Michigan Water!
What is needed and known after years of nothing in Ottawa County, an example for Michigan?

Groundwater Sustainability
Michigan Chapter
Soil and Water Conservation Society
JOHN A. YELLICH, CPG
DIRECTOR
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JOHN.A.YELLICH@WMICH.EDU
269-387-8649
Michigan Statehood, **January 26, 1837**
Geological Survey, First Department **January 26, 1837**
Travel Promotions for Michigan
Water is Michigan – 1950’s to present
What is Michigan Geology?

What is Michigan’s most critical natural resource in the LP and UP for today and future generations?

Water!

Michigan glacial geology in the LP is:

• Not uniform, vertically and laterally and what does it contain?
  – Surface and subsurface geology contains these natural resources
    • Groundwater
    • Surface water
    • Aggregates
    • Agricultural soils
    • Wetlands

What do we know about the geologic & water resource?
Almost NOTHING!
Michigan glacial geology is perhaps the most complicated discontinuous lithologic units that have been recorded.

- There are multiple stages of ice advances and retreats having crossed Michigan (200,000 to ~10,000 years ago).
- Glacial movement has resulted in the deposition of various glacial deposits and features and they include aggregates and water bearing sand zones, and
- Glacial moraines, which have the most important term, glacial till, is not in the only database, Wellogic terminology table. Till - no economic aquifers or aggregates documented.
Michigan Geological Survey (MGS)-
October 2011

PA- 167 - MGS to Western Michigan University with the Legislative mandate for the Michigan Geological Survey:

• Provide scientifically validated research and the data necessary for appropriate natural resource protection, discovery, assessment and management.

• Act as an independent, un-biased authority on geological matters underpinning Michigan’s natural resource protection and management.

• Provide and preserve geologic records that can support the natural resource decision makers, public and private.

• **NOTE:** Michigan did not provide any funding to MGS in 2011!

MGS is mandated to compile geologic data and was the only Great Lakes state without an annually funded geological survey, **UNTIL October 1, 2022!**
Regulatory, Consulting and Mi WWAT interpretations and decisions are made using this map.

- This 1982 surficial geology map is based on 1915 (Leverett & Taylor) data, with minimal changes in 1955 (Helen Martin), 1982 (Farrand & Bell). This is ONLY a surficial geology map.
- No subsurface validation.

The role of the Survey is to provide unbiased updated surface and subsurface geology in priority areas.

Where is the Water?
Western US-South Dakota watershed drainage Map, a comparison

South Dakota the entire state.
~70+ watershed/basins that can contain water

~30 basins may only have 1 – 3 formation aquifers that need to be mapped - you can do large multi-basin modeling.

Entire State has eight to 20 geologic units/formations that can contain water in the entire state of South Dakota
Michigan has been told you can map water resources for the entire state with a single groundwater model.
NOT!
Michigan Watersheds, geology NOT the same

86 major water sheds in Michigan

Groundwater modeling in Michigan needs **validated geology for subsurface data** for each watershed – **NOT** statewide models.

Michigan glacial geology is NOT continuous. **Hundreds of glacial formations**, not the same! **One Water shed** can have 5–10 formations and multiple aquifers.
Mapping-Michigan versus adjoining states!

Federal matching dollars in the last 29 years

- **Michigan**, no dedicated funds in 29 years, not until 2014, $44,000 to support mapping in Cass County, < 10% mapped. ($1.751 M = $72.9 K/yr).

- **Illinois**, mapping in high impact and use areas, many priority areas for 3D mapping, ~ 30% mapped. ($4.987M=$207.8 K/yr).

- **Indiana**, mapping in high impact areas, some priority 3D mapping, ~ 40% mapped. ($4.276 M=$178.2 K/yr).

- **Ohio**, funding from energy and minerals, geo-hazards for mapping in addition to Fed funds ~ 80% mapped ($3.069 M=$127.9 K/yr).

- **Wisconsin**, mapping impact areas, $3.762 M = $156.7k/ year

- **Minnesota**, State funding (~$2M/yr) map the entire state, $2.834 M = $118.3k/year.

All data from MGS mapping programs is OPEN FILES.
Kicking the geology can down the road!

1970’s - Michigan legislature did not maintain survey funding

- 1970’s- Legislature determined consultants and staff can provide the geologic data.
  - State could then compile the data, but no compilation dollars?
  - No urgency in doing subsurface or surface mapping.
- So where is the “geology can” now?
  - No funding for the state departments to compile the data.
  - “Use what we have”, “no time, no money” has been the mantra for geologic data.
  - Data costs money to compile and maintain so there were no staff costs attached to data compilation. Everyone must compile it themselves.
- What did Michigan do to stimulate a greater understanding of the natural resources for the economy for the last 30 years?
  - NOTHING!
- Only subsurface database in 2003, is Wellogic, it is not Validated
- Here are some examples of “kicking the geology can down the road”!!!
Michigan stakeholders were not told in 2000-03 they needed validated geologic data!

