



Credit Valley Conservation
 Nottawasaga Valley Conservation
 Toronto and Region Conservation
 Lake Simcoe Region Conservation
 Central Lake Ontario Conservation
 Kawartha Conservation
 Ganaraska Region Conservation
 Otonabee Conservation
 Lower Trent Conservation

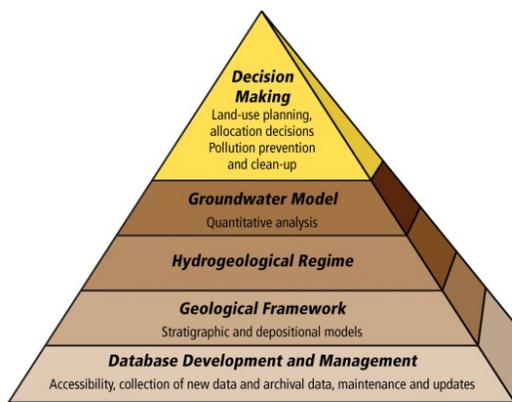


ANNUAL PROGRAM OVERVIEW (2018) & WORK PLAN (2019)

TO: YPDT Executive Steering Team
FROM: Steve Holysh & Rick Gerber
DATE: March 26, 2019
RE: **2018 Overview/2019 Work Plan – Oak Ridges Moraine Groundwater Program (ORMGP; formerly YPDT-CAMC)**

Background

The Oak Ridges Moraine Groundwater Program (ORMGP) was initiated in 2001, driven by the encroachment of development onto the Oak Ridges Moraine and the recognition of an absence of high quality environmental data and analyses, particularly with respect to groundwater. Since inception, the program has provided partner agencies with an actively managed water-related database and the regional geological and groundwater context for on-going day-to-day water resource management activities (e.g. development review, PTTW review, watershed management, source water protection, etc.). The framework for the program is succinctly summarized in the adjacent figure, taken from the Council of Canadian Academies 2009 report “The Sustainable Management of Groundwater in Canada.”



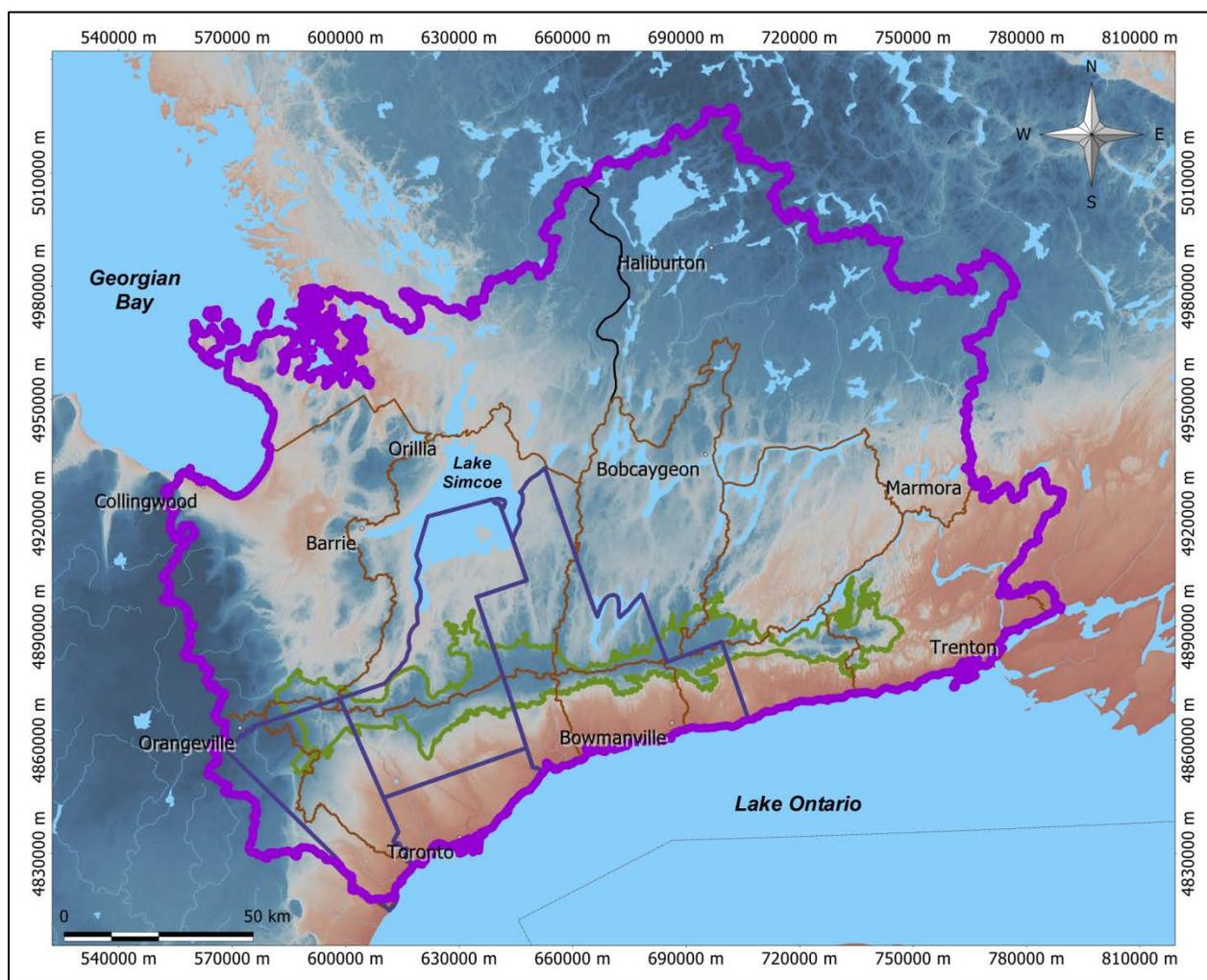
Mandate

The mandate of the ORMGP partnership is to provide a multi-agency, collaborative approach to collecting, analyzing and disseminating water resource data as a basis for effective stewardship of water resources. The ORMGP builds, maintains and provides to partnered agencies the regional geological and hydrogeological context for ongoing groundwater studies and management initiatives within the partnership area.

