Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Advances in Risk Communication for Sites with Large Data Sets

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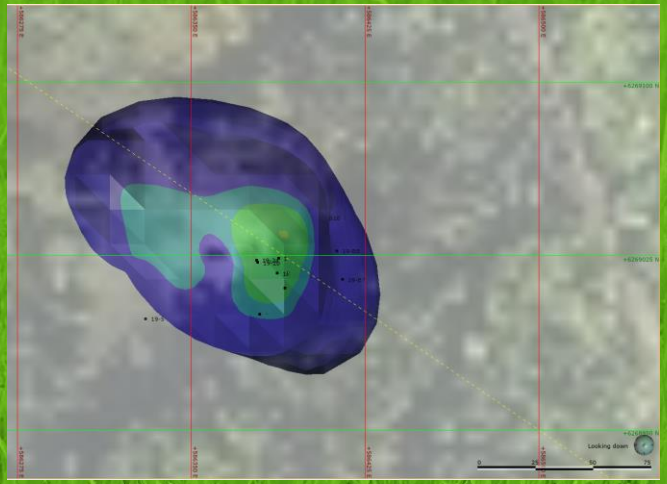
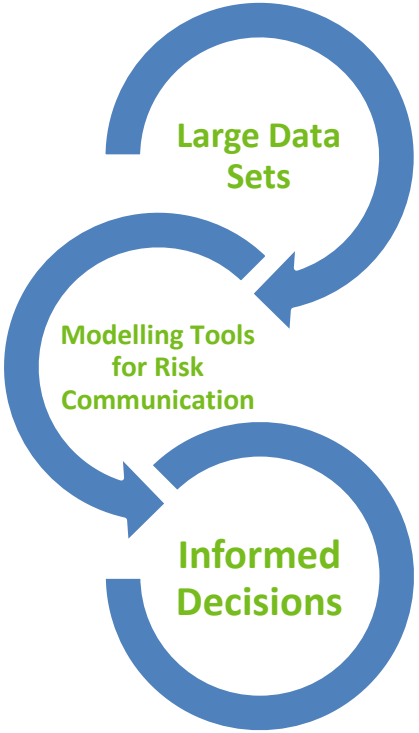
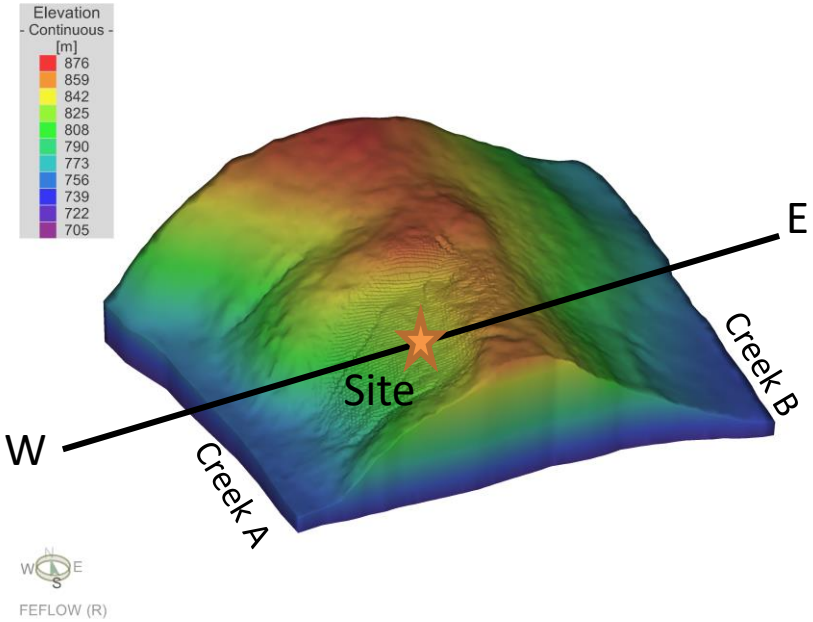


