15.0 HYDROGEOLOGY OF PORT AU PORT ADA

15.1 General Description of Area

15.1.1 Location & Extent

The Port au Port ADA covers an area of approximately 26,200 hectares along the southwest coast of Newfoundland, encompassing the majority of the Port au Port Peninsula. The boundary of the Port au Port ADA is shown on Drawing No. 1034406-15-1 in Appendix 15a.

The Port au Port ADA overlaps the communities of Aguathuna, Boswarlos Piccadilly, West Bay Centre, West Bay, Tea Cove, Black Duck Brook, Long Point, Blue Beach, Winterhouse, Salmon Cove, Three Rock Cove, Mainland, Cape St. George, Petit Jardin, Grand Jardin, De Grau, Red Brook, Marches Point, Loretto, Sheaves Cove, Lower Cove, Ship Cove, Jerry's Nose, Abrahams Cove, Campbells Creek, Man of War Cove, and Felix Cove,

The main access to the Port au Port ADA is provided by Provincial Highway Route 460 (Port au Port Highway/Kippens Road/Hanson Memorial Highway), which leads west from the Trans Canada Highway approximately 25 km east of Stephenville to the community of Cape St. George, located at the tip of the peninsula. Near the community of Abraham's Cove, secondary Highway Route 463 (Lourdes Road) branches off Highway Route 460 and provides access to northern portions of the ADA. In addition, various graveled roads and ATV trails leading from Highway Routes 460 and 463 also provide access to some areas within the ADA.

15.1.2 Physiography, Topography & Drainage

The Port au Port ADA is located within the physiographic region referred to as the West Coast Lowlands. This physiographic region is characterized by a low-lying coastal plain that is bounded by various upland regions, including the Lewis Hills and Serpentine Range in the north, the Long Range Mountains in the east, and the Anguille Mountains in the south. The Port au Port Peninsula forms an extension of the lowland that juts out approximately 40 km into the Gulf of St. Lawrence, and is connected to the main part of the island by a narrow, approximately 500 m wide isthmus located near the community of Port au Port. The peninsula has rugged undulating terrain that ranges from 50 to 150 m above sea level over much of the area. The southern half of the peninsula is semi-mountainous, with elevations rising to 325 to 350 m above sea level in the White Hills area. Coastal areas in the vicinity of Port au Port Bay are relatively even and slope gently to the coast, but become more rugged with coastal cliffs and rocky reef beaches along the western and southern sides of the peninsula. A rocky promontory, referred to as "The Bar", underlies the northern extent of the ADA, and defines the west side of Port au Port Bay.

No significant stream and river drainage systems are present on the Port au Port Peninsula, however the ADA encompasses sections of the lower course of a number of small watercourses that drain directly into the Gulf of St. Lawrence, including Red Brook, Falls Brook, South Brook, Harry Brook, Victors Brook, Mainland Brook, and Contre Brook. The headwaters of these stream systems originate in the upland area along the southern portion of the peninsula. Several small ponds are also present in the area. Five (5) surface water Public Protected Water Supply Areas (PPWSA) overlap the Port au

Port ADA and its drainage catchment area, including Port au Port West/Aguathuna/Felix Cove – Jim Rowe's Brook, Cape St. George – Rouzes Brook, Mainland – Caribou Brook, Lourdes – Victors Brook, and Piccadilly Head – Unnamed Brook. In addition the ADA also overlaps the Sheaves Cove – Unnamed Brook unprotected water supply.

15.1.3 Climate, Vegetation & Agricultural Land Use

The Port au Port ADA is located within the Western Newfoundland ecoregion, one of the largest ecoregions in the province, stretching from the Codroy Valley in the south to Bonne Bay in the north and extending inland from the west coast and including much of the Long Range Mountains. This ecoregion is characterized by a humid climate with a relatively longer frost-free period compared to other parts of the island. The Port au Port Peninsula forms a subregion within the Western Newfoundland ecoregion, and the moderating effects of the ocean tend to make summers cooler and winters warmer in this area compared to other areas within the ecoregion. No specific climate data is available for the Port au Port ADA. In lieu of this, climate data obtained from Environment Canada's nearby Stephenville Airport monitoring station dating back to 1971 was used to characterized climatic conditions in the ADA. The monthly mean temperature in the area is 4.6°C, ranging from a high of 16.2°C in August to a low of -7.5°C in February. Average annual precipitation in the area is 1,352 mm, of which 73% falls as rainfall and 27% as snowfall. January is typically the wettest month, and April is typically the driest month (Environment Canada, 2008). In the ADA, there are an average of 1,324 growing degree days (base temperature 5^{o}C) for the year and 1,205 growing degree days for the vegetative season (i.e., May to September).

The landscape in the vicinity of the Port au Port ADA is dominated by rock and limestone heath barrens with local stands of balsam fir and black spruce. Conifers are the dominant trees, but small stands of deciduous trees, including white birch and trembling aspen also occur. In addition, scattered fen and dome and slope bogs occur throughout. Based on agricultural land use information provided by the NL Department of Natural Resources Agrifoods Division, approximately 938 hectares (i.e., 4% of the total landmass of the ADA) is currently utilized for agriculture, with pasture and forage land representing the most significant proportion of the ADA's agricultural land use.

15.2 Geology

15.2.1 Surficial Geology

The surficial geology of the Port au Port ADA is summarized in Drawing No. 1034406-15-2 in Appendix 15a, and is based on most recent 1:50,000 scale mapping of the area by Batterson (2001a,b,and c), as well as descriptions of surficial geology provided in Greenlee and Heringa (1984) and Hender (1989). For the purposes of this study, surficial geological units on existing maps have been simplified into four (4) groups, including exposed bedrock, areas of bog, areas of till and areas of sand and gravel.

Till deposits are present throughout the ADA occurring as both thin discontinuous veneer (typically less than 2 m thick), and more extensive moraine deposits with local thicknesses up to 20 m. The composition of the veneer and moraine tills are variable and bedrock-controlled, but generally consists of a moderate to exceedingly stony, silt loam to loam sand derived from dolomite, limestone and minor siliciclastic sedimentary rocks. The veneer and moraine tills are locally eroded and dissected, particularly along stream and river channels. Only small isolated areas of sand and gravel deposits of

glacial outwash and fluvial origin are present within the ADA. Sand and gravel units shown in Drawing No. 1034406-15-2 in Appendix 15a also include un-subdivided marine terraces that contain various silt and clay deposits in addition to sands and gravels and occur extensively in coastal areas of the ADA. Along with glacial units, local deposits of organic and peaty soils are also present throughout the ADA, overlying either till or bedrock. Bedrock outcrop is exposed within the till and various other surficial deposits over large portions of interior of the peninsula, and typically occur as areas of high ground or coastal cliffs. Bedrock outcrops may be partially or fully concealed by a thin mat of vegetation and sparse forest. However, where exposed bedrock outcrops are commonly streamlined and display glacial striations that indicate west, southwest or south directed ice flow. In addition, local development of rock talus or colluviums occur along steep valleys, and steep sections of coastal cliffs. Available well logs indicate an average overburden thickness in the Port au Port ADA and surrounding area of approximately 6 m.

15.2.2 Bedrock & Structural Geology

The bedrock geology of the Port au Port ADA is summarized in Drawing No. 1034406-15-3 in Appendix 15a, and is based on the regional 1:250,000 scale compilation mapping by Colman-Sadd and Crisby-Whittle (2005), as well as a description of bedrock geology provided in Boyce, et al. (2000) and Knight, et al. (2008).