As such the program will:

- Build and maintain a master database of water-related information that is accessible to all partner agencies;
- Build and maintain a digital geological construction of the subsurface layers that is accessible to all partner agencies;
- Build and maintain numerical groundwater flow models that can be used to address any number of issues that arise at any of the partner agencies;
- Coordinate and lead investigations that will acquire new field data that will strategically infill key data gaps;
- Provide technical support to Drinking Water Source Protection teams to ensure that interpretations used in source protection technical work are consistent with the regional understanding;
- Provide technical support to planning authorities to ensure that Official Plan policies are developed in a manner which makes them consistent with up to date groundwater science as derived from the project;
- Provide technical support to all partnered agencies for addressing other Provincial legislation.

Further information regarding the program can be found at oakridgeswater.ca.



Program area - Note that for data management purposes the program area comprises the entirety of three Source Water Protection (SWP) Regions: 1) Credit Valley/Toronto and Region/Central Lake Ontario (CTC); 2) South Georgian Bay - Lake Simcoe (SGBLS); and 3) Trent Conservation Coalition (TCC). Focus of work is largely directed to the GTA municipalities (York, Peel, Durham, and Toronto) and their associated Conservation Authorities (CAs).

Review – 2018 Highlights

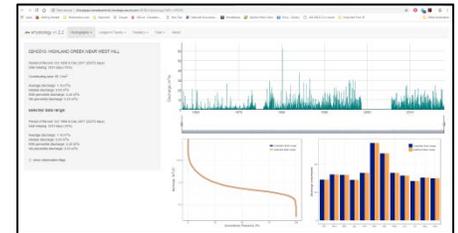


1. Database

- added this year – 18,500 boreholes; 1,700 reports; 31 million temporal records; link to benthic/fisheries data;
- incorporation of additional streamflow and climate statistics/graphs/analyses based on regularly updated data;
- incorporation of scripts to regularly update streamflow and climate data within the database;
- correction and consolidation of elevation data;
- sharing of data with consultants via the program website.

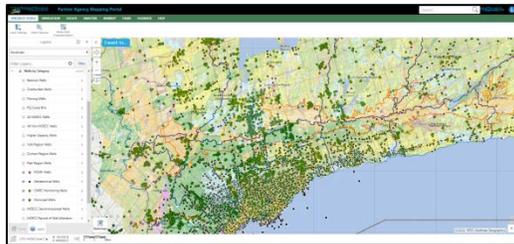
2. Analysis & Modelling

- mapping of potential problematic groundwater areas in Richmond Hill;
- in cooperation with GSC, journal paper published that summarizes geology and nearly 70 years of hydrogeology of Yonge Street Aquifer;
- the proof of concept for utilizing numerical models developed through source protection planning for alternate purposes, was advanced through TRCA ESGRA and Carruthers numerical modelling contributions;
- contributions to Terms of Reference for Durham and Peel Region modelling update studies;



3. Other

- enhancements to mapping section of website (oakridgeswater.ca); established collaborative partnerships with 7 consultant firms;
 - contribution to City of Toronto GW strategy including presentation of program website to development community (BILD) noting its potential to save costs (oakridgeswater.ca);
 - technical collaboration with various agencies including MECP; GSC; OGS; Hydro One; Richmond Hill; Municipality of Clarington; Univ. of Waterloo; Univ. of Guelph;
- Communications – invited to speak at various forums including International Joint Commission, Conservation Authority Collaborative Information Sessions (CACIS), Friends of the Greenbelt Foundation, Greater Golden Horseshoe CAs, GSC/OGS Open House, Ontario Water Works Association (OWWA), Michigan Department of Natural Resources, IAH-CNC, Univ. of Toronto.



4. Budget

- Program delivered within available funds - no planned increase for 2019;

Program Component	2018
Staff Costs (Wages + Benefits)	\$659,500
Office Costs + Disbursements	\$52,300
Computer + Software	\$35,500
Consultant/Services	\$21,200
Administration	\$16,500
Total	\$785,000



Review – 2018 (Detailed Summary)

The following provides a more detailed overview of activities undertaken through the Oak Ridges Moraine Groundwater Program through 2018.

1. DATABASE

Through 2018 the program's database structure remained fairly stable with only a few small changes required to move things forward. The database was refined and improved through 2018 with continued use of SQL 2016 to facilitate database management. As in previous years, the discussion of database issues has been broken into four categories: Additions; Corrections; Accessibility and Software/Hardware Management.