Introduction



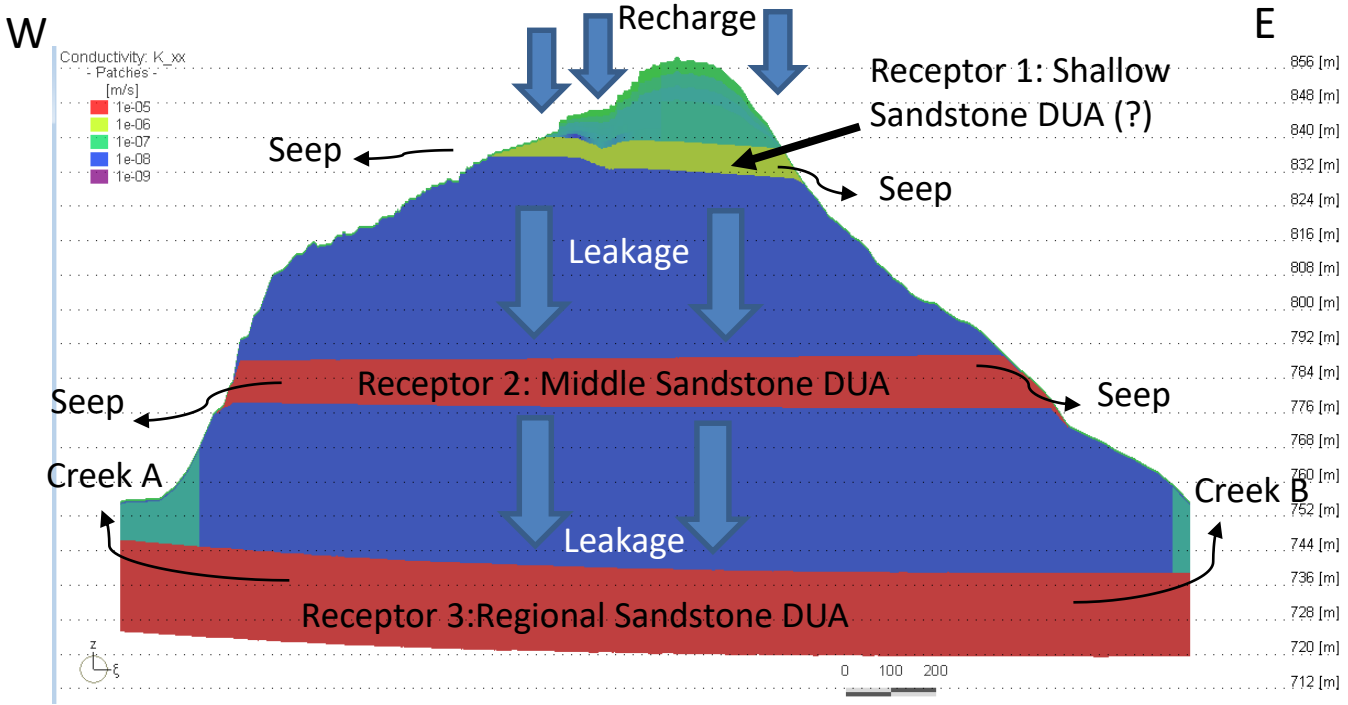
Case Study 1

Vertical Exaggeration
3:1

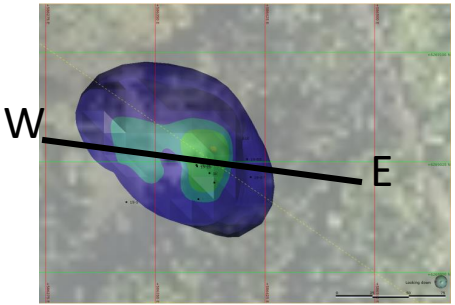


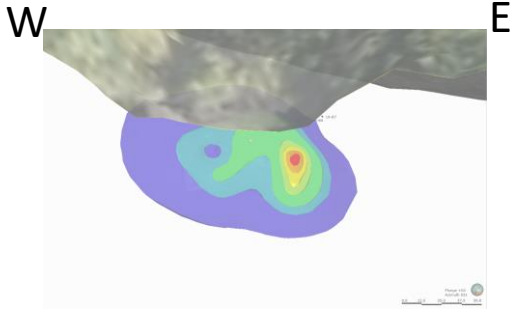
- Oil well drilled in 1979
- Converted to a produced water injection well in 1996
- Decommissioned October 2002
- Residual chloride impacts that may threaten Domestic Use Aquifers (DUAs)

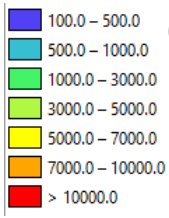
Conceptual Flow Diagram



Chloride Impacts

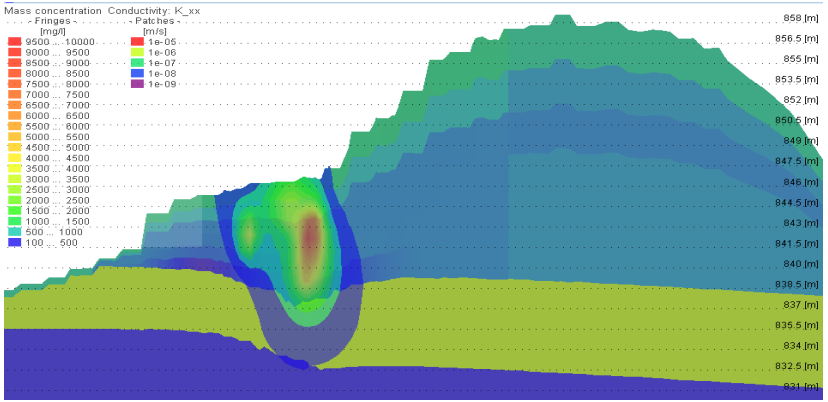






Cl (mg/l)

