Hydrogeological Investigations

Lena Pappas, EGLE Water Use Assessment Section (WUAS)
Michael Pennington, EGLE Wetlands, Lakes and Streams Unit (WLSU)

Why talk about hydrogeos at a wetlands conference?

Some projects may alter local hydrologic conditions by diverting water or changing groundwater levels

EGLE is required to look at both direct and indirect impacts to wetlands and water resources

A hydrogeo is one tool in the toolbox (but there could be others)

EGLE's Team Approach to Hydrogeo Reviews

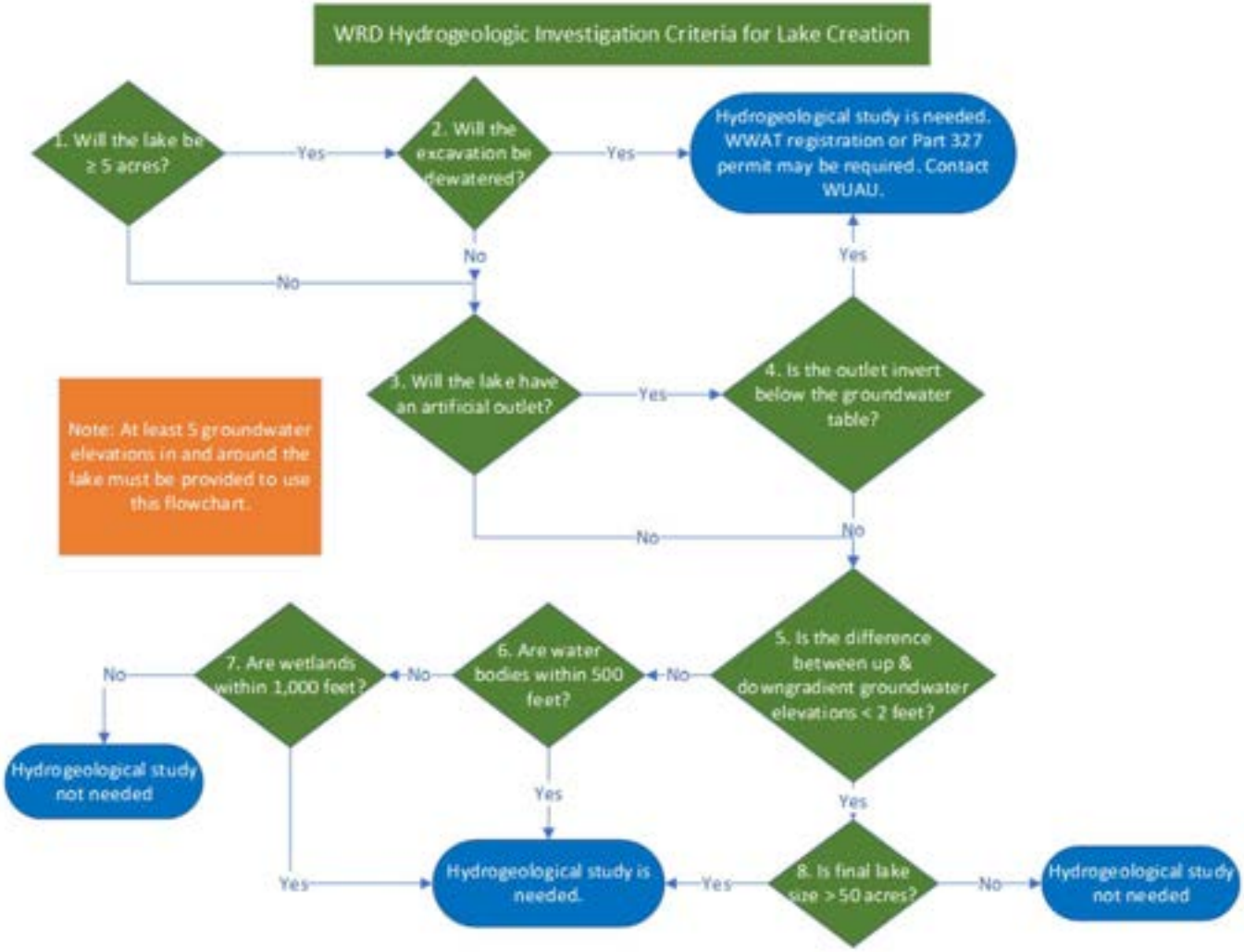
- District Staff (process application)
- Water Use Assessment Unit (reviews hydrogeos and/or numerical models)
- Wetlands, Lakes and Streams Unit (assists in determining potential impacts to wetlands or water resources)

Hydrogeologic Investigation Phases

1. Is a hydrogeologic investigation needed?
2. Is the hydrogeologic investigation complete?
3. Does the hydrogeologic investigation require a groundwater model?
4. Are the hydrogeologic investigation results reliable?

