

# Cudjoe Key Project

Update meeting and report

Cudjoe Key, March 19,2015

## Activities

- Baseline
- Freshwater Injection
- Dye Injection
- Following work

# Modeling with EPA's EHTD Tool

# EPA's EHTD Modeling Tool

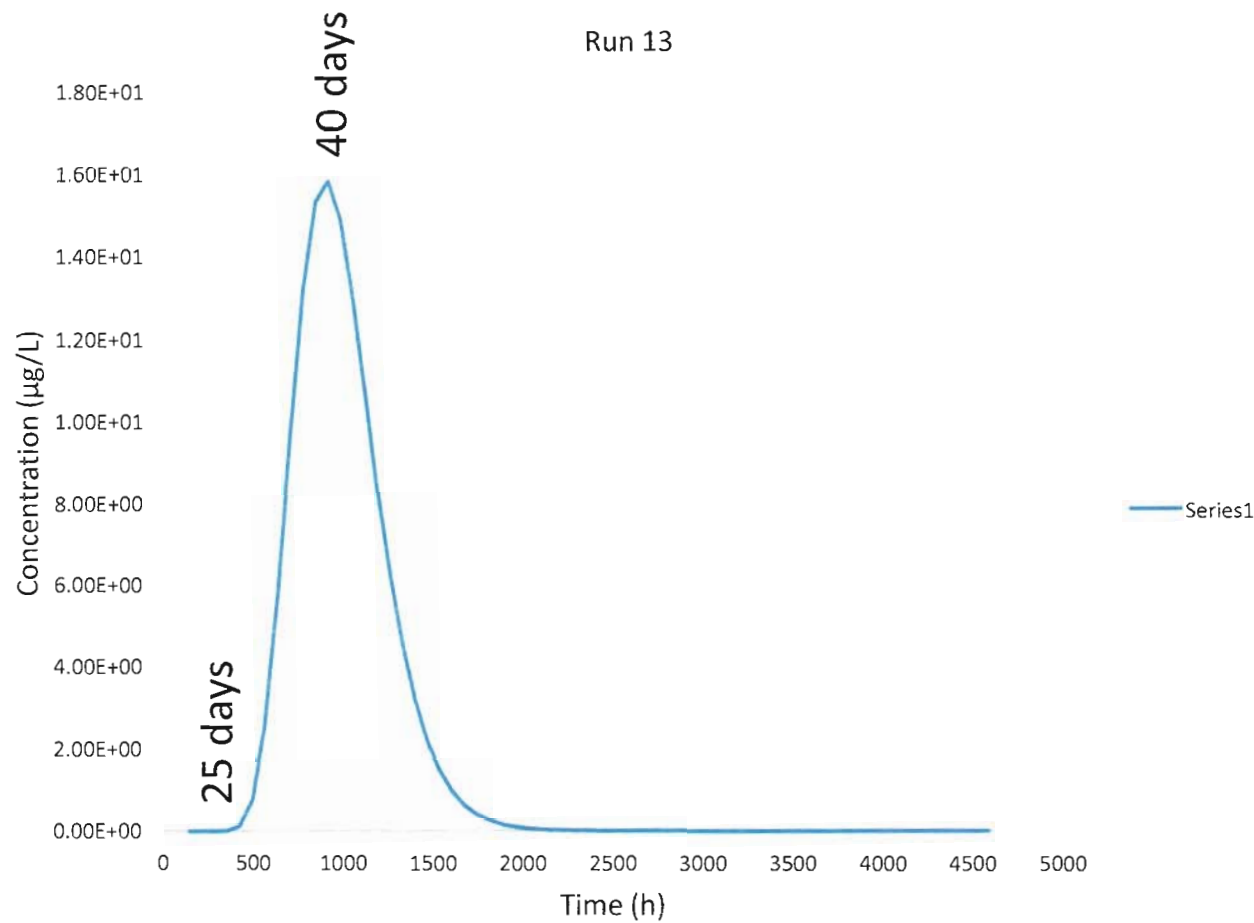
Table 1 Pollutant Dispersion Scenarios.

Parameter	Description
Distance	Distance from injection point to measurement point
Thickness	Injection well effective open length
Injection discharge	Discharge at injection well
Discharge at obs. Point	Approximate discharge at measurement point
Release time	Tracer release time
Porosity	Aquifer porosity

# EPA's EHTD Modeling Runs

Table 2 EHTD Run for CUDJOE Tracer Test Design.

Run	Distance from injection point to measurement point	Thickness	Injection discharge	Discharge at obs. Point	Release time	Porosity	Estimated dye mass	Estimated dye mass
	m	m	m3/h	m3/h	h		g	kg
1	90	10	74.9	3.60E-01	1	0.34	3.95E+03	3.95
2	90	20	74.9	3.60E-01	1	0.34	7.91E+03	7.91
3	90	30	74.9	3.60E-01	1	0.34	1.19E+04	11.86
4	200	10	74.9	3.60E-01	1	0.34	8.78E+03	8.78
5	200	20	74.9	3.60E-01	1	0.34	1.76E+04	17.57
6	200	30	74.9	3.60E-01	1	0.34	2.63E+04	26.35
7	90	10	74.9	3.60E-01	8	0.34	3.95E+03	3.95
8	90	10	74.9	3.60E-01	8	0.6	6.97E+03	6.97
9	200	10	74.9	3.60E-01	1	0.6	1.55E+04	15.5
10	500	10	74.9	3.60E-01	1	0.34	2.20E+04	22
11	90	10	74.9	3.60E+01	1	0.34	597	0.6
12	200	10	74.9	3.60E+01	1	0.34	131	0.13
13	500	10	74.9	3.60E+01	1	0.34	324	0.32



Estimated evolution of the tracer concentration at a measurement point located 500 m away from the injection well. For this case, the detection threshold is surpassed 620 hours approximately after the tracer injection. The concentration peak happens 902 hours after the injection.