1a Additions

Key 2018 additions to the database included:

- An updated WWIS database was obtained in summer 2018 from the MECP and about 15,500 new well records were brought into the database – the MECP well records are up-to-date as of Oct. 2017;
- New boreholes: i) compiled by City of Barrie staff; ii) compiled by York Region and Lake Simcoe CA staff; iii) West Vaughan Sewer boreholes compiled by Golder for York Region, were imported, In addition to the MECP wells, approximately 3,000 additional wells/boreholes were added in 2018;
- Approximately 1,700 new documents were brought into the library, most from the City of Toronto engineering summer student initiative;
- Import/updating of York Region and Durham Region water level and chemistry data;
- Peel Region municipal monitoring data continued to be regularly appended to the database via the Citrix platform by Peel Region staff;
- The MNR's Oil Well records (Oil, Gas & Salt Resources Library) were updated;
- Streamflow data from TRCA was imported into the database thus enabling all of the statistical tools provided through the program website to be performed automatically on all TRCA streamflow monitoring stations;
- The Flowing Water Information System (FWIS) benthic and fisheries data that is housed at the Univ. of Waterloo was linked to the database so that it can be viewed and accessed via the program website;
- Tools were developed to maintain up-to-date climate and streamflow data within the database by automatically acquiring data from Environment and Climate Change Canada website;
- Miscellaneous well and associated data from consulting reports were brought into the database; and
- In total approximately 31 million temporal records (chemistry, water levels, stream flow, etc.) were added in 2018 – this number reflects the import of regional data, as well as the updating of climate and stream flow data from Environment and Climate Change Canada.

1b Corrections

- In 2018 program staff made a concerted effort to review MECP wells with respect to discrepancy between metric and imperial units. This problem was introduced between approximately 2003 and 2008 when the provincial well record form was converted to metric, providing drillers with no option to record depths in imperial units. Many drillers were unfamiliar with metric conversions and continued populating well record forms in imperial units, these were undetected as the records were converted into digital form and imperial measurements were input as metric. The problem was resolved when the form was adjusted, allowing drillers the option to record either in metric or imperial. Many well records were corrected through 2018, although there still remains some work to do on this issue.
- A concern was found with Sitefx imported logger water level data. Upon import, the original units coming into the database via Sitefx imports were stored with units of cmap (centimetres above probe).

If top of pipe reference elevations were adjusted (e.g. as a result of new survey data) then it was proving cumbersome to update those water levels that were stored in cmap units. By converting the original units to a depth (in m) immediately upon importing logger files, the water levels are now much more easily updated as reference elevations change.

- In 2018, MOE wells that have poor coordinates (as indicated by the MOE QA code) were isolated as a separate group so that they could be evaluated and if possible, have their coordinates fixed. With the ability to screen water wells on the website and readily access the original water well record via the MOE website – such corrections to individual wells was simplified.

1c Accessibility

- ORMGP staff continue to build upon the 2017 R statistical package by improving upon the high quality statistical analyses of streamflow information via the program’s website;
- The Citrix Xendesktop platform that was established in 2016 on the ORMGP server at Central Lake Ontario Conservation Authority offices continued to be used by technical ORMGP staff, as well as partner agency staff, to interact with the master database. On the Citrix Server platform, users can access either: i) the master database - for users wishing (and permitted) to make permanent changes; or ii) the “weekly database” (see below), for users looking to review and make use of the most recent data;
- The Citrix system as well as the overall database structure and database management workflows have remained largely unchanged through 2018 and have performed up to expectations. Via the internet, the database and several related software programs can be utilized for viewing and interacting with the master database. Staff will continue to make use of this platform to provide ready access to the program’s database and information.

1d Software/Hardware Management

In order to keep the database up-to-date and readily accessible to the partner agencies there is continual maintenance and review of the program’s software and hardware capabilities. 2018 was a year of general stability with respect to database management, minimal new equipment and/or software was required. In 2018, the following tasks have been undertaken with respect to the program’s software and hardware management:

- In early 2017, database management workflows were reconfigured to work within Citrix platform. These were maintained through 2018. Of particular importance is the backing up of the database, a critical ongoing task of the program:
 - The database resides on a server at CLOCA which is continually backed up through VEEAM backup system server software – should there be a power failure or database glitch, the database can be restored from a short term backup in very short order; the VEEAM software stores multiple versions of the database which are eventually overwritten with subsequent, more recent backups;
 - on a weekly basis (every Sunday) the following steps are automatically transacted:
 - the database is backed up to a different CLOCA based server (this copy is dubbed the “weekly database”) and is made available for use via the program’s website to share data with the outside community;
 - this database is automatically transferred/written to an ORMGP server at TRCA’s offices (used by ORMGP staff to interact with, review and check the database);
 - over the long term, copies of the weekly database are held off-site (along with backups at TRCA and CLOCA) and monthly copies are held indefinitely should they be required;
- 2018 saw the continued use and expansion of the W tables within the database in order to speed up the retrieval of data from maps on the website; W tables synthesize much of the temporal data within the

database (e.g. min, max, avg. values) and are scripted/coded to refresh every weekend so that they are always providing up-to-date information to the website;

- To ensure partners have the ability at their own offices to use software products (e.g Viewlog, Sitefx, and others) to review/access/QA/evaluate their data held in the ORMGP database, a cut of each partner agency data set is distributed (in SQL and/or Access format) at least two times in 2018 (more often if needed/requested).

2. ANALYSIS & MODELLING

The following initiatives were undertaken through 2018.

