

DIGITAL MAPPING TECHNIQUES 2021

The following was presented at DMT'21
(June 7 - 10, 2021 - A Virtual Event)

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2021)

<http://ngmdb.usgs.gov/info/dmt/>



Why Correct Wellogic Database? It's Michigan's only Well Database, and has 30-80% Errors *Michigan Geological Survey*

DMT 2021 - June 10, 2021

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Background – Triage Project

- Michigan in 2021, has many different water issues!
 - Water resources,
 - Water use, High-Capacity (HC) and municipal wells,
 - Groundwater contamination, 2-4D, now PFAS.
 - Geologic mapping is needed to understand groundwater and flow.
 - The only open-source database for basic subsurface data is the *Wellogig Database*.

Issue: Water Wells in the Wellogig database were found to be generalized and had incorrect locations

- Wells can be up to a mile away from where they should be located.
- Since 2003, Michigan has not corrected or trained drillers in proper input of data to Wellogig.



Update – Michigan Water

So, we ask:

What is the value of Michigan water?

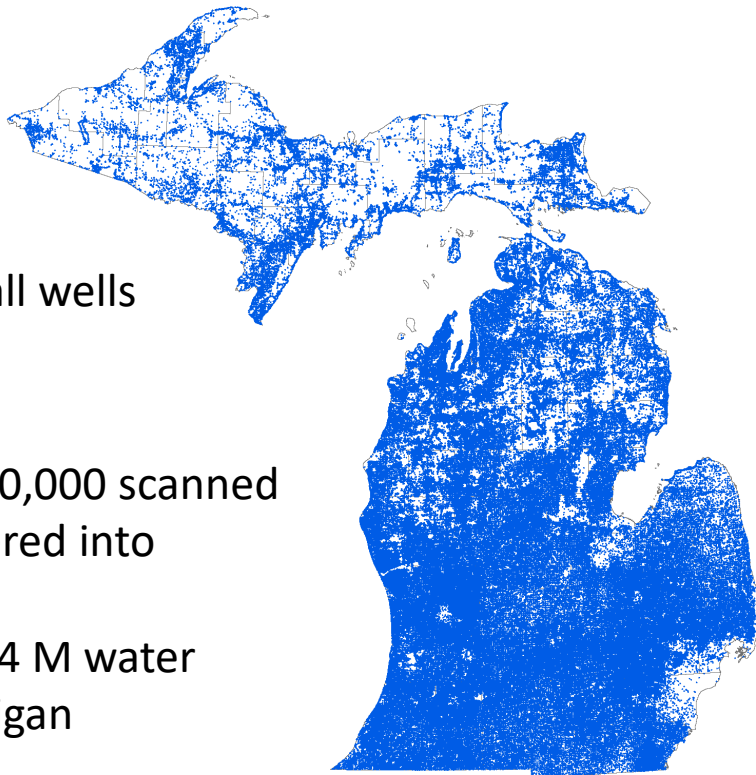
- Michigan has not funded mapping and less than 10% of the State has been mapped.
- No documentation of the location of critical water resources in priority areas, >25% of State.
- Aggregates is another undocumented societal and economic resource for infrastructure!
- Water and aggregates are geologically connected
 - Surface and subsurface
- Michigan has neglected to understand the science of water and aggregates, that is geology
- Who would use the data?
 - Regulators, engineers, geologists, city & county planners, citizens in useable formats and databases!
- Do we know where the water is in Michigan?
 - Does Michigan have any validated database?
 - **NO!**

Wellogic Water Well Summary: # and Type

The only database for subsurface data in Michigan

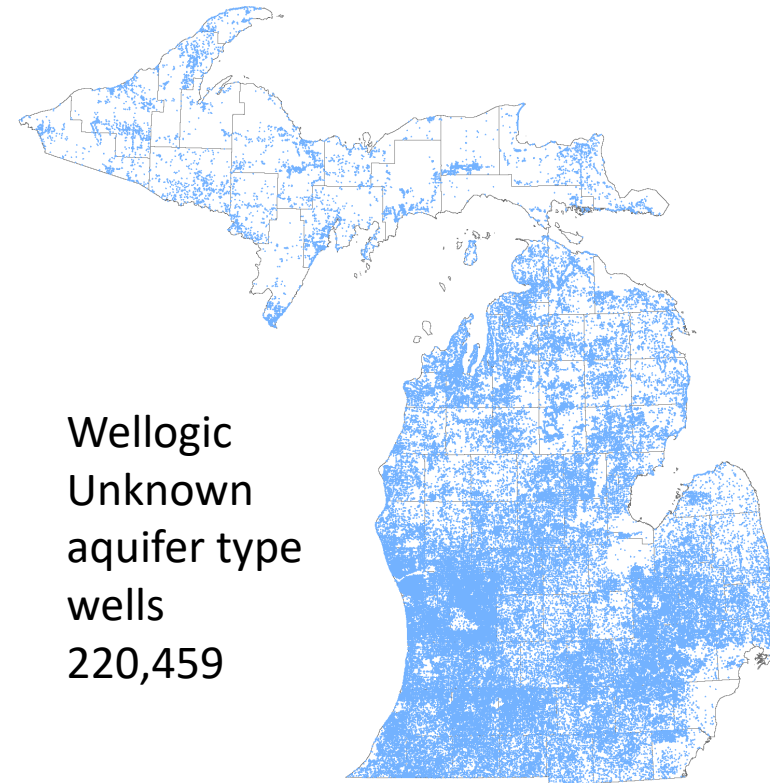
Wellogic DB all wells
713,804

There are >700,000 scanned
Logs not entered into
Wellogic.
There are >1.4 M water
wells in Michigan



