14.0 HYDROGEOLOGY OF HUMBER VALLEY ADA

14.1 General Description of Area

14.1.1 Location & Extent

The Humber Valley ADA is located in western Newfoundland, and includes a main zone (Zone I), and three adjacent smaller satellite zones (Zones II, III and IV), covering a combined area of approximately 42,229 hectares. Zone I is the largest of the three zones, bordering the west side of the Upper Humber River and Deer Lake, and encompassing the communities of Cormack, Reidville, and Nicholsville. Zone II is located immediately south of Zone I, along the east side of Deer Lake, and encompasses the communities of Pasadena, Pynns Brook, Little Harbour and Lake Siding. Zone III is located along the east side of Grand Lake – Sandy Lake, approximately 15 km east of Zones I and II and encompasses the community of Howley. Zone IV is located along the Humber River east of Zones I and II, and encompasses the communities of Little Rapids, Harrison, Russel, Steady Brook and Dogwood. The boundary of the Humber Valley ADA is shown on Drawing No. 1034406-14-1 in Appendix 14a.

The main access to Zone I is provided by Provincial Highway Route 430 (Great Northern Highway), which leads up the Northern Peninsula from the Trans Canada Highway near Deer Lake. Secondary Highway Route 422 (Cormack Road) branches of Highway Route 430 approximately 6 km north of Deer Lake and provides access to the northern part of Zone I. The main access to Zones II and IV is provided by the Trans Canada Highway. Secondary Highway Route 401 (Howley Road) branches off the Trans Canada approximately 30 km northeast of Deer Lake and provides access to Zone III. In addition, various graveled roads and ATV trails leading from the Trans Canada and Highway Routes 430, 422 and 401 also provide access to some areas within the ADA.

14.1.2 Physiography, Topography & Drainage

The Humber Valley ADA is located within the physiographic region referred to as the Grand Lake Lowlands. This physiographic region is characterized by a large northeast-southwest trending intermontane valley bordered on the north by the Great Northern Highlands, on the east by the Atlantic Upland Region (Topsail Plateau), on the south by the Long Range Mountains and on the west by the Blow Me Down Highlands. The lowlands include the large water bodies of Grand Lake, Sandy Lake and Deer Lake, all of which drain south-westward via the Humber River. The center area of the lowland underlying Zone I and Zone IV of the ADA comprises the Deer Lake Basin, which forms a flat valley floor approximately 50 km in length and 15 km wide, and ranging in elevation from 30 to 90 m above sea level. Terrain underlying Zone II of the ADA slopes moderately northwest towards Deer Lake and ranges in elevation from approximately 50 to 275 m above sea level. Terrain underlying Zone III of the ADA slopes gently northwest towards Grand Lake and Sandy Lake and ranges in elevation from approximately 75 to 150 m above sea level. Maximum elevations that exceed 600 m above sea level are present in the upland regions surrounding the ADA.

Zone I of the Humber Valley ADA underlies the lower course of the Upper Humber River, which is the most significant drainage system in the area; while Zone II of the ADA encompasses the lower course of South Brook drainage system. In addition, a number of other smaller unnamed watercourses are

also present in the vicinity of Zones I and II that drain directly into Deer Lake. No significant stream and river drainage systems are present in the vicinity of Zone III of the ADA. Zone IV is located near the mouth of the Humber River. A number of small ponds are scattered throughout the drainage catchment area of the ADA, the most significant of which is Adies Pond. The large water bodies of Grand Lake, Sandy Lake and Deer Lake border the down-gradient boundaries of the zones of the ADA, and do not contribute flow to the ADA's drainage catchment area.

Two (2) surface water Public Protected Water Supply Areas (PPWSA) overlap the Humber Valley ADA and its drainage catchment area, including Pasadena – Blue Gulch Pond PPWSA, which is located in the vicinity of Zone II, and Steady Brook – Steady Brook located in the vicinity of Zone IV. In addition, Zone II of the ADA also overlaps the St. Judes – Chute Brook and St. Judes – Uncle Arthur Brook unprotected water supplies, and Zone III overlaps the Howley – Sandy Lake unprotected water supply. No other PPWSAs are present in within Humber Valley ADA and its drainage catchment area, however, the northern boundary of the Zone II drainage catchment area borders the Reidville – Humber Canal PPWSA.

14.1.3 Climate, Vegetation & Agricultural Land Use

The Humber Valley 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, and is considered one of the most favorable regions for plant growth on the island. The Humber Valley ADA is located within the Corner Brook subregion, which generally experiences warm summers and cool winters, but shows a high degree of climatic variation due to its large size and variation in topography. Moving inland from the coast precipitation increases, winters become colder, snow cover lasts longer, the growing season shortens, and the number of frost-free days lessens. The same trend also occurs from south to north within the subregion. Climate normal data obtained from Environment Canada's Deer Lake Airport monitoring station dating back to 1971 indicates a monthly mean temperature in the area of 3.3°C, ranging from a high of 16.1°C in July to a low of -9.8°C in February. Average annual precipitation in the area is 1,079 mm, of which 67% falls as rainfall and 33% as snowfall. December is typically the wettest month, and April is typically the driest month (Environment Canada, 2008). In the ADA, there are an average of 1,209 growing degree days (base temperature 5^{o}C) for the year and 1,138 growing degree days for the vegetative season (i.e., May to September).

The landscape in the vicinity of the Humber Valley ADA is dominated by good forest growth. The main tree species is balsam fir in association with black spruce and white spruce. Yellow birch, trembling aspen and tamarack are common. Eastern white pine, black ash, balsam popular, and white birch also occur. Slope fens and alder swamps are the dominant wetland type on nutrient rich slopes and valleys. Based on agricultural land use information provided by the NL Department of Natural Resources Agrifoods Division, approximately 2,898 hectares (i.e., 7% of the total landmass of the ADA) is currently utilized for agriculture, with forage, pasture and vegetable crop land representing the most significant proportions of the ADA's agricultural land use.

