APPENDIX 16-B
WETLAND HABITAT COMPENSATION PLAN

Rescan™

Seabridge Gold Inc.

KSM PROJECT
Wetland Habitat Compensation Plan

SEABRIDGE GOLD

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KSM PROJECT
WETLAND HABITAT COMPENSATION PLAN

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Prepared for:

SEABRIDGE GOLD

Seabridge Gold Inc.

Prepared by:

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Executive Summary

Seabridge Gold Inc. (Seabridge) is proposing to develop the KSM Project (the Project), a gold/copper deposit located approximately 65 km north of Stewart, British Columbia (BC). The proposed project lies 20 km southeast of Barrick Gold's recently-closed Eskay Creek Mine and 30 km northeast of the Alaska border.

As part of Project development, at the request of Environment Canada, Seabridge has contracted Rescan Environmental Services Ltd. to develop a comprehensive Wetland Habitat Compensation Plan (WCP). The purpose of this plan is to define, plan, and later execute activities that will compensate for lost wetland area resulting from the construction of the Processing and Tailing Management Area of the proposed Project.

An extensive desktop and field survey was completed to identify and classify wetland habitats within the Project area footprint and sites that would be suitable for wetland compensation in conjunction with fish habitat compensation. This process was driven by previously selected fish habitat compensation sites and evaluated potential sites near the Project and expanding outward until enough suitable sites were located. Three suitable sites have been identified in conjunction with fish habitat restoration: Teigen, Treaty, and Taft creeks. An additional stand-alone wetland compensation site located south of Smithers, BC (Bulkley River) will provide an important wetland area in Northwest BC as well as additional educational, scientific, recreational, and cultural values.

Wetland compensation efforts will follow established protocols of creation, restoration, and enhancement of sites to deliver wetland area and values. Compensation areas will be planted following specific vegetation community targets intended to replace similar ecosystems with those lost in the Project footprint.

Compensation has been set to meet the intent of the Wetland Conservation Policy of Canada to mitigate high magnitude effects that if left unmitigated would constitute a significant effect.

Development of the sites will proceed in a phased manner contemporaneously with Project development. Each phase will follow a similar construction, monitoring, and adaptive management sequence with sign off being sought from regulators after five years. Each phase will also include a long-term monitoring program as an addendum to Environmental Effects Monitoring (EEM).

Success of the compensation project will be measured in terms of meeting the target requirement of wetland area created/restored/enhanced ratio.

Acknowledgements

The KSM Wetland Habitat Compensation Plan was developed by Rescan Environmental Services Ltd. for Seabridge Gold Inc. Sean Cullen (M.Sc., R.P.Bio.), Anne Currie (B.Sc., MPA), and Greg McKillop (B.Sc., P.Geo.) were the Rescan Project Managers. Development and completion of this plan was managed by Wade Brunham (M.Sc., PWS). The Plan was written by Reed Hentze (B.Sc., EP), and Wade Brunham and Dan McAllister (M.Sc., P.Ag.) provided the technical review.

Completion of this plan was made possible by contributions from the KSM Fish Compensation Team: David Luzi (M.Sc.), Doug Griffin (B.S.F), Chris Burns (B.Sc., R.P.Bio), and Steve Jennings (B.Sc., R.P.Bio). Discussions and technical sessions with Environment Canada, Canadian Wildlife Service, Principally Andrew Robinson and Jan Kirkby (M.Sc., R.P.Bio) were particularly useful and provided much needed regulatory guidance. Elizabeth Miller (M.Sc., R.P.Bio; Seabridge Gold Inc.) supported the process and was integral in engaging regulators and promoting the spirit of inclusivity and sustainable development.

KSM PROJECT
WETLAND HABITAT COMPENSATION PLAN

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Anoxic	A term pertaining to wetland surface and ground water where there is a condition of depleted or very little dissolved oxygen.
BEC	Biogeoclimatic Ecosystem Classification. A form of ecosystem classification based upon the integration of regional, local, and chronological site information. Developed by V. J. Krajina, Department of Botany at the University of British Columbia starting in 1949, the system was refined during the 1960s and early 1970s through ongoing collaboration between the University of British Columbia and the BC Ministry of Forests (Government of BC 2012).
BC	British Columbia
BC MOE	British Columbia Ministry of Environment
EEM	Environmental Effects Monitoring. In a very broad sense referring to a process of monitoring the effects a project has on the environment. Effects are monitored by measuring pre-determined metrics or data throughout the life time of a project.
Ecosystem	A volume of earth-space composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred.
Ecotone	A transitional zone between two communities containing the characteristic species of each.
Eutrophic	A term referring to an environment that has been enriched with nutrients. Conversely an environment that is poor in nutrients is considered oligotrophic.
Forb	Non-graminoid herbaceous plants.
Geomorphic setting	Topographic location within the surrounding landscape.
GIS	Geographic Information System. A computer-based system to process spatially referenced data into information for a specific purpose. Primary processes include data management, query, analysis, and visualization.
Graminoid	Herbaceous plants with narrow leaves growing from the base. Includes grasses, sedges, and rushes.
Ha	Hectares. 10,000 m^2 or 0.01 km^2 or 2.47 acres.
Habitat	Land and water used by wildlife. This may include biotic and abiotic aspects such as vegetation, exposed bedrock, water, and topography.
Herb	An annual, biennial, or perennial plant with stems that die back to the ground at the end of the growing season.

Hydric Soil	Soils that display certain taxonomic features indicating low oxygen or anoxic conditions. These features can include but are not limited to colour depletions, mottling of soil colours, gleying of soils and biochemical indicators such as sulphidic odour. Also, by definition, an organic soil with depths > 40 cm is considered a hydric soil.
Marsh	Federal wetland class; nutrient rich mineral wetland; vegetation dominated by graminoids, forbs, and emergent plants (Warner and Rubec 1997).
Mottles	In the context of wetland sciences these represent colour blotches within a soil profile that indicates redox chemical reactions have taken place within the soil.
NAD	North American Datum
Oligotrophic	An environment considered depleted or with minimal nutrients.
RAA	Regional Assessment Area. Area investigated for wetland habitats within the Project area.
Shallow open water	Federal wetland class; wetland with free surface water up to 2 m depth; less than 25% of surface area occluded by emergent or woody plants (Warner and Rubec 1997).
Swamp	Federal wetland class; nutrient rich mineral wetland; vegetation dominated by woody plants > 1 m in height; (Warner and Rubec 1997).
TEM	Terrestrial Ecosystem Mapping
TMF	Tailing Management Facility
Topography	The configuration of a surface, including its relief and the position of its natural and man-made features.
TRIM	Terrain Resource Information Management Data. TRIM data is the set of three-dimensional digital files produced at a scale of 1:20 000 and providing the base data set for the British Columbia Provincial Baseline Digital Atlas. This includes the identification of wetlands and other surface water features.
UTM	Universal Transverse Mercator. A grid-based coordinate system for specifying locations on the surface of the Earth.
WCP	Wetland Compensation Plan. A plan developed and enacted to mitigate and compensate for lost wetland area for any given project.
Wetland class	A wetland classification system based on the general site characteristics such as soil type and the extent and quality of the predominant vegetation cover (Warner and Rubec 1997). The wetland classes; marsh, swamp, and shallow open water are discussed in this document.
Wetland function	A process or series of processes that take place within a wetland, such as erosion control, sediment trapping, storage of flood water, and provision of wildlife habitat (Novitzki, et al. 1997). Environment Canada (Milko 1998) has identified four primary wetland functions: hydrological, biochemical, ecological, and habitat.
Wetland value	The benefits provided by wetland functions to society. Wetlands can have ecological, social, and economic values (Milko 1998).

Wetlands Semi-terrestrial sites where the water table is at, near, or above the soil surface and soils are water-saturated for a sufficient length of time such that excess water and low soil oxygen levels are principal determinants of vegetation and soils development. Wetland areas include both the wet basin and surrounding transitional areas between wetter zones and upland vegetation (Huel 2000). Wetlands can range from sites that contain small, shallow areas of water that are present for only a few weeks after snow melt, to sites that comprise large, permanent open water zones (Stewart and Kantrude 1971).

1. Introduction

1.1 KSM PROJECT

Seabridge Gold Inc. (Seabridge) is proposing to develop the KSM Project (the Project), a gold/copper deposit located approximately 65 km north of Stewart, British Columbia (BC; Figure 1.1-1). The proposed project lies 20 km southeast of Barrick Gold's recently-closed Eskay Creek Mine and 30 km northeast of the Alaska border.

The north and west areas of the Project are situated within the Unuk River Watershed, which crosses into Alaska and discharges into the Pacific Ocean at Burroughs Bay. The eastern area of the Project is situated within the Bell-Irving River Watershed, which joins the Nass River and discharges into the Canadian waters of Portland Inlet. Elevations within the Project area range from approximately 240 m above the confluence of Sulphurets Creek with the Unuk River, to over 2,300 m at the peak of the Unuk Finger, 8 km away.

The Project includes the development within two distinct and geographically separate areas (the Mine Site and the Processing and Tailing Management Area; Figure 1.1-2). The Mine Site comprises open pit and underground mining operations located in the Sulphurets Creek watershed, a major tributary of the Unuk River. The processing plant and tailing management facility (TMF) will be located in the upper tributaries of Teigen and Treaty creeks, which flow into the Bell-Irving River. The two areas will be connected by a pair of parallel tunnels, one tunnel for transport of raw materials and one for transportation.

1.2 PURPOSE

Environment Canada requested that a compensation plan be developed to mitigate the expected loss of wetland ecosystems associated with the development of the TMF. Thus, this plan was developed to meet the expectations of Environment Canada in regards to the Federal Wetland Conservation Policy (Environment Canada 1991).

The purpose of this plan is to define, propose, and later execute activities that will compensate for lost wetland extent for the proposed KSM Project. Although affects to wetland ecosystems will occur in multiple Project phases, high magnitude impacts to wetland extent will result from the construction and operation of the TMF. As such, compensation targets focus on wetland types located and affected within the proposed TMF area, with the objective of compensating for all wetland area lost.

1.3 OBJECTIVES

The objectives of the Wetland Compensation Plan are to:

- integrate wetland ecosystem features into fish habitat compensation to create broader functioning ecosystem compensation benefiting both fish and wetland resources;
- identify areas in the Smithers Forest Region and adjacent areas that would benefit from wetland enhancement and restoration; and
- identify site(s) that could provide research, education, and recreation opportunities resulting in an increase in socio-economic values these habitats provide to Northwest BC communities.

Figure 1.1-1

KSM Project Location Map

PROJECT # 868-016-010 GIS No. KSM-15-262 October 29, 2012

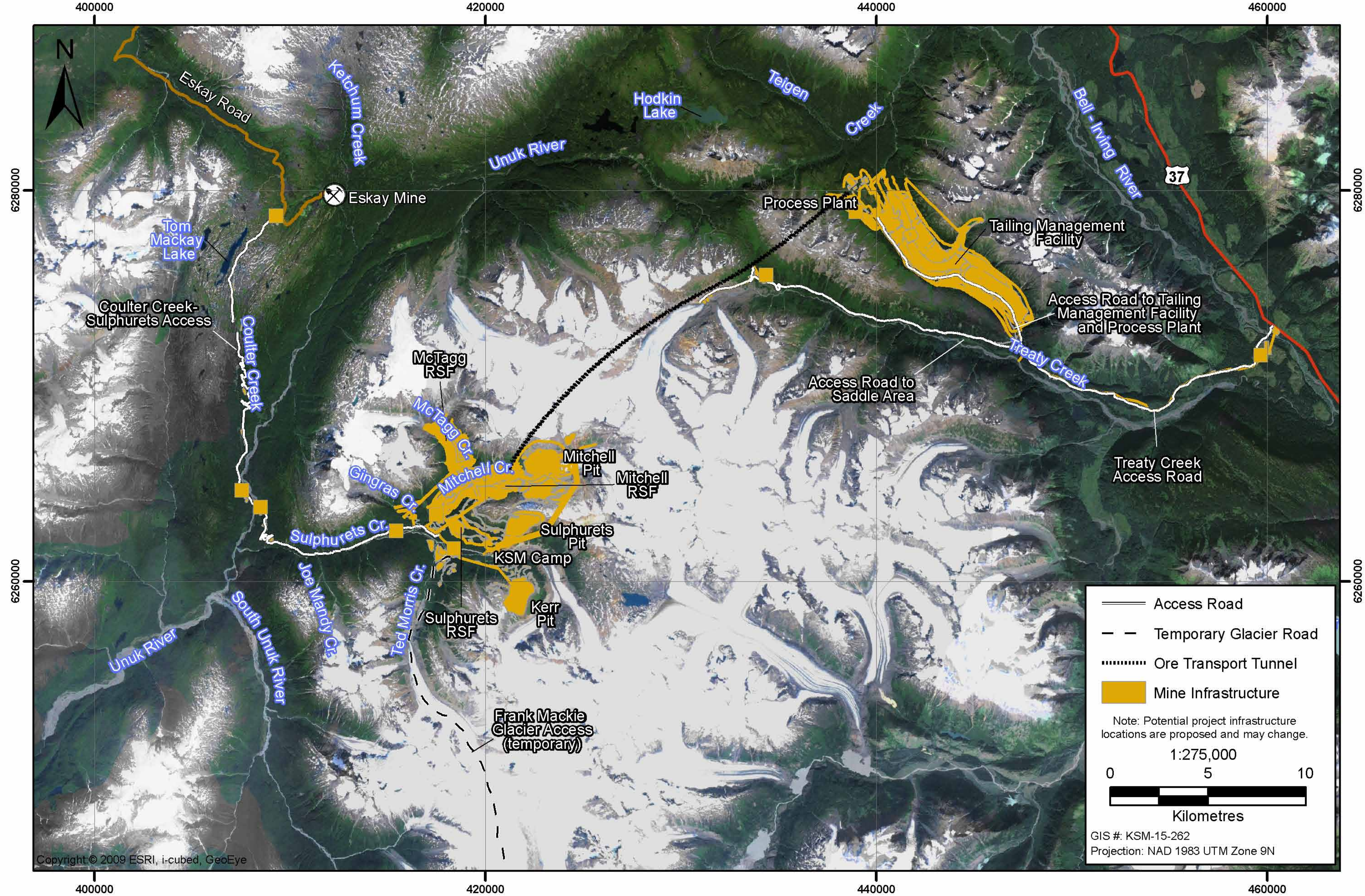

Figure 1.1-2

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KSM Project Layout

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2. Wetlands in Ecological and Project Context

2.1 WETLANDS

Wetlands are defined as “land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activities which are adapted to a wet environment” (National Wetlands Working Group 1988; Warner and Rubec 1997). Wetlands can range from sites that contain small, shallow areas of water that are present for only a few weeks after snow melt, to sites that comprise large, permanent open water zones (Stewart and Kantrud 1971). Wetlands fulfill a wide range of ecological, hydrological, biochemical, and habitat functions including surface water phosphate and nitrogen mitigation, erosion control, and flood mitigation (Bond et al. 1992; Milko 1998; RAMSAR 2009). The British Columbia Ministry of Environment (BC MOE) has identified wetland habitats as “one of the most important life support systems on earth,” providing critical habitat for birds, fish, and other wildlife. Most wildlife in the province use wetland habitat at some point in their life cycle, and many red- and blue-listed species are wetland-dependent (BC MOE 2011).

