Appendix 13-D

Wetland Functional Assessment

NWP COAL CANADA LTD.

Wetland Functional Assessment

Crown Mountain Coking Coal Project

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1.0 Introduction

1.1 Introduction and Objectives

NWP Coal Canada Ltd (NWP) is proposing to develop the Crown Mountain Coking Coal Project (the Project), an open pit metallurgical coal mine located in the Elk Valley coal field in southeastern British Columbia (B.C.). NWP is owned by a joint membership of Jameson Resources Limited and Bathurst Resources Limited (Canada). The Project has 10 coal licenses between several existing metallurgical coal mines in the Elk Valley and Crowsnest coal fields.

The mine is designed to produce approximately 10,150 tonnes per day (tpd) and up to 4.0 million run-of-mine tonnes (M ROMt) per year over a mine life of 15 years. The proposed Project footprint covers approximately 1,300 hectares (ha) and includes three surface extraction areas (north pit, east pit, and south pit), waste rock management areas, plant area (includes raw coal stockpile area, a processing plant, and site support facilities), clean coal transportation route (via an overland conveyor and haul road), rail load-out facility and rail siding (includes various auxiliary facilities), power supply, natural gas supply, explosives storage, fuel storage, sewage treatment, and water supply.

The proposed Project has the potential to cause direct and indirect effects on wetlands and their functional capacity as a result of Project development. Wetlands are complex, dynamic, and difficult to classify, quantify, and evaluate (Hanson, et al., 2008). Wetlands can be defined as:

> "Areas where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development. Wetlands will have a relative abundance of hydrophytes in the vegetation community and/or soils featuring "hydric" characters." (p. 6, MacKenzie and Moran [2004]).

Wetland functions refer to the natural processes, such as physical, chemical, and biological processes, that take place within a wetland. Simply put, wetland functions are something a wetland does (e.g., retain water, remove suspended sediment, and provide habitat for plants and animals) (Minnesota Board of Water and Soil Resources, 2010). It is important to understand the functions of a wetland to adequately evaluate potential effects of a project on wetland ecosystems that are inherently complex.

A wetland functional assessment was completed to understand wetland functions supported by wetlands within the Terrestrial Local Study Area (LSA) and wetlands that have the potential to be impacted as a result of the proposed Project (i.e., wetlands within the Project footprint). The assessment of wetland function is intended as a supplementary assessment to the Wetland Ecosystem Baseline Report (Dillon Consulting Limited, 2021). This wetland ecological functions assessment provides an:

- Overview of wetland ecological functions;

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- Summary of wetland functions as they to the five (5) main wetland types (i.e., bog, fen, marsh, swamp, and shallow water);
- Outlines wetland functions supported by wetlands of the Terrestrial LSA; and
- Summarizes wetland functions supported by wetlands that may be directly impacted by the Project.

The hydrogeomorphic approach to wetlands ecological function assessments, which groups functions into physical, chemical, and biological wetland processes (Hanson, et al., 2008), was used to assess wetland functions in the Terrestrial LSA. Wetland functions can be used to determine the value of a wetland to humans but that determination, the relationship between function and value, is variable among people, groups of people and the environmental or societal context in which value is assigned. The assessment of wetland ecological functions in this report focuses on the describing wetlands by the functions that define them and their role in ecology.

2.0 Wetland Ecological Functions

The hydrogeomorphic approach was used and modified, where needed, to complete a wetland functions assessment for wetlands in the Terrestrial LSA (Granger et al. 2005; Hanson et al., 2008; Minnesota Board of Water and Soil Resources, 2010; NovaWet 2011; and Guidugli-Cook et al., 2017). The hydrogeomorphic approach groups wetland functions into hydrological, biochemical, and habitat process categories which are influenced by:

- Landscape position (geomorphic setting) which may include slope, depressions, flats;
- Water source, including how water enters the wetland (e.g., precipitation, ground- and surface-water); and
- Direction and energy of water flowing through the wetland (Davis et al. 2013).

Table 2-1 summarizes hydrogeomorphic functions and associated values within the three key categories of wetland processes: hydrological, biochemical and habitat.

Table 2-1: Hydrogeomorphic Functions and Associated Values (after Hanson et al. 2008)

Functional Category	Function	Value
Hydrological	• Surface water storage and release, short- and long-term • Subsurface water storage and release, short- and long-term • Groundwater flow • Water energy/flow	• Dissipate and reduce energy; prevent and control erosion; sediment drop out • Moderate flood water extremes and replenish groundwater • Moderate water flow and discharge • Erosion control • Moderate climate
Biochemical	• Cycling of nutrients through abiotic and biotic processes • Retention of inorganic and organic particles through chemical or physical processes • Export of organic carbon: dissolved or suspended • Production of biomass (sequestration and storage of carbon) • Decomposition of biomass • Production of soils	• Affects element states, availability, and export • Improved water quality by removal of elements and compounds such as nutrients and pollutants • Sequestration and storage of carbon

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Functional Category	Function	Value
Habitat	• Plant/algae and animal communities • The presence and maintenance of conditions required by species of plants, algae, and animals • Biological productivity and diversity	• Sustain biodiversity • Provide habitat for rare species and communities • Provide human cultural amenities through hunting, harvesting, and recreation

3.0 Wetland Functional Attributes by Wetland Class

Wetlands of the Terrestrial LSA are classified in the Wetland Ecosystem Baseline Report (Dillon Consulting Limited, 2021) using standard classification for the province (MacKenzie and Moran, 2004), regional amendments (McKillop et al., 2018), and the federal Canadian Wetland Classification System (Warner and Rubec, 1997). The provincial and federal classification systems group wetlands into bogs, fens, marshes, swamps and shallow waters. Soils, plant structure and type, landscape position, water quality and abundance, are important for distinguishing wetland type. General classifications are further split into wetland *site associations* based on plant species assemblages, vegetation structure and landscape position. Many wetlands of the Terrestrial LSA are complexes of a variety of wetlands and transitional wetland-terrestrial communities. In addition, transition areas occur between two wetland types and between wetland and upland ecosystems which vary in width and support features characteristic of both communities.

The capacity of wetlands to perform certain functions are related to site-specific factors that vary between wetlands and within wetlands of the five major classes (bog, fen, marsh, swamp, and shallow water (**Table 3-1**; Gopal, 1999; Granger et al., 2005; Hanson et al., 2008; and NovaWet, 2011). Each of the five wetland types (bog, fen, marsh, swamp, and shallow water) can be characterized by their ability to perform certain hydrological, biochemical, and habitat functions. The type of functions performed and the ability of each wetland to perform certain functions varies between wetlands since each wetland is influenced by conditions and stressors specific to each site and environmental setting.

Table 3-1: Wetland Function and Wetland Characteristics Affecting Function

Functional Group	Function	Wetland Characteristics Affecting Function
Hydrological	Water flow moderation and reduction in peak flows	The capacity of a wetland to moderate peak flows and reduce flooding increases with wetland area, water storage volume (temporary and long-term) relative to flood volume, proximity of the wetland to flood source and catchment area. Wetland landscape position: basin, riparian or shoreline.
	Surface water detention	Is the wetland hydrologically connected to or isolated from other wetlands? What are the characteristics of throughflow or outflow? Surface water detention is generally low in wetlands on slopes and dependent on throughflow and outflow in marshes and swamps.

