APPENDIX - C (CLEARVIEW)

GENIVAR CONSULTANTS LP (FORMERLY JAGGER HIMS) TECHNICAL MEMORANDUMS

Clearview:

- Technical Memorandum E1 - 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: Buckingham Woods
    - Table 2: Colling-Woodlands
    - Table 3: Creemore
    - Table 4: New Lowell
    - Table 5: McKean Subdivision
    - Table 6: Stayner

GENIVAR

TECHNICAL MEMORANDUM E1

Date:	August 13, 2010
To:	Don Goodyear, P. Geo. – South Georgian Bay Lake Simcoe Protection Region
From:	Sarah Dignard/Colleen Barfoot/Lloyd Lemon, P.Geo.
Project No.:	071948.01
Subject:	Drinking Water Issues Evaluation – Clearview Township of Clearview

To document the Drinking Water Issues Evaluation for the groundwater supply for the Township of Clearview 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 Township of Clearview municipal water supply is serviced by six separate groundwater supply subsystems: the Buckingham Woods Water Distribution System, the Colling-Woodlands Water Supply System, the Creemore Water Distribution System, the New Lowell Water Distribution System, the McKean Subdivision Water Distribution System and the Stayner Water Distribution System. Some of the municipal water is also provided by the newly installed (2009) pipeline from Collingwood to New Tecumseth. The Township of Clearview services approximately 13,800 people.

Water in the Township of Clearview is obtained from overburden aquifers constructed to depths up to 50 metres. The municipal water supply aquifers in the western part of the Township are shallower and less extensive.

Buckingham Woods Water Distribution System

Water for the Buckingham Woods Water Distribution System comes from three groundwater source wells (Well 1, Well 2 and Well 3) with no reservoir. Well 2 is a standby/backup well and has not recently been used. Chlorine disinfection and iron sequestration is achieved with duty and standby metering pumps. This system serves 17 lots in the community of Osler Bluffs. Wells 1 and 2 are permitted to pump at maximum rates of 91 L/min (131 m^3/day) and Well 3 is permitted to pump at a maximum rate of 85 L/min (122 m^3/day). The wells can operate up to a maximum combined taking of 253 m^3/day.

Colling-Woodlands Water Supply System

Water for the Colling-Woodlands Water Supply System comes from five wells: Well 1, Well 2, Well 3, Well 4, and Well 5. Chlorine disinfection and iron sequestering is achieved with duty and standby metering pumps. This system serves 70 lots. Wells 1, 2, 3, and 4 are permitted to pump at maximum rates of 45 L/min (65 m^3/day) and Well 5 is permitted to pump at a maximum rate of 68 L/min (98 m^3/day). The five wells can operate up to a maximum combined taking of 358 m^3/day.

Creemore Water Distribution System

Water for the Creemore Water Distribution System comes from two wells: Well 1, and Well 2. Chlorine disinfection is achieved with duty and standby metering pumps. This system serves 562 lots in the community of Creemore. Wells 1 and 2 are permitted to pump at maximum rates of 1,023 L/min (1,473 m^3/day). The two wells can operate up to a maximum combined taking of 2,688 m^3/day.

New Lowell Water Distribution System

Water for the New Lowell Water Distribution System comes from three groundwater source wells (Well 1, Well 2 and Well 6) with a grade level reservoir. Wells 3 and 4 were abandoned in mid-2009. Chlorine disinfection is achieved with duty and standby metering pumps. This system serves 240 lots in the community of New Lowell. Well 1 is permitted to pump at a maximum rate of 250 L/min (360 m^3/day), Well 2 is permitted to pump at a maximum rate of 150 L/min (216 m^3/day). Well 6 is permitted to pump at a maximum rate of 174 L/min (251 m^3/day). The wells can operate up to a maximum combined taking of 1,035 m^3/day.

