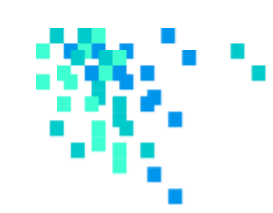




# Update on the Alberta and Saskatchewan Background Salinity & Metals Projects





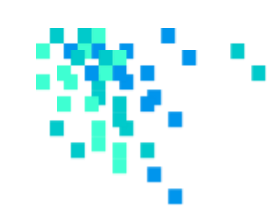
# Project Sponsors and Champions

## Project Sponsors

- InnoTech Alberta
- AUPRF
- CRIN

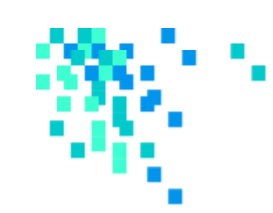
## PTAC RRRC Project Champions

- Rick Rohl, ARC Resources Ltd.
- Jonas Fenn, Whitecap Resources Inc.



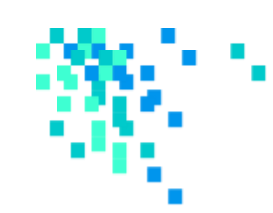
# Agenda

- Problem
- Project Summary & Key Activities
- Approach
- Progress To-Date
- Collaboration Opportunities



# The Problem

- Well known that numerous areas of Alberta have naturally elevated chemical parameter concentrations.
- No public, scientifically vetted resource that accurately predicts background soil salinity and metals chemistry province-wide
- High cost, schedule, and regulatory barriers to prove that elevated parameters are of natural origin
- Efficiency challenges with the number of applications requiring detailed regulatory reviews

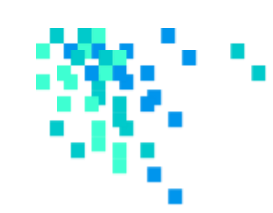


# Project Summary

The Alberta Background Soil Quality System is an interactive map of background soil salinity and metals parameters for use in environmental management.

## Key activities

- Compile, clean and integrate existing soil salinity and metals data
- Analysis to fingerprint background and remove impacted samples
- Develop a predictive background soil mapping system through a phased approach
- Create an interactive web application to deploy the system



# Approach to the Project

## AB Background Soil Quality System

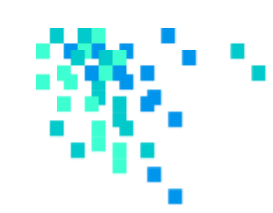
- Background fingerprinting based on pattern recognition **not** concentration
- Modern data science, dimensionality reduction now widely available
- Impacted samples included originally to learn differences between impacted and background

RESULT: Data-driven process removes potential for invisible bias

## Other Background Databases

- Pre-determined concentration limits for background
- Simple statistics were the only tools widely available until recently
- Impacted samples removed based on assumptions, location, experience, etc.

RESULT: Potential for missing naturally elevated parameters



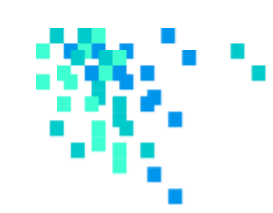
# Data Compilation

- First eight months of the project (August 2021 to April 2022) were spent requesting and collecting data from providers.
- Identity of data providers and details of datasets protected under confidential data sharing agreements.
- Common issue was missing metadata: UTM zones, units, or lab methods.
- Statvis worked with data providers to get data re-exported with all necessary information.
- Over 2,700 data files from eight data owners received for the pilot area.

# Salinity Data Analysis

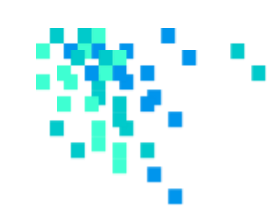
*ABSQS Phase 1*





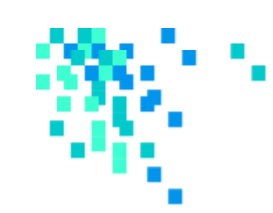
# Data Harmonization

- All datasets were then combined (harmonized) into one master dataset
- Columns were matched based on parameters and metadata values
- Master dataset for the project contained 23,821 records.



