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Legacy
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Multiple Tracer Testing Approaches for Improved Groundwater Flow and Reactive Transport Models

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Session Track 2.4: Advancing science and technology to reduce costs while maintaining or improving protection of human health and the environment: Advances in Environmental Science

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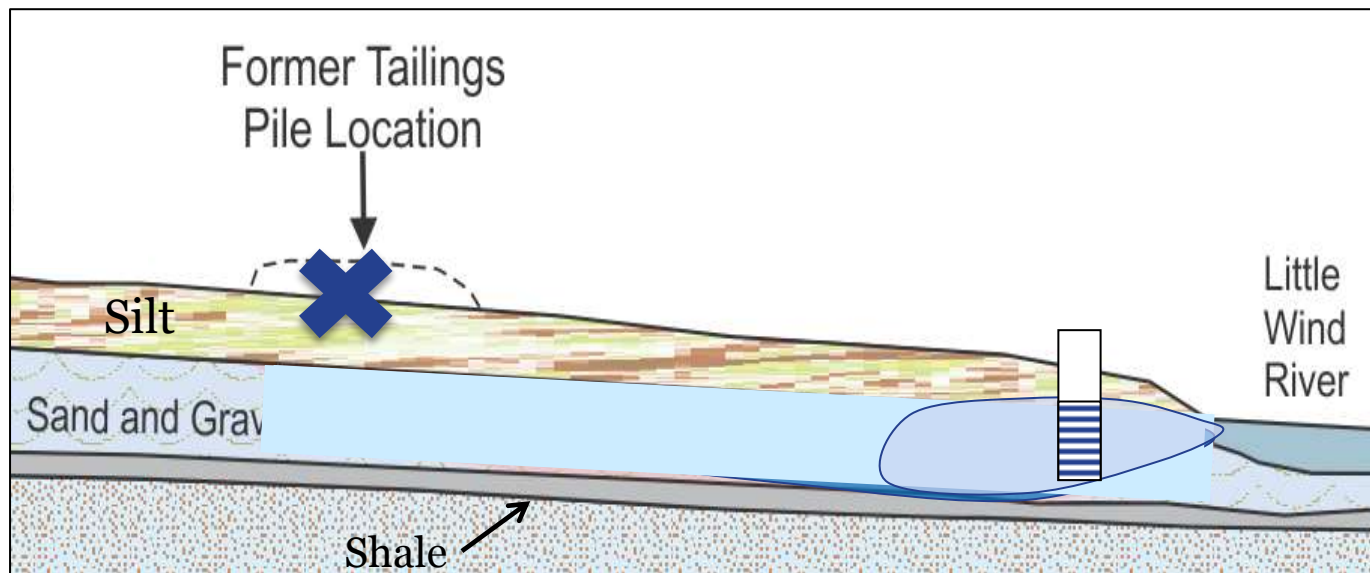
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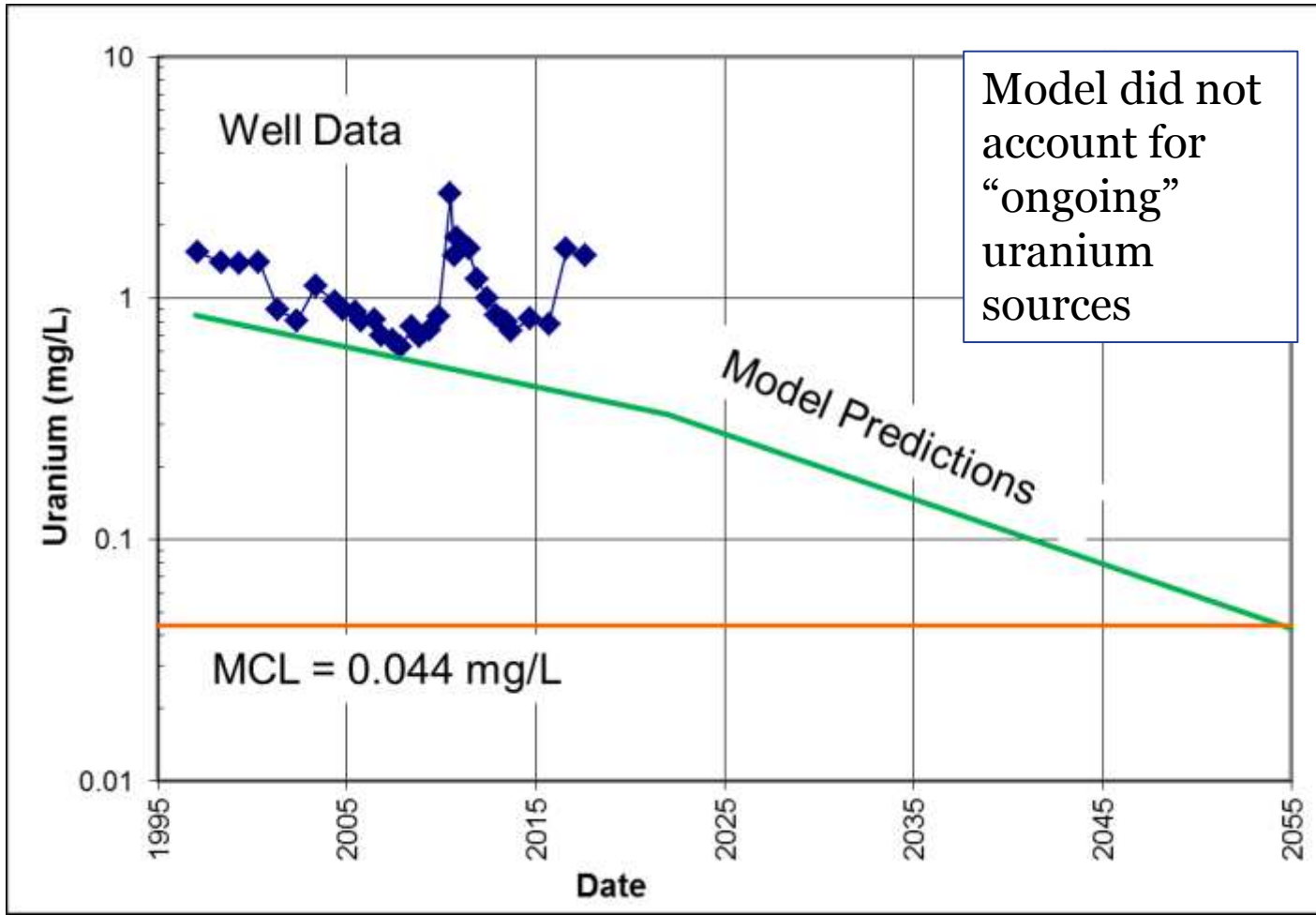
Uranium Ore-Processing Sites

