APPENDIX G

WATER SUPPLY PROTECTION

- Well Water Survey Protocol
- Proposed Controls for the Lower South River Wellfield

WATER SUPPLY PROTECTION

This appendix contains information on domestic water supply for the study area including individual wells and areas supplied by Municipal Town or County services. A preliminary risk analysis indicating wells that could be affected by the Project and therefore will require monitoring is duplicated in this Appendix, from Section 5.2 of the main body of the report. Readers are encouraged to read Section 5.2 for additional information and context. Details on a domestic well monitoring plan are also provided in this Appendix, as well as controls for the Lower South River Wellfield and Recharge Area.

Domestic Water Supply

Table G1 summarizes the general density and frequency of wells within the proposed alignment along existing roads and highways, and indicates the areas supplied by Municipal Town or County services.

Table G.1 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment

Locations	Chainage	Dug Wells	Drilled Wells	Drilled Municipal Supply Well	Dug Surface Water Reservoirs	Assumed Wells (Unknown)	Water Supplied by Municipal Systems	Total Wells (Including Assumed Wells)
RoW from the Western End of the Alignment to Addington Forks Rd.	0+000 to 1+900							
Existing Highway 104	0+000 to 1+900	0	0	0	0	2	No	2
Trunk 4	1+900	10	5	0	0	5	No	20
Addington Forks Rd.	1+900	0	0	0	0	0	Yes	0
RoW from Addington Forks Rd. to West River	1+900 to 5+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Sommers Rd.	North of RoW	0	0	0	0	0	Yes	0
Town of Antigonish	North of RoW	0	0	0	0	0	Yes	0
Trunk 7	4+200	0	0	0	0	0	Yes	0
Church Street Extension	5+400	3	0	0	0	1	Partial: Existing Highway 104 to Cunningham Rd.	4
Cunningham Rd.	5+550	2	0	0	0	2	No	4
RoW from West River to Beech Hill Rd.	5+700 to 6+700							
Existing Highway 104	North of RoW	0	0	0	0	0	Yes	0
Willowdale Lane	North of RoW	0	0	0	0	0	Yes	0
Beech Hill Rd.	6+700	1	1	0	0	1	Partial: North of Existing Highway 104	3
Beech Hill Rd. to Existing Highway 104	6+700 to 10+400							
Existing Highway 104	North of RoW	3	0	0	1	0	Yes: North Side Partial: South Side	4

Table G.1 Estimated Number and Type of Domestic Wells within 500 m of the Proposed Highway 104 Alignment								
Locations	**Chainage**	**Dug Wells**	**Drilled Wells**	**Drilled Municipal Supply Well**	**Dug Surface Water Reservoirs**	**Assumed Wells (Unknown)**	**Water Supplied by Municipal Systems**	**Total Wells (Including Assumed Wells)**
Trunk 4	North of RoW	0	0	0	0	0	Yes	0
MacEachern Loop	North of RoW	1	0	0	0	1	No	2
Existing Highway 104 to the Eastern End of the Alignment	10+400 to 14+825.65							
Existing Highway 104	South of RoW	0	2	0	0	0	Yes	2
Dunn's Loop	10+550	0	0	0	0	3	No	3
South River Loop	South of RoW	2	0	0	0	1	Partial: East End	3
Dunmore Rd.	South of RoW	0	0	0	0	1	Partial: 100 m off Existing Highway 104	1
South Side Harbour Rd.	11+500	0	0	0	0	0	Yes	0
Route 316	South of RoW	2	1	0	0	0	Partial: 100 m Off Existing Highway 104	3
Lower South River Wellfield (Wells and Protected Area)	South of 12+200 to 14+827.65	0	0	6	0	0	County Wellfield	6
Lower South River Mobile Home Park	South of RoW	0	0	0	0	0	Yes	0
Angus MacQuarrie Drive	South of RoW	0	0	0	0	0	Yes	0
Taylor Rd.	13+950	2	8	0	0	2	No	12
Total Wells		**26**	**17**	**6**	**1**	**19**	**N/A**	**69**

Preliminary Risk Analysis

The following comments and assessment of potential risk of well damage from this alignment are based on a field reconnaissance survey on October 10 and 11, 2002, published water well information for each area, and the proposed cut and fill operations planned for the RoW.