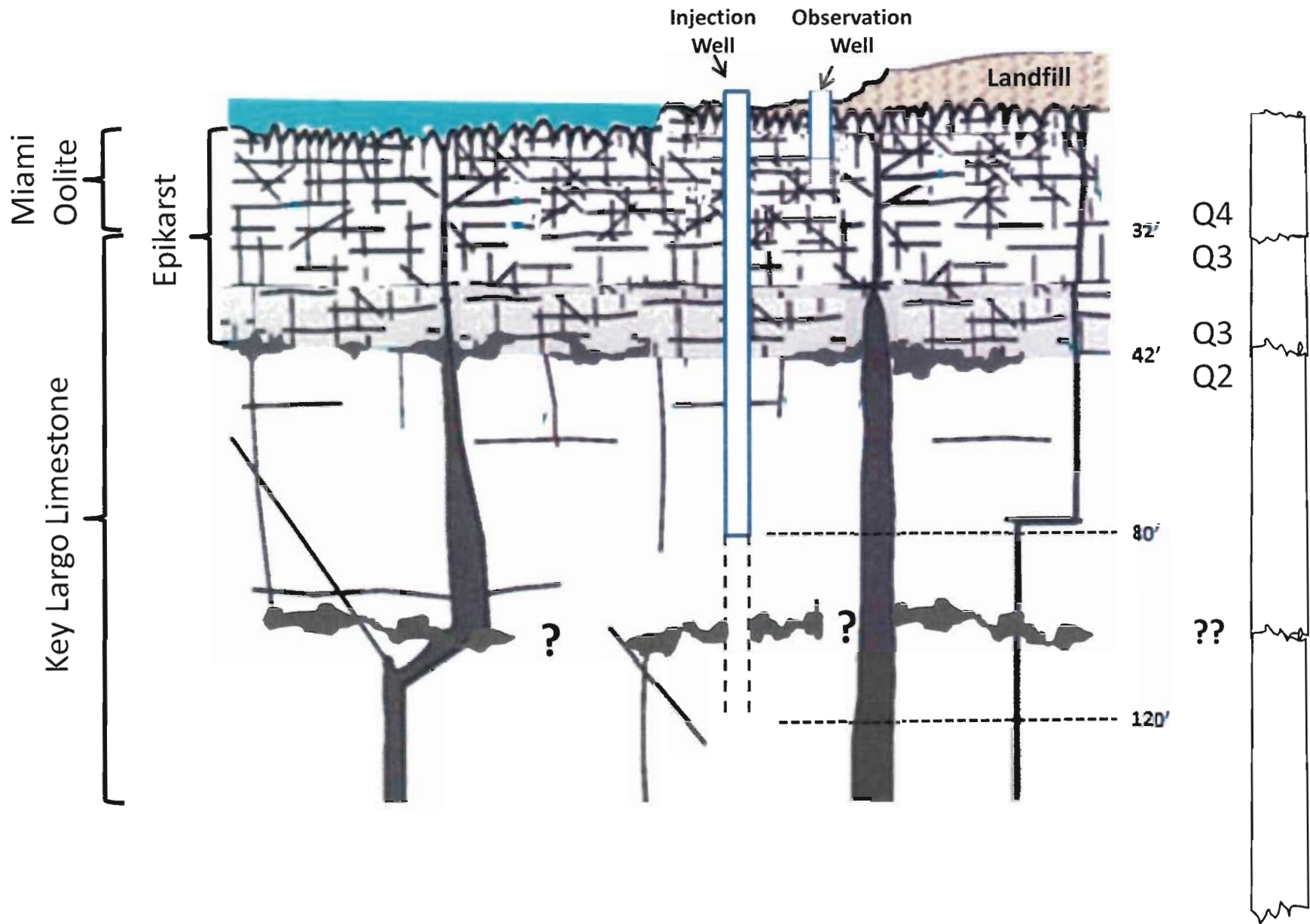


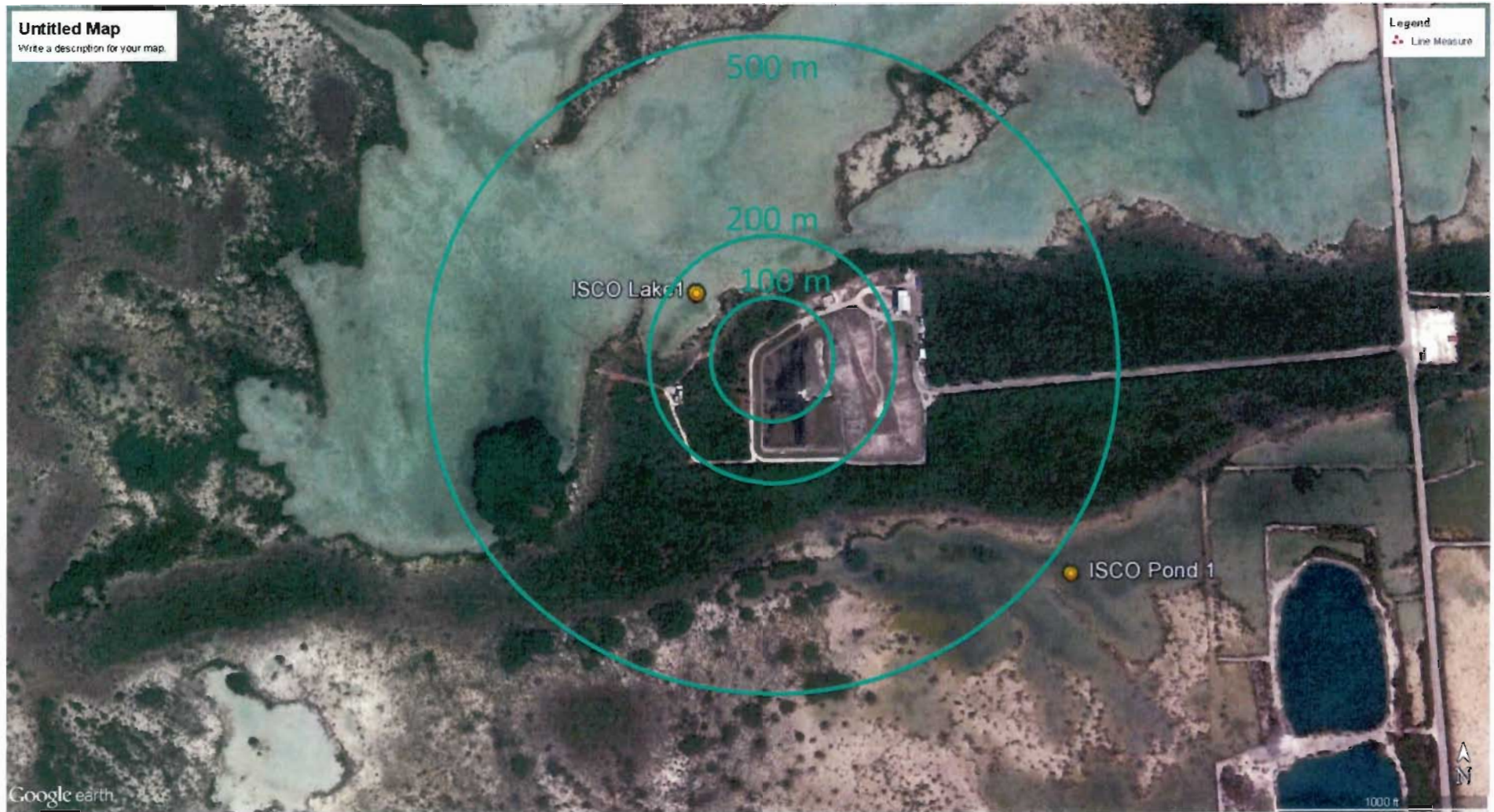
We are monitoring OW1, OW2, OW4, OW5 and IW1 and IW4. Dye Injection was through IW3

