APPENDIX D
Tier Three Risk Assessment Peer Review Comments and Responses

Peer Review Comments: Tier Three Water Budget and Local Area Risk Assessment, Long Point Region, Physical Characterization Report

Major Coments				
Peer Reviewer	Reviewer Comment #	Original Page #	Reviewers Comments	Response
CN	1	22	It is indicated on Page 22 that the key difference between the previous interpretation and pesent interpretation is that the previous interpretation considers the deeper municipal aquifers to be discontinuous and confined. Our interpretation is somewhat different. In our opinion, the key difference lies in the level of resolution of the package of unconsolidated sediments. The previous conceptual model appears to be applicable in some areas, but an oversimplification in others. We would characterize the Barnett model as a “complex geological model”, in contrast to the previous “simplified hydrogeological model”.	Updated text to better highlight the simplified hydrogeologic nature of the flat-lying unit model (termed the "simplified hydrogeologic model"), and complex geologic model that conceptualizes dipping units. "Numerous studies have been completed to characterize the overburden stratigraphy in the Study Area based on the available (hydro)geologic information (e.g. deVries and Dremanis, 1960; Yakutchik and Lammers, 1970; Novakovic and Farvolden, 1974; Barnett, 1978, 1979, 1982, 1987, 1998; Dreimanis, 1966, 1982, 1987, 1995; Hicock, 1992; Banks et al., 2007; Bajc, 2008). Due to the limited amount of subsurface data, an alternative conceptualization exists to the complex geological model described above (initially proposed by Barnett, 1978, 1982, 1987, 1993, 1998). In the alternate simplified hydrogeological model, Yakutchik and Lammers (1970) conceptualized the Quaternary overburden system as flat-lying, relatively continuous layers of alternating fine-grained silt, clay and diamict and discontinuous coarse-grained deposits. All deposits were interpreted to have been laid down either subglacially or under a glaciolacustrine depositional environment (Figure 3-4). This interpretation was based on surficial geology mapping, borehole data, and hydrogeologic data. The flat-lying conceptualization was later adopted by Novakovic and Farvolden (1974) in an investigation of groundwater flow systems in Norfolk and Oxford Counties. The key difference between this earlier interpretation and that adopted in this study is that the earlier model conceptualizes the deeper municipal production aquifers as discontinuous, and confined aquifers that are isolated from ground surface and the overlying shallow aquifer groundwater flow system. In many cases, this representation is sufficient. It becomes problematic along the northwestern margin of the recessional Paris and Galt Moraines, where intervening fine-grained material is limited or absent (as related to the maximum advance of glacial ice to the moraine). These moraine margins align with the communities of Delhi (Paris Moraine), Simcoe, and Waterford (Galt Moraine). The complex geologic model, in contrast, suggests..."
CN	2	33	It is indicated on Page 33, “it was more desireable to reduce the number of model layers where possible to minimize simulation runtimes.” While we appreciate that relatively small runtimes are important for effective modeling, in our opinion the minimization of runtimes is a weak reason to reduce the number of model layers. We support the simplification that has been adopted; however, it seems to us that it might be incorrectly interpreted as an arbitrary simplification introduced by the groundwater modelers that could be avoided by simply acquiring faster computers. There are much better reasons for reducing the number of model layers. As indicated in the subsequent paragraph, there is a good hydrogeologic argument for assigning different hydrostratigraphic units to the same model layer – major units are neither continuous nor do they overlap. It is widespread practice to assign model layers to particular hydrostratigraphic units; this is frequently the simplest approach. However, there is no compelling reason as to why it would be the most appropriate approach from a simulation perspective (for example, it is not more accurate). Not carrying through a model layer in an area where a hydrostratigraphic unit is absent also avoids the possibility that the ‘pinched-out’ unit will exert some hydrogeologic control in the model.	Agreed, text referring to reducing layer numbers for simulation reasons has been removed.
CN	3		Section 5 includes complete descriptions of the municipal supply well construction details. It is important to note that well performance data will also be required to develop estimates of additional well losses during alternative pumping scenarios.	Noted, and text has been added in Section 5 introduction
CN			The borehole logs from the Tier Three drilling program are presented in Appendix B. We understand that a more complete report on the field program will be prepared. We offer the following comments, questions and recommendations on the field program.	
CN			• There appears to be two Intermediate well completions at LP-MW-17. If this is correct,they must be provided distinct designations;	The two intermediate boreholes do have distinct designations LP-MW-17-10 I (85-90ft) and LP-MW-17-10 I (45-50 ft)

CN	4		• During the meeting of December 20, 2011, it was indicated that there are 15 transducers/dataloggers have been installed to record water levels continuously. We count 58 well completions at 26 locations. We recommend that the report on the field program include the rationale for the selection of wells for continuous recording;	Recommendation accepted
CN			• During the meeting of December 20, 2011, it was indicated that two flowing wells were identified during drilling. A very good hydraulic test can be conducted by either uncapping these wells and monitoring the discharge from the well casing until either the discharge stabilizes or ceases; and	It is acknowledged that this would be a good hydraulic test to obtain additional hydrogeological information. However, the scope of the field program is not sufficient to complete these tests. It is noted that approximate K estimates will be obtained from rising/falling slug tests (subsequent comment)
CN			• We recommend that single-well tests be conducted on all of the well installations. In particular, we recommend that slug insertion/withdrawal tests be conducted. The results of these tests can serve two purposes. First, the tests can confirm that the wells provide representative data. Second, the tests will yield local estimates of hydraulic conductivity that can supplement the results of pumping tests, which are averaged over a larger volume of the subsurface.	Rising and falling slug tests were preformed on all boreholes and will be included in the field report.
HW	1		(1) The transition of layer properties between the three zones of the model The use of the same layer, with different properties, to represent different formations does not present a difficulty provided that the report has a clear presentation (map and text) that shows the formations (layers) that are present in the model in each of the three zones and identifies the zonal correspondence between layer number and geophysical unit.	From this comment we assume that the method for presenting the layer properties for each zone was sufficiently clear in the current report. We will endeavour to maintain this in subsequent reports.
HW	2		(2) The Consumptive Use of Water for Irrigation The consumptive use of water for agriculture will be the most important element in risk assessment for quantity. The Tier Two study made a good start to a rational appraisal of current consumptive use but additional attempts should be made to contact a few larger irrigators who have records of actual pumping times and rates to better establish the current pattern of irrigation use. The prediction of future patterns of possible irrigation demand is necessarily uncertain and requires a decision on what policy framework (in terms of allocation of water during scarcity) is to be built into the scenarios used for risk assessment.	We will compare reported pumping rates from selected irrigators to simulated pumping rates from the numerical model There is currently no water allocation policy in Ontario for times of scarcity. The Risk Assessment scenarios will evaluate the impact of water withdrawals on municipal well/intake reliability, given their typical operations (both municipal and non-municipal)
Specific Technical Comments/Questions				
CN	1	2	Will the uncertainty associated with the evaporation-transpiration terms be the only uncertainty assessed in the Tier Three Assessment Report?	No, discussion of uncertainty will be much more comprehensive in the Risk Assessment Report. ET was selected as an example, as this is the largest water budget component, and associated uncertainties may be larger than other water budget components themselves. Text revised to clarify
CN	2	3	It is indicated that the Study Area is limited to the Long Point Region, Catfish Creek and Kettle Creek Conservation Authority jurisdictions. Do the limits of these jurisdictions correspond to physical hydrologic boundaries?	Yes, text added to clarify
CN	3	3	The text refers to the "risk that each of the communities may not be able to meet their current or planned water demands." Risk has a very specific meaning –it is the product of the potential for failure multiplied by the cost of that failure. Here "risk" should really be replaced by the "likelihood".	Text revised "likelihood"
CN	4	11	Only very general references are cited in Figure 2-3. What is the specific source for the identification of the thermal regimes?	Aquatic Resource Assessment (ARA) Mapping from LIO. The specific source has been added, and reference supplied.
CN	5	13	We have always thought that the 'opposite' of a Provincially Significant Wetland is a Locally Significant Wetland, rather than a non-Provincially Significant Wetland.	Correct, text will be revised. Text was revised but labelled as "other mapped wetlands' as they were not specifically designated as 'provincially' or 'locally significant'.

CN	6	14	The parenthetical text seems to suggest that the last glaciation was ~135,000 years ago. Our understanding is that the last glaciation occurred about 12,000 years ago. Do 135,000 years and 12,000years before present mark the beginning and end of the last ice age?	The oldest overburden deposit in the Regional Area is the Catfish Creek Till, which was deposited during the Nissouri Stage (beginning some 25,000 years ago) of the Late Wisconsinan Glaciation. This is only the last glacial episode to occur in southern Ontario. There were multiple glacial events in the Early and Middle Wisconsinan. The Wisconsinan Glaciation started some 135,000 to 115,000 years ago, depending on the source, and ended around 10,000 to 12,000 years ago with the end of the Quarternary Period and start of the Holocene. Text revised to indicate starting and ending times of the Late Wisconsinan glaciation
CN	7	14	If the Marcellus Shale subcrops in areas along the north shore of Lake Erie, how does it reach thicknesses of 12 m in the regional area?	The text placed the subcrop boundary too far south. As is shown in Figure 3-1, the Marcellus Shale subcrops just south of Alymer/St. Thomas. Marcellus reaches a maximum thickness of approx. 12 m at the north shore of Lake Erie. The text has been revised.
CN	8	14	Comparing Table 1 and the explanation in Figure 3-1, it appears that the Hamilton Group and Oriskany Formation are absent from Table 1. Are these units not present (even at depth) in the study area? The rocks of the Guelph Formation, the Lockport Formation, the Clinton-Cataract Group and the Queenston Formation are also not indicated on Table 1. It appears that these units subcrop north of the Tier Three Focus Area. Are these rocks present at depth but only beneath the units in which there is significant groundwater flow?	Units associated with the Hamilton Group are located far outside of the Study Area, near the City of London. They do not extend beneath the Study Area. Oriskany Formation units are located east of the study area, within the Grand River watershed. The Oriskany Formation is highly localized and is not mapped to extend beneath the Study Area. Other bedrock units referenced (Guelph, Lockport, etc...)in the comment are present, but below the Salina Formation. Due to the depth of these units, and the fact that bedrock supplies are not a significant source of water within the study area, it was felt that inclusion of these additional Formations would not benefit the study. It is noted that a similar approach was used for the Tier 2 study. Text has been added to the report indicating this.
CN	9	22	Is the buried Galt Moraine supposed to be visible in the cross-sections in Figures 3-7 and 3-8?	The buried Galt Moraine is bisected by the cross-section illustrated in Figure 3.7. The moraines is the topographically elevated land in the centre of the cross-section that is overlain by coarse-grained sediment outcropping at surface. The cross-section in Figure 3.8 runs perpendicular to the section illustrated in Figure 3.7 and parallel to the buried Galt Moraine. Although it is more difficult to see, the buried crest of the moraine is visible in Figure 3-8, especially in the central part of section, near the municipal wells. The Galt Moraine is more clearly shown in Figure 3.3. Updated Figure reference
CN	10	22	The locations of the wells shown in Figures 3-7 and 3-8 are not shown in Figure 3-6. Are any of these wells projected onto the sections? Which of the logs are derived from geologic logs prepared by professional geoscientists, with surveyed locations? Reference is made to some high-quality boreholes. We recommend that these be highlighted on all maps and cross-sections.	High quality boreholes are included on cross-sections, where present. Figures 3-7, 3-8, and 3-9 illustrate the cross-section locations and interpretations near Waterford. There are no high quality boreholes in the immediate vicinity of Waterford, and none appear on these figures. Wells completed as part of the Tier Three study focused on determining the lateral continuity and interconnectedness of subsurface units in areas of sparse deep data, specifically between the communities of Tillsonburg, Delhi, Simcoe and Waterford. In the immediate vicinity of Waterford, there were sufficient deep water well data to define these units. Additionally, the area surrounding Waterford was not targeted for potential water supply recourses as part of the Simcoe / Waterford Geoundwater Investigation.
CN	11	23	Northwest Well #1 appears to be only about 500 m away from Northwest Wells #2 and #3. Is it likely that a fine-grained unit that is 10 m thick at Wells #2 and #3 is entirely absent at Well #1?	In the Northwest Well Field of Simcoe, there are two fine-grained package intersected by all three wells: a surficial/near surface unit interpreted to be representative of the Wentworth Drift and thick package (20-30 m thick) of Port Stanley Drift resting on bedrock (see Figures. 3-10 and 3-11). At Well #1, uppermost fine-grained unit consists of 5' of "clay, gravel", which thickens toward Wells #2 and #3 to roughly 6' of "clay, silt" or "clay, sand". At Well#3, the surficial "clay, silt" is underlain by approximately 30' of sand with minor clay layers, gravel, and sand. The material underlying the uppermost fine-grained material is predominantly sand. This sand rests on the Port Stanley Drift. All units can be traced between all wells
CN	12	26	It is indicated that water well logs could not support differentiation of the Port Stanley Drift and the Catfish Creek Draft, and instead the units were grouped based on their similar hydraulic properties. What data were available to support the inference of their hydraulic properties?	The term "Hydraulic properties" is incorrect. The text is revised to "geologic properties"
CN	13	26	No reference is made to Figure 3-23.	Text revised to include Figure 3-23 reference
CN	14	29	Referring to the tables in Appendix D (variogram analyses): • What is the variance? • Our understanding is that the column marked “Lag distance (distance of influence between data points)” should actually refer to the “range” • The tables should include units.	The y-axis on the semivariogram is one half the average of differences in value squared for a specified interval. It is commonly referred to as the semivariogram or varigram on the semivariogram plot, which is unitless. That being said, as it is defined as 0.5*Avg(difference in value^2), the units would be m^2 in this case. The y-axis label on plots in Appendix D have been updated to reflect this more formal definition. The range is the pairwise distance, which is reflected in the semivariogram plot. The tables in Appendix D have been updated to have units and "Range" instead of "Lag distance (distance of influence between data points)".
CN	15	29	The reference to a “depth of less than 15 m below ground surface” does not appear to be consistent with the caption of Figure 4-1, ”top of screen less than 15 m BGS.” Our interpretation is that a depth of 15 m refers to a depth to the bottom of the well screen rather than the top.	Mis-labeled on maps. Map titles have been corrected.

CN	16	29	It is indicated that the kriged surface was "constrained to the 10 m DEM of the Regional Area." What does "constrained" mean in this context?	The DEM was used to ensure the shallow water table did not exceed the ground surface elevation, particularly within river valleys, where there was no water well information. Text added to clarify
CN	17	29	It is indicated that a lake elevation of 174 m ASL was used to constrain the elevation of the shallow water level surface along the Lake Erie shoreline. It is not clear what "constrain" means in this context. If the water level in Lake Erie were set as the minimum shallow groundwater level, we would expect the lowest groundwater level to be 174 m ASL. However, it appears from the explanation in Figure 4-1 that the lowest groundwater level is 165 m ASL.	The contours show the lowest elevation to be 175 masl. The legend was adjusted to better show the range of water levels within the displayed area.
CN	18	31	Page 31: Why is a replacement being sought for Chapel Street Well #3?	A replacement was being sought due to the age of the well. Recent rehab works have identified that the well is still viable, and the replacement well has been cancelled. Text referencing the replacement well will be deleted
CN	19	31	The Delhi wells seem to be screened at relatively large depths for GUDI-designated wells. Furthermore, the Wentworth Drift appears to be relatively thick at the locations of the supply wells. Is a clear rationale available for the assignment of the GUDI designation?	MacViro (2002) identified the wells as GUDI due to chemical and isotopic similarities between adjacent surface water and groundwater. The report can be provided if necessary
CN	20	34	Numerical model layer 1 is missing from Figure 4-3b. Furthermore, are we correct in understanding that the hydrostratigraphic unit that Layer 1 represents, Surficial Clay, is not present everywhere in the study area?	Layer 1 is missing from 4-3 because the area that this figure shows does not have Layer 1 present. Layer 1 is only present in the far eastern portions of the study area (Haldimand Clay Plain). Text added to clarify
CN	21	36	Two references are provided for the R.J. Burnside South Oxford Groundwater Investigation, Burnside (2009) and Burnside (2010). Are these two separate reports, or is the 2010 report a finalized version of the 2009 report?	The 2010 reference was in error. Reference removed
CN	22	36	In the second paragraph of Section 4.6.2, the two references to Figure 4-4 should be to Figure 4-5. At the end of the third paragraph, the reference to Figure 4-5 should be to Figure 4-6.	Text revised
CN	23	36	Are there high quality boreholes in the study area in addition to those shown in Figure 4-5?	Figure 4-5 shows the high quality boreholes that were readily available for this study. There is no central repository of high quality boreholes for this area, which makes compiling this information problematic. A longer-term, multi-year project should be to data mine older reports for such high quality information for inclusion in a central water well database. This will be a recommendation of the study.
CN	24	36	Referring to Figure 4-6, of the "picked" boreholes, which ones have surveyed coordinates and were logged by professional geoscientists? What are the "control points"?	Most of the boreholes with hydrostratigraphic picks selected at them were sourced from Water Well Records as captured in the MOE's Water Well Information System (WWIS). The boreholes with surveyed co-ordinates that were logged by a professional geoscientist are displayed on Figure 4-5. These wells included those completed as part of the Tier Three Study across the Study Area, test holes completed by Burnside north of Tillsonburg, one OGS corehole located between Tillsonburg and Delhi, and Simcoe / Waterford Groundwater Investigation test wells completed in the vicinity of Simcoe and Waterford. The control points displayed in Figure 4-6 are hydrostratigraphic picks made along section, but not at a borehole location. These points are selected during the cross-section analysis to better control the interpreted distribution of subsurface units during the interpolation process. Text has been added
CN	25	38-45	Is there a particular reason why the municipal pumping data for Tillsonburg is plotted for 2005-2010 (Chart 1), but for Delhi, Waterford and Simcoe it is plotted for only 2009-2011 (Charts 2,3 and 4)?	The time period for the referenced charts was dependant on the availability of data from the respective municipalities. Norfolk County shifted to a SCADA system in 2009, with monthly data prior to this time not readily available. Text revised to reflect this.
CN	26	40	It is indicated that the capacity of Delhi system will be reduced if withdrawals cease from the Lehman Reservoir. We cannot conceive of this as representing a potentially significant reduction. The permitted withdrawals from the reservoir represent 60% of the total permitted capacity. However, the actual withdrawals in 2009 accounted for only 12% of the total [this is indicated as 14% on Page 42], and about 5% of the permitted withdrawals for the two municipal supply wells.	It is correct that takings from the Lehman Reservoir are a small percentage of system *production.* However, Lehman Reservoir intake does represent 60% of the system *capacity,* which is a major component. The Peer Reviewer is correct that the loss of this capacity may not cause production issues for the water system; however, the statement that the total capacity of the system would be reduced is valid. Text added to clarify that while capacity may be reduced, it would not affect the municipality's ability to meet demands.
CN	27	40	IWC (2010a) and IWC (2010b) appear to be the same report with different dates. Is the September report the finalized version of the April report?	Yes, IWC (2010a) was an earlier version of the report and the reference has been removed as the findings are also in the 2010b reference. References have been updated accordingly.
CN	28	42	It is indicated that a groundwater investigation was undertaken in 2009 to seek additional supplies for Delhi. Why were these supplies sought, if the 2009 takings are only about 40% of the permitted capacity of the two existing wells?	It is understood that this is largely a redundancy measure. As the County may be removing Lehman Reservoir as an alternate source, this would leave them with only two wells. Additional wells would provide redundancy should one existing well be taken offline for maintenance or other issues. Additionally, it is important to note that although average day demand may only be 40% of the permitted rate, maximum day demand (which is used to size a system) may be much higher
CN	29	46	Why as Cedar Street Well #2 abandoned in 2002?	Well #2 (and #1) were replaced due to declining yields. Text revised to add this.

