



# Overview of Groundwater Modeling

Jim Feild, PhD, Wood Environment & Infrastructure Solutions Inc.

Glen Champion, Department of Natural Resources

April 17, 2019

# East Metro Conceptual Site Model Memorandum Outline

---

[Redacted]

[Redacted]

[Redacted]

# East Metro Conceptual Site Model Memorandum Outline

6.0 Summary of CSM and Next Steps (building numerical model)

# Watershed Districts SG-1 Participation

## SCOPE

The following scope of work is anticipated for and requested of watershed districts (WSD) to help inform the co-Trustees (MPCA and DNR), their consultant (Wood), and other supporting State agencies (MDH and MGS) related to the groundwater model:

1. **Data Requests-** Correspond with and respond to the agencies and their consultant to provide information about the watershed. Information requested includes:
  - a. Water quality data within the district;
  - b. Groundwater level monitoring data;
  - c. Surface water elevation data;
  - d. Surface water discharge data;
  - e. Surface water bathymetry;
  - f. Recorded hydrological data;
  - g. Rainfall/recharge data;
  - h. Capital Improvement project information

All data requested should be delivered in native file formats that can be easily used/integrated into modeling efforts (i.e., CAD, GIS, MS Access Database, etc). This specific request is assumed to be provided no more than one week from request by the agencies/consultant team.

# Watershed Districts SG-1 Participation

2. **Drinking Water Supply Subgroup (SG)-1 Meetings-** it is anticipated that WSD members, their consultants or representatives would attend monthly SG-1 meetings in order to stay informed on the project. These meetings occur the third Wednesday of each month from 1-4 pm in the Cottage Grove City Hall training room.
  
3. **Interim reviews and feedback of modeling efforts:** it is anticipated that “homework” related to the groundwater model will be assigned to SG-1 members as well as WSD members, and will include the following:
  - a. Groundwater modeling reviews/collaboration: we anticipate no more than five (5) requests; each request will result in a telecon, review and response, at an estimated level of effort of 2-4 hours (not all homework assigned to SG-1 will need review by WSD members).

# Watershed Districts SG-1 Participation

- 4. Groundwater model workshops:** we anticipate no more than four (4) workshop meetings would be held during model development, at which Wood will present modeling inputs, process, and results. Members will be requested to brainstorm, collaborate, and develop consensus. Each workshop is anticipated to be between 1-3 hours in length. Workshop meetings are set month-by-month as-needed. The ones that are held will take place in the Cottage Grove City Hall training room on the first Wednesday of each month from 9-noon.
- 5. SharePoint Communication:** All Requests for Information (RFI) and project progress are posted and updated on the SharePoint site set up for SG-1. It is anticipated that the WSD would follow, review, and track activity on the SharePoint site once per week (approximately 1 hr effort per week) to stay abreast and informed of project progress.

NOTE: for those WSDs that are ancillary to the East Metro area proper, it is anticipated that SG-1 meeting participation and/or SharePoint communication is all that is required.

# Watershed Districts SG-1 Participation

1. Based on the above scope of work, please indicate your preferred level of involvement

Yes, I agree to full participation

Yes, I agree to partial participation (as defined by WSD)- pick all scope items that you choose to participate in

1. Data Requests

2. SG-1 Meetings

3. Interim Reviews

4. Groundwater Model workshops

5. Sharepoint Communication

No, I choose not to participate

# Watershed Districts SG-1 Participation

2. Is there a topic you would like brought up to SG-1? Please describe.

Yes, \_\_\_\_\_

No

3. Do you have a subject or case study you would like to present to SG-1 related to the GW model? Please describe.

Yes, \_\_\_\_\_

No

4. Are there other persons or entities that should be a part of this process?

Yes

No

If yes, please provide specific names and contact info (e.g., phone number, e-mail address, etc.)



