



NEW ZEALAND
LAND AND GROUNDWATER
CONFERENCE 2024
22 - 24 OCTOBER - AUCKLAND



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Groundwater Surface Water Interactions – Sampling Pore Water to Establish Exposure Point Contaminant Concentrations

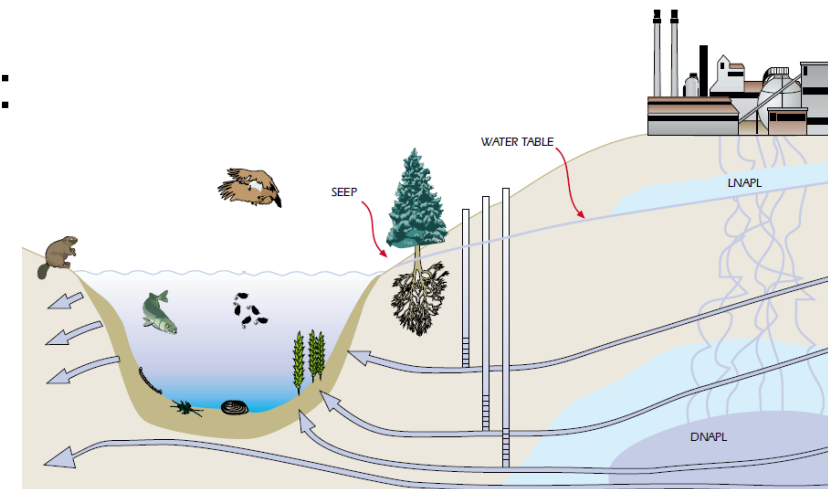
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Nigel Goulding, Sam Parker, & Andrew Fowler (EHS
Support LLC (USA))

Aim to Cover

- Review of the process associated with the flux of groundwater into a surface water environment (theoretical perspective).
- Overview of PushPoint pore water sampling.
- Examples of using PushPoint sampling techniques.
- Overview of “pros and cons” of using this technique.

Groundwater / Surface Water Interface

- Flux of contaminated groundwater into surface water – a complex mix of physical and chemical processes.
- Reasons to understand this discharge may include:
 - Potential ecological risk(s) – surface water environment and sediment (Biological Active Zone (BAZ)).
 - Locate groundwater discharge zone – compliance and remedial design and monitoring.
 - Estimate contaminant load (flux) entering the surface water course.
- Investigating this interface from a commercial perspective – need fast and simple option(s) – **hence focus on pore water and pore water sampling.**



USEPA. Proceedings of the Ground-Water/
Surface-Water Interactions Workshop. 2002.