CN	30	48	In light of the significance of agricultural water takings, we are not sure why any presentation/discussion of these takings is deferred to the development of the numerical groundwater flow model. Will the collection of data on agricultural water takings be a major element of the data collection effort going forward, or is it presently complete?	Discussion of agricultural water takings is being deferred to the numerical modelling phase because this demand will be explicitly modelled within the MIKE SHE model.
CN	31	48	We are somewhat confused about the results of the compilation of non-agricultural water takings. Referring to Page 49, are we correct in understanding that the GRCA 2008 database contained 70 entries for the study area, of which 41 had reported takings? On Page 51 it is indicated that there are a total of 89 non-agricultural permitted takings in the Tier Three Focus Area. Does that include the 70 entries from the GRCA database? We counted 23 municipal supply wells. Is the number of municipal wells (23) and entries from the GRCA database (70) supposed to add to a total of 89? The two values are close, but not equal.	The numbers contained in the summary are errors. They contain a number of duplicates which were removed, but the text was not updated. Summary text updated.
CN	32	50	We have our doubts regarding some of the values listed on the first Table 9. Some of the actual rates are such a small fraction of the maximum permitted that it strikes us that they must either be under-reported, or the permitted rates were out of all proportion to the requirements	It should be noted that the Consumptive Rate is reporting the average annual rate, while the permitted rate is the maximum allowable. In many cases the PTTW is only active seasonally, and may only pump at the max permitted rate for a small duration of all active pumping. This results in an actual rate that is a fraction of the max permitted. Text added to clarify this.
RS	1	34	In your semi-variogram model fits you have chosen a 0 nugget (i.e. passing through (0,0). The nugget accommodates the unresolved measurement error. Given your data set you most certainly have errors at the measurement points. Setting the nugget at 0 results in a poor functional fit as seen in Figures D1 to D14 (except D8); clearly under-fitting for at least first half of total lag distance. Can you provide a reasoning why you chose to fit with a 0 nugget?	Text has been added to Appendix D to justify the use of a zero nugget.
RS	2	49	What is the possibility that users are actually exceeding their permitted daily rate and assume that through the reporting mechanism they are declaring this and thus are fine? Was there any manual checks (contact of permit holders) to confirm that they were actually reporting in error?	There were numerous instances of the rates reported in the WTRS database being higher than the maximum permitted rate by a factor of 1000. Is it presumed that this is related to a conversion error between m3 and L, as it is highly unlikely that the water takings would physically be able to withdraw that much water. WTRS rates that were less than double the maximum permitted rate were not adjusted.
LM	1	Section 6.1	This section refers to the sources of data, specifically the permit to take water database. It is noted that the 2008 PTTW database, provided by the GRCA, was used. Will these values also be used in the calibration process? Is there more current data i.e. 2011 or 2012 data that could be obtained and used in the model?	The GRCA's PTTW database was origininally a 2008 PTTW database; however, they have maintained the database by adding new permits as they are granted, adding reported values, and otherwise improving the database. As a result, the current PTTW database is reflective of 2010 conditions (the time at which a copy of the database was provided to this study). The text has been updated to more accurately refect the vintage of the PTTW database. An average of recent years (e.g. 2008-2011) will be used to represent municipal withdrawals as part of the Risk Assessment
Major Editorial Comments				
CN	1	5	Schroeter & Associates (2008) is not in the list of references [2006 a, b, and c are].	Added
CN	2	39	The references to MOE reports are not in the list of references [1988a, 1988b, 1991], [1994a], [1962a, 1962b], [1990], [1977]. We are quite sure that the Ontario Ministry of the Environment did not exist in 1962.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	3	41	OGS (1994b) and OGS (2002) are not in the list of references.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	4	43	MOE (1964) and MOE (1976) are not in the list of references. 1962 predates the establishment of the Ontario MOE.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	5	45	MOE (1989) is not in the list of references.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	6	46	MOE (1999) is not in the list of references.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	7	46	MOE (1997) is not in the list of references.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	8	46	MOE (1963a) and MOE (1963b) are not in the list of references. 1963 predates the establishment of the Ontario MOE.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	9	46	MOE (1963c) is not in the list of references.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	10	47	MOE (1939) is not in the list of references. 1939 predates the establishment of the Ontario MOE.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	11	47	MOE (1939) is not in the list of references. 1939 predates the establishment of the Ontario MOE.	Improper referencing of well logs. Included well logs in Appendix, and referenced the appendix.
CN	12	49	The second paragraph refers to Section 0. Should this read Section 6.2?	You are correct. Text revised

CN	13	49	The sentence at the end of the second paragraph is incomplete.	Text revised
CN	14	50	The text refers to two Table 9, and the titles for the subsequent tables are both Table 9.	Changed bottom table to Table 10
CN	15	50	The rates on both Tables 9 should read “m3/d”.	Changed
CN	16	54	The reference “Grand River Conservation Authority (GRCA) 200b” should read 2005b.	Changed
CN	17	56	“Scwartz” should read “Schwartz”.	Changed
CN	18		Figure 4-3: For consistency, the title of Figure 4-3B should read “Numerical Model Layers”.	Figure title has been updated to read "Numerical Model Layers"
RS	1	14	"finer grained" should be removed from table 1	Changed
RS	2	17	Usual spelling is glaciofluvial and glaciolacustrine (see OGS or other pubs)	Changed to (glacio)lacustrine to glaciolacustrine throughout report. Removed other instances of brackets
RS	3	49	Incomplete sentence	Changed
RS	4	56	“Scwartz” should read “Schwartz”.	Changed
LM	1	9	last sentence, ‘… Local Area is classified as Moderate or Significant ~~Risk~~ …’	Removed "Risk"
LM	2	23	Second paragraph, ‘… bedrock topography varies ~~in~~ from a high …’	Changed
LM	3	29	Second paragraph, first sentence – remove duplicate comma.	Changed
LM	4	48	second sentence, ‘…estimated population of 5,550 whose ~~these~~ residents …’	Changed

Peer Review Comments:Tier Three Water Budget and Local Area Risk Assessment, Long Point Region, Model Development and Calibration Report

Major Comments

Peer Reviewer	Reviewer Comment #	Original Page #	Reviewers Comments	Response
CN	1		The analysis of the hydrology reveals that in large areas of the study area, one of the most important elements of the water budget is irrigation pumping. Unfortunately, irrigation pumping is difficult to estimate and the reporting of actual withdrawals is just beginning. We are impressed with the approach that has been adopted to estimate irrigation withdrawals. To ensure sustainability of both municipal and agricultural water supplies, long-term water management will be essential. For long-term water management to be effective, agricultural withdrawals must be monitored and reported. The modeling analyses should be reviewed and updated on regular intervals to incorporate changes in irrigation demand, for example every five years.	Agreed - Updating the models periodically would provide a valuable tool to aid in long term water management strategies for the region. A recommendation have been added to address this point (Section 7.4 last point)
CN	2		We concur with the recommended update of the stress classification for Big Otter Creek at Tillsonburg watershed. Based on the most recent data, the revised projection of municipal demand (7,260 m3/d) may itself turn out to be an overestimate. Going forward, this source of uncertainty in this stress assessment should not be significant, as it should be straightforward to track trends in municipal pumping	Agreed that the projected water demand for Tillsonburg may end up being an overestimate. This suggests that the revised percent water demand calculation is a worse-case scenario, and that the percent water demand is extremely unlikely to be above the Provincial threshold (>10%). No revision required
CN	3		In our opinion, the description of the uncertainties in Section 6 is excellent. However, judging by the text in the subsequent sections, it appears that some of the uncertainties are quantifiable while others are not. Our experience suggests that there are “first-order” and “second-order” sources of uncertainty. Second-order sources of uncertainty include the limitations of the modeling approach indicated in Section 6.7. Perhaps the most important first-order source is the physical characterization, which is mentioned only in passing on Page 166.	We agree. Section 6.7 has been added to expand on uncertainty associated with the physical characterization of the region and actions taken to mitigate this uncertainty in the Tier Three.
CN	4		It is indicated on Page 66 that the regional FEFLOW model was considered to be well-calibrated. In our opinion, by the end of Section 2.6.6 the local-scale analyses for the Tillsonburg and Delhi local well fields can also be considered to be well-calibrated	We agree. Text has been updated to indicate that the local scale well fields are also considered well calibrated.
CN	5		We think we have a clear idea of how a groundwater model is calibrated, specifically what parameters are adjusted to improve the match to the targets. However, it is not immediately clear how a physically-based integrated model is calibrated. In our opinion, it would be useful to at least summarize the parameters that are taken to be adjustable. We have gone through the report and our understanding is listed below. · Degree-day coefficient · Threshold value for the release of liquid water from the snow pack · Drain ‘time constant’ · Drain cutoff depth [However, after reading the discussion on Page 81 it is not clear whether this is adjusted after all.] · Parameters for 10 soil classes - Saturated hydraulic conductivity, KS [Are the values the same as for the first model layer of the groundwater flow model?] - Water content at full saturation, qS - Water content at field capacity, qFC - Water content at wilting point, qWP · Parameters for 10 land use classes - Leaf area index - Rooting depth - Manning’s coefficient, n - Depression storage - Paved runoff fraction (?) · Other parameters (horizontal and vertical hydraulic conductivities of material types listed on Table 2-2, for example) Clarification provided by CN email 02.04.2014 "I will be satisfied with a simple listing of all of the parameters (the English identifiers rather than the Fortran variable name) along with an indication of whether they were treated as adjustable or fixed [that is, a table with two columns]. That is more that a listing of the "significant" parameters, but less than what you have suggested. I wasn't expecting either explanations of the parameters or any descriptions of the hydrologic processes that the parameters influence. If someone asked me to do the same for our FEFLOW model of Cambridge, it would start something like this: Layer thicknesses: Not adjusted Horizontal hydraulic conductivities: Adjusted Vertical hydraulic conductivities: Adjusted Recharge distribution and rates: Not adjusted Pumping rates: Not adjusted ... "	A table which identifies the MIKE SHE parameters as well as whether or not they were adjusted during calibration has been added to the document (Section 3.9.1)

CN	6		In our opinion, it only makes sense to refer to "verification" of the MIKE SHE model if climatic conditions during the calibration period, 2000-2009, have been qualitatively different from conditions during the verification period, 1990-1999. If climatic conditions have not varied significantly, we would expect the model to match the data equally well during both periods. Are the general trends of precipitation similar or different during the calibration and verification periods?	The climatic conditions during the verification period are quantitatively different than those of the verification period. In general amount of precipitation observed during the verification period is more varied than those observed in the calibration period. More extreme 'wet' periods are observded in 1996-1997 and more extreme drought periods are observed 1998-1999 than those observed within the calibration period. Text and accompanying figure has been added to Section 3.9
CN	7		We concur that the statistics for the high-quality targets suggest that the MIKE SHE regional model is as well-calibrated as the FEFLOW groundwater flow model (Page 116). The calibration statistics reported on Table 3-41 are essentially the same as those reported on Table 2-4. In our opinion this does not imply that a separate groundwater model need not have been developed. However, it may have important implications regarding the development of future groundwater models, in particular the appropriate level of spatial discretization. The finite element mesh for the groundwater flow model is shown in Figure 2-2. Around the municipal wells, the element dimensions are on the order of 15 m to 30 m. In contrast, the regional MIKE SHE model has a uniform grid spacing of 200 m. It might be argued that additional refinement around the municipal pumping wells is required to represent them appropriately. In our experience, this typically leads to an increase in model precision but not model accuracy. First, there is not always sufficient high-quality hydraulic conductivity and water level data to improve the calibration of conditions around a well field. Second, improvements in the calculation of water levels in the immediate vicinity of pumping wells can be achieved just as well with analytical corrections as with refinement of the mesh. Finally, even the best groundwater model can only account for a portion of the drawdown observed in a pumping well. The model-calculated water level must still be supplemented with additional well losses (due to nonlinear flow processes and skin effects, for example).	We agree that the results do not imply a seperate groundwater model is not needed. We also agree that there is often insufficient conductivity data to support increases in discretization around the well fields. The modelling approach section has been revised to emphasise the fact that there is a need for a dedicated groundwater model. The increase in model resolution for the local scale MIKE SHE models allowed improved characterisation of the water bodies and ground surface topoporaphy which was not possible at the regional scale. This has been clarified in Section 4.1 The increased resolution of the local scale models allowed improved characterisation of surface topography and water bodies which are relevant to the well field characterisation. Topography data for the area was avaialble at 1 m resolution as such the local scale models running at 25 m or 50 m provide a significantly more detailed represetnation of topograhy in these regions.
CN	8		There is no discussion of the consistency between the distribution of recharge in the Focus Area inferred in the current study and the estimates derived from the previous GAWSER analyses outside of the Focus Area. Since the modeling integrates both sets of recharge estimates, we would expect them to be at least roughly consistent around the perimeter of the Focus Area. Our inspection of Figure 2-7 suggests that they are not. As shown below, the recharge rates inferred in the present study appear to be systematically higher. Does one modeling approach tend to have a consistent bias to predict higher or lower recharge estimates?	A comparison of the Tier Three recharge estimates and the Tier Two estimate has been added to Section 3.10 including a new Table 3-17. There is also discussion of the differences between the two estimates. The Tier Three estimates are higher on average than the Tier Two. e.g., Sandy soils represent 64% of the study area and are about 80 mm/y higher in the Tier Three. It has previously been identified that evapotranspiration rates on sandy materials in the Tier Two model were too high. This is likely the most significant cause for difference in the Tier Two and Tier Three recharge estimates. The Tier Three estimate of recharge improves upon the Tier Two estimate of recharge by addressing considerable sources of uncertainty, as outlined in Section 1.3.4, and is considered a more representative estimate of recharge for the region than the Tier Two estimate.
CN	9		Throughout the report, reference is made to the Wentworth Till as having relatively low permeability. This is not consistent with either the value of hydraulic conductivity in the current study that is inferred through calibration or the results of ongoing Tier Three studies in Guelph and the Region of Waterloo. As shown below, the hydraulic conductivity of 1.4×10-5 m/s reported on Table 2-3 exceeds the bounds of typical glacial tills. The recharge rate on the order of 300 mm/yr inferred through calibration is also relatively high. Our understanding of the Wentworth Till is that its properties may be controlled by its fraction of coarse-grained sediments, rather than its clay fraction. We caution against general equation the "till" and "low conductivity".	We agree. The text has been updated to reflect the fact that the low permeability is not an appropriate discription of the Wentworth Till.
HW	1	General	There should be more attention paid in the report to the observed declines in flow-duration curves at very high exceedance levels. These are likely due to flow reductions due to irrigation takings during a few days in dry years and are not represented in the modelling. Changes in the modelling that would include these effects could be suggested.	Discussion has been added to the observed declines in flow duration curvesa at high exceedence levels seen in Kent Creek during the calibration (Section 3.9.3.3) and Big Creek and Big Otter Creek during verification (Section 3.9.4.3). We concur that these declines may indeed be related to irrigation takings during drought conditions. The observations in Kent Creek may be related to the quality of the streamflow estimates and rating curve used to develop streamflow estimates.
DR	1	General	Where possible, the sources used to supply estimates of the key hydraulic parameters, where they were not derived from field measurement, be provided in the text. Reliance on literature values is a common practice but is also a major potential source of uncertainty. If the parameters are used as calibration factors and as such the literature values are simply used as a starting point, this should be clearly stated. Again this is a conventional approach but it would help the reader understand the level of confidence the modeling team had in their parameters.	Text has been updated for clarity about source of estimates

