TOWN OF CALEDON

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November 23, 2007

To: Chris Barnett
Davis & Company
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From: Todd Salter, Manager of Policy, Town of Caledon

Re: Comprehensive Broader Scale Environmental Study, Caledon Aggregate Resource Area 9-A
Draft Part B Report, Volumes 1 & 2, dated June 29, 2007 and Part B Hydrogeological Modeling Task – Draft Report June 2007

The Town of Caledon, Region of Peel and Credit Valley Conservation have completed a review of the above-noted documents and wish to provide the following comments. These comments are based on the agencies' expectations for the Comprehensive Broader Scale Environmental Study (CBSES) as set out in the CBSES Recommended Terms of Reference prepared by the agencies, dated January 23, 2004, and the scope of work outlined in the CBSES "Final Work Plan", prepared by JDCL, dated January 2005, with June 2006 Addendum and September 2006 & January 2007 Revisions. Also taken into consideration are the results of ongoing discussions between agency staff and JDCL team members, particularly in regard to the technical expectations/requirements of Credit Valley Conservation (CVC). Finally, although the agency comments are primarily technical/policy based, the agencies' review of these documents has also been informed by the results public consultation to-date with respect to the CBSES, particularly the January 25, 2007 Public Information Forum and the February 27, 2007 "Objectives Workshop".

It should be noted that these comments have not taken into consideration the draft Part C Report, which was received by the agencies on October 31, 2007, nor the draft Part C Volume 2 Appendix P Municipal Constraints Analysis which was provided to the agencies on November 12, 2007. It is understood from the November 12, 2007 meeting between the agencies, James Dick Construction Limited (JDCL) and Coalition of Concerned Citizens (CCC) that the draft Part C Report contains material that represents a continued evolution in JDCL's approach to certain matters that were addressed initially in the draft Part B Report (e.g. Study Area Objectives, Management Alternatives). Where this is the case, the comments provided in this letter should be considered preliminary, as they may be supplemented/revised based on the agencies' review of the Draft Part C Report. Additionally, if the agencies' review of the draft Part C Report identifies implications that flow backwards into the draft Part B or Part A Reports, the agencies reserve the right to make additional comment on those reports.

MUNICIPAL COMMENTS:

The Draft Part C Volume 1 covering letter refers to this as being a "revised" draft of the Part B Report? The agencies do not recall receiving an earlier of draft of the report for review and comment.

Volume 1 Report, Tables and Appendices
Table of Contents:

- What does Section 6.7 "HIGH for the Supplemental Assessment Area Fisheries" mean? This comment also applies to Section 6.7 itself.

Section 1

- Pg. 1-5, paragraph starting with the words "The results of this analysis…" should end with the wording "…for development of Resource Area 9-A, *if development occurs.*"
- Pg. 1-8 – the discussion on the January 25, 2007 Public Information Forum should explain how the results of the forum were taken into account when preparing the draft Part B Report.
- Pg. 1-9, middle paragraph – thought that more than 59 people attended the Feb. 27, 2007 Objectives Workshop. Need to confirm with Robb Ogilvie's office.

Section 2

- Pg. 2-1, second paragraph – refers to aggregate extraction as the "most likely large scale land use" within the Study Area. The agencies have previously taken issue with the use of such language, and recommend the use of more neutral terminology, such as that negotiated in the context of the CBSES Work Plan. This comment applies elsewhere in the Part B Report where such language is used.
- Pg. 2-1, third paragraph – refers to estate residential subdivisions. As noted in the agency comments on the revised draft Part A Report, it is staff's understanding that the Greenbelt Plan, which includes the entire CBSES Study Area, prohibits such development in the Protected Countryside Area, except perhaps for some small scale residential development in established Hamlets (e.g. Terra Cotta).
- Pg. 2-1, last paragraph – refers to the Greenbelt Plan as "recently released". The Greenbelt Plan came into effect in December 2004.
- Pg. 2-2, second paragraph – again the use of the language "most likely form of land use change".

Section 5

- Pg. 5-1, second paragraph – last sentence indicates that the models used in the CBSES are "not suitable for site specific assessments". The intent of this statement should be clarified and CVC has provided further comments in this regard later in this letter.

Section 6

- Pg. 6-7, last paragraph – the last full sentence indicates that structures are not permitted in the floodplain and could be interpreted to imply that existing structures were constructed illegally. To clarify, it could be reworded to indicate that "although the construction of new structures in the floodplain is now strictly regulated, many structures have been constructed in the floodplain in the past and the potential for those structures…."
- Pg. 6-18 – the cross references to Figures 6.4 and 6.11 under Non-riverine Wetlands appears to be incorrect.
- Although the titles on Figures 6.3 and 6.6 are different, the information presented on the map appears identical. Please clarify.
- Figure 6.10 – please clarify why the patch of woodland in the middle of Cell 1 come up as high sensitivity?

Section 7

- It is recommended that the following Region of Peel Official Plan Objectives should be included in the analysis: 2.4.1.1, 2.4.1.2, 2.4.1.3, 2.4.3.1, 2.4.4.1, 2.5.1. These objectives deal with Natural Hazards and Restoration of the Natural Environment and are relevant to the matters being addressed through the CBSES.
- Pg. 7-2 - the second bullet point and first paragraph at the top of the page refer to the incorporation of the CBSES results into the Caledon Official Plan, or other approved agency documents, in order to be given formal effect and to be used to guide the review of site specific development applications. While the agencies may choose to do this in the fullness of time, it is the agencies' clear expectation, based on the process that is currently underway and the steps identified CBSES/ Rockfort schedule, that the Rockfort Quarry application and supporting technical studies, will be revised to

address the outcomes of the CBSES, whether or not the objectives, targets and other recommendations contained in the CBSES have been formally incorporated into the Caledon Official Plan in parallel with this process.

- Pg. 7-2 last bullet point and top of pg. 7-3 – the reference to the wording contained in Section 5.11.2.2.6 of the Caledon OP is incomplete. The actual wording is as follows "By satisfying the performance measures set out in Section 5.11.2.2.6 a) to h), the Ecosystem Objectives of Section 3.1.2 and the policies relating to additional lands as set out in Section 5.7.3.7.3 are likewise satisfied *insofar as they relate to those specific features*." (emphasis added). The complete policy should be cited, or this wording deleted.
- Pg. 7-7 – the Objectives under the heading "Woodlands, Wetlands and Wildlife" appear to be missing wetlands related objectives and performance measures from the Caledon OP. In addition, Section 2.3.1 of the Peel OP should be added to list.
- There should be a general statement at the beginning of Section 7 that the excerpts quoted in this section are provided for context only and that all applicable OP and other policy and legislation must be read and applied in their entirety.
- It might be helpful to provide a summary of all proposed supplemental "CBSES Objectives" at the end of this section.

Section 8

- As a general comment, the agencies are not supportive of the language being used to characterize the management options, particularly the phrase "This approach acknowledges there will be future land use changes…". The management options outlined in Section 8 are being applied to the Scenarios that have previously been agreed to and documented in Appendix B to the CBSES Work Plan and further described in Section 2 of the draft Part B Report. These management options should be characterized as different potential approaches to managing the potential impacts associated with the different scenarios, as described in earlier sections of the draft Part B Report.
- As another overall comment, Section 8 seems rather generalized and not all points appear to be tailored to this Study Area. (e.g. paragraph at top of pg. 8-5). The agencies will be looking for a more tailored, Study Area specific approach in the Part C report.
- There needs to be a discussion in this section and further elaborated in the corresponding section of the Part C Report regarding long term implementation and operational considerations, for example, the need to consider necessary administrative and financial structures to manage decades of during and post-extraction monitoring, mitigation and Adaptive Management measures.

