5.0 Existing Environment

5.1 OVERVIEW OF PROJECT AREA

The Study Corridor and Proposed RoW are located within the Central Lowlands Ecodistrict, as identified by NSDNR's Ecological Land Classification (Neily *et al.* 2003). This ecodistrict is located within the Valley & Central Lowlands Ecoregion which is relatively warm during the summer, has winter temperatures which average - 4.5^{o}C, and a mean annual precipitation of 1100 - 1300 mm. The climate is conducive to farming and the region has been extensively used for dairy and beef production as well as for growing forage and cereal crops (Neily *et al*. 2003). The Central Lowlands Ecodistrict has a hummocky to undulating topography and elevations which seldom exceed 90 m above sea level (Neily *et al*. 2003). Most of the area within the Study Corridor itself is also low-lying and may be characterized as having a flat to rolling topography except for where the Stewiacke River bisects its northern half and provides a sloping river valley (NSDNR 2006).

Fine textured soils comprised of loams, silts and clays, and derived from underlying Carboniferous rock, dominate the Central Lowlands Ecodistrict. Drainage has been restricted on most of the soils due to glacial compaction (Neily *et al*. 2003). Within the Study Corridor itself, surficial geology is primarily characterized as silty till plain (ground moraine) but alluvial deposits are present along the Stewiacke River (NSDNR 2006). Bedrock geology is of Scotch Village Formation (Cumberland Group) within the southern half of the Study Corridor and of Watering Brook Formation (Mabou Group) within the north. However, the most northerly area of the Study Corridor is underlain by Murphy Road, Pesaquid and Green Oaks Formations of the Windsor Group (NSDNR 2000).

Forests of the Central Lowlands Ecodistrict are predominantly softwood, with only a few well-drained hills having pure stands of tolerant hardwoods (Neily *et al*. 2003). Yellow birch will grow in association with red spruce on the well-drained hummocks and there is an occasional occurrence of American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*) and eastern hemlock (*Tsuga canadensis*) within the ecodistrict. Red spruce (*Picea rubens*) with scattered eastern white pine (*Pinus strobus*) and hemlock has been associated with the better drained sites, with the latter species being found predominantly on steeper slopes near streams and rivers (Neily *et al*. 2003). Forests of black spruce (*Picea mariana*) and scattered white pine are typically found on the imperfectly drained soils and white pine is also known to be associated with the coarser soils derived from the glacial outwash till. Wildfires are considered to have been a dominant natural disturbance process in the ecoregion, but fire suppression since European settlement has reduced this influence on the landscape (Neily *et al*. 2003).

Forestry activity is prominent within the region and most of the area within the Study Corridor reflects this ongoing legacy. Much of the forested area has recently been subject to clear cutting activities or is currently in an early regenerative state following past disturbance and are dominated by early successional trees such as white and gray birch (*Betula papyrifera* and *B. populifolia*, respectively). Otherwise, immature mixedwood stands (generally < 70 years old) dominate the area with lesser amounts of relatively mature mixedwood stands also being present, such as at the most northerly end of the corridor, and in its southern section. Mixedwood stands are predominantly comprised of red spruce, balsam fir (*Abies balsamea*), paper birch and red maple (*Acer rubrum*), although some white ash (*Fraxinus americana*) and yellow birch (*Betula alleghaniensis*) are also present in those that are relatively mature. Along the slope leading down to the Stewiacke River are stands of mature eastern hemlock. The forest within this area also contains other late-successional and shade-tolerant species, including red spruce, sugar maple, and yellow birch. Reflecting the prominence of forestry activities within the area, woods roads are common throughout the Study Corridor and provide habitat for a diversity of ruderal species (*i.e.*, those that are successful in colonizing disturbed habitats but are generally poor competitors with other plants given successional development).

Riparian habitats are present within the Study Corridor along the banks of the Stewiacke River and in association with other watercourses found in the area. Most of the watercourses are of small streams (approximately 1 m in width) and have a muddy substrate and banks formed by the surrounding till. A watercourse in the southern end of the corridor is relatively wide (approximately 3-4 m in width), but shallow.

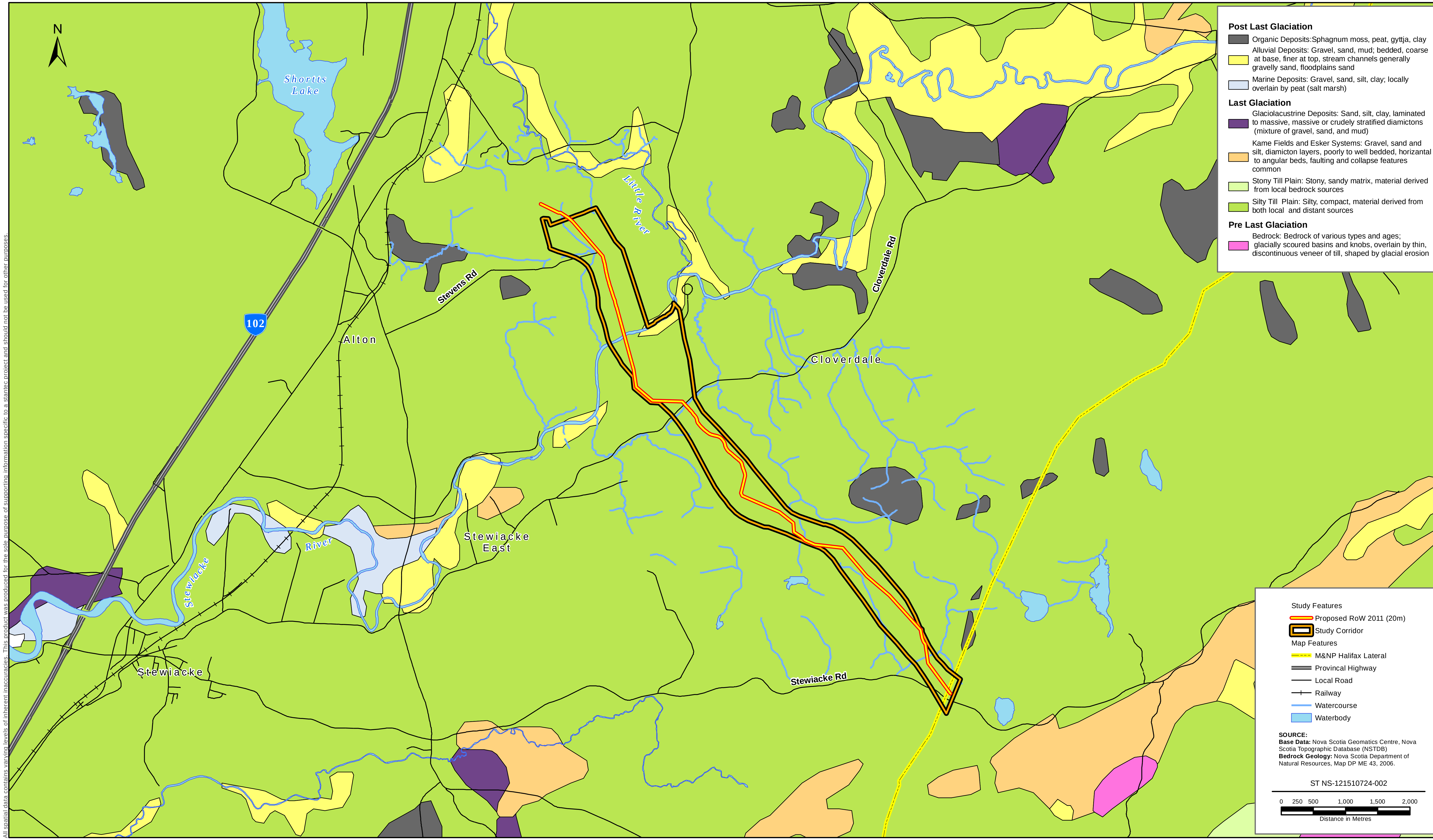
Wetland is prominent throughout the Study Corridor and primarily comprised of treed swamp; although low and tall shrub swamp, fresh marsh, and wet meadow habitats are also present. Treed swamps include those dominated by coniferous, deciduous, and mixed tree content, as well as those that have been recently cut-over by forest management initiatives. Prominent tree species within the swamp habitats include black spruce, red maple, balsam fir, and lesser amounts of American Larch (*Larix laricina*). Speckled alder (*Alnus incana*) is the dominant shrub within most wetlands but other species such as white meadowsweet (*Spiraea alba*) are also prominent in some. A variety of graminoids and forbs are also present and are the dominant growth forms in the freshwater marsh and wet meadow habitat types.

