APPENDIX - N (NEW TECUMSETH)

GENIVAR CONSULTANTS LP (FORMERLY JAGGER HIMS) TECHNICAL MEMORANDUMS

New Tecumseth:

- Technical Memorandum J1 - Drinking Water Issues Evaluation

DILLON CONSULTING LIMITED: WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

- Dillon Consulting Limited WHPA Peer Review Report Memo
- Wellhead Time of Travel Capture Zone Peer Review Evaluation Results
    - Table 1: Alliston
    - Table 2: Hillcrest
    - Table 3: Tottenham

GENIVAR

TECHNICAL MEMORANDUM J1

Date:	August 5, 2010
To:	Don Goodyear, P.Geo. – South Georgian Bay Lake Simcoe Protection Region
From:	Sarah Dignard/Colleen Barfoot/Lloyd Lemon, P.Geo.
Project No.:	071948.05
Subject:	Drinking Water Issues Evaluation – New Tecumseth Town of New Tecumseth

OBJECTIVE:

To document the Drinking Water Issues Evaluation for the groundwater supply for the Town of New Tecumseth in the South Georgian Bay Lake Simcoe Source Protection Region.

OVERVIEW:

Work has been completed to meet the requirements of Technical Rules 114 through 117 of the Technical Rules: Assessment Report, *Clean Water Act, 2006* as provided by the Ontario Ministry of the Environment on December 12, 2008 and as amended in November 2009. The Drinking Water Issues Evaluation portion focuses on identifying recurring water quality impacts or situations with a possibility of impacting drinking water sources in the short-term. This work results in a preliminary list of identified issues.

The approach for the Drinking Water Issues Evaluation is described in more detail in "Technical Memorandum A5 - Drinking Water Issues Evaluation Methods". The steps included:

Step 1: Assemble Available Data

Step 2: Review Data and Identify Drinking Water Issues

Step 3: Evaluate Drinking Water Issues

Step 4: Identify Contributing Area for Drinking Water Issues

Step 5: Prepare List of Drinking Water Issues

Municipal Wells and Aquifers

The Town of New Tecumseth Water Supply is divided into two systems: the Communities of Alliston/Hillcrest which consists of seven groundwater wells altogether; and the Community of Tottenham which consists of four groundwater wells. The New Tecumseth Water Supply also served the town of Beaton until recently.

The Collingwood Water Treatment Plant pipeline has been recently constructed to reach Alliston and Beaton and now serves as the main water supply, with the Alliston wells serving as a supplemental water source as required. There are plans for the pipeline to reach Tottenham by 2014. The groundwater wells are planned to be used less and less as more of the Collingwood surface water will be used, but the well system would be sufficient to supply the Town of New Tecumseth by itself if there is the need for it.

Communities of Alliston/Hillcrest

The community of Alliston receives its water supply from seven municipal wells (Well 1, 4, 5, 6, 7, 8, and the Hillcrest Well). The overburden in the Alliston area consists of a stratified multi-aquifer system, with layered formations which range from clay to coarse sand and gravel. The overburden ranges in thickness from about 80-120 m and rests on shale and limestone bedrock of the Blue Mountain Formation, the Collingwood Formation, and the Trent Group. The overburden sequence contains an upper, middle, and lower aquifer. The upper aquifer is generally unconfined, while the middle and lower aquifers are confined beneath clayey aquitard units which range from 20-50 m in thickness. Wells 1, 4, 5 and 6 are constructed in the lower aquifer. Well 7 is constructed in the middle aquifer, and Well 8 is open to bedrock with connection to the overlying lower aquifer. Raw water from all of the municipal wells servicing Alliston are treated with sodium hypochlorite for disinfection. The rated capacity for the maximum flow rate is 1,642 m^3/day for Well 1; 2,938 m^3/day each for Wells 4, 5 and 6; 4,964 m^3/day for Well 7; 1,964 m^3/day for Well 8; and 821 m^3/day for the Hillcrest Well.

Well 1 is a 200 x 450 mm diameter, 80m deep, drilled well that is double-cased and gravel packed. It is equipped with a vertical turbine well pump. It is constructed in a confined artesian aquifer with a confining layer reported to be 33 m thick and composed of clay and with sand and gravel layers. The well is located within the fully serviced area of Alliston.

Well 4 is a 254 x 508 mm diameter, 75m deep, drilled well. It is double-cased and gravel packed. It is equipped with a vertical turbine well pump. This well is located in an area of intensive agricultural production. It is constructed in a confined artesian aquifer.

