Grand River Watershed Tier 2 Water Budget and Water Quantity Stress Assessment

Peer Review Summary Report

February 2010

TABLE OF CONTENTS

List of Appendices

1. EXECUTIVE SUMMARY

Drinking water source protection is an initiative by the Province of Ontario in which Conservation Authorities (CAs) are working with other partners to help ensure sufficient supplies of safe drinking water for the future. The Technical Experts Committee Report (MOE, 2004) on Watershed-based Source Protection Planning recommended that "water budgets should be progressively developed for the individual watershed as a method of quantifying water storage volumes, fluxes, pathways, and water takings for the combined surface and groundwater resources." The Report also states that the water budget framework and approach is essential to the source water protection planning process as it provides a logical methodology for evaluating threats and issues related to water quantity. Thus, it is important to perform water budget analysis based on sound scientific principles for the success of the source water protection planning process.

The Water Budget and Water Quantity Risk Assessment, as described in the Assessment Report: Guidance Module 7, will produce reporting that describes groundwater and surface water flow networks and their interaction as well as identifying sub-watersheds and local area communities that may not be able to meet current or future water supply demands from existing or planned water supply sources. It is expected that all the activities that require water, both the needs of people and the environment, will be taken into account. The water budget estimates that come out of the Drinking Water Source Protection (DWSP) project are expected to be the authoritative water budget which will be used as a basis for decision making on the range of water management programs including the Low Water Response and Permit-to-Take-Water (PTTW) programs.

Since much of the work for the Grand River Water Budget was completed prior to the DWSP initiative, the current work falls into the preliminary stages of Tier 2 as defined in Guidance Module 7. The first draft of the Grand River Integrated (Tier 2) Water Budget Report was submitted to the Lake Erie Source Protection Region for review by AquaResource Inc. in October 2006. The draft Water Quantity Stress Assessment was submitted for review in February 2009.

In order to develop technically defensible estimates of water budget components, the Province requires that the water budget analysis is peer-reviewed. Provincial direction is provided in an interim guidance document, entitled *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005). A Grand River Peer Review Team was struck in October 2006 and a Terms of Reference was drafted to outline the roles responsibilities and deliverable of the team in accordance with the provincial guidance.

This document summarizes the peer review of the water budget and water quantity stress assessment for the Grand River watershed. This document is intended to summarize the process followed by the Peer Review Team in preparing recommendations to assist in the completion of the Tier 2 Water Budget and the identification of specific subwatersheds for further Tier 3 Risk Assessments. The methodology followed in the preparation of the Grand River Tier 2 Water Budget and Water Quantity Stress Assessment reports is consistent with the Technical Rules prepared by the MOE in 2008 and supports the inclusion of the results in the preparation of Assessment Reports under the Clean Water Act.

2. PEER REVIEW PROCESS

The *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005) describes Peer Review as the process whereby regional source water protection water budget teams engage experts from outside their project team in the development of the water budget on a continuous improvement basis. Peer review, therefore, constitutes outreach to and participation by the broad scientific and engineering communities. Peer review is a continuous process for enhancing water budget products so that the decision or position taken, based on the water budget products, is technically sound and defensible.

Peer Review is aimed at an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, and conclusions pertaining to the water budgets and any supporting documentation. At the end of the Peer Review, it is expected that a documented review will be created to help ensure that activities are technically adequate, competently performed, and properly documented, and satisfy the technical guidance. Peer reviewer comments will be included in the document along with the responses from the water budget technical team and any revisions which may result from those comments. The objectives of the Water Budget Peer Review committee are:

- To ensure that water budgets are scientifically defensible;
- To ensure consistency with the expectations of the water budget technical guidance;
- To validate the water budget deliverables.

Peer review will occur periodically throughout the development of all the phases (Tiers 1, 2 & 3) ensuring that the final water budget is technically sound.

The Grand River Conservation Authority (GRCA) has long been involved in the development of a water budget study, relying upon over ten years of previous work including hydrologic model studies, municipal groundwater studies, Ontario Geologic Survey geological investigations, and water use inventory reports. The study has used, and improved upon, the existing GAWSER hydrologic models and FEFLOW groundwater models.

The study has also built upon current work by the GRCA to compile, digitize, and analyze additional information available from the MOE Permits to Take Water, and directly from water users, about actual water use. Because of the sensitivity of the water budget and stress assessment to water use estimates, a range of assumptions and methods is being used.

The project is being carried out in accordance with the Ontario Ministry of the Environment (MOE) Guidance Module 7 for preparing Water Budget and Water Quantity Risk Assessments. The study fulfills the requirements for the Tier 2 Water Budget and Water Quantity Stress Assessment. On the basis of the detailed conceptual understanding of the watershed generated by its previous work, the GRCA proceeded directly to the Tier 2 reporting stage. The GRCA selected AquaResource Inc. (ARI) to complete the Water Budget and Water Quantity Stress Assessment reports which were submitted for staff and peer review.

2.1. Terms of Reference

In October 2006, Lake Erie Source Protection Region staff developed a Terms of Reference (TofR) to guide the peer review process. The Terms of Reference, found in Appendix A, was developed in accordance with the provincial guidance document, entitled *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005).

The TofR outlines the following details of the peer review:

- Roles and responsibilities of the team members,
- Team composition,
- Conflict of interest,
- Statement of the work required,
- Schedule of peer review milestones, and
- Level of effort required by the peer reviewers.

2.2. Peer Review Committee

The Peer Review Committee consists of:

- The Peer Review Leader,
- The Water Budget Peer Review Team,
- External Technical Experts, and
- Provincial and Conservation Ontario Observers.

The composition of the committee formed in October 2006 is outlined in Table 1. Throughout the duration of the Tier 2 Water Budget project, the composition of the technical resources team has changed slightly, however the core of peer reviewers has remained the same.

Table 1 – Grand River Water Budget Peer Review Committee and Technical Resources

Peer Review Role	**Peer Review Committee**
Peer Review Leader	James Etienne, GRCA
Peer Reviewers	Dr. Dave Rudolph, University of Waterloo
	Dr. Hugh Whiteley, University of Guelph
	Chris Neville, S.S. Papadopulos and Associates
Municipal Reviewers	Dave Belanger, P.Eng, City of Guelph
	Eric Hodgins, P.Geo., Regional Municipality of Waterloo
	Technical Resources
SPP Director	Lorrie Minshall, Lake Erie SP Region
Consultant Team	Paul Martin, Dave VanVliet, Sam Bellamy, AquaResource Inc.
Agency Representatives	Mike Garraway, Scott Bates, Ministry of Natural Resources
	Clara Tucker, Ministry of the Environment
	Jennifer Havelock, Scott Lister, Conservation Ontario
SP Region Staff Support	Gregg Zwiers, Sonja Strynatka, Stephanie Shifflett, Amanda Wong, GRCA

2.3. Completing the Peer Review

The peer review is considered to be complete when peer review comments are incorporated into the water budget products, or reasons are stated why such comments are not to be incorporated. This document includes copies of all the peer review meeting minutes and correspondence that were consolidated into comment matrices used by the consultant to complete the final report drafts for Peer Reviewer acceptance. The matrices include an “action” column which describes the response to Peer Review comments. A complete file of the documentation collected throughout the peer review process is available for review at the GRCA’s Administrative Offices at 400 Clyde Road in Cambridge.

3. WATER BUDGET PEER REVIEW

The preparation of the Water Budget and Water Quantity Stress Assessment by ARI was broken into two phases. Phase 1 involved the collection of background information for the preparation of a Draft Interim Report in October 2006 for peer review. Although the report was initially signed-off by the Peer Review Committee in May 2007 as the Interim Water Budget Report, the time taken to complete the Water Quantity Stress Assessment allowed for the collection of additional data and the development of improved methods for revising the Integrated Water Budget Report. In the Spring of 2009, the report was revised and peer reviewed and subsequently posted in June 2009 using new information and a revised modeling approach applied in Phase 2.

3.1. Committee Meetings

A summary of the meeting agendas, information packages and minutes for the Water Budget Peer Review may be found in Appendix B-1.

Following circulation of the draft report in October 2006, a meeting was scheduled for November 24, 2006 to allow AquaResource Inc. to present a summary of their findings to the Peer Review team. The team was then asked to submit their initial comments and questions for discussion at a subsequent meeting on December 13, 2006. The comments submitted by the Peer Review Team can be found in Appendix B-2. In order to provide an orderly tracking of the comments for discussion and follow-up by AquaResource Inc., a comment matrix was prepared and circulated to the team prior to the December 13th meeting (Appendix B-3). At the December 13th meeting, comments in the matrix were consolidated for discussion, and responses (leading to actions) were added to the matrix in red and blue for the direction of ARI.

3.2. Peer Review Recommendations

In January of 2007 Aqua Resource Inc. took the consolidated comments from the matrix and developed a strategy for revising the Integrated Water Budget Report. One of the main points raised by the Peer Review Team on December 13th was the need to clarify the issue of certainty in the modeling. The December meeting also identified the need to draw a close to the existing conditions scenario and prepare for the future and drought conditions scenarios. Aqua Resource Inc. focused on these points in the development of a revised Integrated Water Budget Report that was delivered to the GRCA in March 2007. This document was subsequently circulated to the Peer Review Team for another round of document review during which the team compared the revisions to their comments in the matrix. The comments received (Appendix B-4) indicated that, while there was a need for more detailed work, it was appropriate for the consultant to proceed to Phase 2 to work on the future and drought scenarios.

3.3. Revised Reporting

Although the initial Integrated Water Budget Report included an assessment of potential stress under existing conditions, it was decided that the assessment reporting should not be posted until the full range of scenarios was completed as part of the Phase 2 work. As a result, the January 2008 Integrated Water Budget Report was posted without stress assessment results.

When the peer review process recommenced in February 2009 (Appendix C-1), the team were provided with a revised Integrated Water Budget Report which addressed some outstanding peer review comments raised by the Region of Waterloo during the Summer of 2007 (Appendix B-4). A summary of the other changes to the document were included in a February 11, 2009 memo from James Etienne to the Peer Review Team (Appendix C-1).

The peer reviewers provided additional comments on the latest Integrated Water Budget Report (Appendix C-2) which were consolidated into a matrix on March 19, 2009 (Appendix C-3). ARI incorporated these comments into the Final Integrated Water Budget Report (June 2009) which was subsequently posted publicly on the Lake Erie Region Source Protection website.

4. WATER QUANTITY STRESS ASSESSMENT PEER REVIEW

Phase 2 of the Water Budget and Water Quantity Stress Assessment by ARI involved the completion of the future and drought scenarios and the identification of significant groundwater recharge areas (SGRAs) in accordance with the new Source Protection Technical Rules (MOE, 2008). The report was revised and ultimately posted in January 2010 based upon final Peer Reviewer input and sign-off.

4.1. Committee Meetings

A summary of the meeting agendas, information packages and minutes for the Water Quantity Stress Assessment Peer Review may be found in Appendix C-1.

The Peer Review committee reconvened in February 2009 to review the draft Water Quantity Stress Assessment report. The committee met to receive a presentation of the report on February 19, 2009. By this time, ARI had revisited the FEFLOW and GAWSER models developed in Phase 1 to address a number of the uncertainties raised by the Peer Review Committee. New water use data and revised models used to bring the Integrated Water Budget report up to date were incorporated into the stress assessment calculations.

The Peer Reviewers submitted their comments and questions for discussion at a subsequent meeting on March 19, 2009. The comments submitted by the Peer Reviewers can be found in Appendix C-2. The comment matrix (Appendix C-3) prepared and circulated to the team for the March 19th meeting was discussed, and responses leading to actions were added to the November 27, 2009 matrix which directed ARI's revisions to the draft report.

4.2. Peer Review Recommendations

The consolidated matrix and subsequent Peer Reviewer comments were used to revise the draft report. The final document was subsequently circulated to the Peer Reviewers in December 2009 for another round of document review during which the team compared the revisions to their comments in the matrix. The Peer Reviewer sign-off correspondence received (Appendix C-4) indicates that the Tier 2 Integrated Water Budget and Water Quantity Stress Assessment reports are scientifically defensible and satisfy the provincial guidelines for water budget documents. For the most part, the Peer Reviewers were satisfied that their comments had been received and addressed in a professional manner by ARI. As a result, the documents provide clear direction for further municipal Tier 3 Water Quantity Risk Assessments

In January 2010, the Peer Review of the Grand River Watershed Tier 2 Water Quantity Stress Assessment was considered substantially complete and the report was posted on the Lake Erie Source Protection website.

5. FUTURE WORK

The Peer Review Committee have recognized that the Tier 2 work completed serves as a "screening tool" for further municipal water quantity risk assessment work. The peer review has been completed within the context of the provincial water budget framework, assessing the completeness and technical accuracy of the documentation. The Peer Reviewers have identified the need for the Source Protection Committee to decide upon the need for additional Tier 3 work and how the technical results (ie. SGRAs) will be applied to the development of source protection policies in the Lake Erie Source Protection Region.

The methodology followed in the preparation of the Grand River Tier 2 Water Budget and Water Quantity Stress Assessment reports is consistent with the Technical Rules prepared by the MOE in 2008 and supports the inclusion of the results in the preparation of Assessment Reports under the Clean Water Act.

5.1. Tier 3 Water Quantity Risk Assessments

The Stress Assessment report identifies the Guelph Eramosa River / Arkell Intake as a municipal surface water supply that meets the requirements to proceed with a Tier 3 Water Quantity Risk Assessment. The report also identifies municipal groundwater sources in the City of Hamilton (Lynden), the Region of Waterloo (West Montrose, Conestogo, Elmira, St. Agatha and the Integrated Urban System), the Township of Centre Wellington (Fergus and Elora), Oxford County (Bright), the Township of Guelph-Eramosa (Rockwood) and the City of Guelph that also meet the requirements for additional Tier 3 work. ARI are currently completing Tier 3 Water Quantity Risk Assessment pilots for the City of Guelph's wells, Eramosa River / Arkell Intake systems, and the Region of Waterloo's Integrated Urban System.

The January 8, 2010 Peer Review comments from Chris Neville suggest that the Tier 3 assessments for Lynden, West Montrose, Conestogo, St. Agatha and Rockwood are "probably not appropriate" due to the relatively small municipal water demands in these communities. Mr. Neville also suggests that Tier 3 work in Fergus and Elora is not "immediately necessary" and should be left until there is a clear indication of future water demand as a result of growth.

5.2. Continuous Improvements

The comments from Chris Neville also refer to some gaps and reservations that should addressed in any future water budget work. He questions if there is sufficient high-reliability data to support Tier 3 analyses that may be "better" than the Tier 2 analyses. Mr. Neville does question the arbitrary selection of a $1km^2$ cutoff area in the delineation of the Significant Groundwater Recharge Areas. The issue of setting an average recharge rate across the entire watershed remains unresolved in other source protection regions and alternate methods should still be considered to determine the sensitivity of this recommendation.

It is recommended that this document and its correspondence be frequently referenced with respect to continuous improvement of the data sets and modeling approaches used in future water quantity assessments.

Appendix A

Lake Erie Source Protection Region Peer Review Terms of Reference

Lake Erie Source Protection Region

Water Budget and Water Quantity Stress Assessment Peer Review

TERMS OF REFERENCE

October 2006

(Revised March 2007)

TABLE OF CONTENTS

List of Figures

List of Tables

1. OVERVIEW

Source water protection is an initiative by the Province of Ontario in which Conservation Authorities (CAs) are working with other partners to help ensure sufficient supplies of safe drinking water for the future. The Technical Experts Committee Report (MOE, 2004) on Watershed-based Source Protection Planning recommended that "the water budgets should be progressively developed for the individual watershed as a method of quantifying water storage volumes, fluxes, pathways, and water takings for the combined surface and groundwater resources." The Report also states that the water budget framework and approach is essential to the source water protection planning process as it provides a logical methodology for evaluating threats and issues related to water quantity. Thus, it is important to perform water budget analysis based on sound scientific principles for the success of the source water protection planning process.

The Water Budget and Water Quantity Risk Assessment, as described in the Assessment Report: Guidance Module 7, will produce reporting that describes groundwater and surface water flow networks and their interaction as well as identifying sub-watersheds and local area communities that may not be able to meet current or future water supply demands from existing or planned water supply sources. It is expected that all the activities that require water, both the needs of people and environment, will be taken into account. The water budget estimates that come out of the Source Water Protection (SWP) project are expected to be the authoritative water budget which will be used as a basis for decision making on the range of water management programs including the Low Water Response and Permit-to-Take-Water (PTTW) programs.

The framework for the water budget process is presented in Figure 1. Please note, however, that, because much of the work for the Grand River, Long Point Region, Catfish Creek, and Kettle Creek was completed prior to the SWP initiative, the current work falls into the preliminary stages of Tier 2 as defined in the Guidance Module 7. The process schematic for the Tier 2 Water Budget and Stress Assessment is attached as Figure 2.

In order to develop technically defensible estimates of water budget components, the Province requires that the water budget analysis is peer-reviewed. Provincial direction is provided an interim guidance document, entitled *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005).

This document is a Terms of Reference for peer review of the water budget and water quantity stress assessment in the Lake Erie Source Protection Region, comprised of the Grand River, Long Point Region, Catfish Creek, and Kettle Creek Conservation Authorities. This Terms of Reference is intended to guide the peer review process and the work of this Peer Review Committee.

2. PEER REVIEW

The *Peer Review Water Budget Interim Direction*, *Version 2.0 (DRAFT)* (dated August 9, 2005) describes Peer Review as the process whereby regional source water protection water budget teams engage experts from outside their project team in the development of the water budget on a continuous improvement basis. Peer review, therefore, constitutes outreach to and participation by the broad scientific and engineering communities.

Peer review is a continuous process for enhancing water budget products so that the decision or position taken, based on the water budget products, is technically sound and defensible.

Peer Review is aimed at an in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, and conclusions pertaining to the water budgets and any supporting documentation. At the end of the Peer Review, it is expected that documented review will be created to help ensure that activities are technically adequate, competently performed, and properly documented, and satisfy technical guidance. Peer reviewer comments will be included in the document along with the responses from the water budget technical team and any revisions which may result from those comments.

The objectives of the Water Budget Peer Review committee are:

- To ensure that water budgets are scientifically defensible;
- To ensure consistency with the expectations of the water budget technical guidance;
- To validate the water budget deliverables.

Peer review will occur periodically throughout the development of all the phases (Tiers 1, 2 & 3) ensuring that the final water budget is technically sound.

3. ROLES AND RESPONSIBILITIES

The Peer Review Committee will consist of:

- The Peer Review Leader,
- The Water Budget Project Team,
- External Technical Experts, and
- Provincial and Conservation Ontario Observers.

3.1. Peer Review Leader

The Peer Review Leader will organize, manage, document, and respond to the peer review of the water budgets. James Etienne, Sr. Water Resources Engineer, Grand River Conservation Authority, will act as the Peer Review Leader and facilitate the meetings for the peer review team.

In particular, the Peer Review leader will:

- Manage the peer review process by following the Terms of Reference,
- Foster an organized and balanced discussion amongst the peer review committee;
- Fill vacancies on the committee;
- Ensure that peer reviewers understand their responsibilities,
- Deal with questions regarding the review process or specific documentation.
- Prepare agendas and background information for the team members;

- Maintain minutes of meetings and provide regular reporting on the activities of the Peer Reviewers,
- Ensure coordination of comments and feedback from the Peer Reviewers regarding the water budgets, and
- Establish and maintain the required peer review record.

3.2. Project Team

The project team is comprised of the lead scientists/engineers preparing the water budget models and reports, including respective CA staff and consultants.

Specific responsibilities of the Technical Leads are to:

- Compile and prepare the required water budget documents, reports, results of analysis, maps and associated technical material for the Peer Review Committee
- Work with the Peer Review Leader on the preparation of required material for the Peer Review meetings such as, agendas, background information, presentations, etc.
- Incorporate the peer review report and the Peer Review Committee's suggestions and modifications into the water budget reports.

3.3. Technical Experts (Peer Reviewers)

The peer reviewers are qualified external team members who are independent of those who performed the work, but who are collectively equivalent (or superior) in technical expertise to those who are performing the work. The peer reviewers should have technical expertise in ground and/or surface water processes, and a good understanding of water budget concepts and approaches

Peer reviewers can be academics, private practitioners, municipal/provincial government staff, adjoining conservation authority staff and others.

The role of the peer reviewers is to:

- Be active and objective participants in the peer review process;
- Read provincial guidance documents and water budget deliverables;
- Perform the review and submit written comments by the agreed deadline, clearly differentiating between 1) comments to be dealt with for the satisfaction of the immediate product, 2) advice with respect to next steps, and 3) comments intended to contribute to the continuous improvement process;
- Protect confidential information and maintain the confidentiality of the product;
- Work positively towards the completion of a satisfactory product (even while understanding the short-comings in the science, analytical tools, data, and understanding).

3.4. Provincial and Conservation Ontario Representatives

Provincial and Conservation Ontario representatives will:

- Ensure that Provincial standards are being followed in the water budget process adopted in this region.

4. MATERIAL TO BE PROVIDED TO THE COMMITTEE

The Peer Review Leaders and the Project Team will provide the following documentation to each peer reviewer:

- A current copy of the water budget products to be peer reviewed, associated background material, and the terms of reference,
- Information concerning the process for the peer review, including the due date of reviewer comments, the format of those responses, and a point of contact for questions,
- A bibliography and/or any particularly relevant scientific articles from the literature to aid in decision-making.

5. PEER REVIEW TEAM

The attached Table 1 lists the proposed committee members, their affiliations and expertise. Additional expertise may be required depending on the subject area. The core peer review team will be asked to help identify other experts to fill these gaps in expertise if and when the need arises.

6. CONFLICT OF INTEREST

Conflict of interest is a situation in which, because of other activities or relationships with other persons, an individual is unable or potentially unable to render impartial assistance or advice. Generally, a conflict of interest arises when the person is affected by his/her private interests, when he/she or his/her associates would derive benefit from incorporation of their point of view in a water budget activity/product, or when their professional standing and status or the significance of their principal area of work might be affected by the outcome of the peer review. Individuals contacted for peer review are expected to report any conflicts of interest that may affect their ability to participate in peer review in an unbiased manner.

7. STATEMENT OF WORK

The water budgets will address both surface and ground water resources. The conceptual models will include a description of all surface water and groundwater features and processes that may affect the quantity, movement, and accessibility of water. The final water budget will be developed with numerical models in Tiers 1, 2, and 3. It must be able to predict and reflect the water quantities and fluxes within hydrologic cycle reservoirs in order to make allocation decisions and to conserve the resource. The peer reviewers will consider the following aspects of the water budget as a tool to assess existing conditions, future development and water use decisions:

Appropriateness of Method

- Does the water budget meet the expectations of the provincial interim direction and the needs of the Source Protection Region?

Scale and Data Sources

- Is the scale of the water budget appropriate for the objectives outlined in the current phase of the project?
- Does the water budget make use of all relevant data sources and data at an appropriate scale both spatially and temporally?
- Does the water budget incorporate water budget outputs from adjacent Regions?

Description of Hydrologic Features and Processes

- Are all components of the water cycle considered in the water budget?
- Does the water budget consider physical hydrologic features on the surface and in the subsurface (i.e., dams, eskers, faults)?
- Are the surface water framework and the hydrostratigraphic framework sufficiently described (i.e. stream connectivity, aquifer distribution)?
- Does the water budget describe the hydraulic properties (including a range of values) of the physical features (i.e. soil characteristics, basin characteristics, hydraulic conductivity, porosity, storage parameters)?
- Does the water budget consider all the natural processes that may affect the quantification of water volumes and water movement (i.e. runoff, evapotranspiration, infiltration)?
- Are the surface and subsurface processes sufficiently explained and ranges of values provided?

Water Usage

- Are all anthropogenic and natural uses of water within the watersheds described and quantified?

Questions, Limitations and Recommendations

- Is the range of uncertainty for all values provided?
- Are the underlying assumptions reasonable and fully explained?
- Are the limitations of the water budget clearly outlined?
- Is the level of detail provided in the water budget sufficient to provide enough information for stress assessment?
- Are data gaps and/or information gaps summarized?
- Do the calculations seem reasonable?
- Do the maps meet the technical requirements?
- Do the maps fulfill their purpose?
- Are the numerical models sufficiently complex to assist with resolution of water quality threats or issues?
- If necessary, what additional work or changes should be undertaken?
- Why should the work be undertaken?

8. COMPLETING THE PEER REVIEW

The peer review will be considered to be complete when peer review comments are incorporated into the water budget products, or reasons are stated why such comments are not to be incorporated.

9. ANTICIPATED SCHEDULE

A tentative schedule and topics are proposed as shown in the following table:

Week of October 23-27, 2006:	Distribution of documents to the water budget Peer Review Committee: • Provincial guidance on water budget and water quantity risk assessment • Peer review committee Terms of Reference • Draft Grand River Water Budget and Preliminary Stress Assessment report • Support material referenced in the draft Report
November 24, 2006	**Grand River Meeting #1:** Overview of the Water Budget and Water Quantity Risk Assessment Framework Confirm Peer Review Committee Terms of Reference Presentation of Grand River Water Budget report, followed by questions and discussion
December 8, 2006	Proposed due date for written Comments/Advice
December 13, 2006	**Grand River Meeting #2:** Discuss / set out action for the consolidated comments and advice. Discuss scope / Terms of Reference for next step Grand River investigations.
March 9, 2007	Initial Long Point Region/Catfish/Kettle Water Budget Peer Review Meeting to agree to Consultant TOR
Week of April 2-6, 2007	Distribution of Grand River Peer Review Report to the Peer Review Committee for review / endorsement
May 31, 2007	Long Point Region/Catfish/Kettle, beginning with hydrology and groundwater reports aiming for TOR for integrated model calibration and water budget report
September 2007	The Peer Review Team will contacted to review the Project Team's progress on the calibration of the Long Point Region/Catfish/Kettle water budget models and to discuss any barriers to meeting the October 2007 deadline for a first draft.
October-November 2007	2 meeting, 8 week process as described above for Long PointRegion/Catfish/Kettle Water Budget and Preliminary Stress Assessment, toward confirming scope for subwatershed scale Water Budget and Stress Assessment refinements
Fall 2007	2 meeting, 8 week process for Grand River Tier 2 Water Budget and Stress Assessment (for drought and future scenarios), toward confirming scope for Tier 3 Risk Assessments
2008	2 meeting, 8 week process as described above for Long Point Region/Catfish/Kettle Tier 2 Water Budget and Stress Assessment (for drought and future scenarios), toward confirming scope for Tier 3 Risk Assessments
	1 meeting, 6 week process as described above for each Tier 3 Water Quantity Risk Assessment investigation (or group of investigations)

Additional meetings or conference calls may be organized to discuss issues pertaining to a specific topic.