Volume 2 Figures

- As a general comment, where the Figures consolidate different categories of features into a single graphic unit, it might be more informative to graphically distinguish between them, e.g. the two different types of High Sensitivity Upland Forests described on pg. 6-15 Volume 1 and identified on Fig. 6.10 in Vol. 2.
- Figures 1.1 and 2.1 use the correct Resource Area 9-A boundary, but subsequent Figures do not. This needs to be corrected.
- Figure 3.4 – please clarify why lake levels are not indicated for Cells 2 & 3?
- Figure 6.2 – the sensitivity of the water supply system in the Amabel Formation has been characterized as "low" because there is generally a lot of water in this formation and it is, therefore, easy to improve wells if they are impacted by changes in the groundwater system (i.e. you can drill them deeper). Potential impacts to local water supplies has been identified as a key issue during the public consultation program, and this sensitivity assessment does not appear to consider the sensitivity of human receptors to negative changes to existing water supplies. This needs to be addressed in the Part C report.
- A number of the impact assessment Figures show all features within Resource Area 9-A being removed, regardless of their significance/sensitivity, even though some of these are acknowledged as Provincially or Regionally Significant and

therefore likely exclusionary constraints. Please explain why is this being done and how will this be reconciled in Part C when the policy conformity assessment is completed?

CVC COMMENTS:

CVC has evaluated these reports with following objectives in mind (Final for CBSES for the Town of Caledon Aggregate Resource Area 9a dated January 2005 with June 2006 Addendum):

- To refine the resolution of the watershed scale hydrologic and hydrogeologic models to that appropriate for the CBSES;
- To identify types of potential impacts to water resources and environmental features identified with in the Study Area from identified land use scenarios;
- Evaluate the approximate nature and extent of theoretical impacts from potential development if measures are not taken to mitigate effects; and
- Provide a basis for identifying mitigation and planning requirements for potential future development.

GENERAL COMMENTS - HYDROGEOLOGY

The following comments are provided related to hydrogeology and potential groundwater issues/concerns. Overall the report was well-written with considerable detail presented. Many of the comments provided here are for clarification purposes, either wanting additional detail or providing further comments on what CVC considers are potential issues that should be better presented or addressed. More detailed comments on the hydrogeological modelling task are provided separately.

GENERAL COMMENTS - FISHERIES

Generally, the sensitivity analysis for fisheries represents a good scientific framework at a regional scale. It is complex, partly as a result of an open approach to accommodate input from CVC. Habitats are assessed from both thermal (cold to warmwater) and flow regime (ephemeral to permanent) perspectives based on groundwater modelling. Even isolated reaches are recognized for greater sensitivity. It takes into account general sensitivities and water specific impacts of concern. The modelling of hydroperiod impacts is particularly appreciated. In addition indirect impacts re: water quality, geomorphology, benthic and riparian wetlands are attempted.

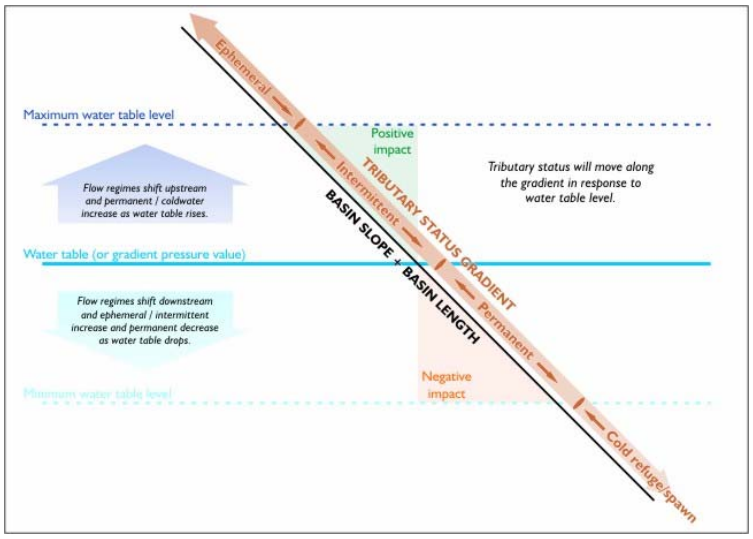
The methodology also attempts application of a Department of Fisheries and Oceans (DFO) risk assessment framework re: tolerance, dependence on habitats, rarity and habitat resilience.

Despite issues identified below, the mapped impact results seem to have a reasonable and objective range of impacts (low to high) presented. The most questionable will be areas adjacent to the extraction zone (i.e. should be high not moderate?).

Sensitivity of Intermittent Streams (Hydroperiod)

CVC specifically requested a hydroperiod analysis based on the dominance of intermittent reaches representing a delicate transition to either contributing habitats or permanently flowing reaches (intermittent reaches also isolate some fisheries). The concern expressed was that these reaches are closer to the threshold of determining the presence and reproduction of fish

within many reaches. A relatively small change in flows can affect flow duration whereas in permanent reaches, only some habitat volume may be lost but not dictate the presence/absence of fish life. This is theoretically presented in the Figure below showing those streams closest to the intermittent-permanent flowing transition would be impacted first by changing watertables.



Intermittent reaches risk losing all productivity with a switch from seasonal to no fish present. At least permanent (warmwater) streams becoming seasonal would still have some production. The most buffered reaches would be those supported by deeper groundwater sources.

This analysis assigned the highest sensitivity to coldwater reaches that by definition do not have a hydroperiod varying year to year. CVC does recognize that it is likely that some warmwater reaches (more dependent on runoff/wetland storage) could become intermittent in a worst case scenario but concerns remain with a change in hydroperiod of only days or weeks on those already intermittent.

CVC still supports that intermittent reaches are less significant or productive/diverse (i.e. reach by reach comparison vs. cumulative extent and formative contributing functions) and least sensitive to temperature, oxygen, food and physical channel changes. Productivity and diversity of permanent warmwater reaches are however generally greater than coldwater communities that is not recognized in the methodology.
The “multi-stage” approach that addresses the diversity of habitats unfortunately overly weights groundwater fed coldwater reaches.

Results also focus on most sensitive (usually coldwater) reaches directly impacted as a worst case scenario to avoid generalizing or averaging catchment wide impacts modelled. It is also appreciated that impact sensitivities can still be traced to individual reaches but there remains a failure to recognize less significant but more widespread impacts (or productivity) in a cumulative manner (vs. reach by reach).

Cumulative impacts downstream of headwaters is not adequately assessed. The Law of Stream Orders states that the majority of a watershed is drained by headwater channels and are cumulatively formative of more habitable channels

downstream. The River Continuum Concept (RCC) also describes the important transition of functions in a downstream direction from contributing to direct fish habitats. Reach by reach comparative assessments do not address the sum of impacts on less significant reaches that are more widespread and extensive but come together to form more productive fish habitats. Catchments directly downstream of one another are assessed in isolation for direct impacts or those indirectly as defined as cascading via disciplinary effects.

Overall the significance of intermittent channels are under estimated or not recognized separate from other functions. This may be addressed by recognizing their greater sensitivity to hydroperiod impacts and their cumulative contributions downstream. The latter is recognized in text but does not clearly relate to scores awarded on a reach by reach basis.

Generally it is important to note that the extraction area would eliminate critical cool/warm water refuge habitat (Rogers Creek) and thus directly cause a HADD. The Credit River Fisheries Management Plan (CRFMP) would recognize all these upstream habitats as coldwater for management and assessment purposes – where does this assessment recognize not only headwater contributions, but also their eventual contribution to coldwater reaches?

Lake filling scenario is presented in the methodology section but results are not presented nor discussed from a fisheries perspective?

Rehabilitation Scenario is described as "passive" by the proponent and simply designates all impacts as low equally across the study area. Given one could expect relatively more impact potential on-site and adjacent to the extraction area, there is a need for greater resolution within the impact categories assigned. Even designations of very low to moderately low may be acceptable.

Water quality and temperature are likely to be affected if not flow regimes. One might also score some positive impacts.

More active rehabilitation measures should be described in Part C including the mitigation of agriculture and on-line ponds. Site level assessments will not be effective if offsite or compensation "banking" is to be considered.