Functional Group	Function	Wetland Characteristics Affecting Function
	Groundwater recharge	Groundwater recharge is not related to wetland type. In general, wetlands located in topographic highs are groundwater recharge sites while wetlands located in topographic lows are groundwater discharge sites. Recharge is related to the difference in wetland and groundwater elevations and recharge cannot occur if wetlands are fed by groundwater or at the same level. Wetland storage capacity affects mass and pressure of water on wetland bottom and the ability of water to pass through soils underlying the wetland (i.e., hydraulic conductivity).
	Shoreline stabilization and erosion reduction	Influenced by constrictions in channelized wetlands that impede flow, friction of wetland bottom, and friction from wetland plants which increases with increasing water velocity. Functional performance is related to vegetation density and location of the wetland within the watershed. Stabilization and erosion reduction is high for shoreline marshes and swamps.
	Climate regulation	Related to evaporation from open water and evapotranspiration from plants. Evaporation and evapotranspiration vary with wetland size and type. Increased evapotranspiration occurs with increased plant density in marshes.
Biochemical	Water quality treatment	A composite indicator of multiple wetland functions; may include nutrient and contaminant removal, and sediment and particulate removal (which see). Wetlands may improve water quality through biochemical and hydrological processes including water and root/vegetation interactions, flow through substrates, and oxidation.
	Nutrient transformation (cycling)	Transformation of N and P to various states. Nutrient transformation is related to suspended organic particulates, type, and abundance of plants (surface area), microbial action, and water retention. Nutrient transformation is high in wetlands with increased biomass, high in permanently flooded and saturated wetland such as fen, marsh, and swamp and moderate in seasonally saturated or temporarily flooded wetlands.
	Nutrient and organic matter export	Transportation of nutrients and organic matter into other wetlands and watercourses can be influenced by flow, biomass production and decomposition, bacteria and plant root interactions, and oxidation. Typically high in marshes.
	Carbon sequestration and storage	Carbon sequestration and storage is related to biomass production and decomposition. Typically highest in wetlands with high biomass production and low decomposition (bogs and fens). Generally high for permanently and seasonally flooded wetlands and low for temporarily flooded wetlands.

Functional Group	Function	Wetland Characteristics Affecting Function
	Sediment and particulate retention/removal	The amount of time water is retained can affect sediment settling), as can water movement, exposure to wind and waves (stirs up sediment and keeps it suspended), sediment size and amount entering wetland, and vegetation (density).
	Nutrient removal: Phosphorus	Adsorption* of P to sediment (see above); adsorption to clay; precipitation with calcium; uptake of dissolved P by plants (short-term removal unless plants are cut and removed from wetland).
	Nutrient removal: Nitrogen	Nitrogen removal is not related to wetland type. Ability of wetland to remove nitrogen can be related to seasonal inundation and saturation that facilitates aerobic and anaerobic processes (nitrification and denitrification).
	Pollutant removal (i.e., metals, toxins)	Pollutant removal can occur through sedimentation, adsorption, precipitation, oxidation, biodegradation, and plant uptake. The organic soils of bogs and fens can react with and adsorb* contaminants.
Habitat**	Provision of habitat for plants and animals	Wetland habitat increases with increasing horizontal and vertical structural complexity and heterogeneity, connections with other aquatic and terrestrial ecosystems, availability of nutrients, food, and water, and the microclimate. Habitat provision in wetlands is variable and site-specific and can be influenced by the presence of significant or sensitive species such as species at risk.

Notes:

*Adsorption refers to adhesion to the surface of solid bodies (The American Geological Institute, 1976).

**Habitat implies the environmental conditions required by groups of species (e.g., fish) and individual species. Wetland habitat function will be influenced by species richness (number of species) and commonness or rarity, locally, regionally, and provincially. A wetland community may have low species richness, but those species may be confined to narrow set of conditions under-represented in the landscape.

Environmental factors affecting wetland functions are outlined in **Table 3-2**. The factors affecting wetland ecological functions highlight the need to consider many different features of a wetland when determining functional capacity including site, landscape, and the variation in the efficiencies and contribution of functions over time, such as seasonal changes expected each year, and ecological changes and trajectories implied over the long term but not necessarily apparent at a particular point in time.

Wetland condition is an important consideration when assessing wetland function and value, but it may be overlooked because it is difficult to determine and stressors affecting condition can be difficult to detect (Guidugli-Cook, et al. 2017). A wetland may deteriorate without loss in wetland extent or change of wetland type (Dahl 2006, cited in Guidugli-Cook et al., 2017). Wetland deterioration will be expressed in the loss or impairment of one or multiple wetland ecological functions.

Table 3-2: Factors Affecting Wetland Ecological Functions (MacKenzie and Moran 2004; Granger et al. 2005; Hanson et al. 2008; NovaWet 2011).

Factor	Considerations in Determining Wetland Function
Hydroperiod	Is the wetland permanent, seasonal, or ephemeral?
Hydrodynamic condition (flows) of surface and groundwater	Are flows stagnant or slow moving or very dynamic or fast?
Hydrological connection: Connected or isolated	Is the wetland connected to other wetlands or watercourses or is it isolated hydrologically?
Characteristics of receiving water	Concentrations of nutrients (P, N), contaminants (toxic elements and compounds), suspended organic matter, suspended mineral particulates (sediment)
Physical and vegetation characteristics of wetland	What is the extent, shape, depth, water storage volume, and density of vegetation?
Characteristics of adjacent wetlands types in wetland complexes	What is the size, shape, and alignment and vegetation composition of adjacent wetland features such as marshes and shallow water, marsh and fen, or different marsh site associations?
Landscape position	Is the wetland on a slope, in a basin, on flats?
Characteristics of surrounding landscape (buffer)	What are the main physical and vegetation features surrounding the wetland, including the slope, soils, meadow, vegetation cover, etc.? What is the level and type of anthropogenic (human-caused) disturbance?
Watershed and catchment areas and characteristics; an area extending beyond the "buffer"	What is extent of the watershed or catchment and what are the main physical and vegetation features within them, including slope, soils, meadow, vegetation cover, etc.? What is the level and type of anthropogenic disturbance?
Proximity to anthropogenic disturbance	If present, what is the physical distance and time since disturbance?
Magnitude and extent of anthropogenic disturbance	Are the results of anthropogenic disturbance reversible or irreversible? What is the period over which they are considered reversible?
Presence of non-native, invasive plant species	What are the potential effects of the plant invasion? What is its extent and density? What are the characteristics of the species, including habitat specificity, tolerance of water, seed production, etc.?
Wetland condition	To be determined at a specific point in time when the wetland is assessed.

Sections 3.1 to **3.5** define the five major wetland types observed in the Terrestrial LSA and rank wetland functions based on estimates of a wetland type's capacity to perform the functions from literature and from baseline information gathered in the Terrestrial LSA (MacKenzie and Moran 2004; Granger et al. 2005; Hanson et al. 2008; NovaWet 2011; Dillon Consulting Limited, 2021). Ratings of "low", "moderate' and "high" indicate the functional capacity, or the level of performance of a particular function. For example, the capacity or "ability" of a wetland to store water may be low if the wetland is shallow and small, or high if the wetland is deep and extensive. "Nil", "variable" and "unknown" are also used, where applicable. Where necessary, two descriptors were combined to indicate a range of possible functions when the function cannot be related solely to conditions of the wetland type. Functions that perform

independently of wetland type are noted by the phrase, “not related to wetland type”. Since the capacity of a wetland to perform a function may vary between wetland types, within wetland types, and between wetlands of different locations, the functional indices indicate how wetland ecological functions for wetlands of a certain type are likely to perform, not how they will perform for a particular wetland.

3.1 Bog

A bog is a wetland of organic soils (peat) that receives no nutrients from groundwater and supports *Sphagnum* moss as its dominant vegetation (MacKenzie and Moran, 2004). Bogs typically have a pH less than five (Keddy, 2010). Vegetation in bogs grows very slowly and lacks diversity because of high acidity, prolonged saturation, and low temperature. *Sphagnum* moss is common in bogs and is usually associated with acidic and low nutrient conditions.