Michigan Lower Peninsula, ~ 60% of drinking water is from glacial sediments, what is important?

There is no scientific glacial or bedrock database that has validated and corrected data.

• Many programs use Wellogic (water well) data, the only database, not geologic.
  – Wellhead Protection,
  – Groundwater level,
  – Depth to bedrock,
  – WWAT, HC well program, etc.

• Wellogic, 2003, was never location validated.
  – Not until 2018-MGS.

• Drillers were never trained to input standard terms.
  – Not until 2015-MGS initiated training.
Wellogic Summary, Drift vs Bedrock

2019-MGS was contracted to validate and correct locations of all Wellogic wells
> 40% of Wellogic wells not on the correct location.

MGS has completed:
- Validated Wellogic Locations: 274,613
- Input scanned historic wells: 220,940

~48% of project completed

MGS inputting 700,000 scanned logs 1950’s to 2003 to Wellogic (~1.3M total # of wells)
MGS, 2015, training well drillers how to log consistently into Wellogic.
Allegan and Ottawa county Wellogic locations validated in 2020
Where does Ottawa need geologic data?

- Fastest growing county in Michigan.
- 2016-17 Ottawa County identified water quantity and quality issues.
- MGS met with County commissioners, concerned officials and agricultural community and discussed data voids.
- Ottawa county did not have a factual summary of impacts, quantity and quality, all estimates.
- MGS, in 2017, met with 8 well drilling contractors and discussed understanding where there are water quantity and quality issues.
- Developed Glacial and Bedrock aquifer maps of known issues, never done before.
2017- Glacial Map – Drillers data

- Ottawa County asked each township where they saw growth in next 20 years (Yellow dots).
- Eight drilling contractors prepared their maps of known water resources, development quantity and quality issues.
- This is the ONLY factual summary.
2017-Marshall Fm., bedrock Map – Drillers data

- Ottawa County asked each township where they saw growth in next 20 years (Yellow dots).
- Eight drilling contractors prepared their maps of known water resources, development quantity and quality issues.
- This is the ONLY factual summary.
MGS mapping Ottawa and Allegan County

• MGS has been collaborating with Ottawa County “Planning” since 2016.
• MGS proposed and received a USGS NCGMP funding grant in 2020 to support mapping Ottawa and Allegan Counties.
• Ottawa and Allegan are listed as priority counties by EGLE-WRD and MPART.
• MGS has teamed with Ottawa County since 2016, and MGS presented where MGS would want to drill and confirmed with Ottawa, where they could use a monitor well, a technical collaboration for both entities.
• MGS mapping and coring details indicate many areas have high clay/till material supporting minimal Glacial aquifer and minimal Marshall SS, bedrock aquifer recharge.
MGS has four glacial geomorphologists working on the Ottawa County map.

- Dr. Patrick Colgan, GVSU, and the other geologists identified areas where drill hole data was needed.
- Discussed with Ottawa Co and identified locations that Ottawa could have a monitor well.
- Six drill sites cleared with Ottawa County staff.
MGS Drilling Targets collaboration with Ottawa County – Core & Monitor well location map

Final drilling - Six Ottawa locations

- Core Hole & Monitor well
- OTT 22-06 120’ TD Drift
- OTT 22-05 125’ TD Drift, no Marshall
- OTT 21-1 M 120’ TD Marshall
- OTT 21-2 185’ TD Coldwater Sh
- OTT 21-3 M 135’ TD Marshall
- OTT 21-4 M 100’ and 185’ TD Drift and Marshall

Glacial drift and Marshall Fm. monitor well technical collaboration.
MGS with Ottawa County, since 2017.
Now working with Allegan Co.
1982 interprets this as lakeplains, moraines (Grn) outwash (Pnk)

1982 Farrand and Bell

2022 Diamicton/till at the surface, three deltas, outwash in channels, Ice Walled lake plains, soils favorable for agriculture.
Cross section index for Ottawa County Map 2022

What MGS does with the data. Cross sections and groundwater flow maps, shown next

Cross Section Index
Cross-Section N to N’ Shown Above
All Cross Sections Shown in Report (Refer to Appendix 1)

- 1 - Zeeland
  - MGS Core/Monitor wells i.e. OTT-21-02
- 2 - Polkton
- 3 - Jamestown
Comparison, Zeeland Drift Groundwater Pre 2000

Glacial/drift aquifer

Post 2000

NOTE: Distribution of water wells
Blue colors represent water level reduction/change in certain areas.
Red indicates increase in water levels in certain areas.
Comparison, Zeeland Bedrock Groundwater Pre 2000

NOTE: Distribution of water wells
Blue colors represent water level reduction/change in certain areas.
Red indicates increase in water levels in certain areas.

