

# Mosaic Belle Plaine Groundwater Rationalization Study



Study Completed by SNC Lavalin  
for Mosaic Belle Plaine

Presenter: Karisa Petruic

Environmental Engineer

SMA Environmental Forum

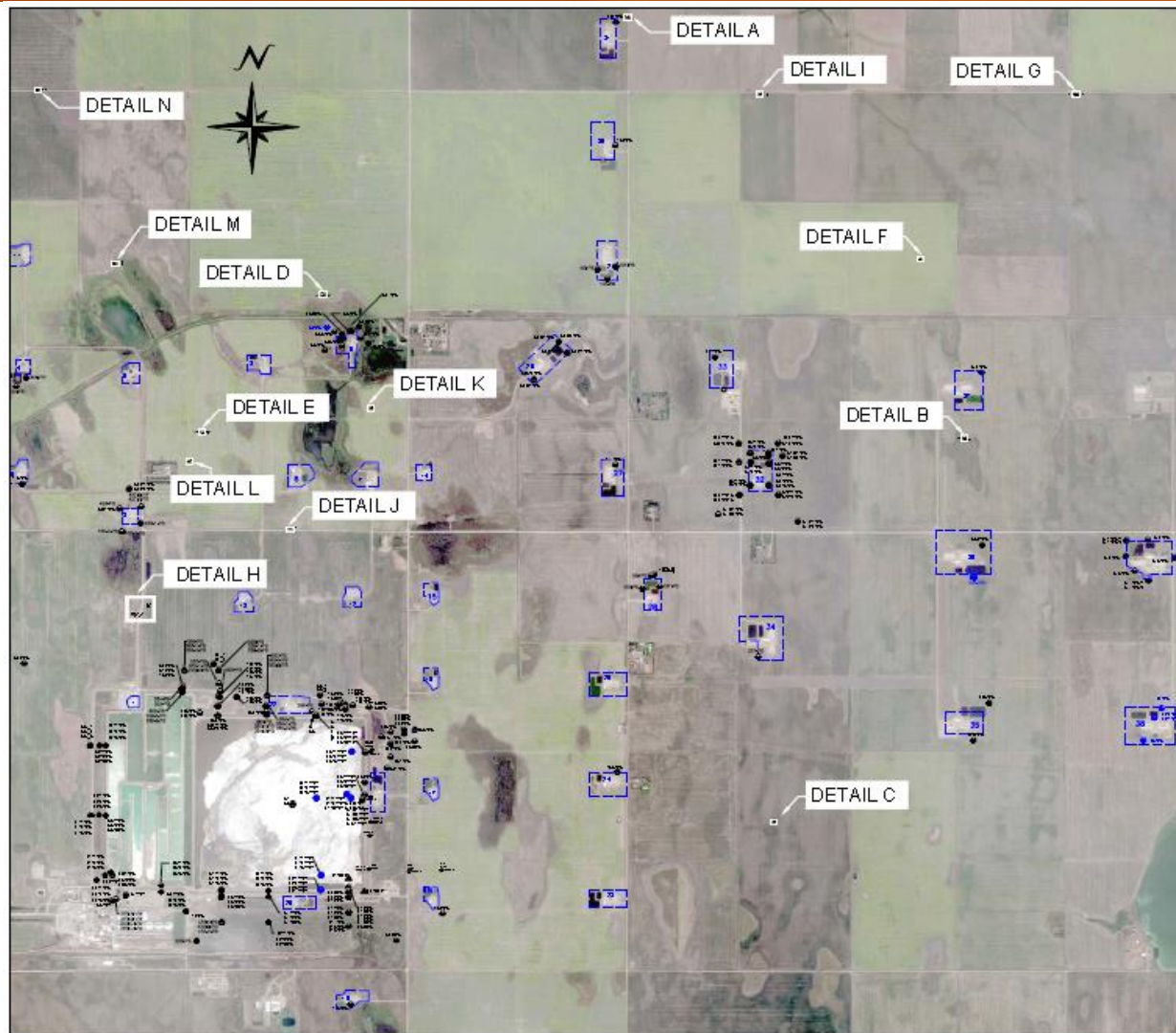


# Outline

- Overview of historical monitoring program
- Overview of site hydrostratigraphy
- Scope of work for rationalization
- Updated monitoring plan and final recommendations



