12.0 HYDROGEOLOGY OF BOTWOOD, LEWISPORTE & COMFORT COVE ADAS

12.1 General Description of Area

12.1.1 Location & Extent

The Botwood, Lewisporte and Comfort Cove ADAs are located in close proximity to each other at the head of the Bay of Exploits, Nortre Dame Bay in north central Newfoundland. The Botwood ADA is located along the west side of the Bay of Exploits, and is the largest of the three ADAs, covering an area of approximately 14,829 hectares, and extending approximately 18 km north from Botwood to Point Lemington, and at its widest point extending west approximately 8 km inland from the coast. The Lewisporte ADA is located approximately 7 km southeast of the Botwood ADA, covering an area of approximately 7,901 hectares along the east side of the Bay of Exploits. The Comfort Cove ADA is located along the east side of the Bay of Exploits, approximately 27 km northeast of the Lewisporte and Botwood ADAs. The Comfort Cove ADA is approximately 2,094 hectares and encompasses the Comfort Cove-Newstead Peninsula, which juts out into the Bay of Exploits between Indian Arm and Loon Bay, and is connected to the main part of the island by a narrow, approximately 500 m wide isthmus located just north of Indian Head Pont. The boundaries of the Botwood, Lewisporte and Comfort Cove ADAs are shown on Drawing No. 1034406-12-1 in Appendix 12a.

The Botwood ADA overlaps the communities of Botwood, Point Lemington and Northern Arm, while the Lewisporte ADA overlaps the communities of Alderburn, Burnt Arm, Laurenceton, Porterville, and Brown's Arm, and the Comfort Cove ADA overlaps the community of Comfort Cove – Newstead.

The main access to the Botwood ADA is provided by Provincial Highway Route 350 (Botwood Highway), which leads north to Botwood and Point Leamington from the Trans Canada Highway near Bishop's Falls and Grand Falls-Windsor. The main access to the Lewisporte and Comfort Cove ADAs is provided by Provincial Highway Route 340 (also known as the "Road To The Isles"), which leads north to Twillingate from the Trans Canada Highway at Notre Dame Junction. Secondary Highway Route 341 (Laurencton Road) branches off Highway Route 340 from Stanhope, just outside Lewisporte, leading to Laurencton, and provides access to the Lewisporte ADA, while secondary Highway Route 343 (Comfort Cove Road) branches off Highway Route 340 at Campbellton and provides access to the Comfort Cove ADA. In addition, various graveled roads and ATV trails leading from Highway Routes 340, 341 and 343 also provide access to some areas within the ADAs.

12.1.2 Physiography, Topography & Drainage

The Botwood, Lewisporte and Comfort Cove ADAs are located within the physiographic region referred to as the Northeast Trough. This physiographic region is characterized by elevations ranging from sea level up to 150 m above sea level, but rises to elevations of up to 300 m above sea level along local ridges, as well as along its western boundary with the adjoining Atlantic Upland Region. The Botwood and Lewisporte ADAs are characterized by undulating to rolling terrain the trends northeast towards the coast. Relief is greatest within the Botwood ADA, ranging from sea level along coastal boundaries to approximately 180 m above sea level along local ridges, including in the Powsells Hills area, located

along the northwestern boundary of the ADA, approximately 2 km south of Point Lemington. Terrain within the Lewisporte ADA is less variable ranging from sea level along coastal boundaries to approximately 100 m above sea level along scattered ridges and hills. The Comfort Cove ADA is characterized by relatively flat-lying to gently undulating terrain and low elevations, with small scattered hills rising to elevations between 30 to 60 m above sea level. There are no significant upland regions in the general vicinity of the ADAs. Coastal areas in the vicinity of the ADAs are rugged and punctuated by numerous bays and islands.

The Botwood ADA encompasses the lower course of the New Bay River drainage system in the northern portion of the site, and the headwaters of Charles Brook drainage system in the south-western portion of the site. A number of other smaller unnamed watercourses are also present in the ADA that either drain into New Bay or the Bay of Exploits. The southern boundary of the Botwood ADA borders the lower course of Northern Arm Brook. The Lewisporte ADA encompasses the lower courses of several small unnamed stream and pond systems that drain directly into the Bay of Exploits, and borders the lower course of the Lily Pond Drainage system along its southern boundary. No significant stream and river drainage systems are present in the vicinity of the Comfort Cove ADA. Small ponds are scattered throughout the drainage catchment areas of the ADAs.

Five Public Protected Water Supply Areas (PPWSA) overlap the Botwood ADA and portions of its drainage catchment area, including the Grand Falls – Windsor – Northern Arm Lake PPWSA, located east of the Botwood ADA within the Northern Arm Brook drainage area, Point Leamington – Little Pond PPWSA, located along the northwest portion of the ADA, and the Point of Bay – Indian Cove Pond PPWSA, Phillips Head – Dogberry Brook PPWSA and Northern Arm – Muddy Hole Pond PPWSA, located along the southeastern portion of the ADA. No PPWSA are present within the Lewisporte ADA or its drainage catchment area. The Comfort Cove – Newstead Steady Cove Pond PPWSA is located within the Comfort Cove ADA.

12.1.3 Climate, Vegetation & Agricultural Land Use

The Botwood, Lewisporte and Comfort Cove ADAs are located within the Northshore ecoregion, a long narrow zone about 20 km wide along the northeastern coast of Newfoundland. Within this zone, summers are relatively warmer and drier than other coastal areas in the province, and soil moisture deficiencies may occur. The vegetation season is shorter and cooler than in central Newfoundland, but the frost-free period is several weeks longer. Climate data obtained from Environment Canada's Botwood monitoring station dating back to 1971 indicates a monthly mean temperature in the area of 4.3°C, ranging from a high of 17°C in July to a low of -8.1°C in February. Average annual precipitation in the area is 986 mm, of which 76% falls as rainfall and 24% as snowfall. October is typically the wettest month, and April is typically the driest month (Environment Canada, 2008). In the ADAs, there are an average of 1,373 growing degree days (base temperature 5^{o}C) for the year and 1,262 growing degree days for the vegetative season (i.e., May to September).