Discharge to Freshwater - CSM

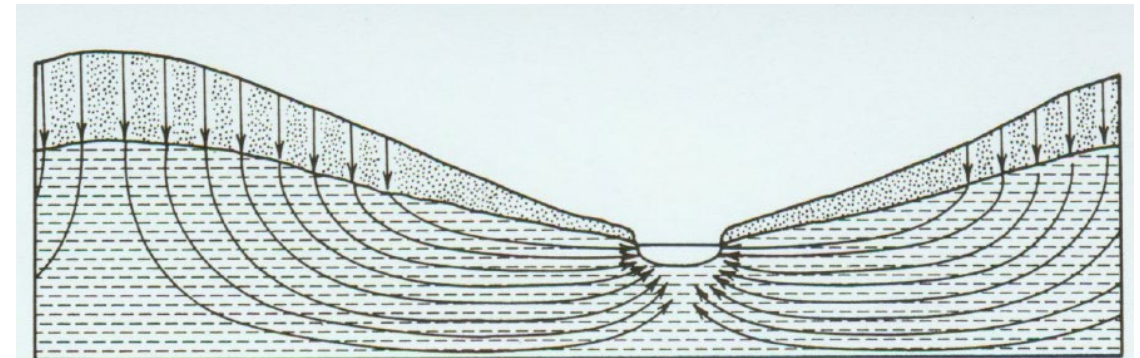
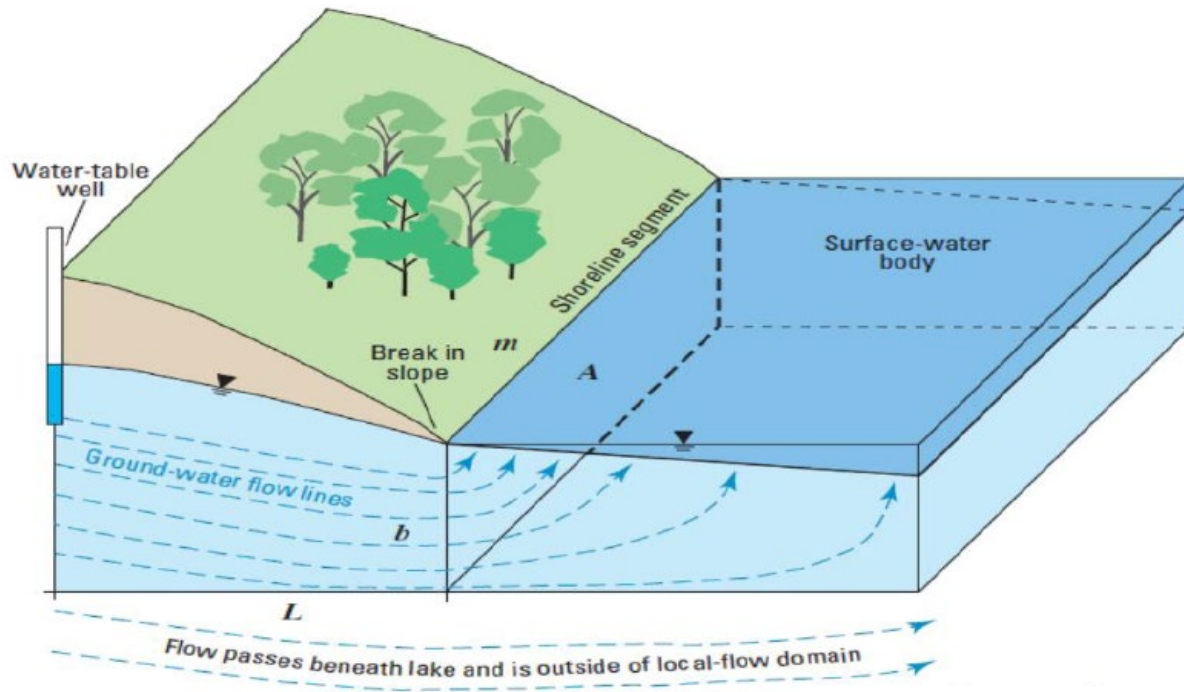
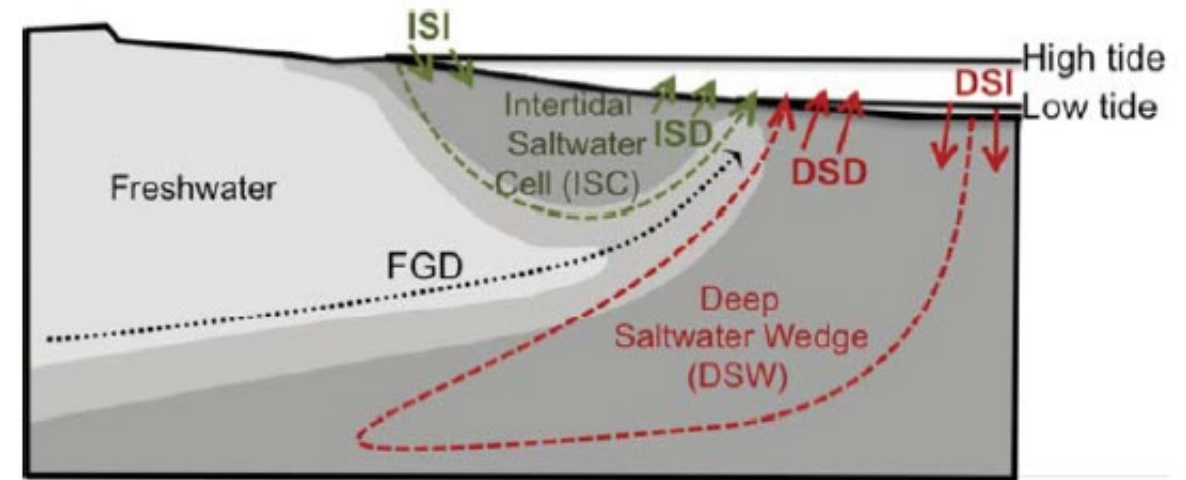
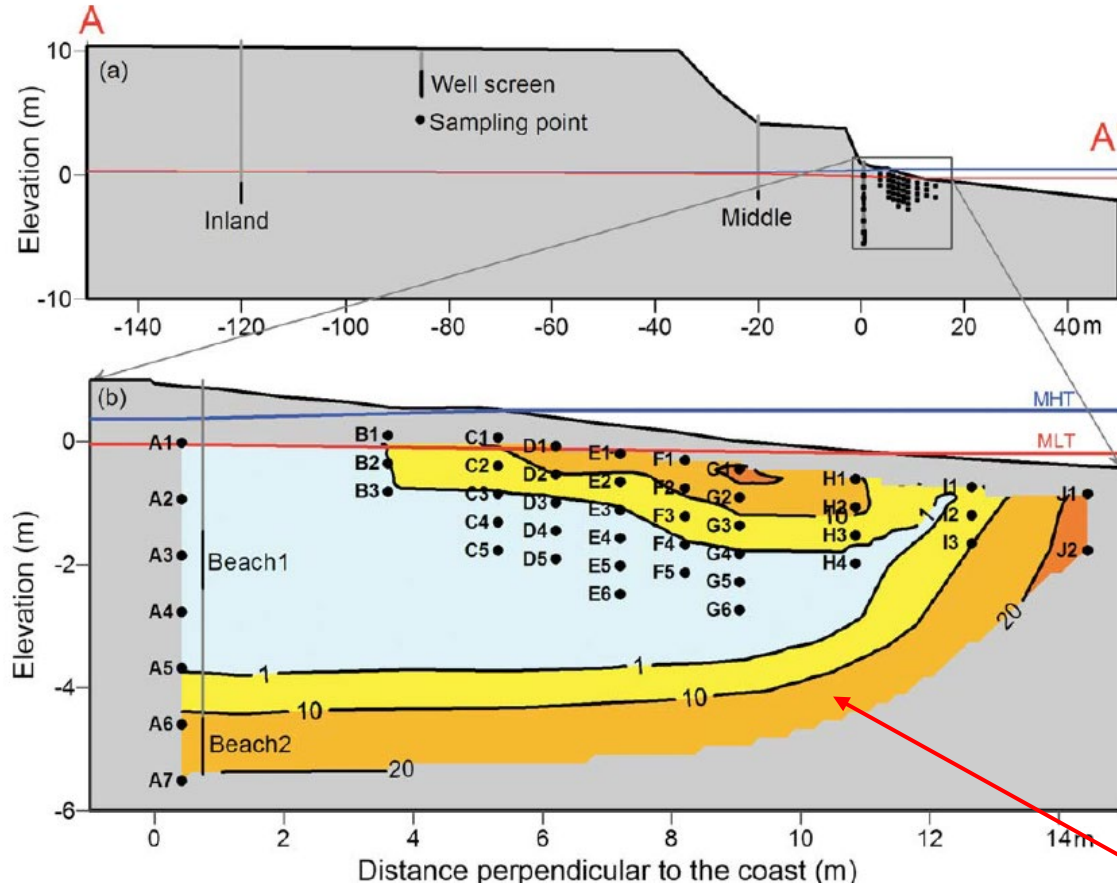


Figure 7.2
Diagrammatic section illustrating ground water flow in a watershed (from King, 1899).