# Overview of Historical Groundwater Program




MOSAIC POTASH - BELLE PLAINE  
SCALE 1: 50,000

# Overview of Historical Groundwater Program



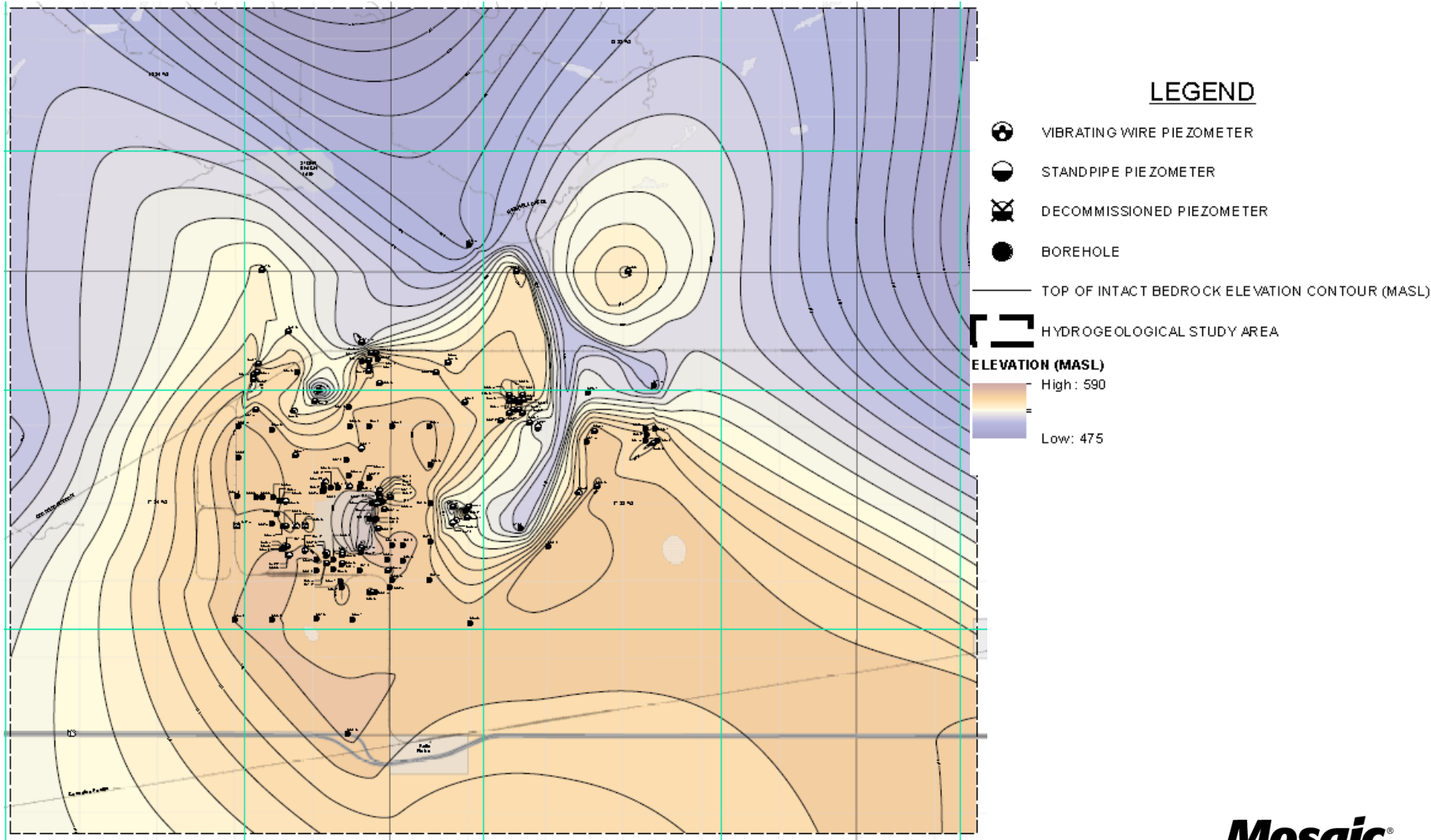
- 312 piezometers were monitored in 2015 across the site
  - Tailings management area (TMA) piezometers
  - Cluster site piezometers
- Several piezometers were dry in 2015 and preceding years since installation
- Several piezometers were highly impacted, and had been so for up to 3 years
- Large undertaking to monitor 312 piezometers, and not all data was value added
- Performed EM surveys but they weren't tied in with the groundwater monitoring program.

# Overview of Site Hydrostratigraphy

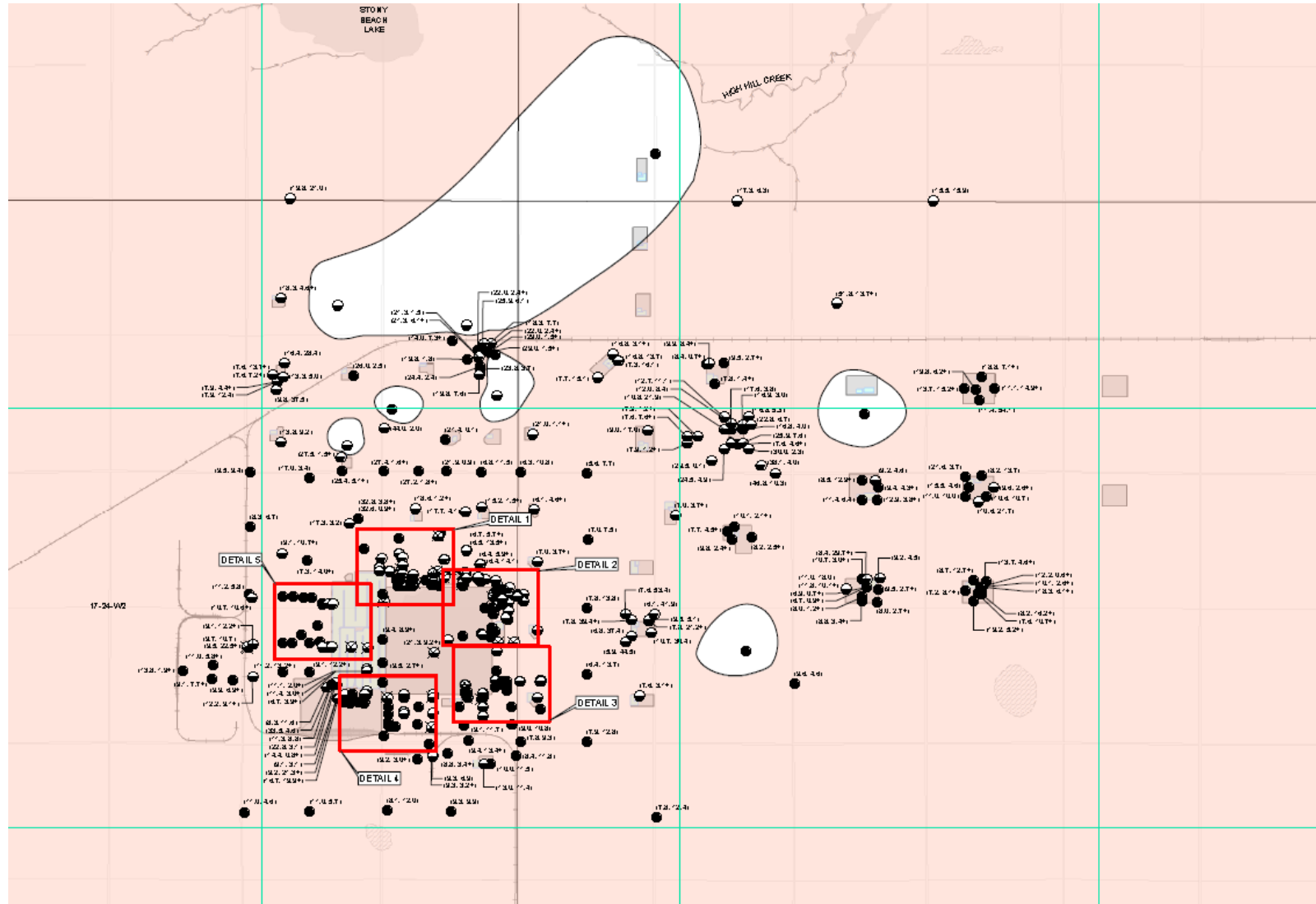
- 
- Analyzed all borehole logs on site to interpret areal limits of aquifer units on site:
    - Intact bedrock
    - Fractured bearpaw shale
    - Lower dundurn intertill stratified deposits
    - Upper dundurn Intertill aquifer
    - Warman intertill stratified deposits
    - Lower floral intertill stratified deposits
    - Upper floral intertill stratified deposits