Google image showing potential fractures and karst features.  
Ground “thruthing” several of these features has confirmed the validity of the  
remote sensing interpretation



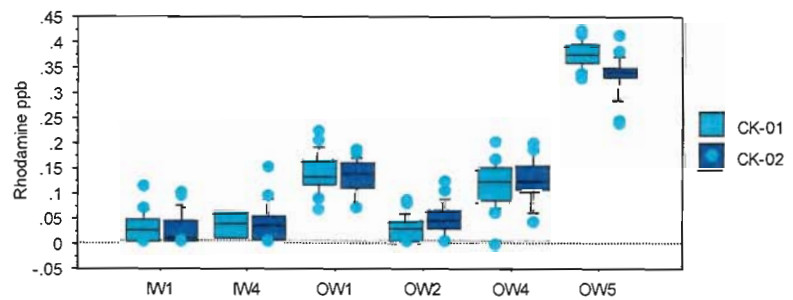
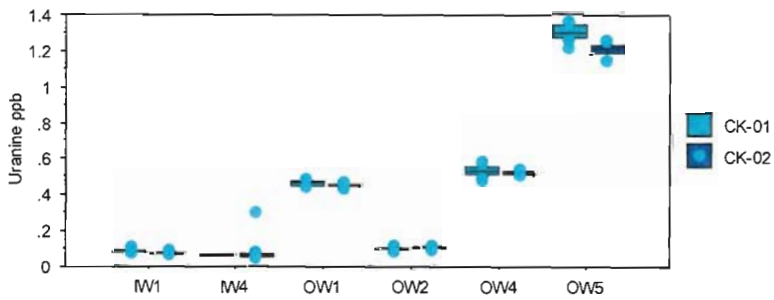
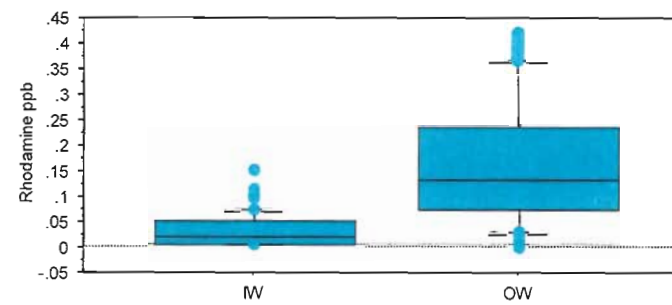
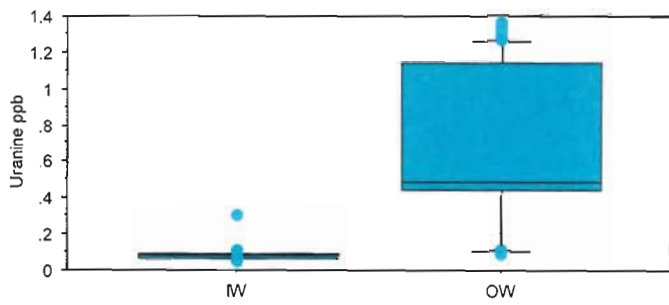
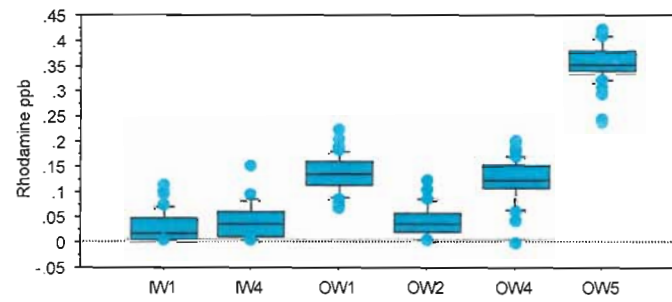
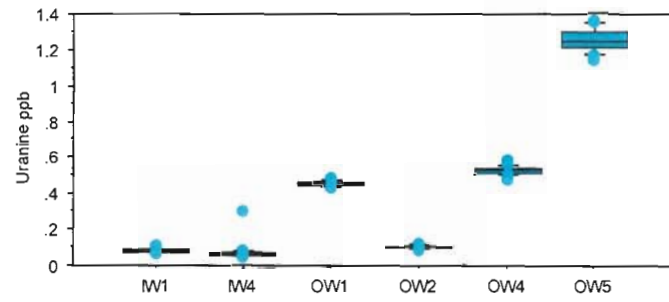
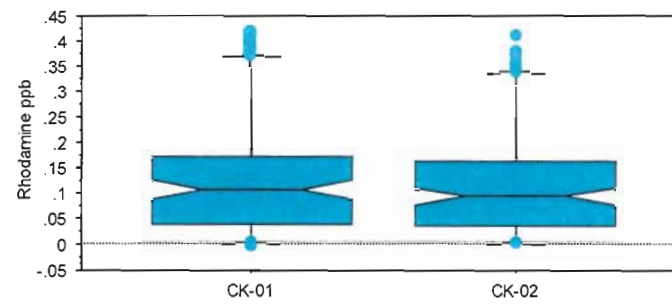
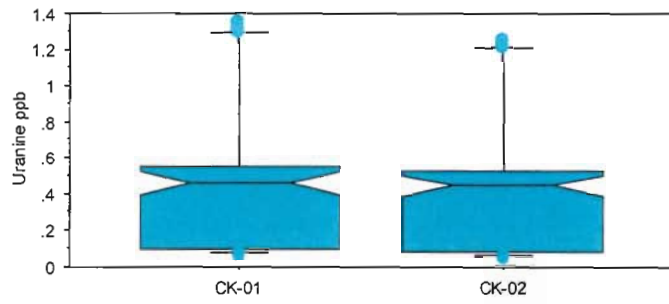
## Interpretation of Underground Geology