10. LOGISTICS

10.1 Peer Review Team Meetings

All members will be notified in advance of the peer review meetings and provided with the appropriate logistical information. Meeting locations may vary however the majority of the meetings will be held at a place convenient to most of the members.

10.2 Remuneration

External Technical Experts will be compensated based on agreed-upon per diem rates plus travel costs.

It is expected that peer reviewers from the Province or other Conservation Authorities participating on behalf of their organization, will not be reimbursed for peer review, other than for travel costs.

Purchase orders will be issued to External Technical Experts for each peer review segment. As per the Anticipated Schedule, peer review segments will be planned as '2 meeting, 8 week' segments or '1 meeting, 6 week' segments with level of effort estimated as follows:

	Assumed hours of effort	
	2 meeting, 8 week segment	**1 meeting, 6 week segment**
Review	16	8
Q&A meeting	4	0
Comment/advice prep	8	4
Meeting to put action to the consolidated comment/advice	4	4
Review peer review report	4	4
Review follow-up Report or RFP	4	4
Total assumed hours of effort for peer review segments	**40**	**24**

If additional meetings or conference calls are scheduled, additional compensation for the External Technical Experts will be paid accordingly.

Figure 1 - Water Budget and Risk Assessment Framework

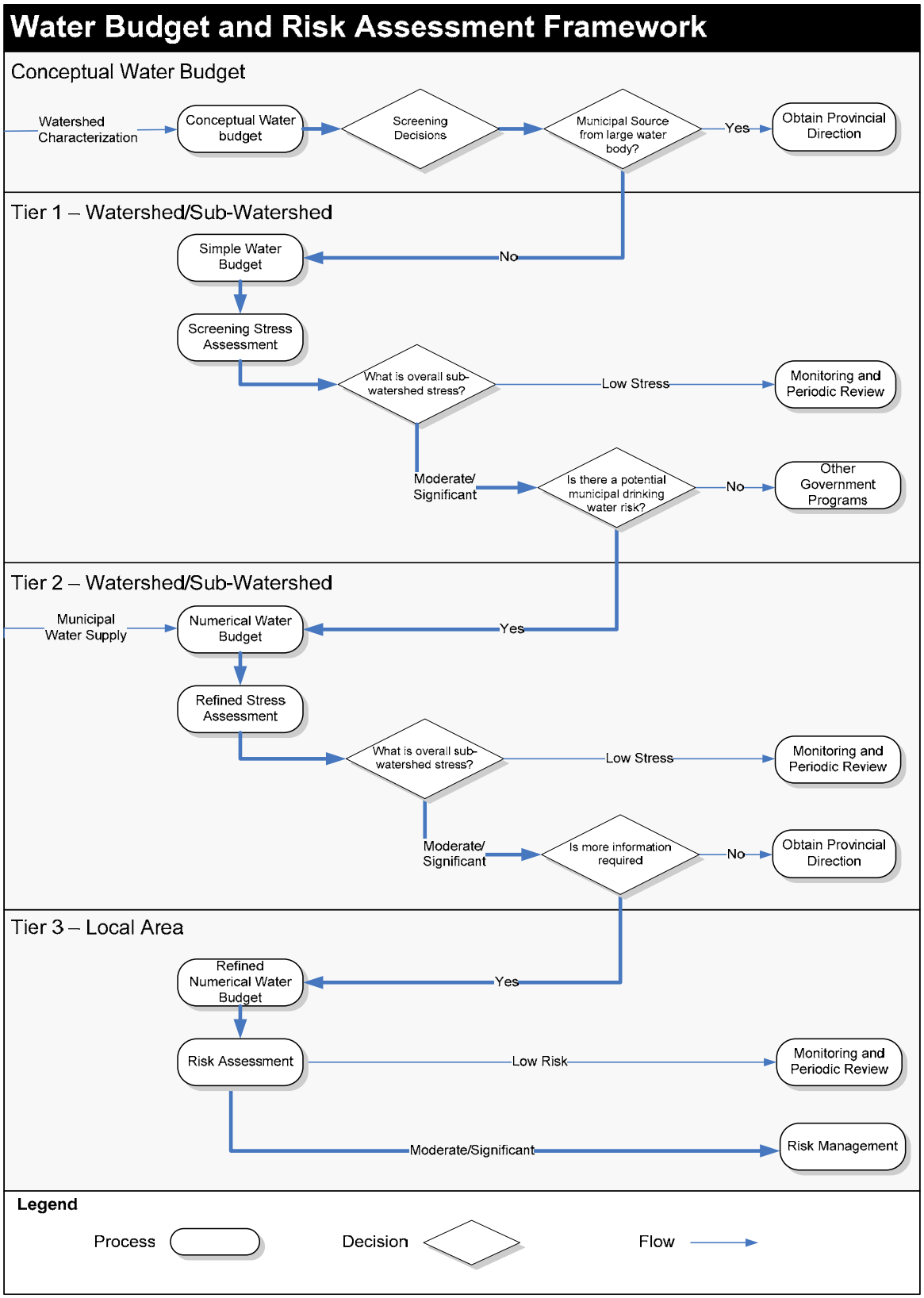


Figure 2 - Tier 2 Water Budget and Stress Assessment Process

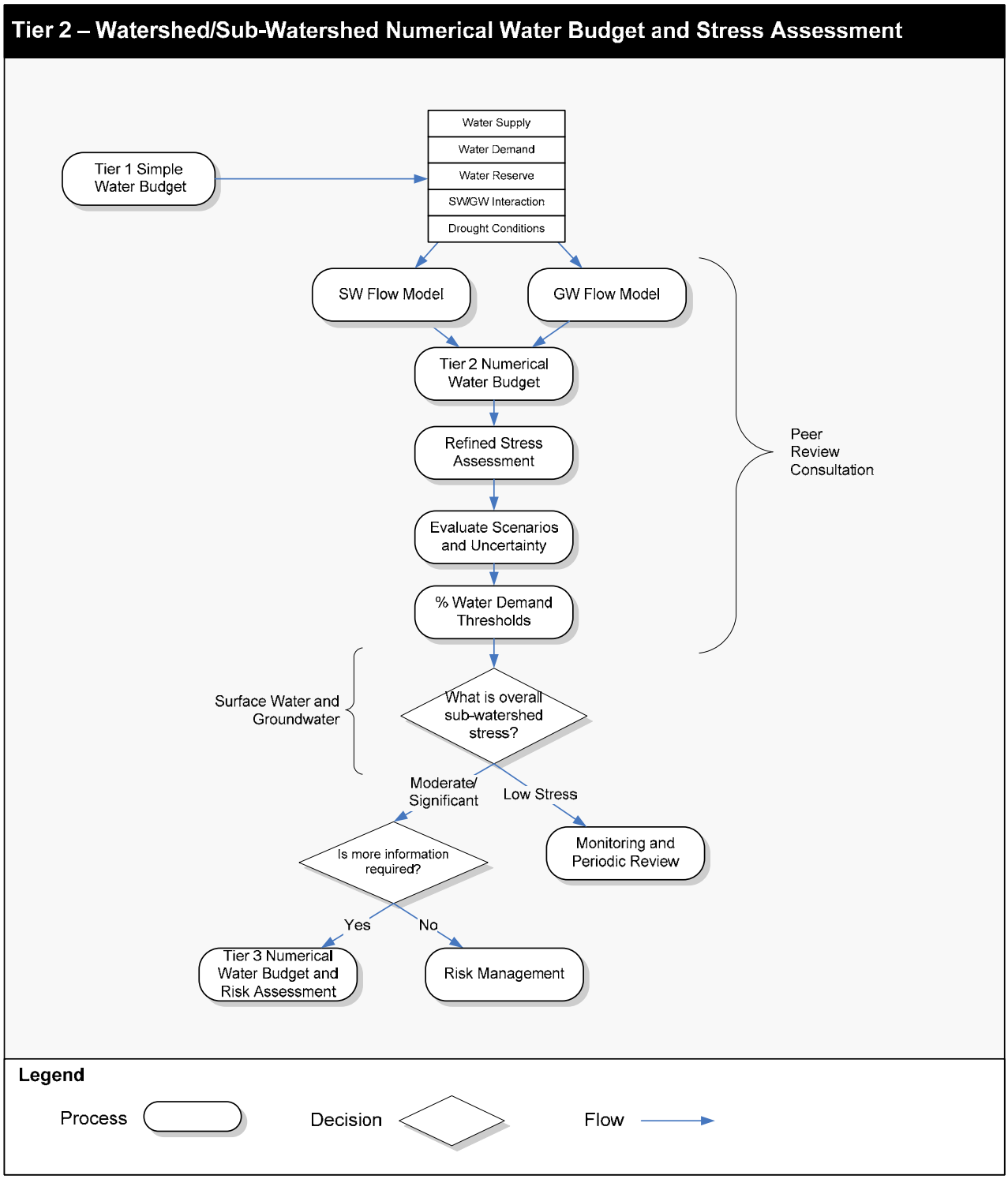


Figure 3 - Study Area.

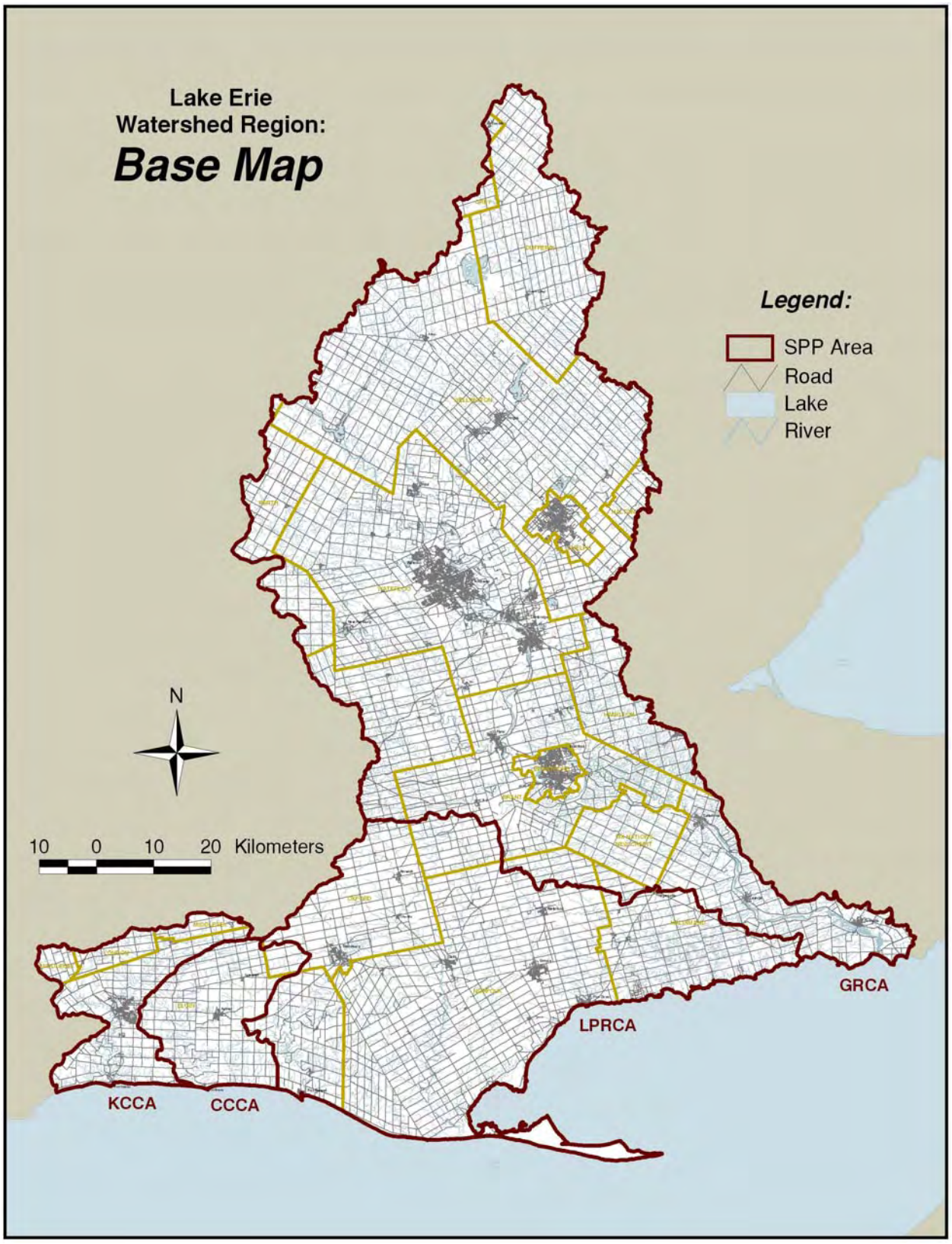


Table 1 - Peer Review Committee for Lake Erie Source Protection Region

Peer Review Role	Grand River	Long Point Region, Catfish Creek, Kettle Creek
Peer Review Leader	James Etienne, P.Eng., Grand River Conservation Authority	James Etienne, P.Eng., Grand River Conservation Authority
Peer Reviewer	Dr. Dave Rudolph, University of Waterloo	Dr. Dave Rudolph, University of Waterloo
Peer Reviewer	Dr. Hugh Whiteley, University of Guelph	Dr. Hugh Whiteley, University of Guelph
Peer Reviewer	Chris Neville, S.S. Papadopulos and Associates	Chris Neville, S.S. Papadopulos and Associates
Peer Reviewer	Dave Belanger, P.Eng, City of Guelph	Dr. Robert A. Schincariol, University of Western Ontario
Peer Reviewer	Eric Hodgins, P.Geo., Regional Municipality of Waterloo	John Warbick, Ministry of Agriculture and Rural Affairs
MNR Representative	Mike Garraway, Ministry of Natural Resources	Mike Garraway, Ministry of Natural Resources
MNR Representative	Scott Bates, Ministry of Natural Resources	Scott Bates, Ministry of Natural Resources
CO Representative	Jennifer Havelock, Conservation Ontario	Jennifer Havelock, Conservation Ontario

Table 2 – Technical Resources for the Peer Review Committee

Project Team	Lorrie Minshall, P.Eng., Lake Erie SP Region
	Paul Martin, AquaResource Inc.
	Dave VanVliet, AquaResource Inc.
	Sam Bellamy, AquaResource Inc.
	Gregg Zwiers, P.Geo., GRCA
	Sonja Strynatka, GRCA
	Stephanie Shifflett, GRCA
	Amanda Wong, GRCA

Appendix B-1

Phase 1 Peer Review Meeting Materials

- **November 24, 2006**
  - **Agenda, slides & minutes**

- **December 13, 2006**
  - **agenda & minutes**

Lake Erie Source Protection Region

Water Budget Peer Review Committee Meeting

November 24th, 2006

GRCA Head Office (400 Clyde Road, Cambridge)

Grand Room

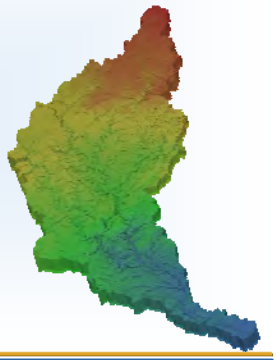
Agenda

10:00 to 10:10	Welcome and Introduction • Purpose of Meeting	J. Etienne
10:10 to 10:20	Roundtable • Participant Expectations	All
10:20 to 10:35	Terms of Reference • Confirmation	J. Etienne
10:35 to 11:05	Water Budget Guidance • Overview	D. VanVliet
11:05 to 11:45	Grand River Water Budget • Powerpoint Presentation	D. VanVliet
11:45 to 12:30	Question & Answer Session	All
12:30 to 1:00	Lunch	
1:00 to 1:45	Question & Answer Session	All
1:45 to 1:50	Next Steps	J. Etienne
1:50 to 2:00	Roundtable • Summary Comments	All

Next Meeting: Wednesday, December 13th, 2006 - GRCA

Grand River Watershed

Framework - Tier 2 Water Budget and Preliminary Stress Assessment



November 24, 2006

Clean Water Act (Bill 43)

Assessment reports

15. (1) The source protection committee for a source protection area shall prepare an assessment report for the source protection area in accordance with the regulations, the rules and the terms of reference.

Contents

(2) An assessment report shall, in accordance with the regulations, the rules and the terms of reference,

(a) identify all the watersheds in the source protection area;

(b) characterize the quality and quantity of water in each watershed identified under clause (a);

(c) set out a water budget for each watershed identified under clause (a) that,

(i) identifies the different ways that water enters and leaves the watershed and quantifies the amount of water that enters or leaves in each way,

(ii) describes the groundwater and surface water flows in the watershed,

(iii) quantifies the existing and anticipated amounts of water taken from the watershed that require a permit under section 34 of the *Ontario Water Resources Act*,

(iv) quantifies the existing and anticipated amounts of water taken from the watershed that do not require a permit under section 34 of the *Ontario Water Resources Act*, and

(v) having regard to the information referred to in subclauses (i) to (iv), describes any **existing or anticipated water shortages in the watershed**;

(d) identify all the significant groundwater recharge areas and highly vulnerable aquifers that are in the source protection area;

Source Protection Modules

1) Watershed Characterization

2) Municipal Water Supply Strategies

3) Groundwater Vulnerability Analysis

4) Surface Water Vulnerability Analysis

5) Issues Evaluation and Threats Inventory

6) Water Quality Risk Assessment

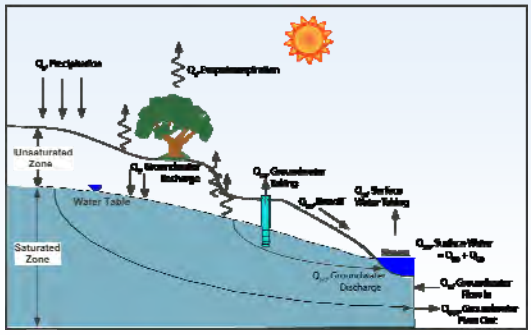
7) Water Budget and Water Quantity Risk Assessment

Underlined modules have significant linkages to water budget

Water Budgets

- Objective: To provide a technically sound methodology for managing the quantity of existing and future sources of water.
- Analysis will address the following questions:
  - Where is the water? (i.e., where are the various watershed hydrologic elements (e.g. soils, aquifers, streams, lakes, located?)
  - How does the water move between these elements? (i.e., what are the pathways through which the water travels?);
  - What and where are the stresses on the water? (i.e., where are the takings?); and
  - What are the trends? (i.e., are levels declining, increasing, or remaining constant over time?).

Water Budgets – Understand the Hydrologic Cycle



Water Quantity Risk Assessment

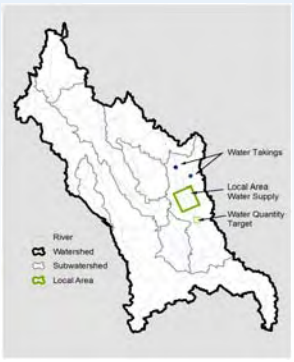
- Objectives:
  - A framework to evaluate the sustainability of current or future water demands. Evaluates surface water intakes or wellheads in the context of the local watershed.
  - Help managers estimate the risk that their drinking water sources may not be able to meet current or future demands
- Approach
  - Estimate hydrologic stress for subwatersheds using a screening technique
  - Apply detailed water budget tools for municipal water supplies situated within stressed subwatersheds

Multi-Tiered Process

- Objective of Multi-Tiered Approach
  - Minimize technical water budget efforts for areas and water supplies that are not under hydrologic stress.
- Tiers
  - Conceptual Water Budget – All source protection areas
  - Tier 1 (Simple) Water Budget and Stress Assessment – All source protection areas
  - **Tier 2 (Complex) Water Budget and Stress Assessment – Watersheds/Subwatersheds under hydrologic stress**
  - Tier 3 (Local, complex) Water Budget and Water Quantity Risk Assessment – Municipal water supplies under a moderate or high level of hydrologic stress

Note: GRCA entered process at Tier 2 with provincial consent

Tiered Process and Scale Considerations



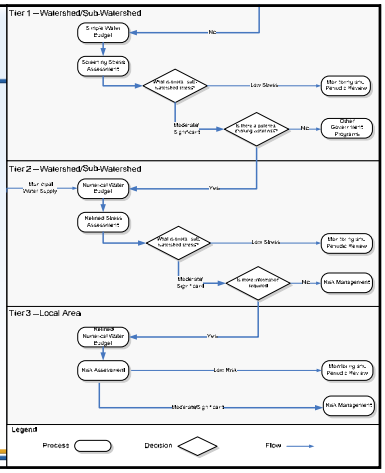
Framework

Conceptual Water Budget

Tier 1 – Watershed / Sub-Watershed

Tier 2 – Watershed / Subwatershed

Tier 3 – Local Area



Tier 2 Water Budget

- Recommended Modelling Approach
  - Continuous surface water model (daily streamflow)
  - Three-dimensional groundwater flow model
- Outputs / Deliverables
  - Calibrated models
  - Maps/tables summarizing key hydrologic parameters, processes
  - Understanding of groundwater / surface water interactions
  - Significant recharge areas
  - Refined water demand estimates
  - Develop understanding of instream flow requirements in 'stressed' areas
  - Tier 2 Stress Assessment

Tier 1 and Tier 2 – Stress Calculation

- Screening-level estimate of water quantity stress calculated as:

$$\% \text{ Water Demand} = \frac{\text{Demand}}{\text{Supply} - \text{Reserve}}$$

  - Demand
    - Estimated average annual and monthly consumptive water demand
  - Supply
    - GW - Average annual recharge, lateral flow in
    - SW – Median monthly streamflow
  - Reserve
    - GW - Calculated as a % of groundwater discharge rate (ignored for Tier 1)
    - SW – Lower decile monthly streamflow

Tier 1 and Tier 2 – Stress Calculation

- % Water Demand calculated:
  - Separately for surface water and groundwater
  - Average annual and monthly demands
  - Forecasted Demand Scenarios
    - Current, 10-Year, 25-Year
- Final subwatershed stress is calculated based on maximum % Water Demand and predefined thresholds

Drought Scenario

- Designed to estimate impacts to municipal water supplies from extreme drought conditions
- Groundwater
  - Eliminate recharge and run transient model for two year period – estimate impacts to municipal supplies
- Surface Water
  - Identify extreme drought period and calculate % Water Demand during the period

Water Demand Estimation

- Estimate **consumptive** water demand.
  - Consumptive demand refers to water taken from groundwater or surface water and not returned locally in a reasonable time period
  - Water budget guidance includes framework and database to adjust PTTW rates based on seasonal usage and consumptive use factors.
- Tier 2 -> 3
  - Refinement of PTTW database to estimate consumptive water demand
    - Reported municipal pumping rates
    - Appendix C, Surveys of water users
  - Estimate non-permitted demand (i.e. rural domestic, agricultural)
  - Refined estimation of future demands

Tier 2 – % Water Demand Thresholds

Groundwater — Subwatershed Stress Level

Scenario	Significant	Moderate	Low
Average Annual	>25%	10-25%	0-10%
Monthly	>50%	25-50%	0-25%

Surface Water — Subwatershed Stress Level

Scenario	Significant	Moderate	Low
Monthly	>50%	20-50%	0-20%

[1] Technical Assessments – All subwatersheds having municipal water supplies with some history meeting water supply quantity requirements will be assigned at least a moderate stress level. Further, if in professional opinion there is potential of water supply shortages, the stress level would be assigned at least a moderate stress level.

Tier 3 – Water Quantity Risk Assessment

- Completed for municipal sources that are located within watersheds/subwatersheds that have been assigned a Tier 2 moderate or significant degree of stress
- Objective
  - A detailed water budget tool for water managers to assess water use and impacts from water demands
  - Evaluate the risk that a community may not be able to meet its current or future water demands from a water source.
- Complex groundwater and/or surface water numerical models.
  - These models should be developed with the accuracy and refinement needed to evaluate hydrologic or hydrogeologic conditions directly at a water supply well or intake.
  - The scope of these models must also be developed with sufficient spatial scale to evaluate the potential impacts of increased future water demands on external water quantity receptors

Tier 3 – Water Reserve Estimation

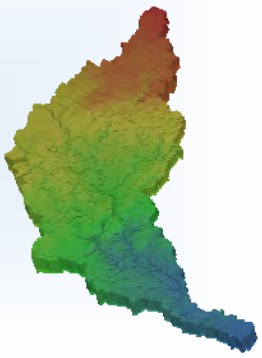
- Water reserve may represent the following:
  - the requirement for minimum streamflow to be sustained to support anthropogenic or ecological needs. Locations corresponding to specific reserve requirements will be classified as 'water quantity receptors' as part of the water quantity risk assessment. .
  - the requirement for groundwater levels to be sustained to support anthropogenic or ecological needs. The requirement to sustain groundwater levels may be determined by individual ecological features that depend on water levels being at a certain elevation.
- Significant effort is expected to define water reserve for Tier 3 assessments

Tier 3 – Summary of Approach

1. Builds on the water budget work undertaken at Tier 2 by:
   a. further characterizing water intakes and intake performance
   b. refining estimates of future demand and water quantity threats
   c. identify hydrologic or hydrogeologic water reserve requirements
2. Water budget modelling
   a. Develop and calibrate the surface water / groundwater models
   b. Run various scenarios including current and future demand conditions, drought conditions
3. Estimate the **water quantity exposure** of a surface water intake or groundwater supply well from intake **reliability**.
4. Estimate the **tolerance** of the municipality's primary water sources to water quantity shortages by considering existing backup or storage facilities and the success of conservation measures.
5. Estimate impact from takings on water reserve targets
6. Based on a combination of water quantity exposure, supply tolerance, and impact on reserve targets, assign the appropriate level of **water quantity risk** to the municipality's groundwater well and/or surface water intake.
7. Estimate the significance of **water quantity threats**.