Existing Highway 104 (North and South of 0+000 to 14+825.65)

The majority of the existing Highway 104 is serviced by either Municipal Town or County Water with the exception of seven properties with civic addresses on the highway that were either confirmed or suspected of having a drilled or dug well. These properties include: two with drilled wells (Smith & Fraser Homes and Softspray Car Wash (Civic Nos. unknown)); three with dug wells (Civic Nos. 3770, 4278 and one unknown civic number); and two unknown wells at the western end of the alignment (Civic Nos. 2416 and 2448).

The two drilled wells are not likely to be affected by the re-alignment. The dug well at 3770 Highway No. 104 is discussed in the Beech Hill Road (6+700) section, and the unknown wells at 2416 and 2448 Highway No. 104 are discussed in the Trunk 4 (North of 0+000 to 1+900) and Addington Forks Road (0+000 to 1+900) section.

The two dug wells at 4278 Highway No. 104 and Kent Mobile Homes are located north and downgradient of the 9+300 to 9+550 where a filling operation of up to 23 m will take place. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages. The closest dug well will be monitored during construction of the highway and underpass.

County of Antigonish municipal water lines exist in the approximate area of 10+400 where the proposed alignment meets the existing alignment of Highway 104. Construction in this area will plan for the presence of underground services in this area.

Trunk 4 (North of 0+000 to 1+900) and *Addington Forks Road (0+000 to 1+900)*

Eighteen residences or commercial properties on Trunk 4 west of Antigonish and immediately north of the proposed western connection to Highway 104 are served by both drilled wells (Civic Nos. 2376, 2388, 2456 and two unknown civic numbers) and dug wells (Civic Nos. 2354, 2547, 2573, 2647, 2667 and five unknown civic numbers). In addition, the presence of a well could not be confirmed but is suspected at four properties (Civic Nos. 2406, 2428 and two unknown civic numbers). The closest observed drilled and dug wells are approximately 100 m and 50 m north of the RoW, respectively. Two properties within 50 m on the south side of the RoW

(Highway 104) could not be accessed during field reconnaissance, but would also have a drilled or dug well.

Seven domestic well logs for this area (Tables 5.9 and 5.10) indicate that dug wells have an average well depth of 6.6 m and a well yield of 568 L/min. Drilled wells had an average depth of 40.4 m, casing length of 28.1 m; well yield of 47.9 L/min (1.1 to 113.6. L/min), and overburden thickness averaging 38.5 m (range 23.0 to 65.6 m), which suggests deep glacial deposits in this vicinity.

The underpass does not involve a major cut (*i.e.*, is not greater than 6 m); therefore the dug wells which are within 50 m down gradient along Trunk 4 are not likely to be dewatered. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent downgradient dug wells to the north of the RoW. The closest dug well will be monitored during construction of the highway and underpass in this area.

Residences along Addington Forks Road within the study area are serviced by Antigonish County water. The proposed underpass must accommodate underground services in this area.

Table G.2 Summary of Dug Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells (Trunk 4)						
Minimum	4.9	4.9	914.4	567.8	3	4.9
Maximum	8.2	8.2	914.4	567.8	4.1	8.2
Mean	6.6	6.6	914.4	567.8	3.5	6.6
Median	6.6	6.6	914.4	567.8	3.5	6.6
Number	2	2	2	1	2	2

Table G.3 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish

Location	Well Depth (m)	Casing (m)	Diameter (mm)	Est., Yield (L/min)	Water Level (m)	Overburden Thickness (m)
All Wells						
Minimum	16.4	0	0	1.1	-0.3	0
Maximum	122.7	54.1	200	567.8	34.4	67.7
Mean	42.8	19.1	143.5	61.2	10.9	18.2
Median	40.4	19.7	152.4	37.9	9.8	16.4
Number	61	61	61	60	59	61