DR	2	General	It is not completely clear in the text what the major differences between the conceptual model developed for the Tier 2 work and that which was finally developed for the Tier 3 study were. Recharge seems to be one parameter that changed considerably and it makes one wonder if the Tier 2 results were influenced by the different parameter set to a point that the conclusions (which drive the Tier 3 work to some degree) might have been biased. It would be useful to be as clear as possible in explaining how the results from the two modelling efforts varied and what specifically were the key improvements in the Tier 3 results. This just helps the reader understand the evolution of the modeling process a bit more clearly.	The Tier Three modelling effort and field study addressed a number of significant sources of uncertainty present within the Tier Two modelling effort. These uncertainties have now been identified in Section 1.3.4. Section 2.3 on the hydrostratigraphic framework has been updated to discuss the main differences between the Tier Two and Tier Three conceptual models
DR	3	General	The discussion of uncertainty is well done and easy to follow. It would be valuable to the reader if the modeling team could provide an indication of the influence the different sources of uncertainty would have on the overall results of the study. Are any of these sources of uncertainty so significant that it puts the conclusions in question? I do not think so but it would be useful to include the modeller's feelings on their overall confidence relative to these several sources of uncertainty.	We agree. Section 6.9 has been added to communicate our confidence in the models given the scope/objective of the study.expand on uncertainty associated with the physical characterization of the region and actions taken to mitigate this uncertainty in the Tier Three.
RS	1	General	For clarification, with my review timeline being after Christopher Neville and Hugh Whiteley had circulated their comments, I was able to read their comments prior to my review. In many cases I had similar concerns / comments as listed by my fellow reviewers. Unless I could provide additional insight into these comments I have not repeated them below	
Specific Technical Comments/Questions				
HW	1	2	streamflow-generation model instead of surface water mode	Section 1.3 has been updatec
CN	1	3	In Figure 1-2 it is not straightforward to distinguish between the boundaries of the conservation authorities and the limits of the Their Three Focus Area. We suggest that a presentation of the limits of the study area be deferred to Section 2.2, where the rationale for setting the limits of the Focus Area is introduced. We further suggest that the introduction of the rationale be consolidated with the additional discussion in Section 2.5.1.1.	Figure 1-1 was revised by colour-coding the three watersheds and we thought that this change would help to limit the purpose of Fig. 1-2 to showing the Tier Three Focus Area in relationship to the towns and the major rivers. This is how it is referred to in the text. Section 2.2 has been renamed from "Study Area" to "Regional Study Area". The purpose for having separate sections in the text that refer to the same figures is to differentiate between the Tier Two study area (same as the Regional Study Area), the Tier Three Focus Area, and the model domains for the regional-scale Feflow model and the intermediate-scale focus area MIKE SHE model. We hope this is clear from in the wording and organization of the text.
HW	2	5	good to mention drought-management planning as a potential us	Agreed. Drought management plans are identified as a potential use in Section 1.
HW	3	6	map of subwatersheds - one upper Big subwatershed not name	The figure has been updatec
CN	2	11	It is indicated that the conceptual model was updated with lithology from 26 multi-level boreholes "and other updates" obtained through the Tier Three field program. What are these other updates?	The other updates consisted of high quality borehole logs from boreholes commissioned in other ongoing studies conducted by consultants in the area. These studies were located in Delhi, Tilsonburgh, Simcoe and Port Rowan. Section 2.3 has been updated to remove this ambiguity about the 'other updates'
CN	3	12	The list of attributes of FEFLOW includes "advanced boundary conditions to avoid potential impacts of non-physical boundary conditions on the simulation results". What is being alluded to here?	These are "Fluid-Transfer" or Type 3, Cauchy boundaries that are used for streams. The use of Cauchy boundaries in the groundwater model prevents the non-physical situation of a fixed head stream boundary continuing to freely contribute water to the subsurface as the water table in the aquifer falls below the stream bottom. These details were moved from this list and added to the descripion of the boundary conditions in Section 2.5.3.2.
CN	4	13	The model area shown in Figure 2-2 looks roughly rectangular. However, when the indicated length of 135 km is multiplied by the width, 60 km, the area is 8,100 km2, which is about double the reported area 4,000 km2. Is one of the reported dimensions incorrect?	The dimensions stated within text are the maximum extents of the a rectangle bounding the regional model domain (Long Point, Kettle Creek and Catfish Creek CAs). As the CAs are not exactly rectangular, the demensions cannot be multiplied in such a way to arrive at area. The text has been clarified to address this. Fig 2-2 shows the Focus Area (1,000 m2) and only a portion of the full regional study area
CN	5	15	While we agree that it is a good thing to try to minimize computational effort, we do not agree that this is sufficient reason to justify a reduced number of model layers. An appropriate justification for limiting the number of layers is presented elsewhere in the report: particular hydrostratigraphic units are absent over large areas of the model, so the same layer can be used to represent different units.	We agree. That statement was not meant to be the justification, but the end result. Section 2.5.1.3 has been updated accordingly.
CN	6		We suggest that Figure 2-3 be replaced with a figure to match each of the three zones listed on Table 2-2 and shown in Figure 2-4. We offer the following additional comments on Figure 2-3: · There is no Model Layer 1; · The white area denoting Paleozoic Bedrock is assigned a gray color in the legend;· and In the legend, the pattern that is applied to Model Layer 8 apparently refers to both layers 8 and 9.	This is a generalized geological representation of the area. This was not meant to be a direct representation of one of the geologic zones but rather the entire area. Section 2.5.1.3 has been updated to clarify this.
CN	7		It is indicated that the Marcellus Formation is distinguished from the rest of the Unweathered Paleozoic Bedrock unit. How? Is the area where the Marcellus Formation is present assigned different material properties, for example?	The Marcellus Formation has lower horizontal hydraulic conductivity than the other bedrock unit, but similar vertical K. Section 2.5.1.3 updated to clarify.

RS	1	16	It is stated that "...there was not enough evidence to support the existence of a continuous weathered portion of bedrock at a regional scale" and therefore you removed the weathered bedrock layer and went only with the unweathered Paleozoic bedrock layer. The Paleozoic bedrock layer was exposed to weathering regionally not locally. The OGS refers to the uppermost few meters of the Paleozoic bedrock as 'jointed, weathered, porous and the most extensive, continuous, fresh water aquifer in southern Ontario'. Is your description not at odds with this? Do you have evidence that the weathering is not continuous in the study area?	26 continously cored boreholes extending to the top of bedrock were drilled across the study area as part of the field study program (Appendix D). An additional borehole was advanced by the Ontario Geological Survey northwest of Delhi (OGS-SNP08-01a; Barnett 2008). Competent bedrock was found at the top of bedrock in all but four boreholes. Fractured bedrock was found in two locations between Delhi and Simcoe (LP-MW-08-10 and LP-MW-22-10) and two near Tillsonburg (LP-MW-20-10 and LP-MW-23-10). Text added in Section 2.5.1.3 and in Section 2.3 to indicate that a continuous, highly weathered bedrock was not represented in the conceptual model. The calibrated conductivity of the bedrock allows for areas that may be weathered.
CN	8	17	We are not sure we understand what is presented in Figure 2-8. If we understand the figure correctly, the upper portion shows how the stratigraphy is represented in the model. If this is correct, the bedrock appears to be represented by a layer that is about 10 m thick. In contrast, the lower figure suggests that some wells extend to much greater depths in the rock, with similarly deep static water levels. Is the information for these deep holes reliable'	The upper portion of the Figure 2-6 [not Figure 2-8] was truncated at the bottom and was missing the full 50m thickness of the bottom bedrock layer. The figure has been updated. There were a limited number of domestic wells that extended to greater depths in the rock. These had static levels that were not reliable at a regional scale.
CN	9	22	It is indicated that values of hydraulic conductivity were applied "to be consistent with values from previous studies". What previous studies are referred to here? Is it possible to cite a specific section of the Physical Characterization report? The hydraulic conductivities for the bedrock that are inferred through calibration, 6.5×10-6 to 5×10-5 m/s appear to be relatively high for unweathered bedrock in southern Ontario.	Section 2.5.2 has been updated to reflect that initial estimates of bedrock K were taken from the Tier 2 study, Fine-grained material was also initially estimated from the Tier 2 study at 1e-8 m/s, and the remaining estimates were taken from the field study slug tests. Table A-1 in Appendix A has notes for each K-Zone that give the source of the initial estimate. Unweathered bedrock in the Tier 2 study had Kxy=6e-5 m/s and Kzz=6e-6. This study has unweathered bedrock (KZones 8000 & 9000) with Kxy=5e-5 m/s and Kzz=5e-7.
RS	2		It is noted that slug tests were performed for a number of units and that hydraulic conductivity (K) values were obtained from these tests. It should be clearly noted what units were assigned K values based on slug tests, literature values, or more extensive field testing such as pump tests. Each one of these approaches has its own level of uncertainty and scale of influence. The limitations of K determinations should also be discussed more clearly in the Uncertainties section. Slug tests are very 'local' in nature and may only test a small area around a well which may reflect a disturbed K zone. Some citation is given in the notes for Table A-1 but this is not sufficient.	Slug and pumping tests were available for this study for a limited number of units. Section 2.5.2 has been updated and the notes of Table A-1 indicate where where those results are used to provide initial estimates of hydraulic conductivity. More notes have been added to Table A-1 to indicate the source of initial estimates of K for KZones that were sub-divided. A discussion of uncertainties has been added to Section 6.7
CN	10	23	It is indicated that regional flow of potable water in the Study Area does not occur at a depth beyond the bottom of the model. This does not assist in understanding regional groundwater flow, as the bottom of the model is implicitly an impermeable boundary. It would be more meaningful to indicate that the bottom of the model has been set at an elevation (or depth) below which active groundwater flow is assumed to be negligible, and to report what that depth is.	Agreed. Section 2.5.3 updated to clarify.
RS	3		Missing from the report is a model to model validation comparing results from the Tier 2 model to the more advanced Tier 3 modeling. For example there should be a discussion of how Tier 2 estimates of recharge differ from the Tier 3 recharge values. It is clear from Figure 2-7 that a significant discontinuity exists between the Tier 2 recharge values outside the Tier 3 study area. It appears that recharge values increase by an entire contour interval (i.e. 100 mm/year). This should be discussed.	Please refer to response to CN Major Comment #8 for discussion on recharge differences. Section 3.10 has been updated.
RS	4	25	On my first read through this section it seemed odd to me that for a Tier 3 study river/stream stage values would be taken from as you state "the available DEM". These elevations are tied to boundary conditions and thus their values are of critical importance. Later in the report you mention the "available DEM" was at a 1 m resolution - not normal. This resolution and accuracy/precision of the DEM should be discussed earlier. In addition I assume you would have confirmed the DEM generated river/stream elevations at WSC or other surveyed in gaging stations? This should also be stated if done.	Text had identified the quality of DEM data in Section 2.5.1.3 prior to this section. This Section (2.5.3.2) has been revised to remind reader of the quality of data used for setting boundary conditions. There was limited field data for river and stream stage elevation and thus these were not used in the construction of the regional groundwater flow model. The groundwater flow results are relatively insensitive to minor variations in the stage elevation given the scale of the regional model.
RS	5		"As with streams, lake stage was taken from DEM elevations" – What lakes are you referring to here. Lake Erie forms a major boundary condition with the model and has elevations available through WSC and GLERL/NOAA. Why would you take this time varying elevation off a DEM (if in-fact you did)? Section 2.6.1 states you used WSC gages for some elevations – you need to be clear in Section 2.5.3.3 also.	Section 2.5.3.2 has been updated to state that only the ponds near Waterford and Simcoe were represented by specified head boundaries with the stage taken from the DEM. Lake Erie was specified as fixed head boundary condition of 174 masl consistent with the Tier Two study. Section 2.6.1 states that baseflow (and not elevations) frrom the gages were used in calibration
CN	11	27	There appears to be two interpretations of the term "boundary condition". In Section 2.5.3.2, recharge, streams, rivers and lakes are referred to as boundary conditions. In Section 2.5.3.3, reference is made to "perimeter boundary conditions". In our opinion, it makes more sense to reserve the term "boundary condition" to those elements of the model around its perimeter that fix either the groundwater level or its gradient. In general, recharge, streams, rivers, lakes, and pumping wells, do not do that. Rather, they are internal sources and sinks of water.	We refer to anything that fixes a variable within the differential equations for flow, or is a souce or sink of water, as "Boundary Conditions". In the report we distinguish easily grouped boundary conditions that can be described through text and figures. Section 2.5.3 has been updated and provides an introduction to these groups.
RS	6		Figure 2-9 and 2-10 does not clearly define what boundary conditions are applied to those regions of the perimeter that were not constant head. I assume that the areas labelled in yellow as "Model Boundary" are no-flow boundaries?	Yes, your assumption is correct. Section 2.5.3.3 has been updated to clarify.

CN	12	33	For an internally consistent steady-state calibration, the time period over which the recharge and pumping are averaged should be the same. Inconsistent averaging periods are adopted in the current study: · Pumping data: 2005-2010; and · Recharge estimation: 1960-2010. It is not clear why this approach has been adopted for the current study. Does it matter? Our appreciation of the pumping data suggests that it is not possible to confirm that the average municipal pumping rates between 1960 and 2010 and between 2005 and 2010 are similar. Is it possible to confirm that the average recharge rates over these two periods are similar?	We confirmed that the recharge rates for 1960-2010 and 2005-2010 are relatively similar with average recharge rates of 304 mm/year and 328 mm/year. Text has been added toSection 2.6 to clarify this.
CN	13		Ideally, the calibration targets should be estimated as average water levels over the same period as the averaging of the pumping and the recharge. This is not possible for "spot" levels culled from MOE water well records; an implicit tradeoff is made between temporal consistency and spatial coverage. What time period was used for the averaging of the water levels from the high-quality targets?	High-quality targets were created from data that ranged from 2001 to 2012. Section 2.6.1.1 has been updated to clarify this along with some discusion about the use of MOE water well data.
CN	15	34	Contrary to what is suggested in the last paragraph, no stream gauges are shown in Figure 2-13.	The stream guages have been added to Fig. 2-13. Also added was a set of missing HQ head targets around Tillsonburg
RS	7	Fig 2-14,15	How can the potentiometric surface from the model fall outside the model domain (northern portion) and inside the model domain (western portion)?	The figure has been updated to clearly indicate that the surface corresponds to observations which have been interpreted into a surface. The model simualted potentiometric surface is represented by contours. Section 2.6.2.1 has been updated to clarify.
Matrix Team		Fig 2-17	Figure 2-17 is missing the PGMN well residuals	Fig 2-17 was updated to include PGMN well residuals
CN	16	37	Referring to Table 2-2, do "Shallow" and "Deep" interstadial aquifers refer to model layers 4 and 6, respectively? Or do they refer to layer 2 and either/or/both layers 4 and 6?	Shallow refers to Layer 2 and Deep refers to Layer 6. We refer to Layer 4 as the intermediate interstadial aquifer. Section 2.6.2.1 has been updated to clarify
CN	14	41	It is indicated that the period of coverage of the MOE water well records is from 1939 to 2011. Has "regional" groundwater use been consistent over this period, considering typical seasonal and annual variations? Intuitively, we would expect that agricultural withdrawals have increased significantly over this period, particularly with the evolution of centrifugal pumps.	Section 2.6.1.1 was updated to explain the use of MOE water well records. It is expected that agricultural takings have increase over this period though we are not aware of specific data which characterizes this.
CN	17		We infer from the discussion that an "excellent" match to a high-quality target is interpreted as a residual of ±2.5 m. What is the basis for this judgment?	Seasonal variations in water level in high-quality monitoring wells are up to 2.5 m and thus 2.5 m a steady-state residual was considered excellent. Section 2.6.2.2 has been updated.
CN	18		It is indicated that test well TW1-09 had an "anomalously deep static water level", which is likely due to it not encountering an interstadial deposit "until depth". What does this mean? Does this mean that at this location no aquifer is present, while a continuous aquifer is incorporated in the model? Is there a history of water levels at this location, or just one static water level? If a time history is available, is the "anomalous" measurement observed consistently through time?	The text has been moved to later in Section 2.6.2.2 and the well is discussed with others that are outliers.
CN	19	45	Figures 2-19 and 2-21 do not appear to provide a consistent account of the residuals for the high-quality targets. Our inspection of Figure 2-19 reveals: - 2 residuals between +5 m and +10 m; - 2 residuals > + 10 m; and - 3 residuals between < -5 m and -10 m. Our inspection of Figure 2-21 reveals: - 2 residuals between +5 m and +10 m; - 1 residual > + 10 m; and - 2 residuals between < -5 m and -10 m.	The vertical axes for Figure 20 and 21 truncated the extremes of the dataset and caused the discrepency with Fig. 2-19. The axes have been adjusted. One outlier on Fig 2-19 had bad data for the observed level and has been corrected.
HW	4		define "difference" as simulated minus observed i.e. + means simulated head is higher	Section 2.6.2.2 text has been updated to provide a definition of residual error ("difference").
HW	5		there are only 7 high quality wells with > 5 m head difference; would it be possible to include an examination of these seven with individual comments on whether there is any explanation available for the discrepancy in each case ?	Labels were added to figure 21 to identify 6 outliers, discussion of each has been added to Section 2.6.2.2; one outlier had bad data for the observed level and has been corrected.
CN	20	46	Our interpretation of Figure 2-21 suggests that several targets appear to be anomalous. This strikes us as unusual, as all of the targets shown in Figure 2-21 are high quality. Is there anything special about the locations corresponding to the residuals that we have circled below?	Labels were added to figure 21 to identify 6 outliers, discussion of each has been added to Section 2.6.2.2; one outlier had bad data for the observed level and has been corrected.
CN	21	47	What are the ranges assumed in normalizing the RMS residuals?	Ranges have been added to Table 2-4.
CN	22		It is indicated that an error of ±5 m is "generally accepted" to be inherent in the use of water well record data. Is it possible to point to a source for this "generally accepted" value?	This is based on professional experience with MOE water well data and is consistent with many Tier Three and other modelling studies in Ontario. There are no published academic references to our knowledge.
RS	8		In my opinion the Tier 3 model calibration statistics should be discussed in comparison with the Tier 2 model calibration statistics. A great deal of effort went into the advanced Tier 3 modeling. However, a cursory review of the Tier 2 calibration statistics shows only a slight improvement. Mean error is way down which is good but other statistics are not that different.	The statistics for the Tier Two model using the current calibration targets have been added to Table 2-4 and the discussion in Section 2.6.2.2. Although when looking at the individual statistics there appears to be only a slight improvement with the Tier Three model, given the regional scale, and the improvements to the conceptual model, we see these stastical improvements as significant.
HW	6	48	uncertainty in the actually actual baseflow conditions due to xxx and yyy ????	Section 2.6.2.3 has been expanded to address sources of uncertainty in the baseflow ranges calculated from observed streamflow.
CN	23		It indicated that initial specific storage values were estimated from literature values. What is the source of the literature values?	Section 2.6.3.1 has been updated to indicate the source of the Specific Storage values.
CN	24		The operational storage coefficient for drainage at the water table is the specific yield, defined as the difference between the porosity and the residual water content, qr. What value was assumed for qr?	Residual saturation was set at 0.0025. We incorrectly used the term porosity when we meant drainable/fillable porosity or specific yield which was set at 20% this was deemed reasonable for fine sand with silt fractions (Domenico and Schwartz, 1990)