Grand River Watershed

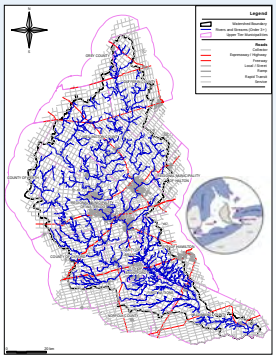
Summary of Water Budget Report



November 24, 2006

Summary of Report

1. Introduction
2. Watershed Characterization
3. Water Demand
4. GAWSER Model
5. FEFLOW Model
6. Integrated Water Budget
7. Water Quantity Stress Assessment
8. Conclusions



2. Watershed Characterization

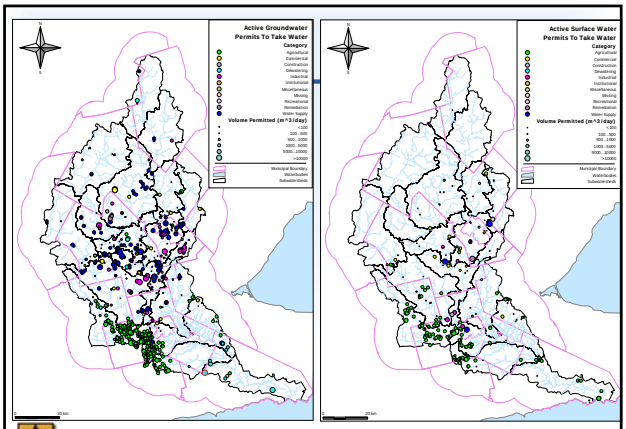
- Concise watershed-based discussion with general subwatershed details
- Topography and Physiography
  - Moraines and general physiographic zones
- Geology
  - Bedrock geology, bedrock valleys, surficial geology
- Hydrogeology
  - Generalized hydrostratigraphic units, significant regional aquifers
- Surface Water Hydrology
  - Subwatershed-based characterization of predominant hydrological processes and observations. Includes climate, wetlands, water control structures, land cover

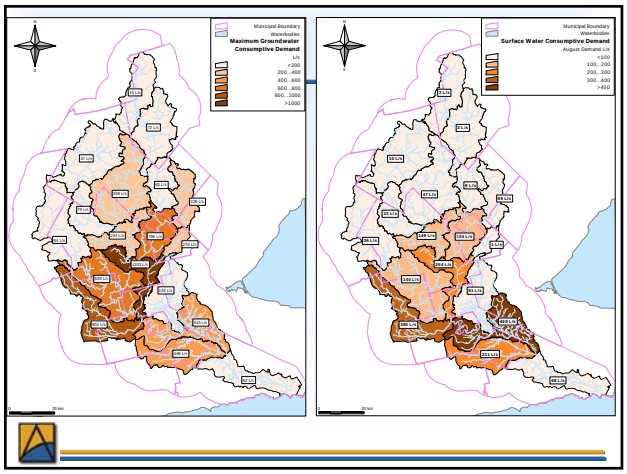
3. Water Demand

- Estimated consumptive surface water and groundwater demand
  - Consumptive demand refers to the amount of water not returned to the same hydrologic or hydrogeologic source (i.e. stream or aquifer)
- Follows water budget guidance (Appendix C, Water Demand Estimation)
- Water demands include:
  - Reported municipal pumping rates
  - Estimated consumptive demand for other permitted users (i.e. aggregate)
  - Non-permitted agricultural use
  - Unserviced domestic water use

3. Water Demand – Consumptive Use Factors

Category	Specific Purpose	Consumptive Factor	Category	Specific Purpose	Consumptive Factor
Agricultural	Field and Pasture Crops	0.8	Institutional	Hospitals	0.25
Agricultural	Fruit Orchards	0.8	Institutional	Other - Institutional	0.25
Agricultural	Market Gardens / Flowers	0.9	Institutional	Schools	0.25
Agricultural	Nursery	0.9	Miscellaneous	Dams and Reservoirs	0.1
Agricultural	Other - Agricultural	0.8	Miscellaneous	Heat Pumps	0.1
Agricultural	Sod Farm	0.9	Miscellaneous	Other - Miscellaneous	1
Agricultural	Tender Fruit	0.8	Miscellaneous	Pumping Test	0.1
Agricultural	Tobacco	0.9	Miscellaneous	Wildlife Conservation	0.1
Commercial	Aquaculture	0.1	Recreational	Aesthetics	0.25
Commercial	Bottled Water	1	Industrial	Manufacturing	0.25
Commercial	Golf Course Irrigation	0.7	Industrial	Other - Industrial	0.25



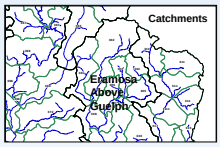


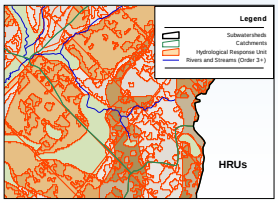
4. GAWSER Model

- Model selection
  - GAWSER model used by GRCA since late 1980's
- Simulate hydrologic processes in response to long-term climate dataset:
  - Runoff, evapotranspiration, recharge, soilwater and groundwater storage, and streamflow
- Current project activities focus on calibration refinement and low-flow streamflow estimates
  - Recharge rates increased significantly in lower permeability soils as compared to initial estimates

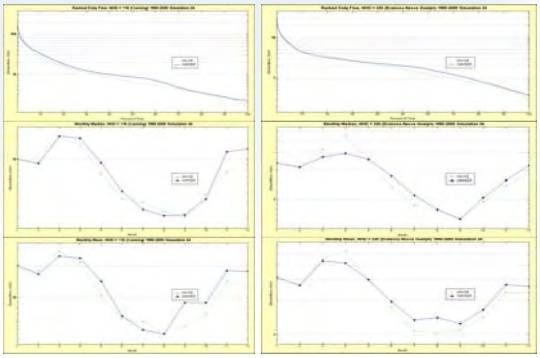
4. GAWSER Model - Development

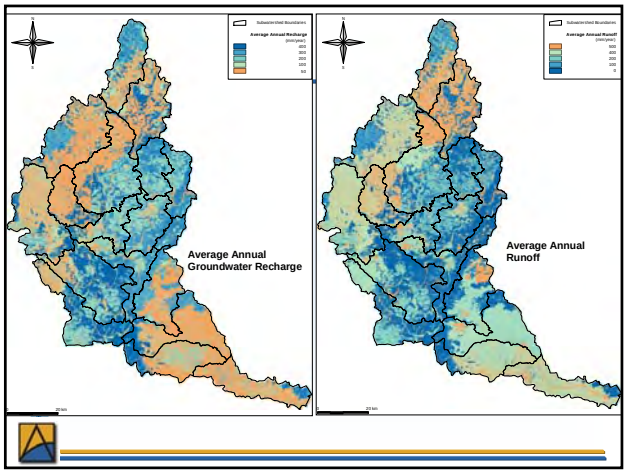
- Climate data
  - Climate data 'cleaned up' by GRCA. 13 Zones of Uniform Meteorology' delineated
- Catchment delineation
- Hydrologic Response Units (HRUs)
  - Land areas sharing similar geology and land cover





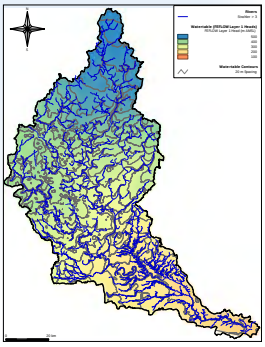
4. GAWSER Calibration Refinement



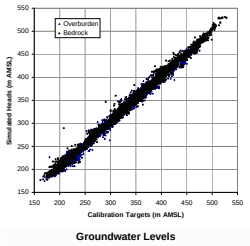


5. Groundwater Flow - FEFLOW

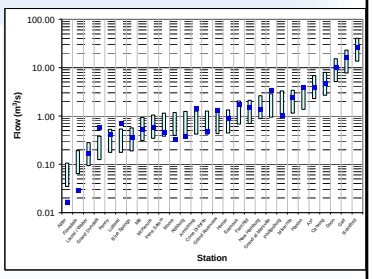
- Waterloo Hydrogeologic (2005)
  - Development of conceptual model and preliminary calibration
- Current work
  - Higher recharge rate estimates (GAWSER)
  - Boundary conditions revised around model border
  - Delineation of Calibration Regions
  - Eramosa member added
  - Subwatershed-scale calibration refinement with some smaller-scale considerations (i.e. Mill Creek)



5. FEFLOW – Calibration Metrics



Groundwater Levels



Baseflow Estimates

6. Integrated Water Budget

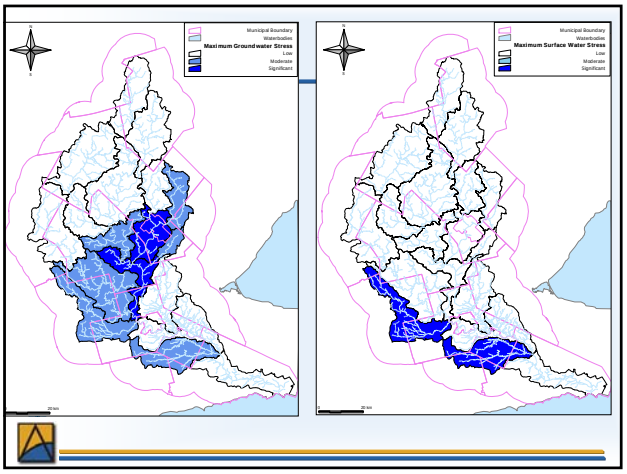
- Evaluate GAWSER and FEFLOW results for each subwatershed and moraine areas
  - Basic hydrologic parameters
- Discuss water budget results for each subwatershed and moraine areas
  - comment on significance of water demand
  - Assess calibration

6. Integrated Water Budget – Subwatershed Results

Basin	Area (sq km)	GAWSER (mm/year)				FEFLOW (mm/year)					
		Precip	ET	Runoff	Rech	Rech	Bound-ary	Lake	River	Wells	Inter-Basin	Flow In Ratio
Grand Above Legatt	365	988	469	338	182	177	0	-5	-150	-1	-21	-12%
Grand Above Shand To Legatt	426	988	464	351	173	173	-2	-29	-136	-4	-1	-2%
Grand Above Conestogo To Shand	640	925	487	277	161	162	0	-2	-123	-12	-25	-16%
Conestogo Above Dam	566	936	495	322	129	126	-31	-14	-54	-2	-25	-44%
Conestogo Below Dam	254	968	487	361	121	124	0	0	-210	-4	91	73%
Grand Above Doon To Conestogo	248	897	500	195	202	210	0	-6	-195	-32	23	11%
Eramosa Above Guelph	230	892	506	135	251	247	-16	0	-248	-27	45	12%
Speed Above Dam	242	894	529	118	247	248	0	-10	-225	-1	-11	-5%
Speed Above Grand To Dam	308	899	510	154	225	231	0	0	-173	-75	17	7%
Mill Creek	82	888	507	87	294	307	0	0	-204	-40	-63	-20%
Grand Above Brantford To Doon	274	896	496	161	239	256	0	-1	-215	-121	81	32%
Nith Above New Hamburg	545	992	503	343	147	146	-28	0	-80	-2	-36	-44%
Nith Above Grand To New Hamburg	583	945	508	154	283	290	0	0	-213	-32	-45	-16%
Whitemans Creek	404	945	512	175	258	263	-29	0	-210	-14	-11	-15%
Grand Above York To Brantford	476	896	495	281	121	124	-27	0	-127	-10	40	10%
Fairchild Creek	401	866	468	257	141	143	4	0	-130	-7	-11	-5%
Mckenzie Creek	368	945	481	336	126	130	3	0	-92	-11	-29	-29%
Grand Above Dunnville To York	356	945	465	387	94	91	9	-4	-82	-5	-8	1%
Total Watershed	**6,769**	**933**	**491**	**262**	**190**	**182**	**-8**	**-4**	**-147**	**-18**	**-4**	**-7%**
Moraine Assessment Zones												
Elmira	230	913	486	267	160	157	0	-8	-65	-13	-71	-45%
Orangeville	371	932	508	186	239	235	-8	-1	-158	-1	-67	-32%
Paris/Galt	480	894	517	85	292	269	-3	-1	-166	-41	-78	-28%
Waterloo	993	955	496	252	207	206	-1	-2	-121	-35	-48	-24%

7. Water Quantity Stress Assessment

- Estimates of demand, supply, and reserve determined from GAWSER and FEFLOW results
- Surface Water
  - Supply – Median monthly flow (1980-2000)
  - Reserve – Lower decile monthly flow (1980-2000)
- Groundwater
  - Supply – Recharge + lateral flow into watershed (if watershed has a net inflow of water)
  - Reserve – 10% of groundwater discharge in the subwatershed



8. Conclusions

- Water Use
  - Methodology for estimation of consumptive demand resulted in more realistic water budget calculations
  - Need for additional monitoring data to validate consumptive estimates
- GAWSER
  - Calibration refinement resulted in higher recharge estimates that are more consistent with expected values
- FEFLOW
  - Acceptable regional-scale calibration (~ 2% NRMS)

8. Conclusions

- Water Quantity Stress Assessment. The following subwatersheds are identified as being under moderate or high stress.
  - Whiteman's Creek (Groundwater and Surface Water)
  - McKenzie Creek (Groundwater and Surface Water)
  - Nith Above Grand to New Hamburg (Groundwater)
  - Eramosa River Above Guelph (Groundwater)
  - Speed River Above Grand to Dam (Groundwater)
  - Grand Above Brantford to Doon (Groundwater)
  - Mill Creek (Groundwater)
  - Grand Above Doon to Conestogo (Groundwater)
  - Grand Above Conestogo to Shand (Groundwater)
  - Nith Above Grand to New Hamburg (Groundwater)

8. Conclusions - Gaps

- Modelling Gaps
  - GAWSER. Water takings not included
    - GAWSER is not 'mass conservative' with respect to groundwater storage
  - FEFLOW
    - Local calibration requirements
- Stress Assessment
  - Scenarios not considered
    - Future demand
    - Drought
  - Historical observations
    - Historical observations of water quantity stress
  - Water demand estimates
    - Consumptive ratios have not been validated using monitoring data

Source Water Protection Water Budget Peer Review Meeting Minutes

November 24th, 2006

Present: *Peer Review Leader*
James Etienne – GRCA
Peer Reviewers
Hugh Whiteley – University of Guelph
Chris Neville – S.S. Papadopulos & Associates
Dave Belanger – City of Guelph/CH2M Hill Canada Ltd.
Eric Hodgins – Regional Municipality of Waterloo
Robert Schincariol – University of Western Ontario
Peer Review Representatives
Mike Garraway, Scott Bates – Ministry of Natural Resources
Jennifer Havelock – Conservation Ontario
Project Team
Lorrie Minshall, Gregg Zwiers, Stephanie Shifflett – GRCA
Paul Martin, Dave Van Vliet, Sam Bellamy – AquaResources Inc.

Regrets: *Peer Reviewer*
Dave Rudolph – University of Waterloo

Introduction

J. Etienne welcomed the Peer Review Team and explained the purpose of the meeting and review process.

Participant Expectations

The Peer Review Team discussed their expectations for the peer review process which included the assessment and development of a report from a scientific view point so it is scientifically defendable for wide distribution. The review will address concerns aimed at; limiting uncertainty with respect to the type of data used, the assessment of model results and arriving at a clear understanding of the watershed being modelled. The review will assist in the delivery of a final product to the Conservation Authority that satisfies municipal, provincial and consultant expectations.

Terms of Reference (TOR)

L. Minshall discussed that the objectives of the TOR with respect to the duties of the participants, the timeline of the process and the hours required.

Presentation on the Tier 2 Framework

D. Van Vliet presented an overview on the Framework for Tier 2 Water Budget and Preliminary Stress Assessment.

Presentation on GRCA's Water Budget

D. Van Vliet provided a summary presentation of the Grand River Water Budget Report.

Question and Answer Discussions

J. Etienne facilitated discussion on a number of questions from the peer reviewers including:

- Level of evaluation and data needs,
- Scale and stress levels,
- Gaps in the report and
- Differences between Tier 2 and Tier 3.

Action Items

As a result of the meeting the following action items were generated:

- AquaResource will provide a Table of Contents for the Technical Appendix. Data used in the Water Budget and requested by the Peer Review Team will be put on the ftp site or be provided in a CD the week of November 27th for the Peer Review Team.
- J. Etienne will contact D. Rudolph to bring him up to date on the November 24th meeting.
- Peer reviewers are asked to submit any additional comments or questions to J. Etienne for circulation to all project team members.
- Written comments are due in to J. Etienne by December 11th (or sooner) to allow for consolidation, preparation and circulation prior to the next meeting.

Next Meeting

The next meeting, scheduled for 10am-2pm on December 13th at the GRCA, will be held to review the consolidated comments and agree on actions to be taken to address the comments. The meeting may include some time for review of technical work.

Lake Erie Source Protection Region

Water Budget Peer Review Committee Meeting

December 13th, 2006

GRCA Head Office (400 Clyde Road, Cambridge)

Grand Room

Agenda

10:00 to 10:05	Welcome and Introduction • Purpose of Meeting	J. Etienne
10:05 to 10:15	Review of Previous Meeting Minutes • Minutes Attached	All

10:15 to 1:45	Review Consolidated Peer Reviewer Comments
	• Errors and Omissions
	• Data Input
	• Modelling
	  o GAWSER
	  o FEFLOW
	• Terminology (ie. "significant stress")
	• Identify Actions to Address Comments
	  o Needed to complete Tier 2 (analysis, calibration, refinement)
	  o Editorial correction
	  o Deferred
	  o Work required in Tier 3
		All

12:00 to 12:30	Lunch	All
1:45 to 1:55	Next Steps • Review Action Items	J. Etienne
1:50 to 2:00	Roundtable • Summary Comments	All
Time permitting	Technical Review	

Next Meeting: tbd

Source Water Protection Water Budget Peer Review Meeting Minutes

November 24th, 2006

Present: *Peer Review Leader*
James Etienne – GRCA
Peer Reviewers
Hugh Whiteley – University of Guelph
Chris Neville – S.S. Papadopulos & Associates
Dave Belanger – City of Guelph/CH2M Hill Canada Ltd.
Eric Hodgins – Regional Municipality of Waterloo
Robert Schincariol – University of Western Ontario
Peer Review Representatives
Mike Garraway, Scott Bates – Ministry of Natural Resources
Jennifer Havelock – Conservation Ontario
Project Team
Lorrie Minshall, Gregg Zwiers, Stephanie Shifflett – GRCA
Paul Martin, Dave Van Vliet, Sam Bellamy – AquaResources Inc.

Regrets: *Peer Reviewer*
Dave Rudolph – University of Waterloo

Introduction

J. Etienne welcomed the Peer Review Team and explained the purpose of the meeting and review process.

Participant Expectations

The Peer Review Team discussed their expectations for the peer review process which included the assessment and development of a report from a scientific view point so it is scientifically defendable for wide distribution. The review will address concerns aimed at; limiting uncertainty with respect to the type of data used, the assessment of model results and arriving at a clear understanding of the watershed being modelled. The review will assist in the delivery of a final product to the Conservation Authority that satisfies municipal, provincial and consultant expectations.

Terms of Reference (TOR)

L. Minshall discussed that the objectives of the TOR with respect to the duties of the participants, the timeline of the process and the hours required.

Presentation on the Tier 2 Framework

D. Van Vliet presented an overview on the Framework for Tier 2 Water Budget and Preliminary Stress Assessment.

Presentation on GRCA's Water Budget

D. Van Vliet provided a summary presentation of the Grand River Water Budget Report.

Question and Answer Discussions

J. Etienne facilitated discussion on a number of questions from the peer reviewers including:

- Level of evaluation and data needs,
- Scale and stress levels,
- Gaps in the report and
- Differences between Tier 2 and Tier 3.

Action Items

As a result of the meeting the following action items were generated:

- AquaResource will provide a Table of Contents for the Technical Appendix. Data used in the Water Budget and requested by the Peer Review Team will be put on the ftp site or be provided in a CD the week of November 27th for the Peer Review Team.
- J. Etienne will contact D. Rudolph to bring him up to date on the November 24th meeting.
- Peer reviewers are asked to submit any additional comments or questions to J. Etienne for circulation to all project team members.
- Written comments are due in to J. Etienne by December 11th (or sooner) to allow for consolidation, preparation and circulation prior to the next meeting.

Next Meeting

The next meeting, scheduled for 10am-2pm on December 13th at the GRCA, will be held to review the consolidated comments and agree on actions to be taken to address the comments. The meeting may include some time for review of technical work.

Appendix B-2

Phase 1 Draft Document Peer Review Comments

- **December 8, 2006 e-mail from Hugh Whiteley**
- **December 12, 2006 memo from Chris Neville**
- **January 9, 2007 memo from Dave Rudolph**

James Etienne

From: hwhitele@uoguelph.ca
Sent: Friday, December 08, 2006 12:10 PM
To: David Van Vliet \\(AquaResource\\)
Cc: James Etienne
Subject: RE: Peer Review Meeting - Water Budget and Water Quantity RiskAssessment

Preliminary Comments on Integrated Water Budget Report

I find that the core analyses in the report are fully satisfactory. I have suggestions as given below of areas where some additional explanation of the procedures used are needed for full comprehension of the hydrological assumptions that underlie the results obtained.

(a) Period for long-term analysis

The latest 30-y Climate Normal Period is the best base for for long-term water balance as the stability of the precipitation portion of the balance (as regards effects of short term erratic occurrence of wet and dry periods) is well established and 30 y has been demonstrated to produce this stability. Where a shorter period is used some estimate should be given of the amount of difference to be expected because the Climate Normal Period was not used.

(b) Calibration of the GAWSER model (section 4.4)

The flowrate sequences generated by GAWSER for a specific gauge location make include baseflow generated by a distribution of recharge from HRUs to either a fast or a slower groundwater storage/transmission element. As presently constituted an individual HRU in GAWSER can only be directed to one of the two groundwater elements, an HRU cannot be split between them. Each of the HRUs as listed in Table 4.3 is assigned to one or other of the fast or slower elemnts.

The report should include a paragraph description of the generation of baseflow outflow in GAWSER and the table of HRUs should give the allocation of them to the baseflow-generating elements (fast or slower). It is important that readers of the report realise that the fast response shallow groundwater system is included in the GAWSER streamflow response and that recahrge to this part of the groundwater system is included in the GAWSER estimates of recharge.

(c) FEFLOW model calibration section 5.2.2

In the comparison of FEFLOW results to groundwater discharge (Figure 54) the origin of the groundwater discharge (baseflow)data should be described clearly. I understand it to be the period mean for separated baseflow for a gauging station with the assumption made that all the separated baseflow is groundwater discharge. I think this is a reasonable approach and the assumption that esesentially all the separated flow is from groundwater is reasonable for the Grand given the separation techniques that was used. It should be made clear that the faster responding segment of the groundwater disharge system is put into the baseflow component and that this is consistent with the GAWSER streamflow calibration as noted above. This means that recahrge amounts from GAWSER are properly compared with recharge amounts used in FEFLOW.

At some point it would be good ro point out that the shallower part of the groundwater system (mostly portions of the overburden layer with shallow depths to watertable and short flow paths to discharge locations) are unlikely to be used for water supply and thus recharge to this part of the system cannot be considered adding to the reliability of groundwater for extraction

(d) SUBWATERSHED WATER BUDGET RESULTS 6.2

To reinforce the equilibrium assumption in the mass-balance results presented in this section there should be an introductory comment that calculations are based on no change over time in water stored (as surface water, soilwater, or groundwater). As a result all water entering the subwatershed is accounted for as some type of output The inputs and outputs should be listed as a reminder.

(e) Section 2.4.3 Evapotranspiration

The term evapotranspiration creates problems because not all users agree on the intention that led to the coining of the term. Dr. Penman hated the term evapotranspiration because he correctly feared it would obscure the underatanding that there is only one process in physics for transforming liquid water to water vapour and that process is fully described as "evaporation". Transpiration is not evaporation but is rather the transfer mechanism that transports liquid water to the stomata of leaves where the liquid water evaporates.

Based on this I suggest the following wording for this section

Evapotranspiration is an inclusive term for the amount or rate of transfer of liquid or solid water into atmospheric water vapour at the watershed surface. Evapotranspiration is the sum of sublimation of snow or ice, and evaporation of liquid water in surface depressions (streams, ponds, lakes,) evaporation of liquid water held as films on vegetation or on other surfaces, evaporation of liquid water in leaf stomata (transpiration), evaporation of liquid water in soilwater pores exposed to the atmosphere, evaporation from groundwater in locations where the watertable is exposed to the atmosphere. In summer, and for vegetated surfaces, the main contribution to evapotranspiration is transpired water.

(f) General comment on the term soilwater.

I prefer, for consistency and as a fully scientific notation, that "soilwater" be used in place of "soil moisture". It is then fully parallel to groundwater and surface water and thus reinforces the understanding of tranferability among these forms. I guess I should favour the term vapourwater rather than water vapour for full consistency!

Hugh Whiteley
December 8 2006

Review comments on

Integrated Water Budget Report: Grand River Watershed

AquaResource Inc.
Draft October 2006

Christopher J. Neville
S.S. Papadopulos & Associates, Inc.
Last update: December 12, 2006

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1. These review comments will be limited to only substantive remarks. In reading the report we have accumulated several editorial comments. We would be willing to transmit our marked-up version of the draft report to the authors.