Technical Model Contributions

Through 2018, in addition to the numerous analyses highlighted below, ORMGP staff continue to communicate with software developers to discuss modelling code, at a high technical level, and to provide input regarding suggested fixes and/or improvements to existing software codes (e.g. discussions continue to be held with the developers of GSFLOW, HydroGeoSphere, Defl3DFM, Mike SHE, and GWVistas). Staff also continued to monitor and provide input to assist the Lake Ontario Collaborative Group with modelling considerations in Lake Ontario.

Durham Region Numerical Model Update

In 2018 staff worked with Durham Region staff to prepare the Terms of Reference document for an update to the Regional Municipality of Durham numerical model. Subsequent to preparation of the Terms of Reference, ORMGP staff were then integrated into the Durham review and selection team to oversee the selection of the preferred consultant for this important Durham Region project.

Peel Region Numerical Model

The Region of Peel was encouraged by program staff to renew and update the existing numerical modelling within Peel Region which for parts of the region dated back to 2007 (the “West Model”), and Peel staff agreed. In 2018 ORMGP worked with Region of Peel staff to prepare a technically sound Term of Reference document for circulation to consultants. The Terms of Reference was adjusted towards the end of the year to incorporate the modelling needs of CVC.

Model Subcommittee

The modelling subcommittee convened in 2018 to exchange ideas and techniques for enhancing numerical model use across the program study area.

Yonge Street Aquifer

In partnership with staff from the Geological Survey of Canada and York Region, a detailed analysis of the geology and hydrogeology of the Yonge Street Aquifer was finalized and published in the Canadian Journal of Earth Sciences (Gerber et al, 2018, “Conceptual hydrogeological model of the Yonge Street Aquifer, south-central Ontario: a glaciofluvial channel-fan setting”).

Ecologically Significant Groundwater Recharge Areas – TRCA

This project was undertaken with a goal of re-purposing source protection numerical models in the support of activities not related to the Drinking Water Source Protection Program and the Technical Rules that governed its original purpose and thus not previously undertaken using the original model. In the case of this ESGRA project, ORMGP was approached to assist with the delineation of Environmentally Significant Recharge Areas (ESGRAs) across the TRCA watershed area. ORMGP staff initially modified the York Tier 3 Source Protection (YT3) model to incorporate the entirety of the TRCA jurisdiction (i.e. expansion to the west to cover Mimico and Etobicoke Watersheds and to the east to incorporate part of the Lynde Creek Watershed in CLOCA’s jurisdiction. This model is being referred to as the TRCA Expanded Groundwater Flow Model (TEGWFM). Once the model was expanded, the ESGRA delineation process as outlined by

Marchildon, et al (2015) (<https://oakridgeswater.ca/Journal%20Articles/Marchildon-et-al-2015-Methodology-for-ESGRAs.pdf>) was employed to delineate ESGRAs across the TRCA jurisdiction. In addition, while this work was being undertaken, the requirement outlined in the 2017 Growth Plan (MMAH, 2017) to delineate Significant Surface Water Contributing Areas (SSWCA) was also noted, and a similar particle tracking methodology was proposed for SSWCA delineation. This was also delivered as part of the exercise. TRCA staff are currently using various statistical analyses to arrive at final ESGRA delineation.

Carruthers Creek Watershed Evaluation

Similarly to the above initiative, this project was also undertaken with a goal of testing the re-purposing or deployment of numerical models in the support of activities not directly connected with source protection planning. In this case, as the Carruthers Watershed is being considered for further development and TRCA staff were interested in determining how five different development scenarios might change/impact groundwater recharge and eventual cold water discharges to Carruthers Creek and its contributing tributaries. The TEGWF model (see above) was used for this undertaking and proved to be a solid tool for exploring/testing the potential impacts on the natural flow system from differing development scenarios.

Surface Water Analyses

Through 2018 the surface water analysis package that is currently running on the program's website has been continually enhanced and refined. Different statistical analyses are available on the site and the data from Environment and Climate Change Canada's website is regularly being uploaded into the program's database. This ensures that statistical analyses and the database itself are up-to-date. Users continue to be able to select a stream gauge location and then undertake a wide variety of analyses of the data. The user is able to change the selection of the range of days for which any analysis will be undertaken and the statistics are updated dynamically as the date range is changed. Standard streamflow analyses such as baseflow separation, flow frequency analyses and trend analyses are all available on the website.

Richmond Hill Analyses

ORMGP staff have had considerable experience in the Richmond Hill area, in particular with the artesian conditions that naturally exist on the south slope of the Oak Ridges Moraine within the Town. This condition occurs as a result of the pinching out of the Oak Ridges Moraine aquifer sediments in moving from north to south as the elevation declines from the crest of the moraine. The Oak Ridges Aquifer pinches out between the overlying Halton Till and the underlying Newmarket Till. Wells or excavations that breach the upper confining Halton Till aquitard can lead to considerable groundwater problems that cost significant time and money to resolve. Through 2018, ORMGP staff have assisted Town and York Region staff to better delineate areas within the Town where proposed developments/excavations might result in 'unexpected' groundwater problems.

Miscellaneous technical support

York

- continued to assist in facilitating data migration from York database into the ORMGP Master database (import of 2018 water level, pumping and chemistry data);
- provided technical support for refinements to the York regional groundwater model;
- provided technical support on Richmond Hill flowing well and dewatering history.

