the digital elevation model in GIS. Bathymetry for Whale Tail, Mammoth and Nemo Lakes was provided by Agnico. For the smaller lakes that were deep enough to operate a boat, bathymetry was determined using a Humminbird 798ci HD SI Sonar unit. The sonar unit recorded georeferenced standard and side-scan sonar data. Straight, parallel boat runs, orientated to best characterize the lake's features, were used to record slightly overlapping side-scan images of the lake bottom. Additional sonar recordings were then made to obtain standard sonar data for as much of the lake bottom as was practical. A stake was driven into the ground at the water's edge on the day that the Sonar data were collected and this elevation was later determined by a survey crew, so that the depth data could be converted to elevations and integrated with the digital elevation model. Visual point observations of the substrate were also made, either from the surface where the water was clear and shallow enough, or using an Aqua-Vu 740c underwater colour video system where the water was deeper. All visual substrate observations were georeferenced with a Garmin GPSmap76CSx gps unit.

The side-scan images were processed using ReefMaster software (ver. 1.8) to create a single georeferenced side-scan mosaic of the lake's bottom, and the standard sonar data were processed to create maps of bottom hardness and water depth. ReefMaster determines bottom hardness by analysis of the sonar output/input ratio, and lag, to calculate a unitless relative hardness and roughness value that is displayed as a colour-coded map. The georeferenced data (side-scan image, bottom hardness and water depth maps, and visual point observations) were layered using GIS software (QGIS version 2.8). In anticipation of the need to prepare substrate mapping, on September 2, 2014, oblique aerial photographs were taken, from a helicopter, of the shoreline and near-shore areas of Mammoth Lake, Whale Tail Lake, Nemo Lake and the adjacent smaller lakes and ponds. Additional oblique photographs were taken in June and August of 2016. Using the overlaid data, with reference to the oblique aerial photographs (n=229), the areas of the various substrate types were identified and hand digitized as polygons in GIS, creating substrate maps. With the exception of Nemo Lake this was done for each lake in its entirety. For Nemo Lake substrate mapping was only prepared in the area that would be impacted by the freshwater intake, as no other alterations of Nemo Lake are anticipated.

A few small, shallow ponds near the north end of Whale Tail Lake were too shallow to permit use of a boat and motor. The depths and substrates in these ponds were visually assessed from shore in 2015, and depth and substrate mapping was prepared based on those observations, aerial imagery, and the oblique aerial photographs taken in 2014 and 2015.

All habitat type area calculations and mapping were completed by Dougan and Associates using standard GIS methods consistent with mapping procedures used in AEM (2012) and Phaser Lake offsetting plan. The digital elevation model was used to determine depth and the depth information was overlain with the substrate layers, determined as decribed above, to delinate polygons with the characteristics of habitat types 1 through 9. The area of habitat types 1 – 9 was determined by summing the area of those polygons.

For the operations and post-closure phases, depths were determined using the water elevations proposed for each phase and the digital elevation model. The substrate under baseline conditions was left unchanged unless a physical change was made to the habitat (i.e. a dike was built or grid shoals were built). These alterations are described in the sections that describe the changes in habitat area during the operations and post-closure phases. If connecting channels were flooded so that they became lake habitat, their new habitat types was assigned based on their depth and their existing coarse substrate. If small streams were flooded so that they became lake habitat their new habitat type was based on depth and their existing substrate. The substrate for terrestrial areas that are flooded during operations or post-closure was assigned based on the ecological land classification community types, as shown in Table 2-2.

Table 2-2. Substrate category assigned to flooded terrestrial areas based on the terrestrial ecological land classification community types that are present under baseline conditions.

Substrate Category	ELC Community Type
Coarse	Boulder/gravel
	Lichen/rock
Fine	Graminoid tundra
	Wet graminoid
	Sand
Mixed	Graminoid/Shrub tundra
	Heath tundra
	Heath upland
	Heath upland/rock complex
	Lichen tundra
	Shrub tundra
	Shrub/heath tundra

2.1.2 Habitat Suitability Index ($HSI_{sp,nu,fo,ow}$)

The habitat suitability term represents the relative quality of each habitat type for each life function of each fish species present in the region. In the case of this HEP, the life functions spawning, nursery, foraging and overwintering were considered. Habitat suitability for each life function is indicated through a ranking of 0, 0.25, 0.5, 0.75 or 1. HSIs for all fish species[2] and habitat types used in this HEP are shown in Table 2-3. The HSIs for the lake habitats (habitat types 1 – 9) were developed through a series of consultations and workshops beginning in July 2011 with KivIA, HTO, and DFO in Baker Lake, and a series of workshops held with Golder Associates and DFO between November 2011 and December 2011 (by webex and in Ottawa). The process is further described in AEM (2012). Further review of the HEP by Dr. Ken Minns (August, 2017) recommended continued use of this method by Agnico Eagle. As stated previously, for the time being, it has been conservatively assumed that habitat type 10 will provide no fish habitat (i.e. all HSIs are zero) with the understanding that HSIs and the provision of habitat units will be re-evaluated if field investigations demonstrate that there is no stratification or that fish use the pelagic zone above a chemocline.

The HSIs for habitat types 11, 12, and 13 were assigned based on their habitat characteristics and the fish sampling conducted as part of the Whale Tail pit baseline

[2] Addresses, DFO 1- Freshwater Environment – Habitat Losses technical comment regarding consideration of all species, including bottom dwellers. Agnico Eagle (April, 2017). April 7th, 2017 submission NIRB File No. 16MN056 Application No: 124683/ NWB File No. 2AM WTP ---- : Receipt of Technical Review Comment Submissions for the NIRBs Review and NWB Consideration of Agnico Eagle Mines Ltd's " Whale Tail Pit" Project Proposal and associated Water License Application

investigations, taking into consideration the HSIs previously developed for lake habitats[3]. The connecting channels have primarily boulder and cobble substrate. There is shallow water above the substrate during the spring freshet in most of these channels but later in the summer there is only interstitial flow. No adult large-bodied fish have been observed or captured by electrofishing in these connecting channels and hoop nets set in or immediately downstream from these connecting channels in 2015 and 2016 captured no fish. A single Arctic Char was captured in a gill net set across the connecting channel between Lake A18 and Whale Tail Lake from June 22 – 28, 2016 and July 2-8, 2016. Based on these data, these connecting channels do not provide foraging habitat for large-bodied fish (foraging HSI = 0). Juvenile Lake Trout and juvenile Lake Whitefish have been captured by electrofishing in the connecting channels and it has been assumed that juvenile Arctic Char and juvenile Burbot can also use this habitat during the open-water season. Therefore, for all large-bodied species the connecting channels have been assigned the same nursery HSIs as coarse substrate in the 0 – 2 m lake depth stratum. The connecting channels freeze during the winter and therefore have been assigned HSIs of zero for overwintering for all species and zero for spawning for fall/winter-spawning species, which includes all of the large-bodied species that are present.

Slimy Sculpin and Ninespine Stickleback, the two small-bodied species that are present in the study area, have both been captured in the connecting channels and are likely to use the shallow areas and interstitial spaces in much the same way that they do in shallow areas with coarse substrate in lake habitats. Therefore, for these two species the HSIs for coarse substrate in the 0 – 2 m deep stratum has also been used for the connecting channels.

The dimensions of the small streams in the Whale Tail Pit primary study area are summarized in Appendix A, Table A 4. These streams typically have multiple channels and are shallow, with mean depths ranging from 6 cm to 17 cm. Peat is the dominant substrate in the majority of the watercourses and only watercourse A55-A17 is dominated by coarse substrates. These watercourses freeze in the winter and have been assigned HSIs of zero for overwintering for all species and zero for spawning for fall/winter-spawning species, which includes all of the large-bodied species that are present.

Electrofishing catches in these streams were dominated by Ninespine Stickleback and Slimy Sculpin and for these two species the HSIs for fine and for coarse substrates in the 0 – 2 m lake depth habitat (Habitat Types 1 and 3 respectively) were applied to Habitat Types 12 and 13 for spawning, nursery and foraging.

One or more juveniles of all of the large-bodied species were captured in the small streams, although the numbers were low. The nursery HSIs for fine and for coarse substrates in the 0

---

[3] The stream habitat types were developed in response to DFO 4 and 8 Information Request. Agnico Eagle (January, 2017). DFO- 4 and 8 – Freshwater Environment- Habitat Alteration. January 20th, 2017 submission RE: NIRB File No 16MN056 Application No: 124683/NWB File No. 2AM WTP ----: Information Requests Received from Parties Regarding Agnico Eagles Mines Ltd's "Whale Tail Pit" Project.

– 2 m lake depth habitat (Habitat Types 1 and 3 respectively) have been applied to Habitat Types 12 and 13 for the four large-bodied species.

The absence of adult large-bodied fish from the electrofishing catches in the small streams is consistent with them being so shallow, and confirms that, as would be expected, there is little if any foraging in these streams by adults of the large-bodied species. It is thought that the few individuals that were captured in gill nets or hoop nets set in these streams were moving between lake habitats. The small streams have been assigned a HSI of zero (0) for foraging by the four large-bodied species.

Table 2-3. HSI values for the Whale Tail fish species (sp=spawning, nu=nursery, fo=foraging, ow=overwintering). *Habitat type 10 is applied to all pit and pit cap areas regardless of depth and substrate.

Habitat Type	Depth	Substrate	Arctic Char				Lake Trout				Round Whitefish			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0.25	0.25	0	0	0.25	0.75	0
2	<2 m	Mixed	0	0.25	0.25	0	0	0.5	0.5	0	0	0.75	0.5	0
3	<2 m	Coarse	0	0.5	0.5	0	0	1	0.75	0	0	0.75	0.5	0
4	2-4 m	Fines	0	0.5	0.5	0.75	0	0.5	0.5	0.75	0	0.25	1	0.75
5	2-4 m	Mixed	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75	0.5	0.75	0.75	0.75
6	2-4 m	Coarse	1	1	1	0.75	1	1	1	0.75	1	1	0.75	0.75
7	>4 m	Fines	0	0.25	0.5	1	0	0.25	0.5	1	0	0.25	1	1
8	>4 m	Mixed	0.5	0.5	0.75	1	0.5	0.5	0.75	1	0.25	0.25	0.5	1
9	>4 m	Coarse	1	0.5	1	1	1	0.5	1	1	0.75	0.5	0.5	1
10*	pit area	pit area	0	0	0	0	0	0	0	0	0	0	0	0
11	connecting channel	Coarse	0	0.5	0	0	0	1	0	0	0	0.75	0	0
12	stream	Fines	0	0.25	0	0	0	0.25	0	0	0	0.25	0	0
13	stream	Coarse	0	0.5	0	0	0	1	0	0	0	0.75	0	0

Habitat Type	Depth	Substrate	Burbot				Slimy Sculpin				Ninespine Stickleback			
			SP	NU	FO	OW	SP	NU	FO	OW	SP	NU	FO	OW
1	<2 m	Fines	0	0.25	0.25	0	0	0	0.25	0	1	1	1	0
2	<2 m	Mixed	0	0.75	0.5	0	0.25	0.25	0.5	0	0.5	0.5	0.75	0
3	<2 m	Coarse	0	1	0.5	0	1	1	1	0	0	0.25	0.75	0
4	2-4 m	Fines	0	0.25	0.25	0.75	0	0	0.25	0.75	0	0	0.5	0.75
5	2-4 m	Mixed	1	0.5	0.75	0.75	0.25	0.25	0.5	0.75	0	0	0.25	0.75
6	2-4 m	Coarse	0.75	0.5	1	0.75	0.75	0.75	1	0.75	0	0	0.25	0.75
7	>4 m	Fines	0	0	0.25	1	0	0	0	1	0	0	0	1
8	>4 m	Mixed	1	0	0.75	1	0	0	0.25	1	0	0	0	1
9	>4 m	Coarse	0.75	0.25	1	1	0.5	0.5	0.5	1	0	0	0	1
10	pit area	pit area	0	0	0	0	0	0	0	1	0	0	0	0
11	11	connecting channel	0	1	0	0	1	1	1	0	0	0.25	0.75	0
12	12	stream	0	0.25	0	0	0	0	0.25	0	1	1	1	0
13	13	stream	0	1	0	0	1	1	1	0	0	0.25	0.75	0

2.1.3 Life Function Weight

This HEP values all life functions equally, with a weight of 0.25 each assigned for spawning, nursery, foraging and overwintering.

2.1.4 Species Weight

The overall species weights used in the HEP method sum to 1 across species. The species weights for various Meadowbank offsetting plans are comprised of a biomass weighting and a fishery value weighting:

Species weight = (biomass weight/2) x (fishery weight/2)

In the conceptual Whale Tail pit offsetting plan (Agnico, 2016) the biomass weight was based on the relative biomass of the species determined during fish-outs of Meadowbank site lakes that have been drained, with one percent allocated to each of slimy sculpin and ninespine stickleback, as they are not susceptible to the gill nets used in the fish-outs. Also, in the conceptual Whale Tail pit offsetting plan (Agnico, 2016) a modification of this approach was proposed that included an aboriginal fishery value which would be determined through community consultations (as requested by DFO for the updated Vault Lake no net loss plan; February, 2016). However in subsequent discussions, DFO has indicated a preference for all species to be weighted equally[4]. Therefore, each of the six species that are present in the study area has a weight of 0.165 in the calculations presented in this document.

2.1.5 Access Factor

In a workshop conducted in February, 2012 (The Basic Concepts of No Net Loss Accounting - February, 2012) Dr. Charles K. Minns suggested the use of an access factor when fish assemblages are expected to change in the offsetting scenario. According to this concept, the access factor is 1 for any species present in the habitat area, and 0 for any species not present (Table 2-4). Each species receives an access factor in both the loss and gain calculations. Therefore, the opening of access to a habitat area for a species (that did not have access previously), results in an increase of habitat units. Similarly, the loss of access results in a loss of habitat units. These gains or losses may be complete (i.e. affect all species), or partial (only some species are affected). The presence or absence of a species in loss calculations is typically based on the observed presence/absence of each

---

[4] Agnico Eagle (January, 2017). KivIA – IR – Aquatic- Final fish habitat offsetting plan. January 20th, 2017 submission RE: NIRB File No 16MN056 Application No: 124683/NWB File No. 2AM WTP ----: Information Requests Received from Parties Regarding Agnico Eagles Mines Ltd's "Whale Tail Pit" Project. &

Agnico Eagle (April, 2017). DFO 5- Freshwater Environment – Changes to Lake Ecosystem Productivity. April 7th, 2017 submission NIRB File No. 16MN056 Application No: 124683/ NWB File No. 2AM WTP ---- : Receipt of Technical Review Comment Submissions for the NIRBs Review and NWB Consideration of Agnico Eagle Mines Ltd's " Whale Tail Pit" Project Proposal and associated Water License Application species during baseline monitoring studies (AEM, 2012, 2013, 2016). If a change in access is predicted for an offset scenario (i.e. due to the removal of a barrier to fish movement) the change would need to be confirmed as part of compensation monitoring.

Table 2-4. Access factor theoretically applied to each species for habitat loss and gain calculations, based on presence/absence (or anticipated presence/absence, for offsetting projects).

Scenario	Access Factor	
	Losses	Gains
Species Present	1	1
Species Not Present	0	0

Typically, the access factors applied are based on the observed presence/absence of each species during baseline monitoring studies (AEM, 2012, 2013, 2016). For the calculations in this report, an access factor of 1 has been applied for all six fish species that have been captured in the study area. The effect of isolating the north-east pond during operations has been addressed by conservatively estimating that habitat is temporarily 'lost' during that time period, but re-gained during post-closure.

2.1.6 Habitat Co-factor

The habitat co-factor represents any changes to non-mapped habitat quality (thermal, hydrological, biological or chemical regimes) that will occur as a result of impacts or offsetting. The use of this factor is suggested by Dr. Ken Minns, and his suggested values as presented in a workshop for DFO in February, 2012 are shown in Table 2-5. No habitat co-factor has been applied to the HEP calculations presented in this report

Table 2-5. Habitat co-factor for various pre- and post-compensation scenarios, according to Minns, 2012.

Change in regime	Description	Baseline conditions factor	Post-closure factor
Degradation (expected)	Thermal, hydrologic, chemical and/or biological regime shifts away from preferred state for fish habitat	1	> 0 and < 1
No change	-	1	1
Enhancement (anticipated or proposed)	Thermal, hydrologic, chemical and/or biological regime expected to shift towards preferred state for fish habitat	> 0 and < 1	1

SECTION 3 • HABITAT LOSSES

In order to mine Whale Tail Pit, a series of three dewatering dikes will be constructed to isolate the pit area. The area within those dikes will be dewatered to allow mining to occur (operations phase). When mining is completed, the dikes will be breached, allowing the pit and adjacent lake basin area to flood and water elevations to return to baseline conditions (post-closure phase). Site infrastructure during these operations and post-closure phases is shown in Figure 3-1 and Figure 3-2.

This section describes calculation of habitat losses occurring as a result of mining activities during both the operations and post-closure phases, compared to baseline conditions. Extents of losses and gains were calculated for all impacted areas using the HEP described in Section 2. However, since flooding of terrestrial zones is only planned to occur over a 4-7 year period prior to drawdown, fish habitat availability during the operations phase is conservatively not considered a habitat offset, and calculations were performed for reference only. In the final net change calculation, only differences between baseline and post-closure conditions are compared.

3.1 BASELINE CONDITIONS

3.1.1 Site Description

Baseline site conditions are described in Section 1.

3.1.2 Habitat Units Calculation

As calculated using the HEP described in Section 2, depth zones, substrate types (fines, mixed, coarse), and habitat types under baseline conditions throughout the primary study area are shown in Figure 3.3, 3.4 and 3.5, respectively.