14.2 Geology

14.2.1 Surficial Geology

The surficial geology of the Humber Valley ADA is summarized in Drawing No. 1034406-14-2 in Appendix 14a, and is based on most recent 1:50,000 scale mapping of the area by Batterson (2000b,c,d and e), as well as descriptions of surficial geology provided in Kirby, *et al.* (1997). 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 consist of a sandy loam derived from siliciclastic and calcareous sedimentary rocks, and minor granitic intrusive rocks. In addition, small areas of hummocky till are locally present within the ADA. Within the ADA, sand and gravel material of glacial outwash and fluvial origin is also widespread, occurring primarily as plain and terrace deposits along major stream and river valleys. The most significant occurrences of sand and gravel are present along the Humber River and Upper Humber River in Zones I, II and IV. In addition, a significant accumulation of glacial fluvial sand and gravel is also present at the Head of Grand Lake in the vicinity of Zone III. The glaciofluvial sand and gravel deposits, as well as the veneer and moraine tills are commonly eroded, particularly along stream and river channels, and are dissected with numerous meltwater channel scars. Sand and gravel units shown in Drawing No. 1034406-14-2 in Appendix 14a also include un-subdivided lacustrine terraces that contain various silt and clay deposits in addition to sands and gravels and occur locally within the ADA, particularly along the shores of Deer Lake. Along with glacial units, local deposits of organic and peaty soils are scattered throughout the ADA, 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 ADA, and typically occur as areas of high ground. 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 both southwest and northwest directed ice flow. In addition, local development of rock talus or colluviums occur along steep valleys, the most significant of which occurs along the south valley flank wall of the Humber River in the vicinity of Zones II and IV. Available well logs indicate an average overburden thickness in the Humber Valley ADA and surrounding area of approximately 9 m.

14.2.2 Bedrock & Structural Geology

The bedrock geology of the Humber Valley ADA is summarized in Drawing No. 1034406-14-3 in Appendix 14a, 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 Kean, *et al*. (1995).

The ADA is mainly underlain by a thick sequence of fluvial, alluvial and lacustrine sandstones, siltstones, shales and evaporitic rocks of the Carboniferous Deer Lake and Anguille groups, and Howley Formation. These Carboniferous sedimentary units represent clastic fill deposited within a large pull-apart successor basin, referred to as the Deer Lake Basin, following Devonian Acadian orogenesis, and rest unconformably on Cambrian to Ordovican rocks of the Humber Zone. The Cambrian to Ordovican rocks of the Humber Zone are exposed along the western boundary of Zone I

and IV, and comprise both an autochthonous (non-transported) succession of shallow water, calcareous and siliciclastic sedimentary rocks (Goose Tickle Group, Table Head Group, St. George Group, Weasel Group, Port au Port Group, Reluctant Head Formation, and Labrador Group), and an allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks (Pinchgut Lake Group, Humber Arm Allochthon intermediate structural slices, Humber Arm Allochthon low structural slices and Fleur de Lys Supergroup). Precambrian granite and grantic gneiss that form the Long Range Mountains are present along the northwest boundary of Zone I. Rocks of the Dunnage Zone are in fault contact with the Humber Zone rocks immediately west of Zone III.

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 northeast-trending folds with a penetrative crenulation cleavage, and development of thrust faulting, as well as faulting with dextral strike-slip movement. The Long Range Fault, a regional northeast trending shear zone that defines the boundary between the Humber and Dunnage tectonostratigraphic zones is located along the eastern boundary of Zone III.

14.3 Hydrogeology

14.3.1 Hydrostratigraphy

The groundwater potential of the various geological units within the Humber Valley 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 107 drilled bedrock wells and four (4) drilled surficial wells from eight (8) 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. 1034406-14-3 in Appendix 14a.

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 Humber Valley 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 Humber Valley ADA is defined based on the estimated well yields obtained from the driller's records.

14.3.1.1 Surficial Hydrostratigraphic Units

The surficial deposits within the Humber Valley 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 14.1. 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 and more extensive moraine deposits over much of the ADA and is generally comprised of a sandy loam. There are no documented data on their groundwater potential in the Humber Valley 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

Sand and gravel deposits of glacial outwash and fluvial origin are also widespread within the ADA, occurring primarily as plain and terrace deposits along major stream and river valleys. The most significant occurrences of sand and gravel are present along the Humber River and Upper Humber River in Zones I, II and IV. In addition, a significant accumulation of glacial fluvial sand and gravel is also present at the Head of Grand Lake in the vicinity of Zone III. These deposits are potentially significant groundwater aquifers. Four (4) wells from the community of Cormack were available to characterize the groundwater potential of this unit in the ADA. 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 45 to 120 L/min at well depths of 13 to 19 m, and an average yield of 64 L/min at 15 m depth. However, median yield and depth estimates of 45 L/min at 15 m depth are more likely representative of the typical groundwater potential of this unit.

Table 14.1 Summary of Overburden Drilled Well Information for Humber Valley 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	Cormack	4	15.4 (14.5)	13.4-19.3	63.8 (45)	45-120

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

14.3.1.2 Bedrock Hydrostratigraphic Units

Well record information is available for the Carboniferous sedimentary cover rocks that underlie the majority of the ADA, as well as the combined Cambrian to Ordovician allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks of the Pinchgut Lake Group,

Humber Arm Allochthon low and intermediate structural slices and the Fleur de Lys Supergroup, present along the western boundaries of Zone I and IV of the ADA. The well yield and depth characteristics of these various strata are summarized in Table 14.2.

No water well information was available for the combined Cambrian to Ordovician autochthonous (non-transported) succession of shallow water, calcareous and siliciclastic sedimentary rocks (Goose Tickle Group, Table Head Group, St. George Group, Weasel Group, Port au Port Group, Reluctant Head Formation, and Labrador Group), present along the western boundaries of Zone I and IV of the ADA, or the area of Precambrian Granite and Granitic Gneiss basement rocks present along the northwest boundary of Zone I. Therefore groundwater potential within these units was inferred based on well records for similar lithologies in other ADAs. The groundwater potential within the Humber Arm autochthonous rocks was inferred based on well records for wells completed within similar lithologies in the Port au Port ADA. No hydrogeologic information was available from any of the other ADAs investigated with which to evaluate the groundwater potential of the Precambrian Granite and Granitic Gneiss basement rocks within the ADA. However, these units are expected to have low permeability similar to that of the granitic rocks present in the Terra Nova ADA.

