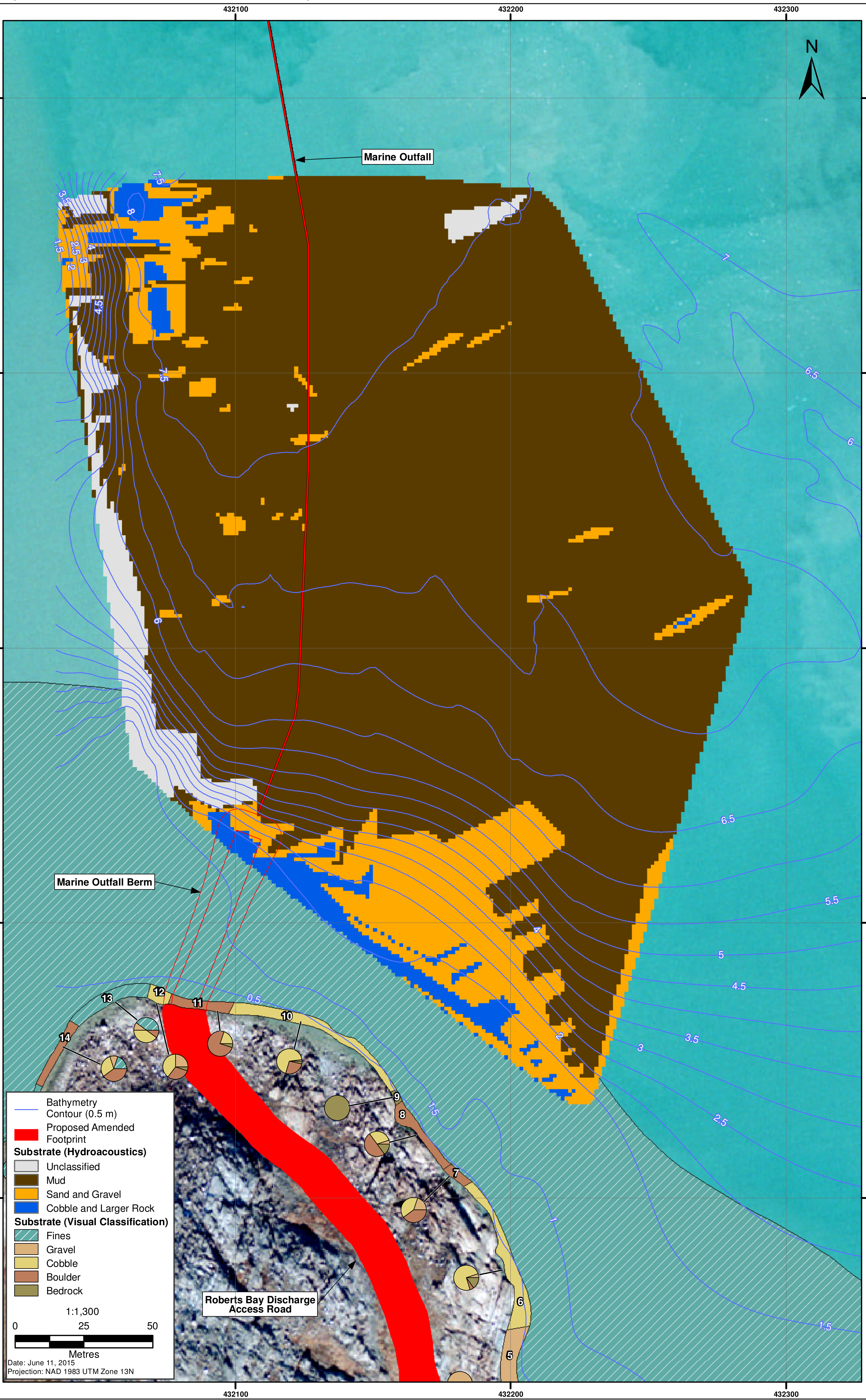
Figure 4.4-4

Substrate Composition in the Vicinity of the Proposed Marine Outfall Berm in Roberts Bay from Hydroacoustic and Underwater Video Surveys, 2010



Marine Fish Community

Out of the total 20 species captured over the last decade in Roberts Bay, 14 fish species were encountered during most recent 2009 and 2010 fish community studies (Tables 4.4-3 and 4.4-4; Rescan 2010b, 2011a). The majority of the 14 fish species recently found in Roberts Bay are marine in habitat preference, but some, like the Arctic flounder and starry flounder, are known to enter low-salinity habitats (Walters 1955). Others, which are known to be strictly marine fish species have been captured in freshwater systems, likely a result of the fish remaining in areas of tidal influence (i.e., in the salt wedge underneath the surface freshwater layer). Five salmonid species are exceptions to this rule. Arctic Char and some local populations of Lake Trout encountered in 2009 and 2010, in addition to Arctic Cisco, Lake Whitefish and Least Cisco from previous studies (Golder 2007, 2008), are anadromous, meaning they spawn and rear in freshwater but migrate to the sea on a seasonal basis to forage (W. B. Scott and E. J. Crossman 1973; W.B. Scott and E.J. Crossman 1973). Ninespine Stickleback have three life-history types: freshwater, brackish, and anadromous (Arai and Goto 2005). The sticklebacks captured in this study followed either an anadromous or brackish water life history.

Saffron cod, Pacific Herring and Sculpin species were the most abundant species captured during gillnet sampling in the vicinity of the marine outfall berm during 2009 (Rescan 2010b), whereas in 2010, Fourhorn Sculpin, Saffron Cod and Greenland Cod dominated the catch (Rescan 2011a). Differences in species composition could be observed between early (late July/Early August) and late (late August/early September) sampling periods (Rescan 2010b, 2011a). For example, in 2009, Pacific Herring (40%) dominated catches during the early sampling period, whereas Saffron Cod were most prevalent (63%) later in the summer. Moreover, although Arctic Char only comprised 1% of captures during early sampling in 2010, later in the summer, captures constituted 21% of the catch. Relatively high numbers of capelin and Pacific herring were caught in 2003 and 2007 (Golder 2003, 2008) due to a focus in those two years on intercepting along-shore fish migrations. Sampling in 2009 caught more pelagic and bentho-pelagic species because more sampling effort was expended with gillnets in offshore areas than in previous years (Rescan 2010b).

Roberts Bay Fish Habitat Compensation Monitoring

As part of the Doris North Project infrastructure, a rock jetty was constructed in early July 2007 at the south end of Roberts Bay for barge loading and off-loading. The jetty was constructed perpendicular to shore and measured 95 m in length, varying in width from 5.3 to 35 m (Rescan 2009a).

The construction of the jetty resulted in the alteration and/or loss of 0.176 ha of fish habitat. To compensate, four underwater rock reefs (or shoals), each measuring 31.25 m long by 12 m wide and spaced approximately 19 m apart, were constructed west of the jetty in 2008. The four compensation shoals were equivalent to 0.150 ha of fish habitat. In combination with the below high-water side-slope area of the jetty (0.164 ha) which would provide additional habitat for fish and invertebrates, the net gain of fish habitat is equivalent to 0.138 ha.

Authorization for the construction of the jetty in Roberts Bay was granted from Transport Canada and Fisheries and Oceans Canada (DFO) in June 2007. The Fisheries Authorization (DFO File No: NU-02-0117) granted for the construction of the jetty addresses the following conditions for monitoring in Roberts Bay:

- the implementation of a sediment transportation and deposition monitoring program;
- a photographic record of construction activities (*completed in 2008*); and
- The implementation of a fish habitat monitoring program.

For the sediment transportation and deposition monitoring program, bathymetric comparisons of Roberts Bay pre-construction and Year-3 post-jetty construction showed similar patterns to what was observed during Year-1 and Year-2 post-jetty comparisons (Rescan 2009a, 2010c). Changes in bed elevation in Roberts Bay were observed to the north and east of the jetty. Other observations with respect to change in bed elevation may be related to variability of detailed data for that area or steepness of slope.

The fish habitat monitoring program was developed to monitor the stability and successful use of fish habitat compensation structures, specifically the jetty and shoals in Roberts Bay. As part of this program, the following components were sampled at the jetty and compensation shoals in Roberts Bay: periphyton biomass (as chlorophyll *a*), cell density and taxonomic composition; benthic invertebrate density and taxonomic composition; fish community composition and catch-per-unit-effort (CPUE); and macroalgae community composition and percent cover (Rescan 2009a, 2010c).

Results of the first year of monitoring (Rescan 2009a) indicated that periphyton and benthic invertebrate communities had established themselves on the compensation shoals in Roberts Bay. Periphyton assemblages were numerically dominated by blue-green algae and diatoms. The benthic invertebrate community composition on both the jetty and compensation shoals was dominated by amphipods, followed by polychaetes.

Year-2 monitoring results confirmed that periphyton and benthic invertebrate communities had established themselves on the compensation shoals in Roberts Bay (Rescan 2010c). Periphyton assemblages were again numerically dominated by cyanobacteria and diatoms. The filamentous cyanobacterium, *Anabaena cylindrica*, was the most abundant species on Roberts Bay shoals. The benthic invertebrate community composition was dominated by amphipods. *Lagunogammarus setosus* and *Ischyrocerus anguipes* were the most abundant species on the compensation shoals.

From minnow trap and crab trap efforts, a total of 19 fish from two species were captured at the Roberts Bay shoals (Rescan 2010c). The jetty, which was only sampled during the July sampling period, yielded a total of 16 fish from two species. Overall, saffron cod and fourhorn sculpin were the dominant species by number for the shoal habitat and side-slopes of the jetty in Roberts Bay.

Visual snorkel surveys indicated that various genera of algae, invertebrates and fish were inhabiting and/or utilizing the compensation structures. Macro-algae were not visually plentiful on the shoals or the jetty in Year 1. This was expected given that the compensation structures in Roberts Bay were new habitat and the natural succession of the algal communities was expected to take several years.

Euphausiids (krill, of the order Euphausiacea) were the most abundant invertebrate observed throughout the visual surveys conducted in Roberts Bay. This shrimp-like crustacean plays a key role in marine food webs as it is known to be a main prey item to many marine vertebrates.

Table 4.4-3. Life History Characteristics of Fish Species Captured during Marine Fish Community Surveys in Roberts Bay

Species	Scientific Name	Primary Habitat-Depth Range	Spawning		Fry Emergence	Habitat Preference		
			Timing	Habitat Preference	Timing	Juvenile Rearing	Adult Rearing	Overwintering
Arctic Char (anadromous)	*Salvelinus alpinus*	Marine-Benthopelagic/ Freshwater	Sept - Oct[1]	Freshwater lakes[1]	April - July[2]	Freshwater lakes and rivers[1]	Marine, nearshore coastal areas, benthopelagic[1]	Freshwater lakes[1]
Arctic Cisco (anadromous)	*Coregonus autumnalis*	Marine/Freshwater	Sept - Oct[4]	Freshwater rivers[3]	May - June[4]	Marine, nearshore, shallow brackish[3]	Marine, nearshore, offshore, near surface	Marine, nearshore brackish water, freshwater rivers[3,4]
Arctic Flounder	*Liopsetta glacialis*	Marine-Demersal	Jan - June	Marine, Shallow coastal areas	15 days after spawning	Marine, nearshore, shallow brackish	Marine, nearshore, offshore, demersal	Marine, nearshore, offshore, benthic[5]
Arctic Shanny	*Stichaeus punctatus*	Marine-Demersal	Feb - Mar[10]	Marine, subtidal, boulder and cobble substrates[10]	July - August[10]	Marine, subtidal, gravel and cobble substrates[10]	Marine, subtidal, boulder and cobble substrates[10]	Marine, subtidal, boulder and cobble substrates[10]
Banded Gunnel	*Pholis fasciata*	Marine-Demersal	-	Marine, benthic, shallow subtidal[5]	May - June[11]	Marine, benthic, shallow subtidal[5]	Marine, benthic, shallow subtidal[5]	Marine, benthic, shallow subtidal[5]
Capelin	*Mallotus villosus*	Marine-Pelagic	Mid July - late Aug	Marine, sand and gravel beaches with strong wave action	15 days after spawning	Midwater in estuaries and offshore marine areas	Marine, offshore	Marine, offshore
Fourhorn Sculpin	*Triglopsis quadricornis*	Marine-Demersal	Mid-winter	Marine, benthic, nearshore, gravel substrate	3 months after spawning	Marine or brackish, very shallow, nearshore	Freshwater, brackish, marine nearshore, demersal	Marine, nearshore, lakes
Greenland Cod	*Gadus ogac*	Marine-Demersal	Mar - Apr[8]	-	Apr - May	Marine or brackish, demersal[8]	Marine and brackish, marine nearshore, demersal[7]	Marine, nearshore, estuaries[8]
Lake Trout (anadromous)	*Salvelinus namaycush*	Marine-Benthopelagic/ Freshwater	Oct - Nov[2]	Freshwater lakes	March - April[2]	Freshwater	Freshwater, brackish, benthopelagic	Freshwater
Lake Whitefish (anadromous)	*Coregonus clupeaformis*	Marine-Benthopelagic/ Freshwater	Nov - Dec[2]	Freshwater rivers and lakes	April - May[2]	Freshwater or brackish[5]	Freshwater, brackish, benthopelagic[5]	-
Least Cisco (anadromous)	*Coregonus sardinella*	Marine-Benthopelagic/ Freshwater	Sept - Nov[5]	Freshwater, deep pools of rivers and lakes over sand and gravel substrates[2]	Spring[2]	Marine, nearshore, estuaries, move downstream to sea upon hatching[2]	Freshwater (upriver migration in spring and summer), marine, nearshore, estuaries (downstream migration following spawning)[2]	Estuaries, brackish water[12]
Longhead dab	*Limanda proboscidea*	Marine-Demersal	June - Sept[5]	Marine, benthic, shallow[5]	July - Oct	Marine, benthic, shallow[5]	Marine, benthic, shallow[5]	Marine, benthic, shallow[5]
Ninespine Stickleback	*Pungitius pungitius*	Marine-Benthopelagic/ Freshwater	Spring[5]	Freshwater, nearshore areas in lakes, ponds, streams[5]	15 days after spawning	Freshwater or brackish, shallow, sheltered	Brackish, shallow, sheltered	Freshwater, brackish
Pacific Herring	*Clupea pallasii*	Marine-Pelagic	June-Sept	Protected nearshore brackish areas, clean substrate or algae	July	Marine or brackish, nearshore	Marine, offshore, pelagic	Marine, offshore
Poacher[a]	-	Marine-Demersal	-	-	-	-	-	-
Saffron Cod	*Eleginus gracilis*	Marine-Demersal	Feb - Mar	Marine, nearshore, under ice, clean sand or pebble substrate	April - June	Marine or brackish, nearshore, shallow (< 25 m)	Marine or brackish, nearshore occasionally offshore, demersal	Marine or brackish
Sand Lance[b]	*Ammodytes americanus*	Marine-Dermersal	Nov - Feb	Marine, nearshore, bottom-dwellers	Jan - April	-	-	-
Shorthorn Sculpin	*Myoxocephalus scorpius*	Marine-Dermersal	Nov - Dec[9]	Marine, nearshore, rocky bottom[9]	Mid-March to mid-April[9]	Marine or brackish, mid-water benthic[9]	Marine or brackish, nearshore, demersal[5]	Marine or brackish[5]
Snailfish[c]	-	Marine-Demersal	-	-	-	-	-	-
Starry Flounder	*Platichthys stellatus*	Marine-Demersal	Spring	Marine, shallow nearshore	5 days after spawning	Estuaries, rivers, shallow marine nearshore	Brackish or marine, demersal, shallow to mid-water, sand and mud substrate, low salinity	Marine, deep water up to 300 m

Notes:

Species in bold were captured during most recent 2009 - 2010 surveys.

Dashes indicate information not available.

Demersal = bottom feeders; Pelagic = feed in open water; Benthopelagic = feed in open water and on bottom

[1] *DFO 2004;* [2] *Scott and Crossman 1973;* [3] *Fechhelm et al. 1999;* [4] *Gallaway et al. 1982;* [5] *Froese and Pauly 2013;* [6] *Reist and Chang-Kue 1997;* [7] *Mikhail and Welch 1989;* [8] *Morin et al. 1991;* [9] *Ennis 1970;* [10] *Farwell et al. 1976;* [11] *Ochman and Dodson 1982;* [12] *Craig et al. 1985*

[a] *Exact species unconfirmed , no information available on life history timing.*

[b] *Species unconfirmed but likely northern sand lance, Ammodytes americanus, based on geographical position, and inshore capture.*

[c] *Exact species unconfirmed, but possibly Liparis fabricii; no information available on life history timing.*

Table 4.4-4. Spawning and Fry Emergence Timing for Confirmed Marine Species in Roberts Bay

Species	Life stage	Habitat	Substrate	Month: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Arctic Flounder	Spawning	Marine, Shallow coastal areas	Mud bottoms (fines)	■	■	■	■	■	■						
	Fry emergence	Marine, Shallow coastal areas	Mud bottoms (fines)		■	■	■	■	■	■					
Arctic Shanny	Spawning	Marine, subtidal	Cobble/boulder		■	■									
	Fry emergence	Marine, subtidal	Cobble/boulder							■	■				
Banded Gunnel	Spawning	Marine, benthic, shallow subtidal	-												
	Fry emergence	Marine, benthic, shallow subtidal	-					■	■						
Capelin	Spawning	Marine, beaches with strong wave action	Sand/gravel							Mid	■				
	Fry emergence	Marine, beaches with strong wave action	Sand/gravel							Late	■	Early			
Fourhorn Sculpin	Spawning	Marine, benthic, nearshore	Gravel	Mid winter	■										
	Fry emergence	Marine, benthic, nearshore	Gravel				■	■							
Greenland Cod	Spawning	Marine, benthic, nearshore	-			■	■								
	Fry emergence	Marine, benthic, nearshore	-				■	■							
Longhead Dab	Spawning	Marine, benthic, shallow	Mud (fines)/Sand						■	■	■	■			
	Fry emergence	Marine, benthic, shallow	Mud (fines)/Sand							■	■	■	■		
Pacific Herring	Spawning	Protected nearshore brackish areas	-						■	Little information on exact timing	■	■			
	Fry emergence	Protected nearshore brackish areas	-							■	Little information on exact timing	■	■		
Poacher[a]	Spawning	Marine, bottom-dwellers	-												
	Fry emergence	Marine, bottom-dwellers	-												
Saffron Cod	Spawning	Marine, nearshore, under ice	Sand/gravel		■	■									
	Fry emergence	Marine, nearshore, under ice	Sand/gravel				■	■	■						
Sand Lance[b]	Spawning	Marine, nearshore, bottom-dwellers	Sand	■	■									■	■
	Fry emergence	Marine, nearshore, bottom-dwellers	Sand	■	■	■	■								
Shorthorn Sculpin	Spawning	Marine, nearshore	Rocky											■	■
	Fry emergence	Marine, nearshore	Rocky			■	■								
Snailfish[c]	Spawning	Marine	-												
	Fry emergence	Marine	-												
Starry Flounder	Spawning	Marine, shallow nearshore	Sand			■	Spring	■							
	Fry emergence	Marine, shallow nearshore	Sand			■	Spring	■							

Notes:

Species in bold were captured during most recent 2009 - 2010 surveys.

Dashes indicate data not available.

Yellow and green highlighted cells refer to spawning and fry emergence timing, respectively.

[a] *Exact species unconfirmed, no information available on life history timing.*

[b] *Species unconfirmed but likely northern sand lance (Ammodytes americanus), based on geographical position and inshore capture.*

[c] *Exact species unconfirmed, but possibly Liparis fabricii; no information available on life history timing.*

Various species of adult, juvenile and young-of-the-year fish were observed during snorkel surveys in Roberts Bay (Rescan 2009a, 2010c). Young-of-the-year fish (probably gadids) were the most common fish observed on the shoals. Their abundance shows that the jetty and shoal structures provide shelter and/or a food source for fish.

In summary, monitoring of the compensation structures in Roberts Bay showed enhancement success as defined in the Fisheries Authorization. Primary and secondary producers have established themselves on the rock shoals and the side-slopes of the jetty of Roberts Bay. In addition, the monitoring program has documented the use of the shoals and rip-rap slopes of the jetty by fish prey and fish of multiple age classes.

4.4.3 Marine Birds

Marine birds surveys have been conducted in Roberts Bay from 2006 to 2010. Aerial surveys as well as ground-based nesting surveys have been conducted for some or all of the survey years. In addition, a ship-based survey was conducted in the late summer of 2010 in order to document the distribution of seabirds in Roberts Bay and Melville Sound.

Table 4.4-5 presents the seabirds that have been recorded in Roberts Bay. Twelve species of seabirds have been found to use Roberts Bay for foraging, travel, or staging. This list does not include shorebirds that nest near the shore and use the terrestrial areas surrounding the bay, such as sandpipers and plovers.

Table 4.4-5. Seabirds Present in Roberts Bay

Common Birds	Species Name	Occasional/ Incidental	Species Name
Common Eider	(*Somateria mollissima*)	King Eider	(*Somateria spectabilis*)
Red-breasted Merganser	(*Mergus serrator*)	Yellow-billed Loon	(*Gavia adamsii)*
Pacific Loon	(*Gavia pacifica*)	Common Loon	(*Gavia immer*)
Long-tailed Duck	(*Clangula hyemalis*)	Tundra Swan	(*Cygnus columbianus*)
Canada Goose	(*Branta canadensis*)		
Red-throated Loon	(*Gavia stellata*)		
Herring Gull	(*Larus argentatus*)		
Glaucous Gull	(*Larus hyperboreus*)		

4.4.3.1 Aerial Surveys

Aerial surveys for marine birds have been conducted from 2006 to 2010. In 2009 and 2010, the survey area was increased from 225 km^2 to 475 km^2, and included Roberts Bay, Hope Bay, and Reference Bay. Surveys were timed to coincide with two important periods: the northern migration/establishment of nesting territories and the brood rearing/fall staging period.

During 2009, one aerial survey was conducted in July and five surveys were conducted in August. Surveys were conducted along 11 parallel survey transects spaced 2 km apart and covering the coastal area of Hope Bay, and both Roberts Bay and Reference Bay. The total numbers of birds ranged from 3 to 133 in Roberts Bay, 9 to 72 in Hope Bay and 3 to 90 in Reference Bay. The results for Roberts Bay were increased by a single group of 85 long-tailed ducks. Without that one group, Roberts Bay consistently contained the lowest number of seabirds.

During 2010, three aerial surveys were conducted in July and four in August. Roberts Bay had the lowest number of birds: from three to 28 in July and from two to 15 in August. Also, more birds were observed in August than in July in all inlets. The total number of birds in Hope Bay ranged from 39 to 97 in July, and from 72 to 146 in August. In Reference Bay, the number of individual birds ranged from 18 to 30 in July and from 12 to 79 in August.

In 2010, the five most abundant species were: herring gull, red-breasted merganser, glaucous gull, common eider, and Pacific loon. Long-tailed ducks were absent from all surveys in 2010, but the number of both glaucous and herring gulls were higher in 2010 than in 2009.

Seabird densities calculated during periods of low marine traffic (i.e., August 2009 and July 2010) were not statistically different than those calculated during periods of high marine traffic (i.e., August 2010). These results suggest that the increase in marine traffic did not have a detectable effect on seabird densities in Roberts Bay.

4.4.3.2 Barge Survey

A barge survey was conducted aboard the “Sea Commander” vessel from August 10 to 12, 2010. During the survey, one observer scanned for seabirds and marine mammals from either the port or starboard side of the vessel; the observer selected the side that had the least wind and glare to minimize error in species identification. The observer scanned from the bow of the vessel to a bearing of 270° (port side) or 90° (starboard side) from the bow. Survey speed varied from 4 to 7 knots (7 to 13 km per hour). The survey involved the vessel travelling from the Roberts Bay jetty to Cambridge Bay and back.

The seabirds identified on the survey included three common murres and four pacific loons. In addition, two unknown loons and one unknown gull were observed. These unknown birds likely belong to the several gull and loon species known to occur in the area (Table 4.4-5). None of the identified species are of conservation concern in Nunavut. The common murres were observed near the narrow entrance into Melville Sound. Three of the pacific loons were observed in the same area as the common murres. The fourth pacific loon was observed in upper Bathurst Inlet, along with the unknown loons and gull.

4.4.3.3 Nesting Surveys

Ground-based searches for nesting seabirds were conducted during July in 2006, 2009, and 2010 on islands smaller than 20 ha in Roberts Bay, Hope Bay, and/or Reference Bay. Thirteen islands were surveyed in 2006 in Hope Bay (12 islands) and Roberts Bay (one island). In 2009 and 2010, all three inlets were surveyed. During 2009, 41 islands were surveyed and 3 nests were observed, although none of them were seabirds (2 in Roberts Bay). 2009 was a poor year for surveying due to a very late spring and poor summer weather conditions. During 2010, 87 islands were surveyed and 28 active nests were recorded, four of which were located in Roberts Bay. In each of these surveys, Roberts

Bay contained the least available island habitat for seabird nesting and consequently the lowest numbers of nesting birds.

In July 2006, searches of 13 islands in Hope Bay and Roberts Bay yielded three common eider nests (one depredated) an one red-breasted merganser nest. All nests were located in Hope Bay. Two eider nests had clutch sizes of six and three, while the red-breasted merganser had a clutch size of seven. Common eiders were often seen in the area while red-breasted merganser sightings were less frequent (Miramar 2007).

In 2009, only three nests were found, none belonging to seabirds. Mixed groups of common eiders and red-breasted mergansers were often noted on island beaches. The lack of nesting activity was attributed to poor weather, a late spring, and high ice coverage in mid-July.

In 2010, 28 active nests were found, five belonging to seabirds: four common eider and one red-breasted merganser nests. Twenty-two glaucous gull nests were found and one herring gull nest. In addition, one semipalmated plover pair with a young chick was observed.

4.4.4 Marine Mammals

Three species of marine mammals, the beluga whale (*Delphinapterus leucas*), ringed seal (*Pusa hispida*), and bearded seal (*Erignathus barbatus*), have been observed in marine environments surrounding the Doris North Project. Beluga whale are infrequent summer visitors to Bathurst Inlet based on historical evidence (Stewart and Burton 1994; Priest and Usher 2004; NPC 2008a). Both seal species have a holarctic distribution and frequent the Bathurst Inlet and Coronation Gulf area throughout the year. Ringed seals are the more abundant of the two species (Priest and Usher 2004). This species is common throughout the Arctic, making it difficult to identify important areas of critical habitat. However, higher populations are known to occur in the eastern Arctic, including Lancaster Sound, Barrow Strait, and Baffin Island (NPC 2008a).

The range of narwhals is predominantly thought to occur in the eastern Arctic, with two populations; the Baffin Bay and Hudson's Bay populations. The area of narwhal habitat closest to the Project site is approximately 500 km east near Gjoa Haven (NPC 2008a). Narwhals have not traditionally been observed as far west as Bathurst Inlet. However, in 2011 a pod of narwhals was observed for the first time in recorded memory in Cambridge Bay (Alex Buchan 2011, pers. comm.).