1. Is a hydrogeologic investigation needed?

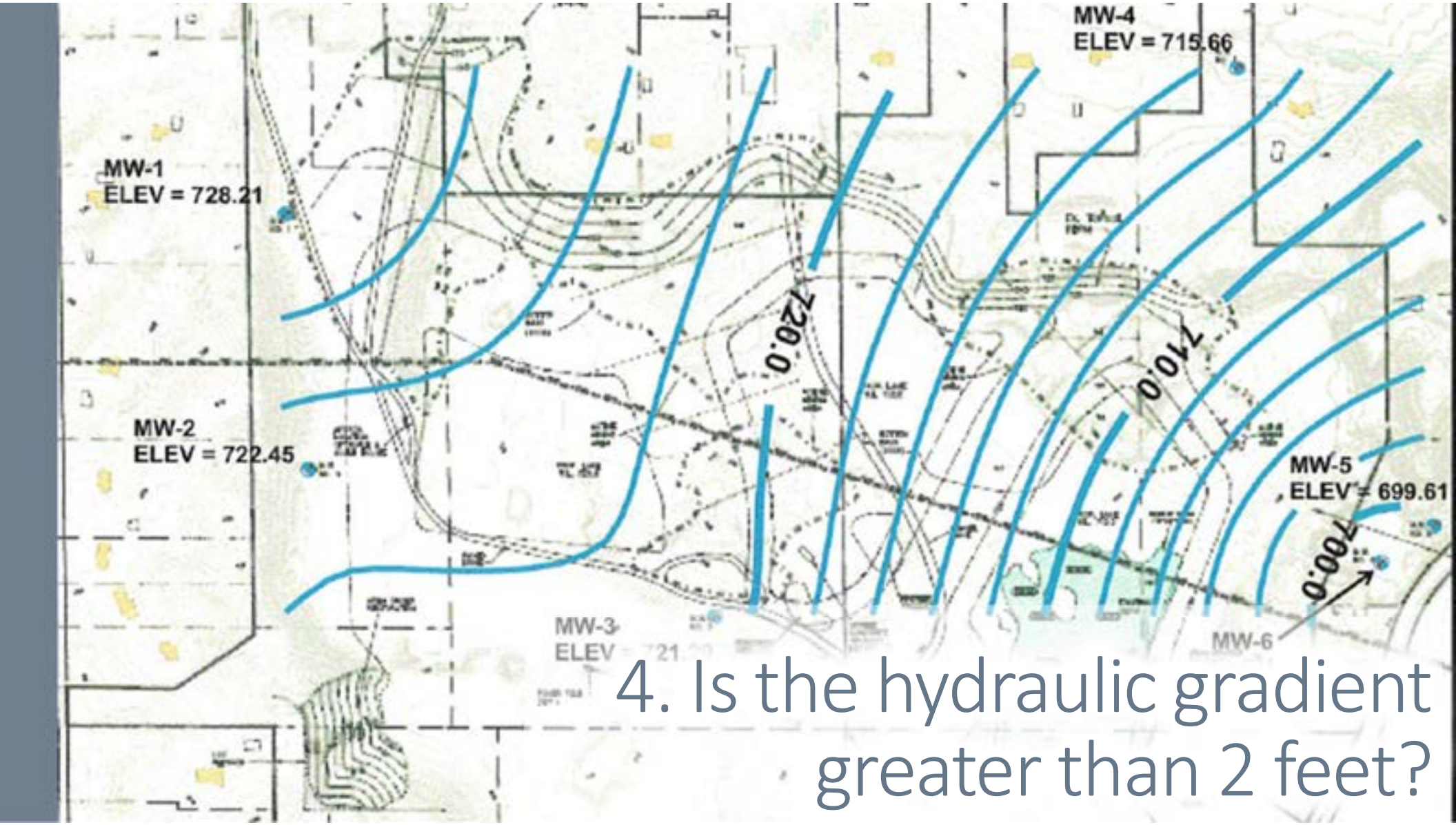
Hydrogeologic Investigation Flowchart



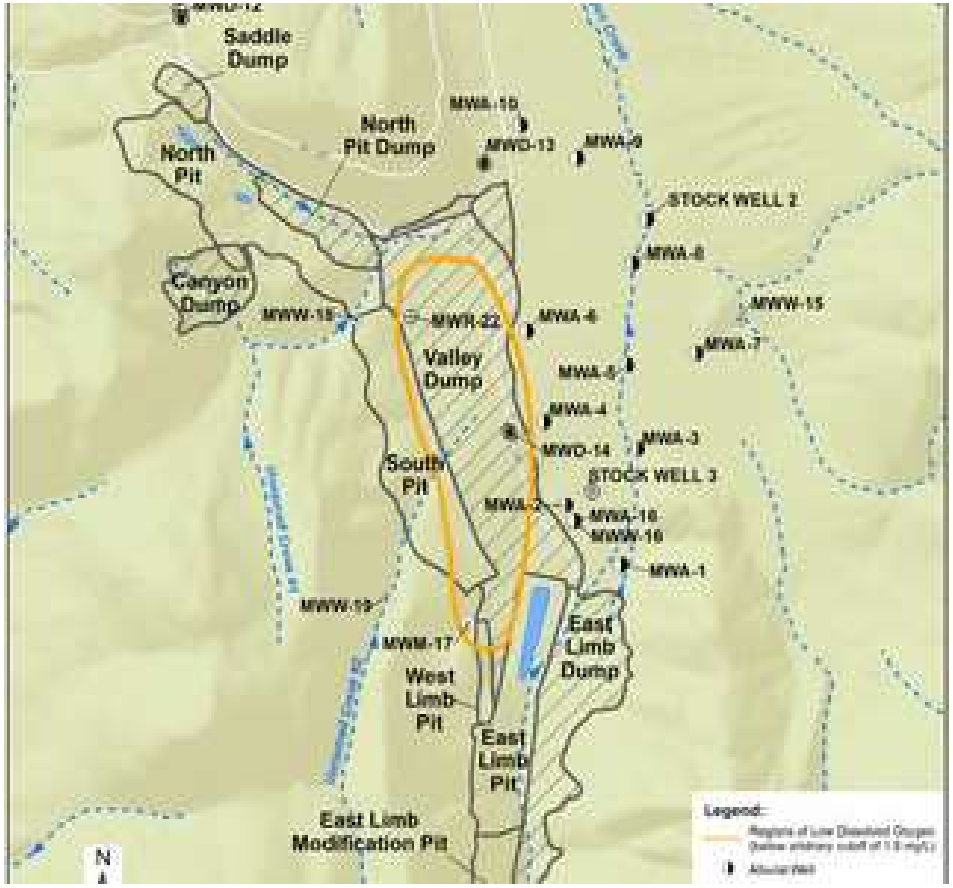
1. Will the excavation be dewatered?

2. Will the lake have an artificial outlet?

3. Is the outlet invert below the groundwater table?

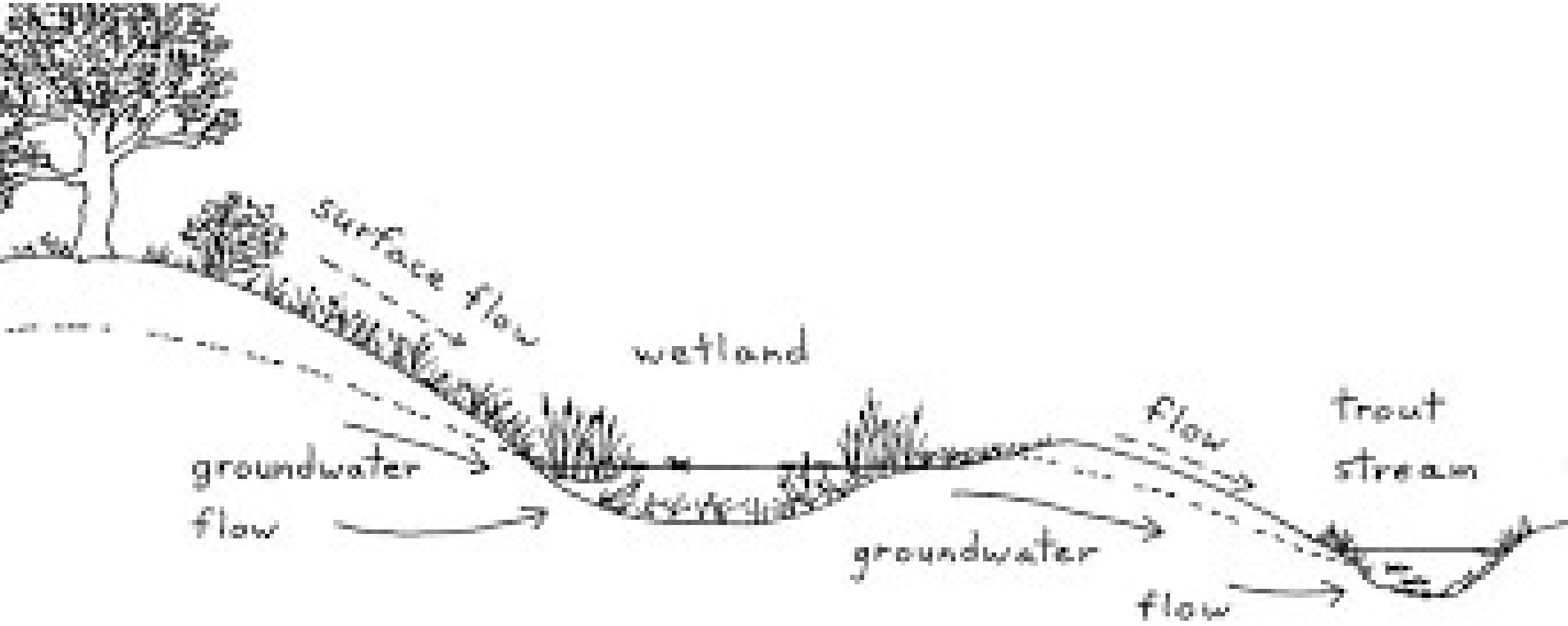


4. Is the hydraulic gradient greater than 2 feet?

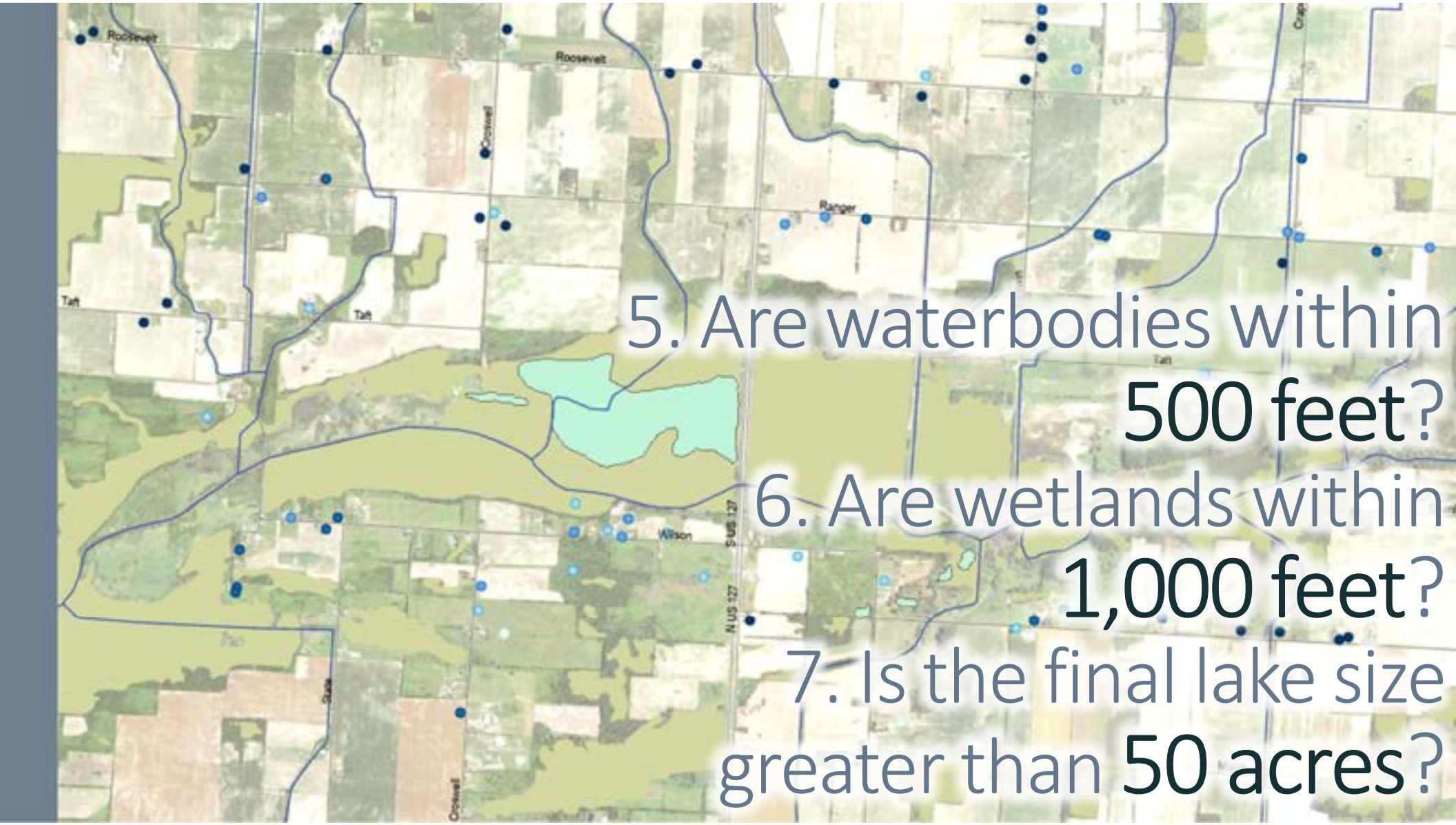


Monitoring Well Network

A minimum of **5 wells** must be present to consider the application complete.