Well 5 is a 250 x 500 mm diameter, 78 m deep, drilled well that is double-cased and gravel packed. It is equipped with a vertical turbine well pump. This well is located on the southern edge of Alliston, in an area that is becoming increasingly industrialized. It is constructed in a confined aquifer, with the clayey confining layer providing a degree of protection from local contamination from pesticides, herbicides, or potential industrial contaminants.

Well 6 is a 300 x 600 mm diameter, 72 m deep, drilled well that is double-cased and gravel packed. It is equipped with a vertical turbine pump. This well is located in the same area as Well 4. There is a soft clay and silt confining layer with a thickness of approximately 20m that separates the upper aquifer and the water supply aquifer. This well is constructed in a confined artesian aquifer.

Well 7 is a 305 x 610 mm diameter, 51 m deep, drilled well. It is double-cased, gravel packed, and equipped with a vertical turbine well pump. This well is located downgradient of an area that is primarily low-intensity agricultural land. The well is constructed in an aquifer that is confined to an erosional channel within the Newmarket Till.

Well 8 is a 300 x 600 mm diameter, 80 m deep, drilled well. It is also equipped with a vertical turbine well pump. This well was not run for the period of January 1st, 2007 to December 31st, 2007. This well is currently off-line upon and waiting approval for service.

The Hillcrest Well is a 150 mm diameter, 80 m deep, drilled well that is equipped with a submersible well pump. It is located within the fully serviced area of Alliston. The well is constructed in the bedrock, however, it is expected that the well is sustained by water from the coarse sand aquifer overlying the bedrock.

Community of Tottenham

The Community of Tottenham receives its water supply from four groundwater production wells. Wells 4 and 5 are known as the Walkem Drive Wells, and Wells 6 and 7 are known as the Coventry Park Wells. The rated capacity for the maximum flow rate is 1,633 m^3/day each for Wells 4 and 5; 1,728 m^3/day for Well 6 and 1,669 m^3/day for Well 7.

Well 4 is a 300 mm diameter well, with a depth of 89 m. It is fitted with a submersible well pump. This well is constructed in a supply aquifer which has a 60 m thick confining layer which is composed of unoxidized clay.

Well 5 is a 400 mm diameter well, with a depth of 89 m. It is fitted with a submersible well pump. The thick, clay rich sediments which overly Well 4 also overly Well 5. Well 5 has a 53m thick confining layer, also composed of unoxidized clay, present between the surface and the supply aquifer.

Well 6 is a 150 mm diameter well, with a depth of 88 m. It is fitted with a submersible well pump. There are 71.3 m of fine grained clay and silt overlying the aquifer in which Well 6 is constructed. A new well has been drilled recently approximately 150 feet from the current well in order to eventually replace Well 6.

Well 7 is a 250 mm diameter well, with a depth of 88 m. It is also fitted with a submersible well pump. Like Well 6, there is approximately 74.1 m of fine grained clay and silt overlying the supply aquifer.

***Step 1:* Assemble Available Data**

The data sources that were reviewed to identify potential issues included:

- Certificates of Approval (2005);
- Permits to Take Water (2004);
- Engineer's Reports (2001);
- Alliston Groundwater Supply – GUDI Assessment (2004);
- Annual Water Supply Water Quality Monitoring Reports (2006-2007);
- Raw Groundwater Quality Data (2000, 2006, 2007, 2008); and
- Operator Interview.

Ms. Lisa McGuire, Water/Wastewater Compliance Technician for the Town of New Tecumseth, was interviewed to obtain operator insight into potential issues identified in the published data as well as identifying potential issues that may not have been identified in published data to date.

***Step 2:* Review Data and Identify Drinking Water Issues**

A set of tables have been prepared to document a series of potential issues from the raw and treated water at the Town of New Tecumseth as identified from various data sources. The tables are as follows:

Table Number	Town of New Tecumseth Water Works	Water Type	Water Source
J1-1A	Alliston / Hillcrest	Raw	Well #4
J1-1B			Well #5
J1-1C			Well #6
J1-1D			Well #7
J1-1E			Hillcrest Well
J1-1F		Treated *	
J1-1G		Raw	Well #1
J1-1H			Well #8
J1-2A	Tottenham	Raw	Well #4
J1-2B			Well #5
J1-2C			Well #6
J1-2D			Well #7
J1-2E		Treated *	

* The treated water data collected may reflect the use of any or all wells in that particular water system.