# Potential Groundwater Model Objectives

Objectives	SG-1 Responses		Objective will be met?	Explanation of Current GW Model
	AVERAGE	RANGE		
<b>1) General:</b>				
Combine all current models, data from the previous models, and new data (i.e., Washington County Geologic Atlas) to build a new regional model. This new regional model would then be the basis for an infinite series of sub-models that could be used for local issues in the future and aid in answering questions specific to each area.	<b>H</b>	<b>Unk-H</b>	<b>Yes</b>	A water budget analysis will be used to evaluate and compare recharge, groundwater withdrawals from pumping, and baseflow within the model domain. Sections of the new and improved model can be cut out, enlarged, re-gridded and used to answer small scale but very important questions that are local area specific
<b>2) Groundwater Quantity (Elevation) Concerns Accounting For:</b>				
2.1 All significant withdrawals currently within the model domain under multiple pumping scenarios (i.e., high pumping rates, average pumping rates, low pumping rates)	<b>H</b>	<b>H</b>	<b>Yes</b>	Future groundwater elevation trends will be evaluated under various aquifer stresses. Model will address an increase in pumping rates associated with population growth, a rate consistent with no population growth (i.e., current pumping rates), and decrease in pumping rates usually associated with water usage efficiency.
2.2 Potential new water supply wells to meet growing demands on groundwater resources	<b>H</b>	<b>L-M-H</b>	<b>Yes</b>	The model will address capture zones as follows: <ul style="list-style-type: none"> <li>1) For specific climate scenarios (see 2.3 below), define the capture zones for each well/wellfield;</li> <li>2) Define the areas from which the well(s) will draw water and estimated travel times; and</li> <li>3) Assess influence of water bodies on drawdown and capture (lakes, rivers, streams)</li> </ul>

# Potential Groundwater Model Objectives

Objectives	SG-1 Responses		Objective will be met?	Explanation of Current GW Model
	AVERAGE	RANGE		
2.3 Droughts	M-H	Unk-L-M-H	Yes	<p>The model will be used to evaluate the effects of climatological changes, in the form of recharge (precipitation), on the capture zones. These scenarios will include the following:</p> <ol style="list-style-type: none"> <li>1) Past 5 to 10 years which represents a higher than normal precipitation period;</li> <li>2) Normal (average) precipitation period;</li> <li>3) Moderate drought condition period (late 1980s); and</li> <li>4) Extreme drought conditions period (1920s).</li> </ol>
2.4 Seasonal changes in surface water levels within the model domain	M	Unk-L-M-H	Limited	See 2.1 through 2.3 above
2.5 Assess aquifer safe yield	H	M-H	Yes	<p>The model will address groundwater flow field and drawdown (cones of depression and capture areas) by modeling current (2019) pumping rates (base case scenario) associated cones of depression and capture areas to assess sustainable yield. Three cases for each wellfield:</p> <ol style="list-style-type: none"> <li>1) Rates required according to Master Plan for each municipality (Middle case scenario);</li> <li>2) Rates according permit limits (Upper end scenario); and</li> <li>3) Assume no change from 2019 current rates (Lower Case scenario).</li> </ol>
2.6 Year-to-year and seasonal variability in water demands	M-H	M-H	Yes	See 2.1 through 2.3 above
2.7 Climate change and recharge	M	L-M-H	Yes	<p>See 2.1 through 2.3 above. The model will attempt to address the question:</p>

# Potential Groundwater Model Objectives

Objectives	SG-1 Responses		Objective will be met?	Explanation of Current GW Model
	AVERAGE	RANGE		
				<p>How do these scenarios affect Pumping Rates and capture zones described in 2.2 above?</p> <p>Additional data needs include any recharge projects on the horizon that can be modeled to evaluate the effects on plume migration, pumping rate changes, and capture zones.</p>
2.8 Others?				
<b>3) Groundwater Quality and Plumes:</b>				
3.1 Optimization of rates (lower or higher) for wellfields affected by contamination (PFAS or other contaminants). The optimized rate will be driven by the need to reduce or limit plume migration or capture contamination as part of remedial options.	<b>H</b>	<b>M-H</b>	<b>Yes</b>	The groundwater model can be used, for example, to examine the extraction of groundwater for ex-situ treatment or change pumping rates in order to cause migration of the plume in a different more beneficial direction (e.g., away from a surface water body or municipal well).
3.2 Contaminant migration and groundwater flow paths to evaluate capture zones and see where the groundwater contamination affecting a well/wellfield or surface water body originated.	<b>M</b>	<b>L-M-H</b>	<b>Yes</b>	<p>MODPATH – Particles and pathlines can be introduced into any of the scenarios described above and support assessing capture zones. This is a conservative methodology of looking at contaminant migration and groundwater flow paths, not just looking into the future, but also tracking particles and pathlines backwards in time to see where groundwater affecting a well/wellfield or surface water body originated.</p> <p>The model will not be used to make responsible party determinations in cases of unknown sources.</p>