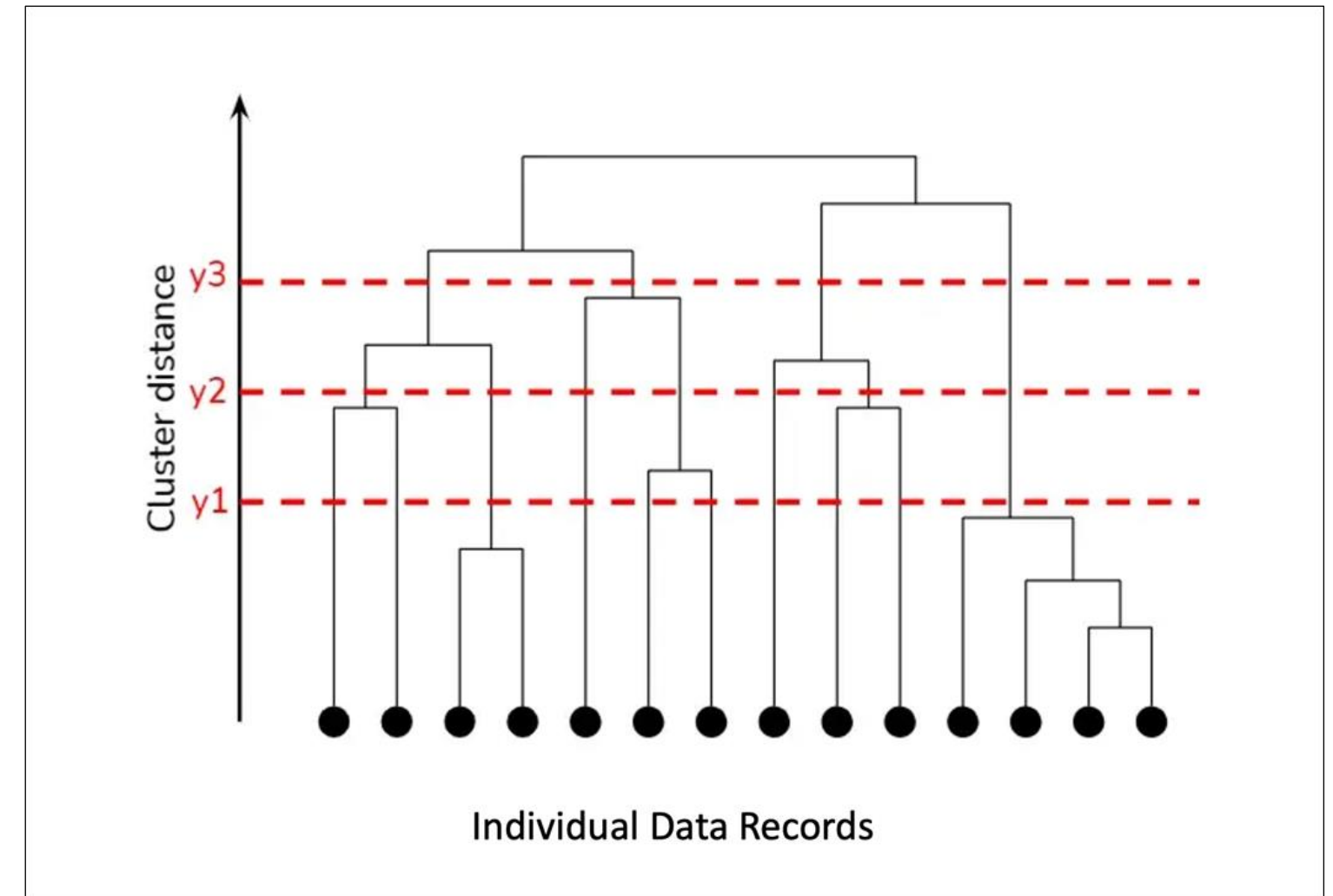
# Data Cleaning

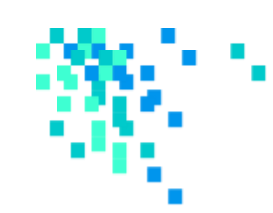
- Dataset cleaned to remove erroneous or duplicated data.
- For initial analysis dataset was limited to samples with all nine salinity parameters of interest (EC, SAR, pH, calcium, magnesium, potassium, sodium, chloride, and sulphate).
- These steps removed 143 data records, leaving 23,678 data records



# Data Exploration

- Data was explored using hierarchical cluster analysis and correlation plots
- Goal was to achieve a level of granularity that allowed impacted samples to be identified