Humber Arm Autochthon Complex

No documented data is available for the groundwater potential of the combined Cambrian to Ordovician autochthonous (non-transported) succession of shallow water, calcareous and siliciclastic sedimentary rocks present along the western boundaries of Zone I and IV of the ADA. However based on well data for similar lithologies in the Port au Port ADA, 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

A total of eight (8) well records from the communities of South Brook and Little Harbour were used to characterize the groundwater potential of the combined Cambrian to Ordovician allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks. These units are present along the western boundaries of Zone I and IV of the ADA. Based on well data, 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.

Carboniferous Sedimentary Cover Rocks

A total of 99 well records from the communities of Howley, Reidville, Pynns Brook, Nicholsville, Pasadena, and Cormack were used to characterize the groundwater potential of the Carboniferous sedimentary cover rocks. This unit underlies the majority of the ADA. Based on well data, the Carboniferous sedimentary cover rocks strata are considered capable of providing wells with low to moderate yields, having water yields ranging from 0.5 to 273 L/min at well depths of 13 to 131 m, and an average yield of 39 L/min at 41 m depth. However, median yield and depth estimates of 22 L/min at 38 m depth are more likely representative of the typical groundwater potential of these units.

Precambrian Granite and Granitic Gneiss

No documented data is available for the groundwater potential of the Precambrian granite and granitic gneiss basement rocks present along the northwest boundary of Zone I. However, based on records from two (2) water wells within granitic rocks in the Terra Nova ADA, these units are 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 14.2 Summary of Bedrock Drilled Well Information for Humber Valley 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 (Goose Tickle, Table Head, St. George, Weasel, Labrador, Port au Port groups, & Reluctant Head Formation)	Shallow water, carbonate and siliciclastic sedimentary rocks	Port au Port ADA	132	50.4 (44.8)	12.1-128	37.1 (15.9)	0.1-728
Humber Arm Allochthon (Pinchgut Lake Group, Humber Arm Allochthon low & intermediate structural slices, & Fleur de Lys Supergroup)	Deep water sedimentary, igneous and metamorphic rocks	South Brook Little Harbour	8	42.3 (47.6)	9.8-67.1	17.9 (5.7)	2-68.2
Carboniferous Sedimentary Rocks (Deer Lake & Anguille groups & Howley Formation)	Siliciclastic and minor carbonate and evaporitic sedimentary rocks and coal beds	Howley Reidville Pynns Brook Nicholsville Pasadena Cormack	99	40.8 (37.6)	12.5-131.1	39.1 (21.8)	0.5-273
Precambrian Granite and Granitic Gneiss*	Crystalline basement, undifferentiated	Terra Nova ADA	2	-	13.4, 73.2	-	18, 20

*Groundwater yield estimates for Precambrian granite and granitic gneiss basement rocks based on well data for granitic rocks in the Terra Nova ADA

14.3.2 Groundwater Flow System

The Humber Valley 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 areas of high ground and discharging in various wet lowland areas, ponds, lakes and rivers. It is expected that the shallow groundwater system in the ADA will be largely controlled by surface runoff and local recharge, while at moderate depths the flow system may be influenced by lateral inflow of groundwater from up-gradient areas located east and west of the ADA. 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.

14.4 Water Quality

14.4.1 Surface Water Quality

Surface water quality data for the Humber Valley ADA was obtained from two sources, including:

1. Ambient water quality data collected as part of the Canada–Newfoundland Water Quality Monitoring Agreement, from two (2) water quality monitoring sites in the ADA and surrounding area –
    - Humber Valley @Little Falls (NF02YL0011, 1986-2007); and,
    - Humber Valley @ Humber Village Bridge (NF02YL0012, 1986-2007).
2. 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 -
    - Reidville - Humber Canal (WS-S-0214, 1987-2005);
    - Pasadena - Blue Gulch Pond (WS-S-0529, 1998-2006);
    - Pynn's Brook - Pynn's Brook (WS-S-0601, 2000-20006);
    - Howley - Sandy Lake (WS-S-0365, 2000-2006); and,
    - Steady Brook - Steady Brook (WS-S-0712, 1988-2007).

A summary of chemical data obtained from these surface water sources over their respective monitoring periods is provided in Tables 14.3 and 14.4 in Appendix 14b, 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), calcium-sodium-chloride-sulfate-bicarbonate (Ca-Na-Cl-SO_4-HCO_3), and sodium-calcium-chloride-sulfate-bicarbonate (Na-Ca-Cl-SO_4-HCO_3) type waters. Surface water in the area is soft to slightly hard, neutral to slightly acidic, 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 and turbidity in both ambient surface water quality locations, mercury at the Humber Valley – Humber Village Bridge ambient surface water location, and arsenic iron, lead, manganese, pH, true color and turbidity in some of the protected 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.

Further concentrations of boron and mercury at the Humber Valley – Humber Village Bridge ambient surface water location, and manganese in the Steady Brook protected public water supply exceeded 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 84 to 97. 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. The Humber River at the Humber Valley - Little Falls and Humber Village Bridge ambient water quality monitoring stations are not considered potable water sources, and would require treatment for disinfection, as well as to improve the aesthetic quality of the water and to reduce the levels of mercury in areas where elevated levels of this parameter that exceed CDWQG is identified. In addition, concentrations of boron and mercury at the Humber Valley – Humber Village Bridge ambient surface water location, and manganese in the Steady Brook protected public water supply that exceeded CCME CWQG-AWU may limit usage of these surface water sources as potential agricultural water supplies without appropriate treatment.