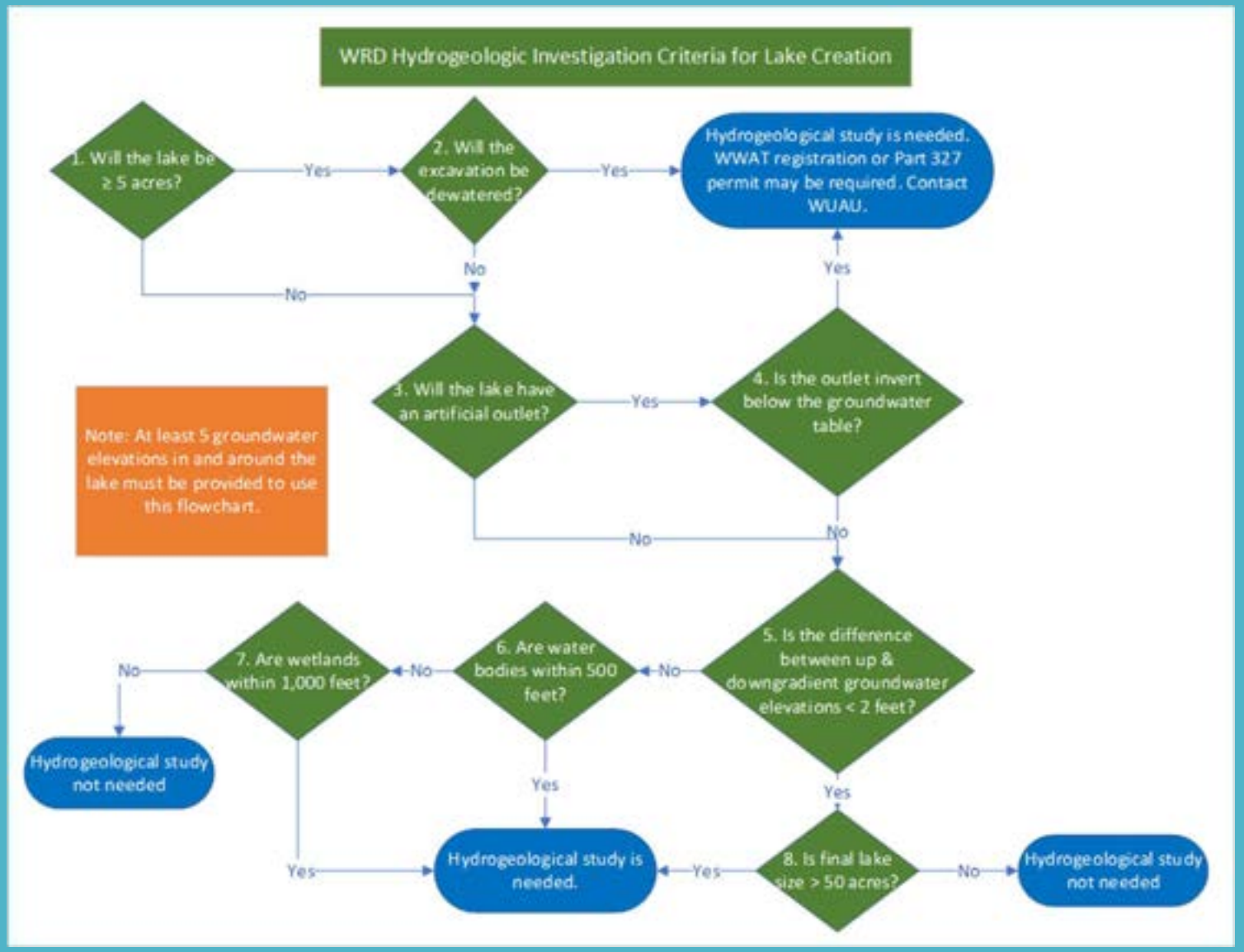
Surficial aquifers can include measurements from settling ponds, lakes, naturally occurring streams, monitoring/observation wells, and/or piezometers.



5. Are waterbodies within 500 feet?

6. Are wetlands within 1,000 feet?

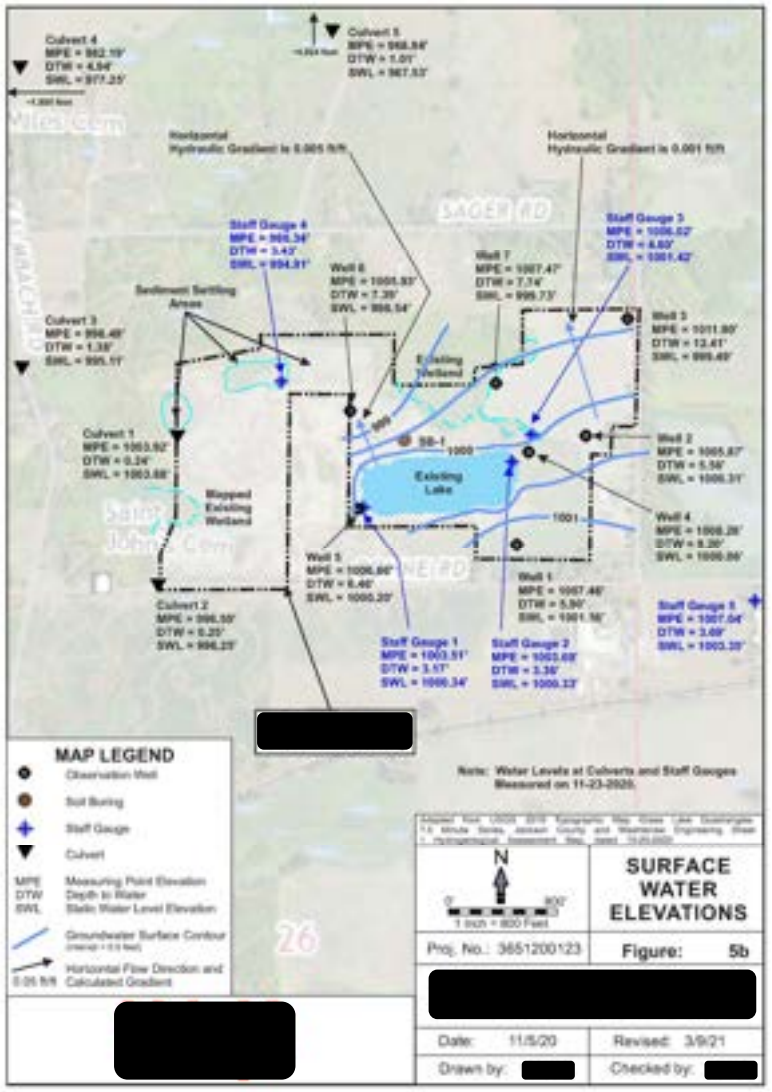
7. Is the final lake size greater than 50 acres?


WRD Hydrogeologic Investigation Criteria for Lake Creation
1. Will the lake be ≥ 5 acres?
Yes
2. Will the excavation be dewatered?
Yes
Hydrogeological study is needed. WWAT registration or Part 327 permit may be required. Contact WUAU.
No
No
Yes
3. Will the lake have an artificial outlet?
Yes
4. Is the outlet invert below the groundwater table?
Note: At least 5 groundwater elevations in and around the lake must be provided to use this flowchart.
No
No
5. Is the difference between up & downgradient groundwater elevations < 2 feet?
No
6. Are water bodies within 500 feet?
No
7. Are wetlands within 1,000 feet?
No
Hydrogeological study not needed
Yes
Yes
Yes
Hydrogeological study is needed.
Yes
8. Is final lake size > 50 acres?
No
Hydrogeological study not needed

2. Is the hydrogeologic investigation complete?

Hydrogeologic Investigation Completeness Checklist

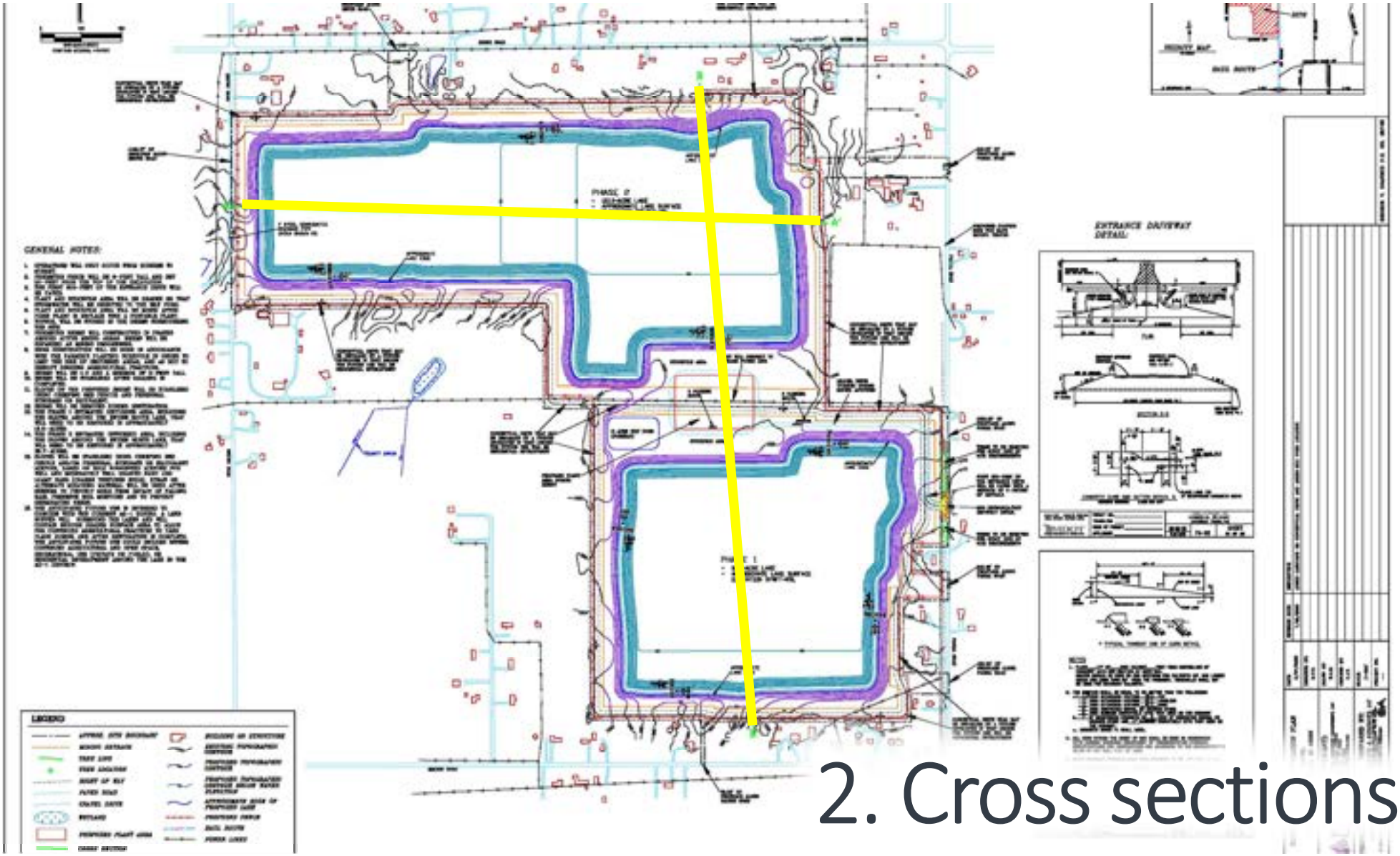
Hydrogeologic Investigation Component		Report Page(s)
1	Baseline Site Maps	
2	Cross Sections	
3	Proposed Conditions Map and Project Description	
4	Five Groundwater Monitoring Wells	
5	Potentiometric Surface Maps of Baseline and Final Conditions	
6	Wellogic Well Logs	
7	Pumping Rate(s) and Water Withdrawal Assessment Tool (WWAT) Registration (if needed)	
8	Drawdown Prediction Model Selected	
9	Drawdown Predictions	