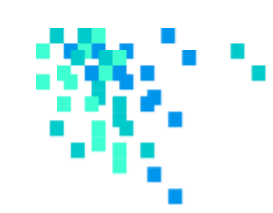




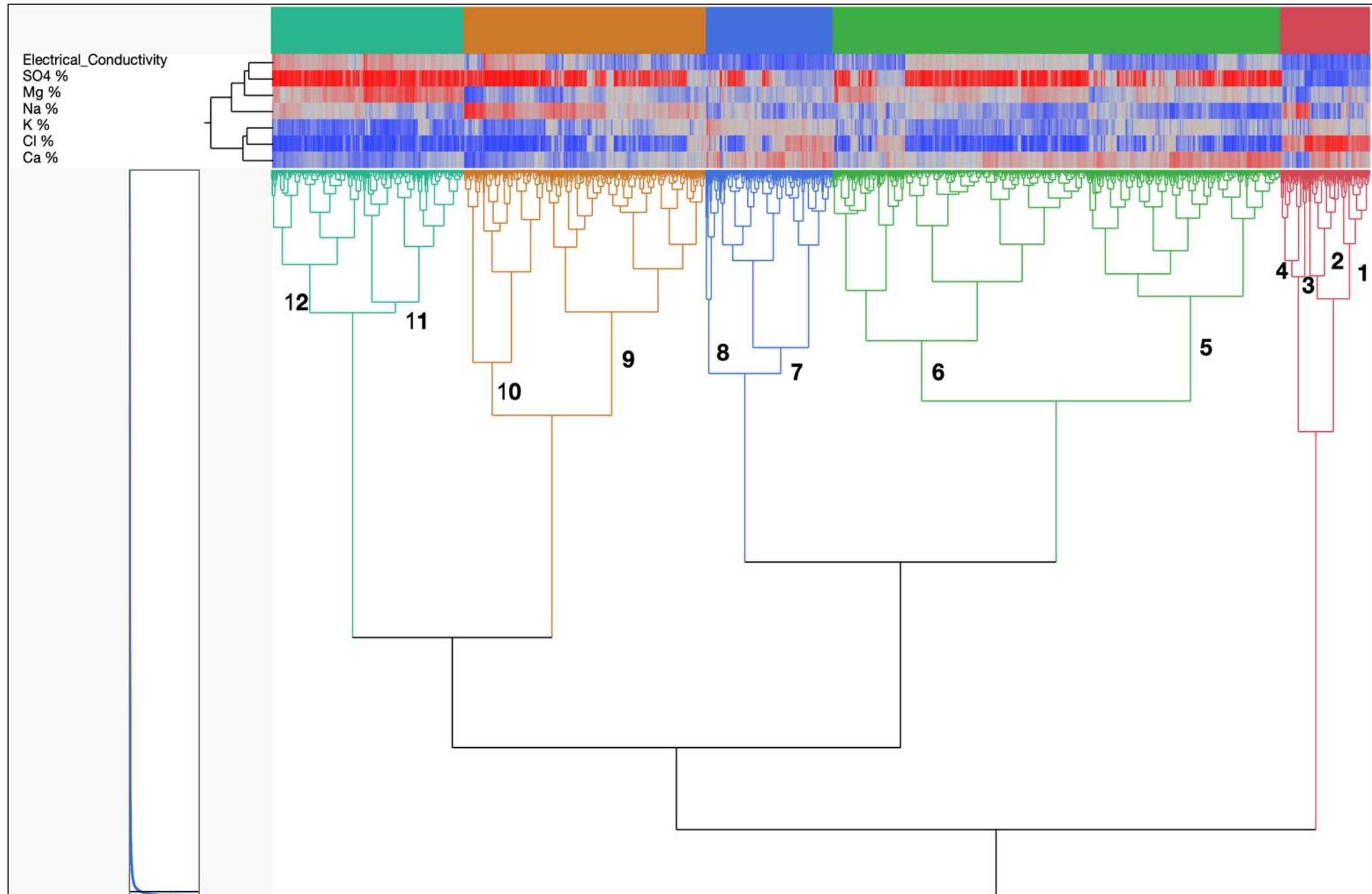
# The Ideal Background Dataset

- Removed samples with:
  - non-detect values for calcium, chloride, magnesium, potassium, sodium, sulphate or EC
  - ionic imbalance of more than 25%
  - greater than 100 mg/kg chloride (SST rule of thumb for impacted.)
- Remaining ideal background dataset contained 3,775 data records