Hydrological

A bog is almost exclusively fed by precipitation (Government of Alberta, 2015) and develops where precipitation exceeds evapotranspiration over the year (Siegel, 1988). Recharge and discharge in bogs is low because most water is added through precipitation and lost through evapotranspiration (Siegel, 1988). The capacity of bogs to perform key hydrological functions:

Hydrological Function	Capacity to Perform Function
Water flow moderation/reduction in peak flows	Nil-low
Surface water detention	Moderate
Groundwater recharge	Low
Shoreline stabilization/erosion reduction	Low
Climate (local/micro scale) regulation	Low

Biochemical

Bogs are acidic, nutrient poor (MacKenzie and Moran, 2004) and low in dissolved minerals (Warner and Rubec, 1997). They are sensitive to changes in pH and nutrient concentrations (Siegel, 1988). The capacity of bogs to perform key biochemical functions:

Biochemical Functions	Capacity to Perform Function
Water quality treatment	High
Nutrient transformation (cycling)	Moderate
Nutrient and organic matter export	High
Carbon sequestration and storage	High
Sediment and particulate retention (i.e., prevent downstream movement)	Nil-Low
Nutrient removal (phosphorus)	Nil-Low
Nutrient removal (nitrogen)	Not related to wetland type
Pollutant removal (e.g., metals, toxins)	High

Habitat

Bogs are typically located in relatively flat areas (Siegel, 1988). They are dominated by *Sphagnum* moss and support specialized plants adapted to extreme conditions of low nutrients and high acidity (Government of Alberta, 2015). Plants grow slowly and species diversity is low (MacKenzie and Moran, 2004; Government of Alberta, 2015). The capacity of bogs to provide key habitat functions:

Habitat Functions	Capacity to Perform Function
Organisms, general (specialized and significant species; species at risk)	High
Invertebrates	Moderate-high
Fish	Nil
Amphibians	Low
Birds (water associated)	Low
Mammals	Low-moderate
Native plant species richness	Low-moderate
Rare/uncommon native plant species	Moderate-high
Rare/uncommon native plant community	Moderate-high
Non-native species richness	Low

3.2 Fen

A fen is a wetland of permanently saturated organic soils (peat) that typically support sedges, grasses, and brown mosses as its dominant vegetation (MacKenzie and Moran, 2004; Keddy, 2010).

Hydrological

Fens are permanently saturated wetlands (Government of Alberta, 2015) that have a fluctuating water table (Warner and Rubec, 1997) and receive water from a variety of sources (Government of Alberta, 2015) including nutrient enriched groundwater and precipitation (Siegel, 1988). The capacity of fens to perform key hydrological functions:

Hydrological Functions	Capacity to Perform Function
Water flow moderation/reduction in peak flows	Low-Moderate
Surface water detention	Moderate
Groundwater recharge	Low-Moderate
Shoreline stabilization/erosion reduction	Low
Climate (local/micro scale) regulation	Low-Moderate

Biochemical

Water in fens is generally rich in dissolved minerals (i.e., minerotrophic), concentrations of dissolved solutes and has a pH of 5 or greater (MacKenzie and Moran, 2004). Water chemistry can vary considerably between fen classes (Government of Alberta, 2015). The capacity of fens to perform key biochemical functions:

Biochemical Functions	Capacity to Perform Function
Water quality treatment	Moderate-High
Nutrient transformation (cycling)	High
Nutrient and organic matter export	Moderate-High
Carbon sequestration and storage	Moderate-High
Sediment and particulate retention (i.e., prevent downstream movement)	Low
Nutrient removal (phosphorus)	Low
Nutrient removal (nitrogen)	Not Related To Wetland Type
Pollutant removal (e.g., metals, toxins)	High

Habitat

Fens are peatlands that support a variety of plants including non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses (MacKenzie and Moran, 2004). They provide forage habitat for ungulates and habitat for small mammals and arthropods (MacKenzie and Moran, 2004). Birds, bats, and insects may benefit from openings in forest canopy typical of fens (MacKenzie and Moran, 2004). The capacity of fens to provide key habitat functions:

Habitat Functions	Capacity to Perform Function
Organisms, general (specialized and significant species; species at risk)	Moderate-High
Invertebrates	Moderate-High
Fish	Low
Amphibians	Moderate
Birds (water associated)	Low-Moderate
Mammals	Moderate-High
Native plant species richness	Moderate-High
Rare/uncommon native plant species	Moderate-High
Rare/uncommon native plant community	Moderate-High
Non-native species richness	Low

3.3 Marsh

A marsh is a mineral wetland of emergent grass-like plants (sedges, rushes, and grasses) that is seasonally or permanently flooded (MacKenzie and Moran, 2004). Typically, plant communities are dominated by one or two plant species (MacKenzie and Moran, 2004).

Hydrological

Marshes flood early each season and can remain flooded year-round; although many marshes experience significant drawdown by mid- to late- summer, exposing wetland bottom substrates (MacKenzie and Moran, 2004). Water levels fluctuate in response to flooding, evapotranspiration, groundwater recharge, or seepage (Warner and Rubec, 1997). Marshes generally have a variety of water sources that provide a complex groundwater and surface water interaction (Government of Alberta, 2015). The capacity of marshes to perform key hydrological functions:

Hydrological Functions	Capacity to Perform Function
Water flow moderation/reduction in peak flows	Low-High
Surface water detention	Moderate-High
Groundwater recharge	Low-Moderate
Shoreline stabilization/erosion reduction	Moderate-High
Climate (local/micro scale) regulation	Moderate-High

Biochemical

Marshes are generally rich in dissolved minerals (i.e., minerotrophic) and nutrients (i.e., eutrophic) which contributes to the high productivity (production of biomass) and decomposition rate (Warner and Rubec, 1997). Freshwater marshes tend to be alkaline due to increased dissolved minerals including calcium, potassium carbonate, or potassium bicarbonate (Warner and Rubec, 1997). The capacity of marshes to perform key biochemical functions:

Biochemical Functions	Capacity to Perform Function
Water quality treatment	High
Nutrient transformation (cycling)	High
Nutrient and organic matter export	Moderate-High
Carbon sequestration and storage	Low-Moderate
Sediment and particulate retention (i.e., prevent downstream movement)	High
Nutrient removal (phosphorus)	High
Nutrient removal (nitrogen)	Not Related To Wetland Type
Pollutant removal (e.g., metals, toxins)	Moderate-High

Habitat

Marshes are mineral wetlands dominated by grass-like (graminoid) plants including rushes, grasses and sedges, and other herbaceous species (Warner and Rubec, 1997). Marshes have less than 25% shrub and woody cover (Government of Alberta, 2015). In B.C., plant communities in marshes are typically comprised of one or two plant species (MacKenzie and Moran, 2004). Marshes are highly productive and heavily used by wildlife and provide ideal cover and forage habitat for waterfowl and amphibians (MacKenzie and Moran, 2004). The capacity of marshes to provide key habitat functions:

Habitat Functions	Capacity to Perform Function
Organisms, general (specialized and significant species; species at risk)	Moderate-high
Invertebrates	High
Fish	High moderate
Amphibians	High
Birds (water associated)	High
Mammals	Moderate-high
Native plant species richness	Low
Rare/uncommon native plant species	Low-moderate
Rare/uncommon native plant community	Moderate
Non-native species richness	Moderate

3.4 Swamp

A swamp is a wetland dominated by shrubs or trees rooted in mineral hydric soils (Keddy, 2010). Swamps are nutrient-medium to nutrient-rich with a well-developed herb-layer reflective of nutrient levels. Sedges are characteristic of nutrient-medium swamps, and ferns and forbs are characteristic of nutrient-rich swamps (MacKenzie and Moran, 2004). Swamps have high water tables and a varied microtopography of mounds supporting shrubs and trees unable to grow in the low areas of permanently or semi-permanently saturated soils.