5.2 GEOPHYSICAL ENVIRONMENT

5.2.1 Surficial Geology

Based on surficial geology mapping for the area (Stea *et al.*, 1992), surficial soils along the pipeline corridor (refer to Figure 5.1) consist of silty till plain deposits derived during the last glaciation, as well as alluvial deposits in areas along the Stewiacke River. The till plain deposits are generally silty and compact. Mapping by Stea *et al*. (1992) suggests that the thickness of the till ranges from 2 m to 25 m. The variation of till thickness along the proposed pipeline corridor is unknown; however, based on water well records within 2 km of the pipeline (NSE Well Log Records 9.1 m to 38.7 m of till was encountered overlying bedrock (average 23.5 m).

The alluvial deposits are anticipated to be primarily gravel and sand, becoming coarser with depth and ranging in thickness from < 1 m to as much as 20 m. The thickness of any alluvial deposits present along the Stewiacke River within the proposed pipeline corridor is unknown.



PREPARED BY: M. Huskins-Shupe	ALTON NATURAL GAS PIPELINE PROJECT	FIGURE NO.: 5.1
REVIEWED BY: K. Fraiser		DATE: Dec 13, 2011
CLIENT: alton	**Surficial Geology**	Stantec

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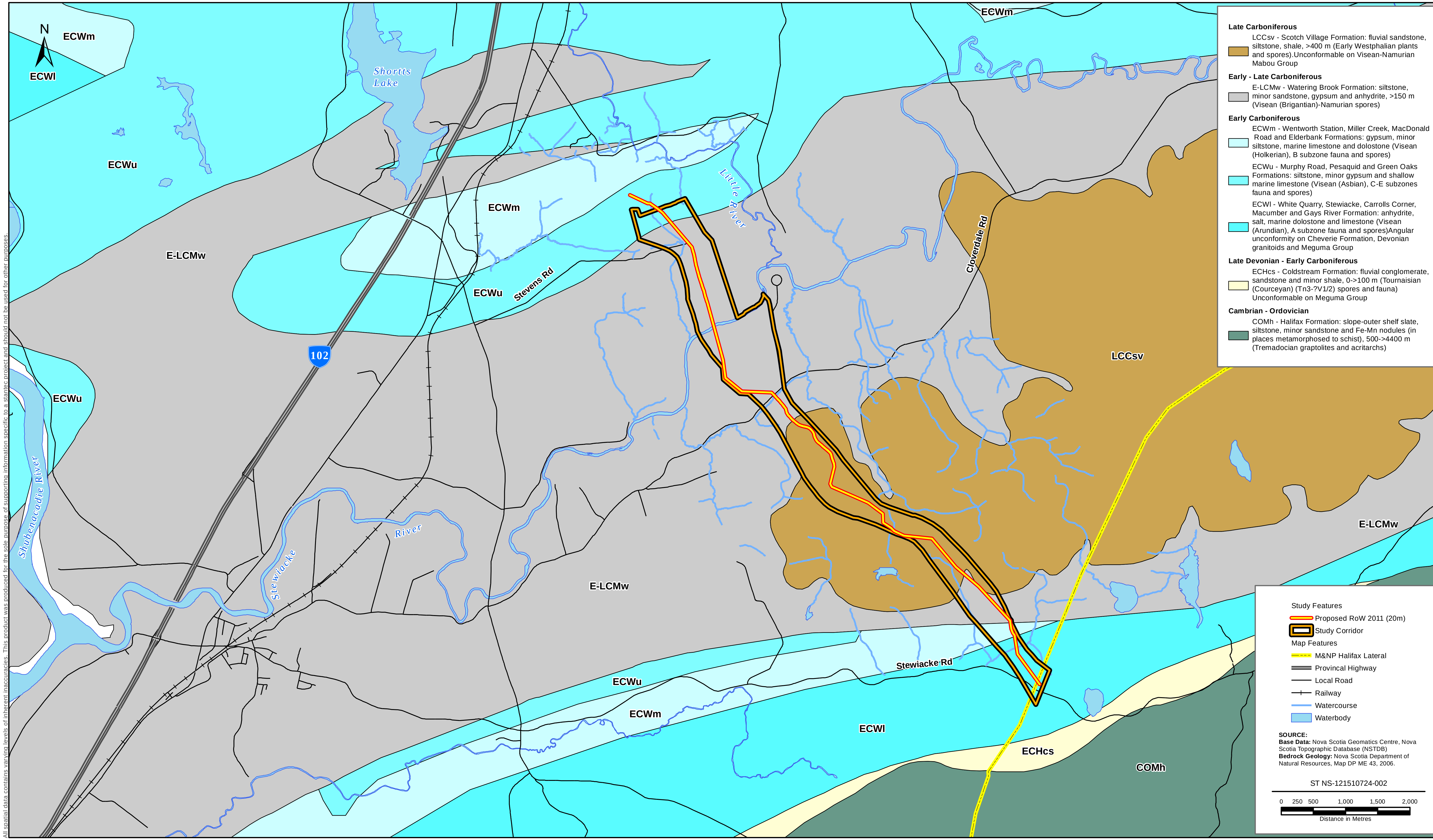

PREPARED BY: M. Huskins-Shupe

REVIEWED BY: K. Fraiser

CLIENT: alton

ALTON NATURAL GAS PIPELINE PROJECT

Bedrock Geology

FIGURE NO.: 5.2

DATE: Dec 13, 2011

Stantec

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5.2.2 Bedrock Geology

Bedrock geology information is based on available mapping by Keppie (2000). The proposed pipeline corridor is underlain by the following bedrock units (refer to Figure 5.2):

- Carboniferous-aged Lower Windsor Group, consisting of anhydrite, salt, marine dolostone and limestone (at the southern tip of the proposed pipeline corridor);
- Carboniferous-aged Middle Windsor Group, consisting of gypsum, minor siltstone, limestone and dolostone (underlying a portion of the southern end of the proposed pipeline corridor);
- Carboniferous-aged Scotch Village Formation of the Cumberland Group, consisting of siltstone and shale (underlying approximately 1/3 of the pipeline corridor on the southern side);
- Carboniferous-aged Watering Brook Formation of the Mabou Group, consisting of siltstone, minor sandstone, gypsum and anhydrite (underlying majority of the pipeline corridor, and primarily on the north side); and,
- Carboniferous aged Upper Windsor Group, consisting of siltstone, minor gypsum and limestone (underlying the northernmost portion of the Study Corridor).