McKean Subdivision Water Distribution System

Water for the McKean Subdivision Water Distribution System is comprised of three groundwater source wells (Well 1, Well 2 and Well 3) with a grade level reservoir. Chlorine disinfection and iron sequestering is achieved with duty and standby metering pumps. This system serves 140 lots in the Hamlet of Nottawa. Well 1 is permitted to pump at a maximum rate of 163 L/min (235 m^3/day), Well 2 is permitted to pump at a maximum rate of 114 L/min (164 m^3/day), and Well 3 is permitted to pump at a maximum rate of 456 L/min (657 m^3/day). The wells can operate up to a maximum combined taking of 1,055 m^3/day.

Stayner Water Distribution System

Water for the Stayner Water Distribution System comes from groundwater source wells (Well 1, Well 2 and Well 3) with an elevated reservoir. Well 2 is being replaced by a new well due to high levels of nitrate. Chlorine disinfection and iron sequestering is achieved with duty and standby metering pumps. This system serves 1575 lots in the community of Stayner. Well 1 is permitted to pump at a maximum rate of 909 L/min (1,309 m^3/day), and Wells 2 and 3 are permitted to pump at maximum rates of 1,818 L/min (2,618 m^3/day). The three wells can operate up to a maximum combined taking of 6,545 m^3/day.

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

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

- South Simcoe Municipal Groundwater Study by Golder Associates (2004);
- Annual Summary Report (2006);
- Annual Water Supply Water Quality Monitoring Reports (2003-2007);
- Raw Groundwater Quality Data (2001, 2005); and
- Operator Interview.

Mr. Mike Rawn, Water/Sewer Superintendent, 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 Township of Clearview as identified from various data sources. The tables are as follows:

Table Number	Township of Clearview Water Works	Water Type	Water Source
E1-1	Buckingham Woods	Raw and Treated	Well #1
E1-2	Colling-Woodlands	Raw and Treated	Well #1
E1-3	Creemore	Raw and Treated	Well #1
E1-4A	New Lowell	Raw	Well #1
E1-4B			Well #6
E1-4C		Treated*	
E1-5A	McKean	Raw	Well #1
E1-5B			Well #3
E1-5C		Treated*	
E1-6A	Stayner	Raw	Well #1
E1-6B			Well #2
E1-6C		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 2001 and 2007. Raw water data has been provided for only some of the wells, but the treated water data applies to all wells within each system.

***Step 3:* Evaluate Drinking Water Issues**

The E1 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 E1 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 E2 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 E1 tables are not considered to be Drinking Water Issues. Parameters common to most systems in the Township of Clearview 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 or treated water is not persistent or indicative of deterioration of raw water quality. Disinfection is in place and is effective.
- The organic parameter n-nitrosodimethylamine was also detected on rare occasions in trace concentrations under circumstances that are not persistent and was only detected at Stayner Well #2 which is being replaced. This parameter is not considered to be a Drinking Water Issue. Concentrations are consistently less than the ODWQS value.
- Methane was found to be occasionally exceeding ODWQS values in the raw water at some wells. This parameter is naturally-occurring. Based on the evaluation process, this parameter is not considered to have potential to result in the deterioration of the water quality. The current treatment system in place is effective at treating this condition through degassing.
- Iron and manganese concentrations persistently exceeded ODWQS aesthetic values in the raw water at some wells but is not considered to represent a specific Drinking Water Issue. A treatment system in place at most locations that is efficient at treating this condition.

- Aluminum and organic nitrogen were occasionally exceeding ODWQS aesthetic or operational values in the raw or treated water at some wells but are not considered to represent a specific Drinking Water Issue. Aluminum is likely caused as a byproduct of the iron sequestration treatment system when present in the treated water.
- The original Well 2 at the Stayner Water Distribution System has been taken off-line and is being replaced with a new well due to high levels of nitrate. However, nitrate is not considered to represent a specific Drinking Water Issue because levels did not exceed ODWQS at Well 2, but were only considered high. The provided data records levels of up to 6.6 mg/L while the ODWQS value is 10 mg/L. Very limited raw water data for this well was provided and it was therefore impossible to confirm is this was an increasing trend. The original well with the high levels of nitrate is no longer a concern as the well is off-line and is being replaced.
- Concentrations of sodium are consistently less than the ODWQS value of 200 mg/L in some of the raw and treated water from the Township of Clearview wells. The sodium concentration data usually displays no discernable trend. 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 or septic system effluents from water softeners. Reduction of sodium use in the contributing watershed would be beneficial to the drinking water quality.
- Hardness, sulphate and turbidity are naturally-occurring parameters that are not displaying increasing trends. These parameters are not considered to result in the deterioration of the water quality as long as increasing trends do not develop.
- Organic parameters, such as trihalomethanes, are present in trace concentrations in water, likely as byproducts of disinfection processes by chlorination. Concentrations are typically well below ODWQS values and do not display increasing trends.