Net change in habitat units between the baseline, operations, and post-closure scenarios are detailed in Sections 3.2 and 3.3, below

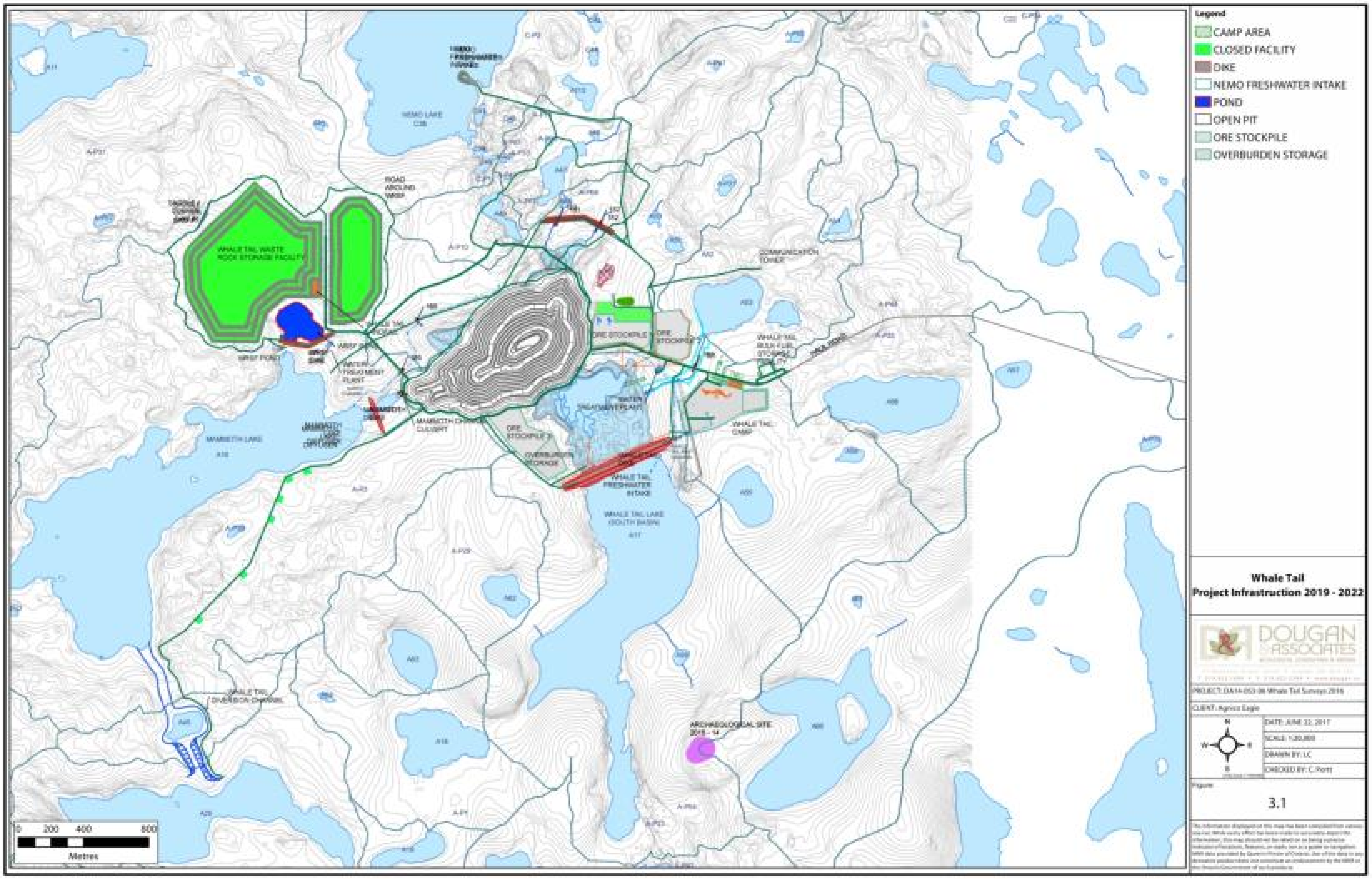

Figure 3-1. Whale Tail Project infrastructure during operations, 2019 to 2022 (does not show flooding that will occur in Whale Tail Lake – South Basin).

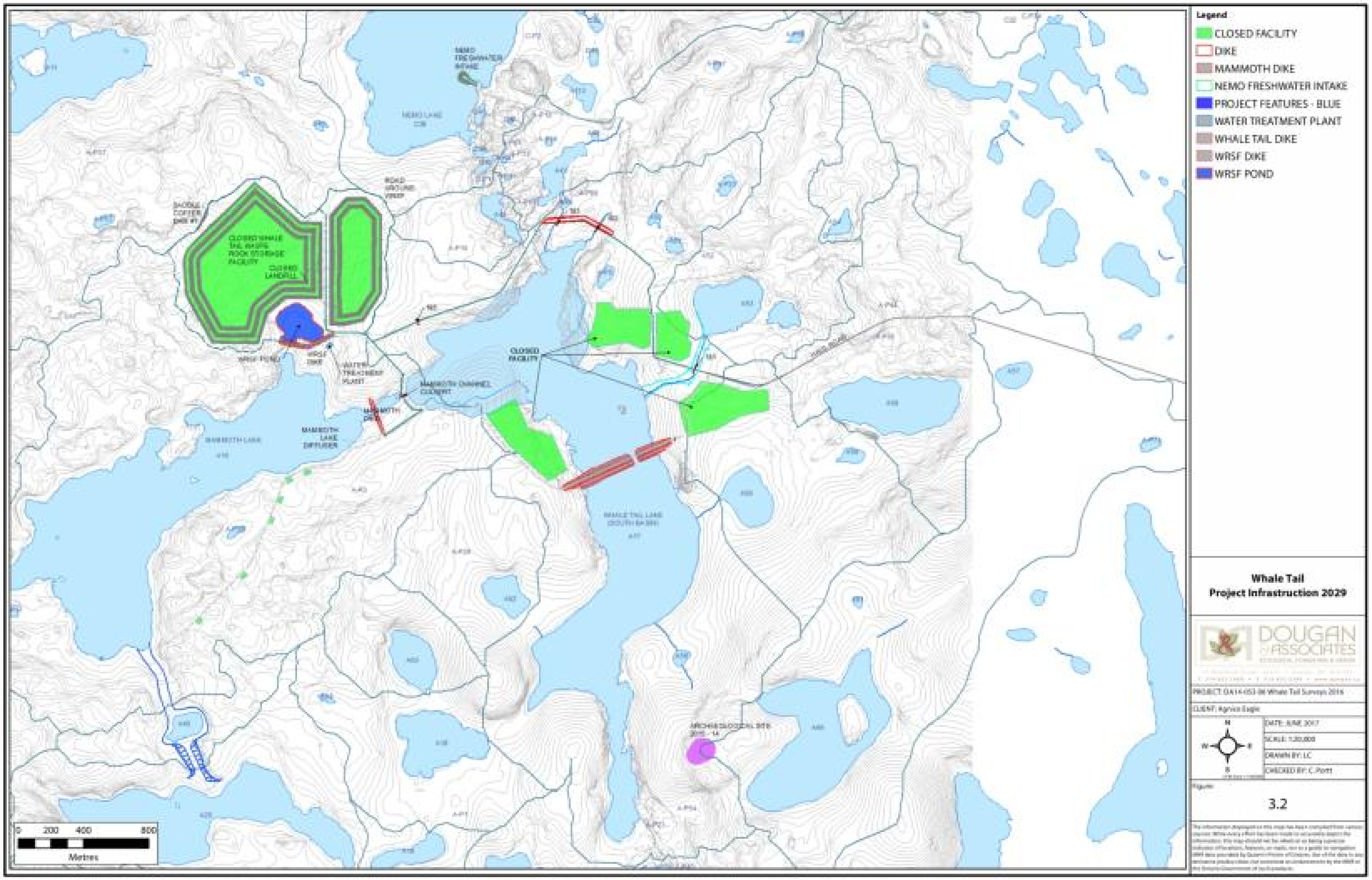

Figure 3-2. Whale Tail Project Infrastructure 2029 (post-closure phase).

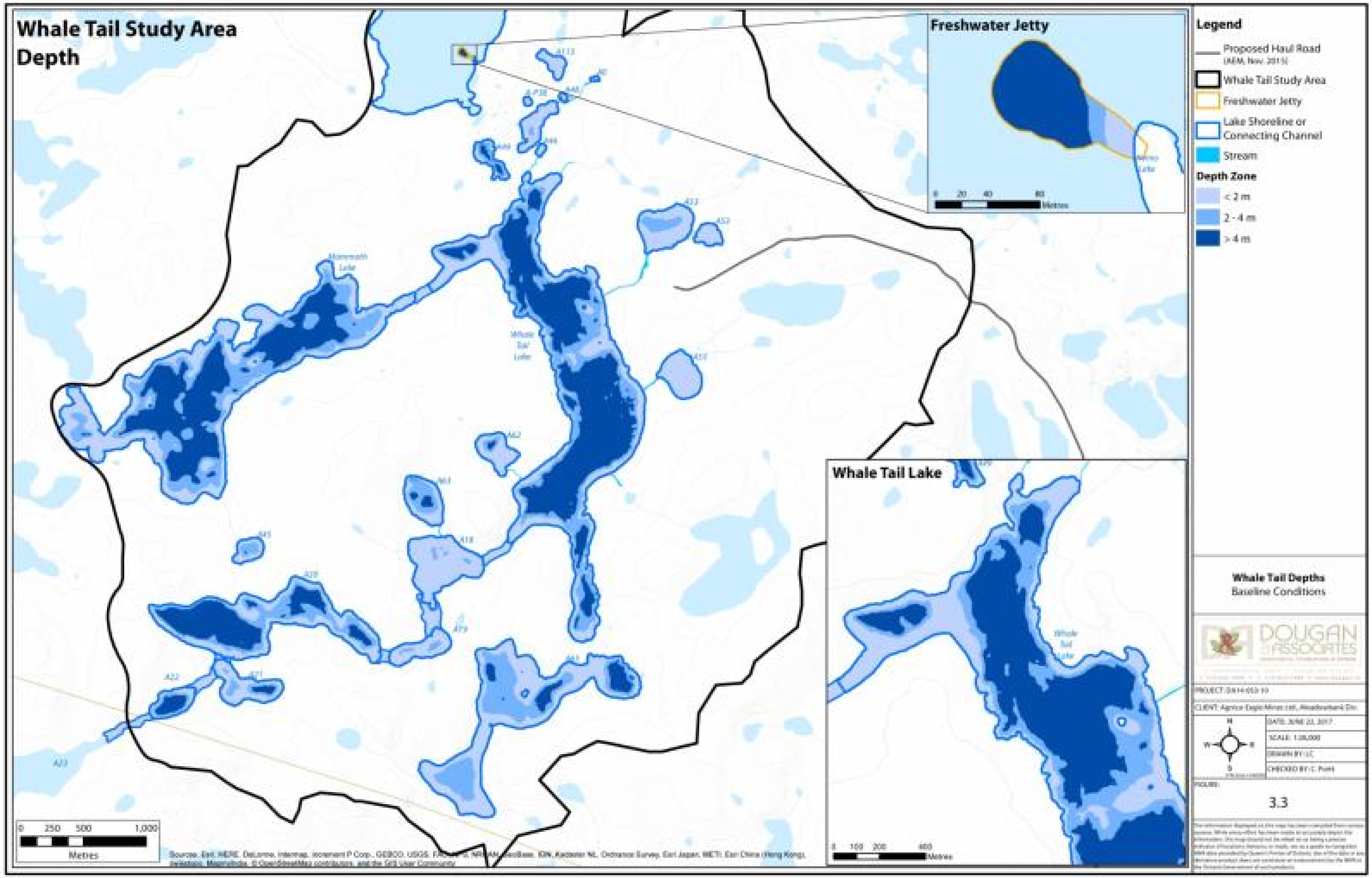

Figure 3-3. Whale Tail pit lake study area depths under baseline conditions.

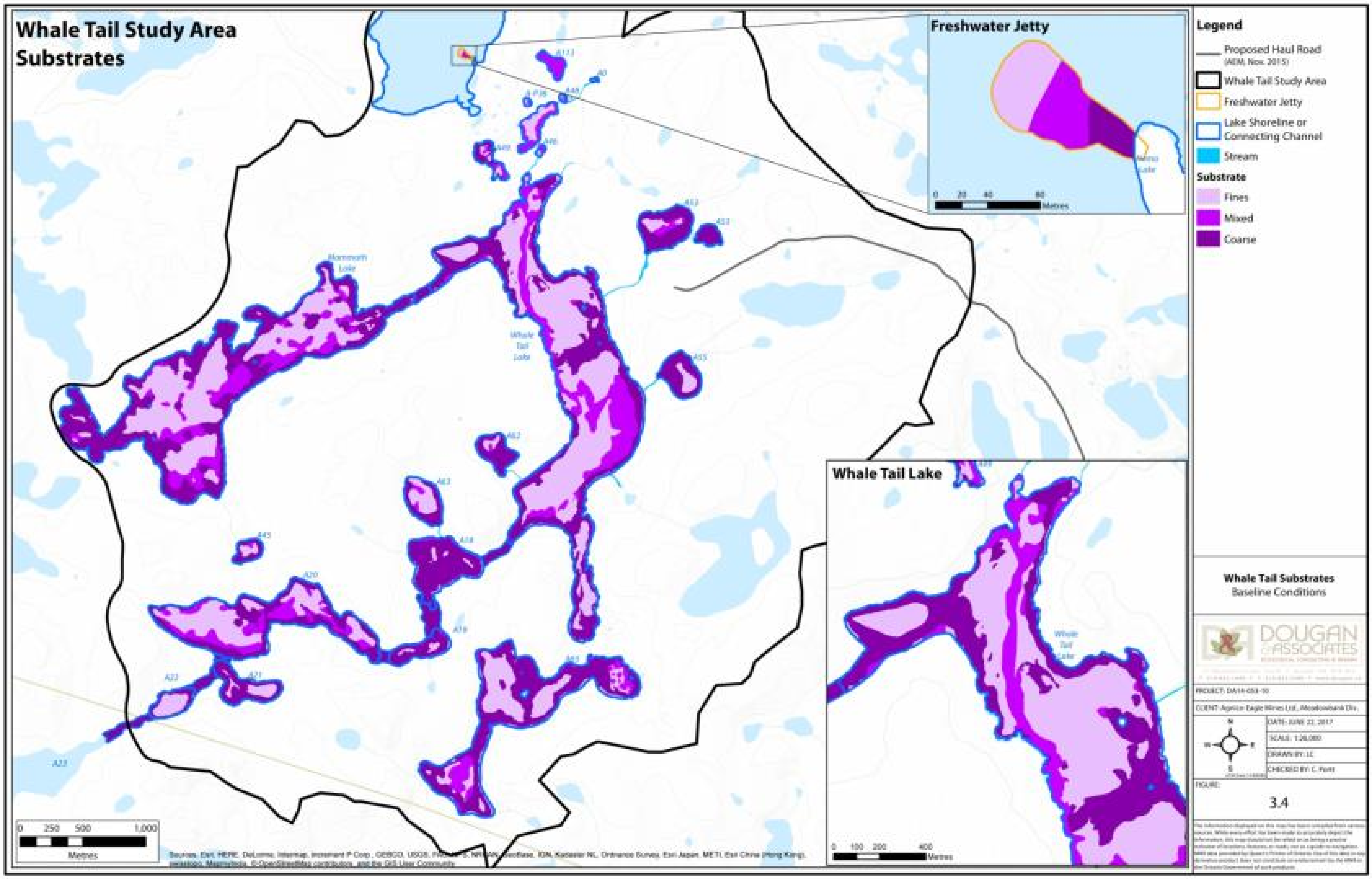

Figure 3-4. Whale Tail pit study area substrates under baseline conditions.

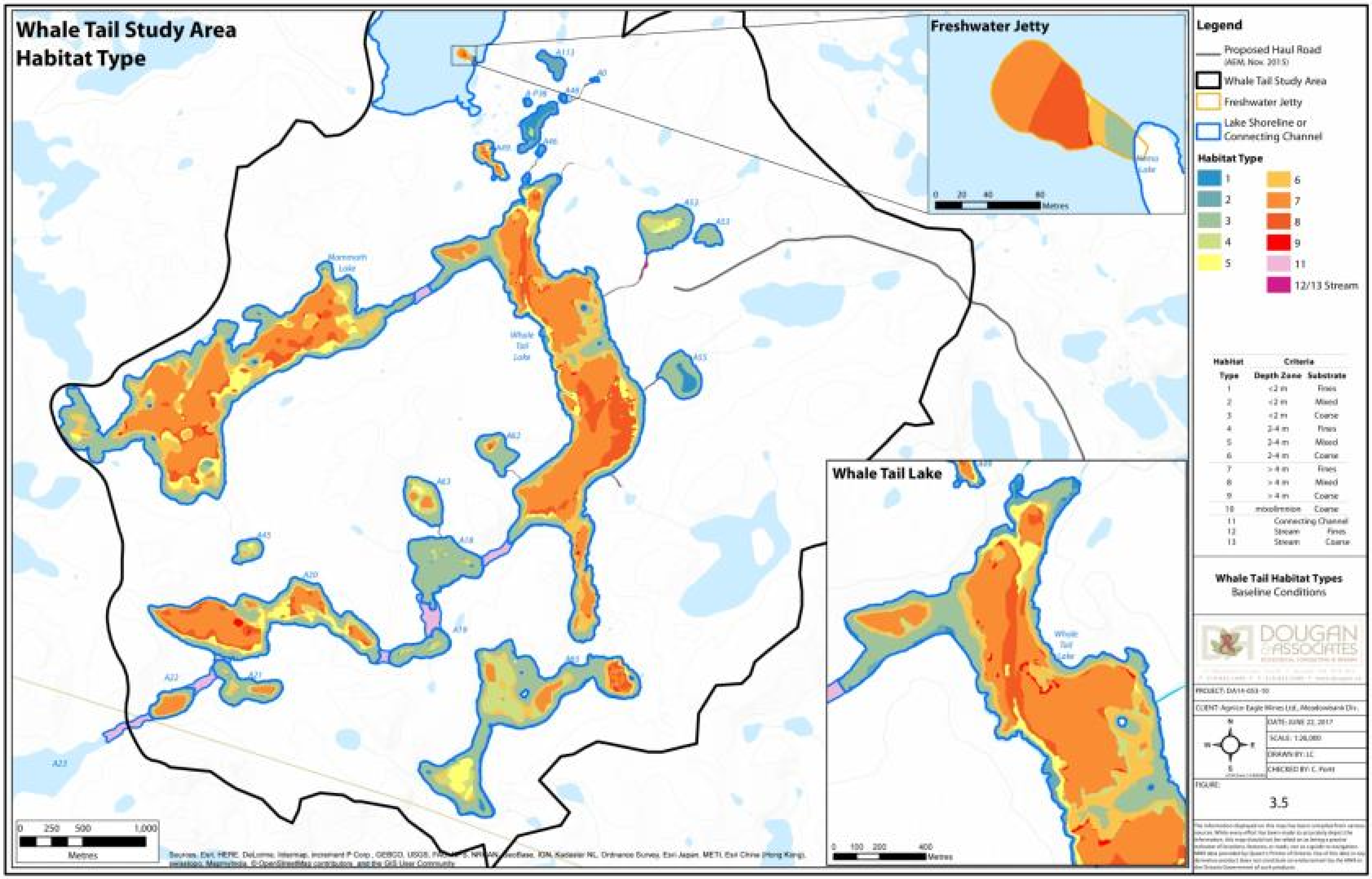

Figure 3-5. Whale Tail pit study area habitat types under baseline conditions.

3.2 OPERATIONS PHASE

3.2.1 Site Description

The area to be enclosed by dikes and dewatered during mine operations includes the northern basin of Whale Tail Lake and a small portion at the east end of Mammoth Lake, as well as the connecting channel between those two lakes. The exterior surface of the dikes will be coarse substrate.

An area to the north of Whale Tail Lake, that includes a number of small lakes and ponds which currently drain to Whale Tail Lake, would be isolated by the north dike. In this area, referred to as the north-east pond, the water level would rise to 156.47 masl, resulting in the flooding of some terrestrial areas. This area would drain to Nemo Lake. For the purposes of offset planning, it has been assumed that fish from Nemo Lake would not have access to the north-east pond and therefore it will be completely isolated. It has also been assumed that, due to the limited amount of deep habitat in the north-east pond, fish might not survive the winter there. Therefore the habitat present in the area occupied by north-east pond under baseline conditions is assumed to be ‘lost’ during the operations phase. If monitoring determines that fish survive there, an operations phase offsetting credit could be calculated.