2.2 WETLANDS ECOSYSTEMS AT BASELINE

Six Broad Ecosystem Classification (BEC) units occur within the Project region, including both coastal and interior units (Table 2.2-1). Four of the six BEC units are forested, while two are alpine/parkland units. The two alpine BEC units, Boreal Altai Fescue Alpine undifferentiated parkland (BAFAunp) and Coastal Mountain-heather Alpine undifferentiated parkland (CMAunp), together contribute more than 40% of the study areas.

Table 2.2-1. BEC Units in the Regional Project Area

BEC Unit Name	Description	BEC Unit Label	RSA Extent[1] (ha)	RSA Extent[1] (%)
Boreal Altai Fescue Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	BAFAunp	87,995	26
Coastal Mountain-heather Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	CMAunp	65,036	19
Coastal Western Hemlock - Wet Maritime Subzone	Low elevation forest (coastal)	CWHwm	17,835	5
Engelmann Spruce – Subalpine Fir Wet Very Cold Subzone	Subalpine forest (interior)	ESSFwv	81,443	24
Interior Cedar Hemlock - Very Wet Cold Subzone	Low elevation forest (interior)	ICHvc	47,404	14
Mountain Hemlock - Leeward Moist Maritime Variant*	Subalpine forest (coastal)	MHmm2	38,294	11
Total			**338,008**	**100**

[1] RSA=Regional Study Area as defined in the 2009 Vegetation and Ecosystem Mapping Baseline Report (Rescan 2010).
** The official ecological classification of the Mountain Hemlock BEC unit near the KSM Project is currently incomplete; subzones and/or variants are not yet recognized or documented for this area. However, data collected by field personnel during the 2008 to 2012 baseline field studies, and consultation with the Research Ecologist at the Ministry of Forests and Range office in Smithers, resulted in reclassification of the KSM Project location from MHun (undifferentiated) to the Mountain Hemlock leeward moist maritime (MHmm2) BEC unit.*

Wetland ecosystems accounted for approximately 509.8 ha representing less than 3% of land base within the Regional Assessment Area (RAA; Figure 2.2-1 and Table 2.2-2). This figure is less than the published 5.6% estimated wetland land base in British Columbia (BC MOE 2011). Large portions of the RAA consist of rocks, ice, or large dynamic river floodplain systems, environments that tend to preclude the formation of many wetland ecosystems. The average size of a wetland ecosystem within the proposed infrastructure areas is 2.2 ha with the largest wetland area estimated at approximately 85 ha.

Table 2.2-2. Area of Wetland Classes in the KSM Regional Assessment Area

Wetland Class	Lost (ha)	Total Present in the Regional Assessment Area (ha)
Fen	39.4	70.6
Marsh	0.4	35.6
Swamp	19.0	361.8
Open Water	0.6	41.8
Total	59.3	509.8

Wetlands were classified into federal class (Warner and Rubec 1997) and vegetation association (Mackenzie and Moran 2004). Four of the five federal wetland classes (fen, marsh, swamp, and shallow open water) were observed in the RAA (Table 2.2-2). A number of wetlands mapped by British Columbia Terrain Resource Information Management (TRIM) data were also identified and integrated into the reported data.

2.3 WETLAND FUNCTIONS AT BASELINE

Wetland functions are the processes or series of processes wetlands carry out, such as their ability to regulate water levels to attenuate flow, filter water to improve water quality (biochemically as well as physically), and provide aquatic and terrestrial habitat for aquatic and semi-aquatic species. Wetland function can be separated into four distinct categories (hydrology, biochemical, ecological, and habitat; Milko 1998). The following is a description of wetland functions identified for each observed wetland class.

2.3.1 Fen Wetland Functions

2.3.1.1 Fen Hydrological Functions

The hydrological functions of fens are moderate to low (Hanson et al. 2008). For example fens can provide some mitigation of local flooding but the value of this function is largely related to downstream flows and the potential impacts of changes to these flows. The remoteness of the KSM Project precludes a substantial benefit from flood mitigation function as downstream infrastructure is limited. However, these wetlands could likely provide some mitigation for stream bed scouring, sediment loading, and temperature mitigation for cold water species.

Fens provide a ground water recharge capacity; however, the capacity is highly dependent on basin size, location in the watershed, substrate, and local groundwater gradients (Hansen et al. 2008). Smaller wetlands have a greater perimeter to volume ratio than larger wetlands and have been demonstrated to better support groundwater recharge (Weller 1994). The majority of fens observed within the baseline study area were relatively small. Approximately 89% of all fen wetlands mapped were less than 2 ha (Table 2.3-1) Thus, it is likely that fen wetlands in the baseline study area provide important groundwater recharge functions.

PROJECT # 868-016-10 GIS No. KSM-22-038 October 29, 2012

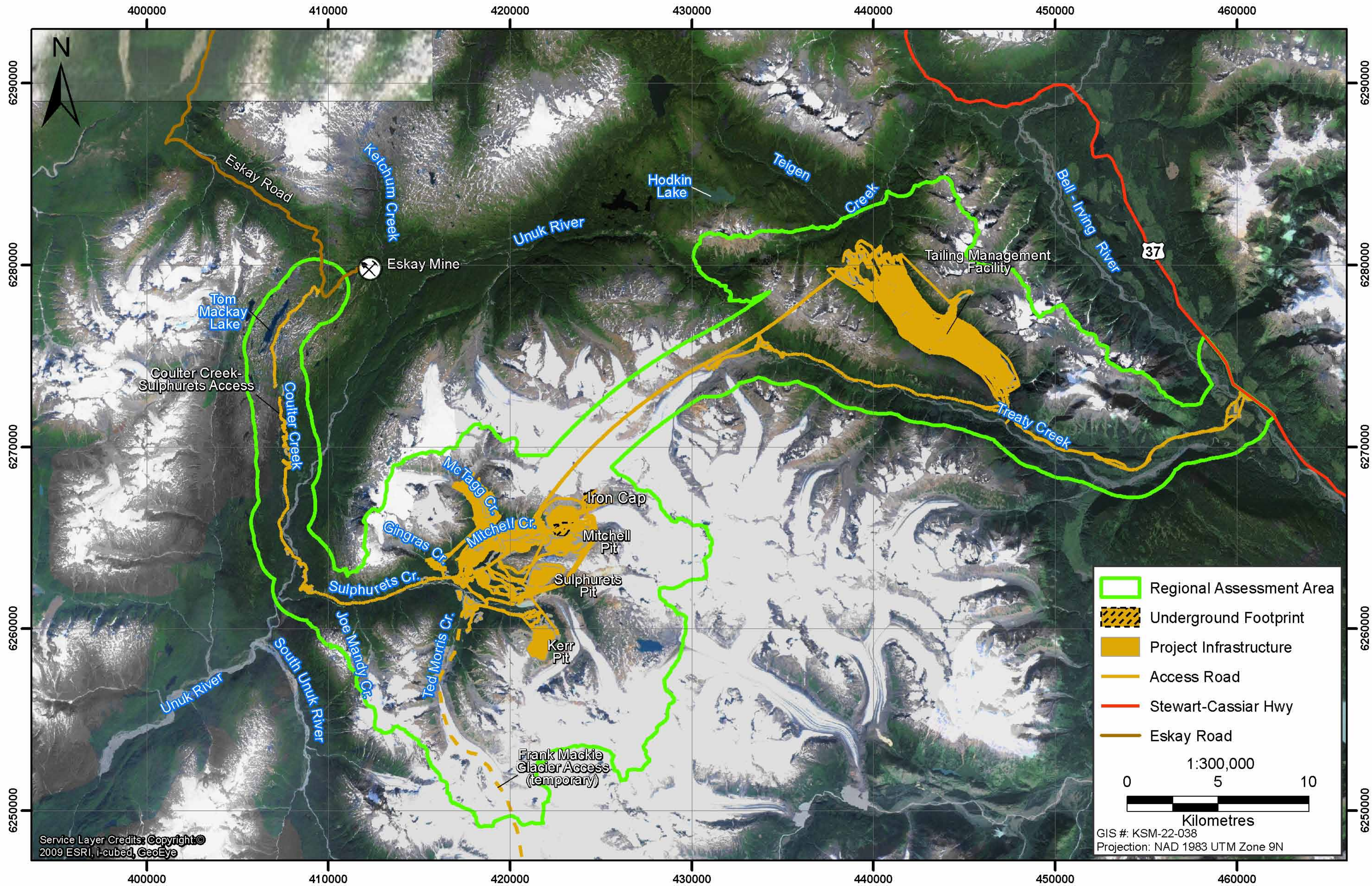

Figure 2.2-1

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Regional Assessment Area

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Table 2.3-1. Distribution of Fen Wetland Size

	< 0.1 ha	0.1 - 0.25 ha	0.25 - 0.5 ha	0.5 - 2 ha	2 - 5 ha	5 - 10 ha
Count	1	13	19	24	3	4
% Count	1.6	20.3	29.7	37.5	4.7	6.3
Area	0.08	2.3	7. 1	24.1	7.2	30.5
% Area	0.1	3.2	9.9	33.8	10.1	42.8

2.3.1.2 Fen Biochemical Functions

The biochemical functions of fens are potentially high (Hanson et al. 2008). This potential is difficult to quantify because biochemical functions are influenced by a myriad of site-specific factors such as ambient temperature, local geology, base water chemistry, vegetation species, aspect, slope, drainage, etc. It is generally accepted that fen ecosystems can improve water quality, actively facilitate nutrient storage, transformation and transport, and store carbon.

Fens, like other wetland classes, facilitate the nitrification/denitrification process (Reilly 1991; Gilliam 1994). Fens can be considered both carbon sinks and carbon sources depending on the wetland condition. This is determined by the stability of the ecosystem and whether the system is developing (active peat accumulation and vegetation deposition), flooded (such as during extreme precipitation events), drained (through anthropomorphic disturbance), or in decline (drying out through natural successional processes).

2.3.1.3 Fen Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity, complexity, and rarity within the landscape.

Collectively, fen wetlands are among the most floristically diverse of all wetland classes (Bedford et al. 2003). A search of rare or threatened wetlands revealed that the majority of potentially red- or blue-listed wetland ecosystems potentially occurring in the Project area were fen communities. The fact that fen communities were present underscores the importance of the ecological function of these wetland ecosystems. Additionally, wetland mapping reveals that more than 50% of the fens in the baseline study area exist in complex with another wetland class. This increases the habitat diversity and complexity which further supports the importance of ecological function and contributes to habitat function.

2.3.1.4 Fen Habitat Functions

The habitat function of fens is related to their biological productivity (Hanson et al. 2008). The biological productivity of the fen can be attributed to a number of factors including; surrounding landscape type and use, stand age, complexity of landscape patterns, availability of specific habitat types for specific species within the area, uniqueness of habitat types available at various scales and adjacency to a particular habitat with another habitat to identify only a few. In early spring open sedge areas provide forage opportunities for grizzly and black bears (Plate 2.3-1). Treeless wetland areas adjacent to mature trees provide forage habitat for bat species throughout the growing season when insects are abundant (Plate 2.3-1). In spring and summer, emergent and submergent vegetation in open water areas provide moose browse (Plate 2.3-2). In addition, a number of migratory bird species and signs of use were observed in fens within the RAA, particularly where fens were in complex with shallow open water (Plate 2.3-3).

Plate 2.3-1. KS49 – Open fen areas with high sedge components provide early spring forage for grizzly and black bears. These open areas surrounded by mature trees also provide aerial forage opportunities for many bat species.

Plate 2.3-2. KS64 – A small subalpine shallow open water wetland in complex with a surrounding fen wetland. Note the aquatic vegetation, which can provide forage opportunities for moose.

Plate 2.3-3. KS20 – Migratory bird sign observed within this fen complex.

2.3.2 Marsh Wetland Functions

2.3.2.1 Marsh Hydrological Functions

The hydrological function of marshes is high when compared to other wetland classes and is strongly connected to the wetland sub-form (Hanson et al. 2008). The hydrological function of marshes typically includes water flow moderation, groundwater recharge, and shoreline erosion protection. Marshes adjacent to surface water features, such as lakes, rivers and creeks receive a portion of their water during high water events. Marsh wetlands in these positions are extremely valuable at storm water retention; however, that value is directly related to downstream reaches and potential infrastructure located in these areas. The remoteness of the KSM Project precludes a substantial benefit from this function as downstream infrastructure is limited. Marsh wetlands do provide some mitigation for stream bed scouring, sediment loading, and temperature mitigation for cold water species using these areas.

2.3.2.2 Marsh Biochemical Functions

The biochemical function of marsh wetlands is high compared to other wetland classes and upland areas but varies depending on local physical processes, interaction between root/bacteria assemblages, substrate, and oxidation (Hanson et al. 2008). Biochemical functionality can range between wetland complexes and temporally within a single wetland, depending on season and the processes indicated above.

Marshes, like other wetland classes, facilitate the nitrification/denitrification process (Reilly 1991; Gilliam 1994), and are thus major contributors to the nitrogen cycle in the environment.

Phosphorus absorption is facilitated through the deposition of suspended solids or dissolved phosphorus within wetlands. Floodplain marsh complexes tend to be important sites for phosphorus removal from the water column and improving water quality (Walbridge and Struthers 1993).

Marsh wetlands can reduce sulphate to sulphide, which can be released to the atmosphere as hydrogen, methyl, and dimethyl sulfides or is bound to wetland sediments such as complexes of phosphates and metal ions (Mitsch and Gosselink 1993). These sulphides, when released to the atmosphere, can produce condensation nuclei and effect regional climates, while produced complex metal phosphates remove metals from free water within the water table.

Marshes filter suspended solids in the water column when they come into contact with wetland vegetation. Live and dead vegetation, leaves and stems, slow down the velocity of the water allowing suspended solids to settle thus removing potential pollutants from the water column (Johnston 1991).

Marshes can be considered both carbon sinks and carbon sources depending on the wetland condition. This is determined by the stability of the ecosystem, developmental stage of the ecosystem, flooded (such as extended flooding during extreme precipitation events), drained (through anthropomorphic disturbance), or in decline (drying out through natural successional processes).

All wetland soils contain some concentration of metals. Metals may exist in wetland soils or vegetation and enter wetlands through surface water, groundwater flow, and aerial deposition. Wetlands can remove metals from surface and groundwater by binding metals to iron and aluminum ions via adsorption to clay surfaces or through carbonates precipitating as inorganic compounds. They can also form complexes with organic soils (Gambrell 1994). Marsh wetlands remove more metals from slow flowing water since there is more time for chemical processes to occur before the water moves out of the wetland.

2.3.2.3 Marsh Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity and complexity, and rarity within the landscape. No listed marsh types were identified as potentially occurring in baseline study area. Marshes were not commonly observed as complexes with other wetland types. Due to the limited contributions of marsh communities to ecosystem complexity ecological function is not considered a primary function of these wetland classes within the baseline study area.

2.3.2.4 Marsh Habitat Functions

The habitat function of marsh wetlands is generally high but variable (Hanson et al. 2008). Marshes are the most heavily used wetland class for most wetland-using wildlife species. They are typically eutrophic and support large standing crops of palatable vegetation, plankton, and aquatic invertebrates. They are the favoured wetland class for most waterfowl, amphibians, and semi-aquatic mammals because they provide good cover, open water, and food (Mackenzie and Moran 2004). Marsh and open water complexes provide opportunities for beaver habitation, which was observed within the RAA (Plate 2.3-4).