The Port au Port ADA lies within the Humber tectonostratigraphic zone and is underlain by Late Precambrian siliciclastic basinal rift sedimentary rocks, Cambrian to Late Ordovician shallow marine sedimentary rocks, overthrusted Precambrian to Ordovician deepwater basinal sedimentary rocks, melange and ophilitic rocks, and Late Silurian to Carboniferous sedimentary cover rocks. The oldest rocks in the area occur along the southwest coast of the peninsula and comprise Late Precambrian to Early Cambrian rift-related basinal siliciclastic and calcareous sedimentary rocks of the Labrador Group. The Labrador Group is overlain by a succession of Middle Cambrian to Late Ordovician carbonate platformal sedimentary rocks, which extend over the majority of the peninsula and form the Port au Port Group, Table Head Group, Goose Tickle Group and Long Point Group. This sedimentary sequence, typically referred to as the Humber Arm autochthon (non-transported) sequence is structurally overlain by an allochthon (transported) complex of deep water sedimentary, igneous and metamorphic rocks (Humber Arm Allochthon intermediate structural slices, and Humber Arm Allochthon low structural slices) present in the northeastern portion of the ADA between the communities of Tea Cove and Boswarlos. Locally within the ADA, an overlap sequence of Late Silurian to Carboniferous sedimentary rocks comprising siliciclastic and minor carbonate and evaporitic sedimentary rocks and coal beds unconformablely overlie the Cambrian to Ordovican rocks of the Humber Zone.

The Carboniferous rocks that underlie the ADA have undergone regional northeast-trending folding and faulting related to the Pennsylvanian to Permian Maritime Disturbance (Alleghenian Orogeny). The allochthonous and autochonous rocks of the Humber Zone have undergone complex, multiphase deformation associated with Ordovician Taconic and Devonian Acadian orogenesis, and are characterized by northeast-trending folds with a penetrative crenulation cleavage, as well as thrust faulting, and faulting with dextral strike-slip movement. The Round Head Thrust, which resulted in structural thickening of the Humber Arm autochthonous sequence, is located in the northwestern portion of the ADA.

15.3 Hydrogeology

15.3.1 Hydrostratigraphy

The groundwater potential of the various geological units within the Port au Port ADA was assessed utilizing available records for water wells completed within each unit obtained from the NLDEC-Water Resources Management Division Drilled Water Well Database for wells drilled between 1950 and March, 2008. The data provided in the well records are organized by community and includes information on the well depth and yield, well casing depth and diameter, depths to water bearing zone(s), plus data on the quality and use of the water and the driller's description of the depth and lithology of the overburden and bedrock units encountered.

A total of 140 drilled bedrock wells and one (1) drilled surficial well from 16 communities in the ADA and surrounding area had adequate well data to evaluate the groundwater potential of various surficial and bedrock strata in the ADA. Since lithologic information provided in the well records was of insufficient detail to define the bedrock encountered in each individual drilled well, the wells were assigned to their respective geologic units based on the community in which the wells were located and the corresponding underlying geologic unit, as shown on the bedrock geology map provided in Drawing No. 1034406-15-3 in Appendix 15a.

The groundwater potential of each geological unit was quantified by assessing the reported well yields and depths from the records of wells completed within each unit. Reported yields for drilled wells in the Port au Port ADA and surrounding area is based on airlift testing carried out by the driller at the time of well installation to obtain a rough estimate of well capacity, and does not necessarily represent the short or long term safe yield of the well, or the groundwater yield characteristics of the corresponding aquifer. To accurately determine such values, aquifer testing, including step drawdown and constant rate pump testing must be conducted, ideally with monitoring of groundwater levels in nearby observation wells. No aquifer testing has been carried out on any of the drilled wells in the ADA and surrounding area. Therefore, in the absence of this data, the groundwater potential of the various geological strata in the Port au Port ADA is defined based on the estimated well yields obtained from the driller's records.

15.3.1.1 Surficial Hydrostratigraphic Units

The surficial deposits within the Port au Port ADA have been subdivided into two broad hydrostratigraphic units, including one comprised of till deposits, and the other predominantly of sands and gravels. The yield and depth characteristics of these units are summarized on Table 15.1. No water well information was available for the till deposits present in the ADA. Therefore groundwater potential within this overburden unit was inferred based on well records for similar overburden material in the St. John's ADA.

Till Deposits

The till deposits form both thin veneer or more extensive moraine deposits over much of the ADA and is generally comprised of a moderate to exceedingly stony, silt loam to loam sand. There are no documented data on their groundwater potential in the Port au Port ADA. However, based on records of water wells within similar till material in the St. John's ADA, the range of yields from wells within the till can be expected to vary from 10 to 70 L/min at depths of 9.5 to 35 m. The average yield is

estimated to be approximately 40 L/min at 21 m depth. However, median yield and depth estimates of 34 L/min at 20 m depth are more likely representative of the typical groundwater potential of this unit.

Sand and Gravel Deposits

Only small isolated areas of sand and gravel deposits of glacial outwash and fluvial origin are present within the ADA. Marine-derived sand and gravel units also occur locally along coastal areas of the ADA. These deposits are potentially significant groundwater aquifers. Only one (1) well from the community of Boswarlos was available to characterize the groundwater potential of this unit in the ADA. Based on limited data, wells within the sand and gravel can be expected to yield 55 L/min at a depth of 27 m.

Table 15.1 Summary of Overburden Drilled Well Information for Port au Port ADA

Overburden Unit	Communities	No. of Wells	Well Depth (m)		Well Yield (L/min)	
			Mean (Median)	Range	Mean (Median)	Range
Till*	St. John's ADA	6	21.3 (19.6)	9.5-35	39.5 (33.5)	10-70
Sand & Gravel	Boswarlos	1		26.8	-	55

* Groundwater yield estimates for the till deposits based on well data from the St. John's ADA

15.3.1.2 Bedrock Hydrostratigraphic Units

Well record information is available for the combined Cambrian to Ordovician autochthonous (non-transported) succession of shallow water, calcareous and siliciclastic sedimentary rocks (Labrador, Port au Port Long Point, Table Head, and Goose Tickle groups) that underlie the majority of the ADA, as well as the overlap sequence of Late Silurian to Carboniferous sedimentary rocks that unconformablely overlie the Humber Arm autochthon sequence locally within the ADA. The well yield and depth characteristics of these various strata are summarized in Table 15.2.

No water well information was available for the combined Cambrian to Ordovician allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks of the Humber Arm Allochthon low and intermediate structural slices present in the northeastern portion of the ADA. Therefore groundwater potential within these units was inferred based on well records for similar lithologies in the Humber Valley ADA.

Humber Arm Autochthon Complex

A total of 132 well records from the communities of Abrahams Cove, Aguathuna, Three Rock Cove, Ship Cove, Sheaves Cove, Salmon Cove, Red Brook, Campbells Creek, Black Duck Brook, De Grau, Felix Cove, Cape St. George, Mainland, Marches Point, and Piccadilly were used to characterize the groundwater potential of the combined Cambrian to Ordovician autochthonous (non-transported) succession of shallow water, calcareous and siliciclastic sedimentary rocks. These units underlie the majority of the ADA. Based on well data, the Humber Arm Autochthon rocks are considered capable of providing wells with low to moderate yields, having water yields ranging from 0.1 to 728 L/min at well depths of 12 to 128 m, and an average yield of 37 L/min at 50 m depth. However, median yield and depth estimates of 16 L/min at 45 m depth are more likely representative of the typical groundwater potential of these units.

Humber Arm Allochthon Complex

No documented data is available for the groundwater potential of the combined Cambrian to Ordovician allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks present in the northeastern portion of the ADA. However, based on well data from similar lithologies from the Humber Valley area, the Humber Arm Allochthon rocks are considered capable of providing wells with low yields, having water yields ranging from 2 to 68 L/min at well depths of 8 to 10 m, and an average yield of 18 L/min at 43 m depth. However, median yield and depth estimates of 6 L/min at 48 m depth are more likely representative of the typical groundwater potential of these units.