Two survey methods were implemented for the documentation of marine wildlife in the regional study area. An aerial survey was flown in the early spring of 2010 to document the presence and distribution of seals on the pack ice in Melville Sound and the northern portion of Bathurst Inlet. Incidental observations of seals and seal holes were also recorded during aerial surveys for caribou during May of 2011. A ship-based survey was also conducted in late summer of 2010 between Cambridge Bay and Roberts Bay to document the presence of larger marine mammals, such as belugas, that may frequent the greater area in the summer.

4.4.4.1 Aerial Survey

Aerial surveys conducted during the spring of 2010 indicate that seals are quite common in Bathurst Inlet and Melville Sound. . During the aerial surveys on June 3, 4, and 5, 2010, seal and breathing hole observations within 500 m from either side of the helicopter were recorded. In addition, incidental observations of seals or breathing holes (i.e., observations greater than 500 m from the helicopter or during ferry flights to and from Doris Camp) were also recorded.

A total of 777 seals were observed during aerial surveys on June 3 to 5, 2010, comprised of 87 bearded seals, 386 ringed seals, and 322 unknown seals (Table 4.4-6). In addition, there were 129 observations of open breathing holes on the sea ice. Of the seals that were observed, a total of 48 bearded, 210 ringed, and 41 unknown seals were observed on transect. Of the breathing holes that were observed, 79 were observed on transect. The remaining observations were recorded incidentally.

Table 4.4-6. Results of the Spring Seal Survey, 2010

		Species									
		Bearded Seal		Ringed Seal		Unknown Seal		Total Seal Observations		Breathing Hole	
Survey Area	Transect	On[1]	Inc.[1]	On[1]	Inc.[1]	On[1]	Inc.[1]	On[1]	Inc.[1]	On[1]	Inc.[1]
Melville Sound	MS1	2	2	4			2	6	4	7	
	MS2	4	4	16		1	8	21	12	7	
	MS3	3	3	18	9	1	8	22	20	6	
	MS4	4	2	19	1	1	10	24	13	11	1
	MS5			4	4	1	2	5	6	7	
	MS6	7		8	6	4	4	19	10	7	1
	MS7	5		11		2	8	18	8	6	
	MS8	3		13	1		14	16	15	3	1
Coronation Gulf	CG1	2		57	4	5	65	64	69	12	1
	CG2	4	1	40	5	21	41	65	47	6	
	CG3	14	5	20	6	5	7	39	18	7	1
Transit to/from Doris Camp			22		122		112		256		45
Survey Total		**48**	**39**	**210**	**158**	**41**	**281**	**299**	**478**	**79**	**50**
Grand Total Observations		**87**		**386**		**322**		**777**		**129**	

[1] *On = Observed on transect, Inc. = incidental observation (more than 500 m from the helicopter or during ferry flights)*

Seals and breathing holes were more frequently observed in upper Bathurst Inlet and in the Coronation Gulf in comparison to areas within Melville Sound. The highest number of bearded and ringed seals per km was recorded on in the Coronation Gulf.

The relatively large number of unknown seals recorded during the spring seal survey results from seals frequently diving before positive species identification could be made. In addition, many seals were too far from the helicopter to enable positive species identification.

Incidental observations of seals and breathing holes were also collected on May 22, 2011, during a caribou survey. A total of 25 seals at breathing holes were observed, with one each in Roberts Bay and Reference Bay and the remainder (92%) in Hope Bay. Seal holes were more prevalent at a greater distance (i.e., 3-4 km) from shore, presumably to avoid predation from land-based predators such as wolverine. A wolverine was observed stalking a seal at an ice hole approximately 0.5 km from shore in Hope Bay. Due to the low numbers of seals and seal holes observed in Roberts Bay, this area is not considered an important area for seals during the winter.

4.4.4.2 Barge Survey

A barge survey was conducted aboard the "Sea Commander" vessel from August 10 to 12, 2010. During the survey, one observer scanned for seabirds and marine mammals from either the port or starboard side of the vessel; the observer selected the side that had the least wind and glare to minimize error in species identification. The observer scanned from the bow of the vessel to a bearing of 270° (port side) or 90° (starboard side) from the bow. Survey speed varied from 4 to 7 knots (7 to 13 km per hour). The survey involved the vessel travelling from the Roberts Bay jetty to Cambridge Bay and back.

Few marine wildlife species were recorded during the barge surveys from August 10 to 12, 2010. A total of two ringed seals, one bearded seal, and one unknown seal were observed. One ringed seal was recorded at the entrance of Roberts Bay while the other was recorded midway through Melville Sound. The bearded seal and the unknown seal were both observed at the entrance of Melville Sound.

4.5 POTENTIAL ENVIRONMENTAL EFFECTS

This section presents the potential interactions of the proposed Project (installation of subsea pipeline and diffuser in Roberts Bay) with the Roberts Bay environment including:

- Discharge of Tailings Impoundment Area (TIA) excess water and excess groundwater to Roberts Bay has the potential to influence the water quality of Roberts Bay; and
- Installation and decommissioning of the subsea pipeline and diffuser system has the potential to affect fish habitat.

Mitigation measures are presented that would reduce or eliminate potential effects.

4.5.1 Potential Interactions

The discharge of TIA effluent and and groundwater into Roberts Bay has the potential to interact with the following environmental components of Roberts Bay:

- Water quality;
- Sediment quality;
- Ice thickness;
- Marine fish and fish habitat; and
- Marine wildlife (marine mammals and seabirds)

The discharge of TIA effluent and groundwater to Roberts Bay has the potential to influence the water quality of Roberts Bay, as the concentrations of non-salt parameters in the discharge could be different than existing background concentrations in Roberts Bay. The TIA and groundwater discharge program has been designed to meet all discharge standards, as described in more detail below.

Sediment quality could potentially be influenced by the discharge of TIA effluent and groundwater to Roberts Bay. However, the subsea pipeline will end in a multiport diffuser, which will cause the discharge to rise, thereby reducing or eliminating the potential contact with the seabed sediments. Further details are described below.

The temperature of the TIA effluent and groundwater may not be identical to the temperature of Roberts Bay water at all times of the year. In order to address any concerns about the potential for the proposed Project to influence the timing or thickness of ice in Roberts Bay, the potential for changes in ice thickness are described below.

The installation of the subsea pipeline and diffuser system and associated infrastructure (e.g., marine outfall berm and ballast weights) has the potential to influence marine fisheries in Roberts Bay. A DFO self-assessment will be completed in advance of construction once detailed engineering is available and if serious harm is identified an Offset Plan will be developed and a DFO authorization obtained. A conceptual Marine Offset Plan is included in section 4.5.5.2. .

As the discharge of TIA effluent and groundwater to Roberts Bay has the potential to influence the water quality of Roberts Bay, there is the potential to influence the food sources for marine fish and wildlife (e.g. seabirds, mammals) in Roberts Bay. These potential interactions are dependent on the potential water quality changes and habitat changes. The proposed Project is being designed such that marine CCME guidelines for the protection of marine life will be met in Roberts Bay during the entire period of TIA and groundwater discharge. Marine CCME guidelines are Canadian national guidelines that are meant to be protective of all marine life, and by designing the Project to ensure that these threshold guidelines will be met, food sources of marine fish and wildlife should be protected.

4.5.2 Water Quality

The discharge of TIA effluent and groundwater to Roberts Bay has the potential to influence the water quality of Roberts Bay, as the concentrations of non-salt parameters in the discharge could be different than existing background concentrations in Roberts Bay.

During construction, limited activity such as securing the pipe anchors to the sediment surface will cause localized, very temporary increases in suspended solids and their related constituents (e.g., total metals). This material will be quickly dispersed throughout Roberts Bay and conditions would quickly return to baseline levels within days after the activity ceased.

The following text focuses on when there is active discharge of TIA effluent and groundwater into Roberts Bay.

4.5.2.1 *Mitigation by Design*

The TIA and groundwater effluent will meet the legally-required MMER limits within the pipeline prior to discharge via the multiport diffuser in the marine environment.

In addition, the Project has been designed such that CCME guidelines for the protection of marine life will be met within Roberts Bay for the duration of groundwater and TIA effluent discharge. CCME guidelines are conservative, often employing order of magnitude safety factors based on toxicological tests, and are designed to be protective "of *all* forms of aquatic life and all aspects of aquatic life cycles, … including the most sensitive life stage of the most sensitive life species over the long term" (CCME 1999).

The predicted quality of the TIA and groundwater discharge is described in Package 6-3. All groundwater and TIA water quality concentrations are predicted to be less than MMER limits within the pipeline, and if needed, the discharge will be treated to meet marine CCME guidelines within Roberts Bay (CCME 2015).

In order to achieve this Project design, the baseline chemistry of Roberts Bay, along with the water circulation dynamics of Roberts Bay were used to provide threshold levels that the TIA effluent and groundwater must meet in order to maintain Roberts Bay water quality concentrations below marine CCME guidelines for the duration of planned TIA and groundwater water discharge.

4.5.2.2 *Predicting TIA Effluent and Groundwater Discharge Targets*

TIA effluent and groundwater targets were calculated such that marine CCME guidelines for the protection of marine life would be met for the duration of TIA and groundwater discharge to Roberts Bay. If CCME guideline concentrations cannot be met in Roberts Bay, the TIA effluent and groundwater will be treated to ensure guideline levels are met.

The following information is used to calculate the TIA effluent and groundwater discharge targets:

- background Roberts Bay water chemistry;
- water circulation within Roberts Bay;
- exchange rate of Roberts Bay water with Melville Sound;
- performance of the proposed multi-port diffuser;
- 6-year mine life;
- anticipated discharge volume of TIA effluent and groundwater; and
- CCME guidelines for the protection of marine aquatic life..

TIA and groundwater water quality target concentrations were developed for all parameters with marine CCME guidelines with a few exceptions. Dissolved oxygen is not modelled; rather the marine CCME guideline is used as the TIA effluent and groundwater target concentration (DO: $\geq$ 8.0 mg/L). pH is also not modelled, and the marine CCME guideline range is used for the TIA effluent and groundwater target concentrations (pH: 7.0–8.7).

CCME Marine Water Quality Guidelines used for TIA Effluent and Groundwater Discharge Targets

Table 4.5-1 presents the CCME water quality guidelines for the protection of marine aquatic life. These concentrations were used as upper limits that could be reached in Roberts Bay during TIA and groundwater discharge, and were used to generate the estimated TIA effluent and groundwater water quality concentrations that ensure these guideline levels will not be surpassed in Roberts Bay.

Table 4.5-1. Marine CCME Guidelines along with Assumed Concentrations for Target Roberts Bay Water Quality

Parameter	Units	CCME Guideline Concentration	Assumed Parameter for Modelling	Assumed Target Concentration for Modelling
pH[1]	pH units	7.0-8.7	pH	7.0 to 8.7*
Nitrate-N[2]	mg/L	45	Nitrate-N	45
Dissolved Oxygen[1]	mg/L	8	Dissolved Oxygen	8*
Salinity	‰	<10% change of natural salinity	Salinity	<10% change of natural salinity
Temperature[3]	°C	<1°C variation compared to natural temperature	Temperature	Not included
Total Arsenic	mg/L	0.0125	Total Arsenic	0.0125
Total Cadmium	mg/L	0.00012	Total Cadmium	0.00012
Chromium (Cr^{3+}) Chromium (Cr^{6+})	mg/L	0.056 (III) 0.0015 (VI)	Total Chromium	0.0015
Mercury (inorganic)	mg/L	0.000016	Total Mercury	0.000016

[1] pH and dissolved oxygen were not modelled. Rather, the CCME guidelines for the protection of marine life were used as the target TIA effluent concentrations. The CCME guideline for dissolved oxygen is for a minimum of 8 mg/L for coastal and estuarine environments. If natural concentrations are greater than 8 mg/L, then the guideline specifies that human activities should not result in a decrease of more than 10% of the natural concentration at any one time. If natural concentrations are below 8 mg/L, as they can be during the under-ice season in Roberts Bay, then the natural concentration becomes the interim dissolved oxygen guideline.

[2] Long-term CCME nitrate-N guideline for the protection of marine life. Short-term guideline is 339 mg N/L (CCME, 2015b).

[3] based on an estimated 40:1 dilution of TIA effluent within 10 m of the diffuser during the ice-covered period, TIA effluent would have to be discharged at 40°C to increase surrounding ambient water by 1°C. This is highly unlikely and therefore temperature is not modelled.

Chromium (trivalent and hexavalent) and mercury (inorganic) each have specific, non-total metal CCME criteria. However, using total values is the most conservative approach. As a result, some assumptions were made regarding what total metal concentrations would become target concentrations for Roberts Bay. For chromium, it is assumed that setting the target guideline at 0.0015 mg/L would ensure that both trivalent and hexavalent species would remain below potentially toxic levels. The same rationale is used for the assumption that the total mercury guideline is the same as the CCME guideline for inorganic mercury (0.000016 mg/L).

Nitrate

The marine CCME guideline for nitrate is intended to protect marine organisms from toxic levels of nitrate. However, nitrate can also act as a nutrient in marine waters, and there is the potential for changes in Roberts Bay due to nitrate as a nutrient rather than causing toxicity.

Roberts Bay is an oligotrophic system (i.e., low nutrient concentrations, low primary productivity), with phytoplankton growth controlled by light during the ice-covered season and by nitrogen availability during the summer.

The introduction of nitrate at marine CCME guideline levels has the potential to cause classic eutrophication changes in Roberts Bay, by potentially increasing phytoplankton growth during the summer, which could result in increased organic matter sinking to depth, where it would be decomposed by bacteria and use up oxygen in the bottom waters, thereby potentially decreasing dissolved oxygen. However, by having the diffuser at 40 m depth, below the upper sun lit portion of the water column, nitrate in the TIA effluent and groundwater will not be readily available to phytoplankton, which will be photosynthetically active in the upper water layers. Phytoplankton, being single-celled plants, require sunlight to survive. During the summer months, all of the nitrate is consumed in the upper water column (above the pycnocline), but higher nitrate concentrations remain below the pycnocline throughout the summer, and phytoplankton are not photosynthetically active at deep depths.

Hence, by discharging TIA effluent and groundwater at a deep depth of 40 m, it is not anticipated that the introduction of nitrate at marine CCME guideline levels will cause any eutrophication effects in Roberts Bay.

Roberts Bay Background Water Quality Concentrations

As the multiport diffuser will be located at 40 m depth, only water quality from similar depths, and most importantly below the pycnocline (the pycnocline serves as a barrier between water above and below it), were used to model TIA and groundwater water quality target concentrations.

Data were used from the sampled depths below the pycnocline (i.e., 20–40 m) and included data from both the ice-covered (April) and open-water seasons (July-September). The sampling sites used were located approximately 500 m seaward of the proposed multiport diffuser, and unless indicated, the background concentrations were the median value calculated from all water quality samples collected between 20 and 40 m from 2009 to 2011. If a concentration is below detection, the detection limit value was used. Table 4.5-2 presents the background water quality concentrations used.

Model Assumptions

The goal of the modelling exercise is to calculate TIA effluent and groundwater target concentrations to ensure that the water quality of Roberts Bay remains below marine CCME guideline concentrations for the duration of TIA and groundwater discharge to Roberts Bay.

Table 4.5-2. Roberts Bay Background Water Quality used for Calculating TIA Effluent and Groundwater Discharge Targets

Parameter	Units	Detection Limit	Concentration Used as Roberts Bay Background for Modelling
pH[1]	pH units	0.01	7.77
Nitrate-N	mg/L	0.006	0.067
Dissolved Oxygen[1]	mg/L	0.1	10.66 (summer)[2] 9.64 (winter) [2]
Salinity	‰	0.002	27.05[2]
Temperature	°C	0.002	-0.49[2]
Total Arsenic	mg/L	0.0002	0.00094
Total Cadmium	mg/L	0.00002	0.000056
Total Chromium	mg/L	0.0001	0.0001
Total Mercury	mg/L	0.00001	0.0000013

Note: All data and detection limits are from samples collected at sites WT4/ST4/RB1 from 2009 to 2011. Total chromium values were based on the 2010 minimum detection limit. All other data selection criteria were identical (same sampling sites, sampling depths, months of sampling).

[1]pH and dissolved oxygen were not modelled. Rather the CCME guidelines for the protection of marine life were used as the targeted TIA/groundwater concentrations.

[2] Salinity, temperature, and dissolved oxygen values are an average of all measurements collected between 20 m and 40 m depth at a mid-Roberts Bay (WT4/ST4/RB1) station from 2009 to 2011.

A monthly time-stepped model is completed for each water quality parameter, so that the concentration of that parameter in Roberts Bay remained just below the respective marine CCME guideline.

The model runfor a hypothetical scenario included TIA effluent and groundwater discharge over a 6-year period to Roberts Bay, after which there is no discharge.

One of the key factors influencing the water quality dynamics in Roberts Bay is the exchange between Roberts Bay and Melville Sound. Based on field measurements of under-ice and open-water currents, the absence of a sill at the mouth of Roberts Bay, and numerical modelling based on ocean currents (see Section 4.3.3 of this report for more information), the following assumptions were made, which reflect the current understanding of water circulation in Roberts Bay:

- During the winter months, there is very little exchange of water between Roberts Bay and Melville Sound;
- During the summer months, wind drives the circulation of Roberts Bay, and surface and deep waters move from Roberts Bay into Melville Sound and vice versa; and
- Roberts Bay water is flushed completely with Melville Sound water during the open-water season.

During the winter, exchange between Roberts Bay and Melville Sound is extremely low and TIA effluent and groundwater is expected to “pool” during this period. During the summer, TIA effluent and groundwater discharged into the deep layer (below the pycnocline depth of 10–12 m) is expected to be flushed completely into Melville Sound every month. This is conservatively addressed in the model by assuming that 33% of deep water exits Roberts Bay during each of the months of July, August, and September, in other words, Roberts Bay would be flushed once during the open-water season or three times less than predicted by circulation modelling (Rescan 2012b).

Additional assumptions used for the model include:

- background water quality concentrations in the deep water (below the pycnocline) of Roberts Bay based on 2009–2011 data (since the discharge will be at 40 m);
- TIA effluent and groundwater would be discharged into Roberts Bay over a 6-year period;
- the combined TIA effluent and groundwater would be discharged at a constant rate of approximately 80 L/s during the summer months (i.e. June, July, August and September), while the remainder of the year only groundwater would be discharged and at a rate of 35 L/s;
- Discharge TIA effluent and groundwater would be trapped between 20 m and 40 m in Roberts Bay;
- during the winter months, groundwater would pool within Roberts Bay;
- during the summer months, 33% of Roberts Bay water would move into Melville Sound in July, August, and September. This assumption allows for nearly 100% of deep Roberts Bay water to move into Melville Sound each summer;
- Roberts Bay water quality concentrations must remain below marine CCME guideline concentrations for the duration of discharging TIA effluent and groundwater (see Table 4.5-1); and
- All parameters act conservatively. No biological or geochemical processes were considered.

4.5.2.3 TIA Effluent and Groundwater Targets Results

Table 4.5-3 presents the calculated TIA effluent and groundwater targets that would ensure that Roberts Bay water quality remains below CCME guidelines for the duration of TIA and groundwater discharge to Roberts Bay. It also includes the maximum CCME guidelines for parameter concentrations predicted in the TIA effluent and groundwater model (document P 6-3).

Time-stepped graphs for each parameter are provided in Figures 4.5-1 through 4.5-3. For the scenario of discharging TIA effluent and groundwater to Roberts Bay for a period of 6 years, the model results indicate that concentrations would increase slowly during the winter months when there is no exchange between Roberts Bay and Melville Sound and the groundwater "pools" within Roberts Bay. During the open-water water season, when winds are high and exchange between Roberts Bay and Melville Sound is greatest, concentrations decrease rapidly. Overall, an equilibrium is established after four years, with peak concentrations reaching CCME guideline limits (the upper limit set in the model) when Roberts Bay is ice-covered, and the lowest concentrations reached annually during the summer when exchange with Melville Sound is greatest.

Table 4.5-3. Calculated TIA Effluent and Groundwater Water Quality Targets to Ensure that Roberts Bay Water Quality Remains Below Marine CCME Guidelines

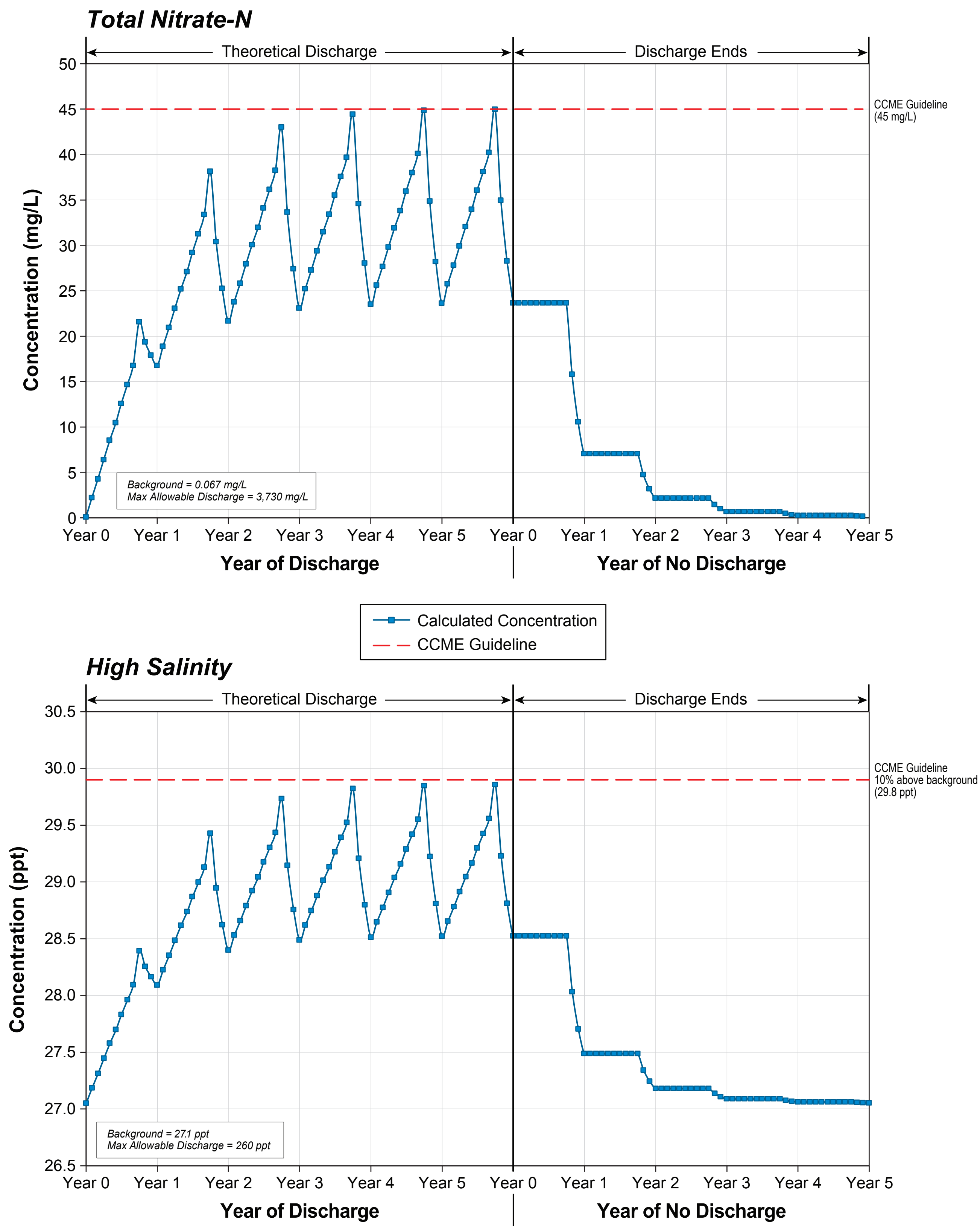
Parameter	Units	Allowable Concentration in TIA for 6 Years of TIA and Groundwater Discharge	Predicted Maximum TIA Effluent and Groundwater Concentrations (SRK 2015)
Oxygen[1]	mg/L	8.0	NA
pH[1]	pH units	7.0– 8.7	NA
Nitrate-N	mg/L	3,730	1.815
Salinity	‰	0-260	26.7[2]
Total Arsenic	mg/L	0.960	0.00627
Total Cadmium	mg/L	0.0053	0.000302
Total Chromium	mg/L	0.0425	0.00620
Total Mercury	mg/L	0.00131	0.0000639

[1] *Oxygen and pH were not modelled; rather the CCME guidelines for the protection of marine life were used as the targeted TIA concentrations.*

[2] *Predicted salinity calculated from predicted chloride concentration (Salinity = 1.80655 × [Chloride])*

Figure 4.5-1

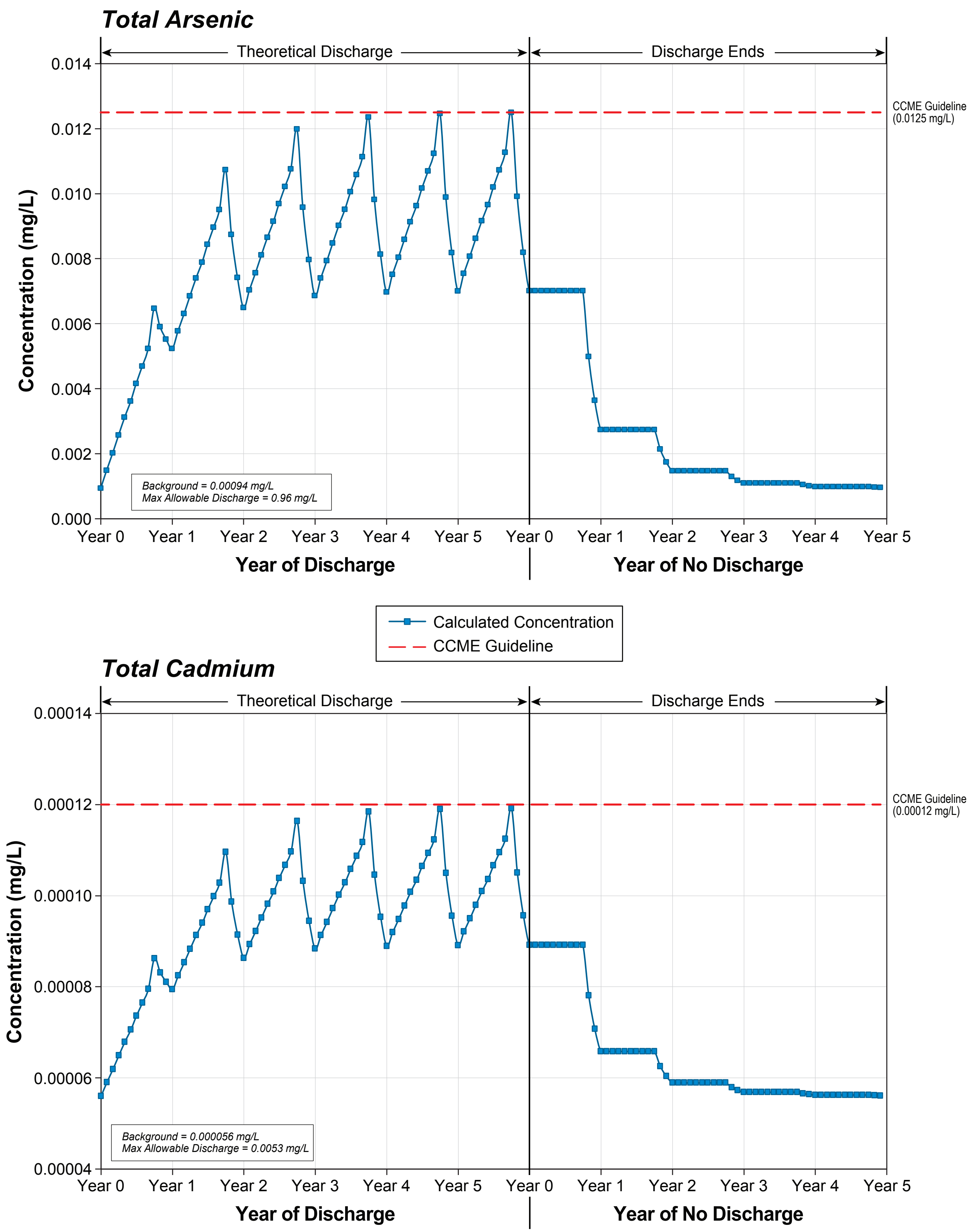
Time Evolution of Total Nitrate-N Concentrations and High Salinity in Roberts Bay during TIA and Groundwater Discharge



Note: Allowable Effluent Concentrations are based on continuous 80 L/s of discharge during open-water season and 35 L/s during ice-covered season.

