



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
 Conservation Halton

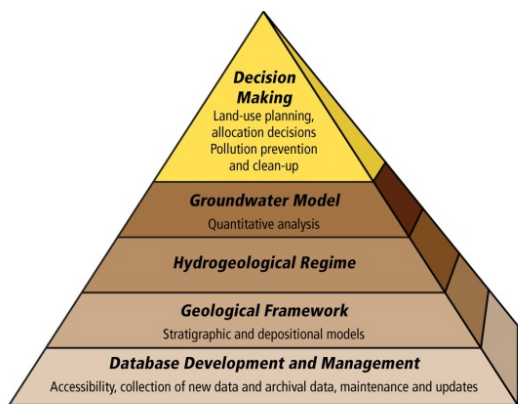


ANNUAL PROGRAM OVERVIEW (2022)
&
WORK PLAN (2023)

TO: ORMGP Executive Steering Team
FROM: Steve Holysh and Rick Gerber
DATE: May 9, 2023
RE: **2022 Overview/2023 Work Plan – Oak Ridges Moraine Groundwater Program (ORMGP)**

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.



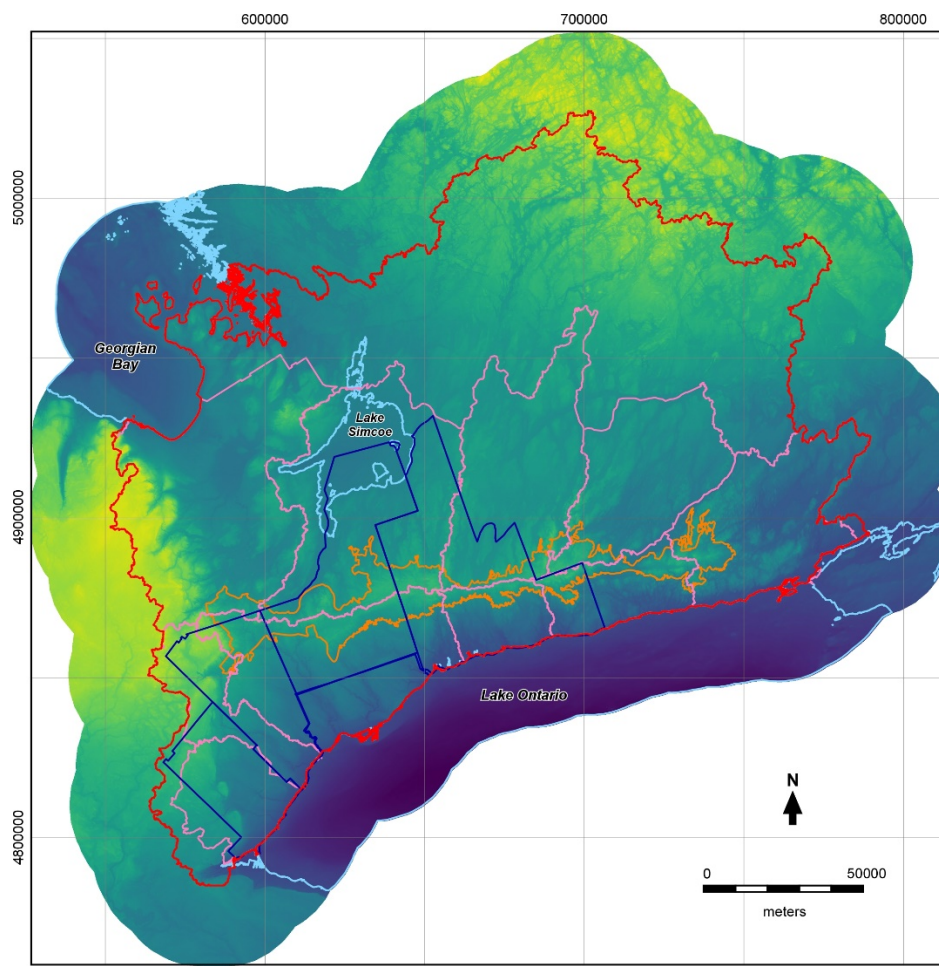
Mandate

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 interpreted 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 current 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: 1) the entirety of three Source Water Protection (SWP) Regions: a) Credit Valley/Toronto and Region/Central Lake Ontario (CTC); b) South Georgian Bay - Lake Simcoe (SGBLS); and c) Trent Conservation Coalition (TCC); and 2) the Halton Region and Conservation Halton portion of the Hamilton Halton SWP area. Focus of work is largely directed to the GTA municipalities (York, Peel, Durham, Halton and Toronto) and their associated Conservation Authorities.