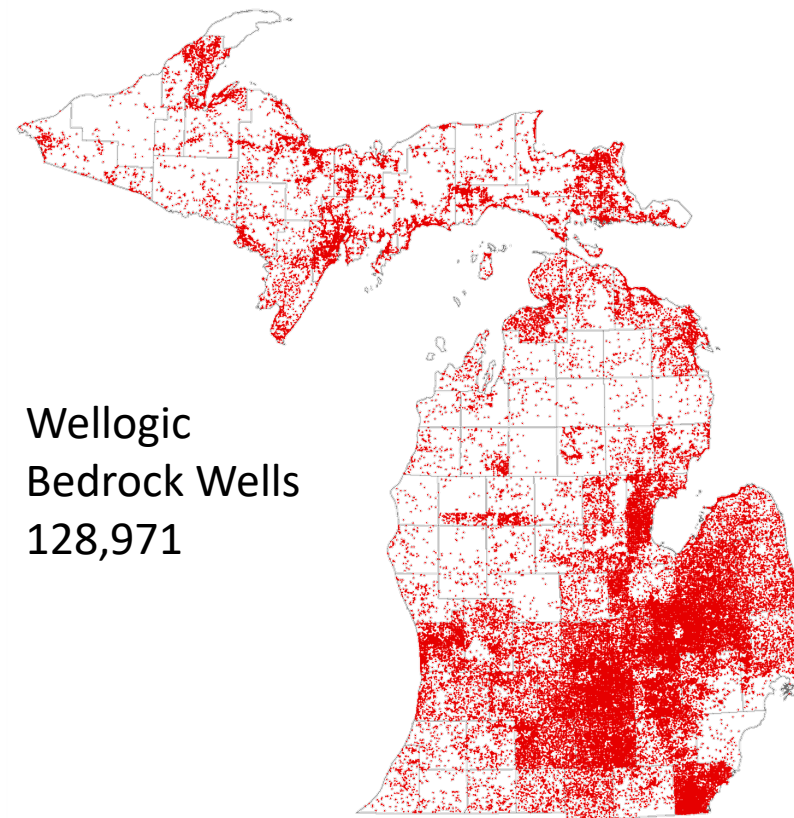
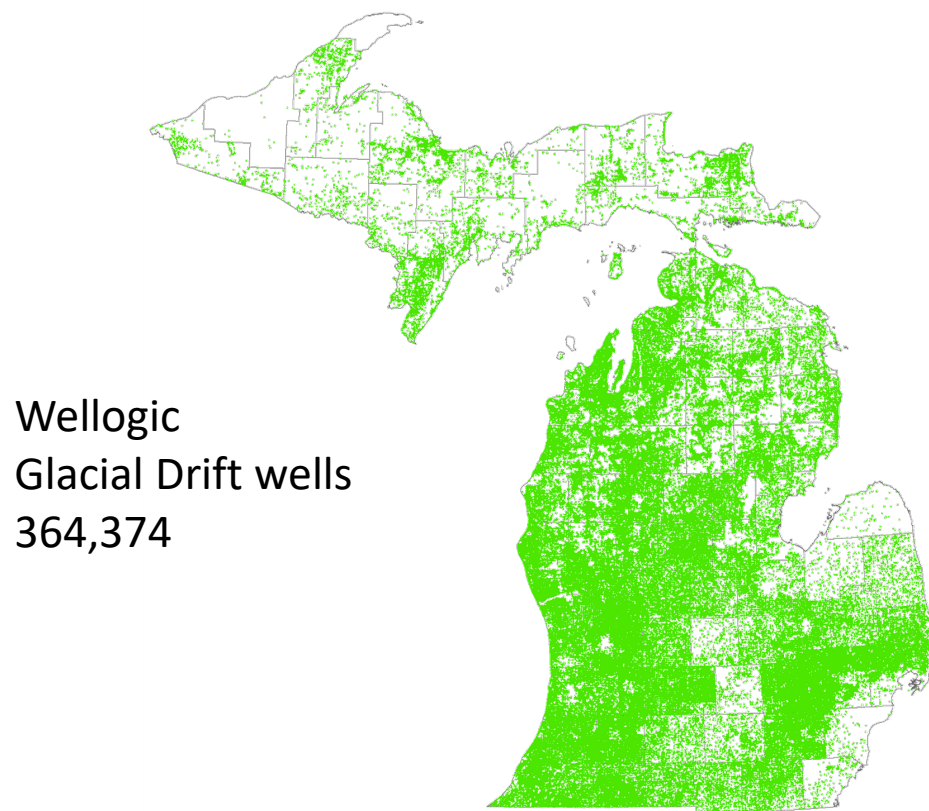
Wellogic DB initiated in 2003
Well data update, June 2021

Wellogic
Unknown
aquifer type
wells
220,459



Note Aquifer Type field in Wellogic
can often be unreliable

Wellogig Summary: Drift Vs Bedrock



Wellogig DB in 2003
Well data update, June 2021

Note Aquifer Type field in Wellogig can often be unreliable



Current Database, Water Well Logs: Wellogic

Quality geologic information is useful and can be an essential data set

- However, when using Wellogic, the only database, there are a number of problems!
 - Lack of glacial terms makes interpretation difficult,
 - Quality of the lithologic terms/descriptions range from outstanding to totally useless,
 - Therefore, unreliable and it makes them difficult to impossible to correlate subsurface units and all must be reviewed carefully,
 - Cuttings descriptions & depths not always correct.
- NOTE: Many drillers are now inputting quality data
- MGWA wants MGS to train drillers in using standard sample terms
- MI has used these Wellogic logs as the primary source for preliminary mapping of aquifers and other units in the subsurface for ~18 years, since 2003?
- Wellogic cannot produce real 3D geological interpretations, the data is not science.
- **Errors in location, pre-2020, 35-80% not located correctly or corrected, everyone using the database had to validate location to use the data.**

