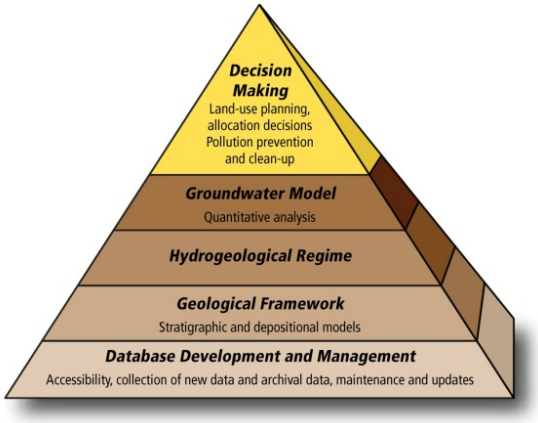
Credit Valley Conservation
Nottawasaga Valley Conservation
Toronto and Region Conservation
Lake Simcoe Region Conservation
Central Lake Ontario Conservation
Kawartha Conservation
Ganaraska Region Conservation
Otonabee Conservation
Lower Trent Conservation

ANNUAL PROGRAM OVERVIEW (2019)
&
WORK PLAN (2020)

TO: YPDT Executive Steering Team
FROM: Steve Holysh & Rick Gerber
DATE: March 31, 2020
RE: 2019 Overview/2020 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.