<u>General Comments on all sections of Terrestrial Impact Analysis</u>

- The methodologies for assessing sensitivity and impact for Upland Forests (Section 6.4), Non-Riverine Wetlands (Section 6.5), and Riverine Wetlands (Section 6.6) have all assessed sensitivity based on the "significance or designation" of the feature, not based on its actual sensitivity of the feature to changes in groundwater levels. Significance or designation in most cases has very little to due with the sensitivity of the feature to changes in groundwater level. A non-provincially significant wetland can be as sensitive as a provincially significant wetland; or a particular provincially significant wetland may not be sensitive to changes in groundwater levels as they may rely on surface water not groundwater to maintain their hydrologic regime. As a result, vegetation communities, regardless of their designation, may be more vulnerable to disease, infestation, and invasion by exotic species due to stress resulting from the changes in hydrology and subsequent soil moisture regime. These secondary stressors may result in a shift in community type, or in the degradation or loss of these features.

  Consequently, CVC is of the opinion that the sensitivity analysis for Upland Forests and Non-Riverine Wetlands should be based on the degree to which a feature has formed or relies on groundwater to maintain community structure, function, and composition. CVC would suggest that "highly sensitive" features would be those features that are located in areas where there is groundwater discharge, or a shallow water table. Moderate sensitivity could be features that require both surface and groundwater, and low could be features that rely on mostly surface water (i.e.

water table deeper). This may be accomplished using a combination of groundwater modelling, field measurements, and observations.

For Riverine Wetlands, sensitivity analysis would be similar to Upland Forests and Non-Riverine Wetlands for groundwater, but needs to include changes to base flows and over-bank flows.

- Assessment of the level of impact is used to illustrate a relative level of change and does not necessarily represent the acceptability or appropriateness of the impact, or in other words, a result of "low level of impact" does not necessarily mean that the impact is acceptable.

- Just because a feature is not designated does not mean that it is not significant. In many cases, no one has visited these other natural areas to properly assess their significance, and as a result some significant natural areas may still be unknown.

- All features within the extraction area should be identified as highly impacted as they would be removed from the landscape through the extraction process.

SECTION 1 – INTRODUCTION

SECTION 1.2 – PART B APPROACH AND REPORT OUTLINE

p1-3v) This methodology describes changes from present baseline conditions. With respect to fisheries please state that assessments may also have to consider historical (agricultural impacts noted) or rehabilitation potential. The Credit River Fisheries Management Plan (CRFMP) recognizes the protection of habitat potential (i.e. not just present baseline).

p1-4) Seven main receptors. Please clarify how wild life was assessed in this approach.

p 1-5) You have not discussed the role of the goals and objectives i.e. how they will be used to select the preferred management option.

SECTION 2 – LAND USE SCENARIOS

In the discussion in Part C on other land uses please include a discussion on water extraction (e.g. water bottling).

SECTION 2.2 – GENERAL INFLUENCE OF AGGRAGATE EXTRACTION

Here or under General Influences please also note water quality impacts including dissolved oxygen, nutrient enrichment and increased risks of contaminating lake and groundwater from runoff and spills.

Page 2-3, Section 2.2, last paragraph – the report indicates that the greatest changes to the hydrologic cycle have occurred due to transitions from natural areas to agricultural and urban land uses. It should be noted that the impacts from these land use changes are largely due to the broad scale at which the changes occurred. For example, it is not expected that the transition of an area the size of Resource Area 9A from natural to agricultural would result in the same groundwater impacts predicted from Scenarios B or D.

Page 2-3 – Last para., last sent - Missing reduction in evapotranspiration resulting from removal of vegetation.

Page 2-4, fourth paragraph – The report refers to the impacts of active extraction as 'temporary'. While some effects of aggregate extraction may be 'temporary' there will be potential long term impacts to the groundwater flow system depending on the extent of extraction and the location of the extraction within the groundwater flow system and the geologic setting. More importantly, the length of time of 'temporary' extraction is considerable in this case, given that the extraction itself may take decades and then will take many decades after extraction for water levels to recover, as discussed on Page 5-18. The impact during this 'temporary' time is critical in the overall assessment of extraction in the resource area. More detailed comments on this issue are provided for the Groundwater Modelling report.

Page 2-5, first paragraph – The report describes the expected impacts on groundwater levels once rehabilitation is completed; however, more discussion is needed to highlight some of the challenges of mitigating and monitoring the potential impacts of this hypothetical land use change, both during and after rehabilitation. For example, is it expected that monitoring of water levels and maintenance of lower permeability barriers (and other potential mitigation measures such as pumping from one cell to another, etc.) will need to continue between the completion of active extraction and the rehabilitation stage, and after rehabilitation is complete?

Page 2-6 – 3rd bullet point - Changes in flow pattern may affect riverine wetlands, and riparian communities.

Page 2-6 – 5th bullet point - Other impacts to water quality as a result of reduced baseflows should be noted including: an increased concentration of pollutants and an increase in stream temperature, leading to impacts on dissolved oxygen concentrations.

Page 2-6 – 2nd last bullet point - Increased, or decreased water levels and hydroperiod in vernal pools. Decreases in groundwater levels may result in loss of vernal pools, or shortened hydroperiods which may which may render the pools unsuitable for the successful reproduction of salamanders. The Jefferson salamander is a nationally and provincially threatened species is known to exist in the study area and are dependant on these vernal pools. Jefferson salamander is an obligate vernal pool species which means that it only breeds in vernal pools and cannot use other types of wetlands to successfully reproduce.

Page 2-6 – last bullet point - See comment above.

Page 2-7 – First bullet point, Third sentence
Replace the word "cleaner" with the word(s) "clearer" or "less sediment laden".

Page 2-8, final bullet – The report indicates that groundwater temperature impacts may occur where groundwater travel time to a surface water discharge is 'short'. *Is there an estimation of what a 'short' travel time would be in the Study Area?*

Page 2-8 – last bullet point - Have you considered how increased groundwater temperatures might affect the rate of evaporation in wetlands and vernal pools? Potential results – increased rate of evaporation, decreased hydroperiods, increase productivity?

Page 2-9 – 4th bullet point - Decreased groundwater levels would also affect forest and vernal pool hydrologic regimes

Page 2-9 – 5th bullet point - Add riparian habitats, vernal pools, and forest. All vegetation communities are susceptible to changes in groundwater levels.

Page 2-9 – 6th bullet point - Changes in flooding also alters disturbance regime (flood frequency, flood extent, flood duration, erosion, and deposition) which may also influence vegetation community structure and composition.

Page 2-9 – New bullet - Increased noise and dust associated with quarry operations and increase road traffic may result in disturbance and subsequent degradation of area flora and fauna

Page 2-9 – New bullet - Increased road traffic and road widths may negatively affect the ability of species to migrate across the study area and will result in increased road mortality.

SECTION 3 – SENSITIVITY ANALYSIS AND IMPACT ASSESSMENT APPROACH

SECTION 3.1 – STRESS-RESPONSE ASSESSMENT FRAMEWORK

There is no reference or further detail in this section provided for the hydroperiod analysis, critical to the fisheries assessment framework.

Page 3-3 – *Should the paragraph that begins 'Selection of relevant primary indicator parameters…' be a separate bullet?*

Page 3-5 – 1st para. - Add text to indicate that an assessment of the level of impact is used to illustrate a relative level of change and does not necessarily represent the acceptability or appropriateness of the impact, or in other words, a result of "low level of impact" does not necessarily mean that the impact is acceptable.

SECTION 3.2 – LAND USE SCENARIOS

Page 3-9, 1st paragraph – There should be a disclaimer that the land use scenarios are for modeling purposes only and should not be assumed to be approved land uses.

Page 3-9 , last paragraph – As commented on for the groundwater modelling report, there should be some discussion, somewhere in the report, as to how representative the existing groundwater conditions are, such as length of time over which the data were collected, variability precipitation patterns during the time of data collection (i.e. was it dryer or wetter than normal?).

Page 3-11, third paragraph – Although discussed elsewhere in the report, a comment should be made here regarding what is meant by rehabilitation, in the context of Scenario C. Rehabilitation discussions are driven by water levels in the lake cells, and as indicated in page 3-13 and page 5-18, this will take many years after extraction has been completed. So although a sensitivity analysis is being conducted on the optimal rehabilitation scenario, this will not occur until decades after extraction has ceased and it is important to highlight this.

Page 3-11, fourth paragraph – The report indicates that full optimization of rehabilitation conditions is not feasible or appropriate. This applies to the CBSES study but should not be expected to apply for a site-specific application.