# Baseline Conditions

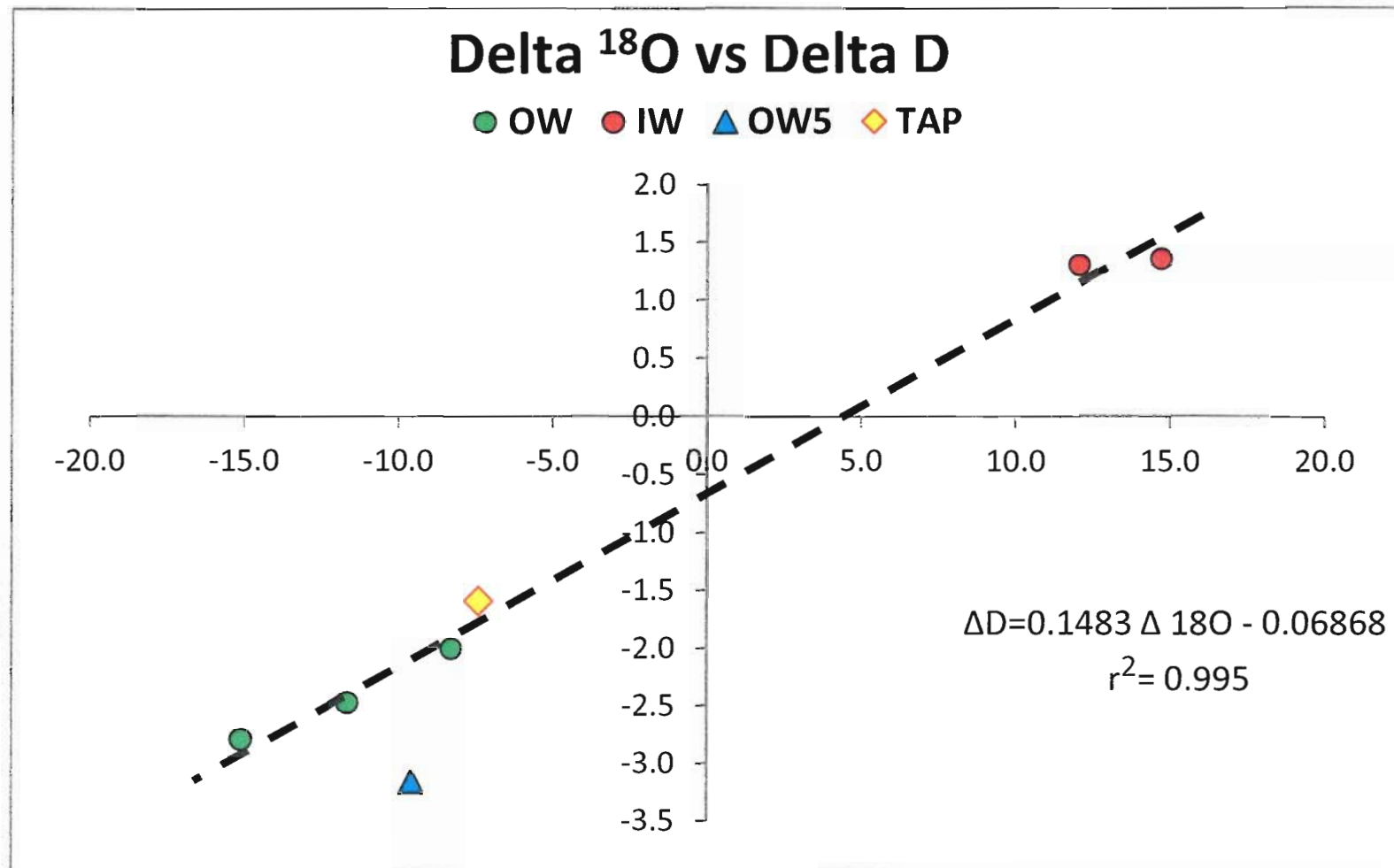
- Purging OWs took place on Feb 17<sup>th</sup> while IWs were purged on Feb 18<sup>th</sup>
- ISCO Autosamplers were installed on Feb 19<sup>th</sup> & Feb 20<sup>th</sup> and water hourly sampling began
- The Lake and Pond to the north and south of the plant respectively were also sampled for baseline assessment. Daily sampling has continued since then