14.4.2 Groundwater Quality

The groundwater quality data for the Humber Valley ADA consists of analyses from eight (8) private drilled wells from the communities of Cormack and Reidville 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 14.5 in Appendix 14b, and are 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 ADA can be classified as a calcium-sodium-bicarbonate-chloride-sulfate (Ca-Na-HCO_3-Cl-SO_4) type water. Groundwater in the area ranges from slightly hard to very hard, slightly basic, and of moderate alkalinity. Classification of groundwater according to dissolved-solids and specific conductance indicates fresh conditions for the Reidville well, and fresh to very saline conditions for the Cormack wells.

With the exception of arsenic, chloride, fluoride, iron, pH, sodium, sulphate, total dissolved solids and turbidity, concentrations of all other parameters tested in the wells meet CDWQG. The guidelines for chloride, iron, pH, sodium, 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, turbidity and color, and corrosion in the case of chloride and pH.

In addition, concentrations of arsenic, chloride, fluoride, and total dissolved solids detected in some of the private drilled wells in Cormack exceeded CCME CWQG-AWU for both irrigation and livestock water use.

Insufficient monitoring data was available to determine Canadian Water Quality Index (CWQI) values for groundwater in the ADA. However, available chemical data indicates that groundwater at least in the vicinity of Cormack is poor. Treatment would be required to improve the aesthetic quality of the groundwater in this area, as well as reduce arsenic and fluoride in areas where elevated levels of this parameters that exceed CDWQG are identified. In addition, the concentrations of arsenic, chloride,

fluoride, and total dissolved solids present in some of the private drilled wells in Cormack 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 specific conductance, total dissolved solids and chloride levels present in the majority of wells in Cormack are likely due to the underlying Carboniferous sedimentary strata, which contains intercalated evaporite beds.

14.5 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 Humber Valley ADA is estimated on the basis of a local groundwater catchment area equivalent to the area of the ADA of approximately 42,229 hectares, and a conservative recharge coefficient of 10% of the mean annual rainfall (i.e., 10% of 1,079 mm, equivalent to 108 mm). Based on these values, the groundwater recharge to the Humber Valley ADA is estimated at $4.6x10^7 m^3$/year or 1,079 m^3/hectares/yr.

Groundwater use in the ADA is currently limited to minor domestic, municipal, commercial, heat pump and industrial wells. No information is available regarding existing agricultural (i.e., irrigation and livestock) water demands in the Humber Valley 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 14a

Drawings

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

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

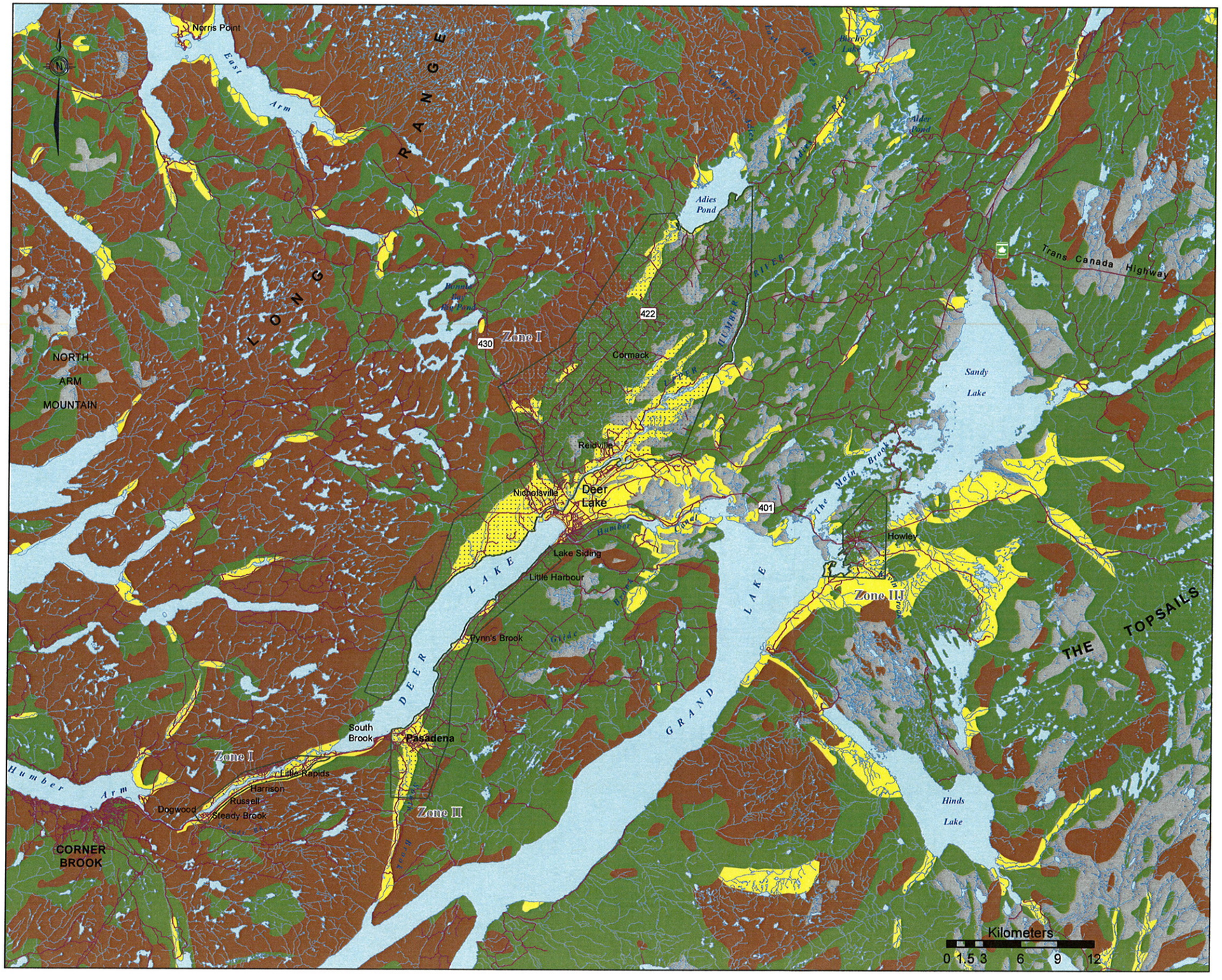
DRAWING TITLE:

HUMBER VALLEY ADA LOCATION AND DRAINAGE

Jacques Whitford

SCALE: 1:500,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: JLB	REV. No. 0
DRAWING No.: 1034406-14-1	
MAP FILE: 1034406-59.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
- Waterbody
- Agricultural Development Area

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

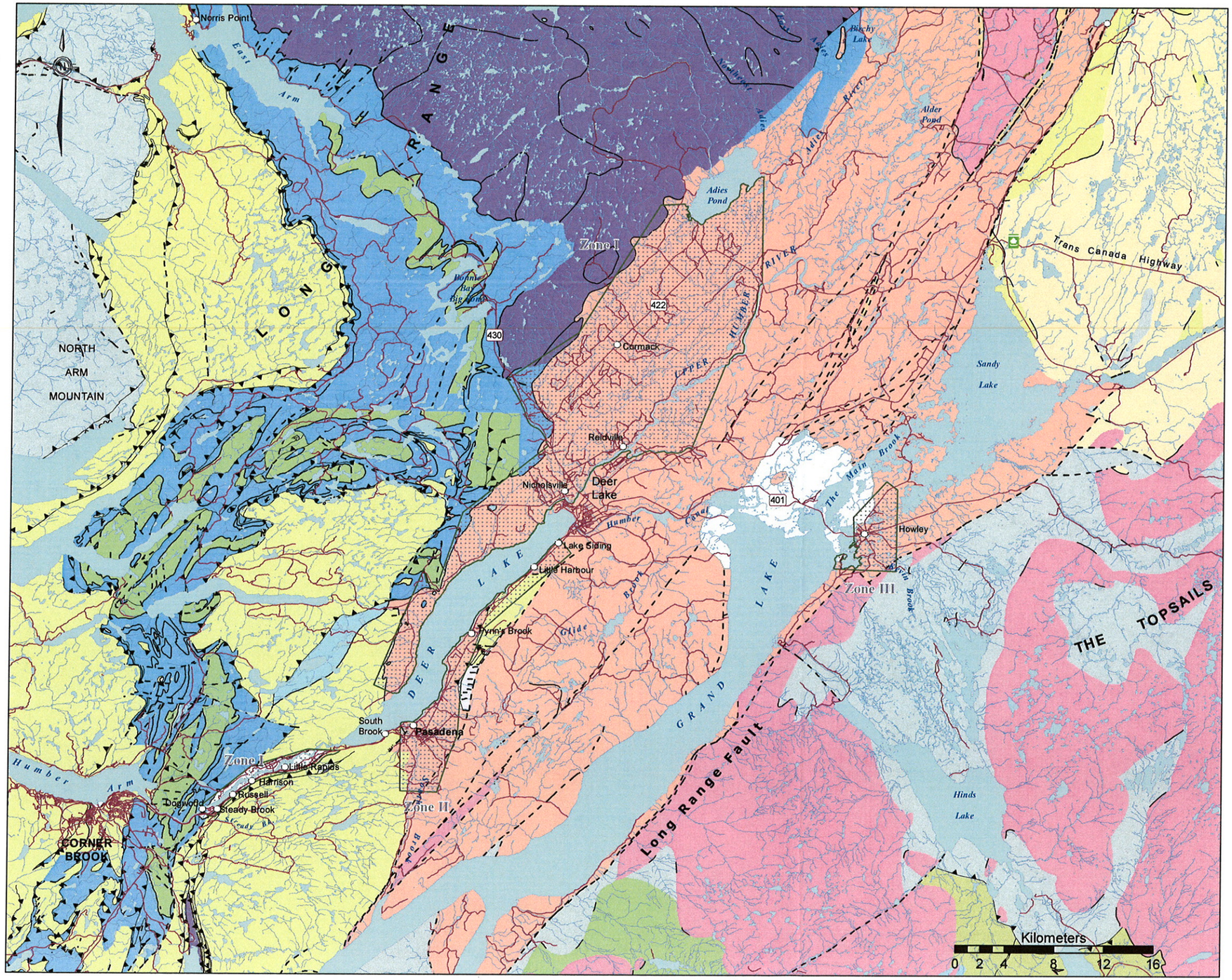
HUMBER VALLEY ADA SURFICIAL GEOLOGY

Jacques Whitford

SCALE: 1:325,000	DATE: 03/06/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: MCH	REV. No.: 0
DRAWING No.: 1034406-14-2	
MAP FILE: 1034406-59.MXD	

Jacques Whitford

DD/MM/YEAR



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 (Deer Lake Group, Anguille Group and Howley Formation)

Early to Late Silurian

Subaerial felsic, intermediate and mafic volcanic and pyroclastic rocks; fluviatile red sandstone, conglomerate and limestone (Sops Arm Group)

Felsic pyroclastic rocks; mafic to intermediate volcanics; and granite (Sheffield Lake Complex)

Intrusive Rocks

Silurian to Devonian

Posttectonic granitoid suites and minor unseparated volcanic rocks

Gabbro and diorite intrusions, including minor ultramafic phases (Porterville gabbro)

Humber Zone

Allochthon Complex

Cambrian to Ordovician

An allochthonous (transported) complex of deep water sedimentary, igneous and metamorphic rocks (Pinchgut Lake Group, Humber Arm Allochthon - intermediate and low structural slices, Fleur de Lys Supergroup)

Allochthon Sequence

Cambrian to Ordovician

An autochthonous (non-transported) succession of dominantly carbonate, shallow water sedimentary rocks (Goose Tickle, Table Head, St. George, Weasel, Port au Port, and Labrador groups, Reluctant Head Formation)

Basement

Precambrian

Crystalline basement, undifferentiated

Dunnage Zone (Notre Dame Subzone)