Vegetation in the vicinity of the Botwood, Lewisporte and Comfort Cove ADAs generally consists of continuous forest of black spruce and balsam fir, except where heathland barrens dominate coastal headlands. Local stands of white spruce forests occur within a narrow zone along the coast. 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 66 hectares of the Botwood ADA (i.e., <1% of the total landmass of the ADA) is currently utilized for agriculture, with fallow and vegetable crop land representing the most significant proportion of the

ADA's agricultural land use. While approximately 111 hectares of the Lewisporte ADA and 214 hectares of the Comfort Cove ADA (i.e., 1% and 10% of the total landmass of the ADAs, respectively) is currently utilized for agriculture, with forage, pasture and vegetable crop land representing the most significant proportion of these ADAs' agricultural land use.

12.2 Geology

12.2.1 Surficial Geology

The surficial geology of the Botwood, Lewisporte and Comfort Cove ADAs is summarized in Drawing No. 1034406-12-2 in Appendix 12a, and is based on regional scale compilation by Liverman and Taylor (1990), as well as descriptions of surficial geology provided in Van de Hulst (1993) and Liverman and Taylor (2000b). 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 ADAs 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 veneer and moraine tills comprise a moderately stoney, sandy loam derived from black slate, shale and siltstone, and minor medium-grained granite. The veneer and moraine till deposits are locally eroded and dissected with numerous meltwater channel scars. In addition, small areas of hummocky till occur locally. Within the ADAs, sand and gravel deposits of glacial outwash and fluvial origin are limited and generally confined to stream and river valleys, with the most significant occurrence of these deposits present along Northern Arm Brook in the Botwood ADA. Sand and gravel units shown in Drawing No. 1034406-12-2 in Appendix 12a also include un-subdivided marine terraces that contain various silt and clay deposits in addition to sands and gravels and occur locally particularly along coastal areas in the Lewisporte ADA. Along with glacial units, local deposits of organic and peaty soils are common throughout the ADAs, overlying either till or bedrock. Numerous ridges and knobs of bedrock outcrop are exposed within the till and various other surficial deposits that underlie the ADAs, and typically occur as areas of high ground and 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 north to northeastward directed flow. Available well logs indicate an average overburden thickness in the Botwood, Lewisporte and Comfort Cove ADAs and surrounding areas of approximately 8 m.

12.2.2 Bedrock & Structural Geology

The bedrock geology of the Botwood, Lewisporte and Comfort Cove ADAs is summarized in Drawing No. 1034406-12-3 in Appendix 12a, 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 McNicoll, et al. (2006).

The Botwood, Lewisporte and Comfort Cove ADAs lie within the Exploits Subzone of the Dunnage tectonostratigraphic zone and are underlain by both Lower to Middle Ordovician subduction zone-related rocks and Late Ordovician to Early Devonian sediment-dominated overstep basin sequences. The oldest rocks underlying the ADAs consist of Cambrian to Middle Ordovician island-arc and subduction zone-related volcanic and associated sedimentary rocks, including the Dunnage Melange,

Philips Head Igneous Complex and Wild Bight and Exploits Group. Within the Botwood ADA, the Wild Bight Group is locally overlain by a thick unit of Late Ordovician (Caradocian) chert and shale of the Shoal Arm Formation. In the northern portion of the Botwood ADA, this formation is conformably overlain by a Late Ordovician to Early Silurian shoaling-upward sequence of marine sandstone, shale and conglomerate of the Badger Group. The Badger Group is also present along the southern boundary of the Lewisporte ADA and is conformably overlain by the Silurian Botwood Group, a sequence of subaerial mafic and felsic volcanic and volcaniclastic rocks and shallow marine to subaerial sandstone, siltstone and conglomerate. The Botwood Group is also present along the southern boundary of the Botwood ADA, where it is in fault contact with the older Cambro-Ordovician subduction zone-related volcanic and sedimentary rocks, and is intruded by various gabbroic and grantitic rocks of the Silurian Hodges Hill intrusive suite. In the southern portion of the Comfort Cove ADA, the Dunnage Melange is intruded by the Early Devonian Loon Bay granite.

The Ordovician and Silurian volcanic and sedimentary rocks that underlie the ADA have undergone regional folding and faulting related to Silurain Salinic and Devonian Acadian orogenies. Rocks in the area are generally folded into northeast-plunging open folds with steep limbs. Northeast-directed thrust faults and high angle faults with strike-slip offsets are also common, the most significant of which is the Northern Arm Fault, located along the southern boundary of the Botwood ADA, which separates the Botwood Group from the older Cambro-Ordovician subduction zone-related volcanic and sedimentary rocks. In addition, various joint sets and fracture zones occur within rocks underlying the ADAs related to deformation.

12.3 Hydrogeology

12.3.1 Hydrostratigraphy

The groundwater potential of the various geological units within the Botwood, Lewisporte and Comfort Cove ADAs 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 159 drilled bedrock wells and seven (7) drilled surficial wells from ten (10) communities in the Botwood, Lewisporte and Comfort Cove ADAs and surrounding areas had adequate well data to evaluate the groundwater potential of various surficial and bedrock strata in the ADAs. 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. 1034406-12-3 in Appendix 12a.

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 Botwood, Lewisporte and Comfort Cove ADAs and surrounding areas are 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 ADAs and surrounding areas. Therefore, in the absence of this data, the groundwater potential of the various geological strata in the Botwood, Lewisporte and Comfort Cove ADAs is defined based on the estimated well yields obtained from the driller's records.

12.3.1.1 Surficial Hydrostratigraphic Units

The surficial deposits within the Botwood, Lewisporte and Comfort Cove ADAs 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 12.2. No water well information was available for the till deposits present in the ADAs. 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 and more extensive moraine deposits over much of the ADAs and comprises a moderately stoney, sandy loam. There are no documented data on their groundwater potential in the Botwood, Lewisporte and Comfort Cove ADAs. 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

Sand and gravel deposits of glacial outwash and fluvial origin occur sparingly within the ADAs, and are generally confined to stream and river valleys, with the most significant occurrences of these deposits are present along Northern Arm Brook in the Botwood ADA. Marine-derived sand and gravel units also occur locally, particularly along coastal areas in the Lewisporte ADA. These deposits are potentially significant groundwater aquifers. Seven (7) wells from the communities of Brown's Arm and Laurenceton were available to characterize the groundwater potential of this unit in the ADAs. Based on well data, the sand and gravel deposits are considered capable of providing wells with moderate to high yields, having water yields ranging from 24 to 272 L/min at well depths of 13 to 24 m, and an average yield of 78 L/min at 19 m depth. However, median yield and depth estimates of 50 L/min at 19 m depth are more likely representative of the typical groundwater potential of this unit.