The tables are designed to document:

1) The source reports or data that result in the identification of a parameter as a potential Drinking Water Issue;

2) Results of comparison of observed parameter concentrations to relevant benchmarks and situations where:

   a. Parameter concentrations exceed the primary benchmark established by the Ontario Drinking Water Quality Standard (ODWQS);
   b. Parameter concentrations exceed a locally established benchmark value (typically a background concentration);
   c. Parameter concentrations exceed the established method detection limit (MDL) [typically applied for organic chemical parameters];

3) Professional judgment on the reliability of the data based on the number of measurements and the relative consistency of the observed occurrence;

4) The nature of observed trends in parameter concentrations;

5) Input from local System Operators and other Stakeholders as to the significance of the parameter as a Drinking Water Issue;

6) Whether treatment is in place for the observed parameters and its effectiveness; and

7) The nature of the source of the parameter listed as a potential issue.

Trends were determined through graphing municipal water supply system water quality data. Parameters listed on the preliminary list of drinking water threats for each well have been assessed graphically for trends. The available data has been provided between 2000 and 2008.

Step 3: **Evaluate Drinking Water Issues**

The J1 series of tables have been developed to identify Drinking Water Issues in accordance with the "Decision Process for Identification and Evaluation of Drinking Water Issues" as presented in Figure A5-1 of "Technical Memorandum A5 - Drinking Water Issues Evaluation Methods".

The positive or negative responses entered in the J1 series of tables correspond to the steps in the decision process. Professional judgment was built into the decision process in the evaluation of data reliability to identify anomalous conditions and in the consideration of operational insights. Trend analysis was used to identify parameters that are projected to exceed the ODWQS within approximately 50 years. The J1 series of tables also allow for the identification of the source of the potential Drinking Water Issue, whether treatment is in place, and its effectiveness.

For each of the water works systems, all of the parameters identified in the J1 tables are not considered to be Drinking Water Issues. Parameters common to most systems in the Town of New Tecumseth that were removed from consideration include:

- Coliforms and E.Coli are typically absent but can be observed on rare occasions in low numbers. The presence of coliforms and E.Coli in the raw water is not persistent or indicative of deterioration of raw water quality. Disinfection is in place and is effective.
- Hardness has persistently exceeded aesthetic or operational objectives. This is considered to be a naturally-occurring parameter and does not display an increasing trend. This parameter is not considered to result in the deterioration of the water quality for use as a source of drinking water.
- Concentrations of iron and turbidity have occasionally exceeded aesthetic or operational objectives. Iron is sequestered at both Alliston and Tottenham and treatment has been effective at reducing concentrations. Turbidity concentrations are considered to be a result of the treatment process. Work is currently underway to optimize the treatment process in order to reduce turbidity and iron concentrations. These parameters are considered to be naturally-occurring and are not likely to result in the deterioration of the water quality for use as a drinking water source.
- Organic nitrogen concentrations occasionally exceed ODWQS aesthetic objectives. This parameter is not considered to result in the deterioration of the water quality for use as a drinking water source.
- Aluminum concentrations have occasionally exceeded operational objectives at Well 5 at Alliston/Hillcrest. The data does not display an increasing trend. This parameter has only been observed under circumstances that are considered to be anomalous and is not considered to result in the deterioration of the water quality for use as a source of drinking water.
- Concentrations of sodium are consistently less than the ODWQS value of 200 mg/L in the raw and treated water from the Town of New Tecumseth wells. The sodium concentration data does not display a trend. The treated reservoir data at Tottenham does display an increasing trend but concentrations are not expected to exceed the ODWQS value within the next 50 years. Sodium is therefore not considered to be a Drinking Water Issue at these locations but should be closely monitored. Concentrations have exceeded the guideline of 20 mg/L. Sodium is a concern at 20 mg/L as the Medical Officer of Health is to advise individuals on low-sodium diets. Observed concentrations of sodium are variable and the source has not been confirmed, but is typically related to winter de-icing, septic system effluents from water softeners or natural causes. Reduction of sodium use in the contributing watershed would be beneficial to the drinking water quality.
- The organic parameter 2,4,6-trichlorophenol was detected in trace concentrations on one occasion at Alliston Well 1. It is considered to occur under a circumstance that is not persistent.

- Organic parameters, such as trihalomethanes, are present above ODWQS guidelines in treated water at the Tottenham reservoir as byproducts of disinfection by chlorination. Work is currently in progress to optimize the treatment process in order to reduce concentrations of trihalomethanes and other treatment byproducts. The data does not display increasing trends.

***Step 4:* Identifying Contributing Area for Drinking Water Issues**

No parameters were identified as Drinking Water Issues at the Town of New Tecumseth groundwater wells.

***Step 5:* Prepare List of Drinking Water Issues**

No parameters were identified as Drinking Water Issues at the Town of New Tecumseth groundwater wells.