Undifferentiated

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

PROJECT TITLE:

HYDROGEOLOGY OF AGRICULTURAL DEVELOPMENT AREAS, NEWFOUNDLAND AND LABRADOR

DRAWING TITLE:

HUMBER VALLEY ADA BEDROCK GEOLOGY

Jacques Whitford

SCALE: 1:325,000	DATE: 11/03/2008
DRAWN BY: JLB	CHECKED BY:
EDITED BY: JLB	REV. No.: 0
DRAWING No.: 1034406-14-3	
MAP FILE: 1034406-59.MXD	

APPENDIX 14b

Water Chemistry Data

Table 14.3 Surface Water Chemistry, NL Ambient Water Quality Monitoring Sites, Humber Valley ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Humber Valley @Little Falls NF02YL0011 (1986-2007)[1]			Humber Valley @ Humber Village Bridge NF02YL0012		
			Irrigation Water	Livestock Water	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L $CaC0_3$	na	na	na	1.7	16.8	7.2	3.6	12.4	9.8
Aluminum	mg/L	na	5	5	0.02	0.31	0.13	0.051	0.18	0.08
Ammonia	mg/L	na	na	na	-	-	-	-	-	-
Antimony	mg/L	0.006	na	na	0.00001	0.00002	0.00001	0.00001	0.00002	0.00001
Arsenic	mg/L	0.01	0.1	0.025	0.00004	0.0004	0.00014	0.0001	0.0002	0.0001
Barium	mg/L	1	na	na	0.01	0.02	0.01	0.007	0.01	0.008
Beryllium	mg/L	na	0.1	0.1	0.0001	0.009	0.004	0	0.07	0.01
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	0.0004	0.005	0.003	**1**	**3.6**	**2.8**
Bromide	mg/L	na	na	na	-	-	-	-	-	-
Cadmium	mg/L	0.005	0.005	0.08	0.000002	0.0001	0.00005	0	0.0001	0.00002
Calcium	mg/L	na	na	na	2.11	3.19	2.65	3.82	4.8	4.29
Carbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	1.96	3.76	2.85	3	4.23	3.46
Chromium	mg/L	0.05	na	na	0.0001	0.002	0.0003	0	0.003	0.0003
Copper	mg/L	1*	0.2 - 1	0.5-5	0.0002	0.02	0.001	0.0002	0.01	0.0008
Dissolved Organic Carbon	mg/L	na	na	na	-	-	-	3.2	7.6	4.7
Fluoride	mg/L	1.5	1	1 - 2	-	-	-	-	-	-
Hardness	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-
Iron	mg/L	0.3*	5	na	0.08	0.84	0.30	0.04	0.60	0.09
Kjeldahl Nitrogen	mg/L	na	na	na	0.16	0.16	0.16	0.09	0.14	0.11
Langelier Index	-	na	na	na	-	-	-	-	-	-
Lead	mg/L	0.01	0.2	0.1	0.00003	0.002	0.0003	0.00002	0.001	0.0003
Magnesium	mg/L	na	na	na	0.56	0.79	0.64	0.77	0.94	0.84
Manganese	mg/L	0.05*	0.2	na	0.001	0.08	0.02	0.003	0.11	0.007
Mercury	mg/L	0.001	na	0.003	0.00001	0.00001	0.00001	**0.005**	**0.02**	**0.008**
Nickel	mg/L	na	0.2	1	0.0001	0.0006	0.0003	0.0002	0.0027	0.0003
Nitrate	mg/L N	45	na	na	-	-	-	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	-	-	-	-	-	-
Nitrite	mg/L	na	na	10	-	-	-	-	-	-
Orthophosphate	mg/L P	na	na	na	-	-	-	-	-	-
pH	Units	6.5-8.5*	na	na	6.05	7.4	6.69	5.9	7.41	6.96
Potassium	mg/L	na	na	na	0.18	0.31	0.23	0.22	0.26	0.24
Reactive Silica	mg/L SiO2	na	na	na	0.65	3.98	1.98	2.41	3.23	2.70
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0.0001	0.0003	0.0001	0	0.0004	0.0001
Silver	mg/L	na	na	na	0.000001	0.00001	0.000004	0.000001	0.0001	0.000026
Sodium	mg/L	200*	na	na	1.68	2.07	1.87	2.06	2.2	2.16
Specific Conductance	uS/cm	na	na	na	19	56	33	35	55.2	41.3
Sulphate	mg/L	500*	na	1,000	0.73	1.39	1.06	1.61	2	1.75
Sulphide	mg/L H2S	0.05*	na	na	-	-	-	-	-	-
Thallium	mg/L	na	na	na	0.000002	0.000009	0.000004	0.000001	0.00001	0.000003
Tin	mg/L	na	na	na	-	-	-	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	-	-	-	-	-	-
Total Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-
Total Phosphorus	mg/L	na	na	na	-	-	-	0.0004	0.03	0.004
Total Suspended Solids	mg/L	na	na	na	-	-	-	-	-	-
True Color	TCU	15*	na	na	-	-	-	-	-	-
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.08	2.5	0.52	0.08	4.4	0.44
Uranium	mg/L	0.02	0.01	0.2	0.02	0.13	0.03	0.00004	0.0001	0.0001
Vanadium	mg/L	na	0.1	0.1	0.0001	0.001	0.0003	0.00008	0.0004	0.0002
Canadian Water Quality Index (CWQI)	-	-	-	-	-	-	93.93	-	-	87.82
Zinc	mg/L	5*	1 - 5	50	0.0002	0.07	0.002	0	0.01	0.001

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 Ambient Water Quaility Database available through the Canada and Newfoundland/Labrador Aqua Link (CANAL) website.