RS	9	49	Section 2.6.3. Transient calibration is only effective if the period being calibrated against has conditions (i.e. pumping rates, climate effects, water table variations) that are significantly different from the steady state calibration period. You should confirm this was the case.	Section 2.6.3 has been updated to explain why the transient calibration period was chosen and the climactic variations that are captured during that time.
RS	10		Section 2.6.3.1. (Specific Storage) You state initial specific storage (Ss) values were estimated from literature values but give no references. This is done often elsewhere in the report where you simply state "from literature values". This is not acceptable as sources vary in their quality and site specificity. Are you referring to generic textbook values or pump test reports (of which there will be many for your site)? The values provided in Table 2-5 do not conform well to standard values reported in the literature. You assign a value of 10-5 (I can only assume m-1 the standard units for Ss) to six of the material types; this appears to be a value you simply assigned and never calibrated as the material types assigned this value should have significantly different values of Ss (i.e. they have significantly different values of aquifer compressibility). For my literature references I am using Table 3.4 in Anderson and Woessner (Applied Groundwater Modeling) which is adapted from several works by Domenico and is also referenced / repeated in Batu 1998 (Aquifer Hydraulics: A Comprehensive Guide to Hydrogeologic Data Analysis) and in the program materials for AQTESOLVTM a leading aquifer test analysis software package.	Discussion has been added to Section 2.6.3.1 to address the sources of Specific Storage values, the uncertainity in field estimates, and the challenges in calibration. The transient calibration is fairly insensitive to the Ss of individual units. The high specific storage values have been adjusted to be in line with the Ss of similar material and the model results have been updated throughout.
RS	11		Section 2.6.3.1. (Specific Yield and porosity) You uniformly assign a porosity value of 0.2 (20%) and state no field measurements were available. Again you reference "...this literature value" without citing your source. First I find it odd no field measurements of porosity were made. You implemented a field program and collected undisturbed cores. Porosity is a fairly easy parameter to measure in the lab. Porosity values can also be 'backed out' for granular material using grain-size relationships and K values. Were there no pump test reports available that could establish field scale specific yield and porosity values? Finally, in my opinion, a value of 0.2 for porosity is low. Standard textbook references for porosity of materials listed in your Table 2-5 range from 0.25 to 0.50. Some consolidated glacial tills can have a porosity of ~ 0.2. Work my group has done on outwash sand and gravels in Southern Ontario (Markle and Schincariol, Journal of Hydrology, 338, 2007) determined porosity values at 0.27 to 0.29 depending on the method of evaluation. The Dillon study for Dorchester used a model calibrated value for porosity of 0.25.	We incorrectly referred to specific yield as porosity in the text. This has been corrected - see comment CN#24. Grain-size analysis was not conducted on the drill samples. Pumping tests - The two shallow unconfined aquifer pumping tests conducted in Waterford and Sincoe NW that could reveal field-scale specific yield were impacted by a constant head boundary infered to be the adjacent ponds. We are not aware of any other data that would give us values of porosity in the study area.
CN	25	49 & Appendix A	The units of the specific storage are not indicated. This is important because the specific storage [L-1] is confused frequently with the storage coefficient [dimensionless]. The values of specific storage listed on Table 2-5 seem to be too high to be representative, and are more typical of confined storage coefficients.	The units of specific storage are m-1. The text and tables in the report have been updated. The transient calibration is fairly insensitive to the Ss of individual units. The high specific storage values have been adjusted to be in line with the Ss of similar material and the model results have been updated throughout
CN	26	50	We have no idea what the scaling functions are, what their physical basis is, and why they are required. Are they required to downscale year-average recharge rates to 15-day intervals? How exactly do they work? An illustrative example calculation would be helpful.	Section 2.6.3.2 has been revised to clarify how transient recharge was represented in FEFLOW. Scaling functions are required to convert the extremely variable, spatially distributed annual average recharge that was estimated on a cell-by-cell basis into 15-day variable recharge without having to calculate each cell separately
CN	27	57	Our impression is that Well W016-1 in the text corresponds to W016-3 in Figure 2-34 and Appendix B.	Text was in error and has been corrected to W016-3
CN	28		Referring to Figure 2-34, it appears that wells W013-1 and W014-1 are on top of each other, as are wells W015-1 and W016-3. Are they completed in different aquifers?	Both sets of wells are at the same location but are completed in different aquifers. Section 8.6.5.1 has been updated to clarify this
CN	29		We concur that the results presented in Figures 2-35 and 2-36 appear to confirm that the model can reproduce the observed seasonal variability in groundwater levels. However, part of the reason the drawdowns appear to be matched more closely (Figure 2-35) is because the scale of the drawdown axis is reduced by half relative to the scale of the water level axis (Figure 2-36). We recommend that the two figures be plotted with the same scales.	The figures have been updated to have axes with the same scale.
RS	12		The approach of picking a well which matches one of your calibration goals (stated in section 2.6.4) is good. Are there no monitoring wells that show a regional response to pumping variations that could be used to illustrate your other calibration goal?	PGMN well W170-2 shows the regional response to seasonal water level changes. There are two examples of wells influenced by municipal pumping variations in section 2.6.5.2 entitled "Local Calibration Results". We did not interprete any data to show a regional response to pumping variations.
CN	30	57 & Appendix B	Appendix B: For PGMN well W215-1, the record of observations includes large drawdowns that are not reproduced by the groundwater model. The data resemble those of a well that is pumped periodically. Is the well ever sampled, which might account for the sudden declines in water levels?	Discussion for this well has been added to Section 2.6.2.2.

RS	13	59	There seems to be a systematic delay in the model responding to declining head values in some cases, and both increasing and declining head values in others (e.g. Figures 2-35, -36, -39). Do you have a hypothesis why this is occurring? Could it be related to the lack of connectedness you referred to earlier when discussing the higher than field observed ground water levels?	Section 2.6.5.1 has been updated. Our interpretation of the results is that there are delays at particular wells for limited times, but this is not systematic. We observe that the model may over estimate the high or low water level at times for various monitoring wells that causes the simulated hydrograph to separate from the observed hydrograph. E.g., Figure 2-36; The model overestimates the water level between Jan to March 2007 and is this gives the appearance that there is a delay in decline. In this example, the inflection points of the simulated and observed hdrographs at Jan and March 2007 are matched, and the slope of the hydrographs are the same. By Late 2007, the hydrographs are again matching with a similar low water inflection point. Discrepencies in the simulated and observed water levels could be explained by the modelled timing and amount of recharge at the local scale being based on regional climate data that does not contain the local-scale and short-term variations. The uncertainity in the conceptual model and the parameterization in a regional model also provide possible explainations. Text has also been added to Section 2.6.5.1 to note that the observed water levels are monthly averages with more detailed hydrographs now given in Appendix B. The greater variability of the non-averaged hydrographs make it harder to see mis-fits for some of the wells. The objective of the regional FEFLOW model was to test the new hydrostratigraphic model and provide regional parameters to the local scale MIKE SHE models for local calibration.
CN	31	60 & Appendix B	Appendix B: Four of the observed hydrographs for Tillsonburg observation wells are particularly erratic: TW2-92, TW6-75, TW6-86 and TW7-75. The records of observations include wide swings in water levels, including relatively large negative "drawdowns". The trends in the observations are not reproduced by the groundwater model. Has anyone investigated the cause of the erratic levels? Are these data reliable?	Discussion has been added to Section 2.6.5.2: *The observed data for the Tillsonburg monitoring wells consists of manual water levels measured monthly. This data cannot be correlated with the instantanous pumping activity in the supply wells. Pumping is represented in the model by monthly average rates, but typically, supply wells are cycled on and off. Water level measurements taken when a well is turned off do not represent the pumped water level or the average water level in the aquifer and the supplied data does not capture the short-term water level variability.* *Although these data are not fully reliable, they qualitatively demonstrate the performance of the model as the simulated waterlevels match a majority of observed data. The water level data for the wells was supplied as depths below a reference point, but the operator was not able to provide the elevations of the reference measuring points. Thus water level elevations could not be calculated. Drawdown for these monitoring points was calculated relative to the average water level for the available data. Negative drawdown represents observed water levels above the average water level.*
CN	32		The simulated water levels for TW5-66 are significantly more variable than the observations. What is the source of this variability?	This Tillsonburg observation well is located adjacent to Well 6A. Pumping is represented in the model by monthly average rates that do not capture the short-term variability. The model may also be over-estimating the responsiveness of the aquifer at this location. We did not have enough observation data to warrent subdividing the conductivity zone that supplies this well, and thus the model may not capture any local variability (e.g., Higher conductivity zone). There is a reasonable fit at wells conceptualized to be in the same aquifer unit (TW1-61 and TW3-89).
HW	7	62	since the only consistent discrepancy is with the head for well 11 it would be good to add a sentence about the head discrepancy and to emphasize that the drawdown simulation is good.	Text has been added to Section 2.6.5.2
RS	14	62, 63	There are a significant number of mismatches (observed versus simulated heads/drawdowns) in these figures. They should be discussed separately. Without a discussion it is hard to accept your statement that the model closely represents the general observed timing and magnitude of water level responses to both pumping and seasonal recharge.	Text has been added to section 2.6.5.2 to discuss the general lack of reliability in the observed data. See comment RS #13, CN #31 and 32
CN	33	62 & Appendix B	It is indicated that there are 12 monitoring wells in Delhi. We count 13 wells in Figure 2-37; however, it appears that either no data are available or not data are presented for the Gilbertville monitoring well. If no data are available for this well, we recommend that it be removed from Figure 2-37.	The label for Gilbertville is there to identify the town rather than a well location. This label has been removed to avoid ambiguity.
CN	34		For observation well MW12/91 there is an abrupt decline in the water level in 2009. The simulated results suggest no decline. The data look suspiciously like the elevation of the measuring point changed or that water levels are being mis-reported	Yes, this appears to be a problem with the observed data, but we did not remove it. We discuss the reliability of the data in comment CN#31 and 32
CN	35		For the Delhi observation well "Wetlands", are we correct in understanding that monitoring of water levels ended in 2006?	Yes, all data collected is shown.
CN	36	Appendix B	· The observations appear to be identical for Simcoe Cedar St. Well 1 MW S4 and MW S5. · The observations appear to be identical for Simcoe Cedar St. Well 2 MW S4 and MW S5. · The observations appear to be identical for Simcoe Cedar St. Well 3 MW S4 and MW S5.	The data is correct. They are not identical, but appear so.
HW	8		somewhere, perhaps here, there should be comment on whether the improvements to the Tier Two model produce any significant changes in model results that would alter any conclusions drawn from model results in the Tier Two report	The Tillsonburg subwatershed was the only area with high uncertainty associated with the groundwater stress assessement. As a result it is being re-evaluated as part of this study. Text has been added describing this to Section 1.3

HW	9	66	For Mike She the definitions for precipitation and for evapotranspiration suggest that intercepted water (on vegetation and other above-ground surfaces) is somehow allowed for (i.e. intercepted water that is evaporated/sublimed is subtracted from precipitation to obtain water reaching the ground. Is this correct ? If so the process dealing with intercepted water should be described as the amount of water intercepted and returned to the atmosphere is appreciable for areas with permanent full-canopy-coverage vegetation	Interception storage is accounted for within the MIKE SHE model. The descriptions of the hydrologic processes in Section 3 that are considered in the model have been revised to indicate this is considered in the model.
HW	10		groundwater recharge: water from rainfall or snowmelt which infiltrates the Earth's surface and passes through the vadose zone to enter enters the groundwater or subsurface flow regime.	Section 3 text updated to reflect new wording.
RS	15		You can only state "The regional groundwater flow model improves upon the Tier Two model ..." if you compare and contrast the calibration data and compare results for the two models.	See comment RS #8:
HW	11	68	in the description of evaporation from the vadose/(unsaturated soilwater) zone there is evaporation directly from soilwater storage that is not mentioned (from bare (unvegetated) soil surfaces) i.e. it is not all transpiration.	Section 3.1.2 text updated to add evaporation to the vadose zone
HW	12		it appears that the areal distribution of snowpack within a calculation unit (i.e. proportion of surface that is snow covered and proportion bare) is not allowed for but is included in the calibration of the melt factor (I assume this factor is temporally variable) and the wet and dry proportions of the snowpack. It would be more directly physical to include the areal snowpack depth distribution as it varies with time and the approximation in Mike She should be mentioned.	Section 3.1.3 has been updated to explain how the areal distribution of snow is considered wtihin MIKE SHE.
HW	13	69	3.1.5 Channel flow - I doubt that the required accuracy for the channel cross-section data used to run a one dimensional channel-flow model can be obtained from the DEM's available for this application - was additional channel cross-section data based on field surveys used to check the cross-sections ?	The GRCA supplied a high resolution 1 m DEM for the study area encompassed by the MIKE SHE model. Section 3.1.5 has been updated to indicate the quality of the DEM data used.
HW	14		3.1.6 in the vertical unsaturated flow what interval/layering is used in the calculation ?	Section 3.1.6 has been updated: The unsaturated zone is vertically discretized through one dimensional cells of variable thickness. The discretization of the unsaturated zone is typically most fine in the uppermost portion of the unsaturated zone and increases in coarseness at depth.
HW	15		interflow It would be worth noting that the interflow simulation would allow for buried-pipe-drainage outflow but that little or none is present in the study areas	Section 3.1.7 has been updated to indicate that the model can also consider buried pipe drainage.
CN	37	70	Why do the climate data extend only to 2005?	Many climate stations in this region have been closed and as such infiling observations based on nearby climate stations is only possible for some of the climate stations. Section 3.2 has been updated to clarify this
CN	38	72	Was a factor used to convert snow to 'water equivalent', or were separate values of 'precipitation as rainfall' and 'precipitation as snow' supplied to the model'	A factor of 10% was used to convert snowfall to rainfall. Section 3.2.1 has been updated to clarify
CN	39		It is indicated that wind speed data were adjusted from the observation elevation to a reference elevation of 2.0 m. How is this adjustment made? Is this a standard calculation for which a reference can be provided?	Wind speed is adjusted based on the Wind Profile Power Law which is a standard equation in atmospheric science. Section 3.2.4 has been updated to reflect this and a reference is provided.
CN	40		It is indicated that "the minimum average wind speed in observation was adjusted to 0.5 m/s". Does this mean that for every day for which the average wind speed was less than 0.5 m/s, the reported value was replaced by 0.5 m/s?	This is correct. The text has been updated to clairfy how the data was processed.
HW	16		Solar radiation - the component of radiation used as input should be specified - I expect it is incoming shortwave solar radiation	Incoming shortwave radiation is correct. Section 3.2.3 has been updated to clarify.
RS	16	75	Why are the Ks values reported in Table 3-3 so different for the ones presented in Table 2-2? Furthermore Table 2.2 refers to the Wentworth Drift (K=1.4E-05 m/s) and in Table 3-3 you refer to the Wentworth Till (7.5E-08 m/s). Same with the Port Stanley Drift (Table 2.2) and Port Stanley Till (Table 3-3) – two orders of magnitude difference in K. If you are referring to "field saturated hydraulic conductivity (i.e. K at field capacity) that is a different parameter then you have described in this section. Furthermore, the 'saturated conductivity' for your soil classes are 1 to 2 orders of magnitude lower than typical literature values that are normally referred to in major reference books (e.g. Clapp and Hornberger 1978, 14:601-694, Water Resources Research).	The values specified in the table 'Calibrated and Field Estimates of Hydraulic Conductivity' are horizontal conductivity (Kxy) values whereas the values presented in the 'Surficial Geology Parameters' table are vertical conductivity values (Kz). Given that anisotropy ratios in materials can range from 1:1 to 1:100 a difference in order(s) of magnitude between Kxy and Kz is not unusual. Table 3-3 has been updated to indicate that the conductivity values are for vertical conductvity (Kz). Section 3.4 has been edited to clarify.
CN	41	78	Referring to the fourth bullet of Section 3.6.1, what are the "coupling issues" between MIKE SHE and MIKE 11?	Text has been added to Section 3.6.1 to expand on this
CN	42		What are "open downstream boundary conditions"?	Text in Section 3.6.3 has been revised to clarify that open water level boundary conditions were set. Open boundary conditions permit inflow to and outflow from the model.