2. It is clear that a significant effort was devoted to the data compilation, analyses and documentation. In our opinion the work has been conducted at a very high technical standard. The introduction of the report indicates that the objective of the surface and groundwater modelling is to better characterize hydrological processes above and below the ground surface throughout the watershed, to support the evaluation of the watershed's water budget and estimation of the impacts of current and future water demands. In our opinion this objective has been achieved. The report may serve as a model for excellence in the synthesis of hydrologic data and interpretations at the watershed scale.

3. The report contains an excellent summary and analysis of surface water flow at the subwatershed scale.

   With respect to groundwater, in our opinion the report serves as an invaluable reference document for understanding regional-scale conditions, and for placing more refined analyses within the appropriate physical context. When reviewing the results of the groundwater modelling we recommend that emphasis be placed on the phrase "*throughout* the watershed".

4. In our opinion, the water budget analyses and stress assessment is particularly useful for focusing attention for further investigation and characterization. It will be particularly important to establish close links between the "guardians" of the regional-scale analyses and municipalities charged with collecting and acting upon local-scale hydrologic data.

5. We expect that the water budget report will be an important reference document. Therefore, in our opinion it is particularly important that the sources of mapping information be acknowledged appropriately. For example, who conducted the mapping of the physiography shown in Figure 5, the bedrock geology shown in Figure 8, or the Quaternary geology shown in Figure 11?

6. We have reviewed the supplementary materials and in our opinion they are excellent additions to the draft report. The materials have gone a long way towards addressing our requests for additional information that was conveyed during the first peer review meeting.

7. The report could benefit from a clear definition of the concept of "subwatershed." With respect to surface water flow it may be possible to define a subwatershed as a sub-basin that has a single outlet. However it is not so obvious how this definition can be extended to the groundwater flow system. There may be significant flow between "sub-groundwater sheds". This has important implications with respect to the assignment of stress designations. In our opinion, the assignment of stress levels to the groundwater system at the subwatershed scale provides a convenient, and relatively fine-scale of resolution; however, it is somewhat artificial and needs to be recognized as such. In our opinion, one of the important strengths of the analysis is the reporting of interpretations at the subwatershed scale: the analyses demonstrate the need to place Tier 2 and Tier 3 local-scale stress assessments within the larger context. When considering the development of additional groundwater resources it is essential that sustainability be considered with respect to at least the subwatershed, and in the case of major developments we will certainly argue for evaluation within the context of the entire watershed.

8. We are puzzled by the summary statistics for water use. According to our calculations, the components listed on Tables 1.2 and 3.1 add up to 87%. What is the other 13%? In this context does municipal water use represent gross water takings or net (i.e., consumptive use)?

9. In our opinion it is important to make a fundamental distinction between the surface water and groundwater modelling approaches that have been adopted. The FEFLOW model is a distributed while our understanding of the GAWSER model is that it is not with respect to flow in the subsurface. GAWSER has a component for storing groundwater; is it capable of routing groundwater storage between adjoining subwatersheds?

10. The report indicates that the FEFLOW and GAWSER models are loosely coupled through recharge rates assigned for the groundwater flow model. Is the coupling checked by comparing net groundwater inflows to surface water features calculated with the groundwater model against baseflows used in the calibration of the GAWSER analyses?

11. When referring to the calibration of the groundwater model, in our opinion it is important to note that the water level targets are approximate, and have a wide range of reliability. Although the groundwater analysis is described as "steady-state", this is not quite correct. A steady-state analysis refers to a formal time-averaged analysis. In contrast, the analysis is constrained with water level targets that are compiled over a relatively long period of time. The water level information from the MOE water well records do not provide an impression of conditions at a particular state of the system in time and there is also no way to check whether the water levels are representative of long-term average conditions.

12. Referring to Section 2.3.1, it is important to note that the information in the MOE water well record do not represent static conditions. These may refer to conditions in which a particular domestic supply well is not pumped, but there may be significant pumping elsewhere in a subwatershed. For example, we can only make rough guesses of what static conditions must have been like in the Region of Waterloo or the City of Guelph.

13. We agree that the bedrock valley features may play an important role in the regional hydrogeology. However, it is important to note that in some cases these valleys may not be hydrologically significant, as they may be filled with fine-grained materials. Without detailed drilling and especially data from long-term hydraulic testing or municipal supply well performance records, these features should be regarded as hypothetical. It is also important to note that the valleys may act as transmissive conduits for flow, but not as significant 'undeveloped' groundwater resources.

14. We strongly support the significant efforts to refine the estimates of water takings. The permitted withdrawals of 33 m^3/s represent about double the low flow summer target for the Grand River at Brantford. The improved estimate of actual pumped volume of 7 m^3/s is less dramatic; however, it still represents about half of the low flow summer target.

15. Referring to Table 3.10, there are significant differences between the subwatershed and watershed scale consumptive demands for five of the subwatersheds. What do these differences indicated? How are the values listed on Table 3.9 related to those on Table 3.10?

16. Referring to Figure 39, are these annual average water demands particularly relevant? Would it not be more appropriate to compare maximum monthly demand with minimum low flow requirements?

17. Although the calibration statistics for the groundwater model appear to fall within the bounds of informal criteria for model acceptance, in our opinion it is essential to keep in mind one particular number from the calibration. The Root-Mean-Square Error is about 8 m. We interpret this as a measure of the likely mismatch between the regional model and conditions at a site-specific location. That is, for an analysis at the scale of an individual wellfield, as a first approximation we would expect water levels calculated with the regional model to be within ±8 m of observations from dedicated, high reliability monitoring wells.

18. In our opinion, the groundwater stress assessments listed on Table 7.10 are reasonable. The label of "Moderate Stress" should not serve as the argument for a moratorium on further development of groundwater resources in designated areas. Rather, the designations should serve as indications that additional investigation and refined analyses are required.

Integrated Water Budget Report
Grand River Watershed
Peer Review Report
David L. Rudolph

January 9, 2007

1). Introduction

The document is very well written and extremely comprehensive in scope. The water budget and preliminary water quantity stress assessment for the Grand River Watershed is a unique case in Ontario because of the large extent of the data available and the degree of previous analysis that has been completed in the area by GRCA and others. As such, the study team has the advantage of an enormous amount of previous knowledge to draw from, including their own experience, yet also is faced with the challenge of compiling all of this information into a coherent package and providing an overall interpretation within the context of the provincial guidance modules. In contrast to most other watershed areas in the Province that are undertaking the watershed characterization and water budget components of the Source Water Protection program, the Grand River has been able to move directly to the Tier 2 level, something that may take many of the other areas years to achieve. As such, the Grand River report will be looked at as an example to follow across the province in addition, of course, to being the document that provides recommendations on how to proceed to Tier 3 within the Grand River watershed itself.

I believe the study team (AquaResources) has done an exceptionally good job at synthesizing the information relevant to the water budget and water quantity stress assessment for the Grand River watershed. I do, however feel that there are key components of the overall analysis and the fundamental data itself that have not been explained or represented to a sufficient degree in the document. For the report to be able to stand alone, without the benefit to the reader/user of a separate watershed characterization and Tier 1 document available to provide additional background information, several additional sections should be included in the final report. One key issue relates to the degree of certainty associated with the data sets used in the analysis and the confidence that the study team has in the observations/recommendations that are presented in the report. Another important component of the overall assessment that could be expanded in the report is an overall discussion of the previous work that has been done associated primarily with the modeling exercises. The new modeling results presented in the report should be compared to previous results, explained how they are an improvement/extension to what was previously known and where possible validated through comparison with previous work. For the sake of this peer review report, an initial section providing details on the major components of the report that this reviewer feels could benefit from expansion or inclusion will be presented first. This will be followed with detailed points relevant to the existing document.

2). General Comments on Report Structure

a). The report should include an executive summary of the major approaches used in the assessment and the conclusions.
b). To put the new work associated with this study in context, a fairly brief review of previous relevant studies and modeling efforts should be included at the start of the report. On P. 9, it is noted relative the development of the FeFlow model, that this task was undertaken as part of the study. A short summary of each of the main modeling studies should be provided with a discussion of the basic results and the limitations of the results that would compel the study team to have to extend the modeling efforts. This is particularly important for the past GAWSER modeling and the regional-scale groundwater modeling that was recently completed by WHI. This section would provide the reader with a clear idea of what was still lacking in the numerical analysis in context with the insight required for the water balance/quantity stress assessment work. In other words, why was it necessary to model this area yet again? What aspects of the water quantity risk assessment could not be done at the Tier 2 level with the existing model results? At the end of the report it would be very valuable to show how different the conclusions would have been if the previous modeling had been relied upon rather than the new results of the combined GAWSER and FeFlow models. It is also important to take into account other published work that is directly relevant such as the detailed modeling conducted in the Waterloo Moraine area (by AquaResources personnel) and the work completed by Prof. Jon Sykes and his research team in the Department of Civil Engineering at the University of Waterloo who developed detailed distributions of groundwater recharge over the entire watershed. These studies provide excellent opportunities to compare the final results from the new modeling to other calibrated and peer reviewed work.

c). The results of the modeling are critical to assigning the stress rankings throughout the watershed and the study team can provide a major service to the ultimate users of the work in the Grand River area and many other groups that will be looking towards Grand River for guidance (including the Province). This service would be in the form of a section that presents and discusses two issues. The first are the certainty issues related to the data that were employed to populate the numerical models and used for the overall interpretations presented in the report. Specifically, the study team will be in a unique position to critique the accuracy, weaknesses and confidence that they and others should have in the different data sets that they used in there analysis. This insight should be captured in the report so that a degree of confidence associated with the major conclusions can be determined. This also provides guidance as to what additional data should be collected in the future to improve these conclusions. In many cases, that fact that the data are not as complete or accurate as the analysts would want has very little influence on the analysis as the overall hydrologic model is not overly sensitive to that data. The study team should provide a discussion on the value and sensitivity of the different data sets in terms of their influence on the decisions that have to be made with respect to the stress rankings. In addition to providing commentary on the data certainty, the modeling tools themselves should be critically discussed with respect to the assumptions that are inherent in their approaches and how these assumptions or

limitations may impact the accuracy or certainty of the conclusions drawn on the basis of the overall modeling results. This issue is expanded upon below.

3). Specific Comments

These comments are grouped in 2 topic areas with reference to locations in the text where they appear. There is no specific order implied by the listing.

3a). Modeling

1). As other groups across Ontario begin to move towards the Tier 2 level of analysis, they will be faced with model selection issues. It would be very useful both for this specific report and for the sake of others that will look to it for direction to explain why GAWSER was chosen for the surface (HRU-type) model above all of the other commercially available codes such as Mike-11. It is clear that a main reason for this is that the GRCA has invested a lot of time in developing the GAWSER model of the watershed and it makes perfect sense to use it but what are the drawbacks of doing this. In other words, if you had had no previously available modeling of the surface water systems, would you have chosen GAWSER and why? There is no discussion of the limitations of a model like GAWSER and how it is linked to a fully 3-D groundwater flow model. Indeed some of these problems became obvious as the calibration proceeded as discussed below.

2). It is not clear how the uniqueness of the GAWSER model results can be assessed from the point of view of the ratio between the evapotranspiration (ET) flux and the estimated groundwater recharge values. A wide range of parameter sets can achieve excellent matches to the stream flow data and as shown in this study, very acceptable (existing results) calibrated results can be achieved with inappropriate recharge values (discussed below in detail). During recent peer review meetings, Dr. Hugh Whitley provided very insightful explanations of how confidence in the uniqueness of the model results can be explained and justified. This should be captured and provided in the report in addition to what has already been provided.

3). The method of calculating ET in the model is discussed at several points in the document and it is not completely consistent. The most detail treatment is contained on P. 92. Here the explanation is that ET is based on an estimate of potential ET (PET) based on open water body values prescribed to the model. Then these values are modified by the code to represent available water in the soil column. This is possibly the most critical calculation in GAWSER with respect to the information it will supply to the groundwater model and it should be explained a bit clearer. What assumptions are being made in this approach and how would these assumptions influence the estimated groundwater recharge rates?

4). At most of the MET stations used within this study, values of daily and monthly ET are calculated routinely and in fact are available in some cases on the internet in real time. This information should be referred to and compared to values calculated by GAWSER as a validation approach.

5). Also in terms of model validation, the groundwater recharge estimates derived from the GAWSER model should be compared to those determined from the previous modeling studies that have been carried out in the area (previous GRCA modeling efforts, Waterloo Moraine study, Laural Creek study and even the data from the Oak Ridges Moraine work would be of interest to compare).

6). Do the groundwater modelers feel that the spatial scale of the recharge variations based on the HRU's fine enough to capture the variability needed for the groundwater flow simulations and how was this assessed? Or is it really over kill as the regional flow simulation is not all that sensitive to precise spatial variability on the recharge as long as the total is about right?

7). The simulation of the winter conditions is referred to in several locations throughout the document from a theoretical point of view but there should be a brief, yet clear explanation of how winter was incorporated in this specific study. It is a bit confusing and it appears to have been a factor in calibration later on in the work. Specifically, a list of infiltration adjustment factors is introduced on P. 90 somewhat out of the blue and again puts into question the way GAWSER estimates recharge and these should be explained and justified in more detail.

8). On P. 93 a short note states that based on the results from the groundwater model, the GAWSER recharge estimates were deemed to be low and the GAWSER simulations were revisited to generate more recharge. This seems like a circular argument as the recharge values from GAWSER were intended to drive the groundwater flow model and are considered to be much more accurate than could be derived from inverse model calibration with the groundwater simulator. What was this decision based on? Was this through attempts to calibrate the flow model with the GAWSER numbers and not being close? What this does is essentially prescribe the recharge values that the modeler wants from the surface water code and then leads to modifying the parameters within the surface water code to achieve these values, which really defeats the purpose. Other modifications to the flow model including hydraulic parameters and boundary conditions could have achieved the same goal. On what basis are the flow model results considered to be correct thus putting into question the GAWSER results. This needs to be explained in the text. Interestingly, what this illustrates is that the highly calibrated GAWSER model that has been used for all of GRCA's work to date now seems to be based on incorrect estimates of water partitioning between the different compartments of the hydrologic cycle. This again raises the question of assessing model uniqueness.

9). At the very beginning of the discussion of the FeFlow results it should be clearly stated that the groundwater flow system will be modeled in a steady state mode. After all of the detailed transient work done with the GAWSER model, one is thinking transiently and now all of the temporal detail provided by GAWSER is averaged over the year and this should be stated up front.

10). On P. 109 it is stated that the "soil infiltration parameters" of the near surface sediments in the flow model needed to be increase by an order of magnitude relative to

those used in GAWSER inferring a vadose zone process in FeFlow. The way the FeFlow model is being used to estimate vadose zone water movement is not described in the document and should be, particularly considering that these are steady state calculations.

11). The flow model is calibrated to over 8000 head values. Over what time period do these data cover? It would seem useful to also indicate how well the model matches data collected during the 1980-1999 time period if possible.

12). In fact the recharge values were used as a calibration parameter also but this is buried in the discussion of having to change the GAWSER results to match what the flow model appeared to need.

13). There should be a discussion of how these modeling results compared to the previous WHI modeling results for the regional flow system. What has been added in terms of insight and in physical representation of the natural system based on the new modeling exercise? If all of the decisions had been based on the previous modeling results, how different would the conclusions been with respect to evaluating levels of water quantity threat or risk? Again, this is very useful insight for all other groups moving to the Tier 2 level.

14). In the end, how did the calibrated K distribution compare to the initial estimated values and those used in other similar models? Just a statement on this would be useful.

3b). Miscellaneous
1). P. 26: Figure 12 does not illustrate the relationship between the river/surface water system and the regional groundwater flow field.

2). Fig. 15: The color scheme makes it difficult to see the variations in precipitation.

3). It might be useful to combine information from Tables 1.2 and 3.3 to illustrate the magnitude of consumptive use from the major water uses in a separate table.

4). There should be a scale bar and an explanation of the numbers presented in Figure 41.

5). Table 4.4 needs additional explanation. (mentioned above)

6). The draft document has been annotated with typographic errors and minor issues. This will be returned to the GRCA for transfer to the study team if it is considered useful.

Appendix B-3

Phase 1 Peer Reviewer's Comments Matrix

- **December 12, 2006 first draft**

- **As addressed in March 2007 revised report**

GRCA Water Budget Peer Review Comments Matrix

Category	Raised by	Comment	Assigned to	Response
Errors and Omissions				
	Chris N.	It is particularly important that the sources of mapping information be acknowledged appropriately. For example, who conducted the mapping of the physiography shown in Figure 5?		The final version of the document will include appropriate acknowledgements for all mapping.
	Chris N.	According to our calculations, the components listed on Tables 1.2 and 3.1 add up to 87%. What is the other 13%? In this context does municipal water use represent gross water takings or net (i.e., consumptive use)?		87% represents the top 10 water takers. This will be further explained in the report.
	Chris N.	When referring to the calibration of the groundwater model, it is important to note that the water level targets are approximate, and have a wide range of reliability. Although the groundwater analysis is described as "steady-state", this is not quite correct. A steady-state analysis refers to a formal time-averaged analysis. In contrast, the analysis is constrained with water level targets that are compiled over a relatively long period of time. The water level information from the MOE water well records does not provide an impression of conditions at a particular state of the system in time and there is also no way to check whether the water levels are representative of long-term average conditions.		More detail about the calibration of the model will be added to the report.
	Chris N.	Referring to Section 2.3.1, it is important to note that the information in the MOE water well record do not represent static conditions. These may refer to conditions in which a particular domestic supply well is not pumped, but there may be significant pumping elsewhere in a subwatershed.		Editorial clarification will be added to the report.
	Chris N.	Bedrock valley features may play an important role in the regional hydrogeology. However, it is important to note that in some cases these valleys may not be hydrologically significant, as they may be filled with fine-grained materials. Without detailed drilling and especially data from long-term hydraulic testing or municipal supply well performance records, these features should be regarded as hypothetical. It is also important to note that the valleys may act as transmissive conduits for flow, but not as significant 'undeveloped' groundwater resources.		Editorial clarification will be added to the report. The expected and hypothetical role of bedrock valleys will be referenced.

GRCA Water Budget Peer Review Comments Matrix

Category	Raised by	Comment	Assigned to	Response
Data Input				
	Hugh W.	If the Climate Normal Period is less than 30 years, some estimate should be given of the amount of difference to be expected because the Climate Normal Period was not used.		Sam will provide clarification in the report regarding the long term climate series, surface water and groundwater periods. Sam will also develop a scenario to consider the sensitivity of different climate periods.

Category	Raised by	Comment	Assigned to	Response
Modelling – GAWSER				
	Hugh W.	The report should include a paragraph description of the generation of baseflow outflow in GAWSER and the table of HRUs should give the allocation of them to the baseflow-generating elements (fast or slower).		Description to be added to the GAWSER section of the report clarifying the fast response shallow groundwater system.
	Chris N.	GAWSER has a component for storing groundwater; is it capable of routing groundwater storage between adjoining subwatersheds?		Description to be added to the GAWSER section of the report clarifying the fast response shallow groundwater system.

GRCA Water Budget Peer Review Comments Matrix

Category	Raised by	Comment	Assigned to	Response
Modelling – FEFLOW				
	Hugh W.	In the comparison of FEFLOW results to groundwater discharge (Figure 54) the origin of the groundwater discharge (baseflow) data should be described clearly.		Description to be added to the FEFLOW section of the report clarifying the fast response shallow groundwater system.
	Hugh W.	At some point it would be good to point out that the shallower part of the groundwater system (mostly portions of the overburden layer with shallow depths to watertable and short flow paths to discharge locations) are unlikely to be used for water supply and thus recharge to this part of the system cannot be considered adding to the reliability of groundwater for extraction.		This is a scale issue with respect to the level of detail. This issue may need to be resolved at the Tier 3 stage.
	Chris N.	When reviewing the results of the groundwater modelling we recommend that emphasis be placed on the phrase “throughout the watershed”.		This will be emphasized in editorial changes.
	Chris N.	The report indicates that the FEFLOW and GAWSER models are loosely coupled through recharge rates assigned for the groundwater flow model. Is the coupling checked by comparing net groundwater inflows to surface water features calculated with the groundwater model against baseflows used in the calibration of the GAWSER analyses?		Text will be added to the Integrated Water Budget section stating that calibration was achieved reiterating that recharge rates are shared in both models. Since both calibrate reasonably, it give confidence across the watershed.
	Chris N.	Although the calibration statistics for the groundwater model appear to fall within the bounds of informal criteria for model acceptance, in our opinion it is essential to keep in mind one particular number from the calibration. The Root-Mean-Square Error is about 8 m. We interpret this as a measure of the likely mismatch between the regional model and conditions at a site-specific location.		Qualifiers will be added to the report stating how the calibration statistics should be applied.

GRCA Water Budget Peer Review Comments Matrix

Category	Raised by	Comment	Assigned to	Response
Terminology				
	Chris N	The groundwater stress assessments listed on Table 7.10 are reasonable. The label of "Moderate Stress" should not serve as the argument for a moratorium on further development of groundwater resources in designated areas. Rather, the designations should serve as indications that additional investigation and refined analyses are required.		A better description of the rationale will be provided in the text of Section 7.1. This same rationale should be applied to all the categories.
	Hugh W.	The term "evapotranspiration" creates problems because not all users agree on the intention that led to the coining of the term.		Recommended wording for a clear definition will be considered.
	Hugh W.	The term "soilwater" should be used in place of "soil moisture", for consistency and as a fully scientific notation.		The use of the term will be reviewed in the documentation
	Chris N.	The report could benefit from a clear definition of the concept of "subwatershed." With respect to surface water flow it may be possible to define a subwatershed as a sub-basin that has a single outlet. However it is not so obvious how this definition can be extended to the groundwater flow system.		Discussion is needed to consider the appropriate scale to apply subwatershed boundaries to.

GRCA Water Budget Peer Review Comments Matrix

Category	Raised by	Comment	Assigned to	Response
Other				
	Hugh W.	To reinforce the equilibrium assumption in the mass-balance results presented in Section 6.2 (Subwatershed Water Budget Results) there should be an introductory comment that calculations are based on no change over time in water stored (as surface water, soilwater, or groundwater). As a result all water entering the subwatershed is accounted for as some type of output The inputs and outputs should be listed as a reminder.		Clarification to be added to the report.
	Dave R.	The report needs to include a section that discusses the confidence in datasets and the models used to address the issue of certainty. This section should also help identify the data gaps in the information available for assessment of the Water Budget.		Discuss is needed to establish the outline for the preparation of a section on certainty.
	Chris N.	The water budget analyses and stress assessment is particularly useful for focusing attention for further investigation and characterization. It will be particularly important to establish close links between the "guardians" of the regional-scale analyses and municipalities charged with collecting and acting upon local-scale hydrologic data.		The Conservation Authority is the key to coordinating these assessments.
	Chris N.	Referring to Table 3.10, there are significant differences between the subwatershed and watershed scale consumptive demands for five of the subwatersheds. What do these differences indicated? How are the values listed on Table 3.9 related to those on Table 3.10?		Discuss the differences identified (unit consumptive and watershed consumptive) and how they should be further explained in the documentation.
	Chris N.	Referring to Figure 39, are these annual average water demands particularly relevant? Would it not be more appropriate to compare maximum monthly demand with minimum low flow requirements?		The term "annual" needs to be added to the y-axis title. The figure was intended to show consumption and not comparisons to monthly flows.

GRCA Water Budget Peer Review Comments Matrix

Page (Oct/06)/(Mar/07)	Raised by	Comment	Response (proposed action in red)/(action taken in blue)
Errors and Omissions			
(7) / (7,60)	Chris N.	According to our calculations, the components listed on Tables 1.2 and 3.1 add up to 87%. What is the other 13%? In this context does municipal water use represent gross water takings or net (i.e. consumptive use)?	87% represents the top 10 water takers. This will be further explained in the final report. Comments added.
(12) / (14 & all maps)	Chris N.	It is particularly important that the sources of mapping information be acknowledged appropriately. For example, who conducted the mapping of the physiography shown in Figure 5?	The final report will include appropriate acknowledgements for all mapping. Acknowledgements added and mapping amended.
(21) / (24)	Chris N.	Bedrock valley features may play an important role in the regional hydrogeology. However, it is important to note that in some cases these valleys may not be hydrologically significant, as they may be filled with fine-grained materials. Without detailed drilling and especially data from long-term hydraulic testing or municipal supply well performance records, these features should be regarded as hypothetical. It is also important to note that the valleys may act as transmissive conduits for flow, but not as significant 'undeveloped' groundwater resources.	Editorial clarification will be added to the final report, with reference to the expected and hypothetical role of bedrock valleys. Revised text added.
(26) / (25)	Chris N.	Referring to Section 2.3.1, it is important to note that the information in the MOE water well record do not represent static conditions. These may refer to conditions in which a particular domestic supply well is not pumped, but there may be significant pumping elsewhere in a subwatershed.	Editorial clarification will be added to the final report. Revised text added.
(112) / (124-132, 139-140)	Chris N.	When referring to the calibration of the groundwater model, it is important to note that the water level targets are approximate, and have a wide range of reliability. Although the groundwater analysis is described as "steady-state", this is not quite correct. A steady-state analysis refers to a formal time-averaged analysis. In contrast, the analysis is constrained with water level targets that are compiled over a relatively long period of time. The water level information from the MOE water well records does not provide an impression of conditions at a particular state of the system in time and there is also no way to check whether the water levels are representative of long-term average conditions.	More detail about the calibration of the model will be added to the final report along with a description of the limitations of the data and models used in Tier 2 (ie. static vs. reported). The location of well level data and missing sections in data gaps with a focus on high water use areas without sufficient monitoring wells should be highlighted in a data gaps section. Chapter 5 includes significant changes to the calibration sections and an added section on calibration uncertainty.