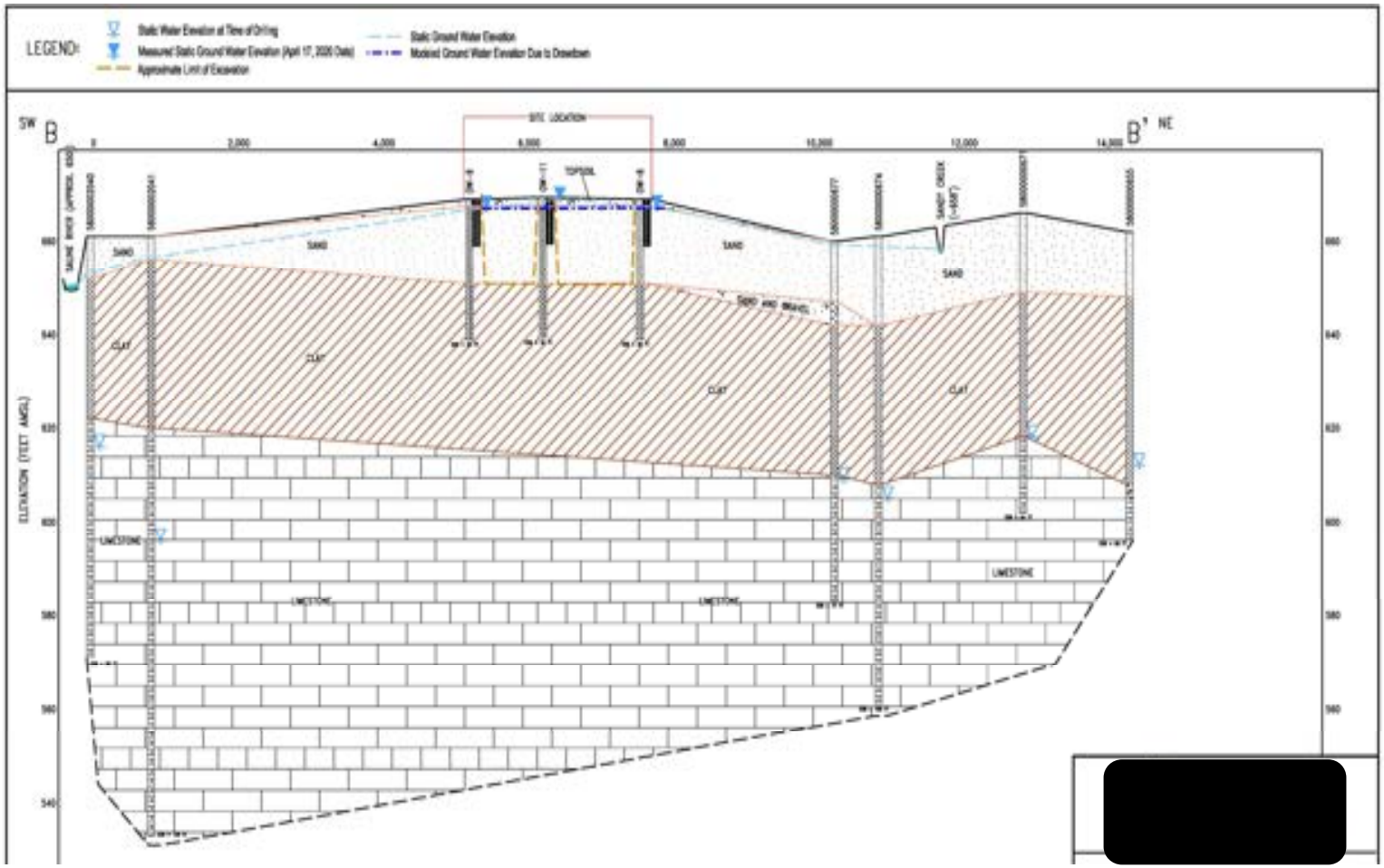
Maps should include:

- Property boundary,
- Proposed lake boundary,
- Boring or monitoring well locations,
- Test pits or settling ponds,
- Sensitive areas (streams, wetlands, private wells, etc.)