Discharge to Marine Water - CSM

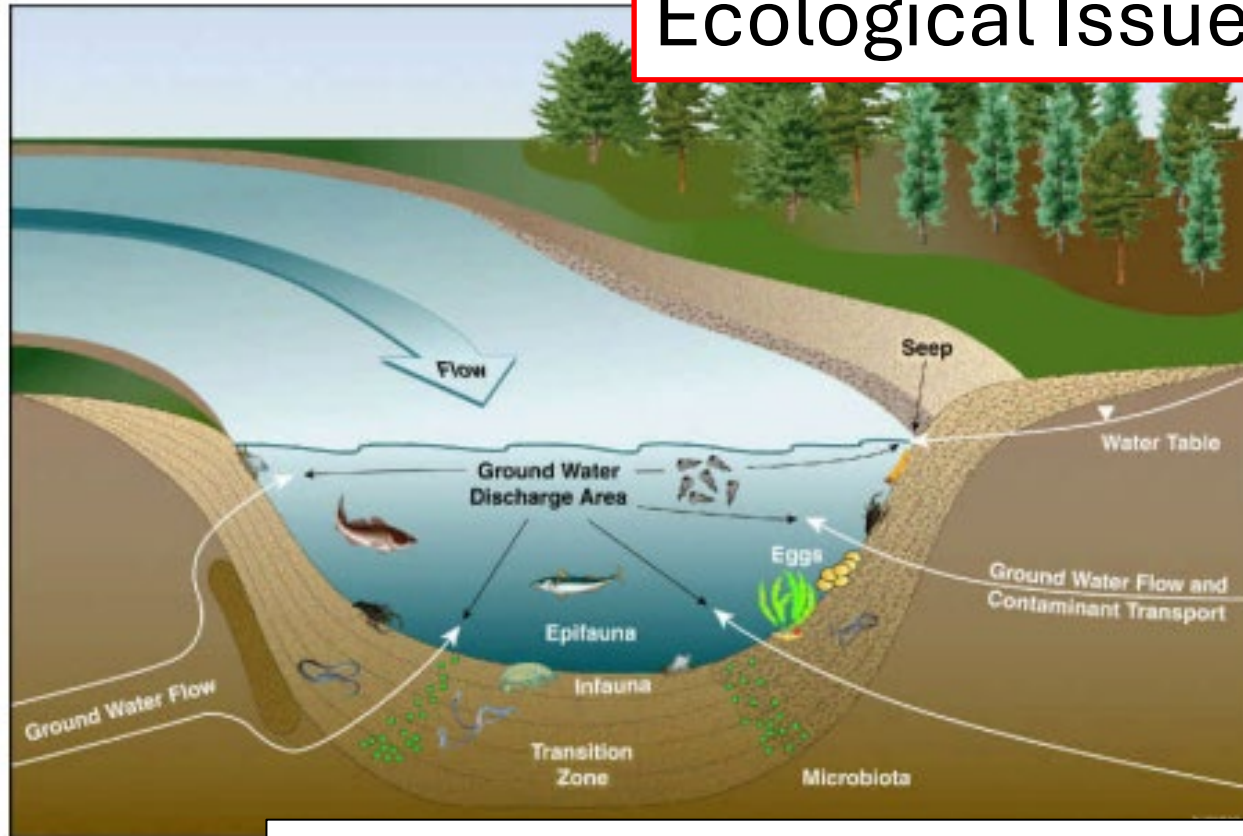


Abarca et al. Transient groundwater dynamics in a coastal aquifer: The effects of tides, the lunar cycle, and the beach profile. Water Resources Research. 2013.

Salinity (ppt)

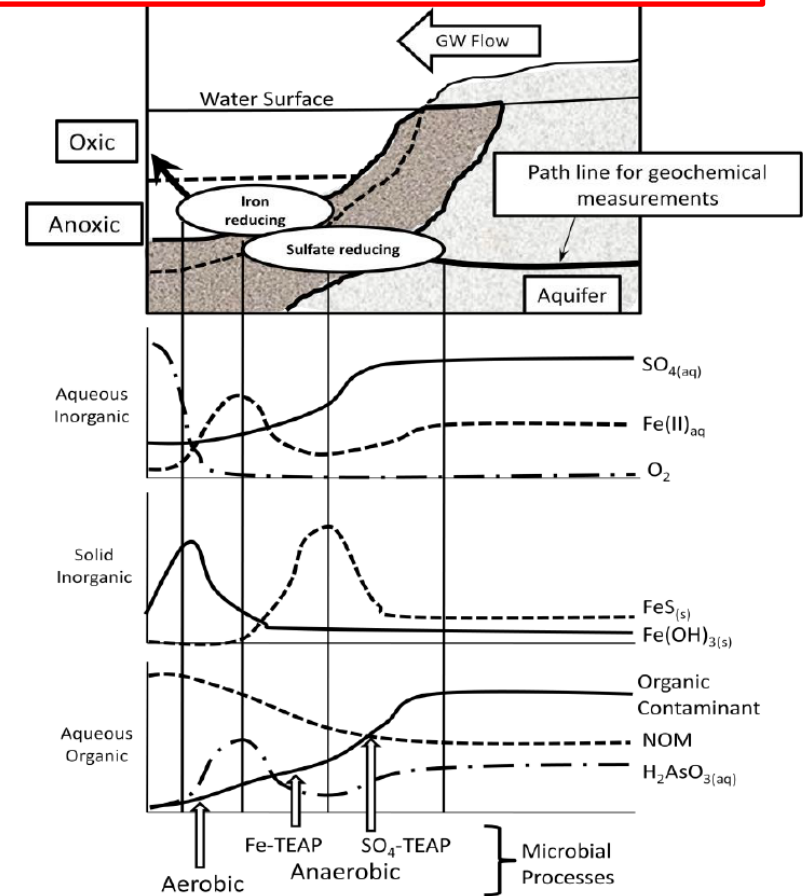
Complex Issues at the Groundwater / Surface Water Interface

Ecological Issues



ECO Update/Ground Water Forum Issue Paper. Evaluating Ground-Water/Surface-Water Transition Zones in Ecological Risk Assessments. USEPA 2008.

Geochemical Issues



Ford. The Impact of Groundwater-Surface Water Interactions on Contaminant Transport with Application to an Arsenic Contaminated Site. USEPA. 2020.