Peel

- met with senior project management team to provide overview of program (March 2018);
- provided technical support in preparing Terms of Reference for Region-wide modelling;
- provided training to new co-op intern student;

Durham

- supported Region and Burnside staff to ensure migration of correct data into database;
- worked with Ross Hodgins (retired MOECC) to capture historical knowledge into the program's files;

- provided modelling support to ensure the emergency well replacement in Sunderland complied with DWSP Director's Technical Rules;
- checked Durham data within database to ensure consistency with data assembled by Region's consultant - imported and updated database through fall 2018 in preparation for future numerical modelling initiatives;
- provided technical assistance in preparing numerical update Terms of Reference and in helping with project start up with selected modeling consultants.

Toronto

- several meetings with City staff to coordinate path forward on Groundwater Strategy;
- met with, and trained four summer students on the program and on how to process consultant reports for library access through the program website;
- organized field trip for students to show geology/hydrogeology of Toronto area;
- attended a ½ day City of Toronto workshop with the development community to present website, provide on-site demonstrations of the Program's analysis system and offer access to data to assist them in making better land management decisions;

TRCA

- Supported staff by utilizing existing numerical models to delineate the ESGRAs across the TRCA jurisdiction;
- assisted with coordination of Geological Survey of Canada/University of Ottawa work to further analyse the Highway 407/Pickering BH (e.g. water sampling, geophysics, X-ray fluorescence spectrometry (pXRF), etc.);
- imported stream flow monitoring data into the database allowing all TRCA stations to have statistical analyses performed via the program website;
- provided technical modelling support to assess potential future development scenarios on the flow system within the Carruthers Watershed;
- assisted in adding new wells and importing of monitoring data into the program's database;
- presented the ORMGP website during international GIS day;
- provided technical review on TRCA's wetland modelling report;
- provided an overview of ORMGP to Environmental Assessment planners.

LSRCA

- provided technical support and advice on LID suitability project in the East Holland Watershed;
- reviewed modelling report of the East Holland Watershed;

CLOCA

- continued to provide technical support with respect to the Ontario Hydro facility in the Municipality of Clarington;

CVC

- assisted staff with a transport pathway pilot study intended to support source protection planning efforts by determining the aquifer of completion for all wells located within municipal well capture zones;
- updated the database to flag existing (or add to the database), and name appropriately, all municipal pumping wells in northerly communities of the Credit Watershed (e.g. Orangeville, Hillsburgh, Erin, etc.)
- provided cross-sections from the regional FEFLOW model;
- provided assistance with transferring the Erin-Hillsburgh numerical model;
- helped to identify all municipal pumping wells within the northern parts of the watershed;

NVCA

- provided assistance to staff in getting water level data organized and ready for import into the program database;

ORCA

- Provided assistance in developing the Terms of Reference for Norwood modelling to meet SWP requirements;

3. OTHER PROGRAM INITIATIVES

Over the course of 2018 a number of other initiatives also formed part of the overall work program.

Website – Arranged partnership agreements with consulting firms in early 2018 and maintained relationships through the year. At the end of 2018 there were seven consulting firms that had partnered with the ORMGP, and whose staff are now actively using the password protected side of the website. ORMGP staff track the number of logins to the site by each consultant partner and provide that information back to the consulting firm so they can assess the value received back to the company.

Through 2018 the partnership with GIS staff from Central Lake Ontario Conservation Authority (CLOCA) continued with a focus on enhancing the program’s mapping section of the website. Enhancements to the Geocortex mapping tool on the website continue to improve the ability of users to efficiently explore the vast data and information sets assembled under the program.

In 2018, some of the more significant updates to the website included the following:

- addition of the characterization tool allowing users to characterize an area in terms of the surficial geology and land use;
- separation of climate stations to show active stations as a separate category from historical climate stations that are no longer active;
- to better transfer knowledge of the subsurface groundwater environment, the program began to collect information on sites that had provided difficult conditions in the past (e.g. sites that had flowing conditions, sites where permanent dewatering is now taking place, sites where groundwater quality has been impacted by salting practices, etc.). These “Groundwater Knowledge/Insight Locations” provide future practitioners with a snapshot of areas that might prove to be troublesome from a groundwater perspective.

Report Library – in 2018 the City of Toronto hired four summer students to assist in moving reports into the program database. As in previous years, in 2018 a student was retained for part of the summer to further assist in getting other miscellaneous reports and boreholes into the database. Additional work will be required to extract key borehole and water level data from these boreholes.

Also in 2018 we met with Hunter GIS staff and have arranged to acquire, for incorporation into the program library, a number of consultant reports that the company has assembled over the past several decades. This partnership should prove to be of significance given the large number of reports involved.

Field Work – Staff continue to monitor a suite of approximately 40 wells to help in characterizing specific hydrogeological settings that have been identified across the study area.

Ontario Climate Advisory Committee – as part of the task of considering the future use and updating of the available groundwater flow models across the program study area, staff continued to attend and contribute to this working group that advocates for best management practices in terms of collecting, managing and distributing climate information in Ontario.

Standards Council of Canada – Being recognized as leaders in environmental data management, the ORMGP was invited to attend the SCC’s committee for climate data standards for managing climate information across Canada.

Communications/Analyses

In 2018 ORMGP staff were invited to present or meet with various external agencies on behalf of the partner agencies.