Silurian to Carboniferous Sedimentary Cover Rocks

A total of eight (8) well records from the community of Boswarlos was used to characterize the groundwater potential of the Carboniferous sedimentary cover rocks. This unit is present locally within the ADA. Based on well data, the Carboniferous sedimentary cover rocks strata are considered capable of providing wells with low yields, having water yields ranging from 2 to 69 L/min at well depths of 15 to 90 m, and an average yield of 21 L/min at 40 m depth. However, median yield and depth estimates of 9 L/min at 32 m depth are more likely representative of the typical groundwater potential of these units.

Table 15.2 Summary of Bedrock Drilled Well Information for Port au Port ADA

Rock Group	Rock Type	Communities	No. of Wells	Well Depth (m)		Well Yield (L/min)	
				Mean (Median)	Range	Mean (Median)	Range
Humber Arm Autochthon (Labrador, Port au Port Long Point, Table Head, and Goose Tickle groups)	Shallow water, carbonate and siliciclastic sedimentary rocks	Abrahams Cove, Aguathuna, Three Rock Cove, Ship Cove, Sheaves Cove, Salmon Cove, Red Brook, Campbells Creek, Black Duck Brook, De Grau, Felix Cove, Cape St. George, Mainland, Marches Point, Piccadilly	132	50.4 (44.8)	12.1-128	37.1 (15.9)	0.1-728
Humber Arm Allochthon (Humber Arm Allochthon low & intermediate structural slices)	Deep water sedimentary, igneous and metamorphic rocks	Humber Valley ADA	8	42.3 (47.6)	9.8-67.1	17.9 (5.7)	2-68.2
Silurian to Carboniferous Sedimentary Rocks (Codroy and Clam Bank groups, and Red Island Road formation)	Siliciclastic and minor carbonate and evaporitic sedimentary rocks and coal beds	Boswarlos	8	39.8 (32.3)	15.2-90.2	21 (9.1)	2-69

15.3.2 Groundwater Flow System

The Port au Port ADA and surrounding area is underlain by an unconfined aquifer system contained within the overburden material and underlying shallow bedrock. The movement of groundwater through the overburden material is controlled by primary porosity, while groundwater flow within the underlying

bedrock can be expected to mainly occur within secondary openings, such as fractures and joints, and will be variable depending on the frequency and interconnection of these structural features.

Shallow groundwater flow within the ADA is controlled by water table conditions and local variations in topography. Groundwater is thought to be recharging along the topographic highs and discharging in various wet lowland areas, ponds, lakes and rivers, as well as along the coast. An ocean island setting is inferred for the area underlying the Port au Port ADA, with a freshwater aquifer lens sitting above a denser saltwater aquifer system assumed to be present at some unknown depth in deeper portions of the underlying bedrock.

15.4 Water Quality

15.4.1 Surface Water Quality

Surface water quality data for the Port au Port ADA is limited to water quality monitoring data collected by the NL Department of Environment - Water Resources Management Division from five (5) protected public surface water supplies in the ADA and surrounding area –

- Cape St. George - Rouzes Brook (WS-S-0121, 1988-2006);
- Lourdes - Victor's Brook (WS-S-0430, 1998-2007);
- Mainland - Caribou Brook (WS-S-0440, 1994-2007);
- Piccadilly Head - Unnamed Brook (WS-S-0539, 1988-2007); and,
- Sheaves Cove - Unnamed Brook (WS-S-0642, 2001-2006).

A summary of chemical data obtained from these surface water sources over their respective monitoring periods is provided in Tables 15.3 in Appendix 15b, and is compared to the Canadian Drinking Water Quality Guidelines (CDWQG) (Health Canada, 2007), as well as the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (CWQG-AWU) (October, 2005).

Based on major ion chemistry, surface water in the ADA and surrounding area can be classified as a combination of calcium-sodium-bicarbonate-chloride-sulfate (Ca-Na-HCO_3-Cl-SO_4), and calcium-sodium-chloride-sulfate-bicarbonate (Ca-Na-Cl-SO_4-HCO_3) type waters. Surface water in the area is moderately to very hard, neutral to slightly basic, and of moderate alkalinity. Classification of surface water according to dissolved-solids and specific conductance indicates fresh conditions.

With the exception of arsenic in the Piccadilly Head protected public water supply, and iron, manganese, turbidity and color in several of the protected surface water supplies, concentrations of all other parameters tested meet CDWQG. The guidelines for iron, manganese, turbidity and color are aesthetic objectives only and levels of these parameters detected at the surface water locations evaluated do not pose any health concerns, however problems may be experienced such as foul taste, deposition or staining.

Concentrations of all parameters tested at the surface water sites meet CCME CWQG-AWU for irrigation and/or livestock water use.

Based on chemical data, surface water quality within the ADA is generally considered good to excellent, returning average Canadian Water Quality Index (CWQI) values ranging from 90 to 100. However, a negative Langelier Index at several of the public surface water supplies indicates that water is unsaturated with calcium carbonate and it will tend to be corrosive, leading to potential leaks in the distribution system in these areas. Treatment would be required to improve the aesthetic quality of the water, as well as to reduce levels of arsenic levels in areas where elevated levels of this parameter that exceed CDWQG are present.

15.4.2 Groundwater Quality

The groundwater quality data for the Port au Port ADA consists of analyses from eight (8) private drilled wells from the communities of Campbell's Creek, Marches Point, Boswarlos, Piccadilly, Sheaves Cove, and Three Rock Cove, as well as seven (7) protected public supply drilled wells for the communities of Sheaves Cove (WS-G-0643), and Ship Cove-Lower Cove-Jerry's Nose (WS-G-0648, WS-G-0840, WS-G-0839, WS-G-0838, WS-G-0649, and WS-G-0837) collected by the NL Department of Environment - Water Resources Management Division. A summary of chemical data obtained from these water wells is provided in Tables 15.4 and 15.5 in Appendix 15b, and is compared to the Canadian Drinking Water Quality Guidelines (CDWQG) (Health Canada, 2007).

Based on major ion chemistry, shallow groundwater in the ADA can be classified as a combination of calcium-sodium-bicarbonate-chloride-sulfate (Ca-Na-HCO_3-Cl-SO_4), calcium-sodium-chloride-sulfate (Ca-Na-Cl-SO_4), calcium-magnesium-chloride-sulfate-bicarbonate (Ca-Mg-Cl-SO_4-HCO_3), calcium-sodium-chloride-sulfate-bicarbonate (Ca-Na-Cl-SO_4-HCO_3), and sodium-calcium-bicarbonate-chloride-sulfate (Na-Ca-HCO_3-Cl-SO_4) type waters. Groundwater in the area ranges from moderately to very hard, slightly basic, and of moderate to high alkalinity. Classification of groundwater according to dissolved-solids and specific conductance generally indicates fresh conditions. Classification of groundwater according to dissolved-solids and specific conductance generally indicates fresh conditions. However moderately saline conditions were present in the Boswarlos private drilled well.

With the exception of chloride, iron, lead, manganese, pH, sodium, sulphate, sulphide, total dissolved solids, turbidity and color present in several of the private and protected public supply drilled wells, concentrations of all other parameters tested in the wells meet CDWQG. The guidelines for chloride, iron, pH, sodium, sulphate, sulphide, turbidity, and color are aesthetic objectives only and levels of these parameters detected in the wells do not pose any health concerns, however problems may be experienced such as foul taste, deposition or staining in the case of iron, sodium, sulphate, sulphide, turbidity and color, and corrosion in the case of chloride and pH.

In addition, concentrations of chloride, sulphate, manganese, and total dissolved solids present in several of the private drilled wells, and manganese present in several of the protected public supply drilled wells exceeded CCME CWQG-AWU for both irrigation and livestock water use.