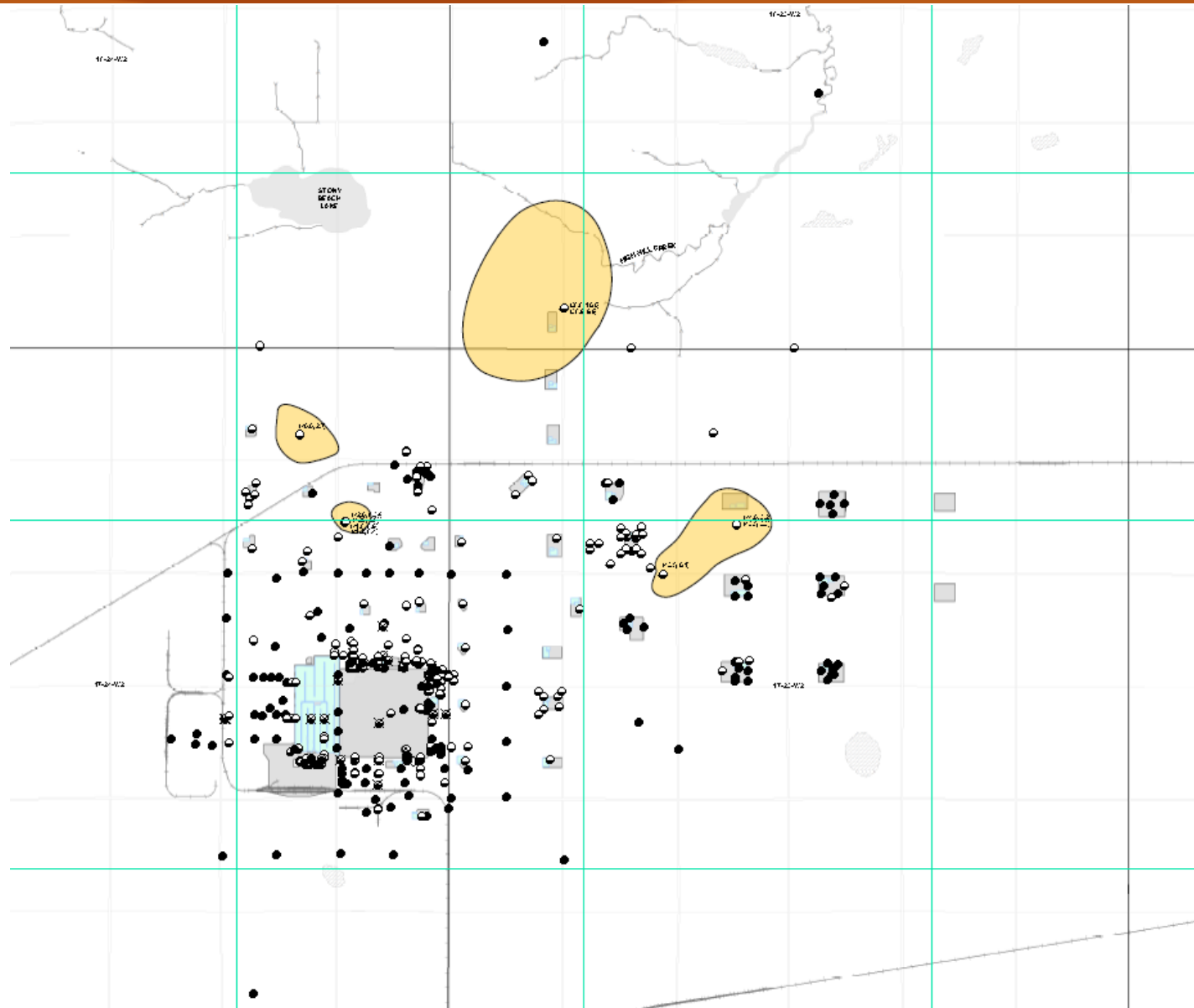
# Areal Limits of Interpreted Intact Bedrock Elevations