Bedrock - Marshall aquifer, Pre 2000

No Bedrock wells drilled after 2010
Post 2000
Detailed plots of Bedrock and Drift Wellogic water levels with time. Changes in WL, includes MGS/Ottawa Core/monitor wells, minimal to NO recharge.

NOTE: No Bedrock wells post 2010, glacial till/clay, but note, orange-sand and gravel at surface
Detailed plots of Bedrock and Drift Wellogic water levels with time. Changes in WL, includes MGS/Ottawa Core/monitor wells, minimal to NO Recharge.

NOTE: No bedrock wells post 2010, glacial till/clay, but note, orange-sand and gravel at surface.
Polkton Map - Bedrock Groundwater Pre 2003

Polkton Township/Coopersville
Bedrock Groundwater Flow Map
Water Well Locations
Polkton Township & Coopersville, Michigan

The map is localized groundwater flow created by the bedrock well data for the given area within Ottawa County, as well as validated water well locations within the county. The surface elevation drops along the Grand River with a topographic high to the Northeast. In correlation, the groundwater elevation is lowest along the Grand River. The elevation goes from blue at the lowest points to red at the highest.

The map also shows elevation contours at 10 feet intervals with index contours every 50 feet generated from LiDAR data taken from 2016-2018.

Legend
- OTT 22-05 Drill Hole
- Welllogic Water Wells
- Aquifer Type: Well Type
- Drift: Type 1
- Drift: Type 2
- Drift: All Other Wells
- Rock: Type 1
- Rock: Type 2
- Rock: All Other Wells
- Unknown: Type 1
- Unknown: Type 2
- Unknown: All Other Wells

Demographics
- Schools
- PLSS Sections
- 1 Townships

Road Classification
- Interstate
- Other Freeway
- Other Principal Arterial
- Minor Arterial
- Major Collector
- Minor Collector
- NFC Local
- Non-Certified

Hydrologic Features
- Water Bodies
- Rivers & Drains

Coordinate System: NAD 1983 Hotine Oblique
Mercator Azimuth Natural Origin

Concours: 10 feet Intervals
Index Contours: 50 feet

Polkton-No Bedrock wells drilled after 2003, so only pre 2003 bedrock groundwater plotted
NOTE: Blue colors represent water level reduction/change in certain areas. Red indicates increase in water levels in certain areas.
MGS OTT 22-05, Bedrock, Marshall Fm, no aquifer, silica cemented sand.
NOTE: Drift wells, glacial till/clay. Note- orange-sand and gravel at surface, With minimal sand to recharge lower drift aquifers, slow recharge.
MGS - OTT 22-05, Bedrock, Marshall Fm, no aquifer, silica cemented sand.
NOTE: Drift wells, glacial till/clay, but note, orange-sand and gravel at surface, With minimal sand to recharge lower drift aquifers, slow recharge.
So where does Michigan need to go?

Multiple objectives to achieve validated, unbiased geologic data.
MI WWAT Applications vs detailed GEOLOGIC Map Products

Approximately 60% of the LP groundwater comes from glacial material
Mi WWAT Applications >70 GPM through 2021 for comparison
Beginning in ~2003 (Water Withdrawal Assessment Tool- well drillers logs, non-factual model)

This is a summary of mapping of the detailed combined surface and subsurface by MGS, USGS or others for Lower Peninsula.

Less than 10% Detailed MGS mapping.
* Quads (~56 Sq Mi)
  • Black - Surface only with validation of borings
  • Red - surface + some subsurface drilling / geology 3D
Let's review the history of Data!
EGLE - Estimated 30,000 sites
Hazardous Substances Released to the Environment

201 - Contaminated Facilities

213 - Open LUST Releases

1980's Pre - CERCLA to present - geologic data
No geologic data compilation - Until now!
What is the new Michigan contaminant crisis?

Michigan – the Water Wonderland!

- Perfluorinated Alkyl Substances (PFAS) – Soils and water multiple locations and there may be more.
- Geologic mapping-completed counties Berrien, Cass, St. Joseph, Barry, Calhoun, Kent, Kalamazoo, Genesee, Van Buren.
- Where Michigan has open file subsurface geologic data (Red/Blk).
- What’s wrong with this picture?
- Stop using just water well data.
- Mapping and drilling data is needed to define the full aquifer section for each watershed.
- Let’s compare recent results.
Compare

Calhoun County 1982 Map
Calhoun County 2017 Map

All can see the level of detail in new mapping.