- In January, presented to senior Ministry of the Environment staff from a wide number of divisions (e.g. Source Protection, GIS, Policy, Monitoring, etc.) on the program and the website that has been assembled to provide ready access to the public as well as to partner agencies;
- Chaired panel discussion on the Future of Source Water Protection Modelling at the annual Ontario Geological Survey (OGS)/Geological Survey of Canada (GSC)/Conservation Authority Open House held in February in Guelph, Ontario;
- Presented a website overview to the Conservation Authority Collaborative Information Sessions (CACIS) conference in May in Orillia, Ontario;
- Presented the ORMGP’s numerical model management and custodianship program to the Ontario Water Works Association (OWWA) Source Protection Workshop in February;
- Presented a paper “Groundwater reporting and management – an example from Ontario Canada” at the Resources for Future Generations Conference held in June in Vancouver, British Columbia;
- Continued to provide technical expertise and peer review to the Town of Richmond Hill regarding development proposals in sensitive area of artesian pressures on the flank of the Oak Ridges Moraine;
- In order to attract consulting partnerships to the program staff made presentations during 2018 at the following consulting companies: Cole Engineering, Burnside Environmental, exp, Azimuth Environmental, SLR Consulting, Groundwater Environmental Management Services (GEMS), Golder Associates, and Greenland International – most of these became Program partners or were already partners when the presentations were held;
- Staff were invited to attend and present at an International Joint Committee (IJC) meeting in Anne Arbour Michigan on “Great Lakes Surface and Ground Water Model Integration Review”
- Staff were invited to present ESGRA and SSWCA methodology to the Southern Ontario Stream Monitoring & Research Team (SOSMART) in November;
- Interactive day with Grade 4 students discussing water and geology (Pleasantville Public School, Richmond Hill);
- Provided a webinar overview of the program website to the Michigan Department of Natural Resources;
- Presented a Program update to the Greater Golden Horseshoe Conservation Authorities;
 - Presented an overview of the program website to the Greenbelt Foundation.

4. BUDGET SUMMARY

The four senior partners (City of Toronto, Regional Municipalities of York, Peel and Durham) each contributed \$175,000 in 2018 (Total of \$700,000). In addition, work undertaken in collaboration with SWP, resulted in some additional technical work (website development and model harmonization) being contributed to the program. The program’s base expenses for the 2018 are summarized below; 2017 costs, as well as estimated 2019 base costs are also provided.

Program Component	2017	2018	2019 (est.)
Staff Costs (Wages + Benefits)	\$659,200	\$659,500	\$675,000
Office + Disbursements	\$61,500	\$52,300	\$55,000
Computer + Software	\$16,600	\$35,500	\$35,000
Consultant/Services	\$28,400	\$21,200	\$25,000
Administration	\$12,900	\$16,500	\$15,000
Total	809,000	\$785,000	\$805,000

The program was completed within an acceptable budget in 2018. With the additional funds obtained through the consultant revenues for website access, and with carryover amounts from previous source protection related work, there is accommodation within the program budget to cover the excess expenditures over revenues for 2018 and 2019. Therefore no budget increase has been requested for 2019. This will be reviewed for 2020.

2019 WORK PLAN – ONGOING/UPCOMING TASKS

1. DATABASE RELATED

Task 1.1 – Report Library Capture

In 2019 program staff will be working with Hunter GIS staff to input additional reports into the library. The reports cover a broad geographic range and will help to infill many areas where no previous work has yet been made available.

- **Benefits:** Improved access to subsurface information across program area.
- **Estimated Timeline:** Ongoing through 2019.

Task 1.2 – Fostering and Enhancement of Consultant Partnerships

Over the course of 2019 staff will continue to monitor external partner agency use of the program website and encourage further use of the site. Tracking of consultant use has shown disparity in the utilization of the website by different consultants. Staff will be investigating means of increasing traffic to the website and encouraging existing users to provide feedback, especially should they find erroneous data. Staff will also be encouraging other companies to join the partnership.

- **Benefits:** This task will help to ensure that consultant partners are engaged in the program in a meaningful way, allowing them to contribute to make the information and data sets more useful and accurate in going forward to improve water-related decision making.
- **Estimated Timeline:** Ongoing through 2019.

Task 1.3 – Knowledge Management Capture

In 2018 a new Location Type “Groundwater Knowledge/Insight” was added to the database with the goal of transferring key groundwater knowledge from the past to current and future groundwater practitioners. In 2019 work will continue in this regard as more stories/lessons are captured and added to the website. The intent of these new locations is to capture stories/information that might have significant bearing on future groundwater practitioners (e.g., flowing conditions, buried valleys, areas of poor water quality, etc.).

- **Benefits:** This exercise builds on the types of data and knowledge capture activities that are already undertaken through the program. To date, the type of information collated into these locations is either not found in any of the ORMGP library reports, or the information is not readily apparent without detailed reading and review of many specific reports. Having a mapped layer of such ‘cautionary locales’ where a synthesized story is readily available via the ORMGP website benefits the overall understanding of water resources across the study area.
- **Estimated Timeline:** Ongoing through 2019.