# Interpreted Areal Limits of Fractured Bearpaw Shale

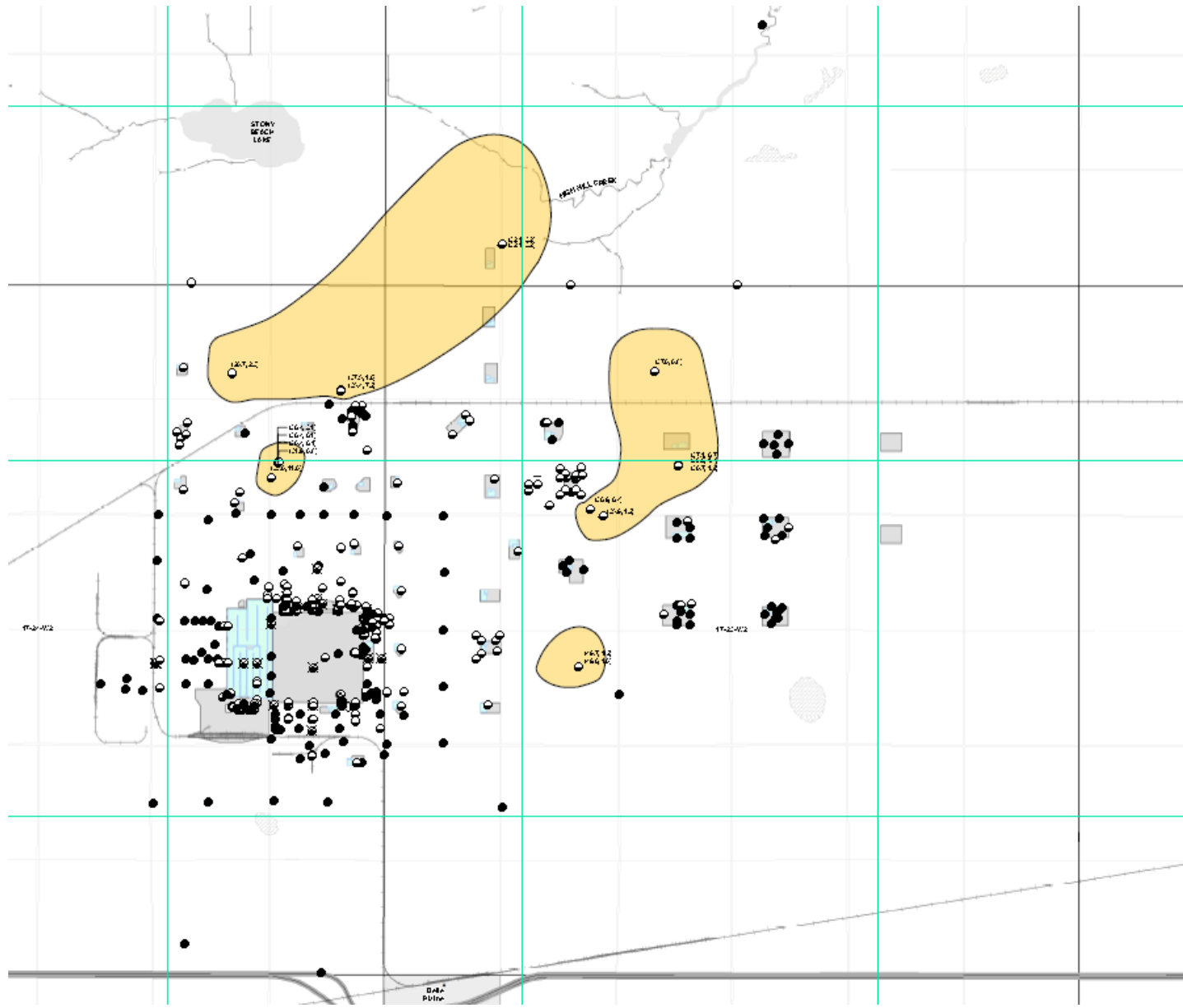


# Interpreted Areal Limits of Lower Dundurn Intertill Stratified Deposits

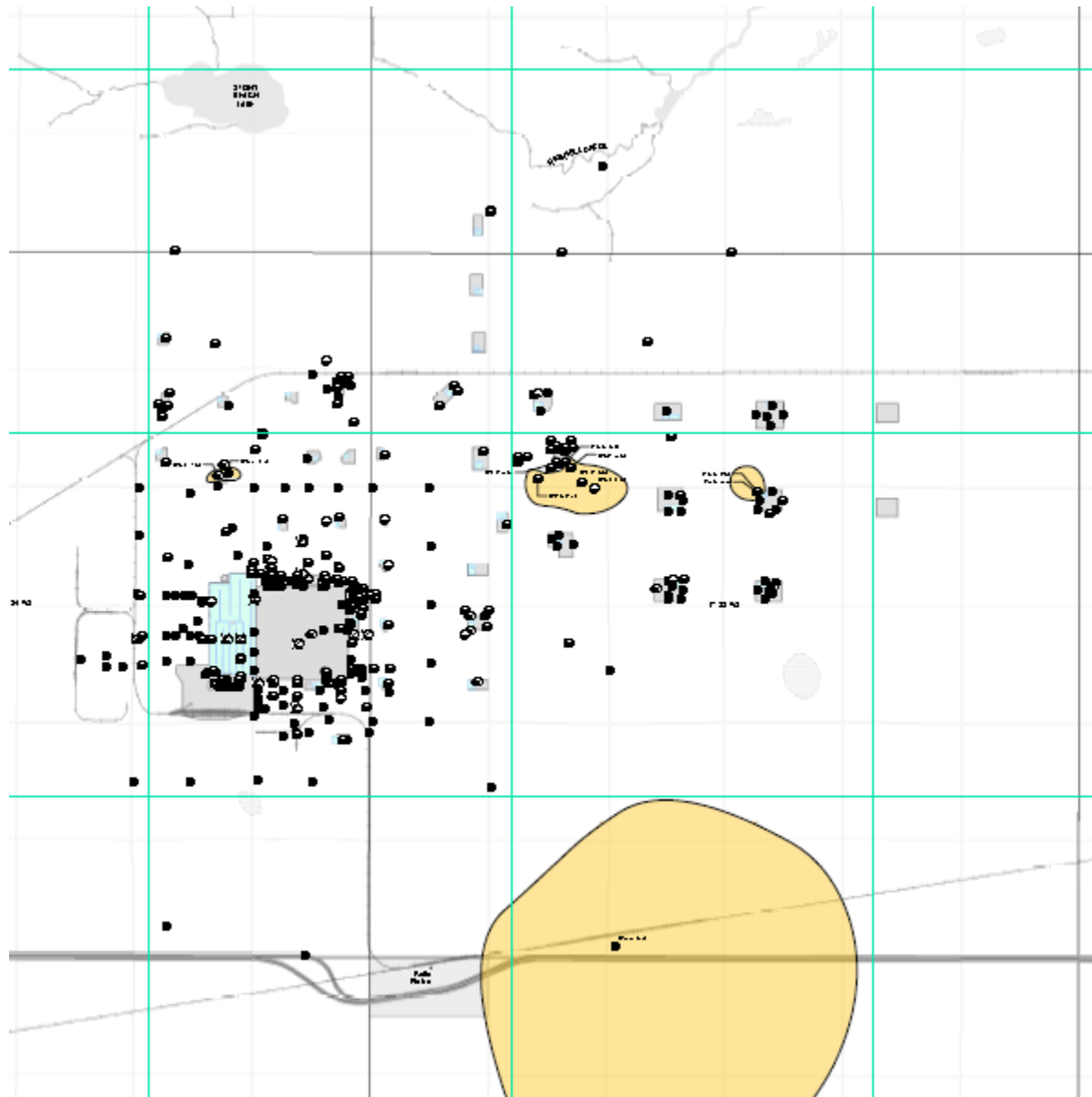