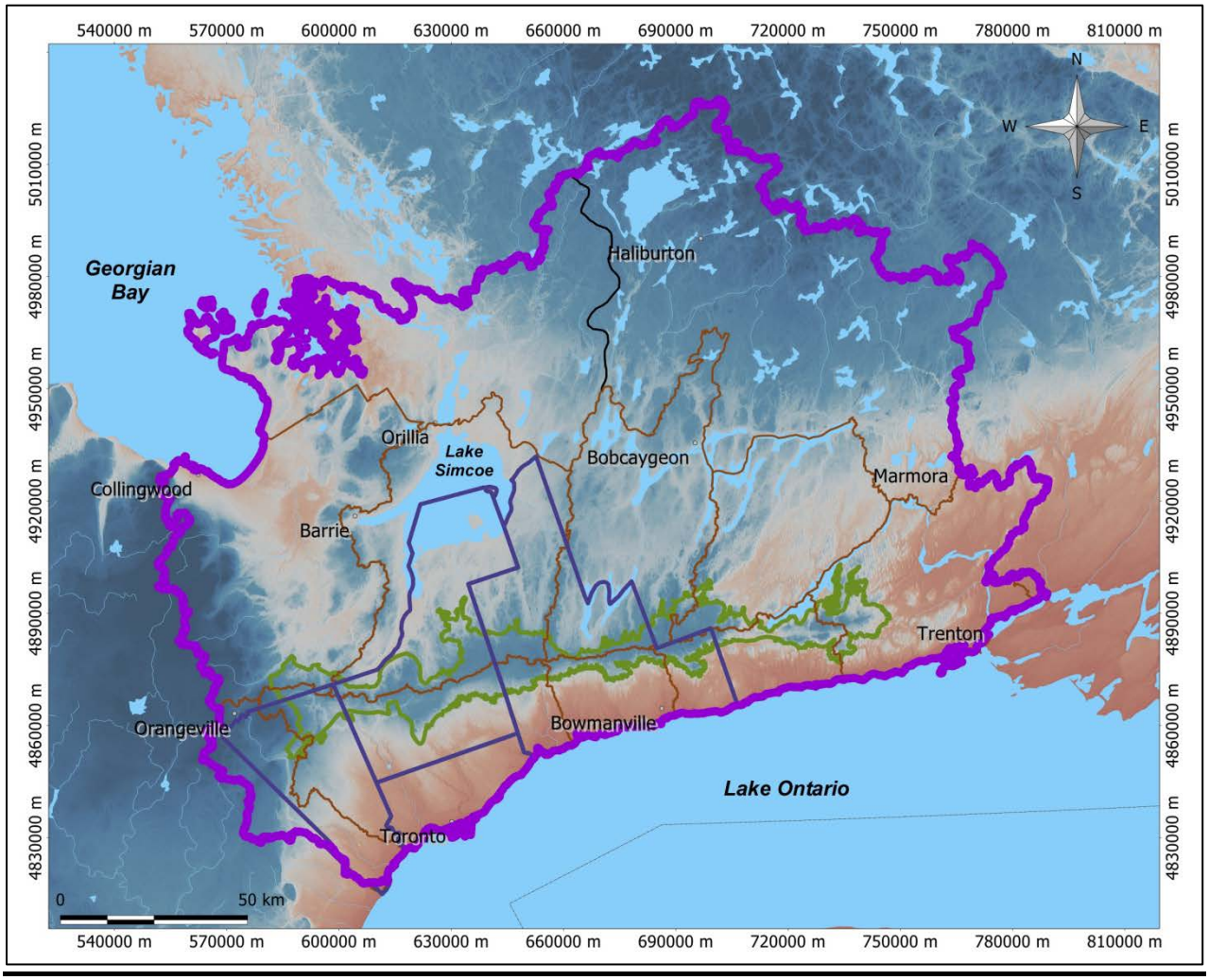
Mandate

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, maintain and disseminate 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.

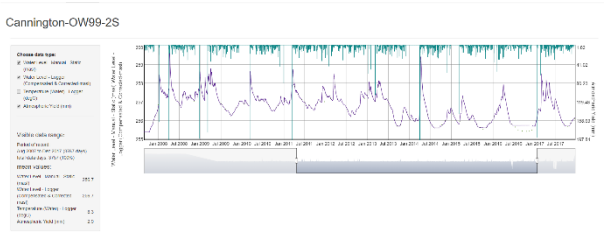


Program area - Note that for data management purposes the program area comprises the entirety of three Source Water Protection (SWP) Regions: 1) Credit Valley/Toronto and Region/Central Lake Ontario (CTC); 2) South Georgian Bay - Lake Simcoe (SGBLS); and 3) Trent Conservation Coalition (TCC). Focus of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

Review – 2019 Highlights

1. Database

- added this year – 10,200 boreholes; 1,100 reports; 20 million temporal records;
- 2019 logins to website: Consultants = 2,957; Agency Staff = 3,737; Public = 2,197;
- development of statistics/graphs to investigate GW level behaviour;
- addition of "Groundwater Knowledge/Insight" locations to database and website;
- incorporation of TRCA streamflow stations/data onto website;

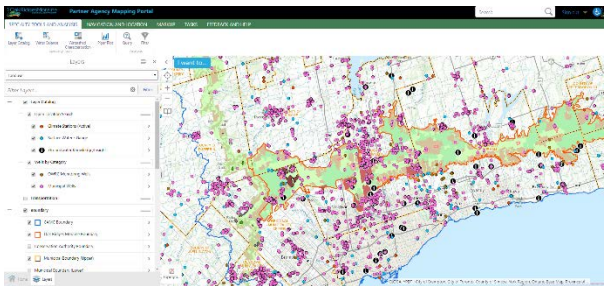


2. Analysis & Modelling

- initiated and or finalized mapping of potential problematic groundwater areas in Aurora, Toronto, north Peel, Richmond Hill;
- continued work on harmonizing geology and long-term groundwater recharge estimates across ORMGP area;
- in cooperation with GSC, two open file reports on sediment geochemistry released;
- four numerical model consultant sharing agreements;
- assist LSRCA with mapping process for optimizing LIDs placement;
- technical insights and contributions to modelling studies for Durham, Peel and CVC;

3. Other

- enhancements to mapping section of website (oakridgeswater.ca); established collaborative partnerships with 7 new consultant firms (14 in total); meetings with Halton Region re joining program;



- contribution to City of Toronto GW strategy;
- technical collaboration with various agencies including MECP; GSC; OGS; Hydro One; Richmond Hill; Federal Commissioner of Sustainable Development, Canadian Standards Association.
- Communications – invited to speak at various forums including: PGO – Webinar; CTC committee, special session at Latornell Conference, GSC/OGS Open House, U. of T, GAC-MAC-IAH Conference, Institute of Civil Engineers.

4. Budget

- Program delivered within available funds - no planned increase for 2020;

Program Component	2019
Staff Costs (Wages + Benefits)	$684,000
Office Costs + Disbursements	$52,000
Computer + Software	$53,500
Consultant/Services	$33,500
Administration	$14,800
Total	**$837,800**

Review – 2019 (Detailed Summary)

The following provides a more detailed overview of activities undertaken through the Oak Ridges Moraine Groundwater Program through 2019.