GRCA Water Budget Peer Review Comments Matrix

Data Input			
(31) / (32)	Hugh W.	If the Climate Normal Period is less than 30 years, some estimate should be given of the amount of difference to be expected because the Climate Normal Period was not used.	The final report will provide clarification regarding the long term climate series, surface water and groundwater periods, including a scenario to consider the sensitivity of different climate periods (see handout provided). Hugh will be satisfied with a comment in the report explaining the difference and how it is not much different than measurement error. Revised text added.
Modelling – GAWSER			
(83)	Dave R.	Would we use GAWSER if we had started the Water Budget process from scratch?	Yes, it is preferable to use a hydrologic model with the groundwater model. The recharge certainty decreases as the scale decreases (i.e. more certainty on the watershed scale and less on the HRU scale). In the end, the recharge produced by GAWSER may not be completely correct, but it is better than any other method that has been used regularly in practice. A reference to the certainty of the recharge data will be added into the certainty/uncertainty section of the final report. While GAWSER is preferred it is not without weaknesses that will need updating at some point in the future.
(83)	Hugh W.	The report should include a paragraph description of the generation of baseflow outflow in GAWSER and the table of HRUs should give the allocation of them to the baseflow-generating elements (fast or slower).	Description to be added to the GAWSER section of the final report clarifying the fast response shallow groundwater system.
(90)	Chris N.	GAWSER has a component for storing groundwater; is it capable of routing groundwater storage between adjoining subwatersheds?	Description to be added to the GAWSER section of the final report clarifying the fast response shallow groundwater system.

GRCA Water Budget Peer Review Comments Matrix

Modelling – FEFLOW			
(Gen)	Dave R.	What additional information does the groundwater model add to the Tier 2 Water Budget?	It made the results of the stress assessment justifiable and helps answer other parts of the Tier 2 Water Budget such as key hydrologic processes, and significant recharge areas. It will also help with drought scenarios and inter basin transfers. Also the coupling of the models helped to iteratively calibrate both (i.e. FEFLOW said that GAWSER recharge did not make sense so we went back to GAWSER and recalibrated it). No further action required.
(110)	Hugh W.	At some point it would be good to point out that the shallower part of the groundwater system (mostly portions of the overburden layer with shallow depths to water table and short flow paths to discharge locations) are unlikely to be used for water supply and thus recharge to this part of the system cannot be considered adding to the reliability of groundwater for extraction.	This is a scale issue with respect to the level of detail. This issue needs to be resolved at the Tier 3 stage.
(112)	Chris N.	Although the calibration statistics for the groundwater model appear to fall within the bounds of informal criteria for model acceptance, in our opinion it is essential to keep in mind one particular number from the calibration. The Root-Mean-Square Error is about 8 m. We interpret this as a measure of the likely mismatch between the regional model and conditions at a site-specific location.	Qualifiers will be added to the final report stating how the calibration statistics should be applied.
(119)	Hugh W.	In the comparison of FEFLOW results to groundwater discharge (Figure 54) the origin of the groundwater discharge (baseflow) data should be described clearly.	Description to be added to the FEFLOW section of the final report clarifying the fast response shallow groundwater system.
(120)	Chris N.	When reviewing the results of the groundwater modelling we recommend that emphasis be placed on the phrase “throughout the watershed”.	This will be emphasized in editorial changes to the final report.
(126)	Chris N.	The report indicates that the FEFLOW and GAWSER models are loosely coupled through recharge rates assigned for the groundwater flow model. Is the coupling checked by comparing net groundwater inflows to surface water features calculated with the groundwater model against baseflows used in the calibration of the GAWSER analyses?	Text will be added to the Integrated Water Budget section of the final report stating that calibration was achieved reiterating that recharge rates are shared in both models. Since both calibrate reasonably, it gives confidence across the watershed.

GRCA Water Budget Peer Review Comments Matrix

Terminology			
(Gen)	Hugh W.	The term "soilwater" should be used in place of "soil moisture", for consistency and as a fully scientific notation.	The use of the term will be reviewed in the final report.
(Gen)	Chris N.	The report could benefit from a clear definition of the concept of "subwatershed." With respect to surface water flow it may be possible to define a subwatershed as a sub-basin that has a single outlet. However it is not so obvious how this definition can be extended to the groundwater flow system.	It is acknowledged that surface subwatersheds and groundwater flow systems do not have the same boundaries. The final report will Include discussion on the different aquifer units if possible, taking some of the aquifer layers and developing more information as part of Tier 2 (regional wide system only).
(92)	Hugh W.	The term "evapotranspiration" creates problems because not all users agree on the intention that led to the coining of the term.	Recommended wording for a clear definition will be considered in the final report. Uncertainty about evapotranspiration is low in the regional model because we have good streamflow data to compare it with. But it is difficult to measure for use as an input to a model.
(161)	Chris N	The groundwater stress assessments listed on Table 7.10 are reasonable. The label of "Moderate Stress" should not serve as the argument for a moratorium on further development of groundwater resources in designated areas. Rather, the designations should serve as indications that additional investigation and refined analyses are required.	A better description of the rationale will be provided in the text of Section 7.1. This same rationale should be applied to all the categories.

GRCA Water Budget Peer Review Comments Matrix

Other			
(Gen)	Dave R.	The report needs to include a section that discusses the confidence in datasets and the models used to address the issue of certainty. This section should also help identify the data gaps in the information available for assessment of the Water Budget. Can we use Tier 2 to prioritize additional data needed? Can we focus on specific parameters?	Tier 2 should end where it identifies the data gaps. Work needs to start now on data gathering for Tier 3. The Tier 2 regional model is important for identifying inter basin groundwater transfer. Some areas in the watershed may need additional steps in the regional model even if they don't go to Tier 3. Water Use uncertainties will be updated as the water budget is refined in future versions. This will be achieved as PTTW permit holders are required to report actual consumption.
(Gen)	Chris N.	The water budget analyses and stress assessment is particularly useful for focusing attention for further investigation and characterization. It will be particularly important to establish close links between the "guardians" of the regional-scale analyses and municipalities charged with collecting and acting upon local-scale hydrologic data.	The Conservation Authority is the key to coordinating these assessments. No further action required.
(81)	Chris N.	Referring to Table 3.10, there are significant differences between the subwatershed and watershed scale consumptive demands for five of the subwatersheds. What do these differences indicated? How are the values listed on Table 3.9 related to those on Table 3.10?	The differences identified (unit consumptive and watershed consumptive) will be further explained in the final report.
(82)	Chris N.	Referring to Figure 39, are these annual average water demands particularly relevant? Would it not be more appropriate to compare maximum monthly demand with minimum low flow requirements?	The term "annual" needs to be added to the y-axis title. The figure intended to show consumption and not comparisons to monthly flows.
(127)	Hugh W.	To reinforce the equilibrium assumption in the mass-balance results presented in Section 6.2 (Subwatershed Water Budget Results) there should be an introductory comment that calculations are based on no change over time in water stored (as surface water, soilwater, or groundwater). As a result all water entering the subwatershed is accounted for as some type of output The inputs and outputs should be listed as a reminder.	Clarification to be added to the final report.

Appendix B-4

Phase 1 Peer Review Final Comments on March 2007 Revised Grand River Integrated Water Budget Report

- **May 11, 2007 letter from Chris Neville**
- **May 15, 2007 letter from Hugh Whiteley**
- **May 30, 2007 e-mail from Dave Rudolph**

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

May 11, 2007

Mr. James Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Rd.
P.O. Box 729
Cambridge, ON
N1R 5W6

Subject: Grand River Watershed Integrated Water Budget Report (March 2007 draft)

Dear Mr. Etienne:

We have reviewed the revised draft of the *Grand River Watershed Integrated Water Budget Report*, dated March 2007. In particular, we have reviewed the report to assess the responses to the peer review comments. In our opinion, the revised draft adquately addresses the peer review comments. In this letter we present some general reflections, several remarks regarding specific responses to the peer review comments, and two detailed follow-up questions.

General reflections

The format of the responses to the peer review comments has been somewhat inconvenient. In particular, it has been necessary to search through the full March 2007 draft to check whether the peer comments have been addressed. Ultimately this has not been detrimental, because it has forced us to re-read the entire report. In several instances the report has been revised to include significant additional discussion. The additional materials provide essential qualifiers on the methodology and results of the water budget study.

The revised text carefully clarifies the appropriate use of the results of the study. The qualifier at the end of the Executive Summary is an excellent addition.

The revised text indicates in several places that the groundwater model is developed to support regional analyses. We recommend that the final text provide some specific guidance regarding the implications of the scale of analysis. In particular, we believe that it is important to emphasize that to a large extent the groundwater flow model is not constrained by local high-quality data. These data must be considered in Tier 3 evaluations, and in our opinion it is prudent to expect that local-scale analyses may be significantly different from the regional analysis. Furthermore, the results of Tier 3 stress assessments may differ from the results of the Tier 2 assessments.

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WWW.SSPA.COM

Finally, it is indicated on Page 164 of the March 2007 draft report that the analysis shall be considered as a 'Preliminary Tier 2' stress assessment. This needs to be added to the last paragraph of the section of the Executive Summary *Scope of Current Effort*. Are we correct in understanding that the water budget report will be a stand-alone document, and that the submission for Tier 2 will comprise the water budget report and an addendum that addresses future demands and drought scenarios?

Specific responses to the peer review comments

Some of the following comments may reflect our inattention, rather than point to omissions in the March 2007 draft.

1. Errors and Omissions, Comment #10 (Page 50): The response to the comment indicates that a map of the WWTP discharges can be added to Section 4.3.7. Are we correct in understanding that this map has not been added?

2. Data Input, Comment #2 (Gen - Eric H.): The response to the comment refers to a Technical Memo Appendix. Are we correct in understanding that the March 2007 draft does not include a Technical Memo Appendix?

3. Data Input, Comment #5 (Page 39): Where are the limitations [of the analysis of] storm water management, interflow, cracked clay and bedrock systems discussed in the March 2007 draft report?

4. Modelling - FEFLOW, Comment #3 (Page 110): The response to the comment indicates that the final report will respond to the specifics of the comments. Are these addressed in the March 2007 draft?

5. Modelling - FEFLOW, Comment #10 (Page 120): Did this comment refer to inconsistencies between local and regional-scale analyses, or to the fundamental 'artificiality' of a watershed-scale perspective when looking at extensive deep bedrock flow systems? Has this issue been addressed in the March 2007 draft?

6. Modelling - FEFLOW, Comment #16 (Page 92): We are not sure we agree with the suggestion that the uncertainty regarding evapotranspiration is low because "we have good streamflow data to compare it with". Shouldn't the response to the comment suggest instead that the uncertainty with respect to recharge is relatively low – in a cumulative sense – because relatively reliable estimates of surface water baseflows are available?

To: Mr. James Etienne, P.Eng.

Page: 3

7. Modelling - FEFLOW, Comment #23 (Gen - Eric H.): Is the issue of the certainty in the assessment changes in water levels over time discussed in the March 2007 draft?

8. Modelling - FEFLOW, Comment #25 (Page 72): The response to the comment indicates, "Level of detail in mapping to be considered in the final report." We are not sure what this response means and whether the comment has been addressed in the March 2007 draft.

Follow-up comments

We are puzzled by two details in the March 2007 draft.

1. Page 117: The report indicates, "In general, specified boundary conditions within the model were minimized through the latest revisions". What are *specified* boundary conditions? Does this refer to *specified-head* boundary conditions in the interior of the model? Does the perimeter of the model include any *specified-head* boundary conditions?

2. Page 124: The report indicates the following numbers of water level targets: 7,953 (selected from the MOE water well information system); 6,596 (targets currently being used by the Region of Waterloo); and 2,056 (targets in the Guelph-Puslinch Groundwater Study). The text indicates, "many of those wells [the Region of Waterloo and Guelph-Puslinch targets] are duplicates of the MOE database". However, on Page 125 it is indicated that there were "~16,500" water level targets plotted in Figure 53. The total of 7,953+6,596+2,056 = 16,605, which is close to the value of 16,500. Are we correct in understanding that the duplicates have not been removed from the set of calibration targets?

We hope that are comments are helpful, and we thank you for the opportunity to participate in this interesting and important study.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Christopher J. Neville, M.Sc., P.Eng.
Vice President, Senior Hydrologist

CJN/cjn
P:\ssp0994-04_Letter_Etienne_20070511.doc

H.R. Whiteley P.Eng

226 Exhibition St

Guelph ON. N1H 4R5

May 15 2007

James B. Etienne, P.Eng.

Senior Water Resources Engineer

Grand River Conservation Authority

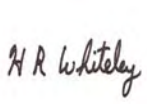
400 Clyde Road, Cambridge, ON N1R 5W6

RE: Integrated Water Budget Report March 2007.

I confirm that I am satisfied that the final draft Grand River Tier 2 - Existing Conditions report has satisfactorily addressed earlier concerns expressed in the peer review process. In particular the report meets the requirements for documentation of Conceptual Understanding

I judge this report to be ready for broader circulation and posting and is an adequate basis for the next phase of analysis that includes consideration of Future Conditions, Drought Conditions, designation and review of Significant Recharge Areas and Evaluation/Prioritization of Tier 3 Studies.

Yours truly,



Hugh Whiteley P.Eng.

From: Dave Rudolph [drudolph@uwaterloo.ca]
Sent: Wednesday, May 30, 2007 1:06 PM
To: James Etienne
Subject: RE: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting

James,
I will be fine to sign off now on Grand River.
D
See you tomorrow,

-----Original Message-----
From: James Etienne [mailto:jetienne@grandriver.ca]
Sent: May 28, 2007 9:20 AM
To: drudolph@uwaterloo.ca
Subject: RE: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting

-->
Hi Dave:

Yes. AquaResources are sending me a package for distribution today or tomorrow.

Sincerely,

James

P.S. Do you have an ETA on your Grand River comments?

size=2 width="100%" align=center>
From: Dave Rudolph [mailto:drudolph@uwaterloo.ca]
Sent: Monday, May 28, 2007 9:16 AM
To: James Etienne
Subject: RE: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting

Hi James,
Will any material be sebt our to us prior to Thursday's meeting?
Thanks,
Dave

-----Original Message-----
From: James Etienne [mailto:jetienne@grandriver.ca]
Sent: May 17, 2007 4:02 PM
To: drudolph@uwaterloo.ca
Subject: RE: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting
-->
Hi Dave:

I was re-reading this e-mail to make my final arrangements for the May 31st Long Point meeting, and I noticed that you were asking about sign-off for the Grand River Water Budget. I have attached my April 30th e-mail about this. I apologize if it did not reach you previously.

With respect to invoicing, Lorrie would like to keep the books up to date with project progress, so if you could sum up your work on this first phase of the Grand River Water Budget and send an invoice, it would help. Similarly, you may want to send something in for Long Point after the May 31st meeting.

Sincerely,

James

size=2 width="100%" align=center>

From: Dave Rudolph [mailto:drudolph@uwaterloo.ca]
Sent: Wednesday, May 09, 2007 11:27 AM
To: James Etienne
Subject: RE: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting

Hi James,
I have put this down in my agenda and it looks good at this point. By the way, do we havce sign off requirements for the grand work still pending? Also should I send an invoice some time?
Cheers,
Dave

-----Original Message-----
From: James Etienne [mailto:jetienne@grandriver.ca]
Sent: May 9, 2007 10:50 AM
To: drudolph@uwaterloo.ca; Rob Schincariol; hwhitele@uoguelph.ca; Christopher Neville; Warbick, John (OMAFRA)
Cc: water@catfishcreek.ca; jennifer@kettlecreekconservation.on.ca; Bill Baskerville; Bates, Scott (MNR); mike.garraway@ontario.ca; Jennifer Havelock; Lorrie Minshall; Gregg Zwiers; Sonja Strynatka; Stephanie Shifflett; Amanda Wong; Jeff Pitcher; PMartin@AquaResource.ca; Sam Bellamy; David Van Vliet (AquaResource)
Subject: RE: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting
-->
To the Kettle/Catfish/Long Point Water Budget Peer Review Team:

I have now finalized the booking of the Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting on **Thursday May 31, 2007 from 10:00 am to 1:00 pm** (including lunch) at the GRCA Head Office in Cambridge. The goal for the meeting will be to review the data available to AquaResource and their proposed methodology to ensure that the Peer Review Team will have a satisfactory water budget product to review by October 1st. I will be working with AquaResource to ensure that a package is sent out to all participants in advance of the meeting for their review of the progress to date and to allow for the preparation of discussion questions at the meeting. Please confirm your attendance by May 25th so I can make arrangements for lunch.

Sincerely,

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6
Tel: 519-621-2763 ext. 298 (ext. 2298 effective May 26th)
email: jetienne@grandriver.ca

size=2 width="100%" align=center>

From: James Etienne [mailto:jetienne@grandriver.ca]
Sent: Monday, April 23, 2007 3:19 PM
To: Rob Schincariol; drudolph@uwaterloo.ca; hwhitele@uoguelph.ca; Neville, Chris; Warbick, John (OMAFRA)
Cc: Bill Baskerville; water@catfishcreek.ca; jennifer@kettlecreekconservation.on.ca; Lorrie Minshall; pmartin@aquaresource.ca
Subject: Kettle/Catfish/Long Point Preliminary Water Budget Peer Review Meeting

To the Kettle/Catfish/Long Point Water Budget Peer Review Team:

As discussed previously, AquaResource Inc. has commenced its conceptual review of the Kettle/Catfish/Long Point Water Budget. In the Terms of Reference for the project, May 31st was targeted as the date for a

progress meeting to seek input from the Peer Review Team. AquaResource have set aside this date for a presentation, and I would like to confirm the availability of the Peer Review Team on that date as well as May 30th, June 4th and June 5th as alternates. AquaResource intends to send out a briefing package a week before the meeting to allow everyone to see where they are at and to allow you to prepare questions about the proposed methodology to get a draft report prepared by September 30th. Please advise if you are available on the 31st, or your preferred alternate date if you are not free.

Sincerely,

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6
Tel: 519-621-2763 ext. 298
email: jetienne@grandriver.ca

Appendix C-1

Phase 2 Peer Review Meeting Materials

- **Phase 2 Peer Review schedule**
- **February 11, 2009**
  - **Integrated Water Budget Update memo**
- **February 19, 2009**
  - **agenda, slides & minutes**
- **March 19, 2009**
  - **agenda & minutes**

James Etienne

From: James Etienne
Sent: Wednesday, November 19, 2008 3:20 PM
To: 'Christopher Neville'; 'hwhitele@uoguelph.ca'; 'drudolph@uwaterloo.ca'; 'heric@region.waterloo.on.ca'; 'Dave.Belanger@guelph.ca'
Cc: 'Bates, Scott (MNR)'; 'mike.garraway@ontario.ca'; Lorrie Minshall; Stephanie Shifflett; Gregg Zwiers; 'Scott Lister'; 'PMartin@AquaResource.ca'; DVanVliet@AquaResource.ca; 'sbellamy@aquaresource.ca'; Amanda Wong
Subject: Tentative Grand River Tier 2 Phase 2 Water Budget Peer Review Schedule

To the Grand River Water Budget Peer Review Team:

Last week, Lorrie Minshall & I met with AquaResource Inc. to discuss timing for the preparation of a Phase 2 draft report. At this time, ARI are working towards a target circulation date for the draft report in early February 2009. With this date in mind, I have prepared the following tentative peer review schedule based upon the initial 8 week time frame set out in the Peer Review Terms of Reference:

February 2	Distribute draft report
	Report review period
February 19	First meeting to allow ARI to present the results of the report and receive initial questions from the peer reviewers
	Comment period
March 4	Submission of peer reviewer comments
	Consolidation of comments into a matrix by GRCA
March 10	Circulation of comment matrix
March 12	Second meeting to address peer review comments
	ARI revises report to address comments
	GRCA prepares revised matrix documenting how and where comments have been addressed
March 23	Redistribution of the report with annotated comment matrix
March 30	Peer reviewers sign off on the revised report

Recognizing where this period sits within the March Break and university end of term, can I please receive comments regarding the availability of the peer review team to work to this schedule.

Sincerely,

James B. Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Road, Cambridge, ON N1R 5W6
Tel: 519-621-2763 ext. 2298
email: jetienne@grandriver.ca

Table 1 - Peer Review Committee for Lake Erie Source Protection Region (February 2009)

Peer Review Role	Grand River	Long Point Region, Catfish Creek, Kettle Creek
Peer Review Leader	James Etienne, P.Eng., Grand River Conservation Authority	James Etienne, P.Eng., Grand River Conservation Authority
Peer Reviewer	Dr. Dave Rudolph, University of Waterloo	Dr. Dave Rudolph, University of Waterloo
Peer Reviewer	Dr. Hugh Whiteley, University of Guelph	Dr. Hugh Whiteley, University of Guelph
Peer Reviewer	Chris Neville, S.S. Papadopulos and Associates	Chris Neville, S.S. Papadopulos and Associates
Peer Reviewer	Dave Belanger, P.Eng, City of Guelph	Dr. Robert A. Schincariol, University of Western Ontario
Peer Reviewer	Eric Hodgins, P.Geo., Regional Municipality of Waterloo	John Warbick, Ministry of Agriculture and Rural Affairs
Peer Reviewer		Deborah Goudreau, P.Eng., County of Oxford
Peer Reviewer		Bob Fields, C.E.T., Norfolk County
MNR Representative	Mike Garraway, Ministry of Natural Resources	Mike Garraway, Ministry of Natural Resources
MNR Representative	Scott Bates, Ministry of Natural Resources	Scott Bates, Ministry of Natural Resources
MOE Representative	Clara Tucker, Ministry of the Environment	Clara Tucker, Ministry of the Environment
MOE Representative	Rick Vantfoort, Ministry of the Environment	Rick Vantfoort, Ministry of the Environment
CO Representative	Scott Lister, Conservation Ontario	Scott Lister, Conservation Ontario

Table 2 – Technical Resources for the Peer Review Committee (February 2009)

Project Team	Lorrie Minshall, P.Eng., Lake Erie SP Region
	Paul Martin, AquaResource Inc.
	Dave VanVliet, AquaResource Inc.
	Sam Bellamy, AquaResource Inc.
	Gregg Zwiers, P.Geo., GRCA
	Stephanie Shifflett, GRCA
	Amanda Wong, GRCA

GRAND RIVER CONSERVATION AUTHORITY

MEMORANDUM

TO:	**Grand River Water Budget Peer Review Team**	**DATE:**	11 February 2009
FROM:	**James Etienne, P.Eng.**	**FILE:**	
CC:			
RE:	**Tier 2 Phase 2 Water Budget Peer Review**		

REMARKS: ☐ *Urgent* ☒ *For your review* ☐ *Reply ASAP* ☐ *Please Comment*

The draft February 2009 Integrated Water Budget Report for the Grand River Watershed was circulated to the Water Budget Team on February 4th for review and discussion at a Peer Review Meeting on February 19th. In response to this circulation, I have been asked to provide a summary of the most recent changes to the document relative to the Phase 1 Peer Review process.

During the Phase 1 Peer Review in late 2006 and early 2007, the document included the initial Water Budget and a Stress Assessment of the existing water use scenario. During this first peer review, comments were received and collated into a matrix document (see attached). Through discussions with the team and AquaResource Inc. (ARI), a number of the comments were addressed in a revised document dated March 2007, while some comments were deferred to be addressed during Phase 2.

One comment that affected the interim presentation of the document was an agreement to post the initial Water Budget without the stress assessment for the existing scenario. As a result, ARI produced the January 2008 edition which did not include the Stress Assessment chapter or any other summary comments about the existing scenario. As a result, the Water Budget components of the March 2007 and January 2008 documents were essentially unchanged. The January 2008 Water Budget, is currently posted on the Lake Erie Source Protection Region website.

The February 2009 draft Water Budget document has incorporated the outstanding peer review comments from the Phase 1 process and also includes updates to the calculations resulting from the use of new water demand estimates. A second volume is currently being completed by ARI that includes the stress assessments for the existing water use, future water use and drought scenarios. Because Volume 1 of the 2009 draft does not include the Stress Assessment chapter, the following summary of changes is in comparison to the January 2008 Water Budget. In total, the new document is 25 pages longer, including 4 new tables and 14 more figures. The following paragraphs summarize the main changes to each chapter of the Water Budget report.

Chapter 1.0 - Introduction
The introduction summarizes the major reasons for changing the current Water Budget, which includes revised water demand estimates, the addition of PGMN monitoring data as well as recommended changes from the first phase of Peer Review. *Section 1.5 – Scope of Assessment* identifies the separation of the Water Budget and the Stress Assessment into two volumes and includes references to the latest definitions from Guidance Module 7 that provides instructions for evaluating threats to water quantity.

Chapter 2.0 – Watershed Characterization
In general, this chapter has seen numerous wording changes in response to previous comments. *Section 2.2.1 – Bedrock Geology* now includes 3 new cross-sections (*Figures 10-12*) to characterize the geology. *Section 2.3.4 – Groundwater Monitoring* has been added, including *Figures 17-24*, to provide PGMN groundwater level characterization using the provincial monitoring database.

Chapter 3.0 – Water Demand
This chapter has been totally revised using the most recent municipal water use figures (*Table 3.1*) and a totally new approach to agricultural water demand consistent with the approach applied in the 2008 Kettle/Catfish/Long Point Water Budget. *Section 3.2.3 – Permitted Agricultural Water Use* has been added, and new pumping rates and consumptive demands have been calculated. As a result, *Sections 3.4.3, 3.5 & 3.6* have been totally rewritten. In addition, new *Tables 3.5, 3.6 & 3.12* and *Figures 47 & 48* have been brought into the document.

Chapter 4.0 – GAWSER Model
This chapter has been modified in response to the previous Peer Review comments. Several minor additions to the chapter include *Section 4.3 – Purpose of Modelling* and *Figure 55 – Wastewater Treatment Plant Flows*.

Chapter 5.0 – FEFLOW Model
This chapter has been modified in response to the previous Peer Review comments. Several minor additions to the chapter include *Section 5.1 – Purpose of Modelling*. *Figures 68, 69 & 71* have been recreated using a new colour legend and alternate units.

