# Quinte
# Source Protection Region

# TIER 2 WATER BUDGET

# PEER REVIEW RECORD

# (Mar, 2009 – April, 2010)

**April, 2010**

To fulfill requirements of the Provincial Source Water Protection program Quinte Conservation has completed Tier 2 water budgets for the Tweed & Ameliasburgh subwatersheds within it's Source Protection Region. The Tweed subwatershed contains wells providing supply to the Village of Madoc and the Ameliasburgh subwatershed is an intake on Roblin Lake providing water supply to the residents in the Hamlet of Ameliasburgh. As part of this process the scientific work, results, and reports are presented to a peer review team for review and comment.

The peer review team is shared between the Cataraqui Source Protection (SP) Area and the Mississippi-Rideau and Quinte Source Protection Regions. The four member core peer review team was chosen by staff from the three SP Region's based on the person's expertise and local knowledge. The members of the review team are listed below in Table 1 including two members which were added near the end of the process. Please note that these two members were added to address the absence of a peer review member for review of the Cataraqui Regions water budget work.

In addition, to the core team, the peer review meetings were attended by representatives from the Ministry of Natural Resources, Conservation Ontario, and neighbouring Source Protection Regions including the Trent Conservation Coalition Source Protection Region.

**Table 1: Members of the Peer Review Team**

| Name | Expertise | Affiliation |
|---|---|---|
| Dr. W.E. Watt | Hydrology | Professor Emeritus, Queen's University |
| Bill Hogg | Climate | Retired from Environment Canada |
| Dr. Michel Robin | Hydrogeology, Academic | Professor, University of Ottawa |
| Darin Burr | Hydrogeology, Consultant | Dillon Consulting |
| Rob Muir * | Hydrology | Dillon Consulting |
| Igor Iskra * | Hydrology | Dillon Consulting |

* Additional Peer Review Team members added for the final review of surface water hydrology reports.

Two peer review meetings were held between March 2009 and December 2009 for which information on Quinte's Tier 2 water budget activities were presented. At some of the meetings presentations were also provided by other members of the group. The agenda and minutes from these meetings are provided in Appendix A with a brief summary given below in Table 2.

**Table 2: Schedule of Peer Review Meetings**

| Meeting | Date | Time | Purpose of Meeting | Status |
|---|---|---|---|---|
| Meeting #13 | Mar 12, 2009 | 10am-3pm | Quinte Tier 2 – Work Plan | Complete |
| Meeting #14 | Dec 15, 2009 | 10am-3pm | Quinte Tier 2 Presentation of Draft Reports (Ameliasburgh & Madoc). | Complete |
| All the peer review meetings were held Cataraqui Region Conservation Authority office in Kingston. | | | | |

**Madoc Report (Tweed Subwatershed)**

Three draft versions of the water budget report were prepared and dated Dec 2, 2009, January 29, 2010, and March, 2010 respectively. The first draft was distributed to the peer review team for the Dec 15, 2009 meeting. From this meeting and input from the MNR it was found that additional work was required. A digital draft copy of the report dated January 29, 2010 was prepared and re-circulated via email for comments. Based on comments received a final draft report dated March, 2010 was prepared and submitted to the MNR for approval. Based on comments received a final draft report was prepared.

Peer reviewers were asked to provide written comments on the reports. Verbal comments were also recorded during meetings. Comments were provided by either inserting them directly into the Word document, by emailing them to the peer review leader, or verbally during discussions over the telephone and at peer review meetings. Comments are generally summarised on the enclosed table provided in Appendix B including the response of Quinte Conservation.

**Ameliasburgh Report**

Three drafts of the Tier 2 water budget for Ameliasburgh were prepared and reviewed by the peer review team. These were:

1. First Draft December 4, 2009 (with slight revisions issued December 17, 2009),
2. Second Draft March 2, 2010, and
3. Third Draft April 19, 2010.

Comments from the peer review team were received and incorporated into the report. A record of all comments received and how these were addressed is included in Appendix C. Some comments were provided as 'track changes' within the document while others were received in other forms of electronic media. For recording purposes all comments were copied into a form that included fields for the Commenter, Comment, Page or Reference, Response and Responder.

A final report was completed on April 26, 2010.

## Status Update for Quinte

As of April 2010, Quinte Conservation has completed their peer review and is submitting their Final Tier 2 Water Budget Reports for the Madoc and Ameliasburgh Systems. The reports have been completed with peer review comments incorporated from the meetings and review. The list of attached Appendices is as below.

| Appendix | Name | Components |
|---|---|---|
| Appendix A | Agenda & Minutes | Meeting #13 Agenda & Minutes<br>Meeting #14 Agenda & Minutes |
| Appendix B | Peer Review Record – Madoc | Table of Peer Review Comments. |

## Appendix A:

## Agenda & Minutes

# Cataraqui / Mississippi-Rideau / Quinte Source Protection Regions

# WATER BUDGET PEER REVIEW TEAM

**Meeting # 13**

Date: Thursday, March 12, 2009

Time: 10 am to 3 pm

Location: Outdoor Centre – West Hall
Cataraqui Region Conservation Authority
1641 Perth Road, Glenburnie, ON

Lunch will be provided

**Proposed Agenda**

| Time | Item | Lead |
|---|---|---|
| 10:00 - 10:15 | • Welcome<br>• Introductions<br>• Approval of proposed agenda | Sean Watt |
| 10:15 - 11:00 | Climate Change for Assessment Report | Sean Watt |
| 11:00 – 11:30 | Quinte: Tier 2 Ameliasburgh Work Plan | Bryon Keene |
| 11:30 - 12:00 | Quinte: Tier 3 Madoc Work Plan | Mark Boone |
| **12:00-1:00** | **LUNCH** | |
| 1:00 – 1:45 | Cataraqui: Tier 2 Sydenham Lake Work Plan & Model Selection | Colin Clarke |
| 1:45 – 2:00 | Cataraqui: Tier 2 Lansdowne | Sean Watt |
| 2:00 - 3:00 | • Other Business<br>• Next Meeting<br>• Adjournment | Chair |

# Minutes of Meeting
# Source Protection Peer Review
# Quinte, Cataraqui

**Held at Cataraqui Region Conservation Authority**
**March 12, 2009 10:00 AM**

**Present:**

| Name | Agency | Name | Agency |
|---|---|---|---|
| Sean Watt | CRCA | Michel Robin | University of Ottawa |
| Bryon Keene | Quinte Conservation | Darin Burr | Dillon Consulting |
| Colin Clarke | XCG Consulting | Bill Hogg | Reach Consulting |
| Ed Watt | XCG Consulting | Jana Levison | CRCA |
| Mark Boone | Quinte Conservation | Tessa DiOrrio | South Nation |
| Laura Landriault | MNR | Michel Kearney | City of Ottawa |
| Scott Lister | Conservation Ontario | | |
| | | | MNR |

**Absent:**

| Name | Agency | Name | Agency |
|---|---|---|---|
| Karyn Cornfield | Mississippi-Rideau | Sarah MacHardy | MNR – Kemptville |
| | | Bryan Sears | MNR - Kingston |

Sean Chaired the meeting.

***Introductions*** were heard around the table.

Agenda was presented.

***Climate Change Presentation***
Sean Watt discussed climate change requirements and sources of information on climate change. He stated that the consensus of reports suggests an increase in temperature. No consensus on precipitation, some reports predict an increase and some a decrease, both generally within the uncertainty of the data. Possibly more extreme events, earlier freshet, less snow storage, longer dry periods.

Some discussion took place over 'trends' and time periods and cycle lengths of climate. Bill noted that 30-year cycles can be discovered in the data by analyzing stations with 100 years+ of record.

Recommendations coming from Sean's summary included conservation, further monitoring, research etc. Michel R. suggested that further research would also be needed on groundwater/surface water interaction.

Going forward with climate change requirement in source protection requirement. Bill pointed out that we can do little to predict locally what will happen. Best would be to acknowledge it can occur and adapt. Michel R. agreed that making predictions is risky. Better approach is to ask what are likely scenarios? Look at scenarios with a sensitivity analysis approach. Then investigate the potential impacts of the scenarios.

Michel R. discussed his 2003 investigation at U of Ottawa. They reviewed climate years in specific ranges of precip. to investigate results. They found little impact from mild changes in climate.

General consensus for direction is to provide a summary of the research. Sensitivity analysis is not needed, but could be considered. Drought scenarios are a sensitivity analysis of sorts anyway. We could provide some local interpretations with our understanding of the systems how Climate Change could impact water.