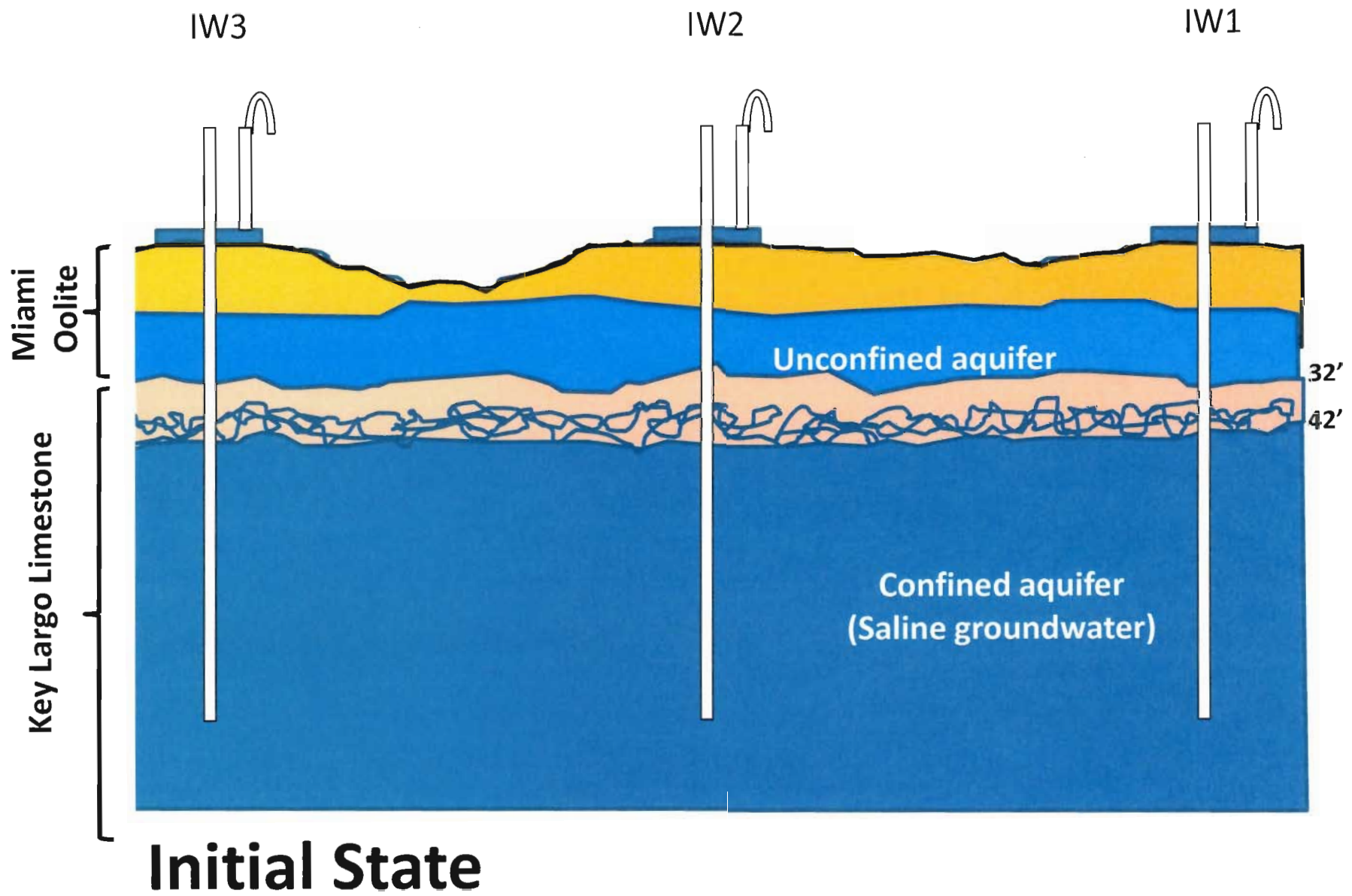
# Significant Results

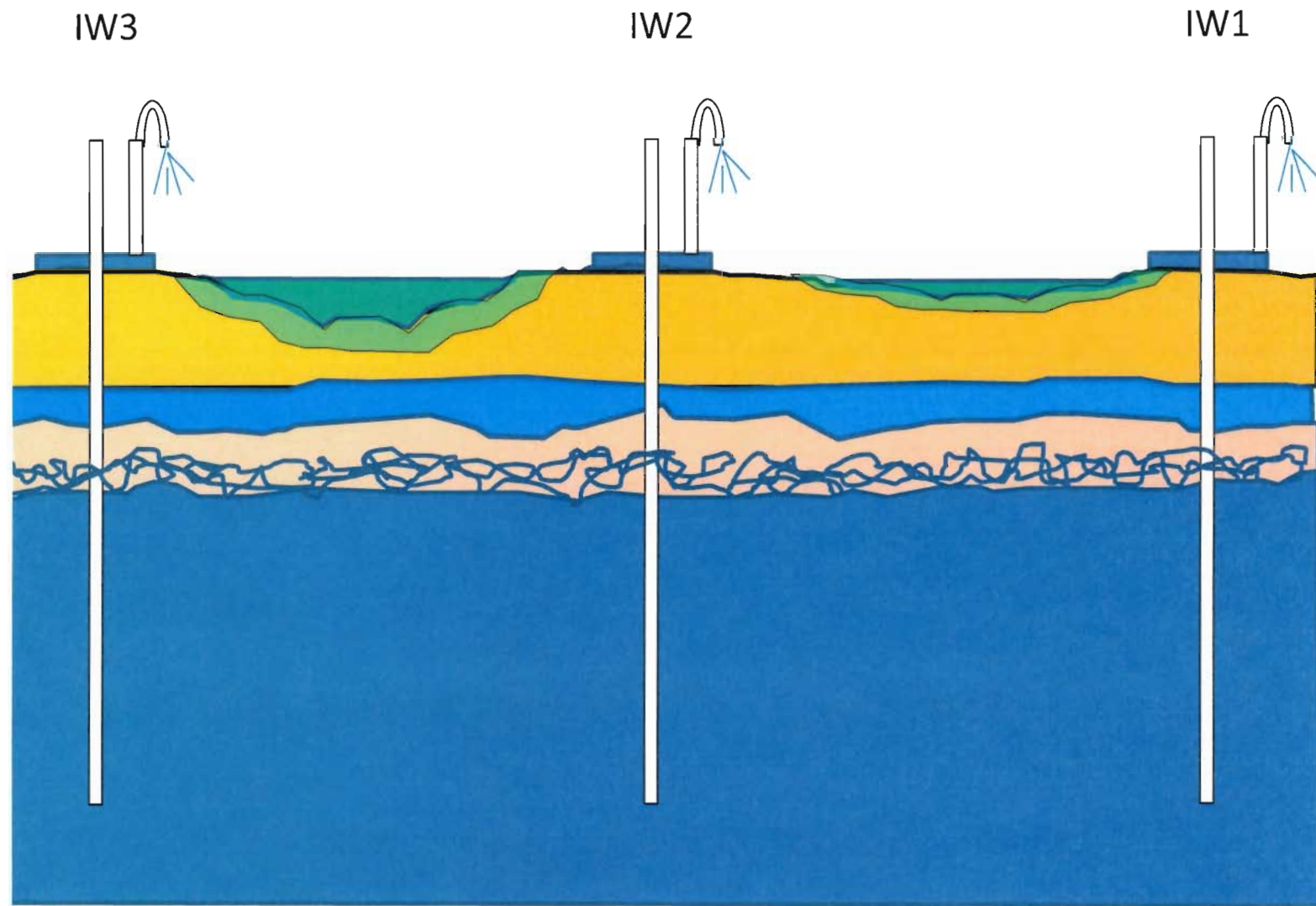
- Uranine and Rhodamine-like substaces are present in shallow ground waters, especially in OW5 located west of the injection wells, where it reaches more than 1 ppb Uranine and 0.4 ppb Rhodamine
- Lake, Pond and IWs sporadically show traces of this substance
- Analytical methods were adapted to correct for this potential signal interference

Surface and “deep” ground waters are isotopically different and plotted points fall along a straight line. OW5 is the odd one, with yellowish water, perhaps preferentially draining from the landfill