Groundwater Discharges to the Ocean

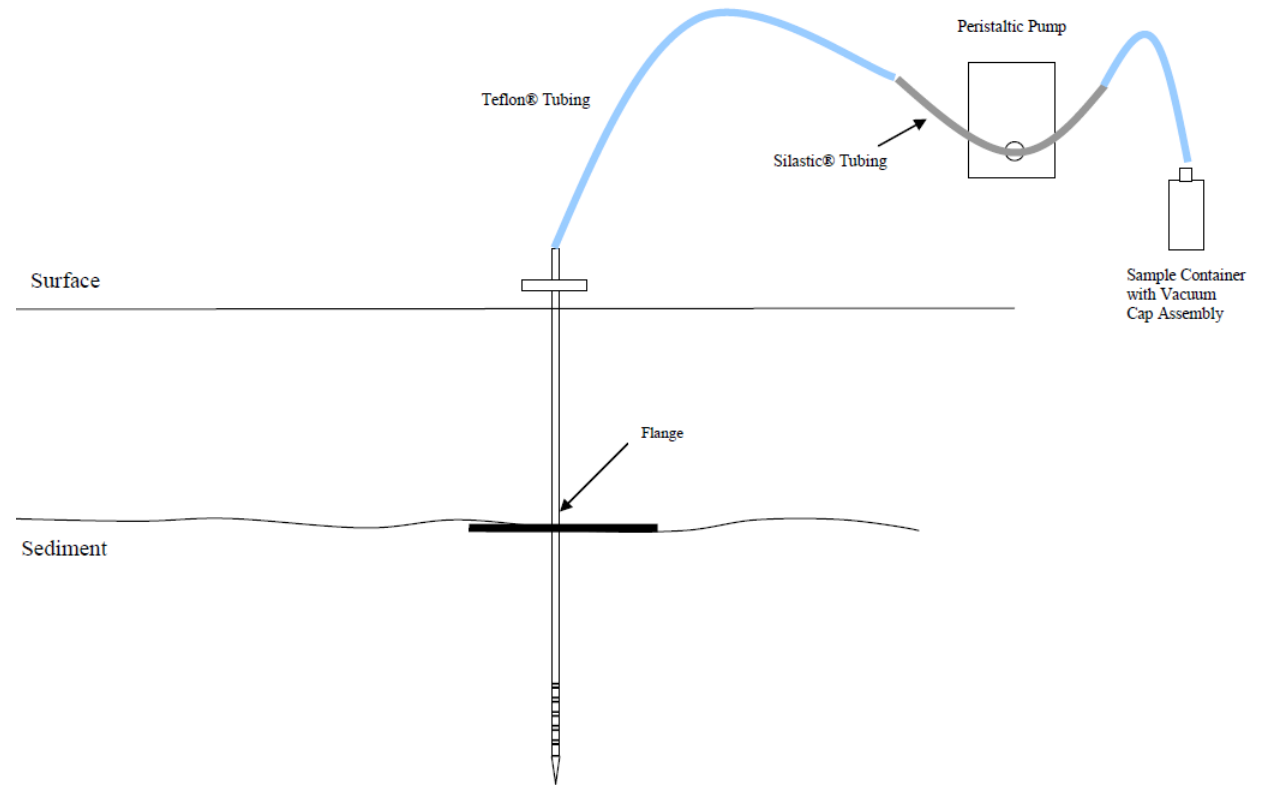


Study has involved solid phase assessments (including XRF/XRD assessment of precipitates) combined with pore water sampling to evaluate geochemical reactions in plume discharge zones.