***Quinte Presentation***

Bryon presented methodology and workplan for Ameliasburgh Subcatchment for Tier 2. Quinte intends to use the Prince Edward County model based on the GAWSER platform for the budget. Groundwater input is unknown and Quinte intends to do some simple groundwater characterization to add to understanding of the Roblin Lake area.

The lake has a small catchment, but could have a large portion of groundwater contribution. There are mimimal lake level records to help confirm rise and fall of lake levels with relation to climate conditions (P/ET), or GW discharge. There is also a lack of intake depth related to water levels. It was thought a diver might be needed to locate the intake, and measure the depth.

There was a suggestion that GW discharge/recharge could change depending on the season. In summer, the higher ET would result in a loss of lake water, and could allow GW to discharge into the lake, but in rain/runoff times in the fall and spring, the extra surface water recharge the groundwater.

There is a question on the source of water to the lake, and some suggestions for confirming/quantifying are using infrared images to look for warm/cool spots, looking at water level changes in the lake, and perhaps conductivity or seepage measurements. These would all help to confirm GW discharge to the lake.

There were also discussions around whether P (precipitation) or Q (streamflow) was the better indicator of drought conditions when looking at the drought scenarios for Tier 2 work. Many around the table felt that Q was a better indicator of drought conditions than P. It was noted that the lowest annual flow does not necessarily give the lowest monthly flow, and that using one to substitute for the other may miss important information from the period of record.

There was further discussion about the specific 2 and 10 year drought scenarios required in the Technical Rules, and whether they would in fact be indicative of actual drought scenarios. It was felt that the period of record has an influence on whether the Tech Rules drought scenarios will provide the correct data to consider drought conditions.

There was also discussion around a calibrated model. The rules do not specifically say that the models need to be calibrated, though the consensus was that they must be, and would be of minimal use if they were not.

Mark Boone presented the methodology for a Tier 3 investigation of Madoc groundwater system. He explained why he is moving directly to Tier 3 and what work would be required to complete requirements of a Tier 2 in the director's rules.

Mark will look at GW recharge rates in PGMN wells and explained his method of calculating monthly recharge by producing a monthly distribution. The peer review team liked this concept, but cautioned against using a very short duration monitoring record that shows counterintuitive recharge distribution. Mark has several more years of record that he will be incorporating that will improve the distribution.

Mark then explained the process from the guidance and director's rules to describe how stress is evaluated for Tier 3.

There was again some discussion here about the Tech Rules drought scenarios, and whether 2 years of no recharge was in fact a worse condition that the lowest average precipitation over 10 years.

***Cataraqui Presentation***
Ed Watt left the meeting at this point.

Colin presented Catarqui approach to Tier 2. Sydenham Lake subwatershed is to be investigated for surface water intake. Lansdowne is also going to a Tier 2 for groundwater.

Sydenham Lake setting was discussed including the dam (controlling the lake) and subwatershed characteristics.

Model selection. Colin reviewed the surface water models available and summarized the abilities of each to meet project criteria. HSPF was selected by consensus of the Peer Review Team.

Interaction issues were discussed between surface water and groundwater models and reservoir routing. The solution was to develop a custom routing model for the lake.

The team was generally supportive of this approach.

Sean introduced the methodology for Lansdowne municipal well. Stress assessment levels did not send to Tier 2, but declining water levels suggests further study. The well has some issues and treatment upgrades are proposed. Workplan is similar to Quinte. Sean has not developed in detail the workplan for this well.

***General Discussion***
Any other issues? None brought forward.

***Next Meeting***
The next meeting may be triggered either by Quinte or M-R in late May and early June.

The meeting was adjourned at 2:15 PM

# Agenda
# Joint Quinte/Cataraqui Peer Review

## Date: Dec 15, 2009

10 am - Cataraqui - Sydenham Lake subwatershed (surface water supply)

11 am - Cataraqui - Lansdowne subwatershed (groundwater supply)

12 pm - lunch

12:30 pm - Quinte - Madoc subwatershed (groundwater supply)

1:30 pm - Quinte - Ameliasburgh subwatershed (surface water supply)

3 pm - adjournment

# Minutes of Meeting
# Source Protection Peer Review
# Quinte, Cataraqui

**Held at Cataraqui Region Conservation Authority**
**Dec 15, 2009 10:00 AM**

**Present:**

| Name | Agency | Name | Agency |
|---|---|---|---|
| Sean Watt | CRCA | Michel Robin | University of Ottawa |
| Bryon Keene | Quinte Conservation | Darin Burr | Dillon Consulting |
| Colin Clarke | XCG Consulting | Rob Muir | Dillon Consulting |
| Ed Watt | XCG Consulting | Igor Iskra | Dillon Consulting |
| Mark Boone | Quinte Conservation | Shan Mugalingam | TCC |
| Lynn Milford | MNR | Michel Kearney | City of Ottawa |
| Scott Bates | MNR | Sean Stirling (via Video) | Intera Engineering |
| Nafeeze Hooseinny | MNR | Lukas Calmbach | Schlumberger |
| Bill Hogg | Consultant (Retired Climatologist) | Sharon Wadley | Schlumberger |

**Absent:**

| Name | Agency | Name | Agency |
|---|---|---|---|

Sean Chaired the meeting.

***Introductions*** were heard around the table.

Agenda was presented.

***Cataraqui Presentation – Lansdowne Well***
Sean Stirling presented via video link. He explained the geology of the area and overviewed the field program for data collection and understanding groundwater flow. Important results by packer testing showed the sandstone layer was not as highly conductive as thought – $10^{-6}$.

He discussed the development of the model and the approach used to delineate the WHPAs for the well (A, B, C, D). There was some modification to their modelling methods from Tier 1 to Tier 2. Sean presented the results of the water balance using the new approach. Modelling showed 60 mm/yr of recharge. Distributed recharge to spring 66% and fall/winter 33%. No recharge in summer. Earlier Malroz recharge was about 250 mm/yr for their sandstone.

Stress assessment. They used a consumption factor for the municipal water taking as 1.0 for the first scenario. They looked at two more scenarios with reduced consumption factor to see the sensitivity. Determined drought with Kingston record. 10-yr moving average was still above 900 mm/yr. 1971 was lowest single year with 750 mm that year. 2-yr drought showed an 8 m drop in groundwater levels. The change in water level during 10-yr drought was in the range of 1 m. Drought scenarios were investigated using comparison to stress levels. These would suggest Moderate stress. (Minute taker's note – the stress categories for drought should be applied differently).

Sean concluded his presentation and took questions. Darin Burr asked about the porosity assumed. Sean stated 5%.

Michel R. asked about storage coefficient and stated that it would be very important to have a good understanding of effect of assumption of storage coefficient. This would influence stress. Sean agreed.

Mark asked about percent water demand calculations for Tier 2 on drought scenarios. Rules do not require you to do percent water demand on drought. These need to be run to determine if wells would run dry. Sean agreed and said the wells would not go dry in the 10-yr drought, but do go dry in 2-yr drought. Scott B. agreed that percent water demand is not used to define stress.

Michel R. How was supply calculated? Recharge had a lateral inflow and storage was provided to the model by the change in storage value. Michel was concerned this is double accounting. Sean will review this. Scott B. GWin is used not GWnet in the stress. This is the basis of the establishment of the stress thresholds. Supply is to be recharge and lateral flow in only. Summer has no recharge, but Scott says annual is to be distributed monthly by dividing annual recharge by 12. This is the official way to complete the assessment. Drought assessments are transient.

Scott B asked about consumptive factor. This should be in relation to the source. He deferred to the peer review team to comment on use of consumptive factor.

Scott B asked about growth assumption. The use of 20% needs to be confirmed. Sean W stated that 20% was used based on County projections. This was fine.

Rob M asked about water demands – were they incorporated into the numerical model. No, not in the model but considered in the stress calcuations.

***Quinte Presentation – Ameliasburgh Intake – Tier 2***

Bryon presented results for Ameliasburgh Subcatchment for Tier 2. Quinte intends to use the Prince Edward County model based on the Gawser platform for the budget.

Bryon started with a quick recap of the Tier 1 stress assessment for the Quinte, and then reviewed the Tier 2 work plan for Ameliasburgh.

Harold Schroeter took over the presentation to provide the details of the water budget modeling. He outlined the model GAWSER (Guelph All-Weather Sequential Events Runoff) model. The model used was an extension/update of a previous model for the Quinte subwatersheds.
Local climate and flow data were used for calibration, and consideration of the stress assessment work.