1. DATABASE/WEBSITE

Through 2019 the program's database structure/schema remained robust. The information contained within the database was refined and improved through 2019 with continued use of SQL 2016 to facilitate database management. As in previous years, the discussion of database and website issues has been broken into four categories: Additions; Corrections; Accessibility and Software/Hardware Management.

1a Additions

- An updated WWIS database was obtained in spring 2019 from the MECP and about 12,300 new well records (including decommissioning records and well upgrades) were brought into the database – the MECP well records are up-to-date as of September 2018;
- New boreholes: i) compiled by City of Barrie staff; ii) tied to projects in York Region were entered or imported into the database. In addition to the MECP wells, approximately 750 additional wells/boreholes were added in 2019;
- Approximately 1,100 new documents were brought into the library from Peel Region, Hunter GIS and from the City of Toronto;
- Streamflow data from the TRCA gauge stations was added to the database – as a result, all of the streamflow statistics were automatically calculated for these new stations and made available via the website;
- new "Views" (queries on the database) created as needed to facilitate access to, and presentation of, specific combinations of database components onto the website;
- Miscellaneous well and associated data from consulting reports were brought into the database; and
- In total approximately 20 million temporal records (chemistry, water levels, stream flow, etc.) were added in 2019 – 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 moving forward with a review and update of the geological surfaces program staff continued to review and correct MECP wells with respect to: i) discrepancy between metric and imperial units and ii) poor geological interpretations; and iii) incorrect locations. Most of the unit issues have been corrected, however it is expected that future wells with more subtle unit issues will reveal themselves as they are inspected.

1c Accessibility

- 269 new accounts were created in 2019: 1) 160 for consultant partners bringing total to 264 consultant user accounts; and 2) 109 for partner agency staff bringing total to 340 technical staff user accounts;
- The program's website was re-launched in 2019 with a new look (ORMGP vs YPDT – CAMC) using new design software that will facilitate updates into the future;
- 2019 saw the introduction of non-MECP (MOE) BH logs in .PDF format to the website (Boreholes Map – choose "Boreholes with Supplementary Log") – this allows for consultant logs and other older logs from GSC or OGS staff to be readily accessed on the website. In 2019 over 500 BH logs have been uploaded to the database/website;

- ORMGP staff continue to build upon the R statistical package by improving upon the high quality statistical analyses of streamflow level information via the program's website;
- Statistical and trend analyses of the long term climate data were added to the program's website using R related procedures;
- Piper Plots were made available on the website in 2019 to allow for analysis of water chemistry data; views were created in the database to assist with the generation of Piper Plot analyses (i.e. to look at ion charge balances, to extract and format the major cations and anions);
- Based on the ion distribution, in 2019 all of the ground water chemistry samples were classified into one of four different water types – this is shown on the water quality map on the website;
- The website Report Library/Document interface has been updated, and behind the scenes the process of managing and uploading documents to the website has been adjusted to make the process more efficient;
- 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 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; and
- In 2019 there was a successful upgrade to the Citrix environment however the basic format and structure of the system remained largely unchanged. The system is largely performing up to expectations although staff continue to work out problems with the occasional user disconnection. Via the internet, the database and several related software programs can be utilized for viewing and interacting with the master database. Staff 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.

2019 saw three significant equipment purchases:

1. a Dell EMC SCv300 network storage device (which was cost shared with CLOCA to help with storage of various numerical models and runs, database backups, etc.);
2. a Dell Poweredge T640 Server which has enabled improved load balancing for the virtual machines that provide web page services, GIS, Geocortex mapping services, database hosting, remote desktop machines, etc.; and
3. a new Dell Precision 7530 laptop.

In 2019, the following tasks continue to be undertaken with respect to the program's software and hardware management:

- database management workflows that were reconfigured to work within Citrix platform in 2017 have continued to be used through the 2019 calendar year. As in the past, the backing up of the database continues to be a focus of the program and was unchanged in 2019:
    - 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;
- 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 2019 (more often if needed/requested).

2. ANALYSIS & MODELLING

The following initiatives were undertaken through 2019.

Technical Model Contributions
Through 2019, 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, Raven, and CSHS HydRology).

Durham Region Numerical Model
With the selection of a preferred consultant, in 2019 staff worked with Durham Region staff to attend meetings and to review key inputs to the numerical model, in particular the refined geological surfaces. ORMGP staff communicated regularly as required with the technical consultant and with Durham staff to ensure that the modelling was proceeding as per the submitted proposal.