Past Model of Natural Flushing

- Tailings have been removed, assumed source removed
- Contaminant plume in alluvial sands and gravels, assumed limited attenuation (uranium moving only slightly slower than groundwater flow rates)
- Examples: Rifle, Riverton, Grand Junction, Naturita, etc.



Actual Data Compared to Model Predictions



Grand Junction, Colorado, Site

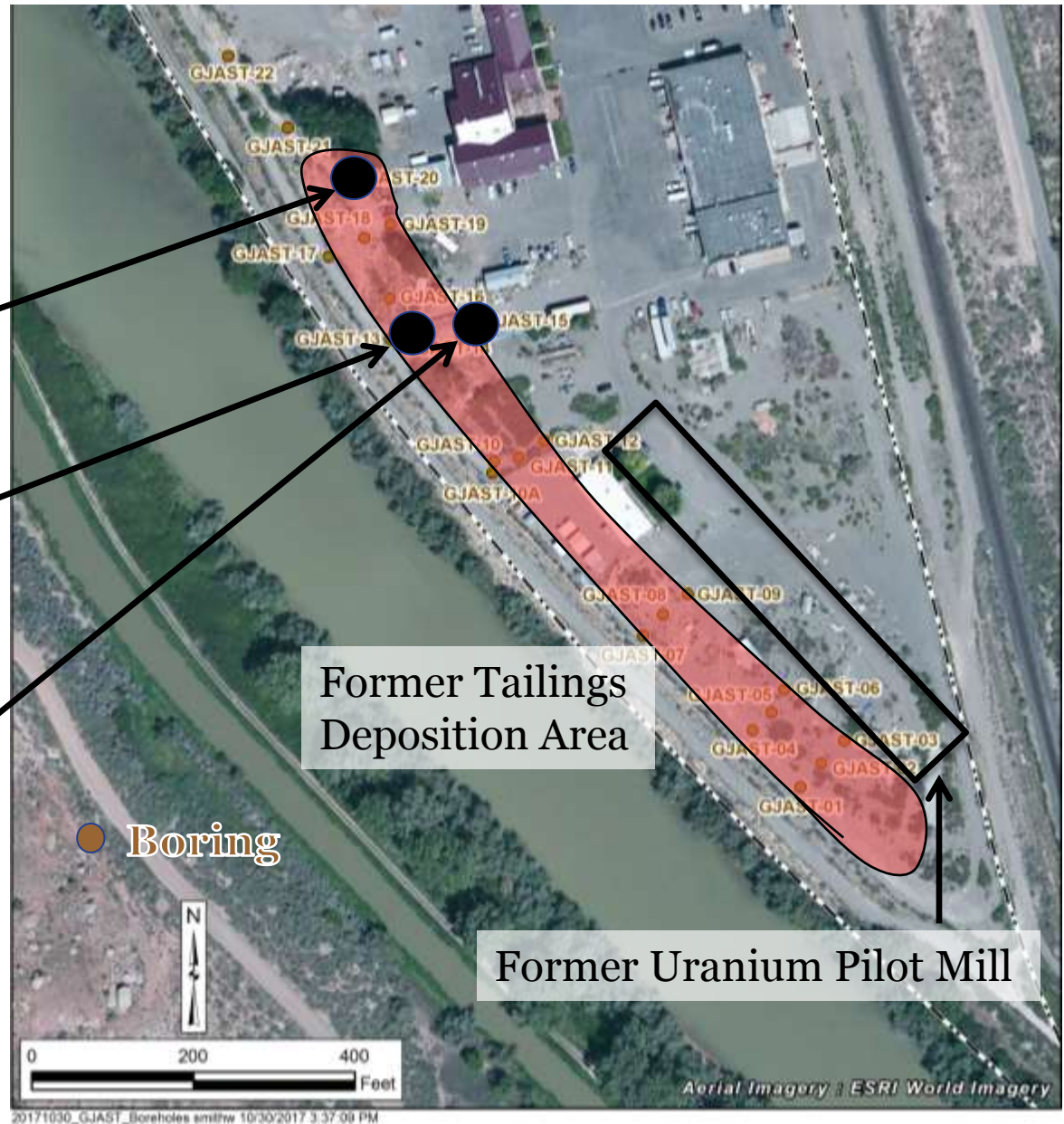


Three Areas for Tracer Testing

Gypsum and uranium below water table

Uranium in the unsaturated zone

Naturally reduced zone, organics with elevated uranium



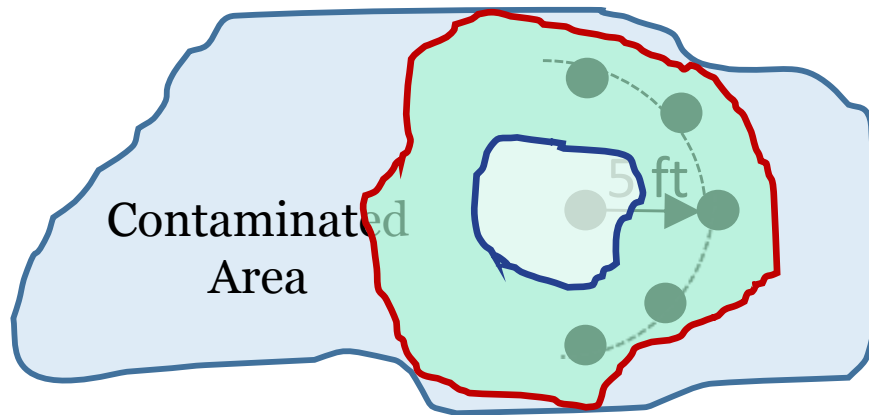
Tracer Testing Objectives

- Evaluate methods to better understand contaminant release and transport processes at the field scale related to plume persistence
- Provide data for revising site conceptual models and estimating reactive transport modeling parameters
- Ultimate goal: improved predictions of contaminant transport (especially uranium)
- Approach is applicable at other sites, but first use Grand Junction site as a demonstration

Tracer Testing Methods and Derived Data

- Saturated zone push-pull test (single well injection and extraction)
 - Dispersion, dual porosity, adsorption/desorption, gypsum dissolution
- Saturated zone cross-hole test (inject in one well and extract from another well)
 - Same as push-pull test
- Unsaturated zone infiltration with saturated zone cross-hole test
 - Adds data on unsaturated zone release rates/processes