RS	17	81	There is controversy in the literature as to just how important interflow really is. Can you summarize what percentage of your flow moved via interflow so the reader can judge how important a process it was in your model?	The previous reference to "interflow" being simulated in MIKE SHE was in error. As MIKE SHE only includes a 1-D (vertical) representation, it is not able to physically simulate the processes that are thought to be responsible for interflow. Rather, a non-physical process ("drains") has been introduced to represent the hydrograph component that may be sustained by tile drains, extremely shallow groundwater systems, or interflow. Due to this process being non-physical and including a variety of hydrologic processes that may or may not constitute "interflow", we feel it would not be appriopiate to report this term as "interflow". Section 3.1.7 revised to remove the term "interflow" and replace with "drain flow".
CN	43	83	It is indicated that the "specific area assumed for irrigation was a calibration parameter that was adjusted based on reported irrigation rates." Does this refer to the area specific to each farm, or to the fraction of agricultural land that is assumed to be irrigated'	The area refers to the irrigation area assumed for each water taking. Section 3.8.2.2 has been updated to clarify this.
CN	44	83	We doubt that dug ponds are typically filled by groundwater. We would instead expect that a pond would only be dug in a material of relatively low permeability and that it would be filled by rainfall and some runoff.	The Peer Reviewer's line of thinking is correct for many other watersheds in Southern Ontario; however, due to the pervious nature of the Norfolk Sand Plain and the shallow depth to groundwater, it is not the case for the Study Area. The majority of agricultural irrigation withdrawals are from dugout ponds in the Sand Plain, which would recieve very little overland runoff. Net preciptiation (minus ET) falling on the pond surface would be insufficient to sustain withdrawals for a year. A reference has been added confirming that the majority of dugout ponds in the Norfolk Sand Plain are withdrawing groundwater (Personal Communication - Rebecca Shortt - OMAF Irrigation Engineer
CN	45	83	Our understanding of the water budget is that the sum of "overland flow to streams" and "baseflow to streams", that is, the "total streamflow", represents the net cumulative inflow to the streams (and therefore, the total streamflow leaving the water budget area). Is our understanding correct?	This is correct. Table 3-7 has been updated to show that that 'total streamflow' is comprised of 'overland flow' and 'baseflow'.
RS	18	83	Can you cite some literature, reports, or reasons for selecting the screen intervals of 8 to 10 m and 28 to 30 m?	Text should have reference hydrostratigraphic units rather than depths. Shallow wells were screened in the Norfolk Sand Plain/Interstadial Sediment. Deep wells were screened in the second Interstadial Sediment Layer. Section 3.8.2.3 has been updated to reflect this.
RS	19	84	You state you calibrated the MIKE SHE model to "observed conditions (typically streamflow)". Did you not calibrate to ground water levels? You state you calibrated to ground water levels in section 3.9.4 why ignore it here?	Section 3.9 updated to include water levels in calibration targets.
HW	17	85	2nd para I think the partitioning of precipitation should be into overland flow, recharge to groundwater, and evapotranspiration. Streamflow is the result of this partitioninc	Agreed. Section 3.9 has been updated to reflect this.
HW	18	85	In Table 3-6 is interflow included in "overland flow" or in baseflow - I suspect it is included in "overland flow" which then should be labelled overland and interflow. If possible the table should list overland flow and interflow as separate annual amounts	Drainflow is accounted for in baseflow. The terms of Equation 1 have been updated to indicate this.
CN	46	86	It is indicated that the water budget of the regional-scale model produces a good estimate of total streamflow during the calibration and verification period. This conclusion is supported by the results presently subsequently in the report (Section 3.9.2), and not by the results listed on Table 3-6 itself. The results listed on Table 3-6 only confirm that the model on aggregate conserves water.	Section 3.9.2 has been revised to remove the conclusion that a good total streamflow estimation of model is indicative of the reasonableness of the water budget.
CN	47	86	In our opinion, it is impossible to tell from Figure 3-5 that the spatial distribution of evapotranspiration is correlated with the surficial geology. The color gradations are too subtle to suggest any trends.	Figure 3-5 has been updated to increase the contrast between levels.
RS	20	86	I think the statement "The water budget of the regional-scale model produces a good estimate of total streamflow during the calibration period ..." could be strengthened by cross-validating with previous modeling studies (e.g. Tier 1 and 2)	Section 3.9.2 has been revised to remove the conclusions drawn from the estimate of total streamflow. The statement is supported by subsequent results but not supported at this point in the report. See CN #46.
HW	19	90	see comment on partitioning earlier p 85 also p 91 and elsewhere.	Text has been updated with revised description here and in other parts of the document where the partitioning description was used

HW	20	100-101	the overestimation of flows for Kent Creek (80% and > probability of exceedence), and for Big Creek (40% and > but especially above 95 %) make the model results problematic for drought-period risk assessment. Since the Big Creek results are influenced by systematic underestimation of winter-period flows it would be better to do duration curves for growing season only (say d 120 to d 300) Only Kent Creek seems to have overestimation of flows in summer/fall droughts. (This may not be important for regional-scale modelling)	Due to the observations being collected by a local consultant, rather than Water Survey of Canada, Kent Creek flow estimates have a higher degree of uncertainty than other gauges used for calibration/verification. In addition to the Kent Creek gauge not being operated by WSC, the gauge has only been active for 4 years, which limits the range of flows that a rating curve can be developed for. Given this uncertainty in observed flow values, the difference between simulated and observed values at high exceedence probabilities is not considered to be significant. Text has been added to Section 3.9.3.3, describing this uncertainty, and its significance on the divergence between simulated and observed values as shown in the ranked duration curve. The calibration ranked duration plot for Big Creek (now Figure 3-22) shows simulated flows to match observed flows extremely well (at all exceedence probabilities). We presume that the Peer Reviewer was commenting on the verification ranked duration plot for Big Creek (now Figure 3-38), where a significant divergence is evident at 90%. Many of the ranked duration plots illustrate simulated flows being higher than observed flows for the verification period. It is noted that the verification period includes the 1998-1999 drought, which was a significant drought event that was the impetus for the Ontario Low Water Response Program. It is expected that this difference is caused by non-standard irrigation practices being implemented in area watercourses during this extreme drought. These non-standard practices may include creating small dams to facilitate water withdrawal, which is not able to be replicated within the MIKE SHE model. Text has been added to Section 3.9.4.3 discussing this phenomenon, and its impact on extreme low flow conditions.
CN	48	107	It is indicated that calibration statistics for monthly flow for the Lynn River gauge at Simcoe "indicate a reasonable calibration." The Log-NSE statistic is 0.55. On Page 94 of the report it is indicated that a value of the NSE "greater than 0.6 is considered reasonable". Doesn't this imply that the match for Lynn Creek is less than reasonable?	The Section 3.9.4.2 has been revised to clarify that it is expected that model performance during the verification period may not match the performance of hte model druing the calibration period as the model was not specifically calibrated against the verification observation set. In light of this fact the Log-NSE mean monthly flow value of 0.55 achieved in Lynn River is considered reasonable.
CN	49	115	Why are there targets from 105 high-quality monitoring in the MIKE SHE model, but 108 targets for the FEFLOW model (Table 2-4)?	Three PGMN wells fall outside of the focus area of the MIKE SHE model and as such there are 3 less high quality observations that are included in this evaluation. Section 3.9.5.1 has been updated to clarify.
RS	21		Some of the monitoring wells in Figure 3-41 are significant outliers. One would not expect this for high quality data. A better discussion of this is warranted	Text has been added that refers the reader to Section 2.6.2.2, where each outlier is discussed in detail as part of the FEFLOW calibration documentation
CN	50	117	We concur that irrigation pumping should depend directly on precipitation. Our alternative plot of the results presented on Table 3-14 confirms that the MIKE SHE regional model captures the expected dependence.	This table is now 3-15
CN	51		It is indicated that variations in the quantity of irrigated land through the late 2000s and into the 2010s is a significant source of uncertainty in the estimation of simulated irrigation demand. Is this uncertainty in the calibration and/or verification period of the current model, or for future projections, or both?	Section 3.9.6 revised to clarify that the quality of irrigated land in the study area is a significant source of uncertainty in the calibration period, verification period and any future projections made with the model.
HW	21	120	a quibble unit is /y not /yr other charts /d not /day	All text, tables, figures and maps have been updated to conform to this abrieviations of '/y' for per year and '/d' for per day.
CN	52	121	Without further information, we are not convinced that the median recharge is a more representative measure than the mean recharge In our experience, the most appropriate measure of the average recharge is the recharge weighted by area ∑ ∑ Here Ri and DAi are the recharge rate and area of each grid block, and NB is the number of grid blocks in the model. For a uniform grid, is this in fact the same as the median? Is the median calculated in the present study as ∑	Section 3.10.1 has been revised to emphasize that median is a another statistical measure in additon to the mean which may be considered.
CN	53		The visual display in Figures 3-44 and 3-45 are interesting, but negative values do not represent recharge and should be excluded from any statistical calculations. Where there is discharge, the recharge is rejected.	The graphs are illustrating groundwater flux, recharge to the saturated zone and discharge from the saturated zone. Text and figures have been revised
RS	22		What are the referred to "expected rates" for recharge. Again no reference is given to past reports to justify this statement.	Text and Table 3-17 have been added to Section 3.10.1 comparing the Tier Two (GAWSER) recharge rates with the Tier Three (MIKE SHE) modelled recharge rates
RS	23	124	The summary wording under section 4 can be improved. Reading your current description I have to ask - How can you evaluate a local-scale model against a regional-scale model on which it was built? Would this evaluation not simply tell you if you have made a 'model building' or 'model input' error and not really evaluate the model itself? Later it does come out that the local-scale models were significantly modified to include features not present in the regional models but this is not addressed in the summary wording	Summary text of Section 4 has been updated to indicate that additions/refinements were made to the local scale model.

CN	54	126	Our understanding is that the hydrologic parameters inferred through calibration of the regional-scale MIKE SHE model (200 m×200 m) are retained for the local-scale models (25 m×25 m and 50 m×50 m). It strikes us as more appropriate to expect these parameters to be scale-dependent.	It is expected some level of scale dependency in the model parameters exists. However the comparison of local-scale model water balances to regional model water balances indicates that whatever scale dependency exists it is not introducing significant differences in water balance values. Section 4.1 has been updated to clarify this
CN	55	131	Is anything known about the properties of the materials that line the bottom of the Lehman Reservoir?	Reservoir Bathymetry data indicate sediment near the reservoir outlet at a maximum depth of 0.7 m. The upstream drainage area of the reservoir is primarily within the Norfolk Sand Plain and therefore we expect that any sediment builidup will introduce a minimal resistance to flow. Section 4.1.1.2 has been updated to include this information
CN	56	134	Reference is made to local aggregate pits in close proximity to the Waterford municipal wells. Are the aggregate pits the lakes around the wells? Are there any active pits with active dewatering in the vicinity of the wells?	Materials are being actively extracted from the pits but no dewatering practices are active. Section 4.1.2.1 has been updated to clarify this.
CN	57	152	The reported changes in storage are summarized below. We do not know what to think of the reported changes in storage. For some of the local-scale models, the magnitudes of the storage changes are of the same order-of-magnitude as the pumping. For a ten-year solution, should we expect the change in storage to be negligible? If we cannot, how can we distinguish between the actual changes in storage and the overall error in the water balance?	The start of the simulation period for calibration is the year 2000 which follows a very significant drought period in 1998-1999. As a result of this, a certain degree of storage accumulation is expected as the depressed groundwater levels increase with the return to more average climatic conditions. Section 4.2 has been modified to include this.
CN	58	153-158	To allow proper comparison between the observed and simulated differences in water levels, we recommend that Figures 4-16/4-17, Figures 4-18/4-19, and Figures 4-20/4-21 be re-plotted with axes of the same scale.	Data have been re-plotted on single figures to allow for comparison.
CN	59	155	It is indicated that the results plotted in Figures 4-18 and 4-19 indicate that "a reasonable representation of the local groundwater system has been achieved by the Simcoe North Well Field local-scale model." The results shown in these figures do not seem to support this conclusion. The plot of observed levels indicates that the water levels in DP3 exceed the pond level, such that there is an upward hydraulic gradient. In contrast, the simulated levels for DP3 are systematically lower than the pond levels. Are we missing something?	Data had been plotted erroneously. Simulated data does conform to the same upwards gradient direction found in the observations. Data has been re-plotted
CN	60	157	We cannot make out what is plotted in Figure 4-21. What lines are supposed to represent the observed and simulated levels at DP1?	Data has been re-plotted and simplfied by reducing the plot to one drive-point.
CN	61	163	The discussion of the uncertainty in the climate data should be supplemented with an indication that solar radiation and wind speed data are available from only one location	Section 6.2 has been updated to identify use of a single location to characterize radiation and wind speed
HW	22		not sufficient to fully reflect all spatial climate variability in short-duration weather event	text updated
HW	23		extremely localized precipitation rainfall events	text updated
CN	62	165	It is indicated that numerical error can exist internally within a model, "although this is generally minor." It is only possible to say this if some confirmatory checks have been made. These checks might include developing sub-model water budgets for critical areas of the model and repeating the simulations with successively smaller convergence criteria	This section was intended to be a a general comment with regard to FEFLOW and Galerkin Finite Element Solution. It was not an assessment about this particular model. The Section 6.8 has been updated to clarify
Major Editorial Comments				
CN	1	throughout	Throughout the text: Data are plural	
CN	2	Ex. Sum. iii	We think that the second sentence of the fifth paragraph should read "The smaller local-scale models allowed a significantly higher spatial resolution than the regional-scale model, which was required to simulate…'	Text updated
CN	3	3	The boundaries of the individual conservation authorities are not indicated in Figure 1-1	Figure Updated
CN	5	5	A "set" rather than a "series" of scenarios will be modelled	Text revised
CN	6		Section 5 presented presents an updated …	Text revised
CN	4	13	The second sentence of Section 2.5.1.2 reads: "This shows the level of discretization contained within the mesh." What is "this"? A reference to Figure 2-2 appears to be missing.	Text updated with reference.
RS	1		The mesh figure (Figure 2-2) is not referenced in this section. The figure and its appropriate subareas should be properly referenced as you move through the discussion of the mesh. The PTTW dataset also needs to be appropriately referenced as to its location in the report.	Reference to the mesh figure 2-2 has been added to Section 2.5.1.2. For the PTTW dataset, the reader is referred to the characterization report
RS	2	Fig 2-6	Title should be reversed to reflect presented order (i.e. FEFLOW and Conceptual model cross-sections). To the non-geologist / modeller it might not be clear which is which	Figure 2-6 has been updated
CN	7	33	It appears that the calibration targets derived from MOE water well records are shown in Figure 2-12, and the high-quality targets are shown in Figure 2-13. If that is correct, we recommend that the titles of the figures reflect this distinction	Figure 2-12 now shows all the head targets used in the regional model. Fig 2-13 shows the high-quality data at the Focus Area scale.
CN	8	34	The last sentence should read "…of estimated baseflow for each gauge location.	Text updated
CN	9	38	The last sentence should read "… the spacing of the contours and the direction of simulated groundwater flow matches match what was were interpreted from observed data observations."	Text updated
CN	10	48	The third line of Section 2.6.2.3 should read "… active and inactive stream gauge locations compared to the estimate estimated baseflow range computed for each…	Text updated
RS	3	Fig 2-18, 19	The 1:1 line and 5 m and 10 m intervals should be labelled directly on the plot as done in Figure 3-41.	Figures updated
CN	11	49	The second line of the second paragraph of Section 2.6.3.1 should read "… hydrostratigraphic unit units …"	Text updated

CN	12	57	Reference is made to a “few” regional monitors. Referring to the beginning of Section 2.6.5.1, is “a few” seven?	Text updated to more appropriate language.
CN	13		The third line of Section 2.6.4 should read “The matching of absolute water level elevations …”	Text updated
CN	14	62	In the Delhi section, the reference to Figure 2-38 should instead be to Figure 2-37	Text updated
CN	15		The first word of the first sentence in the Delhi section should read “Figures” instead of “Figure”.	Text updated
RS	4	68	What is the * referring to in *°C in section 3.1.3?	Text updated. Should have read "mm snow/d/°C'
CN	16	73	The fourth line should read “… following description elements form from the OGS mapping	Text updated
CN	17	84	The second paragraph of Section 3.9 should read “As hydrologic models are a simplification are simplifications of the real world, a margin of error between the simulated and observed streamflow are is expected.”	Text updated
CN	18	85	In our opinion, the next-to-last sentence of Section 3.9 would be more correct written as “The calibration process focused on a suite of metrics to gauge the model’s representation of match to the observations.”	Text Updated
CN	19	86	The first sentence of the last paragraph of Section 3.91.1 should read “Examination of the spatial distribution of evapotranspiration and groundwater discharge provide provides a …	Text updated
CN	20	100	The first sentence of the second paragraph of Section 3.9.2.3 should read “… simulated and observed daily discharge provides an assessment of how well …	Text Updated
CN	21	Fig. 3-21	The title of the figure should read “Big Otter Creek at Tillsonburg Rand Ranked Duration Curve (2003 to 2009)”.	Text Updated
CN	22	118	In the last sentence of the last paragraph, the reference to Figure 3-41 should instead be to Figure 3-43.	Text Updated
CN	23	124	The last sentence should read “The local-scale mode model domains are illustrated on Figure 4-1.”	Text Updated
RS	5	131	The Lehman reservoir should be identified in the preceding figures	Figures Updated
CN	24	138	The third sentence of the second paragraph should read: Figure 4-9 shows the refined watercourse watercourses modelled …”	Text updated
CN	25	138 & 144	“compliment” should instead be “complement”	Text updated
CN	26	148	The sentence should read “The surficial geology of the Simcoe South Well Field model is predominated by predominantly sand with some significant silt and alluvial deposits (Figure 4-14).”	Text Updated
CN	27	152	The first sentence of Section 4.2 is missing its period	Text Updated
CN	28	153	The references to the number of ponds are confusing. The second sentence below the table refers to “groundwater heads in the ponds bed and water levels within the pond” and the next sentence refers to “groundwater discharge into the pond”. Should the reference instead be consistently to ponds?	Text updated to fix sentences referencing the ponds.
CN	29		Data implicitly refer to observations, so “observed data” is redundant and can be replaced by “data” or “observations”.	Text updated
CN	30	159	We think that the second bullet of Section 4.3 should read “simulated local-scale groundwater gradients were comparable to those observed by drive point piezometers in the regions”.	Text updated
CN	31		The last sentence of the first paragraph of Section 5 should read something like, “Small variations were found It was found that small variations in either water demand or supply terms could result in a low potential for stress …” The same suggestion applies to the first paragraph of Page iv of the Executive Summary.	Text updated
CN	32		In the final bullet, the period after takings is superfluous	Text updated
RS	6	164	Should reference the “other models commonly applied in southern Ontario”	Text updated
CN	33	166	The next-to-last sentence of Section 7 should read “The remaining municipal supply wells are expected to have significant interactions with surface water features are and will be evaluated using fully integrated models.’	Text updated

Peer Review Comments: Long Point Region Tier Three Water Budget and Local Area Risk Assessment