5.2.3 Hydrogeology and Groundwater Resources

A desktop evaluation to determine the presence of potential water wells within approximately 500 m of the proposed natural gas pipeline was completed using the most recent aerial photography (*i.e.*, 2009) and the most recent topographic mapping (*i.e.*, 1997). During the assessment, water supplies were assumed to be located on properties with one or more structures present. It was determined that there is one well located within 500 m of the pipeline. No ground truthing of the desktop study was completed and therefore the actual number of water wells is unknown, but is not expected to be significant.

Overburden Aquifers

Overburden (surficial) aquifers along the pipeline route consist mainly of glacial till, more specifically poorly permeable silt tills deposited over the Carboniferous, Windsor bedrock terrain. These deposits typically provide yields of around 1.0 to 4.5 Lpm to dug wells ranging in depth from 3 to 10 m. Localized areas of saturated sand and gravel may provide significantly higher yields. Quality is generally suitable for potable uses; however, some wells in till over the Windsor terrain may yield moderate to hard water quality.

Bedrock Aquifers

According to the Nova Scotia Well Log Database of logs for wells constructed between 1940 and 2004, drilled wells in the vicinity of the Project are generally installed in sedimentary bedrock. This is corroborated by Nova Scotia bedrock geologic mapping which indicates that the Project is underlain by bedrock of both the Mabou and Windsor Groups which are both composed of sedimentary units (Keppie 2000). A summary of the pertinent well properties included in these logs is presented in Table 5.1.

TABLE 5.1 Summary of Water Well Records in the Vicinity of the Project

	Well Depth (m)	Casing Length (m)	Estimated Yield (L/min)	Water Level (m)	Overburden Thickness (m)
Minimum	11.9	10.4	9.5	4.3	9.1
Maximum	74.1	57.2	114	18.9	38.7
Average	43.9	32.6	37.2	8.7	24.1
Median	41.8	31.9	30.4	6.4	27.1
Number	8	8	7	5	8

Source: Nova Scotia Environment (NSE). 1940-2004. Well Driller Logs.

Groundwater quality from Mabou Group bedrock can be expected to be of good chemical quality with a tendency toward hardness. Iron and manganese concentrations in excess of relative aesthetic guidelines are found in approximately half of all wells located in Mabou Group bedrock (Gibb and McMullin 1980).

As the pipeline route does not cross any areas underlain by Halifax Formation slates, acid drainage is not considered to be a risk for this pipeline route.

Within the Windsor Group bedrock, the most expected concerns are high hardness levels, sulphate, total dissolved solids (TDS) and iron (Chang 1970). Aesthetic drinking water guidelines for sulphate, TDS and iron are 500 mg/L, 500 mg/L and 0.3 mg/L, respectively. Although there is no guideline for hardness, levels between 80 and 100 mg/L are considered acceptable, levels greater than 200 mg/L are considered to be poor but tolerable, and those in excess of 500 mg/L are considered to be unacceptable (Health Canada 2006).

In addition to the above naturally-occurring water quality issues, common problems reported by Nova Scotia well owners include: elevated sodium and chloride from road salt; coliform bacteria from surface sources impacting poorly constructed dug and drilled wells; and low pH and/or associate plumbing corrosion in shallow wells constructed in sand aquifers or fractured crystalline bedrock.

Locations of Water Wells

Based on the desk top review and NSE Water Well records, there appears to only be one well within 500 m of the pipeline. This well (No. 002352) is in the community of Lanesville, and is located near the south end of the pipeline route in the Windsor Group (Lower) bedrock. Two other wells (No. 002614 and 002627) are located between 500 m and 1,000 m from the pipeline. These wells are near the centre of the pipeline route, in the community of Cloverdale, along Cloverdale Road, in the Mabou Group (Watering Brook Formation) bedrock.

5.2.4 Sinkholes and Slope Stability

This section addresses geological issues related to potential effects on pipeline stability and integrity including sinkholes and slope stability.

Sinkholes

Sinkholes are cone- or funnel-shaped depressions that occur in loose surface materials where they cover thick beds of limestone, gypsum, or anhydrite, and develop from the collapse of underground caverns formed in the bedrock. Their occurrence is a potential geological hazard, particularly where structures rest on or near the surface.

The Study Corridor is underlain by sedimentary rocks of Carboniferous age and older metamorphic ("basement") rocks of lower Paleozoic age. The area has also been glaciated, leaving glacial deposits of variable thickness. The Paleozoic basement rocks are quartzites and slates of the Meguma Formation, which comprise much of the terrain of southern Nova Scotia.

The lowermost Carboniferous rocks which lie on top of the basement rocks are sandstones and conglomerates of the Horton Group. The Horton Group rocks are themselves overlain by thin to thick beds of carbonate (limestone, dolomite), gypsum, anhydrite, and halite (salt) of the Windsor Group. These Windsor Group rocks typically develop sinkholes of various sizes. The Proposed RoW cannot practically avoid crossing the Windsor Group bedrock, which runs in bands across most of the central section of the province and study area.

Sinkhole development generally increases with human activities such as mining and road and utility installation. For this reason, the Proposed RoW has been selected to avoid mining areas where dewatering and alteration of groundwater occurs.

Slope Stability

Unstable slopes could affect the integrity of the pipeline if a slope failure were to occur. Generally, this is not deemed to be a problem within the proposed route as steep slopes (*i.e.*, greater than 15% gradient) have generally been avoided and field reconnaissance to determine the potential for instability did not indicate concerns. The only location within the Proposed RoW that approaches 15% is at the approaches to the Stewiacke River. Preconstruction, construction, and post-construction safety factors should be calculated using conventional geotechnical methods of analysis.

The effects of sinkholes and slope stability on the integrity of the Project, if any, are expected to be manageable through further study, avoidance routing, and mitigation.

5.3 FISH AND FISH HABITAT

The Fish and Fish Habitat section summarizes the results of aquatic field surveys conducted by Stantec aquatic ecologists along the proposed gas line corridor linking the Alton Gas storage site and the M&NE Halifax Lateral (see Figures 5.3A and 5.3B). This work was undertaken primarily to provide baseline information for the EA. In particular, the surveys were intended to identify fish habitats within the Proposed RoW and locate watercourse crossings that may require federal or provincial authorization. The habitat assessment information was also used to support future evaluation of design options or crossing structures and mitigative measures to avoid harmful effects to fish habitat and reduce or avoid navigation restrictions.