Bryon came back to detail the stress assessment work. He identified the water use data used for the assessment, as well as the meteorological data used for the drought conditions.

The final result for the stress assessment was low for current conditions, and low for all the drought scenarios. There was still approximately 1 m of water over the intake in all the scenarios. However, it was noted that it was “only” 1 m by MNR, and that it could be a concern. Bryon looked specifically at the Roblin Lake subwatershed in addition to the Ameliasburgh Tier 1 subwatershed as per the Rules.

Michel R. asked why the GAWSER model was run for the Moira River when the site of interest was in another watershed? This subwatershed was run for the Madoc work, not the Ameliasburgh work, and was presented by Bryon and Harold to be complete, rather then Mark repeat things later.

Ed W. asked about the GAWSER model, and the calibrations, and variations of the model results. He asked whether the Sawquin Creek data was calibrated (it was not, there was no data to calibrate to), and why the Consecon Creek simulated vs. observed flows seemed so different. He noted that perhaps the 50% difference in observed vs. simulated might mean the stress numbers

should also be modified by the same amount. Harold suggested a sensitivity analyses on the values, to see how much they affect the stress values.

There was also the suggestion that the WSC flow measurements under ice condition have not been as good as the past, and this may explain some of the difference in observed vs. simulated for the March flows.

Ed also noted on pg 43 of the report the difference of ET on the lake vs. the creek, and that winter ET was much higher than expected give ice cover on the lake.

Darin B. asked about the GW infiltration from the HydroG study.

Rob M noted that if you have a high $Q_{10}$, you can easily overestimate the stress value in the %WD equation.

Ed also noted that the Nash-Sutcliffe statistic would be worthwhile to consider to see how far off simulated vs. observed values really are. Harold agreed.

Bill H was concerned with the climate stations used in the analyses. He was concerned that Trenton is a great station with a much longer record, and it was not used. Bryon noted that they did compare Trenton, and it showed similar data to the stations used in the analyses, and he would add text to the report to reflect that.

Bryon also noted that the streamflow is probably a better indicator of drought conditions that precipitation stations, and Bill agreed. However, Bryon also noted that the Rules do not allow consideration of the streamflow records for drought conditions.

Scott B also mentioned that the 10 year drought condition requirements of the rules are actually wrong, and the 10 year drought as noted in the rules is not really much of a drought, it is very close to average conditions (as we are all finding in the analyses). He noted that MNR will try to have this changed in the Rules, and will be issuing some updated guidance on this.

***Lunch at 12:30 PM***

***Quinte Presentation – Ameliasburgh Intake – Tier 2***
Mark Boone presented the Tier 3 investigation of Madoc groundwater system.

Colin Clark, Sharon Wadley (schl), Bill Hogg, Lukas Calmbach. (schl) arrived for the afternoon session.

Mark provided the Tier 1 setting that triggered the Tier 3 investigation. He also pointed out that he was requested to complete a Tier 2 investigation due to the technical rules. Tier 3 was triggered not by stress indication, but because of a pumping interruption. This advanced us to Tier 3.

GW model required transient analysis. Used monthly distribution learned from PGMN wells and applied to annual recharge.

Lukas presented the Madoc groundwater model – its development, data sources, and area of study. GW flow is determined from high ground to lakes and rivers. Overburden was very thin and caused difficulty with the model. This was handled by merging the overburden with the bedrock in various zones and assigning recharge values to each zone. Median was about 90 mm annually. Model development was tested with observations of 11 high quality well measurements.

Result of modelling shows that the well can be sustainably pumped for both current and future needs in all hydrologic conditions reviewed.

Some intervening comments were made:
Michel R asked about the calibration of the flux at the lake. Answer, these were compared with the GAWSER surface water model. Darin asked about the cone of influence stopping at Deer Creek. Roughly 60% of well withdrawal was provided by Deer Creek (though this is not confirmed with field work, and seems high to the modeler). What is the rationale for going to such a level of complexity with the modelling? Answer: during calibration Schlumberger had difficulty getting a good match. Ed W asked about the accuracy of the well elevations. Answer: Schlumberger reported root mean squares for the 11 surveyed (OLS) wells with the 389 no-surveyed wells. Ed W commented on the comparison between GAWSER 'infiltration' and 'recharge' from Schlumberger. He reminded us of the difference between 'Slow' and 'Fast' recharge. Bill H asked about validation. Schlumberger stated they had really only one data set to use and it was not a true validation exercise. They would need other sets to test the model. It was suggested that breaking the data in two pieces, and calibrating with one while validating with the other would be acceptable. Validation is a gap.

Darin asked about Deer Creek flows. Summer drought months may have 20% supplied from Deer Creek. Scott B said that further field work will be required for Tier 3 adherence. He will discuss this later. Ed W asked about the future growth areas and why 50% impervious was selected. It may be a poor assumption to state that recharge would drop by 50%. Recent science shows development may actually increase recharge. Reduction of recharge is conventional wisdom and is conservative.

Lukas continued his presentation to show that the stress assessment is Low. However, since the well was pumped dry in 2007 the conclusion is that the watershed receives a Moderate assignment of stress.

Mark discussed risk assessment. Exposure and tolerance were evaluated. High tolerance and low exposure results in Low Risk.

Scott B agreed that there are a lot of subtleties to the rules. Perhaps with some further review we can look at the need for a full Tier 3. The current report does not fully address Tier 3. Since we have a large effect on Deer Creek we have not established the instream flow requirements for Deer Creek. These must be accounted for. Madoc also has a planned system demand that could exceed the committed demand. Review definition of committed demand. Quinte would have more work to do to evaluate the other water users. Flows will need to be documented in Deer Creek. Need municipal involvement in Tier 3.

Shan M asked can Quinte Conservation change their minds and retract a Tier 3 knowing that the overpumping was an operational error not a true lack of water. Scott B said we could look at this option.

Darin asked if indeed Deer Creek is being affected by the pumping. There is no way of knowing as no complaints have been received.

***Cataraqui Presentation – Sydenham Lake***
Ed Watt, Shan M left the meeting at this point.

Colin reminded the group that the model development memo was submitted some time ago for comment. Sydenham watershed is part of Milhaven Creek watershed. The outflow from the lake is known to go dry in the summer.

Colin presented the Sydenham report. Scott B stated that rule curve scenarios get into a Tier 3 type of assessment. Final stress is Significant because of Technical Rules. A Tier 3 is required. ET was modelled with Hargreaves equation.

Scott B noted that you do not need to go to a drought scenario if a Moderate or Significant stress is revealed from percent water demand. First instance where you identify a Moderate or Significant stress then you advance on to the next Tier of study.

***Timeline for reception of Comments***
Comments need to be received by January 15th. Comments can be submitted via the comment feature from Word. Word version is preferred.

***Next Meeting***
The next meeting may be triggered either by Quinte or M-R in late May and early June.

The meeting was adjourned at 2:15 PM

## Appendix B:

## Madoc Peer Review Record

# Quinte, Tier 2 and 3 Waterbudget
# Peer Review Comment Record: Madoc Wells

**Reports Reviewed:**
QUINTE Tier 3 Numerical Groundwater Flow Modelling for Water Budget Assessment – December 11, 2009 (Schlumberger Water Services Ltd.)
Quinte Tier 2 Assessment of Subwatershed Stress Levels – December 16, 2009 (Schlumberger Water Services Ltd.)

| Commenter | No. | Comment | Response | Responder |
|---|---|---|---|---|
| **Ed Watt** | 1 | Why bold for 5.1 etc.? | This is bold in original test | Lukas Calmbach |
| Watt | 2 | P10, s2.8: Because all well casing elevations have not been surveyed in by first-order leveling, all wells should not carry equal weight in the optimization objective function. This is alluded to at the end of the section; it should be at the top! Also, weights should be given. | A weight factor of 2 was applied to high quality targets, this been specified on page 10 | Calmbach |
| Watt | 3 | **P10:** "greater precedence"??? | This was reworded | Calmbach |
| Watt | 4 | **Table 3.1:** 6 significant figures: a bit much squared! | Numbers for baseflow VALUES was rounded | Calmbach |
| Watt | 5 | **P 18, s4.2.2:** Should provide details on why "stream stages" are not available. Surely, they could be modelled. | It was made clear in the text that no measured stream and lake stage data was available as model input | Calmbach |
| Watt | 6 | P. 22, s5.1: Why is the term "Residual" used? It appears to be defined as the difference between "calculated heads" and "observed heads". If observed heads are considered to be accurate, then a more appropriate term would be "model error". | Residual is a common term used in modeling. The observed head is not necessarily considered accurate since location and elevation errors may often exceed the model error. | Calmbach |
| Watt | 7 | In my opinion, a groundwater model that underestimates, on average, by 8.9 m at one well and overestimates by 21 m at another well is not acceptable. Clearly, there is something wrong with the model, and | This is a large regional model and it cannot be expected that a high | Calmbach |