Based on monitoring data available for the Sheaves Cove protected public supply drilled well, groundwater within the ADA is generally considered excellent, returning an average Canadian Water Quality Index (CWQI) value of 97. However, chemical data indicates that poor groundwater quality and saline conditions are present in the vicinity of Boswarlos. Treatment would be required to improve the aesthetic quality of the groundwater in the ADA, as well as reduce levels of lead in areas where elevated levels of this parameter that exceed CDWQG are identified. In addition, the concentrations of chloride, sulphate, manganese, and total dissolved solids present in several of the private drilled wells,

and manganese present in several of the protected public supply drilled wells that exceeded CCME CWQG-AWU for irrigation and/or livestock water use may limit usage of these groundwater sources as potential agricultural water supplies without appropriate treatment. The elevated chloride, sodium, specific conductance, sulphate, and sulphide levels present in the Boswarlos private drilled well is likely due to the Carboniferous strata, which contains intercalated evaporite beds.

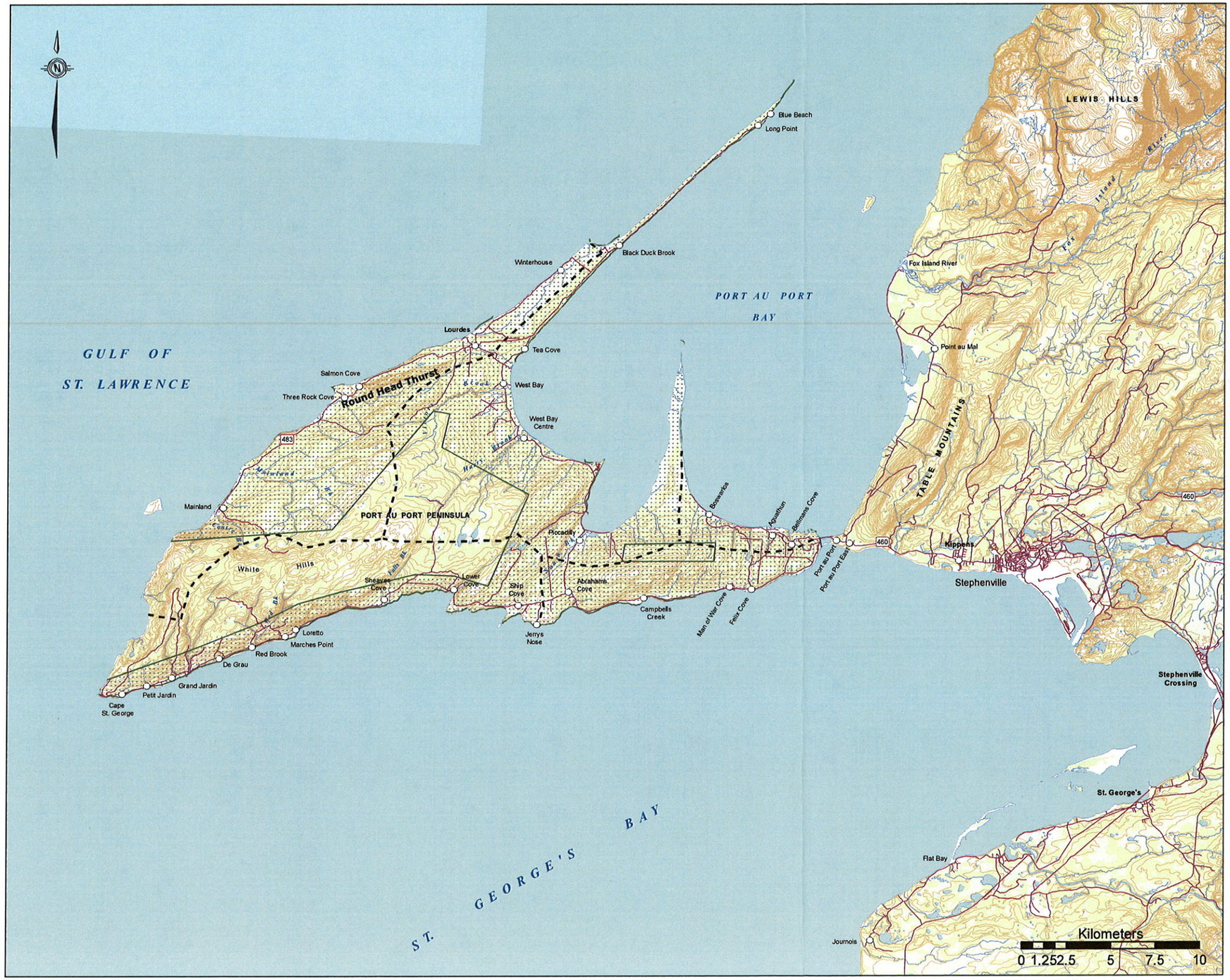
15.5 Groundwater Recharge & Availability

Recharge to the shallow groundwater system underlying the ADA is by direct infiltration of rainfall, after runoff and the requirements of evaporation and plant transpiration have been met, and is directly related to rainfall, infiltration characteristics and size of the recharge zone. A common practice in estimating the long term groundwater recharge for an area is to multiply the groundwater catchment area by the percent of precipitation estimated as able to infiltrate. The recharge to groundwater in the Port au Port ADA is estimated on the basis of a local groundwater catchment area equivalent to the area of the ADA of approximately 26,200 hectares, and a conservative recharge coefficient of 10% of the mean annual rainfall (i.e., 10% of 1,352 mm, equivalent to 135 mm). Based on these values, the groundwater recharge to the Port au Port ADA is estimated at $3.5x10^7 m^3$/year or $1,352 m^3$/hectares/yr.

Seven (7) protected public groundwater supplies are present in the vicinity of the ADA, including one public groundwater supply for the community of Sheaves Cove (Water Supply No. WS-G-0643) that serve a population of approximately 59, and seven public groundwater supplies for the community of Ship Cove-Lower Cove-Jerry's Nose (Water Supply Nos. WS-G-0648, WS-G-0649, WS-G-0837, WS-G-0838, WS-G-0839, WS-G-0840) that serves a population of approximately 343. The remainder of the water wells in the ADA are limited to minor individual domestic, commercial, industrial and public supply wells. No information is available regarding existing agricultural (i.e., irrigation and livestock) water demands in the Port au Port ADA, thus preventing an accurate balance of groundwater supply and demand to be estimated, and making it difficult to evaluate groundwater supply potential for future agricultural development in the area. However, considering the current, overall under-utilization of groundwater in the area from other users, it is expected that an adequate supply of groundwater of sufficient quality is available to meet and/or augment water supply requirements for various existing and future agricultural needs in the ADA.