Figure 4.5-2

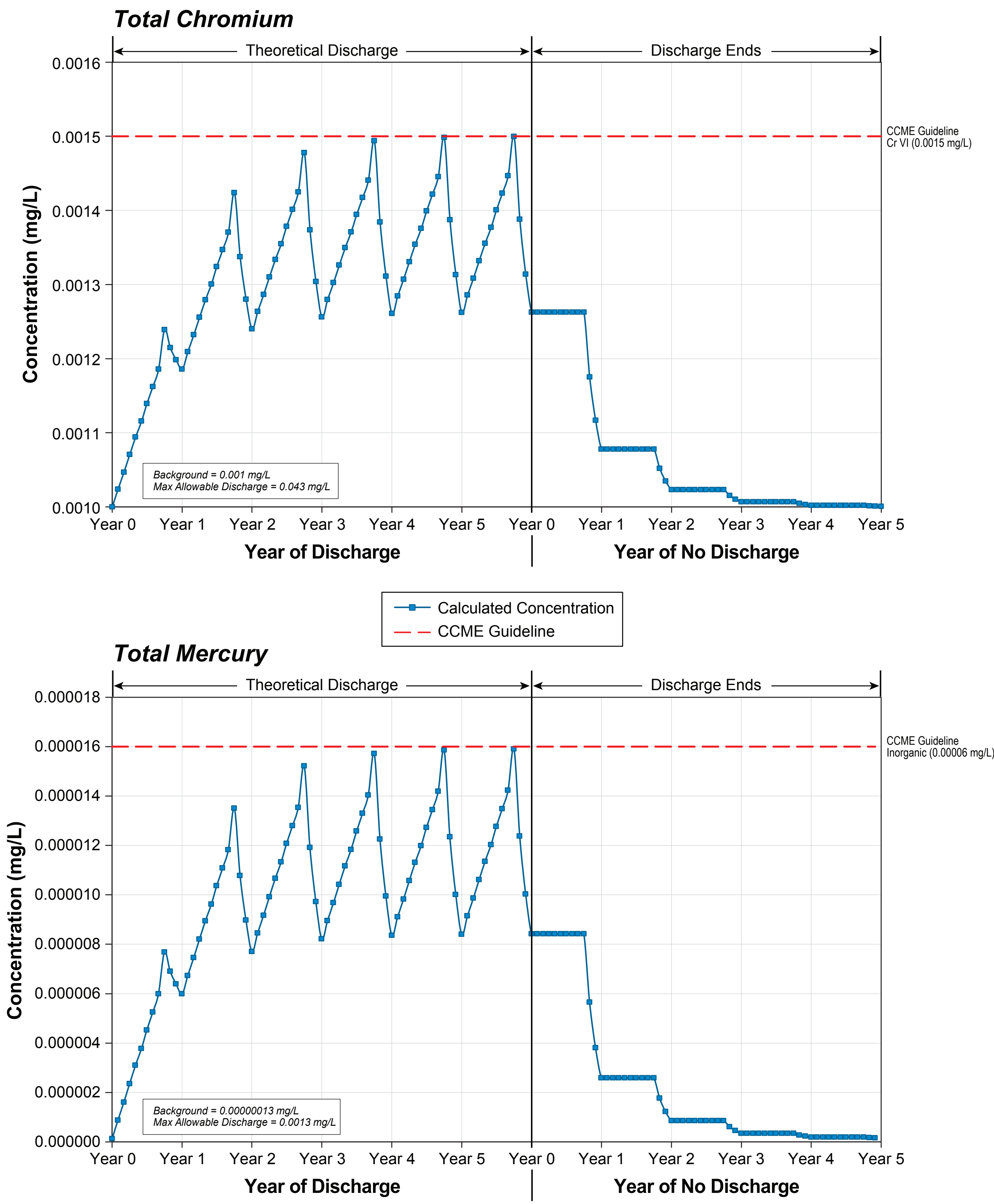
Time Evolution of Total Arsenic and Total Cadmium Concentrations in Roberts Bay during TIA and Groundwater Discharge



Note: Allowable Effluent Concentrations are based on continuous 80 L/s of discharge during open-water season and 35 L/s during ice-covered season.

Figure 4.5-3

Time Evolution of Total Chromium and Total Mercury Concentrations in Roberts Bay during TIA and Groundwater Discharge



Note: Allowable Effluent Concentrations are based on continuous 80 L/s of discharge during open-water season and 35 L/s during ice-covered season.

After TIA effluent and groundwater is discontinued, all parameters return to baseline levels within 3 to 4 years due to exchange between Roberts Bay and Melville Sound. This time period would be shorter if full flushing occurs within one month during the open-water season (the model assumes 33% flushing for July, August, and September).

The modelling results indicate that the estimated TIA and groundwater targets to meet CCME guideline concentrations in Roberts Bay are substantially greater than the predicted maximum TIA and groundwater end-of-pipe concentrations (Table 4.5-3; Package 6-3). In the case of arsenic, the predicted target concentration of 0.96 mg/L is nearly twice the allowable MMER mean monthly maximum concentration of 0.5 mg/L. This suggests the estimated water quality targets will not be approached in the TIA effluent and groundwater and water quality concentrations in Roberts Bay will be much lower than CCME guideline levels. As CCME guidelines are protective of marine life, no adverse effects on water or biota are expected. In addition, any changes to Roberts Bay water quality will be short term in nature, as background water quality concentrations are expected to be achieved a few years after TIA and groundwater discharge has ceased.

4.5.2.4 Summary of Potential Effects on Water Quality

By keeping water quality concentrations below marine CCME guideline levels in Roberts Bay for the duration of discharging TIA effluent and groundwater into the deep layer of the bay, the magnitude of any change to water quality would be below the threshold that would be considered significant. Marine CCME guidelines are conservative, often employing order of magnitude safety factors based on toxicological tests, and are designed to be protective "of all forms of aquatic life and all aspects of aquatic life cycles, … including the most sensitive life stage of the most sensitive life species over the long term" (CCME 1999). Hence no adverse effects on water quality and hence marine life are expected.

Because Roberts Bay water flushes with Melville Sound water on an annual basis, and likely within a month, the duration of any water quality changes will be short term (there will be increases in water quality concentrations during the winter months when groundwater is discharged), and background water quality conditions are expected to return within 3 years after TIA and groundwater is no longer discharged to Roberts Bay. Hence, water quality changes in Roberts Bay are expected to be completely reversible.

4.5.3 Sediment Quality

Because of the inclusion of a multiport diffuser at the end of the subsea pipeline, the TIA water and groundwater will mix vigorously and rise to a trapping depth above the diffuser. The TIA water and groundwater is expected to have little interaction with the Roberts Bay sediments.

In addition, the TIA effluent and groundwater will be largely free of suspended materials as it will meet the end-of-pipe MMER limit of < 15 mg/L total suspended solids (TSS).

Hence, the TIA effluent and groundwater is not anticipated to adversely affect the sediment quality of Roberts Bay.

4.5.4 Ice Thickness

Discharge of groundwater during the winter could introduce a source of heat to Roberts Bay that is not present under natural conditions. Any warming of water during the winter could potentially affect the ice thickness or freeze up timing in Roberts Bay.

The temperature of the groundwater during the winter is expected to be approximately 2°C. This temperature is necessary so that the on-land portion of the pipeline does not freeze. Higher temperatures will be avoided because they will require additional power in the heat-traced overland pipeline.

Over the winter, approximately 8.2×10^5 m^3 the groundwater will be discharged over a 9-month period at a rate of 35 L/s. The discharge will mix into a 20 m thick layer of water representing approximately 160×10^6 m^3 of water at a temperature of approximately 0°C. The discharge will be trapped by the density gradient in this layer. The discharge would warm the 20 m thick layer by no more than approximately 0.01°C.

As the diffuser will be located at 40 m depth, and the groundwater will remain below the pycnocline and not interact directly with the sea ice, the maximum change of 0.01°C in deep waters in Roberts Bay is not expected to have an effect on ice thickness or the timing of freeze up in Roberts Bay.

4.5.5 Marine Fish and Fish Habitat

4.5.5.1 Marine Discharge

Roberts Bay is inhabited by at least 20 species of marine, brackish and anadromous fishes (see Section 4.4.2) that are part of commercial, recreational and aboriginal (CRA) fisheries or those that support such fisheries. Smaller species, such as Arctic Cisco, Least Cisco and Capelin, provide a food base for larger species such as Arctic Char, anadromous Lake Trout and Greenland Cod. Other organisms commonly eaten by Arctic marine fishes include a variety of zooplankton and benthic invertebrates.

By discharging TIA effluent and groundwater into Roberts Bay, there is the potential for adverse changes to the water quality of Roberts Bay. This could result in adverse effects on marine aquatic life, including the health of fish, as well as the organisms that fish feed upon.

However, the Project has been designed such that marine CCME guideline concentrations will be met in Roberts Bay for the duration of TIA effluent and groundwater discharge. These guidelines are meant to protect all forms of aquatic life and all aspects of the aquatic life cycles from anthropogenic chemical and physical stressors, including the most sensitive life stage of the most sensitive species over the long term. In the case of marine fish, the most sensitive life stages are typically the eggs and pelagic larval stage. By keeping water quality concentrations below marine CCME guideline levels, no adverse residual Project effects on fish or fish resources are anticipated in Roberts Bay.

4.5.5.2 Marine-based Infrastructure

The nearshore areas of Roberts Bay provide habitat for at least 20 species of marine fish (see Section 4.4.2, tables 4.4-3 to 4.4-4). These fishes utilize a variety of habitat types and are anticipated to be present within or adjacent to the proposed marine-based infrastructure. Flatfishes (e.g., Arctic Flounder and Starry Flounder) inhabit mud/sandy bottoms. Sculpins, gunnels, and cod inhabit areas of hard substrate with vertical relief for shelter. Arctic Char, Lake Trout, and Pacific Herring inhabit the mid-water column.

Based on depth and substrate preferences of CRA fish and those supporting such fish in Roberts Bay, the placement of material and structures in the water through the installation of the marine outfall berm, subsea pipeline and diffuser has the potential to affect fish and fish habitat during construction and beyond. The approach to the marine discharge is subject to change with ongoing engineering, Project planning and environmental considerations. For this amendment application the intent is to install 2.29 km (including diffuser) uninsulated subsea pipeline (273 mm diameter) will be installed in Roberts Bay to discharge the TIA effluent at 40 m depth through a 95 m long, 20 port diffuser. The pipeline will be installed through a newly-constructed marine outfall berm, emerging from its toe (document P6-6)). The pipeline, initially contained within a protective 24” diameter (610 mm) steel pipe, will be buried within the approximately 90-m long rock fill marine outfall berm structure (~94.5 m at base of structure), and then will emerge in Roberts Bay below the 3 m isobath. This clearance should provide a 1 m allowance from the pipeline being impacted from the annual sea ice, which is up to 2 m thick.

Berm installation will involve the placement of two layers of geogrid covering an area of 2,490 m² on the seabed prior to placement of rock fill. Placed rock will cover approximately 1,550 m² of the seabed, leaving 940 m² of geogrid to be exposed below the MHHWL, extending outwards ~5 m from the toe of the marine outfall berm (document P6-6; Table 4.5-4) It is expected that this exposed geogrid will rapidly be covered by sediments through tidal deposition. The berm structure will be comprised of clean Run of Quarry (ROQ) and Rip Rap (i.e., armor rock), with smaller substrate sizes ranging from 250 - 500 mm in diameter, and upwards of 1 to 1.5 m for the larger Rip Rap that will be required at the toe of marine outfall berm. The Rip Rap has been sized to protect the marine outfall berm during a significant storm event.

Table 4.5-4. Detailed Information of Habitat Alteration or Loss of Fish Habitat and Proposed Offsetting in Roberts Bay

Habitat	Area (m²)
Altered/Loss	
Marine Outfall Berm	1,550
Ballast Weight Footprint (438 ballasts)	140
Pipeline Footprint (2,291 m pipeline)	628
Total Impacted Habitat	2,318 (0.23 ha)
Offsetting Area	
Surface area of marine outfall berm (side slopes)	650

(continued)

Table 4.5-4. Detailed Information of Habitat Alteration or Loss of Fish Habitat and Proposed Offsetting in Roberts Bay (completed)

Habitat	Area (m^2)
Ballast Weight Surface Area	930
Offsetting shoals - two shoals at 680 m^2	1,392
Total Proposed Offsetting Habitat	2,972 (0.29 ha)
Potential Pipeline Offsetting (2,196 m excluding diffuser, no settlement)	Up to 1,745
Total Proposed + Potential Pipeline Area	Up to 4,717 (0.47 ha)

Notes: Estimates are based on 438 exposed ballast weights sitting on the seafloor.
Ballast weight footprint is 0.4 × 0.8 = 0.32 m^2.
Diameter of pipeline is 0.273 m.
Ballast weight surface area (each 2.12 m^2) excludes area of pipeline passing through.
Offsetting habitat shoal dimensions are 10 m × 50 m x 1.5 m.

After emerging at the 3 m isobaths at the toe of the marine outfall berm, the pipeline, still protected within the 24"diameter (610 mm) steel pipe for approximately 5 m, will continue along the bottom for approximately 2,191 m to the 40 m isobaths, ending at the diffuser (document P6-6). The current design of the proposed pipeline is expected to have a footprint of up to approximately 628 m^2 if 50% settlement occurs (i.e., no suspension), including the larger steel pipe emerging from toe of berm and continuing up to the first 5 m from toe of berm (Table 4.5-4).

The pipeline will be ballasted with concrete weights that will stabilize (and possibly suspend) the pipeline along the bottom of the seafloor. Each ballast weight is expected to have a footprint of approximately 0.8 m × 0.4 m or 0.32 m^2 (SRK 2015). The ballast weights will be spaced at approximately 5 m intervals for a total of 2.29 km, requiring 438 exposed ballast weight units. Thus the total footprint of the ballast weights will be approximately 140 m^2 (Table 4.5-4). The impacted area from the installation of the pipeline may be limited to the ballast weight footprints and marine outfall berm if no settlement occurs.

Potential effects to CRA fish (and supporters of such fish) and their habitat include the permanent destruction or alteration of fine substrates, which are used by a number of species in Roberts Bay for spawning, feeding and rearing (Tables 4.4-3 to 4.4-4). There is also the potential to affect fish and fish habitat during construction works. To properly assess all potential effects of the proposed marine works including new infrastructure footprints placed below the mean high high water level (MHHWL; i.e., marine outfall berm, subsea pipeline, diffuser and ballast weights), TMAC will conduct a DFO Self-Assessment once detailed engineering is confirmed to determine whether *serious harm* could occur from proposed marine works; any residual effects following such an assessment is addressed through the development of an Offsetting Plan. A preliminary self-assessment has been conducted with most current information with main conclusions summarized below. The objectives of completing a DFO Self-Assessment/Offsetting Plan for the proposed marine works is to provide DFO with the information it needs to determine if a *Fisheries Authorization* is required for this Project under the newly amended Section 35 of the *Fisheries Act* (1985), and to propose a strategy for mitigation/monitoring of fish and fish habitat potentially affected by the proposed works.

With current information, the total area permanently altered/lost by the construction of the subsea pipeline and associated infrastructure (i.e., ballast weights and marine outfall berm) falling below the mean high high water level HHWL) will be upwards of approximately 2,318 m² (Table 4.5-4), consisting primarily of fine/mud substrates, which are abundant in Roberts Bay, as summarized in Section 4.4-2. Based on preliminary review, these works have the potential to impact CRA fish species. In keeping with the *Fisheries Protection Policy (FPP) Statement* (DFO 2013a) supporting the newly amended *Fisheries Act* (1985), and replacement of the previously applicable *No Net Loss* (NNL) guiding principle of the *Policy for the Management of Fish Habitat* (DFO 1991), if a project is likely to cause *serious harm to fish* after the application of avoidance and mitigation measures, then the proponent must develop a plan to undertake offsetting measures to counterbalance (i.e., offset) the unavoidable *serious harm to fish*. Because the proposed works are associated with a permanent alteration or loss of fish habitat, these works constitute *serious harm to fish* and may require offsetting measures. The current objective of the FPP is to ensure that the productivity of the CRA fisheries are maintained or improved through proposed offsetting works.

Marine fish offsetting options accepted by DFO have historically employed either biological or physical (habitat) manipulation of the marine environment (Sikumiut 2011). Manipulation of the biological habitat primarily involves establishing nearshore aquatic vegetation (e.g., eelgrass) to serve as foraging, shelter, and/or nursery habitat for both fish and invertebrate species (CRD Environmental Services 2002; DFO 2004a). This method has been somewhat effective in maintaining or increasing productivity at marine areas in southern Canadian latitudes, particularly in British Columbia (DFO 2006). However, re-vegetation has limited value in the Arctic, where ice scour in the nearshore marine environment prevents aquatic vegetation from becoming established (Stephenson and Stephenson 1972; DFO 2009).

Alternatively, physical manipulation, often in the form of creating artificial reefs, has been an acceptable and effective offsetting measure in the Arctic marine environment (DFO 1991; Rescan 2010h). Artificial reefs have the capacity to increase productivity in the nearshore environment by providing habitat for multiple trophic levels in the marine food web:

> *An artificial reef enhances fish aggregation and production habitat required by various invertebrates and fishes. Increased habitat complexity and heterogeneity of habitats created by the artificial reef provide a multitude of microhabitats for many invertebrates. These in turn provide food for fishes and many invertebrates. The reef also provides shelter for many fishes and motile invertebrates* (DFO 1991).

Many studies of fish recruitment to artificial habitats indicate that concrete block structures are useful in creating fish habitat, particularly in sediment bottom areas where no other hard substrate exists (Sherman, Gilliam, and Spieler 2002). Particularly useful is the creation of ledges, crevices and similar shelter sites within these concrete structures (Ebata et al. 2011). Gadids (cod) and Cottids (sculpins) are particularly attracted to complex hard substrates (Tupper and Boutilier 1995). In Roberts Bay, this would include four of the most common marine fishes: Greenland Cod (*Gadus ogac*), Saffron Cod (*Eleginus gracilis*), Fourhorn Sculpin (*Triglopsis quadricornis*) and Shorthorn Sculpin (*Myoxocephalus scorpius*). This process of colonization has already been documented on the Roberts Bay jetty and compensation shoals (Rescan 2009a, 2010c). In addition to providing vertical shelter for fish, the rough concrete surface of the ballast weights will form a settlement substrate for algae and sessile invertebrates, which may form a food source for small fishes and macroinvertebrates.

To address the potential for residual effects leading to serious harm, it is proposed that the permanent alteration/loss of habitat located within the footprint of the proposed works will be offset through a combination of infrastructure design and offsetting replacement habitats including: the use of coarse rocky substrates (dominated by ~1 m^2 diameter rip rap at toe of berm, remaining substrates between 250 to 300 mm in diameter) for construction of the marine outfall berm (surface area below MHHWL of approximately 650 m^2); new surface area created by the concrete ballast weights (up to 930 m^2 with each ballast contributing up to 2.12 m^2); and following the artificial reef approach presented above, the creation of two rock shoals measuring approximately 680 m^2 with the following dimensions: 50 m long, 10 m wide, and 1.5 m high (Table 4.5-4). The proposed location for installation of these rock shoals would be within the eastern portion of Roberts Bay, near the Little Roberts Outflow.

Overall, this proposed and preliminary offsetting plan will result in a total of 2,972 m^2 of newly built rock habitat after the loss of marine fish habitat due to proposed marine works, with a net increase of approximately 654 m^2 of high quality marine fish habitat in Roberts Bay (Table 4.5-4). An additional 1,745 m^2 of surface area may also be provided by the pipeline. There is the potential for a total of up to 4,717 m^2 to be provided through the proposed infrastructure and new offsetting habitats (Table 4.5-4).

The colonization and fish use of the marine outfall berm, habitat shoals and ballast weights/pipeline will be monitored using a variety of methods (see Section 4.6.2 for more details of the proposed monitoring program), and timeframe as done for the Roberts Bay Compensation Monitoring Program associated with the marine jetty (Rescan 2009c, 2010g).

Importantly, the pipeline and its construction is not expected to obstruct the migration of marine fish such as capelin, which undergo seasonal movements to spawning grounds east of Roberts Bay as installation will be timed to occur during the most appropriate window to ensure minimal interference with sensitive life stages of most fish species known to exist in Roberts Bay. Best management practices and procedures to ensure *no serious harm* to fish will be employed during installation (DFO 2013c), including those employed during the construction of the jetty in nearshore environments (SRK Consulting (Canada) Inc. 2005, 2007).

4.5.6 Marine Wildlife

4.5.6.1 Marine Mammals

Two of the three possible marine mammal species, ringed seal and bearded seal, were detected during aerial and barge surveys conducted in 2010. Ringed seals are an abundant seal species, distributed widely across the Arctic (Hammill 2009). Bearded seals have a much lower population density in the Canadian Arctic and a much patchier distribution than do ringed seals (Kovacs 2009). Ringed seals are the only seal present in the Arctic regions that are able to maintain open breathing holes in landfast sea ice throughout the winter, constantly abrading the edges of holes with their teeth to keep them open (Hammill 2009; Kovacs et al. 2010). This ability allows the ringed seals to have a much wider distribution than bearded seals, which are generally associated with drifting pack ice and rely on open waters leads, such as polynyas, throughout the winter (Kovacs et al. 2010).

Ringed and bearded seals also feed on different food items that correspond to their varying distributions. Ringed seals primarily feed on ice-associated organisms, such as Arctic cod, polar cod, and large zooplankton (Wathne, Haug, and Lydersen 2000). Bearded seals rely on benthic organisms and are thus more often found within shallow waters with drifting pack ice (Kovacs 2009). Seals are not abundant in Roberts Bay, although they are abundant in Melville Sound. For seals that may be present in Roberts Bay, water quality will remain below marine CCME guidelines and there are no adverse effects expected for aquatic life and fish that seals may be feeding on. Considering the mobile nature of ringed and bearded seals, and that Roberts Bay is not a permanent residence for these seals, any exposure to the TIA effluent will be temporary and no direct effects on the seals is expected.

The third marine mammal that has historically been observed in Melville Sound is the narwhal; however, this species has not been observed during baseline studies of Roberts Bay. Narwhals may not use this area, or are infrequent visitors to Roberts Bay. Narwhal were present for the first time in many years in 2011 in Cambridge Bay, and were reported in Melville Sound. With water quality remaining below CCME guidelines, no adverse effects are predicted for any of the invertebrate or fish diet of narwhals, thus no adverse effects are predicted for narwhals.

4.5.6.2 Seabirds

During aerial surveys conducted in August 2010 in Roberts Bay and adjacent bays, relatively few of the 19 seabird species that could possibly occur in the area were observed, with the lowest numbers in Roberts Bay itself. Regionally, small islands within Parry Bay and Melville Sound appear to be important areas for nesting common eiders and for supporting colonies of other seabirds such as glaucous gulls (Hoover, Dickson, and Dufour 2010).

Relatively little nesting activity has been observed in Roberts Bay and in adjacent bays between 2006 and 2010, and Roberts Bay consistently hosts the lowest density of seabirds of the surveyed inlets (Rescan 2011b). For seabirds that may be present, water quality will remain below marine CCME guidelines and there are no adverse effects expected for aquatic life and fish that seabirds may be feeding on.Mitigation, Management and Monitoring

4.5.7 Mitigation by Project Design

The following are major mitigation features that have been incorporated into the design of the proposed Project:

1. The TIA effluent and saline groundwater will be discharged to the marine environment rather than the freshwater environment. This will eliminate potential adverse effects to the freshwater environment, and discharge the TIA effluent and groundwater to a more appropriate receiving environment where the saline nature of the water will not result in adverse effects to resident marine organisms.
2. Any TIA effluent and groundwater discharged to the marine environment will meet the MMER limits prior to discharge. This includes passing the required MMER toxicity tests.
3. The overall Project has been designed so that the water quality in Roberts Bay will remain below CCME guidelines for the protection of marine and estuarine life for the duration of

operation of the TIA. By using Canadian guidelines that are meant to be protective of all marine life, the TIA and groundwater discharge will not have significant adverse effects on the marine ecosystem in Roberts Bay.

4. The shoreline crossing of the pipeline has been designed to avoid disturbing sensitive shoreline fish habitat.
5. In keeping with the DFO's FPP, the permanent alteration/loss of habitat is intended to be offset through the creation of new habitat consisting of ballast weights and two shoals, in addition to the habitat provided by the side slopes of the marine outfall berm, which will provide surface area for colonization of algae and invertebrates, and habitat for demersal fish.
6. The timing of the construction of the marine outfall berm, as well as the installation of the pipeline and diffuser will follow the appropriate timing windows as provided by DFO.
7. The diffuser is being located at 40 m depth to ensure that the TIA and groundwater effluent remains below the productive, sun-lit portion of the water column in Roberts Bay. This will minimize the potential for nutrients (e.g., nitrogen) in the TIA and groundwater to cause changes to the Roberts Bay ecosystem, and mitigate the potential for interaction of slightly warmer TIA effluent and groundwater interacting with the surface ice.

4.5.8 Adaptive Management Plans

In addition to Project Design mitigation features, there are also additional mitigation measures that would be in place, which would allow for adaptive management if unexpected environmental concerns arise.

4.5.8.1 Aquatic Effects Monitoring Program (AEMP)

There is currently an approved (by Environment Canada and the Nunavut Water Board) AEMP in place for the Doris North Project, with two near-shore sites in Roberts Bay and one reference site in Ida Bay. TMAC is intending to modify the monitoring in Roberts Bay to include the geographical area of the proposed diffuser and potential area of influence of the TIA effluent and groundwater. An additional deep-water marine reference site will also be included. The final marine AEMP sites will be determined in consultation with Environment Canada and with due consideration of the requirements of the Environmental Effects Program as required under the Mining and Metals Effluent Regulations. Some monitoring plan considerations are discussed below.