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| | | not just turbulence affecting the accuracy of the readings. | precision can be obtained locally. In addition, the pumps are shut off and started daily while the model uses monthly averaged pumprates. | |
| Watt | 8 | P23, s.5.2: In order to evaluate the importance of the drops in creek stage given (0.06 m and 0.16 m), the reader should be given the starting values of creek stage. | This has become irrelevant since the discussion on the discussion was reduced. The discussion of the water takings from the streams is now kept on a qualitative rather than a quantitative level. | Calmbach |
| Watt | 9 | **P23, s5.2:** Can the assumption of constant water level in Moira Lake be justified by observations or anecdotal reports? This should be clarified. | It has been clarified in the text that the constant lake stage is due to the lack of historic data | Calmbach |
| Watt | 10 | **P24, s5.4:** Again, provision of the starting creek levels would help. | See comment 8 | Calmbach |
| Watt | 11 | P25, last para: More explanation is required to convince me high model uncertainty leads to low uncertainty in stress. If this is indeed the case, why do you ned a model? | The modeling results may have a high uncertainty, in particular when run in transient mode. However the model could be used to confirm that even for conservative input parameters, the resulting water stress is still low. | Calmbach |
| Lynne Milford, MNR | 12 | The MOE technical rules have been incorrectly referenced throughout the document. The technical rules were released in December 2008 and the recent update was posted on the EBR in November 2009. The Water Budget and Water Quantity Risk Assessment Guidance Model was released in March | Appears to refer to the Quinte report | Calmbach |

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|---|---|---|---|---|
| | | 2007. Please revise in the document. | | |
| Milford | 13 | pg 5 – 2nd paragraph, 1st sentence: consider revising to "*… the decision was made to further develop this model to cover a larger area* | Appears to refer to the Quinte report | Calmbach |
| Milford | 14 | pg 9: Please consider adding a more descriptive caption to Table 1. | Appears to refer to the Quinte report | Calmbach |
| Milford | 15 | pg 9: Final paragraph: The second sentence is quite awkward to read, consider rewording. | Appears to refer to the Quinte report | Calmbach |
| Milford | 16 | Is it unclear if when the replacement Rollins well was installed a new permit was assigned under the PTTW or was the existing permit for the old well simply transferred over to the new well. Please clarify. | Appears to refer to the Quinte report | Calmbach |
| Milford | 17 | The future scenario that is to be undertaken should be based on Official Plan projections from the municipalities. It would be good to indicate if the municipality has future projections in their official plan or not. If not then it is fine to use another method to estimate future growth however your rational should be clear in the document. This is of particular importance since you have equated the existing plus future growth to be the committed demand for the system. | The future rates have been based on | Calmbach |
| Milford | 18 | To complete the requirements of the Tier 2, drought scenarios need to be completed as well, the SGRAs delineated at the Tier 1 (entire SPA) scale must be updated to reflect the Tier 2 (subwatershed) scale. | Mark Boon has checked with Hastings County and they have done a population growth study which projects rates out to 2035 (25 years), however their growth projection is lower at 18 % vs the 26 % we used. The model was rerun with this lower growth rate. | Calmbach |
| Dillon | 19 | Pg 4, Section 2.2.1: A large number of separate hydraulic | The zonation is an | Calmbach |

| | | | | |
|---|---|---|---|---|
| | | conductivity zones are used. Considering the general lack of K data, is such a large number of zones warranted? Usually, in cases where data is sparse, a simpler K zonation is often better unless a direct relationship between lithology, fractures and bulk K can be established. The concern is that having so many K zones will result in calibration being less meaningful and the chosen K values in any given zone not being based on actual conditions but just a by-product of a fitting exercise that has non-unique solutions. | attempt to account for the different thicknesses of the the overburden. The rational is explained in the report, page 4, section 2.2.1 | |
| Dillon | 20 | Pg 8, Section 2.7, 3rd paragraph : The description of the application for NPW wells in this section suggests that the NPW represents all non-permitted takings within zones 157 and 158; while the more detailed description in Appendix B, suggests that the NPW value is instead based on proportioning the total non-permitted demands from the whole model domain to zones 157 and 158 based on fraction of area. Please clarify which case is correct. | This has been reworded | Calmbach |
| Dillon | 21 | Pg 12, Section 3. 2nd paragraph : Section states that flow to the wells is generally from the north and west, with some water being taken from Deer Creek. Previous work conducted by Dillon suggested a component from the northeast as well. It would be useful if the difference between the two models were explained. | This was reworded, the general direction is North, locally there may be SW and SE directed flow lines. | Calmbach |
| Dillon | 22 | Pg 12, Section 3. 3rd paragraph : The number of blue and red dots are few. What is the threshold value used in (m) residual for each dot.transport pathways. | Three is no threshold value. Unfortunately in the residual map MODFLOW, the well symbols are plotted over the proportional size points and may cover symbols representing small residuals (having a small radius) | Calmbach |
| Dillon | 23 | Pg 15, Section 3.3, 1st paragraph: The well locations appear to not be shown correctly.<br><br>Based on Q1, It appears that the dominant direction of groundwater flow (and therefore capture zone) is north and northwest, which I expect is different that what was modeled for the capture zone | This section on page 15 and the corresponding figures have been removed from the report, as the SHPA Q1/Q2 are not required for the Tier2 | Calmbach |

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| | | analysis (more of a northwest, north and northeast extent). | study. | |
| Dillon | 24 | Pg 20, Section 4.2.5: Is the screen target elevation the top or bottom or the screen? | This was reworded to "screen midpoint" | Calmbach |
| Dillon | 25 | Pg 22, Section 5.1: A table showing the elevations of the screen in the pumping wells, and the modelled predicted elevations at each scenario would be helpful.<br><br>Considering the large difference between actual and predicted water levels at Whytock well and the resolution of the model and the uncertainty in the input data, is the analysis using the modelling approach meaningful? | The transient model is used on a regional scale only in the Tier Two analysis. The calibration results are considered to be appropriate at this scale. Given the fractured environment, a close local fit cannot be expected. | Calmbach |
| Dillon | 26 | It is reported that the model indicates 367 m3/day of water coming from the creek during current conditions. This is slightly greater than 60% of the total flow of the well field. Under drought conditions, the model estimates 547 m3/day from the creek, which is close to 100% of the wellfield rate? Are these percentages reasonable? Is there any flow data in the creek that shows this loss?<br><br>Is it possible that the amount of flow from the creek is overestimated, and that the drawdown cone extends further east of the creek? Sensitivity analysis should be performed to investigate this.<br><br>If the predicted numbers are true, I would expect some type of impact to the creek during normal conditions, and perhaps worth of further investigation | This has been changed to a more qualitative statement and a recommendation stating that the Groundwater-surface water interaction requires additional investigations | Calmbach |
| Dillon | 27 | Pg 29, Section 8.1: Additional recommendations are to measure flow in Deer and Madoc Creek, and measure along profile to see if there are reductions as creek flows near wells. | See comment 26 | Calmbach |
| Dillon | 28 | Pg 3, Section 2: Table 1 and Table 2 are referred to in this section; however, the reference does not appear to match with the tables shown | This was corrected in the text | Calmbach |
| Dillon | 29 | Pg 4, Section 3: Table 4 and 5 show difference recharge terms by month. For Tier 2, the monthly supply term is the same (annual supply/12). | All recharge terms have been replaced by annual supply/12 | Calmbach |