Use of PushPoint Pore Water Sampling to Sample the Groundwater/Surface Interface



Figure 3. Pore Water Sampler Deployment Using a Peristaltic Pump to Sample



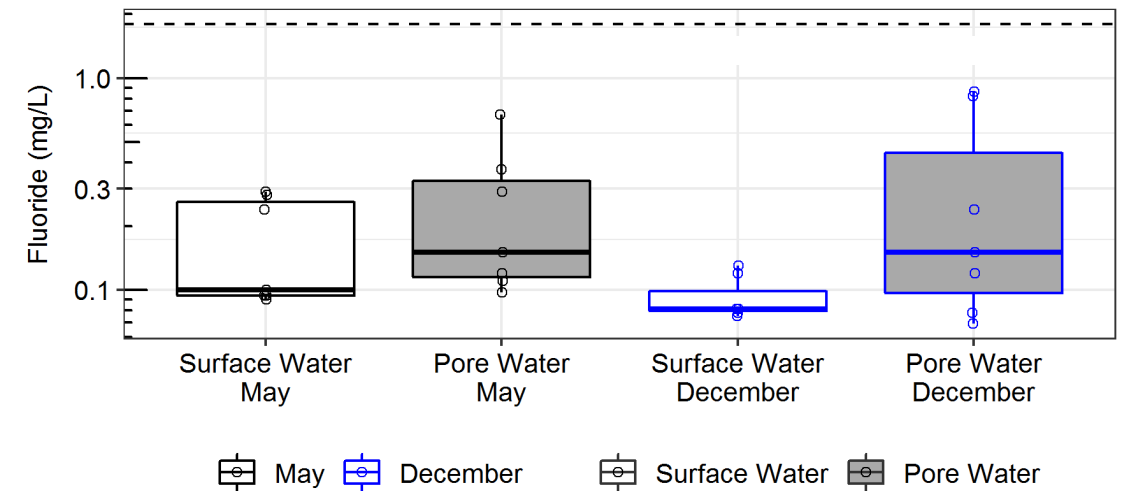
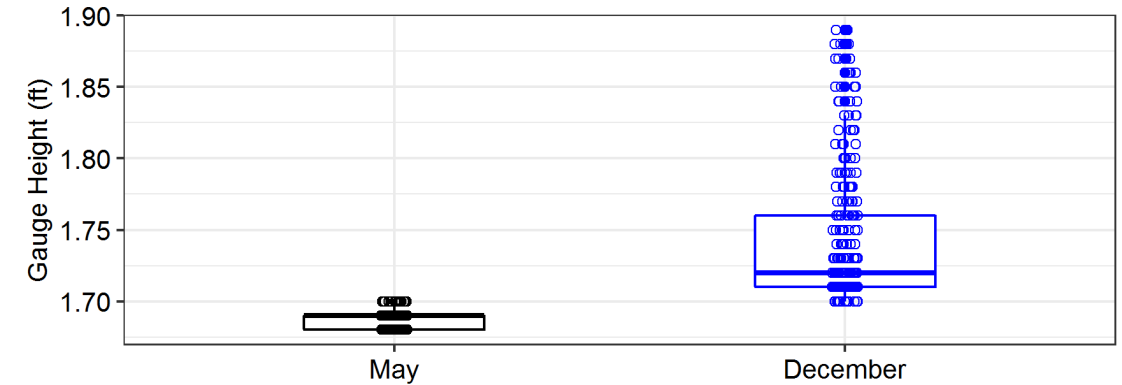
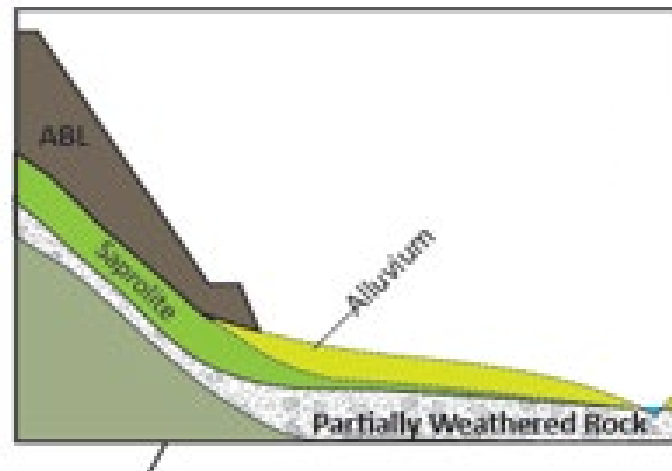
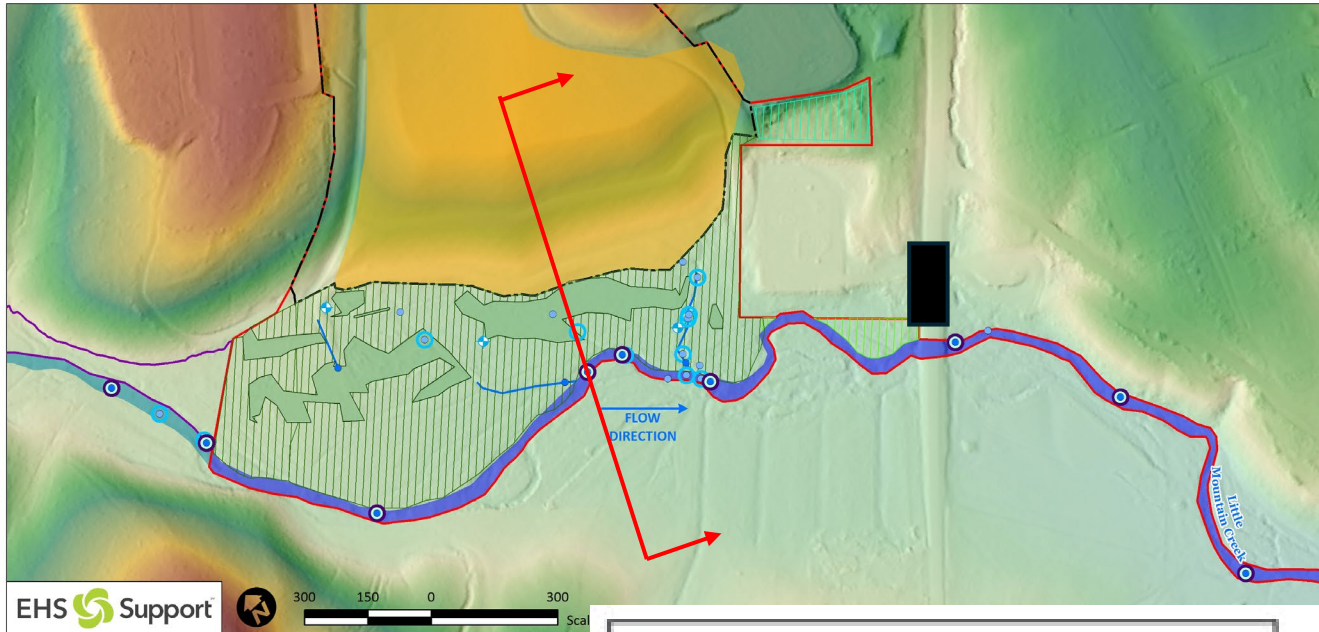
USEPA. Standard Operating Procedure. Pore Water Sampling. 28
February 2013.