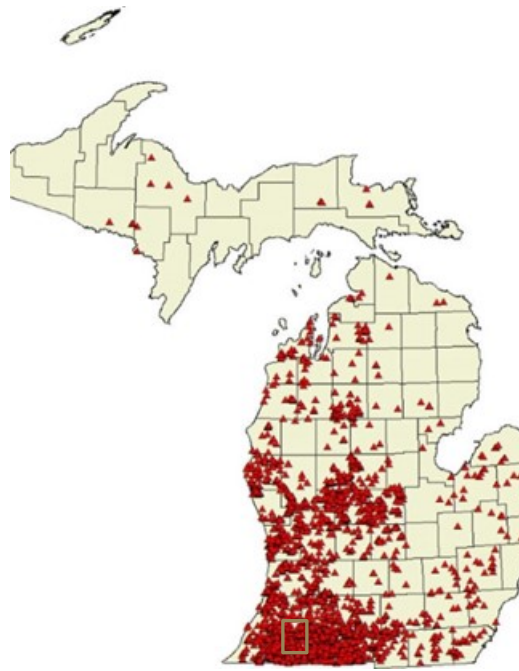
No!

MI WWAT Application vs Detailed GEOLOGIC Map Products- Examples!

Approximately 60% of the LP groundwater comes from glacial material

MI WWAT Applications > 70 GPM (High Capacity) through 2019 for comparison

Beginning in ~2003 (Water Withdrawal Assessment Tool– Well Drillers logs, non-factual model, a screening tool, ONLY!)



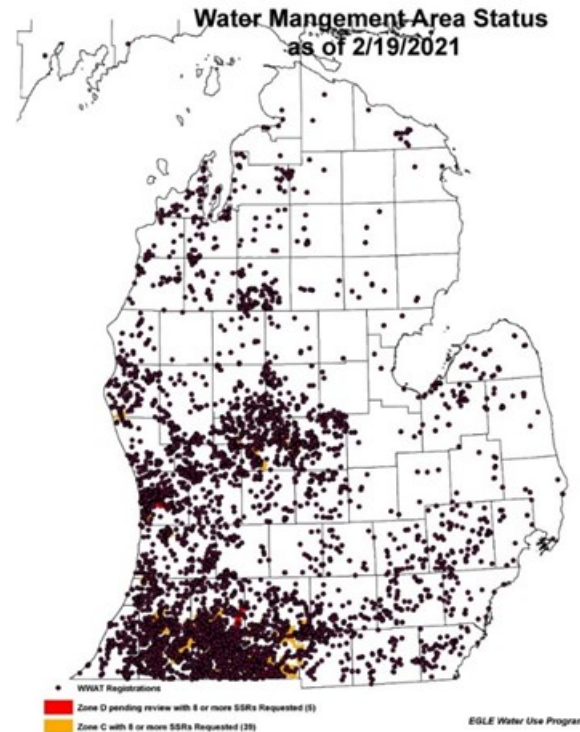
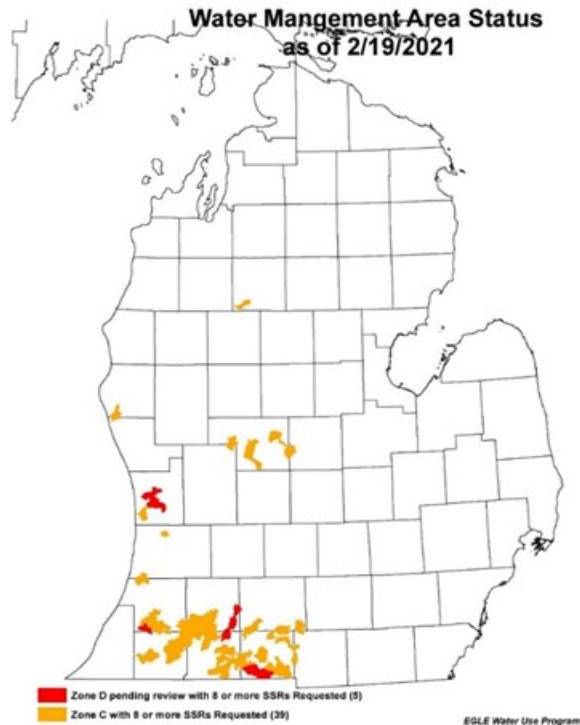
This is the real summary of mapping of the detailed combined surface and subsurface by MGS, USGS or others for Lower Peninsula

Less than 10% Detailed MGS mapping

- **QUADS (~56 sq mi)**
- **Black – Surface only with validation of borings**
- **Red – Surface + some subsurface drilling/geology 3D**
- **Water Impacts (Cl, As)**

EGLE – High Capacity (HC) Stressed Areas, HC Applications,

MGS - Maps



Orange and red, water management areas having 8 or more Site Specific Review (SSR) data documentation (\$20-60k/permit) required to prove no impacts to streams

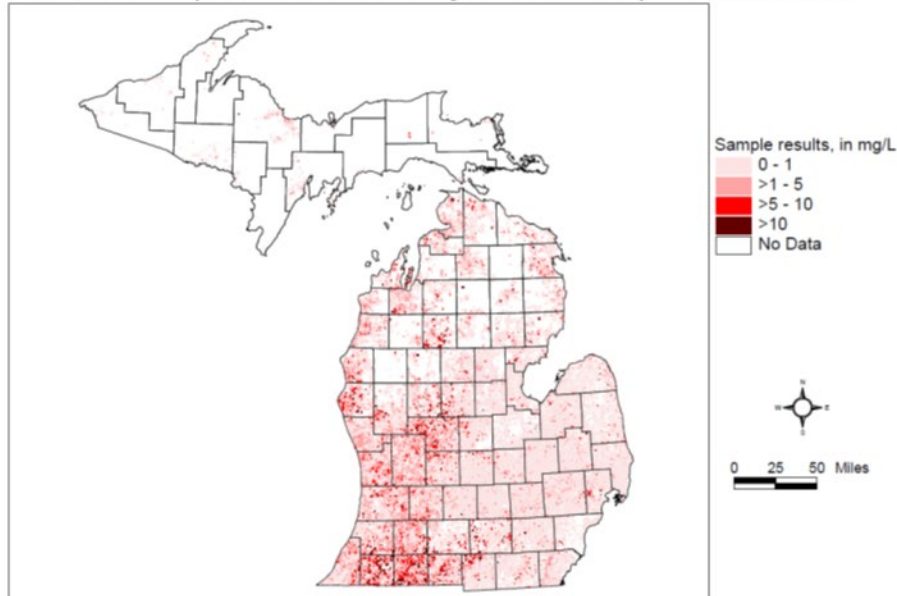
Dark red dots, High Capacity (HC) > 70 GPM applications

Many water demand areas require geologic mapping, now being proposed, compare with left two figures.