LAL/SJD:nah

Table J1-1A **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Well #4
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Hardness				Y				Y				N				Y	Y	N	Y			Y	N	N	NO	Y				
Iron				Y				Y				N				Y	Y	N	Y			Y	N	N	NO	Y			Y	Y
Sodium				Y						Y		N	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-1B **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Well #5
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Aluminum				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO			Y		
Hardness				Y				Y				Y		Y			N	Y	Y		Y		N	N	NO	Y				
Organic Nitrogen				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO			Y		
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-1C **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Well #6
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y			Y	Y
Organic Nitrogen				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO			Y		
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO	Y				

Table J1-1D **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Well #7
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Hardness				Y				Y				Y		Y			N	Y	Y		Y		N	N	NO	Y				
Iron				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y			Y	Y
Organic Nitrogen				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-1E **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Hillcrest Well
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Organic Nitrogen				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO			Y		
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-1F **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Treated Water
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2006-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y						Y			Y				Y	Y	N	Y			Y	N	N	NO			Y		
Chemicals																														
Sodium			Y							Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-1G **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Well #1
Issues Review Date: August 26, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2007-2008
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
2,4,6-trichlorophenol				Y						Y		Y				Y	Y	N	Y			Y	N	N	NO			Y		
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				

Table J1-1H **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Alliston/Hillcrest
Drinking Water Source: Well #8
Issues Review Date: August 26, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2007-2008
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y		Y			N	Y	Y			Y	N	N	NO	Y				
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-2A **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Tottenham
Drinking Water Source: Well #4
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000,2006-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y			Y	Y
Organic Nitrogen				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-2B **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Tottenham
Drinking Water Source: Well #5
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Confirm Presence: Persistent (Always, <90%)	Confirm Presence: Majority of Tests (40-90%)	Confirm Presence: Occasionally (5 - 40%)	Confirm Presence: Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y			Y	Y
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-2C **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Tottenham
Drinking Water Source: Well #6
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																		
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y			Y	Y
Organic Nitrogen				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-2D **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Tottenham
Drinking Water Source: Well #7
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
													Confirm Presence																		
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Persistent (Always, <90%)	Majority of Tests (40-90%)	Occasionally (5 - 40%)	Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Pathogens																														
Coliforms			Y					Y				Y				Y	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y			Y	Y
Organic Nitrogen				Y				Y				Y	Y				N	Y	Y			Y	N	N	NO	Y				
Sodium				Y						Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table J1-2E **Evaluation of Drinking Water Issues**

Municipality: Town of New Tecumseth
Community: Tottenham
Drinking Water Source: Treated Water (Reservoir)
Issues Review Date: June 8, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2000, 2006-2007
Interview (person/title/date):

Parameter	Identified From							Compare Water Quality Data to Benchmarks				Confirm Data Reliability							Evaluate Trends					Operational Consideration	Drinking Water Issue	Source of Issue			Treatment	
	Watershed Characterization	Operator Interview	Annual Water Quality Reports	Raw Water Quality Data	Treated Water Quality Data	PGMN Data	Other	Raw Water Quality Exceeds ODWQS	Treated Water Quality Exceeds ODWQS	Above Detection Limit	Above Local Background	Sufficent Data	Confirm Presence: Persistent (Always, <90%)	Confirm Presence: Majority of Tests (40-90%)	Confirm Presence: Occasionally (5 - 40%)	Confirm Presence: Rarely (<5%)	Anomalous Circumstance	Data Reliable	Trend Reviewed	Increasing	Reducing	Constant/Uncertain	Will Exceed ODWQS within 50 Years			Natural	Threat (Known)	Threat (Unknown)	In Place	Effective Mitigation
Chemicals																														
Hardness					Y				Y			Y	Y				N	Y	Y			Y	N	N	NO	Y				
Iron					Y				Y			Y	Y				N	Y	Y			Y	N	N	NO	Y			Y	Y
Sodium					Y					Y		Y	Y				N	Y	Y	Y			N	N	NO			Y		
Trihalomethane			Y						Y			Y	Y				N	Y	Y			Y	N	N	NO		Y			
Turbidity			Y						Y			Y				Y	N	Y	Y			Y	N	N	NO			Y		

July 29, 2010

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Attention: Mr. Don Goodyear, Source Protection Manager

WHPA Peer Review Report

Dear Mr. Goodyear:

Dillon Consulting Limited (Dillon) was retained by the Lake Simcoe Region Conservation Authority (LSRCA) to conducted Peer Reviews of well head protection area (WHPA) mapping for 86 municipal groundwater systems. These systems are located in the South Georgian Bay Lake Simcoe Source Protection Region. External management of the project was conducted by Mr. Dave Ketcheson, P.Eng of Azimuth Environmental Consulting Inc. The results of the peer review are issued in the form of digital spreadsheet files that are attached to this letter. The project scope and peer review methodology is summarized in the letter herein.