Page 3-13, Scenario E – It is agreed that it will be difficult to assess lake filling conditions at this stage given the infinite number of scenarios. Should some discussion be presented as to how this might be done on a site specific basis as individual

developments move forward? Would an assessment and development plan be necessary for development of the entire resource area prior to first extraction taking place? Or does the operator "first out of the gate" get to potentially control what might happen on other properties as their "mitigation plan" may severely limit how extraction in other portions of the resource area can be mitigated?

SECTION 4 – DIRECT IMPACTS OF DEVELOPMENT OF RESOURCE AREA 9-A

Page 4-1 – 1st paragraph - Please confirm what the extent of the "study area" is meant to be.

Page 4-2 – 4th para. - Add text to indicate that other unevaluated wetlands in the Resource Area could potentially be part of the Caledon Mountain Provincially Significant Wetland once they have been inventoried and evaluated according to the Ontario Wetland Evaluation System for southern Ontario.

Page 4-2 – 1st para. - What is the Northeast Wetland? There are no records or maps.

Page 4-2 – 3rd para. - Describe connections (What do they link [e.g. PSW – ANSI, Core Woodlands – PSW, Paris Moraine – Niagara Escarpment]? What are their composition [e.g. forest, wetland, fisheries], functions [e.g. migration, terrestrial habitat, fish habitat, waterway, floodplain, etc.], and condition [e.g. degree natural vegetation, width, length, barriers]?) that will be impacted or removed, and potential implications.

Page 4-2 – Last para. - Add text - Rockfort Drain and Hutchinson Swale provide surface water contributions to PSW.

Aquatic Features / Habitats

Page 4-2i) Reach length data (Table 4-2) within footprint should be used to assess greater extent and cumulative impacts on intermittent headwaters.

Page 4-3 i) Please state that 52% of stream loss within the footprint is not direct fish habitat would represent a normal distribution (law of stream orders) for most watersheds, in that the low order streams are greater in extent. This should not be used only to suggest minimal impacts would affect fish. Please recognize such a cumulative loss of contributing habitats impacts would be expressed directly in downstream fish communities.

Page 4-3 ii) Please clarify the definition of ephemeral given their location in relation to other flow regimes. In this case Figure 4-1 shows the headwaters are permanent coldwater and then change downstream to ephemeral (vs. intermittent?) for a significant distance and increase in watershed area. Nevertheless it is recognized as seasonal habitat with limited productivity and survival (not normally associated with ephemeral reaches). It is being suggested this differs from other more productive seasonal habitats in intermittent channels. Please state this suggests the uniqueness and complexity of this study area.

Page 4-3 iii) That removal of indirect contributing flows is primarily a localized seasonal impact to another seasonal main branch attempts but minimizes downstream and cumulative effects. Other specific downstream reach influences should be more consistently assessed. Also state that flows are not the only function of contributing habitats.

Page 4-3 iv) The tributaries in the 2 easterly cells to be removed must be defined, explained why not or estimated on available information.

SECTION 5 – SURFACE AND GROUNDWATER IMPACT ASSESSMENT MODELS

SECTION 5.1 – SURFACE WATER ASSESSMENT MODEL DEVELOPMENT

Page 5-1, second paragraph – The report indicates that the modelling approach '*is appropriate for this Study and the relative comparison of development scenarios as presented herein. The approach, does, however, limit the use of these models such that they are not suitable for site-specific assessments*.' It would be helpful for the report to provide some general details on what further level of modelling effort and local refinement would be expected for a site-specific application. This would make it clear to the reader why the models used for the Part B Study would not be appropriate for a site-specific study. It would also be helpful to identify whether there are any other applications within the Study Area for these models (e.g., if there were multiple applications for development within the Resource Area). More detailed discussion of some of the model's limitations is provided in CVC comments on the Groundwater Modelling report.

SECTION 5.2 – GROUNDWATER ASSESSMENT MODEL DEVELOPMENT

Page 5-5, Section 5.2 – As noted in comments on the Modelling Report, there should be a discussion of the limitations of representing the unweathered Amabel aquifer as an equivalent porous medium with homogeneous hydraulic properties. A discussion of the limitations of running steady-state versus transient simulations should also be included. These discussions could be tied in with the discussion of some of the expectations for site-specific models suggested for Section 5.1. More detailed comments on the model are provided in the CVC comments on the Groundwater Modelling report.

Page 5-6, first full paragraph – Also as noted in the modelling report the discussion of the boundary conditions needs to be expanded. This should be done in the modelling report and referenced in the Sensitivity Analysis report.

SECTION 5.3 – SCENARIO ANALYSIS

Figure 5-26 – missing from PDF version of Part B report.

Page 5-11, third paragraph – The 'natural dewatering influence of surface water features in this area' requires further explanation. Is this meant to refer to losing reaches of tributaries?

Page 5-13 – 2nd paragraph – We would suggest that references to specific hydraulic buffers such as earthen buttresses or grout curtains should be removed as their specific use was not evaluated in this work.

Page 5-13, Point 2 – Consideration should be given to subdividing the area into multiple cells/lakes for rehabilitation. Will this be addressed in detail in Part C, as this is a critical component of the potential development of the overall Resource Area, as per our comments for Page 3-13?

Page 5-14, Paragraphs 2 and 3 – As per the comments above, these issues need to be addressed in detail in Part C, as all the current sensitivity analyses have shown is that there is a theoretical potential to rehabilitate the Resource Area after a long term water balance has been achieved.

Page 5 -16, Primary Indicator #4 – It should be noted that this statement refers to the rehabilitated condition. Is this also true under active extraction prior to rehabilitation?

SECTION 5.4 – WATER BUDGET

Page 5-18 and 5-19, Water Budget – As per comments above, this issue needs to be addressed in detail in Part C as the water balance is critical to minimize impacts, and it could take decades to achieve a water balance equilibrium.

Pg 5-19 – last paragraph - Should note potential impacts of climate change – precipitation and evapotranspiration values and subsequently water budget may be affected by climate change in the future.

SECTION 6 – IMPACT ASSESSMENT

As indicated in the comments on the Groundwater Modelling Report, some impacts (e.g., groundwater level drawdown) are shown to extend beyond the Study Area limits and to the model boundaries. There should be some discussion of whether significant impacts could be expected outside of the Study Area, and how the model boundaries have affected the extent of the impacts.

SECTION 6.1 – WATER SUPPLY (GROUND WATER/AQUIFER YIELD)

Page 6-3, second paragraph – It should be noted that minor increases in groundwater levels may occur under rehabilitation conditions in some parts of the Study Area. This does not address the potential impacts during active extraction, which is when water levels would have the greatest potential to be impacted. Given the fractured nature of the bedrock it will be difficult to predict impacts during active extraction.

Page 6-5, bottom paragraph – it is stated that under Scenario B the overall impact on water supply is moderate above the Escarpment (areas R1, R2, R3, S1, S2 and the top portion of R6). Area R4 was not listed and shows significant drawdown on Figure 6.3. This is a substantial impact and all subcatchments should be discussed for all indicators.

Page 6-6, first paragraph – Here and elsewhere in the report it is suggested that a decrease in groundwater levels that is less than the seasonal fluctuations observed in the Study Area is of relatively little significance. Since the groundwater model is intended to represent average annual conditions and relative impacts, a simulated decrease in groundwater levels would occur in addition to seasonal and long term 'natural' fluctuations and may be very significant. This should be reflected in the report.

SECTION 6.2 – PROPERTY DAMAGE/FLOODING

Table 5.6 - Catchments R3 and R4 show a decrease in the 2-year peak flow of approximately 85% and 25% respectively under Scenario C, the long-term rehabilitation, water proportioned to downstream reaches, within in the main body of the text (under the impact assessment section) there should be a discussion as to why that is.

Table 5.10 - Catchment R3 shows a decrease in groundwater discharge of approximately 100% and 42% for Creeks and Riverine Wetlands respectively under scenario C. In addition, under scenario C the total discharge to the creeks decreases by 45%. A discussion should be included within the main body of the text (under the impact assessment section) explaining why this is happening.