1. Detailed maps

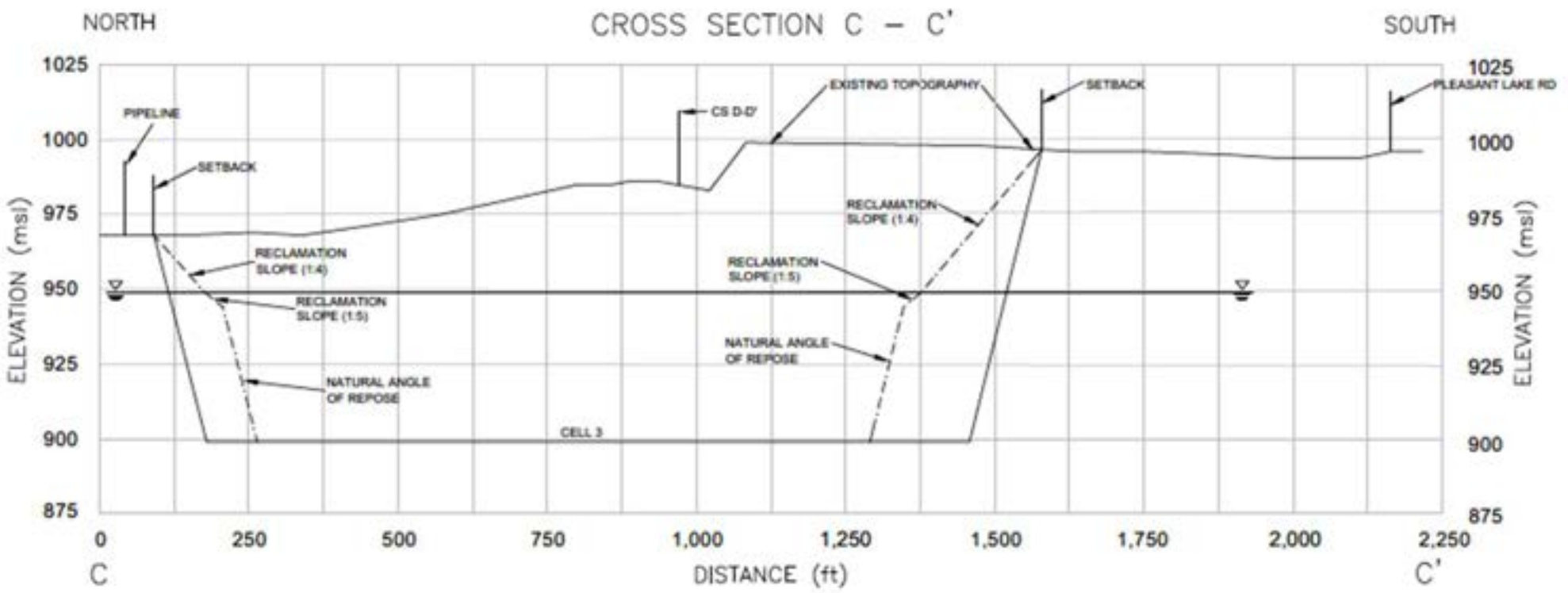


2. Cross sections



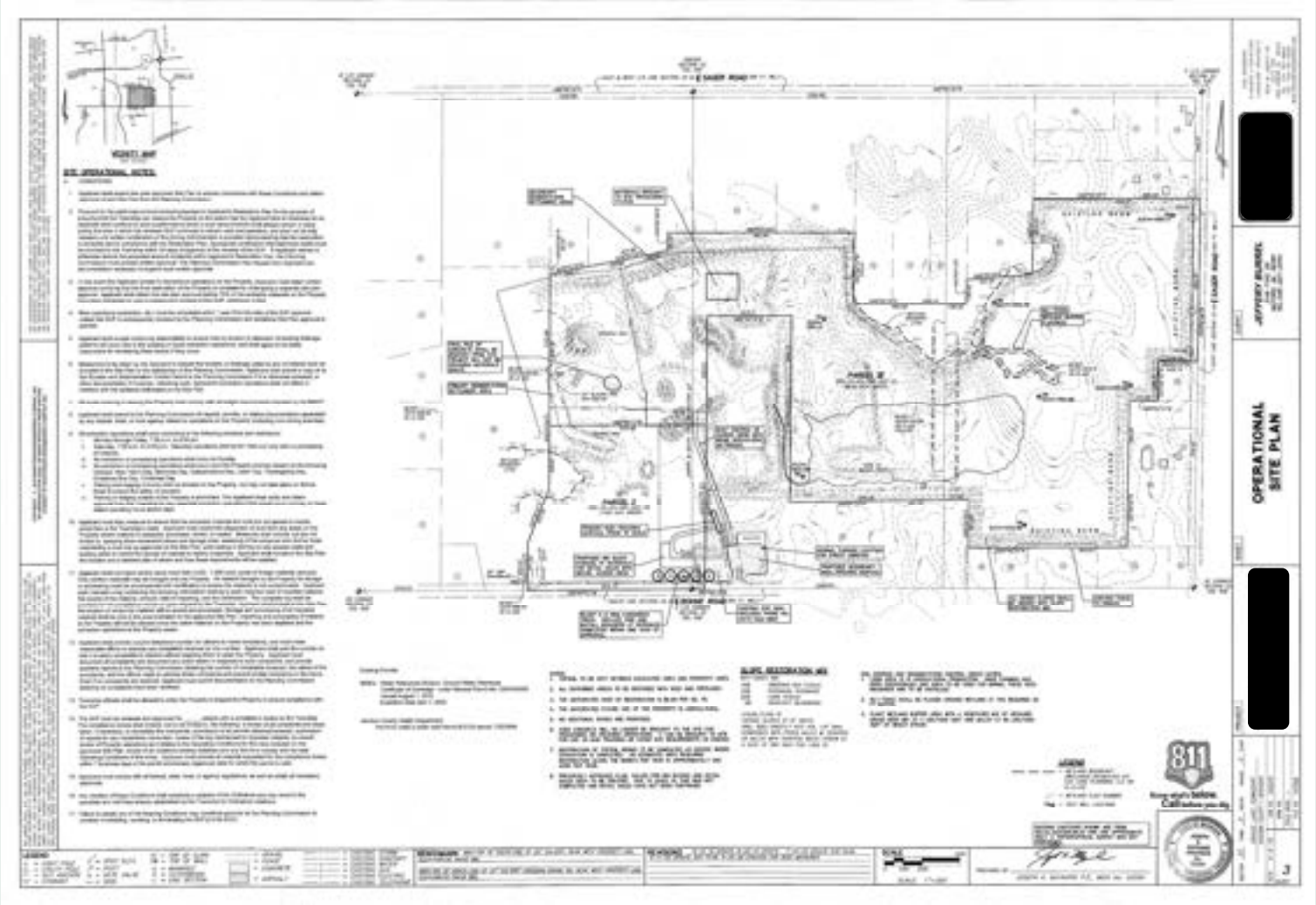
Cross Section CSM

- CSM = Conceptual Site Model
- Vertical and lateral interpretation of geologic material connectivity

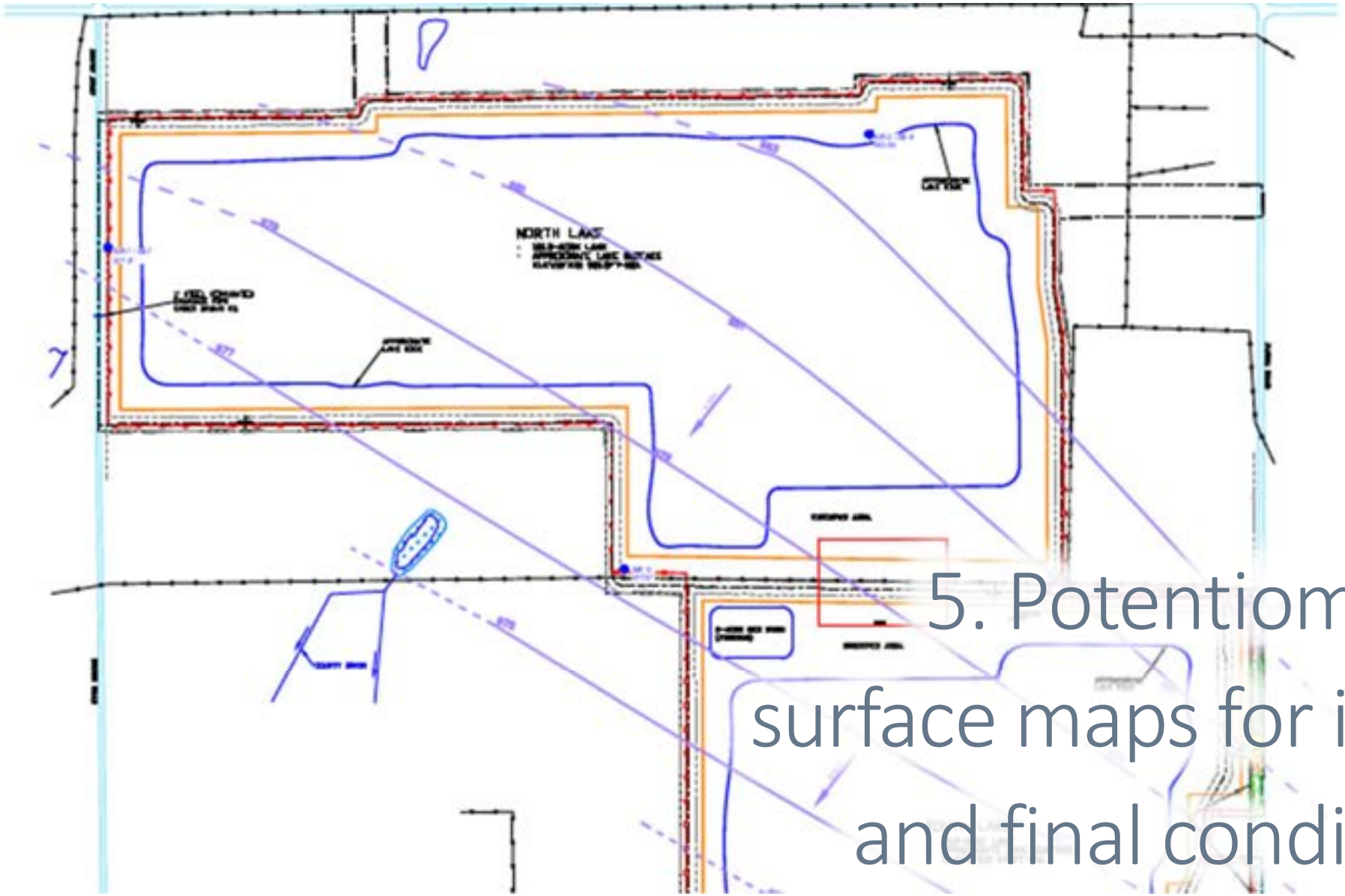


This cross section would not be considered complete. No geologic information is shown.