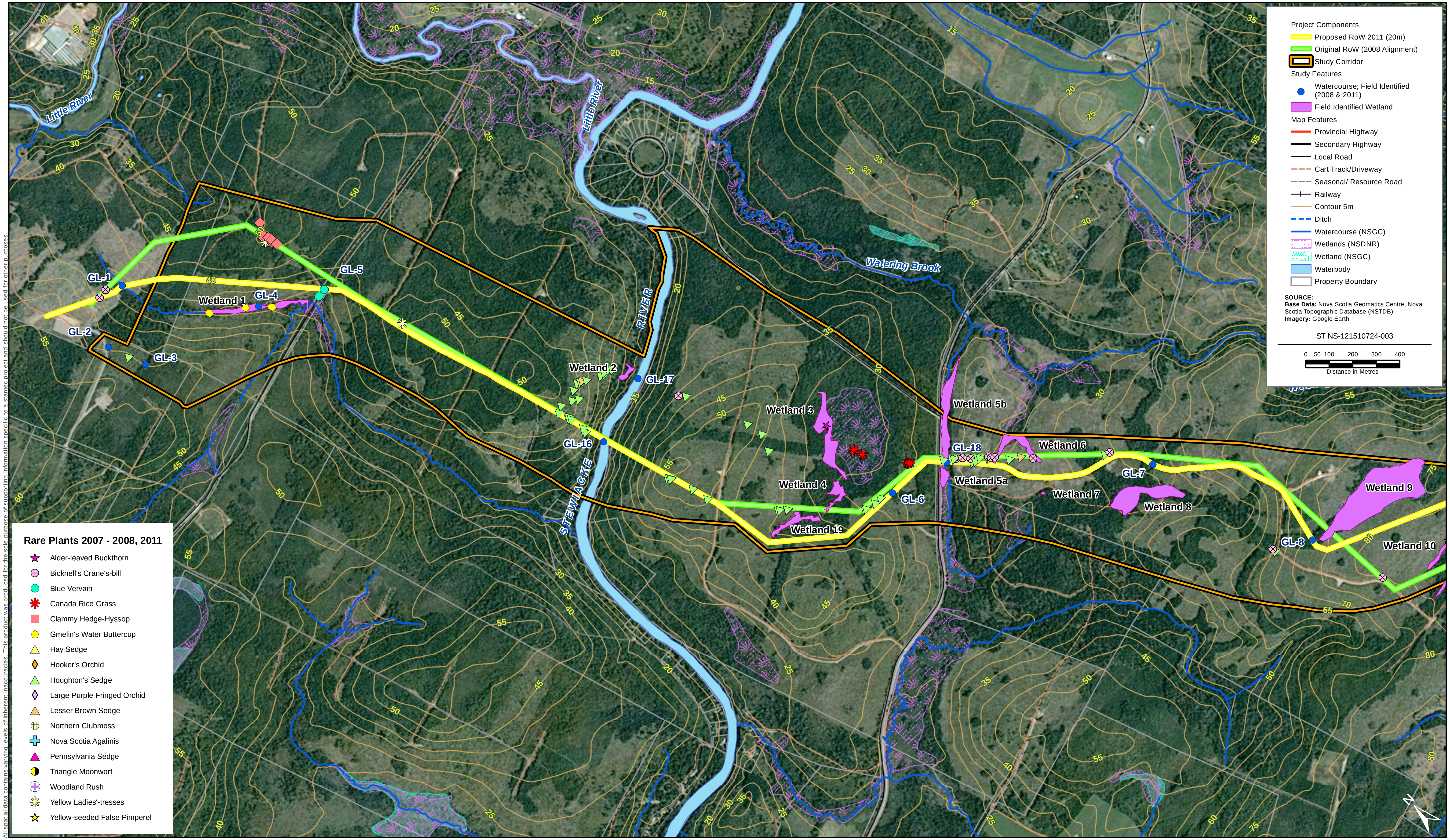
Watercourses were identified through a review of existing 1:10,000 scale maps and field observations taken by the surveyors marking the proposed gas line centerline. From the review of these sources, eight watercourses and five drainage channels were identified within the currently proposed RoW (2011 alignment). An additional seven watercourses were identified in the 2008 RoW which has been superseded (Figures 5.3A and 5.3B).

To provide baseline data of existing conditions, field assessments were conducted by aquatic scientists from July 8 - 28, 2008 and November 17, 2011. During these surveys eight watercourses were identified and five drainage channels observed within the proposed RoW. Additional watercourses were identified in the 2008 RoW alignment during the field assessments; however only the watercourses to be crossed by the currently proposed RoW route will be discussed in this assessment. Detailed habitat assessments were completed for all watercourses observed within the 100 m habitat assessment zone upstream and a 100 m habitat assessment zone downstream of the proposed pipeline corridor.

The detailed habitat assessments employed internal Stantec sampling protocol. The sampling protocol used is based on multiple existing protocols including the Environment Canada CABIN protocol (Canadian Aquatic Biomonitoring Network; Reynoldson *et al*. 2007), the Ontario Benthos Biomonitoring Network (OBBN) protocol (Jones *et al.* 2005), and the modified New Brunswick Department of Natural Resources (NBDNR) and Fisheries and Oceans Stream Assessment Protocol (Hooper *et al*. 1995). The stream assessment included the identification of physical units (*i.e.*, run, riffle, or pool), designation of substrate type, and description of the riparian zone. The presence or absence of macrophytes, algae, over-head cover, and woody debris was also recorded since all of these habitat features affect the ability of the watercourse to support fish communities. The depth and width (wetted and bankfull) of streams and rivers were recorded as well.

One *in-situ* water quality sample was taken within each identified watercourse. The water quality measurement was taken within 10 m of the downstream end of the pipeline route centerline. The flow state at the time of the water quality sampling was also recorded. Measurements were collected using a handheld water quality meter (Yellow Springs International (YSI) 556 MPS unit) and included dissolved oxygen, pH, water temperature and specific conductivity.

Based on the potential presence of *SARA* species within the Study Corridor (Inner Bay of Fundy population of Atlantic salmon), an electrofishing survey was not conducted. Given this, special consideration of potential habitats for *SARA* species found within the Study Corridor were noted.



All spatial data contains varying levels of inherent inaccuracies. This product was produced for the sole purpose of supporting information specific to a stantec project and should not be used for other purposes.

PREPARED BY: M. Huskins-Shupe	ALTON NATURAL GAS PIPELINE PROJECT	FIGURE NO.: 5.3 A
REVIEWED BY: K. Fraser	**Watercourses, Wetlands and Distribution of Plant Species of Conservation Concern Encountered During Field Surveys**	DATE: Dec 13, 2011
CLIENT:		Stantec

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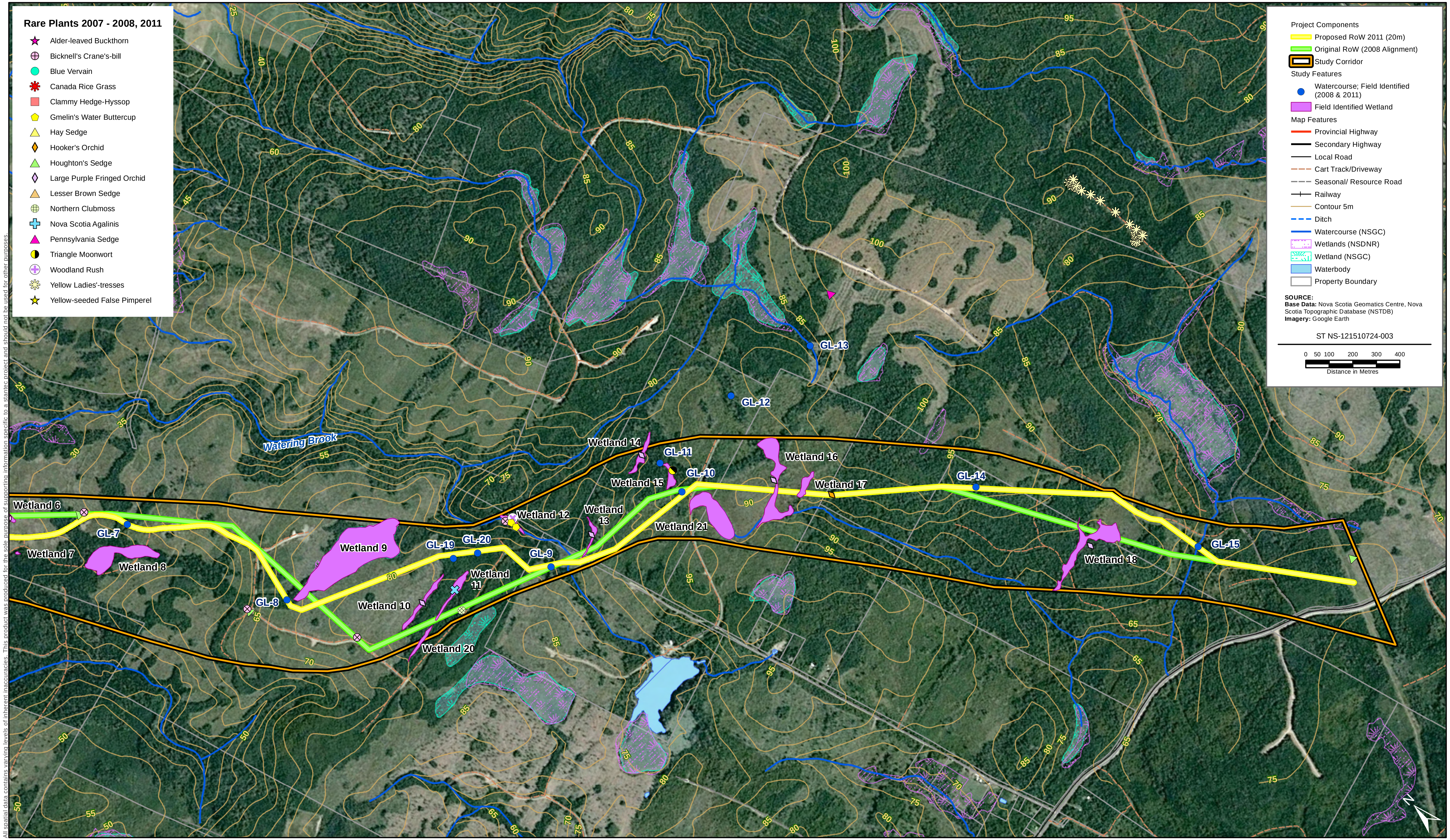