Agriculture represent ~25% of Michigan's economy

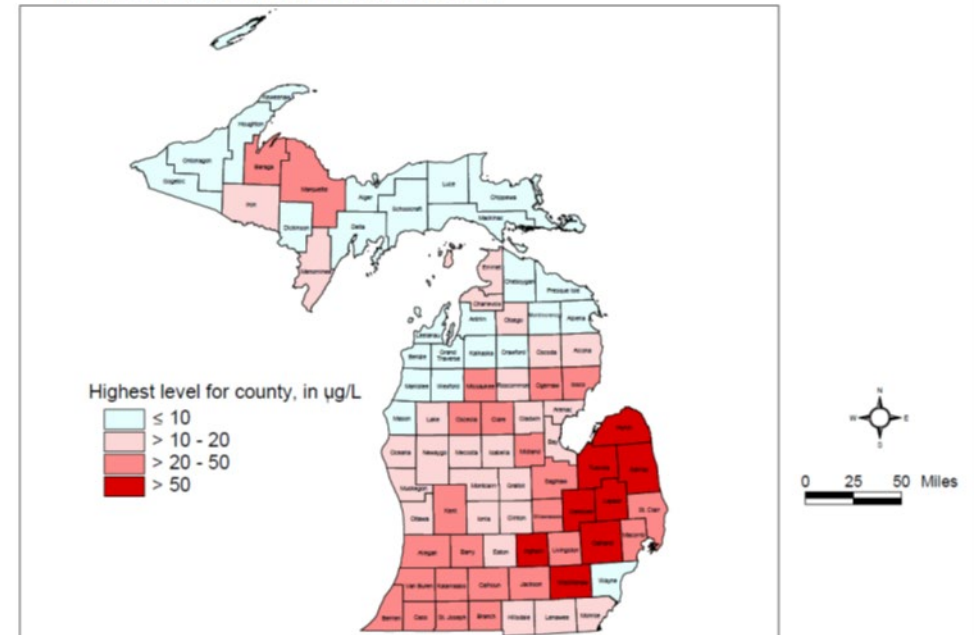
Existing Groundwater Impacts Contaminants

Nitrate Samples, Results Averaged Over 1 Square Mile Area



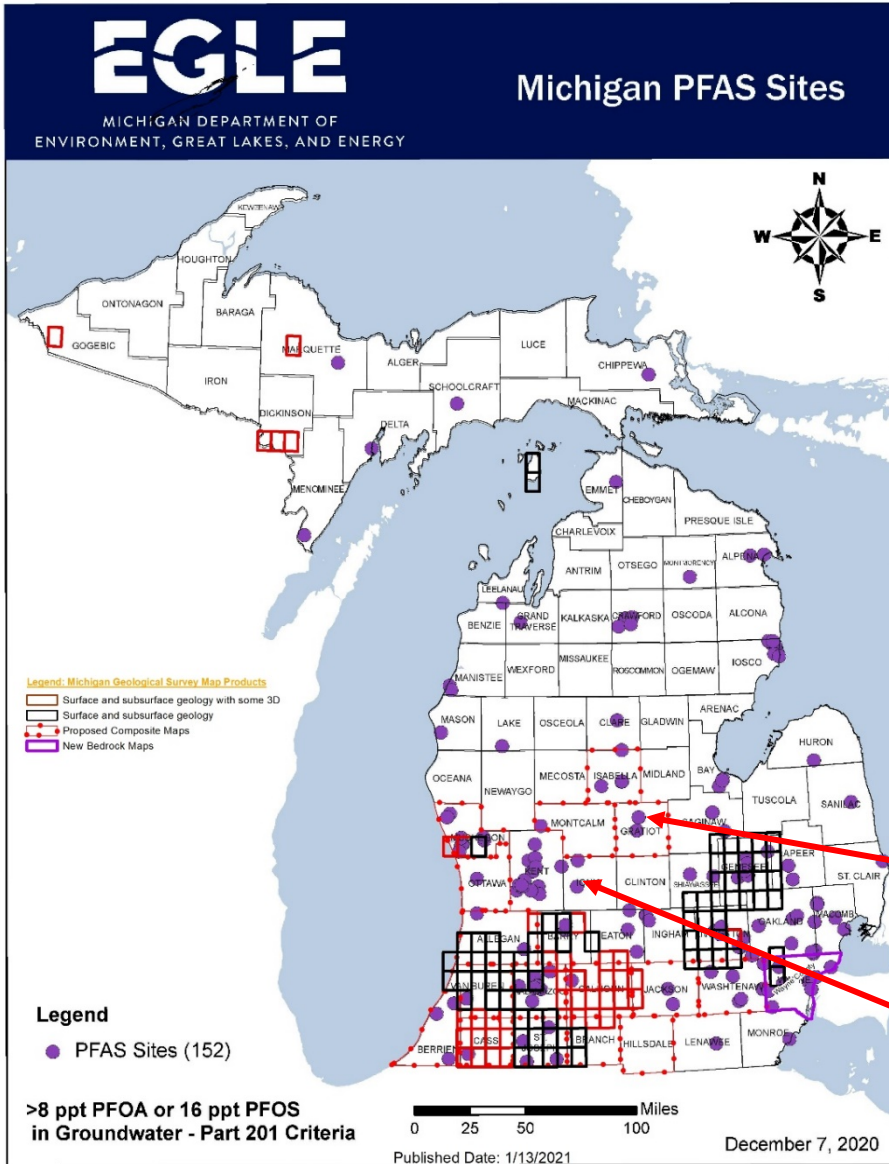
Source: DEQ WaterChem Database, 1983-2003 samples

Arsenic Levels in Groundwater



Source: DEQ WaterChem Database, 1983-2003 samples

Where do we need geologic data?