PROJECT SCOPE

LSRCA retained Dillon to conduct a 'high level' peer review of the WHPAs that were largely delineated as part of previous WHPA or regional groundwater studies, at a time prior to the finalization of the Director Rules. In general, WHPA delineation was based on an assortment of different model types, including fixed radius, 2-D analytical solutions and numerical 3-D flow modeling. In general, more sophisticated models were applied to those systems where more data was available. The focus of the peer review was on whether the methodologies were consistent with those outlined in the Directors Rules, rather than a more traditional technical modeling critique. Evaluations also identified critical issues or deficiencies that would have implications on subsequent steps in the source protection process, so that these may be addressed as part of the Assessment Report. The review also identify long-term opportunities for improvement in subsequent rounds of the process, recognizing the various levels of effort applied in WHPA delineation across the region (i.e., analytical vs. numerical methods), and the availability of data in the various WHPA settings.

Peer reviewers were Rob Kell, M.A.Sc., P.Eng, P.Geo.; Jeff Hachey, M.Sc. and Darin Burr, M.Sc. P.Geo, all hydrogeologists with Dillon.

...continued

Evaluation of the WHPAs was performed in a systematic fashion following a "score card" approach. The score card contained both objective and subjective criteria that were evaluated for each system. This template approach enabled reviewers to maintain a level of consistency during the reviews, and was suited to the "high level" nature of the evaluation. The criteria that were evaluated is listed below:

Objective Criteria	**Subjective Criteria**
Was modeled pumping rate appropriate?	Complexity of geological Setting
Were approved models and methods used?	Appropriateness of Flow Model
	Reasonableness of input parameters
	Adequate incorporation of natural flow field
	Model Calibration
	Incorporation of Uncertainty

For each criterion, a score between 1 and 10 was awarded. In general, a score <5 for any of the criteria would be given if a critical concern was identified that would either significantly affect the reliability of the WHPAs, or is a contravention of the elements of the Directors Rules. An exception for this rule would be the evaluation of the uncertainty criterion. Failure to adequately incorporate uncertainty into the model results was not deemed a requirement of the Director Rules and therefore would not necessarily cause the system to "fail". Details on conditions that would cause an unacceptable evaluation at the criteria level are presented in the score card sheets.

All systems were given a "pass", "fail" or "conditional pass" result, depending upon the analysis results. A "pass" ranking was given for those systems were the methodology was generally consistent with the Director Rules, and no critical deficiencies were noted. A "conditional pass" was granted, where the potential for considerable uncertainty in the results existed, but either little data was available to improve the accuracy of the results, or it was the reviewer's opinion that the uncertainty on the results would not significantly alter the enumeration of land parcels that may contain significant threats.

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Following criteria scoring, the individual scores were weighted, and summed to produce an overall system score (between 1 and 10) for the WHPA delineation. Higher the score, the more favorable are the results of the evaluation. Please note that this scoring is a relative ranking between the systems, and is not to be interpreted as any type of marking. For example, a score of 6 does not mean a 60% mark, but rather is a system whose delineated WHPAs are deemed more conservatively robust (in lieu of available data) than a system that receives a score of 5. Theoretically, a system evaluated via fixed radius that is very conservative could receive a higher system score than a detailed numerical model result that is not conservative, as the risk of under-representing the area where significant threats may be lower.

RESULTS

The results of the evaluation are presented on digital Excel™ spreadsheets for each system, and are grouped by township or separated municipality name. Rationale for the individual criteria evaluations, along with the criterion scores, overall system scores and recommendations for future improvement are presented on the individual sheets.

LIMITATIONS

This report was prepared exclusively for the purposes, project and site location(s) outlined in the report. The report is based on information provided to, or obtained by Dillon Consulting Limited ("Dillon") as indicated in the report, and applies solely to site conditions existing at the time of the assessment. Although a reasonable assessment was conducted by Dillon, Dillon's assessment was by no means exhaustive and can not be construed as a certification or acceptance of the reviewed reports. Rather, Dillon's report represents a reasonable review of available information within an agreed work scope, schedule and budget. Further review and updating of the peer review reports will be required as local and site conditions, and the regulatory and planning frameworks, change over time.

This report was prepared by Dillon for the sole benefit of our Client. The material in it reflects Dillon's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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CLOSURE

We appreciate the opportunity to work with LSCRCA on this assignment. If you have any questions about this report, please contact the undersigned.

Yours sincerely,

DILLON CONSULTING LIMITED

Darin Burr, M.Sc., P.Geo.
Project Manager

DTB:amb
Encl.