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| Robin | 30 | P. 4: Figure 5 does not give regional groundwater flow (whatever that mean); it gives water table elevation. Title and text should be changed or, preferably, approximate flow lines could be given with arrows of sizes that would reflect the magnitude of the flux. | Figure has been changed | Calmbach |
| Robin | 31 | P. 4: How were the conductivities combined and arrived at in the first place? Ie were they simply re-guessed? Or was there some sort of averaging? If the flux is mostly vertical in the first layer then a weighted harmonic mean should be used. | The hydraulic conductivity of the combined layer was calculated as the harmonic average of both layers, assuming that most of the groundwater flow is vertically directed near the top of the aquifer | Calmbach |
| Robin | 32 | P. 5: Improper logic: the idea of the equivalent pm approach is to represent the fractured network as an anisotropic system, not to justify using an isotropic system. The decision to use a isotropic K should be based on some other logic. I would surmise here that, depending on the type of rock and the dominant fracture orientation, the anisotropy could well vary from one rock to another. More discussion and explanation is required here. | When representing a fractured system with the equivalent porous medium approach, the effect of fractures on the flow can be reproduced by introducing anisotropy for the hydraulic conductivities, increasing the hydraulic conductivity parallel to the fracture planes. Dillon, 2007 has analyzed fractured, but only measured the strike of faults visible on aerial images. In the absence of information on the three dimensional orientation of the faults, it was assumed that within this generally flat lying rocks, the majority of the | Calmbach |

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| | | | fractures would be parallel to the bedding plane and there the vertical conductivity was set to one tenth of vertical conductivity. | |
| Robin | 33 | P. 5:If the porosities are known, it would be better to use the actual values rather than an average, because the porosities will have a large impact on the advective times. | The information on the spatial distribution of the porosity was insufficient to provide a more refined porosity distribution in the model | Calmbach |
| Robin | 34 | P. 6: This is incorrect. Give a better definition. | The boundary conditions in a numerical flow model define the flow conditions at the interface between the model domain and the outer world. | Calmbach |
| Robin | 35 | P 6: I am not sure of the relevance of this sentence. | Sentence was removed | Calmbach |
| Robin | 34 | This is a 3-D model; there should be bc's specified all around the domain for each layer and also at the bottom of the lowest layer. The default in MODFlow is probably no-flow conditions at these locations. | Since the model domain represents the entire watershed, no flow bc's for all layers are a fair assumption. A sentence was added defining the noflow conditions at the bottom of the model | Calmbach |
| Robin | 35 | P 6: Somewhere in this paragraph there should be a sentence to explain the difference between a river bc and a drain bc. | MODFLOW uses the drain boundaries to simulate the effects of hydrologic features which remove water from the aquifer at a rate proportional to a head, while rivers may add or remove water from the | Calmbach |

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| | | | aquifer depending on the head difference between river stage and the water table. | |
| Robin | 36 | Not clear. | Sentence was removed: "In Visual MODFLOW, the casing depth is represented by the top and bottom of screen fields." | Calmbach |
| Robin | 37 | Why are consumptive factors taken into account here? The amount of water pumped should be affected by consumptive factors only when part of the water is returned directly to the same aquifer. It seems to me that this is mostly not the case here. The water is returned (almost directly) to surface water bodies. | True, The consumptive factor is important for the quarry wells, the term was removed from the discussion of the rates in the municipal wells | Calmbach |
| Robin | 38 | Should mention that while the NRMS is important, as it gives, on average, a feel for how well the model is calibrated, equally important is the spatial distribution of the residuals. A map of the residuals will be presented in Fig 13. | Added sentence: While the NRMS is convenient as it allows to express the quality of the calibration in a single value, it is equally important to assess the calibration by reviewing the spatial distribution of residuals. A map of the residual head distribution is presented in Figure 13. | Calmbach |
| Robin | 39 | p. 11: Sorry, but this is sloppy terminology. The map presents no flow line whatsoever. This is an equipotential map of layer 1, and is therefore a simulated watertable elevation map. How does the h correspond to other layers? | Sentence was replaced by: Figure 12 presents the simulated water table elevation map. | Calmbach |
| Robin | 40 | p. 11: Map is a bit unclear: were all obs wells used as calibration targets? If so then the dot size should be made proportional to the magnitude of the residual and the legend should be modified accordingly. | The residuals are made proportional, but in many cases the well symbol is larger than the residual | Calmbach |

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| | | | symbol and is hidden. The map was redone. | |
| Robin | 41 | p. 14: Nothing is mentioned about type I bc's. Is it realistic that they be maintained constant in time? In times of drought the water levels may drop; would the drop be sufficient to affect the model? It is easy enough to have time-varying type I bc's the question is: what levels to use? OK see 4.2.2 may be this issue should be mentioned here and the reader could be referred to 4.2.2 | Constant head boundaries are now included in the list, a reference is made to 4.2.2.: Time-varying conditions at constant head boundaries | Calmbach |
| Robin | 42 | p. Chick this with Mike Garaway. For a while MNR required that the outflow NOT be considered (which makes no sense to me); check to make sure that this was reconsidered and that the outflow are now part of the calculation. | This is what is required by the Technical Rules | Calmbach |
| Robin | 43 | See previous comment. | See 42 | Calmbach |

## Appendix C:

## Ameliasburgh Peer Review Record

# Quinte, Tier 2 Water Budget
# Peer Review Comment Record:
# Ameliasburgh Intake

**Reports Reviewed:**
Draft – Tier 2 Water Budget - Ameliasburgh Subcatchment - Prince Edward County Quinte Tier 2, Revised Draft December 17, 2009 (Michel Robin commented on the earlier version December 4th, 2009)

## Table 1: First Draft Peer Reviewer Comments

| Commenter | No. | Comment | Response | Responder |
|---|---|---|---|---|
| **Michel Robin (MJLR)** | 1 | It would be helpful to show the features described above on fig 2.2; fig 2.1 is superfluous (almost the same info as in fig 1.2) | Done. | Bryon Keene |
| MJLR | 2 | On page 10. Re: Section 2.1 with respect to return of water withdrawals from the lake not being returned to the lake. "Not clear what is happening here. I would surmise that flow is actually returned to R Lake depending on bedrock topography in the vicinity of the lake." | I have attempted to clarify this in the text. Golder Figure 10 suggests groundwater flow is northerly toward the escarpment in the serviced area. Groundwater may not be returned to the lake. | Bryon Keene |
| MJLR | 3 | On page 10. An actual DEM map or topo map would be useful here to understand the overall picture. | Added topography to Figure 1 | Bryon Keene |
| MJLR | 4 | Page 11. Is the lake actually perched hydrogeologically; ie with an inverted water table below it and a air phase at atmospheric pressure? Or is it simply high up on the escarpment? The text should clarify. | Sorry, wrong terminology. The lake intersects the groundwater table. The lake is located high on top of an escarpment. I have attempted to clarify this in the report. | Bryon Keene |
| MJLR | 5 | Page 12. In my opinion, this should be called Net horizontal groundwater inflow. Inflows and outflows can be fairly large but the difference is (the Net inflow) is very small. | Agreed. | Bryon Keene |
| MJLR | 6 | Page 14, Regarding Average, 2-yr and 10-yr drought. These should be defined here (as in the Sydenham report). | Done. | Bryon Keene |

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| MJLR | 7 | Section 3.7 Uncertainty. I think that there is room to be a lot more quantitative in this section. The title of the section suggests that a description of uncertainty determination will be presented (ie how is uncertainty evaluated?). These 2 sentences are void of content. | Details of uncertainty have been totally revised. See response to comments 17 to 24. | Harold Schroeter |
| MJLR | 8 | Section 3.7 first ppg, last sentence, 'Values' of what? | See response to comments 17 to 24. | Harold Schroeter |
| MJLR | 9 | Ibid, ppg 3, If this is the case, then what is the uncertainty associated with the % stress. | See response to comments 17 to 24. | Harold Schroeter |
| MJLR | 10 | Section 4.1, Why the Moira catchment in fig 4.1 and PEC in fig 4.2? wasn't there a model developed for Sawguin Cr? Need to explain. | The Sawguin Creek Model is comprised of areas 504, 505, and 506. See Map 4.1 | Bryon Keene |
| MJLR | 11 | Regarding Table 11, This is actually a flux (flow would be in m^3 per month), Same correction for a number of occurrences. Could also be written as $10^{-3}$ $m^3$ $m^{-2}$ $mth^{-1}$ | It was our intention to show the water budget in terms of mm/month. The total flow column is a simple addition of the Runoff +Infiltration columns – all of which are expressed in mm/month. | Bryon Keene |
| MJLR | 12 | Section 6.3, first ppg. This is hard to visualize, considering that the lake is on a topographic high and that it may be perched? | GW seeps are reported by locals. QC attempted to find these with temperature monitoring but were not successful, partly because our probe would not reach bottom at the deeper portion of the lake. | Bryon Keene |
| MJLR | 13 | Section 6.3, Regarding Golder's estimate of groundwater discharge of 215 c.m./day to Roblin Lake, 'How did they estimate this?' | There is a fairly lengthy discussion of their modelling in Appendix B. They used a Modflow model and provincial well data calibrating with measurements of water levels in wells and a couple of pump tests performed by Mark Boone. | Bryon Keene |
| MJLR | 14 | Section 6.3, regarding last ppg discussing the Golder model, The escarpment intersects the lake???? | Sorry, the lake intercepts the groundwater table. | Bryon Keene |