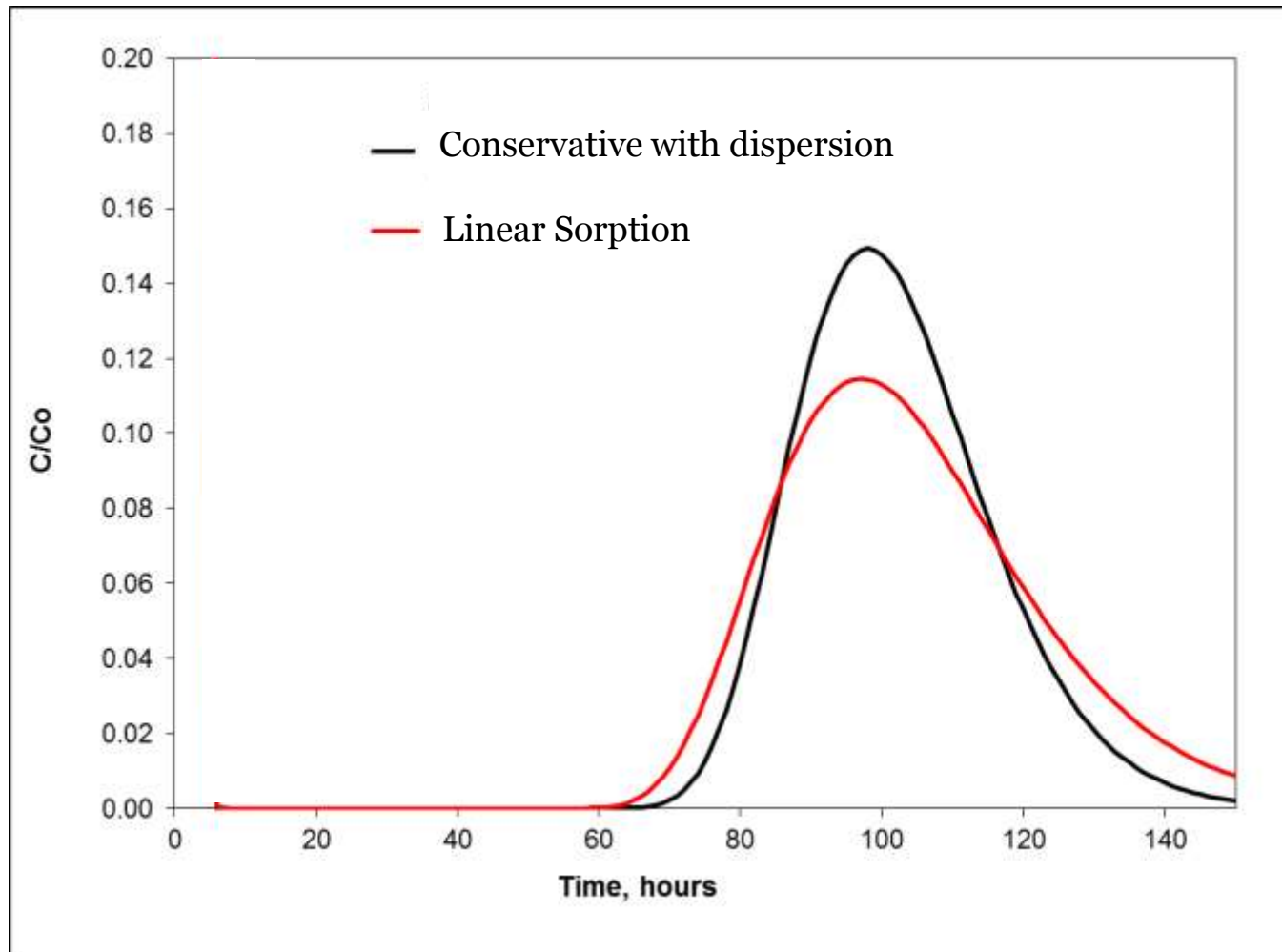
Push-Pull



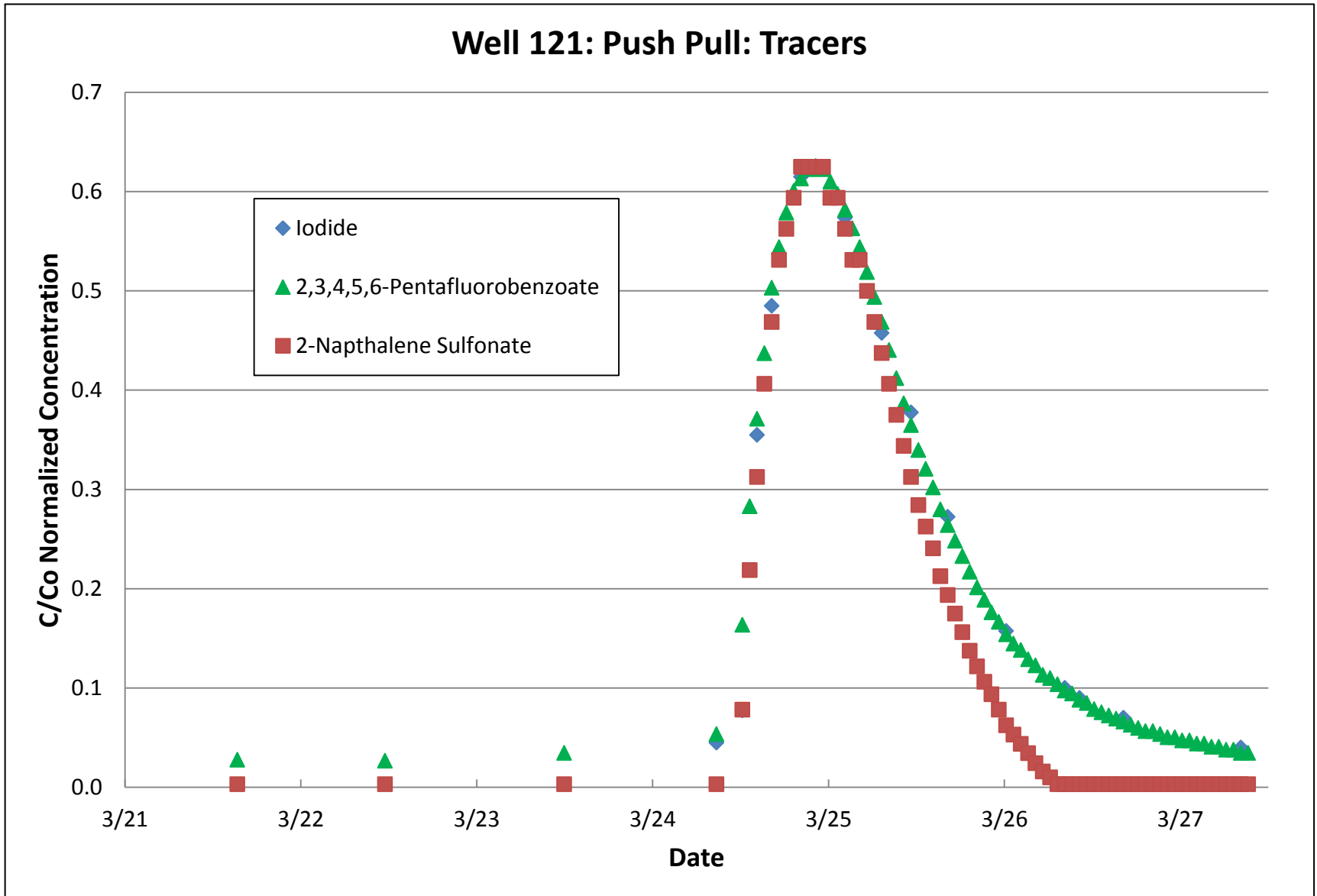
“Push” river water with