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

No parameters were identified as Drinking Water Issues at the Township of Clearview groundwater wells.

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

No parameters were identified as Drinking Water Issues at the Township of Clearview groundwater wells.

LAL/SJD:nah

Table E1-1 **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: Buckingham Woods
Drinking Water Source: Well #1 and Supply System
Issues Review Date: April 28, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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			Y	N	N	NO			Y	Y	Y
Chemicals																														
Aluminium				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				
Iron				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y			Y	Y
Manganese				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		

Table E1-2 **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: Colling-Woodlands
Drinking Water Source: Well #1 and Supply System
Issues Review Date: April 28, 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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			Y	N	N	NO			Y	Y	Y
E. Coli			Y					Y				Y				Y	N	Y	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				
Methane				Y				Y				N				Y	Y	N	Y			Y	N	N	NO	Y				
Trihalomethanes				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		

Table E1-3 **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: Creemore
Drinking Water Source: Well #1 and Water Supply
Issues Review Date: April 28 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Sodium				Y	Y					Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		
Trihalomethanes				Y						Y		Y			Y		N	Y	Y			Y	N	N	NO		Y			

Table E1-4A **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: New Lowell
Drinking Water Source: Well #1
Issues Review Date: April 28 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Ammonia				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				
Methane				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		
Sulphide				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		

Table E1-4B **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: New Lowell
Drinking Water Source: Well #6
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Ammonia				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				
Methane				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		
Trihalomethane				Y						Y		Y			Y		N	Y	Y			Y	N	N	NO			Y		

Table E1-4C **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: New Lowell
Drinking Water Source: Treated Water Supply
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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

Table E1-5A **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: McKean
Drinking Water Source: Well #1
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Ammonia				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				
Iron				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y			Y	Y
Manganese				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		
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		

Table E1-5B **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: McKean
Drinking Water Source: Well #3
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Ammonia				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				
Iron				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y			Y	Y
Manganese				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		
Turbidity				Y						Y		Y			Y		N	Y	Y			Y	N	N	NO			Y		

Table E1-5C **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: McKean
Drinking Water Source: Treated Water Supply
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	Y	N	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Sodium			Y							Y		Y	Y				N	Y	Y			Y	N	N	NO			Y		

Table E1-6A **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: Stayner
Drinking Water Source: Well #1
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	N	Y	Y			Y	N	N	NO			Y	Y	Y
E.Coli			Y					Y				Y				Y	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Ammonia				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				
Iron				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y			Y	Y
Trihalomethanes				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		

Table E1-6B **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: Stayner
Drinking Water Source: Well #2
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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	N	Y	Y			Y	N	N	NO			Y	Y	Y
E.Coli			Y					Y				Y				Y	N	Y	Y			Y	N	N	NO			Y	Y	Y
Chemicals																														
Hardness				Y				Y				Y			Y		N	Y	Y			Y	N	N	NO	Y				
Nitrosodimethylamine (NDMA)				Y						Y		Y				Y	Y	N	Y			Y	N	Y	NO			Y		

Table E1-6C **Evaluation of Drinking Water Issues**

Municipality: Township of Clearview
Community: Stayner
Drinking Water Source: Treated Water Supply
Issues Review Date: April 29 2009

Information Sources:
Watershed Characterization:
Annual Water Quality Reports: 2001-2007
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