All spatial data contains varying levels of inherent inaccuracies. This product was produced for the sole purpose of supporting information specific to a stantec project and should not be used for other purposes.

PREPARED BY: M. Huskins-Shupe	ALTON NATURAL GAS PIPELINE PROJECT	FIGURE NO.: 5.3 B
REVIEWED BY: K. Fraser	**Watercourses, Wetlands and Distribution of Plant Species of Conservation Concern Encountered During Field Surveys**	DATE: Dec 13, 2011
CLIENT:		Stantec

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Between 2008 and 2011, the proposed pipeline route went through multiple iterations. Upon finalization of the preferred pipeline route in late 2011 the mapping was reviewed to determine if the new crossing locations fell within the 200 m section of habitat previously assessed in 2008. The following Table 5.2 displays the 2008 and 2011 crossing coordinates with a brief description of where the 2011 crossing location is located in relation to those assessed in 2008. Those crossing locations which are not crossed by the current proposed pipeline route will not be discussed within Section 5.3.2 (Fish and Fish Habitat).

TABLE 5.2 Comparison of 2008 and 2011 Crossing Locations

	2008 Route		2011 Route		Relation of 2011 Route to 2008 Route
	Easting	Northing	Easting	Northing	
GL-1	479085	5005345	479103	5005301	Approx. 50 m DS
GL-2	478877	5005157	Not crossed with current alignment		-
GL-3	478937	5004995	Not crossed with current alignment		-
GL-4	479451	5004829	Not crossed with current alignment		-
GL-5	479759	5004696	479700	5004680	Same Location
GL-6	480779	5002390	480791	5002369	Approx. 50 m DS
GL-7	481732	5001668	481658	5001674	Approx. 75 m DS
GL-8	481930	5000950	481910	5000968	Approx. 100 m DS
GL-9	482800	5000275	482800	5000275	Same Location
GL-10	483418	5000122	483418	5000108	Approx. 25 m US
GL-11	483439	5000260	Not crossed with current alignment		-
GL-12	483854	5000250	Not crossed with current alignment		-
GL-13	484241	5000162	Not crossed with current alignment		-
GL-14	484285	4999207	484315	4999240	Approx. 50 m US
GL-15	484770	4998370	484802	4998396	Approx. 100 m US
GL-16	480079	5003387	480079	5003388	Same Location
GL-17	480370	5003475	Not crossed with current alignment		-
GL-18	-	-	481095	5002363	Assessed in 2011
GL-19	-	-	482622	5000536	Assessed in 2011
GL-20	-	-	482533	5000594	Assessed in 2011

Species at Risk

There are two freshwater fish species and one mussel species in Nova Scotia with special conservation status as designated by *SARA*:

- Atlantic whitefish (*Coregonus huntsmani*) – Endangered;
- Atlantic salmon [Inner Bay of Fundy (iBoF) population] (*Salmo salar*) – Endangered and;

- Yellow lampmussel (*Lampsilis cariosa*) – Special Concern.

Of these species the iBoF population of Atlantic Salmon has the potential to inhabit watercourses within the Study Corridor.

Atlantic Salmon

The Inner Bay of Fundy Atlantic salmon is anadromous meaning they spawn in fresh water, but spends much of its life at sea. Inland, this fish favours natural stream channels with rapids, pools and gravelly bottoms in which hatchlings can hide from predators. The fish prefer cool water that is free from chemical and organic pollution, and that maintains temperatures between 15°C and 25°C in summer. When living in the Bay of Fundy itself, these salmon prefer relatively stable water temperatures—between 1°C and 13°C year round (COSEWIC 2006a) with a preference around 8°C. Recent studies on sea surface temperatures show how limiting the marine environment is for iBoF salmon (COSEWIC 2006a).

Spawning in October or November begins the Atlantic salmon lifecycle as the pea-sized orange eggs are fertilized in riverbeds. Two to six years after hatching as freshwater fish, they adapt to saltwater life and head out to sea. Within the iBoF about 93% of the fish return to spawn after one winter at sea, the majority of these one sea-winter fish are females (73%) (COSEWIC 2006a).

IBoF Salmon runs that totaled 30,000 to 40,000 in the mid 1980s declined to less than 500 in 1998. In 2003, fewer than 100 adults are estimated to have returned to the 32 rivers known to historically provide habitat (COSEWIC 2006a). In fact, juvenile salmon have not recently been detected in nearly half of this fish's historic spawning grounds.

A growing body of evidence suggests that the rapid decline in numbers of iBoF salmon is due to low marine survival rather than an inability to spawn and live successfully in freshwater rivers and streams. The reasons for the salmon's low marine-survival rates are not fully known, but may be due to ecological changes in freshwater habitat by forestry, agriculture and road development. Tidal barriers such as dykes, dams and causeways placed at the mouths of rivers and streams may also be a factor, as might commercial salmon farms, which can attract predators, alter habitat, obstruct migration and harbour disease. Illegal fishing of wild salmon remains a problem. While access to spawning and rearing habitat declined over the past two hundred years, it does not correspond with the collapse over the previous couple decades (COSEWIC 2006a).

The iBoF salmon has been listed as endangered under *SARA* since June 2003. A recovery strategy that includes identification of their critical habitat has been developed (DFO 2010).

5.3.1 Species of Conservation Concern

There are two species designated as under consideration by COSEWIC while not currently afforded the additional protection of a *SARA* designation there is potential in the future for the following two species to receive that designation:

- American Eel – (*Anguilla rostrata*) – Under Consideration; and
- Striped Bass [Inner Bay of Fundy Population or iBoF] (*Marone saxatilis*) - Under Consideration.