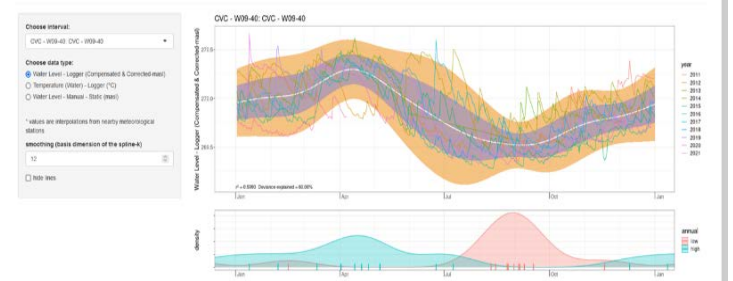
1. Database

- added this year – over 18,000 borehole records; 392 reports; 19 million temporal records;
- 2022 logins to website: Consultants = ~5,000; Agency Staff = ~5,000; Public = ~4,000;
- work initiated with City of Barrie to import data to database;
- incorporation of new geological picks and re-organization of database “Picks” tables;
- Added MNR stream temperature data;

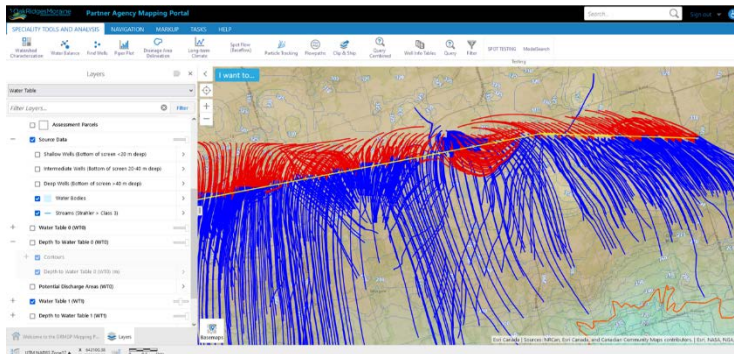
2. Analysis & Modelling

- incorporation of numerical modelling results to website with enabling of particle tracking;
- ‘Area of Concern’ mapping in Stouffville;
- continued work on geology ‘harmonization’ with organization and incorporation of geological picks;
- introduction of spot flow analysis tool on website mapping platform;
- technical insights and contributions to modelling studies for Halton, Peel and CVC;

Annual variability/High-Low Occurrence



3. Other



- completed GW flux and salt loadings to L. Ontario report for MECP;
- Communications – invited to present to the Internet of Water;
- 2 ORMGP related video presentations (STORM and NGWA) made available via link on website;
- continued collaborative partnerships with consultants (20 firms in total);
- Data Snapshots added to Home Page

4. Budget

- Program delivered within available funds - no planned increase for 2023;

Program Component	2022
Staff Costs (Wages + Benefits)	\$736,535
Office Costs + Disbursements	\$43,358
Computer + Software	\$36,513
Consultant/Services	\$51,058
Administration	\$25,220
Total	\$892,684



Review – 2022 (Detailed Summary)

The following provides a more detailed overview of activities undertaken through the Oak Ridges Moraine Groundwater Program through 2022.

1. DATABASE/WEBSITE

Through 2022 the program's database structure/schema remained robust. The information contained within the database was refined and improved through 2022 with continued use of SQL 2016 to facilitate database management. 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 March 2022 from the MECP and 15,234 new well records (including decommissioning records and well upgrades) were brought into the database – at the time of this import the MECP wells were up to date as of about March 2021;
- New boreholes: i) from Region of Halton databases acquired with modelling related projects; ii) tied to older City of Toronto geotechnical and hydrogeology reports; iii) older wells missing from Halton Region or new wells drilled in Peel, Durham and/or York Region; iv) other miscellaneous BHs entered from documents in the report library were added to the database over 2022; and v) boreholes and outcrops from the Ontario Geological Survey study in south Simcoe County were added. In addition to the MECP wells, approximately 2,950 additional wells/boreholes were added in 2022;
- Archived stream temperature data (obtained in early 2000s using HOBO loggers) was acquired from MNR and added to the database. Data was linked to existing spot flow stations if they were already in the database;
- Approximately 398 new documents were brought into the library over 2022;
- Nearly 500 new surface water locations were added, many of them spot flow stations that were provided from Conservation Halton, but also some stations from CVC;
- New climate stations, largely collecting only rainfall data, from Peel and York Regions were also added to the database along with their data;
- PGMN wells updated more regularly with linkage to Provincial Wiski system
- In total approximately 19 million temporal records (chemistry, water levels, climate, stream flow, etc.) were added in 2022 – this number reflects the import of regional data (from York, Peel, Durham and Halton), updating of the PGMN water levels and chemistry, 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 and hydrogeological 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; iii) checking to ensure decommissioning records were properly identified (not misidentified as wells) and iv) 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