The Whale Tail Dike will bisect Whale Tail Lake into north and south basins. South of the Whale Tail Dike the water level will rise from 153.02 (baseline; see Section 1.3) to 156 masl during operations. This will result in the flooding of terrestrial areas, so that a number of lakes now connected to each other or to Whale Tail Lake (South Basin) by connecting channels (lakes A18, A19, A20, A21 and A22) or small streams (lakes A55, A62, A63), or have no surface connection to Whale Tail Lake (lake A65), would become contiguous. This larger contiguous waterbody is referred to as the Whale Tail Lake (South Basin) and is an *expanded Whale Tail Lake*; fish salvaged during the fishout of Whale Tail Lake (North Basin) will be transferred to the Whale Tail Lake (South Basin) (Agnico Eagle, 2017a). The Whale Tail Lake (South Basin) will drain to Lake A45 via a constructed channel and Lake A45 will drain to Mammoth Lake via an existing boulder feature. The boulder feature between Lake A45 and Mammoth Lake does not exhibit surface flow under existing conditions, even during spring freshet. It has not yet been determined if it will be necessary to modify that connection, but for the purposes of the habitat calculations it has not been assigned any fish habitat value during any phase of the project.

Lake A53, east of Whale Tail Lake, currently drains to the portion of Whale Tail Lake that would be dewatered via a small stream. A new watercourse will be constructed to convey this flow to the south basin of Whale Tail Lake. The lower reach of the existing watercourse will be eliminated. The proposed route of this realignment is shown in Figure 3-1. It has been assumed that the width and the proportions of fine and coarse substrates of the realigned portion will be the same as those of the existing watercourse.

There will be a reduction in the flow to Mammoth Lake and downstream during the period when the expanded Whale Tail Lake is filling, before flow via Lake A45 occurs. Flow into Mammoth Lake approaches zero during the latter part of the ice-free season under baseline conditions. During the period when the expanded Whale Tail Lake is filling, the water level in Mammoth Lake is expected to be at or near what is its minimum elevation under baseline conditions. This will occur again during closure when the pit is refilling. This temporary condition has not been incorporated into the HEP calculations.

In addition to the alterations within the Whale Tail Lake and Mammoth Lake drainages, a water intake jetty would be constructed in Nemo Lake that will result in a change in depth and substrate, including an area that will be raised so that it is above the water surface and no longer fish habitat. The jetty will have coarse substrate.

3.2.2 Habitat Units Calculation

Changes in habitat area and habitat units between the baseline conditions and the operations phase as calculated using the HEP described in Section 2 are provided for each habitat type in Appendix B, Table B-1. At the request of DFO, the locations and areas of habitat losses and gains and habitat modified are presented in Appendix B, Table B-2. Change in habitat for each lake/stream system are provided in Appendix B, Table B-3. Overall, there is a 49.24 ha increase in the area of fish habitat and a 42.93 increase in the number of habitat units during operations.

As indicated previously, for the operations phase, the extent of flooding and the depths were calculated based on an elevation of 156 masl elevation for the expanded Whale Tail Lake and no change from baseline conditions to the elevation of Mammoth Lake. The dike side slopes and the freshwater jetty in Nemo Lake will have coarse substrate. The constructed channel connecting the expanded Whale Tail Lake to Lake A45 will be less than 2 m deep and have coarse substrate. It has been assumed that the connection between Lake A45 and Mammoth Lake will continue to be subsurface/interstitial during operations and that it will not provide fish habitat. The depth zones, substrate types (fines, mixed, coarse) and habitat types for the operations phase are shown in Figure 3.6, 3.7 and 3.8 respectively

There are relatively small decreases in the habitat area and habitat units in Nemo Lake as a result of the construction of the freshwater intake jetty. The area of Mammoth Lake is decreased due to the construction of the Mammoth dike and the dewatering of the portion of Mammoth Lake that is east of that dike, resulting in a concomitant number of habitat units.

The expanded Whale Tail Lake during operations (407.3 ha) includes the portion of Whale Tail Lake that is not dewatered or covered by the Whale Tail dike (plus the other existing lakes, connecting channels and streams that are within the flooded area (280.0 ha), land that is flooded (127.4 ha), and the portion of the south side of the Whale Tail dike that is below the water (0.4 ha). The total area of habitat lost, including the habitat that is isolated in the north-east pond, is 73.7 ha. In addition to the increase in habitat area, during the operations phase the habitat value increases in some of the existing habitats where depth increases, contributing to the overall increase in habitat units.

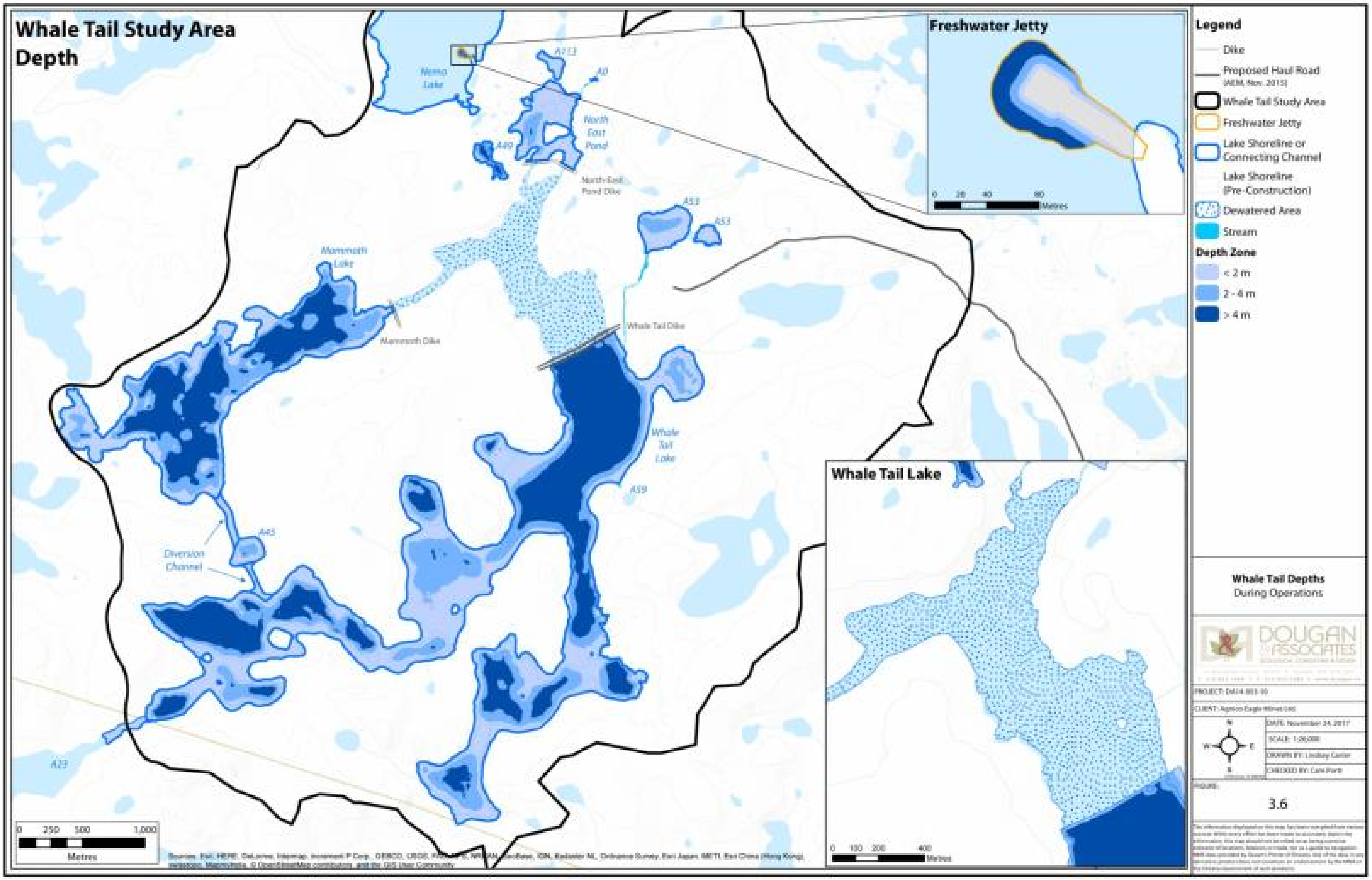

Figure 3-6. Whale Tail Pit study area depths during operations.

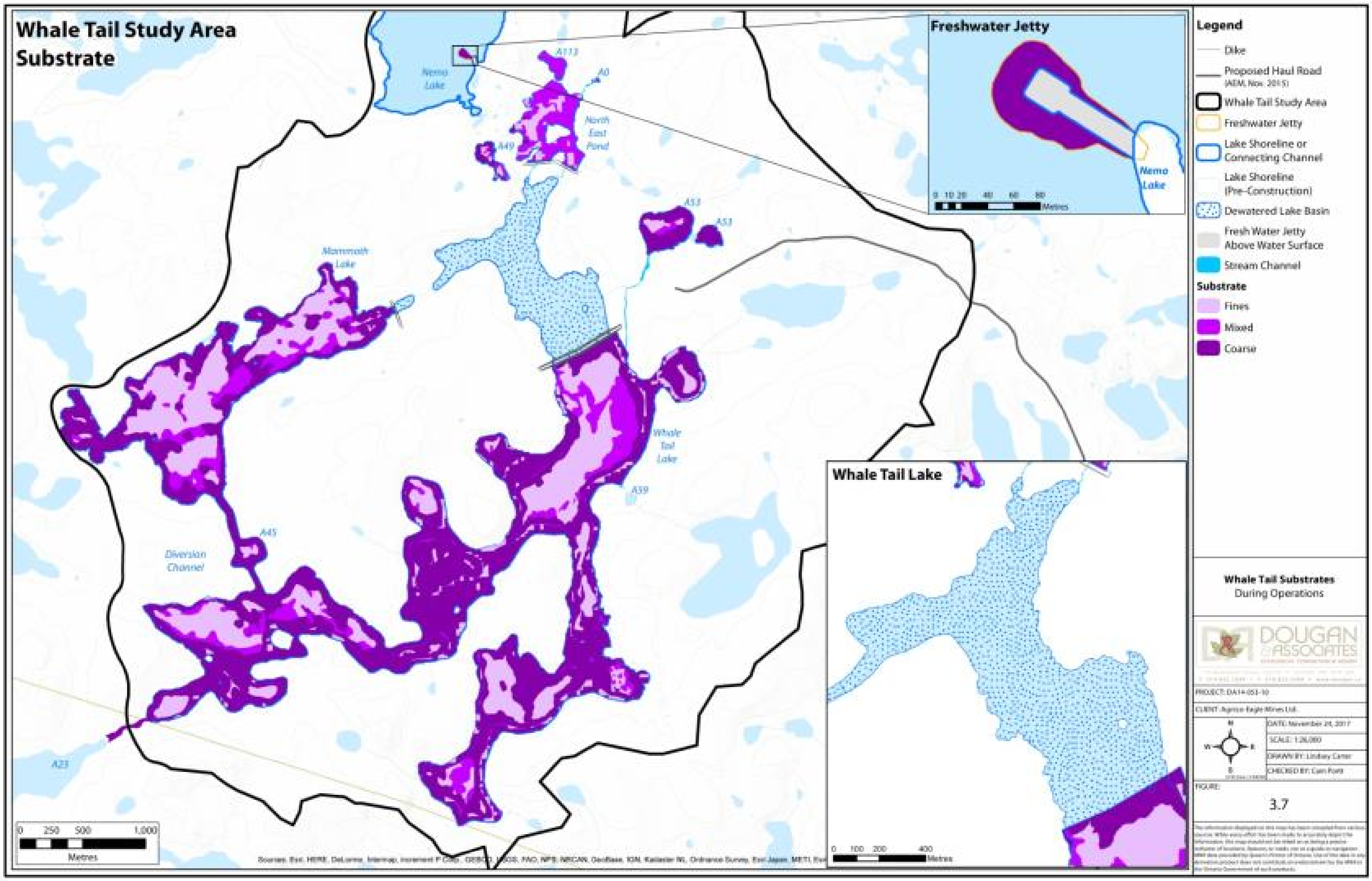

Figure 3-7. Whale Tail pit study area substrates during operations.

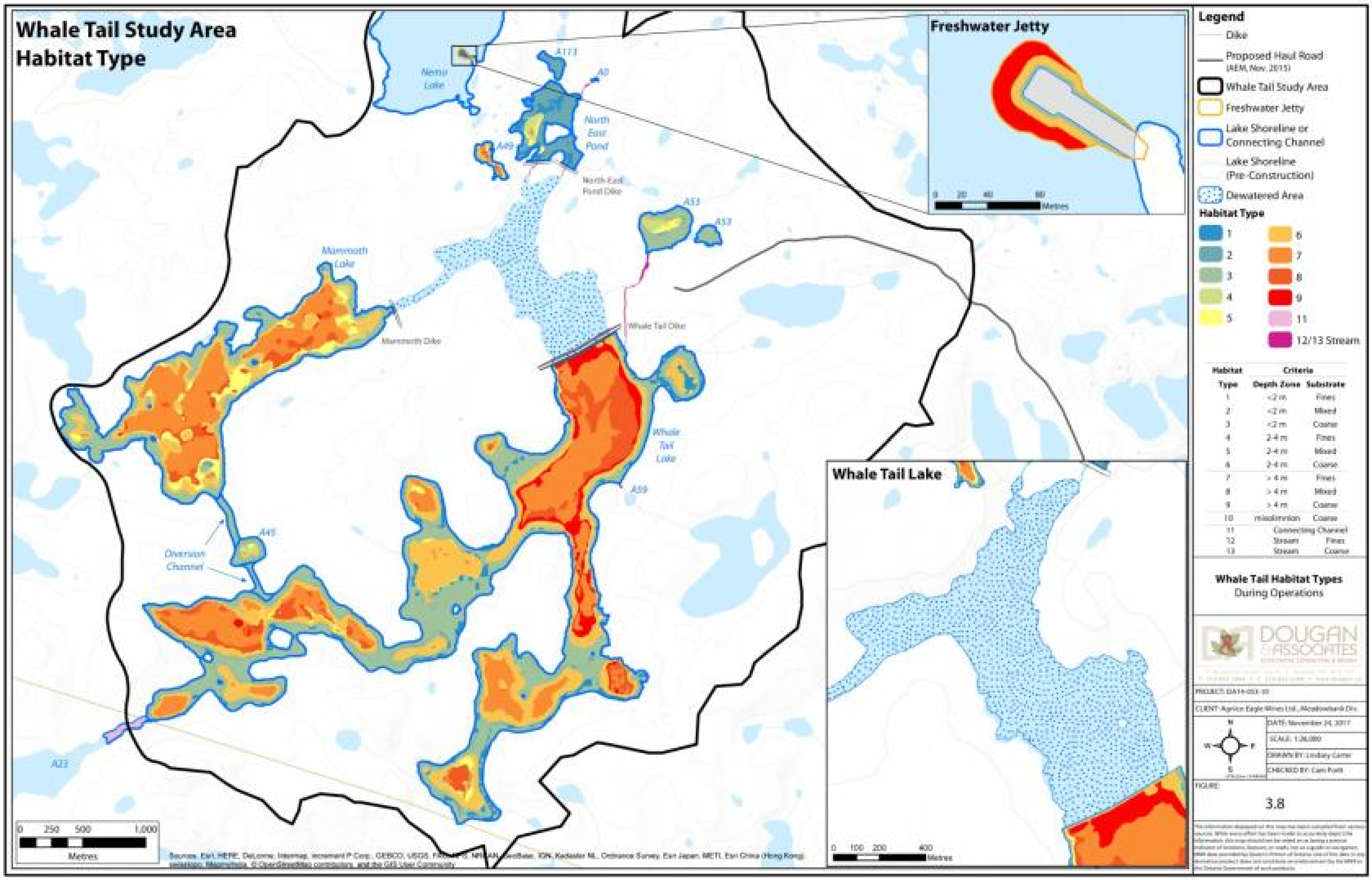

Figure 3-8. Whale Tail pit habitat types during operations.

3.3 POST-CLOSURE PHASE

3.3.1 Site Description

Consistent with approved closure plans reviewed during the NWB/ NIRB review, based on current water quality predictions and on the current mine plan for Whale Tail Pit, it is assumed that dewatering dikes would be breached and water levels would return to pre-mine elevations following mine closure by 2029 (refer to Figure 3-2). Therefore, aquatic habitats would revert to their pre-mine condition with the following exceptions:

1. The area of Whale Tail Lake will be increased by 26.17 ha as a consequence of terrestrial areas being excavated and becoming part of the flooded pit and pit cap, post-closure. This area has also been assigned Habitat Type 10.

2. The Whale Tail Dike that bisects Whale Tail Lake will be breached but not removed following mine closure. Therefore it will continue to occupy a portion of what was previously Whale Tail Lake and a portion of it will be above the water. For the purposes of habitat calculations, it has been assumed that a 100 m wide breach will be created in the Whale Tail Dike. This area has been assigned Habitat Type 3..

3. The Mammoth Dike that isolates the eastern end of Mammoth Lake will be reduced in height, so that it becomes shallow lake habitat with coarse substrate (Type 3 habitat).

4. The North-east Dike will be breached at the locations where two small watercourses existed pre-construction, so that the watercourses are re-established and the lakes and ponds are reconnected to Whale Tail Lake through the approved access road culverts.

5. The portion of the watercourse connecting Lake A53 to Whale Tail Lake that was re-aligned will be returned to its former channel.

6. Roads that are flooded post-operations will remain in their operations phase condition and have mixed substrate.

7. A jetty to the attenuation pond that is in the dewatered area during operations will remain in its operations phase condition and have coarse substrate.

8. The jetty for the freshwater intake in Nemo Lake will remain in its operations phase condition.

3.3.1 Habitat Units Calculation

Net changes in habitat area (ha) and habitat units (HUs) between the baseline and the post-closure phase, without offsetting (i.e. habitat losses), are summarized in Table 3-1 for each habitat type. The locations (lakes/steams) and areas of habitat losses and gains and habitat modified are presented in Appendix B, Tables B-4 and B-5.

Depth zones, substrate types (fines, mixed, coarse), and habitat types following closure and reflooding of the pit, in the absence of any measures to offset for harm to fish habitat, are shown in Figures 3.9, Figure 3.10 and 3.11 respectively. For these calculations it was assumed that the elevations of all lakes would revert to their pre-construction levels. It was also assumed that substrate within the area that was dewatered did not change from pre-construction conditions unless it was excavated as part of the pit or the pit cap (where substrate is irrelevant because these areas are assigned Habitat Type 10), or covered by infrastructure (dikes, roads, jetties).

There is the same small reduction in both habitat area and habitat units in Nemo Lake as during operations, due to the construction of the freshwater jetty which will remain in place post-closure. There is no reduction in either the habitat area or the habitat units in Mammoth Lake because the Mammoth Dike is lowered and is coarse substrate, thus becoming Type 3 habitat.

Post-closure, 27.9 ha of habitat is added to Whale Tail Lake due to the excavation of the pit. This includes 27.4 ha that was terrestrial habitat under existing conditions; the remainder was part of the connecting channel between Whale Tail and Mammoth Lakes. There is a loss of 1.7 ha from Whale Tail Lake because part of the Whale Tail dike remains above the water and another 0.1 ha is lost because a portion of the water attenuation pond ramp remains above the water. The result is a net increase of 26.2 ha in the area of Whale Tail Lake.