American Eel

The American Eel has a wide distribution on the western side of the Atlantic Ocean from Venezuela to Greenland and Iceland, including the Sargasso Sea (southern North Atlantic). Its native Canadian range includes all fresh water, estuaries and coastal marine waters that are accessible to the Atlantic Ocean, from Niagara Falls in the Great Lakes up to the mid- Labrador coast.

A catadromous species American Eels spawn in the Sargasso Sea and eggs hatch within roughly one week. The larvae (leptocephali) are passively, but widely, dispersed by surface currents of the Gulf Stream system to western shores of the Atlantic Ocean. When larvae reach 55 to 65 mm long, they metamorphose into ‘glass eels’, a post-larval stage characterized by a lack of pigment. As they approach coastal estuaries, they become pigmented or ‘elvers’. This stage lasts 3 to 12 months during which they may migrate up rivers or remain in brackish or salt waters eventually becoming ‘yellow eels’ (DFO 2010). The yellow stage marks the growth phase where the skin thickens and sexual differentiation occurs. Between 8 and 23 years are required to become ‘silver eels’, at which time they are physically and physiologically adapted to migrate the thousands of km back to their spawning grounds (COSEWIC 2006b).

The American Eel is faced with a number of threats. Climate change may be causing a deviation of the Gulf Stream system to the north, which could interfere with larval transport to coastal areas. Dams and other barriers result in habitat loss and fragmentation and contribute to reduced or delayed recruitment. Turbines may also contribute to increased mortality or injury of downstream migrants depending on turbine design and eel size. Biological (exotic species, parasites) and chemical contaminants, and commercial fishing are threats in some regions (COSEWIC 2006b).

Striped Bass

There is historical evidence of striped bass spawning in five Atlantic Canadian rivers: the St. Lawrence Estuary, the Miramichi River in the southern Gulf of St. Lawrence, and the Saint John, Annapolis and Shubenacadie rivers, which drain into the Bay of Fundy. Striped bass still spawn in the Miramichi (southern Gulf) and Shubenacadie (Bay of Fundy) rivers (COSEWIC 2004). The Bay of Fundy is also frequented by striped bass that breed in rivers in the United States.

The Shubenacadie River today supports a relatively stable population of striped bass with spawning occurring in the Stewiacke River, a tributary of the Shubenacadie. Indirect abundance indices from a recreational fishery indicate a decline occurred between 1950 and 1975. Early estimates from more recent tagging programs and surveys suggest the population has stabilized (COSEWIC 2004). Members of the population migrate to Grand Lake in winter where there is potential for them to be illegally taken in the ice fishery for smelt (DFO 2010).

Historically, three rivers draining into the Bay of Fundy supported striped bass spawning populations, but repeated spawning failures led to the disappearance of the Annapolis and Saint John River populations. These disappearances are thought to be due to changes in the water's flow, and a degrading water quality. In the Shubenacadie River population, the only remaining spawning population in the Bay of Fundy, the presence of the introduced chain pickerel in overwintering sites may constitute a threat in addition to bycatch from various commercial fisheries (DFO 2010).

Populations declined from 50,000 to < 4,000 individuals between 1995 and 2000. More recently the population has increased to 29,000 estimated in a 2002 study with the Shubenacadie population totaled between 18,000 and 27,000. At least 15,000 individuals were of reproductive age (COSEWIC 2004). A 2011 study conducted by the Nova Scotia Agricultural College (NSAC) and the proponent estimated that 24,000 spawning females were present. This study gathered data over the past three years and indicated four major annual spawning events. Total egg production for the 2011 season was around 22 billion based solely on eggs in the main channel. Eggs were distributed as far as 10 km upstream from the Alton site and 18 km out into the Cobequid Bay.

Increasing water temperatures in the spring trigger the movement of striped bass inland to their spawning grounds in fresh or slightly brackish waters. Spawning (which can last up to 3 to 4 weeks for large spawning aggregations) tends to take place at twilight when temperatures rise above 10° C. Eggs are suspended in the water column for 2 to 3 days before hatching. Larvae require an abundant supply of zooplankton to survive. Striped bass remain at the larval stage for one to two months before they undergo a metamorphosis to their juvenile form at which point they are approximately 20 mm long (DFO 2010).

Young-of-the-year move downstream over the summer where they continue to feed and grow in estuaries and coastal bays. Older fish migrate along the coast in search of prey, which includes small fishes such as juvenile herring, smelt and tomcod. In the fall, Canadian populations of striped bass move back upstream where they overwinter in brackish or fresh water, likely to avoid low ocean temperatures.

Males reach maturity sooner than females at roughly 3 years of age. Females mature at anywhere from 4 to 6 years of age. Adults are repeat spawners, with females producing between 50,000 and 1.5 million eggs.

Provincial Fish Species of Conservation Concern

There is one species of freshwater fish listed under the Nova Scotia *Endangered Species Act*. That species is the Atlantic whitefish, which is also listed under *SARA*. Given that Atlantic whitefish are not known to inhabit the watershed associated with this Project, their listing under the *Endangered Species Act* did not affect the assessment.

Fish species anticipated to be found within the Study Corridor have also been given various at-risk designations provincially. These include Atlantic salmon, brook trout (*Salvelinus fontinalis*), Gasperau (*Alosa pseudoharengus*) and striped bass. Atlantic salmon and striped bass are listed by the Nova Scotia Department of Natural Resources (NSDNR) as “Red”, indicating that they are known to be or thought to be at risk. Atlantic Canada Conservation Data Centre (ACCDC) considers striped bass to be globally widespread and abundant but locally extremely rare and may be especially vulnerable to extirpation. ACCDC considers Atlantic salmon to be globally widespread and abundant but locally rare with the potential to be vulnerable to extirpation due to rarity or other factors. Salmonids are generally considered a sensitive family of fish, indicative of good water quality in relation to pH, dissolved oxygen, and metals (or other contaminant) levels. Brook trout are also salmonids and as such are similarly sensitive to several environmental conditions. NSDNR lists brook trout as “Yellow”, or sensitive to human activities or natural events. Brook trout is not listed on federal or provincial lists of conservation concern. ACCDC considers brook trout it to be globally widespread and abundant and locally widespread, fairly common, and apparently secure with many occurrences, but of long term concern. Gasperau is listed as “Yellow” by NSDNR and described by ACCDC as globally and locally widespread and apparently secure with many occurrences, but of long term concern.

5.3.2 Freshwater Fish and Habitat

For the majority of the watercourses, the 2011 pipeline crossing locations fell within the area of habitat previously assessed in 2008 (see Table 5.2). Three watercourses were assessed in November 2011 as they were discovered during field surveys conducted for the 2011 alignment. Table 5.3 displays all watercourse crossings identified for the 2011 route including the watercourse crossing location, and the timeframe in which the assessment of fish habitat and measurement of water quality were undertaken.