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: BUCKINGHAM WOODS - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**Buckingham Woods**
Reviewed Report:	**Buckingham Woods Groundwater Modelling and Capture Zone Development (Golder, 2010); South Simcoe Groundwater Study, Appendix G: Township of Clearview.**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**Local 3-D Modflow**
Score:	**7.3**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_051410_1**

System Characteristics

Hydrogeological Complexity	Medium - confined to semi confined surficial aquifer. Confining layer spatially discontinuous
Spatial variability in Aquifer Vulnerability	Medium, partially confined (discontinuous), no anthropogenic impacts in aquifer noted
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	Three wells service Buckingham Woods, wells #1, #2, and #3. All wells are completed in the upper surficial aquifer (Golder, 2010). Due to their proximity, wells #1 and #2 were modeled as one point sink, while well #3 was input on its own. Wells from the nearby Collingwoodlands area were also incorporated into the model, although capture zones were not developed for these wells. Interference between these two wellfields were not noted in Golder report. WHPA zones B-, C-, and D were all established using forecasted pumping rates (17.9 m3/day for wells #1 and #2 combined, and 45.2 m3/day for well #3). It is not stated in report how modelled long term usage rates (or, future pumping rates) were calculated, as there is no discussion relating to maximum growth potential. It is unclear if the pumping rates are based on the concept of lesser value of planned or permitted, as neither rate is not discussed. Low score given as a result of lack of information relating to ultimate expansion of the area.	None	Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	3-D Analytical Solution is permissible	None	Perform continuous updating and verification/validation of the model data.
Subjective Criteria					
3a. Is geological setting complex?	10	8	Medium complexity. Multiple aquifers in area, and wellfield for system is completed in partially confined overburden aquifer. Aquitard is spatially discontinuous. Presence of escarpment divide upgradient, and Georgian Bay downgradient will make flow field more predictable. Discontinuous confining layers throughout geological system. No significant water quality issues reported. Adequate number of data well water level points available.	None	
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	Multiple aquifers in area, and wellfield for system is completed in partially confined overburden aquifer. Aquitard is spatially discontinuous. Confining overburden layers presumed to decrease in thickness to the north (Georgian Bay), and to the south (Niagara escarpment). Hydraulic conductivity distribution based on cross-sections	None	Improve geological model by additional borehole construction

			developed for the area.		
4. Is Flow Model Complexity Appropriate?	10	8	Yes - 3D numerical flow model used, model is deemed adequate. There seems to be a good number and distribution of calibration wells across the model domain. Information obtained from MOE WWR QA/QC'd for increased model accuracy. As previously mentioned, presence of escarpment and Georgian Bay will lead to more predictable flow field	None	Additional monitoring wells positioned upgradient of well field would be beneficial to validate model
5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Generally yes - K values of shallow aquifer are based on pumping test. Other hydraulic parameters based on published values, however appear reasonable relative to availability of data. Incorporation of groundwater takings from Collingwoodland wells is noted, and appropriate. Recharge (200 mm/year) may be high, however was the subject of a sensitivity analysis. Also, it should be noted that a 1:1 ratio of horizontal:vertical hydraulic conductivity in all layers of the model was used, which may be questionable.	None	Additional field work would improve estimates. Simulations with lower recharge values should be performed.
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	7	Yes - observed head values and natural flow field were used to calibrate the model, boundary conditions appear acceptable. Presence of escarpment and wetland upgradient, and Georgian Bay downgradient will make capture zones more predictable. Also, it is noted that drain boundary conditions were assigned to simulate more minor surface water features. This assumes that all surface water features are gaining (i.e. sinks) in the model. Also, it is noted that Pretty River was assigned as a constant head boundary, rather than using the river boundary condition within MODFLOW. This could be further validated by adjusting boundary conditions during sensitivity analysis.	None	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10				
8. Was the Model Calibrated?	5	7	Yes- Calibrated to MOE Water Well Record data and available monitoring well water level data. The model RMS was 4.6%, which is acceptable (generally RMS values <10% are deemed acceptable), and absolute residual mean was 3.8 m. Calibration parameters used were hydraulic conductivity, and recharge which are the most common means to calibrate flow model. Boundary conditions could be adjusted to attempt to improve fit.	None	Model should be calibrated to the local hydrogeological system, and results of calibration process should be presented.
9. Was Uncertainty considered in the analysis?	5	6	Limited uncertainty analysis, performed by increasing the length and width of capture zones by 20%, which may be arbitrary. A more classical approach to incorporation of model uncertainty may be preferred. This could include incorporation of the output from multiple runs adjusting various input parameters (i.e. recharge, hydraulic conductivity, boundary conditions) to construct "composite" ToT travel zones.	None	Perform uncertainty analysis at the local scale by varying input variables, and consider uncertainty in flow field
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