2.3.3 Swamp Wetland Functions

2.3.3.1 Swamp Hydrological Functions

The hydrological function of swamp wetlands is dependent on the wetland sub-form; it is low for mid-slope or tidal swamp wetlands, but generally high for riparian swamps (Hanson et al. 2008). Treed and shrubby riparian swamp wetlands slow the velocity of runoff and have the capacity to store water for extended periods. This function was directly observed in the TMF. Water from previous precipitation events was observed slowly discharging into local watercourses from adjacent swamp wetlands (Plate 2.3-5).

Plate 2.3-4. KS29 – Beaver lodge observed within this marsh wetland complex.

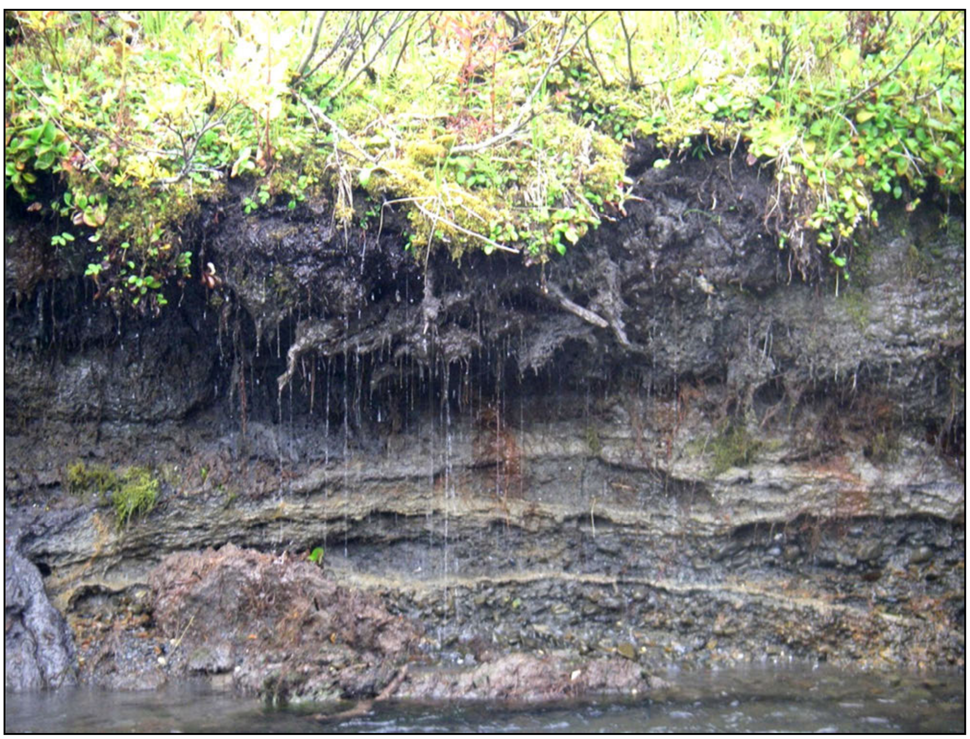


Plate 2.3-5. Water infiltrating into a stream from an adjacent swamp complex, maintaining downstream hydrology.

2.3.3.2 Swamp Biochemical Functions

The biochemical functions of swamps can be similar to marsh wetlands; variable, but generally quite high compared to other wetland classes and upland ecosystems with the variability arising from local physical processes, interaction between root/bacteria assemblages, substrate, and oxidation (Hanson et al. 2008). The areas swamps likely provide numerous biochemical functions such as nutrient and organic export and carbon storage and sequestration.

Swamps, like other wetland classes, facilitate the nitrification/denitrification process (Reilly 1991; Gilliam 1994).

Phosphorus absorption is facilitated through the deposition of suspended solids or dissolved phosphorus within wetlands. This is likely to occur in riparian associated swamp complexes (Walbridge and Struthers 1993).

Swamps are both carbon sinks and sources depending on the wetland condition and stability. The high accumulation of organic matter and slow decomposition rates of vegetation that can occur in forested swamps enable these swamps to sequester carbon at a relatively higher rate than many other wetland classes.

Riparian swamps have the capability to filter suspended solids in the water column as these solids come into contact with wetland vegetation. Live and dead vegetation, leaves, and stems slow down the velocity of the water allowing settling of suspended solids and removal of potential pollutants from the water column (Johnston 1991).

2.3.3.3 Swamp Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity and complexity and rarity within the landscape. No listed swamp types were identified as potentially occurring in the Project area, however swamp habitats were observed. Swamps were generally observed in complex wetland ecosystems with other wetland classes and vegetation associations. Based on this complexity the ecological function of swamp wetlands is as a component of wetland complexes and is considered relatively high when in complex as compared to single class wetland ecosystems.

2.3.3.4 Swamp Habitat Functions

Some habitat functions of swamps are closely related to their vertical structure as the vertical structure in swamps support more diverse avifaunal assemblages than any other wetland class (MacKenzie and Moran 2004). In addition, forested swamps typically have an open canopy that appears to be favoured by many bird and bat species (MacKenzie and Moran 2004; Lausen 2006). The habitat functions of swamp wetlands within the Project area is considered moderate to high due to the existing habitat diversity and structure within the Project area. Black spruce skunk cabbage complexes provide spring forage for grizzly and black bears (Plate 2.3-6). In winter, spring, and summer months willow swamp complexes can provide moose with thermoregulation sites as well as browse opportunities (Plate 2.3-7).

2.3.4 Shallow Open Water Wetland Functions

2.3.4.1 Shallow Open Water Hydrological Functions

The hydrological functions of shallow open water wetlands are high, especially as they relate to water storage (Hanson et al, 2008). The majority of the baseline study area's wetlands, small shallow open water wetlands, were misidentified by TRIM as open water lakes (not wetlands). Although these sites are mapped as lakes, these small (< 2 ha) open water features within the baseline study area are typically associated with or are a part of wetland habitats, particularly in the alpine and subalpine areas. The primary hydrological function of these wetlands is water storage within the landscape. Water is held in these shallow open water wetlands for prolonged periods, extending into the drier summer months, which provides a source of freshwater to adjacent ecosystems and wildlife during these periods.

Plate 2.3-6. KS27B – Black spruce skunk cabbage swamp. Skunk cabbage provides early forage for grizzly bear and black bear species.

Plate 2.3-7. KS35 – Willow swamp complex surrounding larger open fen complex. Example of areas that provide thermoregulation and forage opportunities for large mammals such as moose.

2.3.4.2 Shallow Open Water Biochemical Functions

Biochemical function performance is dependent on nutrient/sediment loading rates, flow through rates and volumes, retention time, wetland capacity, volume to surface area ratios, and productivity. Due to the relatively small size and location of these wetlands, these shallow open water wetlands do provide some capacity to remove sediments by allowing them to settle out in their slower moving waters.

2.3.4.3 Shallow Open Water Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity and complexity and rarity within the landscape. No listed shallow open water types were identified as potentially occurring in the Project area. Shallow open waters were generally observed in complex wetland ecosystems with other wetland classes and vegetation associations (Plate 2.3-2). The ecological function of the shallow open water wetlands within the baseline study area is as a component of wetland complexes and is considered relatively high when compared to single class wetland ecosystems.

2.3.4.4 Shallow Open Water Habitat Functions

The habitat function of shallow open water wetlands is highly variable (Hanson et al. 2008); however, these sites offer exclusively aquatic habitat. As such, if present, their level of function is dependent on the availability of such habitat within the landscape and the presence of locally valued species that may use such habitat. Wetlands in the baseline study area provide important open water habitat for migratory birds, mammals, and ungulates such as moose (Plate 2.3-8).

Plate 2.3-8. KS22 – Subalpine shallow open water wetland providing water for surrounding ecosystems and wildlife as well as open water habitat for waterfowl.

2.4 ENVIRONMENTAL ASSESSMENT RESULTS

The direct loss of wetlands was identified where the Project footprint overlapped identified wetlands. The area of wetland loss associated with specific Project components was summarized for each wetland class (Table 2.4-1). The loss of these wetlands includes physical loss of wetland area and associated wetland function loss. Lost wetland functions were identified by identifying the lost wetland classes and evaluating these classes against a set of criteria equating wetland class and known wetland functions (Hanson et al. 2008).

Table 2.4-1. Wetland Area Lost per Wetland Class

Wetland Class	Lost (ha)	Total Present in the Regional Assessment Area (ha)	Percent of Class Lost in the Regional Assessment Area
Fen	39.4	70.6	56%
Marsh	0.4	35.6	1%
Swamp	19.0	361.8	5%
Open Water	0.5	41.8	1%
Total	59.3	509.8	12%

The total direct loss of wetland extent within the RAA is 59.3 ha or approximately 12% of wetland ecosystems. When these data are stratified by wetland class it is evident that high magnitude impacts result to fen wetlands with a losses of or 56% (39.4 ha), with lower magnitude impacts to all other identified classes in all other Project areas (Table 2.4-1).

A further analysis of the location of loss of wetland within the Project shows that the vast majority of impacts are as a result of the TMF and directly associated infrastructure and access corridors (Table 2.4-2).

Table 2.4-2. Area of Lost Wetland Class and Associated Mine Infrastructure - Maximum Disturbance

Project Area	Fen (ha)	Marsh (ha)	Swamp (ha)	Open Water (ha)	Total (ha)
Process Plant and TMF					
Treaty Creek Access Road	0.8				0.81
Coulter Creek Access Corridor	<0.1	0.2	0.3	0.1	0.7
Construction Camps					
Camp 3 – Eskay				0.1	0.1
Camp 7 – Unuk North			0.2		0.2
Tailing Management Facility					
North Cell	9.3	0.2	9.9		19.3
South Cell	4.7		5.1		9.9
Centre Cell	16.0		3.5	0.1	19.6
Treaty Ore Preparation Complex	8.3				8.3
Mine Site					
Sulphurets Laydown Area	0.2				0.2
Kerr Pit				0.2	0.2
Total	**39.4**	**0.4**	**19.0**	**0.5**	**59.3**

Disturbance within the TMF represents the largest impact to wetland ecosystems and the greatest concentrated loss of wetland area and function within the RAA. The lost wetland functions for all wetland classes are summarized in Table 2.4-3. As the majority of loss of wetland extent is to fens and swamps, the majority of loss to function will be to those functions associated with these wetland classes.

Table 2.4-3. Summary of Primary Lost Wetland Functions

Wetland Class	Wetland Functions			
	Hydrological Functions	**Biochemical Functions**	**Ecological Functions**	**Habitat Functions**
Fen	Groundwater recharge, potential downstream flood mitigation	Carbon storage, nutrient cycling, water quality improvements	Wetland complexes and habitat diversity	Large mammal foraging habitat, migratory bird habitat, bat foraging habitat (open areas)
Marsh	Downstream flood mitigation	Nutrient cycling, water quality improvements	Wetland complexes and habitat diversity	General wildlife habitat, large mammal foraging habitat, bat foraging habitat (open areas)
Swamp	Water retention, downstream flood mitigation	Carbon storage, nutrient cycling, water quality improvements	Wetland complexes and habitat diversity	General wildlife habitat, large mammal foraging and thermoregulation habitat, fish habitat (riparian swamps), bat roosting areas where large trees are present
Shallow Open Water	Extended water storage within the landscape	Water quality improvements	Wetland complexes and habitat diversity	General wildlife use, fish habitat, migratory bird habitat, bat foraging habitat (open areas)

Note: Primary lost wetland functions for this Project are limited to the fen and swamp wetland classes due to their number and relative land cover within the TMF.

3. Conceptual Approach to Compensation

3.1 COMPENSATION TARGET

Wetland compensation will address the loss of wetland extent and overtime the loss of wetland functions. Wetland function is difficult to quantify and directly compensate for because of the myriad of site specific variables. As wetland function is generally related to the classes of wetland ecosystems present and the complexity of these ecosystems, compensation efforts will focus on providing target ecosystems that are predicted to provide similar functions to those ecosystems that will be lost during development. This is known as “like for like” compensation.

In Section 2.2 it was determined that wetlands affected by the project TMF are the riparian areas of North Treaty and South Teigen creeks. The primary lost wetland functions of these wetland ecosystems include:

- **Hydrological** - groundwater recharge, water retention, and potential downstream flood mitigation;
- **Biochemical** - carbon storage, nutrient cycling, water quality improvements;
- **Ecological** - wetland complexes and habitat diversity; and
- **Habitat** - large mammal foraging habitat, migratory bird habitat, bat foraging habitat (open areas), general wildlife habitat, and thermoregulation habitat, fish habitat (riparian swamps), and bat roosting areas where large trees are present.

This plan focuses on the replacement of riparian swamp wetland complexes.

3.2 COMPENSATION METRICS

A primary metric used for planning and eventually assessing the success of wetland compensation is the area of wetland habitat gained or lost during a project. A ratio of greater than 1:1 (compensation wetland area: lost wetland ecosystem area) is used by many jurisdictions (Robb 2002; Rubec and Hansen 2009). A ratio of increased wetland compensation area is used for many reasons. Some examples include the temporal lags in compensation wetland functionality and human limitations in designing and creating predictable habitat functions that may have taken hundreds or thousands of years to develop in a natural setting (Hansen et al. 2008; Rubec and Hansen 2009; Moreno-Mateos et al. 2012).

Area ratios are also used due to the operational simplicity of measuring area, which in turn enables regulators to readily identify “success” or short comings of a compensation goal rather than determining complex ecological functions and values gained or lost.

There are no regulations or policy statements regarding wetland compensation ratios currently in place in BC; however, it is generally expected industry and scientific practice that greater than 1:1 wetland compensation is necessary for projects that impact wetland ecosystems.

This compensation plan is divided into two primary components: 1) wetland area, addressing a greater than 1:1 ratio of area for wetland ecosystem compensation during project development; and 2) value added, an additional socio-economic valuation component in a restored/enhanced/created compensation wetland, which includes an educational component. The educational component of the compensation plan will promote and sustain ongoing educational opportunities in the region on the importance of wetland ecosystems, functions, and values to communities, in addition to potential biological, ecological, biochemical, and successional studies.

In addition to these two primary components, a commitment for additional wetland restoration areas will be addressed during the Project Closure Phase. This will result in a predicted wetland area exceeding a 2.5:1 ratio (restored/created: disrupted wetland ecosystem area) upon completion of the Closure Plan.

Although reclamation at Closure is not considered as compensation it will result in approximately 2.5 times as much wetland area being created than currently exists. These wetlands will compensate for lost wetland area and will provide additional education, recreation, and research values not currently present within the region.