- Through 2022, 20 consultant companies were partnered with the ORMGP under consultant agreements (Azimuth, WSP, exp, Golder, GEMS, Dillon, Burnside, Hatch, IBI, Jacobs, Gaman, Terraprobe, Soil Engineers, Matrix Solutions, SLR, Aqua Insight, Salas O'Brien, Thurber, Watermark, GW Environmental Management);
- 455 individual accounts now exist for consultant partners;
- user accounts for technical agency staff remained relatively stable at 384 accounts - several staff turnovers/moves have resulted in a small number of accounts deleted and others created; several staff from local municipalities, primarily in York Region (Vaughan, Richmond Hill, etc.) have requested accounts to the ORMGP website and have been periodically using the site;
- similar to past years, the 2nd year engineering course in Water Resources Engineering at the University of Guelph used the ORMGP website for required hydrology assignments. Temporary student accounts were created so that students could access the site to complete assignments. Staff are looking at ways to expand this student/University interaction. In fall 2022 Queen's University also engaged with the ORMGP to make use of one of the ORMGP held numerical models for a 4th year hydrogeology assignment;
- Part way through 2022 the way in which the website tracks visitors (both partners on the passworded side and also on the public side) was somehow changed, such that users didn't have to log in as frequently (i.e. bookmarking maybe was improved). As a result, the log in numbers for 2022 are all estimates based on the limited data that was acquired from the site. New software will be used in 2023 to improve the counting of visitors and how they make use of the ORMGP website. On the public side of the website, the number of visits is estimated to be approximately the same as in 2021 at around 3,500 - the website continues to attract general users looking for water related information;
- Building upon the introduction of non-MECP (MOE) BH logs in .PDF format (go to Boreholes Map – choose "Boreholes with Supplementary Log") to the website, around 170 new PDFs were uploaded and added in 2022 with the total of available non-MECP BH logs now reaching 2,939. This initiative allows for these consultant logs and other older logs from GSC or OGS staff to be readily accessed on the website;
- In 2022, the process of building a new tool to allow for staff at partner agencies to import logger data into the master database continued. Building on the work of the 2021 summer student, significant progress was made completing the coding for this tool. The task is anticipated to be ready for use in the summer of 2023.
- The many 'R' based statistical tools available for groundwater level hydrograph analyses, piper plots, as well as for climate and surface water analyses on the website have continued to be adjusted and refined to deliver high quality analyses to technical staff visiting the ORMGP website;
- The Citrix Xendesktop platform, which allows for partner agency staff and ORMGP staff to access the program's database and ORMGP files continues to be one of the main ways for staff to interact and update the ORMGP database.
- 2022 also saw a large increase in metadata and information sheets (built in GitHub to allow for easy updating and editing) that describe maps and analyses available on the ORMGP website. This will continue through 2023 (see [ORMGP Metadata 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. Two new laptop computers were

required in 2022. The many software licences required to maintain the program were all renewed as required throughout 2022.

Through 2022, with the waning of the Covid pandemic, ORMGP staff returned to the office on a regular schedule, with most work taking place remotely. Remote access to the program's servers, operated out of CLOCA's offices, was smooth and remained seamless throughout 2022.

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 2022 calendar year. As in the past, the backing up of the database continues to be a focus of the program and was unchanged in 2022:
 - 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 separate CLOCA based fileserver (this copy is dubbed the “weekly database”) and is subsequently made available: i) for use via the program's website to share data with the outside community; and ii) as the ‘weekly’ database which may be accessed by the partners through the ORMGP Citrix machines. This database has both read and write access and can be used for training and testing purposes.
 - a copy of this backup is placed on a separate ORMGP server (newly introduced at CLOCA) that functions as a central storage facility holding database versions dating back in time. These older backups are available on a monthly basis. The previous eight weekly backups are also stored here.
 - 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, backup copies of the database are held off-site (along with backups at CLOCA) should they be required;
 - The primary numerical model archive (part of the model custodianship program) is held on a server at CLOCA. A duplicate archive is kept off site and synchronized regularly. For added redundancy, two additional copies of the archive are also kept in separate locations off-site, however they are synchronized less regularly.
- To ensure partners have the ability at their own offices to use software products (e.g., Viewlog, Sitefx, and others) and to review/access/QA/evaluate their data held in the ORMGP database, a cut of each partner agency data set is usually distributed (in SQL and/or Access format) at the ORMGP technical meetings (i.e., usually twice per year or more often if requested). In 2022 this database access was provided remotely using Drop Box.

2. ANALYSIS & MODELLING

Technical Modelling Contributions

Through 2022, 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 Geocortex, GSFLOW, HydroGeoSphere, Raven, and CSHS HyDRology).

Peel Region Numerical Model

Peel Region’s numerical modelling project, with a revised focus and a new modelling team (Aqua Insight) was also ongoing throughout most of 2022. The modelling initiative was revised to focus on the update/revision to the delineation of WHPAs for several Peel communities. ORMGP staff assisted Peel as required during this work.

Storage of Gridded Data (FEWS)

Work within the Delft-FEWS environment progressed through 2022 with efforts advanced in refining water budgets in preparation for updates to the water budget tool, and in being able to directly read/display FEWS results via the website. The program’s ability to manage gridded sets of information continued to improve in 2022.