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

GENERAL

System Name:	**Collingwoodlands Well Supply**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Clearview, Appendix G**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**USEPA WHPA/GPTRAC**
Score:	**6.8**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_050810_1**

System Characteristics

Hydrogeological Complexity	Low
Spatial variability in Aquifer Vulnerability	Low
Known water Quality Issues	None, with the exception of iron, manganese and ON

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations	
				Critical Deficiencies	Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		10	Modelled rate is the same as the PTTW average rate. The total rate for the 5 wells is 187 m3/day. The 2001 average use was 52 m3/day.	None	Determine committed population requirements to ensure that it is within permitted rate. Confirm with municipality that modelled rates represent likely conditions. Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	2-D Analytical Solution is permitted by technical rules	None	Perform continuous updating and verification of the model data
Subjective Criteria					
3a. Is geological setting complex?	10	8	Low complexity. Shallow (< 8 m deep) confined overburden aquifer. The confining material is a stony clay till having thicknesses of 4 to 6 m in the area. A relatively high score given because aquitard appears generally continuous in capture zone area	None	
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	Model based primarily on water well records and geological mapping, which shows that the geology is moderately consistent in the area. Recharge area is clearly the Niagara Escarpment which is nearby. Confined nature of single aquifer system allows a simple conceptual model to be adequate.	None	
4. Is Flow Model Complexity Appropriate?	10	7	Yes - 2D analytical flow model used, however, considering predictable groundwater flow direction (wells are in a valley near the Niagara Escarpment), and confined nature of aquifer, model is deemed adequate.	None	
5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Transmissivities based on pumping tests conducted for all wells	None	Report recommends that the hydrogeological parameters be verified, as they differ from those at the neigbouring Buckingham Woods system

6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	N/A		None	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10	8	Yes - Analytical model results use natural flow field as input. The chosen direction of regional groundwater flow is very predictable, and the recharge area is the Niagara Escarpment to the southwest	None	
8. Was the Model Calibrated?	5	7	2-D Analytical model cannot be calibrated; however, actual data (potentiometric surface) is used in analysis.	None	
9. Was Uncertainty considered in the analysis?	5	1	Final capture zones were determined based on a single (best) model setup, and uncertainty only mapped for WHPA-D. It is noted that the report states that multiple simulations were conducted as part of an uncertainty analysis; however, the uncertainty analysis is only incorporated into WHPA-D	None	Incorporate the results of the sensitivity analysis into capture zone development for WHPA-B and C as well.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

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

GENERAL

System Name:	**CREEMORE WELL SUPPLY**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Clearview, Appendix G, Golder August 2004**
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_050810_2**