Key PushPoint Pore Water Sampling Equipment

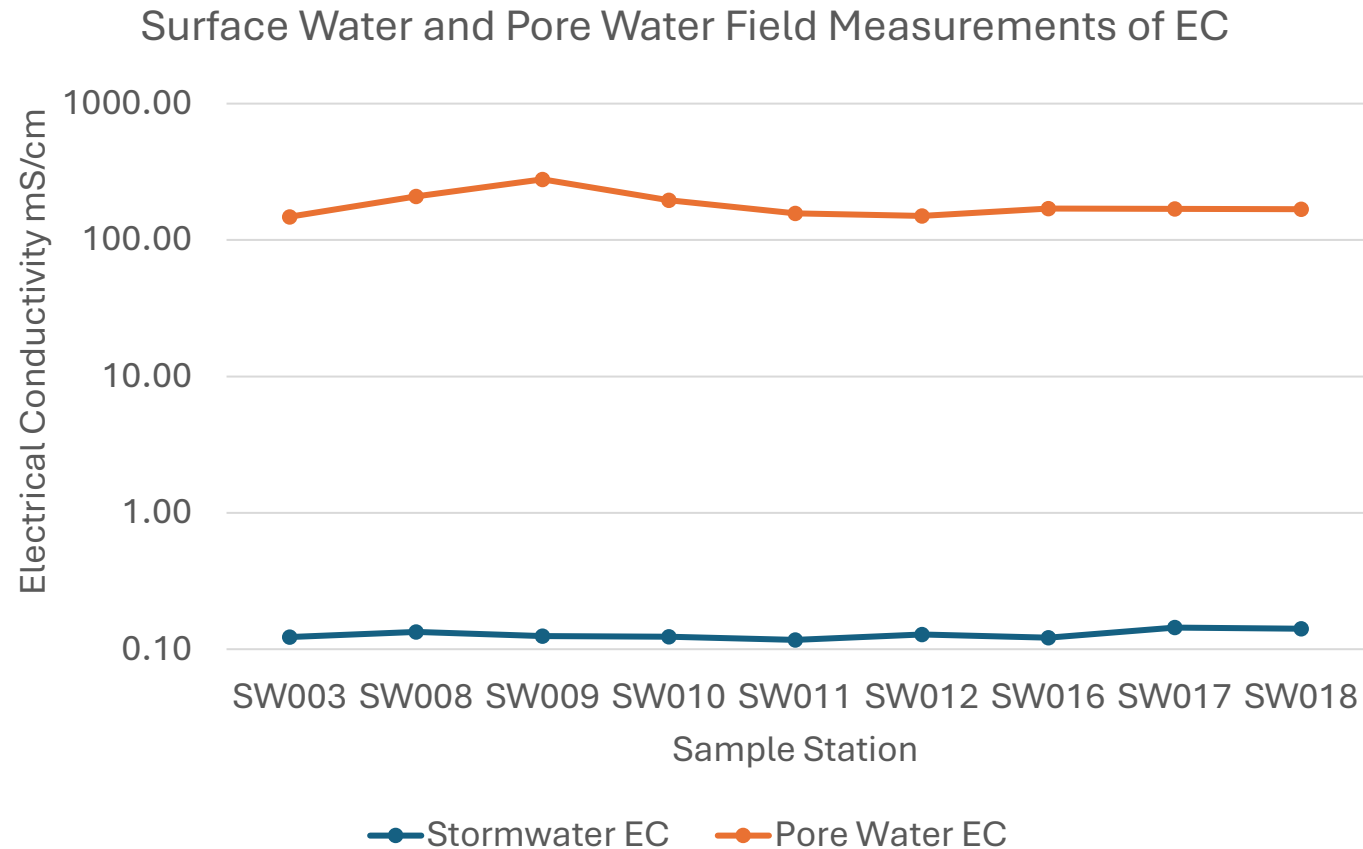


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<https://www.mheproducts.com/>

Landfill Groundwater Discharge



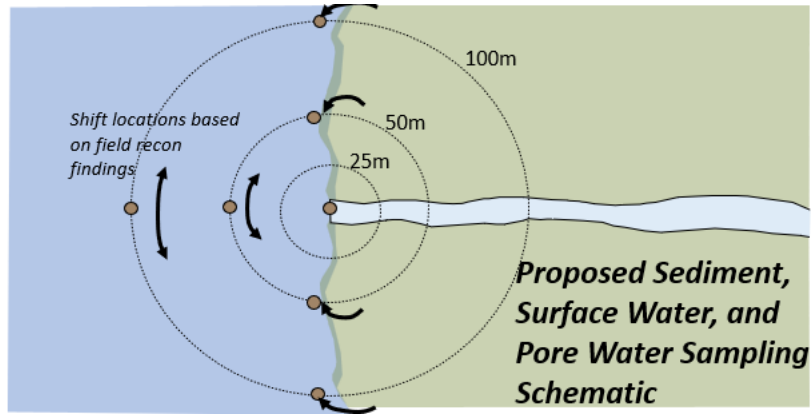
Field Sample Results - May



South Island Manufacturing Plant

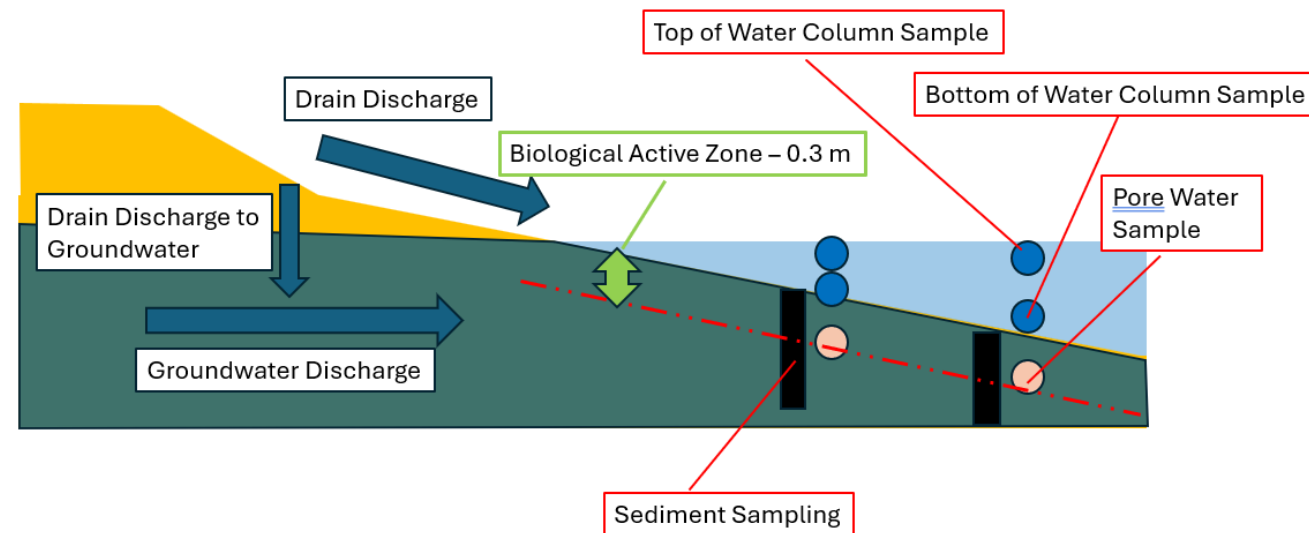


Sampling and Analysis Plan



- Information on:
 - Top and bottom water column contaminant concentrations – freshwater lens.
 - Sediment contaminant concentrations.
 - Pore water contaminant concentrations.