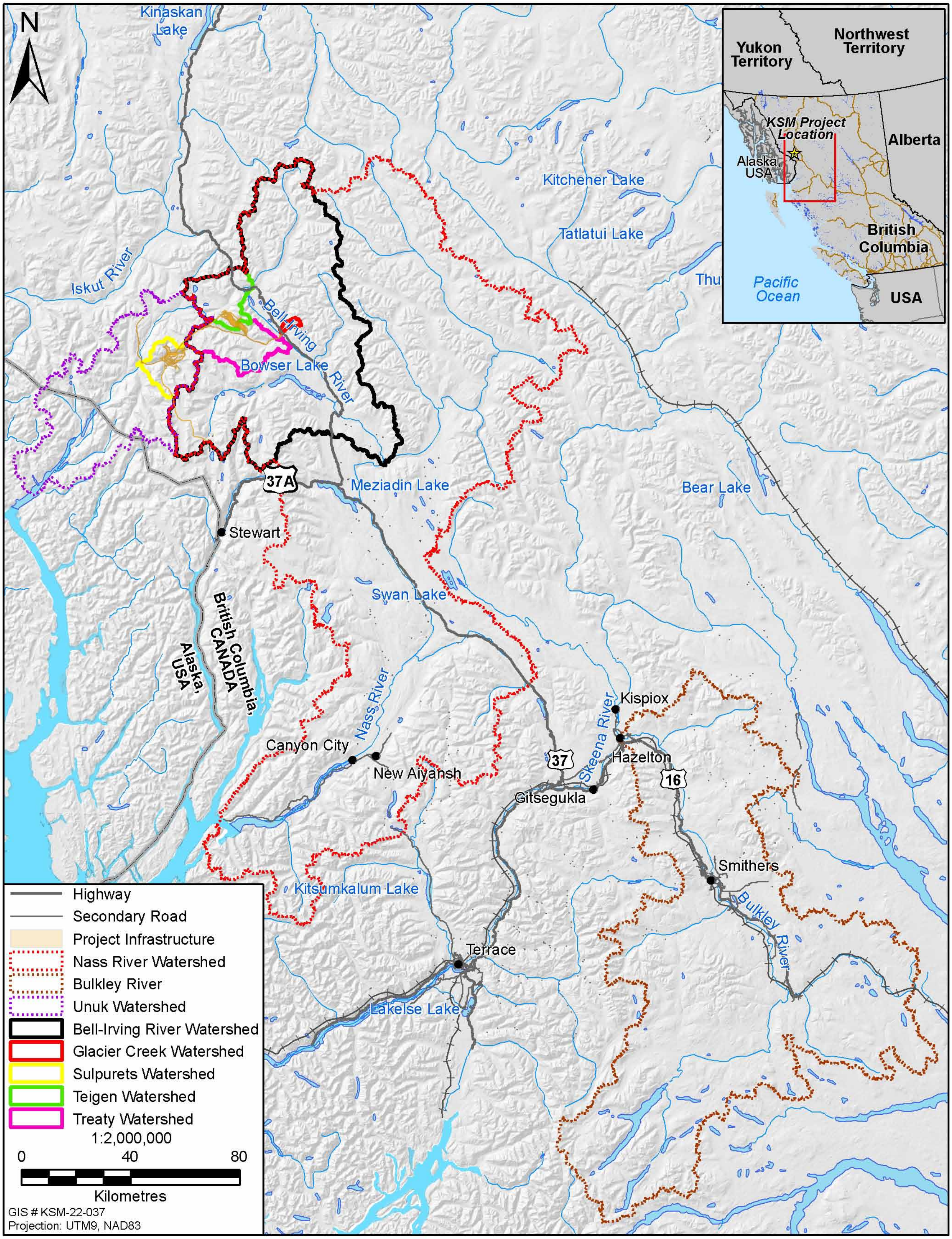
A long-term monitoring plan and adaptive management are essential requirements to maximize potential restoration success. The monitoring program will track vegetation composition and structure, hydric soils development, wetland extent, vegetation species composition and biomass at permanent plot centres within compensation areas. This program will include a photo point monitoring component that will be used to visually track ecosystem development and supplement annual data collection and analysis. Collected data will facilitate adaptive management strategies driving the final trajectory of the compensation project. The wetland compensation monitoring program (Section 7) is independent of the long-term Environmental Effects Monitoring (EEM) proposed for ecosystems located near Project operations (Section 26.22).

3.3 CONCEPTUAL SITE SELECTION

From a wetland function perspective it is desirable to keep compensation as close as possible to the affected area, as this allows the local losses of wetland function to be mitigated and addressed at an appropriate ecological scale. This scale is generally determined by project size and effects, often best represented at the watershed scale. In an ideal situation compensation efforts will always occur as close to the project as possible, outside of functionally lost habitat as determined by evaluation, and within the same watershed as the disturbance. This ensures that wetland functions are retained within that individual affected watershed and local area.

Compensation efforts that are too distant from an affected area lose the ability to replace lost wetland hydrological, biochemical, ecological, and habitat functionality that may be specific to a given location. While compensation may offset the loss of some functions, it may also support functions that are unrelated to those lost. Thus, there exists the potential for a net loss of wetland function within the watershed where the project is located. Taking this into account, wetland compensation in close proximity to impacts is not always possible in remote and pristine areas; particularly, for those projects located within undisturbed alpine and subalpine areas.

The direct impacts to wetlands within the Local Assessment Area are geographically located in Sulphurets Creek watershed, with the majority of the wetland impacts for the TMF proposed at the upper tributaries of two watersheds: the Teigen and Treaty creeks watershed. As such, efforts to locate compensation opportunities were primarily directed in these watersheds. Site selection, however, incorporated a multitude of factors (Section 5). Once these factors were identified, additional opportunities were assessed at the next watershed level (expanding the area): the Unuk River Watershed to the west (Teigen and Sulphurets creeks as tributaries) and the Bell-Irving River Watershed to the east (Treaty Creek as a tributary). Once these areas were fully investigated additional opportunities were examined as beneficial for both wetland function and value for the region in general (Figure 3.3-1).



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Watersheds within the Regional Area Used for Compensation Site Selection

Figure 3.3-1

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The site selection processes identified that compensation activities conducted in the immediate location of this Project would likely fail to provide maximum ecological benefit. Unaffected wetlands in this area are currently functioning at a naturally occurring capacity; thus, any efforts to enhance these pristine wetlands could likely result in reduced or negatively altered wetland function. Due to the overall proposed size of the Project, the pristine condition of the existing unaffected wetlands in the area, and the confines of the surrounding alpine and subalpine geography, the range for the compensation activity was expanded from the Treaty and Teigen Creek watersheds to the Unuk and Bell-Irving watersheds scale and beyond.

3.4 COMPENSATION ACTIVITIES

Specific compensation activities will be selected based on the chosen compensation site. Best management practices for wetland compensation are typically one of the following, in order of preference (Department of Environmental Protection 2005; Wetland Stewardship Partnership 2009):

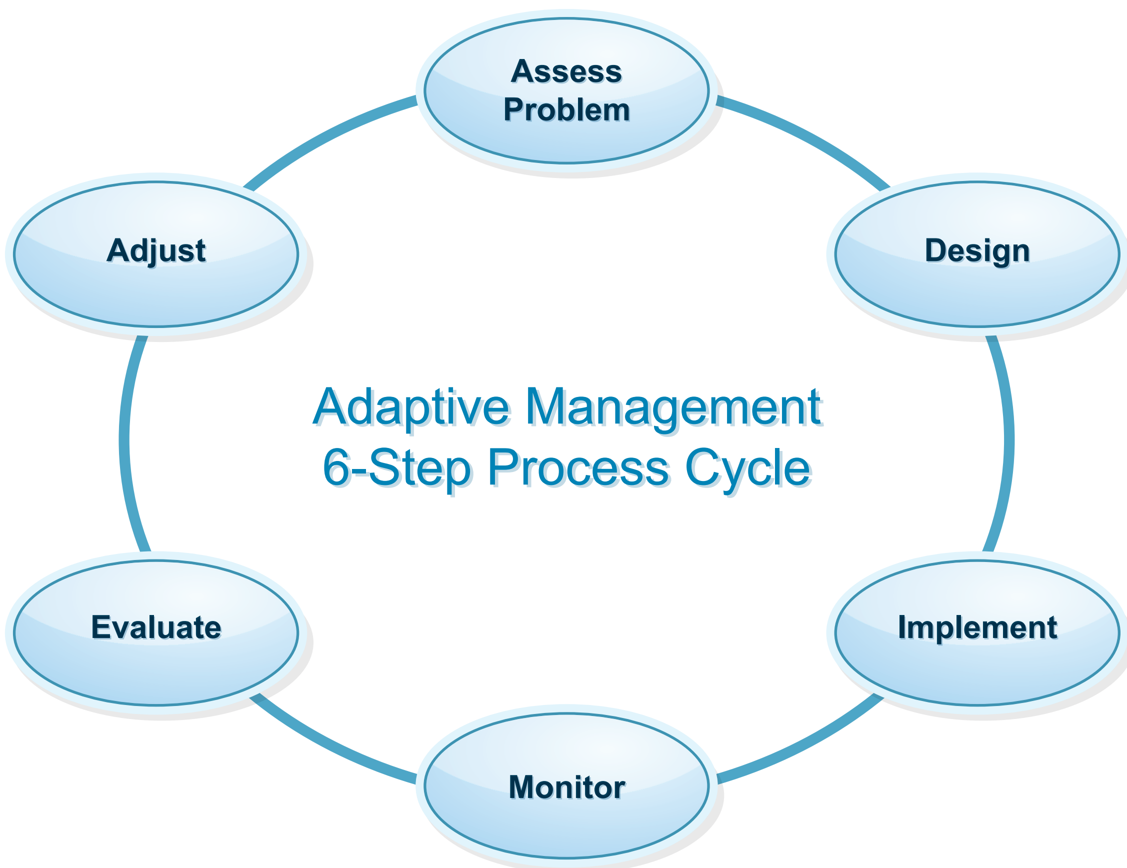
1. **Restoration** - returning a damaged wetland as close as possible to its original condition prior to the damage.
2. **Enhancement** - making changes or improvements to wetlands to enhance existing functions or values performed by the wetlands.
3. **Conservation** - conserving wetlands in an adjacent area that are equivalent or exceed the area damaged and that might otherwise be subject to an unregulated activity.
4. **Creation** - shaping dry land so that it will become wetland with the physical and biological characteristics of the area lost or damaged. Creation of a properly functioning wetland can be difficult to achieve, expensive, often unsuccessful in meeting the goals set out, and should be a last resort for mitigation.

This compensation plan will use a combination of wetland restoration, enhancement, and creation methodologies. For example, development of wetlands at fish compensation sites will focus on the enhancement of existing wetland areas in conjunction with the creation of shallow open water features and shallow vegetated riparian wetlands. Restoration of vegetation and hydrology will also be used outside of the fish compensation areas on an identified degraded and impacted wetland.

3.5 MONITORING

Compensation monitoring for each site will be initiated in the year following creation, enhancement, and restoration efforts. The intent is to use an adaptive management strategy as represented in Figure 3.5-1.

This adaptive management strategy relies heavily on monitoring to identify potential issues with the enacted plan and a commitment by the proponent to make reasonable changes to mitigate negative outcomes and ensure that products can reach a preferred outcome over time. This plan has been developed following the latest methodology in peer reviewed science; however, every site is unique and thus variable. Using this strategy will allow for the adaptation of unforeseen and unpredictable events within the compensation areas and will provide some variability of the species composition within the re-vegetation zones.



Graphical Representation of Adaptive Management Strategy

Figure 3.5-1

The primary concern will be maintenance of wetland hydrology and the development of wetland vegetation towards a preferred trajectory. Specific monitoring criteria at each compensation site will include:

- conducting wetland plant inventories recording:
  - general plant species composition;
  - prevalence index of hydrophytic wetland species;
  - ratio of non-native and invasive species to native species;
  - presence of rare or threatened species;
- identifying and recording the locations of high water marks, and identifying wetted elevations of open water;
- assessing soil moisture and the development of hydric soil characteristics;
- identifying and recording the wetland edge based on wetland hydrology indicators, the dominance of hydrophytic vegetation, and the presence of hydric soil characteristics;
- conducting general wildlife use observations within the compensation area;
- recording water quality metrics within shallow open water habitats; and
- conducting fixed photo point monitoring to track ecosystem succession.

It is expected that monitoring will be conducted annually for a minimum period of 10 years with long-term monitoring continuing throughout the life of the mine at reduced frequencies. This effectively enables adaptive management strategies as well as ongoing maintenance.

At Year 11 monitoring intensity and frequency will be reduced to once every five years, for the next 20 years, and then once every 10 years, for the remainder of the Project (until Closure). This monitoring strategy and length will enable the proponent to improve efficiency of plan delivery as well as efficacy of future compensation activities that may arise. This will also ensure that wetland ecosystems persist in these compensation areas for as long as the Project is in Operation and as long as wetlands have been removed from the Project location.

It is predicted that sign-off of “success” by regulators will be requested at Year 5 of the fully implemented compensation plan. The final goal being a stable wetland area with wetlands of sufficient size to potentially provide wetland functions within the compensation landscape.

3.6 REPORTING

Monitoring reports will be submitted to regulators at Years 1 through 5 with the expectation of a “project complete” sign-off in regards to wetland compensation by Year 5.

Monitoring will continue annually at each site for Years 6 through 10 with reporting as an addendum to the EEM Plan during odd years. This monitoring is required to establish a “stable” successional trajectory for the vegetation, which will in turn ensure that functionality has been mitigated and compensated for in some way. Year 10 of the monitoring plan will be the last year that the wetland areas will be monitored.

4. Compensation Targets

Results from the environmental assessment identify that 59.3 ha of wetlands and associated wetland functions will be lost during Construction and Operation of the Project. Of these losses, the 39.4 ha of loss associated with the TMF was identified as high magnitude and requiring compensation. The majority of this loss will be to fens and swamp ecosystems within the TMF. The potential primary functions lost to development in these areas include:

- **Hydrological** - groundwater recharge, water retention, and potential downstream flood mitigation;
- **Biochemical** - carbon storage, nutrient cycling, water quality improvements;
- **Ecological** - wetland complexes and habitat diversity; and
- **Habitat** - large mammal foraging habitat, migratory bird habitat, bat foraging habitat (open areas), general wildlife habitat, and thermoregulation habitat, fish habitat (riparian swamps), and bat roosting areas where large trees are present.

The primary compensation target will be the creation and enhancement of approximately 48 ha of hydrologically stable wetland area.

5. Proposed Wetland Compensation Projects

As the primary effects of the Project will be on riparian wetlands and associated fish habitat, it was determined that the most ecologically relevant and practically viable compensation activities would be to develop functioning ecosystems supporting both fish and wetland compensation objectives. It was determined that macro site selection for wetland compensation would be directed by the development of the fish compensation plan. In turn, a team lead by a wetland scientist evaluated areas within the preliminary fish habitat plan; identified areas that would be suitable for both wetland and fish habitat creation, restoration, and enhancement; and worked at arms-length with the fish habitat compensation professionals to develop a combined wetland/watercourse ecosystem approach to compensation.

To add additional wetland area and value to the compensation plan, an investigation of degraded or otherwise impacted wetland ecosystems along Highway 37 from the Bob Quinn area through Smithers, BC was conducted. This investigation identified a number of potential sites that would benefit from enhancement and would contribute to the required compensation area. In particular, one site was identified with the potential to provide wetland research, education, and recreational values that are not currently supported by affected wetlands in the Project area.

5.1 FISH HABITAT IN RELATION TO WETLAND COMPENSATION

5.1.1 Background

Due to a number of Project interactions with fish habitat, a Fish and Fish Habitat Compensation Plan was developed. The fish habitat compensation plan relates specifically to fish habitat impacts resulting from the deposit of deleterious substances into the TMF, which includes the proposed seepage collection ponds. The proposed TMF is situated within the upper reaches of two watersheds, South Teigen and North Treaty creeks.