Interpolated in 3D via Leapfrog Software

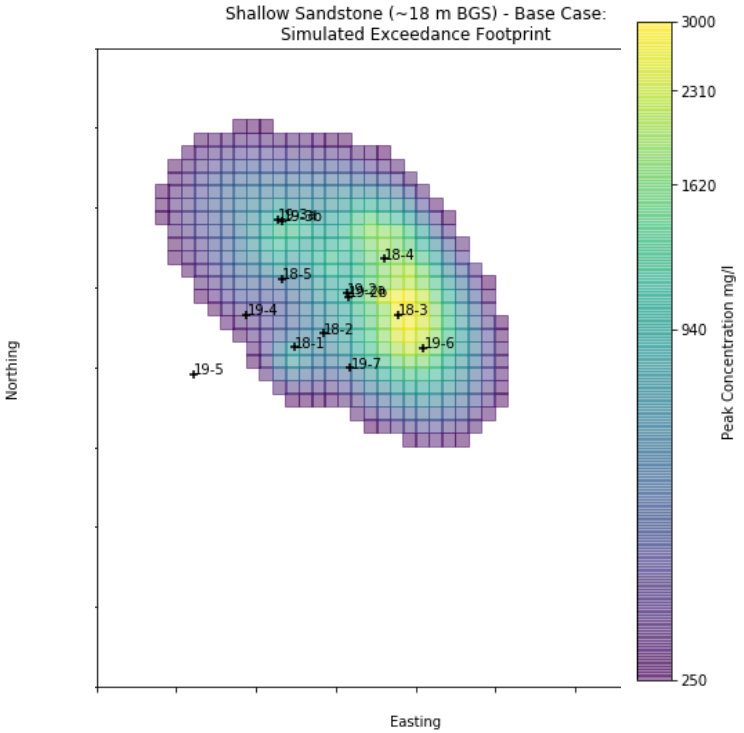


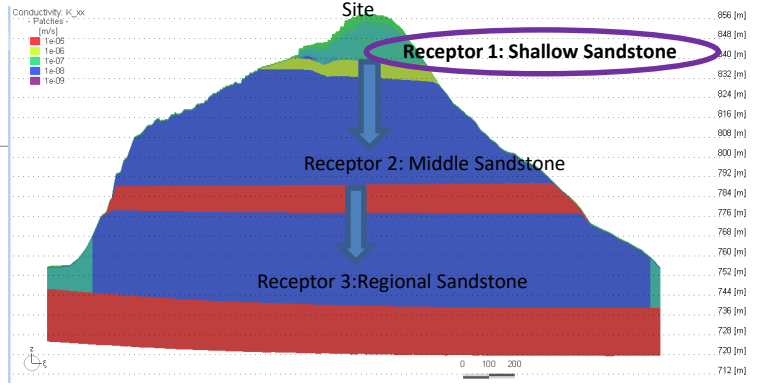
Translated into FEFLOW (GW Modelling Software) to run 3D fluid flow and mass transport simulations

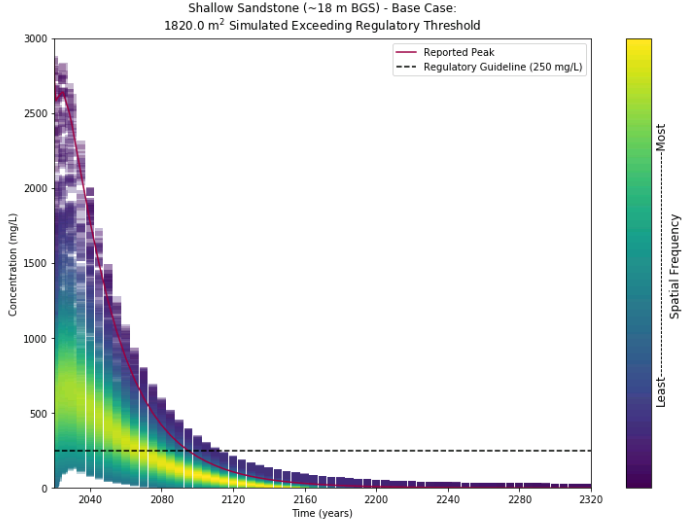
Big Questions

- What potential impacts could occur?
- What can we do to mitigate?
- How effective will that mitigation be?
- How do we visualize all this and convey it to those making the decisions?