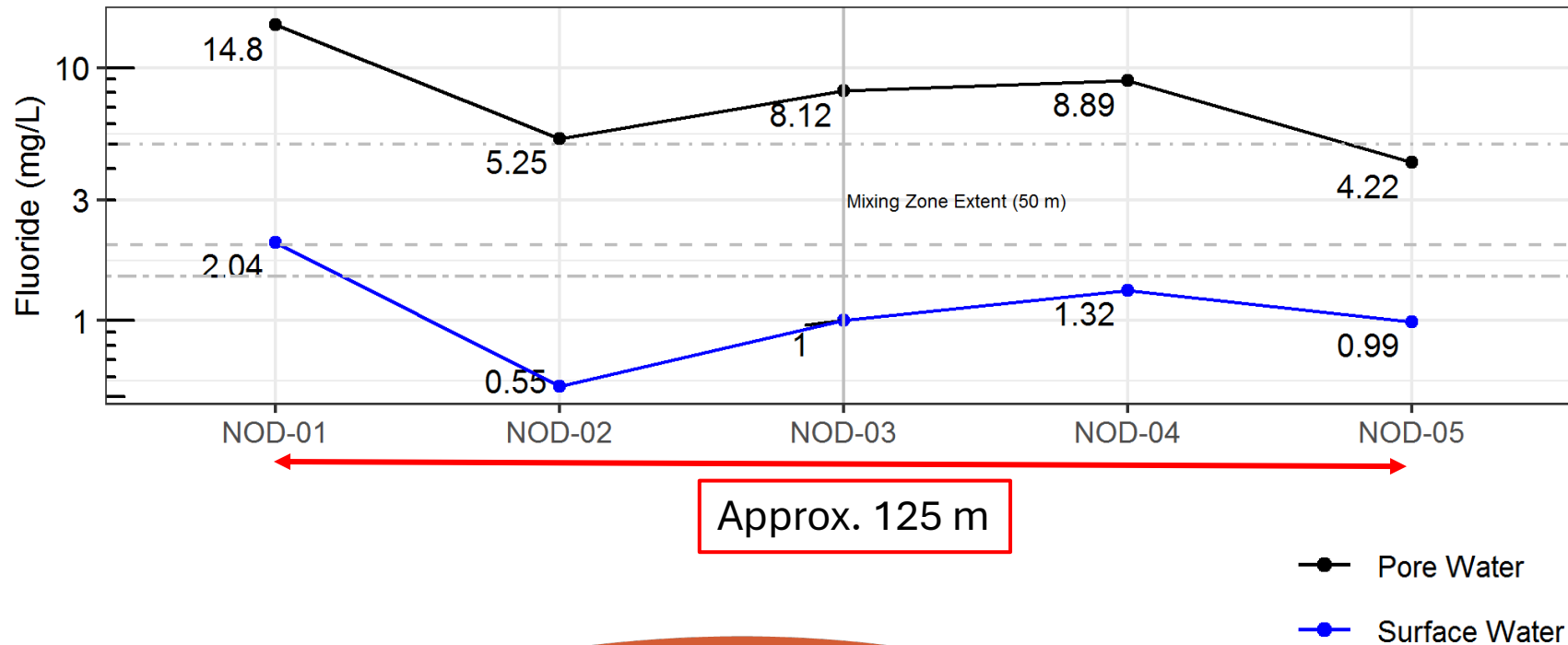
Drain Discharge Area Sampling / CSM



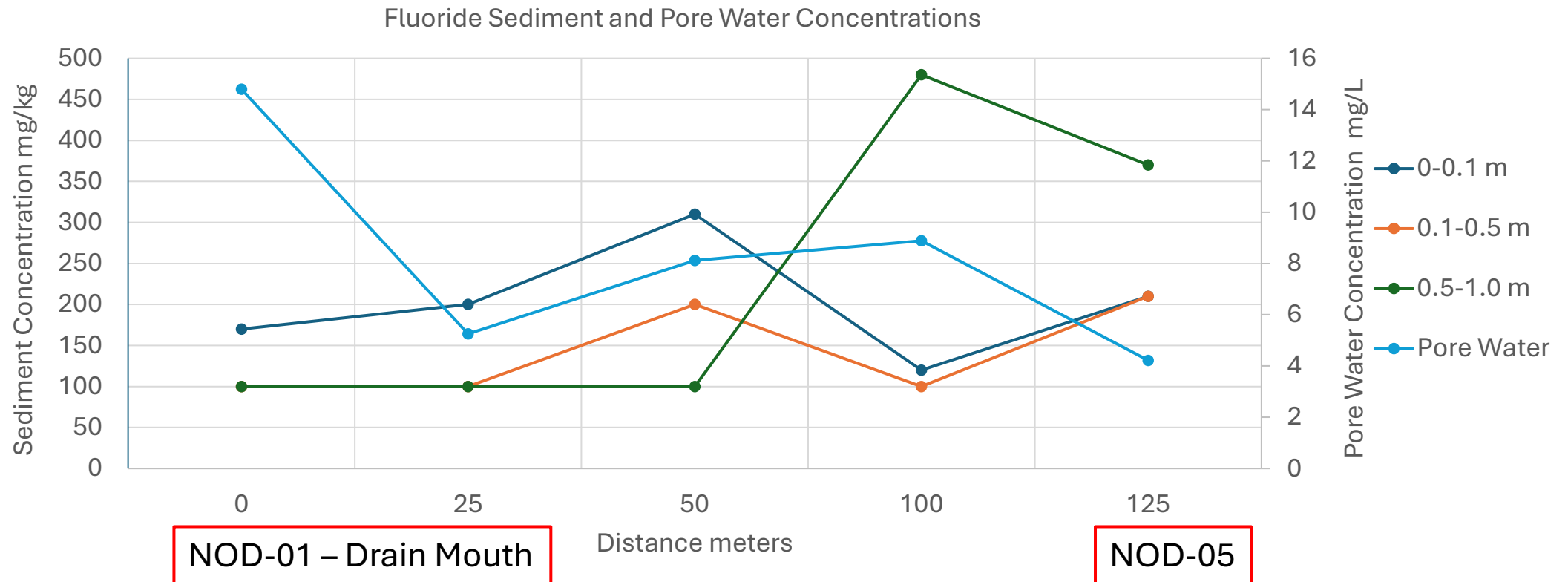
Surface Water and Pore Water Sampling Along Drain Alignment