Task 1.4 – Updated Version of Database

In 2019 staff are working on an updated database release, which, along with other smaller changes/updates, includes two significant changes in how specific tasks are accomplished within the database. Several years ago, in order to better keep track of how X/Y coordinates and elevations were changing over time within the database, staff added two tables to the database (D_Location_Elev_History and D_Location_Coord_History) to better track how locations might be corrected/updated through time. Because these changes were tracked independently staff were finding it difficult at times to determine whether a particular elevation change was linked to a coordinate update or to a new survey of the location for example. This was important in determining whether all of the elevation data tied to a particular location (i.e., geological layers and picks elevations, water level measurement and water found elevations, etc.) was indeed processed and correct. In 2019 it is proposed that these two “History” tables will be brought together so that database users will know specifically for each location the coordinate and elevation changes that have taken place over time. At the same time staff will be

examining the storage of elevation data within the database itself. It might prove more reliable to simply store all database records in units of depth and then undertake conversions to elevation only when data is processed for export to the website etc. This task has to be coordinated with key software that staff are using including Sitefx and Viewlog.

- **Benefits:** This task will provide for improved management of coordinate and elevation changes within the database as well as improved management of elevation related data within the database.
- **Estimated Timeline:** Fall 2019.

Task 1.5 - Improved migration of consultant data into the database

In 2018 staff made progress on this front by: i) providing a form for clients of our partner consultant firms to sign that would allow the consulting firm to provide project specific data, information, and/or reports back to the program; and ii) by providing data entry templates/forms (for BHs, water levels, water quality, etc.) to partner agencies so that they can include them in Terms of Reference documents for subsurface and or groundwater investigations. In 2019 staff will work more closely with partner agencies to ensure greater adoption of these forms into Terms of Reference and contract documents that will explicitly require the use of ORMGP templates as a requirement of winning any particular groundwater related project. Staff will also work to ensure that successful consultants are aware that reports submitted back to partner agencies will be uploaded into the program library.

- **Benefits:** It would be beneficial to all agencies if consultants could readily transfer collected information directly via standard templates that would facilitate importing of data into the database.
- **Estimated Timeline:** Ongoing through 2019.

Task 1.5 - Continued improvement and expansion to the database

The database is now about 70 gigabytes in size and continues to grow as new information is appended. Up-to-date climate and streamflow data are regularly acquired from Environment and Climate Change Canada and input to the database. Providing updates are made available from the Province (there have been no provincial updates available for release since several months prior to last year's Provincial election), both the WWIS and PTTW will be updated in 2019. Data from various partner agencies will continue to be imported into the database.

- **Benefits:** Improved data quality and additional data input to the database will enhance any work undertaken in the ORMGP area, whether it is in support of development, construction activities, or other.
- **Estimated Timeline:** Ongoing through 2019.

2. WEBSITE, ANALYSIS & NUMERICAL MODEL RELATED

Key initiatives planned for 2019 relate to communication and outreach and will focus on continued enhancement of the program's website to deliver data, information and knowledge in an easily accessible manner. Over 2019, the goal for the website is to build upon earlier successes by offering newer and better ways to access, view and analyze data, all to benefit partner agency staff. Staff will continue to explore additional statistical options that SQL 2016 presents in terms of its linkage with the "R" statistical software package (additional charts, graphs, etc.). The technical content currently available on the website will be enhanced by providing additional insight pieces that succinctly summarize different hydrogeological analyses that have made effective use of the vast store of data in the database. A prominent goal of the program's website continues to be to reduce the need for extensive knowledge regarding how to use various individual specialized software packages (e.g. Sitefx, GIS, SQL Management Studio).

Task 2.1 - Model Harmonization

With some 70 numerical models having been generated across the geographical study area of the program, staff continue to work towards a single “authoritative” geological framework across the study area by incorporating insights from these models. The work involves incorporating new well/geological data as well as examining the interpretations from existing numerical models to re-build a revised geological framework. The work will also take advantage of the ongoing numerical modelling in Durham and Peel where the geological layering is being refined/adjusted as part of the model update projects.

- **Benefits:** This task will consolidate the many numerical model geological frameworks as well as new data into an “authoritative” set of surfaces that will extend across the entirety of the Oak Ridges Moraine study area. For each agency, this will continue to prove to be a significant benefit in that they can confidently provide a set of information and interpretive layers to any ongoing capital works project that involves subsurface excavation or tunneling. When provided to consultants, the set of layers allows for all parties (including staff and consultants working in adjacent agencies) to speak with a common language when referring to the subsurface stratigraphy.
- **Estimated Timeline:** Ongoing through 2019

Task 2.2 - Mapping of Known Groundwater Problem Areas

In 2018 the mapping of areas with upward hydraulic gradients and artesian conditions were mapped across the Town of Richmond Hill. In 2019 it is proposed that this mapping be extended to cover a broader area. There has been an indication from partner agencies that this kind of mapping would be beneficial within Peel Region and staff will be looking to expand the current mapping towards the west. It should be noted that there was a significant amount of data and expertise within Richmond Hill which facilitated the mapping. Even though a wealth of information exists within the program information and analysis system, the mapping might prove less accurate in other areas. Regardless, such mapping will still prove beneficial in delineating areas where concerning subsurface conditions might be expected. These can then be factored into consideration for construction/infrastructure projects.

- **Benefits:** By having an understanding of subsurface conditions prior to project commencement, partner agency staff (both consultants and government) can provide preliminary knowledge regarding overall project cost and necessary efforts. Such regional maps can provide a screening tool prior to the detailed work necessary for project design.
- **Estimated Timeline:** Summer 2019.