Hydrological

Swamps generally receive water from groundwater rich in dissolved minerals (minerotrophic) (Warner and Rubec, 1997) and water levels fluctuate throughout the year (Government of Alberta, 2015). The capacity of swamps to perform key hydrological functions:

Hydrological Functions	Capacity to Perform Function
Water flow moderation/reduction in peak flows	Moderate-high
Surface water detention	Moderate-high
Groundwater recharge	Low
Shoreline stabilization/erosion reduction	Moderate-high
Climate (local/micro)) regulation	Moderate

Biochemical

Swamps are generally nutrient rich (Government of Alberta, 2015) with a well-developed herb-layer that reflects nutrient levels (MacKenzie and Moran, 2004): sedges are characteristic of nutrient-medium swamps, and ferns and forbs are characteristic of nutrient-rich swamps (MacKenzie and Moran, 2004). The capacity of swamps to perform key biochemical functions**:**

Biochemical Functions	Capacity to Perform Function
Water quality treatment	Moderate-high
Nutrient transformation (cycling)	High
Nutrient and organic matter export	Low-moderate
Carbon sequestration and storage	Low-moderate
Sediment and particulate retention (i.e., prevent downstream movement)	High
Nutrient removal (phosphorus)	High
Nutrient removal (nitrogen)	Not related to wetland type
Pollutant removal (i.e., metals, toxins)	Moderate-high

Habitat

Swamps are typically dominated by over 30% tree or tall shrubs (Warner and Rubec, 1997) and support sedges, ferns, and forbs in the herb-layer (MacKenzie and Moran, 2004). Swamps provide wildlife habitat for a variety of wildlife including birds, bears, and ungulates (MacKenzie and Moran, 2004). The capacity of swamps to provide key habitat functions:

Habitat Functions	Capacity to Perform Function
Organisms, general (specialized and significant species; species at risk)	Low-high (variable)
Invertebrates	Moderate
Fish	Low-moderate
Amphibians	Low-moderate
Birds (water associated)	Moderate-high
Mammals	Moderate-high
Native plant species richness	Moderate-high
Rare/uncommon native plant species	Moderate
Rare/uncommon native plant community	Moderate-high
Non-native species richness	Low

3.5 Shallow Water

Shallow water wetlands are permanently flooded wetlands supporting submerged or floating aquatic plants which may have grass-like plants with less than 10% cover (MacKenzie and Moran, 2004; MacKillop et al., 2018). Shallow water wetlands often occupy the edges of lakes. Water depth is usually between 0.5 m to 2 m but may be up to 5 m (MacKenzie and Moran, 2004; Keddy, 2010). They support simple plant communities influenced by water clarity and depth (MacKenzie and Moran, 2004).

Hydrological

Water in shallow water wetlands is still or slow-moving and usually between 0.5 m to 2 m deep (MacKenzie and Moran, 2004). They have seasonally stable water levels and consist of at least 75% open water (Warner and Rubec, 1997). Shallow water wetlands may be isolated or connected hydrologically with inflow and flow channels. The capacity of shallow water to perform key hydrological functions:

Hydrological Functions	Capacity to Perform Function
Water flow moderation/reduction in peak flows	Low-moderate
Surface water detention	Moderate-high
Groundwater recharge	Unknown
Shoreline stabilization/erosion reduction	Low
Climate (local/micro) regulation	Moderate

Biochemical

Water composition and chemistry will vary wildly between shallow water wetland types. Mineral, pH, and nutrient levels are heavily influenced by hydrology, geology, nutrient flux, and vegetation (Warner and Rubec, 1997). The capacity of shallow water to perform key biochemical functions:

Biochemical Functions	Capacity to Perform Function
Water quality treatment	Moderate-high
Nutrient transformation (cycling)	Moderate
Nutrient and organic matter export	Low
Carbon sequestration and storage	Low
Sediment and particulate retention (i.e., prevent downstream movement)	Moderate-high
Nutrient removal (phosphorus)	Moderate-high
Nutrient removal (nitrogen)	Not related to wetland type
Pollutant removal (i.e., metals, toxins)	Moderate-high

Habitat

Shallow water wetlands have an open water with 25% or more floating and submerged aquatic vegetation (Government of Alberta, 2015). They may support 10% or less cover of grass-like plants (e.g., sedges) (MacKenzie and Moran, 2004; MacKillop et al., 2018). The capacity of shallow water to provide key habitat functions**:**

Habitat Functions	Capacity to Perform Function
Organisms, general (specialized and significant species; species at risk)	Unknown/variable
Invertebrates	Moderate-high
Fish	Moderate-high
Amphibians	High
Birds (water associated)	Moderate
Mammals	High
Native plant species richness	Low
Rare/uncommon native plant species	Low-moderate
Rare/uncommon native plant community	Moderate
Non-native species richness	Moderate

4.0 Surveyed Wetlands in the Local Study Area

Thirty-six wetlands covering 39.23 ha were documented in the Terrestrial LSA (**Table 4-1**). Marshes and swamps cover the largest area of all wetland types, at 13.86 ha (35.33%) and 13.44 ha (34.26%) respectively. The remainder of the Terrestrial LSA is occupied by transitional/successional marsh-fen wetlands at 5.39 ha (13.74%), and shallow water wetlands at 3.74 ha (9.53%). Fens and bogs cover approximately 2.76 ha (7.04%) and 0.04 ha (0.10%), respectively. Non-wetland groups such as floodplains and transitional mineral wetlands documented within the Terrestrial LSA are not included in this functional assessment.

Most wetlands of the Terrestrial LSA occur in wetland complexes which further complicates classification and an assessment of wetland ecological functions. Factors that affect functions of one wetland community in a complex are likely to also affect the functions of the co-occurring wetland communities of that complex.

Table 4-1: Wetland Area by Wetland Class

Wetland Classification	Wetland Area	
	Wetland Area (ha)	Percentage of the Terrestrial LSA
Bog	0.04	0.10
Fen	2.76	7.04
Transitional/Successional Marsh-Fen	5.39	13.74
Marsh	13.86	35.33
Swamp	13.44	34.26
Shallow Water	3.74	9.53
Total	**39.23**	**100.00**

The two bogs occupied the smallest wetland area, 0.01 ha and 0.03 ha, fens covered 0.16 ha to 1.5 ha, marshes 0.01 ha to 2.56 ha, swamps 0.2 ha to 4.86 ha, and shallow water wetlands from 0.02 ha to 0.93 ha.

Wetland complexes, which comprise two or more wetland types or classes, are difficult to assess because of the increased potential interactions between the composite wetlands and inclusion of transition areas which can be difficult to discern and in which functions may perform differently than either of the adjoining wetlands. Twenty-two (22) of the 36 wetlands were wetland complexes. Eleven (11) wetland complexes comprised two wetland classes, six comprised three wetland classes and five comprised four wetland classes. Swamp and marsh made up the greatest area within wetland complexes, followed by the fen-marsh transitional wetland, fen and shallow water.

4.1 Watersheds and Catchment Areas

Four watersheds occur within the Terrestrial LSA and include Grave Creek and its tributaries; Harmer Creek and its tributaries; and Alexander Creek and its tributaries. Wetland catchment areas were determined as part of the baseline wetland ecosystems assessment (Dillon Consulting Limited, 2021) to distinguish the area within these watersheds and drainage systems that contribute surface water to specific wetlands, wetland complex, or group of wetlands.

Watershed function is controlled by processes within the wetland and the catchment and watershed in which they occur. The movement of water, sediment, nutrients, chemicals, woody debris and other elements into wetlands is influenced by the climate, geology, soils and hydrology of the watershed and catchment (Bedford, 1999, cited in Granger et al., 2005). Generally, wetlands with larger catchments are more greatly affected by storm water and flooding (U.S. Environmental Protection Agency, 2016).

The Elk River watershed (**Table 4-2**) is anticipated to have the greatest wetland area of the four watersheds surveyed as part of the baseline assessment and the Harmer Creek watershed is the only watershed in which marshes and swamps did not make up the greatest wetland areas.