3. Detailed project description



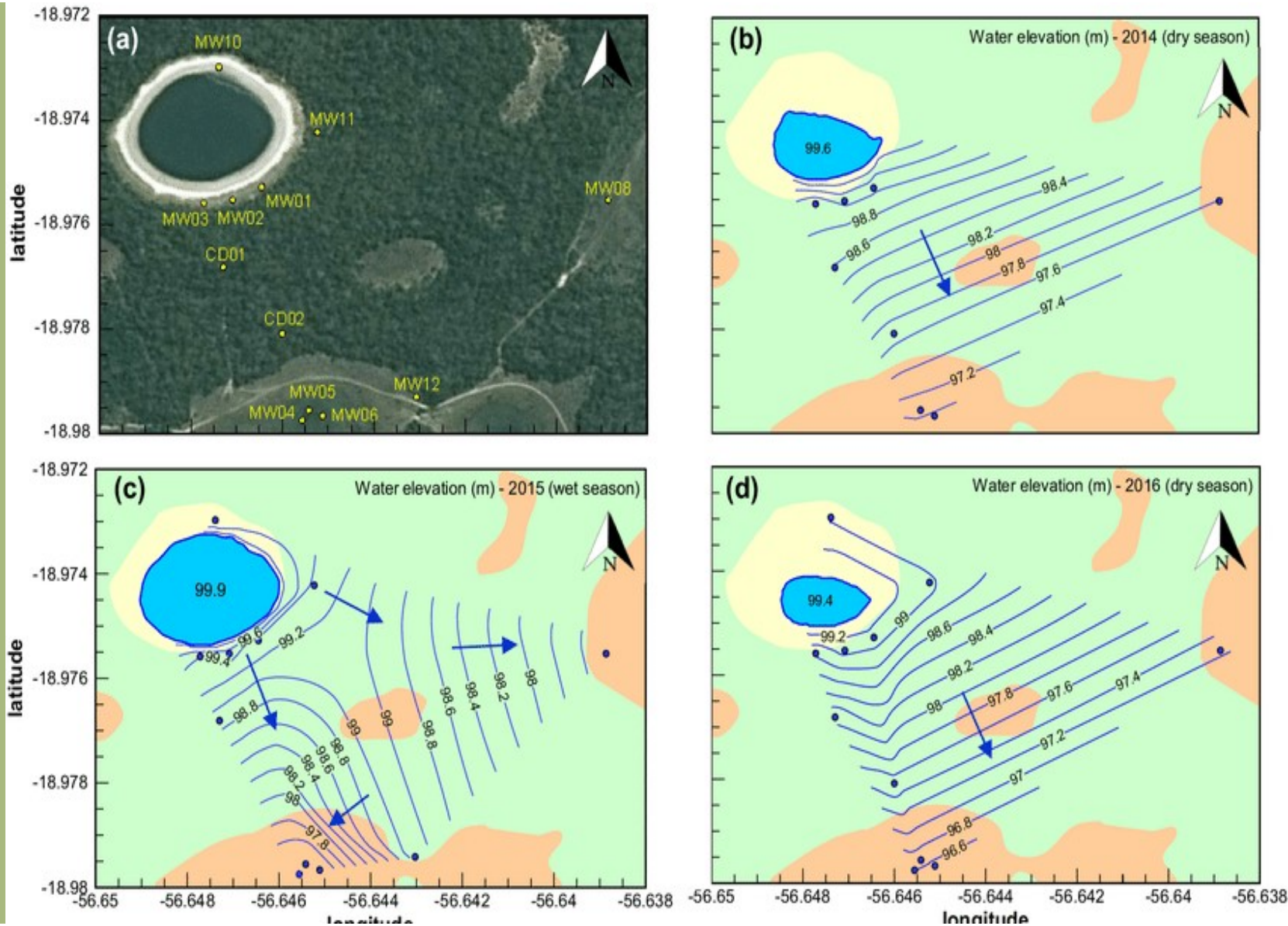
4. Sensitive Areas



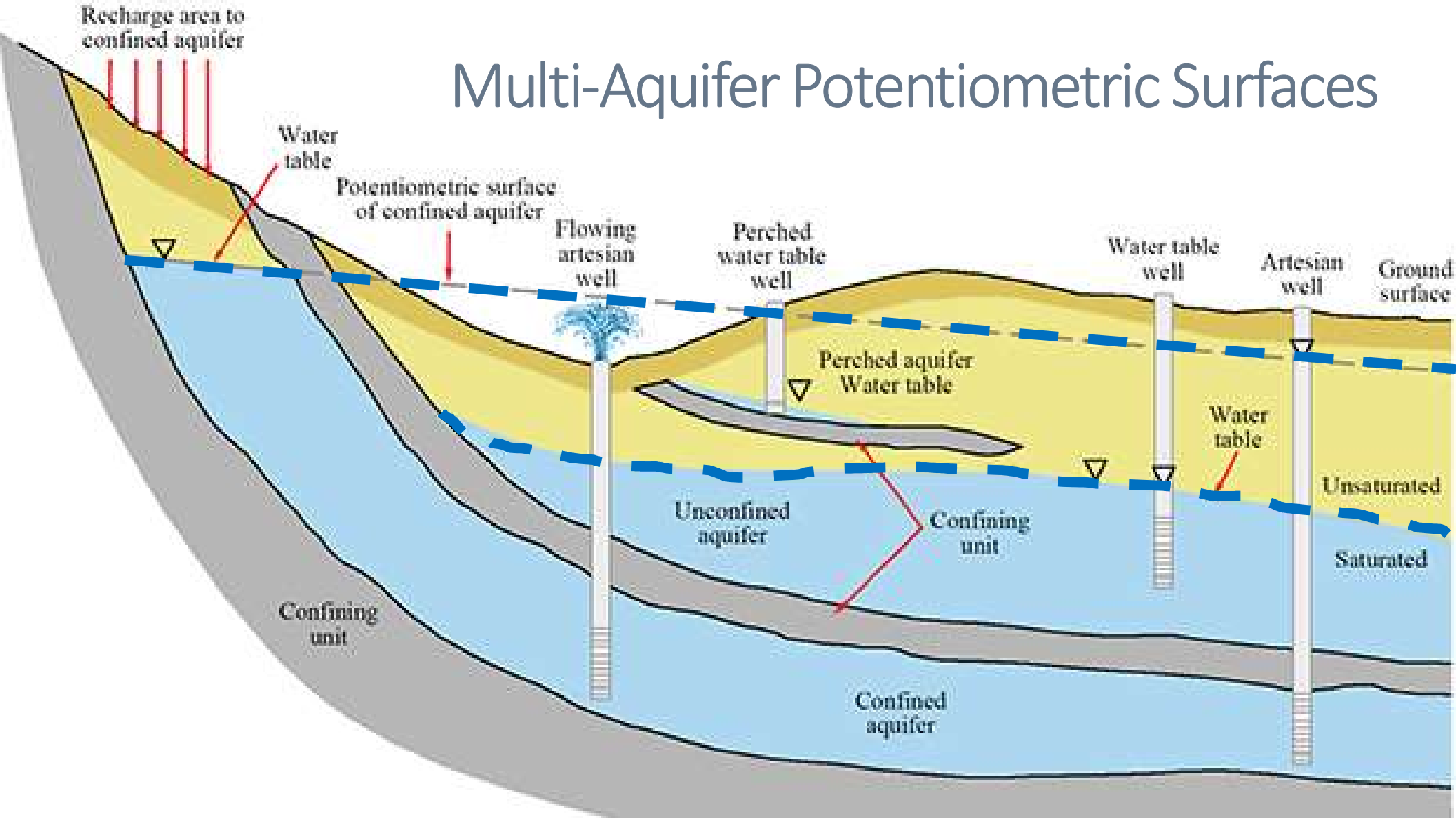
5. Potentiometric surface maps for initial and final conditions

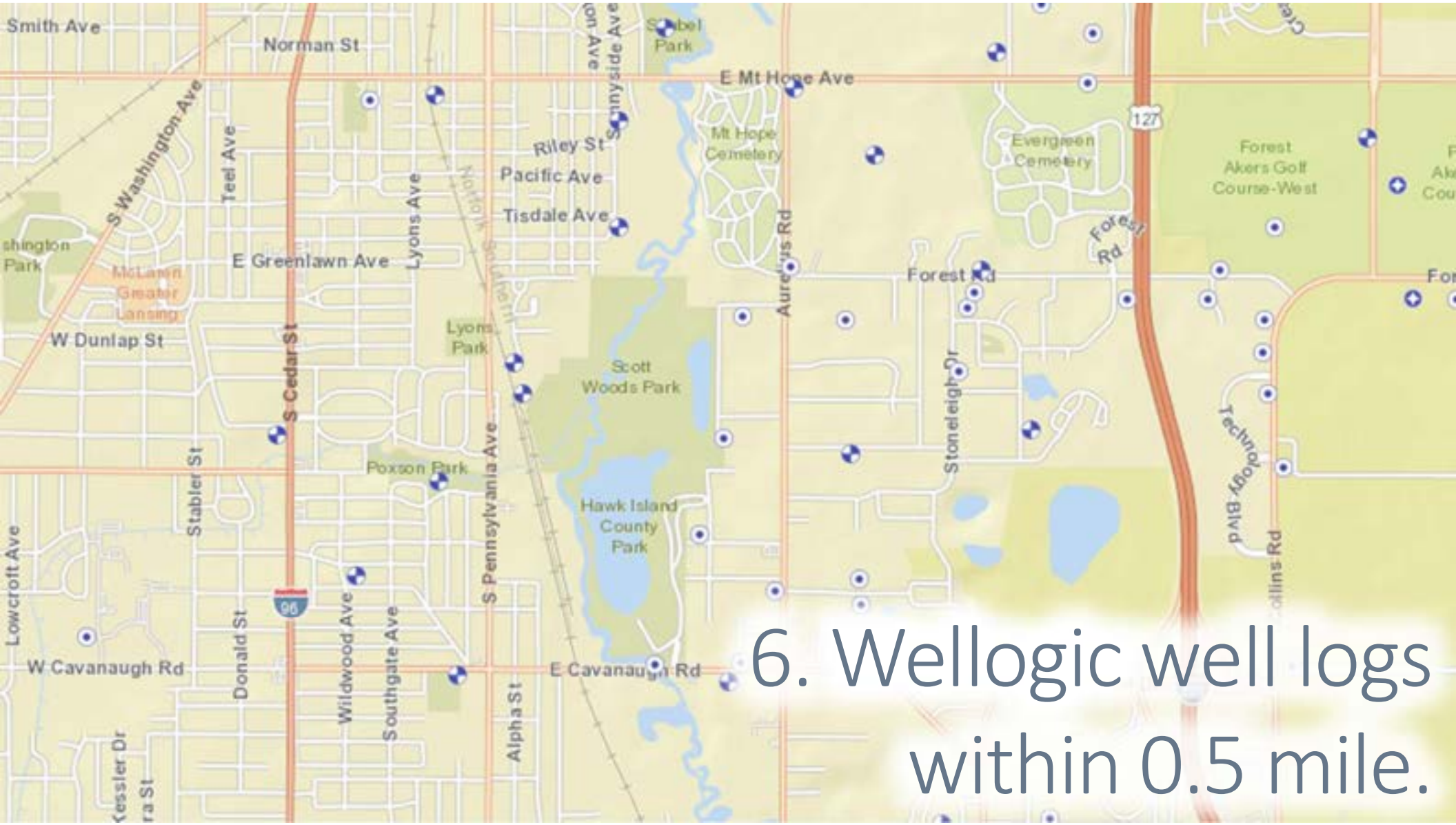
Measure groundwater in a similar time frame

(within 48 hours)