The marine portion of the current Doris North AEMP monitors water quality, dissolved oxygen, sediment quality, phytoplankton biomass, benthic invertebrates, and marine bivalves. The proposed new monitoring locations could be adjacent to the proposed diffuser location (100 m) and seaward of the proposed diffuser location, perhaps half way between the southern shoreline of Roberts Bay and Melville Sound. The frequency of the current marine AEMP sampling is four times per year for water quality, dissolved oxygen, and phytoplankton biomass. Sediment quality and benthic invertebrates are sampled one time per year during the summer. Marine bivalves are sampled one time every three years. The final monitored endpoints and frequency for the modified plan will be determined in consultation with Environment Canada.

Potential endpoints for the modified Roberts Bay monitoring program may be designed to determine whether:

- the water quality in the bay is within below marine CCME guidelines,
- phytoplankton biomass levels are being influenced by nutrient input,
- sediment quality or benthic communities are being influenced by the TIA effluent and groundwater discharges, and
- the discharge of TIA effluent and groundwater is causing any changes in marine bivalve metal concentrations.

If results from the AEMP show that adverse environmental changes are occurring, TMAC can implement adaptive management measures that could potentially change the quality, quantity, or timing of the TIA and groundwater discharge to Roberts Bay. Examples of potential adaptive management measures could be:

- Reviewing the Water Management Plan (document P5-3) . Aspects such as how much water is discharged and the timing of the discharge could be reviewed to see if changes could be made.
- Addition of Treatment. Treatment measures for the TIA effluent and groundwater prior to discharge to Roberts Bay could be added and optimized if needed.

4.5.8.2 Marine Fisheries Mitigation and Offsetting Monitoring Plans

As part of ensuring that there is no serious harm resulting from the construction and presence of the subsea pipeline and associated infrastructure (i.e., ballast weights and marine outfall berm), in Roberts Bay, a utilization monitoring program is proposed to confirm the utility of the various structures (i.e., marine outfall berm, ballast weight/pipeline and habitat shoals) in offsetting the possibility for serious harm.

The marine outfall berm, ballasts and pipe will be monitored comparable to the Roberts Bay Compensation Monitoring Program. If the monitoring shows that any of the structures are not being colonized as expected and used as fish habitat, TMAC could adapt by discussing results with DFO and determining whether the monitoring program could be modified, and/or whether additional mitigation measures should be considered.

4.5.9 Mitigation and Compliance During Pipeline Installation

During the installation of the Marine Outfall Berm and pipeline, mitigation measures similar to those outlined in the Jetty Expansion Fisheries Authorization (DFO No. NU-10-0028) will be followed, in addition to applying relevant measures to avoid causing harm in fish (DFO 2013c).

4.5.10 Cumulative Effects

No significant negative cumulative effects are anticipated from proposed works as the intent of the offsetting is to result in no residual effects to CRA fisheries. The addition of larger and coarser substrates will increase habitat heterogeneity available to fish inhabiting Roberts Bay.

5. ARCHAEOLOGY

HBML and more recently TMAC also retained Points West Heritage Consulting Ltd. to consider potential for impacts on heritage resources (Appendix A).

The majority of the Project area has been surveyed in detail and archaeological sites within most of the proposed expanded footprint area are known, documented and mitigable.

A preliminary reconnaissance level survey of the general area within the footprint of the Roberts Bay Discharge Access Road, been conducted and there are no archaeological sites recorded. Detailed surveys of these specific areas are planned for summer 2015.

6. SOCIO-ECONOMIC

6.1 INTRODUCTION

This chapter focuses on screening of the potential socio-economic effects of the proposed changes to the Project.

With respect to the socio-economic effects of the Project, the activities/infrastructure addressed in this chapter include:

- An initial mining rate of 1,000 tonnes per day (tpd; yearly average ore mining rate) will occur with the installation of the first mill stage followed by a subsequent increase to 2,000 tpd once the second mill stage is installed. A total of approximately 2,500,000 tonnes of ore will be processed from these deposits.
- Accessing the Doris subdeposits, resulting in an extension of mine life to a total of approximately six years, and a mill life of approximately four years.

The chapter provides:

1. information on recent socio-economic baseline conditions and description on changes that have occurred since the 2005 Doris North Final EIS submission (Miramar 2005);
2. information on the actual recent and expected future direct employment and expenditures by the Project;
3. review of the 2005 Doris North Final EIS mitigation and effects assessment conclusions; and
4. a screening of the effects of the proposed changes in the Project in relation to the identified mitigation and effects assessment conclusions.

6.2 EXISTING SOCIO-ECONOMIC BASELINE FOR HOPE BAY

A description of the socio-economic setting was included in the Doris North Final EIS (Miramar 2005). The following provides information on recent socio-economic baseline conditions and description of changes that have occurred since the 2005 Doris North Final EIS submission. Predominantly, this is related to updates from the 2006 and 2011 Census and the 2011 National Household Survey (NHS)[1]. The use of 2011 NHS and census data provides an indication of changes and trends over time. The information provided in this report is focused on the Valued Socio-economic Components (VSECs) as presented in Miramar (2005).

---

[1] Data from the 2011 NHS should be used with caution, particularly in making comparisons with 2006 or earlier census years because of a change in the survey methodology and reliability, with the primary concern being the response rates achieved and the representativeness of the data.

6.2.1 Demographic Change

6.2.1.1 Population

The population of the Kitikmeot Region is estimated to have grown to 6,010 persons in 2011, up 12% from 5,361 persons in 2006 (and up 11.3% from 4,816 persons in 2001; Statistics Canada 2011, 2006, 2001). Despite rapid population growth, the region has the lowest population in Nunavut, representing approximately 18% of the territory's population (NBS 2013c).

The 2011 NHS reported the population of Cambridge Bay to be 1,610, an increase of 9% from 1,477 in 2006. Cambridge Bay is the largest community in the Kitikmeot Region, followed by Kugluktuk and Gjoa Haven, with estimated populations of 1,450 and 1,280, respectively. Kugaaruk is the smallest community, with 770 inhabitants, followed by Taloyoak, which has a reported population of 900.

Population increase between 2006 and 2011 is notably high in Gjoa Haven and Kugaaruk (20% and 21%, respectively), followed by Taloyoak (11%) and Kugluktuk (11%) which are more reflective of the territorial average (12%). Cambridge Bay (9%), though notably lower in comparison to the other Kitikmeot communities, experienced population growth at a rate approximately 1.5 times higher compared to the national rate for the Aboriginal population in 2011 (Statistics Canada 2011). As for the whole of Nunavut, strong natural population increase (birth rate minus death rate) and a net in-migration from other areas of Canada are the main factors that contributed to the population growth in the communities (Statistics Canada 2010b).

For all communities, a high proportion of the population is Aboriginal, primarily Inuit. For the Kitikmeot Region as a whole, in 2011, the population is reported to be 90% Aboriginal, totalling approximately 5,445 individuals, of who 5,410 were Inuit (Statistics Canada 2011; NBS 2013a). For Cambridge Bay, approximately 77% of residents are Inuit. This proportion is higher in all the other Kitikmeot communities, with more than 90% of residents identifying as Aboriginal. The Nunavut average is 85% (NBS 2013c), much higher than the national average of 0.2% (Statistics Canada 2007). The breakdown of each community's 2011 demographic characteristics is shown in Table 6.2-1.

Table 6.2-1. Kitikmeot Community Populations, 2011

Community[1]	Population			
	Total Population 2011	Inuit Population (%)	Median Age (years)	2006 to 2011 Change (%)
Cambridge Bay	1,610	77%	27	9%
Kugluktuk	1,450	91%	24	11%
Gjoa Haven	1,280	96%	21	20%
Taloyoak	900	97%	21	11%
Kugaaruk	770	98%	18	21%
Kitikmeot	6,010	90%	23	12%
Nunavut	31,906	85%	24	8%

[1]Because of the seasonal and/or low number of permanent residents in the communities of Omingmaktok and Bathurst Inlet, reliable statistics for these communities are not available and thus omitted from the table.
Source: Statistics Canada (2011); NBS (2013c).

Recent population estimates by the Nunavut Bureau of Statistics indicate that populations in the Kitikmeot continue to increase. Most notable is the 24% population increase in Kugaaruk, from 770 in 2011 (Statistics Canada 2012) to an estimated 953 in 2014 (NBS 2014c).

6.2.1.2 Age Distribution

All communities have a young population, with a median age ranging from 27 years in Cambridge Bay to only 18 years in Kugaaruk (see Table 6.2-3). The entire Kitikmeot Region is reported to have a median age of 23 years, making it slightly younger than Nunavut's median of 24 years and much younger than the Canadian median of 41 years (Statistics Canada 2011).

With the exception of Cambridge Bay, approximately one third (31 to 42%) of the population within Kitikmeot communities is under the age of 15. These proportions were substantially higher than the 17% for Canada overall. Kugaaruk had the youngest population among the Kitikmeot communities (Statistics Canada 2011). Government projections predict that the population will age slightly by 2036, although it is still expected to remain substantially younger than the Canadian average (Nunavut Bureau of Statistics 2010).

6.2.2 Employment Opportunities

According to the 2011 NHS, the potential labour force in the five Kitikmeot communities (excluding Bathurst Inlet and Omingmaktok), consisting of the total population over 15 years of age, is approximately 3,925 people. The active labour force (individuals employed and unemployed) is approximately 2,410, indicating an average participation rate of 61.4%. This level of participation is lower than the Nunavut average of 63.4% and the Canadian average of 66.0% (Statistics Canada 2011).

The participation rate ranged from 71% in Cambridge Bay to a low of 48% in Kugaaruk in 2011 (Table 6.2-2). The unemployment rate in all communities in 2011 is relatively high compared to the national average of 7.8% and it is also higher than the Nunavut average of 18%, except for Cambridge Bay, which reported an unemployment rate of 14%. Participation rates decreased from 2006 to 2011 by 10% in Kugaaruk and 6% Taloyoak, and increased by 4% in Kugluktuk; minimal changes were observed in the other communities. Unemployment rates increased from 2006 to 2011 in all communities with the exception of Taloyoak, where there is a slight decrease in unemployment.

Table 6.2-2. Participation and Unemployment Rates for Kitikmeot Communities, 2006 and 2011

Community	Participation Rate[1]		Unemployment Rate[2]	
	2006	2011	2006	2011
Cambridge Bay	71%	71%	10%	14%
Kugluktuk	60%	64%	22%	31%
Gjoa Haven	61%	59%	30%	34%
Taloyoak	58%	52%	28%	27%
Kugaaruk	58%	48%	21%	28%

[1] Participation rate is defined as the share of the potential labour force (total population 15 years and older) that is active (either employed or unemployed).
[2] Unemployment rate is defined as the share of the active labour force that is unemployed.
Source: Statistics Canada (2007); NBS (2013a).

A portion of the non-Inuit population residing in the Kitikmeot Region have relocated from southern communities for the purpose of employment. However, the large majority of the population in the Kitikmeot communities are Inuit and this segment of the population is experiencing rapid growth, meaning that Inuit comprise the majority of the labour force. The labour force statistics of the Aboriginal identity population[2] in the Kitikmeot communities varies somewhat from those presented in Table 6.2-2 for the total population. Understanding the employment circumstances of Inuit enables a better understanding of the resident labour force potentially available for future employment.

In all communities, participation rate is slightly lower and unemployment rate is slightly higher among the Aboriginal identify population (Table 6.2-3). Participation rates for males are generally higher as compared to females (from 4% higher in Kugaaruk to 10% higher in Cambridge Bay), as are unemployment rates, with the expectation of Taloyoak where the unemployment rate for females is slightly higher. Regionally, participation is higher for males (by 7%), employment is similar between males and females (1% difference), and unemployment is higher for males (by 6%).

Table 6.2-3. Participation, Employment and Unemployment Rates of the Aboriginal Identity Population in the Kitikmeot Communities, 2011

	Participation Rate[1]		Employment Rate		Unemployment Rate[3]	
	Total	M/F	Total	M/F	Total	M/F
Cambridge Bay	64%	69/59%	51%	53/51%	21%	25/15%
Kugluktuk	60%	64/57%	39%	41/38%	35%	35/33%
Gjoa Haven	57%	62/53%	36%	36/37%	36%	42/31%
Taloyoak	50%	54/46%	35%	39/32%	30%	29/32%
Kugaaruk	47%	48/44%	35%	31/39%	28%	35/18%

[1] *Participation rate is defined as the share of the potential labour force (total population 15 years and older) that is active (either employed or unemployed).*
[2] *Employment rate is defined as the share of the total population 15 years of age and older that is employed.*
[3] *Unemployment rate is defined as the share of the active labour force that is unemployed.*
Source: Statistics Canada (2007); NBS (2013a).

Inuit are experiencing engagement in the wage economy to a greater extent than has been realized in the past. Employment rates in the region vary by community, from lows of 35 and 36% in Gjoa Haven, Taloyoak, and Kugaaruk to a high of 51% in Cambridge Bay. Unemployment rates were considerably higher in Gjoa Haven and Kugluktuk; 36% and 35%, respectively, representing relative increases from 2006 when the higher unemployment rates in the Kitikmeot were 32% and 31%, in Gjoa Haven and Taloyoak. In comparison, the unemployment rate for the Canadian Aboriginal population in 2011 is15%.

[2] Statistics Canada uses the term Aboriginal identity population to refer to all persons who reported identifying with at least one Aboriginal group, that is North American Indian, Métis, or Inuit, and/or those who reported being a Treaty Indian or a Registered Indian, as defined by the *Indian Act* of Canada.

This focused account of Aboriginal labour force characteristics shows greater balance in participation rates between the Kitikmeot, Kivalliq, and Baffin Regions (56.9%, 58.9%, and 55.8%, respectively). In terms of unemployment among the Aboriginal identity population, the Kitikmeot remains highest of the three regions (30%), while the Kivalliq and Baffin Regions (23%; 21%) more closely reflect the territorial average (23%).

6.2.3 Education and Training

In 2011, approximately 28% of the potential labour force in the Kitikmeot Region (i.e., those aged 15 years and over) had some form of post-secondary education (Statistics Canada 2011). Amongst those aged 25 years and over, this proportion increased to 40%.

In general, high school completion rates remain low in all communities in 2011. A large majority of Kitikmeot residents aged 15 to 64 are without a high school certificate or diploma; namely three quarters of residents in Kugluktuk, Taloyoak, and Kugaaruk, over two-thirds of Gjoa Haven residents and almost half of Cambridge Bay residents (Table 6.2-3; Statistics Canada 2011). Cambridge Bay residents had the highest level of educational attainment among the communities, with 36% of residents holding a postsecondary certificate, diploma, or degree. However, for all Kitikmeot communities high school incompletion is well above the Canadian average of 20% (Statistics Canada 2011).

The most common reasons for not finishing school reported by young Inuit men included that they wanted to work (18%), they were bored (18%), or they had to work (14%). The most commonly cited reason by Inuit women for not finishing school is pregnancy/taking care of children (24%). Reasons were similar across Inuit regions (Statistics Canada 2008).

The low level of high school completion and pursuit of education continues to be a challenge in the region. Attendance rates of those enrolled in school can be low (e.g., 50 to 70%). In some communities there can be a number of individuals who have never gone to school (P. Cipriano, pers. comm.). Given the size of class cohorts in earlier grades (i.e., 20 to 25 students), the typical number of students graduating with a grade 12 education continues to be low – from approximately two to eight each year from each community (P. Cipriano, pers. comm.; G. Pizzo, pers. comm.). Similar challenges remain for attracting students to post-secondary education.

There were 21 secondary school graduates in the Kitikmeot in 2013. In 2013, there were 218 second school graduates in Nunavut. Of those, approximately half of the graduates were from the Baffin Region (120), and more than a third from the Kivalliq (77), while only a small number were from the Kitikmeot (21; NBS 2013f). Notably, while male graduation rates in Nunavut have often been somewhat lower compared to female graduation rates, there is much less gender variability in graduates in 2010/2011 (approximately 1%) and 2011/2012 (2%). In 2012/2013, gender variability increased somewhat (approximately 11%), once again reflecting the trend that had been most common over the past decade; with male graduation rates lower in comparison to female graduation rates.

Public school attendance in the Kitikmeot has declined slightly since reaching a high of 71% in 2005/2006, which was maintained until recently. Of all Kitikmeot students, grades 9, 10 and 11 had the lowest attendance rates in 2010/2011 (60%, 54 % and 60%, respectively). Notably, students enrolled in grade 12 have higher than average attendance rates. Public school attendance is somewhat higher in the Baffin (70.3%) and Kivalliq (73.5%) regions comparatively (NBS 2013d).

Similarly, across Nunavut, public school truancy rates in 2010/2011 were also highest in the Kitikmeot Region (25%) and have increased over the past three years. Truancy rates indicate the percentage of total school days for which a student has unexcused absences (NBS 2013e).

In the Kitikmeot Region, Cambridge Bay had a relatively high proportion of the population in 2011 with a university certificate or diploma (12%) compared with all the other communities. It also had the highest proportion of residents with a college degree or diploma (18%). However, attainment levels for apprenticeship and trade certifications were approximately equivalent across all communities but were slightly higher in Kugaaruk (Statistics Canada 2011).

6.2.4 Contract and Business Opportunities

As for the territory as a whole, the Government of Nunavut dominates the service sector and is the major economic driver of the local communities. This heavy dependency on the public sector is the result of circumstances such as a harsh climate, geographic remoteness, small population, and underdeveloped infrastructure systems that have led to constraints for private sector economic development in the territory.

Cambridge Bay is the largest and most diversified economy and is the business hub for the Kitikmeot Region, with an economy that is fairly balanced across the sectors (J. MacEachern, pers. comm.). Other communities have relatively few private sector businesses. These businesses mainly focus on providing essential services required by the community, which are not provided by government agencies, or on providing goods and services to government programs (e.g., housing). Businesses provide a wide range of services, including those that focus on goods and services to industry and the general public.

Many communities in the Kitikmeot Region do not maintain a registry of businesses. However, a central registry of Inuit-owned businesses is maintained by NTI (Table 6.2-4; NTI 2014). This excludes businesses that do not meet the criteria for being deemed Inuit-owned (e.g., the Northern Store). Further information on community business and services was obtained from field visits and interviews, as presented below. In addition, the Municipality of Cambridge Bay has provided a listing of businesses operating within the community (J. MacEachern, pers. comm.).

Because of the opportunities afforded by government spending on housing and infrastructure, each Kitikmeot community has at least one prominent firm providing construction services. These services can include housing and building construction, heavy equipment operation and excavation, road construction and maintenance, pad construction, and crushing to provide aggregate, as well as the rental of trucks, tools, and equipment (B. Schoenauer, pers. comm.). These businesses provide a relatively large number of private sector jobs, particularly during the summer construction season, and for smaller communities they typically provide the greatest number of jobs outside of government. The construction businesses include, but are not limited to, Kalvik Enterprises (Cambridge Bay), Kitnuna Projects (Cambridge Bay), Kikiak Contracting (Kugluktuk), CAP Enterprises (Gjoa Haven), Lyall's Construction (Taloyoak), and Koomiut Co-operative Association (Kugaaruk), among others. For example, in Taloyaok the largest private sector employer is Lyall's Construction, with approximately 20 local employees, followed distantly by the Co-op Store and the Northern Store (J. Oleekatalik, pers. comm.).

Table 6.2-4. Profile of Registered Inuit Firms in the Kitikmeot Region

Community	Type of Business	Number of Firms
Cambridge Bay	Construction, contracting, and property management	6
	Accommodation and housing	3
	Retail	2
	Air transportation	2
	Medical, safety, and paramedical	2
	Logistical services, expediting, and remote site management	4
	Multiple services to mining sector	3
	Mine development and training	1
	Trade and services	2
	Explosives	1
	Catering, camp management, and janitorial services	2
	Translation and language services	1
	Lodge and guide outfitting	1
Kugluktuk	Construction, contracting, and property management	3
	Accommodation	1
	Retail	2
	Taxi	1
Gjoa Haven	Construction, contracting, and property management	1
	Accommodation	2
	Retail	1
	Consulting	1
	Lodge and guide outfitting	1
Taloyoak	Construction, contracting, and property management	2
	Accommodation	2
	Retail	1
	Trade and service	1
	Translation and language services	1
Kugaaruk	Construction, contracting, and property management	1
	Accommodation	1
	Retail	1
	Fish sales	1

Source: NTI (2014)

Co-operatives are a popular business model in Nunavut. Each Kitikmeot community has a co-operative (co-op) retail store that sells food, clothing, and a broad range of household items. With the exception of Kugaaruk, communities also have a competing Northern Store. Co-operatives operate the Inns North hotel chain and also hold a number of other contracts for providing services in the community. For example, in Kugaaruk, the Koomiut Co-op Association Ltd. operates the retail store and hotel; provides accommodation units for rent, heavy equipment services, construction services, and cable television systems; holds the POL (petroleum, oil, and lubricant) service contract for the community; and is the agent for air service (First Air and Canadian North) and ATV and snowmobile sales (Yamaha and Polaris; L. Flynn, pers. comm.).

Mining service businesses have developed in Cambridge Bay, including medical and safety services, expediting and logistical services, site management, catering, and janitorial services. These companies have benefited from business opportunities associated with the Doris North exploration and construction activities, as well as other mining sector activities in the Kitikmeot Region. In total, there are approximately 100 businesses operating in Cambridge Bay.

Construction of the new Canadian High Arctic Research Station (CHARS) in Cambridge Bay began in August 2014. The facility is to be operational by 2017 and have a staff of approximately 35 to 50 season, part-time, and full-time staff (Prime Mininster of Canada 2012), and will bring additional business opportunities to the community (J. MacEachern, pers. comm.). NTI registered firms participating in the construction of CHARS include: Kitnuna Projects Inc., Canadrill Ltd., Sanaqatiit Construction Ltd., QC/Scarlet Security Services Ltd., Kitikmeot Caterers, and Nunavut Eastern Arctic Shipping Inc. (AANDC 2015a).

In addition to Cambridge Bay, the mining sector has also had beneficial economic effects on other Kitikmeot communities, including Kugluktuk (because of the Diavik and EKATI operations in the NWT) and Kugaaruk (because of local exploration activities of companies such as Diamonds North and Indicator Minerals; L. Flynn, pers. comm.).

In smaller communities, businesses and other organizations are involved in providing a wide range of services and providing services outside of their core client group. This is necessarily as a result of servicing relatively small, isolated populations that cannot support a large number of businesses. For example, it is not uncommon for community Housing Associations, which are primarily responsible for the management and maintenance of public housing for the Nunavut Housing Corporation, to provide fee-for-service maintenance services outside of public housing on an as-required basis (i.e., accept work orders from private home owners; G. Dinney, pers. comm.; H. Tungilik, pers. comm.). Because of the on-hand inventory and ability to source building supplies, private home owners may also purchase construction materials directly from Housing Associations, which effectively operate as local building supply stores.

6.2.5 Community Health

6.2.5.1 Health Status

Self-reported health status, data that are collected through the national census, provides an overall measure of health. The results for the Kitikmeot Region are shown in Table 6.2-5. While more recent health data is available for Nunavut as whole, the census information provided in Tables 6.2-5 and 6.2-6 remain the most recent data available at the community level.

Table 6.2-5. Self-rated Health Status, 2006

Community	Proportion of Population (% 15 years of age and over)		
	Excellent or Very Good	Good	Fair or Poor
Cambridge Bay	43%	38%	19%
Kugluktuk	45%	39%	16%
Gjoa Haven	49%	33%	16%
Taloyoak	43%	39%	16%
Kugaaruk	50%	37%	11%

Note: Values for Taloyaok and Kugaaruk are estimated.
Source: Statistics Canada (2008).

Table 6.2-6. Prevalence of Selected Chronic Conditions, 2006

Community	Proportion of Population (% 15 years of age and over)				
	Arthritis or Rheumatism	Digestive Problems	Respiratory Problems	Cardiovascular Problems	Communicable Disease
Cambridge Bay	20%	10%	11%	18%	8%
Kugluktuk	10%	9%	7%	15%	7%
Gjoa Haven	13%	11%	11%	21%	n/a
Taloyoak	12%	12%	n/a	27%	n/a
Kugaaruk	13%	11%	11%	21%	n/a

Notes: n/a = data not available. Communicable diseases include hepatitis, tuberculosis and HIV/AIDS.
Source: Statistics Canada (2008).

Perceptions of health were fairly consistent across communities, with 43 to 50% of residents reporting excellent or very good health, 33 to 39% reporting good health, and 11 to 19% reporting fair or poor health. These Kitikmeot community self-rated health status scores were comparable or similar to the Canadian average of 56% excellent or very good, 27% good, and 17% fair or poor (Statistics Canada 2008).

Census information also includes self-reported chronic conditions (Table 6.2-6). The prevalence of chronic conditions in the Kitikmeot were indicated to be generally at the same level as in Canada overall. Cardiovascular problems tended to be higher in Taloyoak than in any other community. For the two communities for which data on chronic communicable disease were available, the rate of incidence is higher than the Canadian average, while the incidence of arthritis and rheumatism were less common in Kitikmeot communities than in Canada overall (Statistics Canada 2008). This is not unexpected given the much younger population in the Kitikmeot. Notably, the percentage of Nunavummiut that reported having a regular medical doctor in 2013 is notably lower (17%) in comparison to the rate of Canada (85%; Statistics Canada 2013).

In addition to the above overall indicators of health status, there are a number of individual statistics that stand out as distinct for Nunavummiut compared to the Canadian population as a whole. This includes a lower life expectancy, a higher infant mortality rate, a higher incident of low birth weight, higher smoking rates, higher rates of infant respiratory tract infections, higher rate of tuberculosis, and high rates of sexually transmitted infections (STIs) such as chlamydia and gonorrhoea (NTI 2008). In 2013, life expectancy in Nunavut is approximately 10 years less than the Canadian population as whole, the infant mortality rate is more than double the national rate, the percentage of daily smokers is approximately three times the national average, and deaths due to respiratory disease are about four times the national rate. There has also been a notable decline over the past decade in the percentage of Nunavummiut who perceive their health to be good or excellent, from a highs of 52% and 54% in 2003 and 2007, to a historical low of 35.7% in 2013 (Statistics Canada 2014).

6.2.5.2 Health Care Utilization

The level of health care utilization is also an indicator of overall health because it is a measure of the extent to which the population seeks health care services.

The vast majority of visits are for primary care due to illness or injury. Other health centre utilization categories, shown in Table 6.2-13, are associated with public health programs. Of these, the most heavily utilized is the Chronic Disease Program. It is also noteworthy that the number of visits for the Well Man Program is extremely low compared to participation in Well Woman and Well Child. In general, men are more reluctant to access the health services that are available to them (C. Evalik, pers. comm.).

Within each community in the Kitikmeot at least one social worker is employed who provides child and family services, child and adult protection, crisis intervention, and family counselling services (Rescan 2013). In 2012, there were a number of children in foster care in regional communities and also outside the territory (Table 6.2-14). Children and adults who require residential care (e.g., people who have behaviour issues, disabilities, or are incarcerated) are relocated outside the territory, as this level of care is not available in Kitikmeot communities. Of approximately 38 children in care, 15 children were in care outside the territory. Additionally, there were 39 adults in care outside the territory in September 2012 (Table 6.2-11; Evalik 2012).