Although the area of Whale Tail Lake increases, the number of habitat units in Whale Tail Lake decreases by 14.2. This reduction is largely because the pit and pit cap occupy 30.3 ha that were part of Whale Tail Lake under baseline conditions. Post-closure, this area is assigned habitat type 10, which has been assigned zero fish habitat value.

The net change between baseline and post-closure conditions, or overall project related fish habitat losses in the absence of offsetting, is a loss of 14.5 habitat units.

Table 3-1. Net change in fish habitat during the post-closure phase, without offsetting (losses).

Habitat Type	Hectares			HUs		
	Baseline	Post-closure - no offsetting	Net Change	Baseline	Post-closure - no offsetting	Net Change
1	1.58	1.26	-0.32	0.38	0.30	-0.08
2	4.60	4.55	-0.05	1.29	1.28	-0.01
3	81.42	71.44	-9.99	32.23	28.28	-3.95
4	11.30	10.11	-1.19	4.24	3.79	-0.45
5	15.87	14.89	-0.98	9.26	8.68	-0.57
6	41.71	37.90	-3.82	31.72	28.82	-2.90
7	128.36	114.45	-13.91	48.14	42.92	-5.22
8	30.87	28.77	-2.10	16.08	14.99	-1.09
9	3.76	3.79	0.03	2.54	2.57	0.02
10	0.00	58.30	58.30	0.00	0.00	0.00
11	2.15	1.50	-0.65	0.65	0.45	-0.20
12	0.58	0.58	0.00	0.10	0.10	0.00
13	0.18	0.18	0.00	0.05	0.05	0.00
Total			**25.33**			**-14.45**

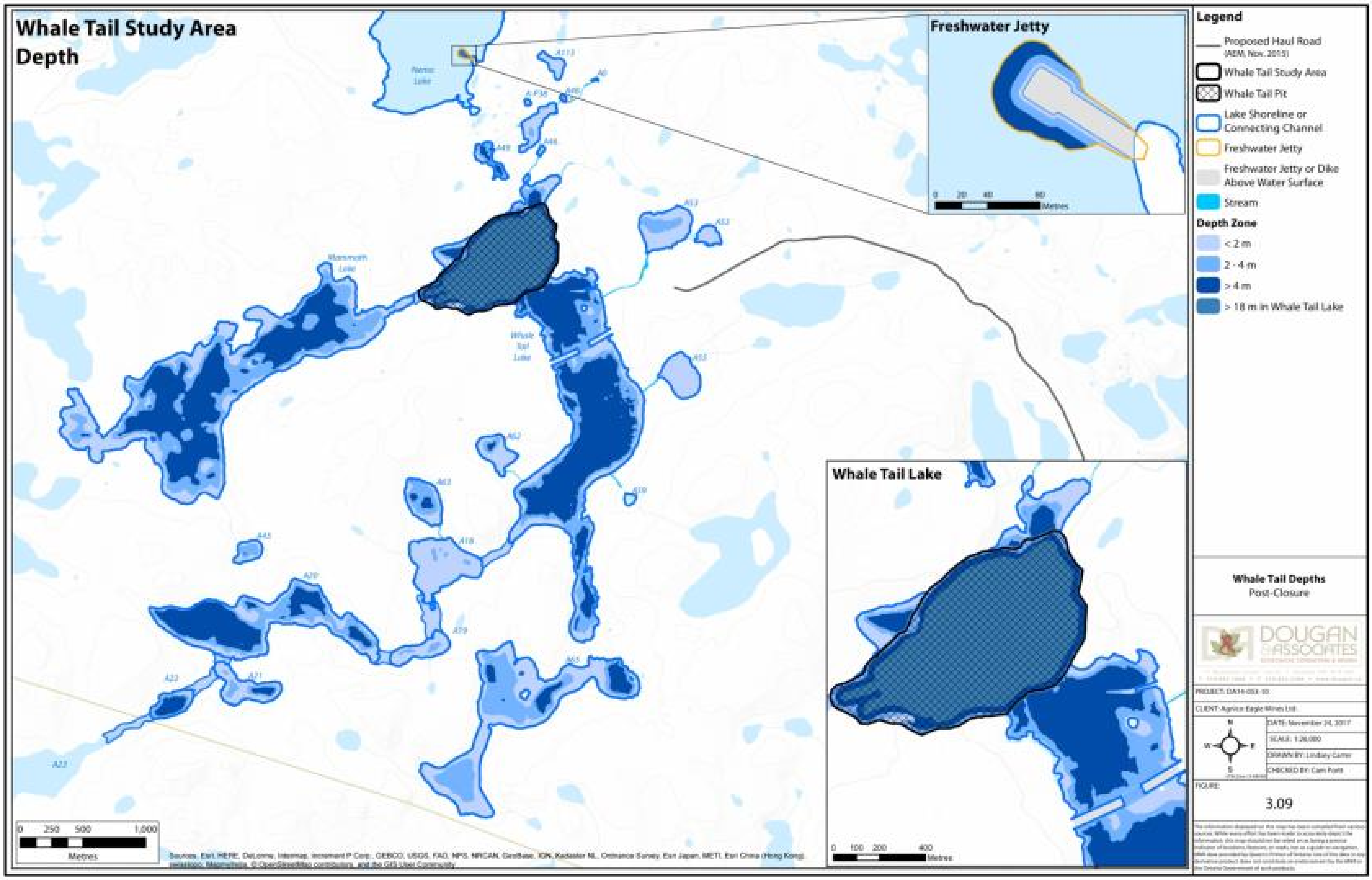

Figure 3-9. Whale Tail pit depths post-closure with no offsetting.

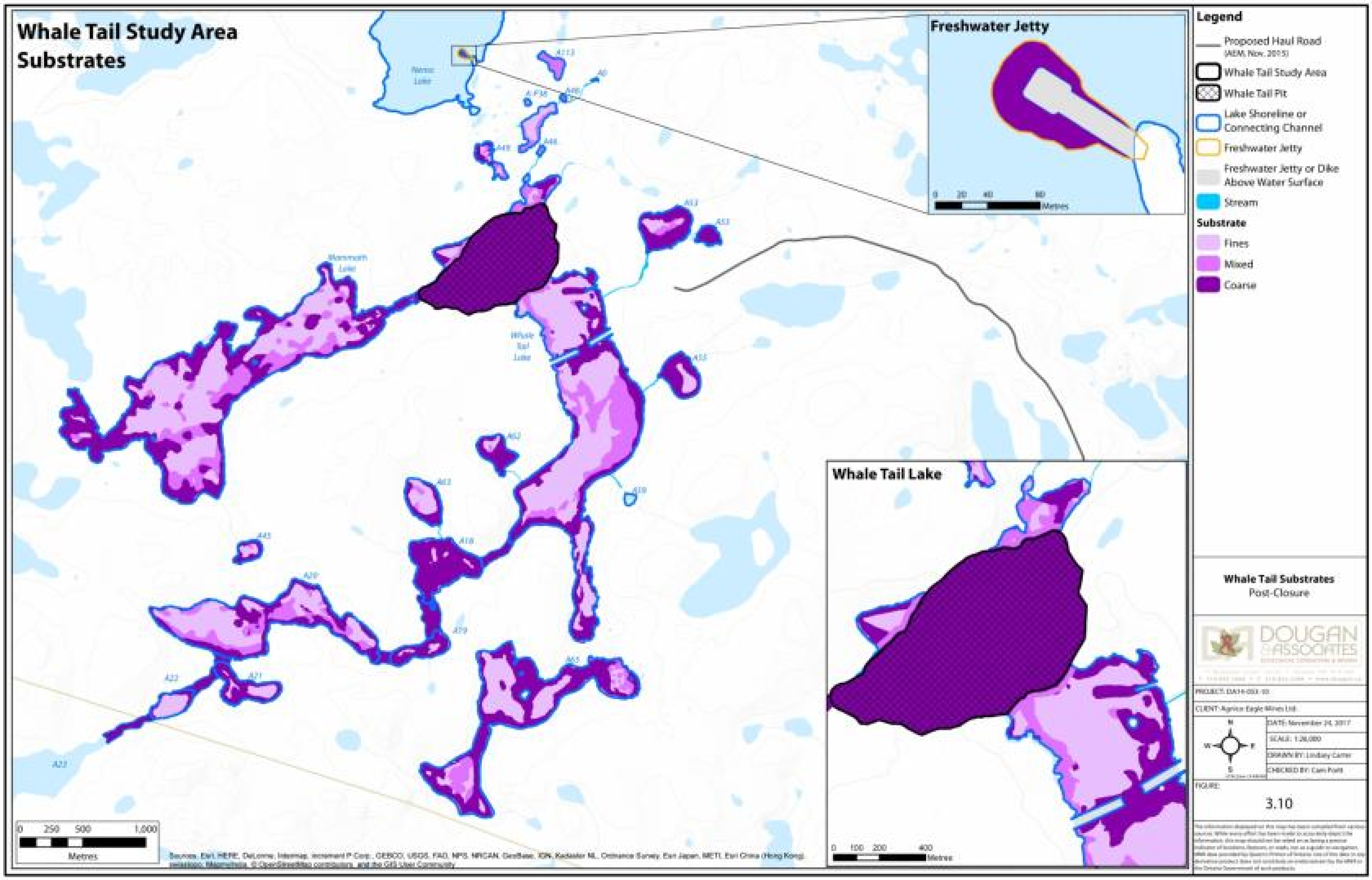

Figure 3-10. Whale Tail pit substrates post-closure with no offsetting.

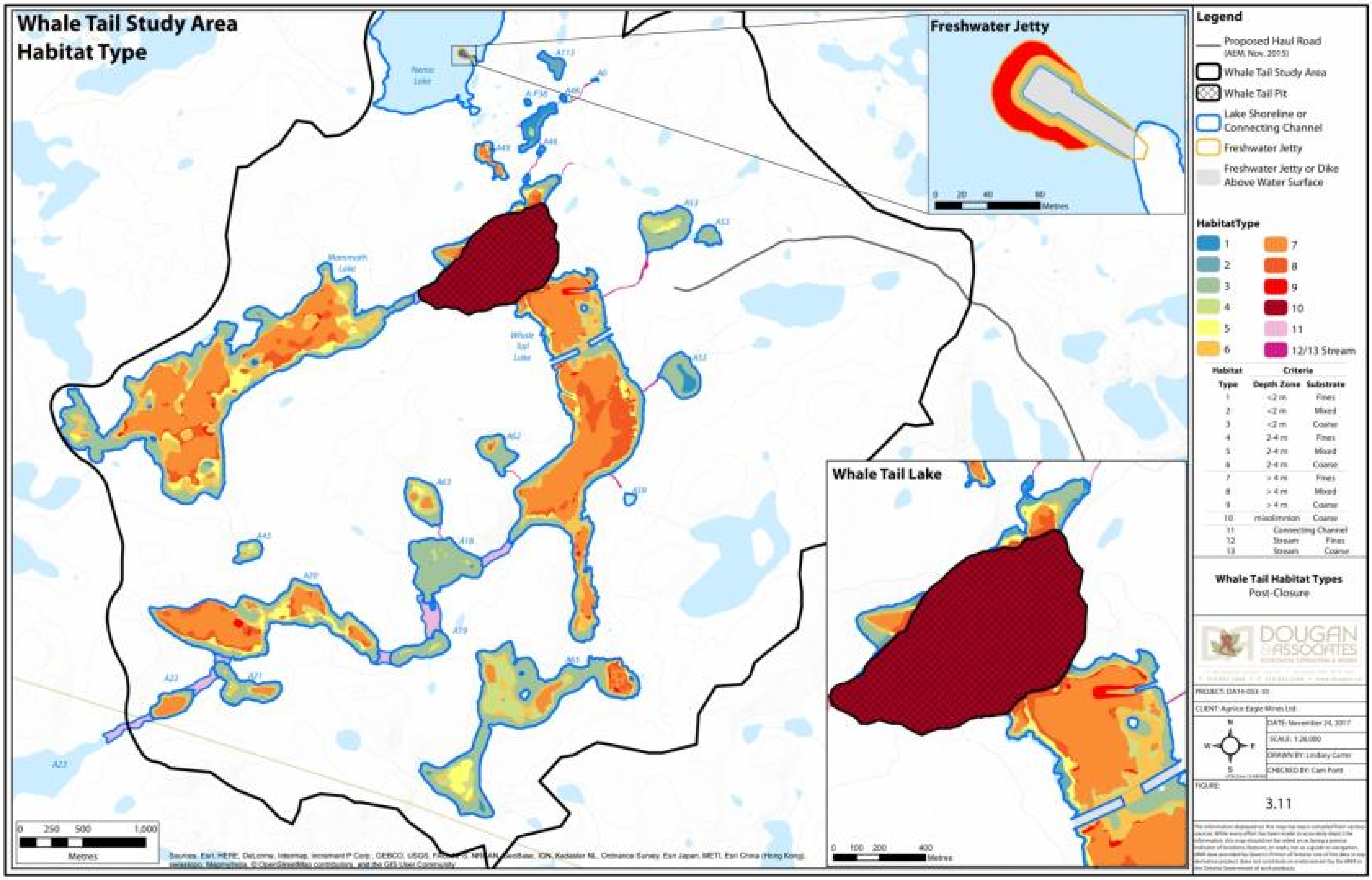

Figure 3-11. Whale Tail pit habitat types post-closure with no offsetting.

SECTION 4 • OFFSETTING MEASURES

The substantial increase in habitat area and habitat units in the expanded Whale Tail Lake during the operations phase is expected to result in an increase productivity of the aquatic system (Minns and Portt, 2017 pers. comm. June 14). Following closure, however, without offsetting, even though there will be an increase in the area of aquatic habitat due to the flooding of areas excavated as part of the pit, there will be a net decrease of 14.45 habitat units compared to baseline conditions. This occurs because no habitat value is attached to the pit or pit cap. Offsetting is required to address this loss.

Offsetting measures may be grouped into the following general categories (Fisheries and Oceans Canada, 2013):

- Habitat restoration and enhancement, which includes physical manipulation of existing habitat to improve habitat function and productivity;
- Habitat creation which is the development or expansion of aquatic habitat into a terrestrial area;
- Chemical or biological manipulation, which includes chemical manipulation of water bodies, and stocking of fish or shellfish, management or control of aquatic invasive species;
- Complementary measures, which are investments in data collection and scientific research related to maintaining or enhancing the productivity of commercial, recreational or Aboriginal fisheries.

A combination of habitat creation, by raising the water level of Whale Tail Lake, habitat enhancement, and complementary measures to offset the loss of habitat units is presented below.

4.1 HABITAT ENHANCEMENT AND CREATION

It is proposed that, as an offsetting measure, a sill is installed in the connection between Mammoth Lake and Whale Tail Lake that allows flow from Whale Tail to Mammoth Lake but maintains Whale Tail lake at an elevation of 154.02 masl, which is 1 m higher than its baseline elevation. This increase would create new habitat around the periphery of Whale Tail Lake and the connecting channel between Whale Tail Lake and Mammoth Lake, as well as around the portion of Mammoth Lake that is east of the sill (Figure 4.1). It will also create a small amount of additional habitat along the Whale Tail Dike due to the water level increase.

The 1 m increase in water elevation will also result in some habitat modifications. Small sections of the streams that are tributary to Whale Tail Lake will be converted to lake habitat, as will the remaining section of the connecting channel between Whale Tail Lake and Mammoth Lake and a portion of connecting channel A18-A17. Depth will increase in the portion of Mammoth Lake that is east of the Mammoth Lake dike and throughout Whale Tail Lake.

Coarse substrate has the highest habitat value and conversion of mixed or fine substrate to coarse substrate is a common habitat enhancement practice. Therefore, in addition to increasing the water level by 1 m east of connection between Whale Tail Lake and Mammoth Lake, the roads within the area that is flooded will be scarified to convert them from mixed to coarse substrate and 8.77 ha of rock shoals will be constructed in areas of fine substrate within the portion of Whale Tail Lake that is dewatered during operations (Figure 4.2). The shoal construction converts those areas to coarse substrate and was assumed to increase their elevation by 1 m. The elevation of the roads was assumed not to change due to scarification.

The depth zones, substrate types (fines, mixed, coarse) and habitat types for the post-closure phase with these offsetting features (a 1 m increase in the water level elevation east of the Mammoth dike, scarification of the roads and construction of 8.77 ha of grid shoals) are shown in Figures 4.3, 4.4, and 4.5, respectively. These offsets provide an increase of 21.26 ha and 15.03 habitat units over the post-closure scenario without offsets (Table 4-1) (Changes relative to baseline for each lake or stream are summarized in Appendix B Table B-6).

These planned offsetting features result in an offsetting gains to losses ratio of approximately 1:1 (gains of 15.03 HU and losses of 14.45 HU).

Table 4-1. Habitat area (ha) and habitat units (HUs) gained from the implementation of the proposed habitat enhancement and creation offsetting measures.