Table G.3 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish						
Location	**Well Depth (m)**	**Casing (m)**	**Diameter (mm)**	**Est., Yield (L/min)**	**Water Level (m)**	**Overburden Thickness (m)**
Residential Drilled Wells in the Vicinity of 0+000 to 1+900						
Minimum	23	13.8	152.4	1.1	-0.3	23
Maximum	65.6	54.1	152.4	113.6	13.1	65.6
Mean	40.4	28.1	152.4	47.9	8.2	38.5
Median	34.4	23.3	152.4	30.3	9.2	25.3
Number	5	5	5	5	5	5
Residential Drilled Wells in the Vicinity of 1+900 to 5+700						
Minimum	16.4	0	101.6	11.4	0.3	0
Maximum	122.7	37.1	152.4	219.6	34.4	32.8
Mean	45.9	18.5	139.7	42.5	16.5	17.6
Median	41.8	22	152.4	28.4	13.5	19.7
Number	16	16	16	16	16	16
Residential Drilled Wells in the Vicinity of 5+700 to 10+400						
Minimum	23.3	6.6	101.6	7.6	4.9	0.7
Maximum	64	36.1	152.4	567.8	32.8	29.5
Mean	42.9	19.2	145.1	98.7	10.6	15.1
Median	41.8	20	152.4	37.9	7.5	18.9
Number	14	14	14	13	13	14

Table G.3 Summary of Drilled Well Information - Proposed Highway 104 Alignment Antigonish						
Location	**Well Depth (m)**	**Casing (m)**	**Diameter (mm)**	**Est., Yield (L/min)**	**Water Level (m)**	**Overburden Thickness (m)**
Residential Drilled Wells in the Vicinity of 10+400 to 14+825.65						
Minimum	24.6	6.6	0	7.6	0	1.3
Maximum	72.2	30.8	152.4	151.4	19.7	45.9
Mean	37.8	17.8	136.7	43.2	8.5	13.4
Median	34.4	16.4	152.4	26.5	9.2	9.8
Number	21	21	21	21	21	21
County of Antigonish Water Supply Wells (South of 13+000)						
Minimum	41.8	12.2	152	50	-1	4.5
Maximum	67.7	27.4	200	200	10.5	67.7
Mean	55.9	16.9	171.2	113	4.1	29.2
Median	61	13.4	152	90	1.5	26.8
Number	5	5	5	5	5	5
Sources: NSDEL Well Drillers Logs 1969-2000 and C.J. MacLellan & Associates Inc. 2002.						

Sommers Road (Northwest of 2+600)

Residences along Sommers Road within the study area are serviced by Antigonish County water. The proposed RoW passes south of Sommers Road.

Town of Antigonish (North of 3+800 to 5+900)

The residential and commercial buildings of the Town of Antigonish are supplied by municipal services. The proposed RoW passes south of the town and does not enter into the town limits.

Trunk 7 (4+200)

Residences along Trunk 7 within the study area are serviced by Antigonish County water. The proposed underpass will plan for underground services in this area.

Church Street Extension (5+400) and Cunningham Road (5+550)

Five residences or commercial properties situated along Church Street Extension and Cunningham Road are served by dug wells (185 Church Street Ext. and two unknown civic numbers, and 280 Cunningham Road and an unknown civic number). In addition, the presence of a well could not be confirmed but is suspected at three properties (155 Church Street Ext., 73 Cunningham Road and one unknown civic number on Cunningham Road). Wells in this area are

within 50 m of the RoW. The street is serviced by County water north of the junction of Church Street extension and Cunningham Road. Well logs were not available for this area.

Work at this crossing will involve placement of a service road and discontinuing a portion of Church Street Extension and Cunnington Road. The RoW will pass over top of two wells listed above (dug well at 280 Cunnington Road and the suspected well at the unknown civic number on Cunningham Road and commercial operation). There is also major fill planned for 5+630 to 5+870. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Willowdale Lane (North of 5+950 to 6+100)

Residences along Willowdale Lane are serviced by Antigonish County water. The proposed RoW passes south of Willowdale Lane.

Beech Hill Road (6+700)

Beech Hill Road is serviced by County of Antigonish municipal services north of the existing Highway 104. South of the existing Highway 104 are three wells within the study area. One drilled well (County of Antigonish building), one dug well (Department of Natural Resources building) and one unknown well. The proposed highway overpass here will have to take into consideration potential for water quality impacts to these wells as well as the dug well at Civic No. 3770 along the current Highway 104.