System Characteristics

Hydrogeological Complexity	Partially confined overburden aquifer that is discontinuous
Spatial variability in Aquifer Vulnerability	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?		10	Creemore is serviced by two wells located within close proximity to one another. They are relatively deep wells (depth approximately 45 m). 50 day to 25 year ToT based on PTTW average use for a combined rate of 1228 m^3/day which is above the recorded average rate for 2001 of 731 m^3/day. Due to their close proximity, they were modelled as one well.	None	The model should be updated if future water supply needs are defined. The rates used were based on those listed for average day taking in the PTTW and were 67% greater than those recorded for the Creemore system in 2001.
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	Medium complexity. The Creemore Aquifer is a local buried tunnel valley which is narrow in the west and broadens to the east in the area of Avening and Cashtown Corners. The municipal aquifer is regionally extensive and becomes unconfined 3 km east of Creemore.	None	If planned 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	6	Yes the geologic model requires a 3-D numerical modelling approach given the partially confined nature of the aquifer which has significant "windows" in the confining layer which is absent to the east of Creemore.. As well topography and surface drainage (Mad River) are important and a 3-D model incorporates these features as well.	None	Improve geological model by additional borehole/well construction gathered on a local scale.
4. Is Flow Model Complexity Appropriate?	10	7	Yes - 3D numerical flow model used, however at the regional scale; moderate complexity of aquifer, model is deemed adequate.	None	Additional monitoring wells positioned upgradient of well field would be beneficial to validate model. Verification of regional model results with results generated on a local scale may also be beneficial.

5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Yes - Hydraulic conductivity ranges that were input to the calibration process were based on pumping test, and were assigned spatial variability in model. Aquifer hydraulic conductivities in the calibrated model were in the 10^{-4} m/s range and aquitard hydraulic conductivities were in the 10^{-7} m/s range. Aquifer porosity of 0.30, aquitard porosity of 0.20 and bedrock of 0.10 were use in the model. Three recharge zones were used representing a coarse sand area in the western portion of the valley, a fine sand plain located in the main portion of the valley and a low recharge area representing exposed shale bedrock. Recharge rates were and ranged from 70 to 225 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	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. Flow is from the Escarpment high topography areas to the Mad River valley.	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	9	Model was calibrated to 67 wells and had a relatively low NRMS of 4.79%. The calibration wells were selected for their location and depth.	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale.
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.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high.	None	

Table 4: MCKEAN SUBDIVISION - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**McKean Subdivision Well Supply**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Clearview, Appendix G**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**USEPA WHPA/GPTRAC**
Score:	**6.4**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_050810_1**

System Characteristics

Hydrogeological Complexity	Low to Medium, generally uniformly confined overburden aquifer
Spatial variability in Aquifer Vulnerability	Low
Known water Quality Issues	None, with the exception of iron, manganese (which is likely natural) and ON

EVALUATION RESULTS

Criterion		Awarded Score	General Comments	Comments / Recommendations	
				Critical Deficiencies	Long-term opportunities
Objective Criteria					
1. Were reasonable pumping rates used and documented?		5	Modelled rate reported to be based on predicted future growth for the community, pro-rated by the maximum well yields for each of the three wells. A lower score given because of lack of documentation. The modelled rates vs PTTW max are Well 1 (35.6 m3/day, 134.1 m3/day); Well 2 (164.2 m3/day, 25.8 m3/day), Well 3 (656.6 m3/day, 61.3 m3/day). The total modelled pumping rate from each well was 122.7 m3/day vs the 2002 Average usage of 104 m^3/day.	None	Determine committed population requirements to ensure that it is within permitted rate. Confirm with municipality that modelled rates represent likely conditions. Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	2-D Analytical Solution is permitted by technical rules	None	Perform continuous updating and verification of the model data
Subjective Criteria					
3a. Is geological setting complex?	10	8	Low to Medium complexity. Moderately shallow (< 20 m deep) confined artesian overburden aquifer (regional aquifer A2), The top of the aquifer is locally found at depths of 4.3 to 16.5 mbgs. Confining material is clayey silt till, 5 to 10 m in thickness. A relatively high score given because aquitard appears generally continuous in capture zone area	None	
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	7	Model based primarily on water well records and geological mapping. It is not clear how many high quality data points were used to map potentiometric surface. Confined nature of single aquifer system allows a simple conceptual model to be adequate.	None	
4. Is Flow Model Complexity Appropriate?	10	5	Yes - 2D analytical flow model used, however, considering moderately predictability groundwater flow direction (Georgian Bay to northeast, and escarpment to southwest), and confined nature of aquifer, model is deemed adequate. It is noted that potentiometric surface (Figure 6.2.3) suggests that upgradient conditions may also be to the south, and not just to the south west.	None	A calibrated numerical model would be required to assess the significance of upgradient conditions to the south.