tracers, followed by river water without tracers, allow for some “drift” time. Then “pull” it all back.

Dispersion and Sorption Influence

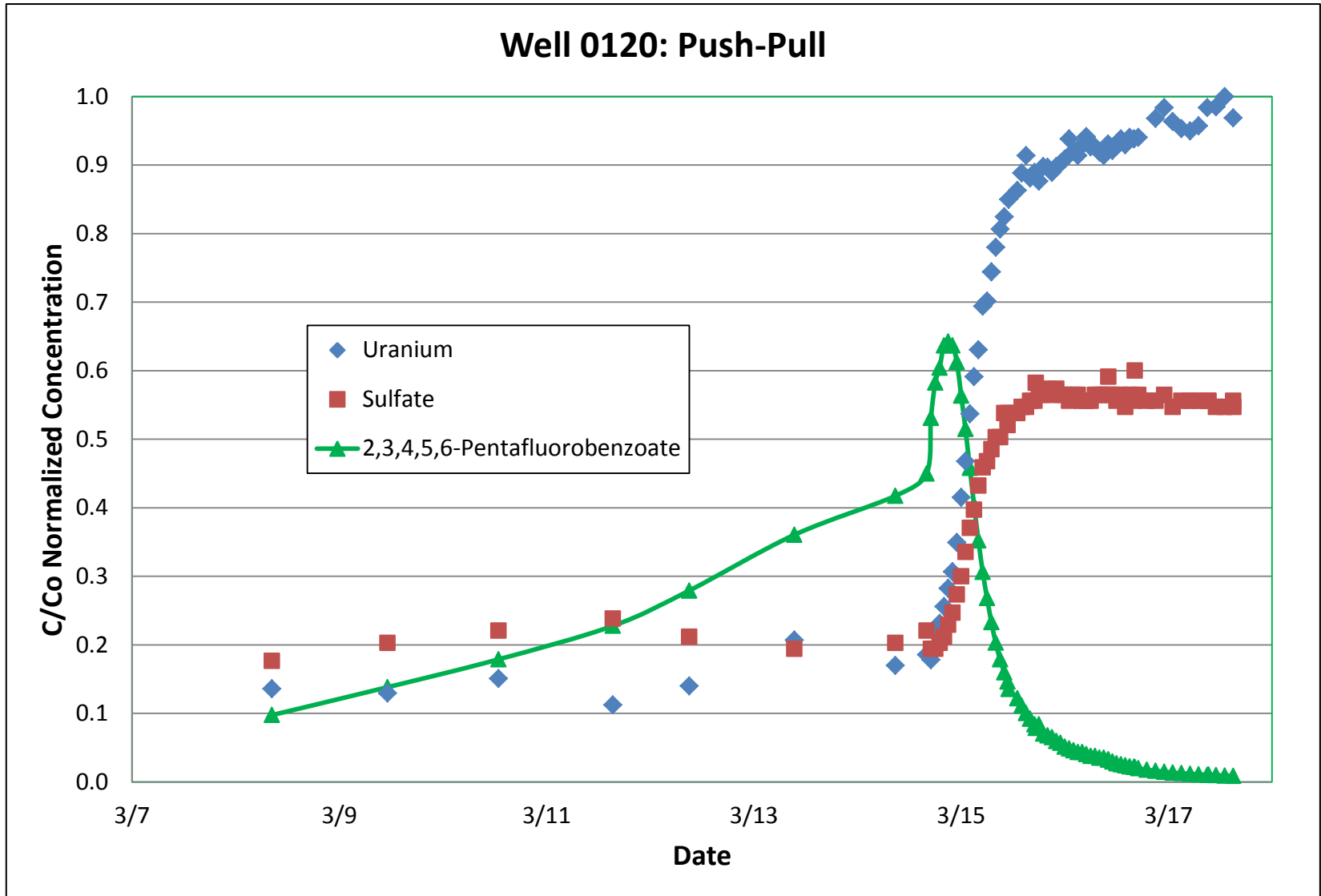
- Five-hour injection, 45-hour chase, two-hour drift