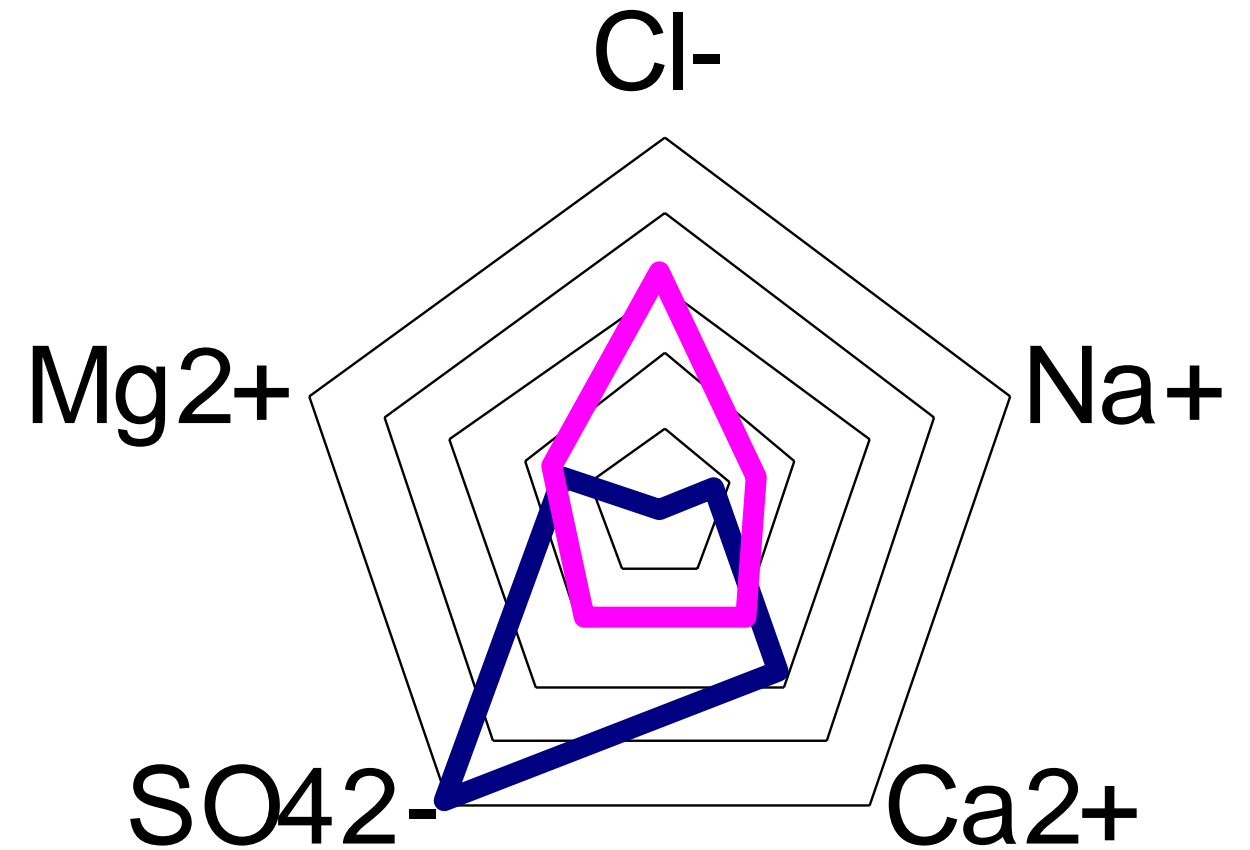


# Hierarchical Cluster Analysis – Salinity



# Conclusions

- 18,105 of the 23,821 data records in the dataset were identified as background
- Average radar plots generated for each cluster

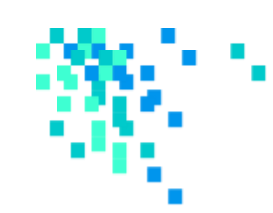


**Summary Statistics from Background Dataset that Define Cluster 1**

	K %	Mg %	Ca %	Na %	SO4 %	Cl %
Mean	2.43	30.79	39.18	27.61	35.35	64.65
Min	0.92	10.66	19.21	10.72	1.33	37.92
Max	4.30	52.43	57.68	50.53	62.08	98.67
Median	2.40	29.21	38.73	26.27	37.41	62.59
Quantiles95	3.54	47.61	52.57	46.90	51.04	89.49

# Metals Data Analysis

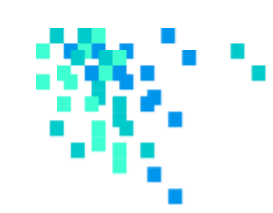
*ABSQS Phase 1*



# Data Harmonization

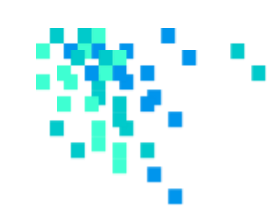
- Master dataset was created comprised of 2,078 data records with one or more metals parameters reported





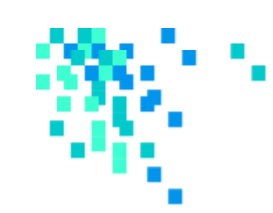
# Data Cleaning

- Barite-barium, non-barite barium, boron, hexavalent chromium, and uranium were removed due to inconsistent reporting.
- Tin and silver had poor levels of detectability and were also removed.
- 15 metals parameters in the analysis ready dataset—antimony, arsenic, beryllium, cadmium, chromium (total), cobalt, copper, lead, mercury, molybdenum, nickel, selenium, thallium, vanadium, and zinc
- Remaining non-detects imputed using multiplicative lognormal replacement – robust estimates.
- The analysis-ready dataset contained 1,405 samples with 15 metals available for statistical analysis.