Peel Region Numerical Model
Peel Region also embarked on a renewed modelling initiative in 2019. ORMGP staff continue to assist Peel Region staff in communicating insights to the technical consultant selected for the modelling. Although the project has been delayed due to difficulties with the consulting team, the study is still on track to provide a significant update to the overall understanding of Peel Region's groundwater and surface water resources.

Model Subcommittee
The modelling subcommittee convened in 2019 to exchange ideas and techniques for enhancing numerical model use across the program study area. A central theme of the 2019 meeting was on water budgets with some focus on recharge and infiltration.

Hydraulic Conductivity and Transmissivity
In 2019 work was ongoing to implement a database routine that determines the transmissivity and hydraulic conductivity of aquifers. The routine makes use of the interpreted screened aquifer unit, based on the ORMGP geological model(s), coupled with the short term pumping data obtained from the MECP/MOE water well records and the geological models. Using an iterative routine, the K and T are calculated. Once completed, this information will be made available on the website.

Groundwater Knowledge/Insight Locations
Continued work with Ross Hodgins (retired MOECC) to capture historical knowledge into the program's files.

Surface Water Analyses

As in the past, through 2019 the surface water analysis package that is currently running on the program's website has been continually enhanced and refined, based on the recommendations and needs of partner agencies. Stream flow data from Environment and Climate Change Canada's website is regularly being uploaded into the program's database and various statistical analyses have been added to the website. As new data is regularly added, the statistical analyses are automatically updated. Users continue to be able to select a stream gauge location and then undertake a wide variety of analyses of the data (e.g. baseflow analysis, flow frequency, trend analyses, cumulative discharge, etc.). 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.

Geological Layer Harmonization

2019 saw advancement in the harmonization of geological layering across the study area. In addition to assisting with the reworking of the geological layers in Peel and Durham through their modelling initiatives, ORMGP staff also began to examine and make new picks at recently added wells. Geological work/picks were focused across parts of Toronto and on the bedrock surface. Some focused examination of the York Tier 3 geological layering was also undertaken.

Regional Groundwater Recharge Estimation

In conjunction with the geological harmonization, significant improvements to the methodology for interpolating, at a fine resolution, the ORMGP data into a contiguous long-term average recharge estimate were undertaken. 2020 will see the introduction of these estimates to the water balance themed Geocortex map on the web site.

Climate Data

In 2019 a series of climate statistics and trend graphs were added to the program's website. Users can now look to the website to see a variety of climate related graphs and statistics (i.e. seasonal trends, monthly trends, return period, standardized indices, etc.). As an example of the practicality of this, visitors to the website can now quickly determine whether the previous month was either hotter/colder or wetter/drier than the long term average.

Richmond Hill, Aurora, Peel, Toronto "Areas of Concern" Mapping/Analyses

ORMGP staff have had considerable experience in the Richmond Hill area, and in particular with the artesian conditions that naturally exist on the south slope of the Oak Ridges Moraine within the Town. In 2019, this knowledge was again used by town officials in reviewing development applications. 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 breech the upper confining Halton Till aquitard can lead to considerable groundwater problems that cost significant time and money to resolve. Through 2019, ORMGP staff have moved beyond Richmond Hill, to Aurora, Toronto and parts of Peel Region, and using the same principles, have prepared final or draft mapping that shows areas where proposed developments/excavations might result in 'unexpected' groundwater problems (and associated costs).

Miscellaneous technical support

York

- Assisted with review of cored borehole logs from Richmond Hill and Mount Albert;
- provided technical support on Richmond Hill flowing well and dewatering history to finalize "Areas of Concern Mapping";
- technical and modelling support for work being undertaken in Nobleton;
- worked with York staff to prepare "Areas of Concern" mapping for Town of Aurora.

Peel

- assisted with preparation of geological cross-sections;

- provided overview/tour of website to nearly 200 Peel Region staff at three “Lunch and Learn” sessions (summer 2019);
- provided technical support in meetings for Region-wide modelling initiative;
- met with planning staff (November 2019) to discuss Mayfield area planning and to show website and how Peel staff could integrate components of website into planning work flows;
- initiated work to investigate “Areas of Concern” mapping for south part of Town of Caledon;

. **Durham**

- supported Region and Burnside staff to ensure migration of data into database;
- provided ORMGP website overview to senior Durham Region management team;
- met with Durham staff and technical modelling consultant team to provide technical input to the regional modelling initiative.