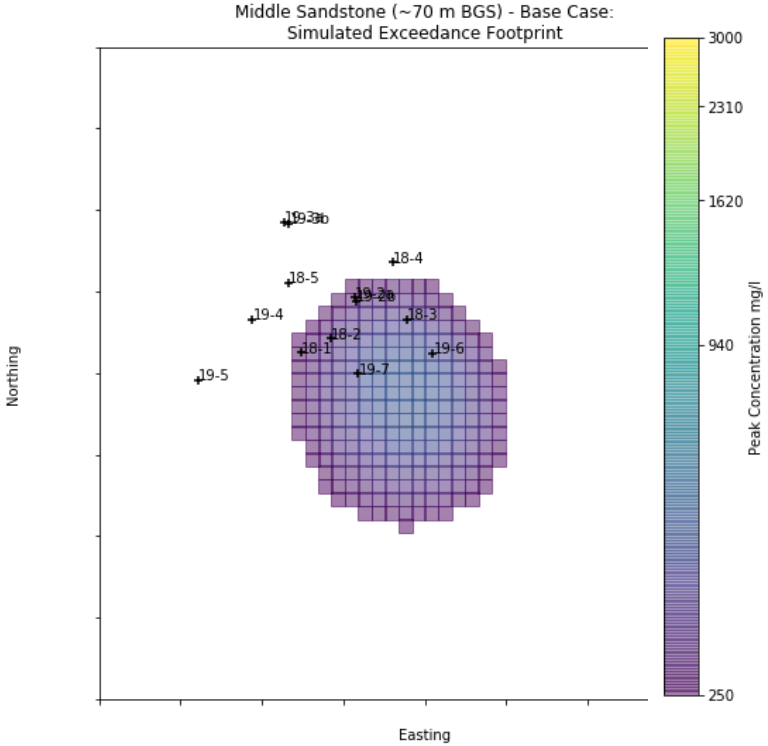
Shallow Sandstone

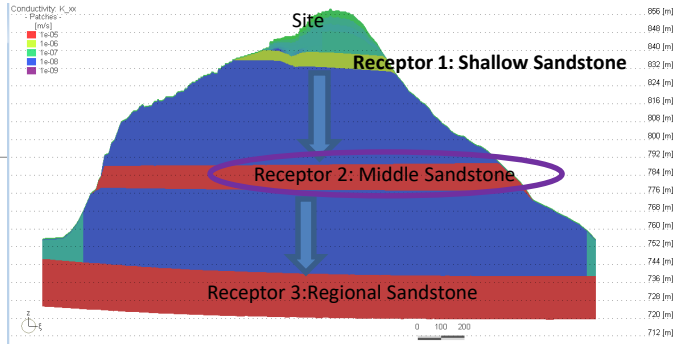


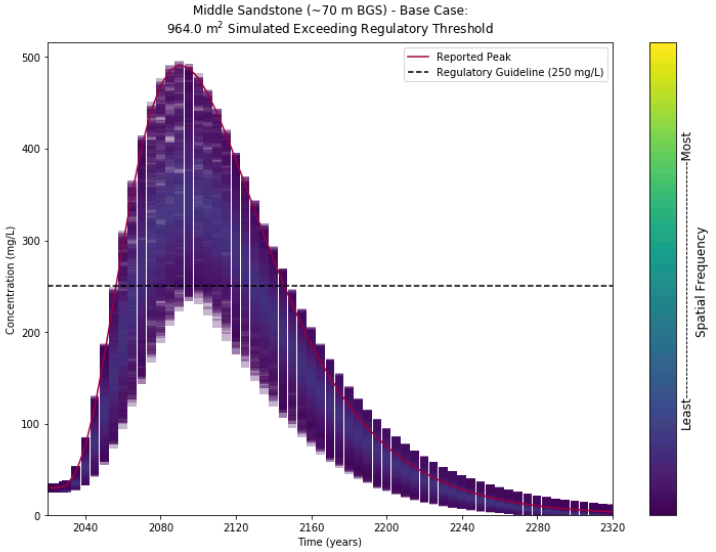




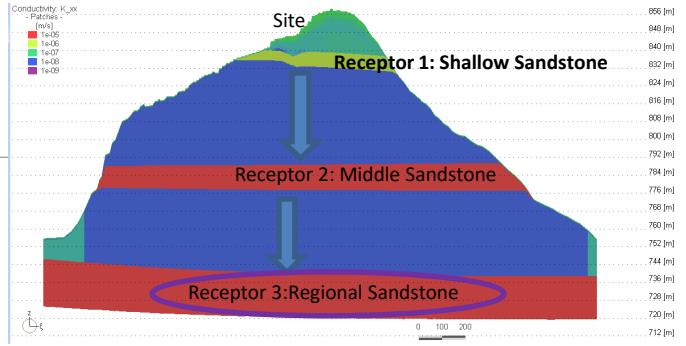
Middle Sandstone



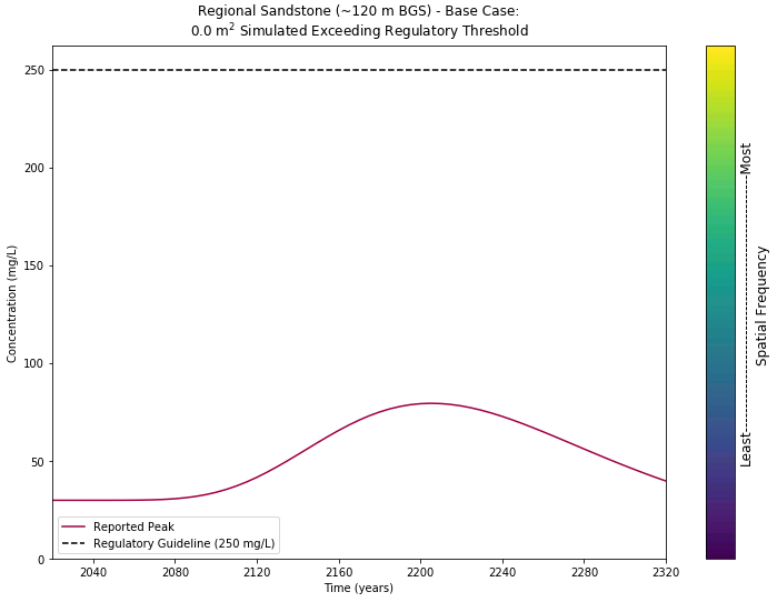




Deep Sandstone



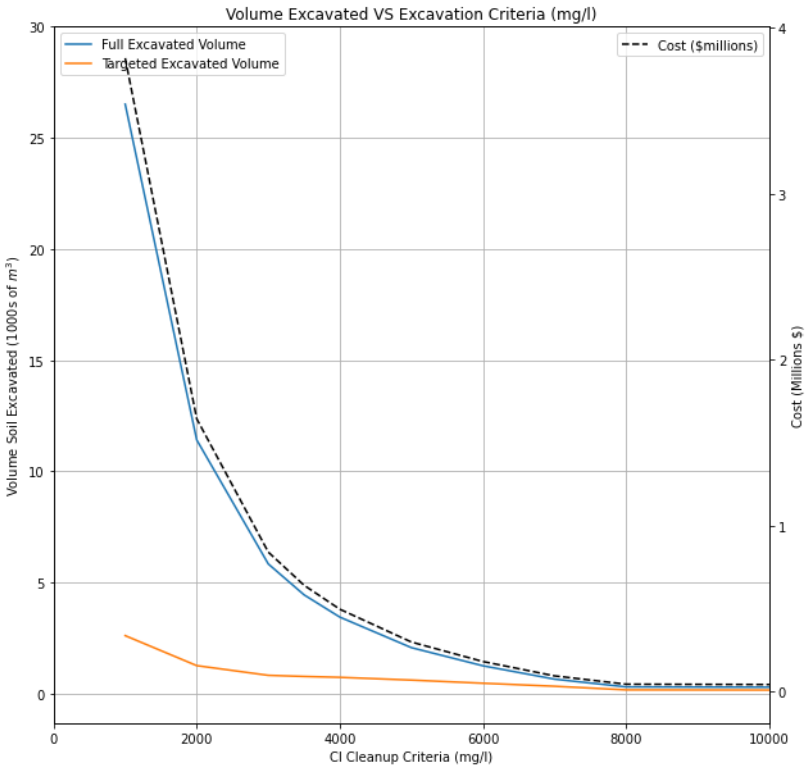
No exceedance



What if we excavate?

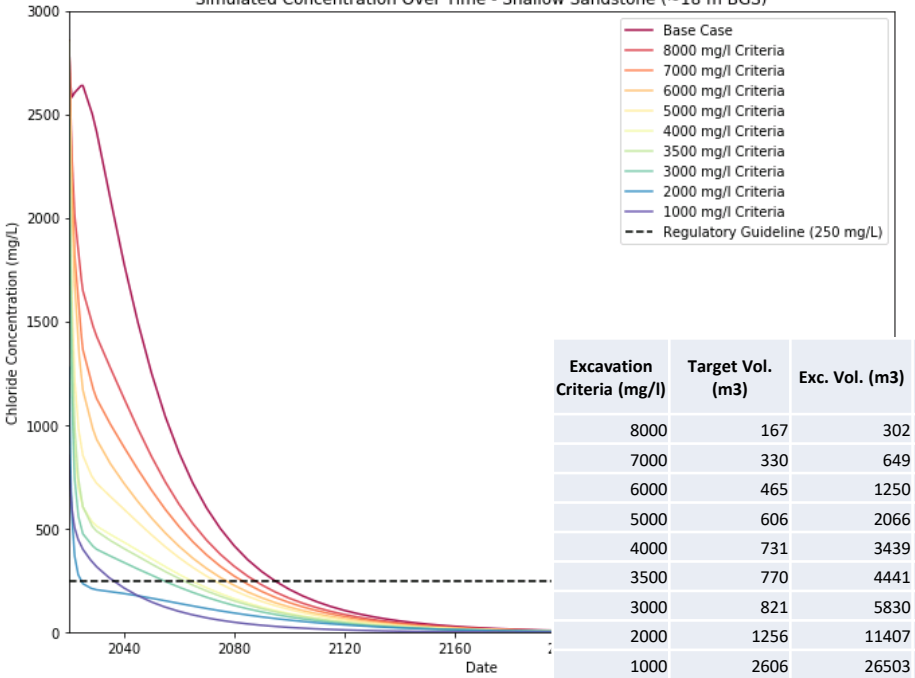
- Target a certain concentration criteria:
  - E.g. “remove all material above X mg/l chloride and replace with clean infill”
- How much material corresponds to a certain criteria?
- How much will we have to dig to get at it?
- How much will it cost?
- How effective it be in mitigating impacts?

Excavation Scenarios



Excavation Criteria (mg/l)	Target Vol. (m3)	Exc. Vol. (m3)	Estimated Cost
8000	167	302	$43,331
7000	330	649	$93,457
6000	465	1250	$179,960
5000	606	2066	$297,477
4000	731	3439	$495,239
3500	770	4441	$639,473
3000	821	5830	$839,544
2000	1256	11407	$1,642,542
1000	2606	26503	$3,816,501
Do Nothing	0.00	0.00	$0