Major Comments				
Peer Reviewer	**Reviewer Comment #**	**Original Page #**	**Reviewers Comments**	**Response**
HW	1		In the Executive Summary there are several places where the basis for the "interpretation" that connectivity exists, and is introduced in the modelling, is not supported by a quick summary of the supportive evidence such as the GUDI status of wells and any pump test results that are available. The bald statement that the interpretation was made should have this sort of support briefly given in the Executive Summary - otherwise it comes across as an arbitrary judgement.	The text has been edited to add the evidence of windows and hydraulic connection that was discussed in the characterization report
HW	2		The logic for the use of Tier 2 criterion for SGRA delineation in the Focus Areas is not clear to me. Further justification is needed.	Provincial guidance indicates that when the Tier Three study only considers a portion of the previous study's domain, SGRA thresholds from the previous study and the updated groundwater recharge rates from the Tier Three study should be used to refine the SGRA mapping (AquaResource 2012). This text has been added to the report.
HW	3		The assumption made in the Risk Assessment analysis that wells are maintained to show no loss of performance over time should be given more prominence in the Summary	Text has been added in the summary and the recommendation section to emphasize this point
CN	1	recommendations	We concur with the general sense of the recommendations. However, in our opinion they are not all sufficiently detailed to point the way towards concrete action.It is recommended that monitoring programs be enhanced and maintained. Going forward, the ongoing collection of climate data will be crucial, as it is these data that "drive" the entire water budget. The final report for the Tier Two Integrated Water Budget (AquaResource, 2009) includes maps of the precipitation monitoring stations in the Long Point, Catfish Creek and Kettle Creek Conservation Authorities (Maps 2.15a,b,c). Are all of the precipitation stations associated with the individual conservation authorities remaining active? Are all of the precipitation stations designated "Other Rain Gauge" permanent installations? In our experience, the reliability of surface water and groundwater models is dependent to a large degree upon the availability of continuous streamflow records from permanent gauging stations. Are all of the stations indicated in Maps 2.18a,b,c of the Tier Two Integrated Water Budget Report active? Compared with the Long Point Region CA (Map 2.18a), the number of gauging stations for the Catfish Creek CA (Map 2.18b) and Kettle Creek CA (Map 2.18c) are relatively sparse. Are there any plans to increase the coverage beyond three gauging stations in each watershed? Are there any geographical/stratigraphic gaps in the existing groundwater monitoring program?	A bullet point regarding climate data has been added to the recommendations. We are not aware of the future plans for the precipitation stations, nor the streamflow gauging stations.
CN	2	recommendations	It is recommended that flow gauging be enhanced. The critical surface feature with respect to pumping the Cedar St. Well Field is Kent Creek. As shown here in Figure 1 (in PDF), there are two Water Survey of Canada gauges in the vicinity of Simcoe. Inference of reductions in the baseflow of Kent Creek requires continuous stream gauging upstream and downstream of the Cedar St. Well Field. Are there permanent gauging stations for continuous monitoring of the flow in Kent Creek?	Norfolk County continues to monitor flow in Kent Creek. Currently, there are two gauging stations for continuous monitoring: one upstream and one downstream of the well field. Text has been added to strengthen the recommendation.
CN	3	recommendations	It is recommended that the municipal wells be maintained routinely and rehabilitated when necessary. How frequently should the wells be tested to assess whether rehabilitation is required? How should the results of the testing be presented?	The municipal operator of the well should determine the frequency of testing based on its experience of how quickly well performance changes.
CN	4	recommendations	It is recommended that the insights gained from the Tier Three Assessment be incorporated into the regional models maintained by the Lake Erie Source Protection Region. How can this be done? Should the adjustments made to the material properties during the refined calibration of the Tier Three model be incorporated in the Tier Two model? What should be done if the mesh of the Tier Three model has been refined? Can the models be updated by professionals other than the developers of the Tier Two and Tier Three models?	A separate study needs to be undertaken to determine how the model updates could be best accomplished. Discussions about the maintainance of the Tier Three models are ongoing at the provincial level.
CN	5	recommendations	We suggest that an additional recommendation be incorporated in the final report: Any ongoing assessment of conditions at the Cedar St. Well Field, including any well performance testing, should be supported by focused modelling analyses.	We have added the recommendation as suggested
CN	6		It may seem like a minor point, but we recommend that any reference to the moderate or significant "stress level" of a subwatershed be qualified as the potential for moderate or significant stress.	Text has been updated throughout

CN	7		Why have both a FEFLOW groundwater model and separate "integrated" MIKE SHE models been developed? Is it because the simulation of groundwater flow in the MIKE SHE models has been deliberately simplified? Or is it because it is not practical to calibrate the groundwater component of the MIKE SHE model?	The reasoning for the modelling approach taken has been articulated in the revised numerical model: "To represent the complex hydrological and hydrogeological conditions of the Norfolk Sand Plain and complete the Tier Three Risk Assessment for Delhi, Waterford, Simcoe and Tillsonburg, the project scope includes the use of both a traditional groundwater flow model, as well as an integrated model. A dedicated groundwater flow model is required to provide an efficient tool for the calibration and parameterization of groundwater flow in the region. Municipal supply wells that are expected to have minimal interaction with surface water features will be evaluated using the groundwater flow model. Municipal supply wells that are expected to have significant interactions with surface water features will be evaluated using a fully integrated model." Groundwater flow was not simplified in the MIKE SHE models and uses the same layers and parameterization as the FEFLOW model. The text has been updated to incorporate the reasoning behind the application of a dedicated groundwater flow model and an integrated model.
CN	8		The treatment of the future supplies from the Cedar St. infiltration gallery and the Lehman Reservoir concern us. It is indicated that these sources may be decommissioned. In our opinion, there are good reasons for doing so. However, the Cedar St. infiltration gallery and the Lehman Reservoir are still included in the Allocated Rates carried through the analyses (Table 3.4). In our opinion, it would be safer to exclude the capacity from these sources from the consideration of future supplies. The exclusion of takings from the Lehman Reservoir is likely to have a minor effect on its associated Local Area Risk Assessment: the average taking between 2008-2012 represents only about 10% of the total Allocated Rate and the Wells 1 and 2 appear to have sufficient additional capacity to make up for decommissioning the Lehman Reservoir intake. In contrast, the capacity of the Cedar St. wells may already be limited and the infiltration gallery takings between 2008-2012 represent 25% of the total Allocated Rate. These calculations reinforce the concerns expressed in the report regarding the Cedar St. Well Field.	Although these supplies are included in the allocated rates, they are not increased from the current withdrawal rates. Even though they maybe decommissioned in the future, this has not been decided and the municipalities chose to retain them for this study as "business as we know it".
CN	9		We concur with the rationale for assigning a Significant Risk Level to Local Area A (Simcoe). The data presented in Figures C7, C8, C9 and C10 speak for themselves. It is clear that the water levels in the Cedar St. wells are at "action levels". However, before any action is undertaken, we recommend that some additional analyses be devoted to trying to understand why current pumping levels are a cause for concern. Are there limitations in the design of the Cedar St. wells? We recommend that the figures for the Cedar St. wells be supplemented with an indication of the stratigraphy. It is recommended in **Groundwater and Wells** (Driscoll, 1986) that wells in unconfined aquifers should be screened across the bottom one-third of the aquifer. With screens longer than this, it may inevitable that the water level declines into the well screen. Have the conditions of the Cedar St. wells deteriorated through time? We recommend that the historical performance of the wells be reviewed. In particular, the original estimates of the capacities of the wells (and the analyses supporting these estimates) should be reviewed. Have the specific capacities and nonlinear well loss coefficients changed through time? Have the wells ever been rehabilitated, and if so has the rehabilitation restored the capacities of the wells? Are there limitations in the aquifer in the vicinity of the Cedar St. wells? Compared to the locations of the other municipal well fields, are the Cedar St. wells pumping from an aquifer that has a relatively low hydraulic conductivity and/or a non-pumping saturated thickness that is relatively small? Are the Cedar St. wells being overpumped relative to their capacity? Are the Cedar St. wells located in an area where the recharge is relatively low? Has regional pumping affected background (i.e., non-pumping) groundwater levels in the vicinity of the Cedar St. wells? In Figure 2 (in PDF), the delineated Local Area A (Simcoe) is superimposed on a map showing the distribution of regional pumping (adapted from Figure 2-11 of the **Model Development and Calibration Report**). It is clear that there is a relatively large number of groundwater takings in the vicinity of Simcoe area. Although these takings are beyond the limits of Local Area A, is it possible that their cumulative effect is to depress regional groundwater levels?	The purpose of the Risk Assessment is to determine the assignment of Risk Level. The suggested additional analyses would best be considered under the Risk Management Measures Evaluation Process. The cumulative effect of regional pumping (the large number of water takings in the vicinity of Simcoe) on the regional groundwater levels are included in the scenarios used to delineate the WHPA-Q1 and Local Areas. This has been clarified in the text of Section 4.1.1.
CN	10	34	We infer from the text on Page 34 that the rationale for setting 1 m as the threshold for delineation of the WHPA-Q1 is that this value is approximately equal to the magnitude of the seasonal water level fluctuations (0.6 m to 2 m). It is important to note that when long-term records are available it is possible to distinguish between sub-metre changes in water levels and seasonal fluctuations. An example is shown below (there was a significant increase in pumping in the late 1990s). In our opinion, a more defensible rationale for the WHPA-Q1 threshold might be that, on average, it is unlikely that the calibrated groundwater model can achieve matches to water levels that are closer than the natural variations in the targets.	The text has been edited as suggested.

CN	11	46	One aspect of the analyses puzzles us. Referring to Page 46, for example, it is indicated that the drought scenarios simulated with both MIKE SHE and FEFLOW incorporated the full transient climate record (1950 to 2010). How is that possible, considering that pumping trends were evaluated only for the period of 2008-2012? What assumptions were made regarding the pumping between 1950 and 2008?	The 2010 mean monthly pumping rates were used in the MIKE SHE model to represent pumping during long term transient simulations 1960-2010. The 2010 pumping rates were used as a representation of current conditions. The drought scenarios are intended to act as a surrogate for the full variability of climate, but using only current pumping as per the technical rules.
CN	12		We are not convinced that the tolerance of the Simcoe Well Field is high. Four of the five wells are problematic, and might become more so if the withdrawals from the Cedar St. infiltration gallery cease.	Simcoe currently has the ability to meet existing peak demand with the existing wells and storage systems, and it has never experienced problems meeting peak demand. Under Technical Rule 107(2), it has a high tolerance as "at all times during that assessment, the system would have been capable of meeting the peak demands of users of the system."
CN	13		It is not immediately obvious how the results presented on Table 6.1 constitute local area water budgets. Since these results are so important, we recommend that the definition of a water budget be indicated explicitly and that the table be supplemented with a calculation of the water balance (accumulating the ΣIN and ΣOUT terms below). For Local Area 1: ΔS =963+(−4)+(930)+(−322)+(−117)−384−1065=1 mm/yr The magnitude of ΔS matches that reported on Table 6.1, but not the sign. S $\Delta S = \sum IN - \sum OUT$ $= (P + OB_{in} + SB_{in} + Q_{stream-1\,in} + Q_{stream-2\,in})$ $- (ET + OB_{out} + SB_{out} + Q_{stream-1\,out} + Q_{stream-2\,out} + Q_{pumping})$ Collecting terms: $\Delta S = P + (OB_{in} - OB_{out}) + (SB_{in} - SB_{out}) + (Q_{stream-1\,in} - Q_{stream-1\,out})$ $+ (Q_{stream-2\,in} - Q_{stream-2\,out}) - ET - Q_{pumping}$ Here: ΔS = storage change P = Precipitation ET = Evapotranspiration $Q_{pumping}$ = Pumping OB = Overland boundary flow SB = Subsurface boundary flow $Q_{stream\text{-}1}$ = Overland flow to streams $Q_{stream\text{-}2}$ = Baseflow to streams	The sign for Local Area A's water budget was incorrect and has been updated. An equation has been added to the text to clarify the summation of the water balance terms. This equation description is the same presented in the numerical modelling report.
CN	14		The delineation of the SGRAs is reasonable. As shown here in Figure 4 (in PDF), the SGRAs essentially coincide with coarse-textured glaciolacustrine deposits of the Haldimand Sand Plain.	Agreed. Comment added in the text
Specific Technical Comments/Questions				
CN	15	viii	The designation of "Unweathered Paleozoic Bedrock" cannot be interpreted literally everywhere, as in the Haldimand Clay Plain the Dundee and Onondaga Formations contain sufficient discontinuities to provide domestic water supply.	The word "Unweathered" was deleted to be consistent with the modelling and characterization reports
CN	16	ix	Do "Wentworth Till" and "Wentworth Drift" refer to the same unit? "Wentworth Drift" is used consistently on Table IV, but both "Till" and "Drift" are used in the text. Is the Wentworth unit referred to as an aquitard solely because "till" is frequently equated with "low hydraulic conductivity"? Our experience elsewhere in southern Ontario suggests that the Wentworth unit is in fact relatively permeable (it is described as stony, sandy silt till).	The reference to 'Wentworth Till' was erroneous and has been corrected to 'Wentworth Drift'. Erroneous instances of 'Port Stanley Till' have also been corrected to 'Port Stanley Drift'. The study team does agree that the Wentworth unit can be coarse grained and act as an intermediate aquifer/aquitard in other places in Ontario, but it is referred to an aquitard in this study (consistent with the Characterization and Modelling reports) due to the relatively fine-grained texture observed in this study in contrast to the sands and interstadial sediments. We have removed some references to it as an aquitard in the text where a simple designation as a "confining", "lower permeability", or "separating" unit suffices.
CN	17	x	What does "semi-confined" mean? Does it mean that the over/underlying materials are not completely impermeable?	"Semi-confined" was meant to convey that there are windows in the confining layer that are interpreted to cause hydraulic connection between the shallow and intermediate aquifers. This term has been removed to be consistent with descriptions of similar hydrostratigraphy in the report.
CN	18	xi	It is indicated that an integrated model was not used for the simulation of the Delhi wells because these wells "are interpreted to have minimal interaction with surface water features". Our understanding is that the integrated models serve more than this function (although the FEFLOW does simulate groundwater/surface water interaction, albeit with a simplified approach). The integrated models allocate precipitation, which FEFLOW cannot do. What was the basis for assigning recharge in the Delhi area?	The regional integrated model was used for groundwater recharge estimation in the Delhi model area. The minimal interaction with surface water features dictated that a detailed integrated model was not necessary for simulation of this well field. As such the well field was simulated using FEFLOW but recharge was taken from the regional MIKE SHE model. The text has been updated to clarify this.
CN	19	xi	It is indicated that the integrated models partitioned precipitation into evapotranspiration, groundwater recharge and streamflow. Should "streamflow" be replaced by runoff? Our understanding is that recharge is effectively the baseflow component of streamflow.	The text has been altered to remove the references to specific hydrologic components. The statement was intended to be a general comment on the model's overall calibration mentioning some of its key hydrologic components. It was not intended to be a exhaustive description of model hydrologic processes
CN	20	5	It is indicated that the models developed for the Tier Three assessment are "scaled appropriately". What does this mean?	The text has been updated with "scaled with enough refinement".
CN	21	12	In the last sentence, it is indicated that commercial development is anticipated to be minor with "a just a couple parcels" [sic]. How many is "just a couple"? Two, or more than two but fewer than several?	The text has been revised to indicate that commercial development anticipated is minor and "limited areas" within northern Delhi have been identified for development.

CN	22	15	It is indicated that to account for the proposed development shown in Figure 2.1, recharge in the FEFLOW model is reduced proportionally to the amount of impervious area, while in the MIKE SHE models the effects of land use change are represented by updating the vegetation and overland flow. Are these approaches equivalent? That is, are the recharge rates in the FEFLOW reduced by the percentages listed on Table 2.1, and in the MIKE SHE model the % imperviousness is specified according to the same values? Are we also correct in understanding that the values on Table 2.1 are interpreted as being the recharge reductions in the absence of any mitigation measures?	Groundwater recharge was reduced in FEFLOW by the impervious percentages listed in Table 2.1. Within MIKE SHE the developed areas were also prescribed an impervious fraction according to Table 2.1 which, for the most part, reduces the recharge in these areas by the corresponding percentage in the table. MIKE SHE also represents the proposed development through revised vegetation parameters (which will affect evapotranspiration), and revised overland flow characteristics (depression storage and surface roughness) that are appropriate for the new land use. In our experience, for this Tier 3 assessment, the impact of increased impervious fraction on recharge reductions in MIKE SHE is much greater than the loss of recharge due to changing vegetation or overland flow characteristics. As the FEFLOW approach does not account for changes in recharge due to changes in evapotranspiration or the overland flow characteristics of the developed areas, it is not equivalent to the MIKE SHE approach. In this Tier Three, FEFLOW is only used for the Risk Assessment of the Delhi system where the future land use changes are over 2 km from the municipal wells and are not predicted to have a measurable impact on the wells [see Table 4.5; column G(3)]. Values on Table 2.1 do not include any mitigation measures.
CN	23	23	Referring to Table 3.6, the elevation of the top of the pump is apparently not relevant in the analysis, as the safe minimum pumping level is specified as the elevation of the top of the well screen plus 1 m.	The elevation of the top of the pump is provided for information only.
CN	24	26	The formula used to calculate the nonlinear well loss coefficient, Equation (2) is derived from Equation (1); however, its use may lead to poor practice. If the values of *C* estimated with Equation (2) for different pairs of pumping rates and drawdowns are not the same, the only thing we know is that the assumption that the pumping well drawdowns follow Equation (1) is invalidated. A better approach is to plot all of the specific drawdowns, *sw/Q*, versus the pumping rates, *Q*, and decide first whether Equation (1) is appropriate in a general sense. If it is, the value of *C* can be estimated from the slope of the line of best fit.	Both approaches are outlined in the 2011 provincial Water Budget and Water Quantity Risk Assessment Guide. It is recognized that the graphical method may be a better approach depending on the data, but in this case the method used had little impact on the results. For this project, 13 Wells were analyzed and 8 used single-steps for the calculation - thus giving the same results using either calculation method. Two wells were estimated using Walton, 1962. One wells had the same result using both methods. The two remaining wells (Delhi) had very close results as shown in the table.