Fluoride Concentration within the North Drain Drainage Sequence



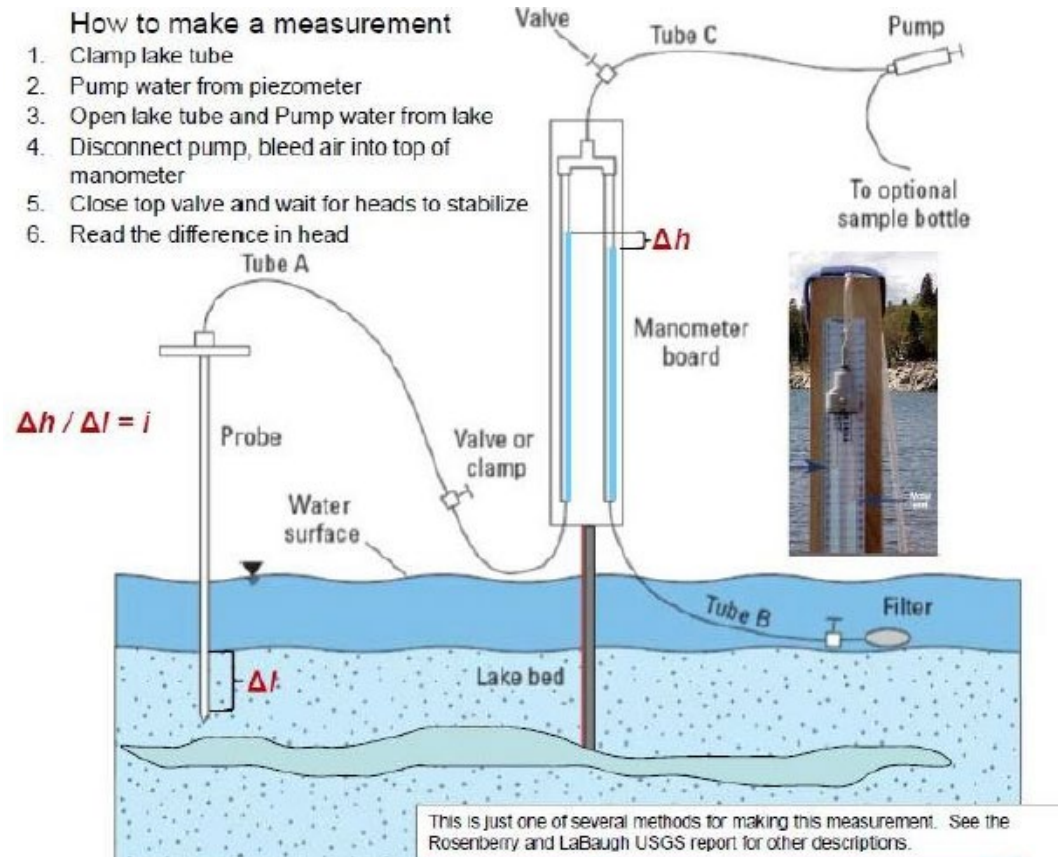
Sediment and Pore Water Fluoride Concentrations



Practical Issues

- Can recover pore water samples from 0.1 m depth in sediment without entraining surface water (favourable site conditions).
- Potentially recover 20-30 samples daily (depending on geology).
- A field meter is needed that requires a small volume of field sample.
- Specific conductance (EC) field parameters are least likely to be affected by sampling and are a good indicator of surface water impact.
- Temperature can be a good field indicator of groundwater discharge.
- Effective for conservative ions, metals, and organics.
- Sample collection methods for VOCs need to consider VOC loss (options to avoid this).

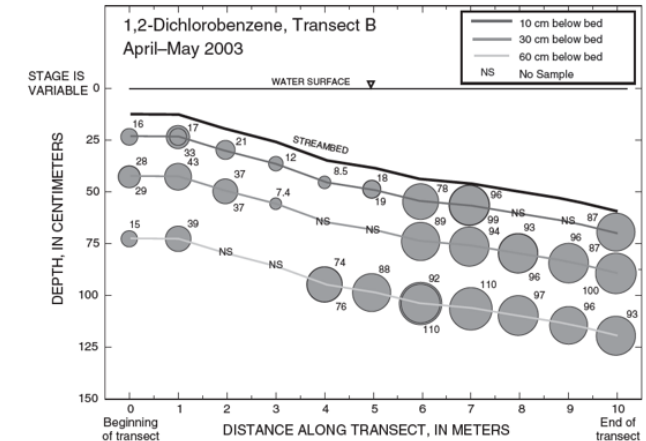
Can Collect Hydraulic Head Field Data



MHE Products - <https://www.mheproducts.com/>

Advantages

- Pore water sampling can help focus/define the location of permanent groundwater monitoring wells.
- Can be used to look at vertical profiles and mixing in the aquifer. Sampling can be conducted at different depths depending on sediment types.
- Collection of geochemical parameters allows for unmixing of models to quantify groundwater to surface water ratios (mixing) in pore water.



Zimmerman, Massey and Campo.
Pushpoint Sampling for Defining Spatial and
Temporal Variations in Contaminant
Concentrations in Sediment Porewater. 2005.

Advantages

- Pore water to quantify mass flux by transects and grids applied across a discharge area (important for PBT contaminants such as PFAS).
- The data can be easily utilised in risk assessment as they reflect an aqueous phase for sediment (pore water) that can be directly compared to criteria or Sensitive Species Distribution (SSD) derived criteria.
 - Most toxicity testing is done in an aqueous phase.
 - Does not require calculating partitioning that is subject to assumption based errors.
- Can leave sampler in place and sample on multiple occasions.

Disadvantages

- Spot samples being collected (a point in time).
- Might not be able to re-sample at the exact sampling station during future sampling events.
- Physical condition of the underlying sediment may prevent sampling (clay substrate can't be sampled).

Conclusions

- Flux of groundwater into a surface water system – a complex process.
- PushPoint pore water sampling provides a quick (fast) and simple method to **empirically** help validate and improve the quality of the CSM.
- USEPA-approved process/procedure.

References

- Abarca, Karam, Hemond, and Harvey. Transient groundwater dynamics in a coastal aquifer: The effects of tides, the lunar cycle, and the beach profile. Water Resources Research. Vol 49. 2013.
- EHS Support New Zealand Ltd. Environment Southland Independent Monitoring Programme Coastal Marine Area (CMA) Investigation Tiwai Point. November 2023.
- Ford. The Impact of Groundwater-Surface Water Interactions on Contaminant Transport with Application to an Arsenic Contaminated Site. USEPA. 2020.
- MHE Products - <https://www.mheproducts.com/>
- Pitz. High-resolution, Pore-water Sampling Near the Groundwater/Surface Water Interface. Department of Ecology. Washington State. 2008.
- Zimmerman, Massey and Campo. Pushpoint Sampling for Defining Spatial and Temporal Variations in Contaminant Concentrations in Sediment Porewater. USGS. 2005.
- USEPA. Proceedings of the Ground-Water/Surface-Water Interactions Workshop. 2002.
- USEPA. Standard Operating Procedure. Pore Water Sampling. 28 February 2013.