Table 12.1 Summary of Overburden Drilled Well Information for Botwood, Lewisporte and Comfort Cove ADAs

Overburden Unit	Communities	No. of Wells	Well Depth (m)		Well Yield (L/min)	
			Mean	Range	Mean	Range
Till*	St. John's ADA	6	21.3 (19.6)	9.5 - 35	39.5 (33.5)	10 - 70
Sand & Gravel	Brown's Arm Laurenceton	7	18.9 (18.9)	12.9-24	77.7 (49.5)	24-272.8

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

12.3.1.2 Bedrock Hydrostratigraphic Units

Well record information is available for the majority of bedrock units located within the Botwood, Lewisporte and Comfort Cove ADAs, including the combined Cambrian to Middle Ordovician island-arc and subduction zone-related volcanic and associated sedimentary rocks of the Dunnage Melange, Philips Head Igneous Complex and Wild Bight and Exploits groups, as well as the combined Late Ordovician marine sedimentary rocks of the Shoal Arm Formation and Badger Group, and the Botwood Group. The well yield and depth characteristics of these various strata are summarized in Table 12.2.

No water well information was available for the areas of Silurian - Devonian granitic rocks that occur along the southern boundaries of the Botwood and Comfort Cove ADAs (i.e., Hodges Hill intrusive suite and Loon Bay granite, respectively). Groundwater potential within the Silurian – Devonian granitic rocks was inferred based on well records for wells completed within similar strata in the Terra Nova ADA.

Cambrian to Middle Ordovician Subduction Zone-Related Rocks

A total of 80 well records from the communities of Comfort Cove – Newstead, Brown's Arm, Porterville, Philips Head, Point of Bay and Bulley's Cove were used to characterize the groundwater potential of the combined Cambrian to Middle Ordovician island-arc and subduction zone-related volcanic and associated sedimentary rocks of the Dunnage Melange, Philips Head Igneous Complex and Wild Bight and Exploits groups. These units underlie portions of all three ADAs. Based on well data, the Cambrian to Middle Ordovician subduction zone-related rocks are considered capable of providing wells with low yields, having water yields ranging from 0.3 to 182 L/min at well depths of 9 to 122 m, and an average yield of 19 L/min at 49 m depth. However, median yield and depth estimates of 9 L/min at 43 m depth are more likely representative of the typical groundwater potential of these units.

Shoal Arm Formation and Badger Group

A total of 21 well records from the community of Point Lemington were used to characterize the groundwater potential of the combined Late Ordovician marine sedimentary rocks of the Shoal Arm Formation and Badger Group. These units are present within the Botwood and Lewisporte ADAs. Based on well data, the Shoal Arm Formation and Badger Group strata are considered capable of providing wells with low yields, having water yields ranging from 1 to 230 L/min at well depths of 12 to 113 m, and an average yield of 24 L/min at 54 m depth. However, median yield and depth estimates of 14 L/min at 46 m depth are more likely representative of the typical groundwater potential of these units.

Botwood Group

A total of 58 well records from the communities of Northern Arm, Laurenceton, and Botwood were used to characterize the groundwater potential of the Botwood Group. This unit underlies the majority of the Lewisporte ADA, and is also present along the southern boundary of the Botwood ADA. Based on well data, the Botwood Group strata are considered capable of providing wells with low yields, having water yields ranging from 1 to 273 L/min at well depths of 12 to 98 m, and an average yield of 31 L/min at 47 m depth. However, median yield and depth estimates of 10 L/min at 45 m depth are more likely representative of the typical groundwater potential of this unit.

Silurian - Devonian Granite

No documented data is available for the groundwater potential of the Silurian - Devonian granitic rocks that occur along the southern boundaries of the Botwood and Comfort Cove ADAs. However, based on records from two (2) water wells within similar granitic rocks in the Terra Nova ADA, this unit is considered capable of providing wells with low yields, reporting yields of 18 L/min at 73 m depth, and 20 L/min at 13 m depth, respectively.

Table 12.2 Summary of Bedrock Drilled Well Information for Botwood, Lewisporte and Comfort Cove ADAs

Rock Group	Rock Type	Communities	No. of Wells	Well Depth (m)		Well Yield (L/min)	
				Mean (Median)	Range	Mean (Median)	Range
Dunnage Melange, Philips Head Igneous Complex, and Wild Bight and Exploits groups)	Subduction zone volcanic and sedimentary rocks	Comfort Cove - Newstead Brown's Arm Porterville Philips Head Point of Bay Bulley's Cove	80	48.5 (42.7)	9.1-121.9	19.5 (9.1)	0.3-181.8
Shoal Arm Formation/ Badger Group	Marine sandstone, shale, chert and conglomerate	Point Lemington	21	54.4 (46.2)	12-112.8	24.3 (13.5)	1-230
Botwood	Bimodal volcanic and siliciclastic sedimentary rocks	Northern Arm Laurenceton Botwood	58	47.4 (45.3)	12.2-97.6	30.9 (9.6)	1-272.8
Loon Bay Batholith Hodges Hill Intrusive Suite	Silurian – Devonian Granite	Terra Nova ADA	2	-	13.4, 73.2	-	18, 20

*Groundwater yield estimates for granitic rocks based on well data from the Terra Nova ADA

12.3.2 Groundwater Flow System

The Botwood, Lewisporte and Comfort Cove ADAs and surrounding areas are 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 ADAs 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. It is expected that the shallow groundwater system in the ADAs will be largely controlled by surface runoff and local recharge. while at moderate depths the flow systems in the Botwood and Lewisporte ADAs may be influenced by lateral inflow of groundwater from regional up-gradient areas to the southeast and southwest. An ocean island setting is inferred for the area underlying the Comfort Cove 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. Based on a review of water well records for the area, groundwater levels are generally assumed to be within 6 m of the ground surface and to be a subdued reflection of the topography.