Excavation Scenario Results



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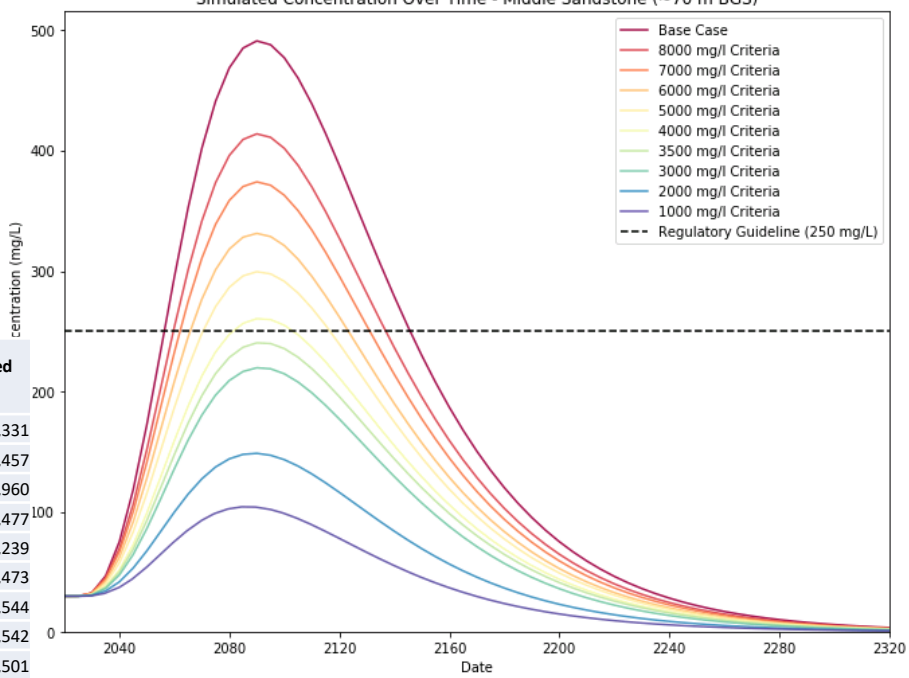
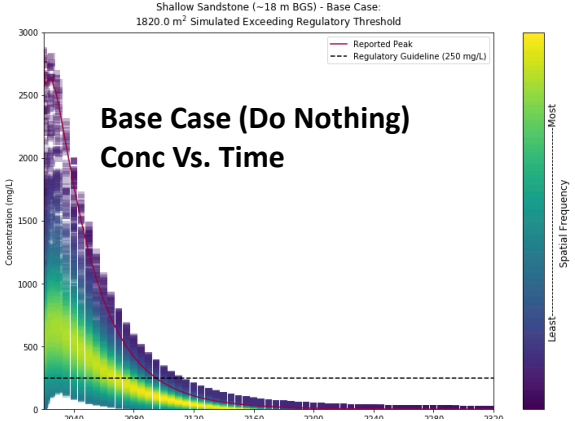
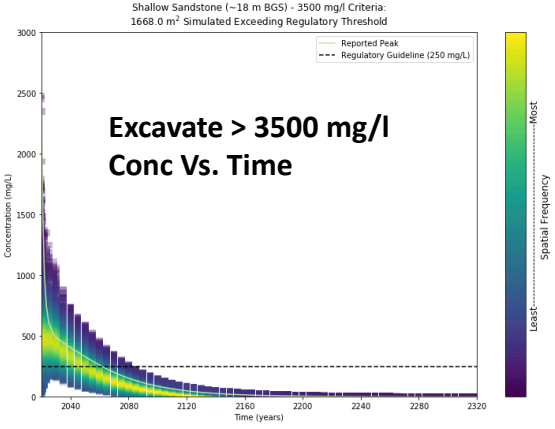


3500 mg/L Excavation: A Closer Look

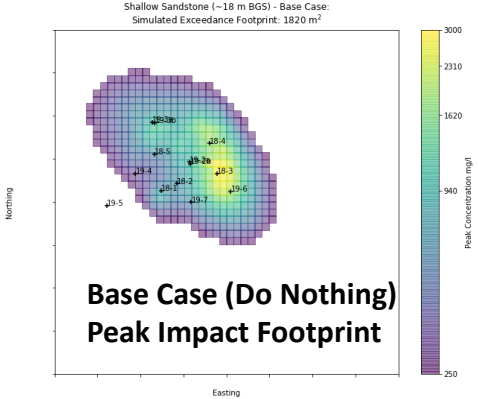


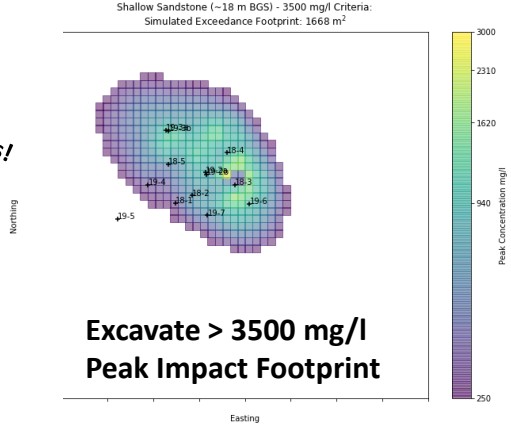


If you excavate all soil greater than 3500 mg Cl/L...

Conc VS. Time changes!

Impact footprint changes!



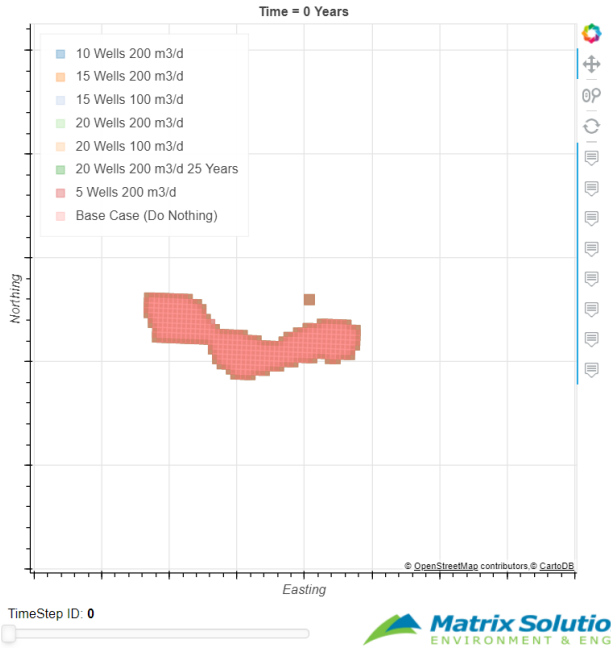


Case Study 2: Interactive Visualization of Model Scenario Results

- Contaminant plume migrating eastward through DUA
- Different pumping configurations (# of locations/rates/duration of pumping) considered
- Each run through the model and results presented in interactive html