5. Are model input parameters (recharge, porosity, K) reasonable?	5	8	Generally yes - K values are based on pumping tests, and porosity is reasonable. Recharge is not required for model.	None	
6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	N/A		None	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10	7	Yes - Analytical model results use natural flow field as input. The chosen direction of regional groundwater flow compares well with the presence of Georgian Bay to the northeast, and the alignment of the escarpment to the southwest. However, a review of topography mapping and the reports potentiometric surface map (Figure 6.2.3) suggests that there may also be a southerly upgradient direction. A lower score is given because analytical solution does not take into account the potential southerly upgradient component	None	A review of water levels could be performed to assess the significance of upgradient conditions to the south
8. Was the Model Calibrated?	5	7	2-D Analytical model cannot be calibrated; however, actual data (potentiometric surface) is used in analysis.	None	
9. Was Uncertainty considered in the analysis?	5	1	Capture zones were determined based on a single (best) model setup, and uncertainty only considered for WHPA-D. It appears the uncertainty was incorporated into the gradient direction (+/- 10 degrees).	None	Incorporate the results of the sensitivity analysis into capture zone development for WHPA-B and C as well.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

Table 5: NEW LOWELL - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**New Lowell Well Supply**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Clearview, Appendix G**
Terms of Reference:	**Ontario Ministry of the Environment and Energy, 2001; Groundwater Studies, 2001/2002, Technical Terms of Reference, November 2001.**
Model Type:	**USEPA WHPA/GPTRAC**
Score:	**6.8**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_050810_1**

System Characteristics

Hydrogeological Complexity	Medium, confined but multiple well fields
Spatial variability in Aquifer Vulnerability	Low
Known water Quality Issues	None, with the exception of iron and manganese

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	Modelled rate reported to be based on predicted future growth for the community. The modelled rate for the 5 wells was 510 m3/day, while is higher than the 2001 average of 212 m3/day and higher than the PTTW average of 403 m3/day. While no documentation is present supporting the future rate, the combined modelled rate was higher than the PTTW average and therefore a high score was given.	None	Determine committed population requirements to ensure that it is within permitted rate. Confirm with municipality that modelled rates represent likely conditions. Should pumping regime change, then model should be updated.
2. Were rule-approved models and methods used?		Pass	2-D Analytical Solution is permitted by technical rules	None	Perform continuous updating and verification of the model data
Subjective Criteria					
3a. Is geological setting complex?	10	9	Low complexity. Aquifer (regional aquifer A2) is confined below a regional aquitard that is 45 m thick near the well.	None	
3b. Is Geological Model / Understanding Adequate for assessment method selected?	10	8	Model based primarily on water well records and geological mapping, which shows that the geology is consistent in the area. Well confined nature of single aquifer system allows a simple conceptual model to be adequate.	None	
4. Is Flow Model Complexity Appropriate?	10	6	Yes - 2D analytical flow model used. Gradient assumed to be constant in area, which has been identified in the report as a point of uncertainty, and therefore the score is slightly reduced.	None	Confirm gradients and aquifer transmissivity. It is noted that analytical solution cannot consider affects of pumping well interference. Improved capture zones could be developed using a numerical model.
5. Are model input parameters (recharge, porosity, K) reasonable?	5	7	Pumping tests have been conducted on 3 of the 5 wells. Overall, input parameter values appear reasonable	None	Undertake pumping test in Wells 1 and 2 to confirm that transmissivity is uniform in area.