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| MJLR | 15 | Section 6.3, estimates of discharge. What is meant here by "infiltration"? I don't think that we are comparing like things here. | Infiltration from the surface water model is intended to represent that portion of the precipitation that is measured at a streamflow gauge as slow runoff. It is interpreted as precipitation that recharges groundwater. | Bryon Keene |
| MJLR | 16 | Section 6.3, page 41, regarding discussion on interpretation of recharge amounts. This is on top of an escarpment. Does the Golder's model account for groundwater loss to deeper groundwater systems? | I reviewed this with Mark Boone. The 20 $m^3$/day value is interpreted to mean loss to a deeper aquifer. However, the escarpment intersects the deeper aquifer and we believe it would discharge to surface below the escarpment. Support for this is an observation by Mark Boone just east of the Roblin Lake outlet along the escarpment where seeps were noted during a landfill review. Golder model indicates horizontal conductivity is 10X vertical for the units modelled. | Bryon Keene |
| MJLR | 17 | Uncertainty, Section 7. This section needs work: ordering of thoughts and better quantification. | Completely revised section | Harold Schroeter |
| MJLR | 18 | Ibid, What is "Standard error of the data"? Do you mean the standard deviation? (standard error is the standard deviation of a statistic, such as the mean) | See Comment 17 | Harold Schroeter |
| MJLR | 19 | Ibid, What do you mean by "potential" | See Comment 17 | Harold Schroeter |
| MJLR | 20 | Ibid, Not clear. This works only if uncertainty is expressed as the standard deviation. | See Comment 17 | Harold Schroeter |
| MJLR | 21 | Ibid, How does this translate in terms of the other variables? | See Comment 17 | Harold Schroeter |
| MJLR | 22 | Ibid, I don't understand what this means. Do you mean enhance the resolution? And of which parameter? | See Comment 17 | Harold Schroeter |
| MJLR | 23 | Ibid, Clarify what is meant by statement in comment c) | See Comment 17 | Harold Schroeter |

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| MJLR | 24 | Ibid, Comment g) This is an observation but not a reason why "uncertainty in the computed water balance quantities were reduced" as stated at the beginning of the bullet list. This should be a concluding statement. | See Comment 17 | Harold Schroeter |
| Ed Watt | 25 | Problems in Table of Maps: Maps 5.1 and 6.3 | OK, thanks | Bryon Keene |
| EW | 26 | Problem in Table of Tables: Table 19 | OK, thanks | Bryon Keene |
| EW | 27 | P3, section1, Justification problem | OK, thanks | Bryon Keene |
| EW | 28 | P1, Discussion of intake location should be revised to correspond with Bryon's comments at the meeting. | This has been revised | Bryon Keene |
| EW | 29 | Table 1, Table 1 is not cited in the text. | It is now cited. | Bryon Keene |
| EW | 30 | Table 1, Why is Ameliasburg a Subcatchment and the other 2 drainage areas? | All are now termed "subcatchments" | Bryon Keene |
| EW | 31 | Table 1, 4 significant figures is one more than the WSC gives! | Reduced to 3 | Bryon Keene |
| EW | 32 | Page 10, line 9, Replace "The figures" with "Figures 1 and 2". | OK, thanks | Bryon Keene |
| EW | 33 | Page 10, line 11, Replace "the first figure" with "Figure 1". | OK, thanks | Bryon Keene |
| EW | 34 | Figure 3 is not cited in the text. I t should precede the two section figures. | done | Bryon Keene |
| EW | 35 | Figure 3, Replace cross section with section to agree with figure captions (1, 2, and 3). | Renamed these "profiles" | Bryon Keene |
| EW | 36 | Equation 1, Add $GW_{out}$ to RHS of equation. | See comment 5. Replaced term with Net GWin. | Bryon Keene |
| EW | 37 | Equation 1, $\Delta S$ is not an output as stated in sentence above figure. | OK, clarified this. | Bryon Keene |
| EW | 38 | P13, section 3.2, No longer AES. | OK, corrected this. | Bryon Keene |
| EW | 39 | References to maps 4.3, 4.4 and 4.5 should precede their appearance in the text. | OK, thanks | Bryon Keene |
| EW | 40 | Map 5.1 is cited, but I cannot find it in the revised version. | Sorry, it is now in the new draft | Bryon Keene |
| EW | 41 | Table 3 is not cited in the text. | OK, thanks | Bryon Keene |
| EW | 42 | Table 4 is not cited in the text and it should be all on one page. | OK, thanks | Bryon Keene |
| EW | 43 | Add reference to Figure 4. | OK, thanks | Bryon Keene |
| EW | 44 | Add reference to Figure 5. | OK, thanks | Bryon Keene |
| EW | 45 | P25, line 4, Replace "The table provided below" with "Table 5". | OK, thanks | Bryon Keene |
| EW | 46 | P27, line 2, Replace "a single table below" with "Table 8". | OK, thanks | Bryon Keene |
| EW | 47 | P27, Why are Sawguin Creek 04-P-4024 values in Table 6 identical to Roblin Lake current demands in Table 8? Would not the takings be 100 % consumptive for Roblin Lake and less than 100 % for Sawguin Creek? | OK, corrected this. | Bryon Keene |
| EW | 48 | P29, 1956 to 1966 is 11 years. | These are water years, October | Bryon Keene |

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| | | | 1956 to September 1966. | |
| EW | 49 | P30, table 9, Some of these stations are a long way from Prince Edward County. Why were they included and why was Bancroft selected for the example? | Bancroft and other northern stations were included since we were running the model for entire Quinte watershed. This was for Deer Creek needs as well. The Sawguin Creek work used the Mountainview station, however. Poor choice on our part to show Bancroft. This has been replaced with Mountainview. | Bryon Keene |
| EW | 50 | P32, section 6.1, Output not output | OK, thanks | Bryon Keene |
| EW | 51 | P33, table 10, Why are values for other than median and 10% flows given? And why are flows given in $m^3/s$. All other values are given in mm. | Other values are removed from the table. CMS units are a direct output from the model and my stress calculations use cms. | Bryon Keene |
| EW | 52 | P33, table 10, Too, too, too many significant figures. The indicated precision is not appropriate, especially considering the possibility that the simulated median is too large by a factor of 3 for the case of Consecon Creek, where observed flows were available to calibrate the model. | OK, these have been reduced | Bryon Keene |
| EW | 53 | P34, line 23, I don't believe that one can measure the water surface elevation in a lake to the nearest mm! | You haven't met my surveyor! Agreed. We will reduce to nearest cm. | Bryon Keene |
| EW | 54 | Figures 12, 13, and 14, Ordinate scale should start at 108.6 to show critical water surface elevation. | Done | Harold Schroeter |
| EW | 55 | Check the rules to see if stress calculations are required for Roblin Lake. If they are, why use modelled **inflows**? Surely, hydrologic principles require **outflows**. | Agreed, but provincial direction does not permit outflow because that invokes storage into the calculation. They do not permit the use of storage in Tier 2.<br><br>The province has agreed to permit Roblin Lake area of | Bryon Keene |

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| | | | study to be used for drought scenarios, while maintaining Ameliasburgh area of study for stress calculation. Therefore issue is redundant. | |
| EW | 56 | P33, Table 13, Why are values for other than median and 10% flows given? And why are flows given in $m^3/s$. All other values are given in mm. | See comment 52 | Bryon Keene |
| EW | 57 | P38, Replace "The following table" with "Table 16". | Done | Bryon Keene |
| EW | 58 | Map 6.1, Replace "Medium" with "Moderate". | Done | Bryon Keene |
| EW | 59 | Map 6.2, Replace "Medium" with "Moderate". | Done | Bryon Keene |
| EW | 60 | Map 6.3, Replace "Medium" with "Moderate". | Done | Bryon Keene |
| EW | 61 | 5 SIGNIFICANT FIGURES!! (in Golder recharge estimate) | Reduced to three. | Bryon Keene |
| EW | 62 | P44, What does an annual comparison have to do with a monthly water budget? | Golder result does not lend to comparison with monthly amounts from the surface water model. Annual is provided for basis of comparison. | Bryon Keene |
| EW | 63 | P46, I think that Roblin Lake outflows should have been used to calculate stress. | See comment 55, province has directed us to use Sawguin subwatershed for stress calculation. | Bryon Keene |
| EW | 64 | Appendix A, Should have a title and pages should be numbered. | Done | Bryon Keene |
| EW | 65 | Appendix B, Should have a title | Done | Bryon Keene |
| EW | 66 | The output from the potential evapotranspiration model must be multiplied by a factor (ETFAC) in order to provide a balance. The following statement, "For the present applications, ETFAC was found to be 0.54", does not instill confidence in the model. Any model, or sub-model such as that for PET, that must be multiplied by about one half is not, in my experience, a model. However, a simple comparison of modelled monthly ET with Tier 1 water budget values would help reduce the uncertainty. | This has been discussed in Section 7. | Harold Schroeter |
| EW | 67 | The model does a poor job of simulating median and $90^{th}$ percentile monthly flows for Consecon Creek for July, August and September. In every case, it over simulates. For example, for August, the simulated median flow is at least 3 times as large as the observed. | Agreed. The model was revised and rerun with improved | Harold Schroeter |