Each community in the Kitikmeot Region employs an individual responsible for home care who provides support to the elderly, disabled, and people recovering from major surgery. Community health profiles indicate there were approximately 113 people receiving home care and seven people receiving palliative care in the Kitikmeot communities in 2012 (Evalik 2012).

The proportion of the population accessing heath care professionals varies and may be an indicator of overall levels of access to health care services. Visits to a nurse occurred for a substantial proportion of the population, being highest in the smallest communities of Taloyoak and Kugaaruk. Access to the specialized care of a doctor or dentist or orthodontist occurred much less frequently (Rescan 2013).

Notably, in all communities, diseases of the respiratory system accounted for the largest specified portion of health center visits in 2012 and over the past decade (NBS 2014a).

6.2.5.3 Suicide

Suicide has been a prominent social issue in Nunavut communities. The extent to which death by suicide has occurred and the degree of suicide-related trauma is far greater than that experienced by many other jurisdictions (Government of Nunavut et al. 2010). For example, in 2009 across Nunavut the RCMP reportedly responded to a total of 983 calls where persons were threatening to or attempting suicide (Government of Nunavut et al. 2010).

Research that reviewed medical examiner's reports for suicide in two Nunavut communities between 1980 and 1998 found that 68% of suicides were preceded by the breakup of a romantic relationship and another 20% were preceded by an arrest (Kral 2009). However, recent research findings indicate the suicide rate among teenage boys in Iqaluit is much lower compared to teenage boys in other Nunavut communities. Research to better understand the differing protective and risk factors that characterize larger centers is underway (Rogers 2014).

The total number of suicides in Kitikmeot communities is shown in Table 6.2-7. The rate has been particularly high in Kugluktuk (average annual rate of 190 per 100,000 population) followed distantly by the other communities, with Gjoa Haven the lowest at an annual average rate of 52 (per 100,000 population). Young Inuit males typically make up the largest proportion of these deaths (Government of Nunavut et al. 2010). The total number of suicides in the Kitikmeot Region ranged between three and five from 2009 to 2012[3] (GN DEDT 2013). In 2012, there were 27 suicides in Nunavut; 81% were committed by individuals under the age of 29 (GN DEDT 2013).

Table 6.2-7. Suicides in Kitikmeot Communities, 1999 to 2008

Community	Total Number of Suicides	Average Annual Rate (per 100,000 population)
Kugluktuk	22	190
Cambridge Bay	7	65
Gjoa Haven	5	52
Kugaaruk	5	80
Taloyoak	5	70

Source: Hicks (2009).

On January 16, 2014, Nunavut's chief coroner called a public inquest into suicide in the territory following 45 deaths by suicide in 2013, Nunavut's worst year since it became a territory in 1999. As of January 16, 2014, there had been three deaths by suicide among Nunavummiut (Nunatsiaq 2014a).

The high suicide rates in Nunavut have been attributed to the rapid social change that has occurred and the sense of discontinuity and loss of self-reliance that this has caused. Governments are undertaking initiatives to improve mental wellness and address some of the causes of social discontinuity at the community level. Factors that have been identified to reduce the likelihood that

[3] There were three suicides per year in the Kitikmeot in 2009, 2010, and 2012 and five suicides in 2011.

an individual will consider suicide include having a stable home life, being educated, being employed, and the receipt of mental health care as required (Government of Nunavut et al. 2010).

6.2.6 Housing Demand

According to the Nunavut Housing Needs Survey (2009/2010), the most common type of housing is the Kitikmeot communities is classified as public housing, representing three quarters of the housing stock in Gjoa Haven and Taloyoak, two-thirds in Kugaaruk and Kugluktuk, about half in Cambridge Bay. The second most common type of housing is privately owned housing, followed by staff housing and other types of rented housing (Statistics Canada 2010a). Public housing units are subsidized rented dwellings under the Nunavut Housing Corporation (NHC) and are available to Nunavummiut who meet certain eligibility requirements. Private market rental units are owned by private individuals, corporations, or other organizations and are made available on the rental market (Nunavut Bureau of Statistics 2011).

The availability of suitable housing is an important issue for all Kitikmeot communities. Overcrowded housing is considered to have health and other implications including, for example, violence, depression, stress, and a higher incidence of infectious diseases (Inuit Tapiriit Kanatami 2007; NTI 2008). A large number of dwellings in the Kitikmeot Region are crowded according to the National Occupancy Standard (Table 6.2-8). These rates are slightly higher than in Nunavut as a whole, where approximately 35% of dwellings are overcrowded.

Table 6.2-8. Dwellings Occupied by Usual Residents Classified as Crowded, 2009/2010

Community	Crowded Dwellings		Crowded Dwellings Regularly Using the Living Room as a Sleeping Area	
	Number	Proportion of Total	Number	Proportion of Total
Cambridge Bay	170	35%	80[E]	17%
Kugluktuk	130	34%	50	13%
Gjoa Haven	130	57%	70	30%
Taloyoak	100	56%	50	28%
Kugaaruk	70	50%	30	20%
Kitikmeot Region	610	43%	280	20%
Nunavut	**2,930**	**35%**	**1,470**	**18%**

Note: A dwelling is classified as crowded if there is a shortfall of bedrooms based on the National Occupancy Standard.
[E] = estimated.
Source: NBS (2011).

Overcrowding is particularly prevalent in the eastern Kitikmeot communities of Taloyoak, Gjoa Haven, and Kugaaruk, affecting the majority of homes. In the western Kitikmeot, overcrowding is experienced in approximately one-third of homes (Kugluktuk, 34%; Cambridge Bay, 35%).

Recent census data further highlights overcrowded conditions in the Kitikmeot communities. In the eastern Kitikmeot communities of Gjoa Haven, Taloyoak, and Kugaaruk, more than 50% of households have four or more persons per home and approximately 20% are two-or-more family households. Notably, almost half of the homes in Kugaaruk (42%) and over one third of homes Gjoa Haven (36%) provide accommodation for six or more people (Table 6.2-9; Statistics Canada 2012).

According to the Nunavut Housing Needs Survey, in addition to overcrowded conditions, over a quarter (27%) of the Kitikmeot housing stock required major repairs for items such as defective plumbing or defective electrical wiring, leaking oil or sewage tanks, or a broken hot water heater (NBS 2010).

As noted earlier, public housing is the most common type of housing tenure in the region. Comparatively lower amount of public housing (49%) in Cambridge Bay which is linked to higher than average privately owned and staff housing within the community. Cambridge Bay serves as the regions service hub. Prevalence of owner-occupied dwellings ranges from approximately 13% in Taloyoak to 30% in Cambridge Bay. Notably, in the Kitikmeot Region the average monthly shelter cost is $1,270 and only 6% of owner-occupied households spend 30% or more of total household income on shelter costs (Statistics Canada 2011). Staff housing and private market rental units form less substantial proportions of available housing in the communities

Even though public housing is common, it is in high demand; the Nunavut Housing Needs Survey (NBS 2010) reported a shortage of public housing and large waiting lists for applicants. The survey also noted that the majority of applicants remain waiting for public housing for an average of one to two years. Again, the issue is more prevalent in the eastern Kitikmeot communities where the percentage of the population (15 years of age or older) on the waiting list for public housing ranges from approximately 23% in Kugaaruk to a high of 33% in Taloyoak. Comparatively, the percentage of the population in Cambridge Bay waiting for public housing is lower (12%).

While cost is not the primary factor that limits access to housing, understanding the dynamics at play behind housing tenure and cost provides insight as to the elements contributing to current circumstances in the region. Table 6.2-10 summarises the average and median cost for shelter of owned and rented dwellings. Notably, the median is lower in all cases, substantially so in some communities. Low median rents further exemplify the sizeable portion of individuals who reside subsidized housing. Across the Kitikmeot, average monthly shelter costs for rented dwellings ranged from $653 in Cambridge Bay to $271 in Kugaaruk in 2011 (Statistics Canada 2011). Among owned dwellings, monthly shelter costs in Cambridge Bay more accurately reflect the Territorial average. Interestingly, monthly shelter costs for owned dwellings in the Kitikmeot are lowest in Taloyoak, the second smallest community in terms of population.

Funding for new public housing in Nunavut typically stems from the Nunavut Housing Corporation (NHC), the federal government, and the Canada Mortgage and Housing Corporation (CMHC). The recent 'Agreement for Investment in Affordable Housing' which involves matching funds from the CMHC and GN (2011-2014; CMHC 2013), announced that construction of 73 public housing units was completed in year two of the program (2012/2013) providing suitable housing for approximately 325 Nunavummiut[4] (CMHC 2013).

[4] Based on Nunavut's public housing occupancy rate of 4.44 - NBS. 2010. *Nunavut Housing Needs Survey Fact Sheet - Nunavut* .

Table 6.2-9. Housing in Kitikmeot Communities (Census 2011)

	Total Number Private Dwellings	Total Number of Persons in Private Households	Household Size						Two-or-More Family Households
			I Person	2 Persons	3 Persons	4 Persons	5 Persons	6 or More Persons	
Cambridge Bay	505	1,590	110	125	85	80	55	55	35
Kugluktuk	400	1,440	70	75	75	70	40	75	40
Gjoa Haven	275	1,280	30	20	40	40	45	100	50
Taloyoak	205	895	25	25	30	30	30	65	40
Kugaaruk	155	770	10	15	15	35	20	65	30
Kitikmeot	1,540	5,980	240	255	245	250	190	355	195
Nunavut	8,660	31,700	1,575	1,590	1,380	1,360	1,095	1,655	920

Source: Statistics Canada (2012).

Table 6.2-10. Shelter Costs in the Kitikmeot Communities, 2011

	Average Monthly Shelter Cost for Owned Dwellings ($)	Median Monthly Shelter Cost for Owned Dwellings ($)	Average Monthly Shelter Cost for Rented Dwelling ($)	Median Monthly Shelter Cost for Rented Dwelling ($)
Cambridge Bay	$1,523	$1,383	$653	$269
Kugluktuk	$1,272	$1,201	$413	$110
Gjoa Haven	$1,049	$933	$457	$161
Taloyoak	$706	$692	$364	$122
Kugaaruk	$1,117	$918	$271	$120
Kitikmeot Region	$1,270	$1,075	$473	$133
Nunavut	$1,522	$1,343	$654	$311

Source: Statistics Canada (2011)

6.2.7 Crime

From 2001 to 2013 across the Kitikmeot Region, violent and non-violent crime rates decreased slightly. Notable is the regional decline in violent crime between 2009 and 2013, following a steady increase from 2001 to 2009. The regional rate of non-violent crime has also decreased over this time period, despite slight increases in Taloyoak and Kugaaruk. Rates of both violent and non-violent crime in Kugaaruk rose above those reported in 2001.

For other violations (i.e., mischief, bail violations, disturbing the peace, arson, and offensive weapons) and federal statute violations (including drug-related offenses) Cambridge Bay and Kugluktuk stand out as having the highest crime rates from 2001 to 2013. Kugluktuk, in particular, had relatively high rates of other violations from 2003 through 2006 and in 2013 has surpassed rates of other violations and federal statute violations in Cambridge Bay. In other communities, crime patterns are less evident and have, in many instances, shown substantial fluctuations.

Despite population increases in all communities (see Section 6.2.1), the total number of criminal violations steadily declined in Cambridge Bay, Gjoa Haven, and Taloyoak between 2009 and 2013. In Kugluktuk, there is a notable decrease in theft (from 109 to 46 incidences) and rise in disturbance of the peace (from 41 to 132 incidences), while the total number of violations in Kugaaruk increased for all crimes. The most common types of criminal violations are mischief, assault, and disturbing the peace in each of the Kitikmeot communities, with the exception of Kugaaruk where the most common violations were mischief, assault, and administration of justice (NBS 2014b).

The number of calls for service (Table 6.2-11) is also an important indicator of the level of demand on policing services in each community, as a call for service may not necessarily result in a police-reported incidence of crime. For each community in the Kitikmeot Region, the number of calls for service has increased between 2010 and 2012, most notably in Kugaaruk where the increase is approximately 186% over the two years. Prisoner counts (number of admissions or arrests) have also increased in each community (Table 6.2-28). However, the increase has been small in Taloyoak (3%) and Cambridge Bay (6%), despite relatively larger increases in calls for service in those communities. The increase in prisoner counts has been much more substantial in Kugluktuk (43%), Gjoa Haven (51%), and Kugaaruk (71%), and is more reflective of the increase in calls for service.

Table 6.2-11. Police Calls for Service and Prisoner Count, 2010 to 2012

	Calls for Service (number of calls)			Prisoner Count (number of admissions)		
Community	2010	2011	2012	2010	2011	2012
Cambridge Bay	1,408	1,541	1,718	842	892	894
Kugluktuk	804	1,010	1,180	289	378	414
Gjoa Haven	426	444	576	166	146	251
Taloyoak	394	540	450	146	147	151
Kugaaruk	76	192	217	17	30	29

Assault has been the most common violation in the Kitikmeot region in recent years, and accounted for more than half of all violations in 2012 by individuals age 18 and over. Males were more than three times as likely as females to be charged with assault (in 2010, 2011, and 2012). Trends are similar for Kitikmeot youth aged 12 to 17 years over the same time period; however, female adults have typically accounted for approximately one quarter of total violations, while female youth accounted for approximately one half (NBS 2013b, 2013g).

Crime in the Kitikmeot communities is described as primarily consisting of family violence or domestic assaults, sexual assaults, thefts (mainly of ATVs and snowmobiles), break and enters, liquor and drug violations, and mischief (i.e., disturbing the peace, property damage; J. Atkinson, pers. comm.; P. Bouchard, pers. comm.; C. Gauthier, pers. comm.; D. Malakhov, pers. comm.; L. Sharbell, pers. comm.). Bullying, as well as physical and sexual abuse, are issues faced by youth, while drug and alcohol abuse and family violence cross all age groups (L. Sharbell, pers. comm.). Women can be the target of abuse by men (C. Gauthier, pers. comm.). Abuse of the elderly is also reported as being an issue in some communities (D. Malakhov, pers. comm.).

There are a number of underlying issues that are believed to attribute to crime in the Kitikmeot communities. The overcrowding of houses places stress on individuals and families, leading to family violence and substance abuse issues (L. Sharbell, pers. comm.). Much of the crime has been related to the abuse of alcohol and drugs (J. Atkinson, pers. comm.; P. Bouchard, pers. comm.; C. Gauthier, pers. comm.; D. Malakhov, pers. comm.; L. Sharbell, pers. comm.). Marijuana is the main drug that is available within Kitikmeot communities, but there are indications that this may be changing, particularly for the larger communities such as Cambridge Bay where cocaine and crack cocaine are appearing (C. Gauthier, pers. comm.). In terms of crimes committed by youth, boredom is believed to be the main reason there is a prevalence of ATV and snowmobile thefts, damage of property, break and enters, and mischief calls (J. Atkinson, pers. comm.; P. Bouchard, pers. comm.; L. Sharbell, pers. comm.). There is typically an increase in crime during the winter months when individuals are confined within the community and within homes, particularly during the holiday season (L. Sharbell, pers. comm.).

6.3 OTHER MAJOR RESOURCE PROJECTS

6.3.1 Mine Development and Mineral Exploration

The potential for mine development in the west Kitikmeot Region is recognized to be high, and recent mining and mineral exploration activities have contributed substantially to local and regional economies and employment (NPC 2004). In the Kitikmeot Region, the major commodities of interest are gold, zinc, and copper, although the region is also known to host diamonds, platinum group elements, and uranium. Past-producing mines in the Kitikmeot include the Lupin gold mine and Jericho diamond mine, both located southeast of Kugluktuk, and the Roberts Bay and Ida Bay silver mines, located southwest of Cambridge Bay near the Hope Bay gold project. Exploration activity in the region in 2014 focused primarily on gold, while exploration for base metals is minimal (AANDC 2015b).

Despite market conditions, there is an increase in active mineral tenure in the Kitikmeot in 2014 with the recent addition of three Inuit-Owned Land parcel Exploration Agreements, eight prospecting permit applications, and more than one hundred newly staked claims. In 2014, there were 110 permits, 4,278 claims, and 492 leases in Nunavut that were in good standing. Within the

Kitikmeot Region there are no operating mines, three advanced exploration projects, and 14 active mineral exploration projects. Table 6.3-1 details exploration projects and advanced exploration project in the Kitikmeot Region in 2014.

Table 6.3-1. Exploration Projects in the Kitikmeot Region, 2014

Closest Community	Project Name	Commodity	Operator
Bathurst Inlet	Hackett River	Base Metals	Glencore Xstrata plc
	George (Back River Project)	Gold	Sabina Gold & Silver Corp.
	Goose (Back River Project)	Gold	Sabina Gold & Silver Corp.
	Wishbone	Base Metals and Gold	Sabina Gold & Silver Corp.
	High Lake (Izok Corridor Project)	Gold and Base Metals	MMG Limited
	Izok Lake (Izok Corridor Project)	Base Metals and Gold	MMG Limited
	Ulu	Gold	Mandalay Resources Corp., WPG Resources Inc.
	Hood River	Gold	WPC Resources Inc.
	Itchen Lake	Gold	Transition Metals Corp., Nunavut Resources Corp.
Cambridge Bay	Doris (Hope Bay Project)	Gold	TMAC Resources Inc.
	Madrid (Hope Bay Project)	Gold	TMAC Resources Inc.
	Boston (Hope Bay Project)	Gold	TMAC Resources Inc.
	Chicago (Hope Bay Project)	Gold	TMAC Resources Inc.
Kugluktuk	Coppermine River	Copper	Kaizen Discovery Inc.

Source: AANDC (2015b)

There are now two operational mines in Nunavut - Agnico-Eagle's Meadowbank Gold Mine near Baker Lake (in the Kivalliq Region) and Baffinland's Mary River iron ore mine (in the Baffin Region; Baffinland 2014). Agnico Eagle received federal approval for their Meliadine Gold Mine Project to advance to permitting in January 2015 (Lawson Lundell LLP 2015). Meliadine is located near to the currently operating Meadowbank mine, which will undergo a reassessment in order to expand its open pit operations to include the Phaser Pit, planned to come into production by 2017 (Nunatsiaq News 2015b). Notably, the Meadowbank mine was the only operational mine in Nunavut in 2013, a year in which the mining sector accounted for 18% of Nunavut's GDP (NWT & Nunavut Chamber of Mines 2015).

There are three advanced exploration projects in the Kitikmeot, which are partially on Inuit-Owned Land parcels; namely, Hood River (WPC Resources), Izok Corridor (MMG), and Hope Bay. Recently, MMG notified the NIRB of their intention to further delay updates to the Izok Corridor project description while attempting to identify additional mineral resources. The status of the project will be revisited in late 2015 (Nunatsiaq 2014b). Also recently, WPC Resources completed its 2014 field exploration program on both the Ulu and Hood River properties, announcing the results will be used to prioritize drill targets for the 2015 drill program (AANDC 2015b).

Sabina Gold and Silver Corp. plans to submit their Back River Final Environmental Impact Statement (FEIS) in 2015. The final hearings and project decision are expected by late 2015 or early 2016 (Sabina Gold & Silver Corp. 2015). Areva Resources Canada's Kiggavik Uranium Project has advanced in the environmental review process, submitting their FEIS in September 2014. The final hearing in the review of the Kiggavik Project was completed in March 2015 from which the NIRB concluded that the Kiggavik Uranium Mine Project should not proceed at this time (NIRB 2015) as the Kiggavik Project as presented has no definite start date or development schedule.

Also in the Kitikmeot, the Lupin gold deposit was in production from 1982 to 1998 and again from 2000 to 2005. At the time of closure, 400,000 ounces of gold were estimated to remain. As of 2013, Lupin was owned by Elgin Mining Inc. The Lupin mine project was closed indefinitely in mid-2013 following corporate financial losses and falling gold prices and is now inactive (Nunatsiaq 2013; AANDC 2015b).

Natural Resources Canada's annual estimates of spending on exploration and deposit appraisal in the Canadian territories clearly identify 2011 as a peak year for spending in Nunavut and Yukon. In 2014, an estimated $148 million was spent, a reduction of 72% since 2011 (Table 6.3-2). Natural Resources Canada did not look at spending intentions in 2015, but suggested there is potential for further decline (Nunatsiaq News 2015a). For Canada, the total expenditures estimates for 2014 also decreased (by 10%; to $2.12 billion). Nunavut experienced the largest decline in spending of all provinces and territories between 2013 and 2014 (-43%); however, Nunavut retained its position as fifth in Canada in terms of overall investment (AANDC 2015b; NWT & Nunavut Chamber of Mines 2015).

Table 6.3-2. Mineral Exploration in the Canadian Territories, 2006 to 2014

	Mineral Exploration Spending (millions)								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Nunavut	$210.6	$338	$432.6	$187.6	$256.7	$536	$427	$258	$148
Northwest Territories	$176.2	$193.7	$147.7	$44.1	$81.7	$94	$136	$78	$103
Yukon	$106.4	$144.7	$134	$90.9	$156.9	$332	$292	$101	$88

Source: Natural Resources Canada (2015)

Overall in 2014, there were 13 new prospecting permits issued, bringing the total number to 110. There were no new mineral lease or coal licences issued; the standing total was 167 recorded claims (as at November 1, 2014). Twenty-two land use permits were issued and 20 extensions granted, for a total of 173 active land use permits (AANDC 2015b).

6.3.2 Oil and Gas Exploration and Development

Oil and gas-related exploration and development in Nunavut are concentrated in the Eastern Arctic (northern Hudson Bay and around Baffin Island), the Arctic Islands, and Sverdrup Basin (INAC 2011c, 2011d) ((INAC 2011b, 2011a). A number of exploratory and delineation wells are concentrated in the northwest of Qikiqtani Region (NPC 2008b). Two of the largest undeveloped gas fields in Canada are in the Arctic Islands (INAC 2000).

As of 2008, the only oil and gas infrastructure in the Kitikmeot region was an exploratory well in northern Kitikmeot, on Prince of Wales Island. The majority of the southern Kitikmeot region is not recognized as having oil and gas potential (NPC 2008b). Discovered oil and gas supplies in Nunavut and offshore in the Arctic are described in Table 6.3-3. The discovered gas supplies in the Arctic Islands are comparable to those in the Beaufort Sea-Mackenzie Delta Region; however, industry has not shown a strong interest in the exploration and development of reserves in the Arctic Islands (INAC 2009).

Table 6.3-3. Oil and Gas Resources in Nunavut and Arctic Offshore

Resources	Discovered Resources		Undiscovered Resources		Ultimate Potential	
	10^6m^3	MMbbls	10^6m^3	MMbbls	10^6m^3	MMbbls
Oil Resources	51.3	322.9	371.8	2339.4	423.1	2662.3
Gas Resources	449.7	16.0	1191.9	42.3	1641.6	58.3

Source: INAC (2009).

More recent data describing discovered, undiscovered, and potential oil and gas deposits in Nunavut are not available; however, current estimates discussed at the recent Oil & Gas Summit, held in Iqaluit in January 2015, place Nunavut's conventional undiscovered resources at 25 percent of Canada's conventional crude oil resources and 34 percent of Canada's conventional natural gas resources (Government of Nunavut 2014; Nunatsiaq News 2015c). To date most of Nunavut's known oil and gas potential is in the high Arctic where extremely high infrastructure costs and challenges associated weather have rendered investment uneconomical.

6.4 EMPLOYMENT AND EXPENDITURES BY THE PROJECT

As part of the proposed Project changes, TMAC would like to access the Doris subdeposits. This would result in an extension of the Doris North Project mine life to a total of six years. Associated with this is an initial mining rate of 1,000 tonnes per day (tpd; yearly average ore mining rate) that subsequently increases to 2,000 tpd once the second mill stage is installed. An estimated total of 2,500,000 tonnes of ore will be processed from these deposits. This will result in a change in the direct employment and expenditures by the Project compared to the information presented in the 2005 Doris North Final EIS submission (Miramar 2005). An examination of how employment and expenditures are predicted to change with the proposed Project amendment serves as a basis from which to screen potential changes in the predicted socio-economic effects.

6.4.1 Project Employment

Direct employment on the Project from 2009 to 2014, including both owner employees and contractors working on site, is summarized in terms of person-days worked and full-time equivalent (FTE) in Table 6.4-1. Person-days worked is typically based on a 12-hr work day and an FTE is standardized to a 2,080-hour year.

Table 6.4-1. Direct Doris North Employment, 2009 to 2014

	2009	2010	2011	2012[1]	2013[2]	2014[3]
Person-days Worked	30,453	67,687	102,819	35,202	10,019	12,167
Full-time Equivalent (FTE)	175.7	390.5	593.2	203.1	58	70
Inuit Person-days Worked (% of total person-days worked)	11%	13%	15%	20%	16%	14%
Monthly Average Number of Workers[4]	83	82	282	130	48	93

Notes: Employment includes both owner employees and on-site contractor workers.
[1] *Estimate for Q1 to Q3.*
[2] *Estimate for Q2 to Q4.*
[3] *Estimate for Q1 to Q3.*
[4] *Based on number of individuals recorded as working at least one day on site in a given month.*
Source: A. Buchan, pers. comm.

The amount of work provided by the Project increased substantially from approximately 176 FTEs (30,450 person-days) in 2009 to 593 FTEs (102,820 person-days) in 2011. In 2012, employment fell significantly due to the Project entering Care and Maintenance and the following change of ownership. Total employment was approximately 58 FTEs in 2013, while the Project remained in Care and Maintenance, but increased to 70 in 2014 (Table 6.4-1).

There was a monthly average of 48 workers on the Project in 2013 and 93 workers in 2014, consisting of both TMAC employees and contractors (Table 6.4-1). In 2014, personnel at the site were predominantly contractors, with a daily average of 7 in the first quarter (Q1), increasing to 75 in the last quarter (Q4) as activity associated with the Project increased. Throughout 2014, a total of 18 individuals were directly employed by TMAC; Inuit represented from 10 to 29% of total project workforce depending on the season.

Following the acquisition of the Project by TMAC, the percentage of person-days worked in 2013 that consisted of Inuit from Kitikmeot communities was approximately 16% (Table 6.4-1). This includes both TMAC employees and contractors. TMAC has been successful in engaging Inuit as part of the Project workforce, and has been able to retain a core number of skilled and experienced workers. In 2014, the percent of person-days worked by Inuit for Kitikmeot communities was approximately 14% (Table 6.4-1).

In 2013, the Project hired approximately six employees from Cambridge Bay, seven from Kugluktuk, two from Taloyoak and three from other communities (A. Buchan, pers. comm.). A total of approximately 10,019 person-days of work were generated by the Project in 2013; out of this, approximately 1,580 person-days of work experience accrued to Inuit workers. In 2014, there were notable increases in the total of person-days worked (12,167) as well as person-days worked by Inuit (1,685).

In 2014, TMAC employees consisted of 80% male and 20% female permanent salaried employees (A. Buchan, pers. comm.). In comparison, TMAC employees consisted of 73% male and 27% female by person-days worked in 2013 (A. Buchan, pers. comm.). In 2010 and 2011, female and male employment by person-days averaged approximately 20% and 80%, respectively (A. Buchan, pers. comm.). Similar to 2013, TMAC hired one student to work at the Project in 2014. Comparatively, in 2010, there were 16, and in 2011, 20 individuals, primarily students, hired as Environmental Field Assistants to work on the Project (A. Buchan, pers. comm.).