Table 4-2: Wetland Classes per Watershed of the Project Local Study Area

Wetland Classification	Surveyed Watersheds							
	Alexander Creek Watershed		Harmer Creek Watershed		Grave Creek Watershed		Elk River Watershed	
	ha	%	ha	%	ha	%	ha	%
Bog	0.04	0.10	0	0.00	0	0.00	0	0.00
Fen	1.26	3.21	0	0.00	0	0.00	1.5	3.82
Fen/Marsh	0.07	0.18	0	0.00	0	0.00	5.32	13.56
Marsh	4.64	11.83	0.03	0.08	2.03	5.17	7.16	18.25
Swamp	3.98	10.15	0	0.00	1.14	2.91	8.32	21.21
Shallow Water	2.27	5.79	0.17	0.43	0.56	1.43	0.74	1.89
Total	**12.26**	**31.25**	**0.20**	**0.51**	**3.73**	**9.51**	**23.04**	**58.73**

Surveyed wetlands of the Terrestrial LSA have a total catchment area of 7,314.60 ha. Shallow water wetlands have the largest total catchment area, followed by marshes, swamps, the fen/marsh transitional wetland, fens, and bogs. The potential contribution of sediment, nutrients, chemicals, pollutants, woody debris, other organic matter, and floodwaters from the catchments is greatest for shallow water wetlands, marshes, and swamps, much less for fen/marsh transitional wetlands and fens and least for bog. The relative contribution of processes will vary between watersheds and catchments with different characteristics relating to geology, hydrology, soils, vegetation, slope, etc.

4.2 Biodiversity

The biodiversity in terrestrial and aquatic ecosystems are intimately connected (Penuluna et al., 2015). Forests surrounding wetlands influences, and is influenced by, wetland functions and processes. Undeveloped uplands are usually more important than wetlands for groundwater recharge (Adamus et al. 1991, cited in Granger et al. 2005). Many animals use both wetlands and forests periodically and seasonally. For some, the wetland and surrounding forest are critical to their survival (e.g., amphibians, beaver) while others show an affinity to wetland riparian forests (e.g., owls) and some use either wetlands, forests, or both for foraging during migration or the breeding season (e.g., birds, bats, bears, ungulates). Some species, especially those at higher trophic levels[1], may exert greater influence over the function of aquatic ecosystems than others, and their removal from human-created stressors in the aquatic, aquatic-forest interface, or the forest surrounding (buffer) will affect aquatic functions (Penuluna et al., 2015).

4.3 Water Flow and Storage

Wetlands with higher flow volumes tend to have greater water treatment capacity because they retain water, facilitate nitrogen and phosphorus transformation and adsorption, process organic waste, and removes suspended sediment (U.S. Environmental Protection Agency, 2016). These wetlands also have an increased capacity to transport organic material and nutrients downstream (Smith et al., 1995)

In general, wetlands with higher flows have greater functional capacities. **Table 4-3** lists wetlands based on in field estimates[2] of flow. Flows are labelled based on a hydrodynamic index for surface and groundwater, from no flow to high flow: stagnant (St), sluggish (Sl), mobile (Mo), dynamic (Dy), and very dynamic (Vd) (MacKenzie and Moran 2004). Flows in bogs and fens are stagnant to sluggish while in marshes, swamps, and shallow water they range from mobile to dynamic. Wetlands with greater surface water detention periods have greater biochemical functional capacities for removing nutrients, contaminants, sediment, and organic matter.

Data from surveyed wetlands in the Terrestrial LSA indicate 22.22 ha (56.64%) are permanent wetlands, 12.85 ha (32.74%) are seasonal wetlands, and 2.77 ha (7.05%) are ephemeral wetlands. Marsh and swamp contribute the greatest areas to permanent wetlands; swamp contributes the greatest area to seasonal wetlands, followed by marsh and the fen/marsh transitional wetlands; and swamp contributes the greatest area to ephemeral wetlands. Wetlands can help recharge groundwater aquifers (Brinson 1993) and maintain seasonal flows in rivers and streams (Smith et al., 1995).

[1] Trophic level – a level relating to food and energy in an ecosystem, with carnivores at the top, above primary consumers (i.e., herbivores) and producers (e.g., algae, plants) (Allaby, 2005).
[2] Estimates are based solely on a visual examination of slope, water, vegetation, and soils.

Table 4-3: Flow of Surveyed Wetland Classes in the Terrestrial LSA

Wetland Classification	Hydrodynamic Index of Water Flow*									
	St		Sl		Mo		Dy		Vd	
	ha	%	ha	%	ha	%	ha	%	ha	%
Bog	0.03	0.08	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Fen	0.00	0.00	2.76	7.04	0.00	0.00	0.00	0.00	0.00	0.00
Fen/Marsh	2.05	5.23	2.10	5.35	1.24	3.16	0.00	0.00	0.00	0.00
Marsh	1.33	3.39	5.42	13.82	5.57	14.20	1.54	3.93	0.00	0.00
Swamp	1.14	2.91	7.11	18.12	4.43	11.29	0.76	1.96	0.00	0.00
Shallow Water	0.57	1.44	0.54	1.36	1.20	3.06	1.44	3.67	0.00	0.00
Total	**5.12**	**13.04**	**17.94**	**45.72**	**12.44**	**31.71**	**3.74**	**9.53**	**0.00**	**0.00**

***Refers to:** St – stagnant; Sl – sluggish; Mo – mobile; Dy – dynamic; Vd – very dynamic

Table 4-4: Hydroperiod of Surveyed Wetland Classes in the Terrestrial LSA

Wetland Classification	Hydroperiod							
	Ephemeral		Seasonal		Permanent		Unknown	
	ha	%	ha	%	ha	%	ha	%
Bog	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.10
Fen	0.00	0.00	0.75	1.91	0.75	1.91	1.26	3.21
Fen/Marsh	0.62	1.58	3.76	9.57	1.02	2.59	0.00	0.00
Marsh	0.66	1.68	3.19	8.12	9.92	25.27	0.10	0.25
Swamp	1.49	3.79	4.54	11.56	7.42	18.91	0.00	0.00
Shallow Water	0.00	0.00	0.62	1.58	3.12	7.95	0.00	0.00
Total	**2.77**	**7.05**	**12.85**	**32.74**	**22.22**	**56.64**	**1.40**	**3.57**

4.4 Plants and Plant Communities of Conservation Concern

The B.C. Wetland Classification System (MacKenzie and Moran, 2004) presents classifications for wetlands in B.C. that are assigned conservation status ranks by the B.C. Conservation Data Centre (BCCDC). Red-listed wetlands are considered extirpated, endangered, or threatened. Blue-listed wetlands are of special concern, meaning they are sensitive to human activities and natural events and could become Red-listed with the introduction or persistence of threats. Additionally, some plants and plant communities may be rare or uncommon locally (i.e., in the Terrestrial LSA), regionally (i.e., in the East Kootenay), and provincially (i.e., in B.C.) but not assigned a status by the B.C. CDC, possibly because of lack of occurrence information for the element or taxonomic uncertainty. Examples in the Terrestrial LSA include the aquatic moss *Drepanocladus longifolius*, found in WL11.1 and WL16 and considered of least risk or being lost in B.C.; however, only from a few collections in B.C. The bogs of WL3 and WL5.1, which are considered uncommon communities in the east Kootenay, have not been assigned a conservation status by the BCCDC (MacKillop et al., 2008; BCDCD, 2021; Beaty, 2021).

The provision of habitat for organisms is a wetland function (Granger et al., 2005; Hanson et al., 2008; and NovaWet, 2011). Important considerations in ranking habitat function for wetlands includes the number of native species present (species richness) and the conservation status of the species present; that is, whether it is Red-listed, Blue-listed or locally, regionally, or provincially uncommon.

No Red- or Blue-listed (henceforth, "listed") plants or ecological communities were documented in wetlands of the Project footprint but were found in wetlands in the Terrestrial LSA. The provincially Blue-listed wetland moss *Scorpidium cossonii*, typical of rich fens, is a major component of WL3 and is not expected to be impacted as a result of the Project. A few specimens of the liverwort *Moercki flotoviana* were also found at WL3. *Moercki flotoviana* is has not been assigned a conservation rank by the BCCDC (BCCDC, 2021) and is currently known only from a few collections in B.C. (Beaty, 2021). Blue-listed wetland ecological communities were present in 13 wetlands of the Terrestrial LSA. They occupy 10.5 ha, or approximately 27 percent of the total wetland area of the Terrestrial LSA (39.23 ha[3]) (**Table 4-5**). One Red-listed wetland plant community was documented in the Terrestrial LSA, a marsh community in WL14 (**Table 4-5**). Two Red-listed non-wetland ecological communities, the alkaline/saline transitional meadow-wetland communities Ga02$ and Ga03$, were also present in WL14.