TABLE 5.3 Summary of Water Crossings in Proposed RoW (2011 Route)

Stantec Field Reference Number	Watercourse Name	Coordinates Easting	Northing	Date of Habitat Assessment
GL-1	Unnamed Tributary to Stewiacke River	479103	5005301	July 2008
GL-5	Unnamed Channel	479700	5004680	July 2008
GL-6	Unnamed Stream	480791	5002369	July 2008
GL-7	Unnamed Channel	481658	5001674	July 2008
GL-8	Unnamed Stream	481910	5000968	July 2008

TABLE 5.3 Summary of Water Crossings in Proposed RoW (2011 Route)

Stantec Field Reference Number	Watercourse Name	Coordinates Easting	Coordinates Northing	Date of Habitat Assessment
GL-9	Watering Brook	482800	5000275	July 2008
GL-10	Unnamed Channel	483418	5000108	July 2008
GL-14	Unnamed Stream	484315	4999240	July 2008
GL-15	Unnamed Tributary to St. Andrews River	484802	4998396	July 2008
GL-16	Stewiacke River	480079	5003388	July 2008
GL-18	Unnamed Tributary to Watering Brook	481046	5002298	November 2011
GL-19	Unnamed Channel	482622	5000536	November 2011
GL-20	Unnamed Channel	482533	5000594	November 2011

The Proposed RoW (2011 alignment) crosses eight watercourses and five drainage channels. Drainage channels were identified in the field it is anticipated that the drainage channels will not require a permit for Watercourse Alteration from NSE as they do not constitute a watercourse. This designation was determined to be accurate at the time of the survey and was based on channel morphology, water quality and quantity, fish habitat characteristics and substrate composition. The majority of the drainage channels identified within the Proposed RoW were dry at the time of the field assessments, were subterranean in nature and convey water into wetlands or upland depressions therefore not connected to fish-bearing waters.

Habitat assessments were conducted within an area surrounding the proposed pipeline centerline for all watercourses and drainage channels. A summary of their characteristics is shown in Table 5.4; with a full description of fish habitat provided in Section 5.3.3.

TABLE 5.4 Fish Habitat Characterization Summary

Water-course	Name	Watercourse Coordinates[1] (NAD 83)		Watercourse on 1:10000 NSGC maps	Nature of Watercourse	Watercourse Crossing proposed Method	Potential Fish Prescence Within RoW	SARA Species Potentially Present Within RoW	Rationale for Fish Habitat Determination	Estimated Length of Watercourse in RoW	Average Bank Channel Width	Maximum Depth	Bank Stability	
ID	Name	Easting	Northing							(m)3	(m)	(m)	Left	Right
GL-1	Unnamed Tributary to Stewiacke River	479085	5005345	Y	Narrow headwater stream	Dam and Pump	Yes	Yes	Fish Habitat Assessment	25	1.09	0.12		
GL-5	Unnamed Channel	479759	5004696	N	Narrow headwater channel	Dam and Pump	No	No	Fish Habitat Assessment, seasonal flows, no connectivity	25	1.9	0		
GL-6	Unnamed Stream	480779	5002390	N	Narrow headwater stream	Dam and Pump	No	No	Fish Habitat Assessment, seasonal flows, no connectivity	25	1.17	0.11		
GL-7	Unnamed Channel	481732	5001668	N	Narrow headwater channel	Dam and Pump	No	No	Fish Habitat Assessment, seasonal flows, no connectivity	25	1.22	0		
GL-8	Unnamed Stream	481930	5000950	N	Narrow headwater stream	Dam and Pump	No	No	Fish Habitat Assessment, seasonal flows, no connectivity	25	0.93	0.11		
GL-9	Watering Brook	482800	5000275	Y	3rd Order Stream	Dam and Pump	Yes	Yes	Fish Habitat Assessment	25	1.97	0.05		
GL-10	Unnamed Channel	483418	5000122	N	Narrow headwater channel	Dam and Pump	No	No	Fish Habitat Assessment, seasonal flows, no connectivity	25	1.43	0		
GL-14	Unnamed Stream	484285	4999207	N	Narrow headwater stream	Dam and Pump	No	No	Fish Habitat Assessment, seasonal flows, no connectivity	25	0.75	0		
GL-15	Unnamed Tributary to St. Andrews River	484770	4998370	Y	2nd Order Stream	Dam and Pump	Yes	Yes	Fish Habitat Assessment	25	2.68	0.1		
GL-16	Stewiacke River	480079	5003387	Y	Wide, Flat section of River	Horizontal Directional Drilling	Yes	Yes	Fish Habitat Assessment, NSFA & DFO data	25	34	1.64		
GL-18	Unnamed Tributary to Watering Brook	481095	5002363	Y	1st order stream, narrow and slow	Dam and Pump	Yes	Yes	Fish Habitat Assessment	25	1.75	0.36		
GL-19	Unnamed channel	-	-	N	Narrow headwater channel	Dam and Pump	No	No	Fish Habitat Assessment, no connectivity	25	1.05	2		
GL-20	Unnamed Channel	-	-	N	Narrow headwater channel	Dam and Pump	No	No	Fish Habitat Assessment, no connectivity	25	0.7	4		

Stable and vegetated
Bare Stable
Eroding

Water quality was measured *in-situ* at the proposed centerline of the 2008 pipeline route for those watercourses assessed in July 2008. The water quality measurements for GL- 18, 19 and 20 were taken in November 2011 at the centerline of the current route. The water quality measurements taken as part of the 2008 field surveys were assessed to determine proximity to the 2011 alignment. All water quality measurements fell within an area 100 m upstream or downstream of the proposed 2011 pipeline centerline and the results can be considered representative of the water quality for each watercourse and drainage channel along the current route. Table 5.5 summarizes key water quality and quantity information taken during field surveys.

TABLE 5.5 Water Quality Summary

Stantec Field Reference Number	Watercourse Name	Water Temperature (°C)	pH	Specific Conductivity (µs/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Discharge (m^3/s)
GL-1	Unnamed Tributary to Stewiacke River	15.12	4.92	61	5.81	57.9	ND
GL-5	Unnamed Channel	NA	NA	NA	NA	NA	ND
GL-6	Unnamed Stream	16.04	5.35	45	8.36	86	ND
GL-7	Unnamed Channel	NA	NA	NA	NA	NA	ND
GL-8	Unnamed Stream	17.26	4.34	88	2.69	27.9	ND
GL-9	Watering Brook	18.37	6.64	705	7.1	75.5	0.001
GL-10	Unnamed Channel	NA	NA	NA	NA	NA	ND
GL-14	Unnamed Stream	NA	NA	NA	NA	NA	ND
GL-15	Unnamed Tributary to St. Andrews River	18.4	6.19	80	4.59	48.1	0.03
GL-16	Stewiacke River	23.91	7	360	8.26	98.1	22.8
GL-18	Unnamed Tributary to Watering Brook	11.05	6.65	80	7.75	67.8	0.001
GL-19	Unnamed Channel	NA	NA	NA	NA	NA	ND
GL-20	Unnamed Channel	NA	NA	NA	NA	NA	ND

Low pH or acidic waters are common to the eastern shore of Nova Scotia dominated by Halifax formation bedrock. Acidification can be caused by a variety of factors including influences from wetlands, naturally occurring organic acids and geological sources (CCME 2009) as well as anthropogenic effects. The Canadian Council for the Ministers of Environment (CCME) *Guidelines for the protection of* Freshwater *Aquatic Life* (FAL) recommends pH values in the range of 6.5 - 9.0 as suitable for all lifestages of aquatic life. As waters become more acidic fecundity can decrease and may cause issues with the sensitive milt, egg and larval stages. Two watercourses within the Study Corridor exhibited pH within the range recommended by CCME, the remainder exhibit pH values that are lower than guideline values.

The atmosphere and photosynthesis of aquatic plants are the major sources of dissolved oxygen in water and the balance between the input of oxygen and consumptive metabolism of organisms and oxidizable matter received controls the dissolved oxygen content in the water (CCME 1999). The concentration of dissolved oxygen in a watercourse also depends on a number of independent variables that include surface and interstitial water velocity/discharge, hydraulic gradient, sediment texture and porosity, bottom morphology, daily water temperature fluctuation, and the consumptive oxygen demand of the substrate (CCME 1999).