12.4 Water Quality

12.4.1 Surface Water Quality

Surface water quality data for the Botwood, Lewisporte and Comfort Cove ADAs was obtained from water quality monitoring data collected by the NL Department of Environment - Water Resources Management Division from six (6) protected public surface water supplies in the area of the ADAs -

- Grand Falls-Windsor - Northern Arm Lake (WS-S-0291, 1987-2007);
- Northern Arm - Muddy Hole Pond (WS-S-0514, 1987-2007);
- Phillips Head - Dogberry Brook (WS-S-0538, 1988-2006);
- Point of Bay - Indian Cove Pond (WS-S-0559, 1991-2006);
- Point Leamington - Little Pond (WS-S-0556; 1998-2006); and,
- Comfort Cove-Newstead - Steady Cove Pond (WS-S-0185, 1988-2007)

A summary of chemical data obtained from these surface water sources over their respective monitoring periods is provided in Table 12.3 in Appendix 12b, 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 ADAs and surrounding area can be classified as a combination of calcium-sodium-chloride-sulfate-bicarbonate (Ca-Na-Cl-SO_4-HCO_3) and calcium-sodium-bicarbonate-chloride-sulfate (Ca-Na-HCO3-Cl-SO4) type waters. Surface water in the area is soft to moderately hard, slightly acidic to slight basic, and of low to moderate alkalinity. Classification of surface water according to dissolved-solids and specific conductance indicates fresh conditions.

With the exception of iron, manganese, pH, turbidity and color present in some of the protected public surface water supplies, concentrations of all other parameters tested meet CDWQG. The guidelines for iron, manganese, pH, 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 in the case of iron, manganese, turbidity and color, and corrosion in the case of pH.

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 ADAs is generally considered good to excellent, returning average Canadian Water Quality Index (CWQI) values ranging from 91 to 100. However, a negative Langelier Index at all 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. Treatment would be required to improve the aesthetic quality of the water.

12.4.2 Groundwater Quality

The groundwater quality data for the ADAs consists of analyses from four (4) private drilled wells from the communities of Laurenceton, Northern Arm, and Point Lemington, as well as one (1) protected public supply drilled well for the community of Laurenceton (WS-G-0474) 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 12.4 and 12.5 in Appendix 12b, 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, shallow groundwater in the ADAs can be classified as both sodium-calcium-chloride-sulfate-bicarbonate (Na-Ca-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 slightly to very hard, neutral to slightly basic, and of moderate to high alkalinity. Classification of groundwater according to dissolved-solids and specific conductance generally indicates fresh conditions. However, slightly saline conditions were identified in the central well of the Laurencton protected groundwater supply, returning a specific conductance value and total dissolved solids value of 1,250 uS/cm and 708 mg/L, respectively.

With the exception of manganese, total dissolved solids and turbidity concentrations present in several of the private wells, and arsenic, cadmium, iron, lead, manganese, sodium, total dissolved solids turbidity and zinc in the Laurencton protected groundwater supply, concentrations of all other parameters tested meet CDWQG. The guidelines for iron, manganese, sodium, total dissolved solids and turbidity 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, manganese, sodium, total dissolved solids and turbidity, and corrosion in the case of pH.

In addition, one of the private water wells in Laurenceton had a concentration of total dissolved solids that exceeds CCME CWQG-AWU for irrigation water use, and the Laurencton protected groundwater supply had concentrations of cadmium, chloride, iron, manganese, total dissolved solids and zinc that exceed CCME CWQG-AWU for irrigation and/or livestock water use.

Insufficient monitoring data was available to determine Canadian Water Quality Index (CWQI) values for groundwater in the ADAs. However, available chemical data indicates that groundwater in the ADAs and surrounding areas is generally of good quality. However, treatment would be required to improve the aesthetic quality of the groundwater, as well as reduce arsenic, cadmium, and zinc in areas where elevated levels of these parameters that exceed CDWQG are identified. In addition, the concentration of total dissolved solids in the private water well in Laurenceton that exceeds CCME CWQG-AWU for irrigation water, and the concentrations of cadmium, chloride, iron, manganese, total dissolved solids and zinc in the Laurencton protected groundwater supply that exceed 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. Further, the elevated specific conductance, total dissolved solids and chloride levels present in the central well of the Laurenceton protected groundwater supply is likely due to its coastal location and suggests that saltwater intrusion may be a potential issue for water wells installed in coastal areas of the ADAs.

12.5 Groundwater Recharge & Availability

Recharge to the shallow groundwater system underlying the Botwood, Lewisporte and Comfort Cove ADAs 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 Botwood, Lewisporte and Comfort Cove ADAs is estimated on the basis of a local groundwater catchment area equivalent to the respective areas of the ADAs (i.e., Botwood ADA – 14,829 hectares, Lewisporte ADA – 7,901 hectares, and Comfort Cove ADA – 2,094 hectares), and a conservative recharge coefficient of 10% of the mean annual rainfall (i.e., 10% of 986 mm, equivalent to 99 mm). Based on these values, the groundwater recharge to the Botwood ADA is $1.5x10^7 m^3$/year or 986 m^3/hectares/yr, the groundwater recharge to the Lewisporte ADA is $7.8x10^6 m^3$/year or 986 m^3/hectares/yr, and the groundwater recharge to the Comfort Cove ADA is $2.1x10^6 m^3$/year or 986 m^3/hectares/yr.

With the exception of one public groundwater supply for the community of Laurenceton (Water Supply No. WS-G-0805) that serves a population of approximately 184 within the Lewisporte ADA, groundwater use in the Botwood, Lewisporte and Comfort Cove ADAs is currently limited to minor individual domestic and municipal wells. No information is available regarding existing agricultural (i.e., irrigation and livestock) water demands in the Botwood, Lewisporte and Comfort Cove ADAs, 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 ADAs.