Multi-Aquifer Potentiometric Surfaces

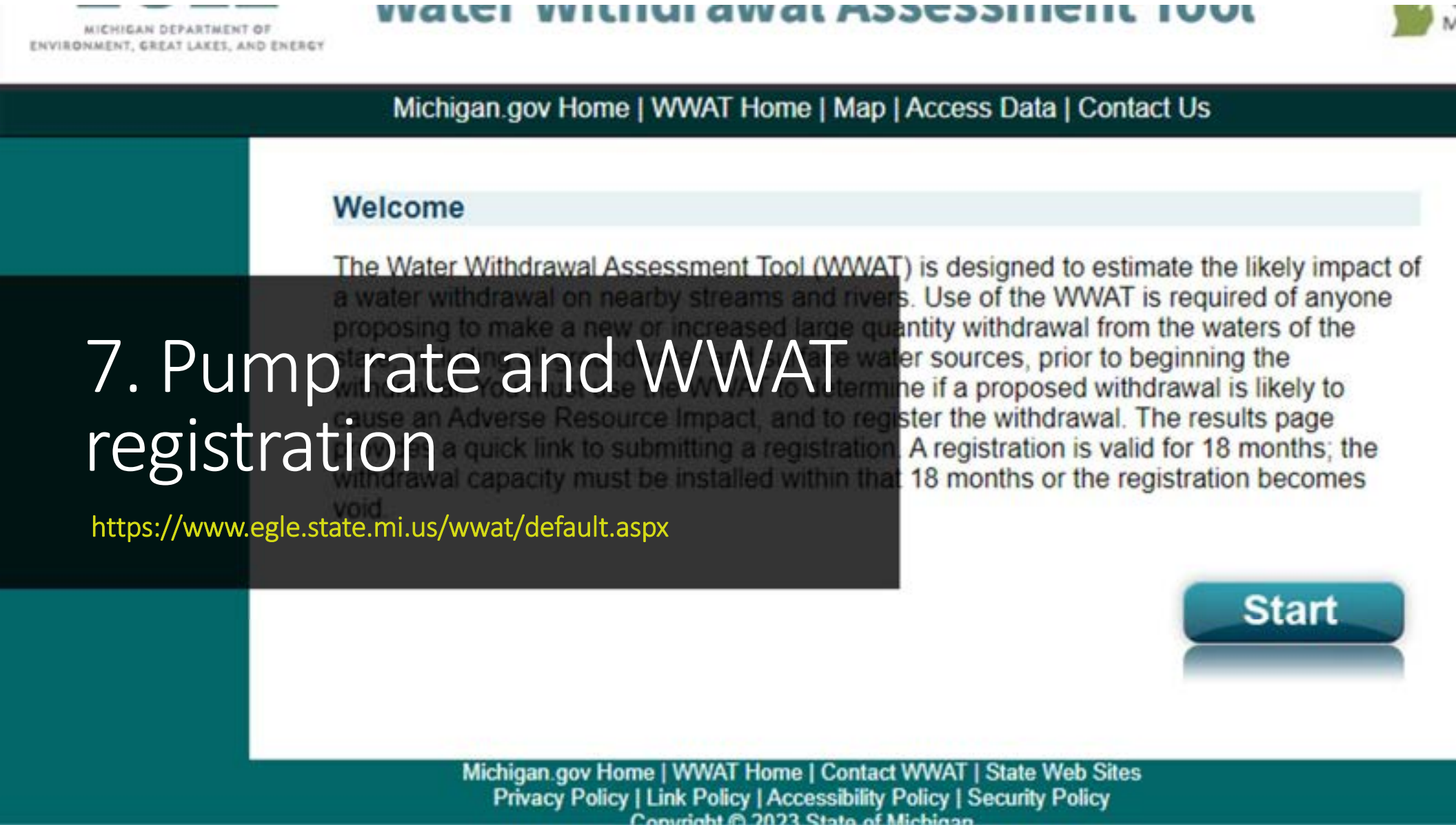




6. Wellogic well logs within 0.5 mile.

7. Pump rate and WWAT registration

https://www.egle.state.mi.us/wwat/default.aspx



Daviau et al. (1985) uniform flux and infinite conductivity horizontal well

Barker (1988) generalized radial flow model

Pumping Tests in Leaky Confined Aquifers

Hantush-Jacob (1955)

Hantush-Jacob (1955) step test

Hantush (1960) early-time solution

Hantush (1960) complete solution

Cooley-Case (1973) water-table aquitard

Neuman-Witherspoon (1969) two-aquifer s

Moench (1985) Cases 1, 2 and 3

Pumping Tests in Unconfi

Theis (1935)

Cooper-Jacob (1946)

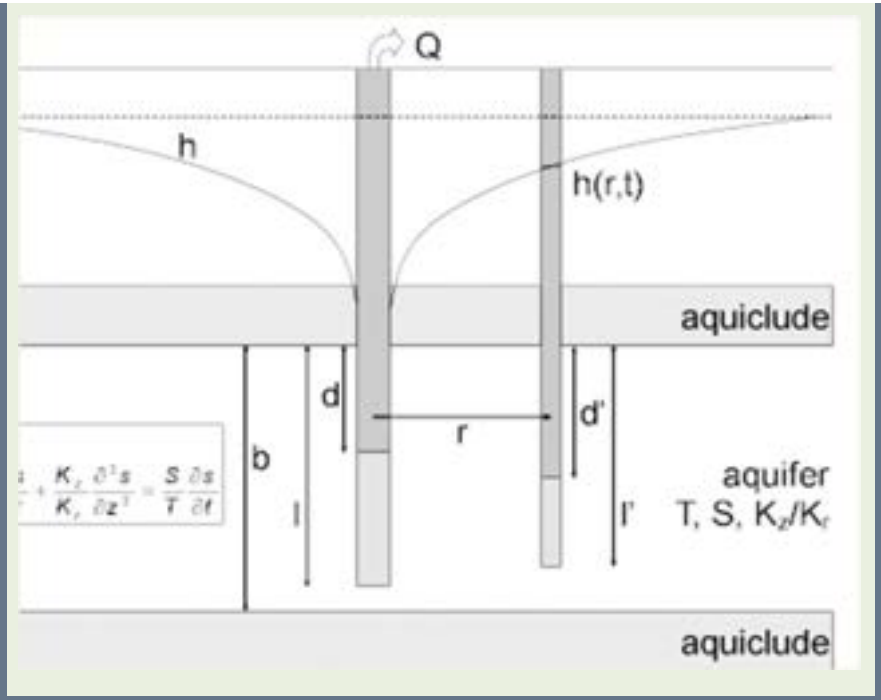
Neuman (1974); Moench (1993, 1996)

Moench (1997)

Tartakovsky-Neuman (2007)

Pumping Tests in Fractured Aquifers

#8. Analytic model selection and assumptions

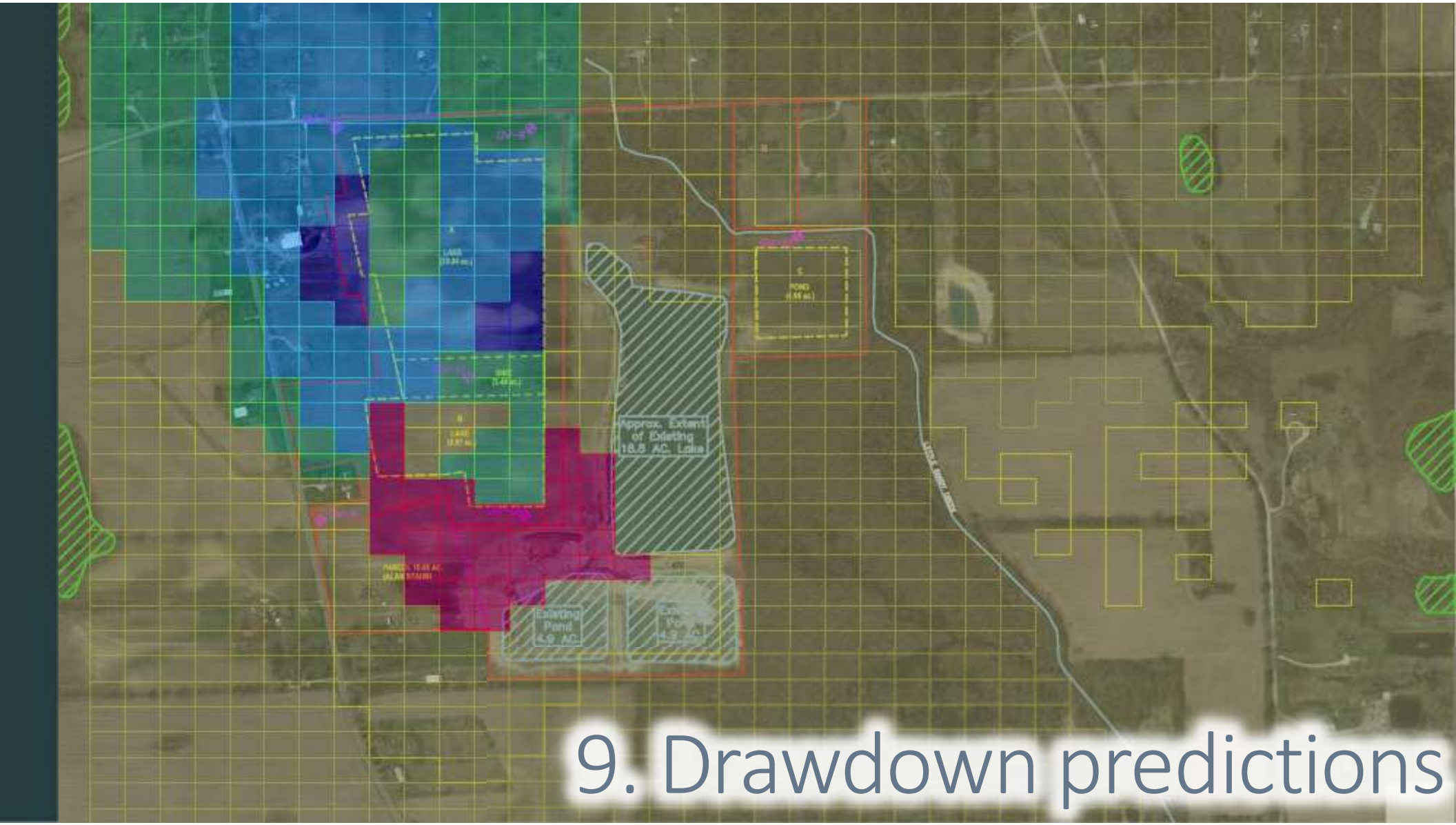


Assumptions

- aquifer has infinite areal extent
- aquifer is homogeneous and of uniform thickness
- control well is fully or partially penetrating
- flow to control well is horizontal when control well is fully penetrating
- aquifer is nonleaky confined
- flow is unsteady
- water is released instantaneously from storage with decline of hydraulic head
- diameter of a pumping well is very small so that storage in the well can be neglected