Time Series/sHydrology Analyses

Through 2022 the groundwater, surface water and climate time series analysis packages, including the graphs and statistics, that are currently running on the program’s website have been continually enhanced and refined, based on the recommendations and needs of partner agencies. Stream flow and climate data from Environment and Climate Change Canada’s website continues to be regularly uploaded into the program’s database. As new data are regularly added nightly, the statistical analyses are automatically updated. Users continue to be able to select a stream gauge or climate station location and then undertake a wide variety of analyses of the data (e.g., seasonal and monthly trend analyses, baseflow analysis, return period, flow frequency, etc.). As an example of the applicability, website visitors can now quickly determine whether the previous month was either hotter/colder or wetter/drier than the long-term average.

The following aspects of the time series/mapping analyses or what is being internally referred to at ORMGP as the “sHydrology” toolkit, were worked on in 2022:

- Many of the tools that were under development over the past few years came to fruition in 2022 and were incorporated into the ORMGP mapping portal under the “Specialty Tools and Analysis” button, these include:
 - “Particle Tracking” tool that allows for users to make use of the insights gained from earlier consultant-led numerical modelling studies to see how groundwater moves beneath any area of interest;
 - “Flowpaths” tool was incorporated so that users can quickly ‘see’ upstream and downstream of their sites of interest to see where water is flowing to/from in nearby streams;
 - “Long-Term Climate” and “Drainage Area Delineation” were given higher profile by adding them to the Tool bar;
 - “Clip and Ship” tool was added, allowing users to download data/maps directly to their home/office computers;

These tools are shown in the figure below which is a screen capture from the ORMGP website.



Screen capture of “Specialty Tools and Analysis” bar from website

- The addition of the Original Static Water Level to the hydrograph plots (check box in lower left corner of hydrograph screen) allows users to quickly see if water levels are similar to original conditions when the well was drilled;
- groundwater level variability, both spatially and temporarily, continues to be investigated;

Geological Layer Harmonization

Work on the geological surfaces in 2022 was aimed at regenerating the geological surfaces in Surfer software. Towards this goal, the geological picks that are used to constrain the surfaces were reorganized within the database. An additional “Picks_External” table was created to host polyline/constraint picks (as opposed to more standard picks made at wells) that were previously held within older software. The Picks_External table also now holds picks tied to the surficial geology mapping published by the Ontario Geological Survey. Polygons that delineate the exposure of certain units at the ground surface were assigned elevations from the DEM and vertex points along the polygon were imported into the table within the ORMGP database. Construction and refinement of geological surfaces into the future can now make use of these picks to better reflect the layers.

Groundwater eBook

Through 2022 work continued on an Oak Ridges Moraine focused eBook to be submitted to an international entity known as the “Groundwater Project” (see [Groundwater Project](#)). The Oak Ridges Moraine will be the only Canadian contribution to the Aquifers of the World section of the Project. The Groundwater Project is an international effort led by Dr. John Cherry to provide free educational groundwater related materials to the global community. The eBook provides an opportunity to showcase the collective ORMGP efforts to a broad global audience. Through 2022, considerable efforts were expended in harmonizing geological/hydrogeological interpretations between different partners contributing to the eBook.

“Areas of Concern” Mapping/Analyses

In 2022 work continued on the “Areas of Concern” mapping (see [ORMGP - Areas of Concern](#)). Work in Whitchurch-Stouffville continued through the year with a draft report circulated late in 2022. In general, this work has a focus on the artesian conditions that naturally exist on the slopes of the Oak Ridges Moraine. This condition occurs as a result of the pinching out of the Oak Ridges Moraine aquifer sediments in moving away from the crest of the moraine as the elevation declines. The Oak Ridges Aquifer pinches out between the overlying surficial aquitard layers (e.g., Halton Till) and the underlying Newmarket Till. Excavations or wells drilled along this part of the moraine, should they breach the upper confining aquitard, can lead to considerable groundwater problems that frequently cost significant time and money to resolve. Mapping is prepared that shows areas where proposed developments/excavations might result in ‘unexpected’ groundwater problems (and by extension, associated increased costs).

Miscellaneous technical support

Due to the Covid work at home directives, support and communication with partner agency staff was conducted via phone and/or on-line through 2022.