# Potential Groundwater Model Objectives

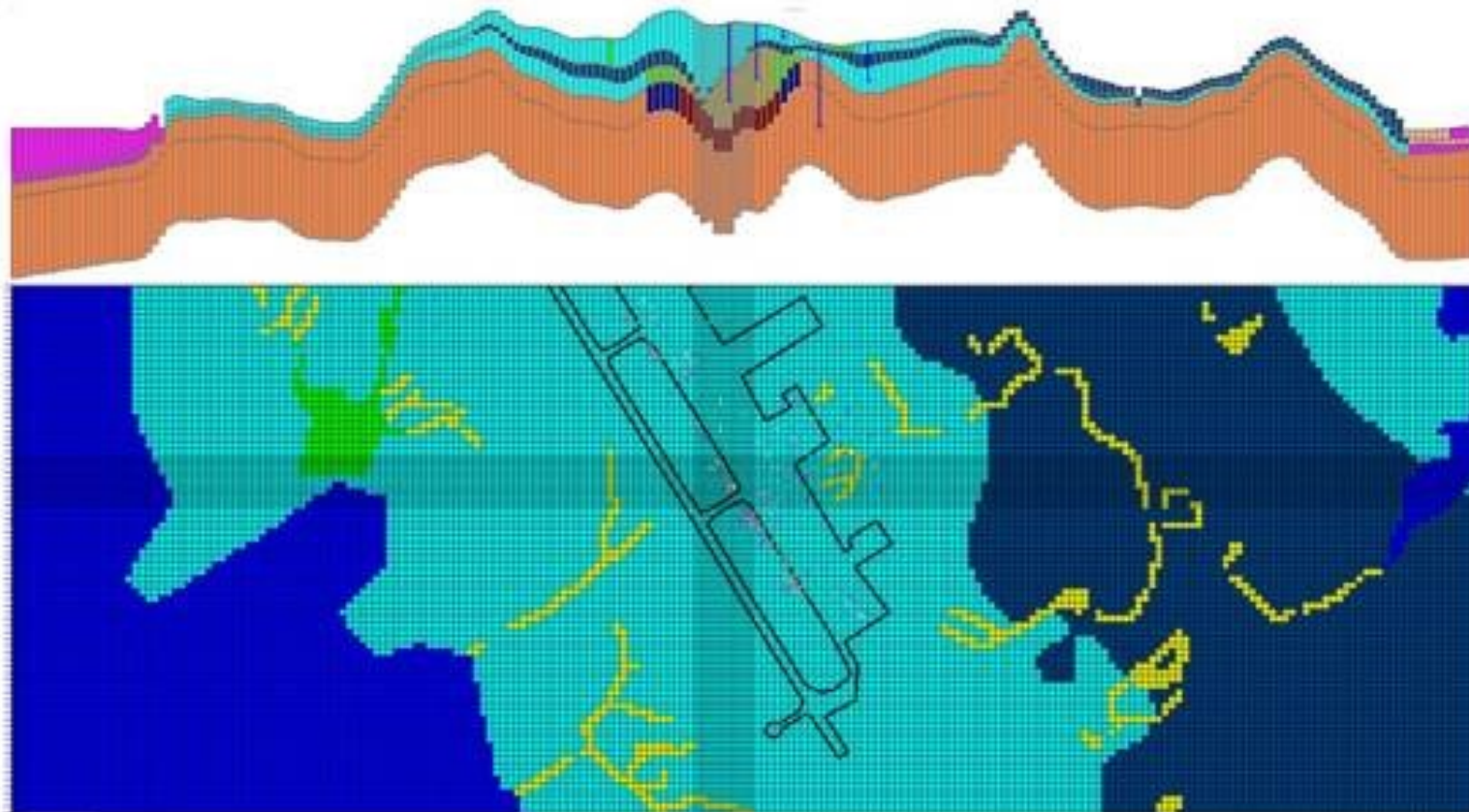
Objectives	SG-1 Responses		Objective will be met?	Explanation of Current GW Model
	AVERAGE	RANGE		
3.3 Delineate changes in PFAS plume flow paths that may result in new or increased contamination of private and non-community drinking-water supply wells.	<b>H</b>	<b>L-H</b>	<b>Limited</b>	See 3.2 above
<b>4) Transport of actual contaminants.</b>	<b>H</b>	<b>H</b>	<b>No</b>	<p>Transport of actual contaminants can be incorporated into any of the scenarios described above (e.g., PFAS, chlorinated solvents, metals, etc.). However, these scenarios will be addressed on a very site-specific need. The current groundwater model will be the basis for these smaller site-specific models. Specific data needs:</p> <ol style="list-style-type: none"> <li>1) Geochemical data               <ol style="list-style-type: none"> <li>a. Organic carbon content</li> <li>b. Mineralogy</li> </ol> </li> <li>2) Source area identification</li> <li>3) Source area concentrations</li> <li>4) Evaluate how agricultural practices such as application of fertilizers could affect groundwater quality</li> </ol>
4.1 Evaluate how agricultural practices such as application of fertilizers could affect groundwater quality.	<b>L-M</b>	<b>L-M-H</b>	<b>No</b>	See 4 above.
4.2 Others?  Respondent: Max contaminant threshold for increasing trends?	<b>-</b>	<b>H</b>	<b>Limited</b>	See 4 above. There is currently only temporal data in specific locations. Concentration trends will only be evaluated where sufficient data exists and if time allows.