APPENDIX 12a

Drawings

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

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

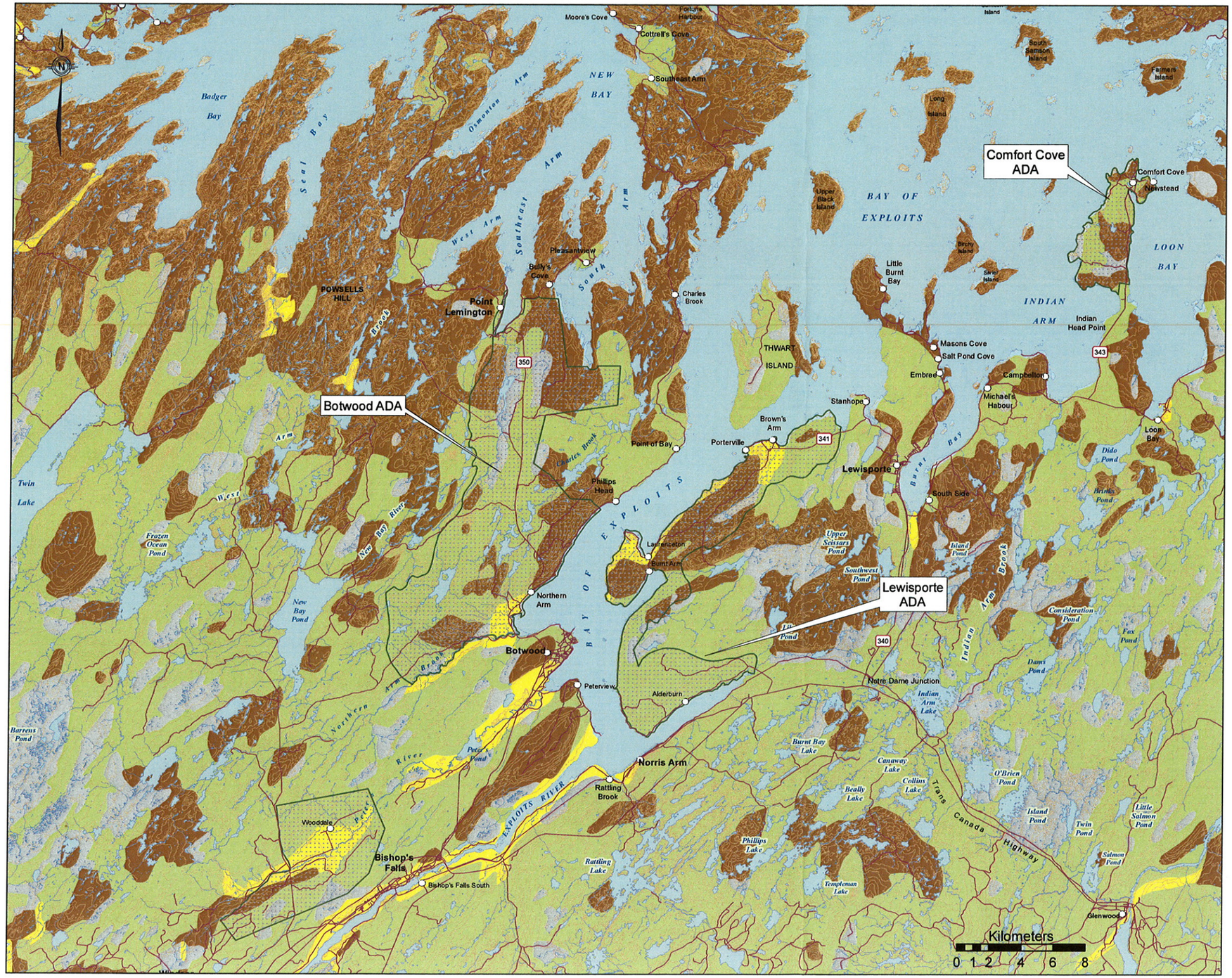
DRAWING TITLE:

BOTWOOD, LEWISPORTE AND COMFORT COVE ADAs LOCATION AND DRAINAGE

Jacques Whitford

SCALE: 1:250,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: JLB	REV. No. 0
DRAWING No.: 1034406-12-1	
MAP FILE: 1034406-XX.MXD	

DD/MM/YEAR



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:

BOTWOOD, LEWISPORTE AND COMFORT COVE ADAs SRUFICIAL GEOLOGY

Jacques Whitford

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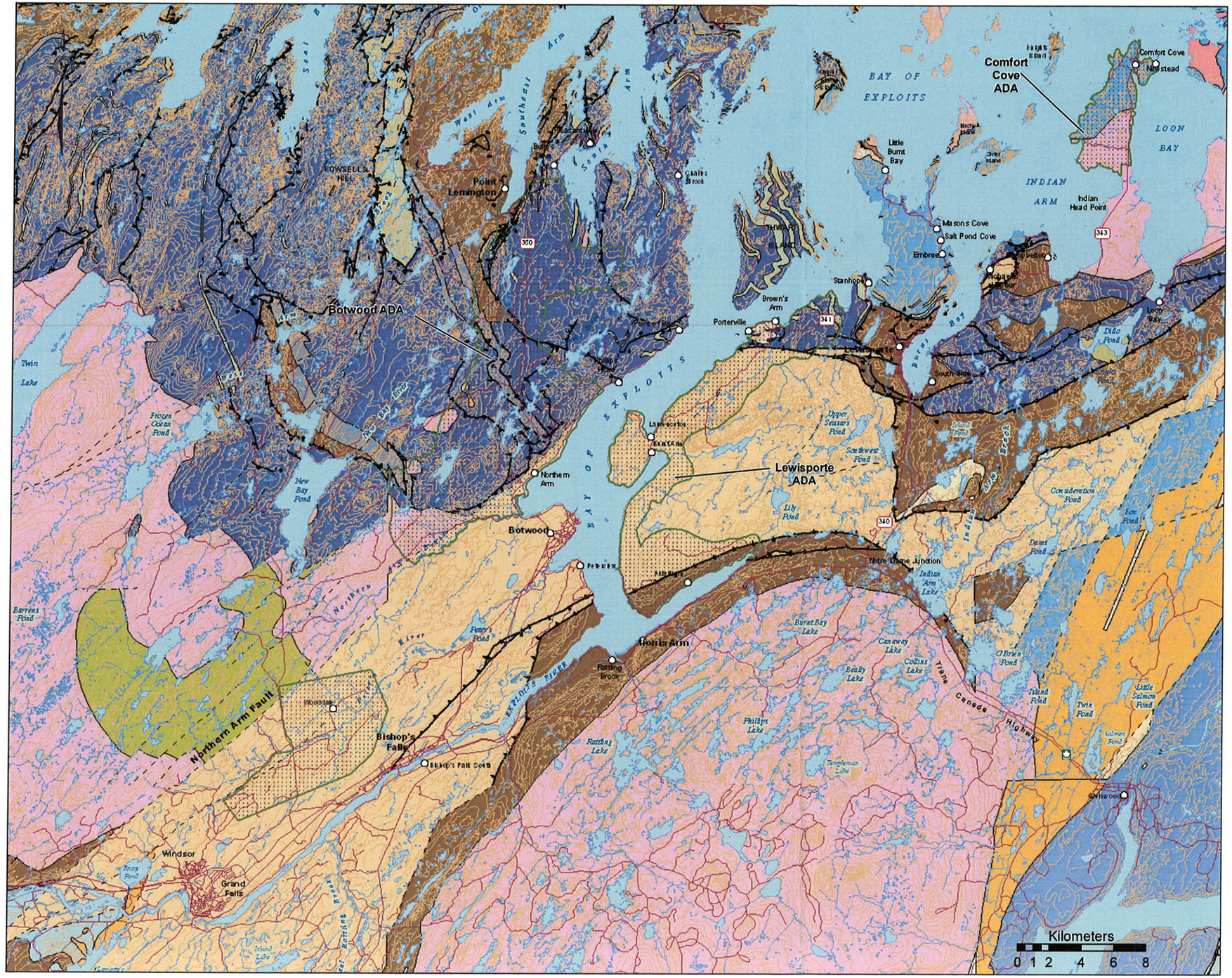