Toronto

- attended meetings to provide continued input on Groundwater Strategy – presentation at Workshop #2 on water tight building designs;
- trained summer students on the program and on how to process consultant reports for library access through the program website;
- meetings with City staff from Toronto Water and Planning to show website and potential use for ongoing work;
- organized field trip for student and staff to show geology/hydrogeology of Toronto area;
- reviewed and provided technical direction on City guidance document for undertaking Hydrological Reviews.

TRCA

- imported stream flow monitoring data into the database allowing all TRCA stations to have statistical analyses performed via the program website;
- presentation of ORMGP database/website to IT and Restoration Services staff;
- provided technical review on TRCA’s methodology for ESGRA Mapping;
- provided technical support regarding the potential development of an Aquifer Thermal Energy Storage (ATES) geothermal system at new office building;
- following 2018 interpretation of the regional groundwater flow model results to produce the raw data points to prepare ESGRAs, in 2019 ORMGP staff assisted in developing and reviewing the documentation of processing of the raw data to delineate the final ESGRAs needed for their watershed planning;
- Worked with TRCA staff to install a climate and groundwater monitoring station in Pickering (Hwy 407 & Lakeridge Road area).

LSRCA

- provided technical support and cross-sections for East Holland Watershed LID suitability project;
- provided technical support on WHPA delineation;

CLOCA

- presentation on ORMGP to Conservation Authority Board;
- continued to provide technical support with respect to the Ontario Hydro facility (i.e. establishment and operation of long-term groundwater monitoring location) in the Municipality of Clarington;

CVC

- technical support provided for MIKE SHE modelling being undertaken in cooperation with University of Guelph
- presentation of website to senior watershed science staff;

NVCA

- presentation on ORMGP to Conservation Authority Board
- provided ongoing assistance/training to staff in getting water level data organized and ready for import into the program database;

Barrie

- Provided technical input to Terms of Reference document to address City staff concerns with proposed new buildings with deep foundations or parking garages which might breach aquifers and alter water quality and/or quantity moving to municipal supply wells;

MECP

- worked with MECP staff and their consultants on a report that investigated ways to update and improve the Water Well Information System database.

Commissioner of Environment and Sustainable Development (Auditor General of Canada)

- met with group to provide input on how federal government is undertaking work on freshwater resources and how work can be improved.

3. OTHER PROGRAM INITIATIVES

Over the course of 2019 a number of other initiatives also formed part of the overall work program.

Website – Partnership agreements with consulting firms were initiated in early 2018 and were maintained throughout 2019. At the end of 2019 there were fourteen consulting firms that had partnered with the ORMGP 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 by the company.

Through 2019 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 2019, some of the more significant updates to the website included the following:

- addition of a "Land Use" themed map that contained land use designations for the Greenbelt, the Oak Ridges Conservation Plan and the Niagara Escarpment Plan. ANSI's and WHPAs were also uploaded to the website – this was owing to requests for this type on information from consulting firms that are using the site;
- as mentioned above, BH logs from non-MECP/MOE wells were added to the website;
- continued addition of Groundwater Knowledge/Insight locations;

Memorandum of Understanding (MOU) – in 2019 work began on the renewal of the ORMGP MOU. The current 10-year MOU expires at the end of 2020. The MOU provides the overarching agreement and commitment between all 13 partner agencies to the program. Draft MOU documents were circulated for review to the partner agencies.

Report Library – in 2019 the City of Toronto hired two summer students to assist in moving reports into the program database. As in previous years, in 2019 the ORMGP retained a summer student to further assist in getting other miscellaneous reports and boreholes into the database. 2019 also saw continued co-operation with Hunter GIS staff to acquire, for incorporation into the program library, a number of consultant reports that the company has assembled over the years. This partnership is proving fruitful as many older unique reports are being 'rescued' and made available via the library.

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, in 2019 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, ORMGP staff were invited to serve on the SCC's committee for climate data standards for managing climate information across Canada. This continued through 2019.

Communications/Analyses
In 2019 ORMGP staff were invited to present or meet with various external agencies on behalf of the partner agencies.