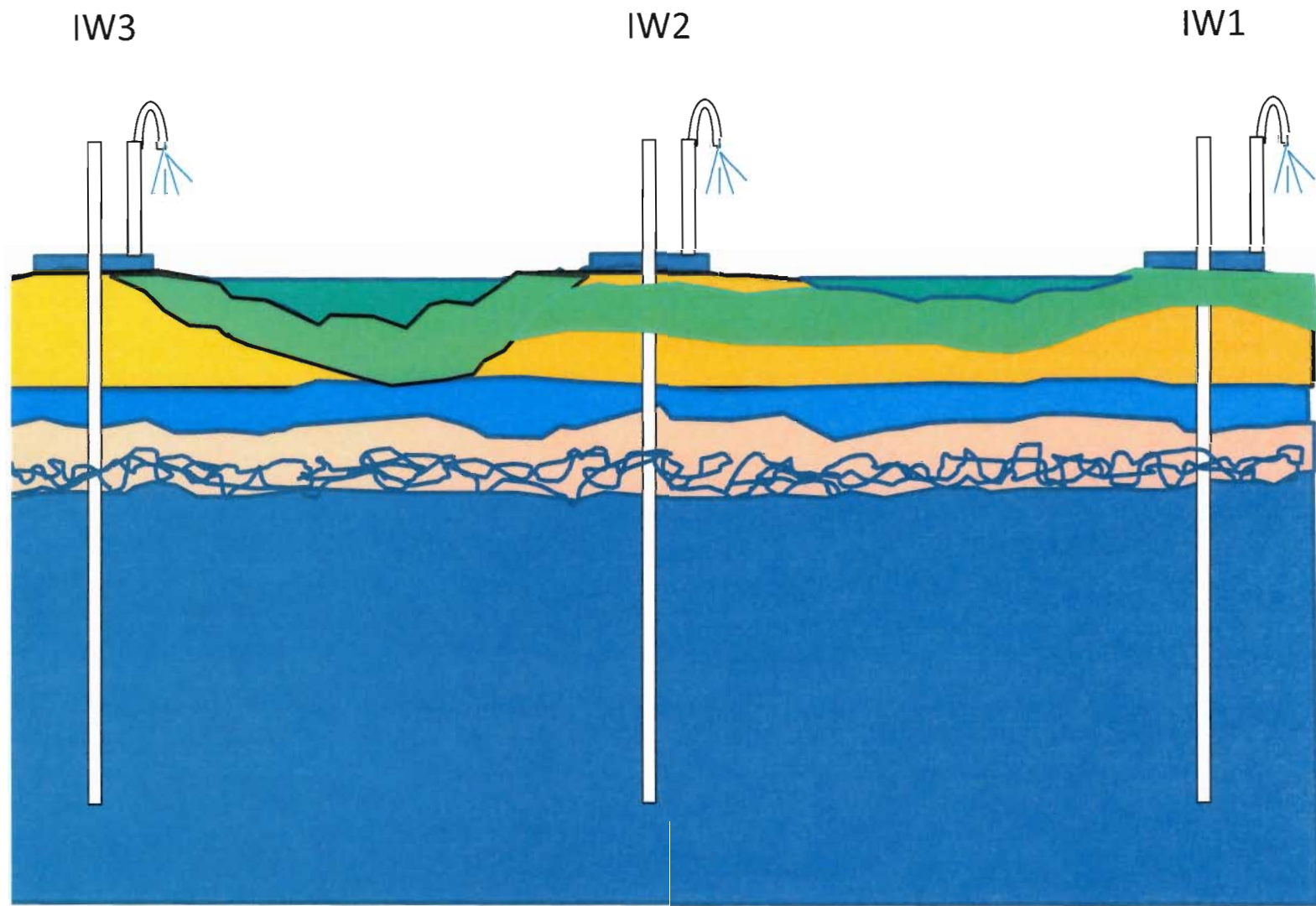


# Fresh water Injection





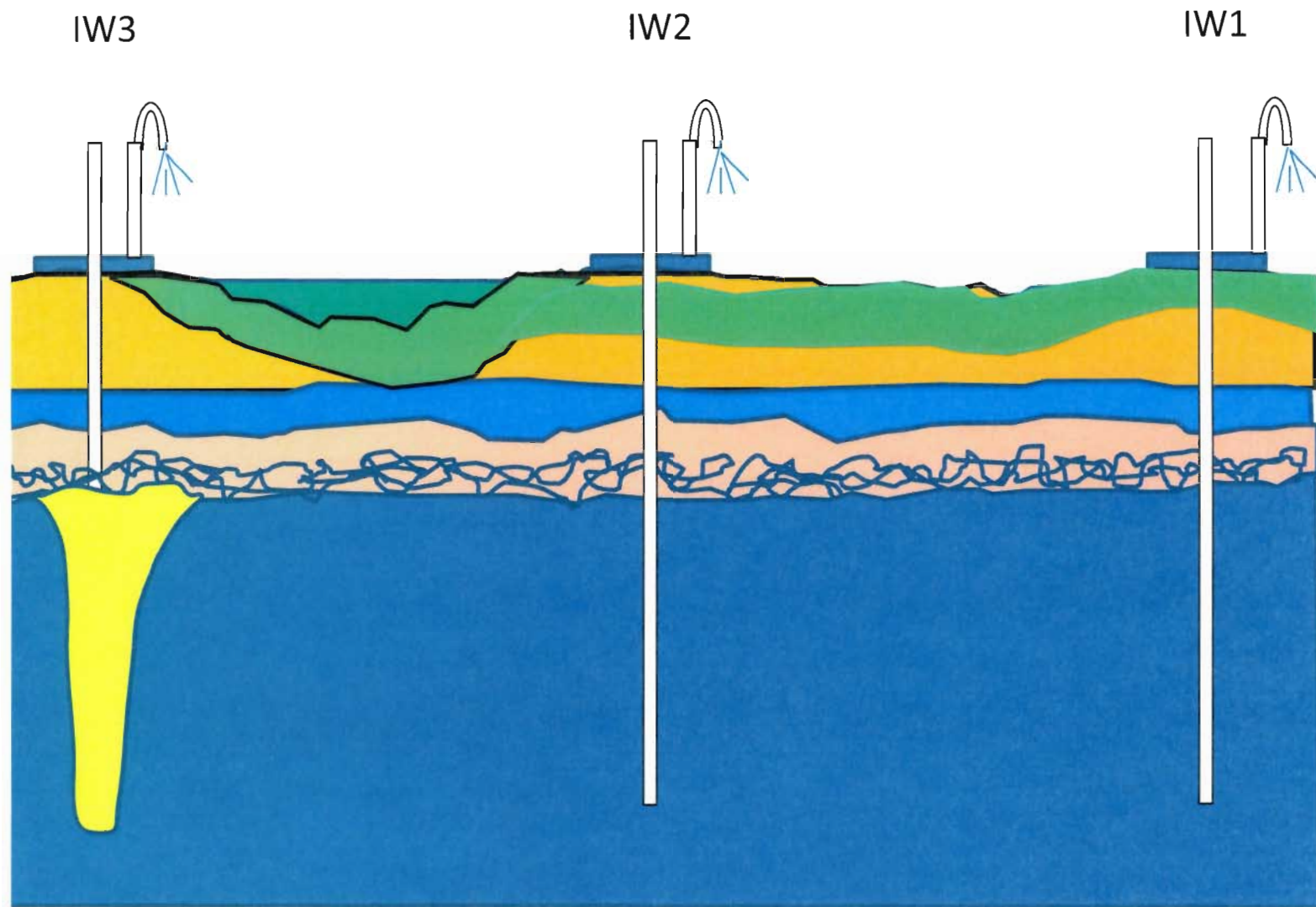
**Fresh water flooding and ponding during freshwater injection due to clogged gauge.**