During operation, Doris North employment opportunities are predicted to be longer-term, with an increasing Inuit share. Based on the previous mine design (Miramar 2005), employment is estimated to average approximately 165 persons and total about 370 person-years during the 27 months of operation. It is also estimated approximately 155 person-years of this would consist of Nunavummiut, representing about 42% of the total mine workforce.

With the planned changes to the Project, total employment from 2016 to 2021 is predicted to average approximately 302 persons over six years (Table 6.4-2). If 42% of the workforce is comprised of Nunavummiut, as predicted in the 2005 FEIS, this would correspond to an average of about 127 workers (compared to 69 in the original FEIS prediction). While TMAC is not prepared to commit to an Nunavummiut hiring target,[5] it is reasonable to anticipate this level of employment being possible during operations based on the experience to date during the construction phase coupled with the mitigating measures planned to support Nunavummiut employment (Section 6.5).

Table 6.4-2. Planned Project Employment, 2016 to 2021

Employment	2015	2016	2017	2018	2019	2020	2021	Total
On-Site	5	43	183	193	193	193	193	1,003
Off-Site	4	11	13	13	13	13	13	80
Mine Contractor	3	47	106	146	146	146	146	740
Total	12	100	302	352	352	352	352	1,822

Project employment between 2016 and 2021 is expected to climb to a high of about 352 workers annually including approximately 146 contract employees, 193 on-site employees, and 13 off-site employees (Table 6.4-2). Over the six year mine life, the Project would employ an estimated 1,003 workers on-site and 80 workers off-site, and the mine contractor would employ about 740 workers (Table 6.4-2).

6.4.2 Project Expenditures

A summary of Project expenditures for 2008, 2009 and 2010 is shown in Table 6.4-3. The share of contracts to the Kitikmeot Corporation and affiliated businesses increased from approximately 27% of annual Canadian spending on Doris North in 2008 to approximately 51% in 2010; from 2008 to 2010, this spending totaled approximately $150 million.

[5] Note that goals for the hiring of Inuit may be defined by the Inuit Impact and Benefits Agreement (IIBA) between TMAC and the Kitikmeot Inuit Association (KIA). This information is considered confidential and is not made public by the parties.

Table 6.4-3. Doris North Direct Expenditures, 2008 to 2010

	2008		2009		2010	
Contractor	Value (million $)	Share of Total (%)	Value (million $)	Share of Total (%)	Value (million $)	Share of Total (%)
Kitikmeot Corporation and Affiliated	$14.2	26.7%	$31.0	39.3%	$104.6	50.6%
Other Kitikmeot-based Businesses	$0.2	0.3%	$6.8	8.6%	$10.6	5.1%
Non-Inuit Businesses	$38.8	73.0%	$41.2	52.1%	$91.6	44.3%
Total	***$53.2***	***100.0%***	***$79.0***	***100.0%***	***$206.8***	***100.0%***

For 2014, an estimated $17.5 million or 40% of Project contract spending went to Kitikmeot-based or Inuit-owned businesses. Of this total, approximately $3.0 million was to Kitikmeot-based businesses; this represented about 7% of total contract spending by the Project. In comparison, approximately $5.6 million went to Kitikmeot-based or Inuit-owned businesses in 2013. In 2012, the total value of contracts was $39.0 million, with 1.4% ($0.5 million) awarded to Kitikmeot-based contractors and 72.1% ($28.1 million) to Kitikmeot Corporation affiliates.

The Project's use of Kitikmeot-based or Inuit-owned businesses will continue. This includes business opportunities for the provision of air transportation, logistical services, camp supplies, medical and safety supplies, and catering, as well as other goods and services.

Planned expenditures of the Project from 2015 to 2021 include capital expenditures of approximately $148.2 million and operational expenditures of approximately $374.4 million, for a total Project expenditure of $522.6 million. The majority of the capital expenses are incurred in 2015 and 2016 in preparation for the Project to become operational. The bulk of operational expenditures occur over three years between 2017 and 2020, peaking in 2018 at $113.1 million (Table 6.4-4).

Table 6.4-4. Planned Project Expenditures (million 2015 dollars), 2015 to 2021

	2015	2016	2017	2018	2019	2020	2021	Total
CAPEX	$75,842	$51,691	$12,526	$4,423	$1,069	$2,693	$0	$148,242
OPEX	$0	$0	$82,496	$113,069	$102,381	$74,328	$2,177	$374,452
Total	$75,842	$51,691	$95,022	$117,492	$103,450	$77,021	$2,177	$522,694

Notes: CAPEX = capital expenditures. OPEX = operating expenditures.

As with employment, the proposed amendment to the Project will result in the prolonging of contract and business opportunities. This will be directly associated with extension of mine life to six years.

6.5 Mitigation and Screening of Socio-economic Effects

This section provides a review of the 2005 Doris North Final EIS mitigation and effects assessment conclusions, and a screening of the effects of the proposed changes in the Project in relation to the identified mitigation and effects assessment conclusions.

6.5.1 2005 Socio-economic Mitigation and Effects Assessment Conclusions

The 2005 FEIS assessed the potential effects of the Project on employment and economy, and community services and infrastructure. Valued Socio-economic Components (VSECs) were selected based on both western scientific data and *Inuit Qaujimajatuqangit.* A summary of the identified potential socio-economic effects of the Project, as well as described mitigation, as specified in Miramar (2005) is provided in Table 6.5-1.

Table 6.5-1. 2005 Socio-economic Effects and Mitigation Summary

Valued Socio-economic Component (VSEC)	Potential Effects	Mitigation
Employment and Economy		
Employment Opportunities and the Economy	• Increased employment opportunities and income • Loss of employees from other industries to the Project • Increased demands on community services • Cost of living increases • Amplified social problems related to increased income • Unemployment following mine closure	• Adhering to the principles of IQ as much as possible • Hire Inuit to facilitate work force transition • Build cultural awareness and enforce harassment policies • Inuit will be given preferential treatment for employment • Promote awareness of employment and service procurement opportunities within Kitikmeot communities • Collaborate with training institutions • Develop and implement a Recruitment Strategy • Provide annual business opportunities forecasts • Host annual Summer Camp for students to get exposure to trades and technology options • Facilitate workshops for family financial management
Education and Training	• Increased training opportunities • Increased educational attainment within the region • Increased skill-base within the region	• Collaborate and partner with relevant agencies and contractors to ensure skill requirements are being met • Education and training providers develop training programs geared toward the long-term employment of women in non-traditional occupations
Contracting and Business Opportunities	• Increased contract and business opportunities • Increased capacity for business within the region	• Provide assistance, feedback, information and lead time to contractors from the Kitikmeot communities on bids and bidding policies • Require and monitor local content plans on major bids • Waive bond provisions at tender for Inuit-owned businesses

(continued)

Table 6.5-1. 2005 Socio-economic Effects and Mitigation Summary (completed)

Valued Socio-economic Component (VSEC)	Potential Effects	Mitigation
Community Services and Infrastructure		
Health Services	• Project-induced/related exposures to disease causing contagion conditions • Project-related unsafe working practices causing injury • Project-induced or related changes in income levels and associated spending patterns, causing stress or substance and/or family abuse • Physical risk levels • Job-related stress levels, which might increase emotional or mental health disorders	• Provision of qualified medical personnel and pre-employment medicals • Develop emergency response and contingency plans • Provision of alcohol and drug education and enforcement of alcohol and drug free site policies • Collaboration with regional health services • Enforcement of safety policies
Social Services	• Job-related issues, such as worksite harassment, safety, undervalued work • Mental or emotional disorders induced by various conditions, including family separation, costs and inaccessibility of child care, substance abuse, stress associated with work, and spousal stress associated with lone household management	• Orientation programs • Facilitating and promoting fairness in the workplace • Provide formal processes for issue resolution • Keeping family groups or community groups of workers together for support while away from home • Provision of free and confidential Employee and Family Assistance Program (EFAP) for support on a wide range of issues
Safety and Protection Services	• Increased alcohol abuse, or deliberate acts or incidents might increase the number of occasions requiring response from the RCMP • Reduced level of service due to increased turnover of RCMP officers in response to elevated on-the-job demands	• Enforcement of alcohol and drug free site • Liaise and collaboration with local protective services • Conduct pre-employment criminal record checks

After mitigation, the residual socio-economic effects identified in the Doris North Final EIS (Miramar 2005) can be summarized as follows:

- Increased expense to the hamlets for recruitment and retraining of workers providing services in the community because workers decide to work at the mine site;
- Increased personal income with the increase in employment and business opportunities;
- Increased cost of living in the communities;
- Increased demands on community services by the individual or family members due to time away from the community and increased personal income;

- Increased demands on housing and other community infrastructure due to immigration of workers; and
- Benefits to quality of life due to increased individual and family income.

The Doris North Final EIS (Miramar 2005) concluded that all residual adverse environmental effects on community services and infrastructure were negligible to minor, and not significant. The Project is predicted to result in benefits in terms of employment, skills development, and the economy.

6.5.2 Screening of Changes to Socio-economic Effects

The proposed amendments to the Project as they potentially affect VSECs are not anticipated to result in any new effects. Thus, the potential effects as identified in Miramar (2005) remain valid.

While the amendments to the Project do not result in any new socio-economic effects, the regulatory environment and community concerns in relation to the development on mining projects have evolved since the completion of the Doris North FEIS in 2005 (Miramar 2005). A review of recent EIS submissions in Nunavut indicates that consideration for the potential direct and indirect effects of a Project on housing and overcrowding conditions within communities is warranted. While a direct effect of the Project is not anticipated, given the practice of multiple points-of-hire and use of a fly-in/ fly-out camp-based operation, there is some potential for in-migration primarily associated with indirect and induced business growth, mainly in Cambridge Bay, when qualified local workers are not available and workers from elsewhere are brought in to meet the demand. Further strain on the housing supply within the Kitikmeot Region may have implications for community services providers and governments.

Table 6.5-2 below identifies the potential for effects to housing conditions on the VSEC Community Services and Infrastructure and identifies mitigation measures to address the effect.

Table 6.5-2. Additional Socio-economic Effects and Mitigation

Valued Socio-economic Component (VSEC)	Potential Effects	Mitigation
Community Services and Infrastructure		
Housing	• Increased demand for housing • Increased conditions of overcrowding	• Collaborating and partnering with local education and training institutions, increasing the number of skilled local people able to access not only Project-related employment but also indirect employment opportunities. • Collaboration with training institutions to meet Project-related employment requirements, and indirectly increasing community capacity.

The following sections revisit the potential socio-economic effects in light of the proposed amendments and the addition of consideration of indirect in-migration and potential related effects to housing demand, including an evaluation of the identified mitigation, monitoring, and management procedures.

6.5.2.1 Mitigation

With respect to employment and business opportunities, TMAC will continue with mitigation initiatives as outlined in Table 6.5-1. This includes working with stakeholders and suppliers from the communities to facilitate the direct and indirect hiring of Nunavummiut throughout operation.

Education and training initiatives in the Kitikmeot Region will be continued so that a greater proportion of Nunavummiut meet the requirements for employment with the Project. Initiatives around the partnerships for training, such as with the Arctic College and/or with the participation of the Kitikmeot Inuit Association (KIA), will continue to be pursued and developed. For example, TMAC is:

- Active on the Cambridge Bay Community Readiness Committee preparing the community for future developments,
- Active on the KIA ASETS Program Working Group aiming to allocate ASETS training funding to the most beneficial effect,
- An active member of the Nunavut Mine Training Roundtable tasked with allocating Government of Nunavut Mine Training funding, and
- Supporting a joint venture in 2015 between TMAC's drilling contractor, Geotech Drilling, and Kitikmeot Corporation to train Inuit drillers for both surface and underground exploration drilling.

It is predicted that with the longer duration of mine operation a greater number of Inuit will be able to take advantage of education and training opportunities. This will result in an increase in the human capital available within Kitikmeot communities, thus supporting continued economic development across the region and minimizing the need for the hiring of workers from elsewhere.

With respect to health services, social services, and safety and protection services, current and planned mitigation will be developed to accommodate the Project changes associated with the proposed amendment. Key mitigation will be as described in Table 6.5-1 (Miramar 2005).

Mitigation to offset indirect population increases potentially affecting the demand for housing within the Kitikmeot includes measures that maximize local participation in employment with Project contractors. This approach minimizes the need for outside workers and potential increases to the demand for housing. Measures include monitoring the local content plan of major contract bids, collaborating and partnering with educational/training institutions to support local initiatives, and providing information to training institutions early to further maximize the inclusion of local skilled people in Project contract work.

In accordance with Article 26 of the Nunavut Land Claim Agreement, in March 2015, TMAC Resources entered into a new Inuit Impact and Benefit Agreement (IIBA) with the Kitikmeot Inuit Association (KIA) for the Hope Bay Project, including activities described in this application. This agreement supersedes the Doris North IIBA which has been in place for the project since 2006, and will be applicable to future phases of the project over the 20 year term of the agreement. The Hope Bay IIBA provides for a comprehensive package of employment, training, contracting and other

Inuit specific provisions designed to provide Inuit with benefits from the Project and to mitigate against any potential adverse effects.

Common to both the Doris North and Hope Bay IIBA, TMAC Resources and the KIA have jointly established an IIBA Implementation Committee whose purpose is to ensure that the provisions of the IIBA are met. The first meeting of the Hope Bay IIBA Implementation Committee will be late July 2015.

6.5.2.2 Residual Socio-economic Effects

Extension of the mine life and increase in the mining rate will result in a change on employment and the economy due to additional economic production, value-added (Gross Domestic Product, or GDP), employment, personal income, and government revenue. The economic benefits of a mine life extension are predicted to occur across Canada, Nunavut and, more specifically, within the Kitikmeot Region. The effects of the additional business activity, employment, and income on communities are expected to change from that assessed in the 2005 FEIS. Specifically, there is expected to be an increase in the total economic benefits of the Project to Nunavut with the increase in the mining rate and mine life, and the increase in the number of workers on-site (see Section 6.4.1).

This increase in economic benefits is directly due to the substantial increase in capital expenditures (CAPEX) and operating expenditures (OPEX). With CAPEX now predicted to be over 3.7 times higher (from an estimated $39.2 million to $148.2 million, excluding the substantial expenditures prior to 2015), and OPEX predicted to be about 7 times higher (from an estimated $53.7 million to $374.5 million), economic benefits to Nunavut are expected to increase proportionally.

The increase in the size of the workforce and the extension of the mine life will also increase the employment benefits to Kitikmeot residents. With achievement of previous objectives, Nunavummiut employment is expected to represent approximately 42% of the workforce; this corresponds to a total of about 127 Nunavummiut workers (compared to the 69 in the 2005 FEIS prediction). Further, this predicted average employment will extend over a six year period, rather than only two years.

With respect to community services and infrastructure, minimal adverse effects are predicted on health care services, community well-being and delivery of social services, housing, and public safety and protection services. The Project is predicted to have a minor effect on in-migration. This is primarily because of the adoption of multiple points-of-hire and a fly-in/fly-out arrangement with well-equipped camp facilities, as well as the high unemployment rates within Kitikmeot communities, which will discourage people from moving to the Kitikmeot Region for mine-related employment. In-migration that does occur will be primarily associated with indirect and induced business growth, mainly in Cambridge Bay, when qualified local workers are not available.

Mitigation measures focused to increase the number of local individuals that obtain Project employment are also expected to indirectly increase community capacity and the level of skilled workers available for other work. An increased skill base increases the chance for indirect employments needs to be met locally. In this way, collaboration with training institutions, while primarily to meet Project employment requirements, also lessens the potential for increases to housing demand. This will minimize any additional demand on community services and infrastructure because of an increase in the local population due to the Project. Further, regional monitoring reports that have assessed the impact of the Hope Bay Project on in-migration have indicated that this has not occurred as a result of the Project (TMAC 2014). For these reasons, the effect of the Project on the demand for housing is expected to be minor.

The expected increase in personal incomes, business incomes, and government revenues that are realized over the extended life of the mine is predicted to result in an increase in the benefits to community services and infrastructure. This is because of the overall positive effects of increases in employment and income on human health and well-being. There may be some increases in socially-damaging behaviour (e.g., gambling, substance abuse), as well as family stress and dysfunction, associated with increases in disposable incomes within communities. Levels of participation in traditional land-based activities may also decline with mine-related employment. However, positive effects on personal financial resources will increase the options available for individuals and increase government revenues to allow for an enhancement of supporting public infrastructure and services.

6.5.2.3 Cumulative Effects

The likely development of other mine projects in the Kitikmeot region and elsewhere in Nunavut is anticipated and included as part of the cumulative effects assessment presented in the Doris North FEIS. The updated list of likely projects as described in Section 6.3 is consistent in size and type with the project list that served as the basis for the earlier cumulative effects assessment, although the specific mix of projects has changed somewhat (Miramar 2005). It is predicted that the proposed amendments to the Project will not substantially change the characteristics of the potential interactions with other projects that may act cumulatively on either employment and economy, or community services and infrastructure. Thus, the cumulative effects assessment conclusions as described in Miramar (2005) are predicted to remain valid.

6.5.2.4 Monitoring and Management

The Project has an existing Socio-economic Monitoring Program that will accommodate the proposed amendment activities.

The Socio-economic Monitoring Program for Doris North defines a number of indicators that have been selected based on the impact predictions and mitigation measures in the FEIS. For each social and economic indicator, specific measures, data requirements, and data sources have been identified, and data collection and reporting is on-going. The Socio-economic Monitoring Program allows for both early detection of adverse effects on VSECs and reporting of impact and benefit objectives for the Project. Extension of the Doris North Project life is not expected to result in the need to change the monitoring program given that there are no material differences in the nature of the predicted residual effects. The Doris North Socio-economic Monitoring Committee (SEMC), which includes members from the KIA, Aboriginal Affairs and Northern Development Canada (AANDC) and the Government of Nunavut (Economic Development and Transportation), provides additional oversight to help ensure that on an on-going basis the monitoring program meets its objectives.

7. CONCLUSIONS

TMAC Resources Inc. (TMAC) has retained ERM Canada (ERM) to prepare a report which considers the potential for effects to the natural and human environment arising from the proposed changes to the Phase 1 Doris North Project. TMAC also retained Points West Heritage Consulting Ltd. to specifically consider potential for impacts on heritage resources (Appendix A).

The conclusion of the effects assessment to the natural and human environment from the proposed changes to the Project are:

- The proposed expansion to the Roberts Bay laydown area involves two sections, one to the south toward the airstrip and another, smaller area to the west near the jetty. Additional footprint expansion is proposed to the area to the southeast of the current infrastructure. The proposed activities for these expanded areas were originally assessed in the Doris North Project FEIS and an expansion of the laydown areas does not change the predicted environmental impacts.
- The proposed change from subaqueous to subaerial deposition of tailings in the TIA is expected to lead to increased dust generation, however, mitigation measures including the use of proven dust suppression methods will be used to maintain dust at acceptable levels.
- The maximum cumulative potential water level decrease due to the extraction of the currently permitted 480,000 mcm/year from Doris Lake is within the range of natural variability, and no adverse effects were are predicted in the Doris North FEIS. Changes to stream outflow will also occur, however these are also be within normal natural fluctuations.
- Additional water losses from Doris Lake are anticipated because in the proposed mine plan, excavations will intersect talik zones that are interconnected with the lake. The cumulative water losses from Doris Lake are predicted to result in serious harm to fisheries and an Offset Plan and DFO Authorization will be obtained.
- TMAC anticipates that saline groundwater will be encountered in the talik under Doris Lake during mining of Doris Central and Doris Connector a. In order to manage saline groundwater as well as reduce potential for negative impacts on the freshwater environment, TMAC will revise management of the underground saline groundwater so that it is collected within sumps (underground) and re-used as much as possible for underground drilling activities. The excess will be discharged directly to Roberts Bay via pipeline and a diffuser on the ocean floor. The on-land portion of the discharge pipeline will follow the existing all-weather road to Roberts Bay with the alignment and entrance to marine environment not at existing jetty but an independent structure on the western side of Roberts Bay
- The potential effects of discharging compliant TIA water into Roberts Bay is not expected to result significant adverse effects on water quality, sediment quality, marine fish, marine fish habitat, or marine wildlife. The Project has been designed such that the water quality in

Roberts Bay will meet CCME guidelines for the protection of marine and estuarine aquatic life for the duration of the operation and decommissioning of the TIA.

- For employment and economy, the proposed amendment to extend the mine life increases overall total benefits. There remains the potential for adverse effects on other community employers if the labour demands of the Project result in a shortage of skilled workers Minimal adverse effects are predicted on health care services, community well-being and delivery of social services, and public safety and protection services.
- The mitigation measures originally proposed for the Doris North Project remain appropriate to address potential socio-economic effects to employment and income, education and training, business opportunities, health services, social services, and safety and protection services.

The potential for environmental and socio-economic effects from the proposed changes to the Doris North Project to the physical, biological and traditional resources can be mitigated through incorporation of design considerations, current mitigation measures and accepted management practices.

REFERENCES

1985. *Fisheries Act*, RSC. C. F-14.

1994. *Migratory Birds Convention Act*, SC. C. 22.

2002. *Species at Risk Act*, SC. C. 29.

2003. *Wildlife Act*, SNu. C. 26.

AANDC. 2015a. *CHARS*.

AANDC. 2015b. *Nunavut Mineral Exploration, Mining, and Geoscience*.

Alberta AMD. 1989. *Air Monitoring Directive - Monitoring and Reporting Procedures for Industry*. Alberta Environment, Environmental Protective Services: Edmonton, AB.

Anthony, P. 2001. *Dust from walking tracks: Impacts on rainforest leaves and epiphylls*. Australia: Cooperative Research Centre for Tropical Rainforest Ecology and Management. http://www.jcu.edu.au/rainforest/infosheets/dust_walkingtracks.pdf (accessed October 2008).

Arai, T. and A. Goto. 2005. Flexible life histories of ninespine sticklebacks, genus *Pungitius*. *Environmental Biology of Fishes*, 74: 43–50.

ASTM. 2010. *ASTM D1739 - 98(2010): Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter)*. ASTM International: West Conshohocken, PA.

Auerbach, N. A., M. D. Walker, and D. A. Walker. 1997. Effects of roadside disturbance on substrate and vegetation properties in arctic tundra. *Ecological Applications*, 7 (1): 218-35.

Baffinland. 2014. *Baffinland Begins Mining Iron Ore*. Online.

Banci, V. 1994. Wolverine. In *The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the Western United States*. Ed. L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski. USDA Forest Service. General Technical Report RM- 254.

CCME. 1999. Canadian water quality guidelines for the protection of aquatic life: Introduction. In *Canadian environmental quality guidelines, 1999*.Winnipeg, MB: Canadian Council of Ministers of the Environment.

CCME. 2011. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table. Updated January 2011. In *Canadian Environmental Quality Guidelines, 1999*.Winnipeg, MB: Canadian Council of Ministers of the Environment.

CCME. 2015. *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table. In Canadian Environmental Quality Guidelines, 1999*. Canadian Council of Ministers of the Environment: Winnipeg, MB.

CEPA/FPAC Working Group. 1998. National ambient air quality objectives for particulate matter – Part 1. In *CEPA/FPAC Working Group on Air Quality Objectives and Guidelines Report*. Cat. No. H26-2/98-220. Minister, Public Works, and Government Services, Canada: n.p.

CESCC. 2005. *Nunavut Ranking Wild Species Canada*. http://www.wildspecies.ca/wildspecies (accessed October 2014).

Church, M. 1974. *Hydrology and permafrost with reference to northern North America*. J. Demers, ed. Ottawa, ON: Secretariat, Canadian National Committee, International Hydrological Decade, Environment Canada.

CMHC. 2013. *Canada Mortgage and Housing Corporation (CMHC) - Nunavut Agreement for Investment in Affordable Housing 2011-2014 - Year 2 (2012/2013)*.

Cody, W. J., K. L. Reading, and J. M. Line. 1993. Additions and range extensions to the vascular plant flora of the Continental Northwest Territories and Nunavut, Canada II. *Canadian Field Naturalist*, 117 (3): 448-65.

COSEWIC. 2002. *COSEWIC assessment and update status report on the grizzly bear (Ursus arctos) in Canada*. Committee on the Status of Endangered Wildlife in Canada: Ottawa, ON.

COSEWIC. 2003. *COSEWIC assessment and update status report on the wolverine (Gulo gulo) in Canada*. Committee on the Status of Endangered Wildlife in Canada: Ottawa, ON.

COSEWIC. 2005. *Nunavut Ranking Wild Species Canada*. http://www.wildspecies.ca/wildspecies (accessed October 2014).

COSEWIC. 2007. *COSEWIC assessment and update status report on the Peary caribou (Rangifer tarandus pearyi) and the barren-ground caribou (Rangifer tarandus groenlandicus) (Dolphin and Union population) in Canada.* www.sararegistry.gc.ca/status/status_e.cfm (accessed October 2007).

COSEWIC. 2010. *Committee on the Status of Endangered Wildlife in Canada*. http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.cfm (accessed December 2010):

COSEWIC. 2014. *COSEWIC Species Database: Caribou, Barren-ground*. http://www.cosewic.gc.ca/eng/sct0/status_change_e.cfm (accessed January 2013).

Cott, P. A. 2007. Fisheries Related Impacts of Water Withdrawal from Ice-Covered Lakes. M.Sc. diss., University of Guelph.

CRD Environmental Services. 2002. *Saanich Peninsula Treatment Plant. Wastewater and Marine Environment Program. 2001 Annual Report.* . http://www.crd.bc.ca/wastewater/saanich_peninsula/documents/SaanichPenWastewMarine2001.pdf (accessed May 2011).

DFO. 1991. *The Department of Fisheries and Oceans: Policy for the management of fish habitat*. Department of Fisheries and Oceans: Ottawa, ON.

DFO. 2004a. *Annual Report to Parliament on the Administration and Enforcement of the Fish Habitat Protection and Pollution Prevention Provisions of the Fisheries Act*. Department of Fisheries and Oceans: Ottawa, ON.

DFO. 2004b. *Cambridge Bay Arctic char*. Fisheries and Oceans Canada, Canadian Science Advisory Section. Stock Status Report 2004/010. 15 p.: Ottawa, ON.

DFO. 2007a. *DFO Nunavut Operational Statement: Culvert Maintenance. Version 3.0, DFO/2007-1329*. Fisheries and Oceans Canada: Ottawa, ON.

DFO. 2007b. *DFO Nunavut Operational Statement: Temporary Stream Crossing. Version 1.0.* . Fisheries and Oceans Canada: Ottawa, ON.

DFO. 2009. *DFO Nunavut Operational Statement on Mineral Exploration Activities. Version 1.0.* . Fisheries and Oceans Canada: Ottawa, ON.

DFO. 2010. *DFO Protocol for Winter Water Withdrawal from Ice-Covered Waterbodies in the Northwest Territories and Nunavut*. Fisheries and Oceans Canada: Iqaluit, NU.