York

- attended liaison meeting with York staff to present and exchange ideas and hear of ongoing work plans at York Region;
- attended Green Lane project meeting to provide modelling input/support;
- assisted with the logging of two cored BH logs from Nobleton area;
- assisted in reviewing data (water levels) when flowing conditions emerged in Aurora;
- worked with York staff to update/synchronize wells in both York and ORMGP databases;
- worked with York staff to transfer annual monitoring data into ORMGP database;
- provided technical input re the geological setting in the Aurora area;
- provided hydrogeological and geological technical support on Whitchurch-Stouffville “Areas of Concern” mapping;

Peel

- Provided technical assistance and review of source water protection modelling and reports;
- Worked with Peel staff to access Peel climate data and to coordinate data access with CVC;
- Provided overview of ORMGP and website to new student staff;
- Along with Peel staff, coordinated the review, correction and updating of pumping/chemistry/water level data for Peel's groundwater-based communities;

Durham

- Incorporated geological picks from recently completed modelling project into the database;
- continued support to Region and Burnside staff to ensure process for migration of monitoring data into database is working and accessible for uploading of data;
- undertook an overview of longer-term data at Durham's groundwater based communities – data was corrected and updated as needed;
- updated private well water levels in southern Durham Region;
- assembled groupings of wells interpreted to be affected by pumping – the WLs from these wells will be made available together on a single graph in 2023;

Toronto

- continued to input reports and boreholes from Toronto into the ORMGP database;
- met with staff to discuss lakebed geology with respect to installation of new chlorination pipe for zebra mussel control to protect water intakes;

Halton

- working with modelling team (Aqua Insight) to provide/exchange data and knowledge;
- providing ongoing technical input and support on modelling, geology, and database corrections to modelling team (Aqua Insight) – this also included the fixing and re-positioning of many key Halton wells in Campbellville, Georgetown and Acton - and the reconsideration of the bedrock valley through Georgetown and Acton;
- compared several external databases acquired from Conservation Halton to look for new wells to import into ORMGP database;
- imported over 100 consultant reports that were made available by Halton staff into ORMGP library;
- incorporation of geological picks from external databases into ORMGP database;
- continued to work with Halton staff to identify/name key wells in the ORMGP database that are important for the Region;

TRCA

- provided overview ORMGP/Sitex training to new staff;
- prepared aquifer maps to support initiative to further develop geothermal energy sources across TRCA jurisdiction;
- provided chloride data from website in support of watershed plans;
- continued to link to TRCA database thus allowing all TRCA surface water stations to have statistical analyses performed via the program website;
- provided a review of screened formations for PGMN wells;
- assisted staff in ensuring monitoring data (Seaton, PGMN, etc.) was brought into database properly and is accessible on the website;

CLOCA

- continued to provide technical support with respect to the Ontario Hydro One facility (i.e., establishment and operation of long-term groundwater monitoring location) in the Municipality of Clarington;

- provided updates from Durham model to CLOCA staff for incorporation into their water budget development review process;

CVC

- provided technical input and review to the Risk and Return on Investment (RROIT) procedure;
- continued to provide technical support for: i) MIKE SHE water quality focused modelling being undertaken in cooperation with University of Guelph;

LSRCA

- provided technical input into several groundwater related projects: Roger's Reservoir wetland, Horseshoe Valley WHPA, ESGRAs.

Conservation Halton

- provided an overview of the ORMGP to technical staff and offered accounts on website;
- incorporation of Conservation Halton wetland and drive point WL data;
- import of Conservation Halton spot flow data;

Barrie

- provided technical training/advice re the capturing of borehole and well information to City staff as they move to integrate many new City wells into the ORMGP database;

MECP

- completed report for MECP staff on groundwater discharge to Lake Ontario (both direct and indirect) as well as the potential contaminant (salt) loading to the lake ([Final Report](#)).

3. OTHER PROGRAM INITIATIVES

Over the course of 2022 several other initiatives also formed part of the overall ORMGP work program.

Website – Partnership agreements with consulting firms were initiated in early 2018 and have continued, with the end of 2022 marking the fifth year of this program. Through 2022 there were twenty consulting firms partnered with the ORMGP whose staff are now actively using the password protected side of the website to aide in their consulting practice. ORMGP staff track the number of consultant logins to the website by each consulting firm and provide that information back to the consulting firm so they can be kept apprised of the value they receive from their ORMGP partnership.

The ongoing partnership between ORMGP and the 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 2022, some of the more significant updates to the website included the following:

- the Home Page of the ORMGP was revamped and re-organized. Key ORMGP documents were made available via the Publications and Reports/ORMGP path;
- a series of new training videos were also initiated in 2022 and are available via the ORMGP home page - ORMGP Support/Website Training path;
- a series of new 'Data Snapshots' was initiated in 2022 to provide quick access to a number of graphs and maps that synthesize key story lines that are emerging from analyses of data held in the ORMGP database. The snapshots are unique because they can be readily refreshed and updated as new data comes into the database. At the end of 2022, seven Data Snapshots have been made available on the ORMGP home page: Chemistry – Isotope Summary; Climate Summary; Climate – Historical Station Count; Geology – Geological Picks; Groundwater Level Variability; Numerical Models; and Streamflow – Hydrograph Separation;