Thiess Equation

- Laterally discrete aquifer distribution (drawdown extends to aquifer boundaries)
- Significant heterogeneity



9. Drawdown predictions

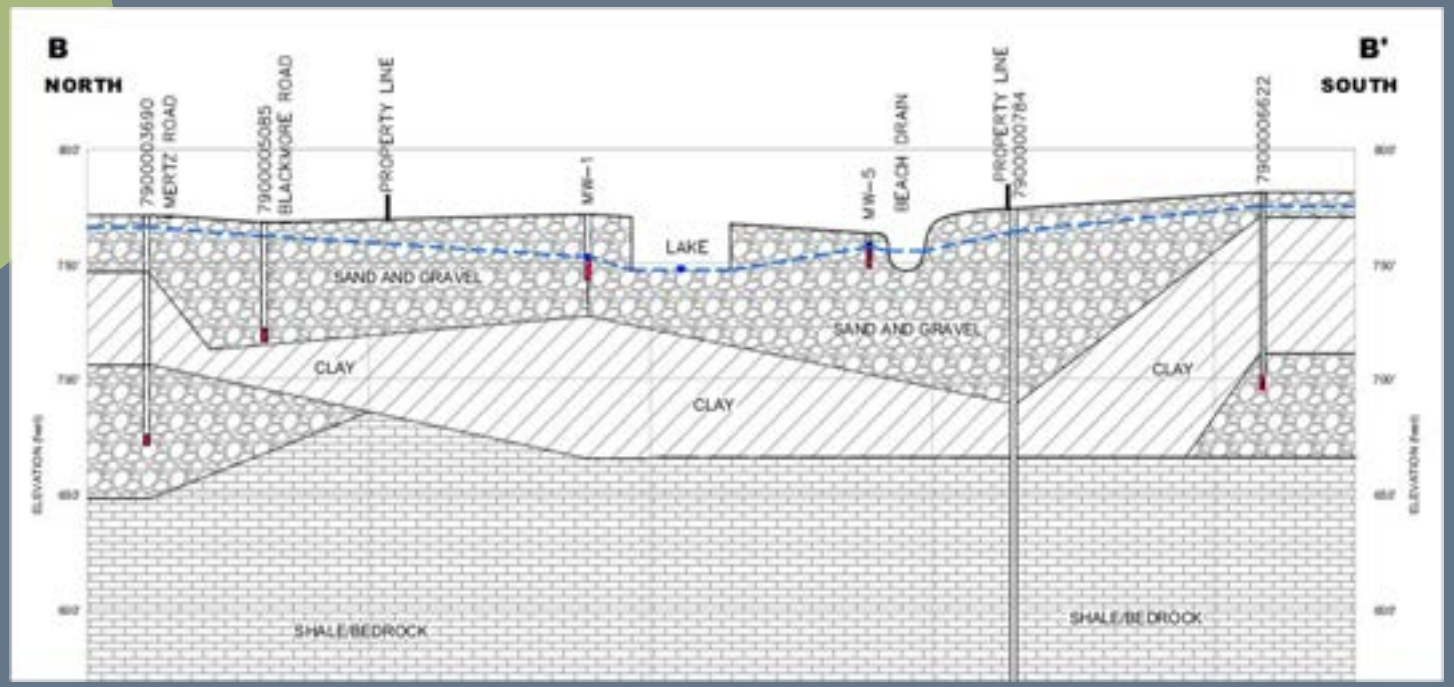
Drawdown Predictions

1. Short-term drawdown
2. Long-term drawdown
3. Hydraulic gradient flattening

3. Does the hydrogeologic investigation require a groundwater model?

Continuous Lateral Flow

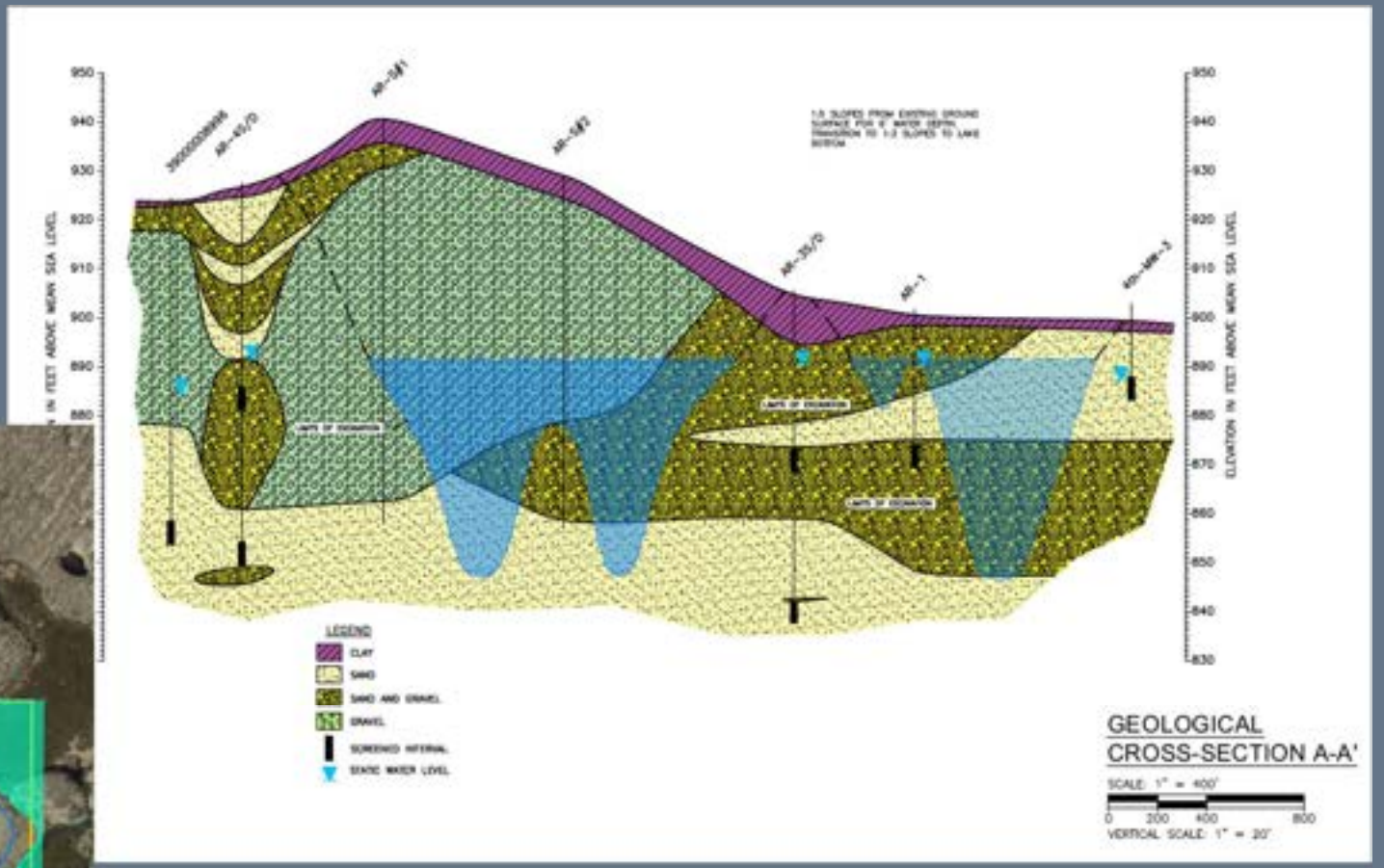
Minimal Heterogeneity



Groundwater Model Not Needed

Variable geology

Strange lake shape



Groundwater Model Needed

Hydrogeologic Investigation Completeness Checklist

Hydrogeologic Investigation Component		Report Page(s)
1	Baseline Site Maps	
2	Cross Sections	
3	Proposed Conditions Map and Project Description	
4	Five Groundwater Monitoring Wells	
5	Potentiometric Surface Maps of Baseline and Final Conditions	
6	Wellogic Well Logs	
7	Pumping Rate(s) and Water Withdrawal Assessment Tool (WWAT) Registration (if needed)	
8	Drawdown Prediction Model Selected	
9	Drawdown Predictions	

4. Are the hydrogeologic investigation results reliable?

So what do we do with the results?

- It depends…
- District Staff work with Wetlands, Lakes and Streams Unit to assess impacts
- Could result in further avoidance/minimization, monitoring conditions, mitigation
- Each project is unique