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 14.4 Surface Water Chemistry, Public Water Supply, Humber Valley ADA Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Reidville - Humber Canal WS-S-0214 (1987-2005)[1]			Pasadena - Blue Gulch Pond WS-S-0529 (1998-2006)[1]			Pynn's Brook - Pynn's Brook WS-S-0601 (2000-20006)[1]			Howley - Sandy Lake WS-S-0365 (2000-2006)[1]			Steady Brook - Steady Brook WS-S-0712 (1988-2007)[1]		
			Irrigation Water	Livestock Water	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alkalinity	mg/L $CaCO_3$	na	na	na	6.2	19	9.7	2.6	33.1	13.3	33.7	59.2	50.1	0	9	5	0	10	2
Aluminum	mg/L	na	5	5	0.003	0.11	0.05	0.005	0.56	0.08	0.02	0.08	0.04	0.09	0.16	0.12	0.03	0.35	0.13
Ammonia	mg/L	na	na	na	0	0.03	0.01	0	0.1	0.02	-	-	-	0	0.14	0.04	0	0.18	0.05
Antimony	mg/L	0.006	na	na	0	0.0005	0.0003	0	0.0005	0.0004	-	-	-	0	0.0005	0.000	0	0.0005	0.0003
Arsenic	mg/L	0.01	0.1	0.025	0	0.025	0.004	0	0.025	0.003	0	0.005	0.003	0	0.001	0.001	0	0.005	0.002
Barium	mg/L	1	na	na	0	0.03	0.008	0	0.025	0.008	0.025	0.03	0.028	0	0.005	0.004	0.005	0.03	0.012
Beryllium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	0	0.03	0.02	0	0.03	0.02	0	0.03	0.02	0	0.03	0.02	0	0.03	0.02
Bromide	mg/L	na	na	na	0	0.03	0.03	0	0.03	0.03	0	0.03	0.02	0	0.03	0.03	0	0.03	0.03
Cadmium	mg/L	0.005	0.005	0.08	0	0.001	0.0004	0	0.001	0.0003	0	0.001	0.0008	0	0.001	0.0004	0	0.001	0.0003
Calcium	mg/L	na	na	na	2	4.09	3.21	1.42	12	4.84	11.5	19.9	16.5	0.5	2	1.3	0.5	2.00	1.4
Carbonate	mg/L $CaCO_3$	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	2	4	3	2	5	3	3	8	5	2	3	3	2	4	3
Chromium	mg/L	0.05	na	na	0	0.005	0.002	0	0.005	0.002	0	0.01	0.005	0	0.01	0.003	0	0.01	0.001
Copper	mg/L	1*	0.2 - 1	0.5-5	0	0.05	0.005	0	0.08	0.005	0	0.01	0.005	0	0.005	0.002	0	0.03	0.005
Dissolved Organic Carbon	mg/L	na	na	na	0.8	4.20	3.18	1	13.7	4.0	1.3	6.4	3.1	4.5	7.2	5.4	4.2	13.8	6.8
Fluoride	mg/L	1.5	1	1 - 2	0	0.09	0.03	0	0.081	0.038	0	0.005	0.004	0	0.1	0.04	0	0.06	0.03
Hardness	mg/L $CaCO_3$	na	na	na	5	10	8	5	26	14	51	53	52	0.5	5	3	0.5	7	4
Iron	mg/L	0.3*	5	na	0.005	0.31	0.04	0.005	0.39	0.04	0.005	0.05	0.03	0.005	0.22	0.15	0.09	0.8	0.24
Kjeldahl Nitrogen	mg/L	na	na	na	0.025	0.28	0.14	0.025	0.55	0.18	0.16	0.25	0.21	0.19	0.3	0.24	0.03	0.55	0.25
Langelier Index	-	na	na	na	-4.34	-3.33	-3.83	-5.94	-2.7	-3.96	-3.41	-0.86	-2.07	-4.75	-3.5	-4.04	-6.94	-5.18	-5.90
Lead	mg/L	0.01	0.2	0.1	0	0.021	0.002	0	0.004	0.001	0	0.001	0.001	0	0.001	0.001	0	0.003	0.001
Magnesium	mg/L	na	na	na	0	0.92	0.60	0	2	1	1.81	2.28	2.08	0	0.68	0.39	0.15	0.54	0.41
Manganese	mg/L	0.05*	0.2	na	0	0.03	0.01	0	0.161	0.015	0.005	0.01	0.009	0.005	0.03	0.016	0.003	**0.21**	0.026
Mercury	mg/L	0.001	na	0.003	0	0.0005	0.0002	0	0.0005	0.0002	0	0.0005	0.0004	0	0.0005	0.0002	0	0.0005	0.0001
Nickel	mg/L	na	0.2	1	0	0.005	0.0032	0	0.005	0.003	0	0.005	0.004	0	0.005	0.004	0	0.005	0.003
Nitrate	mg/L N	45	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate + Nitrite	mg/L N	na	na	100	0.003	4.8	0.31	0	0.151	0.035	0	0.003	0.002	0	0.05	0.026	0	0.15	0.023
Nitrite	mg/L	na	na	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate	mg/L P	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	Units	6.5-8.5*	na	na	6.2	7.5	6.9	5.8	7.5	6.8	7.1	8.1	7.6	6.3	6.6	6.4	5.1	6.7	5.9
Potassium	mg/L	na	na	na	0	0.5	0.3	0	0.58	0.32	0	0.37	0.27	0	0.5	0.3	0.19	0.5	0.3
Reactive Silica	mg/L SiO2	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	mg/L	0.01	0.02 - 0.05	0.05	0	0.005	0.002	0	0.005	0.001	0	0.005	0.003	0	0.001	0.001	0	0.005	0.002
Silver	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/L	200*	na	na	0	7	2	0	5	2	3	4	4	0	5	2	1	4	2
Specific Conductance	uS/cm	na	na	na	30.1	60.9	35.1	25	80	43	89	139	121	19.5	27	23.7	15.9	39.3	23.1
Sulphate	mg/L	500*	na	1,000	1	4	2	2	5	3	4	5	4	1	3	2	0	5	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	21	30	25	18	59	31	68	98	85	14	22	17	10	30	20
Total Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	mg/L	na	na	na	0.001	0.01	0.01	0	0.07	0.01	0	0.005	0.004	0	0.01	0.005	0	0.04	0.008
Total Suspended Solids	mg/L	na	na	na	1	2	2	1	2	2	1	1	1	1	1	1	1	2	2
True Color	TCU	15*	na	na	5	35	23	11	92	26	12	37	23	39	54	47	34	106	60
Turbidity	NTU	0.3/1.0/0.1**	na	na	0.02	1.04	0.29	0	3.4	0.4	0.02	0.4	0.2	0.49	2.4	1.2	0.07	1.7	0.4
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)	-	-	-	-	94	97	95.8	85	97	94	88	94	90	85	86	86	84	86	86
Zinc	mg/L	5*	1 - 5	50	0	0.02	0.005	0	0.01	0.004	0	0.005	0.004	0	0.005	0.004	0.003	0.04	0.008