The work here will involve the placement of up to 9.5 m of fill during the construction of the overpass. There is risk of temporary siltation of dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells.

Trunk 4 (Northeast of 7+000 to 8+300)

Residences along Trunk 4 East of Antigonish are serviced by Antigonish County water. The proposed RoW passes south of Trunk 4 in this location.

MacEachern Loop (North of 9+650 to 10+100)

Two residences and one commercial property are situated along MacEachern Loop. The MacEachern Collision Centre is served by a surface water reservoir. One dug well and one assumed well serve the two residences on MacEachern Loop. These wells are at least 150 m north and downgradient of the proposed RoW so the 11 m deep road cut in this area is not likely to de-water these wells. However, there is risk of temporary siltation of the dug well from vibration during the construction stage. The surface water reservoir is not currently considered potable, so minor degradation of this source is not a significant concern. Well logs were not available for this area.

Dunn's Loop (10+600)

The RoW passes over Dunn's Loop at 10+555. Three residential properties here have unconfirmed wells. Two of the houses owned by Dunn will be within 50 m of the proposed RoW. The third property contains a dilapidated home which may need to be removed during construction. Any well on this property is not currently in use.

The work at this location includes a major road cut up to 18.5 m. If the indicated wells are dug wells, there is risk of de-watering and temporary siltation from vibration during the construction stage. Drilled wells this close to the alignment would be at risk from blasting.

The potential wells in this location will be monitored during construction across Dunn's Loop.

South River Loop (South of 10+650), Dunmore Road (South of 11+350) and Route 316 (South of 12+150)

These roads include partial service by County of Antigonish municipal water, four dug wells (10 and 24 South River Loop, and 4667 and 4669 Route 316), one drilled well (4665 Route 316) and two assumed wells (12 South River Loop and 5285 Dunmore Road). The RoW does not cross these roads but the noted wells are within the study area.

The dug wells along South River Loop are within 50 m upgradient of the RoW, so the proposed 18.5 m deep road cut across Dunn's Loop could result in dewatering of these wells. In addition, there is risk of temporary siltation of the dug wells along South River Loop from vibration during the construction stage. The closest of these wells will be monitored during construction of the highway. The closest wells along Dunmore Road and Route 316 are 200 m and 500 m upgradient of the RoW, respectively, are not expected to be affected by construction of the RoW.

South Side Harbour Road (11+500)