APPENDIX 15a

Drawings



Drainage Catchment Area
Transportation Route
Stream
Contour Line
Agricultural Development Area
Waterbody
Wetland/String Bog
Vegetated Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

PORT AU PORT ADA LOCATION AND DRAINAGE

Jacques Whitford

Jacques Whitford

SCALE: 1:225,000	DATE: 11/03/2008
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EDITED BY: JLB	REV. NO. 0
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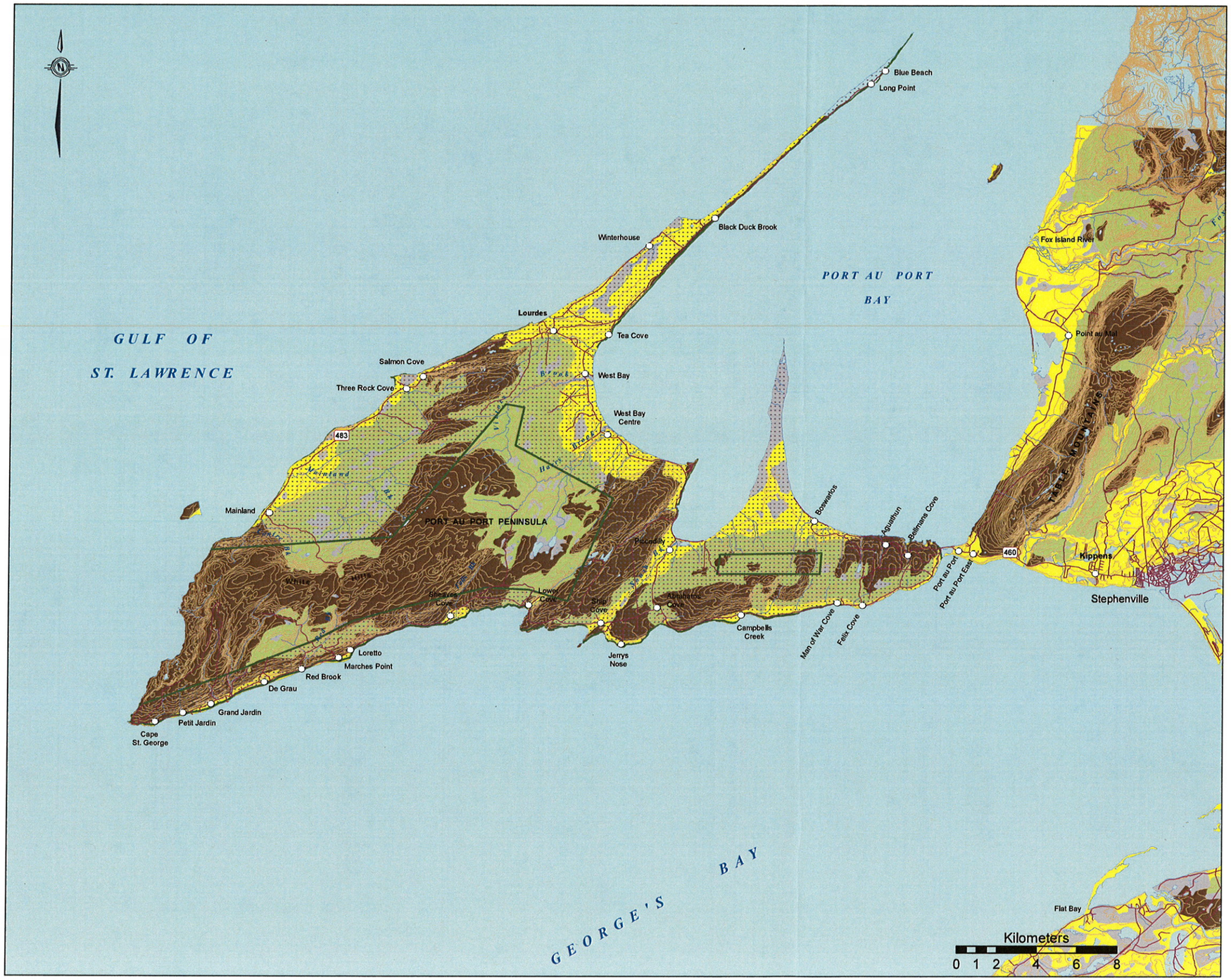

Surficial Geology Legend

- Bog: Poorly drained accumulations of peat, peat moss and other organic matter; developed in areas of poor drainage
- Sand & Gravel: Sands, gravels and silts of glaciofluvial, fluvial, lacustrine or marine terrace origin
- Glacial Till: Till veneer and moraine deposits of varying thickness overlying bedrock. Composed of diamicton (poorly sorted sediment containing a mixture of grain sizes from clay to boulders)
- Rock: Exposed Bedrock, includes areas concealed by vegetation, till veneer, as well as colluvium

- Stream
- Transportation Route
- Contour Line
- Waterbody
- Agricultural Development Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

PORT AU PORT ADA SURFICIAL GEOLOGY

Jacques Whitford

SCALE: 1:200,000	DATE: 03/06/2008
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EDITED BY: MCH	REV. NO: 0
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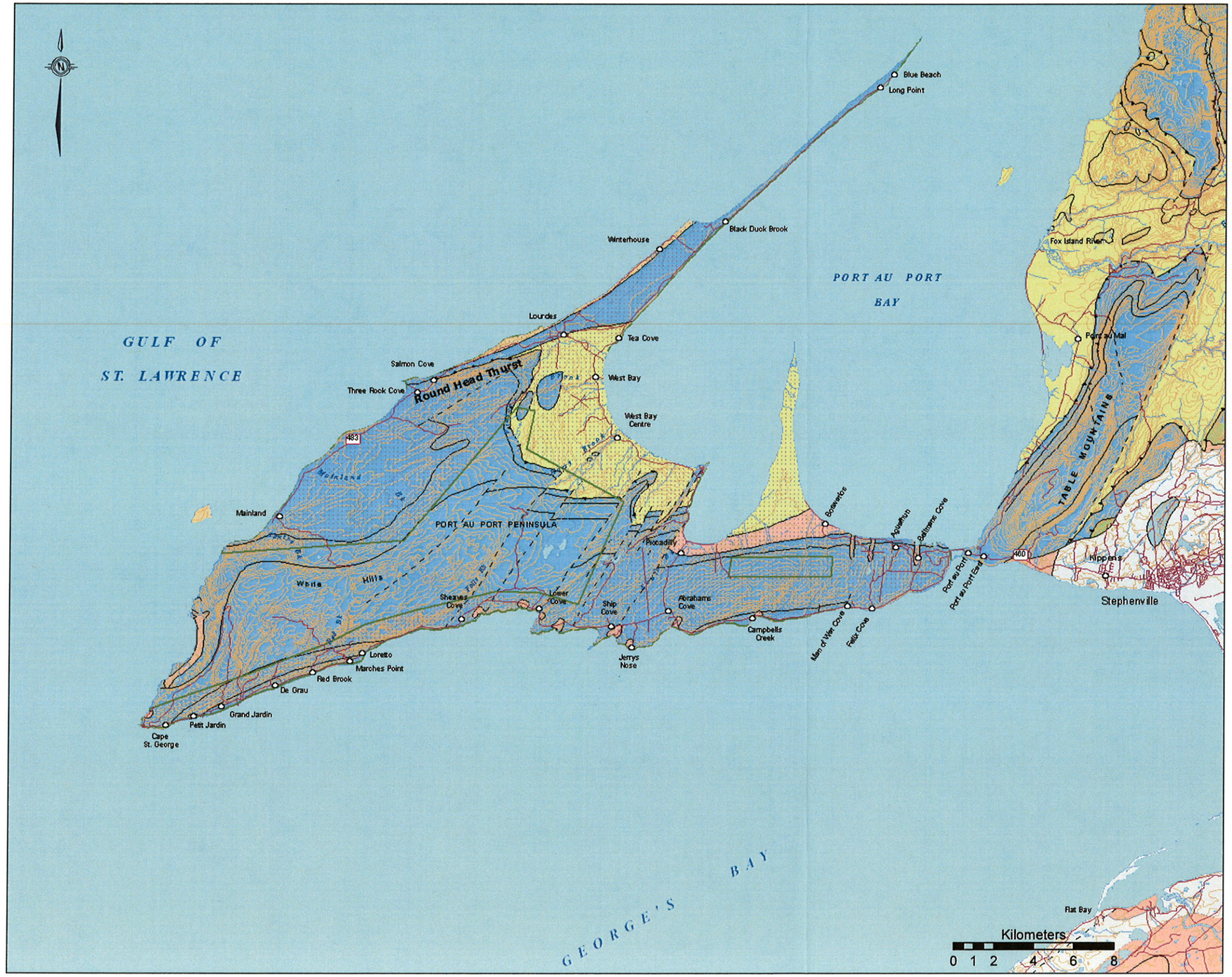