- addition of “Particle Tracking” tool under "Speciality Tools and Analysis" toolbar. This tool fulfils an important part of the ORMGP’s mandate by broadening accessibility to the insights and knowledge that has been gained by the numerous numerical modelling studies undertaken since the early 2000s. Knowledge and insights from the numerical models are largely forgotten and not capitalized upon because the numerical models themselves are very sophisticated and very few staff, either at partner agencies or at the consulting firms, have the expertise to run the models;
- Strahler ordered streams, that are topologically correct, were added to the Surface Water Theme Map, and in addition, the modelled groundwater discharge (from the 2006 Regional Model) was added to the Surface Water Theme Map;
- addition of a “Flowpaths Tool” to the "Speciality Tools and Analysis" toolbar. This tool allows website users to view upstream and/or downstream flow paths from any point. It can also be accessed by right-clicking on the map;
- Source Water Protection data was made available for Trent Conservation Coalition, CTC, Halton-Hamilton and South Georgian Bay-Lake Simcoe regions and is available within the Land Use theme map;
- a Long-Term Estimated Climate Data tool has been added to the "Speciality Tools and Analysis" toolbar, allowing users to explore graphs and analysis of long-term estimated climate data. The tool can also be accessed by right-clicking on any map;
- addition of a Spot Flow (Baseflow) tool to the "Speciality Tools and Analysis" toolbar that allows users to access stream spotflow data from the ORMGP database for any chosen year. The tool shows the gaining and losing stream reaches (and the volume gained or lost per km of stream between measurement points);
- all of the geological picks that have been made over the years were made visible/accessible on the Geology Theme map on the website;
- new Metadata button has been added to the "Feedback and Help" toolbar. The documentation here allows users to search and explore the ORMGP metadata for legend items on each of the different theme maps;
- addition of a “Clip and Ship” tool available in the "Speciality Tools and Analysis" toolbar. The tool allows for the direct download of data and maps from the ORMGP website onto the user’s computer. Three packages of information are available for download (Geology; Hydrogeology; and Hydrology) – the tool focused on site specific studies and is restricted to areas of 18 km² or less;
- significant improvements were made to the Cross-Section tool to allow for more interactive use of the tool (e.g., dynamic push/pull of sections through space, dynamic vertical exaggeration changes, ability to cosmetically change sections by adding/removing grid lines, well names, etc.);

Report Library – early in 2022, the library search interface was adjusted to integrate the two previous methodologies (Library Search and Document Search) into a single search interface. “Library Search” was designed to look for documents using key attributes in the ORMGP database (e.g., author, author agency, title, year, etc.) whereas “Document Search” was designed to make use of the OCR scanning of the .PDF documents, looking for any user-entered word contained within all library documents. With the redesign, these two search routines have now been integrated into a single efficient interface.

Opportunities for partner agencies to hire summer students to help inputting reports and data to the ORMGP remained limited in 2022, owing to Covid still being a concern in the early part of 2022. As a result the number of reports entered into the library was lower than in the past, never-the-less, some 392 reports were added to the program library over 2022, many provided by Halton Region.

Lake Ontario Flux Project – through the early part of 2022 staff worked on a project to assist the MECP in characterizing groundwater movement to Lake Ontario, as well as with estimating the salt flux to the lake via groundwater. A final report was prepared for the MECP in 2022 and is available on the ORMGP website (See [Final Report](#))

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. Some of these monitoring locations have continuous measurements extending back to 1994.

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 2022 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 technical committee for drafting data standards for automated meteorological stations in Canada. Through 2022 ORMGP staff chaired two sub-committees related to the project (NSC3 and NSC4), successfully leading to the preparation of standards that have been circulated to stakeholders for review.

Communications/Analyses

In 2022 ORMGP staff were invited to present or meet with various external agencies on behalf of the partner agencies.

- Assisted with the organization of, and presented at the annual Ontario Geological Survey (OGS)/Geological Survey of Canada (GSC)/Conservation Authority Open House held online in February 2022;
- Continued to be active in SoSmart – in 2022 received stream temperature database from MNR;
- Assisted with TA training and set up ORMGP website accounts for students at University of Guelph enrolled in a fall 2022 engineering hydrology course;
- Provided in person or on-line ‘Lunch and Learn’ or similar talks to the following groups to promote increased use of the ORMGP website: Toronto Inspection, Soil Engineers, Sirati, Thurber, Dillon, Wood, Richmond Hill, Conservation Halton, Jacobs, Geosource, Simcoe, Groundwater Project;
- Provided a professional talk to the Internet of Water, a U.S.-based academic group that is looking to promote the better management and sharing of water related data across the U.S.;
- Invited to present a technical talk on modelling aspects of ORMGP to the hydrology modelling group at the University of Waterloo;
- Invited to present a talk on the ORMGP to York University;
- Met on several occasions with City of Ottawa staff to provide technical support to their Groundwater Information Project (GIP);
- Provided technical review for two papers, one for the Groundwater Project on the use of water wells, and a second for the Canadian Journal of Earth Sciences on characterizing Hydrogeologic Terrains;
- Continued to contribute to the Greenbelt Foundation by serving on the Advisory Committee that reviews incoming proposals;
- Joined Canadian Hydrological Model Stewardship (CHyMS): a Canadian collaboration/web server hosted by the National Research Council Canada to assist in the development of the Raven model.