Canadian Council for the Ministers of Environment (CCME) established a guideline for dissolved oxygen concentration in freshwater through the Canadian Water Quality Guidelines for the protection of freshwater aquatic life (CCME FWAL). This guideline establishes a minimum recommended concentration of dissolved oxygen of 6.5 mg/L for adult lifestages of cold water biota and 9.5 mg/L for juvenile lifestages. At the time of the survey three watercourses within the Study Corridor had above the recommended concentration of dissolved oxygen for adult lifestages of cold water biota, while all the watercourses were below the recommended concentrations for juvenile lifestages on the date sampled; dissolved oxygen concentration is expected to vary seasonally throughout the year with temperatures and discharge.

The lowest dissolved oxygen concentrations were identified at GL-8; this corresponds to the substrate type, water velocity, flow state along with numerous other factors. The streambed of GL-8 was composed of mostly organic matter and fines (silt, sand and clay); this fine substrate matter enables growth of microbes and fauna within the sediment which aids in oxygen depletion at the sediment water interface. The low water velocities and flow state provides a stagnant nature to the watercourses this impedes water column mixing and limits the transfer of atmospheric oxygen to the top of the water column. The highest dissolved oxygen concentrations observed were associated with larger streams and rivers with hard streambed substrate, higher velocities and subsequently greater mixing potential (*i.e.,* Stewiacke River and Watering Brook).

5.3.3 Habitat Assessment Results

GL-1 – Unnamed Tributary to the Stewiacke River

Located 30 m to the east of the well site, GL-1 is an unnamed 1st order stream that contributes to the Stewiacke River approximately 2.25 km south-southeast. The headwaters for this watercourse likely originate a short distance above the crossing as the channel dissipates into subsurface flow 60 m upstream from the gas line crossing. Wetted width and depth increase into the downstream section, indicating an influx of water from drainage or spring seeps. While flow was indeterminate during the time of survey, higher flow periods were evident from the absence of leaf litter along the edges of the channel, this is most likely due to spring meltwater as no vegetation was uprooted along the channel edge. The substrate was predominately sand/gravel with the presence of boulders. Along the entire length of the survey area mosses and algae were present on the rocky substrate; the abundance of moss indicates low flow during the majority of the year. Canopy cover is between 25-50% and consists of coniferous forest which extends more than 100 m from the right bank and ends at clearing for the well site 30 m from the left bank. A couple of patches of vegetation are present between the center line and upstream transect which may limit the passage of large bodied fish. Discharge during the assessment period was non-detectable.

A fishing survey was not carried out in GL-2, as per DFO prohibition for electrofishing in waters potentially occupied by a SARA species (IBoF Atlantic salmon).

PHOTOS 1 & 2 GL-1 crossing location

GL-5 – Unnamed Channel

The crossing at GL-5, was determined to not be a watercourse as the depression showed evidence of ephemeral flows during the spring freshet and contained no water during the survey. The bed of the depression contained large amounts of leaf litter and detritus similar to the surrounding forest floor. The depression was 1.90 m at the CL; continuing "upstream" the depression disperses and becomes undefined. Discharge during the assessment period was non-detectable, as no water was contained within the channel.

A fishing survey was not carried out in GL-5, as no suitable fish habitat was observed.

PHOTOS 3 & 4 GL-5 crossing location

GL-6 – Unnamed Stream

The crossing at GL-6 is the first crossing south of the Stewiacke River, this watercourse ranged in width from 0.66 m -0.77 m with bankfull widths reaching 1.98 m. The water was tea-stained and no flow was observed during the assessment. The substrate ranged from cobble to boulder at the crossing location and upstream with heavy sedimentation observed at the downstream transects. Algal slimes and crusts were present on the majority of the rocky substrate. The sedimentation likely was caused through the erosion of streambanks as no additional sources of sediment were observed. The riparian zone at ground level was covered in moss with the canopy formed of a thin coniferous forest which provided approximately 50% coverage. This forest was cleared starting at 10 m from the right bank and 30 m from the left. The moss encroached into the channel along with terrestrial grasses along drier reaches. Discharge during the assessment period was non-detectable.

A fishing survey was not carried out in GL-6, as no suitable fish habitat was observed.

PHOTOS 5 & 6 GL-6 crossing location

GL-7 –Unnamed Channel

The crossing at GL-7 is located approximately 800 m southeast of the intersection of the gas line and Cloverdale road. The channel width varies from 0.95 -1.22 m. At the time of the survey the only portion which contained water was upstream of the crossing location and consisted of intermittent pooling throughout the 100 m upstream transect, the slope is very gentle which decreases water velocities. Numerous deadfalls crossed the watercourse, including conifers whose roots had been exposed from the erosion of stream banks. Downstream from the crossing location there is increased bank erosion which in turn results in sedimentation in the still waters following bends in the channel. The channel ends with a large berm impounding the channel. The berm is located adjacent to a logging road and prevents the channel from flowing into the ditch alongside the road. The channel follows along the edge of the berm for a short distance approximately 10 m before dispersing. Substrate along the channel is composed of silt and small pebbles; deposition of silt is heavy often covering up to ¾ of the rocky substrate. Upstream where the slope decreases ponding is present with moss growing within the channel. The left and right banks were mainly coniferous forest with de-forested areas up to 10 m from each bank. The trees remaining along the riparian zone provide 25-50% coverage for the channel. Discharge during the assessment period was non-detectable as no water was contained within the channel.

A fishing survey was not carried out in GL-7, as no suitable fish habitat was observed.

PHOTOS 7 & 8 GL-7 crossing location

GL-8 – Unnamed Channel

Crossing GL- 8 was determined on site to not be a watercourse. There was pooling at the crossing location with the average water depth 6.0 cm; a potential wetland begins 10 m upstream from the crossing location and expands in width upstream. Downstream the channel becomes dry approximately 30 m from the crossing location. Along the entire surveyed length of the GL-8 deadfalls have fallen across channel; in one section the flow was completely blocked. The dry channel bed widens downstream from the crossing location and becomes deeply entrenched. The substrate is predominately silt, with sand or pebbles with the pebbles deeply embedded in the silt. At certain locations in the channel bed moss and algae has grown over the substrate. The riparian zone surrounding the channel is mainly coniferous forest and open to clearcuts. The coniferous forest provides 50-75% coverage for the channel. GL-8 had no visible flow during the assessment, but detritus was removed from the center of the channel due to rain events of the previous day. Discharge during the assessment period was non-detectable as no water was contained within the channel.

A fishing survey was not carried out in GL-8, as no suitable fish habitat was observed.

PHOTOS 9 & 10 GL-8 crossing location

GL-9 – Watering Brook

GL- 9 (Watering Brook) was a 1st order perennial stream located south of the Stewiacke River. Several small gravel bottomed pools were present as well as sand/gravel beaches; water depths during the dry season in the small stream were adequate for fish young of the year. Overall Watering Brook provides good fish habitat along its reach. Upstream from the CL the stream meandered through deadfalls with multiple pools and small beaches. The downstream section provided similar habitat with the banks slightly undercut and a drainage channel joining at approximately 60 m downstream from the crossing location. The substrate is predominantly cobble from 5-25 cm in diameter. The rocky substrate was embedded slightly by gravel in the runs and riffles and completely embedded by gravel in the larger pools. The riparian zones on both sides of the channel were mainly coniferous forests for the initial 30 m; beyond that the land was cleared. The canopy provided 25-50% stream coverage, with the presence of macrophytes including mosses, and some aquatic grasses. Discharge during the assessment period was measured at 0.001 m^3/s.