Table 1: ALLISTON - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**ALLISTON WATER SUPPLY SYSTEM**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Town of New Tecumseth, Appendix J, Golder August 2004; Capture Zone and Equipotential Surface Review (Golder, 2010).**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Regional 3-D MODFLOW**
Score:	**6.5**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_051410_2**

System Characteristics

Hydrogeological Complexity	Stratified multi-aquifer system with layers of sand and silt/clay till
Spatial variability in Aquifer Vulnerability	Low to Medium
Known water Quality Issues	None - No human health water quality issues have been reported.

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations: Critical Deficiencies	Comments / Recommendations: Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		7	Alliston has a population of approximately 8,600 people and relies mainly on surface water (via pipeline from Georgian Bay) for its water supply, Groundwater, from seven production supplements surface water during times of peak demand. The modelled pumping rates were determined by dividing the PTTW maximum rate by a peaking factor of 2.0. Overall, a combined rate of 8,153 m^3/day was used in the model compared to a recorded average rate of 6,373 m^3/day in 2001 (a 27.9% increase over the average pumping rate of 2001). Given that this is now a supplemental water source for the community these pumping rates are probably in excess of actual and are deemed acceptable.	None	Should pumping regime or ultimate development change from that predicted, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	6	Stratified multi-aquifer system with layers of sand and silt/clay till. A three aquifer system is present with the aquifers relatively continuous throughout the Alliston area. The upper aquifer (A1) is discontinuous, unconfined aquifer that is primarily used for individual residences. The two lower aquifers (A2 and A3) are confined by overlying low conductivity aquitards, and the municipal wells are installed in these aquifers. The overburden is in the order of 50 to 100 m deep and is underlain by shale and limestone bedrock.	None	If expansion occurs, further pumping tests and aquifer assessment is required. Given the primary reliance on surface water for the community, expansion is probably unlikely.
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	The Alliston aquifers are part of a larger extensive aquifer system that extends throughout the general area. Suitable hydrostratigraphic description including detailed cross-sections and transfer to the 3-D model was completed.	None	Improve geological model by additional borehole construction in the future, or incorporation of additional information should expansion of the system occur, if it becomes available. Given the primary reliance on surface water for the community, expansion is probably unlikely.
4. Is Flow Model Complexity Appropriate?	10	7	Yes - 3D numerical flow model used; moderate complexity of aquifer. Appropriate distribution of hydraulic conductivity for regional scale model. Model is deemed adequate.	None	Confirmation of flow system/capture zones via local scale modelling may be appropriate in the future, if further investigation and aquifer assessment is

					completed at the local scale.
5. Are model input parameters (recharge, porosity, K) reasonable?	5	9	Yes. The ranges of hydraulic conductivities values used as input to the calibration of the model were consistent with pumping tests and literature values. Aquifer hydraulic conductivities were in the 10^{-3} m/s range and aquitard hydraulic conductivities were in the 10^{-7} to 10^{-6} m/s range. Aquifer/aquitard porosity of 0.25 were used. Two recharge zones (low - eastern two-thirds of model) and high - western one-third (uplands area). Values were 80 and 120 mm/year, respectively. It is not clear if recharge values were calibrated in the model.	None	Additional field work would improve estimates, and should be incorporated into the model if information becomes available.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	7	Yes - observed head values were used to calibrate the model, however it should be noted that large regional scale models often lead to acceptable calibration residuals without optimizing parameters. Boundary conditions appear acceptable. No flow boundaries were assigned to the north and margins of the domain and a constant head boundary was applied at the western edge of the model representing the Niagara Escarpment. The Nottawasaga River was the eastern edge of the model and was modelled as a constant head boundary. River boundaries were assigned for the Boyne River, the Pine River and Bailey Creek.	None	Local variation in recharge rates and inclusion within the calibration process may improve the reliability of the model.
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				
8. Was the Model Calibrated?	5	8	Model was calibrated to 154 wells that were screened primarily in A2/A3 and had a NRMS of 7.8%. No mention of river boundary streambed conductance was included in the report. The model was also calibrated to groundwater discharge to a tributary of Boyne River and the model predicts groundwater discharge of 25.5 L/s compared to a measured value at a stream gauge of 30 L/s.	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale. River boundary conductance could be assessed against actual stream flow data
9. Was Uncertainty considered in the analysis?	5	1	Uncertainty analysis was performed by multiplying and dividing the calibrated hydraulic conductivity and recharge values by a factor of 1.5 for only the 25 year ToT zone. Only the "base case" capture zones are shown for 2 and 10 year ToT.	None	Although uncertainty was addressed the capture zones are based on "best case" (calibrated) values.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high.	None	

Table 2: HILLCREST SUBDIVISION - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**HILLCREST SUBDIVISION WELL SUPPLY**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Town of New Tecumseth, Appendix J, Golder August 2004; Capture Zone and Equipotential Surface Review (Golder, 2010).**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Regional 3-D MODFLOW**
Score:	**6.8**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_051410_2**

System Characteristics

Hydrogeological Complexity	Medium, confined tunnel valley aquifer that is regionally continuous
Spatial variability in Aquifer Vulnerability	Medium
Known water Quality Issues	None reported with the exception of iron (0.34 mg/L) and manganese (0.021 mg/L). Not unusual levels for groundwater.