Table 4-5: Area of Red- and Blue-Listed Wetland Communities

Wetland Classification	Provincial Conservation Status Ranking			
	Red-listed		Blue-Listed	
	ha	%	ha	%
Bog	0.00	0.00	0.00	0.00
Fen	0.00	0.00	0.59	1.51
Fen/Marsh	0.00	0.00	0.00	0.00
Marsh	0.55	1.40	2.07	5.27
Swamp	0.00	0.00	7.80	19.88
Shallow Water	0.00	0.00	0.00	0.00
Total	**0.55**	**1.40**	**10.46**	**26.65**

4.5 Animals of Conservation Concern

Many animals were observed in or near wetlands (**Section 4.2**) but no provincially-listed obligate wetland species were among them. Western toad (*Anaxyrus boreas*) is not listed provincially but is listed federally and considered of special concern by COSEWIC (BCCDC, 2021). Western toads have been recorded at 12 different wetlands in the Terrestrial LSA. One adult was observed at WL8.2, a wetland located within the Project footprint.

[3] This excludes areas for non-wetland groups, floodplain and transitional mineral associations, which were included in the Wetland Ecosystem Baseline Report (Dillon Consulting Limited, 2021). The two Alkaline/Saline transitional meadows are Red-listed and total 0.92 ha.

4.6 Anthropogenic Influences

Several wetlands within the Terrestrial LSA have previous anthropogenic disturbance, which in general, reduces the functionality of a wetland. Anthropogenic disturbances can result in changes to the biochemical, hydrological, and ecological functions of a wetland (Maryland Department of the Environment, 2020). Wetlands with previous anthropogenic disturbance may have lower functional capacities compared to non-disturbed wetlands in the Terrestrial LSA but differences will vary with function, type of wetland, the magnitude of disturbance and time since disturbance.

Within the Terrestrial LSA, 41.60% of wetlands are anticipated to have undergone previous existing anthropogenic disturbance. Impairment of functional capacities, based on discernable evidence of anthropogenic disturbance, are, in order of decreasing impairment, swamps, fen/marsh transition wetlands, marshes, shallow water, and fens (**Table 4-6**).

Table 4-6: Wetland Anthropogenic Disturbance by Wetland Class

Wetland Classification	Anthropogenic Influences*			
	Yes		No	
	Ha	%	ha	%
Bog	0.00	0.00	0.04	0.10
Fen	1.50	3.82	1.26	3.21
Fen/Marsh	4.15	10.58	1.24	3.16
Marsh	2.40	6.12	11.46	29.21
Swamp	6.24	15.91	7.20	18.35
Shallow Water	2.03	5.17	1.71	4.36
Total	**16.32**	**41.60**	**22.91**	**58.40**

*The total area of a wetland is included regardless of the portion affected by anthropogenic disturbance.

American beaver (*Castor canadensis*) activity was present in many wetlands of the Terrestrial LSA and can be consider natural, or non-anthropogenic disturbance. Beaver activity can affect wetland functions hydrological, biochemical and habitat functions by:

- Providing water storage during dry conditions and minimize and mitigate flooding and erosion by the storage and slow release of water (Government of Canada, 2019);
- Increasing water detention and reduce sediments, nutrients, and contaminants; and
- Creating habitat for plants and animals.

Beaver activity was observed in 21.87% of wetlands in the Terrestrial LSA, covering approximately 8.5 ha. Beaver activity in the Terrestrial LSA was noted in marshes (3.99 ha), swamps (2.30 ha), and shallow water wetlands (2.29 ha). A breakdown of beaver activity by wetland class is presented in **Table** 4-7**.**

Table 4-7: Wetland Beaver Activity by Wetland Class

Wetland Classification	Beaver Activity			
	Yes		No	
	Ha	%	ha	%
Bog	0.00	0.00	0.04	0.10
Fen	0.00	0.00	2.76	7.04
Fen/Marsh	0.00	0.00	5.39	13.74
Marsh	3.99	10.17	9.87	25.16
Swamp	2.30	5.86	11.14	28.40
Shallow Water	2.29	5.84	1.45	3.70
Total	**8.58**	**21.87**	**30.65**	**78.13**

* The total area of a wetland is included if any portion of the wetland had evidence of beaver activity. That, is, if beaver activity was evident in any portion of the wetland, the whole wetland was included.

5.0 Wetland Functions of Surveyed Wetlands in the Project Footprint

A total of four wetlands occur within the Project footprint, wetlands WL7, WL8.1, WL8.2 and WL8.3, have the potential to be directly impacted by Project development. Wetlands WL8.1, WL8.2 and WL8.3 are located along the same watercourse in a small drainage basin at the source of West Alexander Creek. Wetland WL7 is a small marsh in a near-flat area of an herbaceous meadow on a steep avalanche path. Details on each wetland, and wetland functions supported by each wetland, within the Project footprint are provided in **Sections 5.1** to **5.4**.

5.1 Wetland 7: Wetland Ecological Functions Assessment

Wetland WL7 is a small marsh in a near-flat area of an extensive herbaceous meadow on a steep avalanche path. The functional capacity of WL7 is variable due in part to its small size, plant species composition, deep, humic peat, and its position in a topographically flat area near the toe of a steep slope and avalanche path. Although classified as Wm01 (Beaked sedge - Water sedge marsh), based on the predominance of water sedge, other plants typical of the surrounding herbaceous meadows, were also present, creating a plant community not observed elsewhere in Terrestrial LSA. The thick peat underlying the wetland suggests a fen, but its composition, uniformly fine and humic (von Post 7-8), confirms marsh, and on that basis, the Wm01 association was assigned. WL7 is the highest surveyed wetland at 2,089 m asl and the only wetland surveyed in the ESSFdkw.

Table 5-1: WL7 Key Characteristics from the Wetland Ecosystems Baseline Assessment

BEC	ESSFdkw
Wetland Class (B.C.)	Wm01 Beaked sedge - Water sedge (*Carex utriculata - Carex aquatilis*)
Elevation (masl)	2,089
Surface Area (m^2)	1,012
Hydroperiod	Unknown, not flooded: likely permanently saturated at depth with seasonal fluctuations facilitating decomposition
Groundwater and Surface Water Flow	Stagnant to sluggish
Soil (depth to mineral [cm])	>40 cm (fine: humic)

Table 5-2: WL7 Wetland Ecological Functions Analysis

Functions Category: Marsh	Capacity to Perform Function	Explanation
Hydrologic		
Water flow moderation/reduction in peak flows	Low-moderate	Small wetland with potential to impede flow down slope due to dense vegetation, change in levelness (less slope than surrounding area), and well-developed peat layer in the soil
Surface water detention	Low	Little surface water at the time of wetland field survey. Saturated soils and wetland may be flooded in early spring
Groundwater recharge	Low	Hydrological conductivity of underlying soils is presumed low based on thick peat layer and lack of water mass or head above it
Shoreline stabilization/erosion reduction	Low	Wetland may impede downslope flow and seepage rates over a small area; most flow is groundwater flow
Climate (local/micro) regulation	Low	Evapotranspiration effects presumed similar to those of the surrounding herbaceous community
Biochemical		
Water quality treatment	Moderate-high	Considerable potential to filter and remove particulates and nutrients
Nutrient transformation (cycling)	Moderate-high	Large biomass and fluctuating soil moisture (oxidation)
Nutrient and organic matter export	Moderate	Low flows (mostly groundwater), dense vegetation and thick peat suggest downslope nutrient transport but little organic matter export
Carbon sequestration and storage	High	Small area but significant (fen-like) peat accumulation
Sediment and particulate retention (i.e., prevent downstream movement)	Moderate	Reduced velocity and vegetative obstruction
Nutrient removal (phosphorus)	Low	Uptake in vegetation; little available sedimentation
Nutrient removal (nitrogen)	Low	Potential in the soil upper layers with alternating saturation (anaerobic) and drying (aerobic) processes; small area
Pollutant removal (e.g., metals, toxins)	Low-moderate	Potential uptake in vegetation; alternating saturation and drying (oxidation)