SECTION 6.3 – CHANNEL FORM

The primary indicators have been assessed for all reaches at each reach, however the cumulative effect on the downstream catchments has not been discussed. For example, Indicators #3 and #4 were not assessed for catchment R3 because surface watercourses are proposed to be removed in the development scenarios, but the impacts of those removals on the function of the downstream drainage network should be discussed.

Section 6.3 – Page 6-11 - There needs to be a better description of how the overbank flows have been analysed and assessed. This section should include a map showing the location of the sensitive reaches and cross-sections. Generally speaking, there is a lack of reference to and transition from the Part A document.

Since overbank flows are a secondary indicator for "Riverine Wetlands", the stage/discharge relationship and the location of the sensitive cross-sections relative to riverine wetlands should be shown on a map and discussed.

Section 6.3 – Page 6-14, 4th paragraph - As noted previously for section 3.1 – add text to indicate that an assessment of the level of impact is used to illustrate relative change and does not necessarily represent the acceptability or appropriateness of the impact, or in other words, a result of a "low level of impact" does not necessarily mean that the impact is acceptable.

Page 6-14 – Last para. - Increase or decrease in water table elevation can result in increased stress on vegetation resulting in increased vulnerability to disease, infestation, declines, and mortality rates, which may result in vegetation community shifts in quality of composition, structure, and function.

Page 6-17 & 6-19 – Sensitivity – Non-Riverine Wetlands, & Sensitivity – Riverine Wetlands. - As some marsh and meadow marsh vegetation communities which form under wetter conditions they could be more sensitive to changes in groundwater levels than swamps.

SECTION 6.7 – HIGH FOR THE SUPPLEMENTAL ASSESSMENT AREA FISHERIES

Please clarify what this title means.

The general approach here accurately describes the fishery as an interrelated and cumulative product or end receptor of cascading biophysical indicators such as groundwater and benthics. Although this approach is used to predict impacts on each and every reach and holistically within each catchment it falls short to further assess impacts in a downstream direction throughout the watershed scale. The Law of Stream Orders and the RCC provides a framework of direct links moving in a downstream direction within a channel that is not clearly recognized. 1st paragraph – The selection of indicators (e.g. baseflow, water quality) as outlined by the proponent in the methodology and developed in discussion with CVC is generally acceptable. The proponent, however, should recognize there are limitations related to realistically limiting the number of indicators and that there is a lack of scientific literature and standards available regarding headwater ecology. Contributing functions such as nutrient cycling and energy transfers downstream as described by the RCC are not assessed and are important in a cumulative sense given the dominance of ephemeral and intermittent headwaters. Further discussion and assessment needs to be considered as noted in earlier comments.

P6-22v) The proponent stated that there is a linear relationship (standard technical term) between fish and habitat variables such as groundwater. CVC is simply asking that this be stated as an assumption and not necessarily a fact.

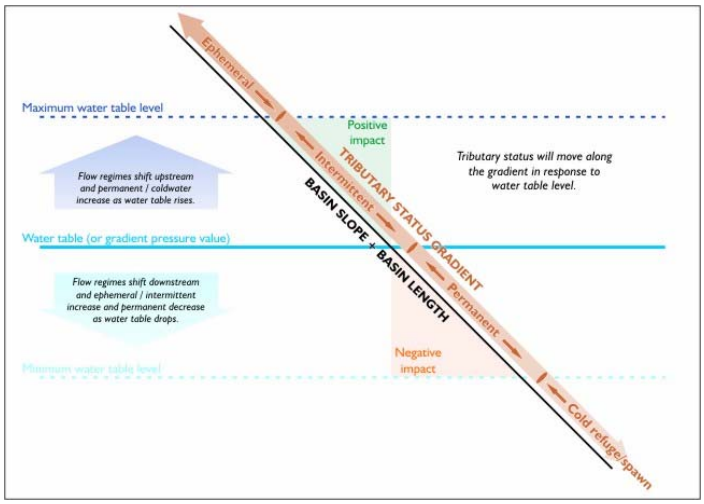
Primary Indicators

Page 6-23 vii) That the model predicts changes at a point along the channel vs. cumulatively in a downstream direction is recognized as a limit to the model. How such cumulative effects are/can be addressed requires further discussion.

Page 6-24 iv) Here duration of flow (hydroperiod) is related to the reproduction of fish. Juvenile fish may not have to develop to be transported downstream. It should be stated that successful recruitment may not normally occur each year but only in wetter years. Furthermore seasonal use may also relate to other functions such as refuge from higher flows in larger orders or as feeding migrations. These fish as "colonists" may simply explore, avoid competition and make decisions based on resources encountered. In some cases new habitats may be colonized in rare flood events such as colonization of the pig pond assumed to be isolated in this study.

Page 6-24 v) By definition perennial habitats do not have a hydroperiod (of no flow) and any reduction would be significant. Please state that perennial streams would be the most resistant (less sensitive) to changes in hydroperiod given the strength of groundwater baseflows, but the significance of any hydroperiod impacts would be great if it did occur. They remain sensitive to baseflow volume changes that are assessed separately.

By extension, it is later suggested that perennial coldwater are most sensitive to hydroperiod than intermittent reaches. This can be disputed by a graphical representation relating water table/gradient changes to flow regimes.



i) Overall Sensitivity

Page 6-26 ii) Please state that the DFO Risk Management Framework has been misinterpreted by some to date (but not necessarily here) such that DFO has arranged a second series of training sessions. The application of selected criteria here seems appropriate but other criteria, including extent, duration and intensity of the impacts are not directly used in the same manner. Extent of fish habitat as defined by DFO is that affected directly by the footprint "as well as areas indirectly affected, such as downstream…" that has not been adequately addressed. Duration such as the estimated 33 years to fill the lake is not addressed either. Intensity has been addressed separately with the groundwater model. DFO normally applies their method to assess individual HADDs at a reach scale and has not traditionally participated or addressed watershed scale or cumulative impacts.

Page 6-27 ii) Also state that isolation affects genetic diversity and health not only the ability to re-colonize reaches.

Page 6-27 iii) Seasonal refuge is being equated with critical habitats as defined by DFO that should be reflected in final impact ratings of high. Please cite or explain where this is the case.

Page 6-28 iii) It is recognized that contributing habitats should be included in this analysis (cumulatively?) but assigns it a very low sensitivity and admittedly on a relative (vs. additive) basis. Please offer further assumptions or discussion on how the impact analysis should be interpreted. (Could have at least recognized as sensitive in the hydroperiod analysis later.)

Rogers Creek – Overall Sensitivity

Page 6-29 R1) A good example of a headwater catchment (cumulatively 1/4 of all) assessed as having low sensitivity in general terms. The only permanent reach, however, is described as not particularly sensitive overall nor to water specific changes? This should represent critical refuge habitat and rate as moderate/highly sensitive. Also refer to p6-27 iii).

Page 6-29 R2 and 3) Why are the small perennial cool and small areas of associated refugia emphasized as small? If comments are directed at extent, be objective and note the great extent of less sensitive reaches throughout or otherwise keep significance (vs. sensitivity) for another analysis in terms of (cumulative) length or total production.

Second Creek – Overall Sensitivity

Page 6-31 S1) Why is perennial warmwater habitat rated very low and an intermittent warmwater reach as in S4 is rated more sensitive at low? (e.g. only rating thermal now but then why comment on flow regime adding to confusion?).

Most Sensitive Reach

Page 6-32 and 33) This does recognize/emphasis the most sensitive reach within a catchment (but criteria applied are not clear) to present a worst case scenario. Please address that this does not address a downstream contributing analysis, and eventually to coldwater habitat downstream.

Still confused with Table 6-11 of most sensitive reaches i.e. does it combine level of impact with sensitivity? i.e. R1 has isolated permanent cool yet isolated permanent warm is selected as most sensitive? Are isolated reaches commonly identified as the most sensitive reaches (what are the dominant factors?).

Hydroperiod

Page 6-35 CVC agrees that hydroperiod could shift some perennial streams to intermittent conditions but also note likewise that intermittent reaches may also become ephemeral (see Figure attached).