Michigan is #1 in the US for PFAS assessments, statewide (EGLE-MPART)->1400 Public water systems.

PFAS areas versus mapping

- Perfluorinated Alkyl Substances (PFAS) – Soils and water
- Multiple locations throughout Michigan and there may be more
- Where Michigan has open file subsurface geologic data
- Red and Black outlines represent MGS mapping products
- 13 red dots outline counties from MI-EGLE-WRD needing geologic data
- EGLE-MPART – PFAS 47 counties needing geology



EGLE – MPART, 2018, Needed location data – PFAS Sites

MGS was requested to compile specific data at PFAS locations

- 2 to 5 mile radius of a PFAS location
- Depth to GW and flow direction, geology, surface water flow, depth to bedrock

Over 30% - 80% of wells did not plot within the 2 to 5 mile radius

- Could not predict direction of groundwater or surface water flow
- Every well location needed validation and/or correction.
- Everyone that used the Wellogic database had to validate the well locations
 - Yes, everyone had to locate the wells, because they were not corrected in the database

MGS, 2018, was awarded grant, Triage, to correct the Wellogic locations in the database

- Also input of ~700,000 Scanned Logs (1960's to 2003 paper files)

Other states are validating data (I.e. locations, Lithology) in well databases

Following is a summary of how the MGS Triage Team is correctly locating the wells



Wellogig Team

Consists of Three Main Groups: Team now has 32 Students (Undergraduate and Graduate) and contract staff.

- Digital Input
 - Verifies legacy (scanned 1960's to 2003) water well logs and input to the current database
- Location Validation
 - Verifying the location of water wells in the current Wellogig database
- Mapping - Specific areas requested by EGLE
 - Using ArcGIS, selective **verified** Wellogig data to create groundwater and surface water maps with associated cross sections for Michigan – EGLE



Wellogic Team – Providing Quality Data

- Team members are trained and work remotely
 - Mostly independent work once training is complete
 - Group training sessions
 - Demonstrate abilities before independent work
 - Only exception to remote work is new paper logs (>6000 paper logs 2017-2021).
 - Many drillers do not have Internet in Michigan, must submit paper
- Communication and Quality Assurance
 - Drop-in online help sessions
 - Biweekly meetings
 - <1hr, problem solving and techniques reviewed
 - Monthly internal and external quality checks and assurance
 - Quarterly training assignments and performance reviews
 - Maintaining quality and improving efficiency
- The main goal of Digital Input and Location Validation is providing quality data for all Wellogic users for data and mapping efforts



Wellogig Team – Digital Input

Goal: Ensure legacy scanned water well logs (logs pre-2000's) are preserved in the Wellogig database, on a per county basis

- If a legacy log exists in Wellogig, ensuring the information is correct (>75% did not have correct data entered)
 - Essential fields: Geology, Geographic Location, Static Water Level, Driller Information, Screen Information, Well Depth, Construction Date. (Difficult to read much of the data on copies of handwritten data)
- If legacy log does not exist in Wellogig, inputting all data, if not at least the essential information into the database
- Legacy log format, 1960's to present has changed five (5) times, difficult to find data on changed forms.
- Location accuracy = 200 feet from location (at least within the parcel of the address described)
- Paper Logs – same method as scanned well logs, but most are post- 2017
- All input to standard Wellogig form (Next slide)

To date ~72,000 scanned and paper logs have been entered or validated!

WATER WELL AND PUMP RECORD

Completion is required under authority of Part 127 Act 368 PA 1978
Failure to comply is a misdemeanor

TAX NO: 38-323-7256 Well ID #: 39000024303

1. LOCATION OF WELL
County: Kalamazoo Township Name: BRADY Fraction: N1/2 Sec 15 T42S R10W Section No.: 1 Town No.: T42S Range No.: R10W

Distance and Direction from Road Intersection:
1/8 MILE NORTH OF EAST U AVE
1/8 MILE SOUTH OF EAST T AVE
500 EAST OF SOUTH 34TH ST.

Street Address & City of Well Location:
11717 S 34TH ST. VICKSBURG MI 49097

Locate with 'x' in Section Below

Sketch Map:
EAST T AVE
EAST U AVE
SOUTH 34TH ST

2. FORMATION DESCRIPTION

FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
CLAY SAND	10	10
SAND CLAY	20	30
CLAY	10	40
SAND	14	54

3. OWNER OF WELL: GLENN STATLER
Address: 11717 S 34TH ST. VICKSBURG MI 49097

4. WELL DEPTH: 54 ft. Date Completed: 6/9/18

5. USE: Household Type I Public Type III Public
 Irrigation Type IIa Public Heat Pump
 Test Well Type IIb Public

6. CASING: Steel Threaded Height: Above/Below Surface: 1.00 ft.
 Plastic Welded
 Other

7. SCREEN: Not Installed Gravel-Packed
Type: 10/32 Diameter: 3
Slot/Gauze: 12 Length: 4
Set Between: 30 ft and 34 ft.
FITTINGS: K-Packer Bremer Check
 Blank Above Screen