	Well Name	C - Using Equation 2	C - Using Graphical Analysis	Note
Waterford	Thompson Rd. Well 3	5.81E-08		single step
	Thompson Rd. Well 4	4.47E-08	4.47E-08	two steps
Simcoe	Northwest Well 1*	3.82E-07		Used Walton, 1962
	Northwest Well 2	1.20E-07		single step
	Northwest Well 3	6.59E-09		single step
	Cedar St. Well 1A	4.64E-08		single step
	Cedar St. Well 2A	4.26E-07		single step
	Cedar St. Well 3	2.09E-07		single step
	Cedar St. Well 4	2.79E-08		single step
	Cedar St. Well 5*	3.82E-07		Used Walton, 1962
	Chapel St. Well 3	6.44E-08		single step
Delhi	Well 1	1.59E-07	1.80E-07	two steps
	Well 2	5.07E-08	5.29E-08	two steps

CN	25	30	It is indicated that system function may be more dependent on a "unit rate of change in the water table elevation" than a "unit flow rate of water". What does these terms mean? Why should system function be dependent on the rate of change in water levels? Wouldn't it instead depend on the magnitude of the change in water levels?	The text has been modified to remove "unit" in describing the rate of change of both the flow and water table elevation. Wetland function is dependent on both the magnitude and rate of change of the water table position. Changes in the timing of annual water level declines and recoveries beneath wetlands will affect the function.
CN	26	63	In the caption of Table 4.6, we suggest that a Negative % Change be interpreted as "Reduced groundwater discharge" or "increased stream leakage to the groundwater system".	change made as per comment
CN	27	71	It is indicated that proximity to water bodies results in reliable water levels within the municipal production wells, and a high certainty that the wells will be able to produce the allocated quantity of water. In our opinion, this positive attributes of pumping close to a large pond should be balanced with the possibility that the subsurface materials between the ponds and the wells will not provide effective filtration.	As the Tier Three study only considers the sustainability of the water supply from a quantity perspective, quality concerns are not articulated in this report.
CN	28	82	It is indicated that the groundwater flow model was calibrated to a fine level of detail with close attention to both local and regional observed water levels. We suggest that the descriptor "regional" be defined as it used in the present context.	The text has been updated to clarify that the groundwater flow model was calibrated to a fine level of detail with close attention paid to observed water levels in both local (municipal well field extent) and regional (the regional groundwater model extent)
CN	50	70	Paragraph 3: "Based on these results, a Low Risk level was assigned to Local Area F (Figure 4.6)." Should this read Local Area **E**?	The text is correctly referring to Local Area F that is delineated as the IPZ-Q for the Lehman surface water intake.
HW	7	v	Is it possible to make a more definitive statement about the surface water infiltration during pumping for the Waterford wells - are they GUDI ??? (see p 16 !) what does modelling show ???? perhaps reference later sections that will clarify - see also p ix "window" interpretation how is this supported by evidence ?	The text has been modified to introduce the GUDI classification of these wells.
HW	8	ix	similar question on any evidence for windows in Simcoe northwest wellfield.	The text has been modified to add the borehole and GUDI classification of these wells as supporting evidence for windows.
HW	9	xi	and not returned to the same water source within 100 d . Explanation 100d is the length of a season and is also about the maximum time constant for recession for the slowest-responding groundwater system.	The definition of "consumptive use" is taken verbatim from the Provincial "Water Budget and Water Quantity Risk Assessment Guide" which recommends scale (temporal, spatial) among other considerations for a water taking to be considered consumptive. A specific time period has not been specified in the provincial guidance and as it is dependent on the characteristics of the area under consideration.

HW	10	xiii	I have raised a question about the defintions used for SGRA's that relate to this section	Provincial guidance indicates that when the Tier Three study only considers a portion of the previous study's domain, SGRA thresholds from the previous study and the updated groundwater recharge rates from the Tier Three study should be used to refine the SGRA mapping (AquaResource 2012). This text has been added to the report.
HW	14	22	Safe Additional Available drawdown definition - the drawdown in additional to what ???? drawdown measured under recent historic pumping conditions (average ? maximum observed ? lowest quartile observed drawdown data ? lowest persisting drawdown ?)	The components used to determine the safe additional available drawdown as per this introductory definition are expanded in the following sections. The drawdown is in addition to the average pumped water level during 2008 to 2012. This is explained in detail in Section 3.3.2 and are indicated on the hydrographs in Appendix C
HW	16	26	what use, if any, is made of the stated increase of **B** with time? does this inctrs with time apply to aquifers under examination ????	The statement that the aquifer loss coefficient, B "which increases with time" has been removed as it is not relevant as B is not used in this study. This statement was taken from an explanation of the theory behind Equation 1.
HW	18	32	There is a question whether outflow from WWTP provide baseflow to a stream. From a flowrate definition they do provide baseflow (Time constant for recession periods very lrge !!!) However it is the expectation in Southern Ontrio that baseflow comes from groundwater and has the properties of low concentrations of some contaminants (especially BOD) and has near constant temperature. The text should refer to baseflow from groundwater as what may be reduced.	The text has been revised to clarify that the municipal intakes have the potential to reduce 'baseflow from groundwater'.
HW	19	62	Similarly, in 4.5.4 it would be good to refer to (3rd last line) ***any reduction in baseflow from groundwter*** to cold water streams	The text has been revised to read '…any reduction in baseflow from groundwater…'
HW	20	63	In the footnote to Table 4.6 I can't see how an increase in groundwater recharge is a negative change in the same way a reduction in groundwater discharge is a negative change.	Foot notes have been revised to fix this error. Please see CN comment # 26.
HW	22	76	You could consider substituting for the last two sentences of the first paragraph, a brief paragraph, basedon the last two sentences and emphasizing that the large amounts of groundwater inflow in some of the Local Areas is a distinctive feature of this geological setting and results from the Local Area being a relatively small part of a much larger flow system in which transverse flow of groundwater is occurring.	The text has been revised to add a paragraph to address the local area where water budget components exceed precipitation. The text has been revised to emphasize that these local areas are part of much larger flow systems and that the water budget characteristics are a result of the distinctive topographic and geologic settings of the local area.
HW	23	79	The logic of using the Tier 2 values for SGRA (Table 6.2) in Tier 3 with an average recharge rate for the Focus area of 310 mm/y is not clear.	Provincial guidance indicates that when the Tier Three study only considers a portion of the previous study's domain, SGRA thresholds from the previous study and the updated groundwater recharge rates from the Tier Three study should be used to refine the SGRA mapping (AquaResource 2012). This text has been added to the report.
RS	2	xii	(5th para.) Suggest you add (Cedar St.) here as the Executive Summary should stand alone and local areas are associated with the wells only in the main report.	The text has been revised and reference to Local Area A has been removed and now refers to the Cedar St. Well field instead.
RS	4	34	(4.1.1) This is not what is plotted on Figures 4.1, 4.2, 4.3. (i.e. the difference was calculated but only the 1 m contour was plotted). The logic here is not very clear. The way it reads now it appears the Seasonal water level change determines the contour interval that defines WHPA-Q1. It is also not clear how you decide on 1 m from the 0.6 to 2 m seasonal fluctuation. NOTE - I have commented previously on how 'unclear' it is as to why the 1 m contour interval is used. Sam's response on this was clear and straightforward. However, the report still make it confusing.	The drawdown contours have been added to the figures. The text has also been expanded to give more reasoning behind selecting a 1 m drawdown to delineate the WHPA-Q1 areas.
RS	5	39	(4.1.2) For consistency you should explain how WHPA-Q1's are defined in the Technical Rules & Reference Guide in previous section ... currently you just describe HOW you delineated them.	The text has been updated as suggested
RS	6	40	(4.1.3) Not clear how you make this conclusion based on the analysis that the Lehman Reservoir itself has a net loss to groundwater.	We have changed the text that is used to support the delineation of the IPZ-Q. Rather than using a water budget approach, particle tracking has now been performed: "Reverse particle tracking in the groundwater model was used to determine if there is an additional area that provides recharge to the aquifer that contributes groundwater discharge to the drainage area. A limited volume of groundwater discharging in the streams is predicted to come from outside the catchment area. Subsurface travel times from the border of the catchment to the stream are in excess of 60 years."
RS	7	59	(4.5.3.3) Do you not mean "all municipal wells" (i.e. except the Cedar St. Wells)? Saying "most" implies that some wells other than the Cedar wells will not be able to pump sustainably.	The text has been revised to read "…all municipal wells…" as suggested.
RS	8	74	(5.2) Actually you present all recharge reduction activities not only those in Local Area A as your wording suggests. Figure 5.1 is fine just reword your sentence.	The text has been revised to read "…to reduce groundwater recharge occurring in and around Local Area A…" so that the text is consistent with the figure.
RS	9	74	(5.3) How does this information help us relate to anything important? The Town may have some relevance as it is within the model domain ... the LP Region is not at all relevant and could imply that waters throughout the LP Region affect this particular local A which is not correct.	The enumeration and categorization of the significant water quantity threats has been done according to the requirements of the MOEE and MNR. Table 5.1 is formatted as per provincial instruction. This is to provide the source protection committee with a summary of the number of threats relevant to various policy-making and implementing agencies.
RS	10	75	(Table 5.1) Again confusing to put the LPSP area in here. It actually looks like there are only 7 municipal wells in the LPSP area from this table.	The enumeration and categorization of the significant water quantity threats has been done according to the requirements of the MOEE and MNR. Table 5.1 is formatted as per provincial instruction. This is to provide the source protection committee with a summary of the number of threats relevant to various policy-making and implementing groups.

DR	1	10	What is the evidence for the window(s) at the Waterford ponds and Simcoe? The concept of windows is brought forward in several locations throughout the text and I recall that this was discussed in detail in the Tier 2 report. A brief explanation of the support for these windows and what they really mean for the conclusions or analysis presented would be valuable.	The text has been modified to add the borehole and GUDI classification of these wells as supporting evidence for windows.
DR	2	31	Figure 3.1 is difficult to read and follow based on the legend and the size of the font in the image. Can this illustration be made a bit clearer? There are several references to it in the text under Other Water Uses section and it is a critical diagram.	The diagram has been edited to improve legibility and to highlight the key information on other water uses
DR	3	32	Section 3.5.1. How sensitive is the model to being able to predict the impact on such small surface water features (cold water streams and PSWs) within such a large computational domain? Very slight changes in hydraulic head may significantly influence flow rate in the streams and wetland function. This is not the case for the water wells that are less sensitive from a risk assessment point of view. If a short note on this sensitivity could be included it might help the SWPC to understand the results better.	Text has been added to the report that highlights which model was used for each of the assessments. The local-scale models were refined from the regional-scale MIKE SHE model and verified with local data. Thus are better able to represent the impacts to hydraulic heads and groundwater discharge for those systems. The assessment method is based on differences between baseline and future scenarios expressed as drawdown or changes in baseflow and not absolute values.
DR	4	34	How was the 1m drawdown threshold selected, is it appropriate for each of the WHPS Q1 areas? Annual water table fluctuations likely vary throughout the study domain and could be evaluated based on the local PGMWells. It would be valuable for the reader to be reminded of where this came from and how it was justified as it is a potentially critical parameter. It might be valuable to demonstrate (or explain in words referring to a figure) how significant would it be if the value was 0.5 m instead of 1m, for instance?	The drawdown contours have been added to the figures to demonstrate the sensitivity of the. The text has also been expanded to give more reasoning behind selecting a 1 m drawdown to delineate the WHPA-Q1 areas.
DR	5	46	In table 4.1, the Feflow simulations are listed as using average annual recharge and bi-monthly recharge. How was this averaging carried out using the MIKE-SHE model results?	Average annual recharge was calculated by averaging the groundwater recharge estimated by MIKE SHE over the simulation period. This estimate of groundwater recharge was used in the FEFLOW steady-state analysis. The transient recharge provided to FEFLOW was represented by scaling the average annual recharge with bi-monthly recharge scaling factors calculated for each of the surficial geology types. For each surficial geology type the time series of groundwater recharge on that soil type was extracted at a 15-day temporal resolution. The groundwater recharge values were converted to scaling functions by dividing the 15-day groundwater recharge volume by the average annual recharge volume for a particular soil type. The generation of transient recharge data for use in the transient FEFLOW simulations is described in detail in section 2.6.3.2 of the numerical modelling report.
DR	6	46	We refer to the MIKE-SHE model as integrated, how detailed is the groundwater system within the MIKE-SHE simulations and how do the results from the MIKE-SHE groundwater model compare with the FeFlow results? The models were run separately for calibration purposes to reduce the computational effort but MIKE-SHE still has the same hydrogeologic domain as Feflow and it is not completely clear why the final simulations were not carried out with the fully integrated code as the groundwater results should be essentially the same from both models. I know this was discussed in some detail but it might be valuable to provide a justification paragraph in the text as the final end users of this report are not as interested in computational efficiency as they are in the confidence level of the results.	The saturated zone structure, properties and boundary conditions within the MIKE SHE model are consistent with those used in the FEFLOW groundwater model. The primary difference between the two models is the resolution of the models. MIKE SHE features a fixed grid resolution FEFLOW features variable computational mesh which is refined around features of interest. The MIKE SHE groundwater calibration was evaluated against static water levels observed at high quality monitoring wells in the MIKE SHE model area. The groundwater calibration statistics for the MIKE SHE model are similar to those of the FEFLOW model for the same data set. These calibration statistics demonstrates consistency between the two models and a reasonable representation of the conceptual groundwater system in both models. This is described in more detail in section 3.9.5.1 of the numerical modelling report To clarify- the fully integrated code was used for all risk assessment work on all of the well fields except Delhi. The Delhi well field is interpreted to have minimal interaction with surface water features and as such the application of the integrated model to the assessment of this well field was not necessary. Locally refined MIKE SHE models were constructed, based on the regional MIKE SHE model, to evaluate the Waterford municipal wells, Simcoe North Municipal Wells, Simcoe South Municipal Wells and the Lehman Reservoir. Text has been added to the Water Budget Tools section of the report to clarify which models were used to assess the well fields.
DR	7	49	In considering scenarios B and E, it seems as though the same climatic data are used in both scenarios. What is the difference in the drought case? How are the average climatic conditions determined? Are they based on an average of all the weather data over the full record?	The same climate data is used in both the drought and "average climate" scenarios. The average water level for the full simulation period was reported for the "average climate" scenario. To determine the water level for the drought scenario, the lowest water level was reported.
DR	8	62	MIKE-SHE also calculates groundwater flux to the surface water features. How do the values from FeFlow and MIKE-SHE compare and it would seem that the MIKE-SHE model would be more accurate in this type of flux estimation as it handles the shallow system in more detail. I may be missing something here and this comes back to point 6 above.	The FEFLOW and MIKE SHE models were not used to assess the change in groundwater flux to surface water features in the same regions for the risk assessment. The response provided to your comment number 6 indicates which models were used for which areas.
DR	9	65	It would be valuable to remind the reader what models were used to evaluate the water table conditions beneath the wetland areas.	The text has been updated to identify that the local scale MIKE SHE models constructed for Waterford and Simcoe were used for PSWs in those model domains and the FEFLOW model was used for PSWs in that region.

DR	10	70	In the moderate category, what is implied by measureable and potentially unacceptable impacts from water extraction? How does this relate to the specific impacts on base flow and wetland areas? This reminder to the reader would help so that one does not have to look back to previous reports or other sections in this report. It has always seemed a bit vague and we just have to let the reader know how this was interpreted for this application.	This is a direct quote from provincial guidance that introduced professional judgement into the consideration of impacts to other water uses. Text has been added: "based on professional judgement and the context of the specific use. (i.e., in this study the maintenance of downstream flow from the Lehman Reservoir).
DR	11	79	It appears that the final conclusions from the Tier 3 SGRA analysis are missing from the report. In Figure 7.1 this appears to be a very large area. How does it compare to the Tier 2 estimates?	Text has been added to the report that compares the results and offers some explanation for the differences.
Editorial Comments				
HW	4	ii	Big Creek, Nanticoke Creek.	change made as per comment
HW	5	ii	remove the phrase "Despite this indication of potential stress" It is not scientifically based and is not needed - all that should be stated is the factual statement "To date the towns of	change made as per comment
HW	6	iv	better to say "tributaries to three creeks are small with the exception of Little Otter Creek which flows south of ……….	change made as per comment
HW	11	8	the verb comprises means " is made up of" or "has as its constituent parts" so it is better grammar to say The Waterford system comprises two overburden......	change made as per comment
HW	12	8	Water from the ***Lehman*** reservoir.....	change made as per comment
HW	13	21	last para second line an extra "the"	change made as per comment
HW	15	22	(i.e. ***near or*** into the well screen,,,,	change made as per comment
HW	17	27	wells ***lose*** efficiency	change made as per comment
HW	21	74	don't use the shorthand "permitted threats" but instead refer to threats from permitted (and non permitted0 uses throughout.	change made as per comment
HW	24	83	Separate the first eight lines as a paragraph. Then add a new paragraph stating that estimates of drawdown in all scenarios was based on wells being maintained to ensure constant well performance with no deterioration over time. The results from the risk assessment scanarios are only valid if this level of maintenance is continued. Then continue with the next paragraph "The Risk Assessment scenarios....."	change made as per comment
HW	25	84	given the addition to the conclusions on p 83 the first bullet point under 3 should read "As noted in Section 8.2 the Risk Assessment Scenarios........	change made as per comment
RS	1	iv	(2nd para.) Typo, "Three's" not "Threes".	change made as per comment
RS	3	16	(3.1.1) 3 characters in grey font.	change made as per comment
CN	29	iii	Point #4: "(i.e., Lehman Reservoir, and wells in Waterford and two areas of Simcoe)"	change made as per comment
CN	30	iv	Paragraph 3: "The Tier Threes Focus Area …'	change made as per comment
CN	31	v	Paragraph 5: "PSWs located nearest to **the** Delhi groundwater wells …"	change made as per comment
CN	32	v	Paragraph 5: "… the Cedar St. Well Field and infiltration galley; and **the** LR16 Complex, …"	change made as per comment
CN	33	vii	Paragraph 2: "(e.g., clay or fine-grained tills)	change made as per comment
CN	34	x	Paragraph 5: Delete the comma after "… a numerical model of groundwater flow"	change made as per comment
CN	35	xii	Paragraph 5: SAAD should be defined the first time it is used.	change made as per comment
CN	36	6	It is indicated that "These conceptual models form the basis for the development of numerical models that *should be* calibrated to represent typical operating conditions under average and variable climate conditions." [Italics added] Should that read "are" rather than "should be"? This comment also applies to the bullets under Items #4, #7 and #10.	change made as per comment
CN	37	10	To be consistent, the start of Item #5 under Section 1.4 should be "applying".	change made as per comment
CN	38	11	Paragraph 7: "Municipal Wells and Intake – Summary Hydrographs – summarize**s** the important well …"	change made as per comment
CN	39	12	Paragraph 5: "Commercial development is anticipated to be minor with just a couple **of** parcels of land …"	change made as per comment
CN	40	16	Paragraph 1: "…were considered consumptive in this study because water is pumped from either the Lehman Reservoir or ~~groundwater~~ aquifers and ~~are~~ **is** discharged to surface watercourses…"	change made as per comment
CN	41	16	Paragraph 5: The "It" at the beginning of the second paragraph is faint.	change made as per comment
CN	42	18	Paragraph 1: "…and a summary of well construction details ~~are~~ **is** provided in Appendix A.	change made as per comment
CN	43	21	Paragraph 5: "…completed an Environmental Assessment, ~~the~~ **there** is no Planned Demand for each system."	change made as per comment

CN	44	24	Paragraph 2: "Where available water level data ~~does~~ **do** not distinguish between pumping and non-pumping conditions,…"	change made as per comment
CN	45	24	Paragraph 2: "Existing average pumped water level elevations are presented in Table 3.6, and ~~this~~ **these** data, …"	change made as per comment
CN	46	24	Paragraph 2: "Where available water level data ~~does~~ **do** not distinguish between pumping and non-pumping conditions,…"	change made as per comment
CN	47	27	Paragraph 1: "Over time, however, wells ~~loose~~ **lose** efficiency …"	change made as per comment
CN	48	51	Paragraph 5: "The minimum water level at the intake ~~is~~ **was** calculated from the simulated results …"	change made as per comment
CN	49	62	Paragraph 2: There is a period missing at the end of the paragraph.	change made as per comment
CN	51	71	Paragraph 2: "1. High capacity – While demands are expected **to** increase by 38% in Waterford …"	change made as per comment
CN	52	79	Paragraph 2: "Areas ~~with~~ within each conservation authority …"	change made as per comment
CN	53	79	Paragraph 3: "Due to the Focus Area ~~being comprised~~ **comprising** mostly of the sand plain, …"	change made as per comment
CN	54	81	Paragraph 4: "This identification of stress potential ~~lead~~ **led** to the requirement of …"	change made as per comment

S. S. PAPADOPULOS & ASSOCIATES, INC.
ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

July 23, 2013

Mr. James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road
Cambridge, Ontario
N1R 5W6

Subject: **Long Point Region Tier Three Water Budget & Local Area Risk Assessment: Physical Characterization Report** (revised, Matrix Solutions Inc., July 2013)

Dear Mr. Etienne:

We have reviewed the revised version of the **Physical Characterization Report** for the Long Point Region (Matrix Solutions, July 2013). In our opinion, the interpretations of conditions in the study area and the reporting provide an appropriate basis for proceeding with the Tier Three study. We recommend that the report be accepted as final.