- Assisted with the organization, contributed a talk and coordinated a panel discussion at the annual Ontario Geological Survey (OGS)/Geological Survey of Canada (GSC)/Conservation Authority Open House held in February in Guelph, Ontario;
- Presented two papers to the annual International Association of Hydrogeologists conference in Quebec City: i) Better Water Management Related Decisions; and ii) Hydrogeology of Channel Systems in Early to mid Wisconsinan Sediments, South Central Ontario;
- Provided a PGO webinar for professional Ontario geoscientists;
- Put forward, organized and contributed presentations to a ½ day session on the ORMGP at the 2019 Latornell Conference in Alliston;
- Provided 'Lunch and Learn' or similar talks at the following locations to promote increased use of the ORMGP website: Terraprobe; ORCA, KRCA, GRCA, LTRCA, NVCA, CLOCA, TRCA, CVC, Peel Region (3 sessions);
- Invited to present to the Institute of Civil Engineers;
- Invited by Severn Sound Environmental Association to present at the Annual General Meeting of the Horseshoe Valley residents association;
- Invited to provide university lectures at University of Toronto (4th Year and Graduate courses in hydrogeology/water management) and at University of Guelph (3rd year Engineering GIS course);
- Met with Halton Region staff to present the ORMGP program – presentation and discussions led to the Region giving consideration to joining the program; and
- Presented at the City of Toronto Groundwater Management Strategy workshop #2 on Water Tight Foundation.

4. BUDGET SUMMARY

The four senior partners (City of Toronto, Regional Municipalities of York, Peel and Durham) each contributed $175,000 in 2019 (Total of $700,000). In addition, the program received $69,000 from consultant subscriptions to the program. The program's base expenses for the 2019 are summarized below; 2018 costs, as well as estimated 2020 costs are also provided. Note that Staff Costs incorporate CLOCA staff allocation to assist with website.

Program Component	**2018**	**2019**	**2020 (est.)**
Staff Costs (Wages + Benefits)	$659,500	$684,000	$690,000
Office + Disbursements	$52,300	$52,000	$55,000
Computer + Software	$35,500	$53,500	$32,000
Consultant/Services	$21,200	$33,500	$30,000
Administration	$16,500	$14,800	$15,000
Total	**$785,000**	**$837,800**	**$832,000**

The program was completed within an acceptable budget in 2019. As was the case for the past two years, carryover amounts from previous Source Water Protection related work will provide accommodation within the program budget to cover the excess expenditures over revenues for 2020. Therefore, no budget increase has been requested for 2020. A budget increase is being proposed for 2021.

2020 WORK PLAN – ONGOING/UPCOMING TASKS

1. DATABASE RELATED

Task 1.1 – Report Library Capture

In 2020 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. Staff will also be assisting City of Toronto students with the processing of any City of Toronto reports. Data capture from these documents into the database will also continue.

- **Benefits:** Improved access to and availability of subsurface information across program area.
- **Estimated Timeline:** Ongoing through 2020.

Task 1.2 – Fostering and Enhancement of Consultant Partnerships

Over the course of 2020 staff will continue to monitor external partner agency use of the program website and encourage further use of the site. Tracking of consultant use continues to show disparity in the utilization of the website by different consultants. In 2020 staff will continue to put forward means of increasing traffic to the website and encouraging existing users to provide feedback. A training/educational one-day workshop is planned for the late spring 2020. Staff will continue to encourage other companies to join the partnership.

- **Benefits:** This task, especially the one-day training/education workshop, will help to ensure that consultant partners are engaged in the program in a meaningful way, allowing them to maximize their use of the website and to contribute to the program.
- **Estimated Timeline:** Ongoing through 2020.

Task 1.3 – Knowledge Management Capture

2020 will see the continued input of new "Groundwater Knowledge/Insight" locations (through discussions with consultants and agency technical staff) to document more water stories/lessons (e.g. flowing conditions, buried valleys, areas of poor water quality, etc.) and add them to the database and website. These locations are an important way of transferring key groundwater knowledge from the past to current and future groundwater practitioners.

- **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 and improves management of water resources across the study area.
- **Estimated Timeline:** Ongoing through 2020.

Task 1.4 – Updated Version of Database

In 2019 staff began work on a database update that would, amongst other tasks, include a joining of two "Location Tracking" tables in the database (D_Location_Elev_History and D_Location_Coord_History) to better track how locations might be corrected/updated through time. This task is still ongoing in 2020.