Generalized Bedrock Geology Legend

Post Ordovician Units

Overlap Sequences

Early Silurian to Early Devonian

- Shale interbedded with sandstone (Ten Mile Lake Formation)
- Shallow marine and non-marine siliciclastic sedimentary rocks, including sandstone, shale and conglomerate (Botwood Group)
- Turbidites consisting of sandstone, shale and conglomerate; other marine sedimentary rocks (Indian Islands Group)

Early Silurian

- Bimodal volcanic rocks; includes siliciclastic sedimentary rocks (Charles Lake Sequence)

Intrusive Rocks

Middle Jurassic to Early Cretaceous

- Gabbro and diabase (Dildo Pond Pluton & Budgells Harbour Gabbro)

Silurian to Devonian

- Granitoid suites, varying from pretectonic to syntectonic, relative to mid-Paleozoic orogenies (Loon Bay batholiths, Long Island Granodiorite, Hodges Hill intrusive suite, Mount Peyton Intrusive Suite, Southwest Brook granite)
- Gabbro and diorite intrusions, including minor ultramafic phases (Porterville gabbro)

Dunnage Zone (Exploits Subzone)

Late Ordovician to Early Silurian

- Shale-matrix melange, containing blocks of ophiolitic, rift, continental slope and foreland basin rocks (Boones Point and Sops Head complexes)

Middle Ordovician to Early Silurian

- Grey, well-bedded greywacke, including conglomerate layers, overlain by grey and minor red conglomerate; sedimentary structures indicate deposition in a mainly turbiditic environment (Badger Group)
- Black shale, slate and argillite, including subordinate chert and greywacke (Lawrence Harbour, Dark Hole and Shoal Arm Formations)

Cambrian to Middle Ordovician

- Melange, containing sedimentary and volcanic blocks of Cambrian to Ordovician age (Duder Group, Dunnage Melange)
- Marine siliciclastic sedimentary rocks, including slate, shale, argillite, siltstone, sandstone, conglomerate, and minor unseparated carbonate, volcanic and intrusive rocks, and schist, gneiss and migmatite (Davidsville Group, parts of Exploits and Wild Bight groups)
- Submarine mafic, intermediate and felsic volcanic rocks, including mafic volcanic rocks of ophiolite complexes; includes unseparated intrusive, sedimentary and metamorphic rocks (Summerford Group, Phillips Head Igneous Complex, parts of Exploits and Wild Bight groups)

Dunnage Zone (Notre Dame Subzone)

- Undifferentiated

Intrusive and Other Plutonic Rocks

Cambrian to Ordovician

- Granitoid intrusions, including trondhjemite of ophiolite complexes
- Mafic intrusions, including unseparated granitoid rocks and ultramafic rocks of ophiolite complexes

- 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:

BOTWOOD, LEWISPORTE AND COMFORT COVE ADAs BEDROCK GEOLOGY

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APPENDIX 12b

Water Chemistry Data

Table 12.3 Surface Water Chemistry, Public Water Supply, Botwood, Lewisporte and Comfort Cove ADAs
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Grand Falls-Windsor Northern Arm Lake WS-S-0291 (1987-2007)[1]			Northern Arm - Muddy Hole Pond WS-S-0514 (1988-2006)[1]			Phillips Head - Dogberry Brook WS-S-0538 (1988-2006)[1]			Point of Bay - Indian Cove Pond WS-S-0559 (1991-2006)[1]			Point Leamington - Little Pond WS-S-0556 (1998-2006)[1]			Comfort Cove-Newstead Steady Cove Pond - WS-S-0185 (1988-2007)[1]		
			Irrigation Water	Livestock Water	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	0	16	4	6	27	11	11	39	23	8.3	21	13	5.7	14	8	2.8	22	16
Aluminum	mg/L	na	5	5	0.025	1.66	0.126	0.025	0.46	0.109	0.01	0.75	0.19	0.02	0.27	0.10	0.025	1.07	0.184	0.01	0.92	0.13
Ammonia	mg/L	na	na	na	0	0.1	0.02	0	0.05	0.02	0	0.03	0.02	0.01	0.12	0.04	0	0.11	0.04	0	0.04	0.02
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	0	0.0005	0.0003
Arsenic	mg/L	0.01	0.1	0.025	0	0.005	0.0009	0	0.003	0.0008	0	0.005	0.002	0	0.005	0.002	0	0.003	0.001	0	0.005	0.002
Barium	mg/L	1	na	na	0	0.025	0.003	0	0.005	0.003	0	0.025	0.007	0	0.025	0.007	0	0.005	0.003	0	0.025	0.006
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	0.01	0	0.03	0.01	0	0.03	0.02	0	0.03	0.01	0	0.03	0.02	0.01	0.03	0.02
Bromide	mg/L	na	na	na	0	0.03	0.02	0	0.03	0.03	0	0.03	0.02	0	0.03	0.02	0	0.03	0.02	0	0.03	0.03
Cadmium	mg/L	0.005	0.005	0.08	0	0.001	0.0002	0	0.001	0.0004	0	0.001	0.0002	0	0.001	0.0003	0	0.0005	0.0002	0	0.0027	0.0005
Calcium	mg/L	na	na	na	0	6	2	2.44	15	4.6	4	24	8.7	2.88	8	3.93	1	23	5	3	15	5
Carbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	1	4	2	2	5	3	2	6	3	3	9	6	2	10	4	7	18	11
Chromium	mg/L	0.05	na	na	0	0.005	0.001	0	0.005	0.002	0	0.005	0.001	0	0.005	0.002	0	0.0025	0.0005	0	0.005	0.002
Copper	mg/L	1*	0.2 - 1	0.5-5	0	0.12	0.007	0	0.04	0.007	0	0.037	0.005	0	0.02	0.005	0	0.005	0.002	0	0.01	0.004
Dissolved Organic Carbon	mg/L	na	na	na	0.5	8.3	4.8	2.3	10.5	5.1	3.1	13.3	6.9	2.2	6.4	4.7	1.7	9.1	5.7	1.2	10.6	6.2
Fluoride	mg/L	1.5	1	1 - 2	0	0.11	0.03	0	0.12	0.03	0	0.14	0.04	0	0.11	0.04	0	0.07	0.03	0	0.12	0.04
Hardness	mg/L $CaCO_3$	na	na	na	0	15	5	7	42	20	10	68	29	7	20	11	3	57	21	15	46	24
Iron	mg/L	0.3*	5	na	0.005	0.2	0.099	0.005	0.15	0.053	0.03	0.2	0.09	0.005	0.09	0.042	0.005	0.55	0.115	0.005	0.19	0.004
Kjeldahl Nitrogen	mg/L	na	na	na	0.08	0.55	0.27	0.03	0.51	0.25	0.09	0.69	0.31	0.19	0.69	0.31	0.1	0.58	0.30	0.13	0.6	0.31
Langelier Index	-	na	na	na	-4.03	-2.41	-3.04	-4.34	-1.89	-3.23	-4.42	-1.37	-2.53	-3.75	-2.59	-3.34	-5.92	-2.62	-4.16	-7.44	-2.54	-3.66
Lead	mg/L	0.01	0.2	0.1	0	0.002	0.001	0	0.001	0.001	0	0.001	0.001	0	0.001	0.001	0	0.001	0.001	0	0.002	0.001
Magnesium	mg/L	na	na	na	0	1	0.3	0	1	0.6	0.5	3.9	1.4	0	0.98	0.56	0	1	0.53	1.26	3	1.97
Manganese	mg/L	0.05*	0.2	na	0	0.12	0.02	0	0.04	0.01	0	0.05	0.01	0	0.032	0.009	0.001	0.02	0.009	0.005	0.15	0.07
Mercury	mg/L	0.001	na	0.003	0	0.0005	0.0001	0	0.0005	0.0002	0	0.0005	0.0001	0	0.0005	0.0001	0	0.00005	0.00002	0	0.0005	0.0002
Nickel	mg/L	na	0.2	1	0	0.005	0.002	0	0.01	0.003	0	0.005	0.002	0	0.005	0.003	0	0.005	0.002	0	0.005	0.003
Nitrate	mg/L N	45	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0	0.05	0.02	0	0.05	0.02	0	0.52	0.09	0	0.05	0.02	0	0.05	0.02	0	0.23	0.03
Nitrite	mg/L	na	na	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate	mg/L P	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5-8.5*	na	na	5.9	6.8	6.4	6.1	7.3	6.8	6.2	7.7	7.2	6.4	7.2	6.9	6.4	7.3	6.7	6.2	7.3	6.8
Potassium	mg/L	na	na	na	0	0.72	0.24	0	0.5	0.3	0	0.5	0.2	0	0.5	0.3	0	0.5	0.2	0	0.73	0.5
Reactive Silica	mg/L SiO2	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0	0.005	0.001	0	0.001	0.001	0	0.005	0.001	0	0.005	0.001	0	0.001	0.001	0	0.005	0.001
Silver	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/L	200*	na	na	0	4	1	0	3	2	0	4	3	2	5	4	0	5	2	5	10	7
Specific Conductance	uS/cm	na	na	na	13	28.5	18.8	26	68	38	35	88	57	33.1	65	45.9	20.8	52	34.1	44.1	94.5	74.3
Sulphate	mg/L	500*	na	1,000	0	4	2	1	5	2	0	4	2	1	4	2	1	4	2	0	7	3
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	7	30	14	12	40	28	23	69	48	26	52	37	19	50	29	39	61	51
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	0.02	0.01	0	0.65	0.09	0	0.1	0.02	0	0.08	0.01
Total Suspended Solids	mg/L	na	na	na	1	2	1	1	2	1	2	2	2	2	2	2	1	2	2	1	2	2
True Color	TCU	15*	na	na	19	57	36	10	61	30	14	81	41	11	52	30	5	52	35	20	64	37
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.15	2.1	0.68	0.05	0.73	0.35	0.05	1.3	0.37	0.1	1.4	1	0.2	1	0.5	0.12	1.1	0.56
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
Vanadium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-	-	0	0	0	-	-	-	-	-	-
Canadian Water	-	-	-	-	92	100	95.1	93	97	94.5	91	93	92.5	94	97	95	93	94	93	91	94	93
Zinc	mg/L	5*	1 - 5	50	0	0.12	0.007	0	0.03	0.006	0	0.005	0.004	0	0.01	0.005	0	0.02	0.004	0	0.12	0.13