If you have any questions regarding our comments, please contact Christopher Neville by E-mail at *cneville@sspa.com*, or by phone at (519) 579-2100.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

LICENSED PROFESSIONAL ENGINEER
C. J. NEVILLE
PROVINCE OF ONTARIO

Christopher J. Neville, M.Sc., P.Eng.
Associate

- Christopher J. Neville: PEO #100013705
  (valid through December 31, 2013)
- S.S. Papadopulos & Associates, Inc.: PEO Certificate of Authorization #100077381
  (valid through June 30, 2014)

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WWW.SSPA.COM

Memorandum

August 21, 2013

To: James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6

From: David L. Rudolph
Hydrogeologist
Peer Review Committee

Re: Acceptance of the Draft Report Long Point Tier 3 Characterization Report

With this memorandum I would like to convey that I accept the edits that have been done by the authors at Matrix Solutions Inc. on the above mentioned Draft report and accept it now as a final version.

I appreciate the opportunity to remain involved in this challenging yet extremely valuable work.

Sincerely,

David L. Rudolph

Hydrogeologist

July 23, 2013

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6

Re: Acceptance of Tier 3 Characterization Report

Dear James,

I have reviewed the "Revised Tier Three Water Budget and Local Area Risk Assessment – Long Point Region – Physical Characterization Report – July 2013" and the associated peer review matrix.

I conclude that the work is scientifically defensible, that the deliverables are consistent with the expectations of the province's source water protection framework, and that the peer review record adequately summarizes the comments of the peer reviewers and how these comments were addressed. I have no outstanding concerns with the work done or the report.

Sincerely,

Rob Schincariol, Ph.D., P.Geo.
Associate Professor, Hydrogeology and Watershed Hydrology
Department of Earth Sciences
University of Western Ontario
London, ON, N6A 5B7

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6
August 21 2013

RE: REVISED LONG POINT TIER 3 CHARACTERIZATION REPORT

James:

I have now reviewed the responses to peer review comments on the Long Point Tier 3 Characterization Report. I am satisfied that the changes made to the report have incorporated all of the comments that required revisions.

I recommend that the report be approved as revised.

Yours truly

H.R. Whiteley P.Eng.

S. S. PAPADOPULOS & ASSOCIATES, INC.
ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

May 27, 2014

Mr. James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road
Cambridge, Ontario
N1R 5W6

Subject: Long Point Region
Tier Three Water Budget and Local Area Risk Assessment:
Model Development and Calibration Report (revised December 2013)

Dear Mr. Etienne:

We have reviewed the revised version of the **Model Development and Calibration Report** for the Long Point Region (Matrix Solutions Inc., December 2013). The revised report was transmitted to the peer review team on May 21, 2014, along with the peer review comment/response matrix. We recognize that a significant effort has been devoted to addressing our comments and revising the report. The responses to our peer review comments are clear and complete. We particularly appreciate that it has been straightforward to confirm that the text of the report has been revised appropriately in response to our comments. We have also appreciated the quick response to the follow-up comments that we transmitted on May 27, 2014.

We recommend that the **Model Development and Calibration Report** be accepted as final.

In our opinion, the models that have been developed are appropriate for the next phase of the Tier Three study, analyses to support the water quantity risk assessment.

If you have any questions regarding our comments, please contact Christopher Neville by E-mail at *cneville@sspa.com*, or by phone at (519) 579-2100. We thank you for the opportunity to participate in this interesting and important project.

To: Mr. James B. Etienne, P.Eng.
Page: 2

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

LICENSED PROFESSIONAL ENGINEER
C. J. NEVILLE
PROVINCE OF ONTARIO

Christopher J. Neville, M.Sc., P.Eng.
Senior Hydrogeologist, Associate

- Christopher J. Neville: PEO #100013705
(valid through December 31, 2014)
- S.S. Papadopulos & Associates, Inc.: PEO Certificate of Authorization #100077381
(valid through June 30, 2014)

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Jeffrey Melchin

From: David Rudolph <drudolph@uwaterloo.ca>
Sent: Wednesday, June 18, 2014 11:18 AM
To: Paul Chin; James Etienne
Subject: RE: Long Point Tier Three Revised Modelling Report

Hi Paul,
Thanks for the note. All of my questions and points on the Long Point Tier 3 modelling report have been addressed and I have no further comments.

Best regards,
Dave

From: Paul Chin [mailto:pchin@matrix-solutions.com]
Sent: Tuesday, June 10, 2014 1:54 PM
To: David Rudolph
Subject: Long Point Tier Three Revised Modelling Report

Hi Dave,
Hope your travels are going well. Can you please provide an email reply indicating that you are satisfied with the revised Long Point modelling report.

Thanks,
Paul

Paul Y.S. Chin, M.Sc., P.Eng.
Hydrogeological Engineer

Matrix Solutions Inc.
Direct: 519-772-3777 x119
Mobile: 519-897-2490

April 21, 2015

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6

Re: Acceptance of Long Point T3 Model Development and Calibration Report.

Dear James,

I have reviewed the 'Tier Three Water Budget and Local Area Risk Assessment – Long Point Region – Model Development and Calibration Report' report (*referred to as 'Version 3' and to be issued as the Final version; as modified April 17, 2015)*, and the associated peer review matrix (*Final version; modified April 17, 2015)*. I conclude that the work is scientifically defensible, that the deliverables are consistent with the expectations of the province's source water protection framework, and that the peer review record adequately summarizes the comments of the peer reviewers and how these comments were addressed. I have no outstanding concerns with the work done or the report.

Sincerely,

Dr. Rob Schincariol, P.Geo.
Associate Professor, Hydrogeology and Watershed Hydrology
Department of Earth Sciences
University of Western Ontario
London, ON, N6A 5B7

Jeffrey Melchin

From: Hugh R Whiteley [mailto:hwhitele@uoguelph.ca]
Sent: May-30-14 2:18 PM
To: James Etienne
Cc: Paul Chin; Sam Bellamy; schincar@uwo.ca; Dave Rudolph; Christopher Neville
Subject: Re: Long Point Tier Three Revised Modelling Report

James:

All of my concerns have been addressed very satisfactorily in the revised modelling report.

I am very impressed by the thoroughness of the review and by the in-depth response to the reviewers' comments. The revised modelling report sets and meets a very high standard for comprehensiveness and accuracy.

Hugh Whiteley P.Eng.

S. S. PAPADOPULOS & ASSOCIATES, INC.
ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

March 3, 2015

Mr. James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road
Cambridge, Ontario
N1R 5W6

Subject: Long Point Region
Tier Three Water Budget and Local Area Risk Assessment
Draft **Final Report** (revised February 20, 2015)

Dear Mr. Etienne:

We have reviewed the revised draft version of the **Long Point Region Tier Three Water Budget and Local Area Risk Assessment Final Report** (Matrix Solutions Inc., February 20, 2015). The revised report was transmitted to the peer review team on February 20, 2015, along with the peer review comment/response matrix. We recognize that a significant effort has been devoted to addressing our comments and revising the report. We particularly appreciate that it has been straightforward to confirm that the text of the report has been revised appropriately in response to our comments.

This letter constitutes our sign-off on the **Final Report**. Our peer review comments have been addressed clearly and completely. We had some minor outstanding concerns for some of the responses to peer review comments, and Matrix Solutions has resolved all of them. For completeness, we have included the offline exchange we have had with Matrix Solutions. We recommend that a "clean" version of the **Long Point Region Tier Three Water Budget and Local Area Risk Assessment Final Report** be accepted as final. The only editorial correction we have on the final draft is the spelling of "Threee" on the front cover.

Resolution of outstanding issues on C.J. Neville's peer review comments

1. In the reply to CN reviewer comment #22, it is indicated that the FEFLOW approach does not account for changes in recharge due to evapotranspiration changes or overland flow characteristics of the developed areas. Does this mean that the way development is handled in the FEFLOW analyses is not equivalent to how it is handled in the MIKE SHE analyses after all?

   Response

   Although the same impervious % values from Table 2.1 are applied according to land use in both FEFLOW and MIKE SHE to account for proposed developments, MIKE SHE has additional parameters that are adjusted to simulate the way development affects recharge and thus the approaches are different. Recharge is a specified model input in FEFLOW and thus is adjusted a priori by scaling pre-development recharge with the % impervious. MIKE SHE calculates recharge explicitly and it will be affected by changes to ET and overland flow due to land use changes. In our experience, for this assessment, the impact of increased impervious fraction on recharge reductions in MIKE SHE is much greater than the loss of recharge due to changing vegetation or overland flow characteristics.

   Matrix Solutions has indicated to us that the peer review record will be updated with the following response.

   "Groundwater recharge was reduced in FEFLOW by the impervious percentages listed in Table 2.1. Within MIKE SHE the developed areas were also prescribed an impervious fraction according to Table 2.1 which, for the most part, reduces the recharge in these areas by the corresponding percentage in the table. MIKE SHE also represents the proposed development through revised vegetation parameters (which will affect evapotranspiration), and revised overland flow characteristics (depression storage and surface roughness) that are appropriate for the new land use. In our experience, for this Tier 3 assessment, the impact of increased impervious fraction on recharge reductions in MIKE SHE is much greater than the loss of recharge due to changing vegetation or overland flow characteristics. As the FEFLOW approach does not account for changes in recharge due to changes in evapotranspiration or the overland flow characteristics of the developed areas, it is not equivalent to the MIKE SHE approach. In this Tier Three, FEFLOW is only used for the Risk Assessment of the Delhi system where the future land use changes are over 2 km from the municipal wells and are not predicted to have a measurable impact on the wells [see Table 4.5; column G(3)]. Values on Table 2.1 do not include any mitigation measures."

Matrix Solutions has indicated that the final report will be updated, with the last paragraph in Section 2.3 replaced with the following.

"The % impervious values listed in Table 2.1 were applied in the FEFLOW model to assess the Delhi system by multiplying the areal recharge distribution determined during numerical model calibration (described in Appendix B) with the % impervious values from Table 2.1 in areas with future land use changes. The remaining municipal systems were assessed using MIKE SHE models where the % impervious values were applied as the directly connected impervious fraction (an overland flow characteristic) of the area of land use change."

2. The last question in CN reviewer comment #22 was not addressed: Are we correct in understanding that the values on Table 2.1 are interpreted as being the recharge reductions in the absence of any mitigation measures? We think that the answer is "Yes.", but it should be spelled out, particularly as mitigation measures will probably become if not mandatory, then at least general practice.

   Response

   Yes, values on Table 2.1 do not include any mitigation measures. The above comment now includes this statement.

3. It is not obvious how the revised version of Figure 3.1 (2015/Feb/11) differed from the previous version (2014/Sept/17).

   Response

   The line colours and fonts were updated to improve legibility as requested in Comment DR #2.

4. It is not obvious how the revised version of Figure 4.2 (2015/Feb/20) differed from the previous version (2014/Sept/15).

   Response

   References to "surface water contributing area" were deleted on Figures 4.1 and 4.2, and in the text describing them. The report now only references the 100 m buffer around the surface water features adjacent to the Simcoe NW and Waterford wells. This was feedback from the peer review meeting.

5. Referring to the revised version of Figure 4.3 (2015/Feb/11), there are lots of wells marked "PTTW - Excluding Tier Three Municipal Supply". Why are drawdown cones shown for only four pumping centers? Could it be that the drawdown cones are delineated for all currently pumping wells (municipal wells and otherwise), but the rates are so low for most wells that no drawdown cones are evident?

   Response

   Yes, the majority of the permitted takings shown on the figure have consumptive rates of less than 70 m^3/d and thus do not show drawdown greater than 0.5 m (the smallest contour line).

6. It was not obvious how the revised version of Figure 4.6 (2015/Feb/11) differed from the previous version (2014/Sept/22).

   Response

   The delineation of the Local Area was slightly modified as it was discovered that the drawdown from an older model version was used in the GIS analysis. The correct drawdown is shown on the revised Figure 4.3, and the revised 2m contour was transferred to this Figure 4.6 as the Local Area.

7. The revised version of Figure 7.1 seems odd. In the previous version of the figure (2014/Sept/30), the whole SGRA area was tan colored, and designated as "Tier 3 SGRA". Now it seems that a portion of the previously tan area has now been colored green and it is only this area that is designated as "Tier 3 SGRA". Is the explanation of the color change included in the revised text of the report?

   Response

   This figure tries to make obvious which SGRAs are within the Study Area of the Tier 3 study and thus were updated from the Tier 2 SGRA delineation. In this study, recharge was not updated outside of the Tier 3 study area (the Focus Area) and thus the SGRAs remain the same as the Tier 2 results outside the Focus Area. This is articulated on page 79 of the [revised] text.

Closing

If you have any questions regarding our comments, please contact Christopher Neville by E-mail at *cneville@sspa.com*, or by phone at (519) 579-2100. We have appreciated the opportunity to participate in this interesting and important project.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

LICENSED PROFESSIONAL ENGINEER
C. J. NEVILLE
PROVINCE OF ONTARIO

Christopher J. Neville, M.Sc., P.Eng.
Senior Hydrogeologist, Associate

- Christopher J. Neville: PEO #100013705
  (valid through December 31, 2015)
- S.S. Papadopulos & Associates, Inc.: PEO Certificate of Authorization #100077381
  (valid through June 30, 2015)

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Jeffrey Melchin

From: David Rudolph <drudolph@uwaterloo.ca>
Sent: Saturday, March 28, 2015 10:00 AM
To: James Etienne
Subject: peer review

Dear Mr. Etienne,

I was able to complete my final review of the draft final report on *"Long Point Region Tier Three Water Budget and Local Area Risk Assessment"* that has been prepared as part of the Source Water Protection program on behalf of GRCA.
I am comfortable with all of the edits that have been completed on the latest version of the text and recommend that it be accepted as the final version. With this email I would like to "sign off" on the report and project.

Please contact me at your convenience if there is any more detail required.

Best regards,
Dave Rudolph

March 7, 2015

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6

Re: Acceptance of ‘Long Point Region Tier Three Water Budget Local Area Risk Assessment’ report.

Dear James,

I have reviewed the ‘Long Point Region Tier Three Water Budget Local Area Risk Assessment’ report (*February 20, 2015 revision*), and the associated peer review matrix. I conclude that the work is scientifically defensible, that the deliverables are consistent with the expectations of the province’s source water protection framework, and that the peer review record adequately summarizes the comments of the peer reviewers and how these comments were addressed. I have no outstanding concerns with the work done or the report.

Sincerely,

Dr. Rob Schincariol, P.Geo.
Associate Professor, Hydrogeology and Watershed Hydrology
Department of Earth Sciences
University of Western Ontario
London, ON, N6A 5B7

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6
March 19, 2015

Re: LONG POINT REGION TIER THREE WATER BUDGET AND LOCAL AREA RISK ASSESSMENT

James:

I have now reviewed the above-noted report as amended and the tabulation of peer-review comments and responses and am fully satisfied by the adjustments made to the report and its attached figures in response to the comments.

The Long Point Region Tier Three Water Budget and Local Area Risk Assessment report is now, in my opinion, complete and fully satisfactory and that the report should be accepted for transmission to the appropriate authorities for approval.

This favourable assessment understates my admiration for the technical skills of the study team which were exercised in the preparation of the reports. The report achieves a very high standard of overall excellence, with the modelling aspects particularly outstanding.

I also wish to acknowledge the skills and diligence of the other peer reviewers who worked in reviewing these documents. The breadth of understanding, and attention to detail shown contributed a great deal to the level of excellence that has been achieved.

Yours truly

H R Whiteley

H.R. Whiteley P.Eng.