This is where we have aggregates?

- Aggregates also mean water.
- Let’s review a recent aggregate assessment for this area.
Aggregate Resources in all glacial types
Reduction of resources by setback, etc.
Resources = 147 Sq mi minus 81 Sq mi restricted = 66 (~45%) Sq mi available.
Including residences in Un-graded resources.
Allendale (01) & Olive Township (03) locations
Ottawa County

August 2021
Zeeland Township (02)

TD 185’, 80 feet of Gypsum (White rock), no glacial (Till) or bedrock aquifer, Coldwater Shale.

August 2021
Training students, Sara Hayes and Sophia White to log core.

Fire station, top of gravel pit, future home development below.
• Two students learning how to log core, Sara Hayes and Yanni Philopoulous.
• Presenting core samples to Ottawa County Water administrator, Mathew Chappuies
• Two completed monitor wells at Jamestown Fire Station
MGS - geologic projects, Past and Future

Supported by MI Water Division, Natural Resources, Agriculture, MPART, others,

Cass, Ottawa, Allegan, Muskegon Counties - WRD, MPART, others

Need maps using new and proven technologies and methods

• MGS confirmed counties having growth and water quantity demands
• Localized geologically derived water quality issues
• 3D maps and reports are needed and developed with validated information, in real time.
• Data in formats (e.g. ArcGIS) accessed by phones, tablets, laptops, actively showing multi layers of data...... in seconds, in the field.
• Secondary MGS mapping products of surface and subsurface data include: Water tables, water bearing zones, surface drainage, aggregates, wetlands, NRCS-Soils, recharge areas, deeper subsurface research and data, etc.
• Interactive electronic standard databases to capture existing and new data.
MGS - geologic projects, Past and Future

MGS products, Continued:

Need maps using new and proven technologies and methods

- Critical Mineral geologic units throughout Michigan.
- 21st Users: Citizen scientists, city and county planners & developers, geologists, earth scientists, engineers, consultants, industry representatives, regulators.
- Where should you get your data, Wikipedia or the Geologic Survey?
Coring, monitor well installation, purging well

Drift/till-130’ Marshall

Well screen 50-60’
So what is the answer to scientific data?

Annual Funding for the Geological Survey, now secured.
A big thank you to all the support from the local and regional Senate and House legislators, local Directors and Managers, county administrators and residents who wrote or noted the benefits of needing geologic data!

• Priority driven areas!
• Use unbiased geological scientist, not data manipulators
  – Scientists and public using data in open file format
• What do we need to understand for today and future generations?
  – Geologic hydrostratigraphy,
  – 3D geology of the entire stratigraphic section,
  – Soil profiles to correspond with subsurface geology,
  – Water storage and recharge are defined,
  – Usage of resources, then

Geologic mapping can support identification and protection of those resources which are associated with:

• Water storage/availability, aggregates, soils, wetlands, PFAS, other,
• WUAC Recommended Geologic mapping, 2014 & 2020
So what is the answer to scientific data?

- Prioritization by EGLE-WRD, EGLE – MPART and supported by United Tribes of Michigan, others (Priorities provided by 10-11-19).
- What counties are most important? 20-25 counties now identified
- Four Counties mapping 3D completed.

### MICHIGAN GEOLOGICAL SURVEY
**SUMMARY OF COUNTY MAPPING PRIORITIES**
PRESENTING THE % OF VALIDATED GEOLOGIC MAPPING PRODUCTS

<table>
<thead>
<tr>
<th>Proposed Priority Counties (Mapping data needed)</th>
<th>EGLE County maps WRD Water Use</th>
<th>Estimate % Completed Maps</th>
<th>EGLE County Maps MPART PFAS Areas</th>
<th>Estimate % Completed Maps</th>
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<tr>
<td>1 Kalamazoo</td>
<td>Branch</td>
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<td>Cass</td>
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<td>3 Allegan</td>
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<td>Oakland</td>
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**NOTE:** This is a specific list of priority counties requiring validated geologic mapping. These two lists were provided in 2018 and 2019 by the EGLE departments of MPART and WRD, respectively. MGS has included a statement of map % completion for each County. This list will be modified as needed after discussions and agreement with EGLE and DNR Departments. The United Tribes of Michigan has endorsed mapping of water resources where needed in the State.
Michigan Geological Survey

Thank you
Questions?

269-387-8649  john.a.yellich@wmich.edu