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 12.4 Groundwater Chemistry, Private Drilled Wells, Botwood, Lewisporte and Comfort Cove ADAs
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Communities[1]			
					Laurenceton		Northern Arm	Point Leamington
			Irrigation Water	Livestock Water	11186	17189	14853	17051
Alkalinity	mg/L $CaC0_3$	na	na	na	153.2	129	112	80.5
Aluminum	mg/L	na	5	5	-	-	0.01	0.068
Ammonia	mg/L	na	na	na	-	0.02	0.002	0.038
Antimony	mg/L	0.006	na	na	-	-	0.003	0.002
Arsenic	mg/L	0.01	0.1	0.025	-	-	0.0002	-
Barium	mg/L	1	na	na	-	-	0.093	0.073
Beryllium	mg/L	na	0.1	0.1	-	-	-	-
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	-	-	0.003	0.039
Bromide	mg/L	na	na	na	-	-	-	-
Cadmium	mg/L	0.005	0.005	0.08	-	-	0.00004	-
Calcium	mg/L	na	na	na	69	14	40.4	25.4
Carbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	**160**	12.9	3.76	3.53
Chromium	mg/L	0.05	na	na	-	-	-	-
Copper	mg/L	1*	0.2 - 1	0.5-5	-	-	0.058	0.01
Dissolved Organic Carbon	mg/L	na	na	na	-	-	1.5	-
Fluoride	mg/L	1.5	1	1 - 2	0.04	-	0.032	0.095
Hardness	mg/L $CaC0_3$	na	na	na	209	38.3	109.9	83.2
Iron	mg/L	0.3*	5	na	0.26	0.17	-	0.006
Kjeldahl Nitrogen	mg/L	na	na	na	-	-	-	-
Langelier Index	-	na	na	na	-	-	-	-
Lead	mg/L	0.01	0.2	0.1	-	-	0.002	0.0019
Magnesium	mg/L	na	na	na	8.9	0.82	2.2	4.8
Manganese	mg/L	0.05*	0.2	na	0.05	0.15	-	0.011
Mercury	mg/L	0.001	na	0.003	-	-	-	-
Nickel	mg/L	na	0.2	1	-	-	-	0.009
Nitrate	mg/L N	45	na	na	-	-	0.19	-
Nitrate + Nitrite	mg/L N	na	na	100	1.2	0.004	0.19	0.02
Nitrite	mg/L	na	na	10	-	-	-	0.02
Orthophosphate	mg/L P	na	na	na	-	-	-	-
pH	Units	6.5-8.5*	na	na	-	8.13	7.88	8.14
Potassium	mg/L	na	na	na	1.6	-	0.58	3.66
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	110	-	4.6	11.1
Specific Conductance	uS/cm	na	na	na	-	-	229	222
Sulphate	mg/L	500*	na	1,000	11	-	3.86	19.7
Sulphide	mg/L H2S	0.05*	na	na	-	-	-	-
Thallium	mg/L	na	na	na	-	-	0.0002	0.0004
Tin	mg/L	na	na	na	-	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	**507**	-	130	140
Total Organic Carbon	mg/L	na	na	na	-	-	-	-
Total Phosphorus	mg/L	na	na	na	0.015	0.04	-	-
Total Suspended Solids	mg/L	na	na	na	-	4	-	-
True Color	TCU	15*	na	na	-	-	-	-
Turbidity	NTU	0.3/1.0/0.1**	na	na	-	18.7	-	0.1
Uranium	mg/L	0.02	0.01	0.2	-	-	-	-
Vanadium	mg/L	na	0.1	0.1	-	-	-	-
Zinc	mg/L	5*	1 - 5	50	0.06	-	0.001	0.004

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 12.5 Groundwater Chemistry, Protected Public Drilled Wells, Botwood, Lewisporte and Comfort Cove ADAs
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Laurenceton East WS-G-0805 (2001)[1]	
			Irrigation Water	Livestock Water	Central Well	West Well
Alkalinity	mg/L $CaC0_3$	na	na	na	225	127
Aluminum	mg/L	na	5	5	0.19	0.46
Ammonia	mg/L	na	na	na	0.04	0.13
Antimony	mg/L	0.006	na	na	-	-
Arsenic	mg/L	0.01	0.1	0.025	0.009	0.019
Barium	mg/L	1	na	na	0.05	0.15
Beryllium	mg/L	na	0.1	0.1	-	-
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-
Boron	mg/L	5	0.5 - 6	5	0.11	0.03
Bromide	mg/L	na	na	na	0.92	0.03
Cadmium	mg/L	0.005	0.005	0.08	0.0004	**0.353**
Calcium	mg/L	na	na	na	11	38
Carbonate	mg/L $CaC0_3$	na	na	na	-	-
Chloride	mg/L	250*	100 - 700	na	**242**	5
Chromium	mg/L	0.05	na	na	0.0005	0.008
Copper	mg/L	1*	0.2 - 1	0.5-5	0.002	0.01
Dissolved Organic Carbon	mg/L	na	na	na	0.3	6.5
Fluoride	mg/L	1.5	1	1 - 2	0.33	0.1
Hardness	mg/L $CaC0_3$	na	na	na	60	120
Iron	mg/L	0.3*	5	na	0.88	**15.8**
Kjeldahl Nitrogen	mg/L	na	na	na	0.05	0.25
Langelier Index	-	na	na	na	-	-
Lead	mg/L	0.01	0.2	0.1	0.001	0.083
Magnesium	mg/L	na	na	na	8	6
Manganese	mg/L	0.05*	0.2	na	0.02	**0.81**
Mercury	mg/L	0.001	na	0.003	0.00005	0.00005
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	0.05	0.05
Nitrite	mg/L	na	na	10	-	-
Orthophosphate	mg/L P	na	na	na	-	-
pH	Units	6.5-8.5*	na	na	8.4	7.4
Potassium	mg/L	na	na	na	6	0.5
Reactive Silica	mg/L SiO2	na	na	na	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0.001	0.001
Silver	mg/L	na	na	na	-	-
Sodium	mg/L	200*	na	na	253	7
Specific Conductance	uS/cm	na	na	na	1,250	238
Sulphate	mg/L	500*	na	1,000	46	2
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	**708**	148
Total Organic Carbon	mg/L	na	na	na	-	-
Total Phosphorus	mg/L	na	na	na	0.005	0.67
Total Suspended Solids	mg/L	na	na	na	-	-
True Color	TCU	15*	na	na	1	5
Turbidity	NTU	0.3/1.0/0.1**	na	na	7.9	97
Uranium	mg/L	0.02	0.01	0.2	-	-
Vanadium	mg/L	na	0.1	0.1	-	-
Water Quality Index (WQI)	-	-	-	-	-	-
Zinc	mg/L	5*	1 - 5	50	0.06	**10.2**

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. Note in the data base, 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 zero.

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