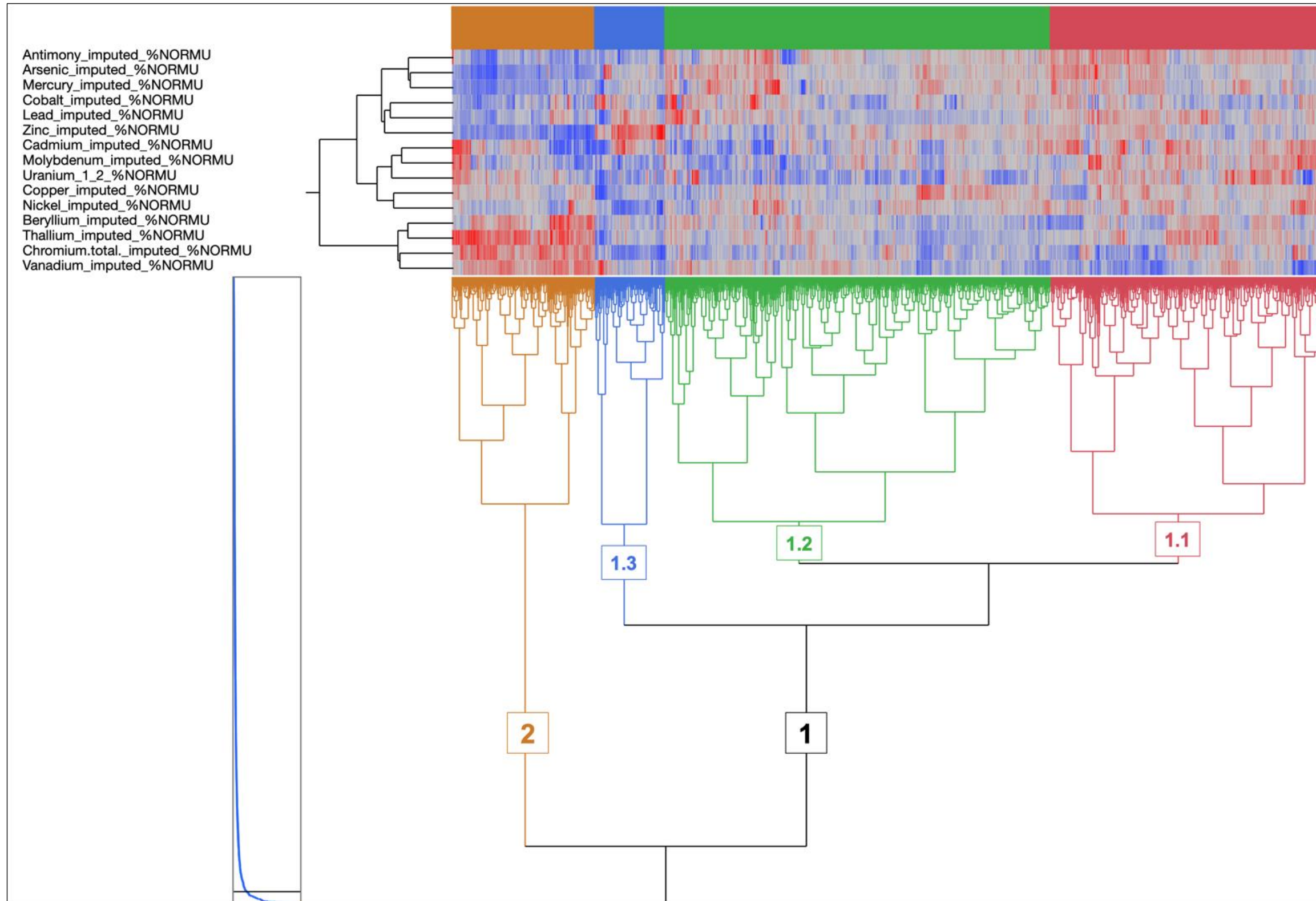


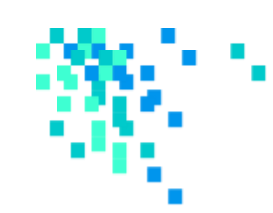
# The Ideal Background Dataset

- Of the 1,405 data records only 72 exceeded one or more Tier 1 guidelines for agricultural land use
- Box-cox transformation was done, an outlier analysis completed, and 258 data records were removed
- Ideal background dataset of 1,075 data records



# Hierarchical Cluster Analysis – Metals

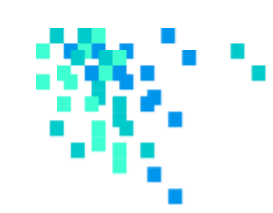




# Conclusions

- 1,183 of the 1,405 data records were identified as background



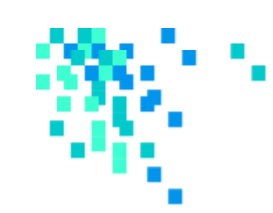


# Recommendations

- ABSQS should be expanded to the full provincial scale (i.e., Phases 2 and 3).
- Parameters of interest should be carried forward but final parameters should be determined based on analysis of the full provincial-scale dataset.
- An attempt should be made to add geospatial coordinates to the list of metadata items included in lab databases going forward.
- Future phases or similar projects should provide additional guidance on data and metadata requirements (i.e., must-haves vs. nice-to-haves).
- Datasets with geospatial coordinates for individual data records should continue to be solicited opportunistically.