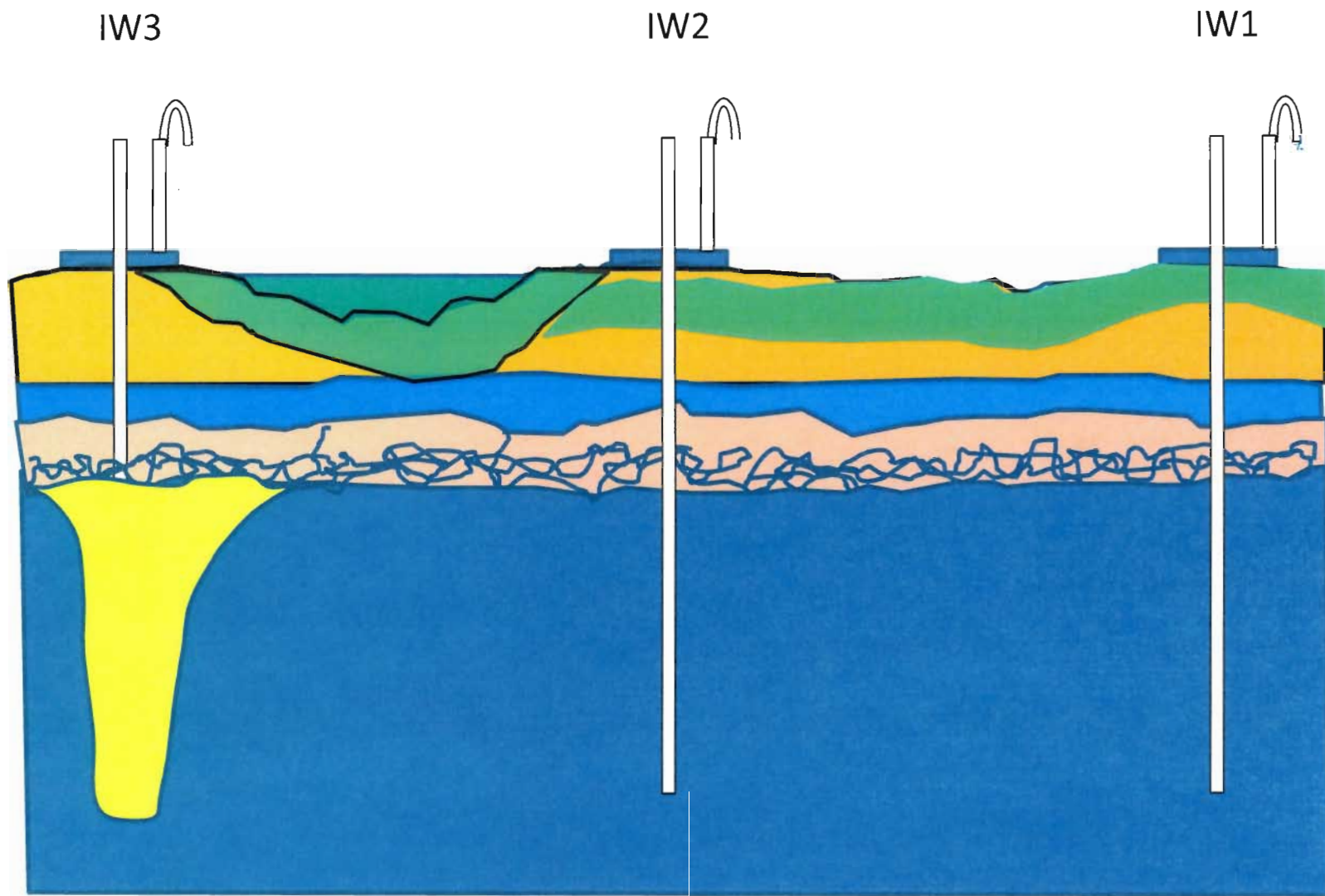
**Flowing snorkels for 2 days saturated soil.**