Habitat Type	Hectares			Habitat Units		
	Post-closure no offsets	Post-closure with offsets	Net Change	Post-closure no offsets	Post-closure with offsets	Net Change
1	1.260	4.176	2.916	0.302	1.001	0.699
2	4.552	11.021	6.470	1.280	3.100	1.820
3	71.436	69.026	-2.410	28.277	27.323	-0.954
4	10.113	6.353	-3.760	3.792	2.382	-1.410
5	14.887	12.433	-2.454	8.684	7.253	-1.431
6	37.897	49.292	11.395	28.817	37.482	8.665
7	114.451	109.449	-5.002	42.919	41.044	-1.876
8	28.774	30.607	1.833	14.987	15.941	0.955
9	3.791	17.016	13.226	2.567	11.521	8.955
10	58.298	58.667	0.370	0.000	0.000	0.000
11	1.499	0.232	-1.267	0.453	0.070	-0.383
12	0.577	0.546	-0.031	0.102	0.097	-0.006
13	0.176	0.155	-0.022	0.053	0.047	-0.007
Total			**21.264**			**15.027**

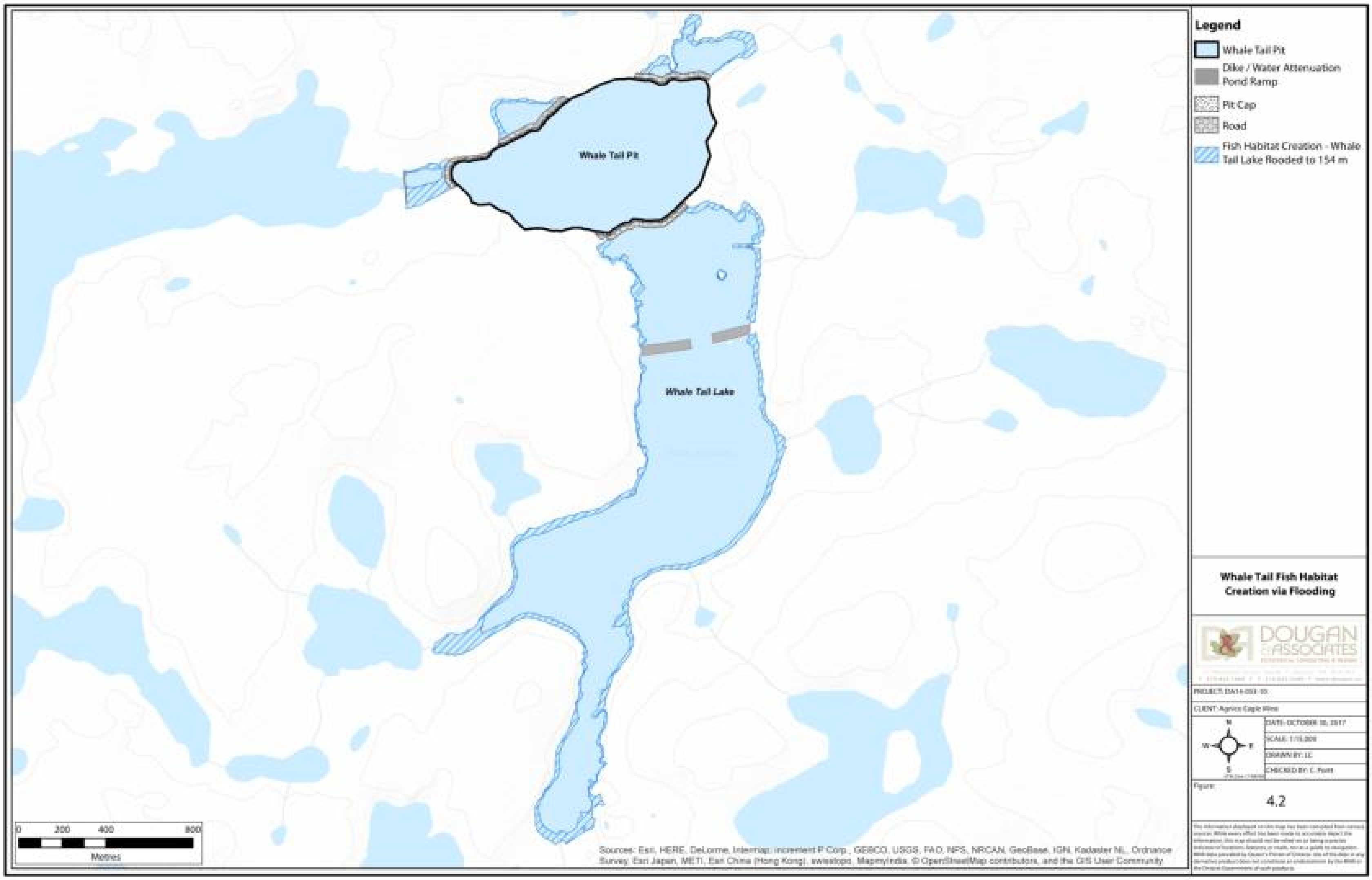

Figure 4-1. Habitat created by increasing the water elevation by 1 m east of the Mammoth Dike.

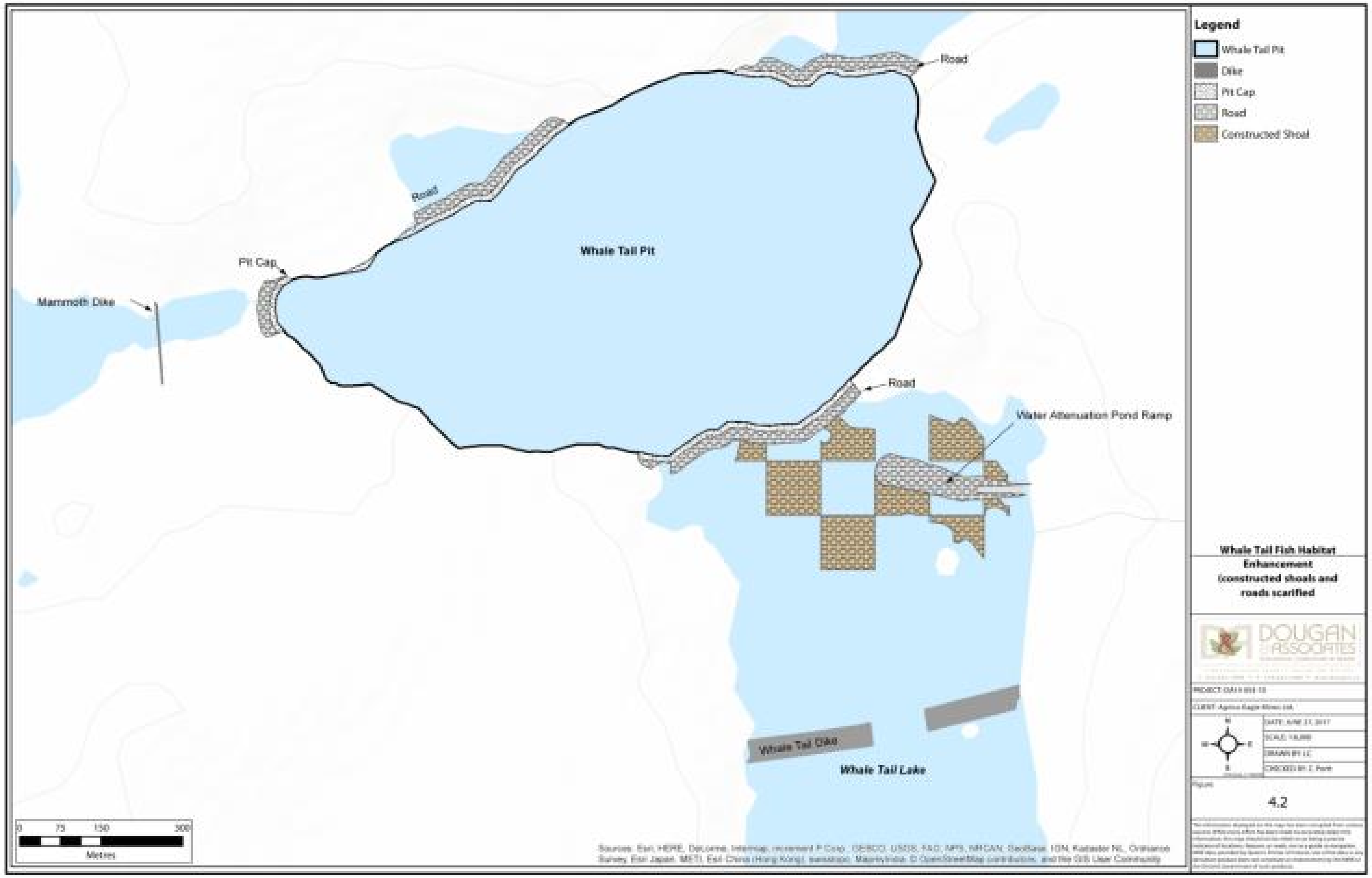

Figure 4-2. Proposed roads scarified and constructed rock shoals proposed as offsetting measures.

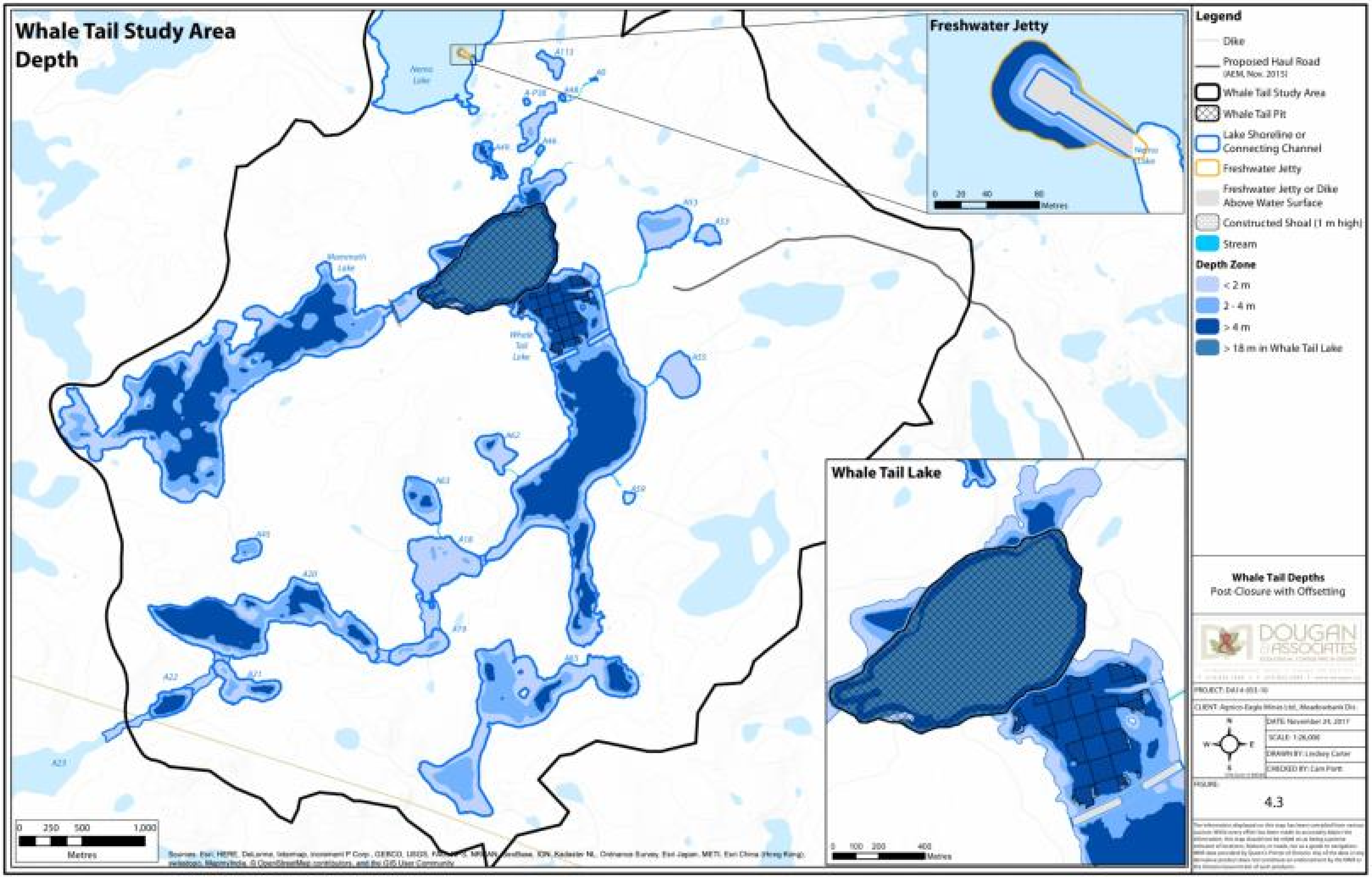

Figure 4-3. Whale Tail pit depths post-closure with a 1 m increase in water elevation east of Mammoth Lake sill, roads scarified and rock shoals constructed for offsetting.

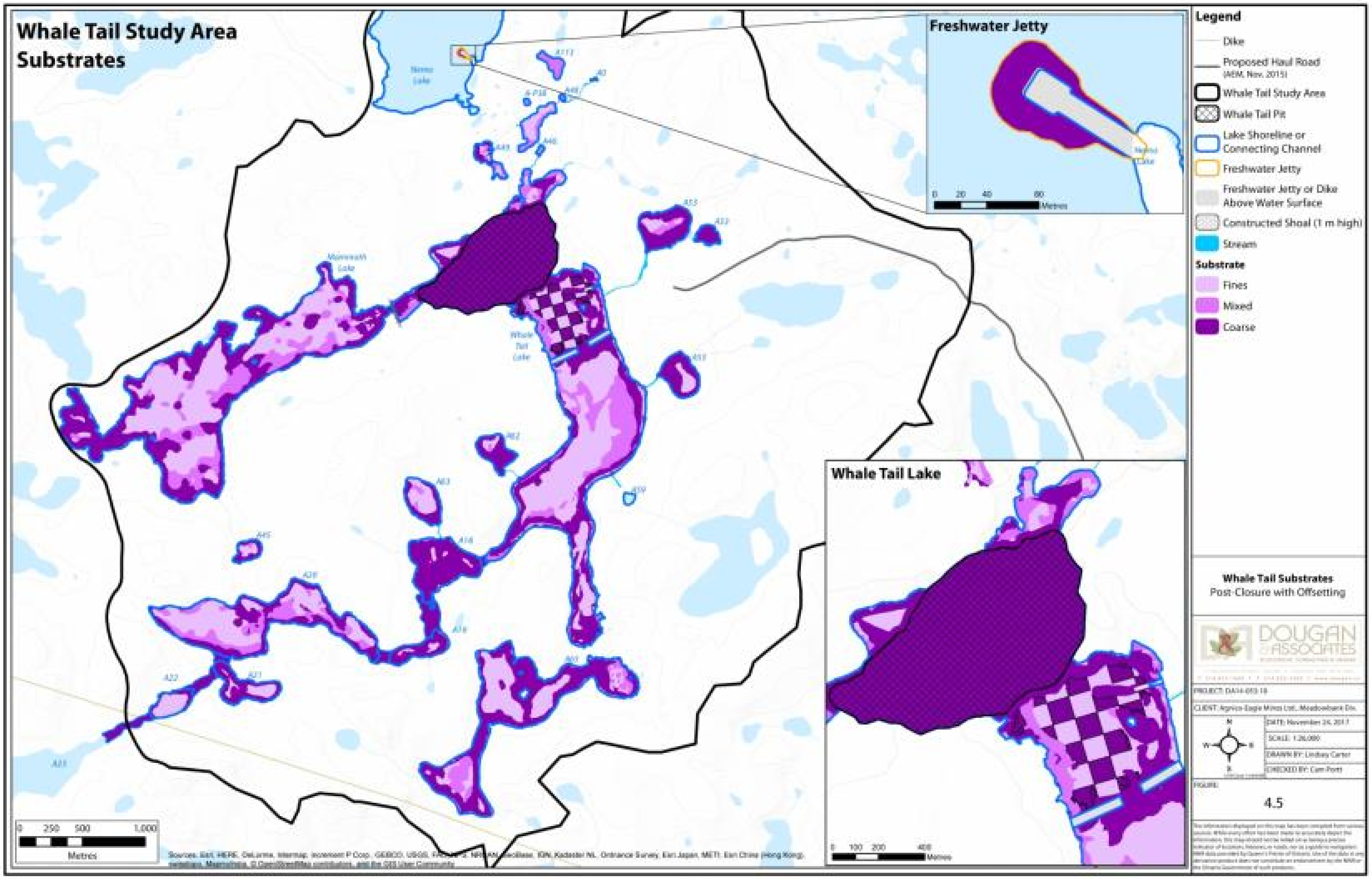

Figure 4-4. Whale Tail pit substrates post-closure with a 1 m increase in water elevation east of Mammoth Lake sill, roads scarified and rock shoals constructed for offsetting.

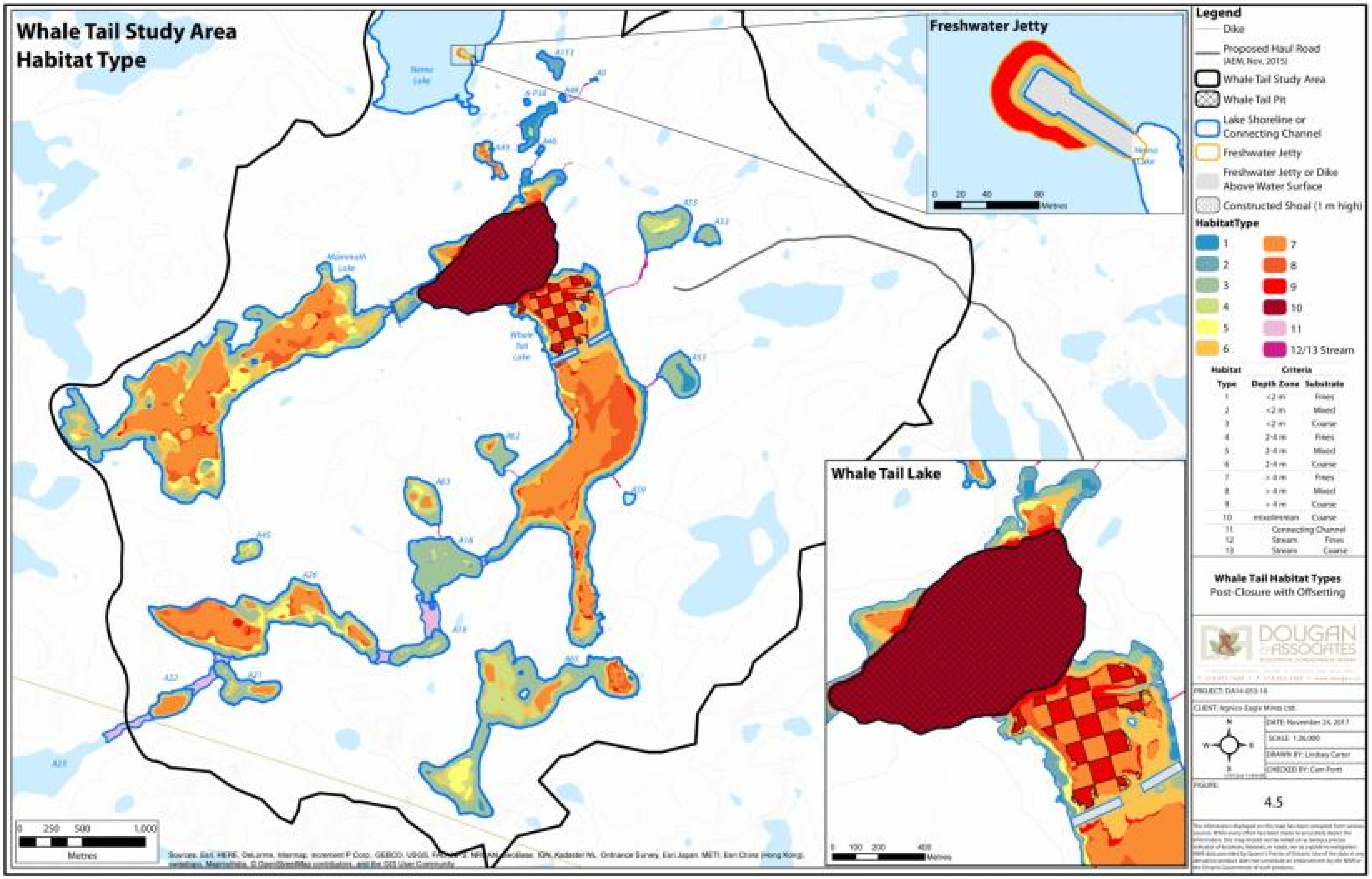

Figure 4-5. Whale Tail pit habitat types post-closure with a 1 m increase in water elevation east of Mammoth Lake sill, roads scarified and rock shoals constructed for offsetting.

4.2 COMPLEMENTARY MEASURES

As defined by Fisheries and Oceans Canada (2013), "complementary measures are investments in data collection and scientific research related to maintaining or enhancing the productivity of commercial, recreational or Aboriginal fisheries." As discussed in Section 1.1, for the Whale Tail pit, DFO has indicated support for complementary measures to provide 60% of the required offsetting. Agnico Eagle is supportive of funding research as a complementary measure to offset habitat losses resulting from the Whale Tail Pit and has provided to DFO for consideration project descriptions for a suite of research activities to benefit local stakeholders and contribute to the understanding of aquatic systems (Appendix C). These complementary measures are valued at 60% of constructed offsets (0.6 * 15.03 HUs = 9.02 HUs), providing a total offsetting ratio of 14.45 HUs lost to 24.05 HUs gained (1:1.66). Through this accounting method, the proposed complementary measures actually account for 38% of total offsets based on HUs (9.02 HUs / 24.05 HUs = 38%).