6. Was natural flow field adequately incorporated into model? (Numerical Model)	10	N/A		None	
7. Was natural flow field adequately incorporated into model? (Analytical Model)	10	7	Yes - Analytical model results use natural flow field as input. The chosen direction of regional groundwater flow is deemed generally predictable. Recharge is from the west. A lower score was given as a uniform gradient was identified in the report as a major assumption.	None	Confirm gradients in area
8. Was the Model Calibrated?	5	7	2-D Analytical model cannot be calibrated; however, actual data (potentiometric surface) is used in analysis.	None	
9. Was Uncertainty considered in the analysis?	5	1	Final capture zones were determined based on a single (best) model setup, and uncertainty only mapped for WHPA-D. It is noted that the report states that multiple simulations were conducted as part of an uncertainty analysis; however, it appears that the uncertainty analysis is only incorporated into WHPA-D	None	Incorporate the results of the sensitivity analysis into capture zone development for WHPA-B and C as well.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high	None	

Table 6: STAYNER - WELL HEAD TIME OF TRAVEL CAPTURE ZONE PEER REVIEW EVALUATION RESULTS

GENERAL

System Name:	**STAYNER WELL SUPPLY**
Reviewed Report:	**South Simcoe Groundwater Study, WHPA-Township of Clearview, Appendix G, Golder August 2004**
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:	**7.4**
Pass:	**Yes**
Critique Ref:	**Sent to Client_Peer Review Score Card Results_050810_2**

System Characteristics

Hydrogeological Complexity	Medium, confined aquifer that is spatially discontinuous
Spatial variability in Aquifer Vulnerability	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?		5	Stayner has two well fields,. One well field has two wells (well 1 and Well 3) and is located east side of Stayner on Sunnidale Street. The second well field has only one well (Well 2) and is located on the south side of town. The system serves a population estimated at 3,600 people. The modelled pumping rates were determined by dividing the PTTW maximum rate by a peaking factor of 2.1. Overall, a combined rate of 3117 m^3/day was used in the model compared to a recorded average rate of 2037 m^3/day in 2001 (a 53.0% increase over the average pumping rate of 2001). A lower score is given because of lack of documentation for future growth; however, rates are deemed adequate.	None	The model could be re-run at rates based on better estimates of water supply needs.
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	Medium complexity. The Stayner Aquifer at Well 2 (A2) is a partially confined aquifer and the well is installed at an approximate depth of 31 m. Well 1 and 3 are installed in a deeper confined aquifer (A3) at an approximate depth of 28 to 31 m.	None	If planned 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	8	Aquifer type is partially confined, with confining layer thickness highly variable, particularly in the vicinity of the production wells. Furthermore, previous modeling (Golder, 2005) identified that 50-day and 2-year capture zones lie within an area of high vulnerability. Increased model accuracy at the local scale may therefore be more important.	None	Improve geological model by additional borehole construction in the future, and incorporating local data to model (especially within the 50-day and 2-year ToT zones previously identified).
4. Is Flow Model Complexity Appropriate?	10	8	Yes - 3D numerical flow model used, however at the regional scale; moderate complexity of aquifer, model is deemed adequate.	None	Additional monitoring wells positioned upgradient of well field would be beneficial to validate model. Verification of regional model results with results generated on a local scale may also be beneficial.

5. Are model input parameters (recharge, porosity, K) reasonable?	5	9	Yes - Hydraulic conductivity ranges that were input to the calibration process were based on pumping test, and were assigned spatial variability in model. Aquifer hydraulic conductivities in the calibrated model were in the 10^{-4} m/s range and aquitard hydraulic conductivities were in the 10^{-7} to 10^{-6} m/s range. Aquifer porosity of 0.25, aquitard porosity of 0.05 and bedrock of 0.10 were use in the model. Four recharge zones were used representing an exposed fractured bedrock zone of high recharge, a fine sand plain located in the main portion of the model, a lower recharge zone representing surficial till overburden and a low recharge area representing the steep slopes of the Escarpment. Calibrated recharge rates ranged from 76 to 224 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	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. Flow is from the west to the northeast.	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	9	Model was calibrated to 157 wells and had a relatively low NRMS of 4.16%. The calibration wells were selected for their location and depth.	None	An examination of residual values (modelled versus actual water levels) plotted spatially would be beneficial at the local scale.
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.
10. What is the Uncertainty?		High	Designation not provided in report, but Dillon recommends that it be assessed as high.	None	