DFO. 2013a. *Fisheries protection policy statement*. Fisheries and Oceans Canada: Ottawa, ON.

DFO. 2013b. *Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada*. DFO. Can. Sci. Advis. Sec. Proceed. Ser. 2013/017. Fisheries and Oceans Canada: Ottawa, ON.

DFO. 2013c. *Measures to Avoid Causing Harm to Fish and Fish Habitat*. Fisheries and Oceans Canada. http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html (accessed May 2015).

Ebata, K., A. Higashi, A. Shiomitsu, S. Saisho, and T. Ikeda. 2011. Development of a small and lightweight artificial reef for Fukutokobushi (*Haliotis diversicolor diversicolor*). In *Global Change: Mankind-Marine Environment Interactions, Proceedings of the 13th French-Japanese Oceanography Symposium*. Ed. H.-J. Ceccaldi, I. Dekeyser, M. Girault, and G. Stora.

Eller, B. M. 1977. Road dust induces increase of leaf temperature. *Environmental Pollution*, 13: 99–107.

ERM. 2015. *Doris North Project: 2014 Hydrology Compliance Monitoring Program*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM Rescan. 2014a. *Doris North Project: 2013 Hydrology Compliance Monitoring Report*. Prepared for TMAC Resources Inc. by ERM Rescan: Yellowknife, NT.

ERM Rescan. 2014b. *Doris North Project: 2013 Meteorology Compliance Monitoring Report*. Prepared for TMAC Resources Inc. by ERM Rescan: Vancouver, BC.

Evalik, C. 2012. *Kitikmeot Community Profiles: Health and Social Services* Regional Director, Kitikmeot Region: n.p.

Farmer, A. M. 1993. The Effects of Dust on Vegetation: A Review. *Environmental Pollution*, 79: 63–75.

GN DEDT. 2013. *Kitikmeot Socio-Economic Monitoring Committee: Fall 2013 Report*.

Golder. 2003. *Inuit Qaujimajatuqangit Literature Review, Gap Analysis and Workshop Results Related to the Doris North Project Hope Bay Belt, Nunavut*. Prepared for Miramar Hope Bay Limited by Golder Associates Limited: n.p.

Golder. 2006. *Bathymetric Surveys - Hope Bay Project*. Prepared by Golder Associates Ltd.: n.p.

Golder. 2007. *Doris North Project "No Net Loss" Plan – Revision 6 Final Report. Golder Report No. 07-1373- 0018-1200F*. Prepared for Miramar Hope Bay Limited by Golder Associates Limited: n.p.

Golder. 2008. *Doris North Project Aquatic Studies 2007. Draft Report*. Prepared for Miramar Hope Bay Ltd.: Edmonton, AB.

Golder. 2009. *Doris Project Area 2008 Hydrology Baseline Update – Draft Report*. Prepared for Hope Bay Mining Limited by Golder Associates: Edmonton, AB.

Government of Nunavut. 2014. *Business Plan: Government of Nunavut and Territorial Coporations, 2014 - 2017.*

Government of Nunavut, Nunavut Tunngavik Inc., Embrace Life Council, and Royal Canadian Mounted Police. 2010. *Nunavut Suicide Prevention Strategy: October 2010*. http://www.tunngavik.com/wp-content/uploads/2011/02/101301-layout-english.pdf (accessed November 2011).

Goward, T. and C. Björk. 2010. *Nunavut Macrolichen Rankings*. Unpublished report for the Nunavut Ministry of Environment: Iqualuit, NU.

Hammill, M. O. 2009. Ringed seals. In *Encyclopedia of marine mammals 2nd ed*. Ed. W. F. Perrin, B. Würsig, and J. G. M. Thewissen. 972–74. San Diego, CA: Academic Press.

Hicks, J. 2009. *Statistical Data on Deaths by Suicide in Nunavut, 1960 - 2008*. Working Group for a Suicide Prevention Strategy For Nunavut. Government of Nunavut, Nunavut Tunngavik Inc., and the Isaksimagit Innusirmi Katujjiqatigiit (Embrance Life Council). http://www.tunngavik.com/documents/publications/2009-04%20SP%20WG%20ENG%20discussion%20paper.pdf (accessed March 2011).

Hoover, A. K., D. L. Dickson, and K. W. Dufour. 2010. Survival and nesting success of the Pacific Eider (*Somateria mollissima v-nigrum*) near Bathurst Inlet, Nunavut. *Canadian Journal of Zoology*, 88: 511–19.

INAC. 2000. *Oil and Gas Nominations Invited for the Arctic Islands of Nunavut*. Bulletin 7(6). http://www.ainc-inac.gc.ca/nth/og/pubs/vol/7_6-eng.asp (accessed April 2011).

INAC. 2009. *Northern Oil and Gas Annual Report 2009*. http://www.ainc-inac.gc.ca/nth/og/pubs/ann/ann2009/ann2009-eng.pdf (accessed April 2011).

INAC. 2011a. *Northern Oil and Gas Branch. Oil & Gas Dispositions. Eastern Arctic Offshore*. Indian and Northern Affairs Canada. http://www.ainc-inac.gc.ca/nth/og/le/mp/ain/earct_pg.pdf (accessed March 2011).

INAC. 2011b. *Northern Oil and Gas Branch. Oil & Gas Dispositions. Sverdrup Basin*. Indian and Northern Affairs Canada. http://www.ainc-inac.gc.ca/nth/og/le/mp/ain/sverdrup_pg.pdf (accessed March 2011).

INAC. 2011c. *Northern Oil and Gas Branch. Oil & Gas Dispositions: Eastern Arctic Offshore*. (accessed March 2011).

INAC. 2011d. *Northern Oil and Gas Branch. Oil & Gas Dispositions: Sverdrup Basin*. http://www.ainc-inac.gc.ca/nth/og/le/mp/ain/sverdrup_pg.pdf (accessed March 2011).

Inuit Tapiriit Kanatami. 2007. *Social Determinants of Inuit health in Canada: A Discussion Paper*. http://ahrnets.ca/files/2011/02/ITK_Social_Determinants_paper_2007.pdf (accessed July 2011).

Johnson, L. 1980. The Arctic charr, Salvelinus alpinus. In *Charrs: Salmonid fishes of the genus Salvelinus*. Ed. E. K. Balen. 928. The Hague, Netherlands: Dr. W. Junk, Publisher.

Kovacs, K. M. 2009. Bearded seal. In *Encyclopedia of marine mammals, 2nd ed* Ed. W. F. Perrin, B. Würsig, and J. G. M. Thewissen. 97–101. San Diego, CA: Academic Press.

Kovacs, K. M., C. Lydersen, J. Overland, and S. Moore. 2010. Impacts of changing sea-ice conditions on Arctic marine mammals. *Marine Biodiversity – Arctic Ocean Diversity Synthesis*: 1–14.

Kral, M. J. 2009. Transforming Communities: Suicide, Relatedness, and Reclamation among Inuit of Nunavut. Doctor of Philosophy diss., McGill University.

Lawson Lundell LLP. 2015. *Federal government approves Meliadine Gold Mine*.

Magoun, A. J. and J. P. Copeland. 1998. Characteristics of wolverine reproductive den sites. *Journal of Wildlife Management*, 62: 1313–20.

McCune, D. C. 1991. Effects of airborne saline particles on vegetation in relation to other variables of exposure and other factors. *Environmental Pollution*, 74: 176–203.

McLoughlin, P. C., M. K. Taylor, H. D. Cluff, R. J. Gau, R. Mulders, R. L. Case, and S. Boutin. 2003. Demography of barren-ground grizzly bears. *Canadian Journal of Zoology*, 81: 294-301.

McLoughlin, P. C., M. K. Taylor, H. D. Cluff, R. J. Gau, R. Mulders, R. L. Case, and F. Messier. 2003. Population viability of barren-ground grizzly bears in Nunavut and the Northwest Territories. *Arctic*, 56: 185-90.

McLoughlin, P. C., L. R. Walton, H. D. Cluff, P. C. Paquet, and M. A. Ramsay. 2004. Hierarchical habitat selection by tundra wolves. *Journal of Mammology*, 85: 576-80.

McPhail, J. D. and C. C. Lindsey. 1970. *Freshwater fishes of northwestern Canada and Alaska.* . Bulletin of the Fisheries Research Board of Canada No. 173.:

Meteorological Services of Canada (MSC). 2004. MSC Guidelines for Co-operative Climatological Autostations, Version 3.0. *Environment Canada, MSC, Surface Weather, Climate & Marine Division, Atmospheric Monitoring Survey Branch*:

Miramar. 2005. *Final Environmental Impact Statement: Doris North Project, Nunavut, Canada*. Miramar Hope Bay Ltd: n.p.

Miramar. 2007. *Doris North Project: Wildlife Mitigation and Monitoring Program*. Prepared for Miramar Hope Bay Limited by Golder Associates Limited:

Mulders, R. 2000. *Wolverine ecology, distribution, and productivity in the Slave Geological Province*. Final Report to the West Kitikmeot/Slave Study Society: Yellowknife, NT.

Natural Resources Canada. 2015. *Exploration plus deposit appraisal expenditures, by province and territory, 2009-2014*.

NBS. 2010. *Nunavut Housing Needs Survey Fact Sheet - Nunavut*

NBS. 2013a. *Labour Force Activity for the total population 15 years and over, for Nunavut, Regions and Communities, 2011 National Household Survey*.

NBS. 2013b. *Number of Adults 18 and Over Charged by Select Violation by Region and Sex, 1999 to 2012*.

NBS. 2013f. *Nunavut Secondary School Graduates, 1999 to 2012*.

NBS. 2013g. *Nunavut Youth 12 to 17 Charged by Select Violations by Region and Sex, 1999 to 2012*.

NBS. 2014b. *Nunavut Criminal Violations by Type and Community, 1999 to 2013*.

NBS. 2014c. Nunavut Population Estimates by Inuit and Non-Inuit, Region and Community, 2006 to 2014. http://www.stats.gov.nu.ca/en/Population%20estimate.aspx.

NPC. 2004. *West Kitikmeot Regional Land Use Plan: Preliminary Draft*. Nunavut Planning Commission: Cambridge Bay, NU.

NPC. 2008a. *Nunavut Wildlife Resource and Habitat Values*. Prepared for the Nunavut Planning Commision by Nunami Jacques Whitford Limited and EDI Environmental Dynamics Inc.: Yellowknife, NT.

NPC. 2008b. *Oil and Gas*. Nunavut Planning Commission. http://www.nunavut.ca/files/16_oil_&_gas.pdf (accessed April 2011).

NTI. 2008. *Nunavut's Health System. A Report Delivered as part of Inuit Obligations under Article 32 of the Nunavut Land Claims Agreement, 1993. Annual report on the State of Inuit Culture and Society*. Nunavut Tunngavik Inc. http://www.tunngavik.com/publications/ (accessed March 2011).

NTI. 2014. *Inuit Firm Registry*.

Nunatsiaq. 2013. *Owner puts Nunavut's Lupin Mine project back into limbo*.

Nunatsiaq. 2014a. *Chief Coroner call public inquest into Nunavut Suicides*.

Nunatsiaq News. 2015c. *Oil-gas summit in Iqaluit this January will shape Nunavut Policy*.

Nunavut Bureau of Statistics. 2010. *Nunavut Community Population Projection 2010 to 2036 Methodological Document*. http://www.eia.gov.nu.ca/stats/population.htm (accessed March 2011).

Nunavut Bureau of Statistics. 2011. *Nunavut Housing Needs Survey Fact Sheets*. http://www.eia.gov.nu.ca/stats/housing.html (accessed April 2011).

NWT & Nunavut Chamber of Mines. 2015. *Northern Mining News*.

Poole, K. G., A. Gunn, B. R. Patterson, and M. Dumond. 2010. Sea ice and migration of the Dolphin and Union caribou herd in the Canadian Arctic: an uncertain future. *Arctic*, 63 (4): 414–28.

Porsild, A. E. and W. J. Cody. 1980. *Vascular plants of continental Northwest Territories, Canada*. National Museum of Natural Sciences: Ottawa, ON.

Priest, H. and P. J. Usher. 2004. *The Nunavut Wildlife Harvest Study. August 2004*. Nunavut Wildlife Management Board: Iqaluit, NU.

Prime Mininster of Canada. 2012. *PM Announces support for Canadian High Arctic Research Station to bring jobs and growth to the north*. http://pm.gc.ca/eng/media.asp?category=1&featureId=6&pageId=26&id=4971 (accessed January 2013).

Recan. 2011. *Doris North Gold Mine Project: 2010 Aquatic Effects Monitoring Program Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Limited: Vancouver, BC.

Rescan. 2001. *2000 Supplemental Environmental Baseline Data Report Hope Bay Belt Project*. Prepared for Hope Bay Joint Venture by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2009a. *Doris North Gold Mine Project: 2009 Roberts Bay Jetty Fisheries Authorization Monitoring Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Limited:

Rescan. 2009b. *Hope Bay Belt Project: 2009 Hydrology Baseline Report*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2010a. *2009 Freshwater Baseline Report, Hope Bay Belt Project*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2010b. *2009 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2010c. *Doris North Gold Mine Project: 2010 Roberts Bay Jetty Fisheries Authorization Monitoring Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Limited:

Rescan. 2011a. *2010 Marine Fish and Fish Habitat Baseline Report, Hope Bay Belt Project.* Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2011b. *Doris North Gold Mine Project: Wildlife Mitigation and Monitoring Program, 2010.* Prepared for Hope Bay Mining Limited by Rescan Environmental Services Limited. January 2011.:

Rescan. 2011c. *Hope Bay Belt Project: 2010 Ecosystems and Vegetation Baseline Report. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.* Vancouver, BC.

Rescan. 2011d. *Hope Bay Belt Project: 2010 Hydrology Baseline Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012a. *Doris North Gold Mine Project: 2011 Numerical Simulation of Roberts Bay Circulation*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012b. *Doris North Gold Mine Project: 2011 Roberts Bay Physical Oceanography Baseline Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012c. *Doris North Gold Mine Project: Hydrology Compliance Report 2012*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012d. *Hope Bay Belt Project: 2011 Hydrology Baseline Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2013. *The Back River Project: Human Environment, Volume 8*. Prepared by Rescan, an ERM company: Vancouver, BC.

Richardson, E. S., J. D. Reist, and C. K. Minns. 2001. *Life history characteristics of freshwater fishes occurring in the Northwest Territories and Nunavut, with major emphasis on lake habitat requirements.* Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2569:

RL&L Environmental Services Ltd./Golder Associates Ltd. 2003. *Doris North Project no net loss plan*. Prepared for Miramar Hope Bay Ltd. by RL&L Environmental Services Ltd./Golder Associates Ltd.: n.p.

Ross, P. I. 2002. Update COSEWIC status report on the grizzly bear Ursus arctos in Canada. In *COSEWIC assessment and update status report on the Grizzly Bear Ursus arctos in Canada*. Ed. T. Ruskeeniemi, S. Frape, L. Moren, and P. Degnan. 1-91. Committee on the Status of Endangered Wildlife in Canada. Report of Phase 1, Permafrost Project GTK-SKB-POSIVA-NIREX-OPG.

Sabina Gold & Silver Corp. 2015. *Sabina Gold & Silver reports on important Back River permitting milestone*. http://www.sabinagoldsilver.com/s/news.asp?ReportID=690639 (accessed February 2015).

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. *Bulletin of the Fisheries Research Board of Canada No 184*:

Scott, W. B. and E. J. Crossman. 1973. *Freshwater Fishes of Canada*. Bulletine of the Fisheries Research Board of Canada No. 184.

Sherman, R. L., D. S. Gilliam, and R. E. Spieler. 2002. Artificial reef design: void space, complexity, and attractants. *ICES Journal of Marine Science*, 59: S196-S200.

Sikumiut. 2011. *Mary River Project Environmental Impact Statement, Vol. 10, Review of Marine Habitat Compensation Works*. Prepared for Baffinland Iron Mines Corp. by Sikumiut Environmental Management Ltd.: St. Johns, NL.

SRK Consulting (Canada) Inc. 2005. *Preliminary Jetty Design, Doris North Project, Hope Bay, Nunavut, Canada*. Prepared for Miramar Hope Bay Limited: n.p.

SRK Consulting (Canada) Inc. 2007. *Turbidity Curtain Specification for the Doris North Jetty*. Technical Memorandum Prepared for Project File. Project Number 1CM014.011. April 24, 2007.

Statistics Canada. 2007. *2006 Community Profiles*. http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E (accessed October 2012).

Statistics Canada. 2008. *2006 Profile of Aboriginal Children, Youth and Adults*. http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/89-635/index.cfm?Lang=eng (accessed March 2011).

Statistics Canada. 2010a. *An analysis of the housng needs in Nunavut: Nunavut Housing Needs Survey 2009/2010*. Income Statistics Division, Statistics Canada:

Statistics Canada. 2010b. *Quarterly Demographics Estimates April to June 2010*. http://www.statcan.gc.ca/pub/91-002-x/91-002-x2010002-eng.pdf (accessed March 2011).

Statistics Canada. 2011. *National Houshold Survey*. http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=PR&Code1=01&Data=Count&SearchText=canada&SearchType=Begins&SearchPR=01&A1=All&B1=All&Custom=&TABID=1 (accessed March 2014).

Statistics Canada. 2012. *Census of Canada 2011*. http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E (accessed January 2013).

Statistics Canada. 2013. *Nunavut (Health Region), Nunavut and Canada (table). Health Profile.* . http://www12.statcan.gc.ca/health-sante/82-228/index.cfm?Lang=E (accessed February 2015).

Statistics Canada. 2014. *Health Trends: Nunavut*. http://www12.statcan.gc.ca/health-sante/82-213/index.cfm?Lang=ENG (accessed February 2015).

Stephenson, T. A. and A. Stephenson. 1972. *Life Between Tide-Marks on Rocky Shores*. n.p.: W.H. Freeman.

Stewart, B. E. and P. M. Burton. 1994. Extralimital occurrences of beluga, *Delphinapterus leucas,* and walrus, *Odobenus rosmarus*, in Bathurst Inlet, Northwest Territories. *Canadian Field-Naturalist*, 108: 488-90.

Swanson, H. K., K. A. Kidd, J. A. Babaluk, R. J. Wastle, P. P. Yang, N. M. Halden, and J. D. Reist. 2010. Anadromy in Arctic populations of lake trout (Salvelinus namaycush): otolith microchemistry, stable isotopes, and comparisons with Arctic char (Salvelinus alpinus). *Canadian Journal of Fisheries and Aquatic Sciences*, 67 (5): 842-53.

TMAC. 2014. Doris North Project: 2014 Socio-Economic Monitoring Program Report.

Tupper, M. and R. G. Boutilier. 1995. Effects of habitat on settlement, growth and post-settlement survival of Atlantic cod (*Gadus morhua*). *Canadian Journal of Fisheries and Aquatic Sciences*, 52: 1834–41.

Walker, D. A. and K. R. Everett. 1991. Loess ecosystems of northern alaska: regional gradient and toposequence at Prudhoe Bay. *Ecological Monographs*, 61 (4): 437–64.

Walters, V. 1955. Fishes of western Arctic America and eastern Arctic Siberia. *Bulletin of the American Museum of Natural History*, 106: 225–368.

Walton, L. R., H. D. Cluff, P. C. Paquet, and M. A. Ramsay. 2001. Movement patterns of barren-ground wolves in the Central Canadian Arctic. *Journal of Mammalogy*, 82: 867-76.

Wathne, J. A., T. Haug, and C. Lydersen. 2000. Prey preferences and niche overlap of ringed seals *Phoca hispida* and harp seals *P. groenlandica* in the Barents Sea. *Marine Ecology Progress Series*, 194: 233–39.

Weaver, J. L., P. C. Paquet, and L. F. Ruggiero. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. *Conservation Biology*, 10: 964-76.

WKRLUP. 2005. *West Kitikmeot Regional Land Use Plan. Draft.* Public Hearing, Cambridge Bay, January 18-19, 2005.

Personal Communications

Atkinson, J. 2011. Acting Non-Commission Officer in Charge, RCMP, Kugaaruk. Interview: February 12, 2011.

Avalak, J. 2011. Hunter, Cambridge Bay. Interview: February 3, 2011.

Bouchard, P. 2011. Non-Commission Officer in Charge, RCMP, Taloyaok. Interview: February 4, 2011.

Buchan, A. 2014. Director of External and Community Relations, TMAC Resources Inc., Cambridge Bay, Nunavut. Personal Communication: September-December 2014.

Cipriano, P. 2011. Principal, Qiqirtaq Ilihakvik High School, Gjoa Haven. Interview: February 7, 2011.

Dimitruk, C. 2011. Kitikmeot Regional Senior Planner, Department of Community and Government Services, Government of Nunavut, Cambridge Bay. Interview: February 2, 2011.

Dinney, G. 2011. Housing Manager, Taloyoak Housing Authority, Taloyoak. Interview: February 4, 2011.

Evalik, C. 2011. Kitikmeot Regional Director, Department of Health and Social Services, Government of Nunavut, Cambridge Bay. Interview: January 28, 2011.

Flynn, L. 2011. General Manager, Koomiut Co-op, Kugaaruk. Interview: February 12, 2011.

Gauthier, C. 2011. Detachment Commander, RCMP, Cambridge Bay. Interview: January 29, 2011.

MacEachern, J. 2011. Economic Development Officer, Municipality of Cambridge Bay, Cambridge Bay. Interview: February 2, 2011.

Malakhov, D. 2011. Constable, RCMP, Gjoa Haven. Interview: February 7, 2011.

Ooleekatalik, J. 2011. Economic Development Officer, Hamlet of Taloyoak, Taloyoak. Interview: February 4, 2011.

Pizzo, G. 2011. Principal, Netsilik School, Taloyoak. Interview: March 21, 2011.

Schoenauer, B. 2011. Manager, CAP Enterprises Ltd., Gjoa Haven. Interview: February 8, 2011.

Setatak, B. 2011. Manager, Ekaluktutiak Hunters and Trappers Organization, Cambridge Bay. Interview: February 3, 2011.

Sharbell, L. 2011. Non-Commission Officer in Charge, RCMP, Kugluktuk. Interview: February 1, 2011.

Tungilik, H. 2011. Housing Manager, Kikitak Housing Association, Gjoa Haven. Interview: February 7, 2011.

Appendix A

Doris North Amendments Consolidated Archaeological Supporting Memo

POINTS WEST HERITAGE CONSULTING LTD.
23531 – 8th Avenue, Langley, B.C. V2Z 2X9 604-534-5054
50041 HWY 814, Leduc County, AB. T4X 0K2 780-980-2079

DORIS NORTH AMENDMENTS
CONSOLIDATED ARCHAEOLOGICAL SUPPORTING MEMO
Prepared by Gabriella Prager, B. Sc., MA
Senior Archaeologist, Points West Heritage Consulting Ltd.
May, 2015

This document consolidates revised versions of previous assessments prepared in 2011 and 2013 and includes updated assessments based on 2014 field work. Only those portions of the proposed amendments that could cause surface ground disturbance have been assessed for archaeological remains.

Tailings Impoundment Area Water Management and Tailings Deposition

The primary concern regarding proposed changes in tailings impoundment area (TIA) water management and tailings deposition from an archaeological perspective relates to potential changes to ground surface disturbance. Changes are proposed to the water discharge location and system. Discharging treated water to Roberts Bay from the TIA will use a pipeline that will follow existing roads between the north end of the TIA through the Doris camp complex, along the airstrip and existing road. From the west end of the existing road, a new road will extend 550m west to the edge of Roberts Bay, which the pipeline will parallel. The developed sections along which the pipeline will run were previously thoroughly investigated prior to construction of the existing developments, and no archaeological resources were found. There are no archaeological concerns for the section of pipeline immediately adjacent to the existing road network. In the case of the Roberts Bay Access Road and discharge pipe, this general area has been previously examined and there are no known sites in the immediate vicinity; however, it is not certain that the specific route to be followed by the western extension of road and pipeline has been assessed in detail. This assessment is planned for the 2015 field season.

There are two revisions to the tailings management system within the TIA footprint. These include tailings placement on land within the south portion of the tailings impoundment area, and a construction of the interim dike with a short access on the east side. Both of these occur within the areas previously surveyed for archaeological resources in 2003 (Prager 2004), 2005 (Prager 2006) and 2010 (Prager 2011). There are no known archaeological sites in these localities. Since past survey coverage was intensive, no archaeological concerns are expected.

Expanded Doris Camp

The area within and immediately adjacent to the existing Doris camp footprint was carefully surveyed for archaeological remains several times prior to construction of the camp. No archaeological evidence was found. Assuming the camp expansion remains within and in close proximity to the existing camp footprint, no archaeological conflicts are anticipated.

Expanded Pad U

Pad U is located along the northwest side of Doris Lake. This area was carefully surveyed several times for archaeological resources in past years and no archaeological evidence was found. Therefore, no archaeological conflicts are anticipated.

Potential Landfill in Quarry 3

A landfill is proposed within Quarry 3, on the east side of the TIA, once this quarry has been used. The entire quarry area was thoroughly examined in 2003 and 2010. One site, NaNh-30, within this quarry has been fully mitigated by detailed mapping and excavation (Prager 2011). There should be no further archaeological concerns with this quarry and subsequent use for landfill.

Roberts Bay Laydown Expansion

Three new laydown areas are proposed at Roberts Bay. Those designated Southwest and Southeast are adjacent to the Primary Road as it turns west approaching Roberts Bay. The Southwest area includes the base and upper edge of a large bedrock outcrop. This area was previously surveyed (Prager 2006) and no archaeological remains were found. One site is recorded on the upper bedrock outcrop but that is a considerable distance west of this laydown area. Although no archaeological concerns are known, the portion of upper bedrock edge included in this laydown is a high archaeological potential landform; therefore, it will be closely inspected this season to confirm no archaeological remains are present. The Southeast laydown area is on low lying tundra that was previously surveyed and was judged low potential for archaeological remains. This area is also well away from any known archaeological sites which occur to the east; therefore, archaeological conflicts are not anticipated. The West laydown area appears to extend over the location of a previously recorded site (NbNh-23) that was fully mitigated by detailed mapping and excavation in 1997 (Prager 1998); therefore, this site is no longer a concern. Another recorded site, NbNh-46, is 200m directly south of the shoreline of the Bay on an elevated section of bedrock. This should be sufficiently distant that this site should be avoidable. The specific bedrock terrain included in this laydown area will be closely inspected this season to ensure no archaeological conflicts since this also has good archaeological potential.

Quarries A, B, D

These three quarries were surveyed for archaeological sites in 2008 (Green 2008) and re-examined in 2009 (Prager 2010). Seven archaeological sites were recorded: Quarry A: NaNh-49, 60, 61; Quarry B: NaNh-62, 63, 64; Quarry D: NaNh-58. These sites were fully mitigated in 2010 (Prager 2011). Consequently, no further archaeological concerns are expected within the quarry boundaries as originally identified. However, site NaNh-49 occurs just outside of Quarry A on the east side of the Doris-Windy All Weather Road (Doris-Windy AWR). Although mitigated by plan mapping and excavation in 2010, this locality provides an ideal opportunity for a possible interpretive site for camp residents and visitors. If it is to be preserved as an interpretive centre, consideration should be given to use of appropriate protective strategies during quarrying activities in Quarry A, particularly blasting, to reduce risk of damage. Furthermore, the degree of ongoing activity related to the explosives facility proposed within Quarry A may increase chances for indirect effects. This can be mitigated by installation of fencing along the east side of the road in this vicinity.