8. STATIC WATER LEVEL: 11 ft. Below Land Surface Flowing

9. PUMPING LEVEL: Below Land Surface
ft. After 1 hrs. Pumping at 1 G.P.M.
 Plunger Bailor Air Test Pump

10. WELL HEAD COMPLETION: Pitless Adapter 12" Above Grade
 Basement Offset Well House

11. WELL GROUTED? No Yes From 0 to 50 ft.
 Neat Cement Bentonite Other
No. of Bags: 174 Additives:

12. NEAREST SOURCE OF POSSIBLE CONTAMINATION:
Type: SEPTIC Distance: _____ ft. Direction: _____
Type: _____ Distance: _____ ft. Direction: _____

13. PUMP: Not Installed Pump Installation Only
Manufacturer's Name: P&W
Model Number: CP-1000 HP: 1/2 Volts: 230
Length of Drop Pipe: 31 ft. Capacity: 18 G.P.M.
TYPE: Submersible Jet Other

14. PRESSURE TANK:
Manufacturer's Name: AMTROL
Model Number: WX-250 Capacity: 44 Gallons

15. ABANDONED WELL PLUGGED? Yes No
Casing Diameter: 2 in. Depth: N/A ft.
PLUGGING MATERIAL: Neat Cement Bentonite Slurry
 Cement/Bentonite Slurry Concrete Grout Bentonite Chips
No. of Bags: 174 Casing Removed? Yes No

16. REMARKS: (Elevation, Source of Data, etc.)

17. DRILLING MACHINE OPERATOR:
 Employee Subcontractor
Name: TIM Z

18. WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
ZANTIER WATER WELLS 2218
REGISTERED BUSINESS NAME: ZANTIER WATER WELLS REGISTRATION NO.: 2218
Address: 10444 E U AVE VICKSBURG MI 49097
Signed: Tim Zantier Date: 7-2-18
AUTHORIZED REPRESENTATIVE



Water Well And Pump Record

Completion is required under authority of Part 127 Act 368 PA 1978.



Failure to comply is a misdemeanor.

Import ID: Tax No: 15-01-300-006 Permit No: 98 County: Kalamazoo Township: Brady

Well ID: 39000024303

Elevation: Latitude: 42.146996 Longitude: -85.429992 Method of Collection: Interpolation-Map

Well Depth: 54.00 ft. Well Use: Household Date Completed: 6/9/1998

Well Type: Replacement Casing Type: Steel - black Casing Joint: Threaded & coupled Casing Fitting: Drive shoe

Height: 1.00 ft. above grade

Diameter: 4.00 in. to 50.00 ft. depth 3.00 in. to 54.00 ft. depth Borehole: 4.00 in. to 54.00 ft. depth

Drilling Method: Cable Tool Pump Installed: Yes Pump Installation Date: HP: 0.50

Manufacturer: Flint & Walling Pump Type: Submersible Pump Capacity: 10 GPM Pump Voltage: 230

Model Number: Drop Pipe Length: 31.00 ft. Drop Pipe Diameter: 1.00 in. Draw Down Seal Used: Unknown

Pressure Tank Installed: Yes Pressure Tank Type: Unknown Manufacturer: Amtrol Model Number: WX-250 Tank Capacity: 44.0 Gallons Pressure Relief Valve Installed: Unknown

Formation Description	Thickness	Depth to Bottom
Clay & Sand	10.00	10.00
Sand & Clay	20.00	30.00
Clay	10.00	40.00
Sand	14.00	54.00

Static Water Level: 17.00 ft. Below Grade Well Yield Test: Yield Test Method: Bailor

Screen Installed: Yes Filter Packed: Yes Screen Diameter: 3.00 in. Blank: 1.00 ft. Above Screen Material Type: Unknown Screen Installation Type: Unknown Slot Length Set Between: 12.00 4.00 ft. 50.00 ft. and 54.00 ft.

Fittings: Neoprene packer

Well Grouted: Yes Grouting Method: Grout pipe outside casing Grouting Material Bags Additives Depth: Bentonite slurry 1.75 None 0.00 ft. to 50.00 ft.

Wellhead Completion: Pitless adapter

Nearest Source of Possible Contamination: Type: Septic tank Distance: Direction:

Abandoned Well Plugged: Yes

Casing Diameter: 2 in. Casing Removed: No Plugging Material: Bentonite chips/pellets No. of Bags: 1.25

General Remarks: Other Remarks:

Signature of Registered Contractor: Date:



Wellogig Team – Location Validation

Goal: Validating the location of the water wells in Wellogig database, on a per county basis (83 counties) (**only the location**)

- Checking the latitude-longitude on the log in comparison to the location of the address/location description on log
- Not all logs can be verified for the location
- Location accuracy is the same as Digital Input (200 feet within the address location or description)

To date ~164,000 well locations have been validated!

Well ID 26000009606 - 6009 Round Lake Rd

Location validation difference between the previously located water well and the newly validated water well



Google Earth

© 2021 Google



Wellogic Team – Mapping (Special)

Goal – Using ArcGIS methods, present the verified data from Wellogic into requested selective locations, groundwater and surface water maps as well as associated cross sections

- Typically, site-specific mapping
- Mapping is done in a 2-mile radius around a site with an extra mile or two radius for associated data
- Cross sections are done for the 2-mile radius
 - Three-dimensional views of groundwater flow
- What all is included with mapping?
 - Cross Sections with well logs and groundwater and bedrock surfaces
 - Surface water flow direction maps
 - Groundwater flow direction maps
 - Bedrock profile for cross sections