Page 6-35 iii) CVC does not accept the concept that “within expected normal variation” are acceptable impacts, as impacts would be “in addition to” even if less than normal variation. The 1/5 to over 1/2 range may still be acceptable but explain how 1/5 was selected (model margin of error)? Can this be translated in terms of weeks or months of flow?

Page 6-35 iv) Why was the most sensitive habitat type used again and compare to how catchment wide results are assessed. Sensitivity in this case requires different criteria and directly related to hydroperiod sensitivity (i.e. the risk of becoming more intermittent).

Also refer to p6-24 iv) and p6-24 iii) in that hydroperiod would be assessed "given the predominance of intermittent and seasonal fisheries within this study area". This would address not only the sensitivity of such habitats but the cumulative impact on headwater features. Hydroperiod impacts need not relate to nor double count thermal classifications of coldwater. Emphasis should be on habitat flow types being impacted this time. Both overall sensitivity and groundwater discharge sensitivity addressed the sensitivity of cold to warmwater fisheries enough.

Page 6-36 i) High Sensitivity to Hydroperiod Change/Reduction should not be applied to coldwater habitats buffered by rich groundwater from deeper aquifer resources.

Page 6-36 ii) Likewise, intermittent reaches should be most sensitive as well as permanent warmwater having the least groundwater component.

Indicators and Related Receptors Used in the Fisheries Impact Analysis

Page 6-38 – 3rd paragraph - Should state that water quality includes dissolved oxygen and temperature, in addition to the mentioned contaminants. It is not clear whether this was also taken into consideration in the qualitative assessment of water quality for the Fisheries Impact Analysis.

Page 6-38 iv) Water Quality is focused on dilution which may work well for some pollutants but consider excess phosphorous that is a common concern as it relates to DO. Phosphorous can actually increase with flows and not be diluted. Please further comment on the appropriateness in assuming a linear relationship. Water quality would be assessed better using adjacent land use data. This would have also included an assessment of all riparian communities rather than just riverine wetlands as selected and included temperature influenced by shade rather then groundwater.

Page 6-39 i) The use of riverine wetlands may double count groundwater influences, yet miss other connected wetlands (most are assumed to be palustrine not isolated), and discounts other riparian communities that more often have been correlated in literature with the aquatic functions and others listed (e.g. shading, organic inputs, temperature). Please explain why the latter functions were not considered.

Page 6-39 - Qualitative Analysis is not well defined. For each of the secondary indicators, should describe how a low, moderate or high impact is determined. It is not clear whether data from Part A were used for the secondary indicators (e.g. water quality).

Integration of the Analysis to Develop the Overall Fish Impact Ranking

This is confusing. How does the methodology place greater emphasis on the magnitude of impact compared to sensitivity as stated? and why?

Overall Fisheries Impact Analysis

Page 6-44 CVC agrees that direct impacts to lower catchments (S3 and S4) would be low, but flow impacts being transmitted downstream must still be accounted for. Note that their upper reaches SA and S2 have high impact ratings. One might expect more of a transition through a moderate impacted reach.

Generally CVC suggests the methodology should give hydroperiod more emphasis than multiple groundwater impacts, such that predicted coldwater reach impacts may decrease marginally and upper reaches impact scores would increase in relative terms.

Page 6-45 Scenario C - Generally all impacts are predicted to be low. CVC assumes this is relative to the unmitigated scenario and does not necessarily determine a HADD is being avoided in relation to baseline conditions? Other assumptions need to be discussed. Why should groundwater impacts, surface flow, water quality and temperature not be impacted to some greater degree near the quarries (vs. low across the board)?

SECTION 6.8 – ACCUMULATIVE IMPACTS (INTEGRATION)

Suggest section should highlight impacts (direct and indirect) for various disciplines, and the potential responses of the system to the stressors (i.e. Effect on water budget, response of flora and fauna to hydrologic changes, effect on landscape metrics [percent natural, size, shape, landscape matrix, connectivity], and disturbance regime).

Page 6-48 Definitions are required as the terms integrated and cumulative have some key differences. Integration of disciplines has been better achieved than cumulative effects in a downstream direction and in addition to natural fluctuations.

Figure 6.22 should illustrate which communities will be removed, since all communities will be highly sensitive to removal.

See Terrestrial Comments in Section 6 regarding assessment of sensitivity and using only significant features in assessment.

All features within the extraction area should be identified as highly impacted as they would be removed from the landscape through the extraction process.

SECTION 7 – STUDY AREA OBJECTIVES

SECTION 7.3 – VARIOUS DISCIPLINES

Page 7-7 – Under Surface Water k) - The references to “3.1.l” and “3.1.m” do not exist and perhaps came from another document; It is believed the reference is to the previous section, Groundwater l) and m). Similar discrepancies are found in the sections that follow (under Fisheries and Woodlands, Wetlands and Wildlife).

Fisheries - Page7-7 DFO objectives are reflected in the reference to HADD. MNR objectives are not referenced. It would be best to reference the CRFMP to reflect all agency and stakeholder objectives in a broader sense of fisheries management.

SECTION 8 – INTRODUCTION TO MANAGEMENT SOLUTIONS

Aquatic

Aspects of improving habitats downstream of the extraction area should take precedence and not just coldwater as more gains may be made in nearby intermittent reaches. Within the quarries, public access may determine the type of fishery and agency participation. Otherwise the best "diversity" to add (not further described) would be in the form of wetlands less than 2 m deep. This is also the greatest challenge as slopes are usually maximized for aggregate extraction. More discussion and detail can be expected at the site level, but more guidance should be provided. More discussion and detail on pit rehabilitation designs is expected for site level applications, but more guidelines and available techniques (e.g. related to wetland creation) should be provided for proponents in Part C.

SECTION 8.2 – MANAGEMENT MEASURES

Pages 8-2 to 8-4, Section 8.2 – This section presents a discussion of the potential management measures that could be implemented during the operational and rehabilitation stages of aggregate developments. All of the management measures are reasonable options to be considered for any future aggregate developments in the Resource Area, and it is appropriate for them to be discussed in the Part B report and expanded on in detail in the Part C report if appropriate. Absent from the discussion of the management measures is consideration of the challenges involved with implementing these measures. Some expected challenges would be:

- Operational issues if multiple properties are developed by different operators at different times
- Developing a monitoring program to direct the management of water and mitigation of impacts;
- Long term maintenance and monitoring of the measures, as development of aggregate operations and gradual transition to a rehabilitated state is expected to take several decades; and
- Knowledge transfer to whoever will be responsible for the long term monitoring and maintenance of the rehabilitated site.

APPENDIX M: SURFACE WATER ASSESSMENT MODEL REFINEMENT AND CALIBRATIONS

Appendix M, Section 2.7 page 13, 1st paragraph, Observed Streamflow

The author should also provide commentary that the streamflows collected as part of the field monitoring are spot flow measurements and that continuous monitoring of streamflow was not undertaken for the reaches. This point becomes even more important during the calibration and validation phase of the modelling, because the observed streamflow data is comprised of spot measurements and cannot be used to calibrate dynamic events within the time-series simulated.

Appendix M, Section 3 page 15, 1st paragraph, Calibration and Validation

The authors should provide a Table comparing the simulated annual flow volumes and the observed annual flow volumes at the gauged sites over the calibration/validation period.

Appendix M, Section 3 page 16, 1st paragraph, Calibration and Validation

The authors should provide a Table listing the calibration parameters, along with their original values and the final calibrated values used in this study.

Appendix M, Section 3 page 16, 2nd paragraph, Calibration and Validation

Given that a fraction of the groundwater from most reaches was routed to either a downstream reach or to a collector reach that represents groundwater that does not reemerge within the study area to better represent the baseflow conditions within the study area, the authors should provide a table listing which reaches were used to divert groundwater to either a downstream reach or a collector reach and by how much (% volume).

Appendix M, Section 3 page 17, 1st paragraph, Calibration and Validation

The calibration process consisted of adjustments to the routing of the groundwater runoff-stream recharge component of the model. In this process, the baseflow from most catchments was partitioned into two streams. A portion was routed to the local stream reach and a portion was routed to either a downstream reach (i.e., Rogers and Second Creek and tributaries) or outside the study area directly or indirectly to the Credit River. A table listing which catchments were used in the above baseflow routing scheme including where the flow was partitioned too and by how much would be useful to the reader.