Task 2.3 – Investigation into Online Model Executables

There has been an interest in ensuring that the numerical models developed over recent years are made available for more widespread use than is currently the case. A possible solution is to develop on-line executables (e.g., input pumping rate, location, and aquifer – model run would return drawdown at a municipal well; run particle tracking routines, etc.) that would allow for non-modelers to gain insights from models for various water management decision-making and quickly assess potential impacts to their water supply.

- **Benefits:** Such tools would allow for technical staff from partner agencies to gain insights from already constructed models thus extending the benefit of the models into the future.
- **Estimated Timeline:** Initial application/tool – fall 2019.

Task 2.4 –Website Metadata

As more practitioners from consultants and partner agencies visit and make use of the website, there is a need to provide additional information as to how specific maps, datasets, layers, analyses tools have been developed. In 2018 staff began to collate metadata regarding specific components of the website. This will continue in 2019 with the goal of having metadata descriptions for all parts of the website by year end.

- **Benefits:** having metadata available on the website will allow users to see how specific maps, analyses, etc. that are available on the website were created. This will provide additional confidence and support to website users such that they are more reliant on using the website's products.
- **Estimated Timeline:** Winter 2019

Task 2.5 – Ongoing Website Improvement

In addition to the mapping section of the website, there is a considerable amount of scientific and background information available over several dozen web pages. This information is not often made use of by visitors to the website. Over the course of 2019 the website will be modernized to take advantage of newer web formats (e.g. story books, better graphics, newer templates, etc.).

- **Benefits:** Fresher modern look to website that will attract users to view and learn more about the ORMGP and its products.
- **Estimated Timeline:** Changes to start in summer 2019.

Task 2.6 – Website Database Access

In order to make more effective use of the program's database, staff will continue to explore ways to provide users with more direct access to the database, and in particular the "Views" since they succinctly synthesize much of the information within the database. It is proposed that access be provided through a searchable mapping interface as well as through direct tables.

- **Benefits:** having on-line access to the database will allow practitioners from partner agencies to show and search for information while at meetings away from the office. This capability will allow outside agencies (e.g. consultants, environmental groups, provincial agencies, etc.) to gain an understanding as to the comprehensive nature and magnitude of the database and foster an appreciation as to how it can change work patterns at many agencies across the study area.
- **Estimated Timeline:** Summer 2019.

Task 2.7 – Enhanced/New Mapping Tools

As the website is used by staff from various public and private sector agencies, we will be seeking input and ideas for improving upon the maps and tools currently available on the website. Through 2019 staff will be working to develop a number of additional tools including the following:

- **Updated Water Budget Tool**
The website currently holds a water budget tool that allows for users to select an area of interest and run a water budget analysis. Over 2019 work will be ongoing to update and refine the water budget tool. The most significant change will be the conveyance to the user of the uncertainty involved in the main water budget components (recharge, Runoff, ET, precipitation). The water budget model will be run 100s of times with slightly modified input parameters to derive a suite of ensemble model results that will reflect all reasonable model runs. At each cell, when the user clicks on the cell they will be able to see, (for that cell) a monthly-average bar graph displaying the maximum and minimum of expected model results (e.g. recharge). Gaining an appreciation for the uncertainty associated with the water budget components will allow practitioners to reflect more reasonable estimates when providing water budget numbers and will give model reviewers an acceptable range of water budget components when reviewing development proposals.
- **"Clip and Ship" or File Export Tool**
Staff will work to develop a tool that will allow users to clip layers and data from the website into an exportable package that can then be used external from the ORMGP website. The exported layers could be used for a number of purposes, for example to create cross-sections or to build localized numerical models.

- **Piper Plots**
To make the water quality samples more usable to website visitors, staff will explore the incorporation of water chemistry plotting methods (e.g. time-series, piper plots) as a web-based features for ORMGP website users.
- **Drainage delineation Tool**
Work will be undertaken in 2019 to develop a tool that will allow users to select a point on the map and have the drainage area to that point be delineated on the map. Such a tool would be linked to the water budget tool. In addition, the characterization tool would also be linked such that these drainage areas could be readily characterized in terms land use and soils.
- **BH Log Generation Tool**
Although this tool is already built and on the website, it can be improved by adding features like the water table and also by making the header at the top of the record more aesthetically pleasing.
- **Additional Shiny Server “R” analyses**
Work will continue on statistical analyses of different temporal datasets including pumping data, groundwater temperature data, long term water levels (including water levels at pumping wells), and select water quality parameters. This will provide additional data analyses summaries to assist in characterizing water resources within the study area.

Benefits: all actions directed to the website will be focused on providing smarter and easier ways to explore the data within the database, thereby reducing the time needed to acquire data for decision making.

Estimated Timeline: Ongoing through 2019.

3. OTHER

Task 3.1 – Renewal of Memorandum of Understanding (MOU)

The program’s current MOU expires in 2020. There have been a number of enhancements/changes to the program in recent years (specifically the program’s website mapping portal and the established partnerships with consulting firms), that should be captured and reflected in the renewed MOU for the program. Partner agencies have also moved forward in many ways, in particular with the concept of ‘open data’. ORMGP staff will initiate a draft document with which to move forward and then strike a committee to assist in moving the MOU forward to reflect the current program. Signatures from all partner agencies will be sought in late 2019/early 2020.

- **Benefits:** The program will benefit from the structure and administrative understanding that will come through an agreement between the partner organizations within the ORMGP.
- **Timeline:** Fall/Winter 2019