4.3 TIMELINE, DESIGN AND CONSTRUCTION OF THE OFFSETTING MEASURES

The following estimated timeline of water management activities is described in the Whale Tail Pit - Water Management Plan Addendum (FEIS, June, 2016). The exclusion of fish from available habitat in Whale Tail Lake – North Basin will extend from the initiation of dike construction (2018), dewatering and the fishout (2019), until re-flooding is complete (2025) and dikes are breached to allow fish re-entry (estimated 2029). Until the expanded Whale Tail Lake – South Basin is returned to baseline water levels (2022 – 2025), a large quantity of supplemental habitat will be available throughout that area due to flooding of terrestrial zones (see Section 3.2).

Construction timing of offsetting features is described in Table 4-2.

Table 4-2. Timing of construction and accessibility of offsetting features (habitat enhancements and creation).

Feature	Construction Complete	Offset Accessible to Fish
Scarification of roads	2022	2029
Construction of shoals	2022	2029
Sill	2025	2029
1-m Increase in Water Level	2025	2029

Preliminary engineering designs for the sill to raise water levels within Whale Tail Lake are provided in Figure 4-6.

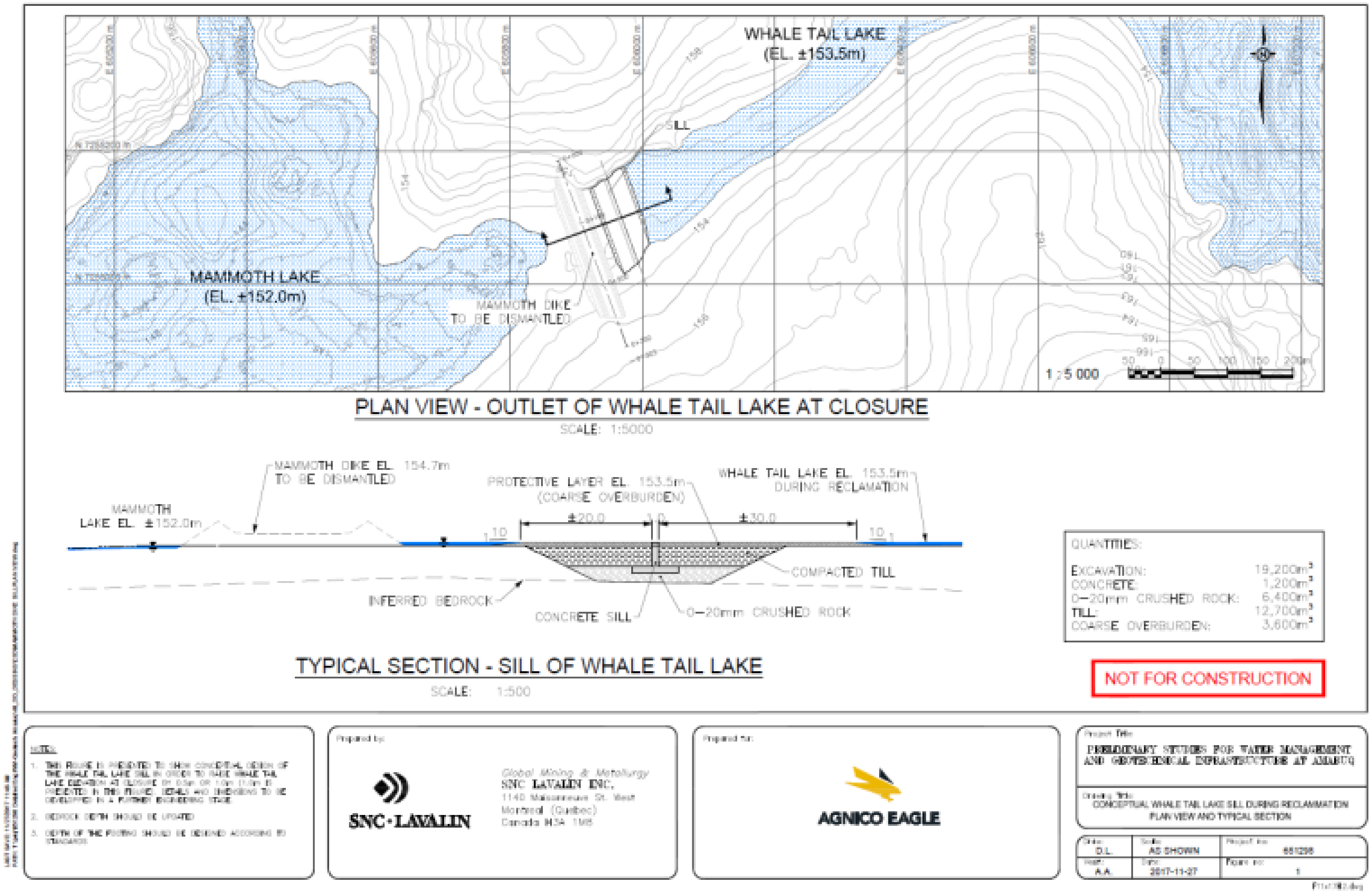

Figure 4-6. Preliminary engineering design for sill to raise water level of Whale Tail Lake by 1 m in the long term.

4.4 MONITORING

Monitoring to confirm that offsetting measures have been properly implemented and are effectively counterbalancing the serious harm to fish habitat occurring in Whale Tail Lake will be conducted as described in Agnico Eagle's Whale Tail Pit Fish Habitat Offset Monitoring Plan (March, 2018).

The planned duration and type of monitoring will allow for demonstration of full ecological functionality of the system (i.e. growth, reproduction and survival), with clearly identified criteria for success. Once criteria for success have been demonstrated, Agnico expects that there would be a reduction in the Letter of Credit (LOC) held by DFO in the amount corresponding to the successful offset.

SECTION 5 • CONTINGENCY OPTIONS

As a requirement in DFO offset planning Agnico Eagle recognizes uncertainty exists in all projections of future conditions. Therefore, Agnico Eagle is proposing three potential contingency options[5] that could be implemented in the case that the primary offsets are determined not to provide functional fish habitat (e.g. if conditions within the reflooded area do not permit breaching of the Whale Tail Dike to allow fish re-entry).

5.1 OPTION 1 – EXPANDED WHALE TAIL LAKE SOUTH BASIN

If deemed feasible, contingency option 1 could involve maintaining all or a portion of the flooded conditions south of the Whale Tail Dike. In concept, the Whale Tail Dike would not be breached to allow fish entry into Whale Tail Lake. As during the operations phase described in Section 3, water would continue to flow into Mammoth Lake through the southern diversion channel, rather than through Whale Tail Lake – North Basin. Based on preliminary planning to support DFOs requirements, habitat area (ha) and habitat units gained through this contingency offsetting option (i.e. maintaining habitat conditions as during operations in the long term) are summarized in Table 5-1. Provided this option is feasible, it could provide an increase over baseline conditions of up to 42.7 HUs, and would therefore provide more offsets than the primary option of habitat enhancement and creation (15.03 HUs). Agnico expects that these supplemental HUs could be banked or utilized towards future offsetting projects. Modifications of contingency option 1, such as a maintaining a lower level of flooding, could also be further investigated.

[5] These options are highly conceptual in support of the base case; as discussed with DFO, these concepts will require greater feasibility and engineering evaluation

Table 5-1. Increase in habitat area (ha) and habitat units (HUs) compared to baseline conditions provided by contingency option 1 (maintaining fish habitat conditions as during operations).

Habitat Location	Hectares	Habitat Units
Nemo Lake	-0.2	0.02
Mammoth Lake	-1.2	-0.47
Whale Tail Lake (South Basin) expanded during operations)	240.1	122.15
Other Lakes and Ponds[1]	-183.62	-77.01
Connecting channels	-8.0	-2.41
Streams	-0.3	-0.06
Diversion Channel A17-A45	1.8	0.54
Total	**48.6**	**42.72**

[1]Other lakes south of Whale Tail Lake become part of expanded Whale Tail Lake.

5.2 OPTION 2 – WHALE TAIL PIT BERM

As per NWB Type A requirements, water quality modeling will continue to be updated on an annual basis until closure. If it is determined that water quality within the flooded basin area could be deficient in nutrients required to support lower trophic levels and fish populations, this second proposed contingency option could aim to construct a berm or dike along the southern edge of Whale Tail Pit, in order to reduce the potential for the pit area to function as a nutrient sink. This feature may help to maintain nutrient supply within the basin area by preventing sediments from being washed into the pit. However further considerations of engineering design and water quality modeling would need to be explored to fully develop and understand the utility of this option.

Overall this contingency option may increase the potential for the primary offsetting option to function as intended as fish habitat, Assuming the berm is feasible and will function as fish habitat, change in habitat units over the primary offsetting scenario would be minimal, maintaining the originally proposed ratio of gains to losses. This contingency option would therefore provide approximately 15 HUs.

5.3 OPTION 3 – ADDITIONAL COMPLEMENTARY MEASURES

Based on the calculation method used here, the currently proposed complementary measures represent 38% of total offsets (9.03 of 24.05 HUs). DFO has previously indicated to Agnico Eagle (meeting March 15, 2017) that they would approve 60% of offsets as complementary measures for the Whale Tail Pit project. Thus, as a contingency option, an additional 5.4 HUs could be obtained through development and funding of supplemental research projects. This contingency option could be used in tandem with Option 2 to help to offset any small reduction in habitat gains that might occur as a result of berm construction.

SECTION 6 • CONCLUSION

There will be serious harm to fish habitat as a result of Whale Tail Pit development during both the operations and post-closure phases, resulting in a loss of 14.5 habitat units.

Accepted methods of habitat enhancement and habitat creation will be utilized, along with complementary measures, to offset the serious harm that will occur.

Offsets proposed for the Whale Tail Pit Project include:

- Construction of a sill in the connecting channel between Whale Tail Lake and Mammoth Lake that will increase the water level in Whale Tail Lake by 1 m;
- Conversion of roads to coarse substrate and construction of 8.77 ha rock shoals, together these represent 15.03 HUs; and
- Complementary measures consisting of a suite of research studies to benefit local stakeholders and contribute to the understanding of aquatic systems, representing 9 HUs.

Combined, this offsetting package achieves a ratio of habitat units lost to habitat units gained of 1:1.66.

SECTION 7 • REFERENCES

AEM, 2012. AEM Meadowbank Division – No Net Loss Plan. October 15, 2012.

AEM, 2013. Meadowbank Mine – Draft No Net Loss Plan Implementation Cost Estimate and Construction Schedule. Version 2. May 2013.

AEM, 2016. Meadowbank Gold Project – Habitat Compensation Monitoring Plan. AEM Meadowbank Division. Version 3. February, 2016.

Agnico Eagle. 2017a. Conceptual Whale Tail Lake (North Basin) Fishout Work Plan. Version 1. February 2017.

Agnico Eagle. 2017b. Fisheries and Offsetting Monitoring Plan Whale Tail Pit. Version 1. June 2017.

C. Portt and Associates. 2018. Whale tail pit 2014 - 2016 fish and fish habitat field investigations: Agnico Eagle Mines Ltd. - Meadowbank Division. xi +157 pp.

C. Portt and K. Minns. 2017. Personal Communication on June 14th, 2017. Toronto, Ontario. Discussion with Portt, Minns and DFO (by webex) regarding HEP model and conceptual offsetting plans including the flooding of Whale Tail Lake (South Basin).

DFO, 2013. Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting. Ecosystem Programs Policy, Fisheries and Oceans Canada. Ottawa, Ontario. November, 2013. ISBN: 978-1-100-22930-0

Appendix A –

Lake Elevations Used for Existing Conditions and Summary of Fish Catches during Baseline Field Investigations

Table A 1. Elevations used to represent baseline conditions for the determination of depths and shorelines.

Lake	Water elevation (masl) determined from the July 21, 2011 imagery
A113	156.47
A18	154.05
A19	154.85
A20	154.77
A21	154.83
A22	155.01
A45	156.47
A47	154.94
A49	159.28
A62	155.59
A63	154.62
A65	154.84
Mammoth Lake (A16)	152.57
Nemo Lake (C38)	156.00
Whale Tail Lake (A17)	153.02

Table A 2. Electrofishing effort and catches in connecting channels between lakes.

Connecting channel	Date	Distance (m)	Juvenile Lake Trout	Juvenile Round Whitefish	Ninespine Stickleback	Slimy Sculpin
A16-A15	8/25/2015	43	1		2	5
	6/21/2016	59				
	6/24/2016	23				
A16-A15 Total		**125**	**1**		**2**	**5**
A17-A16	7/9/2016	189	2	1	1	1
A18-A17	6/26/2015	100				1
	7/5/2015	112				5
	8/30/2015	30	1		6	
	6/22/2016	104				1
	6/25/2016	141				
	7/8/2016	113		16		
	8/20/2016	27			2	
A18-A17 Total		**627**	**1**	**16**	**8**	**7**
A19-A18	7/9/2015	32				
A19-A18 Total		**32**				
Grand Total		**1213**	**5**	**17**	**11**	**17**

Table A 3. Electrofishing effort and catches in small streams in the primary study area. All Arctic Char, Lake Trout, Salvelinus sp. (which are either Arctic Char or Lake Trout), Round Whitefish and Burbot are juveniles. Large catches of Ninespine Stickleback in A46-A17 occurred immediately downstream of a ledge that appeared to impede upstream migration.

Watercourse	Date	Electro-seconds	Distance (m)	Arctic Char	Lake Trout	*Salvelinus* sp.	Round Whitefish	Burbot	Ninespine Stickleback	Slimy Sculpin
A0-A48	8/1/2015	196	10						2	
A113-A47	8/1/2015	68	10						1	
	6/19/2016	160	191							
A113-A47 Total		**228**	**201**						**1**	
A46-A17	6/28/2015	579	201	1					11	8
	7/9/2015	925	148	1					153	8
	7/12/2015	85	na						100	
	8/30/2015	470	36							
	6/22/2016	110	36						20	
	6/24/2016	608	162	1					27	8
	7/7/2016	498	142	1					600	7
	8/19/2016	993	194					1	7	5
A46-A17 Total		**4268**	**919**	**4**				**1**	**918**	**36**
A47-A17	6/19/2016	500	348						1	
A47-A46	7/9/2015	136	17							1
	6/24/2016	77	13							
A47-A46 Total		**213**	**30**							**1**
A48-A47	7/6/2016	1403	147						6	
A49-A47	7/7/2016	290	59							
	8/20/2016	58	7							
A49-A47 Total		**348**	**66**							
A50-A17	6/28/2015	265	51						5	
	7/9/2015	1204	163	2	1				56	9
	8/30/2015	180	52	1				1	2	

Watercourse	Date	Electro-seconds	Distance (m)	Arctic Char	Lake Trout	*Salvelinus* sp.	Round Whitefish	Burbot	Ninespine Stickleback	Slimy Sculpin
	6/22/2016	208	37	1					20	
	6/24/2016	180	38						3	
	7/7/2016	1050	195	1					10	4
	8/19/2016	275	66							2
A50-A17 Total		**3362**	**602**	**5**	**1**			**1**	**96**	**15**
A53-A17	6/20/2015	1664	571						7	
	7/8/2015	2142	182	5					78	77
	8/30/2015	518	359		4					26
	6/18/2016	2565	563						4	4
	7/8/2016	2415	357	1					28	43
	8/26/2016	433	248	3					5	23
A53-A17 Total		**9337**	**2280**	**9**	**4**				**122**	**170**
A55-A17	6/21/2015	996	166						6	
	7/6/2015	3330	167	1		1			20	50
	8/30/2015	483	46				1		17	1
	6/19/2016	917	182	1					1	1
	6/26/2016	1482	159							8
	7/8/2016	676	141	1				1		31
	8/19/2016	758	22						59	7
A55-A17 Total		**8642**	**883**	**3**		**1**	**1**	**1**	**103**	**98**
A59-A17	6/27/2015	730	126	1						6
	7/9/2015	1444	97						2	21
	8/30/2015	535	181	1						7
	6/22/2016	766	126						4	6
	7/7/2016	1115	122			2				24
	8/20/2016	630	56	2					4	8
A59-A17 Total		**5220**	**708**	**4**		**2**			**10**	**72**

Watercourse	Date	Electro-seconds	Distance (m)	Arctic Char	Lake Trout	*Salvelinus* sp.	Round Whitefish	Burbot	Ninespine Stickleback	Slimy Sculpin
A62-A17	7/7/2015	1025	107						1	
	7/7/2016	707	129							
A62-A17 Total		**1732**	**236**						**1**	
A63-A18	7/5/2015	848	81							3
	7/7/2015	793	81							3
A63-A18 Total		**1641**	**162**							**6**
A-P23-A17	6/26/2015	582	95							2
Grand Total		**38702**	**6747**	**25**	**5**	**3**	**1**	**3**	**1260**	**403**

Table A 4. Maximum number of channels, mean total wetted width (sum of the width of all channels at a transect), and mean and maximum depth of small streams in the Whale Tail Study area.

Stream	Maximum number of channels	Mean total wetted width (m)	Mean depth (cm)	Maximum depth (cm)
A0-AP48	2	2.5	8	30
A47-A46	1	2.0	9	21
to A47	1	3.4	6	12
A50-A17	2	0.7	9	26
A53-A17	8	7.6	7	27
A55-A17	2	7.2	17	36
A59-A17	8	6.7	9	20
A62-A17	2	1.2	6	42
A63-A18	2	2.8	7	22
A46-A17	2	1.9	11	36

Appendix B

Habitat Areas and Habitat Units, by Habitat Type, for Preconstruction, Operations, and Post-closure Phases

Table B-1. Habitat areas (ha) and habitat units (HUs) for all habitats under baseline conditions and during operations phase.

Habitat Type	Habitat Area (ha)		Habitat Units (HUs)	
	Baseline	Operations	Baseline	Operations
1	8.39	13.65	2.01	3.27
2	11.27	2.90	3.17	0.81
3	175.40	201.11	69.43	79.61
4	33.11	14.08	12.42	5.28
5	25.09	13.51	14.64	7.88
6	53.63	101.24	40.78	76.98
7	157.88	145.73	59.21	54.65
8	37.97	43.71	19.77	22.77
9	4.90	26.79	3.32	18.14
10	0.00	0.00	0.00	0.00
11	9.38	3.18	2.83	0.96
12	0.70	0.39	0.12	0.07
13	0.19	0.18	0.06	0.06
Total	517.92	566.47	227.76	270.48
Change		**48.56**		**42.72**

Table B-2. Area of habitat that is lost, isolated in the north-east pond, unaltered, modified and created during the operations phase.