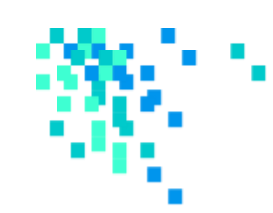
# Salinity Data Analysis

*ABSQS Phase 2*

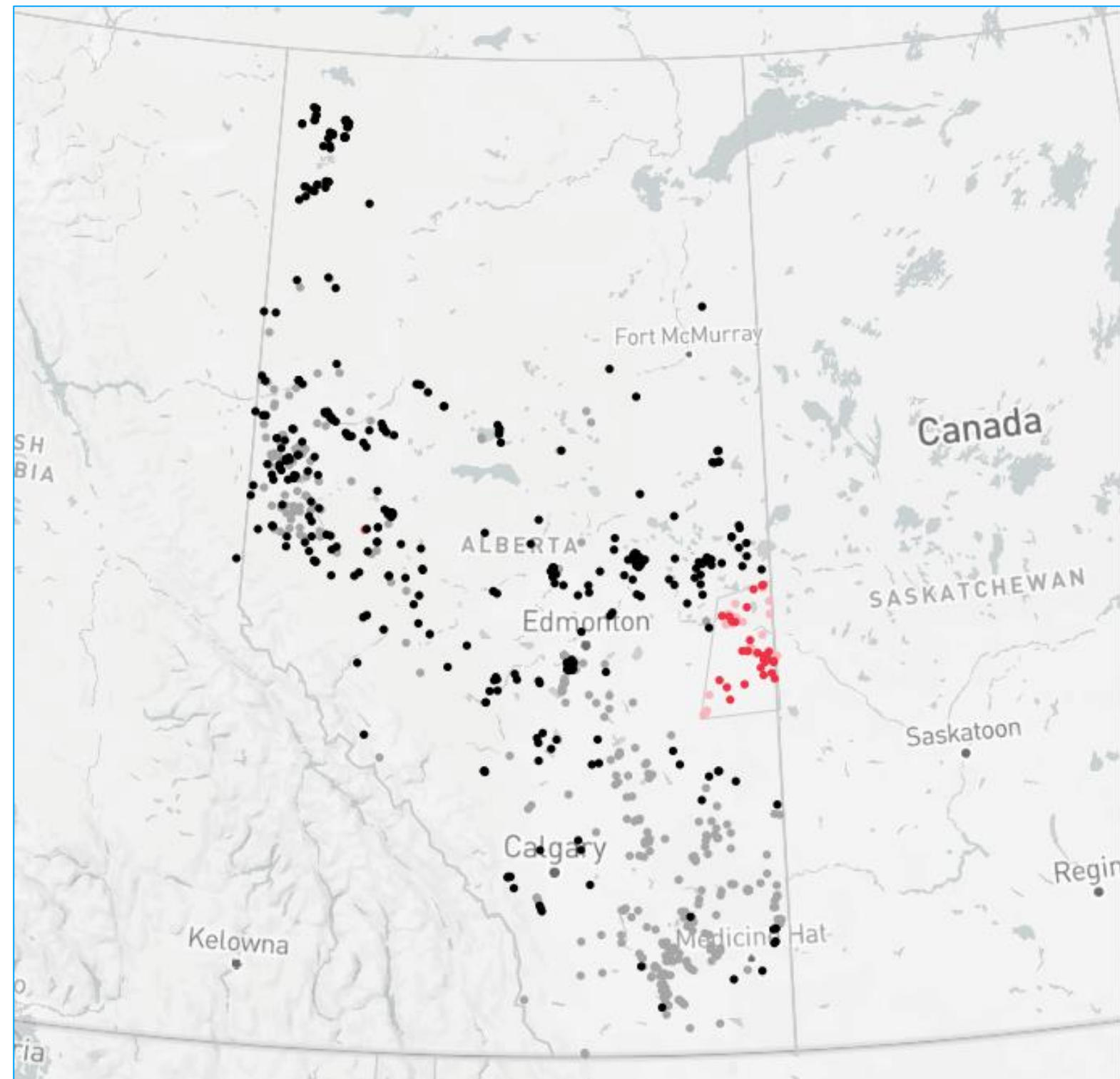


# Data Harmonization

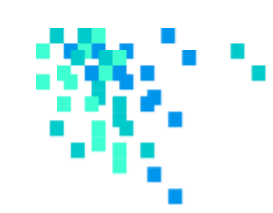
- All datasets were combined (harmonized) into one master dataset
- Columns were matched based on parameters and metadata values
- Dataset cleaned to remove erroneous or duplicated data.
- Master dataset for the project contains 224,902 records with EC, SAR, Cl, SO<sub>4</sub>, Mg, Ca, K, Na.