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 statistics calculated using 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 the 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

Table 14.5 Groundwater Chemistry, Private Drilled Wells, Humber Valley ADA
Hydrogeology of Agricultural Development Areas, Newfoundland & Labrador

Parameter	Units	CDWQG	CWQG-AWU		Communities[1]							
					Cormack							Reidville
			Irrigation Water	Livestock Water	12714	12710	9990	9998	9996	9997	9999	Well #1
Alkalinity	mg/L $CaC0_3$	na	na	na	124	305	76.4	154.4	132.8	94.2	175.4	6
Aluminum	mg/L	na	5	5	-	-	-	-	-	-	-	-
Ammonia	mg/L	na	na	na	-	-	-	-	-	-	-	-
Antimony	mg/L	0.006	na	na	-	-	-	-	-	-	-	-
Arsenic	mg/L	0.01	0.1	0.025	-	-	-	**0.045**	-	0.005	0.018	-
Barium	mg/L	1	na	na	-	-	-	-	-	-	-	-
Beryllium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-
Bicarbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-	-	-
Boron	mg/L	5	0.5 - 6	5	-	-	-	-	-	-	-	-
Bromide	mg/L	na	na	na	-	-	-	-	-	-	-	-
Cadmium	mg/L	0.005	0.005	0.08	-	-	-	-	-	-	-	-
Calcium	mg/L	na	na	na	29	5.9	13.27	24.31	60.6	321	61.83	2.29
Carbonate	mg/L $CaC0_3$	na	na	na	-	-	-	-	-	-	-	-
Chloride	mg/L	250*	100 - 700	na	26	51	22	**320**	**269**	**615**	**207**	10
Chromium	mg/L	0.05	na	na	-	-	-	-	-	-	-	-
Copper	mg/L	1*	0.2 - 1	0.5-5	-	-	-	-	-	-	-	-
Dissolved Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-	-	-
Fluoride	mg/L	1.5	1	1 - 2	0.07	**2.9**	-	-	-	-	-	-
Hardness	mg/L $CaC0_3$	na	na	na	126	22.4	67.8	89.9	306.4	1382.8	244.4	8.7
Iron	mg/L	0.3*	5	na	0.01	0.01	3.136	0.039	0.197	0.525	0.41	0.232
Kjeldahl Nitrogen	mg/L	na	na	na	-	-	-	-	-	-	-	-
Langelier Index	-	na	na	na	-	-	-	-	-	-	-	-
Lead	mg/L	0.01	0.2	0.1	-	-	-	-	-	-	-	-
Magnesium	mg/L	na	na	na	13	1.85	7.047	7.07	37.6	141.1	21.69	0.612
Manganese	mg/L	0.05*	0.2	na	0.005	0.005	-	-	-	-	-	-
Mercury	mg/L	0.001	na	0.003	-	-	-	-	-	-	-	-
Nickel	mg/L	na	0.2	1	-	-	-	-	-	-	-	-
Nitrate	mg/L N	45	na	na	-	-	-	0.037	0.144	0.395	0.148	0.005
Nitrate + Nitrite	mg/L N	na	na	100	2.3	0.008	-	-	-	-	0	0
Nitrite	mg/L	na	na	10	0.001	0.002	0.011	0.002	0.004	0.002	0.002	0.002
Orthophosphate	mg/L P	na	na	na	-	-	-	-	-	-	-	-
pH	Units	6.5-8.5*	na	na	8.22	9.16	8.85	8.97	8.11	8	8.23	6.73
Potassium	mg/L	na	na	na	0.93	0.96	2.75	2.42	5.59	11.27	5.01	0.52
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	16	300	28.99	1,518	1,444	3,042	873.4	2.06
Specific Conductance	uS/cm	na	na	na	269	1,690	350.1	2,577.2	8,434.3	18,555.5	6,627	35.8
Sulphate	mg/L	500*	na	1,000	15	55	22	760	500	700	560	8
Sulphide	mg/L H2S	0.05*	na	na	-	-	-	0.009	0.019	0.022	0.012	-
Thallium	mg/L	na	na	na	-	-	-	-	-	-	-	-
Tin	mg/L	na	na	na	-	-	-	-	-	-	-	-
Total Dissolved Solids	mg/L	500*	500 - 3,500	3,000	291	**1,510**	286	**1,719**	**5,118**	**11,903**	**4,074**	55
Total Organic Carbon	mg/L	na	na	na	-	-	-	-	-	-	-	-
Total Phosphorus	mg/L	na	na	na	0.03	0.03	-	-	-	-	-	-
Total Suspended Solids	mg/L	na	na	na	-	-	-	-	-	-	-	-
True Color	TCU	15*	na	na	-	-	-	-	-	-	-	-
Turbidity	NTU	0.3/1.0/0.1**	na	na	-	-	73.1	0.52	2.15	2.45	1.36	1.65
Uranium	mg/L	0.02	0.01	0.2	-	-	-	-	-	-	-	-
Vanadium	mg/L	na	0.1	0.1	-	-	-	-	-	-	-	-
Zinc	mg/L	5*	1 - 5	50	0.005	0.005	-	-	-	-	-	-

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