Wetlands present within South Teigen and North Treaty watersheds were dominated by pool cover type vegetation with in stream and overhanging vegetation. Most wetlands have tall shrub riparian vegetation and all possess good rearing habitat. Wetlands in North Treaty possesses abundant over-wintering habitat with water depths greater than 1.5 m present in some areas; however, beaver dams restrict fish passage and use of these areas. All wetlands possessed no spawning habitat due to the fine substrates.

5.1.2 Site Investigation

Aerial reconnaissance and ground-truthing of 62 preliminary compensation sites was completed in 2009 and 2010. Sites were ground-truthed on multiple occasions to refine site objectives as well as identify potential compensation opportunities, site-specific constraints, biological relevance, stability, permanence, target species, target habitat, and target life history stages.

The assessment of site-specific constraints and opportunities included water supply magnitude and dependability, flood risk, water quality, sediment supply, gradient, soil stability, site constructability and access, construction costs, stability and durability of in stream structures, obstructions and beaver dam risk, and time to full functionality of site.

A qualitative feasibility assessment, based on professional experience, was conducted in 2009 and 2010 by a water resources engineer to determine the technical feasibility for each compensation site.

Through an iterative process of elimination and refinement, a list of 10 technically feasible fish habitat compensation focus sites were identified (Figure 5.1-1). The sites include:

- Teigen Creek 2;
- Teigen Creek 3;
- Treaty Creek 1;
- Treaty Creek 2;
- Todedada Creek 1;
- Taft Creek 1;
- Upper Taft Creek;
- Oweegee Creek 1;
- Glacier Creek 1; and
- Snowbank Creek 1.

These 10 technically feasible fish habitat compensation sites were further refined following a multidiscipline study of potential negative interactions from developing these projects. For example, a number of wetland ecosystems were identified at the Treaty Creek 2 site. Developing this site would have further negatively affected a number of blue-listed swamp wetlands. The refinement of potential fish compensation sites identified four of these ten projects that would meet required fish compensation objectives while limiting negative effects to listed and sensitive vegetation communities. Of the four compensation projects carried through the screening process, three were identified as having features amenable to wetland ecosystems and thus could provide wetland habitat. These sites are summarized in Table 5.1-1.

Table 5.1-1. Summary of Fish Compensation Sites that Will Meet Wetland Compensation Requirements

Current Name	Former Name	Number of Open Water Features	Water Surface Area <2 m (ha)	Emergent and Transition Wetland Zone Area (ha)	Total Wetland Area (ha)
Teigen Creek	Teigen Creek 2	11 ponds	7.3	4.6	11.9
Treaty Creek	Treaty Creek 1	9 ponds	7.7	1.8	9.5
Taft Creek	Taft Creek 1	10 ponds	2.4	3.1	5.5

5.2 WETLAND COMPENSATION OPPORTUNITIES BEYOND THE IMMEDIATE PROJECT VICINITY

5.2.1 Background

A desktop review of historically affected wetlands along Highway 37 was conducted to identify sites that could potentially benefit from wetland restoration and enhancement. Discussions were initiated with the BC Ministry of Forests, BC MOE, and BC Ministry of Transportation and Infrastructure to identify potential wetland restoration sites that may have been known to these agencies. These discussions led to the identification of affected wetlands in the Snowbank Creek and Van Dyke Camp areas.

Waterbody	Site	Easting	Northing
Teigen Creek	3	440110	6283327
Treaty Creek	1	448500	6271000
Treaty Creek	2	452500	6269000
East Todedada Creek	2	451358	6264449
Glacier Creek	1	460181	6273125
Taft Creek	1	473042	6261126
Snowbank Creek	1	442000	6292000
East Todedada Creek	3	451304	6265224
Oweegee Creek	1	456875	6276477
Teigen Creek	2	439705	6283408

Figure 5.1-1

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Fisheries Compensation Focus Sites

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5.2.2 Site Investigation

5.2.2.1 Snowbank Creek

An investigation of the Snowbank Creek area was conducted in July 2011. This investigation identified widespread flooding associated with poorly installed and maintained water control structures associated with the Snowbank Creek wetland (Plate 5.2-1). The highway was threatened by flooding due to poor water management and impeded wetland hydrological function (Plate 5.2-2).

Plate 5.2-1. Flooded Snowbank Creek area around the south culvert.

Potential compensation activities include improving hydrological connectivity between the east and west sides of the highway and enhancing existing semi-permanent ponds so they become permanent. This would improve the water storage and habitat functions.

5.2.2.2 Van Dyke Camp and Brown Bear Forest Service Road Areas

An investigation of wetlands around the Van Dyke Camp area was conducted in July 2011. This investigation identified two sites that may benefit from restoration activities. The air strip south of Van Dyke Camp at the Brown Bear Forest Service Road is jutting into a large fen wetland (Plate 5.2-3), and a load out area at the Van Dyke Camp is negatively affecting a large wetland (Plate 5.2-4).

Potential compensation activities could include restoration that would involve removing non-wetland material (fill and debris) from wetland areas. This would restore some lost wetland area and would also improve some of the functional aspects of these wetlands simply because they would be restored.

Plate 5.2-2. Water flow at road downstream of north culvert.

Plate 5.2-3. Airstrip near the Brown Bear Forest Service Road jutting into fen wetland.

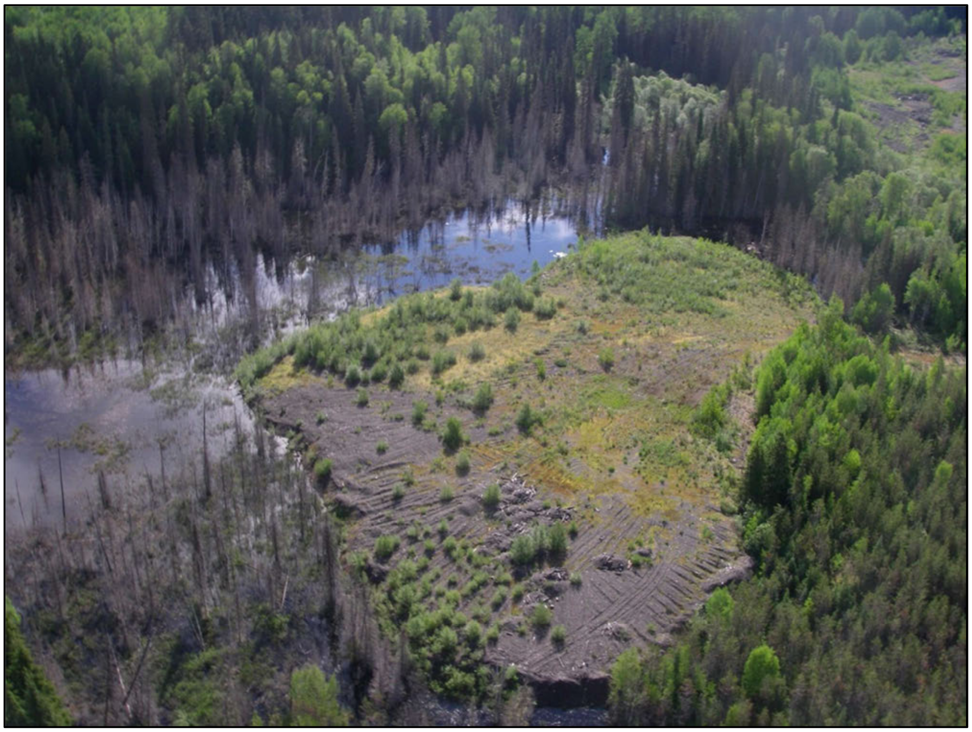

Plate 5.2-4. Load-out area at Van Dyke Camp infilling a large swamp open water complex.

5.2.2.3 Smithers Area Wetland

A wetland adjacent to Highway 16 between Smithers and Telkwa was investigated in August 2011 (Plate 5.2-5). The identified site is an existing ephemeral wetland community dominated by *Carex atherodes* and *Calamagrostis canadensis*. It is currently degraded due to construction and proximity of Highway 16, dominance of invasive Canadian thistle (*Cirsium arvense*), and interruption of past connectivity with the Bulkley River. Potential compensation activities could include removing non-wetland vegetation, reconnecting the sites hydrology to the Bulkley River, and developing a series of perimeter dams to restore hydrology.

5.3 PREFERRED OPTIONS

The preferred options for wetland compensation include the Teigen, Treaty, and Taft creeks fish compensation sites and the Smithers area wetland. These sites are reasonably accessible, locations that coincide with fish habitat compensation and locations that are geographically and geologically capable of wetland restoration. Integrating the wetland compensation with fish habitat compensation resource allocation is optimized and more complex wetland creation and enhancement is possible, providing increased functionality of compensation wetlands. Each compensation site will consist of a deep water (> 2 m deep) fish overwintering zone not to be counted in the wetland restoration area, a shallow open water wetland zone from 2 to 50 cm deep to be developed into a shallow open water riparian marsh zone, and a variable depth swamp and sedge meadow zone. Each zone is targeted to provide different wetland functions.

Plate 5.2-5. Smithers area wetland.

The Smithers area wetland is also a preferred site because of the potential education, recreation, and research values developing this site would provide. The Smithers area wetland is a poorly functioning wetland community that would benefit from enhancement. The wetland ecology, vegetation structure, hydrology, and habitat would all be improved by enhancement and restoration activities.

Preferred compensation sites are summarized in Table 5.3-1.

Table 5.3-1. Summary of Preferred Compensation Areas

Compensation Project Name	Number of Open Water Features	Total Wetland Area (ha)	Distance From the TMF(km)	Wetland Functions and Values
Teigen Creek	11 ponds	11.9	7	Hydrological, Biochemical, Ecological, and Habitat
Treaty Creek	9 ponds	9.5	8	Hydrological, Biochemical, Ecological, and Habitat
Taft Creek	10 ponds	5.5	35	Hydrological, Biochemical, Ecological, and Habitat
Smithers Area Wetland	1-2 ponds	21	275	Hydrological, Biochemical, Ecological, Habitat, Recreation, Research, and Education
Total Area		**47.9**		

These sites represent the preferred locations for wetland compensation based on:

- proximity to Project disturbance;
- association with fish habitat; and
- potential to provide research, education, and recreation values.

However, implementation considerations may affect the final compensation suitability necessitating investigations for new sites amenable to wetland compensation in Northwest BC. For example, construction requirements of fish compensation sites may prevent the establishment of the necessary wetland area. If sufficient wetland area cannot be created at the preferred compensation sites, additional sites will be selected.

6. Implementation Plan

6.1 PLANNING AND CONSTRUCTION SCHEDULE

Sites will be developed on a case by case basis following the same basic protocols and strategies. Wetland habitats will be developed in conjunction with the fish habitat compensation plan in a phased manner, contemporaneously with development. Timing of construction will be driven by the construction of fish habitat at each compensation site to enable optimization of resources and minimizing temporal disturbances.

Based on current timelines for the Project, it is estimated that approved construction would begin in 2014 with the Taft compensation site, Smithers in 2015, Treaty in 2017, and Teigen in 2019. These years will correspond to years one in the following schedules (Table 6.1-1 and 6.1-2). These dates are strictly ties to fish habitat compensation as development of wetland areas at Taft, Treaty, and Teigen will only begin once fish compensation activities begin.

Three sites have been chosen in conjunction with fish habitat compensation areas. These are the Teigen, Treaty, and Taft creeks (Figures 6.1-1, 6.1-2, and 6.1-3). Each site will follow the same basic principles in regard to wetland creation and enhancement; however, each site will also be constructed based on microsite topography and hydrological regimes. In addition, the Smithers area wetland will be restored, and partnerships with community organizations will be established to help realize the research, education, and recreation values (Figure 6.1-4).

It is predicted that it will take approximately one year to physically construct, stabilize soils, begin re-vegetation, and hydrologically open each restoration site. Wetland functions would be developing from that time forward. It is estimated that wetlands will be functional in some capacity by Year 10 following construction; however, wetland functions will naturally continue to dynamically evolve as time progresses.

6.1.1 Typical Construction Sequence for Combined Fish and Wetland Habitat Compensation Sites

Timing for the construction, enhancement, and restoration of wetland habitat sites coupled with fish compensation sites will be dictated largely by the fish compensation timelines. However, the following outline describes the general process that will take place at each wetland compensation site.

Construction activities will begin in late spring (of year 1) following the spring freshet and will involve land clearing, organic material stockpiling, vegetation salvage where possible, and general site layout.

Ponds and associated side channels will be constructed in the dry whenever possible through the use of temporary check dams, water control structures, or diversion channels and required pumps for water control, or other acceptable methods.

Soil stabilization for exposed soils will occur throughout the Project life.

Preparation for seeding and planting will begin in late summer of year 1 with initial seeding and planting of selected species in the fall one of the same year. It is estimated that in-stream and in-pond fish habitat will begin functioning within two years of completion of construction with observable wetland functions developing by Years 3 and 4 for each site.

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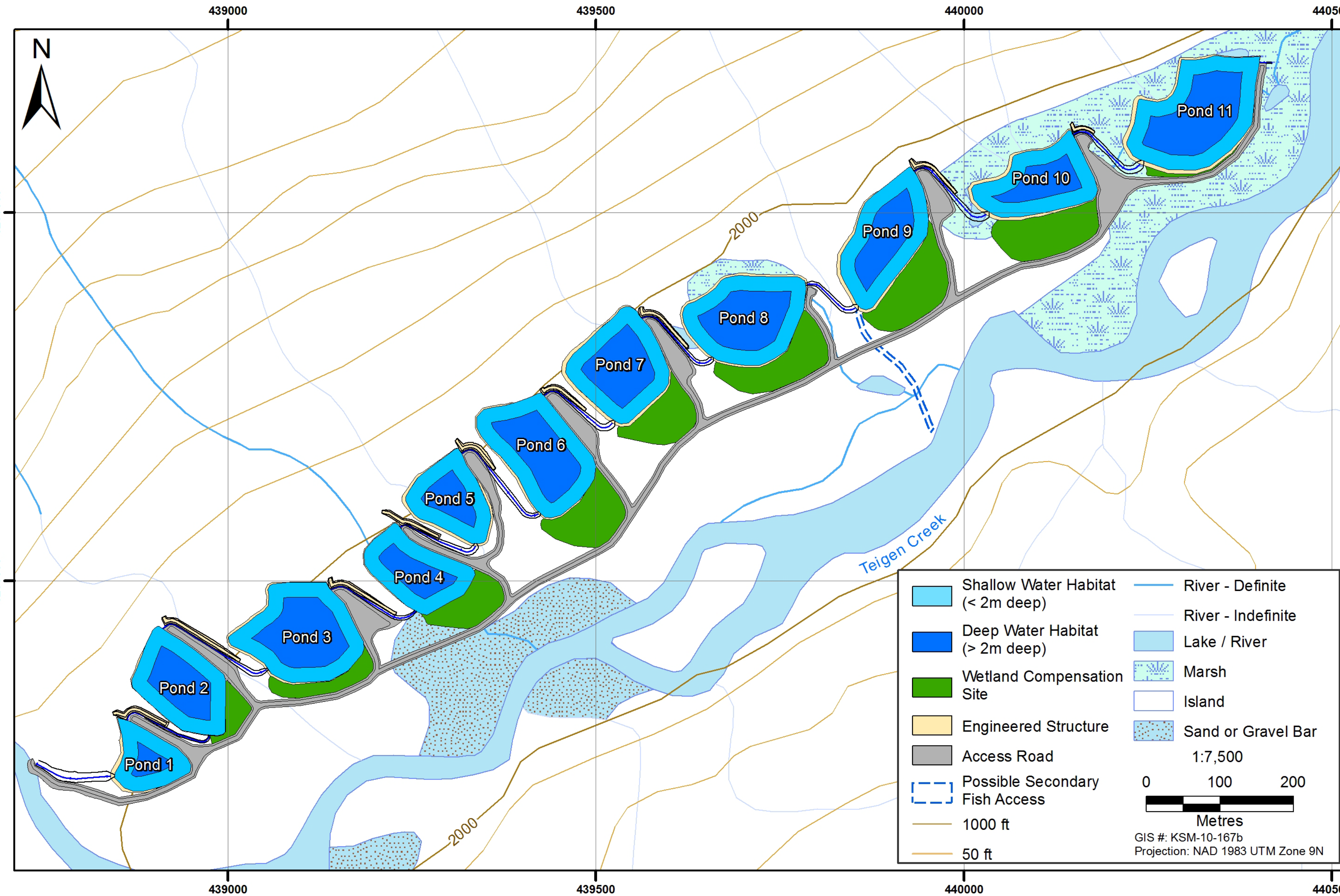