Chapter 6.0 – Water Budget Summary
As a result of the reduced scope of the Water Budget, *Section 6.1 – Introduction* has been rewritten and the original *Table 6.1 – Differences in Average Precipitation for Varying Time Periods* has been removed. The text for *Section 6.3 – Subwatershed Water Budget Results* has been significantly modified throughout to reflect the new water demand values and assumptions used in *Section 3.0*. The previous summary for *Section 6.3.19 – Moraine Assessment Areas* has been removed.

The Stress Assessment will be delivered under a separate cover. This document will consider the implications to the Water Budget of the existing and future water use and drought scenarios.

Chapter 7.0 – Conclusions
This chapter has been totally rewritten to reflect the most recent changes to the Water Budget document.

Sincerely,

James B. Etienne, P.Eng.
Sr. Water Resources Engineer

Attach.

Lake Erie Source Protection Region

Grand River Tier 2 Phase 2 Water Budget
Peer Review Committee Meeting

February 19th, 2009, 11:00am to 2:30pm

GRCA Head Office (400 Clyde Road, Cambridge), Grand Room

Agenda

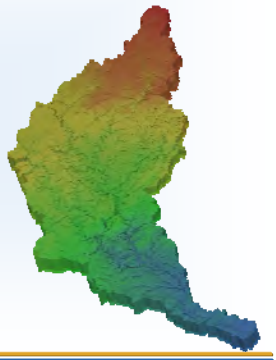
Meeting Objective: Present the findings of the Phase 2 Water Budget to the Peer Review team for provide clarification and to allow the team to formulate their comments for submission and further discussion at the next meeting.

11:00 to 11:05	Welcome and Introduction • Purpose of Meeting • Participant Expectations	J. Etienne
11:15 to 12:30	Water Budget Powerpoint Presentation • Revisions to Water Budget • Stress Assessment • Existing & Future Scenarios • Drought Scenario • Particle Tracking • Significant Groundwater Recharge Areas	P. Martin
12:30 to 1:00	Lunch	
1:00 to 2:00	Question & Answer Session	All
2:00 to 2:25	Peer Review Commenting Process	J. Etienne
2:25 to 2:30	Closing Comments	All

Next Meeting: Thursday, March 12th, 2009 – GRCA (to be confirmed)

Grand River Watershed

Tier II Water Budget and Water Quantity Stress Assessment



February 19, 2009

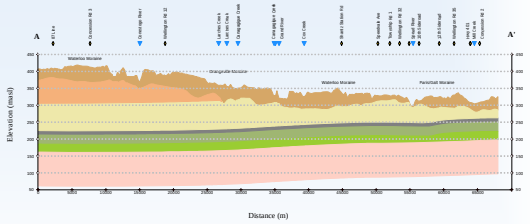
Agenda

- Tier 2 Water Budget Report
  - Summary of Revisions
- Tier 2 Water Quantity Stress Assessment Report
  - Surface Water – Stress Assessment
  - Groundwater – Stress Assessment
  - Significant Groundwater Recharge Areas
  - Summary of Results
- Groundwater Recharge Area Assessment
  - Particle Tracking
- Next Steps

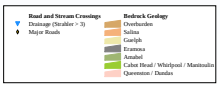
Tier 2 Water Budget Report

- Summary of Changes
  - Editorial changes throughout
  - Characterization
    - Conceptual Geologic Cross-Sections
    - PGMN Hydrographs
  - Water Demand Estimates
    - Consistency with Long Point for Irrigation Demands
    - Updates with GRCA's revisions to PTTW database
    - Municipal demands

Conceptual Geological Model



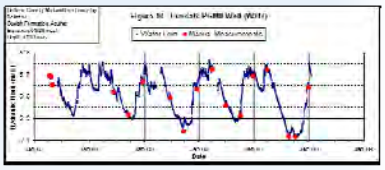
Geological Cross-Sections Added to visualize Regional geology (bedrock units and overburden thickness)

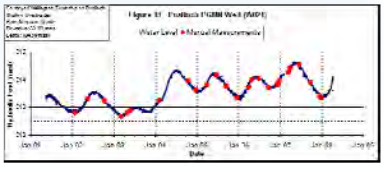


Monitoring Data

Watershed Characterization chapter updated to identify sources of groundwater monitoring data.

Hydrographs for selected PGMN wells are shown to visualize temporal groundwater level fluctuations as well as seasonal response in different types of hydrogeological settings





Water Demand

- Agricultural Demand
  - Pumping rate 60% of Max Permitted
  - 75% consumptive
- PTTW database update
  - Completed by GRCA
  - Included additional reported pumping
  - Recent permits added
  - Incorporated MOE permit scrubbing
- Updated municipal pumping

Tier 2 Water Quantity Stress Assessment Report

Tier 2 Water Quantity Stress Assessment

- Released as independent report
- Objectives of the report:
  - Surface Water and Groundwater Stress Assessment
    - Identify municipal supplies that are located in potentially stressed watersheds (assessment areas)
      - Current and Future Conditions
      - Temporal Stress
    - Drought Scenarios
  - Significant Groundwater Recharge Areas

Tier 2 Stress Calculation

$$\text{Percent Water Demand} = \frac{Q_{DEMAND}}{Q_{SUPPLY} - Q_{RESERVE}} \times 100$$

Surface Water Stress Levels

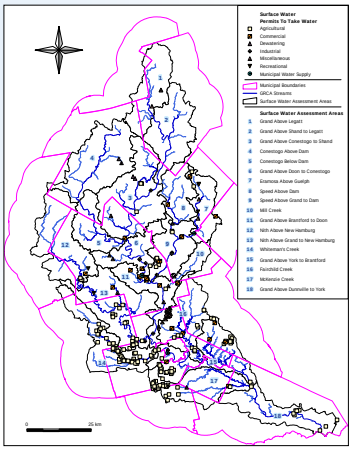
Stress Level Assignment	Maximum Monthly % Water Demand
Significant	≥ 50%
Moderate	≥ 20%
Low	0 - 19 %

Groundwater Stress Levels

Stress Level Assignment	Average Annual % Water Demand	Maximum Monthly % Water Demand
Significant	≥ 25%	≥ 50%
Moderate	≥ 10%	≥ 25%
Low	0 - 9%	0 - 24%

Surface Water Demands

- Permitted surface water users are located across the watershed.
- Municipal surface water users include Guelph, ROW, Brantford
- The GRCA's previously delineated subwatersheds were chosen for the stress assessment.



SW Percent Water Demand (Current Demand)

Assessment Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max Monthly Demand
Grand Above Legatt	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Grand Above Shand To Legatt	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Grand Above Conestogo To Shand	1%	1%	1%	1%	2%	4%	6%	4%	3%	1%	1%	1%	6%
Conestogo Above Dam	1%	1%	0%	0%	1%	1%	3%	4%	3%	0%	0%	1%	4%
Conestogo Below Dam	0%	0%	0%	0%	1%	1%	1%	1%	1%	0%	0%	0%	1%
Grand Above Doon To Conestogo	1%	1%	0%	0%	2%	3%	6%	4%	3%	1%	0%	1%	6%
Eramosa Above Guelph	1%	1%	1%	4%	7%	11%	19%	**29%**	**21%**	6%	1%	0%	**29%**
Speed Above Dam	1%	1%	2%	2%	1%	2%	4%	17%	8%	2%	1%	1%	17%
Speed Above Grand To Dam	0%	1%	0%	0%	1%	2%	5%	7%	4%	1%	0%	0%	7%
Mill Creek	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%
Grand Above Brantford To Doon	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	0%	0%	1%
Nith Above New Hamburg	1%	1%	0%	0%	1%	2%	4%	6%	3%	0%	0%	1%	6%
Nith Above Grand To New Hamburg	1%	1%	0%	0%	0%	3%	8%	6%	3%	0%	0%	0%	8%
Whiteman's Creek	0%	0%	0%	0%	0%	11%	**40%**	**20%**	8%	0%	0%	0%	**40%**
Grand Above York To Brantford	1%	1%	0%	0%	1%	2%	3%	3%	2%	1%	0%	0%	3%
Fairchild Creek	1%	1%	0%	1%	1%	4%	7%	5%	4%	0%	0%	0%	7%
McKenzie Creek	0%	0%	0%	0%	0%	12%	**30%**	**21%**	9%	0%	0%	0%	**30%**
Grand Above Dunnville To York	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	1%

Surface Water Stress Assessment

Assessment Area	Potential Stress Classification (Based on Maximum Monthly Percent Water Demand)	Municipal Water Supply
Grand Above Legatt	Low	None
Grand Above Shand To Legatt	Low	None
Grand Above Conestogo To Shand	Low	None
Conestogo Above Dam	Low	None
Conestogo Below Dam	Low	None
Grand Above Doon To Conestogo	Low	RMOW Mannheim Intake
Eramosa Above Guelph	Moderate	Guelph Eramosa/Arkell Intake
Speed Above Dam	Low	None
Speed Above Grand To Dam	Low	None
Mill Creek	Low	None
Grand Above Brantford To Doon	Low	None
Nith Above New Hamburg	Low	None
Nith Above Grand To New Hamburg	Low	None
Whiteman's Creek	Moderate	None
Grand Above York To Brantford	Low	Brantford, Ohsweken
Fairchild Creek	Low	None
McKenzie Creek	Moderate	None
Grand Above Dunnville To York	Low	None

Estimated Future Municipal Drinking Water Demand (Surface Water)

Municipal System with Surface Water Intake	Assessment Area	Estimated Average Day Municipal Water Demand Increase (L/s)	Increase Applied to Future Surface Water Demand (L/s)	Increase Applied to Future Groundwater Demand (L/s)
Guelph – Eramosa Intake	Eramosa Above Guelph	200	0	200
Region of Waterloo – Mannheim	Grand Above Brantford to Doon	900	450	450
Brantford - Holmedale	Grand Above York to Brantford	280	280	0

-City of Guelph – no future municipal water demands
-Region of Waterloo – future municipal demand split 50/50 between surface water and groundwater
-Brantford – 100 % of future demands from Grand River.

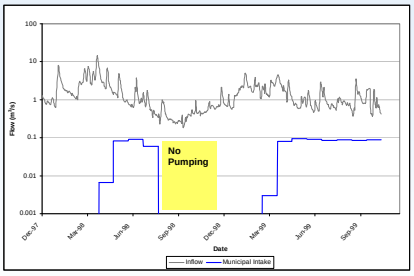
SW Stress Assessment (Future Conditions)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Grand Above Doon to Conestogo												
Supply	20,600	16,300	31,700	35,900	16,800	14,800	12,900	13,600	13,500	17,100	30,900	29,100
Reserve	11,100	8,800	12,800	16,500	13,000	11,200	11,000	10,900	9,800	10,000	12,800	17,500
Current Consumptive Demand	63	59	61	73	84	107	119	113	116	93	90	75
Estimated Additional Consumptive Demand	90	90	90	90	90	90	90	90	90	90	90	90
Total Future Consumptive Demand	153	149	151	163	173	197	209	203	206	183	180	165
Future % Water Demand	2%	2%	1%	1%	5%	5%	11%	8%	6%	3%	1%	1%
Grand Above York to Brantford												
Supply	58,200	51,300	90,900	102,000	52,800	39,500	29,900	29,000	29,600	43,100	70,800	77,600
Reserve	35,500	31,100	43,600	51,800	35,700	24,700	21,700	21,800	19,400	19,300	27,400	49,000
Current Consumptive Demand	129	129	127	137	141	248	276	240	197	140	131	127
Estimated Additional Consumptive Demand	56	56	56	56	56	56	56	56	56	56	56	56
Total Future Consumptive Demand	186	185	183	193	197	304	332	296	254	196	187	183
Future % Water Demand	1%	1%	0%	0%	1%	2%	4%	4%	2%	1%	0%	1%

SW Stress Assessment - Drought

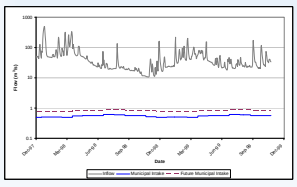
- Objective
  - Assess potential that surface water municipal sources may not be able to meet demands during 2-year drought period
- 2-Year Drought Period
  - 1998-1999

SW Stress – Drought Assessment

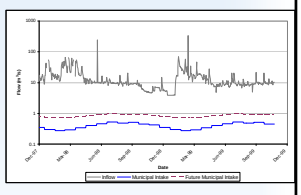


- City of Guelph stopped pumping stopped in 1998

SW Stress – Drought Assessment



ROW

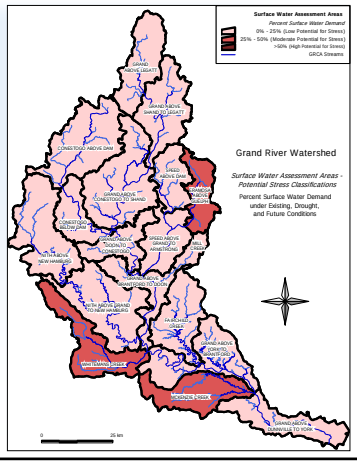


Brantford

Streamflow in Grand River well above historical and future water demand in 1998/1999. No drought concerns.

Surface Water Stress Assessment

- Subwatershed with 'moderate' potential for hydrologic stress under current conditions



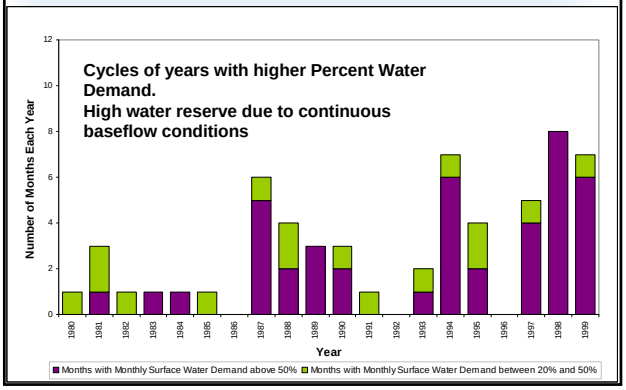
SW Stress Assessment Results

- 'Moderate' potential for hydrologic stress in:
  - Eramosa River Subwatershed
    - Influenced by large water reserve estimate
    - Potential drought impacts
  - McKenzie Creek Subwatershed
    - Agriculture Impacts
  - Whitemans Creek Subwatershed
    - Agriculture Impacts
- Municipal water supplies affected:
  - City of Guelph Eramosa Intake

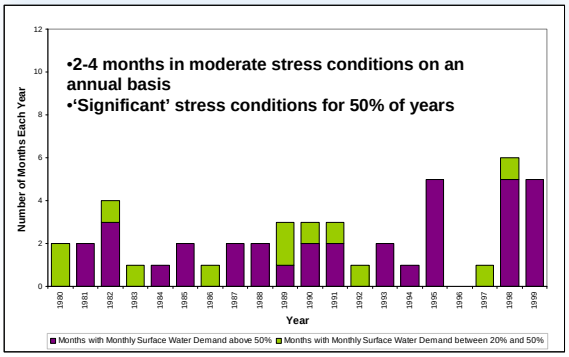
Temporal Percent Surface Water Demand Analysis

- Objective:
  - Analyze potential temporal trends in Percent Water Demand
  - Confirm subwatershed stress classification
- Approach
  - Estimate variable irrigation demand (irrigation demand model)
  - Continuously calculate Percent Water Demand using:
    - Monthly estimates of supply (Q50) and demand
    - Average monthly estimates of reserve (Q90) from 1980-1999

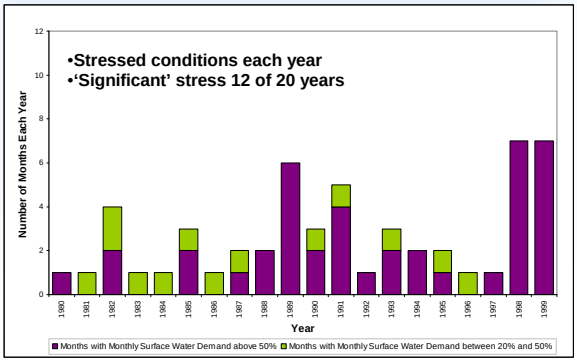
City of Guelph / Eramosa Intake



McKenzie Creek



Whitemans Creek

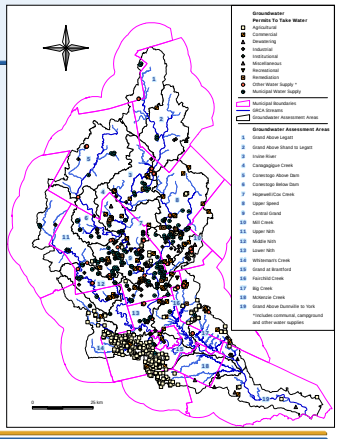


Groundwater Stress Assessment

- Stress assessment areas revised for groundwater stress assessment
  - Existing subwatersheds did not fully encompass municipal systems and aquifers for Guelph and ROW

Groundwater Demands

- Municipal demands most significant
- Others include:
  - Agriculture (Lower Watershed)
  - Aggregate/ Commercial



Groundwater Stress Assessment (Current Demands)

Assessment area	Groundwater Supply (L/s)			GW Reserve (L/s)	Demand (L/s)		% Water Demand	
	Recharge	Flow In	Supply		Average Monthly	Maximum Monthly	Average Water Demand	Max Water Demand
Grand Above Legatt	2,047	0	2,047	184	25	27	1%	1%
Grand Above Shand to Legatt	2,286	157	2,443	223	69	77	3%	3%
Irvine River	1,596	58	1,654	133	81	89	5%	6%
Canagagigue Creek	906	157	1,063	82	251	261	**26%**	**27%**
Conestogo Above Dam	2,246	42	2,288	128	37	40	2%	2%
Conestogo Below Dam	945	789	1,734	172	46	54	3%	3%
Hopewell/Cox Creek	1,377	181	1,558	131	84	108	6%	8%
Upper Speed	4,652	480	5,132	502	926	1030	**20%**	22%
Central Grand	4,133	525	4,658	448	1514	1875	**36%**	**45%**
Mill Creek	765	0	765	65	82	114	**12%**	16%
Upper Nith	2,164	133	2,297	101	33	40	2%	2%
Middle Nith	1,815	399	2,214	196	59	66	3%	3%
Lower Nith	3,807	295	4,102	381	184	269	5%	7%
Whiteman's Creek	3,275	120	3,395	289	105	415	3%	13%
Grand at Brantford	1,024	438	1,462	140	70	195	5%	15%
Fairchild Creek	1,735	203	1,938	176	91	115	5%	7%
Big Creek	777	198	975	61	153	199	**17%**	22%
McKenzie Creek	1,472	119	1,591	122	47	198	3%	14%
Grand Above Dunnville To York	1,019	54	1,073	99	91	116	9%	12%

Future Groundwater Demand

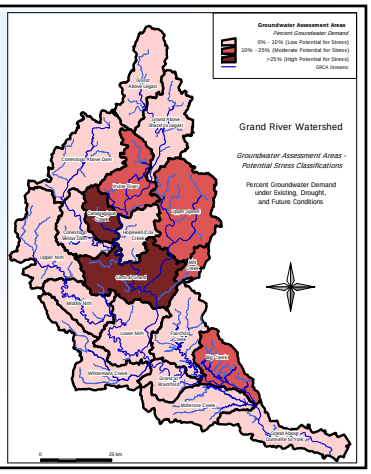
- Future municipal demands provided by GRCA
  - Population projections gathered from municipalities
- Additional future demand assigned to same assessment area as existing municipal supply
- Results
  - Irvine Creek (Elora/Fergus)
    - % water demand -> 10% (existing 5%)

Groundwater Stress Assessment Results

Assessment Area	Potential Stress (Future)	Maximum Monthly Potential Stress (Future)	Water Supplies
Grand Above Legatt	Low	Low	Dundalk
Grand Above Shand To Legatt	Low	Low	Grand Valley, Waldemar Marsville
Irvine River	Low (**Moderate**)	Low	Elora, Fergus
Canagagigue Creek	**Significant**	**Moderate**	West Montrose, Conestogo
Conestogo Above Dam	Low	Low	Arthur, Drayton, Moorefield
Conestogo Below Dam	Low	Low	RMOW Villages
Hopewell/Cox Creek	Low	Low	Maryhill
Upper Speed	**Moderate**	Low (Moderate)	City of Guelph, Guelph/Eramosa, Rockwood
Central Grand	**Significant**	**Moderate (Significant)**	RMOW
Mill Creek	**Moderate**	Low	Puslinch Mini-Lakes (communal)
Upper Nith	Low	Low	Milverton, Wellesley (RMOW)
Middle Nith	Low	Low	RMOW, Plattsville
Lower Nith	Low	Low	RMOW Villages, Drumbo, Paris
Whiteman's Creek	Low	Low	Bright, Princeton
Grand at Brantford	Low	Low	County of Brant (Airport & Mt Pleasant)
Fairchild Creek	Low	Low	St. George
Big Creek	**Moderate**	Low	Lynden
McKenzie Creek	Low	Low	None
Grand Above Dunnville To York	Low	Low	None

Groundwater Stress Assessment

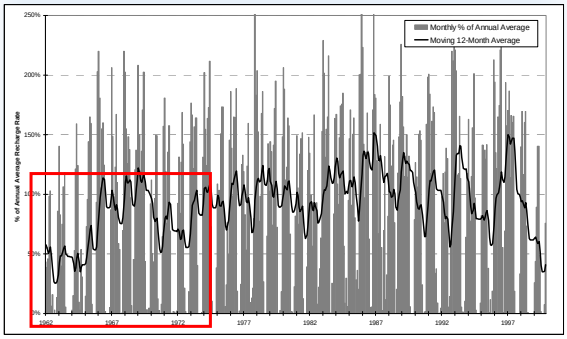
- Current Water Demands
- Upper Speed
- Central Grand
- Canagagigue Creek
- Big Creek
- Irvine Creek (Future)



Transient Conditions

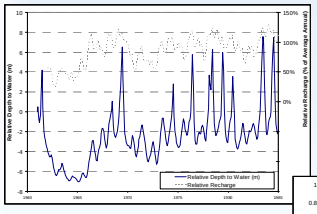
- Transient conditions evaluated on 2 levels
  - Drought Assessment
    - Monthly estimates of relative groundwater recharge. Estimate water level trends at municipal wells during drought period
    - Drought period – 1960-1975 (approx)
    - Examples Shown (Bright, Cambridge G4)
  - Percent Water Demand calculated continuously
    - Estimate based on average annual estimate of Recharge and demand
    - Examples shown (Upper Speed, Mill Creek)
- Both assessments use GAWSER estimated groundwater recharge rates

Transient Groundwater Recharge

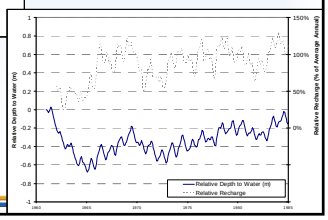


Drought Period

Drought Scenario – Example Results



Bright Well. Maximum drawdown 7 m. Well located in overburden sandy aquifer



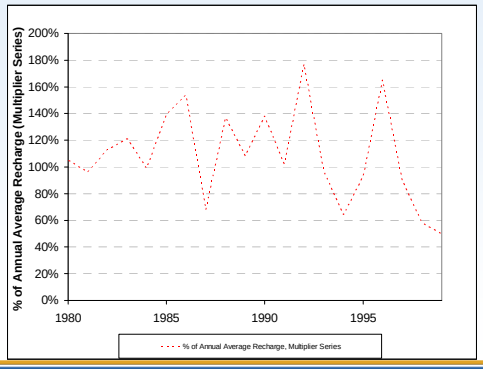
Cambridge G4. Maximum drawdown 0.6 m. Well located in Amabel bedrock formation

Drought Results

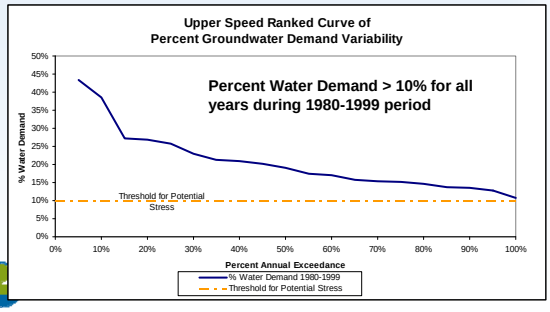
Municipality	Municipal System	Assessment Area	Well Name	Maximum Drawdown (m below initial)	Minimum Drawdown (m above initial)	Absolute Variability (m)
County of Brant	Airport Well Supply	Grand at Brantford	Airport Well	-3.75	+0.71	4.47
County of Oxford	Bright	Whiteman's Creek	Well_4	-7.02	+7.58	14.60
RMOW	Roseville	Lower Nith	R6	-3.03	+0.06	3.09
RMOW	Heidelberg	Conestogo Below Dam	HD1	-3.12	+0.15	3.27
RMOW			HD2	-3.46	+0.16	3.62
Centre Wellington	Fergus	Irvine River	Fergus_6	-3.56	+2.31	5.86
	Elora	Irvine River	Elora_E1	-4.30	+0.08	4.38

- Technical rules assign moderate potential for stress for wellfields experiencing drought effects
- Results of drought assessment are conceptually reasonable
- FEFLOW is not calibrated at wellfield conditions and construction information not available
- Do not recommend making definitive stress assignment based on current results

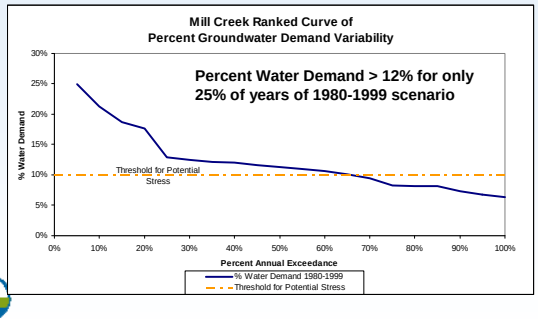
Average Annual GW Recharge (Transient Percent Water Demand Scenario)



Example Ranked Percent Water Demand (Upper Speed)



Example Ranked Percent Water Demand (Mill Creek)



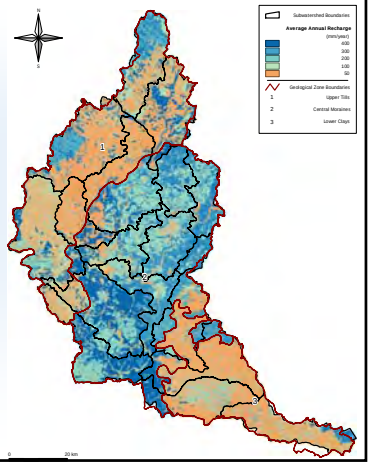
Significant Groundwater Recharge Areas

- ***Part V.2 - Delineation of significant groundwater recharge areas***
- *44. The areas described in subrules (1) and (2) and the subsurface beneath those areas are significant groundwater recharge areas:*
  - *(1) An area with an average annual recharge rate that is greater than the average annual recharge rate for the surrounding watershed by a factor of 1.15 or more.*
  - *(2) An area with an average annual recharge rate that is 55% or more of the rate determined by subtracting the average annual evaporation for the surrounding watershed from the average annual precipitation for the surrounding watershed.*

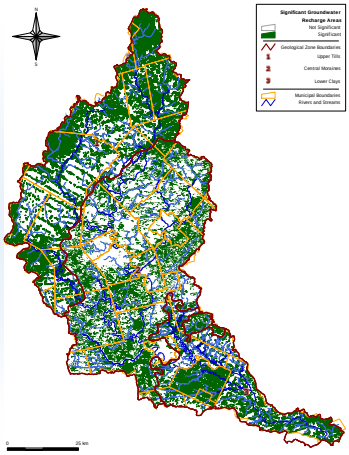
SGRA Thresholds

Physiographic Zone	Average Annual Recharge Rate (AARR) (mm/yr)	Threshold Recharge Rate (AARR *115%) (mm/yr)
Grand River Watershed	179	206
Upper Till Zone	132	152
Central Moraine Zone	253	291
Lower Clay Zone	75	86

Groundwater Recharge (GAWSER)

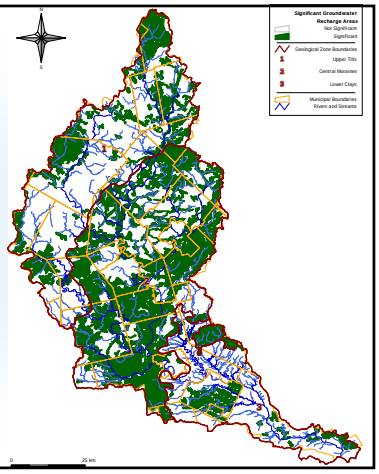


Significant Groundwater Recharge Areas (SGRAs)



Significant Groundwater Recharge Areas (SGRAs)

Areas < 1km^2 removed (filtered)



Summary / Actions for Peer Reviewers

- Surface Water Stress Assessment
  - Eramosa River 'Moderate'.
    - City of Guelph Eramosa Intake requires Tier 3 Assessment
- Groundwater Stress Assessment
  - Central Grand
    - ROW Integrated Urban System (Tier 3 Underway)
    - St. Agatha / New Dundee (?)
  - Upper Speed
    - City of Guelph (Tier 3 Underway)
    - Rockwood
  - Canagagigue Creek
    - West Montrose / Conestogo (?)
  - Big Creek
    - Lynden (?)
  - Communal systems not identified

Summary / Actions for Peer Reviewers

- Results of Stress Assessment
  - How to handle Tier 3's for small systems
    - Particularly where municipal systems are remote to key stressors.
  - Should Irvine Creek be classified as 'Moderate' based only on 25-year population estimate
- SGRAs
  - Multiple alternatives available to delineate SGRAs. Should they be considered without policy direction?
- Issues
  - Results of groundwater drought assessment are uncertain. Should 'Moderate' stress classification be assigned without wellfield calibration?
  - At the very least, well completion information and available monitoring data is required.