Changes to habitat	Area in hectares
Habitat lost during operations	
Lake habitat dewatered	
Nemo Lake filled and above water during operations	0.2
Whale Tail Lake dewatered or covered by dike and above water during operations	69.5
Mammoth Lake dewatered or covered by dike and above water during operations	1.2
Connecting channels dewatered	0.9
Small streams dewatered	0.03
Total habitat lost during operations	74.3
Habitat isolated in north-east pond during operations	
Existing lake and pond habitat	7.6
Existing stream habitat	<0.1
Total isolated in north-east pond (assumed not to be fish habitat, so effectively also a loss)	7.6
Habitat not altered during operations	
Mammoth Lake	150.5
Portion of connecting channel A23-A22	1.4
Portion of watercourse A53-A17	0.4
Total habitat not altered during operations	152.3
Existing Habitat modified during operations	
Existing Nemo Lake covered by freshwater jetty (that remains below water)	0.4
Existing Mammoth Lake covered by Mammoth dike (that remains below water)	0.0
Existing Whale Tail Lake (water level increased)	94.8
Existing Whale Tail Lake covered by Whale Tail dike (that remains below water)	0.4
Other existing lakes in expanded Whale Tail Lake (water levels increased)	177.8
Lake A45 water levels increased	2.9
Existing connecting channels converted to lake habitat	7.1
Existing streams converted to lake habitat	0.3
Total existing habitat modified during operations	283.8
Habitat created during operations	
Land flooded around expanded Whale Tail Lake	127.4
New channel alignment for stream A53-A17	0.2
Connecting channel constructed between expanded Whale Tail Lake and A45	1.8
Land flooded around Lake A45	1.6
Total habitat created during operations	130.9

Table B-3. Changes in habitat area and habitat units between baseline conditions and the operations phase for each lake/stream system.

Lake/Stream	Change from existing conditions to operations phase	
	Hectares	**Habitat Units**
Nemo Lake	-0.2	-0.02
Mammoth Lake	-1.2	-0.47
Whale Tail Lake	240.1	122.15
Other Lakes and Ponds	-183.6	-77.01
Connecting channels	-8.0	-2.41
Streams	-0.3	-0.06
Diversion Channel A17-A45	1.8	0.54
Net change	48.6	42.72

[1]Most become part of the expanded Whale Tail Lake

Table B-4. Areas of habitat that are lost, unaltered, modified or created during the post-closure phase with no offsetting.

Changes to habitat	Area in hectares
Habitat lost during post-closure phase	
Nemo Lake filled	0.2
Streams dewatered	none
Whale Tail Lake (covered by dike and water attenuation ramp and dry post-closure)	1.8
Mammoth Lake (covered by dike and dry post-closure)	none
Total habitat lost during post-closure phase	2.0
Habitat not altered during post-closure phase (includes areas reflooded)	
Mammoth Lake not modified	151.6
Whale Tail Lake habitat not modified	130.6
Connecting channel A17-A16 habitat not modified	0.3
Connecting channel A18-A17 – (a portion is altered in offsetting scenario so required for comparison)	1.3
Streams not altered - (but altered in offsetting scenario so required for comparison)	0.7
Total habitat not altered post-closure	284.5
Habitat modified during post-closure phase	
Existing Nemo Lake covered by freshwater jetty	0.4
Whale Tail Lake and connecting channel A16-A17 converted to pit or pit cap	30.9
Whale Tail Lake and connecting channel A16-A17 converted to roads	2.2
Whale Tail Lake converted to attenuation pond jetty	1.1
Whale Tail Lake converted to dike (portion that is below water)	1.2
Mammoth Lake - (covered by remains of dike, now lowered to become lake habitat)	0.1
Total habitat altered during post-closure phase	35.9
Habitat created during post-closure phase	
Whale Tail Lake habitat created post-closure (due to pit excavation)	27.4

Table B-5. Changes in habitat area and habitat units between baseline conditions and post-closure phase with no offsetting, for each lake/stream system.

Lake/Stream	Change from existing conditions to post-closure phase with no offsetting	
	Hectares	**Habitat Units**
Nemo Lake	-0.2	0.02
Mammoth Lake	0.0	0.00
Whale Tail Lake	26.2	-14.23
Connecting channel A17-A16[1]	-0.6	-0.20
Other connecting channels	0.0	0.00
Streams	0.0	0.00
Total	25.3	-14.45

1. Becomes part of the expanded Whale Tail Lake (South Basin)

Table B-6. Change in post-closure habitat areas and habitat units, relative to baseline, that will result from the proposed offsetting features, for each lake/stream system.

Lake/Stream	Changes resulting from a 1 m increase in the water level upstream from the Whale Tail Lake to Mammoth Lake sill, scarification of roads and construction of 8.77 ha rock shoals, compared to baseline conditions	
	Hectares	**Habitat Units**
Nemo Lake	-0.2	-0.02
Mammoth Lake[1]	-1.2	-0.47
Whale Tail Lake	50.0	1.67
Connecting channel A17-A16[1]	-0.9	-0.27
Connecting channel A18-A17[1]	-1.0	-0.31
Streams	<-0.1	-0.01
Total	46.6	0.58

1. Becomes part of the expanded Whale Tail Lake (South Basin)

APPENDIX C – COMPLEMENTARY MEASURES

SECTION 1 • INTRODUCTION

As suggested by DFO in 2017, a portion of fish habitat offsetting for Whale Tail Pit may be comprised of complementary measures in the form of fisheries-related research. Research projects will be aimed at closing knowledge gaps regarding the biology and habitat requirements of northern fish species, developing tools and validating methods to facilitate and advance ongoing monitoring, and/or characterizing responses of fish-bearing aquatic systems to direct anthropogenic manipulations.

The following research projects are proposed as complementary measures to offset fish habitat losses associated with the Whale Tail Pit project. Conceptual design of each project has been discussed with DFO over the past year. Details of projects that will occur in the nearer term have been established with interested academic partners but may evolve over the life of the project based on initial field experiences. This program will continue to be developed and coordinated by Agnico, in collaboration with academic partners, and reporting to the Meadowbank Fisheries Research Advisory Group (MFRAG; see Section 2.6).

While these projects are proposed as complementary measures, and Agnico will work towards achieving their criteria for success as identified in the Fish Habitat Offset Monitoring Plan (March, 2018), it should be recognized that total funding for complementary measures is detailed in the calculated Letter of Credit (LOC) held by DFO, and described in the Cost Estimate for Whale Tail Offsetting (March, 2018). Depending on the final chosen suite of research projects and their scope, additional studies or objectives may be feasible. Ultimately, projects will be chosen and their direction confirmed or updated annually based on interests of stakeholders including KIA, academic partners, Hunting and Trapping Organizations (HTO) and DFO, through the Meadowbank Fisheries Research Advisory Group (see Section 2.6).

Where appropriate, research projects are designed to work in tandem with existing monitoring programs such as the Core Receiving Environment Monitoring Program (CREMP) and monitoring for habitat enhancement/creation offsetting features. However, research studies are planned to collect supplementary data over and above regular monitoring programs, and to assess scientifically-driven hypotheses, independent of compliance monitoring.

A common goal will be to publish results in peer-reviewed literature to provide a tangible benefit for future assessments of northern fish populations. Outside of deliverables related to scientific publications, Agnico will emphasize and facilitate local community input and capacity building as a component of each study.

SECTION 2 • COMPLEMENTARY MEASURES

Four general topics are proposed as research study directions for Whale Tail Pit complementary measures, with one or more specific associated research projects. Topics include:

1. Assessment of changes in aquatic productivity and fish populations due to flooding of Whale Tail South and downstream lakes during operations

2. Assessment of impacts of the Baker Lake wastewater outflow on aquatic systems including fish and fish habitat

3. Characterization of northern fish species' habitat preferences

    - Literature review and field validation of northern lake fish habitat preferences

    - Arctic grayling occupancy modeling

    - Pit lake habitat use assessment

4. eDNA methods development

The objectives and methods of the associated research studies as planned at this time are described in detail below. Information on approximate total budgets and estimated levels of Agnico support for each project are described in Section 2.5, and role of the MFRAG is described in Section 2.6.

2.1 CHANGES IN AQUATIC PRODUCTIVITY

2.1.1 Introduction

Flooding of the Whale Tail South Basin and upstream lakes during operations will result in a release of nutrients from terrestrial sources into the aquatic system. Although a change in trophic status was also predicted in the EIS in relation to effluent discharge into Mammoth Lake, mitigative options are now being investigated to minimize those impacts, so research projects will focus on the flooded zone south of the Whale Tail dike.

Currently, relatively little information is available in the open literature to support development of productivity models for Arctic lakes. Not only is this information integral to environmental impact assessment, but understanding drivers of productivity will help inform future directions of HEP methods.

The following objectives and methods have been developed in consultation with the proposed lead researcher, Dr. Heidi Swanson (University of Waterloo).

2.1.2 Objectives

Specifically, this research study will aim to understand changes in fish population productivity and habitat use during and after flooding occurs, as determined through relative abundance and/or biomass and condition factor within the resident fish population.

Since flooding activities are planned to occur over a relatively short term (2-3 years), the study will specifically include a focus on small-bodied fish, which are expected to react first to changes in nutrient profiles. Nevertheless, methods will also include hydroacoustic surveys that can assess changes at the community level, and a substantial body of information for condition factor and abundance of large-bodied fish will be collected during the fishout of Whale Tail Lake – North Basin. If elevated water levels are maintained in Whale Tail Lake over a longer term (as proposed as a contingency offsetting measure), post-impact assessments could be carried out using that data.

Changes in productivity will be related to water quality variables and changes in lake morphometry (especially area). Use of newly flooded habitats will be assessed and related to habitat characteristics.

2.1.3 Methods

The following specific methods related to surveillance and analysis of fish populations are planned to be included as part of this study:

- Hydroacoustics surveys, both before and after flooding. Key variable investigated: kg fish/hectare

- Minnow trap/fyke net surveys, both before and after flooding. Key variable investigated: catch per unit effort

- Presence-only surveys, after flooding. Key variable investigated: fish presence in newly-flooded habitats, and relationships with habitat covariates.

- Collection of small-bodied fishes for trophic ecology and growth parameters, both before and after flooding. Key variables investigated: sources of carbon (pelagic or benthic, trophic position, growth rates).

Assessments of changes in fish populations will take into account relationships with the following water quality parameters, some of which are planned to be collected through compliance monitoring programs, and some of which are supplementary:

- Quantity and quality of dissolved organic carbon

- Total and dissolved concentrations of nitrogen

- Total and dissolved concentrations of phosphorus

- TSS

- Chlorophyll-a

- Major anions and cations

- Stable isotope ratios on dissolved inorganic carbon

2.1.4 Timeline

This study is planned to begin in Summer 2018 due to tight timelines related to dike construction and flooding of Whale Tail – South Basin. Based on current mine plans and offsetting measures, this study will occur over a 3 – 4 year time period.

See Section 2.5 for a summary of proposed timelines for each project.

2.1.5 Project Deliverables

As described in the Fish Habitat Offset Monitoring Plan (March, 2018), criteria for success (deliverables) of all research projects are centred around publication of one or more manuscripts per study in a peer-reviewed journal, such that research outcomes would be broadly available to the scientific community. However it is recognized that not all factors affecting outcomes of research projects and suitability of studies for such publication are within the control of Agnico, academic partners, or DFO. As a result, in certain instances, peer-reviewed publication may not be a viable route for dissemination of knowledge gained through these projects. In such cases, Agnico suggests discussions be undertaken between researchers, DFO, and Agnico to determine a mutually agreeable solution (e.g. conference presentations, inter-agency workshops).

Specifically, this study will improve scientific understanding of relationships between productivity of northern fish communities and nutrient inputs derived from natural sources. This information will be valuable for consideration by proponents and regulatory agencies during future assessments of impacts in aquatic systems due to flooding.

2.2 BAKER LAKE WASTEWATER ASSESSMENT

2.2.1 Introduction

Currently, wastewater from the hamlet of Baker Lake is released through a series of tundra ponds into Baker Lake, ultimately affecting fish and fish habitat. Since 2012, Agnico has maintained an interest in characterizing these impacts, and working with the hamlet to ameliorate their wastewater treatment, with significant support from the community. In the fall of 2017, Agnico presented the conceptual research project and potential associated wastewater upgrades to the Hamlet Council, and again received strong support. It was noted by an elder during consultation (Agnico Eagle, 2016)that Airplane Lake, which receives run-off from the wastewater lagoon and landfill was once used by locals for fishing and recreation, but is no longer fished due to concerns of contamination.

Having identified this project as a potential complementary measure for the Whale Tail Pit project, Agnico has begun working with a research team including Dr. Rob Jamieson (Dalhousie University), Drs. Mark Hanson and Charles Wong (University of Manitoba), and Drs. Brendan McConkey and Heidi Swanson (University of Waterloo) to tailor an appropriate research program.

Since this research will directly assess changes in the aquatic system related to fish and fish habitat, and will provide significant value to the local community, Agnico is proposing to partially fund this study as a complementary measure for Whale Tail Pit offsetting. Additional funding will be sought through application for an NSERC CRD, with Agnico acting as industrial partner.

The following objectives and methods have been developed by the research team indicated above.

2.2.2 Objectives

1. Validate passive wastewater treatment system design guidelines for Arctic regions

2. Develop and incorporate human health risk assessment into Arctic wastewater system design and planning process

3. Characterize microbial community structure in Arctic wastewater treatment systems and receiving waters and assess ARG transfer mechanisms

4. Characterize trace metal sources, transport pathways and environmental risks in Arctic wastewater systems

5. Quantify improvements in fish habitat and health associated with Arctic wastewater treatment system upgrades

2.2.3 Methods

Preliminary methods developed by the research team to address these objectives are described below.

1: The hydraulic performance and treatment kinetics of the current wastewater treatment system will be characterized during the 2018 treatment season. Initial field work would be conducted during the spring melt period. The current wetland treatment area would be instrumented with water level loggers to quantify flow rates at several points throughout the system (upstream of Lagoon Lake, outlet of Lagoon Lake, outlet of Finger Lake, inlet to Airplane Lake). Stage-discharge relationships would be developed for each location to relate water level to discharge rate. A rhodamine dye tracer study would also be conducted to characterize the hydraulic retention time and mixing behavior of the current treatment system. The ability of the current treatment system to meet effluent quality criteria for regulated parameters (CBOD5, TSS, etc) would be evaluated. A mass balance modeling approach would be used to derive treatment rate constants for the wetland, and the level of dilution occurring in the system. A similar assessment would be conducted in August to characterize the performance of the current system during the non-melt period.

2: A spatial analysis would be conducted to identify 2-4 alternative locations for a new passive wastewater treatment systems. For each site a conceptual design for a pond-wetland based treatment system would be developed and effluent quality would be predicted for each alternative site using performance models previously developed by our research group. The relative human health risks associated with each option would also be evaluated using quantitative microbial risk assessment (QMRA) approaches. A variety of participatory research approaches would be employed to engage the community and better understand concerns and risks associated with potential options for wastewater management, and to identify an appropriate location for the treatment facility.

3: Once the new facility is constructed and operational the hydraulic behavior and treatment performance would be evaluated using methods previously described in 1. This data would be used to validate the performance model predictions and treatment rate kinetics. Autonomous water quality sensors would also be installed in both the pond and wetland to continuously measure oxygen status, temperature and pH throughout the treatment season.

3: We hypothesize that otoliths provide a history of trace element exposure in fish via water and food pathways that can be used in ecological risk assessment. To test this hypothesis, we will sample for select trace elements in the proposed compartments along the wastewater release pathway (with a focus on Airplane and Baker Lake, plus reference sites), as well as reconstruct the trace element history through sediment coring. The exposures will be evaluated relative to water quality guidelines and hopefully partitioned by source (e.g., background vs landfill vs wastewater). We predict that the new treatment system will reduce trace element release, and that this will be associated with a decline in otolith concentrations. To this end, fish will be sampled pre- and post- construction and otoliths analyzed via laser-ablation ICP-MS.

4: Pathways of contaminant movement tend to focus on large-scale drivers in the Canadian Arctic. We hypothesize that aquatic insects represent a possible vector of metals and ARGs to pristine ecosystems not physically connected to wastewater flows. Emergent insects from the wastewater pathway and reference locations will be captured over the course of the off-ice season, identified, and their metals and ARGs quantified.

5: Standard toxicity bioassays have been developed for many cosmopolitan species, but rarely do their ranges include the Arctic. This element will seek to develop and validate a laboratory-based plant bioassay to screen for contaminants in water and sediments. The test will have two aspects that a user could select; a seedling germination phase and a full plant phase. The data can be then used to screen for the impacts of effluent release, design of treatment wetlands, as well as remediation and restoration efforts at contaminated sites.

6: Shifts in microbial community composition is one of the more rapid biological changes that may occur in response to changing environmental conditions. Microbial communities will be assessed both by 16S and rRNA gene analyses, providing a broad assessment of microbial populations. The researchers' current Polar Knowledge grant (C.Wong, PI) will collect data during and after the 2018 spring melt, and this data will be used to help establish a baseline for microbial community composition for sites near the Baker Lake wastewater treatment system, providing data for reference and potentially impacted sites. This work would be extended to a 'before and after' analysis linked to implementation of a new wastewater treatment system.

7: Antibiotic resistance genes (ARGs) are a type of environmental pollutant, and are associated with the spread of pathogenic drug resistance. ARGs are naturally occurring in the environment, but may increase in abundance through selection by antibiotics. ARGs may also be introduced to new environments through human activities and specifically though wastewaters. We will determine the presence and abundance of known ARGs at near-site and reference lakes and determine if there is a correlation with wastewater and wastewater treatment.

8: The microbial populations that are active in northern climates can differ significantly from populations in temperate climates. Based partly on the data from 6 and 7 we will target selected microorganisms for further characterization, to understand their role in nitrification, denitrification, and antibiotic resistance. A large majority of cold-climate bacteria remain uncultured and we will target these to provide insights into metabolic pathways and gene function. By characterizing the composition and functions of northern wastewater microbial communities, molecular analyses will provide baseline data for optimizing such processes, and evaluate potential risks from antibiotic resistance proliferation.

9: Arctic fishes are often energy-limited, and freshwater Arctic ecosystems can be quite sensitive to nutrient inputs. We hypothesize that fishes living in Airplane Lake will have relatively higher lipid content, growth rates, and condition than fishes living in Baker Lake (prior to the treatment upgrade). Indicators of exposure to contaminants, including GSI and LSI, will also be higher in Airplane Lake than in Baker Lake prior to treatment upgrade. We predict that the new treatment system will result in a decline in indicators of contaminant exposure in fishes in Airplane Lake. Fish growth rates and condition many also decline as nutrient inputs decrease.

2.2.4 Timeline

Initial field work is planned to commence in summer 2018, following further community consultations this spring. Field studies will continue over a five-year duration, including a pre- and post-construction monitoring period. Construction of a new water treatment facility is tentatively planned for 2020.

2.2.5 Project Deliverables

As a large scale, multi-faceted research study, a suite of publications is expected as an outcome of this project. Specifically, these will include guidelines for passive wastewater treatment system design in Arctic regions, assessments of microbial system functions, ARGs and trace metal sources, transport pathways and environmental risks associated with Arctic wastewater systems, development of a toxicity assay for Arctic macrophytes, and analysis of changes in resident fish at organism and population scales in response to upgrades in water treatment technologies. Ultimately, observed responses of fish communities can be related to changes in water chemistry and lower trophic levels, which are significant components of fish habitat quality.