Figure 6.1-1

Teigen Creek Wetland Compensation Site

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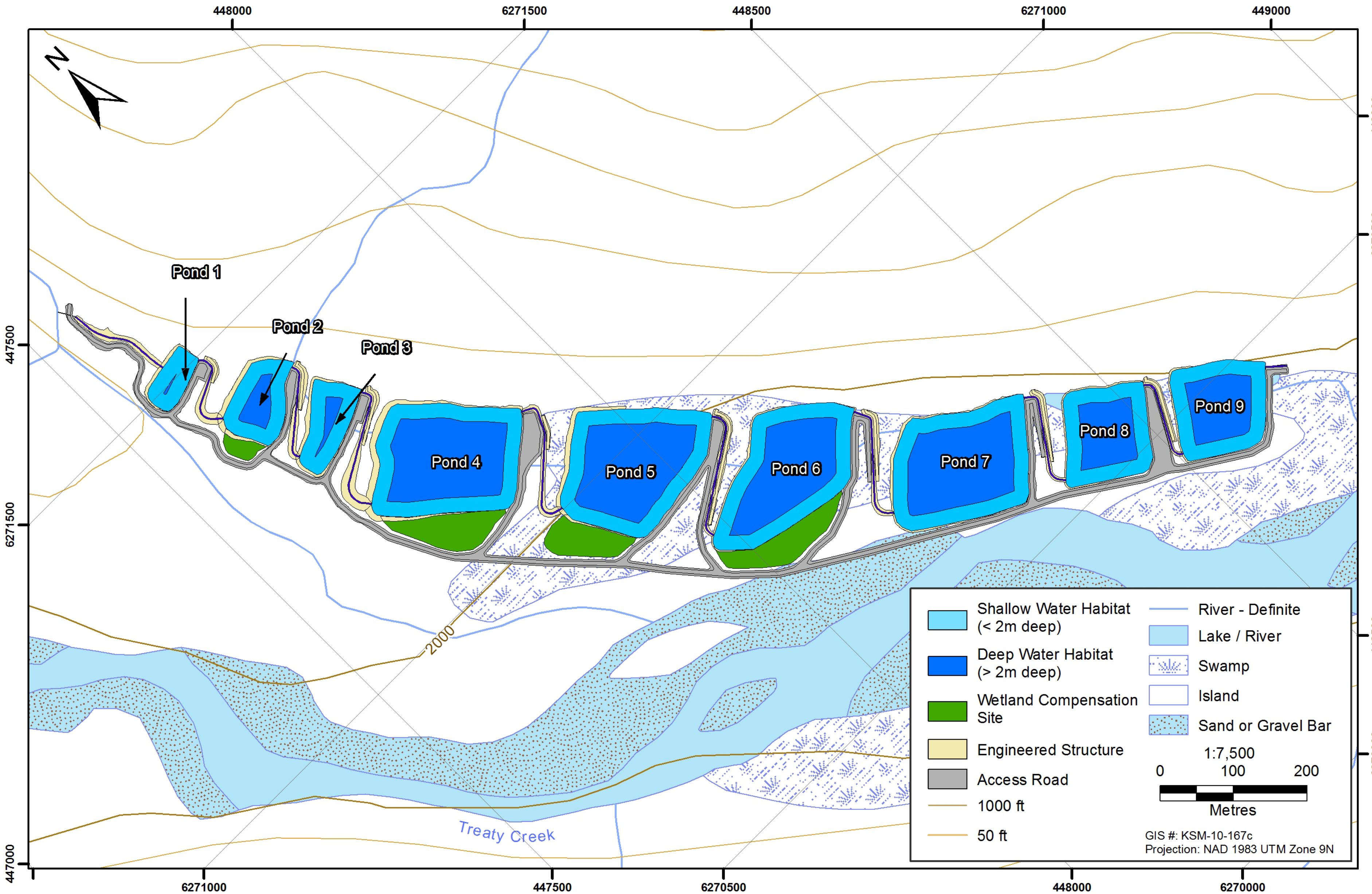

Figure 6.1-2

Treaty Creek Wetland Compensation Site

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Figure 6.1-2

PROJECT # 0868-016-10 GIS No. KSM-10-167a October 29, 2012

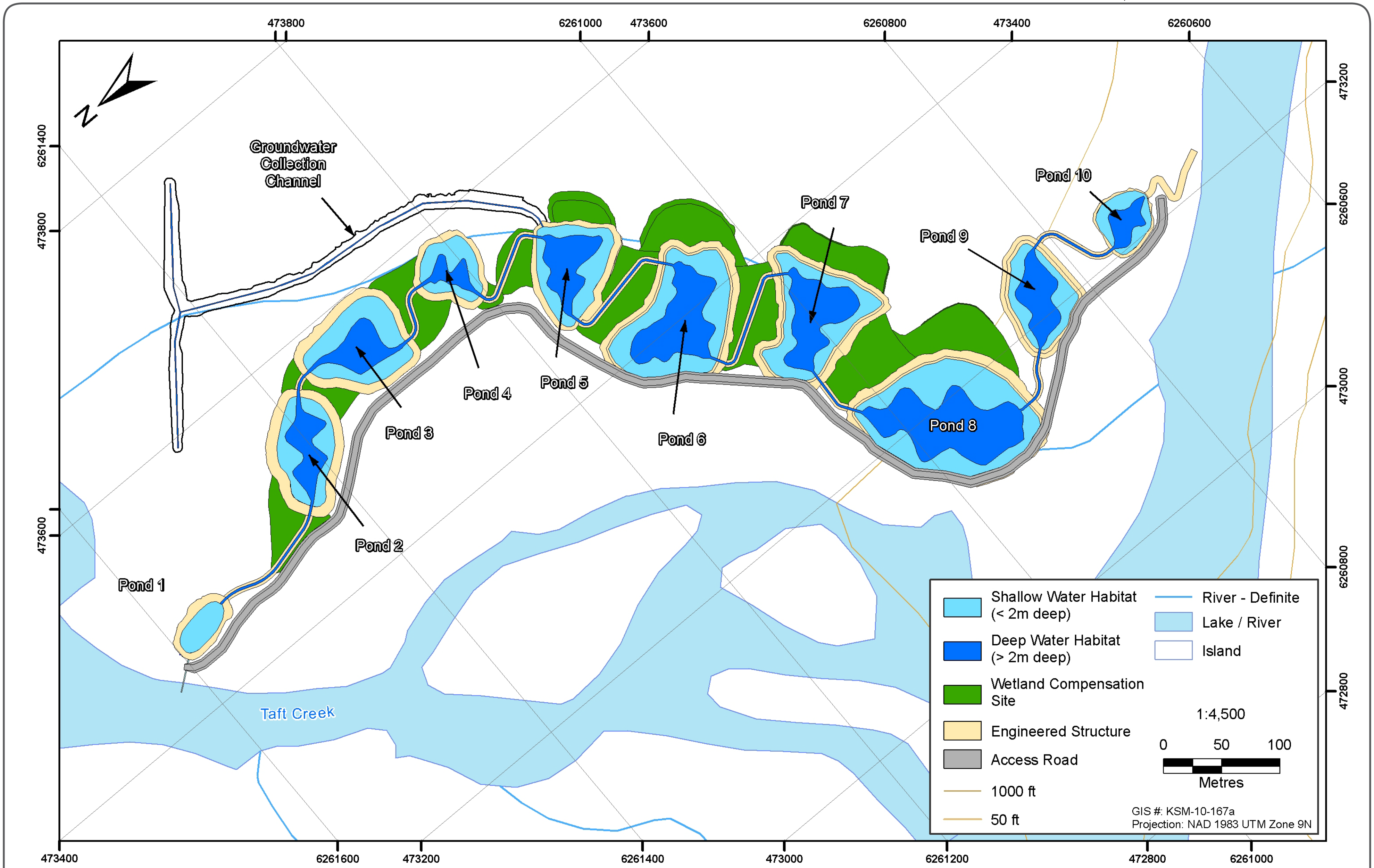

Figure 6.1-3

Taft Creek Wetland Compensation Site

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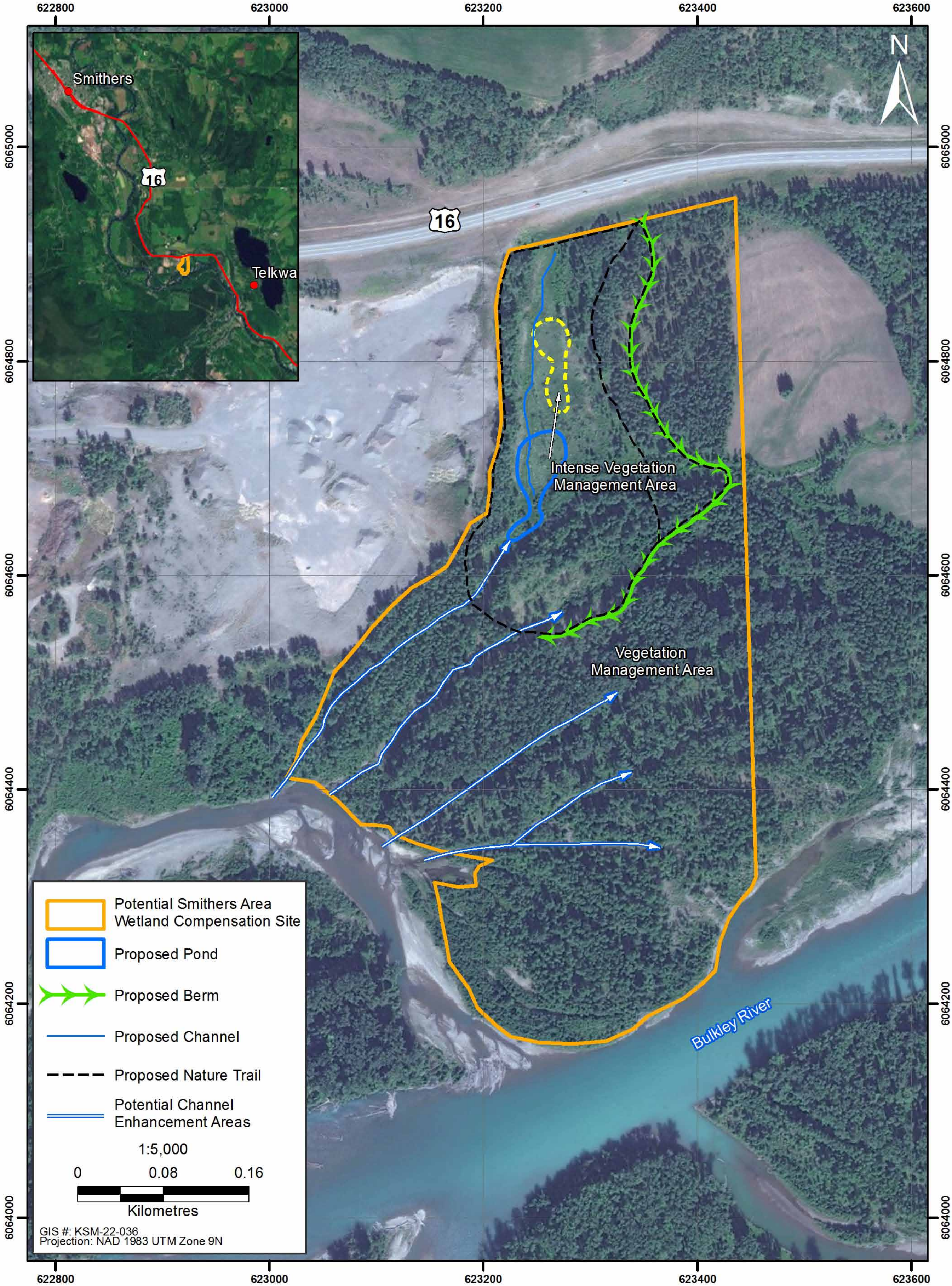

Figure 6.1-4

Bulkley River (Smithers Area) Wetland Compensation Site

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Follow up spring seeding and planting will be required in year two, year two being the first year for formal monitoring activities. Subsequent monitoring of survivorship will determine seeding/planting requirements and vegetation maintenance required to establish stable vegetation throughout the first 10 years of monitoring.

Pending monitoring outcomes at Year 10, the compensation site will be considered hydrologically stable and providing important wildlife and fish habitat functions. Vegetation manipulation and maintenance in wetland areas will end at Year 10 with continued monitoring of the natural succession and development of the site. It should be noted that ongoing maintenance of fish habitat may result in temporary loss of wetland habitats. Any impacts to wetland areas as a result of fish habitat maintenance will be restored to pre-existing elevations, grades, topsoil, and vegetation upon completion of the maintenance. This will be a requirement throughout each and every maintenance activity for fish habitat.

A schedule for the combined Fish and Wetland Compensation projects and milestones is presented in Table 6.1-1.

Table 6.1-1. Fish and Wetland Combined Compensation Site Schedule and Milestones

Compensation Project Year	Monitoring Year	Milestone/Activities
Year 0	none	Site level biophysical studies to record baseline data, establish permanent plot locations as required.
Year 1	none	Site preparation, earth works, water control structures installed, fall planting of salvaged vegetation, and fall seeding
Year 2	Year 1	Spring seeding, planting, beginning of monitoring phase/regulatory reporting
Year 3	Year 2	Re-vegetate as required, soil stabilization as required, monitoring
Year 4	Year 3	Re-vegetate as required, soil stabilization as required, monitoring/regulatory reporting
Year 5	Year 4	Re-vegetate as required, soil stabilization as required, monitoring
Year 6	Year 5	Re-vegetate as required, soil stabilization as required, monitoring/Regulatory reporting/request for regulatory sign-off of site
Year 7	Year 6	Re-vegetate as required, soil stabilization as required, monitoring – EEM reporting
Year 8	Year 7	Re-vegetate as required, soil stabilization as required, monitoring
Year 9	Year 8	Re-vegetate as required, soil stabilization as required, monitoring – EEM reporting
Year 10	Year 9	Re-vegetate as required, soil stabilization as required, monitoring
Year 11	Year 10	Re-vegetate as required, soil stabilization as required, monitoring – end of vegetation manipulation, maintenance, and management/EEM reporting
Year 12	Year 10-20	Monitoring frequency reduced to every 5 years (years 15, 20) – EEM reporting
Year 13	Year 20+ to Closure	Monitoring frequency reduced to every 10 years (years 30, 40, 50 etc. to Closure)/EEM reporting

This same procedure will be followed for each of the three combined Fish and Wetland Habitat compensation sites, with “Year 1” commencing as ground is broken for each site. Due to this proposed phased approach, monitoring and reporting will overlap in subsequent years for all of the proposed sites.