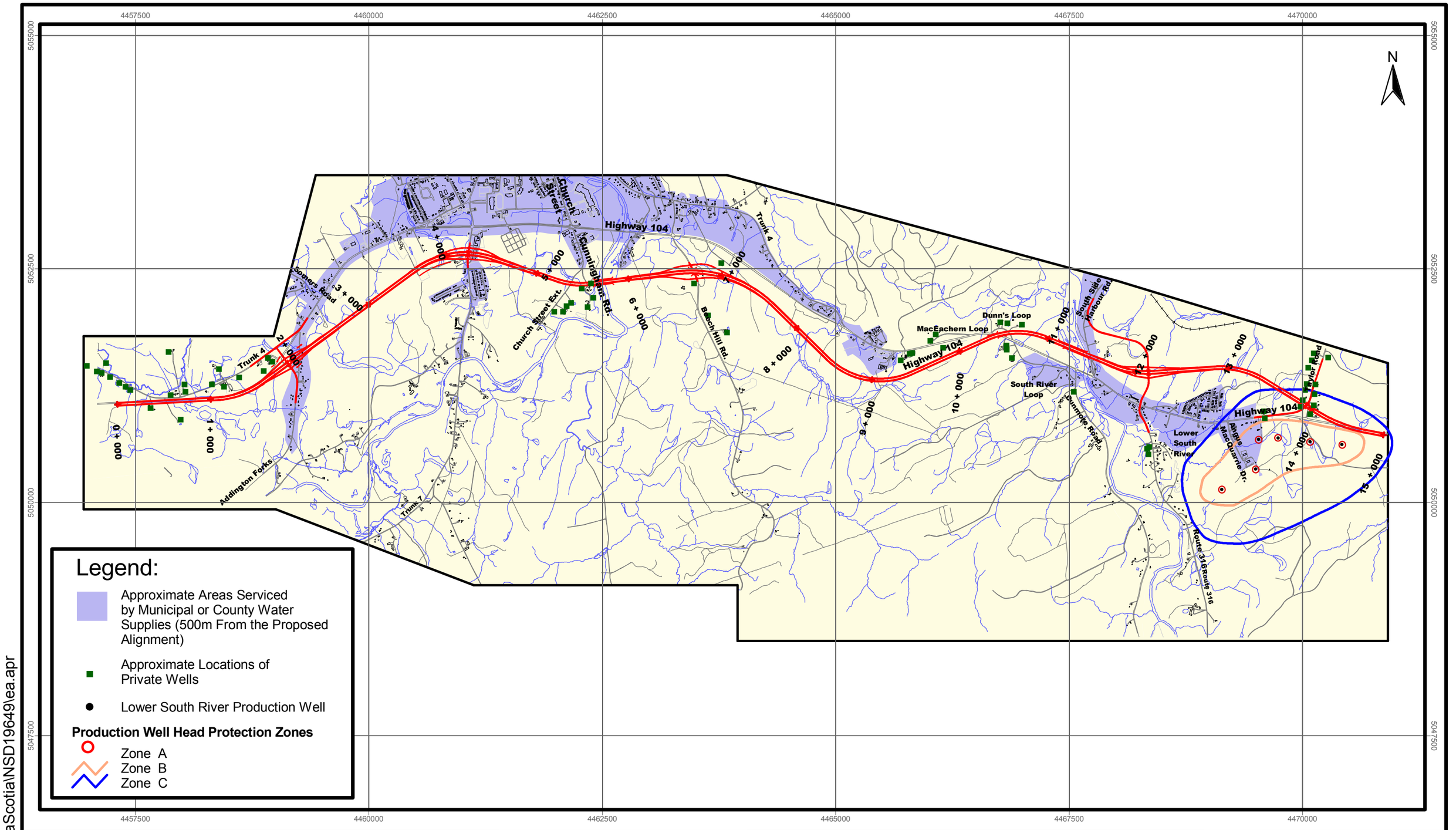
Residences along South Side Harbour Road within the study area are serviced by Antigonish County water. A portion of this road will be discontinued, and relocated, and a highway underpass will be constructed at 12+150.

Lower South River Wellfield Protected Area (South of 12+200 to 14+827.65)

The Lower South River water supply wellfield consists of six production wells. However, information was only available on five of these wells during the preparation of this report. The supply wells have an average depth of 55.9 m, an average casing length of 16.9 m, an average well yield of 113 L/min (50 to 200 L/min), and overburden thickness averaging 29.2 m (range from 4.5 to 67.7 m), which suggests deep glacial deposits in this vicinity. The closest of these wells is within 100 m and upgradient of the RoW which passes through the Zone C protection zone for the wellfield. The location of the wells and protection zone are shown on Figure G.1

The Lower South River Wellfield has a well head protection area made up of three protection zones, each with a different level of protection progressively more stringent as the zones move in closer to the wells. The zones were established to roughly correspond with groundwater travel times of three months for Zone A, the closest protection zone, one year for Zone B and twenty-five years for Zone C, the protection zone with the furthest extent (C.J. MacLellan & Associates Inc. 2002). The recommended activity restrictions, or proposed control measures, for each of these zones are shown in Table G.4. Restrictions are focussed on limiting the storage and use of petroleum fuels and solvents, chlorinated solvents, pesticides, fertilizers to varying degrees within the protection zones. Activities such as sewerage disposal, groundwater production, groundwater heat pumps, forestry development and mining and aggregate removal are also prohibited or limited within these zones.