Along with written publications, researchers will present their studies at scientific meetings, providing experience and developing skills of graduate students.

Outside of the traditional scientific arena, this project has received strong community support in its early stages, and Agnico is fully engaging their Community Relations department to assist researchers in developing a program for consultations and capacity building within the Baker Lake community in regards to this project.

Though costs are not included as a complementary measure, this work will facilitate construction of an optimal wastewater treatment system for the community, which is a clear tangible benefit.

2.3 CHARACTERIZATION OF FISH HABITAT PREFERENCES

In recent years, HEP models for northern species have commonly been based on HSIs developed from Richardson et al. 2001, which itself identified a significant data gap surrounding habitat preferences of these fishes. In order to develop this body of available information and help reduce uncertainty in future habitat assessments, Agnico will help to facilitate one or more research studies on habitat preferences of fish common to the Meadowbank area. Currently, three projects related to fish habitat preferences are proposed.

2.3.1 Lake Fish Habitat Preferences

2.3.1.1 Introduction

In order to work towards updating HSIs for northern lake fish species, Agnico is proposing to collaborate with a team of researchers from various academic institutions and DFO, to support a literature review and field assessment of northern fish species' habitat associations.

The research team would be lead by Dr. Susan Doka (DFO Central and Arctic Region), and would include Tom Hoggarth, Liz Patreau, Bev Ross and Martyn Curtis (DFO Fisheries Protection Program and Ecosystem Management), Drs. Mike Rennie & Nandakumar Kanavillil (Lakehead University), Dr. Ken Minns (DFO Science Emeritus & University of Toronto), Drs. Neil Mochnacz, Paul Blanchfield (DFO Science), as well as graduate students to be determined.

Initially, Agnico is proposing to provide in-kind support for travel and accommodations of field crews on their Meadowbank site for this project, but this involvement could be extended depending on evolution of the study and interests of the MFRAG. More details on initial proposed budgets and levels of support for each project are provided in Section 2.5.

The objectives and methods below were provided by Dr. Doka.

2.3.1.2 Objectives

1. To systematically review the literature and compile unpublished information on northern fish species and their habitat associations and environmental tolerances since the last compilation of data was generated for lakes (Richardson et al 2001). Rivers (last reviewed in Evans et al 2001) may be addressed at a later date. This compilation may include the fish-out database held by DFO Science Winnipeg (Hedges, unpub data).

2. To outline data gaps in our knowledge of northern species and their life-cycle habitat needs and environmental tolerances that would be related to impacts from mining and offset creation or improvements.

3. To sample northern fish communities of several lakes in Nunavut in natural, impacted and offset areas to compare to the literature and data findings above and fill data gaps locally required for an evidence-based approach to calibrating, validating and standardizing evaluation methods for habitat loss and offsets for major projects in the area.

4. To scope the area for a future telemetry project to address a known gap, namely overwintering habitat usage.

2.3.1.3 Methods

Literature review: Following closely the Centre of Environmental Evidence guidelines for systematic literature review, a graduate student with Lakehead University under the cosupervision of Dr. Mike Rennie and Dr. Susan Doka will review primary and grey literature sources as well as canvas for unpublished data (e.g. Golder & Associates 2016) on up to 40 northern species with current fish distributions in lakes of Nunavut and the Northwest Territories.

Meta-analysis and gap analysis: The data extracted from the review will be analyzed using appropriate statistical methods to synthesize the information by life stage (4 stages: spawning, nursery, juvenile and adult habitats) for 40 northern fish species with ranges in Nunavut and the Northwest Territories. Habitat variables of interest include: substrate associations, thermal tolerances and preferends, timing windows, depth associations at different seasons, turbidity tolerances, species-species associations, flows and lake order, cover associations, pH and dissolved oxygen tolerances. Data and information from northern areas will be compared with new and existing information from more southern locales in North America.

Field Sampling: Working with Agnico Eagle Mines – Meadowbank Division to coordinate existing scientific work and travel, the graduate student and DFO support staff will work with consultants to sample up to 6 lakes. Lakes may include Baker Lake (an intended impact site), a proposed offset area, and 4 natural lakes in the vicinity. If possible another impacted lake will be sampled if technically feasible for travel. Techniques used to sample fish distributions will include acoustics (likely BioSonics DTX), trap nets or minnow traps and gill nets, and will link to ongoing e-DNA results (from a separate study) if available. Habitat sampling methods will include bottom acoustics (BioSonics), sediment grabs, longterm logger deployments and multiprobe sonde surveys. We will focus on gap filling if information is already available from the proponent or DFO for certain lakes.

2.3.1.4 Timeline

Initial field assessments will commence in summer 2018, and as currently proposed the study will be conducted over a two- to three-year duration (2018 – 2020).

2.3.1.5 Project Deliverables

The following project deliverables were provided by Dr. Doka.

CSAS or technical document on northern fish species and their habitat associations at northern latitudes to complement Richardson et al 2001.

Also to be included in the above document or separate paper(s):

- Statistical or meta-analysis of data to guide offsetting and restoration in the north as well as updates to tools like HEAT (CSAS SAR 2017, Abdel-Fattah et al 2017a,b and Abdel-Fattah et al 2018, Minns et al 1999).

- Data and knowledge-gap identification to be addressed by future research.

2.3.2 Arctic Grayling Occupancy Modeling

2.3.2.1 Introduction

As a complementary measure for the Whale Tail Pit project offsetting, Agnico is proposing to work with Dr. Heidi Swanson (University of Waterloo) to validate Arctic grayling occupancy models for use in the Kivalliq region, in follow-up to work she has previously conducted in the Northwest Territories[1]. The following background information on occupancy models was provided by Dr. Swanson.

2.3.2.2 Background

Evaluating the effectiveness of habitat offsetting measures requires robust and accurate data on fish populations both before and after enhancements have taken place. Obtaining these data in northern, remote environments is difficult and expensive. As a result, there is often a great deal of uncertainty around the findings.

All methods of fisheries monitoring have advantages and disadvantages, but obtaining robust and reliable data on fish abundance from standard techniques (such as three-pass depletion surveys) is especially problematic in the Arctic, where studies are expensive, logistics (and thus, often timing of surveys) are constantly changing, and backpack or big boat electrofishing (standard in many abundance three-pass depletion surveys) requires trained and certified operators and specialized equipment (which has to be shipped up from the south). In addition, to meet the required intensity of sampling required for abundance estimates, the spatial scale of abundance surveys is often small.

Occupancy surveys and occupancy models are a relatively new (~15 years) method of monitoring technique for animals. Instead of focusing on the number of animals, occupancy models focus on presence/absence. For each study, the spatial scale is carefully considered and adapted to reflect how far fish are expected to move, the scale at which habitats might be being selected, and the presence of any disturbance (or enhancement). Presence/absence of fish is then related to habitat characteristics, such as water depth, velocity, bank type, substrate, etc. When stakeholders need information about abundance, the models can give broad information about 'high,' 'medium,' and 'low' "states" of occupancy if the study and sampling are set up to achieve this. Also, unlike any other model, occupancy studies also consider the probability of detection – that is, if no fish were captured or observed, what was the chance that the fish were there, but weren't found? The probability of detection can then be related to habitat variables. For example, we might be less likely to find fish in a stretch of stream with large boulders – not because there are less fish, but simply because they are more difficult to catch. Probability of detection can also be related to factors that affect catchability such as the experience of the sampler, the substrate, and the weather. When we explicitly take into account how our ability to catch fish is affected by external factors, we are much better able to model the types of habitats that fish are using.

2.3.2.3 Objectives

Objectives of this work will be the development of occupancy models for Arctic grayling in the Meadowbank region, and a comparison of model fit and Arctic grayling habitat predictors in this area with those observed in the NWT.

2.3.2.4 Methods

[1] Baker, L.F., Artym, K.J., Swanson, H.K., 2017. Optimal sampling methods for modelling the occupancy of Arctic grayling (*Thymallus arcticus*) in the Canadian Barrenlands. Canadian Journal of Fisheries and Aquatic Sciences 74, 1564-1574.

Methods will involve characterizing occupancy of Arctic grayling in relation to habitat characteristics. Specifically this occurs through presence-absence surveys (visual, electrofishing) and assessment of habitat characteristics (stream width, depth, velocity, vegetation cover, bank formation, distance to overwintering habitat) for 30-m stream segments (number of replicates to be determined through initial field surveys). Study sites will include anthropogenically-impacted as well as reference systems in the Meadowbank and Baker Lake area.

As a component of previous No Net Loss Plans, Agnico has constructed habitat enhancement features for Arctic grayling spawning, and has been monitoring the success of these features over a number of years. In addition, Arctic grayling habitat may be impacted by wastewater treatment upgrades in the hamlet of Baker Lake, where changes in nutrient regimes and contaminants could affect use of this system by fish. Both of these habitat manipulations provide interesting opportunities to evaluate the use of occupancy models for the Kivalliq region, in comparison to reference systems.

2.3.2.5 Timeline

Initial reconnaissance and habitat characterizations for this study will begin in 2018, and the project is expected to be complete within three years.

2.3.2.6 Project Deliverables

The development and publication of occupancy models for this region will assist proponents and regulators in future assessments of potential new project impacts and design of offsetting measures for Arctic grayling habitat.

2.3.3 Pit Lake Habitat Assessments

2.3.3.1 Introduction

In recent years, significant uncertainty has arisen regarding the capability of pit lakes to act as fish habitat. While DFO previously accepted reflooded pit areas as habitat in offsetting plans, these areas are no longer considered habitat regardless of connectivity or modeled water quality. As a result, data regarding fish use in pit areas will no longer be regularly documented through standard monitoring programs. However, since multiple pits of various sizes at the Meadowbank site are planned to be reflooded in the relatively near term (2025 – 2029), there is an opportunity to thoroughly characterize fish use of pit lake habitat and population growth in re-flooded lakes through a research program.

Currently, monitoring for general fish presence using underwater camera or angling in lake basin areas adjacent to pits forms a component of Agnico's existing Habitat Compensation Monitoring Plan for the Vault pit. However, the proposed research program could intensify methods to document habitat preferences throughout the re-flooded basin and pit area through techniques such as telemetry and sonar, and further compare movements to reference lakes. This assessment could also be expanded to other pit areas (e.g. Phaser pit, Whale Tail Pit) which are not considered as fish habitat in offsetting plans and thus not planned to be monitored for fish use under compliance programs.

Due to the extended timeframe for this project compared to others (field work 2025+), specific researchers and methods have not been identified at this point. However, following approval of the study topic by DFO as a complementary measure, steps could begin to be taken towards preliminary project objectives to be completed in the years prior to commencement of field work, such as initial literature reviews and methods development.

2.3.3.2 Objectives

Characterize fish use of new pit lake habitat in relation to habitat and water quality variables, and particularly in relation to reference systems.

2.3.3.3 Methods

To be determined in consultation with the identified research team. Likely to include literature review and field assessment in multiple flooded pit areas at the Meadowbank site. Potential to collaborate across sites with other interested industry partners.

2.3.3.4 Timeline

Flooding of pits at the Meadowbank site is currently planned to be complete in between 2027 - 2029 (Phaser, Vault, and Whale Tail Pits), after which time field studies could begin. Initial literature reviews and methods development could occur in the years prior to pit reflooding, or Agnico could collaborate with other industry partners if appropriate sites are available in other locations in the nearer term.

2.3.3.5 Project Deliverables

Since significant uncertainty exists in the literature and between fisheries biologists regarding potential for fish use of habitat in flooded pit lakes, this research would help to provide a better foundation for assessing long-term impacts of development projects in the north on local fish populations.

2.4 EDNA METHODS DEVELOPMENT

2.4.1 Introduction

eDNA methods present a potentially useful tool for rapid and non-invasive assessments of fish communities, but have not been significantly developed or validated for Arctic systems. With their relatively low biodiversity and frequently isolated populations, Arctic lakes present a compelling location for eDNA research.

Since assessments of fish communities are conducted frequently for monitoring, fishout, or research purposes across the Meadowbank site, there are regular opportunities to pair eDNA analyses with data from traditional surveys, or to develop stand-alone research studies. Agnico is very interested in developing tools for estimating fish abundance and biomass, as well as furthering field tests for determining species presence/absence.

As a complementary measure for the Whale Tail Pit project, Agnico is proposing to provide partial support for the University of Manitoba COGRAD group's project on development and optimization of non-invasive monitoring tools based on DNA metabarcoding technology to measure fish species assemblage in Canada's Eastern Arctic Kivalliq Region of Nunavut. This project is currently being supported in part by the KIA, and in 2017 Agnico provided transit and accommodation onsite for two researchers to conduct an initial field reconnaissance and sample collection. The background, preliminary objectives, methods, and deliverables of this project as provided by the COGRAD research group are described below.

2.4.2 Background

It is necessary to efficiently monitor water quality and assess fish species distributions in aquatic ecosystem for their effective management and conservation. Traditional monitoring techniques which rely on physical identification of species remain problematic due to non-standardized sampling methods, cost, labour intensity, and their invasive nature. Traditional methods become even more difficult in remote Arctic areas. Hence, there is an urgent need for alternative, efficient and customized techniques for large-scale monitoring of fish populations.

Recently, the environmental DNA (eDNA) method for the direct detection of specific DNA from water has been recognized as a powerful tool for monitoring aquatic species. eDNA– defined as: genetic material obtained directly from environmental samples without any obvious signs of biological source material – is an efficient, non-invasive and easy-to-standardize sampling approach. Coupled with sensitive, cost/field time-efficient and ever-advancing DNA sequencing technology, it may be an appropriate candidate for the challenge of biodiversity monitoring in remote Arctic areas.

2.4.3 Objectives

The main goal of this project is to develop and optimize monitoring tools based on eDNA metabarcoding technology to assess fish species assemblages in in Canada's Eastern Arctic Kivalliq Region of Nunavut and population changes near the Amaruq mine site.

Objectives are:

1. Development and optimization of the eDNA metabarcoding technique adapted for arctic and mining environment aiming the Amaruq site and utilizing the method as a substitute for current fish species determination approaches.

2. Producing guidelines for handling and analyzing of samples and deliver the method and provide training to the local community.

3. Produce long-term reliable and precise baseline data on the distribution of aquatic associated fish species in the Amaruq mine site lakes using developed eDNA technology.

4. Producing data on the physiochemical properties of the lake water including dissolved mineral content to understand if any changes in stated parameters affect the eDNA/fish assemblage results.

5. Examine the impact of flooding Whale Tail Lake South Basin with the coincident changes in physiochemical properties of the aquatic area (e.g., increase in turbidity, dissolved solids) on the fish population using developed eDNA technique.

6. Collecting baseline eDNA and water quality data on lakes nearby Amaruq mine site outside the mining activity (potential candidates include B3 or DS1) and use them as a control for population changes.

2.4.4 Methods

We are proposing a 5-year plan that would involve development and utilizing eDNA metabarcoding approach in order to measure fish assemblage in the Amaruq areas. Environmental DNA metabarcoding technology will be developed and optimize to detect fish species including Arctic Char, Arctic Grayling, Lake Trout, Cisco, Round Whitefish, Burbot, Slimy Sculpin, Ninespine Stickleback, Hybridized Lake Trout/Arctic Char and analyze their relative abundances. For water quality data, temperature, pressure, dissolve oxygen, pH, salinity, conductivity, and dissolved metals including Cu/ Zn/ Cd/Fe/Hg/Mn will be measured (some metrics may be obtained through regular compliance monitoring programs).

Water samples for all parameters will be collected through three sampling period in each year; at melt, midsummer, and immediately prior to freeze up. First round of sampling was done before mining activity starts (July 2017). The second round of sampling will be done at the start and during mining operation and the final round of sampling will be done after mining operations have ceased. The result will be used to assess the influence of mining activity on changes in fish species populations, as measured through eDNA methods.

2.4.5 Timeline

This project is currently proposed to occur over an additional three year field study period (2017 – 2020), and a five-year total time frame.

2.4.6 Project Deliverables

Once optimized for mining restoration, eDNA metabarcoding could allow industry specialists to identify indicators of successful restoration and evaluate restoration with greater frequency and spatial resolution. In addition, biological recovery may be tracked over multiple mining sites to determine if there is a predictable trajectory. This opens up the possibility of effective adaptive management, informing researchers and industry specialists when intervention may be necessary to achieve restoration goals.

Education and training of the local community on collection, storage, shipment of samples to the U of M is a priority, and will be provided by members of the U of M. COGRAD commits to support, involve, or engage Indigenous organizations in this project. We intend to install a rigorous Field Sampling Protocol and to train and educate local people to assist in the project. In addition, we will establish a team at the U of M composed of fish experts (Department of Biological Science) in conjunction with Analytical Chemists (MCAL) and experts in remote sensing.

2.5 LEVEL OF SUPPORT, STUDY TIMELINES, AND DURATION

For each proposed project, the level of support provided by Agnico may differ. Based on initial consultation with each researcher and the funding available as determined by the cost estimate provided to DFO (March, 2018), the estimated value of Agnico's contributions for each study are shown in **Table *1***.

Table 1. Estimated value of direct monetary and in-kind support to be provided by Agnico Eagle for each complementary measure (research project) proposed as fish habitat offsetting for Whale Tail Pit[2].

Project	Researcher[3]	Type of Support	Study Start Date	Study Duration	Estimated Contribution (rounded)[4]
Changes in Aquatic Productivity	Dr. Heidi Swanson, University of Waterloo	Full funding	Summer 2018	3-4 years	$100,000
Baker Lake Wastewater Assessment	Dr. Rob Jamieson, Dalhousie University (et al.)	Partial funding – industrial partner in NSERC CRD (application to be submitted)	Summer 2018	5 years	$630,000
Lake Fish Habitat Preferences	Dr. Susan Doka, DFO Science (et al.)	Mainly in-kind support	Summer 2018	2 years	$50,000
Arctic Grayling Occupancy Modelling	Dr. Heidi Swanson, University of Waterloo	Full funding	Summer 2018	3 years	$150,000
Pit Lake Habitat Assessment	TBD	TBD	TBD	5 years	$450,000
eDNA Methods Development	University of Manitoba COGRAD group	Partial funding	Summer 2018/2019	3-5 years	$240,000
TOTAL Contributions (as calculated through LOC)					$1,618,046.22

2.6 MFRAG, PLAN REVIEW AND UPDATES

A Meadowbank Fisheries Research Advisory Group (MFRAG) will be established to review and approve any changes to research projects proposed under the Fish Habitat Offsetting Plan for Whale Tail Pit. This group will include DFO, Agnico Eagle, KIA, HTO and a third party research advisor. The MFRAG will meet annually to review project progress reports, propose and approve or reject new projects or project components, and assess whether criteria for success have been met.

[2] The contributions are based on the most current available information and may be subject to change. The total Agnico Eagle contribution will be prescribed by DFO, in accordance with agreed upon LOC calculations
[3] Partnerships with KIA, Baker Lake hamlet and DFO are established for respective projects.
[4] Funding is an estimate. Agnico Eagle expects funding to be leveraged by researchers and their respective institutions through additional grant applications. As a result, based on previous experience, it is possible that total project expenditures could double, benefiting the researchers and research projects.

This plan describing complementary measures for Whale Tail Pit fish habitat offsetting will be updated annually to reflect changes and progress in research projects and to track project funding to date.