Gypsum Area Data

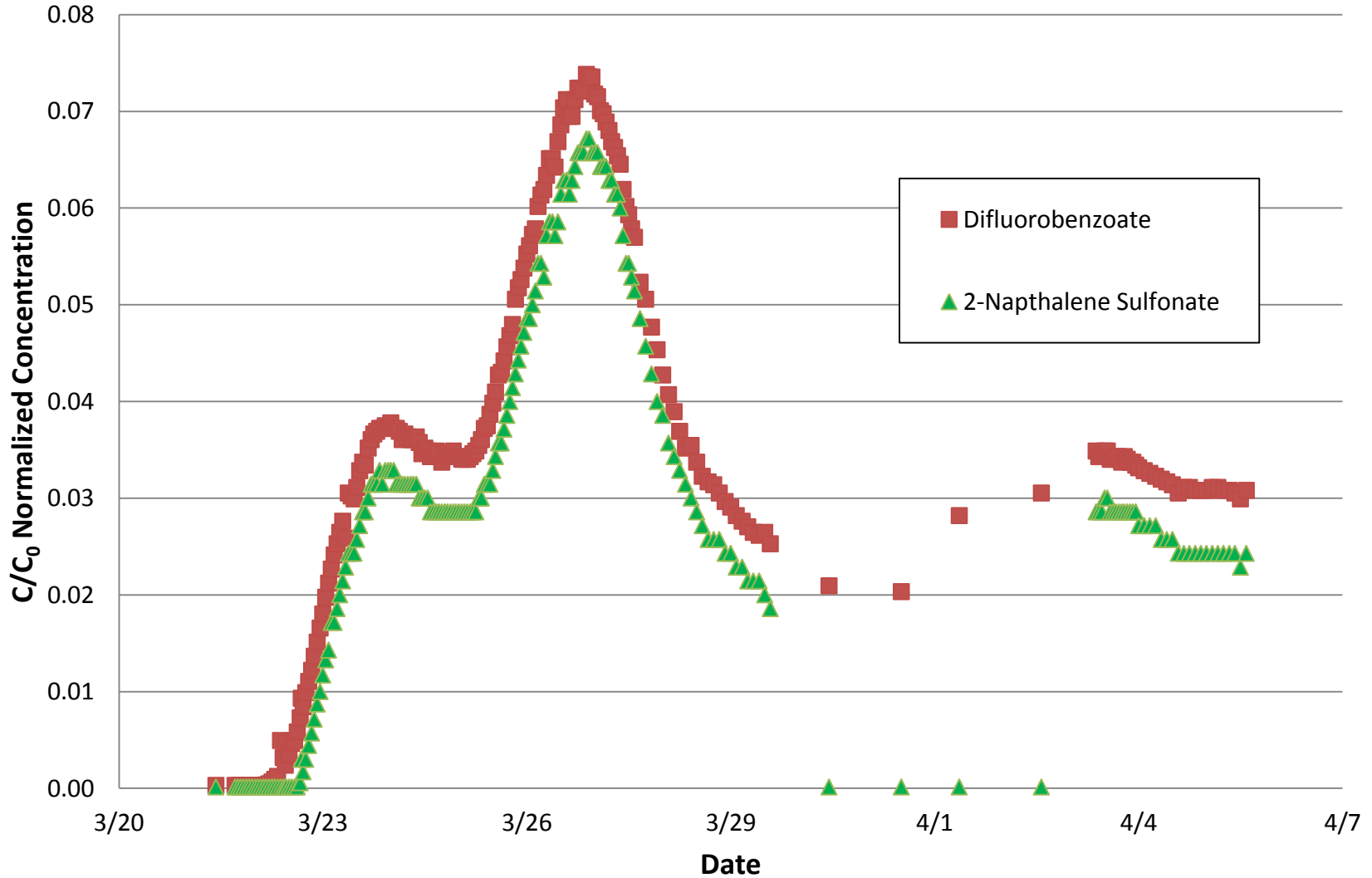


Gypsum Area Data

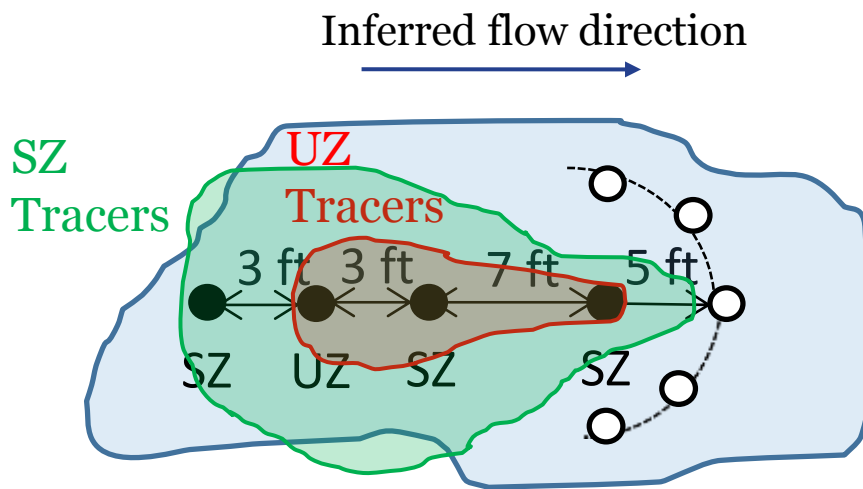


Area with Organics and Uranium

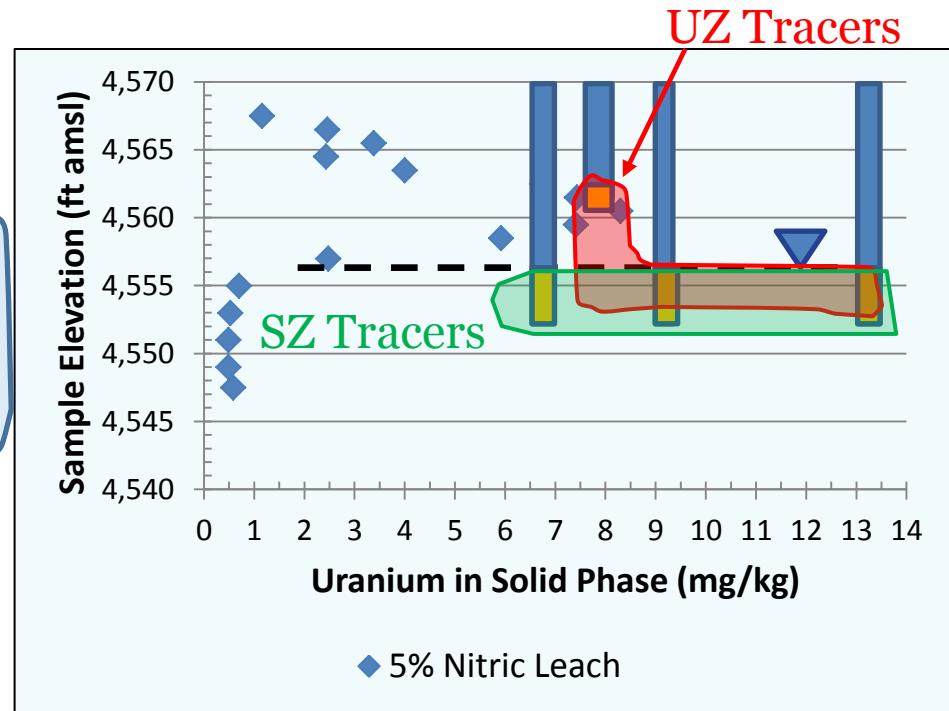
Well 0100: Cross Hole: Tracers



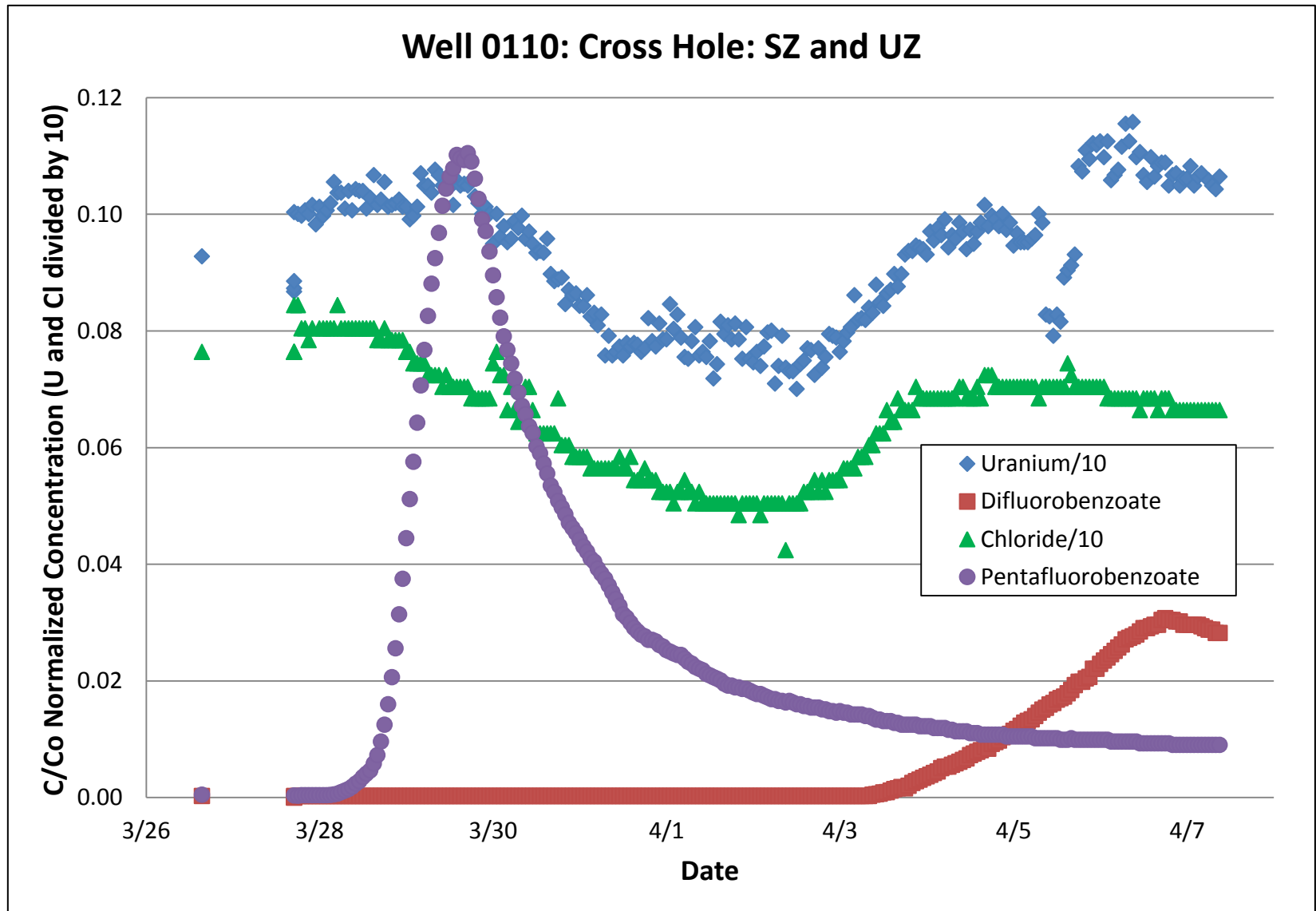
Site with Unsaturated Zone (UZ) and Saturated Zone (SZ) Tracer Test



Test dissolution (infiltration event) of uranium and other constituents in the unsaturated zone



Saturated and Unsaturated Zone Site Data



Summary and Conclusions

- Goal: improved predictions of contaminant transport
- Need to revise past conceptual and numerical models with new information
- Looked at dispersion, dual porosity, sorption, and mineral dissolution
- Multiple tracer testing approaches were used to test the above processes at the field scale
- Results:
 - Good data on dispersion
 - No dual porosity
 - Some sorption of tracer
 - Gypsum dissolution
- Tracer testing results will be used to revise or develop new input parameters for predictions (reactive transport modeling)
- Using Grand Junction as a demonstration site