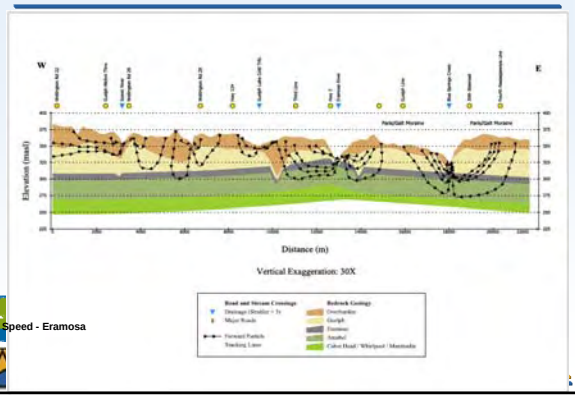
Particle Tracking

- Objective:
  - To refine SGRAs to identify critical recharge areas
- Methodology:
  - Utilize forward particle tracking within FEFLOW to identify SGRAs recharging municipal wells or key GW discharge areas
- Tech Rules removed this flexibility
- Provides
  - insight regarding GW flow system and key source areas
  - Comparison between SW and GW "subwatersheds"

Results Upper Grand

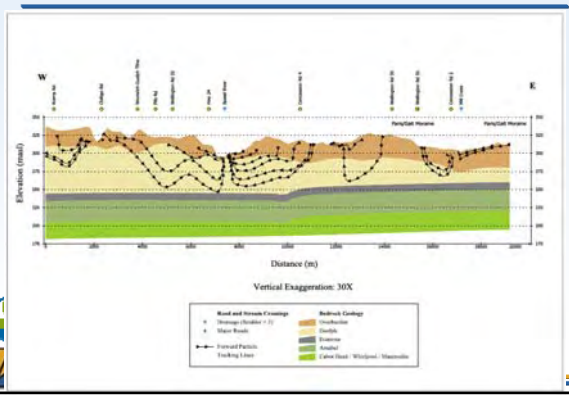
Results – Southern Grand

Above Guelph – Speed/Eramosa Section

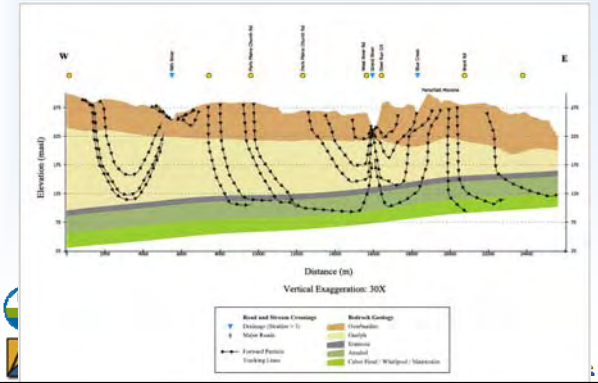


Speed - Eramosa

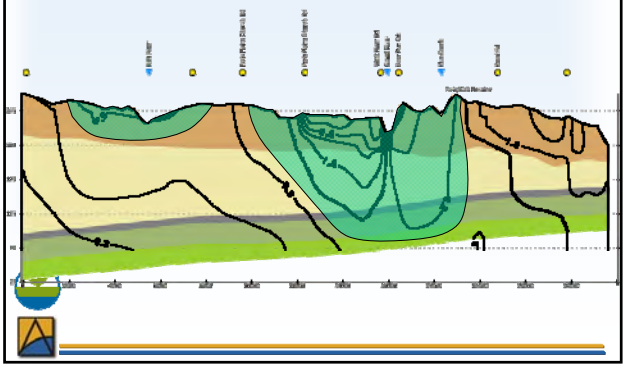
Below Guelph – Speed/Mill Cross Section



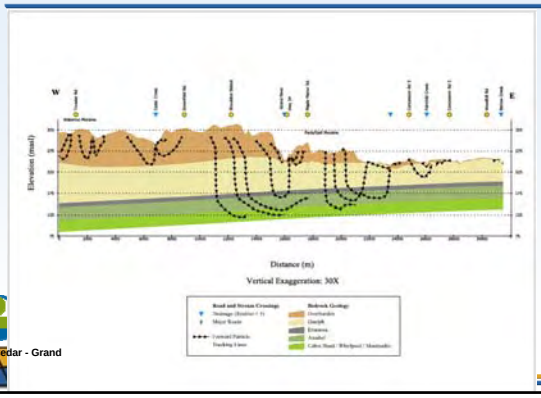
Above Paris - Grand/Nith Section



Above Paris - Grand/Nith Section

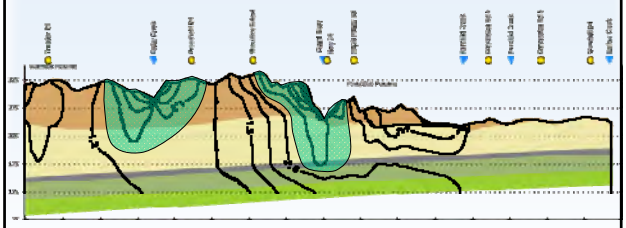


Below Cambridge – Cedar/Grand Section



Cedar - Grand

Below Cambridge – Cedar/Grand Section



Lake Erie Source Protection Region

Grand River Tier 2 Phase 2 Water Budget
Peer Review Committee Meeting

February 19th, 2009, GRCA Head Office

Minutes

Present: *Peer Review Leader*
James Etienne – GRCA
Peer Reviewers
Hugh Whiteley – University of Guelph
Chris Neville – S.S. Papadopulos & Associates
Dave Belanger – City of Guelph/CH2M Hill Canada Ltd.
Eric Hodgins – Regional Municipality of Waterloo
Peer Review Representatives
Mike Garraway, Scott Bates – Ministry of Natural Resources
Scott Lister (by teleconference) – Conservation Ontario
Project Team
Lorrie Minshall, Stephanie Shifflett, Amanda Wong – GRCA
Richard Wootton - Regional Municipality of Waterloo
Paul Martin, Dave Van Vliet (by teleconference), Sam Bellamy, Janna Hamilton – AquaResources Inc.

Regrets: *Peer Reviewer*
Dave Rudolph – University of Waterloo
Peer Review Representatives
Clara Tucker, Heather Malcomson, Richard Vantfoort – Ministry of the Environment
Project Team
Gregg Zwiers – GRCA

Introduction

J. Etienne welcomed the Peer Review Team and explained the purpose of the meeting and review process. MNR has asked that the MOE be included in the Peer Review process. MOE staff were invited to the meeting but were unable to attend due to a prior commitment

Meeting Objective: Present the findings of the Phase 2 Water Budget to the Peer Review team for provide clarification and to allow the team to formulate their comments for submission and further discussion at the next meeting.

Presentation on the Grand River Water Budget and Stress Assessment

S. Bellamy provided a summary presentation of the Grand River Tier 2 Water Budget and Water Quantity Stress Assessment Report. Slides of the presentation are available on the AquaResource FTP site. The presentation addressed the revisions to the Water Budget report as a result of the Phase 2 work, the surface and groundwater stress assessments, transient groundwater recharge conditions for the drought scenario and the approach preferred for defining significant groundwater recharge areas (SGRAs).

Question and Answer Discussions

The presentation prompted discussion and a number of questions from the Peer Reviewers including:

- Sam B. identified the availability of improved/up-to-date water use information that has been used to generate better water demand estimates.
- Richard W. indicated the need to include additional historic groundwater from the Region of Waterloo that pre-dates PGMN records.
- Sam B. outlined the changes in stress designations resulting from the use of new data and the future growth scenario.
- Hugh W. suggested the need to conduct stress assessments for subwatersheds with integrated water sources (ie. the use of Eramosa River water for the Arkell Collector System). Hugh feels a clear definition for the term "integrated system" is required.
- Sam B. pointed out the need for a correction to the groundwater subwatershed boundary near New Dundee.
- The group discussed the approach to dealing with Tier 3 Assessments for a number of small municipal drinking water systems located within moderately or significantly stressed subwatersheds.
- Mike G. recommended that there is a need to clarify the definition of "planned systems" relative to the assessment of the future scenario.
- Sam B. asked the Peer Reviewers for their opinions on the drawdown results under the drought scenario.
- Eric H. explained that drawdown values presented in the Drought Results table are only appropriate for a regional scale and not a local scale.
- The Peer Reviewers agreed that more data and review is necessary to make a judgement on increased stress levels using averages over a larger area.
- Sam B. asked the Peer Reviewers to provide comments on the preferred approach to delineate SGRAs, and if a $1km^2$ filter was appropriate.
- Lorrie M. asked that the particle tracking results for the SGRA assessments be included in the report.

Action Items

As a result of the meeting the following action items were generated:

- AquaResource will make the presentation slides available on their FTP site.
- J. Etienne will prepare meeting notes for circulation to all the Peer Review team members.
- Peer reviewers are asked to submit any comments or questions to J. Etienne for circulation to all project team members.
- Written comments are due in to J. Etienne by March 4th to allow for consolidation, preparation and circulation of a comment matrix prior to the next meeting.
- Peer Reviewers are asked to contact J. Etienne if comments can not be prepared by March 4th.

Next Meeting

The next meeting, scheduled for 10am-2pm on March 12th at the AquaResource office in Breslau, will be held to review the consolidated comments and agree on actions to be taken to address the comments and finalize the reports.

Lake Erie Source Protection Region
Kettle/Catfish/Long Point Tier 2 Phase 2 Water Budget
Peer Review Committee Meeting

March 19th, 2009, 9:30am to 3:30pm
GRCA Head Office (400 Clyde Road, Cambridge), Auditorium

Agenda

Meeting Objective: Review Grand River Tier 2 comment matrix. Present the findings of the Kettle/Catfish/Long Point Phase 2 Water Budget to the Peer Review team and allow the team to formulate their comments for submission and further discussion at the next meeting.

9:30 to 9:40	Welcome and Introduction • Purpose of Meeting • Participant Expectations	J. Etienne
9:40 to 11:30	Grand River Tier 2 Comments • Review of Comment Matrix	All
11:30 to 2:00	Kettle/Catfish/Long Point Tier 2 Water Budget and Stress Assessment Powerpoint Presentation • Revisions to Water Budget • Stress Assessment • Existing & Future Scenarios • Drought Scenario • Particle Tracking • Significant Groundwater Recharge Areas	P. Martin
12:15	Lunch	
2:00 to 2:45	Question & Answer Session	All
2:45 to 3:00	Peer Review Commenting Process	J. Etienne
3:00 to 3:30	Long Point Tier 3 Discussion	All

Next Meeting: Review Kettle/Catfish/Long Point comment matrix (date to be determined)

Lake Erie Source Protection Region

Grand River Tier 2 Phase 2 Water Budget
Peer Review Committee Meeting

March 19th, 2009, GRCA Head Office

Minutes

Present: *Peer Review Leader*
James Etienne – GRCA
Peer Reviewers
Hugh Whiteley – University of Guelph
Chris Neville – S.S. Papadopulos & Associates
Dave Belanger – City of Guelph/CH2M Hill Canada Ltd.
Dave Rudolph – University of Waterloo
Peer Review Representatives
Scott Bates – Ministry of Natural Resources
Scott Lister – Conservation Ontario
Project Team
Lorrie Minshall, Stephanie Shifflett, Amanda Wong – GRCA
Richard Wootton - Regional Municipality of Waterloo
Paul Martin, Sam Bellamy, Janna Hamilton – AquaResources Inc.

Regrets: *Peer Reviewer*
Eric Hodgins – Regional Municipality of Waterloo
Peer Review Representatives
Clara Tucker – Ministry of the Environment
Project Team
Gregg Zwiers – GRCA
Dave VanVliet – AquaResources Inc

Introduction

J. Etienne welcomed the Peer Review Team and explained the purpose of the meeting.

Meeting Objective: Review Grand River Tier 2 comment matrix regarding the Water Budget and Stress Assessment reports.

L. Minshall commented on the timing to complete the Tier 2 Water Budgets and Stress Assessments for the Grand and Kettle/Catfish/Long Point watersheds. The goal is to present the Stress Assessments to the Source Protection Committee this spring. An introductory presentation is being prepared for the April 2nd meeting. Lorrie noted the need to get a peer reviewed report to the province as soon a possible to address the

outstanding “high water use designation” issue in Norfolk County which could influence the timing regarding the completion of the Grand River Stress Assessment report.

Review Grand River Water Budget and Stress Assessment Comments

J. Etienne advised the committee that the comments on the two documents would be reviewed separately starting with the Grand River Tier 2 Integrated Water Budget Report. J. Etienne reminded the peer reviewers that the Water Budget report had been previously peer reviewed in 2007 and that the current version of the report had been revised to bring the data sets up to date, particularly in the Water Demand section. Comments to be addressed by AquaResource Inc. should focus on corrections or concerns with any new material and that the approach used in the 2007 document and already accepted by the Peer Reviewers should not be revised. J. Etienne advised that the responses to the comments would be recorded in the matrix and sent out with the meeting minutes.

The comments on the Water Quantity Stress Assessment report were also reviewed by the group. The comments received from the Peer Review team were added to the comment matrix along with assignment of updating and editorial tasks.

Action Items

As a result of the meeting the following action items were generated:

- J. Etienne will prepare meeting notes for circulation to all the Peer Review team members including a copy of the revised comment matrix with the response and assignment columns filled in as noted during the meeting.

- Peer reviewers will provide comments documenting any outstanding concerns with material in the reports by May 1, 2009.

- AquaResource will make editorial changes to the documents as noted in the Peer Reviewer comments by May 22, 2009.

- J. Etienne will circulate the revised report to Peer Review committee members.

- Peer reviewers will respond in writing with acceptance (that this report fulfills the comment responses) and/or comments by June 1, 2009. This will complete the Tier 2 Peer Review process for the Grand River Water Budget.

- J. Etienne will present the peer reviewed Grand River Water Quantity Stress Assessment report to the Lake Erie Source Protection Committee for their review of the documents on June 4, 2009. The SPC will adopt the appropriate sections from the Water Budget and Stress Assessment reports for inclusion in the Assessment report in the fall of 2009.

Attach.

Appendix C-2

Phase 2 Draft Document Peer Review Comments

- **March 5, 2009 comments from Hugh Whiteley**

Comments by H.R. Whiteley on the Stress Assessment Report

Executive Summary

The Grand River Watershed extends over 6,700 km^2 and currently has 900,000 residents.

3rd para 6-7 lines subwatershed by calculating the percentage ratio of water *demand*s to available surface and groundwater *supply*

Page iii some justification of using 115% for the initial delineation of SGRA's should be given in the full text and in the executive summary. A measure of the % of total recharge contributed by SGRA's using this criterion would be best

Page 9 where ever GAWSER is mentioned and labelled it should be labelled (continuous streamflow-generation model) and FEFLOW labelled as (steady-state groundwater-flow model) or (transient groundwater flow-model) – the latter when transient runs were made.

Table 2.1 in second column heading remove (Subwatershed) as the SWSAA is an unambiguous label

Before Table 2.2 and in Table 2.2 make the order Reported Demand, Estimated Demand, Total Demand with the commentary for takings within the assessment area that had actual reported pumping rates these rates were summed and shown as reported demand; for all other sources an estimate of consumptive uses was made and summed and is shown as Estimated Demand. Total Demand is the sum of Reported and Estimated Demand

Figure 5 the timing of the start of 99 water taking has been questioned and should be checked

P27 last paragraph replace soil moisture with soilwater (throughout)

P44 This is not a comment on the text but a side note. There is a major inconsistency between using 90% of flow as reserve to surface water and 10% of flow as reserve for groundwater. In future revisions to the technical rules this should be examined.

P 52 Fig 19 it would be very helpful from a "public education" perspective to extend the analysis for Fig 19 to the most recent available year so it did not end with a two-year very significant drought. It is also puzzling that the apparent general downward trend in Fig 19 is the reverse of the generally trending upward results from some of the wells in the provincial monitoring network in the water budget report.

P 57 there is also a contrast between the general upward trend in twelve-month moving average % recharge and the downward trend in Fig 19

P57 section 3.5.2. as noted in an earlier discussion the use of single point results for drawdown is not appropriate given the lack of local calibration of the groundwater model. Average drawdown over a set of 5 to 10 points in the vicinity of each site chosen would be more appropriate.

P 68 as noted earlier an examination of the 115% criterion is needed and this examination is best done with a table of % total recharge contributed by areas with rates > average by (say) 5 %, 10 %, 15 %; 20 %; and 25% - or higher if % supplied has not reached 85%.

P 68 Table 4.1 mm/y not mm/yr

P 73 The Grand River Watershed extends over 6,700 km^2 and currently has 900,000 residents.

Comments by Hugh Whiteley on the Integrated Water Budget Report

General comments:

As noted in the Stress Assessment Report where ever GAWSER is mentioned and labelled it should be labelled (continuous streamflow-generation model) and FEFLOW labelled as (steady-state groundwater-flow model) or (transient groundwater flow-model) – the latter when transient runs were made.

Rigour in use of correct SI units adds to the scientific tone of the report and strengthens the impression that it is soundly science-based. Time units are s,h,d,y there needs to be a space between numerals and units, and if numerals are used symbols for units are used, if quantities are given in words units are given in words. for the denominators of ratios use either negative powers or slash and bracketed units (with all units of denominator inside bracket) avoid units like $L/km^2/s$

P 1 and continuing. I think this report will be used as a model for future reporting in the province and it is well worthwhile doing some additional editing for clarity and logic. I have editing suggestions written unto a paper copy that I will hand in. These changes are not essential to fulfill the basic requirement of the study but are justified if use of the study as a model is contemplated. Perhaps the province could provide a small special budget for this editing and in return get extra copies for distribution as a guide.

Figure 2 put names of subwatersheds on Figure 2 using upstream to downstream ordering within the table of names.

P 5 add brief description of common surface soil types and properties for each of the three units.

P 11 the nine process should be listed as (1) accumulation and ablation of snow; (2) Filing and emptying of interception storage and depression storage; (3) infiltration; (4) evapotranspiration {beyond that included as part of (1) and (2)}; (5) generation and routing of overland flow; (6) generation and routing of subsurface storm runoff (interflow); (7) filling and emptying of groundwater storage (recharge and baseflow); (8) routing of flow in channels; (9) routing flow through reservoirs.

1.4.4 I suggest a major rewrite with a special emphasis on the treatment of subsurface storm runoff. This will provide, inter alia, a needed description of what is included in the groundwater-flow model i.e. the representation of groundwater flow excludes ephemeral flows along short-length flow routes that involve either discontinuous saturated zones or very temporary mounding with large vertical and horizontal gradients – water flowing in these ephemeral pathways, although technically groundwater (flow in saturated pores) is not included in either the representation of the groundwater flow system and water flowing in the stream channel that reached the channel through these flow routes is not

included in the determination of baseflow using analysis of hydrographs. A rewrite will make this point and clarify the connection between the streamflow-generation model and the groundwater-flow model and justify the use of recharge from the former (which excludes water entering the interflow route) and results of the latter that are compared to dry-weather baseflow when interflow is not present

P 22 some reference to ongoing geologic studies and possible revisions in descriptors is appropriate

Figure 26 use different (lighter) colour tones so distinctions in precipitation are obvious and road patterns are put into the background – it looks now as if it is intended to show the road pattern

Figure 27 very interesting form of presentation. It is worth concluding that there is a slight dip in precipitation in the mid watershed as shown by > 2/3 of maximums (28/39)being in the UG and > 2/3 of the minimums also 28/39) being in the MG.

Table 2.7 Revise the table to have two columns for urban (1)urban pervious and (2) urban impervious

Shorten names by not repeating river name and list from u/s to downstream i.e. Upper Grand River (1) to Legatt (2) Legatt to Shand (3) Shand to Conestogo

Also explain the big difference in % impervious i.e. Nith to New Hamburg 0 %, Fairchild 13 %

P 61 and everywhere use the terms watershed, watershed area, and subwatershed consistently and don't blur the distinction, use the correct term each time.

Appendix C-3

Phase 2 Peer Reviewer's Comments Matrix

- **March 19, 2009 Revised Integrated Water Budget Comments**
- **November 27, 2009 Stress Assessment Comments**

GRCA Tier 2 Phase 2 Water Budget Peer Review Comments Matrix

Category and Page	Raised by	Comment	Assign to	Response
General		**INTEGRATED WATER BUDGET REPORT**		
General	Hugh W.	As noted in the Stress Assessment Report where ever GAWSER is mentioned and labelled it should be labelled (continuous streamflow-generation model) and FEFLOW labelled as (steady-state groundwater-flow model) or (transient groundwater flow-model) – the latter when transient runs were made. Rigor in use of correct SI units adds to the scientific tone of the report and strengthens the impression that it is soundly science-based. Time units are s,h,d,y there needs to be a space between numerals and units, and if numerals are used symbols for units are used, if quantities are given in words units are given in words. for the denominators of ratios use either negative powers or slash and bracketed units (with all units of denominator inside bracket) avoid units like L/km2/s.	ARI	The report recognizes the full interaction of water components but there are needs for robust groundwater understanding as it integrates with surface supplies. This understanding needs to be conveyed very clearly up front in the executive summary.
General	Stephanie S.	Particle tracking, regional discharge areas and SGRAs should be added to the Water Budget Report.	ARI	The Water Budget report is knowledge based and the Stress Assessment report focuses on implementation. Particle tracking will be included as background in the Water Budget report and SGRAs will be included in the Stress Assessment report.
General	Dave B.	In general, I have found the report to be an excellent discussion of the water budget for the Grand River Watershed. It adequately describes the physical setting, geology, hydrogeology and surface water hydrology of the river basin.	n/a	No response required.
General	Eric H.	I note that none of the Region's August 2007 comments are included in the Grand River Conservation Authority (GRCA) Final Comment Matrix sent by email in February 2009 so it is unclear how these are being addressed. Please add these to the comment matrix so they can be discussed at future Peer Review Committee meetings.	JBE	A peer review paper trail needs to be completed linking the Region's Aug/07 letter to ARI's Phase 2 workplan to address their outstanding comments.
1	Hugh W.	On page 1 and throughout the report, I think this report will be used as a model for future reporting in the province and it is well worthwhile doing some additional editing for clarity and logic. I have editing suggestions written into a paper copy that I will hand in. These changes are not essential to fulfill the basic requirement of the study but are justified if use of the study as a model is contemplated. Perhaps the province could provide a small special budget for this editing and in return get extra copies for distribution as a guide.	ARI/MOE	Edit if required. The MNR can determine if the Water Budget should serve as an example document.
4	Hugh W.	Figure 2 - Put names of subwatersheds on Figure 2 using upstream to downstream ordering within the table of names.	ARI	Naming convention needs to be consistent in the direction of flow.