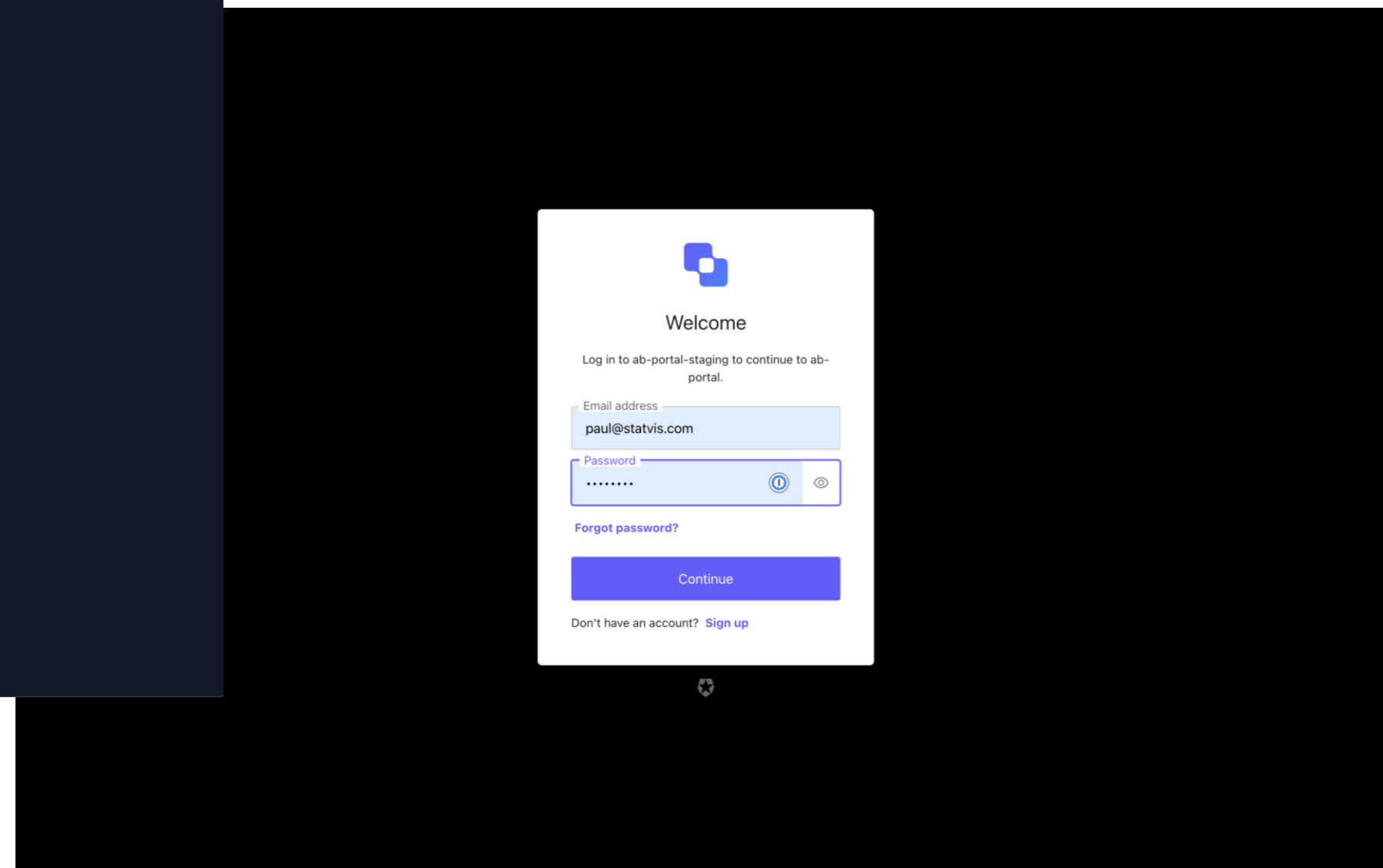
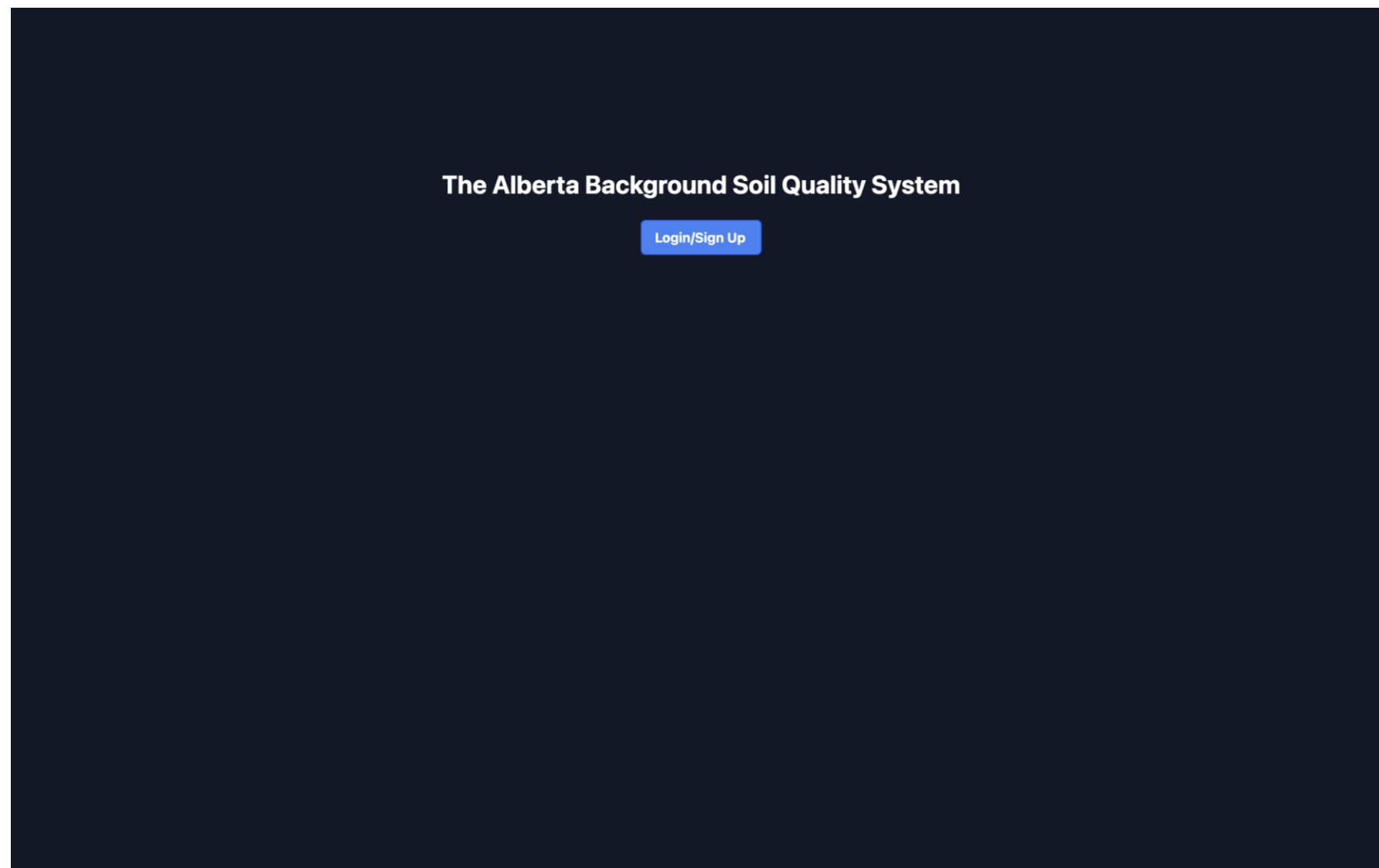
# Full Salinity Dataset