Appendix M, Section 3 page 17, 2nd paragraph, Calibration and Validation

For six of the monitoring sites the simulated flow was lower than the observed flow in some cases by as much as 89%, the most likely explanation according to the authors is snowmelt, however, to further illustrate this point, the date and time when the observed measurement was undertaken should also be included within Table 4.

APPENDIX N: GROUND WATER ASSESSMENT MODEL REFINEMENT AND CALIBRATIONS

See comments in separate document for groundwater modelling report.

PART B
HYDROGEOLOGICAL MODELLING TASK

GENERAL COMMENTS:

The modelling report addresses the requirements of the CBSES work plan, which was jointly developed by the JDCL study team and the agencies. The approach to the modelling task was further refined through discussions between the JDCL study team, their modelling consultants (AquaResource, Bob Walker), CVC staff members (John Perdikaris and Dan Banks), and Ray Blackport (assisting CVC with review).

Under the scope of work for Part B of the CBSES the hydrogeological modelling task involved an assessment of groundwater flow in the study area under a variety of scenarios, including: existing conditions; several potential future aggregate extraction conditions; and final rehabilitation conditions. The Part B modelling portion of the CBSES was developed from the hydrogeological modelling completed by Waterloo Hydrogeologic Inc. (WHI) for a regional scale model of the Credit Valley watershed. The Regional scale model was used to develop a "subdomain" model, focusing on the CBSES Study area as part of the Part A Characterization. The model was not calibrated locally for the Part A characterization.

The focus of the Part B modelling task was to refine the geological characterization of the model on a more local scale (i.e. the CBSES Study Area plus additional adjacent areas surrounding the study area), with calibration of the model to groundwater levels and base flows. The agreed upon work plan required the JDCL study team to refine CVC's regional surface water (HSP-F) and groundwater (FEFLOW) models within the CBSES Study Area and adjacent areas that comprise the model domains. The models were refined using the monitoring data collected by the JDCL study team for the CBSES Part A study, as well as other appropriate sources of data (e.g., data collected by CVC staff, weather station data, etc.).

The refined groundwater and surface water models were used to simulate various land use change scenarios within Resource Area 9A. The agreed upon land use change scenarios included the following:

- Scenario A – Current conditions (i.e., no land use change); The results of this scenario are used to confirm that the models reasonably represent actual conditions in the Study Area and will be compared to the results of the other scenarios in order to show relative impacts from the land use changes.
- Scenario B – Full extraction of the aggregate resources in Resource Area 9A without implementation of any mitigation measures; It is not expected that any aggregate extraction would occur in Resource Area 9A without mitigation measures; however Scenario B is meant to demonstrate the "worst case scenario" in terms of the impacts that could occur from unmitigated development of the Resource Area.
- Scenario C – Final rehabilitation of Resource Area 9A, which would represent conditions after full extraction of the aggregate resources and after the extraction cells have fully filled with water; Different passive mitigation measures (e.g., lower permeability barriers, increasing water levels) were modelled for this scenario in order to determine if certain measures, or combination of measures, may be more or less effective in mitigating impacts.
- Scenario D – Partial extraction of the aggregate resources in Resource Area 9A without implementation of any mitigation measures; This scenario is intended to demonstrate that even partial extraction of aggregate in Resource Area 9A without mitigation measures would cause significant impacts.

- Scenario E – Water budget analysis to estimate the approximate number of years that would pass between the completion of full extraction of the aggregate resources in Resource Area 9A (Scenario B) and reaching the final rehabilitation scenario where the quarry cells would be filled with water (Scenario C).

There are inherent limitations with the modelling approach employed for the Part B Study. Only steady state model simulations were conducted, and no transient model simulations were performed. Transient simulations were originally recommended by CVC staff during the work plan development; however, it was felt by the JDCL study team that it would be difficult and unrealistic at this time to conduct transient simulations as there would be an infinite number of different extraction and rehabilitation scenarios that could be simulated and there would be insufficient transient data to calibrate the model in the broader study area. The primary focus of the modelling was therefore to provide a reasonable calibration of existing hydrogeologic conditions, assess the magnitude of unmitigated impact from extraction, and simulate various extraction mitigation scenarios to assess the potential for rehabilitation of the resource area under post-extraction conditions.

The completed modelling and associated reports fulfill the general expectations of the agreed upon work plan. The modelling report generally presents a clear description of the model development, calibration, and description of the different scenarios and their relative impacts on water levels and flows. The greatest concern with the modelling however is the ability to assess the hydrogeological impact during active extraction and water level recovery between the completion of the extraction phase and reaching the fully rehabilitated condition. As discussed later in these comments, it will take many decades and potentially over a hundred years before post-extraction rehabilitation will occur.

Although the requirements of the work plan were generally met by the modelling work, the report would still benefit from the inclusion of additional information and discussion. There should be a more detailed discussion in the report with respect to the Terms of Reference for the modelling component. The report can be read and generally understood by people familiar with the technical studies. Anyone not familiar with the Terms of Reference and development of the Work Plan however, will have difficulty understanding how the modelling evolved. Perhaps a chronology of events (i.e., meetings, development of work plan, etc.) should be included to assist readers to better understand the modelling process.

General discussion of the limitations of the modelling effort, or specific modelling discussions that should be expanded

The bedrock formations, including the Amabel Formation aquifer, were represented as equivalent porous media in the groundwater flow model. This was agreed upon during the development of the work plan as it is reasonable for a larger scale study, with only some local areas having a higher level of field data collection and hydrogeological assessment related to fracture flow and fracture conditions in the bedrock; however, the assumptions and limitations in this approach should be discussed in the modelling report. In particular, the impact of major lateral fracture zones on local transmissivity of the Amabel Formation and the potential variation in storativity should be discussed. While the Part A Study noted that no large scale karst features have been identified in the Study Area, it is still expected that groundwater flow in the Amabel Formation (particularly the unweathered portion) would be somewhat controlled by fractures and would reflect heterogeneous aquifer properties typical of fractured media. This will be particularly important if modelling is conducted at a more local scale in support of site-specific applications and calibration of any model would require transient simulations to compare against pumping test data, seasonal flow variations, etc..

The groundwater model scenarios were all run as steady-state simulations, which are limited to representing average annual conditions and impacts. Although the model may be “calibrated” to second and third quartile values for groundwater discharge, there is a large range in flows, as much as three orders of magnitude at some locations. This makes it difficult to compare the simulation of average flows in the steady-state model with the large variations in transient annual flows. There

should be a discussion in the report with respect to the implications of comparing the steady state flow results with the actual flow data.

Although "worst case" conditions are supposed to be represented through scenario B (full extraction without mitigation), scenario D (interim extraction) does demonstrate that large impacts occur well before full extraction is completed. The agreed upon development scenarios do not represent the conditions that would occur between different scenarios (e.g., between pre-extraction conditions and active extraction, and between full extraction and full rehabilitation). The current modelling approach does show that under post-extraction rehabilitation conditions various mitigation scenarios can be used to minimize impacts after a general water balance is achieved. However there would be many decades when impacts would occur during active extraction which cannot be addressed under the current modelling approach. There should be some discussion as to how this will be addressed in Part C.

SECTION 1 - INTRODUCTION

SECTION 1.1 - STUDY BACKGROUND

Page 1, Section 1, second sentence is awkward, it would be clearer if it read "the potential for impacts on sensitive components of the natural environment as a result of potential future aggregate extraction", or something similar.

Page 1, general – it is unclear what the Term "Study Area" refers to as there is the model domain, the Study Area and the CBSES Study Area. For example on page 7, with respect to discussions of the Eramosa Member it is stated that it is localized in the Study Area and was observed in some boreholes in the North and West of the Study Area. It is assumed that this Study Area is the Aggregate Resource Area 9A.

Page 1, Section1, Paragraph 3 – The comment regarding the model not being calibrated locally, but consistent with CVC's approved watershed-scale groundwater flow model should either be expanded or left out of this section and discussed more in Section 3.