Functions Category: Marsh	Capacity to Perform Function	Explanation
Habitat		
Organisms, general (specialized and significant species; species at risk)	Low	Dominated by one plant species and very low structural and floristic diversity; the density of vegetation and accumulation of organic matter may provide habitat for invertebrates
Invertebrates	Low-moderate	Unknown, potential for species associated with the unique assemblage of plants and organic soil
Fish	Nil	No pooled water
Amphibians	Low	No pooled water, fluctuating groundwater levels, cold
Birds (water associated)	Low	Small area, no pooled water; short vegetative cover
Mammals	Low	May provide foraging habitat for small mammals
Native plant species richness	Moderate	Water sedge interspersed with meadow herbs
Rare/uncommon native plant species	Low	None observed
Rare/uncommon native plant community	Moderate-high	Plant community uncommon for areas surveyed of the Terrestrial LSA
Non-native species richness	Low	None observed

5.2 Wetland 8.1: Wetland Ecological Functions Assessment

WL8.1 is a small, ephemeral marsh in the lower slope of a large meadow that drains into the shallow water wetland, WL8.2. Wetland WL8.1 wetland is filled periodically during rainfall events during the growing season. The small size and potential water storage volumes of WL8.1 limits the overall functional capacity of the wetland in the landscape (low-moderate); however, the functional capacity of the wetland, particularly for hydrological, biochemical and the provision of habitat for plants with high habitat specificity, could be moderate to high. The presence of an olive-sided flycatcher (Blue-listed and listed as Threatened on Schedule 1 of SARA) during breeding season in trees at the edge the meadow clearing emphasizes the importance of vegetation surrounding wetlands.

Table 5-3: WL8.1 Key Characteristics from the Wetland Ecosystems Baseline Assessment

BEC	ESSFdk1
Wetland Class (B.C.)	Wm16 Bluejoint - Arrow-leaved groundsel (*Calamagrostis canadensis - Senecio triangularis*)
Elevation (masl)	1,877
Surface Area (m²)	377
Hydroperiod	Seasonal, ephemeral
Groundwater and Surface Water Flow	Sluggish
Soil (depth to mineral [cm])	0
BEC	ESSFdk1

The wetland functions analysis in **Table 5-4** are estimates based on values provided in **Section 3.3**, with adjustments to reflect the specific attributes of WL8.1 gathered from site visits.

Table 5-4: WL8.1 Wetland Ecological Functions Analysis

Functions Category: Marsh	Capacity to Perform Function	Explanation
Hydrologic		
Water flow moderation/reduction in peak flows	Low-moderate	Small size with some effect on outflow creek
Surface water detention	Low-moderate	Small size and storage volume
Groundwater recharge	Moderate	Hydrological conductivity of underlying soils presumed moderate but limited area of influence
Shoreline stabilization/erosion reduction	Low	Low volume and flows entering wetland. Wetland has shallow and gradual slopes
Climate (local/micro) regulation	Low	Saturation and cooling of immediate area and downslope channel; small area of influence
Biochemical		
Water quality treatment	Low	Moderate; however, the overall effect is limited by area and volume
Nutrient transformation (cycling)	Low	Potential is limited by area and volume
Nutrient and organic matter export	Low	Potential is limited by area and volume
Carbon sequestration and storage	Low	No organic substrate
Sediment and particulate retention (i.e., prevent downstream movement)	Low-moderate	Potential is limited by area and volume

Functions Category: Marsh	Capacity to Perform Function	Explanation
Nutrient removal (phosphorus)	Low-moderate	Potential is limited by area and volume
Nutrient removal (nitrogen)	Low-moderate	Potential is limited by area and volume
Pollutant removal (e.g., metals, toxins)	Low-moderate	Potential is limited by area and volume
Habitat		
Organisms, general (specialized and significant species; species at risk)	Low-moderate	Low species richness but uncommon composition
Invertebrates	Low-moderate	Unknown; however, habitat possibly limited by frequent dry periods
Fish	Nil	Cannot support fish
Amphibians	Moderate	May contribute early season and periodic living habitat and food downstream
Birds (water associated)	Low	Small wetland with sparse vegetation and low structural diversity; Olive-sided Flycatcher (Blue-listed) recorded at clearing near northern edge of wetland
Mammals	Low	Small wetland with sparse vegetation and low structural diversity
Native plant species richness	Low	Few species present
Rare/uncommon native plant species	Low-moderate	Not observed, but could support specialized species suited to ephemeral wetlands rare in the landscape
Rare/uncommon native plant community	High	Plant community documented at wetland and nowhere else in Terrestrial LSA
Non-native species richness	Low	Not noted but the potential is high because of the wetland's location in a large open field

5.3 Wetland 8.2: Wetland Ecological Functions Assessment

WL8.2 is a large shallow water wetland in a depression between steep slopes at the headwaters of West Alexander Creek. The functional capacity of WL8.2 is low to moderate. The landscape position, shaded and sheltered at base of steep slopes, altitude, and basin topography with a lack of shallows, likely limit many wetland functions and reduce the potential for biomass production. The high storage volume, however, may increase functional capacity for some biochemical functions, especially with input of sedimentation.

Floating and emergent vegetation was not evident during field surveys but there was evidence of dense, unidentified algae during one visit. As noted in the Wetland Ecosystem Baseline Report (Dillon Consulting Limited, 2021), the classification of this wetland is uncertain. The deeper, interior, and west portion of the wetland could be open water with other peripheral areas representing shallow water. A narrow band of sedge marsh (beaked sedge and water sedge) occupies the east edge and becomes more extensive along in the north edge. It is treated here as a shallow water wetland, but the uncertainty suggests open water (lake) may form a portion.

Table 5-5: WL8.2 Key Characteristics from the Wetland Ecosystems Baseline Assessment

BEC	ESSFdk1
Wetland Class (B.C.)	Ww Pondweed (Ww *Potamogeton* sp.)
Elevation (masl)	1,873
Surface Area (m^2)	5,182
Hydroperiod	Permanent
Groundwater and Surface Water Flow	Stagnant to sluggish
Soil (depth to mineral [cm])	Unknown; presumed shallow

Table 5-6: WL8.2 Wetland Ecological Functions Analysis

Functions Category: Shallow Water	Capacity to Perform Function	Explanation
Hydrologic		
Water flow moderation/reduction in peak flows	Moderate	Large area and storage volume but constrained by steep slopes
Surface water detention	Moderate	Large area and storage volume but constrained by steep slopes
Groundwater recharge	Low	Underlying soils presumed to have poor hydrological conductivity based on adjacent geology (i.e., steep, rocky slopes)
Shoreline stabilization/erosion reduction	Low	Little emergent vegetation, no floating vegetation, and few submerged macrophytes
Climate (local/micro) regulation	Moderate	Evaporation from the large surface will affect temperature
Biochemical		
Water quality treatment	Moderate	High potential based on water volume storage moderated by low biomass and potentially low temperatures
Nutrient transformation (cycling)	Low-moderate	Will vary with sedimentation
Nutrient and organic matter export	Low	Low input and production of biomass; low nutrient production and throughput
Carbon sequestration and storage	Low	Low production of biomass