The proposed RoW passes through Zone C. Because the construction period for the highway in this location is anticipated to be less than one year, impacts to the wellfield are not anticipated from construction activities. Development of associated off-RoW works (*i.e.*, pits and quarries, refuelling areas, disposal areas) will have to consider the proposed wellfield control measures (C.J. MacLellan & Associates Inc. 2002) in this area during construction. Post construction controls for road salting and salt storage in this area will need to be in accordance with the proposed control measures for the wellfield outlined in Table G.1.



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Jacques Whitford

NOVA SCOTIA
Transportation and Public Works

SCALE: 1 : 37 500

Date: 12/17/2004

Drawn By: GM

Approved By:

NOVA SCOTIA DEPARTMENT OF TRANSPORTATION & PUBLIC WORKS

ENVIRONMENTAL ASSESSMENT FOR THE PROPOSED HIGHWAY 104 AT ANTIGONISH

Municipal Wellfield and Water Supply Areas

.5 0 .5 1.0 2.0 Km

Map Parameters: 3° MTM, ATS77, Zone 4

DRAWING NO.

NSD16949
FIGURE G.1

Table G4 Proposed Controls for Lower South River Wellfield and Recharge Area

Activities & Materials	Criteria	Zone A Wellhead Protection Zone *1 day to 3 months Delay Time*	Zone B Wellfield Protection Zone *3 Months to 1 Year Delay Time*	Recharge Area Zone C *1 to 25 Years Delay Time*
Petroleum Fuels (gasoline, diesel, fuel oil, jet fuel, lubricating oils)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted with controls	: permitted in containers up to 40,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Petroleum Solvents (paint thinners, degreasers, etc.)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 50 litres capacity : permitted in compliance with NS EFM Plan : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Chlorinated Organic Compounds (dry cleaning chemicals, PCBs, etc.)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 50 litres capacity : permitted in compliance with NS EFM Plan : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Pesticides & Herbicides	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 50 litres capacity : permitted in compliance with NS EFM Plan : not permitted	: permitted in containers up to 1,000 litres capacity : permitted in compliance with NS EFM Plan : permitted
Fertilizers (synthetic and manure)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 1 tonne capacity : permitted in compliance with NS EFM Plan and NS Nutrient Management Plan : permitted with controls	: permitted in containment systems : permitted in compliance with NS EFM Plan and NS Nutrient Management Plan : permitted with controls
Salt (de-icing agents)	Storage Use Bulk Transport	: not permitted : not permitted : not permitted	: permitted in containers up to 1 tonne capacity : limited use permitted (salt-sand mixture) : permitted with controls	: permitted with containment up to 100 tonnes capacity : permitted : permitted
Sewerage Disposal Systems (septic systems)	Activity	: not permitted	: not permitted	: small systems permitted
Groundwater Production well pumping, artesian flow)	Activity	: not permitted other than LSR Wells : abandoned wells should be plugged	: new wells not permitted other than Village Wells : abandoned wells should be plugged	: only house wells permitted : abandoned wells should be plugged
Groundwater Heat Pumps	Activity	: not permitted	: not permitted	: small residential and commercial systems permitted
Forestry Development	Activity	: not permitted	: not permitted	: not permitted
Mining & Quarries	Activity	: not permitted	: not permitted	: small operations permitted

Note: NSEFM Plan - Nova Scotia Environment Farm Management Plan
LSR - Lower South River

Adapted From: (C.J. MacLellan & Associates Inc. 2002)

Blasting in the area of Taylor Road could damage these wells so ripping techniques will be utilized for bedrock removal (if necessary). Since these wells supply a vast area of the county, they will be monitored during construction of the Route 316 connector between 13+500 to 14+827.65.

Lower South River Mobile Home Park (South of 12+500 to 12+950)

The mobile home park in Lower South River is serviced by Antigonish County municipal water. The proposed RoW passes north of the Mobile Home Park.

Angus MacQuarrie Drive (South of 13+000)

Angus MacQuarrie Drive is serviced by the County of Antigonish municipal water and the RoW passes north of this road.

Taylor Road (13+950)

Nine residences or commercial properties on Taylor Road are served by both drilled (Civic Nos. 8, 21, 47, 65 and three unknown civic numbers (owners: Benoit, Landry and one unknown)) and dug wells (Civic Nos. 59 and unknown (owner: MacPherson)). In addition, the presence of a well could not be confirmed but is suspected at two properties (Civic Nos. 112 and 139). The RoW passes over three of these properties (Civic Nos. 8, 21 and 47) and both drilled and dug wells will be within 50 m of the RoW.