# Potential Groundwater Model Objectives

Objectives	SG-1 Responses		Objective will be met?	Explanation of Current GW Model
	AVERAGE	RANGE		
<b>5) Implications to Surface Water Bodies:</b>				
5.1 Identify which surface water bodies (lakes, rivers, streams, etc.) are affected the most by pumping conditions.	<b>M-H</b>	<b>L-M-H</b>	<b>Limited</b>	The model may provide a limited evaluation of surface water bodies.
5.2 Identifying how the baseflow of rivers and/or streams us affected.	<b>M</b>	<b>M-H</b>	<b>Limited</b>	The model may provide a limited evaluation of surface water bodies.
5.3 Identifying lake levels under normal seasonal conditions and how much they change during dry periods.	<b>M</b>	<b>M</b>	<b>Limited</b>	The model may provide a limited evaluation of wetlands.
5.4 Identifying if wetlands are affected (areal extent).	<b>M</b>	<b>L-M-H</b>	<b>Limited</b>	The model may provide a limited evaluation of wetlands.
5.5 Identifying which surface water bodies are most affected by contaminants and/or plume migration.	<b>M-H</b>	<b>M-H</b>	<b>Limited</b>	This will be evaluated by the flowpath scenario described in 3.2 above.
5.6 Others?				

# Definitions – Grids and Cells

## Groundwater Model



# Areal Coverage of Model – Geological Inputs

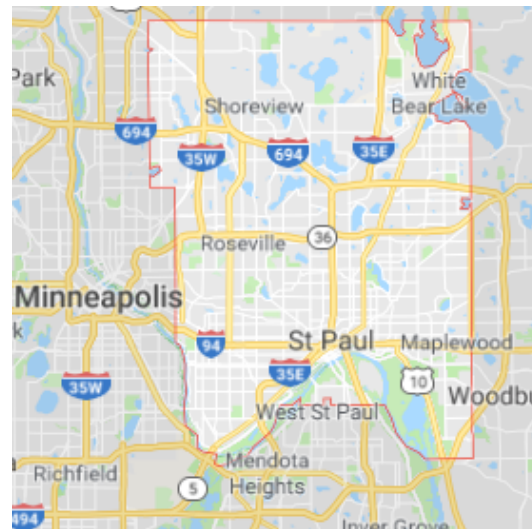
included

Counties currently **missing** in GW Model Lithological Surfaces

Hennepin



Ramsey



Dakota



# Calibration/Verification Data Sets

## Synoptic Groundwater Elevation Measurements Data Sets

-  2011 – 2 sets NE Metro Area
-  2012 – 2 sets NE Metro Area
-  2013 – 2 sets NE Metro Area
-  Winter 1989 – Metro Wide
-  March/August 2008 - Metro Wide
-  Others available from the DNR website