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| | | Given these results for a calibrated model, I would have little confidence in the results of an uncalibrated model for a nearby stream, Sawguin Creek | | |
| Igor Iskra, Dillon | 68 | **Page 12. Section 3.** The water budget equation may also include horizontal ground flow out and surface water flow in. | Agreed. See comments 5 and 36 | Bryon Keene |
| II | 69 | **Page 13.** The meteorological "station locations can be found in Map 5.2 in section 5 of the report". Map 5.2 has only locations of the hydrological gauges. Meteorological stations without attributes are presented on Map 4.3. | This has been corrected. | Bryon Keene |
| II | 70 | **Page 13.** "For modeling purposes, precipitation and temperature data were used from the following six Atmospheric Environmental Stations: Bancroft, Madoc, Cloyne Ontario Hydro, Frankford MOE, Belleville, Mountaiview". It is not clear why data from remotely located Madoc, Cloyne and Frankford stations are used in the current study if the neighbouring Belleville and Mountainview stations have sufficient period of record. | Other stations provided coverage for the entire Quinte Conservation region. They also helped fill in missing data (separate project by Schroeter for the province). | Bryon Keene |
| II | 71 | **Maps 4.1. and 4.4.** The benefits of showing the Moira Catchments and Moira Response Units in the current report are not clear. | Removed Moira. It was included as this report was referenced for Madoc's Tier 2 work. However, the Appendix C hydrologic report is maintained for that purpose. | Bryon Keene |
| II | 72 | **Page 27. Table 8.** The table shows the actual consumptive water demands computed with a consumptive factor of 0.2. However, earlier in the text (page 26), it is said that "from the standpoint of Robin Lake it is assumed that all takings are fully consumptive" since they are not returned to Robin Lake. Should Table 8 have the actual current takings with consumptive factor of 1? | This table has been corrected. | Bryon Keene |
| II | 73 | **Page 27.** Section 5.2.1. "Climate stations are shown on Map 4.3 and listed earlier in Section 2". Should refer to Section 3. | Thank you. Corrected this. | Bryon Keene |
| II | 74 | **Page 27. Section 5.2.2. 2-yr and 10-yr drought.** Concept of averaging precipitation from 6 meteorological stations, some of which are located very far from Robin Lake needs clarification. Why to use Madoc and not to use neighbouring Trenton? Why | We averaged the precipitation to determine the drought period. The precipitation from the actual rain gauge near | |

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| | | not just to take one or two closest climate station(s) with the full record? Based on Table 9 the 10 year drought period should be 1961-1970 (Belleville and Mountainview are the closest stations). | Roblin Lake (Mountainview station) was used for the modelling. I believe station average from all nearby stations better finds the drought period. This is borne out by comparison with Trenton that was left out of the average and also the stream flow record that found the same periods. | |
| II | 75 | **Page 28. Section 5.2.2.** "Rain events are not evenly distributed spatially. Perhaps a better way to identify drought periods is to review stream gauge data". The stream gauge data are also measured at discrete locations scattered throughout and not evenly distributed spatially. The Technical Rules recommend using the records of precipitation not streamflow for identification of the drought periods. | My opinion is expressed in this statement. However, the Technical Rules were used to determine the drought period. | Bryon Keene |
| II | 76 | **Page 34 and Figures 10 and 11.** The authors use "water year" (November 1 to October 31 ) for the 2 year and 10 year water budget calculations. However the calendar year is used for the demand data. Clarification from MOE may be required on what is the "year" in the Technical Rules means: calendar or water year. | The hydrologic model needs to start with a water year to account for the snow accumulation. | Bryon Keene |
| II | 77 | **Page 42**. For a 2 year drought the annual Precip is 660 mm/year and ET is 510 mm/year. The surplus was estimated as 150 mm x 4.5 = 675 mm depth of annual input to the lake. "This is 27 times the annual municipal withdrawals". Our understanding is that ¾ of the Robin Lake catchment has ET of 510 mm/year. The lake surface which represents ¼ of the catchment evaporates at a potential rate. The potential evaporation could be 1.4 times or more of the actual ET. This leaves less of available water in Robin Lake during the drought years. | Agreed, but we are accounting for the entire subcatchment. The 510 mm/yr number does just this. It does not imply ET from the land is 510 mm/yr. That number is aggregate. | Bryon Keene |
| II | 78 | **Page 43. Uncertainty.** According to the Technical Rules the | We have stated this as High in current revision. | Bryon Keene |

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| | | level of uncertainty should be assigned to the results. It is not clear what level of uncertainty "high" or "low" was assigned. | | |
| Lynn Milford, MNR | 79 | Pg 1 – 4th paragraph: Consider removing this paragraph (and the one following) as it speaks to the groundwater Tier 2 evaluation – at this point it is fine to keep them as two separate reports. | Removed all but a cursory reference to the groundwater system. | Bryon Keene |
| LM | 80 | Pg 5 – Section 1.1: Some clarification is needed regarding the terminology used to describe the study area. At Tier 1, a "subwatershed" should be the basis for the stress evaluation however it is referred to as a "subcatchment". At Tier 2 a re-evaluation of these original boundaries may be necessary. The same terminology is referred to in maps 2.1 and 2.2. | I have clarified my terminology to use 'subwatershed' to refer to Tier 1 boundaries used in the study and 'subcatchment' for subdivisions of a subwatershed. | Bryon Keene |
| LM | 81 | Pg 10: For consistency, please refer to Figures 1, 2 and 3 in the text of the document. | All figures and tables have now been referenced. | Bryon Keene |
| LM | 82 | Pg 13 – Section 2.1: At Tier 2, the water use estimates must be refined from those used for the Tier 1 evaluation – total PTTW values should not be used. Please consider strengthening the wording this section to reflect the refinements made (ie. consider removing "where possible" from the last sentence. | Actual usage was used in the calculations. I have removed the "where possible" phrase. | Bryon Keene |
| LM | 83 | Pg 13 – Section 2.3: ET is an important component of the Tier 2 water budget, therefore a bit more of an explanation of estimation methodology should be brought forward from Appendix C. Specifically, it would be of value to explain the rationale for changing to the Linacre method from the Thornthewaite method. | Further explanation has been added. | Harold Schroeter |
| LM | 84 | Pg 24 – second paragraph: There is a reference to municipal water being piped to Fenwood Gardens in the early 2000's due to water quality issues. What was the source of the piped water, where was it from? | Belleville. I have added this. | Bryon Keene |
| LM | 85 | Pg 25: The discussion on future water use anticipates an increase of 28% in 25 years. All future estimates are to be based on actual projections provided by the municipalities in their Official Plans. The future scenario must align with the | I have confirmed this number with PEC planning staff and their growth study. Further detail has been added to the | Bryon Keene |

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| | | planning horizon established by the municipality and should not exceed it. Please confirm with the municipality that this estimate is in line with their planning projections. | report. | |
| LM | 86 | The entire (larger) Ameliasburgh subwatershed should be utilized for the calculation of percent water demand to evaluate the potential for stress. This would be done using the average annual conditions for the subwatershed | I have calculated stress on the basis of Sawguin Creek. I believe Sawguin Creek was agreed as the study area. Stress is well within Low. By expanding the area from 53.3 to 132 $km^2$ and since all active permits are within Sawguin Creek (numerator does not increase), the denominator (supply) will be increased by 2.5 x and stress will drop from 12% to 5%. | Bryon Keene |
| LM | 87 | To evaluate the drought scenario, the scale of the evaluation should be adjusted to correspond to the contributing area of Roblin Lake and the municipal intake | This has been done. | Bryon Keene |
| LM | 88 | The drought scenario should be undertaken using reservoir routing approach and consider the implications of water storage on whether or not the intake would be exposed under the drought scenarios. | This has been done. | Bryon Keene |