- **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 2020.

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 the WWIS, PGMN data and PTTW will be updated in 2020. 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 2020.

2. WEBSITE, ANALYSIS & NUMERICAL MODEL RELATED

As in previous years, key initiatives for 2020 will 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. The long term 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 and consultant staff. Towards this end, staff are routinely exploring additional opportunities 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 continue to 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. An ongoing 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 over 80 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. In 2020 work will continue to build from 2019 activities which saw: i) the review and contribution to ongoing modelling work undertaken in Peel and Durham Regions; and ii) the strategic revising of picks (largely in Toronto and/or associated with the bedrock surface) and the geological interpretation/picking at wells that have been newly added to the database.

- **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 interpretive geological 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 2020

Task 2.2 – Addition of Time Series Analyses for Groundwater Monitoring Wells

Further work is planned to better analyze the data tied to long term pumping and monitoring wells. 2020 will see the introduction of a series of graphing and analysis tools that will help to better understand longer term groundwater level trends, as well as how the groundwater system responds to seasonal fluctuations in water availability. Various questions related to trends can be analysed such as: At any given location does the highest annual water level occur at the same time of year? What is the magnitude of the annual fluctuation in water levels? Do certain monitoring wells reflect the same behaviour? Similar questions can be asked of pumping data and groundwater temperature data.

- **Benefits:** The analysis and presentation of this type of analyses will help to better understand how watersheds function and how water moves through the subsurface
- **Estimated Timeline:** Summer 2020

Task 2.3 - Mapping of Known Groundwater Problem Areas

In 2019 the mapping of groundwater "Areas of Concern", i.e. those areas where subsurface construction works could lead to considerable problems and excessive costs, were finalized for Richmond Hill and Aurora, and additional mapping was initiated in Toronto and in the south parts of Caledon around Mayfield Road. There has been an indication from partner agencies that this kind of mapping would be beneficial.

- **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:** Ongoing through 2020.

Task 2.4 – Investigation into Online Model Executables

Although put forward for initiation in 2019, this task was not tackled owing to other priorities. 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-modellers 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 – Winter 2020.

Task 2.5 –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 2019 staff collated metadata for some components of the website (e.g. water table/depth to water table). Generating additional metadata will continue in 2020.

- **Benefits:** having metadata available on the website will allow users to see data sources and how specific maps and analyses 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 2020.

Task 2.6 – 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 used by visitors to the website. Over the course of 2020 work will continue to make the program website more modernized and to take advantage of newer web formats (e.g. story boards, 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, and by extension, the water resources of south-central Ontario.
- **Estimated Timeline:** Ongoing through 2020.

Task 2.7 – Website Database Access

This task was proposed for 2019 but due to financial constraints as well as other priorities it was not undertaken in 2019. To date, the ability to filter wells and see key information for any well was refined as a capability of the website. However, 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 held in the database. It is proposed that tabular access be provided through a searchable web interface. In the longer term it is planned to link this to the Geocortex Mapping.

- **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**: Fall 2020.

Task 2.8 – 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. As time permits, through 2020 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. Work that began in 2019, will continue to update and refine the water budget tool. Once completed, 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), and how the various estimates vary seasonally and from year-to-year. The water budget model will be run 1000s of times with slightly modified input parameters to derive a suite of ensemble model results that will reflect all reasonable model runs. Ideally, when the user clicks on a 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 reviewers an acceptable range of water budget components when reviewing development proposals.

- **"Clip and Ship" or File Export Tool**
  Staff plan 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.

- **Drainage delineation Tool**
  Work will be undertaken 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 of water budget components, land use, soils, etc.

Benefits: all actions directed to the website will be focused on providing smarter and easier ways to explore the data within the database and associated analyses/estimates, thereby reducing the time needed to acquire data for decision making.
Estimated Timeline: Ongoing through 2020.

3. OTHER

Task 3.1 – Renewal of Memorandum of Understanding (MOU)

The program's current MOU expires in December 2020. Work to renew the MOU was initiated in 2019 and as of early March 2020 the MOU is being reviewed by partner agencies. Work will continue in 2020 to finalize the new MOU and to circulate for signatures.

- **Benefits:** The program benefits from the structure and administrative understanding that will come through an agreement between the partner organizations within the ORMGP.
- **Timeline:** Fall/Winter 2020