Generalized Bedrock Geology Legend

Overlap Sequences

Quaternary

Surficial unconsolidated deposits

Carboniferous

Conglomerate, sandstone, siltstone and mudstone; minor dolomitic limestone, with some oil shale and minor bituminous coal (Codroy Group)

Silurian to Devonian

Shallow marine sandstone, conglomerate, calcareous shale, and thin-bedded limestone (Red Island Road Formation, Clam Bank Group)

Humber Zone

Allochthon Complex

Cambrian to Ordovician

An allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks (Humber Arm Allochthon – intermediate and low structural slices)

Allochthon Sequence

Cambrian to Ordovician

An autochthonous (non-transported) succession of dominantly carbonate, shallow water sedimentary rocks
(Labrador, Port au Port, Table Head, Goose Tickle, Long Point groups)

- Fault, Strike-Slip and High Angle
- Contact
- Fault, Thrust
- Transportation Route
- Contour Line
- Stream
- Waterbody
- Agricultural Development Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

PORT AU PORT ADA BEDROCK GEOLOGY

Jacques Whitford

SCALE: 1:200,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: JLB	REV. No. 0
DRAWING No.: 1034406-15-3	
MAP FILE: 1034406-XX.MXD	

APPENDIX 15b

Water Chemistry Data

Table 15.3 Surface Water Chemistry, Public Water Supply, Port au Port ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Cape St. George - Rouzes Brook WS-S-0121 (1988-2006)[1]			Lourdes - Victor's Brook WS-S-0430 (1988-2007)[1]			Mainland - Caribou Brook WS-S-0440 (1994-2007)[1]			Piccadilly Head - Unnamed Brook WS-S-0539 (1988-2007)[1]			Sheaves Cove - Unnamed Brook WS-S-0642 (2001-2006)[1]		
			Irrigation	Livestock	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L $CaC0_3$	na	na	na	158	196	175	56	137	92	132	165	146	59	106	92	96	151	118
Aluminum	mg/L	na	5	5	0	0.6	0.1	0	0.5	0.1	0	0.2	0.05	0	0.2	0.1	0	0.4	0.1
Ammonia	mg/L	na	na	na	0	0.01	0.004	0	0.04	0.01	0	0.02	0.01	0	0.01	0.01	0	0.02	0.01
Antimony	mg/L	0.006	na	na	0	0.0005	0.0002	0	0.0005	0.0003	0	0.0005	0.0003	0	0.0005	0.0003	0	0.0005	0.0002
Arsenic	mg/L	0.01	0.1	0.025	0	0.003	0.001	0	0.01	0.003	0	0.001	0.001	0	0.025	0.005	0	0.005	0.001
Barium	mg/L	1	na	na	0.02	0.03	0.022	0.03	0.05	0.04	0.03	0.04	0.04	0.025	0.05	0.037	0.01	0.03	0.019
Beryllium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	0	0.03	0.01	0.02	0.03	0.03	0.02	0.03	0.02	0.01	0.03	0.02	0	0.03	0.02
Bromide	mg/L	na	na	na	0	0.03	0.01	0	0.03	0.03	0	0.03	0.02	0	0.03	0.02	0	0.03	0.02
Cadmium	mg/L	0.005	0.005	0.08	0	0.0005	0.0002	0	0.001	0.0004	0	0.0005	0.0002	0	0.001	0.0003	0	0.001	0.0002
Calcium	mg/L	na	na	na	40	56	48	20	42	30	45	60	50	21	40	31	29	51	40
Carbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	13	18	15	10	45	21	10	20	16	6	14	10	7	12	9
Chromium	mg/L	0.05	na	na	0	0.0025	0.0006	0	0.005	0.0025	0	0.002	0.0007	0	0.005	0.002	0	0.005	0.001
Copper	mg/L	1*	0.2 - 1	0.5-5	0	0.01	0.002	0.001	0.04	0.006	0	0.005	0.002	0	0.01	0.003	0	0.005	0.001
Dissolved Organic Carbon	mg/L	na	na	na	1.5	5	2.4	1.7	14	6.3	2.1	9	4.2	1.5	12	7.2	2.6	8	4.2
Fluoride	mg/L	1.5	1	1 - 2	0	0.11	0.05	0	0.17	0.06	0	0.09	0.05	0	0.16	0.05	0	0.05	0.02
Hardness	mg/L $CaC0_3$	na	na	na	163	218	189	93	140	114	144	190	168	94	130	109	96	160	126
Iron	mg/L	0.3*	5	na	0	0.06	0.02	0.005	0.75	0.105	0	0.12	0.04	0.04	0.32	0.12	0.005	0.04	0.019
Kjeldahl Nitrogen	mg/L	na	na	na	0	0.43	0.11	0.01	0.66	0.27	0	0.35	0.12	0.01	0.97	0.41	0.13	0.37	0.22
Langelier Index	-	na	na	na	-0.21	0.73	0.29	-1.78	-0.04	-1.05	-0.26	0.49	0.14	-1.03	-0.03	-0.61	-0.89	-0.1	-0.35
Lead	mg/L	0.01	0.2	0.1	0	0.001	0.001	0.001	0.01	0.002	0	0.001	0.001	0	0.007	0.002	0	0.001	0.001
Magnesium	mg/L	na	na	na	14	19	16	3.63	8.81	6	7	11	9	3.13	6.3	4.71	5	8	6
Manganese	mg/L	0.05*	0.2	na	0	0.014	0.004	0	0.06	0.01	0	0.01	0.003	0	0.03	0.01	0	0.01	0.003
Mercury	mg/L	0.001	na	0.003	0	0.00005	0.00002	0	0.0005	0.0003	0	0.00005	0.00003	0.00001	0.0005	0.00015	0	0.0005	0.0001
Nickel	mg/L	na	0.2	1	0	0.005	0.002	0	0.005	0.004	0	0.003	0.002	0	0.005	0.003	0	0.005	0.002
Nitrate	mg/L N	45	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0.12	0.3	0.2	0.003	0.14	0.052	0.08	0.24	0.20	0	0.137	0.054	0.05	0.32	0.17
Nitrite	mg/L	na	na	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate	mg/L P	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5-8.5*	na	na	7.9	8.6	8.3	6.6	8.3	8.0	8.2	8.5	8.3	6.7	8.4	7.8	7.5	8	7.8
Potassium	mg/L	na	na	na	0	0.8	0.4	0.38	1.02	0.65	0.5	0.7	0.6	0.42	0.54	0.49	0	0.5	0.2
Reactive Silica	mg/L SiO2	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0	0.001	0.0004	0	0.005	0.0016	0	0.001	0.0007	0	0.005	0.002	0	0.005	0.001
Silver	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/L	200*	na	na	9	11	10	3	15	11	11	14	12	5	10	8	6	7	7
Specific Conductance	uS/cm	na	na	na	250	407	360	125	379	245	316	390	346	125	244	212	210	312	262
Sulphate	mg/L	500*	na	1,000	5	8	6	3	11	6	6	9	8	2	6	5	4	7	5
Sulphide	mg/L H2S	0.05*	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	212	265	240	110	242	167	180	240	206	119	186	146	137	203	171
Total Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	mg/L	na	na	na	0	0.04	0.01	0	0.75	0.04	0	0.02	0.01	0	0.07	0.02	0	0.04	0.02
Total Suspended Solids	mg/L	na	na	na	2	2	2	1	10	2	2	2	2	2	4	2	-	-	-
True Color	TCU	15*	na	na	5	40	16	13	98	52	0	55	16	51	97	67	19	73	31
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.12	0.80	0.31	0.08	6.20	1.12	0.2	0.90	0.44	0.17	3	1.12	0.05	1.4	0.51
Uranium	mg/L	0.02	0.01	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canadian Water Quality Index (CWQI)	-	-	-	-	95	100	98	94	95	94	97	97	97	90	92	91	93	96	95
Zinc	mg/L	5*	1 - 5	50	0	0.02	0.004	0.003	0.13	0.015	0	0.011	0.004	0	0.18	0.02	0	0.005	0.002