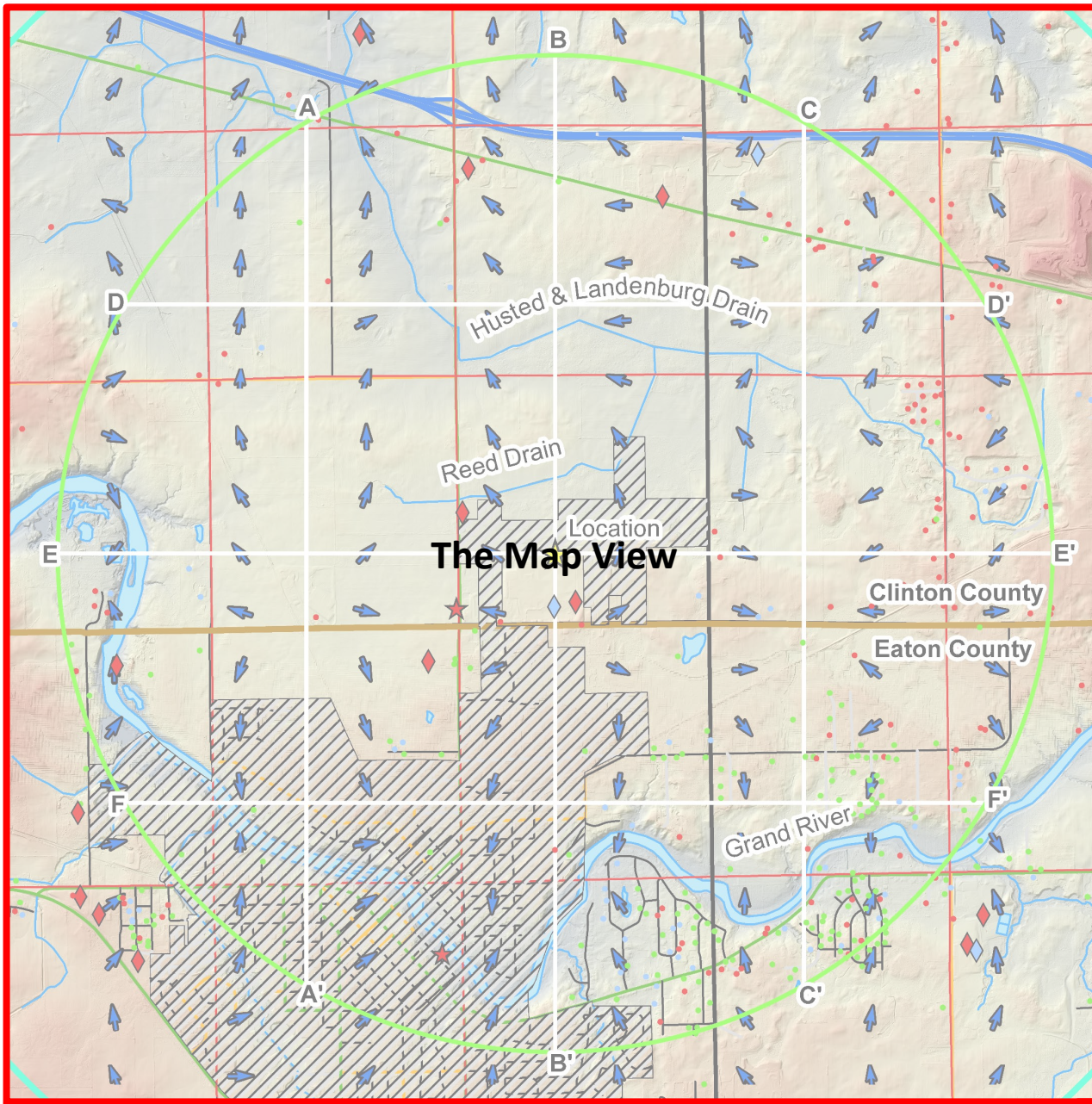


Mapping – Training

Custom Video Series for MGS Triage Workers

- [Mapping Schema Tutorials - Part 1: The Workspace](#)
- [Mapping Schema Tutorials - Part 2: Downloading Data](#)
- [Mapping Schema Tutorials - Part 3: Setting Up the Document](#)
- [Mapping Schema Tutorials - Part 4: Area of Interest and Water Well Setup](#)
- [Mapping Schema Tutorials - Part 5: Creating Groundwater Elevations and Surfaces](#)
- [Mapping Schema Tutorials - Part 6: Establishing Cross Sections](#)
- [Mapping Schema Tutorials - Part 7: The MN Tool - Setup Process and Execution](#)

Quarterly Mach-training sessions utilizing the tools and techniques from the videos



Groundwater Flow Map

Grand Ledge (City of Grand Ledge, Michigan) Water Well Locations and Cross Sections
Grand Ledge, Michigan

The map is a localized groundwater level (GWL) flow directions with Wellogic water well data in the background. The location is on a GWL mound, where groundwater flows both north and south of the location.

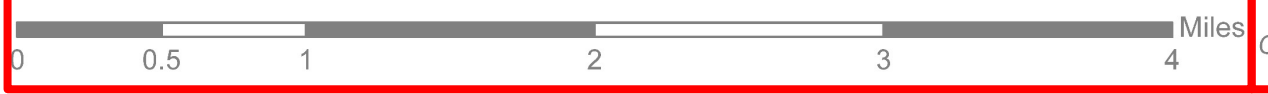
The background information is the DEM and hillshade of the DEM for landform classification.