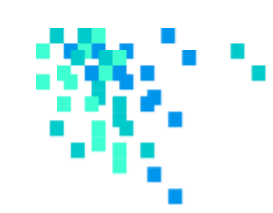




# Web Portal Design







# Static Layers & Location Search

**The Alberta Background Soil Quality System** Logout

Please increase zoom level to at least 12 to view surface water (Current Zoom: 5) Loading layers... Please wait till finished before moving the map

AB Municipal Boundaries  
AB Green White Area

Search

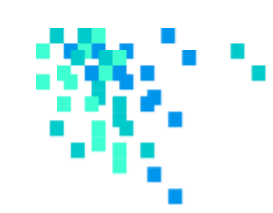
**The Alberta Background Soil Quality System** Logout

Please increase zoom level to at least 12 to view surface water (Current Zoom: 9)

Wabasca-Desmarais, Alb

AB Municipal Boundaries  
AB Green White Area





# Web Portal Design – Static Layers

**The Alberta Background Soil Quality System** Logout

Please increase zoom level to at least 12 to view surface water (Current Zoom: 13)

**AB Municipal Boundaries**

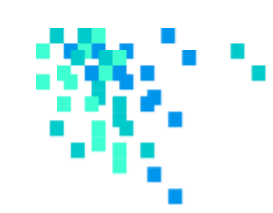
AB Green White Area

AB Surface Water

+  
-

© Mapbox © OpenStreetMap Improve this map © Maxar





# Web Portal Design – Concept for Data Display

**The Alberta Background Soil Quality System** Logout

Please increase zoom level to at least 12 to view surface water (Current Zoom: 13)

**AB Municipal Boundaries**


AB Green White Area

AB Surface Water

Wabasca-Desmarais, ...

**Summary Statistics for Site Located at [LOCATION] Located in Polygon [POLYGON #]**

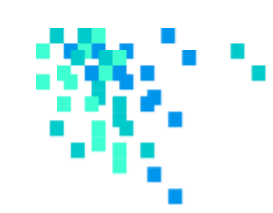
	Ca	Mg	K	Na	Cl	SO <sub>4</sub>	EC	SAR	pH	Sb	As	Be	Cd	Cr	Co	Cu	Pb	Hg
Min																		
Max																		
Mean																		
Median																		
Q1																		
Q2																		
Q3																		



# ABSQS Phase 2 – Remaining Tasks

- Predictive mapping of pilot area
- Stakeholder engagement and model refinement
- Complete web portal
- Complete data analysis for full dataset
- Final reporting for phase

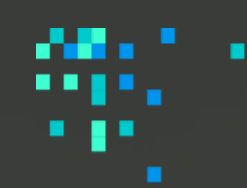




# Saskatchewan Background Database

- Goal is to develop a background geodatabase of soil and groundwater for southern Saskatchewan
- Collaborative project with the Ministry of Energy and Resources and industry partners
- Will be used to assist industry and government and in environmental liability management
- Currently in contracting





# Questions?

Do you have an industry partner that might be interested in contributing data to the project?

If so, please let us know!

Paul Fuellbrandt – [paul@statvis.com](mailto:paul@statvis.com)

Chibuike Chigbo – [chibuike.chigbo@innotechalberta.ca](mailto:chibuike.chigbo@innotechalberta.ca)