4. BUDGET SUMMARY

In 2022 the five senior partners (City of Toronto, Regional Municipalities of York, Peel, Durham, and Halton) each contributed \$175,000, and in addition, the program received \$77,184 from consultant subscriptions to the ORMGP website, resulting in a total revenue of \$952,000 to the program. The program’s expenses for the 2022 are summarized below. 2021 costs, as well as estimated 2023 costs are also provided.

Program Component	2021	2022	2023 (est.)
Staff Costs (Wages + Benefits)	\$729,900	\$736,534	\$796,000
Office + Disbursements	\$82,208	\$43,358	\$45,000

Computer + Software	\$42,630	\$36,513	\$50,000
Consultant/Services	\$27,065	\$51,058	\$80,000
Administration	\$16,187	\$25,220	\$26,000
Total	\$897,990	\$892,684	\$997,000

The program was completed within an acceptable budget in 2022. Program costs were similar in 2022 to 2021. The cost estimate for 2023 is projecting an increase in Consultant/Services as additional hours have been projected for a recently added consultant staff member to contribute more significantly to the program. Additional services from CLOCA GIS/IT staff are also projected for 2023.

Given the tight budget conditions in 2020, and that staff costs/benefits rise by a minimum of the cost of living, staff initiated the process of adding a 'cost of living' adjustment to the ORMGP budget for 2021. Covid derailed this attempt in 2020 and with Halton Region joining the program in 2021, the need for this became less pressing and it was temporarily pushed back. Staff will be looking to add this cost-of-living adjustment to the requested funds from the funding partners going forward.

2023 WORK PLAN – ONGOING/UPCOMING TASKS

As in previous years, key initiatives for 2023 will relate to enhancing: i) the program’s database; and/or ii) communication and outreach. Tasks will generally 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 technical staff in improving decision making. 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 of various individual specialized software packages (e.g., Sitefx, GIS, SQL Management Studio, etc.).

With no suggestions as to the order of importance, through 2023 work will take place on the following aspects of the program.

Work Area 1 – Halton Region and Upper CVC

Throughout 2021 and 2022 work was undertaken to either rename or enter borehole records that were of interest to Halton Region. With this effort largely complete, and with Halton continuing to move forward on their Tier 3 numerical modelling effort, 2023 will see continued work with Halton Region to populate temporal data (water levels, pumping data, and water quality data into the database). At the same time the CTC is looking to incorporate data from the upper parts of the Credit River Watershed (e.g. Orangeville, Erin, Hillsburgh, etc.). ORMGP will work with CTC to capture municipal data into the database. To assist CTC source water team, staff will also assist with technical insights and assistance with renewed source water protection modelling in the upper CVC watershed (Erin area).

- **Benefits:** Provides data so that hydrographs, pumping quantities and water quality can be readily accessed/viewed on ORMGP website. Also, improved understanding of groundwater conditions in the upper parts of the Credit River Watershed will improve overall understanding of the watershed down to Lake Ontario.

Work Area 2 - Continued improvement and expansion to the database

The database is now over 100 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. As updates are made available from the Province, the WWIS, PGMN, PWQMN data and PTTW will be updated in 2023. Temporal data from the partner agencies will also be updated through the year.

- **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 partner agency initiatives, Source Water Protection, development, construction activities, or other.

Work Area 3 – Report Library Capture

In 2023 program staff will resume to work 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. In addition, if students are retained by partner agencies, ORMGP staff will also assist with training and the processing of consulting or other relevant reports. Data capture from these documents into the database will also continue.

- **Benefits:** Improved access to and availability of subsurface information across program area.

Work Area 4 – Fostering and Enhancement of Partner Agency and Consultant Website Use

Over the course of 2023, using the newly installed analytics software, staff will better monitor external partner agency use of the program website and encourage further use of the site. This feedback will assist with

focussing improvement efforts relating to information accessibility and analysis tools that are made available on the website. In 2023, staff will be exploring means (on-line or face to face) for developing and implementing additional training for technical staff at both consulting companies and partner agencies. One example of an initiative that will be available to partner agencies is the idea of having ORMGP staff work for a day at a partner agency, allowing for a mix of informal and formal meetings and training that can: i) increase partner staff awareness of the breadth of information available on the ORMGP website; and ii) provide ORMGP staff with a better idea of the water resources analytical and mapping needs of partner agencies. Staff will continue to encourage other companies to join the partnership. Partner agency staff are also urged to encourage consulting companies to make use of the ORMGP.

- **Benefits:** This task, especially training/education initiatives, will help to ensure that consultant partners remain engaged in the program in a meaningful way, allowing them to maximize their use of the information and data available through the website and to contribute back to the program.