Notes:
CDWQG = Health Canada Canadian Drinking Water Quality Guidelines (March, 2007)
CWQG-AWU = CCME Canadian Water Quaility Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock Water) (October, 2005)
1 = Summary statisitics calculated using chemicial data obtained from the NL Deprtment of Environment - Water Resources Management Division Drinking Water Quality Database.
na = No applicable criteria
* = Aesthetic objective
** = Operational guideline value based on conventional treatment/slow sand or diatomaceous earth filtration/membrane filtration.
"-" = Not analyzed
Shaded = Value does not meet applicable criteria
Bolded = Value does not meet CWQG-AWU for irrigation and/or livestock water

Table 15.4 Groundwater Chemistry, Private Drilled Wells, Port au Port ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Communities[1]							
					Campbells Creek		Marches Point		Boswarlos	Piccadilly	Sheaves Cove	Three Rock Cove
			Irrigation Water	Livestock Water	18348	17021	10552	13819	17022	11381	15669	16135
Alkalinity	mg/L $CaCO_3$	na	na	na	244	245	153.6	221	24.9	262	171	220
Aluminum	mg/L	na	5	5	0.05	-	-	0.05	-	-	-	-
Ammonia	mg/L	na	na	na	0.01	0.02	-	0.01	0.56	-	0.02	0.18
Antimony	mg/L	0.006	na	na	0.01	-	-	0.01	-	-	-	-
Arsenic	mg/L	0.01	0.1	0.025	0.01	-	-	0.01	-	-	-	-
Barium	mg/L	1	na	na	0.5	-	-	0.5	-	-	-	-
Beryllium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-
Bicarbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	0.1	-	-	0.1	-	-	-	-
Bromide	mg/L	na	na	na	-	-	-	-	-	-	-	-
Cadmium	mg/L	0.005	0.005	0.08	0.001	0.0005	-	0.001	0.0005	-	0.0005	0.0005
Calcium	mg/L	na	na	na	80	41	59	61	310	110	42	18
Carbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	140	34	62	24	**343**	19.4	78	52
Chromium	mg/L	0.05	na	na	0.005	-	-	0.005	-	-	-	-
Copper	mg/L	1*	0.2 - 1	0.5-5	0.01	0.08	-	0.01	0.005	-	0.005	0.01
Dissolved Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-	-	-
Fluoride	mg/L	1.5	1	1 - 2	0.11	0.05	0.05	0.07	-	0.16	0.21	0.27
Hardness	mg/L $CaCO_3$	na	na	na	319	185	179	235	1230	353	195	98.5
Iron	mg/L	0.3*	5	na	0.02	0.01	2.6	0.01	0.1	0.01	0.01	0.08
Kjeldahl Nitrogen	mg/L	na	na	na	0.11	-	-	0.05	-	-	-	-
Langelier Index	-	na	na	na	-	-	-	-	-	-	-	-
Lead	mg/L	0.01	0.2	0.1	0.001	-	-	0.001	-	-	-	-
Magnesium	mg/L	na	na	na	29	20	6.4	20	110	19	22	13
Manganese	mg/L	0.05*	0.2	na	0.01	0.005	**0.37**	0.01	0.05	0.005	0.005	0.005
Mercury	mg/L	0.001	na	0.003	-	-	-	-	-	-	-	-
Nickel	mg/L	na	0.2	1	0.005	-	-	0.005	-	-	-	-
Nitrate	mg/L N	45	na	na	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0.22	0.3	0.11	0.35	0.004	0.34	0.23	0.004
Nitrite	mg/L	na	na	10	0.001	0.002	-	0.001	0.001	0.001	0.004	0.001
Orthophosphate	mg/L P	na	na	na	0.01	0.02	-	0.01	0.02	-	0.02	0.02
pH	Units	6.5-8.5*	na	na	7.46	7.94	-	7.34	8.94	7.2	7.88	8.06
Potassium	mg/L	na	na	na	2.64	0.96	2.53	2.09	9.4	1.41	1.36	4.4
Reactive Silica	mg/L SiO2	na	na	na	-	-	-	-	-	-	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	-	-	-	-	-	-	-	-
Silver	mg/L	na	na	na	-	-	-	-	-	-	-	-
Sodium	mg/L	200*	na	na	53	20	36	13	385	12	42	62
Specific Conductance	uS/cm	na	na	na	849	468	-	481	3,300	552	585	511
Sulphate	mg/L	500*	na	1,000	15	9.2	14	12	**1,750**	12	57	6.6
Sulphide	mg/L H2S	0.05*	na	na	-	0.03	-	-	0.47	-	0.03	0.03
Thallium	mg/L	na	na	na	-	-	-	-	-	-	-	-
Tin	mg/L	na	na	na	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	**569**	470	333	360	0.5	427	**537**	440
Total Organic Carbon	mg/L	na	na	na	0.5	1.2	-	0.5	-	-	0.9	1.3
Total Phosphorus	mg/L	na	na	na	0.01	0.02	0.19	0.01	0.02	0.01	0.03	0.02
Total Suspended Solids	mg/L	na	na	na	3	4	-	2	4	-	4	12
True Color	TCU	15*	na	na	-	-	-	-	-	-	-	-
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.2	0.11	-	0.05	0.73	-	0.7	6.95
Uranium	mg/L	0.02	0.01	0.2	-	-	-	-	-	-	-	-
Vanadium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-
Zinc	mg/L	5*	1 - 5	50	0.09	0.08	0.03	0.11	0.02	0.05	0.05	0.02

Notes:

CDWQG = Health Canada Canadian Drinking Water Quality Guidelines (March, 2007)

CWQG-AWU = CCME Canadian Water Quaility Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock Water) (October, 2005)

1 = Chemicial data obtained from the NL Department of Environment - Water Resources Management Division Drinking Water Quality Database

na = No applicable criteria

* = Aesthetic objective

** = Operational guideline value based on conventional treatment/slow sand or diatomaceous earth filtration/membrane filtration.