Nine domestic well logs for this area indicate that drilled wells had an average depth of 34.3 m, casing length of 18.7 m; well yield of 4.4 L/min (1.2 to 12.1. L/min), and overburden thickness averaging 16.5 m (range from 1.2 to 42.7 m), which varied depths of glacial deposits in this vicinity.

A major cut is not planned for the underpass at Taylor Road. However, one of the wells on Taylor Road encountered less than 2 m of overburden. Therefore even a minor cut in this area may encounter bedrock. It should be noted that blasting here could damage drilled wells on Taylor Road close to the RoW. The highway underpass at Taylor Road is also within 100 m of Antigonish County's nearest water supply wells. Work in this area will involve ripping techniques if bedrock removal is necessary. A moderate road cut in this area could de-water dug wells. There is risk of temporary siltation of drilled and dug wells from vibration during the construction stage, and residual effects from uncontrolled salt runoff in the operation stages at adjacent dug wells. The nearest dug wells will be monitored during construction.

Any dug wells located within 50 m of a major highway cut, underpass or overpass will therefore be inspected by the contractor, measured for water level and depth, and inventoried for possible future reference. Dug wells within 50 m are noted along Trunk 4, Church Street Extension, Cunningham Road, Beach Hill Road, Dunns Loop and Taylor Road.

Summary of Monitoring and Follow-up Requirements

Several wells are located within the 500 m assessment boundary, particularly where the alignment crosses existing roads. NSTPW's Construction Contractor will complete an inventory of residential water wells. This would include an interview of the well owner, documentation of well construction specifics, collection of a water sample for chemical and bacteria analysis, and photographic documentation of the well location. A contingency plan will also be developed for the area of the wellfield protection zones to ensure that any potential malfunctions or accidental events are addressed appropriately and in a timely manner to minimize potential impacts to the wellfield that could arise from highway operations.

In the event that any residential wells are found within 500 m of any blasting excavation areas (road cut or quarry), or if dug wells are located within 50 m of a major (> 5 m) overburden cut, these wells will be inspected (measuring depth, yield and water level in dug wells), and sampled for baseline water quality (Rcap-MS and bacteria). Where several drilled wells are present within the proposed 500 m blast monitoring radius, selected representative proximal wells will be inspected, baseline sampled, and closely monitored during the construction phase. The Contractor will implement a contingency plan to provide temporary water during construction, and to repair or replace any wells found to be permanently damaged, in the event that wells are adversely or permanently affected by the Project.

Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is proposed for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the evaluation of effects. The suggested duration of any post-construction monitoring would be the lesser of two years of quarterly monitoring, or stabilization of water level or chemical indicators in wells of concern.

Domestic Well Monitoring Plan

Pre-construction Monitoring

Pre-construction monitoring will be conducted to collect baseline groundwater data for wells potentially affected by deep overburden excavation (dewatering) and blasting.

- After the final alignment has been determined, a more detailed determination of the closest domestic water well locations with respect to the alignment will be made.

- All wells located within 500 m of any blasting will be field truthed and located on appropriate mapping relative to the alignment. The closest wells at each blast site will be inventoried, yield tested and sampled for baseline water quality (*i.e.*, Rcap-MS+bacteria). Low yield wells (< 0.5 igpm) identified within the survey zone will also be inspected, if possible. All inspections and testing will be conducted by a NSDEL certified pump installer.

Post-Construction Monitoring

- Because water levels may change slowly over time in tight glacial till aquifers, follow-up water level monitoring is recommended for shallow dug wells located close to major overburden cuts along the alignment. Natural seasonal variation in water levels will be considered in the evaluation of effects.

- The suggested duration of any post-construction monitoring would be the lesser of 2 years of quarterly monitoring, or stabilization of water level or chemical indicators in wells of concern.

Procedure for Field Truthing and Residential Well Inventory

Field truthing involves a door-to-door survey of residential water well supplies in proximity to a major development. The survey boundary is dependent on the nature and potential severity of the hazards to wells.