Work Area 5 – Geological Layer 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. With the consolidation of all the geological picks in 2022, ORMGP staff are now in a better position to bring together geological insights across the broad ORMGP study area. In 2023, it is anticipated that work will be focused on updating the bedrock surface, with a focus on bedrock valleys and their orientation, with a strong focus on a check of water well records and their position, which has been found to potentially alter bedrock valley thalwegs.

In 2023 staff will continue conversations with staff from the Ontario Geological Survey as well as the Geological Survey of Canada to discuss and possibly incorporate geological layers from the 2020 OGS South Simcoe study, as well as the bedrock geological layering from the recent modelling work undertaken by the OGS and the GSC.

- **Benefits:** This task continues efforts to consolidate geological frameworks from various initiatives as well as new data into an “authoritative” set of surfaces that will extend across the entirety of the 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.

Work Area 6 – Addition/Refinement of Mapping Web Portal

Over the course of 2023 several planned initiatives will be moved forward to enhance the mapping portal on the ORMGP website. Ideas that will be explored include:

- **Chemistry** – although preliminary work has been undertaken on a new tool to better extract and display results of water quality tests, the tool has not been sufficiently developed to enable on the website. Work will continue in 2023 to get this tool website ready.
- **Groundwater Level Variability** – Building upon the Groundwater Level Variability Data Snapshot, ORMGP staff will look to link certain hydrogeologic behaviours observed at different wells situated within various hydrogeological settings. The long-term goal would be to better understand the expected groundwater response in different settings to both seasonal water availability as well as single storm events. These insights would then be transferred to the website either at the well level (different coloured wells) and/or at the landscape scale.
- **Water Budget** – in 2023, making use of newly developed Delft FEWS system, efforts will be extended to work on a renewed water budget tool that will extend water budget coverage westward through the Halton area.

- **Training Videos** – through 2023 additional videos will be prepared and made available on the ORMGP You Tube channel to highlight various aspects of the ORMGP website, and to demonstrate techniques for effective use of the site;
- **GitHub/Metadata** – 2023 will also see continued work on the site’s metadata and technical descriptions on the procedures used to develop products that are made available on the ORMGP website;
- **Online Model Insights** – With the introduction of the Clip and Ship tool in 2022, interest continues in ensuring that hydrogeological insights from the numerical models developed over recent years are made available for more widespread use. Towards this goal ORMGP will continue to explore additional ways that will allow partners to take advantage of the past investments in numerical modelling. Some ideas to consider include allowing for users to explore well drawdown via the ORMGP mapping portal. This could allow for non-modellers to gain insights from models for various water management decision-making and quickly assess potential impacts to their water supply
- **Integrated Planning Map**
In discussions with planners over the past couple of years, it has become apparent that the ORMGP mapping portal, with its many different themed maps, offers the possibility to assist planners with making better land use change decisions from a water management perspective. By overlaying maps such as the surficial geology, depth to water table, and flowing wells it may be possible to colour code certain areas as being either more or less suitable for different types of land use change proposals. ORMGP staff will investigate the possibility of developing an effective planning themed map that can be accessed on the website.
- **Dynamic Maps** – In 2023, expanding upon the introduction of the “Dynamic Data Snapshots”, ORMGP will look to publish more of these maps onto the website.

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.

Work Area 7 - Mapping of Known Groundwater Problem Areas

Mapping of groundwater “Areas of Concern”, (i.e., those areas where subsurface construction works could lead to considerable problems and excessive costs), was initiated in 2019. In 2023 mapping will be completed in Whitchurch-Stouffville and work will continue in Uxbridge Township. There has been an indication from partner agencies that this kind of mapping is beneficial.

- **Benefits:** By 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.

Work Area 8 – eBook

In 2023 work will wrap up on the ORMGP eBook contribution to the Groundwater Project. The eBook will synthesize much of the hydrogeology of the Oak Ridges Moraine area and will be unique in that it will directly link to the ORMGP website allowing readers to explore data as they read through the book.

- **Benefits:** As the only Canadian contribution to the Groundwater Project’s overview eBooks on major global aquifers, the opportunity exists to showcase the work of the program and partner agency staff that have contributed to the program over the years.

Work Area 9 –Website Metadata

The past two years have seen the development of ORMGP’s GitHub built metadata and ‘fact sheets’. 2023 will see the continued development of additional metadata/fact sheet writeups, and to better organize the information

available so it is readily findable on the site. This will provide technical visitors with assurance and documentation as to how specific map products have been produced.

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

Work Area 10 – Communication Strategy

With the support of the Greenbelt, in 2023 ORMGP staff are looking to engage a marketing/strategic communications firm to assist in identifying paths and opportunities to improve the overall awareness of the work being undertaken through our program and to have the program's website become a more regular 'go to' tool to inform land use and water management decision making across the GTA.