Map Description/Observations

Legend

<ul style="list-style-type: none"> ★ Location 2 Mile Buffer Zone 3 Mile Buffer Zone — Cross Sections 	<p>Demographics</p> <ul style="list-style-type: none"> City of Grand Ledge Counties Townships Sections <p>Roads</p> <ul style="list-style-type: none"> Interstate Other Principal Arterial Minor Arterial Major Collector Minor Collector NFC Local Non-Certified
<p>Aquifer Type: Well Type</p> <ul style="list-style-type: none"> ★ 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 	<p>Hydrologic Features</p> <ul style="list-style-type: none"> ↑ GWL Flow Arrows Rivers Water Bodies

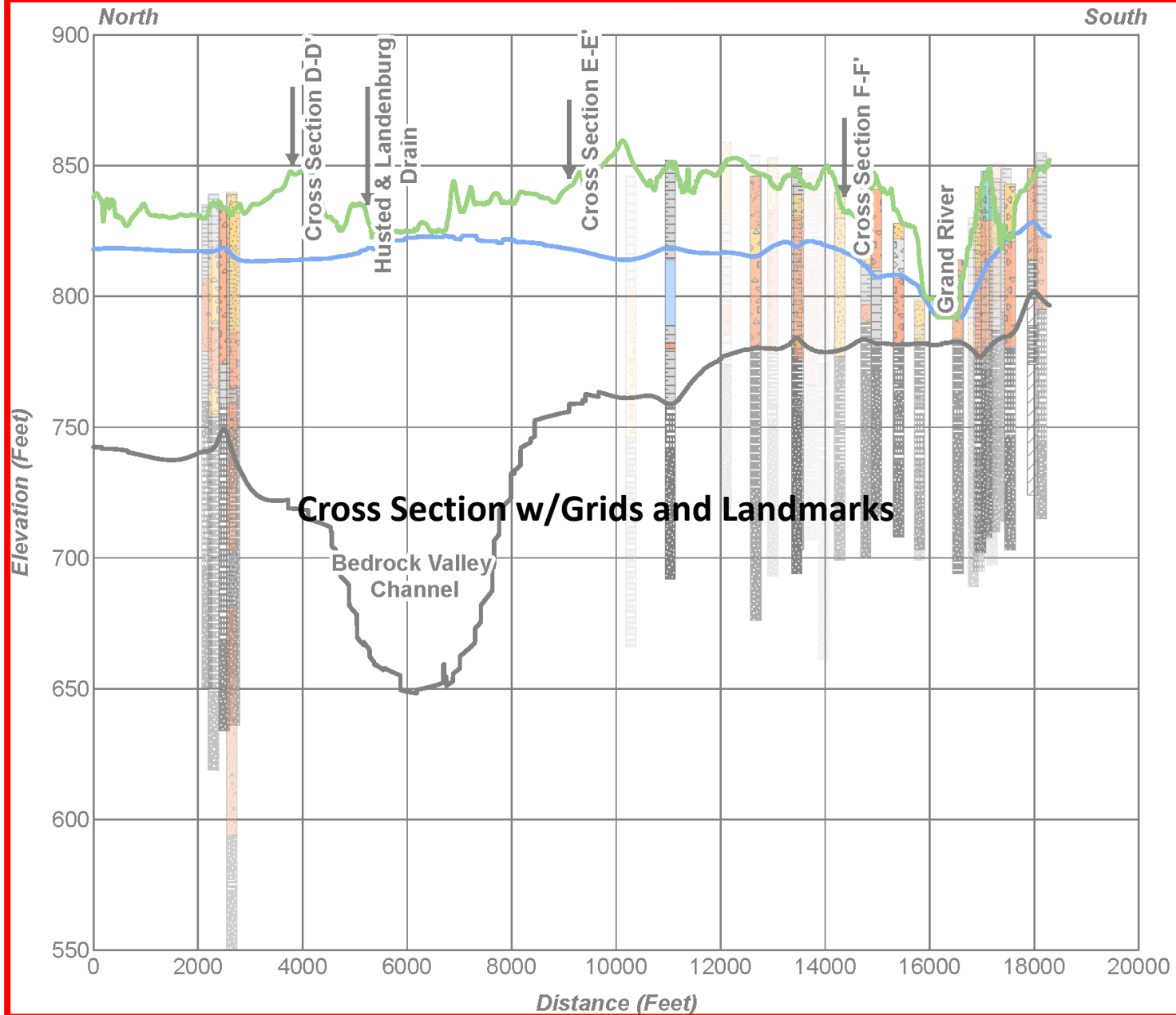
Geographic Context



Coordinate System: NAD 83 / Michigan State Plane Azimuth Natural Origin

Coordinate System

Section C - C'
Grand Ledge Army Aviation Support Facility (AASF)



The cross section outlines water well logs that have intersected the cross section line C - C' or are within 200 meters of the cross section line. Water well logs are faded to represent the distance away from the cross section line; the farther away from the line, the more faded a water well log will appear.

Legend

Quaternary Deposits

- Lithology**
- Coarse Soils (Gravels)
 - Sand
 - Silt
 - Clay
 - Till (Stones)
 - Till (Gravel)
 - Till (Sand)
 - Till (Clay)
 - Unknown Lithology/No Record

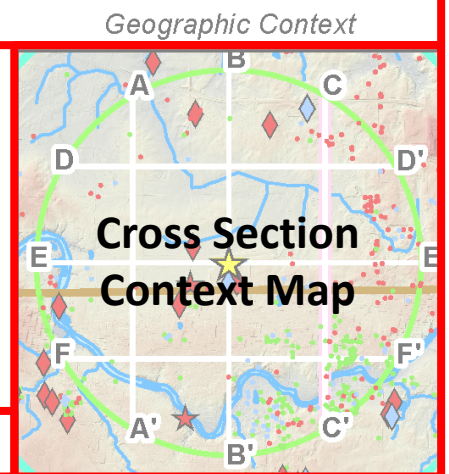
Paleozoic Bedrock

- Lithology**
- Limestone
 - Sandstone
 - Sandstone & Shale
 - Shale

Surfaces

- Topographic Surface
- GWL - All Years
- Bedrock Surface

Screens
No Screens present in cross section, but are included for any glacial drift wells



V.E. 50x



So... What is next?

Adapt techniques to more automation

- Python codes
- Specialized ArcGIS Toolbars

Utilizing the GeMS Schema in mapping efforts to be used for MGS mapping products and to establish a standard

- Taking the well logs and creating surface units

Large-scale mapping efforts

- County-wide surficial maps for groundwater quality assurance
 - Next project: Gladwin County
- Establish standard mapping units for the state (GeMS Schema)



Contact Information

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Questions?

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Michigan Geological Survey