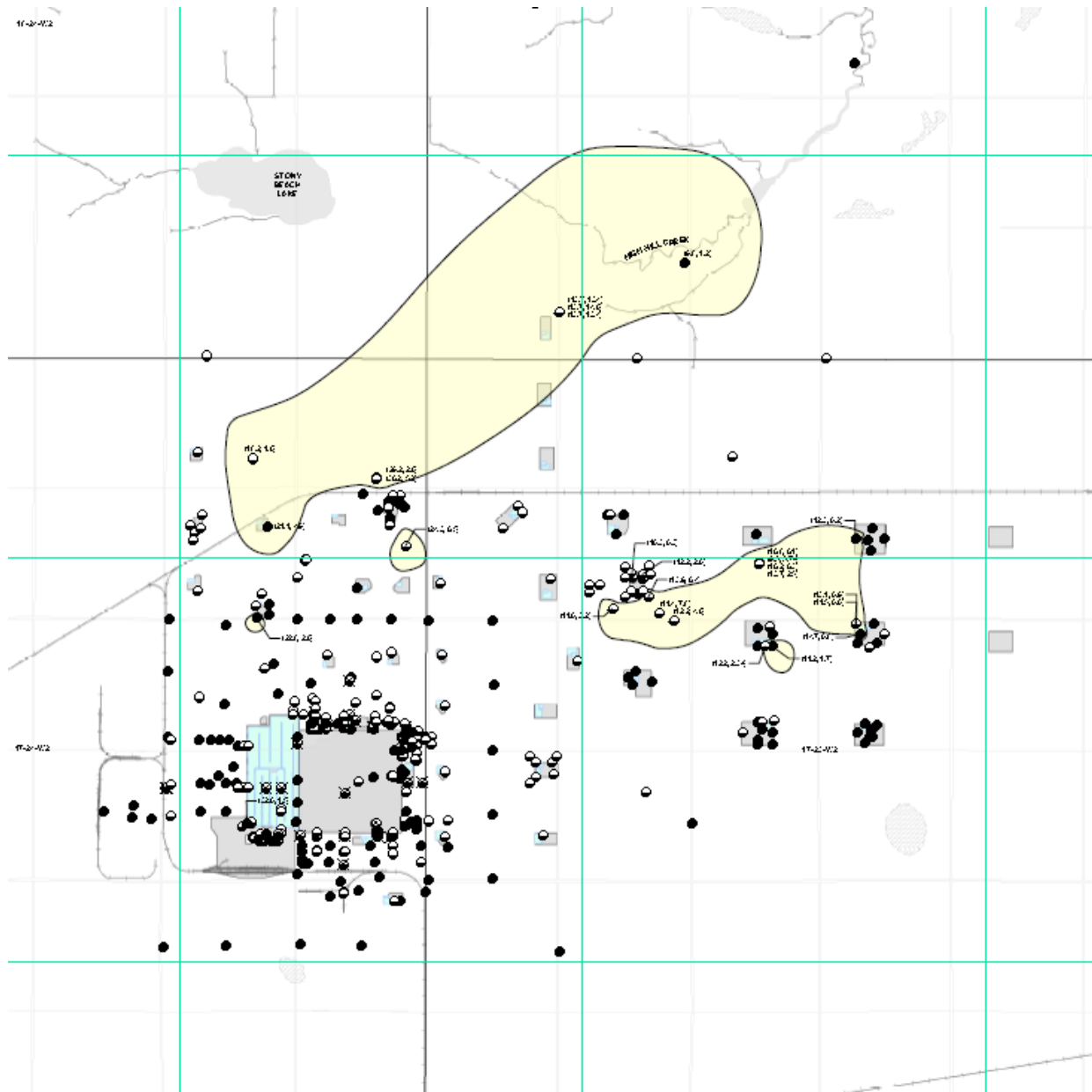
# Interpreted Areal Limits of the Upper Dundurn Intertill Aquifer



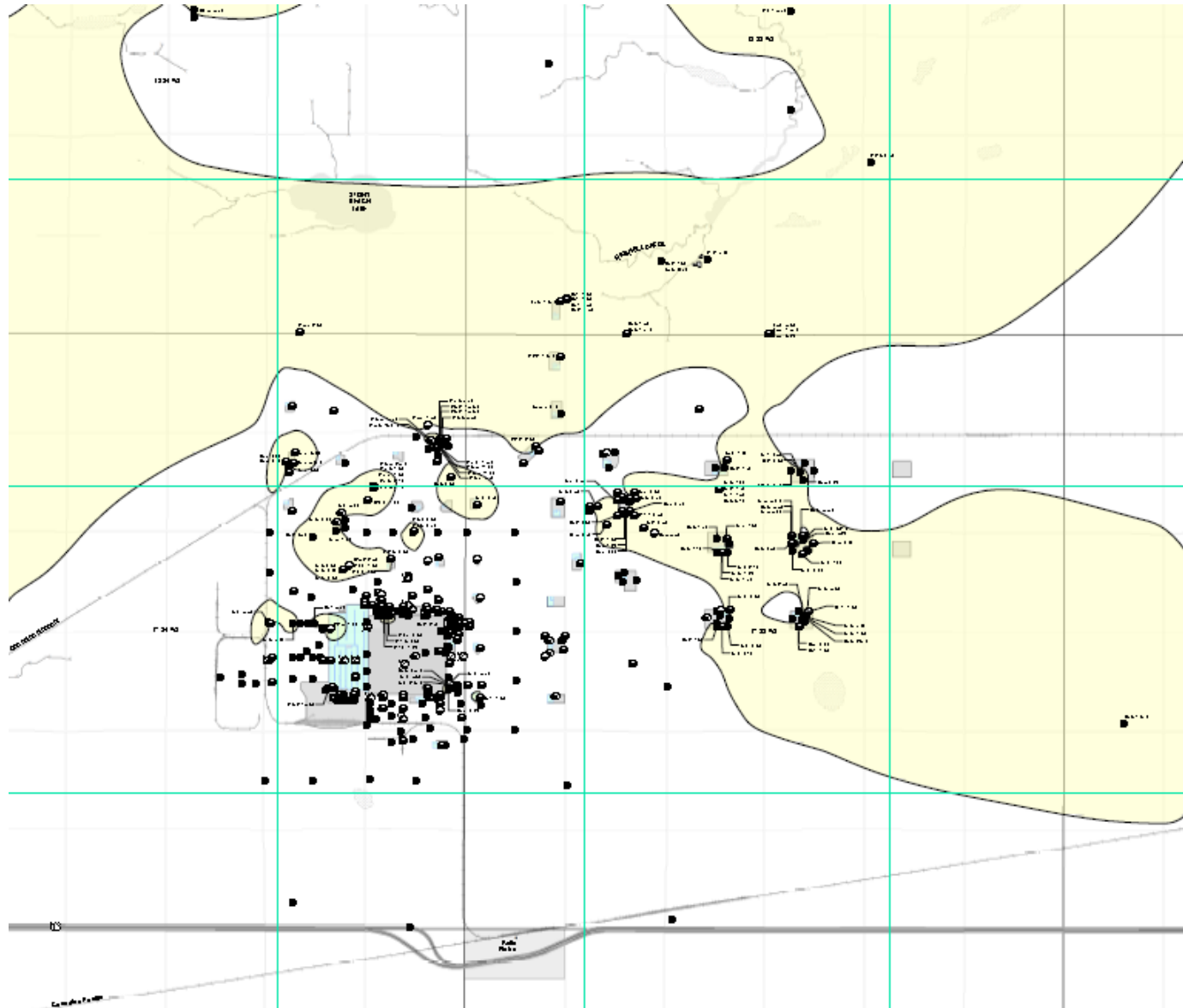
# Interpreted Areal Limits of the Warman Intertill Stratified Deposits