"-" = Not analyzed

Shaded = Value does not meet applicable criteria

Bolded = Value does not meet CWQG-AWU for irrigation and/or livestock water

Table 15.5 Groundwater Chemistry, Protected Public Drilled Wells, Port au Port ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Sheaves Cove WS-G-0643 (2001 - 2007)[1]			Ship Cove-Lower Cove-Jerry's Nose WS-G-0648 (2001 - 2007)[1]			Ship Cove-Lower Cove-Jerry's Nose WS-G-0840 (2001 - 2007)[1]			Ship Cove-Lower Cove-Jerry's Nose WS-G-0839 (2001 - 2007)[1]			Ship Cove-Lower Cove-Jerry's Nose WS-G-0838 (2001 - 2007)[1]			Ship Cove-Lower Cove-Jerry's Nose WS-G-0649 (2001 - 2007)[1]			Ship Cove-Lower Cove-Jerry's Nose WS-G-0837 (2001 - 2007)[1]		
			Irrigation Water	Livestock Water	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L $CaCO_3$	na	na	na	119	214	182	210	235	225	231	250	241	126	193	162	202	255	240	200	210	206	186	217	202
Aluminum	mg/L	na	5	5	0.01	0.11	0.05	0	0.21	0.05	0	0.025	0.005	0.02	0.35	0.074	0	0.04	0.02	0	0.04	0.01	0	0.2	0.03
Ammonia	mg/L	na	na	na	0	0.04	0.01	0	0.08	0.02	0.03	0.07	0.05	0	0.1	0.02	0	0.01	0.00	0	0.01	0.004	0	0.03	0.01
Antimony	mg/L	0.006	na	na	0	0.0005	0.0002	0	0.0005	0.0003	0	0.0005	0.0001	0	0.0005	0.0001	0	0.0005	0.0001	0	0.0005	0.0001	0	0.0005	0.0003
Arsenic	mg/L	0.01	0.1	0.025	0	0.001	0.0004	0	0.001	0.0006	0	0.002	0.0006	0	0.001	0.0003	0	0.001	0.0004	0	0.001	0.0004	0	0.001	0.0005
Barium	mg/L	1	na	na	0.02	0.07	0.04	0.04	0.14	0.05	0.1	0.14	0.12	0.07	0.15	0.10	0.1	0.14	0.12	0.07	0.092	0.09	0.11	0.14	0.13
Beryllium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	0	0.03	0.02	0.01	0.03	0.02	0.05	0.08	0.06	0.01	0.03	0.02	0.02	0.05	0.04	0	0.03	0.01	0.02	0.03	0.03
Bromide	mg/L	na	na	na	0	0.11	0.02	0	0.08	0.03	0	0.23	0.06	0	0.19	0.08	0	0.1	0.03	0	0.24	0.11	0	0.19	0.03
Cadmium	mg/L	0.005	0.005	0.08	0	0.00005	0.00002	0	0.00005	0.00003	0	0.00005	0.00002	0	0.0001	0.00003	0	0.00005	0.00002	0	0.00005	0.00002	0	0.0004	0.0002
Calcium	mg/L	na	na	na	43	80	65	54	69	60	67	91	75	43	73	58	66	80	73	58	70	63	62	82	72
Carbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	29	99	48	19	39	25	48	63	55	42	65	52	40	59	51	39	63	49	31	42	36
Chromium	mg/L	0.05	na	na	0	0.004	0.002	0	0.008	0.002	0	0.011	0.002	0	0.007	0.002	0	0.004	0.001	0	0.003	0.001	0	0.003	0.001
Copper	mg/L	1*	0.2 - 1	0.5-5	0.001	0.008	0.004	0.002	0.009	0.004	0.002	0.062	0.013	0.002	0.012	0.004	0.002	0.013	0.004	0	0.039	0.005	0.006	0.018	0.008
Dissolved Organic Carbon	mg/L	na	na	na	1.7	19.1	5.3	0	2.5	0.9	0.9	2.4	1.4	2.9	5.4	4.4	0.5	1.9	1.3	0	3.7	0.8	1.6	3.9	2.8
Fluoride	mg/L	1.5	1	1 - 2	0	0.19	0.07	0	0.14	0.11	0	0.24	0.17	0	0.19	0.07	0	0.23	0.15	0	0.15	0.09	0	0.16	0.11
Hardness	mg/L $CaCO_3$	na	na	na	128	259	202	209	263	235	241	310	260	136	230	182	214	270	247	215	250	227	192	250	217
Iron	mg/L	0.3*	5	na	0.02	0.13	0.06	0	0.12	0.02	0	0.62	0.16	0	0.64	0.11	0	0.04	0.01	0	0.06	0.01	0	0.09	0.03
Kjeldahl Nitrogen	mg/L	na	na	na	0	0.36	0.13	0	0.11	0.04	0	0.47	0.12	0.025	0.5	0.25	0	0.15	0.06	0	0.3	0.1	0.025	0.3	0.1
Langelier Index	-	na	na	na	-0.45	0.52	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	mg/L	0.01	0.2	0.1	0	0.002	0.001	0	0.044	0.005	0	0.009	0.003	0	0.038	0.006	0	0.006	0.002	0	0.006	0.001	0.044	0.074	0.061
Magnesium	mg/L	na	na	na	5	15	10	10	24	21	16	19	17	7	11	9	12	19	16	16	19	17	8	11	9
Manganese	mg/L	0.05*	0.2	na	0	0.005	0.002	0	0.06	0.01	0.084	**0.215**	0.166	0.005	**0.54**	0.086	0	**0.21**	0.037	0	0.025	0.005	0.05	0.103	0.073
Mercury	mg/L	0.001	na	0.003	0	0.00005	0.00002	0	0.00005	0.00003	0	0.00005	0.00002	0	0.00005	0.00002	0	0.00005	0.00002	0	0.00005	0.00002	0	0.00005	0.00003
Nickel	mg/L	na	0.2	1	0	0.005	0.002	0	0.005	0.002	0	0.005	0.001	0	0.03	0.004	0	0.005	0.001	0	0.005	0.001	0	0.005	0.002
Nitrate	mg/L N	45	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0.11	0.32	0.18	0.05	0.22	0.17	0	0.05	0.02	0.21	0.62	0.47	0	0.31	0.17	0.27	0.45	0.37	0	0.11	0.04
Nitrite	mg/L	na	na	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate	mg/L P	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5-8.5*	na	na	7.5	7.9	7.6	7.4	8	7.8	7.5	8	7.8	7.3	8	7.6	7.4	8	7.7	7.4	8.1	7.8	7.3	8.1	7.7
Potassium	mg/L	na	na	na	0	1	0.3	0	2	1	2	3	2	1	2	1	1	2	2	0	1.1	0.5	0.5	2	1.2
Reactive Silica	mg/L SiO2	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0	0.001	0.0004	0	0.001	0.0005	0	0.001	0.0004	0	0.001	0.0003	0	0.001	0.0004	0	0.001	0.0004	0	0.001	0.0006
Silver	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/L	200*	na	na	24	56	32	12	21	15	27	39	31	24	37	31	29	35	32	23	28	25	20	27	23
Specific Conductance	uS/cm	na	na	na	375	684	562	453	535	492	594	676	622	363	616	493	558	665	608	514	607	547	455	553	503
Sulphate	mg/L	500*	na	1,000	6	64	28	6	12	7	11	13	12	9	18	13	10	11	11	9	11	10	9	14	11
Sulphide	mg/L H2S	0.05*	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	0	460	323	269	400	319	372	439	403	236	408	320	337	432	388	305	395	351	296	408	326
Total Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	mg/L	na	na	na	0	0.03	0.01	0	0.02	0.01	0	0.03	0.01	0	0.17	0.04	0	0.03	0.01	0	0.02	0.01	0	0.03	0.01
Total Suspended Solids	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
True Color	TCU	15*	na	na	3	20	10	0	8	2	0	3	1	2	23	15	0	4	2	0	11	2	8	13	10
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.5	6.5	2.5	0	0.3	0.2	0.3	2.9	0.8	0.4	22.1	3.8	0.3	3	1.0	0.1	1.2	0.3	0.05	0.6	0.2
Uranium	mg/L	0.02	0.01	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Canadian Water Quality Index (WQI)	-	-	-	-	97	97	97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	mg/L	5*	1 - 5	50	0	0.02	0.01	0	0.1	0.02	0	0.04	0.02	0	0.03	0.01	0	0.02	0.01	0	0.011	0.003	0.1	0.17	0.12

Notes:
CDWQG = Health Canada Canadian Drinking Water Quality Guidelines (March, 2007)
CWQG-AWU = CCME Canadian Water Quaility Guidelines for the Protection of Agricultural Water Uses (Irrigation and Livestock
1 = Chemicial data obtained from the NL Department of Environment - Water Resources Management Division Drinking Water Quality Database. Note in the database, prior to March 31, 2004 analytical results less than detection limit were reported as half of the detection limit, while after March 31, 2004 analytical results less than the detection limit were reported as zer
na = No applicable criteria
* = Aesthetic objective
** = Operational guideline value based on conventional treatment/slow sand or diatomaceous earth filtration/membrane filtration.
"-" = Not analyzed
Shaded = Value does not meet applicable criteria
Bolded = Value does not meet CWQG-AWU for irrigation and/or livestock water