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations: Critical Deficiencies	Comments / Recommendations: Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		10	Alliston has a population of approximately 8,600 people and relies mainly on surface water (via pipeline from Georgian Bay) for its water supply, Groundwater, from seven production supplements surface water during times of peak demand. The Hillcrest well is a bedrock well installed in 1958 with a depth of 95.7 m. The modelled pumping rates were determined by dividing the PTTW maximum rate by a peaking factor of 2.0. For the Hillcrest well this resulted in a pumping rate of 410 m^3/day. This pumping rates are probably in excess of actual and are deemed acceptable.	None	Should pumping regime or service are increased , then model should be updated.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	6	Stratified multi-aquifer system with layers of sand and silt/clay till. A three aquifer system is present with the aquifers relatively continuous throughout the Alliston area. The upper aquifer (A1) is discontinuous, unconfined aquifer that is primarily used for individual residences. The two lower aquifers (A2 and A3) are confined by overlying low conductivity aquitards, and the municipal wells are installed in these aquifers. The overburden is in the order of 50 to 100 m and is underlain by shale and limestone bedrock. The Hillcrest well is completed in weathered portion of shale bedrock below a basal confining layer.	None	If expansion (which is currently not planned) occurs, further pumping tests and aquifer assessment is required. At that time, the appropriateness of the model to new data should be assessed.
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	The Alliston aquifers are part of a larger extensive aquifer system that extends through out the general area. Suitable hydrostratigraphic description including detailed cross-sections and transfer to the 3-D model was completed.	None	Improve geological model by additional borehole construction in the future, or incorporation of additional information if it becomes available. This would only occur if the system is expanded which is currently not contemplated.

4. Is Flow Model Complexity Appropriate?	10	8	Yes - 3D numerical flow model used; moderate complexity of aquifer. Appropriate distribution of hydraulic conductivity for regional scale model. Model is deemed adequate.	None	Confirmation of flow system/capture zones via local scale modelling may be appropriate in the future, if further investigation and aquifer assessment is completed at the local scale.
5. Are model input parameters (recharge, porosity, K) reasonable?	5	8	Yes - Hydraulic conductivity values are consistent with both pumping tests and literature values. Aquifer hydraulic conductivities were in the 10^{-4} m/s range and aquitard hydraulic conductivities were in the 10^{-8} m/s range. Bedrock (in which the Hillcrest well is installed in) had a calibrated hydraulic conductivity of 2×10^{-6} m/s. Aquifer porosity of 0.3 used, aquitard at 0.2, bedrock (shale) at 0.10. A recharge values of 180 mm/year was calibrated for the model.	None	Additional field work would improve estimates, and should be incorporated into the model if information becomes available.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	8	Yes - observed head values were used to calibrate the model, however it should be noted that large regional scale models often lead to acceptable calibration residuals without optimizing parameters. Boundary conditions appear acceptable. No flow boundaries were assigned to the north and margins of the domain and a constant head boundary was applied at the western edge of the model representing the Niagara Escarpment. The Nottawasaga River was the eastern edge of the model and was modelled as a constant head boundary. River boundaries were assigned for the Boyne River, the Pine River and Bailey Creek.	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale.
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				
8. Was the Model Calibrated?	5	8	Model was calibrated to 154 wells that were screened primarily in A2/A3 and had a NRMS of 7.8%. No mention of river boundary streambed conductance was included in the report. The model was also calibrated to groundwater discharge to a tributary of Boyne River and the model predicts groundwater discharge of 25.5 L/s compared to a measured value at a stream gauge of 30 L/s.	None	Model should be calibrated to the local hydrogeological system rather than the regional system. River boundary conductance could be assessed against actual stream flow data. .
9. Was Uncertainty considered in the analysis?	5	1	Uncertainty analysis was performed by multiplying and dividing the calibrated hydraulic conductivity and recharge values by a factor of 1.5. Only the "base case" capture zones are shown for 2 and 10 year ToT. It was noted that the model was most sensitive to changes in hydraulic conductivity and that increasing the hydraulic conductivity values by 1.5 increased the length of the capture zones by 30%.	None	Although uncertainty was addressed the capture zones are based on "best case" (calibrated) values.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as moderate.	None	