Page 1 – extra period at end of first sentence of third paragraph

SECTION 1.2 - HYDROGEOLOGICAL MODELLING OBJECTIVES

Page 2, Section 1.2, last two sentences at the bottom of the page need to be clarified (e.g. minimizing impacts on what)

SECTION 1.3 - DATA SOURCES

Page 3, Section 1.3, first sentence – "scale of the CBSES, <u>the</u> data used…"

SECTION 2 – CHARACTERIZATION

SECTION 2.1 – TOPOGRAPHY

Figure 1 – Offline Ponds are shown in the legend but seem to have been omitted from the information on the figure.

SECTION 2.2 – PHYSIOGRAPHY

Figure 3 – information on figure should extend to cover all of CBSES Model Domain

SECTION 2.3 – GEOLOGY

Page 7, Section 2.3.1 – last paragraph, regarding the discussion of the Eramosa Member: While the Eramosa Member may not be included in the model, perhaps a figure should be included of the approximate location of the Eramosa Member for completeness. The Eramosa Member was not included as this was considered conservative, with respect to the impact on water levels and water features in the overburden, North and West of the Resource Area. While this may be true, this also increases the leakage to the bedrock. *Could this have an impact on the water balance in the bedrock*?

Figure 9 - information on figure should extend to cover all of CBSES Model Domain

SECTION 2.4 – HYDROGEOLOGY

Page 9, third paragraph – extra colon (:) before (1) potential impacts
Page 9, Section 2.4.1, first sentence – please note that the correct title for the referenced report is 'Interim Watershed Characterization Report', and that it was finalized in February 2007.
Page 9, seventh paragraph – 'Northwest of the flow divide, groundwater flows towards the West Credit River…'

SECTION 3 – GROUNDWATER FLOW MODEL DEVELOPMENT AND CALIBRATION

SECTION 3.1 – INTRODUCTION

Page 14, Section 3.1.2 – regarding model selection, "FEFLOW was identified as better able to simulate complex geology associated with the Niagara Escarpment". This should be expanded upon.

SECTION 3.2 – MODEL DOMAIN AND FINITE ELEMENT MESH

Page 14, Section 3.2, first paragraph – The report indicates that the extent of the model 'may be' further refined for the Part B analysis. Please modify this sentence so that it describes what was done for the Part B analysis.

SECTION 3.4 – HYDRAULIC CONDUCTIVITY DISTRIBUTION

Page 16, Section 3.4, first full paragraph – "hydraulic conductivities applied to the model are generally consistent with those used in the CVC watershed-scale model as well as the ranges of values estimated for the Study Area". *Were there any significant inconsistencies and if so should they be discussed in more detail in Section 3.6 as related to model calibration?*

SECTION 3.5 – BOUNDARY CONDITIONS

Page 17, Section 3.5.3 – The report indicates that constant head boundaries were applied around the model perimeter to account for groundwater entering and leaving the model domain. Please provide further discussion on the selection of the constant head boundaries, and for completeness, a discussion on the potential implications, if any, on the results of the modelling. Drawdown of groundwater levels extends to the model boundaries for some scenarios and this should also be discussed in the report.

SECTION 3.6 – MODEL CALIBRATION

There should be some discussion of how well the groundwater and surface water models agree in terms of recharge, baseflow, etc., and the significance of any areas of substantial difference.

Page 19, Section 3.6.3, first paragraph – Please delete 'Error! Reference source not found'.

SECTION 3.7 – MODEL CALIBRATION RESULTS

Page 22, Section 3.7.1 – The report indicates that the simulated groundwater levels are slightly above the observed levels in the downgradient part of the Study Area and slightly below the observed levels in the upgradient part of the Study Area. Please provide a discussion of how this trend in the simulated groundwater levels may have impacted the results of the groundwater modelling scenarios. For example, the creation of the lakes in the rehabilitated scenario (Scenario C) would be expected to lower upgradient water levels and increase downgradient water levels. *Would the trend in the calibrated water levels serve to reduce the simulated impacts of this scenario?*

Perhaps there should be a discussion on the calibration to "existing" data and how representative the existing data are- i.e. *Are the water levels used for calibration considered representative, especially in the Resource area? Have the water levels been collected for a sufficient period of time and has the time of collection been during a period of normal precipitation?*

Page 23, Section 3.73, Overall Assessment of Calibration – It is stated that the simulated groundwater discharge is consistently within the range of distribution of observed values, indicating the overall recharge rate is appropriate. The discharge rate or flow rate at many locations can vary by as much as three orders of magnitude so it is difficult to determine how well the model discharge is calibrated to observed volumes of discharge. There is no water balance or "reasonableness" check, comparing total simulated volumes of discharge with observed volumes of discharge. Although the simulated flow is within the range of 50% of the flows over time, on a semi-logarithmic plot, this may not be close to an average or mean baseflow. This should be assessed in more detail.

Page 24, Section 3.7.4, Sensitivity Analysis – *Are the hydraulic conductivities discussed in the conclusions horizontal, vertical or both, with respect to the sensitivity of water level changes?*

The model is described as being relatively sensitive to variations in groundwater recharge with the mean error dropping by -3.9 metres when reducing groundwater by 20%. *Does the reverse hold true when increasing recharge rates? Was the sensitivity of changes in baseflow or discharge assessed, with respect to variations in recharge?* Some discussion should be presented on baseflow as the focus of the discussion in this section is on water levels.

SECTION 3.8 – ESTIMATED POTENTIOMETRIC SURFACES AND WATER BUDGET

See comment on water budget for Section 4.3 below.

SECTION 4.0 – SCENARIOS

SECTION 4.3 – MODEL SCENARIO RESULTS

Page 30, Table 10 – Table 10 presents the total groundwater discharge for Scenario A in each of the sub-catchments and for the entire Study Area. It would be helpful to compare the simulated total discharge (i.e., 22,110 m^3/day for the entire Study Area) to the baseflow measurements that were collected in the Study Area for Part A. Earlier in the report there is a discussion of how well the modelled baseflows compare to the flows measured at individual monitoring stations, and it would also be worthwhile to compare the total simulated groundwater discharge to the total measured flows as an additional way of demonstrating how well the groundwater model matches actual condition.

Figures 40 to 43 – Scenario C15 should be referred to as either the 'preferred' or 'optimal' rehabilitation scenario (not both).

SECTION 5.0 – CONCLUSIONS

SECTION 5.1 – CALIBRATED MODEL

See comments presented in Section 3.7

SECTION 5.2 – SCENARIOS

Scenario A – Existing Conditions - There is general agreement with water level data and geologic conditions on the regional scale of the model, however this does not imply there is agreement at the local scale. It is stated that groundwater discharge should be evaluated at the subcatchment scale. It is also stated that local geologic and hydrogeologic heterogeneities have not been incorporated into the groundwater flow model. It is important to ensure that the model is portrayed in this manner, (i.e., it cannot be used at a local scale and is not calibrated at a local scale). The modelling report provides a general assessment of the conceptual hydrogeologic model for the area and provides a general assessment of the sensitivity of changes to various hydrogeologic parameters at this scale. It serves as a starting point for a more local scale assessment, which will involve a more rigorous calibration to existing local data.

Scenario B –Full Extraction Conditions - Scenario B shows that there are major impacts as a result of unmitigated extraction. As indicated in earlier discussions, the impact of active extraction and the long time frame of active extraction and as well as the time for water level recovery after extraction ceases are major concerns. How these impacts would be monitored, actively assessed and managed needs to be addressed in detail in Part C.

Scenario C – Rehabilitation Conditions - Modelling of various rehabilitation scenarios show that it is conceptually possible to minimize hydrogeological impacts as part of rehabilitation. The concern, as previously indicated, is that this may not occur for many decades or perhaps more than 100 years. The ability to assess the risk and uncertainty during active extraction is the major issue and needs to be addressed in Part C.

Scenario D – Interim Extraction Conditions – Scenario D highlights the issue of hydrogeologic impacts, even with limited extraction conditions as the hydrogeologic impact is nearly as large as during active extraction.