# Interpreted Area Limits of the Lower Floral Intertill Stratified Deposits



# Interpreted Areal Limits of the Upper Floral Intertill Stratified Deposits



# Scope of Project

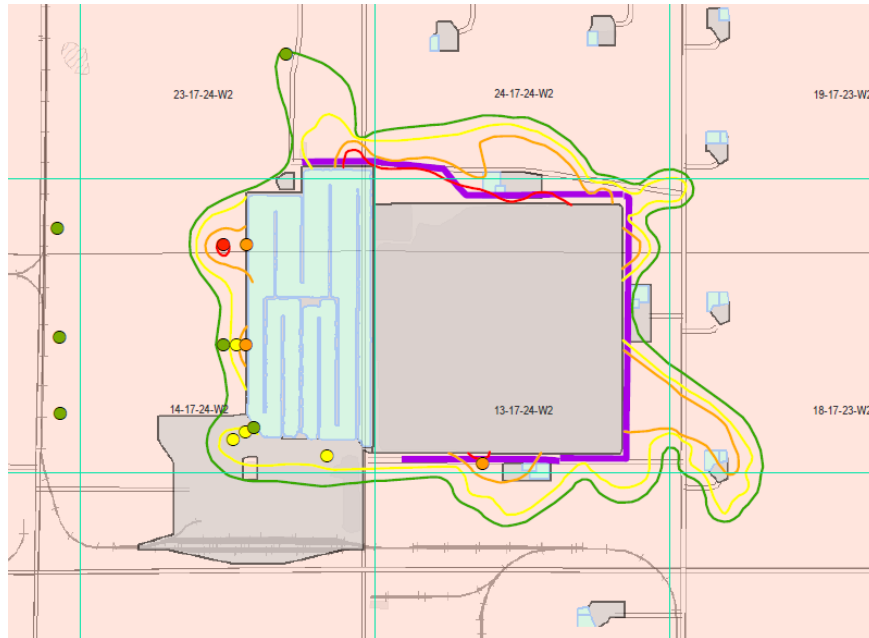
- Analyze data to develop:
  - Chloride distribution maps
  - Potentiometric maps
  - Trends
  - Groundwater flow direction
  - French drain analysis
  - Data gap analysis
  - Decommissioning list
  - Updated monitoring plan



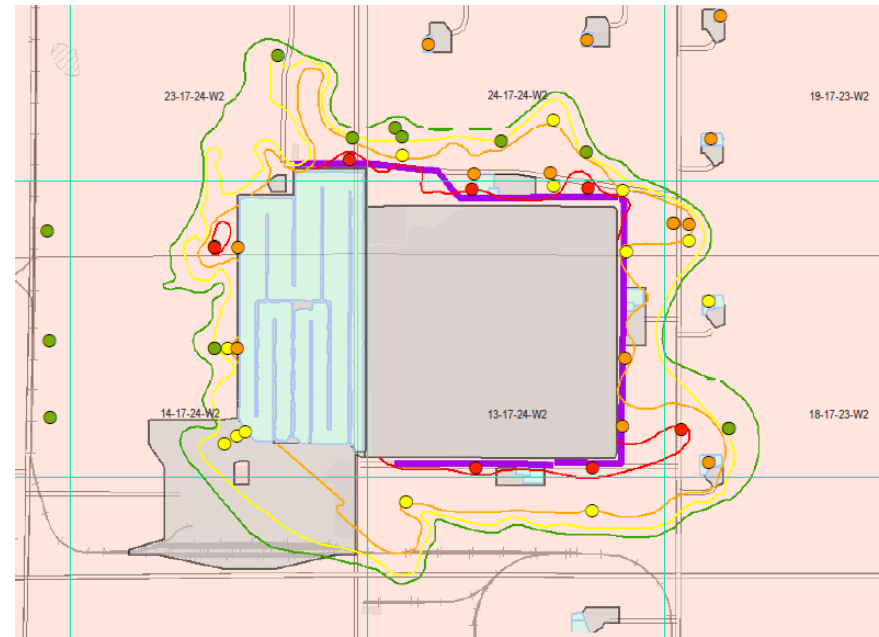
# Chloride Distribution Maps

- Maps developed for:
  - Near surface sediments
  - Fractured bearpaw shale
  - Upper floral formation – not shown
- Maps included all installations across the site into each formation.
- TMA is represented because it has the greatest amount of installations.
- Cluster sites data was limited to start, but the site is working towards having at least one piezometer at every cluster site.