Doris Camp Water Source Relocation to Windy Lake

The revised potable water source is proposed at the same location as the original Windy camp intake; consequently, there should be no archaeological concerns with the intake per se. However, if any new ground surface disturbance for associated facilities is possible, further assessment will be required to determine if any recorded archaeological sites are close or if field surveys are necessary.

Doris Central Vent Raise Pad and Access Road

The proposed Doris Central Vent Raise Access Road extends east from the Doris-Windy AWR. The route crosses mainly flat tundra, and potential for archaeological resources is rated generally low. One known archaeological site (NaNh-49) is approximately 300m south of the point where the road will leave the Doris-Windy AWR as shown on the current plan. Since this site is a good distance away and within a large bedrock outcrop, it is unlikely to be affected by construction and use of this road.

In 2014, the Doris Central vent raise pad and access road were carefully examined by pedestrian surveys using closely spaced transects. One site, NaNh-100, was found in the proposed vent raise pad location. This is a small site containing a partly vegetated stone circle with a hearth and possible support rocks nearby. The vent raise footprint has been reduced in size since 2014 field work, and this site is likely no longer within the direct impact zone, but may be within 30m. This site will be subjected to detailed assessment in 2015 and the proximity of the site to the vent raise facilities will be ascertained. Appropriate site mitigation measures, specifically protection, will be evaluated. This vent raise is situated within designated Quarry I;

much of this quarry was also surveyed for archaeological sites in 2014, and no remains were found. There are no plans to use this quarry in the immediate future.

Doris Connector Vent Raise Pad and Access Road

During 2014 field investigations, this proposed vent raise and associated infrastructure were assessed by ground reconnaissance. The short proposed Doris Connector Vent Raise Access Road extending south from the existing Float Plane Dock Access Road was walked. This route passes over low, flat and periodically wet tundra; thus, it is rated low potential for archaeological resources and no archaeological concerns are anticipated. The small bedrock outcrop on which the vent raise is proposed was inspected by closely spaced pedestrian traverses. Due to significant past disturbance over the entire surface of this landform and the lack of any evidence of archaeological remains, no archaeological conflicts are expected.

References Cited

Green, D. (Golder Associates Ltd.)

2008 Archaeological Impact Assessment of Hope Bay Mining Ltd.'s Hope Bay Gold Project, Nunavut. Report prepared for Hope Bay Mining Ltd., North Vancouver, B.C.

Prager, G.

1998 1997 Archaeological Investigations for BHP's Hope Bay Belt Project, Northwest Territories. Northwest Territories Archaeologists Permit 97-850. Report on file, Prince of Wales Northern Heritage Centre, Yellowknife.

2004 Doris North (Hope Bay) Project, Nunavut. Archaeological Investigations in 2003 (NU Archaeologist's Permit 03-05A). Report on file, Canadian Museum of Civilization, Ottawa .

2006 Hope Bay Belt, Nunavut 2005 Archaeological Investigations Final Permit Report (NU Archaeologist's Permit 05-10A). Report on file, Canadian Museum of Civilization, Ottawa.

2010 Hope Bay Belt, Nunavut, Archaeological Investigations in 2009 Final Permit Report (NU Archaeologist's Permit 09-005A). Report on file, Canadian Museum of Civilization, Ottawa.

2011 Hope Bay Belt Project, Nunavut 2010 Archaeological Investigations Final Permit Report (NU Archaeologist's Permit 2010-014A). Report on file, Canadian Museum of Civilization, Ottawa.

Appendix B

Memo: Approach to Freshwater Fish Offsetting

Memorandum

Date: June 11, 2015

To: Sharleen Hamm

From: Christopher Burns, Kerry Marchinko and Elizabeth Sherlock; ERM Consultants Canada Ltd.

Subject: **Approach to Freshwater Fisheries Offsetting for Doris Lake Outflow/Doris Creek**

The purpose of this memorandum is to identify a procedural framework and potential projects for completing a Freshwater Fisheries Offsetting Plan for the Doris North Project (the Project). A similar approach was adopted for completing a Marine Fisheries Offsetting Plan for the Project-related subsea pipeline and associated infrastructure. The following sections outline how this would be accomplished for project related water quantity effects on fisheries in Doris Lake Outflow/Doris Creek.

1. INTRODUCTION

As a result of proposed Project activity, a change in water quantity is predicted to occur in the Doris Lake Outflow and its downstream creek (Doris Lake Outflow = reaches between falls and lake; Doris Creek = reaches between falls and Little Roberts Lake). As a consequence, fisheries and fish habitat may be impacted in these waterbodies. According to the *Fisheries Protection Policy Statement* (DFO 2013a), if a project is likely to cause *serious harm to fish* after the application of avoidance and mitigation measures, then the proponent must develop a plan to undertake offsetting measures to counterbalance the unavoidable residual *serious harm* to fish. These offsetting measures, also known as offsets, are implemented with the goal of maintaining or improving the productivity of the commercial, recreational or Aboriginal fisheries (DFO 2013b).

The purpose of this Conceptual Freshwater Fisheries Offsetting Plan is to identify a procedural framework for completing a Fisheries Offsetting Plan for Doris Lake Outflow/Doris Creek portion of the Project. The proposed procedural framework was developed to satisfy the *Fisheries Protection Policy Statement* (DFO 2013a) and the federal *Fisheries Act* (1985) requirements.

2. REGULATORY AND POLICY FRAMEWORK

The *Fisheries Protection Policy Statement* (DFO 2013a) supports changes made to the *Fisheries Act* in 2012. The *Fisheries Protection Policy Statement* replaces Fisheries and Oceans Canada's (DFO) no net loss guiding principle for fish habitat within the *Policy for the Management of Fish Habitat* (DFO 1991). The changes to the *Fisheries Act* include a prohibition against causing *serious harm to fish* that are part of, or support, a commercial, recreational, or Aboriginal (CRA) fishery (section 35 of the *Fisheries Act*); provisions for flow and passage (sections 20 and 21 of the *Fisheries Act*); and a framework for regulatory decision-making (sections 6 and 6.1 of the *Fisheries Act*). These provisions guide the Minister's decision-making process in order to provide for sustainable and productive fisheries.

The amendments center on the prohibition against *serious harm to fish* and apply to fish and fish habitat that are part of or support CRA fisheries. Proponents are responsible for avoiding and mitigating *serious harm to fish* that are part of or support CRA fisheries. When proponents are unable to completely avoid or mitigate *serious harm to fish*, their projects will normally require authorization under subsection 35(2) of the *Fisheries Act* in order for the project to proceed without contravening the Act.

DFO interprets *serious harm to fish* as:

- the death of fish;
- a permanent alteration to fish habitat of a spatial scale, duration, or intensity that limits or diminishes the ability of fish to use such habitats as spawning grounds, nursery, rearing, food supply areas, migration corridors, or any other area in order to carry out one or more of their life processes; and
- the destruction of fish habitat of a spatial scale, duration, or intensity that results in fish no longer being able to rely on such habitats for use as spawning grounds, nursery, rearing, food supply areas, migration corridor, or any other area in order to carry out one or more of their life processes.

After efforts have been made to avoid and mitigate impacts, any residual *serious harm to fish* is required to be offset. An offset measure is one that counterbalances unavoidable *serious harm to fish* resulting from a project with the goal of maintaining or improving the productivity of the CRA fishery. Where possible, offset measures should support available fisheries' management objectives and local restoration priorities.

3. FISHERIES OFFSETTING APPROACH

In developing a Freshwater Fisheries Offsetting Plan (the Offsetting Plan) for the Project, a procedural approach is proposed to satisfy the *Fisheries Protection Policy Statement* (DFO 2013a) and the federal *Fisheries Act*, and will allow for flexibility in finding a solution to offsetting Project-related effects.

The proposed procedural approach for the development of an Offsetting Plan is identified below and will be discussed in following sections.

- fisheries and fish habitat assessment;
- habitat evaluation procedure;
- offsetting option identification procedure; and
- offsetting option assessment procedure.

The proposed procedural approach was developed based upon the guidance provided in the *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013b). The approach was also based upon the review of existing fisheries and fish habitat information for the Project, including the Doris-Roberts Watershed. Based upon this review a number of preliminary offsetting options were identified and are discussed in the following sections.

3.1 Fisheries and Fish Habitat Assessment

3.1.1.1 Doris Lake Outflow/Doris Creek

To date, baseline data for Doris Lake Outflow/Doris Creek has largely been restricted to presence/absence assessments and site-specific habitat assessments. Given the link between fish abundance and productivity to the *Fisheries Protection Policy Statement* (DFO 2013a), the *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013b), and the federal *Fisheries Act*; additional baseline data is required to assess fish population abundance in Doris Creek. Furthermore, given the link between fish abundance, habitat quality (e.g., connectivity), and habitat characteristics (e.g., water depth and width) more detailed baseline data is required to assess habitat distribution, connectivity, habitat characteristics in potentially impacted reach(s) of Doris Creek. This habitat data will assist in quantifying the serious harm to fisheries to be offset, validate the habitat-based approach to offsetting, and support future monitoring (a federal requirement of Offsetting Plans).

Population estimates for Doris Lake Outflow/Doris Creek will be derived from closed site multiple-pass removal electrofishing methods. This method is a standard for quantitative fish studies in small streams (Johnston et al. 2007). Within a stream there is typically high spatial variation in fish abundance due to spawning distribution, geomorphic influences (Kruse, Hubert, and Rahel 1997), habitat variability (Newman and Waters 1989), and species competition (Bohlin 1978). To account for this variability, a sufficient number of sites will be sampled to provide adequate precision in population abundance estimates.

Habitat mapping for Doris Lake Outflow/Doris Creek will be obtained from ground-truthed field surveys. During the field survey, mesohabitat types (e.g., pool, riffle, glide, etc.) will be mapped with a differential GPS, classified, and attributes (e.g., bankfull width, depth, substrate composition, fish cover composition) measured.

A connectivity and habitat assessment will be conducted in Doris Creek (downstream of waterfall) and a habitat assessment in Doris Lake Outflow. Data will be gathered by using a transect-based approach, whereby connectivity and habitat data are collected together on a single field trip. Transects will be stratified by habitat units (e.g., riffles) within the potentially impacted reach(s) throughout Doris Creek. Selection will be based on the distribution of mesohabitat units, habitat quality, potential connectivity concerns, and habitat preferences of Arctic Char (or other species such as Lake Trout depending on whether upstream or downstream of falls). Changes in stream depth and width will be modelled to predict Project-related effects on fish resulting from decreased discharge rates.

3.1.2 Doris Lake

Based on available data and hydrological models, the potential for serious harm in Doris Lake was assessed to be low and offsetting is not expected. However, the 23 cm drop in water levels under ice has the potential to expose Lake Trout eggs to desiccation. Baseline fisheries, littoral, shoreline, and pelagic habitat data has been collected for Doris Lake. Existing habitat data provides information pertaining to the spatial distribution of substrates and potential Lake Trout spawning shoals, but sufficient detail to resolve the depth of spawning shoals has not been collected. Lake Trout spawning shoals may be sensitive to water level fluctuations, and the link between Lake Trout spawning habitat to fish productivity, investigations of spawning shoal quality and depth is required to validate that offsetting is not required in Doris Lake as a result of winter water withdrawal. This data will inform the basis of the Offsetting Plan, validate the habitat-based approach to offsetting, and support future monitoring (a federal requirement of Offsetting Plans).

Lake Trout spawning shoal assessments will be conducted using underwater cameras to identify potential spawning shoals. The water surface elevation will be surveyed and shoal depths will be measured in the field. This information will then be used to model Project-related lake level changes, and refine effects predictions on Lake Trout spawning habitat.

3.2 Habitat Evaluation Procedure

Based upon the results of the habitat connectivity and lake level effects assessment, the estimated extent of Project-related effects on fisheries and fish habitat in Doris Lake Outflow/Doris Creek and Doris Lake will be confirmed. A habitat evaluation procedure (HEP) can then be utilized to construct a habitat budget for the Offsetting Plan (USFWS 1980). HEP is a generalized procedure for assessing habitat suitability in streams and lakes.

HEP is a tool for developing habitat budgets for offsetting planning in Canada (e.g., Diavik 1998; BHP Billiton 2002; RL&L/Golder 2003; Rescan 2005, 2007, 2012). The HEP approach has two advantages. First, it provides an objective method to characterize the quality or importance of affected habitats to fish species and aquatic resources. Second, it allows standardization of habitat quality ratings relative to other habitats that have different physical characteristics (e.g., lakes versus streams). This facilitates comparisons among habitat types and ultimately allows affected habitats to be evaluated as a single group for the offsetting calculation.

HEP is an appropriate tool for offsetting fisheries effects in Canada. As identified by DFO in *Science Advice to Support Development of a Fisheries Protection Policy for Canada* (DFO 2013c), a pragmatic habitat quality based approach is an appropriate first step for offsetting (i.e., budgeting) fisheries productivity. Due to difficulties in directly measuring fish production and productivity, biological indices (e.g., fish biomass, salmonid smolt yield, production/biomass, vital rates) or habitat surrogates, such as habitat suitability indices or estimates of primary or secondary production, can be used to indirectly evaluate project-related impacts to fish production and productivity (Randall et al. 2013; Minns et al. 2011). However, it is recognized that data collection and monitoring of biological indices (e.g., fish biomass) will be required to validate a habitat-based approach to offsetting (Randall et al. 2013).

Where the Project is determined to cause *serious harm to fish*, affected habitats will be quantified and characterized in terms of their importance to each fish's life history stage. The HEP produces habitat units (HU) that are indices of both habitat quantity and quality for the affected habitats. This is calculated by multiplying habitat area (measured in m^2) by a habitat suitability index (HSI). As a result, HU are the currency of offset budgeting and planning.

The HEP model relies upon HSI curves for depth, velocity, substrate, cover, water quality, and other attributes. Relevant Arctic Char and Lake Trout HSI curves will be researched, collated, and reviewed for applicability to the Project area. HSI for Arctic Char and Lake Trout spawning and rearing (nursery) habitat were developed in the original Doris North No Net Loss Plan (Golder 2007).

Once the HUs for the affected habitats is known, the identification and budgeting of offsetting options can commence. The offsetting option procedure is discussed in the following sections.

3.3 Offsetting Option Identification Procedure

Fisheries offsetting option identification is an iterative process. Offsetting option identification requires knowledge of local Aboriginal fisheries and community interest/priorities, fisheries population abundance and demography, fish presence, fish distribution, and habitat quality within the Project area. This identification also requires a combination of stakeholder engagement/consultation, desktop and field based assessment.

Listed below is a general desktop approach that will be conducted, prior to field assessments, to identify potential fisheries offsetting options:

- engagement with the local Hunters and Trappers Organization (HTO) and TMAC's Inuit Environmental Advisory Committee;
- background fish and fish habitat literature review for watersheds within and outside of the Project area boundaries;
- background literature review for species-specific habitat limiting factors based upon peer-reviewed documents and professional knowledge;
- identification of factors limiting fish productivity within and outside of Project area watersheds. For example, identification of species and life history stages present, identification of known key habitats (e.g., over-wintering and spawning areas), and identification of anthropogenic impacts within watersheds;
- identification of previously assessed fisheries offsetting options provided in background literature (e.g., environmental consultant reports for the Project area); and
- identification of potential options through remote satellite imagery analysis (e.g., Google Earth).

Once a desktop assessment is complete, field reconnaissance and ground-truthing of the preliminary offsetting options will be conducted. Field reconnaissance also provides an opportunity to identify additional offsetting options. Offsetting options will be visited to refine site objectives, assess value to fishery, site-specific constraints and opportunities, biological relevance, stability, permanence, target species, target habitat, and target life history stage. Assessment of site-specific constraints and opportunities include: water supply magnitude and dependability, flood risk, water quality, sediment supply, gradient, soil stability, site constructability and access, construction costs, stability and durability of instream structures, and time to full functionality of site.

A qualitative feasibility assessment, based upon professional experience, will be conducted for each preliminary offsetting option. This assessment will be conducted by a fisheries biologist and water resources engineer to determine the technical feasibility of the options. Through an iterative process of elimination and refinement, a technically feasible offsetting option(s) will be identified. Each of the technically feasible offsetting option(s) will be discussed with TMAC's Inuit Environmental Advisory Committee.

3.4 Offsetting Option Assessment Procedure

Additional data will be gathered to support the selected technically feasible offsetting option. Additional data may include biological, hydrological, topographical data; however the specific data requirements will ultimately depend upon the offsetting option objectives and design. These data requirements will be determined by the fisheries biologist and water resources engineer, in consultation with regulatory agencies and stakeholder groups.

To assess whether the technically feasible option offsets for the impacted fisheries in Doris Lake Outflow and Creek, a fisheries offsetting budget will be conducted according to the HEP. The HUs for the offsetting option will be calculated (using fisheries and fish habitat assessment data) and compared to HUs for the impacted fisheries in Doris Lake and its outflow. The ratio of offsetting HUs to impacted HUs is dependent on the fisheries value of the impacted area as well as the fisheries value of the offsetting area. For example, high quality habitat may require additional offsetting area in order to ensure no net loss of fish productivity. Alternatively, low quality habitat may be replaced with a smaller area of higher quality habitat. A HU budget will then be finalized for the Offsetting Plan.

4. PRELIMINARY OFFSETTING OPTIONS

During a background review of fisheries and fish habitat information pertaining to the Project area, a number of preliminary fisheries offsetting options were identified. Two preliminary offsetting options are near the vicinity of the Project, and one preliminary offsetting option is located off-site. The purpose of identifying preliminary options was to confirm that an offsetting plan is possible as mitigation for the Project. Each of these options is discussed below.

4.1 Project Vicinity Options

Preliminary offsetting options were identified in the *Doris North No Net Loss Plan* (Golder 2007). Several tributaries of Roberts Lake may be enhanced to provide greater cover or stream depth for rearing juvenile Arctic Char. In addition, two additional sites are located along river systems where waterfalls are believed to restrict adult Arctic Char migration. Both options would involve creating a series of step-pools allowing for adult Arctic Char migration over a waterfall. The assumption was that adult Arctic Char would then gain improved access to suitable spawning and rearing habitat in the lakes upstream of the falls, resulting in increased productivity.

Option 1 involves enhancing tributaries flowing into Roberts Lake to provide additional, higher quality rearing habitat for juvenile Arctic Char and Lake Trout. Predicted losses to fisheries productivity in this watershed system primarily involves Arctic Char and Lake Trout that winter within Roberts Lake, but use Doris Creek in summer for rearing. Rearing habitat for these species appears limited in Roberts Lake (Golder 2007), for example several tributaries to Roberts Lake have been identified as having limited cover and flows restricting or preventing rearing fish use. Enhancement of Roberts Lake tributaries would provide like-for-like offsetting for lost rearing habitat in Doris Lake Outflow and Doris Creek.

Option 2 is located approximately 30 km west (UTM: 13 W 406635E 7551813N) of the Project area. The waterfall is approximately 2.0 to 2.2 m high, and is located on a 450 m channel between two lakes. The first lake has a surface area of 142 ha and discharges directly into the ocean. The second lake (immediately upstream of the falls) has a surface area of 460 ha. Also, the inlet to the second lake has an existing "boulder garden" channel, which is believed to restrict fish passage to a third lake. Modifications to the channel bed would allow for unrestricted migration into the third lake. The third lake has a surface area of 414 ha.

Option 3 is located approximately 15 km west (UTM: 13 W 420258E 7554046N) of the Project area. The waterfall is approximately 1.5 m high, and is located on a 1,100 m channel between the ocean and a lake. The lake has a surface area of 140 ha. Grizzly bears have been observed feeding on Arctic Char in the pool below the falls.

According to the *Doris North No Net Loss Plan* (Golder 2007), the offsetting design options 2 and 3 would involve the development of a step-pool configuration to allow for unrestricted adult Arctic Char migration. The step-pool configuration will be based upon the principle that water is forced to pool up within the stream channel, then drop over a lip or through a constructed opening, thereby causing backwatering into the upstream pool environment. The step-pool configuration is based upon the Rosgen (1996) design, also known as a vortex rock weir. The Rosgen design is used to create step-pool sequences in high gradient bedrock controlled streams, and is typically applied in moderately sloped channels from 2 to 4%. The Rosgen design incorporates large boulders into the stream channel banks and bottom in a chevron configuration, pointing upstream and deflected downwards with gaps. The design scours the centre of the channel below the weir and creates staging pools for migrating fish.

Biological, hydrological, topographical, and engineering investigations will be required to determine the technical feasibility of the preliminary offsetting options. To confirm the biological relevance and objectives of the options and to support the development of the Offsetting Plan, the following data will be acquired:

- habitat assessment and mapping of streams and lakes within the offset watersheds;
- habitat passage assessment at the falls; and
- fisheries community, demography, and abundance sampling (e.g., gillnetting, electrofishing) of streams and lakes within the offset watersheds.

Hydrological, topographical, and engineering data requirements are site-specific and will be determined during a field investigation.

4.2 Off-Site Offsetting Options

One preliminary offsetting option was identified during previous communications between ERM and community members from Gjoa Haven. The specific location of this offsetting option is Koka Lake Outflow. Koka Lake is approximately 1,300 ha and is approximately 25 km by water from Gjoa Haven. The Gjoa Haven community members have indicated that, until recently, both Koka Lake and Koka Lake Outflow served as high value traditional fishing locations for Arctic Char. The community members indicated that the number of Arctic Char passing through the stream into the lake has recently declined, with Arctic Char suffering from higher levels of mortality due to low water depths and a "boulder garden" channel making the stream impassable at times. Community members indicated that Arctic Char catch rates within Koka Lake have also seen a reduction in recent years.

This off-site offsetting option objective would be to improve adult Arctic Char passage through Koka Lake Outflow. The biological basis for this objective is that improving adult Arctic Char passage would allow for increased adult spawning, which would ultimately increase the production of the Aboriginal Arctic Char fishery.

The offsetting design may involve the manipulation of channel bed substrates to create a migration channels through the "boulder garden". These migration channels would be designed to enable fish passage during low flow periods. This technique has been successfully completed in Roberts Lake outflow as fish habitat compensation for the loss of Tail Lake and Tail Lake outflow (Rescan 2010a, 2010b, and 2012). The fish habitat compensation monitoring program has demonstrated an immediate improvement in adult Arctic Char survival through the "boulder garden" after compensation construction works. During pre-compensation works, the mean survival through the "boulder garden" was 62%. Whereas, the mean survival through the "boulder garden" was 94% after post-compensation works (ERM 2015).

Biological, hydrological, topographical, and engineering investigations will be required to determine the technical feasibility of this preliminary offsetting option. The following biological data will be acquired to support the development of the Offsetting Plan:

- habitat assessment and mapping of Koka Lake Outflow and Lake;
- habitat passage assessment at the "boulder gardens"; and
- fisheries community, demography, and abundance sampling (e.g., gillnetting, electrofishing, fish stranding enumeration) of Koka Lake Outflow and Lake.

Hydrological, topographical, and engineering data requirements are site-specific and will be determined during a field investigation.

Prepared by:

Christopher Burns, B.Sc., R.P. Bio.
Senior Consultant, ERM

Review by:

Kerry Marchinko, Ph.D., R.P. Bio.
Principle Consultant, ERM

REFERENCES

1985. *Fisheries Act*, RSC, C. F-14.

BHP Billiton. 2002. *EKATI Diamond Mine: Sable, Pigeon and Beartooth no net loss plan*. Prepared for BHP Billiton Diamonds Inc. by Dillon Consulting Ltd.

Bohlin, T. 1978. Temporal changes in the spatial distribution of juvenile sea-trout *Salmo trutta* in a small stream. *Oikos* 30:114-120.

DFO. 1991. *The Department of Fisheries and Oceans: Policy for the management of fish habitat.* Department of Fisheries and Oceans: Ottawa, Ontario.

DFO. 2013a. *Fisheries protection policy statement.* Fisheries and Oceans Canada: Ottawa, Ontario.

DFO. 2013b. *Fisheries productivity investment policy: A proponent's guide to offsetting*. Fisheries and Oceans Canada: Ottawa, Ontario.

DFO. 2013c. *Science advice to support development of a fisheries protection policy for Canada*. Canadian Science Advisory Secretariat, Science Advisory Report 2012/063: Ottawa, Ontario.

Diavik Diamond Mines Inc. (Diavik). 1998. *"No net loss" plan*.

ERM. 2015. *Doris North Project: 2014 Roberts Lake and Outflow fish compliance monitoring program*. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Vancouver, British Columbia.

Golder. 2007. *Doris North Project "no net loss" plan*. Prepared for Miramar Hope Bay Ltd. By Golder Associates Ltd.: Edmonton, Alberta.

Johnson, D. H., B. M. Shrier, J. S. O'Neal, J. A. Knutzen, X. Augerot, T. A. O'Neil, and T. N. Pearsons. 2007. *Salmonid field protocols handbook: Techniques for assessing status and trends in salmon and trout populations*. Maryland: American Fisheries Society.

Kruse, C. G., W. A. Hubert, and F. J. Rahel. 1997. Geomorphic influences on the distribution of Yellowstone cutthroat trout in the Absaroka Mountains, Wyoming. *Transactions of the American Fisheries Society* 126:418-427.

Minns, C. K., R. G. Randall, K. E. Smokorowski, K. D. Clarke, A. Velez-Espino, R. S. Gregory, S. Courtney, and P. LeBlanc. 2011. Direct and indirect estimates of the productive capacity of fish habitat under Canada's Policy for the Management of Fish Habitat: Where have we been, where are we now, and where are we going? *Canadian Journal of Fish and Aquatic Sciences* 68: 2204-2227.

Newman, R. M. and T. F. Waters. 1989. Differences in brown trout (Salmo trutta) production among contiguous sections of an entire stream. *Canadian Journal of Fish and Aquatic Sciences* 46:203-213.

Randall, R. G., M. J. Bradford, K. D. Clarke, and J. C. Rice. 2013. *A science-based interpretation of ongoing productivity of commercial, recreational or Aboriginal fisheries*. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/112.: Ottawa, Ontario.

Rescan. 2005. *Twin Lakes Diversion Project conceptual no net loss fish habitat compensation plan*. Prepared for BHP Billiton Base Metals by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2007. *Galore Creek Project: Fish habitat compensation plan*. Prepared for Novagold Canada Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2010a. *Hope Bay Belt Project: Updates to the Doris North no net loss plan for Tail Lake*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2010b. *Hope Bay Belt Project: Updates to the Doris North no net loss plan for Tail Outflow*. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2012. *KSM Project: HADD fish habitat compensation plan*. Prepared for Seabridge Gold Inc. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

RL&L/Golder. 2003. *Doris North Project no net loss plan*. Prepared for Miramar Hope Bay Ltd. by RL&L Environmental Services Ltd./Golder Associates Ltd.

Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, Colorado.

US Fish and Wildlife Service (USFWS). 1980. *Habitat evaluation procedures (HEP) ESM 102*. US Department of Interior. Washington, DC.