# Quinte, Tier 2 Water Budget – Ameliasburgh Intake
# Peer Review Comment Record:

**Reports Reviewed:**
Revised Draft – Tier 2 Ameliasburgh water budget – March 2, 2010

## Table 2: Second Draft Peer Reviewer Comments

| Commenter | No. | Comment | Response | Responder |
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| **Scott Bates** | 1 | Page 1: Please make a minor correction to indicate that the assessments were undertaken in accordance with the most recent release of the Assessment Report Technical Rules dated November 16, 2009 (rather than December 12, 2008). There were only minor changes made to the Water Budget portion of the technical rules which should not change your methodology or results. | Done | Bryon Keene |
| SB | 2 | Page 20: Please make a minor addition to the text in Section 3.3 that reads, "*This is discussed further in Section and in Appendix C*". The section that should be specified is 5.3. | Done | Bryon Keene |
| SB | 3 | Page 23: Further to Lynne Milford's comments regarding the calculation of future water use, the discussion on this page in the revised report needs to be modified in several ways. The reference to, and calculations for, a "25-year" time horizon should be removed from the report because the technical rules no longer specify a period of time for future projections (this was in the Guidance Module). As Lynne indicated, the future scenario must align with the planning horizon established by the municipality and should not exceed it, therefore in this instance estimates of future water demand should not be made past 2021 to be consistent with the Prince Edward County planning department Growth and Servicing Strategy. To obtain the correct future municipal pumping rates ($m^3$ per month) you will need to revise the calculations slightly. First, your current population estimates will have to align with the same year (e.g. study year) as your municipal demand estimates. Figure 4 in the report shows three years of pumping (2006-2008), one of which will be assigned as the study year for determining current pumping. Second, the 1% per year population growth rate estimate from Statistics Canada could be applied starting in your study year (e.g. 2007) out to the official plan date of 2021 (e.g. 14 years). This results | Works out to 15% by 2021. This has been corrected. | Bryon Keene |

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| | | in a 14% increase in population between the current date and the official plan date. Conservatively assuming per-capita water use rates remain constant during this time the current pumping rates ($m^3$ per month) could be multiplied by 14% to get future municipal demands. One final point of clarification is that the PEC Growth and Servicing Strategy population estimates do not appear to align with the Statistics Canada growth rate estimates. Given a population of 325 people in 2003 and an estimate of 380 to 405 people in 2021 the growth estimated by the PEC would be between 16.9% and 24.6% over this time period (18 years) with growth rates between 0.94% and 1.36% per year. There appears to be an error with the statement in the report that indicates, "*Assuming 390 persons as a midpoint of the projection and extending this rate from 18 years to 25 years, one obtains a growth rate of 27.7%*". Please revise this section of the document and the associated demand estimates. | | |
| SB | 4 | Page 34: In the report it states, "*Perhaps a better way to identify drought periods is to review stream gauge data. Stream gauges measure output from a catchment that in effect synthesizes precipitation depths over the watershed. Initially, drought periods were identified in this way and then confirmed with precipitation records*". Please consider removing this language and the associated discussion of drought being evaluated in terms of the stream flow records. While this method may be an alternative approach to the method outlined in the Technical Rules it only serves to confuse the reader as to the required methods. Alternatively the report could show the assessment of drought period through precipitation records with a verification using the stream flow records. This appears the be the approach taken (in reverse) as stated on Page 35, "*By inspection of the precipitation records (see Appendix A), we found the lowest 10-yr precipitation period for the region was November 1, 1956 to October 31, 1966 which was accurately predicted by the stream gauge data*". | Reworded such that the streamflow record review provides a check on the precipitation records. | Bryon Keene |
| SB | 5 | Page 43: It appears that the drought scenarios for both the 2-year and 10-year periods have not been run correctly and will require re-assessment. The intent of the drought scenario is to run the hydrologic model on a daily time step (rather than monthly) throughout the selected 2-year drought period using historically observed daily precipitation values while at the same time pumping the existing (Scenario D) and future (Scenario E) municipal rates. As an example, Section 5 of the Sydenham Tier 2 Water Budget Report | The drought scenarios were run correctly. In fact they were run on an hourly basis. They were reported monthly in the charts. Also, the figures have maximum and minimum values reported. These are actually maximum and minimum hourly | Bryon Keene and Harold Schroeter |

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| | | discusses the drought assessment and methods that are required in the technical rules (see figure below for 2-year drought). The stress is then assigned based on the daily water levels evaluated in relation to the circumstances listed in Technical Rule 34(2)(c). Please make the appropriate revisions to the report in relation to the drought scenario. | water level. I have clarified this in the text.<br>What this means is the water level (instantaneous) over the month did not exceed the top line or go below the bottom line. The intent of the rules is followed. | |
| Igor Iskra | 6 | Page 24. Permit for Municipal System – the Village of Ameliasburgh. Our understanding is that the Actual demand for 2008 (a year prior to the Terms of Reference Approval) should be used for the percent demand calculation, not the average 2006-2008 demand. | We have applied to Director to allow the three year average. We elected to use the 3-year average vs Study year of 2007 because the water use for the three years shows demand is falling. The three year average has slightly higher demand than 2007 and is conservative. Still produced a Low stress. | Bryon Keene |
| II | 7 | Table 13 and Table 15. Pages 35-36. Column “50%Dur” and “90%Dur” in Table 13 should correspond to “Qsupply” “Qreserve” in Table 15. Please check numbers, e.g., for Feb and April. | I have relabeled the chart. Numbers are accurate | Bryon Keene |
| II | 8 | Table 15. Page 36. Terminology should be clarified (i.e., does “Usage” mean Demand?) Units for “usage” of L/s should be confirmed? | Demand – yes. I use L/s to avoid too many decimal places or use of scientific notation. | Bryon Keene |
| II | 9 | Page 55. Conclusions and recommendations. It was concluded that a low risk to water quantity be assigned to the Ameliasburgh municipal intake, although the Roblin Lake Subbasin is moderately stressed. MNR input should be sought on the use of Roblin Lake operational / water level data as a consideration in Tier 2, and the potential need to for a full Tier 3 analysis. | MNR has agreed to stress assessment based on Sawguin Creek. | Bryon Keene |
| II | | Figure 1 needs a scale bar and a description for the red line. | We did not change this. | Bryon Keene |
| II | | Table 5, page 25. The terminology “Permitted Consumptive” is unclear and perhaps can be deleted. Our understanding that the consumptive factor for the municipal system is applied to the actual takings as opposed to permitted values. | Removed. | Bryon Keene |

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| II | | Page 33. Table 12. Table values are referred to as lake evaporation in the text (page 31), Potential Evapotranspiration Rates in the table title, and as Daily Potential Evaporation & Evapotranspiration Rates in the table heading. Consistency in the description of the underlying values is required. Our interpretation is that these are lake evaporation values that are adapted to determine potential evapotranspiration (combined evaporation and transpiration) rates. | Table 5-11 has lake evap and 5-12 has potential evapotranspiration rates. I think it is clear. | Bryon Keene |

# Quinte, Tier 2 Water Budget – Ameliasburgh Intake
# Peer Review Comment Record:

**Reports Reviewed:**

Final Draft – Tier 2 Ameliasburgh water budget – April 19, 2010

## Table 3: Finalized Peer Reviewer Comments

| Commenter | No. | Comment | Response | Responder |
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| **Scott Bates** | 1 | Page 58 of your MS-Word document in the Conclusions and Recommendations Section you write, "***It is recommended that*** *the water budget investigations for the Ameliasburgh municipal intake in the Quinte Source Protection Region be concluded by assigning a Low risk to water quantity"*. You should change the word "risk" to the word "stress" because the word "risk" is really associated with a Tier 3 Assessment. | Done | Bryon Keene |
| SB | 2 | Second, the drought mapping provided in the March 2010 version of the report (see attached) identified a moderate stress for the Roblin Lake area under the 2-year drought. From the March report and from your revised April report I believe a "low" stress should be assigned to the Roblin Lake area for both the 2-year and 10-year drought scenarios if you are planning to include these maps in the final report. | We opted to remove the drought map as it did not add to the understanding of the water budget conclusion. | Bryon Keene |