A standard procedure involving a questionnaire is generally used (see attached questionnaire). Each property owner within 100 m (dug wells at risk from dewatering) to 500 m (all wells at risk from blasting) would be contacted and interviewed respecting their well water supply. Specific information will be collected on: type of well (dug, drilled, spring), well depth, diameter, casing length; water levels, well yield or historical yield problems, well location and well completion

methods, and septic field location. Information from the questionnaires will be matched with well drillers logs from the NSDEL Well Driller's Logs databases (1965 to 1978 in books; 1978 to present in database form). Photographs are typically taken of visible well completions, and field comments are made regarding well location and potential for impact from the alignment construction or other constraints such as septic fields, roads, fuel tanks or waste deposits.

A representative unfiltered and unpreserved water sample is collected from the point of use and prior to any water quality treatment systems, for analysis of general chemistry, metals and for total and fecal coliform bacteria. For larger projects, only the closer wells are subjected to chemical analysis; the remaining samples being archived. Results of the water quality analysis are copied to the well owners. Analytical results are retained for up to two years for possible future use in the arbitration of well damage claims.

Dug wells deemed to be at risk to aquifer dewatering by large road cuts are measured for both depth and water levels, and a short yield test is performed by a certified pump installer using the existing pumping system.

Drilled wells at risk to possible damage from major blasting operations are also inspected for depth, water level, and a short yield test is performed by a certified pump installer. Typically this would be done only for the closest few wells deemed to be most at risk, since cost and possible inconvenience to the well owner is involved in the excavation and plumbing modifications.

WATER WELL QUESTIONNAIRE

1.0 OWNER/RESIDENT INFORMATION

Owner/Resident Name: **PID Number:**

Address: **Res. Since?:**

Municipality: **Province:** **Postal Code:**

Phone: **Prev. Owner:**

Number of Occupants: **Estimated Daily Usage:** **Principal Water Usage:**

2.0 WELL INFORMATION

Anecdotal ☐ **Well Log** ☐

Well Type: *Dug* ☐ *Drilled* ☐ *Drivepoint* ☐ *Spring (artesian)* ☐ *Cistern* ▱ *Other*:

Drilled By: **Well Log Available?** *Yes* ☐ *No* ▱

Original Owner: **Aquifer Type:**

Date Drilled: **Well Diameter:** **Well Screen?:** *Yes* ☐ *No* ▱

Well Depth: **Casing Diameter:** **Casing Seal?:** *Yes* ☐ *No* ▱

Casing Length: **Well Stickup:** **Pump Setting:**

Water Depth: **Date:** **Northing:**

Well Location: **Est. Yield:** **Easting:**

Well Accessible?: *Yes* ☐ *No* ▱ **Photographed?:** *Yes* ☐ *No* ▱ **Estimated Yield:**

Pump Type: *Submersible* ☐ *Jet* ▱ *Other*: **Past Pumping Test Performed:** *Yes* ☐ *No* ▱

3.0 WATER QUALITY

Are records of Water Quality Available?

When was well last sampled? **Sampled By?**

What parameters were tested? *General Chemistry* ☐ *Metals* ☐ *Bacteria* ☐ *Other*:

What is general Water Quality?: *Taste* ☐ *Odour* ☐ *Staining* ☐ *Mineralization* ☐ Silt/Sediment ☐ *Other*:

Water Treated?: **Treatment Type?:** *Softener* ☐ *Carbon* ☐ *Other*:

Are there any other wells on your property? Reason why replaced?:

Can a sample be obtained before Treatment/Taps?:

Can a sample or water level measurement be obtained directly from the well?:

What is the normal water level in your well?:

What is the normally observed range of fluctuation? **Seasonally?** **High Usage?:**

Has the well ever gone dry?:

Are there groundwater problems in the area?:

Are there water supply springs near by?:

Type of septic disposal system:

Location of septic disposal system:

Depth of septic disposal system:

4.0 WATER SAMPLE

Sample ID: **Sample Taken From:**

Comments:

Sketch on Back

Interview By: *Date:*