Table 3: TOTTENHAM - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**TOTTENHAM WELL SUPPLY**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Town of New Tecumseth, Appendix J, Golder August 2004; Capture Zone and Equipotential Surface Review (Golder, 2010).**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Regional 3-D MODFLOW**
Score:	**6.3**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_051410_2**

System Characteristics

Hydrogeological Complexity	Stratified multi-aquifer system with layers of sand and silt/clay till
Spatial variability in Aquifer Vulnerability	Medium
Known water Quality Issues	none noted

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations: Critical Deficiencies	Comments / Recommendations: Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		5	Tottenham has a population of approximately 4,800 people and relies obtains it water supply from two well fields and a total of four wells. The modelled pumping rates were determined by using the 2001 average demand plus a growth factor of 1.4.	None	Should pumping regime or ultimate subdivision build out change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3D Numerical flow model is an approved modelling approach	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	7	Stratified multi-aquifer system with layers of sand and silt/clay till. A three aquifer system is present with the aquifers relatively continuous throughout the Tottenham - Beeton - Alliston area. The upper aquifer (A1) is discontinuous, unconfined aquifer that is primarily used for individual residences. The two lower aquifers (A2 and A3) are confined by overlying low conductivity aquitards, and the Tottenham municipal wells are installed in these aquifers. The overburden is in the order of 50 to 100 m deep and is underlain by shale (Georgian Bay Formation).	None	If expansion occurs, further pumping tests and aquifer assessment is required. At that time, the appropriateness of the model to new data should be assessed.
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	The Tottenham aquifer system are part of a larger extensive aquifer system that extends through out the general area. Suitable hydrostratigraphic description including detailed cross-sections and transfer to the 3-D model was completed.	None	Improve geological model by additional borehole construction in the future, or incorporation of additional information if it becomes available.
4. Is Flow Model Complexity Appropriate?	10	7	Yes - 3D numerical flow model used; moderate complexity of aquifer. Appropriate distribution of hydraulic conductivity for regional scale model. Model is deemed adequate.	None	Confirmation of flow system/capture zones via local scale modelling may be appropriate in the future, if further investigation and aquifer assessment is completed at the local scale.

5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Yes. The ranges of hydraulic conductivities values used as input to the calibration of the model were consistent with pumping tests and literature values. Aquifer hydraulic conductivities were in the 10^{-5} to 10^{-3} m/s range and aquitard hydraulic conductivities were in the 10^{-7} m/s range. Aquifer porosity of 0.25, aquitard porosity of 0.15 and bedrock of 0.10 were used in the model. Three recharge zones were used representing low (northeast of Niagara Escarpment) medium (representing most of the domain) and high (representing the Oak Ridges Moraine in the southern margin of the domain). Calibrated recharge rates ranged from 80 to 250 mm/year.	None	Additional field work would improve estimates, and should be incorporated into the model if information becomes available.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	6	Yes - observed head values were used to calibrate the model, however it should be noted that large regional scale models often lead to acceptable calibration residuals without optimizing parameters. Boundary conditions appear acceptable although the text notes that no flow boundaries were assigned o the east and west boundaries of the domain but the figure (Figure 3.3.1) shows constant head and no-flow boundaries on the east and west. River boundaries were assigned for the Nottawasaga River, Humber River, Beeton Creek and Bailey Creek.	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale.
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				
8. Was the Model Calibrated?	5	7	Model was calibrated to 86 wells. The calibration wells varied spatially with most of the wells used to calibrate the aquifer A2 located west and south of the model domain and for A3, the calibration wells are located mainly to the northeast. Calibration parameters used were hydraulic conductivity and recharge. the model calibration had a NRMS of 4.56 %. No mention of river boundary streambed conductance was included in the report. The model was also calibrated to groundwater discharge to the Humber River at two gauge stations although there is no mention is streambed conductance was included in the calibration process.	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale. River boundary conductance could be assessed against actual stream flow data
9. Was Uncertainty considered in the analysis?	5	1	Uncertainty analysis was performed by multiplying and dividing the calibrated hydraulic conductivity and recharge values by a factor of 1.5 for only the 25 year ToT zone. Only the "base case" capture zones are shown for 2 and 10 year ToT. The capture zones from the two simulations were combined for the 25 year Tot only.	None	Although uncertainty was addressed the capture zones are based on "best case" (calibrated) values. Uncertainty should be applied to all final capture zones.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	