Functions Category: Shallow Water	Capacity to Perform Function	Explanation
Sediment and particulate retention (i.e., prevent downstream movement)	Moderate-high	Large storage volume and long potential storage time
Nutrient removal (phosphorus)	Moderate	Few plants for uptake but moderate potential related to sedimentation
Nutrient removal (nitrogen)	Low	Little area of drawdown and alternating aerobic/anaerobic processes
Pollutant removal (e.g., metals, toxins)	Low-moderate	Will depend on sedimentation
Habitat		
Organisms, general (specialized and significant species; species at risk)	Low	Some water-associated birds; invertebrates presumed
Invertebrates	Moderate	Presumed moderate from landscape position and temperature
Fish	Low	No fish documented; however, may have habitat potential based on connectivity to West Alexander Creek
Amphibians	Moderate-high	Western toad observed along shoreline near outflow (WL8.3); temperature and productivity may be prohibitive to other species
Birds (water associated)	Low	Spotted Sandpiper and Hooded Merganser observed
Mammals	Low	Few shallows and presumed low productivity
Native plant species richness	Low	Low diversity and extent
Rare/uncommon native plant species	Low	None observed; low productivity and no distinctive features
Rare/uncommon native plant community	Low	None observed; low productivity and no distinctive features
Non-native species richness	Low	None observed

5.4 Wetland 8.3: Wetland Ecological Functions Assessment

WL8.3 is a small sedge marsh at the outflow and south end of WL8.2 comprising a predominance of beaked sedge. The deposition of organic matter (peat layer) is substantial (20 cm). The functional capacity of WL8.2 is estimated to be low to moderate with a tendency towards moderate because, despite its small size, it appears to be efficient at performing multiple functions. WL8.3 filters organic matter, nutrients, contaminants, and sediment and reduces WL8.2 outflow water velocity. It lacks plant diversity and has limited habitat potential for animals although it may be used for forage and cover by the western toad observed nearby.

Table 5-7: WL8.2 Key Characteristics from the Wetland Ecosystems Baseline Assessment

BEC	ESSFdk1
Wetland Class (B.C.)	Wm01 Beaked sedge - Water sedge (*Carex utriculata - Carex aquatilis)*
Elevation (masl)	1,873
Surface Area (m^2)	316
Hydroperiod	Seasonal / Permanent
Groundwater and Surface Water Flow	Sluggish (could range from sluggish to mobile during freshet or high precipitation events)
Soil (depth to mineral [cm])	20 cm

Table 5-8: WL8.3 Wetland Ecological Functions Analysis

Functions Category: Marsh	Capacity to Perform Function	Explanation
Hydrologic		
Water flow moderation/reduction in peak flows	Low-moderate	Small sized wetland with dense sedges that could reduce outflow velocity
Surface water detention	Low-moderate	Small size and storage capacity
Groundwater recharge	Low-moderate	Hydrological conductivity of underlying soils presumed low to moderate based on thick peat layer; small size.
Shoreline stabilization/erosion reduction	Moderate	Dense sedge reduces outlet erosion
Climate (local/micro) regulation	Low	Small area of influence and under the influence of climatic effects of WL8.2.
Biochemical		
Water quality treatment	Moderate	Considerable potential to filter and remove particulates and nutrients
Nutrient transformation (cycling)	Low-moderate	Positively affected by vegetation but drawdown effects and aeration may be limited
Nutrient and organic matter export	Low-moderate	Traps and retains organic contributions from WL8.2; however, potential for export biomass from sedges
Carbon sequestration and storage	Low-moderate	Small area but significant peat accumulation
Sediment and particulate retention (i.e., prevent downstream movement)	Moderate	Reduced velocity and vegetative obstruction
Nutrient removal (phosphorus)	Low-moderate	Potential uptake in sedges and adsorption from sediment
Nutrient removal (nitrogen)	Low	Limited by frequency of drawdown

Functions Category: Marsh	Capacity to Perform Function	Explanation
Pollutant removal (e.g., metals, toxins)	Low-moderate	Potential uptake in sedge and adsorption from sediment
Habitat		
Organisms, general (specialized and significant species; species at risk)	Low	Dominated by one plant species but density of vegetation and accumulation of organic matter suggests productive invertebrate habitat
Invertebrates	Low-moderate	Unknown; however, potential increase by dense vegetation and accumulated organic matter
Fish	Nil-low	No fish observed. Wetland with shallow and variable flows that could contribute foraging habitat or downstream nutrients
Amphibians	Moderate	Provides potential forage and cover habitat
Birds (water associated)	Low	Small area reduces potential
Mammals	Low	Unlikely to sustain small mammals; possible cover and foraging habitat
Native plant species richness	Low	One dominant species, beaked sedge
Rare/uncommon native plant species	Low-moderate	None observed; however, potential at wetland edge
Rare/uncommon native plant community	Nil-low	None observed
Non-native species richness	Low	None observed

6.0 Conclusion

A total of four wetlands occur within the Project footprint, WL7, WL8.1, WL8.2 and WL8.3, which have the potential to be directly affected by Project development. The capacity of a wetland to perform certain functions is related to site-specific factors that vary between wetland classes. Key functional capacities, those rated as moderate to high, of wetlands WL7, WL8.1, WL8.2, and WL8.3 are summarized in **Table 6-1**. The understanding of key wetland functions provided by wetlands that may be impacted by the proposed Project will help guide wetland restoration as the functional assessment documents what functions will be lost with the removal of the four wetlands and what functions need to be established through wetland restoration to attain no net loss. Additionally, functional information of impacted wetlands identifies appropriate targets during the process of reclamation as wetlands develop, possibly along unforeseen trajectories, or when "stitching" wetlands together in a wetland complex.

There are no known or anticipated adverse effects from the Project on the 32 wetlands outside the Project footprint. Wetland ecosystems and the supported wetland functions outside of the Project footprint, such as those downstream of the Project in Alexander Creek, are not anticipated to experiences changes to surface water quality or quantity as they are not connected to Alexander Creek (i.e., wetlands occur upstream of Alexander Creek tributaries).

Table 6-1: Key Wetland Function of Wetlands within the Project Footprint

Wetland Site ID	Wetland Function	Capacity to Perform Function	Description
WL7	Water quality treatment	Moderate-high	Considerable potential to filter and remove particulates and nutrients
	Nutrient transformation (cycling)	Moderate-high	Large biomass and fluctuating soil moisture (oxidation)
	Nutrient and organic matter export	Moderate	Low flows (mostly groundwater), dense vegetation and thick peat suggest downslope nutrient transport but little organic matter export
	Carbon sequestration and storage	High	Small area but significant (fen-like) peat accumulation
	Sediment and particulate retention (i.e., prevent downstream movement)	Moderate	Reduced velocity and vegetative obstruction
	Native plant species richness	Moderate	Water sedge interspersed with meadow herbs
	Rare/uncommon native community	Moderate-high	Community encountered nowhere else in the Terrestrial LSA
WL8.1	Groundwater recharge	Moderate	Hydrological conductivity of underlying soils presumed moderate but limited area of influence

Wetland Site ID	Wetland Function	Capacity to Perform Function	Description
	Amphibians	Moderate	Wetland contribute early season and periodic living habitat and food downstream
WL8.2	Water flow moderation/reduction in peak flows (flood protection)	Moderate	Large area and storage volume but constrained by steep slopes
	Surface water detention	Moderate	Large area and storage volume but constrained by steep slopes
	Climate (local) regulation	Moderate	Evaporation from the large surface will affect temperature
	Water quality treatment	Moderate	High potential based on water volume storage moderated by low biomass and possibly, low temperatures
	Sediment and particulate retention (i.e., prevent downstream movement)	Moderate-high	Large storage volume and long potential storage time
	Nutrient removal (phosphorus)	Moderate	Few plants for uptake but moderate potential related to sedimentation
	Invertebrates	Moderate	Presumed moderate from landscape position and temperature
	Fish	Moderate-high	Has the potential to support fish based on connectivity to West Alexander Creek
	Amphibians	Moderate-high	Western toad observed along shoreline near outflow; temperature and productivity may be prohibitive to other species
WL8.3	Shoreline stabilization/erosion reduction	Moderate	Dense sedge reduces outlet erosion
	Water quality treatment	Moderate	Considerable potential to filter and remove particulates and nutrients
	Sediment and particulate retention (i.e., prevent downstream movement)	Moderate	Reduced velocity and vegetative obstruction
	Amphibians	Moderate	Provides good potential forage and cover habitat (the western toad attributed to WL8.2 was found near WL8.3

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