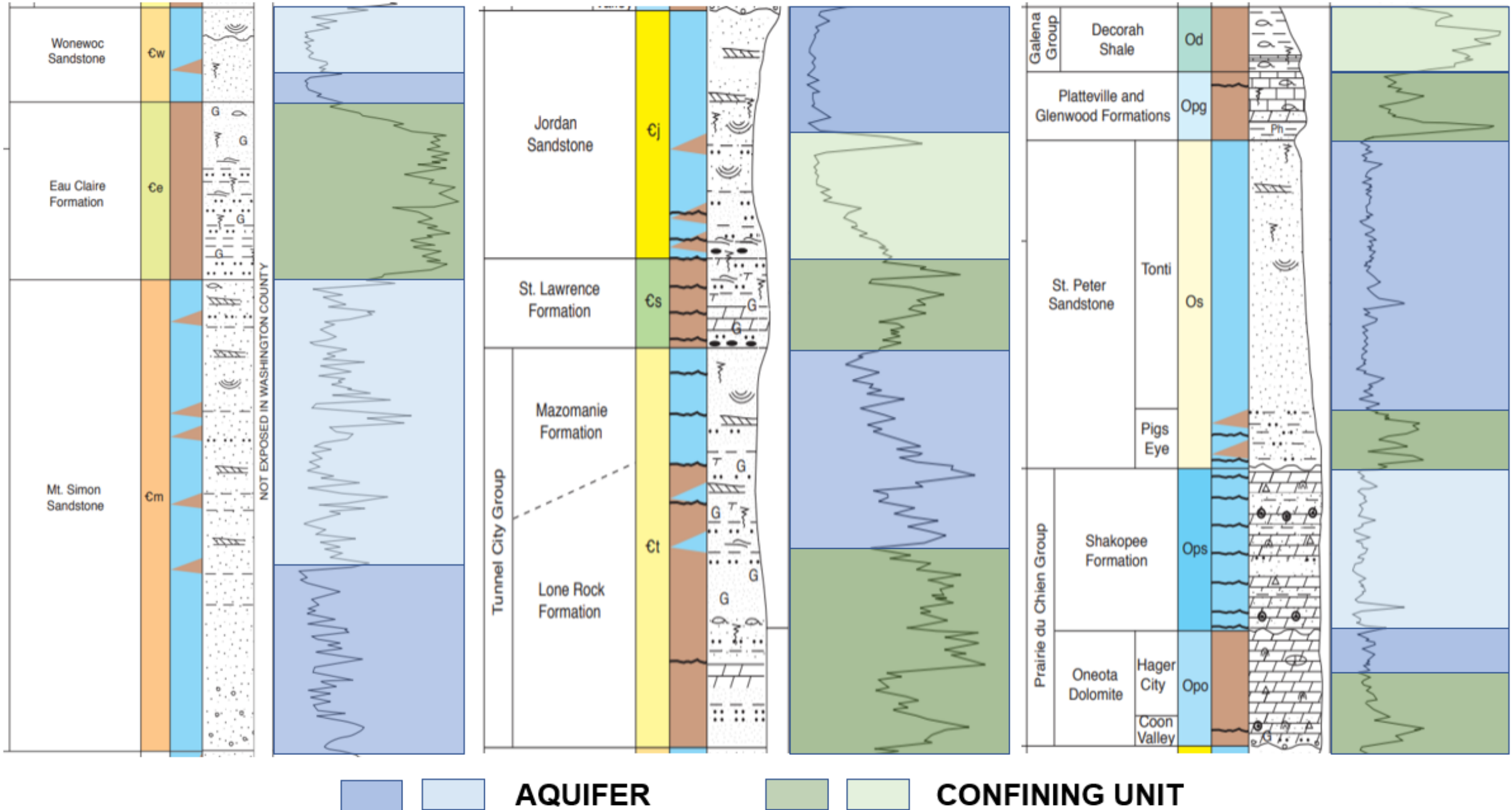


- Plume Definition – defined by others?
- Source Areas – defined by others?
- Concentration Data?

# HYDROSTRATIGRAPHIC FRAMEWORK AND PROPOSED MODEL LAYERS FOR BEDROCK

↑  
YOUNGER

↓  
OLDER



# Next Steps

**Compiling watertable  
elevation data  
for model  
calibration/verification**

**Climatological Analysis  
Presentation in  
May 2019**

**Tritium Qualitative  
Analysis**

# Thank you!

**Jim Feild, PhD**

**Wood, East Metro Groundwater Model Lead**

*james.feild@woodplc.com*

865.266.9492

**Glen Champion**

**DNR, Hydrologist**

*glen.champion@state.mn.us*

651.259.5652