Case Study 2

Demo of html



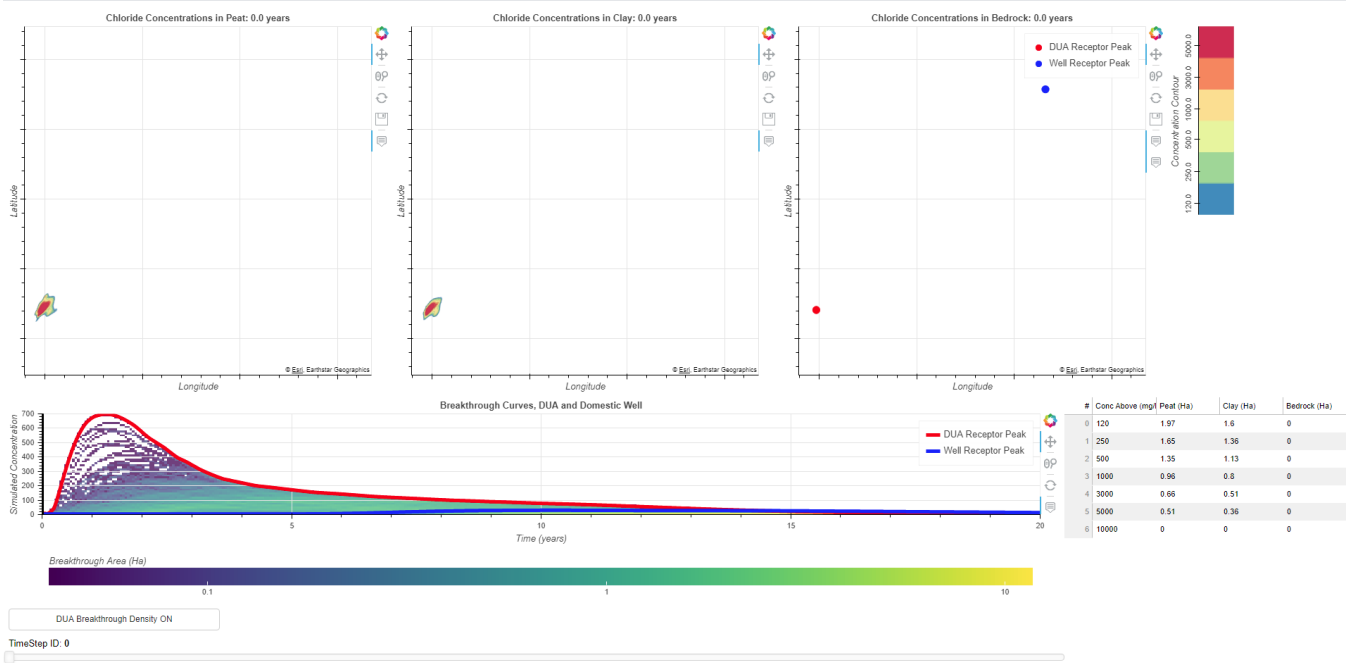
#	Scenario	Plume Footprint (Ha)
0	15 Wells 200 m3/d	308
1	20 Wells 200 m3/d 25 Years	308
2	20 Wells 200 m3/d	308
3	15 Wells 100 m3/d	309
4	10 Wells 200 m3/d	310
5	20 Wells 100 m3/d	310
6	5 Wells 200 m3/d	310
7	Base Case (Do Nothing)	310

Case Study 3: Interactive Quasi-3d visualization of Plume migration

- 3 key geologic layers: Peat->Clay->Bedrock DUA
- Chloride release in peat
- Concerned about DUA receptor and off site well
- Base Case/No additional remediation scenario focus

Case Study 3

Demo of html



#	Conc Above (mg/l	Peat (Ha)	Clay (Ha)	Bedrock (Ha)
0	120	1.97	1.6	0
1	250	1.65	1.36	0
2	500	1.35	1.13	0
3	1000	0.96	0.8	0
4	3000	0.66	0.51	0
5	5000	0.51	0.36	0
6	10000	0	0	0

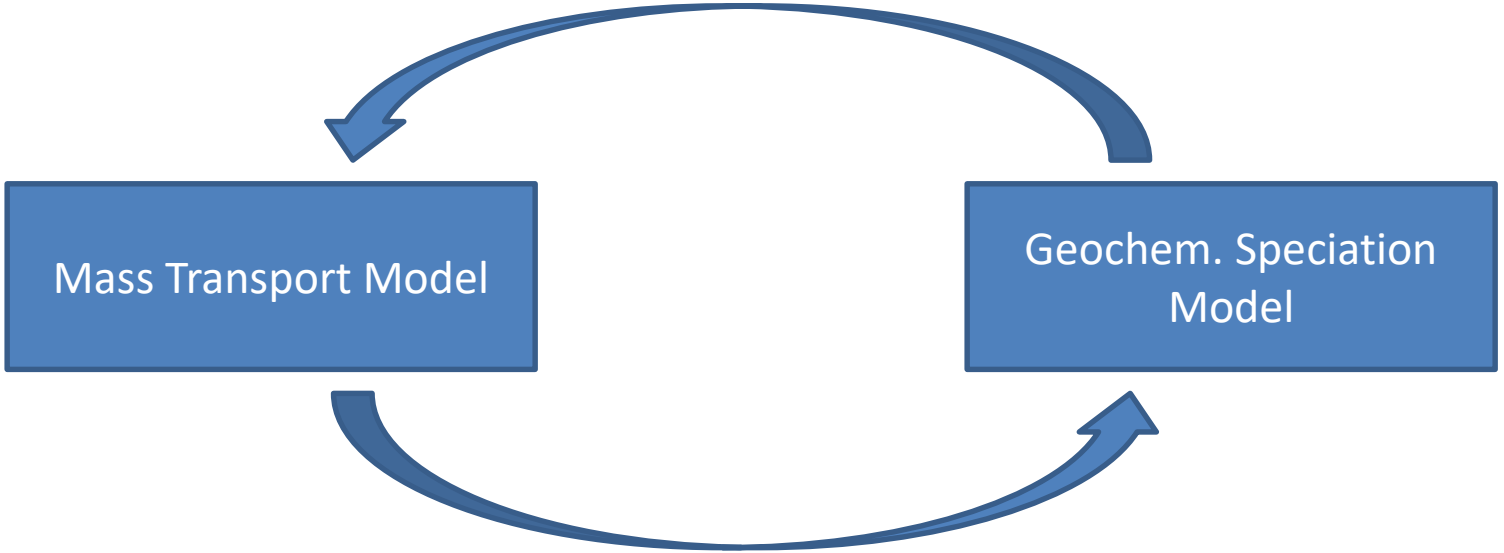
Case Study 4: Sulphur Specific Transport