6.1.2 Typical Construction Sequence for the Smithers Area Wetland Habitat Compensation Site

Timing for the enhancement and restoration of the Smithers area wetland habitat site will begin contemporaneously with Project Development in Year 1. The following outline describes the general process that will take place at each of the wetland compensation sites.

Baseline data measurements and establishment of permanent plot centres and transects will be completed in year 0. In addition, the local community college will be formally contacted and preliminary agreements established in regards to potential curriculum, educational, and research use; coordinated restoration activities; and potential recreational opportunities. Year 0 will also entail overall design planning for potential parking lot locations and potential boardwalk and/or lookout locations within or adjacent to the wetland.

Vegetation management and control begin in year 1 following the spring freshet and will involve a combination of chemical, physical and manual manipulation of the site.

Any land clearing activities, disturbance of the topsoil, excavation of ponds, and extension of water channels will be completed during the fall of year 1. Subsequent reseeding and planting of these areas as well stabilization of shoreline and exposed soils will occur immediately following establishment of new ponds, contours, and drainages.

Ponds and associated side channels will be constructed in the dry whenever possible through the use of temporary check dams, water control structures, or diversion channels and required pumps for water control, or other acceptable methods.

Boardwalks and lookouts will be constructed during the dry season out of available non-toxic materials and constructed in such a manner that wetland functionality is not negatively impacted.

Soil stabilization for exposed soils will occur throughout the Project life.

As this site is predominantly a restoration site, it is estimated that observable wetland functions will re-establish.

Follow-up vegetation management with potential seeding and planting will be required in year 2, with year 2 being the first year for formal monitoring activities. Subsequent monitoring of survivorship and monitoring metrics will determine ongoing vegetation control strategies, seeding/planting requirements and vegetation maintenance required to establish stable vegetation throughout the first ten years of monitoring.

Pending monitoring outcomes in Year 10, the compensation site will be considered hydrologically stable and providing important wildlife and fish habitat functions. Vegetation manipulation and maintenance will end at Year 10 with continued monitoring of the natural succession and development of the site.

A schedule for the Smithers area wetland and milestones is presented in Table 6.1-2.

Table 6.1-2. Smithers Area Wetland Combined Compensation Site Schedule and Milestones

Compensation Project Year	Monitoring Year	Milestone/Activities
Year 0	none	Site level biophysical studies to record baseline data, establish permanent plot locations, potential boardwalk/lookout locations as required; establish formal relationship with local community college

(continued)

Table 6.1-2. Smithers Area Wetland Combined Compensation Site Schedule and Milestones (completed)

Compensation Project Year	Monitoring Year	Milestone/Activities
Year 1	none	Site Preparation, earth works, vegetation control commences, fall seeding
Year 2	Year 1	Spring seeding, planting, beginning of monitoring phase/regulatory reporting
Year 3	Year 2	Vegetation management, soil stabilization as required, monitoring
Year 4	Year 3	Vegetation management, soil stabilization as required, monitoring/regulatory reporting
Year 5	Year 4	Vegetation management, soil stabilization as required, monitoring
Year 6	Year 5	Vegetation management as required, soil stabilization as required, monitoring/regulatory reporting/request for regulatory sign-off of site
Year 7	Year 6	Vegetation management as required, soil stabilization as required, monitoring – EEM reporting
Year 8	Year 7	Vegetation management as required, soil stabilization as required, monitoring
Year 9	Year 8	Vegetation management as required, soil stabilization as required, monitoring – EEM reporting
Year 10	Year 9	Vegetation management as required, soil stabilization as required, monitoring
Year 11	Year 10	Vegetation management as required, soil stabilization as required, monitoring/end of vegetation manipulation, maintenance, and management/EEM reporting
Year 12	Year 10-20	Monitoring frequency reduced to every 5 years (years 10, 15, 20) – EEM reporting
Year 13	Year 20+ to Closure	Monitoring frequency reduced to every 10 years (years 30, 40, 50 etc. to Closure)/EEM reporting

6.2 WETLAND FEATURES WITHIN FISH HABITAT COMPENSATION SITES

The following characteristics will be incorporated into fish compensation sites to also produce wetland features.

1. Shallow transition gradient between open water and upland vegetation to maximize wetland habitats during both wet and dry years.
2. Emergent vegetation to reduce water velocities and promote aquatic invertebrate growth.
3. High densities of quick-growing shoreline emergent vegetation species to establish shoreline stabilization in areas with potential wave action or water motion.
4. Selected water tolerant tree species planted on “islands” at strategic location along the stream bank to produce cover and shade to mitigate for water temperature fluctuations, increase future shoreline stabilization, and provide a source of organic inputs to the water (food source for fish species).
5. Ensure deep water habitats are available between 1 and 2 m in various strategically placed backwater areas.
6. Ensure that all slopes within designed wetland areas prevent backwater isolation and potential stranding and fish kills during very dry conditions.

Vegetation planted within the open water areas will promote oxygen availability in water reducing the risks to fish of low oxygen availability associated with slow moving water and vegetation decay.

6.3 RE-VEGETATION OF COMPENSATION SITES

A vegetation salvage plan will be completed and executed at each compensation site prior to excavation and complete alteration of the site. Salvage will be critical in the reestablishment of locally adapted vegetation species. Salvage techniques will vary from site to site and will be dependent on the species present at each site.

Seeding and planting of restoration areas will be divided into several zones across the wetland/upland ecotone stratified by habitat types. These are:

1. No planting within shallow open water wetland areas with water depths > 50 cm.
2. Shallow emergent vegetation along slopes of less than 3:1 run:rise in areas with less than 50 cm of water depth (seeding and potential cuttings).
3. Designated tree planting on elevated berms or mounds throughout the shallow swamp wetland areas (planting of selected seedlings and saplings in specific areas and densities).
4. Adjacent forested wetland transition zones (seeding, planting of saplings, and cuttings in selected areas based on the flood or drought tolerance of selected species). Planting will use a combination of seedlings, cuttings and salvaged materials at each site.
5. Adjacent upland areas within the wetland buffer that have been disturbed by restoration activities (open soil stabilized against erosion and planting of native sapling and seedling species that replicates the existing stand and shrub structure of the pre-compensation habitat).

At each of the three combined fish and wetland compensation sites, the following wetland zones will be targeted for creation/enhancement through a stratified re-vegetation plan. Plantings will be stratified based upon the hydrological gradient moving away from constructed deep water fish habitat and species tolerance to soil saturation and flooding (Figure 6.3-1). Target vegetation species for wetland compensation zones will be selected following the classification of MacKenzie and Moran (2004). From wettest to driest these include:

1. Shallow open water zone (submergent vegetation):
   - yellow pond-lily and Richardson’s pondweed/site association;
2. Marsh zone (emergent marsh vegetation):
   - beaked sedge and water sedge/(Wm01) site association;
3. Swamp zone (swamp vegetation):
   - Sitka willow and Sitka sedge/(Ws06) site association;
4. Forested wetland/swamp fringe (forested wetland transition and upland buffer):
   - spruce, subalpine fir, skunk cabbage/(Ws11) site association;
   - cottonwood, subalpine fir, devil’s club/(FM03) site association;
5. Adjacent upland/transition (upland buffer):

   - Will be vegetated based upon existing communities within each compensation area.

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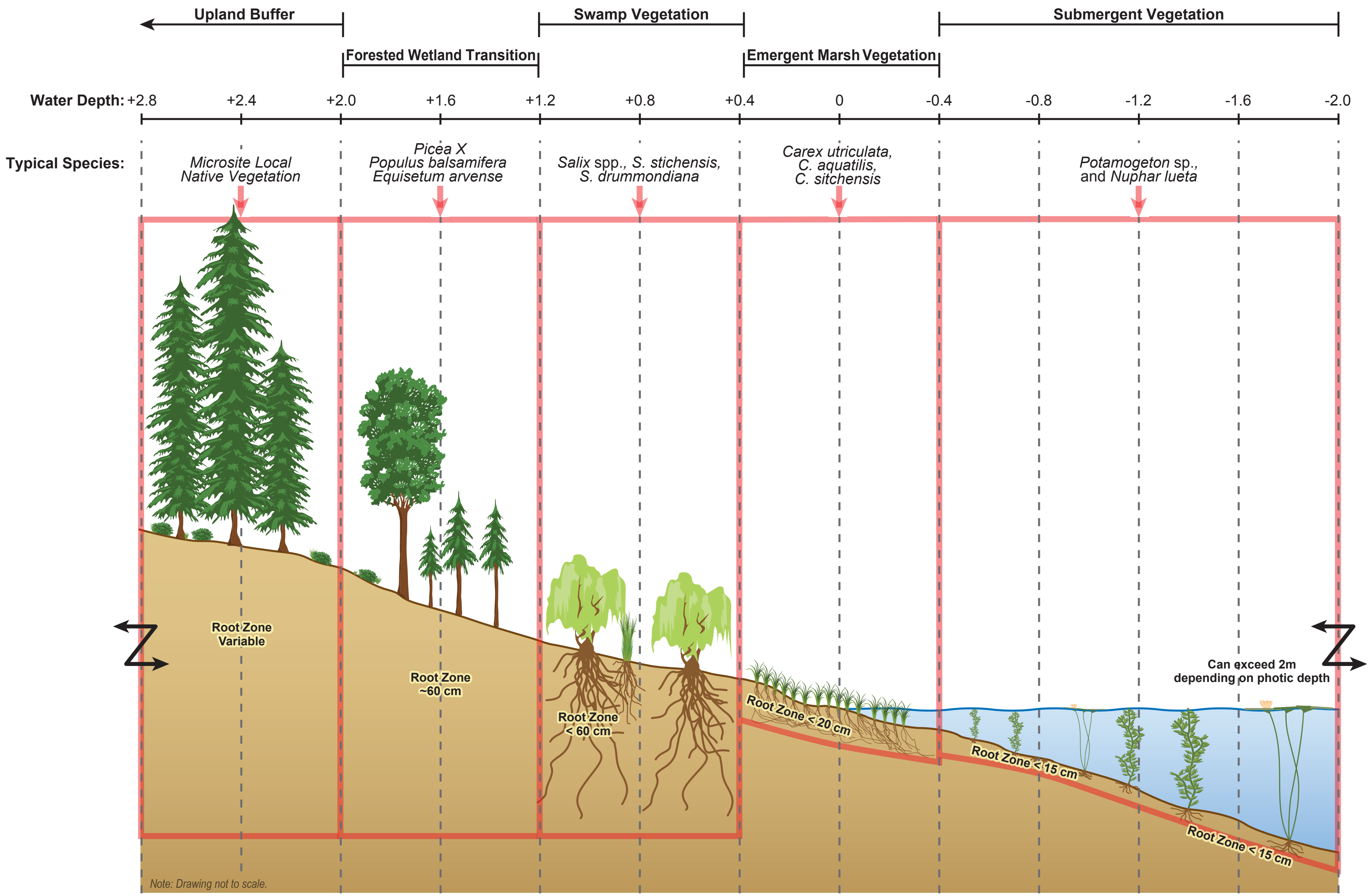

Figure 6.3-1

SEABRIDGE GOLD
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Vegetation Zonation at Compensation Sites

Figure 6.3-1

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Each wetland class may contribute functions as indicated in Table 2.4-2, with adjacent re-established upland wetland buffers potentially providing water quality functions, soil stability, protection for the compensation sites, as well as habitat diversity. The majority of the wetland creation and enhancement within the compensation plan will target Wm01-marsh and Ws06-swamp communities.

The final area of each wetland zone will be determined upon completion of the monitoring phases as the natural dynamic nature of wetland development and wetland hydrology precludes an accurate projection of final wetland classes for the compensation areas. Again, the primary metric of success being overall functioning wetland habitat produced, regardless of class or vegetation association.

A proposed detailed seeding and planting plan is attached to this report as Appendix A. This appendix will be revised when actual planting schedules are realized.

6.3.1 Wetland Seeding and Planting

Pending review of on-site conditions and salvaged plant composition for each compensation site, a re-vegetation strategy will be developed. Vegetation communities will target wetland communities lost in Project wetlands, particularly those associated with habitat for identified wildlife and native fish species. In addition, identified species of cultural significance will be planted at sustainable densities and numbers whenever possible through review of existing First Nations consultation information.

Native seeds and plants are required for all seeding areas. If non-natives are required for temporary bank/slope stabilization, they will be limited to annual species with the intent of native species colonizing these areas. Invasive non-native species or cultivars will not be used during any of the planting regimes at any of the sites.

6.3.2 Upland Seeding and Planting

Disturbed upland sites will be targeted to restore to pre-existing vegetation composition, elevations, and contours where possible. Selected areas of each compensation site will be over planted in Years 1 through 3 to ensure ground cover percentages have been established after five years of monitoring. It is essential that these upland wetland buffers be re-established and protected as they offer complimentary habitats for many species that use wetlands during part of their life cycles and contribute to wetland water quality functions and other wetland/upland ecosystem functions (Boyd 2001; Semlitsch and Bodie 2003; Woolbright 2004; Emmons & Olivier Resources 2006).

Disturbed open ground will be stabilized throughout the Construction Phase with straw mulch or similar product to mitigate erosion events. Prior to large storm events and freshets that may potentially damage the restoration sites, alternative methods may be used such as staked jute blankets, rip rap, geo-grid fabric, or a combination thereof.

6.4 ONGOING MAINTENANCE

Ongoing maintenance of the compensation sites will be driven by compensation monitoring (Section 7). It is estimated that manual vegetation maintenance, potential herbicide treatments, erosion control, and re-planting will be required to ensure project success. Monitoring goals will be established to ensure that the survivability of planted trees and shrubs exceeds 80% each year and 80% by the end of the monitoring period. Monitoring will also identify that suitable ground cover has been established to mitigate soil erosion.

Ongoing maintenance is intended to be completed using methods that minimize disturbance to the compensation and surrounding natural areas. Should a large scale event occur during the monitoring period where maintenance requires large machinery, efforts will be taken to ensure minimal disturbance.

Wetland habitat maintenance may be required as a result of fish habitat specific maintenance programs such as dredging and water control structure maintenance. These activities could result in disturbed wetland habitats, which will result in further wetland habitat maintenance activities.

7. Monitoring Compensation Success

Compensation success will be based upon a greater than 1.25:1 area ratio of all compensation wetlands to impacted wetlands at the end of the five-year regulatory monitoring period for each site. Additional reclamation at Closure will bring the post-Project wetland ration to in excess of 2.5:1. The final year of compensation expected to be six years following the initiation of the last compensation phase at Teigen Creek.

Additional long-term monitoring will continue at decreasing frequencies throughout the life of the mine to enable adaptive management processes and ensure wetlands persist in the compensation sites throughout the mine life (Table 7.1-1).