# Chloride Distribution Maps



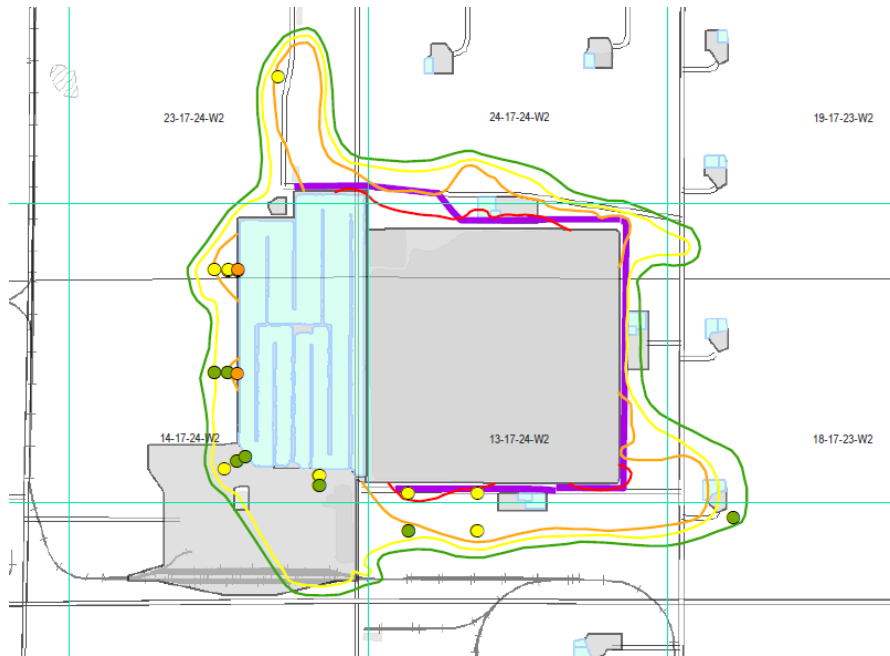
2011



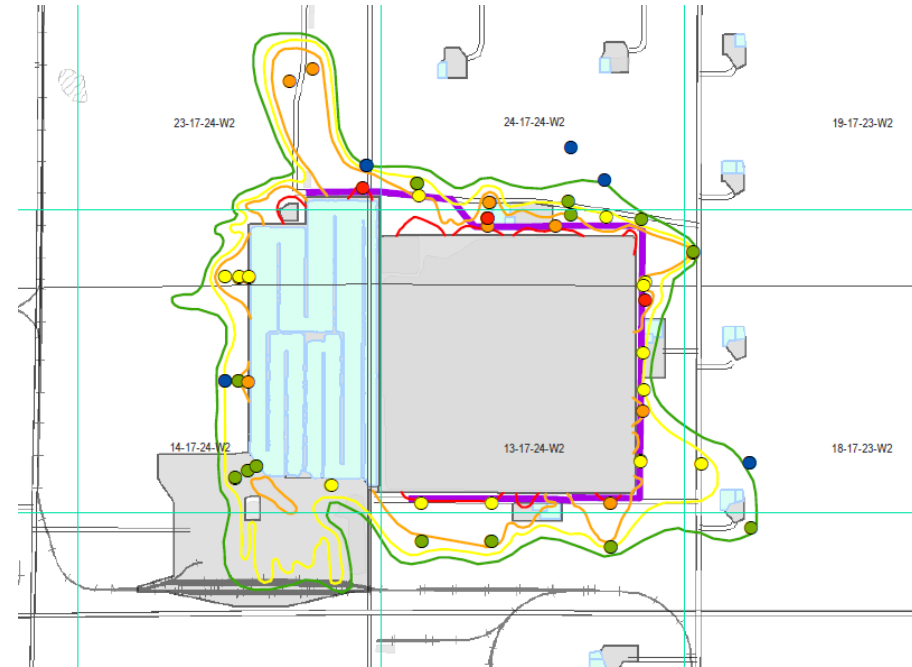
2014

- 2011 vs. 2014 chloride distribution map in fractured shale
- Large increase in the number of installations - better able to show an accurate distribution
- Constrained by EM surveys