- Consider the problem of sulphate transport in a calcite rich environment

$$CaCO_3 + H_2SO_4 + H_20 \rightarrow CaSO_4 * 2H_2O + CO_2$$

- Lower pH →More dissolved Ca → More $CaSO_4$*2 H_2O formation
- Some sulphate will precipitate out as gypsum, some will remain dissolved
  - Only dissolved component “available” for mass transport

Mass Transport Model ←→Geochemical Model

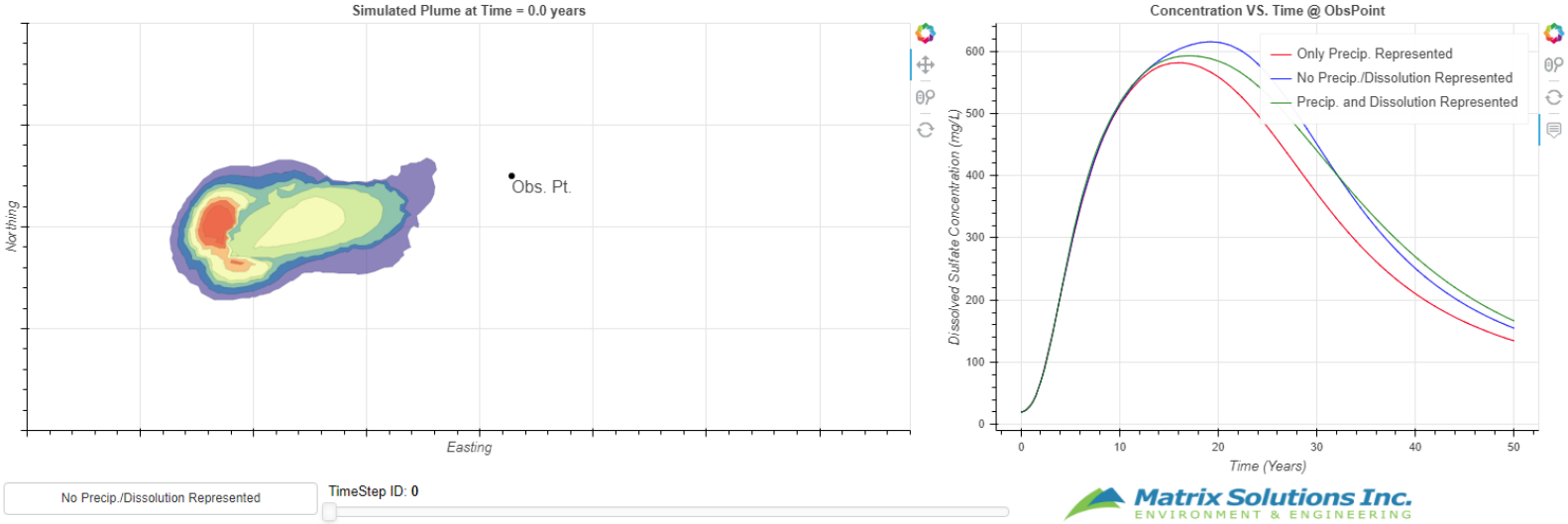


Mass Transport Model ←→Geochemical Model

- In between mass transport model time steps, a geochemical run at each model node (representing a portion space) to determine amount of gypsum precipitation
- Amount of gypsum precipitated at each node stored in an array
- In later time times, dissolution of gypsum occurs as clean groundwater flows through
- Visualize effect of representing this in interactive html

Case Study 4

Demo of html



Summary

- More than just peak breakthrough curves to look at!
  - Area of impact
  - Volume of impact
  - Spatial distribution of impact
  - Duration of impact
  - Temporal

Summary Cont'd

- Increased computational resources + basic programming ability:
  - Execute and convey modelled results to stakeholders transparently, digestibly and quickly – "gets everyone on the same page"
  - Utilize user-interactivity as a means of engagement
  - Can also be used to illustrate key concepts (like gypsum formation/dissolution)
  - Maximize problem understanding → optimized decision making
- Next Step
  - Optimization applications

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