Table 7.1-1. Wetland Compensation Monitoring Schedule

Monitoring Period	Monitoring Frequency	Reporting Frequency	Monitoring Activities
Compensation construction	None	-	-
Years 1 to 5	Annual	Annual as a section of the EEM	Vegetation surveys, tissue metals concentrations, vegetation biomass, soil stabilization and erosion observations, and photo point monitoring.
Years 6 to 10	Annual	Bi-annual, every odd year as a section of the EEM	Vegetation surveys, tissue metals concentrations, vegetation biomass, soil stabilization and erosion observations, and photo point monitoring.
Years 11 to 20	5 years	5 years	Vegetation surveys, tissue metals concentrations, vegetation biomass, soil stabilization and erosion observations, and photo point monitoring.
Years 21 to Closure	10 years	10 years	Vegetation surveys, tissue metals concentrations, vegetation biomass, soil stabilization and erosion observations, and photo point monitoring.

If stable wetland areas are not achieved when sign-off is expected, discussions with the regulator will take place regarding appropriate actions to ensure compliance. These may include:

- the analysis of increased function at the compensation sites coupled with the wetland area;
- an in-depth analysis of the social and educational value of the Smithers area wetland; and
- the creation of more wetland habitat within the compensation sites or new site selection.

Net wetland extent will be assessed and considered successful as follows:

- prevalence index of hydrophytic wetland species within compensation areas have significantly increased over baseline measurements;

- ratio of non-native and invasive species to native species has decreased over baseline measurements;
- presence of hydric soil indicators such as depleted soils and mottles in areas where previous indicators did not exist;
- observed wildlife use has increased over baseline measurements.

Regulatory sign-off will be acquired for each site as it progresses and for the entire project once the final site has been completed and monitored for five years, the final goal being stable wetland areas of sufficient size.

8. Potential Risks and Mitigation

8.1 COMPENSATION SITE LOCATION AND DYNAMIC HYDROLOGY

The wetland compensation areas will be placed within potentially dynamic floodplain areas. The geography near the Project area is mountainous, limiting the availability of suitable sites.

Measures will be taken to protect wetland compensation habitat from 1-in-25-year flooding events. The primary protective measure will be the location of the access road required for construction. Deactivation of the roadways to local traffic will be carried out in a way that provides protective berms around the sites. The berms will provide protection from scouring and washing out of compensation features during expected flood events.

The wetland compensation features will be designed to take advantage of the local topography and local high water tables, enabling simplified construction and water retention within the wetland areas. Wetland hydrology must persist long enough within the growing season to support continued soil saturation and hydrophytic vegetation development.

Basin design as well as vegetation placement and density will take into account potentially identifiable historic flood patterns within the floodplain. Re-vegetation will be carried out using a combination of fast-growing native wetland and upland species. Upland species planted around wetland areas will be planted at increase densities to potentially provide some mitigative effects to floodwaters once they have become established.

In addition to the above measures, the Smithers area wetland is intended to be used as a recreational and educational site and as such there is a potential for natural and human induced damage to constructed boardwalks, lookouts, and parking lot structures associated with this site. Structure sighting, construction activities, and materials will be investigated to strive to minimize potential damage to these items.

8.2 RE-VEGETATION OF FISH HABITAT FEATURES

The success of wetland vegetation establishment will depend upon the depth and area of the fish habitat basins, the slope of the constructed transition zone, potential water flows, velocities and volumes, and basin water retention. Areas with water deeper than 2 m will not be re-vegetated as these are not classified as wetlands.

Open water wetland areas with depths of between 50 cm and 2 m will not be re-vegetated. These areas will be left to re-vegetate naturally over time using seed banks from neighbouring areas and natural dispersion.

Shoreline areas will be re-vegetated using native perennial grass and sedge seed sources, cuttings, and saplings/seedlings of appropriate native shrub vegetation acquired from local sources and native tree saplings representing the currently occurring species composition. This will ensure that re-vegetated species will be genetically adapted to local climate variability and conditions and increase the likelihood of survival.

If vegetation for erosion control is required during establishment of native vegetation it will be limited to annual grasses that will not form alternate climax states that exclude the establishment of target vegetation communities.

Native tree and shrub species adapted to wetland conditions (i.e., *Salix* and *Alnus* genus) will be planted along the shoreline of the proposed fish habitat as well as within the constructed swamp wetland. These will provide shoreline and ground stability, shading to mitigate water temperatures, and future natural sources of nutrient inputs into the aquatic ecosystem (leaf litter, insects, etc.).

Native tree species seedlings will be planted along the transition gradient and selected for tolerance of saturated soil conditions. In some areas trees may be planted on constructed mounds and/or elevated rows within soil saturation zones to promote increased survivorship and recruitment.

Specific species and planting densities and areas will be determined on a site by site approach to customize each and every site to existing conditions rather than a shotgun approach to all the basins. Again, native tree saplings representing the currently occurring species composition will be used in all other areas as required and available.

8.3 LAND ACQUISITION

The chosen compensation sites are all located on crown land. Communications with the Land Tenures Branch, Ministry of Forests, Lands and Natural Resource Operations, is required to ensure that alternative management regimes or development are not planned for these sites. However, the location of these compensation sites generally precludes the likelihood that future development will take place in these areas.

Possible additional actions include the placement of environmental easements on the restoration sites. These easements, including a suitable upland buffer area, would ensure these areas last in natural perpetuity in some form or another, without future anthropogenic development that would remove these features, or functions of these features, from the landscape. The easements would dictate land use and land prescriptions at these sites.

8.4 SITE DEVELOPMENT

Site development will require the use of heavy equipment near adjacent regulated waterbodies and within regulated wetland features. All necessary regulatory permits will be obtained prior to on the ground works with all permit requirements being implemented during construction.

To mitigate for potential fuel, hydraulic fuel, and oil leaks the following mitigation measures must be on hand during construction:

1. All fuelling oil and maintenance of vehicles must take place within a designated maintenance area no less than 30 m from any identified watercourse or wetland.
2. All excavators working within wetted areas must have the hydrocarbon hydraulic fluid exchanged with a non-toxic vegetable substitute.
3. A spill management and containment plan will be developed and in place for each site prior to the onset of development. This shall include enough spill containment and adsorbent materials to accommodate 200% of the volatile fluids in the largest vehicle used on the site.
4. When not in use, all vehicles shall be stored a minimum of 15 m away from any identified water feature, outside of potential flood water levels.

In addition to the potential for contaminant release into the environment there is the potential for flooding of the restoration site. The following measures will be implemented to mitigate and minimize environmental impacts if flooding should occur during construction:

1. A flood contingency plan will be developed and in place prior to the onset of development at each site.
2. Daily monitoring of regional and local weather forecasts and run off conditions will be required by crews in order to effectively predict potential flooding conditions at every work site during construction.
3. Designated storage areas will be identified for machinery in the case of forecast flooding.
4. Designated storage areas for spoils and materials used during construction will be identified outside of the highest flood prone areas.
5. All machinery and erodible materials to be stored/stockpiled outside of flood plain areas whenever possible.

8.5 PUBLIC AND CONTRACTOR SAFETY

A Health, Safety, Environment, and Community Plan will be designed and implemented during the construction and monitoring phases to ensure safety of contractors, monitoring crews, and the public at large. This will likely entail appropriate training for contractors and monitors, appropriate high visibility signage, fencing, and regional notifications (primarily during the construction phase).

8.6 LONG-TERM LAND MANAGEMENT

Long-term land management is an ongoing concern for many wetland rehabilitation, restoration, and/or compensation projects. The fish habitat compensation and the associated wetland habitat compensation has been designed to minimize potentially required maintenance and to allow the site to develop naturally once vegetation has established and a successional trajectory is evident. The intent is to provide a naturally evolving habitat with minimal maintenance during the initial five years of development and zero maintenance once a successional trajectory has been established.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Appendix A

Potential Revegetation Species: Site Requirements, Timing and Densities

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Appendix A. Potential Revegetation: Species Site Requirements, Timing and Densities

Compensation Zone	Suggested Target Community	Vegetation Strata	Species	Planting Type	Sites	Timing	Proposed Density[1] (#/m^2)	Proposed Frequency[1]
Shallow open water	Yellow pond-lily Richardson's pondweed	Tree	-	-	-	-	-	-
		Shrub	-	-	-	-	-	-
		Herbs and dwarf shrubs	*Nuphar lutea*	plugs	aquatic sites to 2 m depth	spring/summer	2	Years 1 and 2 as required
			Potamogaton richardsonii	plugs	aquatic sites to 2 m depth	spring/summer	2	Years 1 and 2 as required
			Polygonum amphibium	plugs	aquatic sites - < 20 cm depth	spring/summer	1	Years 1 and 2 as required
Emmergent marsh	Beaked sedge - Water Sedge (Wm01)	Tree	-	-	-	-	-	-
		Shrub	-	-	-	-	-	-
		Herbs and dwarf shrubs	*Carex utriculata*	transplants	shallow aquatic sites < 5 cm depth	spring/summer	4	
			Carex aquatilis	transplants	shallow aquatic sites < 5 cm depth	spring/summer	4	repeated Years 1 through 3 as required
			Comarum palustre	seeds, seedlings	emergent marsh margins	spring/summer	1	
			Polygonum amphibium	transplants, plugs	shallow aquatic sites < 20 cm depth	spring/summer	1	
			Calamagrostis canadensis	seed	bank stabilization sites	fall	variable	Years 2 and 3 in selected areas
Swamp	Sitka Willow - Sitka Sedge (Ws06)	Tree	*Picea X*	salvage/saplings/ seedlings	drier microsites within swamp area	spring/summer (salvage) fall (saplings/seedlings)	0.25 (salvage), 1 (seedlings)	Years 1 through 5
		Shrub	*Salix sitchensis*	cuttings	variable locations throughout swamp areas	fall/winter	4	repeated Years 1 through 3 as required
			Alnus Incana	cuttings, seed	variable locations along swamp edges	fall	2	repeated Years 2 through 3 as required
		Herbs and dwarf shrubs	*Cornus Stolonifera*	cuttings, division, salvage	swamp fringe microsites (bunches)	variable	0.25	repeated Years 1 through 3 as required
			Lonicera involucrata	cuttings, seed	variable locations throughout swamp areas	variable		Years 2 and 3 in selected areas
			Equisetum fluviatile	seedings	wetter microsites - no surface water	spring/summer		Years 1 and 2
			Juncus balticus	transplants, seedlings	variable, bank stabilization sites	spring/summer	9	Year 1
			Carex aquatilis	transplants	shallow aquatic/wetland microsites < 5 cm depth	spring/summer	2	repeated Years 1 through 3 as required
			Carex sitchensis	transplant, seedlings	shallow aquatic/wetland microsites < 5 cm depth	spring/summer	1	repeated Years 1 through 3 as required
			Equisetum arvense	seed, transplants	throughout drier swamp areas	spring/summer	variable[2]	Year 1
			Calamagrostis canadensis	seed	bank stabilization sites	fall	variable[2]	Years 2 and 3 in selected areas

[1] *Proposed planting density based upon literature review of propogation methods. Actual planting density may change dependent on site conditions, plant/seed stock availability, timing of establishment and survivorship of the previous year.*

[2] *Density to be determined upon completion of year zero baseline studies and inventories.*

All unplanted areas and exposed soils will be stabilized with straw mulch. It is expected that there will be natural recruitment from the seed banks of the area soils during subsequent years past year 1.

Appendix A. Potential Revegetation: Species Site Requirements, Timing and Densities

Compensation Zone	Suggested Target Community	Vegetation Strata	Species	Planting Type	Sites	Timing	Proposed Density[1] (#/m^2)	Proposed Frequency[1]
Forested wetland - swamp fringe	Spruce - Subalpine fir - Skunk cabbage (Ws11)	Tree	*Picea X*	salvage/saplings/ seedlings	evenly spaced throughout forested wetland	spring/summer (salvage) fall (saplings/seedlings)	variable[2]	Years 1 through 3
			Abies lasiocarpa	salvage/saplings/ seedlings	drier microsites - edge of forested wetland	spring/summer (salvage) fall (saplings/seedlings)	variable[2]	Years 1 through 3
		Shrub	*Alnus incana*	cuttings, seed	wetter microsites throught forested wetland	fall	variable[2]	Years 2 through 3
			Lonicera involucrata	cuttings, seed	wetter microsites throught forested wetland	variable	variable[2]	Years 2 and 3 in selected areas
			Cornus stolonifera	cuttings, division, salvage	drier microsites throughout forested wetland	variable	variable[2]	Years 2 through 3
			Vaccinium alaskaense	seedlings	evenly spaced throughout forested wetland	variable	variable[2]	Years 2 and 3 in selected areas
		Herbs and dwarf shrubs	*Gymnocarpium dryopteris*	transplants, plugs	bunched at moist to wet sites	spring	variable[2]	Year 2 in selected areas
			Equisetum arvense	seed, transplants	throughout entire forested wetland	spring/summer	variable[2]	Year 1
			Lysichiton americanus	seedlings, transplants	bunched in wetter microsites	spring	variable[2]	Year 2
			Athyrium filix-femina	seedlings, transplants	evenly spaced through drier microsites	spring	variable[2]	Year 2
			Tiarella trifoliata	seedlings, transplants		spring	variable[2]	Year 2
Adjacent upland buffer restoration zone	Cottonwood - Subalpine fir - Devils club (Fm03)	Tree	*Populus balsamifera*	salvage/saplings/ seedlings	evenly spaced throughout restored buffer	spring/summer (salvage) fall (saplings/seedlings)	variable[2]	Years 1 through 3 as required
			Picea X	salvage/saplings/ seedlings	evenly spaced throughout restored buffer	spring/summer (salvage) fall (saplings/seedlings)	variable[2]	Years 1 through 3 as required
			Abies lasiocarpa	salvage/saplings/ seedlings	evenly spaced throughout restored buffer	spring/summer (salvage) fall (saplings/seedlings)	variable[2]	Years 1 through 3 as required
		Shrubs	*Alnus incana*	cuttings, seed	wetter microsites in uplands - bunches	fall	variable[2]	Years 2 and 3 in selected areas
			Cornus stolonifera	cuttings, division, salvage	wetter microsites in uplands - bunches	variable	variable[2]	Years 2 and 3 in selected areas
			Oplopanax horridus	seed	wetter microsites throughout restored buffer	fall	variable[2]	Years 2 and 3 in selected areas
			Rubus parviflorus	seedlings	wetter microsites along drainages	spring	variable[2]	Year 2
			Viburnum edule	seedlings	wetter microsites throughout restored buffer	spring	variable[2]	Year 2
		Herbs and dwarf shrubs	*Equisetum arvense*	seed, transplants	throughout entire buffer	spring/summer	variable[2]	Year 1
			Gymnocarpium dryopteris	transplants, plugs	bunched at moist to wet sites	spring	variable[2]	Year 2 in selected areas
			Athyrium filix-femina	seedlings, transplants	evenly spaced through drier microsites	spring	variable[2]	Year 2

¹ *Proposed planting density based upon literature review of propogation methods. Actual planting density may change dependent on site conditions, plant/seed stock availability, timing of establishment and survivorship of the previous year.*

² *Density to be determined upon completion of year zero baseline studies and inventories.*

All unplanted areas and exposed soils will be stabilized with straw mulch. It is expected that there will be natural recruitment from the seed banks of the area soils during subsequent years past year 1.