# Chloride Distribution Maps



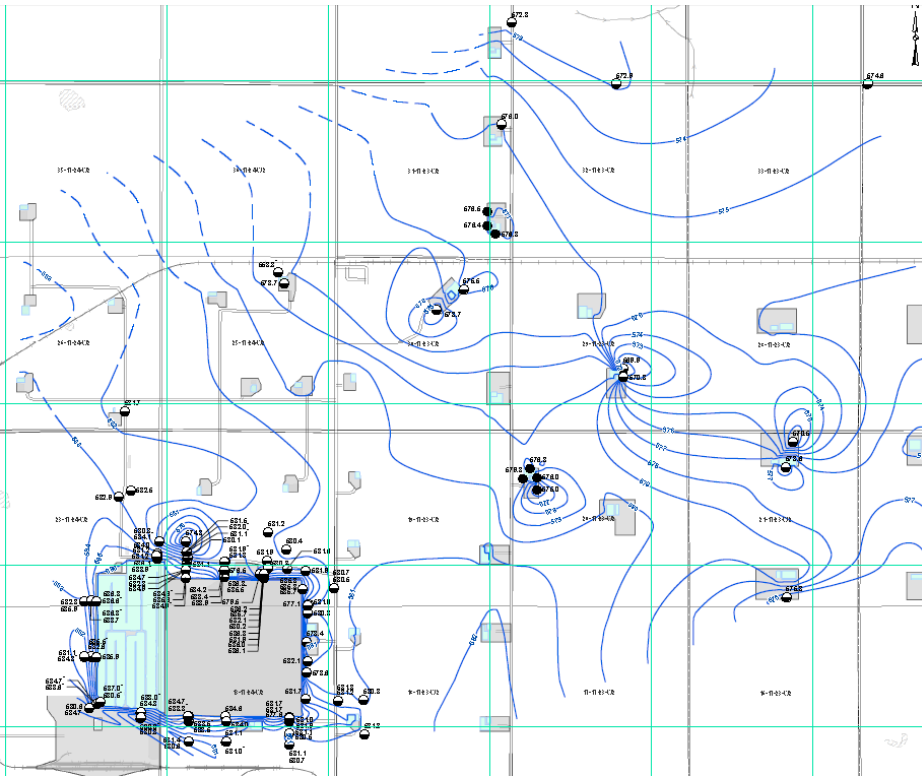
2011



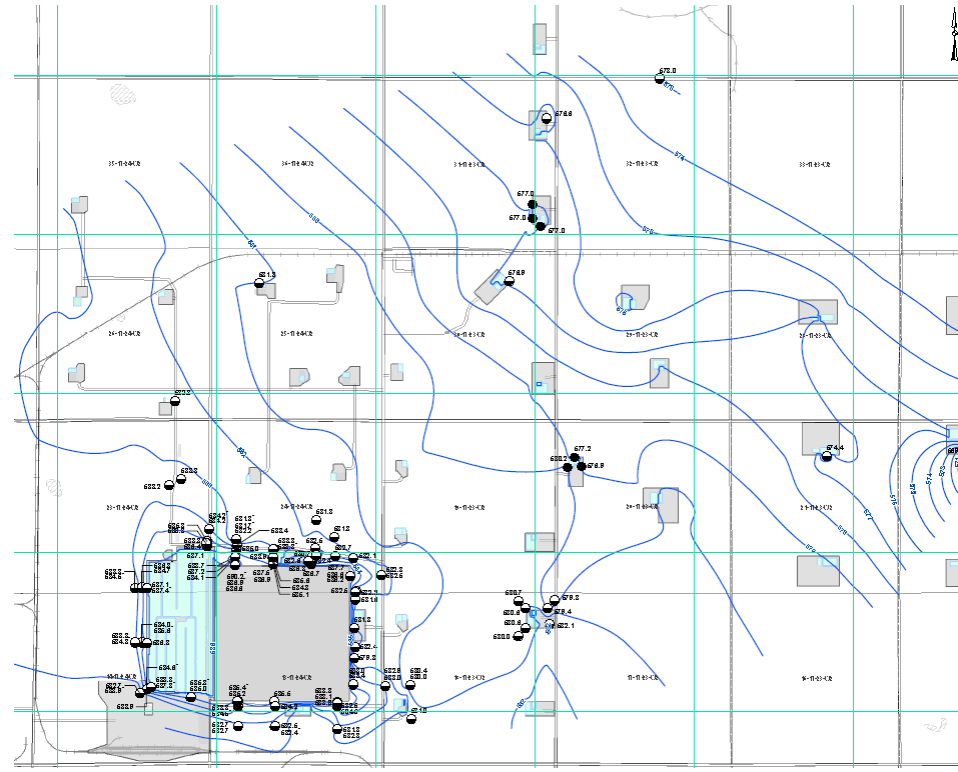
2014

- 2011 vs. 2014 chloride distribution map in near surface sediments
- Large increase in the number of installations - better able to show an accurate distribution
- Constrained by EM surveys

# Potentiometric Maps



2011

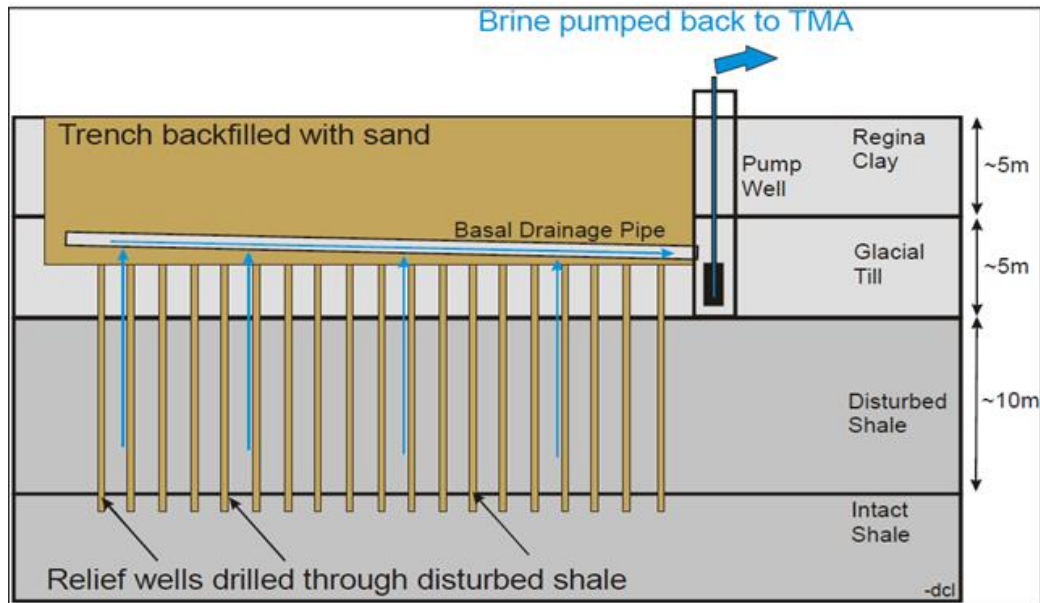


2014

- Potentiometric elevations increased from 2011 to 2014 in formations at the site (shown above is near surface sediments)
- Groundwater flow direction stayed the same, generally north easterly, except for west and south TMA where it goes radially away from the ponds

# French Drain Analysis

- French Drains surround north, east and south of the TMA



- Field review of the sumps, pumps and piezometers within the drain was completed as part of a TMA drainage system assessment.
- Piezometer head levels pointed to a restriction in the composite drain, causing higher head pressure on the north.
- Also recommended on the north to lower the sump elevation to increase maximum drawdown and increase efficiency.



# French Drain Analysis

- East drain appeared to be operating at good efficiency.
  - Recommendation to lower sump pump to the bottom of the drain to increase the maximum drawdown.
- South drain was newly installed, and recommendation to lower pump was also suggested, along with installing piezometers into the drain to monitor performance.
- As a result of these findings, all drains are being back flushed and a camera investigation will be completed to determine the cause of the blockage on the north.
- Pump elevations will also be lowered as recommended to maximize drawdown from the drains.

# Data Gaps and Decommissioning

- Data gaps were identified throughout the study:
  - Adding additional instrumentation around the TMA to identify the leading edge of the plume.
  - Investigate potential impacts identified through EM surveys
  - Install monitoring where none exists, or where impacts need to be confirmed.
- Piezometers were also identified for decommissioning if they are:
  - Damaged
  - Heavily impacted
  - Located upstream of French drains
  - Redundant monitoring
- 28 piezometers were recommended for decommissioning as a result of the study.

# Updated Monitoring Plan/Recommendations

- Recommended to reduce frequency of monitoring to alternate monitoring cluster sites and TMA piezometers every year.
  - Exception is that some piezometers around the TMA are still monitored annually.
  - Reducing sampling efforts where it isn't warranted.
- Monitoring of TMA and cluster site piezometers also lines up with EM survey requirements in the sites approval to operate.
  - EM data and groundwater data can be used in conjunction to examine impacts at the site.
- New piezometers must be visited annually at least 3 times to establish a monitoring trend
- Groundwater rationalization and monitoring program should be revisited every 10 years for a detailed assessment, and every 5 years for a less detailed assessment.

# Final Overview/Summary

- First time we looked at groundwater from a holistic point of view.
- Maximize our results while reducing our efforts where warranted.
- Address data gaps and use a risk based approach.
- Use all aspects of our monitoring plan to work together.

Questions?