5	Hugh W.	Add brief description of common surface soil types and properties for each of the three units.	ARI	Edit as required.
11	Hugh W.	The nine process should be listed as (1) accumulation and ablation of snow; (2) Filing and emptying of interception storage and depression storage; (3) infiltration; (4) evapotranspiration {beyond that included as part of (1) and (2)}; (5) generation and routing of overland flow; (6) generation and routing of subsurface storm runoff (interflow); (7) filling and emptying of groundwater storage (recharge and baseflow); (8) routing of flow in channels; (9) routing flow through reservoirs.	ARI	Edit as required.
13	Hugh W.	Section 1.4.4 - I suggest a major rewrite with a special emphasis on the treatment of subsurface storm runoff. This will provide, inter alia, a needed description of what is included in the groundwater-flow model i.e. the representation of groundwater flow excludes ephemeral flows along short-length flow routes that involve either discontinuous saturated zones or very temporary mounding with large vertical and horizontal gradients – water flowing in these ephemeral pathways, although technically groundwater (flow in saturated pores) is not included in either the representation of the groundwater flow system and water flowing in the stream channel that reached the channel through these flow routes is not included in the determination of baseflow using analysis of hydrographs. A rewrite will make this point and clarify the connection between the streamflow-generation model and the groundwater-flow model and justify the use of recharge from the former (which excludes water entering the interflow route) and results of the latter that are compared to dry-weather baseflow when interflow is not present.	n/a	A major rewrite to the peer reviewed content of the Water Budget report would not be appropriate.
19	Eric H.	Second bullet: please add" ... which makes up a considerable portion of the northern and western portion of the area" to the last sentence to ensure the reader is aware of the distribution of the various moraines within the Central West Area.	ARI	Edit as required.
Appendix A	Dave B.	In the Permit to Take Water Database for the Eramosa River Intake, it is listed as a municipal taking of 0.3 L/s in March. Since the City's permit only allows for taking from April 15 to November 15, this value is questionable.	ARI	Correct as required.

GRCA Tier 2 Phase 2 Water Budget Peer Review Comments Matrix

Watershed Characterization		INTEGRATED WATER BUDGET REPORT		
18	Stephanie S.	Figure 5 – missing data from Dufferin County. This data is available and the map should be updated.	ARI	Edit as required.
19	Stephanie S.	Section 2.1.1 – it is confusing to refer to both the 3 GRCA groupings of moraines and the 4 study groupings. Either only refer to one type of grouping or combine figures 6 and 7 to show how the grouping definitions overlap.	ARI	Edit as required. Take out the groupings.
22	Hugh W.	Some reference to ongoing geologic studies and possible revisions in descriptors is appropriate.	ARI	Edit as required.
27	Scott B.	The statement at the bottom of the page which indicates that the OMNR approved the GRCA to proceed directly with a Tier 2 Water Budget and Subwatershed Stress Assessment should also reference Technical Rule 24 which provides the GRCA an additional mechanism/rationale for beginning at Tier 2.	ARI	Edit as required.
47	Hugh W.	Figure 26 - Use different (lighter) colour tones so distinctions in precipitation are obvious and road patterns are put into the background – it looks now as if it is intended to show the road pattern.	ARI	Edit as required.
47, 50	Stephanie S.	Figure 26/28 – Is 2 decimal places really needed for the map legend? Do we have accuracies to 2 decimal places?	ARI	Edit as required.
48	Hugh W.	Figure 27 - Very interesting form of presentation. It is worth concluding that there is a slight dip in precipitation in the mid watershed as shown by > 2/3 of maximums (28/39)being in the UG and > 2/3 of the minimums also 28/39) being in the MG.	n/a	No response required.
52	Stephanie S.	Table 2.6 – Currently the GRCA uses a flow target of 0.42 at the Leggatt gauge instead of the 0.4 target at Marsville.	ARI	Edit as required.
53	Hugh W.	Table 2.7 - Revise the table to have two columns for urban (1) urban pervious and (2) urban impervious. Shorten names by not repeating river name and list from u/s to downstream i.e. Upper Grand River (1) to Legatt (2) Legatt to Shand (3) Shand to Conestogo. Also explain the big difference in % impervious i.e. Nith to New Hamburg 0 %, Fairchild 13 %	ARI	Edit as required. There is a need for an explanatory note regarding exposed rock. Use <1% rather than 0%.
61	Hugh W.	Throughout the document, use the terms watershed, watershed area, and subwatershed consistently and don't blur the distinction, use the correct term each time.	ARI	Edit as required.
65	James E.	There is no reference to Figure 35(a) in the text.	ARI	Edit as required.

GRCA Tier 2 Phase 2 Water Budget Peer Review Comments Matrix

Water Demand		INTEGRATED WATER BUDGET REPORT		
72	Stephanie S.	Section 3.0 - Need to distinguish between "estimated" and "reported" water use terms better. They need to be defined up front and their use should be consistent within the water budget report and the stress assessment (definitions also need to be up front in the stress assessment report). On the whole this section has confusing terminology; pumping demand vs. water demand vs. consumptive demand, use of estimated as a descriptor and as a term; reported consumptive rates vs. estimated consumptive rates. Do reported rates include consumptive estimates or not? How is a reported consumptive rate different than an estimated consumptive rate?	ARI	Water use terminology requires clarification. Some definitions should be added to improve flow. Check for consistency by section (ie. reported, estimated then total demand). Edit as required to correct any new information brought in.
72	Eric H.	Section 3.0 - As noted in the February 11, 2009 memo from James Etienne of the GRCA regarding changes in the report from previous versions, Section 3: Water Use of the report was substantially rewritten, including new reported, municipal water usage, a new method for calculating agricultural irrigation, and an updated MOE Permit To Take Water (PTTW) database. This new information resulted in very different water-use calculations than in the previous versions of the report. Specifically, municipal water use was lower and several new high PTTWs were added in the northern portion of the watershed. As a result, the water use by subwatershed values changed considerably with the groundwater use up approximately 5% and the surface water use more than double the previous estimate. As permitted water taking is the largest water use, some additional information related to this use should be included in the report. Table 3.1 - Provides the references and years for which municipal water taking was reported and used in the water-use calculations. For the Region, groundwater use is stated to be from 2006 whereas surface water use is stated to be 2001. Please confirm that 2006 data was used for both source types in the water budget and stress assessment.	ARI	Some edits and revisits of the water use data base would be helpful. A comment regarding 2006 water takings for consistency should be included.
76-77	Eric H.	Figures 39 and 40 - A table listing the number of permits per subwatershed by sector should also be developed to provide additional information in support of the figures. This would also help the peer review team review the consumptive water-use calculations as part of the stress assessment.	ARI	Edit as required.
82	Eric H.	Section 3.2.3 - Describes the revised approach to calculate agricultural irrigation permitted water use based on GAWSER generated time-varying soil moisture profiles for the different soil types. Please confirm whether this approach accounts for geographic variations in rainfall. As the frequency and duration of rainfall varies considerably across the watershed, it is important to understand whether this was included in the approach and subsequent water use calculations. If not, some discussion of this is needed in this section and the section on GAWSER uncertainty.	Sam B. & Amanda W.	Revisiting and confirming the consumptive demand estimates will help to clarify this section.

83	Stephanie S.	Table 3.5 – Put in the average annual number of irrigation events. 32 days of pumping is averaged over 122 days for an estimate of 26% of the max pumping rate…but the surface water is evaluated on a monthly basis and groundwater on a max monthly basis so, why was the seasonal water use averaged over the irrigation season and not on a monthly basis? Are we then underestimating the agricultural water use? There is also mention that max water takings can be as high as twice the average and they could be used for a drought scenario. Were they used for the drought scenario or not?	ARI	Edit as required.
93	Eric H.	Table 3.10 - Should be expanded to list estimated and reported water use by sector in a format similar to Table 3.12 to enable comparison of water use.	ARI	Edit as required.
97	Stephanie S.	Table 3.3 - Are consumptive factors applied to both estimated and reported rates? And if so can the statement on the bottom of the page really be said if estimated consumptive factors are used?	ARI	Edit as required.
99, 100	Stephanie S.	Figures 47 & 48 – Would be easier to compare if they had similar scales to the legends.	ARI	Edit as required.
101-102	Eric H.	Figures 49 & 50 – The Grand Above Conestogo to Shand is one of the subwatersheds with increased permitted water taking in comparison to previous versions of the report. Please confirm that reported water taking volumes were used in the calculations for the Crompton (formerly Uniroyal) remediation project in Elmira. If not, the Region has this information readily available and should be used in the assessment given the high water use estimated for this subwatershed.	ARI	Edit as required.
105	Stephanie S.	Figure 51 – Are Dams, wildlife conservation, and hydro operations included in the surface water permitted/pumped parts of this chart?	Sam B. & Amanda W.	Amanda's wetland permits are not being updated. Sam should check with Amanda to determine if there are any "disconnects".
106	Eric H.	Section 3.6.1 - The first and third bullets in Information Gaps makes reference to shortcomings in the permit to take water process, which is not the intent of the section. They also make assumptions relative to these permits that do not reflect the primary reason that municipal well permits have higher rates than average, which is the need to meet peak demand and ensure compliance due to fluctuations in pumping rates at pump start up. While the issues raised in these bullets may be valid, the content should be focused to data gaps such as needed actual reported rates, as opposed to comments on the permitting process. Also the third bullet should not use municipal water supply wells as an example because actual reported rates were used for this sector so there is no information gap.	ARI	Edit as required.
106	Stephanie S.	The third paragraph implies that consumptive factors are not applied to reported pumping rates, but pumping rates and consumptiveness are different aspects. A reported pumping rate is consumptive based on the end use of the water.	ARI	Edit as required.
107	Stephanie S.	There are other takings that are 'grandfathered' as well as municipal takings. It's the municipal takings that we may have a good chance of knowing the pumping rates. It's the "others" that are widely unknown that may prove a greater source of uncertainty.	ARI	Edit as required.

GRCA Tier 2 Phase 2 Water Budget Peer Review Comments Matrix

Modelling – GAWSER		INTEGRATED WATER BUDGET REPORT		
111	Stephanie S.	Figure 52 – labelled as ZUMs, but the map shows climate zones and not the continuous model ZUMs. The continuous model ZUMs and slightly different. Need to replace map.	ARI	Edit as required.
114	Stephanie S.	Figure 53 – Speed Above Dam is labelled as Eramosa Above Guelph. Need to fix.	ARI	Edit as required.
116	Scott B.	Section 3.5 - "Summary Of Estimated Water Use in The Grand River Watershed" should specify for the reader that the subsequent Tier 2 water quantity stress assessment analysis calculates consumptive use based on the "unit" scale.	ARI	Edit as required.
118	Stephanie S.	Section 4.4.6 – The methods GAWSER can use to handle evapotranspiration are discussed, but it is not stated which method was used in the model runs for this study.	ARI	Edit as required.
120	Eric H.	Figure 55 - In the map of the wastewater treatment plants which includes a plant at Baden, this facility does not discharge to surface water as all the waste water is piped to New Hamburg. Please remove this site.	ARI	Edit as required.
127	Stephanie S.	Figure 59 – take out the word “actual” when labelling the evapotranspiration since this implies that it is observed data, when in fact it is model output.	ARI	The distinction between “estimated” and “actual” should be clarified.
128, 129	Stephanie S.	Figures 60 & 61 – could the time period of data and the source (i.e. model output) be put into these figures?	ARI	Edit as required.
135	Eric H.	Section 4.8 - The discussion of uncertainty in the GAWSER modeling, does not make reference to Technical Rule 36. I note that this Rule is specific to undertaking the uncertainty analysis for the stress assessment. However, the Stress Assessment report does not explicitly refer to this Rule either so it is assumed that these sections, and others distributed through both reports will fulfill the requirements. Accordingly more reference to this Rule is needed in the report to assist in evaluating the uncertainty has been adequately assessed. In addition, the organization of the Section is not consistent with the four categories of uncertainty that must be considered in the rule although there is implicit links between the subsections of the report and the technical rule. For example, it is presumed that watershed characterization refers to the "ability of the methods and models used to accurately reflect the hydrologic system". Finally, if other parts of the report do address other components of the Rule, a summary of these should be provided in this or the appropriate section.	ARI	Check that the discussion of uncertainty satisfies the Technical Rules.
137	Stephanie S.	Section 4.8.4 – would be nice if the limitations listed could be referenced with respect to the Grand model. The first one (scale) is, but the others are not.	ARI	Edit as required.

GRCA Tier 2 Phase 2 Water Budget Peer Review Comments Matrix

Modelling – FEFLOW		INTEGRATED WATER BUDGET REPORT		
153	Stephanie S.	How were the stream flows naturalized for baseflow separation?	ARI	Refer to D. Boyd's baseflow paper.
161	Eric H.	Figure 68 - The water table contour lines are too thin/small to be readable and should be changed to match line thickness used for potentiometric surface contours in Figure 69.	ARI	Edit as required.
165	Eric H.	Section 5.4 - The discussion of uncertainty in the FEFLOW modeling, does not make reference to Technical Rule 36. I note that this Rule is specific to undertaking the uncertainty analysis for the stress assessment. However, the Stress Assessment report does not explicitly refer to this Rule either so it is assumed that these sections, and others distributed through both reports will fulfill the requirements. Accordingly more reference to this Rule is needed in the report to assist in evaluating the uncertainty has been adequately assessed. In addition, the organization of the Section is not consistent with the four categories of uncertainty that must be considered in the rule although there is implicit links between the subsections of the report and the technical rule. For example, it is presumed that watershed characterization refers to the "ability of the methods and models used to accurately reflect the hydrologic system". Finally, if other parts of the report do address other components of the Rule, a summary of these should be provided in this or the appropriate section.	ARI	Check that the discussion of uncertainty satisfies the Technical Rules.

Water Budget		INTEGRATED WATER BUDGET REPORT		
169	Stephanie S.	Section 6.0 – There are numerous text errors in this section	ARI	Edit as required
169	Eric H.	Section 6.0 - As mentioned in the Region's March 2007 comments, the absence of sensitivity analysis to assess the importance of individual parameters in the accuracy of predicted water budget calculations is a significant shortcoming in the water budget report and related stress assessment. I note that there were several scenario analyses undertaken as part of the Stress Assessment, but these did not involve recalibration of the underlying GAWSER or FEFLOW models, The implicit assumption for these "scenario" analyses is that the underlying models are sufficiently accurate and unique that other ways of achieving equivalent calibration is not possible, which is not an accurate assumption given the large number of averages and assumptions built into each model. As it is unlikely that additional sensitivity analysis will undertaken at this stage in the reporting, some additional discussion of this should be included in the report as it is critical for future water budget analyses and models to include this type of assessment as part of the modeling.	ARI	Include discussion to address concerns regarding the accuracy of calibration without additional sensitivity analysis.
169	James E.	Last paragraph should correct Table 6.1 reference.	ARI	Edit as required
170	James E.	First paragraph should refer to Table 6.2. Second last paragraph should reference Figures 72 & 73 (not 59 & 60). Last paragraph, correct reference to Table 3.	ARI	Edit as required
170	Stephanie S.	The values in table 6.2 don't match the values in the text. 2nd paragraph "The results suggests…" there is something missing in this sentence.	ARI	Edit as required

GRCA Tier 2 Phase 2 Water Quantity Stress Assessment Peer Review Comments Matrix

Category and Page (revised page)	Raised by	Comment	Assign to	Response
General				
i **(i)**	Hugh W.	The Grand River Watershed extends over 6,700 km2 and currently has 900,000 residents. 3rd para 6-7 lines - subwatershed by calculating the percentage ratio of water demands to available surface and groundwater supply.	ARI	Edit as required
iii **(80-82)**	Hugh W.	Some justification of using 115% for the initial delineation of SGRA's should be given in the full text and in the executive summary. A measure of the % of total recharge contributed by SGRA's using this criterion would be best.	ARI/ MNR/ MOE	Magnitude needs to be assessed in context as well as relative values. Some small areas may be significant. Rule only deals with "relative" significance (Scott B.). Further work is required. Policy will be result. SGRAs need to be contextualized. ARI completed this exercise to satisfy the rules but the value of the exercise needs to be reconsidered. Hugh is concerned about the justification for 115% as a significant threshold. MNR are working with MOE on a justification to address the "randomness" concern.
9 **(11)**	Hugh W.	Wherever GAWSER is mentioned and labeled it should be labeled (continuous streamflow-generation model) and FEFLOW labeled as (steady-state groundwater-flow model) or (transient groundwater flow-model) – the latter when transient runs are made.	ARI	Edit as required

GRCA Tier 2 Phase 2 Water Quantity Stress Assessment Peer Review Comments Matrix

Surface Water Demand				
11 (14)	Hugh W.	Table 2.1 - In second column heading remove (Subwatershed) as the SWSAA is an unambiguous label.	ARI	Edit as required
12 (15-17)	Hugh W.	Before Table 2.2 and in Table 2.2 - Make the order Reported Demand, Estimated Demand, Total Demand with the commentary for takings within the assessment area that had actual reported pumping rates these rates were summed and shown as reported demand; for all other sources an estimate of consumptive uses was made and summed and is shown as Estimated Demand. Total Demand is the sum of Reported and Estimated Demand.	ARI	Edit as required
24 (removed)	Hugh W.	Figure 5 - The timing of the start of 99 water takings has been questioned and should be checked.	ARI	Edit as required
27 (31)	Hugh W.	Last paragraph replace soil moisture with soilwater (throughout).	ARI	Edit as required

GRCA Tier 2 Phase 2 Water Quantity Stress Assessment Peer Review Comments Matrix

Groundwater Demand				
44	Hugh W.	This is not a comment on the text but a side note. There is a major inconsistency between using 90% of flow as reserve to surface water and 10% of flow as reserve for groundwater. In future revisions to the technical rules this should be examined.	n/a	Comment noted
52 (69)	Hugh W.	Figure 19 - It would be very helpful from a "public education" perspective to extend the analysis for the figure to the most recent available year so it did not end with a two-year very significant drought. It is also puzzling that the apparent general downward trend is the reverse of the generally trending upward results from some of the wells in the provincial monitoring network in the water budget report.	ARI	Edit as required
57 (58)	Hugh W.	There is also a contrast between the general upward trend in twelve-month moving average % recharge and the downward trend in Fig. 19. Section 3.5.2. - As noted in an earlier discussion the use of single point results for drawdown is not appropriate given the lack of local calibration of the groundwater model. Average drawdown over a set of 5 to 10 points in the vicinity of each site chosen would be more appropriate.	ARI	Edit as required
Significant Recharge Areas				
68 (81)	Hugh W.	As noted earlier an examination of the 115% criterion is needed and this examination is best done with a table of % total recharge contributed by areas with rates > average by (say) 5 %, 10 %, 15 %; 20 %; and 25% - or higher if % supplied has not reached 85%. Table 4.1 - Units should be mm/y not mm/yr	ARI	Edit as required
(Fig 38, Pg 79)		Figure 38 – An additional figure has been inserted that shows the groundwater use wells relative to the SGRA lands.		
Conclusions				
73 (88)	Hugh W.	The Grand River Watershed extends over 6,700 km2 and currently has 900,000 residents.	n/a	Comment noted

Appendix C-4

Phase 2 Peer Review Final Comments on December 2009 Water Quantity Stress Assessment Report

- **December 18, 2009 Phase 2 sign-off letter from Hugh Whiteley**
- **January 7, 2010 Phase 2 sign-off e-mail from Dave Rudolph**
- **January 8, 2010 Phase 2 sign-off letter from Chris Neville**

226 Exhibition St
Guelph ON N1H 4R5

December 18 2009

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

RE: Tier 2 Water Quantity Stress Assessment Report Grand River Watershed Final Report December 2009

I have completed my review of the Final Report December 2009 for Tier 2 Water Quantity Stress Assessment for the Grand River watershed.. All of my comments have been dealt with successfully. In my opinion the comments of other peer reviewers have also been incorporated.

I commend the authors of this report for the high standards of accuracy, completeness and clarity displayed in the report. The report, in my opinion, satisfy all the requirements for Tier 2 reports and provide an exemplary reporting format that could be used by the province as a guide..

Yours Truly

H R Whiteley

Hugh Whiteley P. Eng.

From: Dave Rudolph [drudolph@uwaterloo.ca]
Sent: Thursday, January 07, 2010 12:38 PM
To: James Etienne
Subject: Final Draft of Grand River Tier 2 report

Dear James,
Thank you for forwarding the final version of the Grand River Tier 2 Water Quantity Stress Assessment Report along with the comment matrix. I have read through the document and the reponses to the peer review comments that have been provided by the consultants. I am satisfied that all of my suggestions and concerns have been fully address and I consider the document and study complete.

Thank you for the opportunity to participate in this interesting project and I hope the work assists the Source Water Protection Committee in their deliberations.
Sincerely,
Dave Rudolph

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

January 8, 2010

Mr. James Etienne, P.Eng.
Senior Water Resources Engineer
Grand River Conservation Authority
400 Clyde Rd.
P.O. Box 729
Cambridge, Ontario
N1R 5W6

Subject: Grand River Watershed: Tier 2 Water Quantity Stress Assessment Report (Final report, December 2009) – Sign-off letter

Dear Mr. Etienne:

We have reviewed the report **Grand River Watershed: Tier 2 Water Quantity Stress Assessment**, dated December 4, 2009. In this letter we present a summary of our opinions, along with some final reflections of a more general nature.

Summary

The report describes evaluations conducted to support source protection planning for municipal water supplies under the *Ontario Clean Water Act* (2006). The report is the second part of the documentation of the Tier 2 Phase 2 water budget and water quantity stress assessment conducted for the Grand River watershed. We recommend that the report always be read in conjunction with its companion, the **Integrated Water Budget Report** (the latest draft is dated February 3, 2009).

In our opinion, the approaches adopted for the assessment are consistent with the Ontario Ministry of the Environment Technical Rules for the *Clean Water Act* (December 12, 2008; noting that the most recent version of the rules is dated November 16, 2009), and with the draft guidance documents for the Assessment Report (MOE, October 2006).

In our opinion, the analyses have been conducted with appropriate skill and professional judgement. The text of the report is clear and concise, and the figures are appropriate. In general, we concur with the conclusions, and in our opinion it is unlikely that we would obtain significantly different results from an independent analysis. The results of the analyses provide sufficient justification for additional focused Tier 3 studies.

General reflections

1. The format of the peer review comments matrix does not lend itself to a straightforward sign-off. The peer review comments are keyed only to page numbers in the draft and final reports, and the responses are typically "Edit as required." Therefore, in most cases it is difficult to assess whether the comments on the February 2009 draft have been addressed adequately. We recommend that for the most substantive peer review comments, the comment matrix be supplemented with specific indications of how the comments have been addressed, as is done for the response to Eric Hodgins' comment that is keyed to pages 55-61. In our opinion, the most substantive peer review comments are those that are keyed to pages 18, 22, 24, 29, 34, 38, and 44.

2. The undertone of many of the peer review comments is a wariness regarding the potential application of the results of the Tier 2 stress assessment. In our opinion, it cannot be overemphasized that the Tier 2 analyses are a screening assessment, and not an identification of areas in the Grand River watershed that are undergoing hydrologic stress. We are concerned by some of the wording in the final report. In particular, in the Executive Summary it is indicated that:

   - The classification of an area as having a moderate or significant potential for stress is important because the area may require a Tier 3-level assessment; and
   - Muncipal systems located with groundwater assessment areas that are identified as having a moderate or significant potential for stress would be subject to the requirement to complete a Tier 3 assessment.

   This wording suggests to us that Tier 3 studies are some kind of punishment. In our opinion, this is clearly not the intent of the process. Rather, we interpret the results as an indication that funding to support further studies should be focused on these areas. In the case of the Region of Waterloo and the City of Guelph, long-term programs to understand and manage water resources effectively are in place, and should continue to be funded adequately.

3. In our opinion, a separate category should be conceived for groundwater assessment areas that are highlighted at the Tier 2 level, but for which Tier 3 studies are probably not appropriate. These include the municipalities that have relatively small water demands: Lynden, Montrose, Conestogo, Rockwood, and St. Agatha. It is also indicated that Tier 3 studies for the Irvine River assessment area are not "immediately necessary". We question whether in any of these areas there are sufficient high-reliability data to support Tier 3 analyses that are somehow "better" than the Tier 2 analyses. It may be possible to refine the existing analyses in these areas, but in the absence of additional wellfield-scale data this does not constitute an improvement.

To: Mr. James Etienne, P.Eng.

Page: 3

4. In general, we concur with the delineation of the Significant Groundwater Recharge Areas shown in Figure 37. The analysis presented in Figure 34 is an excellent addition that provides valuable support for the adoption of the 115% criterion. We recognize that the selection of cutoff area of 1 km^2 is arbitrary. However, in our opinion the designations shown in Figure 36 are not workable, and some filter must be applied.

5. Our experience as peer reviewers for other source protection regions suggests that a key issue with respect to the delineation of Significant Recharge Areas is not resolved. This issue is the setting of the average recharge rate that is used as the baseline for the "115% calculation." For this study, the average recharge rate has been interpreted as the average rate over the entire area of the Grand River watershed. The effect of this choice is that the bulk of the Significant Groundwater Recharge Areas correspond to the Central Moraines. There is nothing wrong with this. However, we are left wondering whether significantly different results would be obtained if the "related groundwater recharges areas" were associated with the three major physiographic regions, rather than the entire watershed.

We thank you for the opportunity to participate in this interesting and important study.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Christopher J. Neville, M.Sc., P.Eng.
Vice President, Senior Hydrologist

CJN/cjn
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