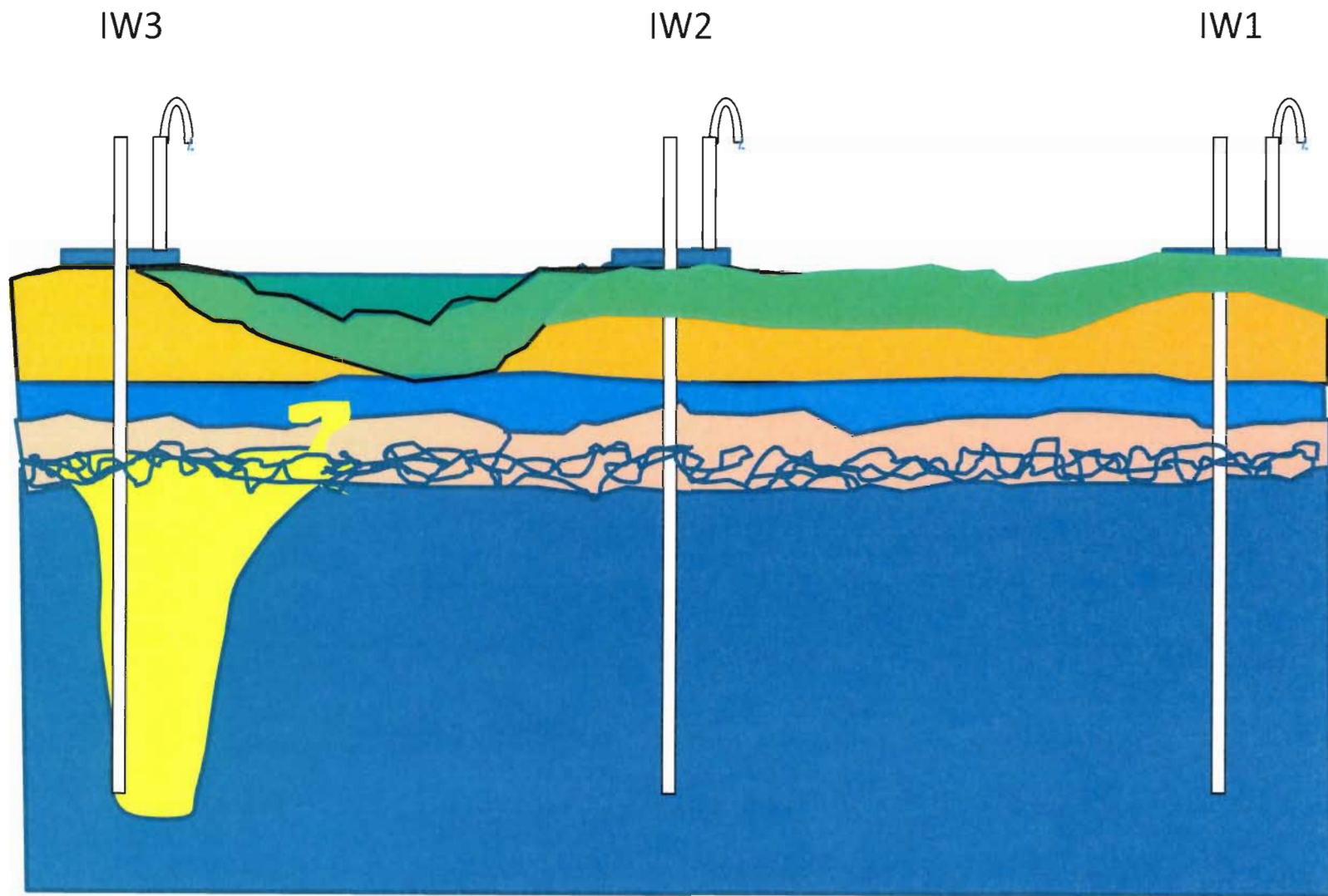
Plastic containers trapped by the flowmeter caused spills through the snorkels and flooding of injection wells area



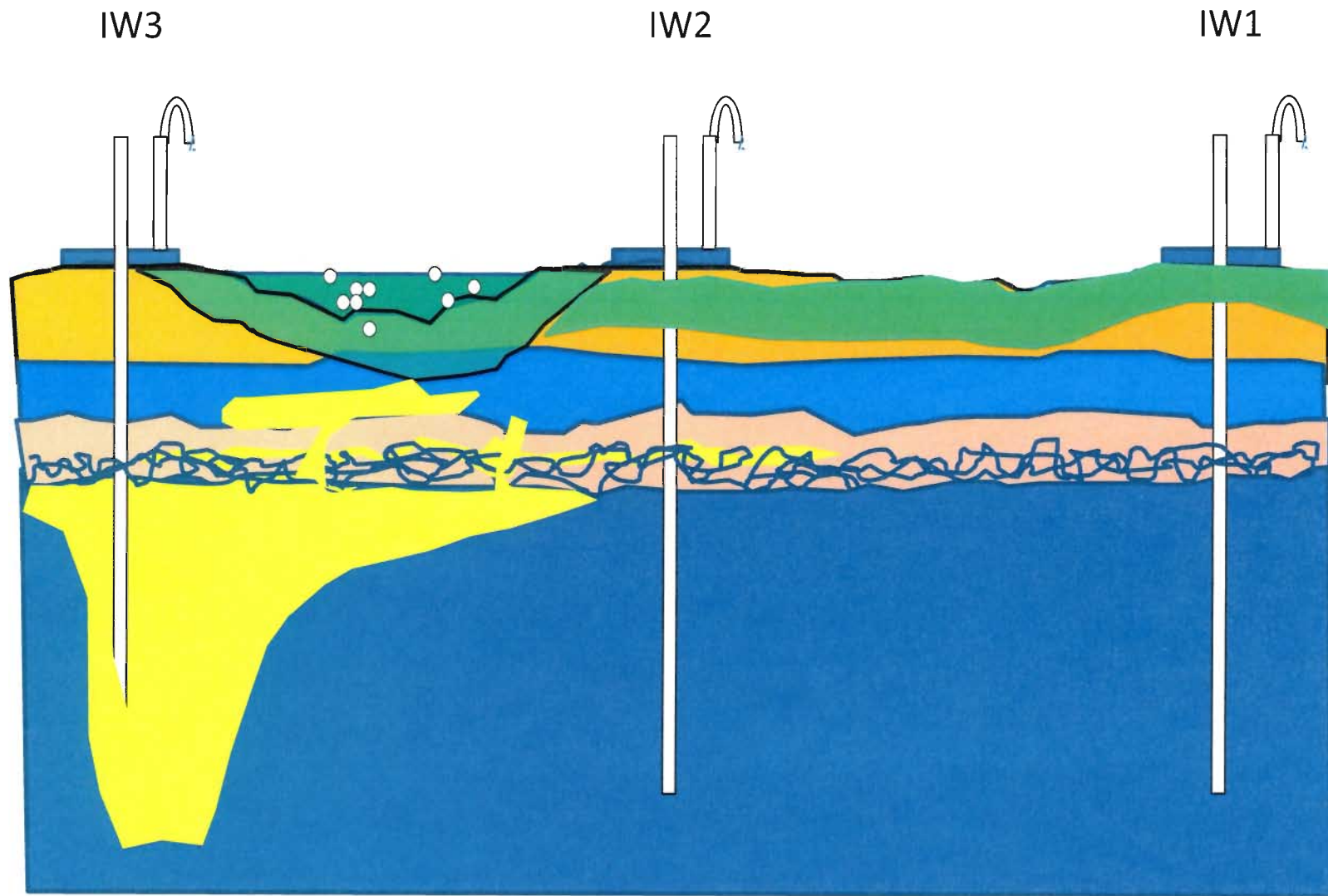
**Re-injecting Freshwater**



Injected tap water suffers buoyancy due to density differences and moves upward



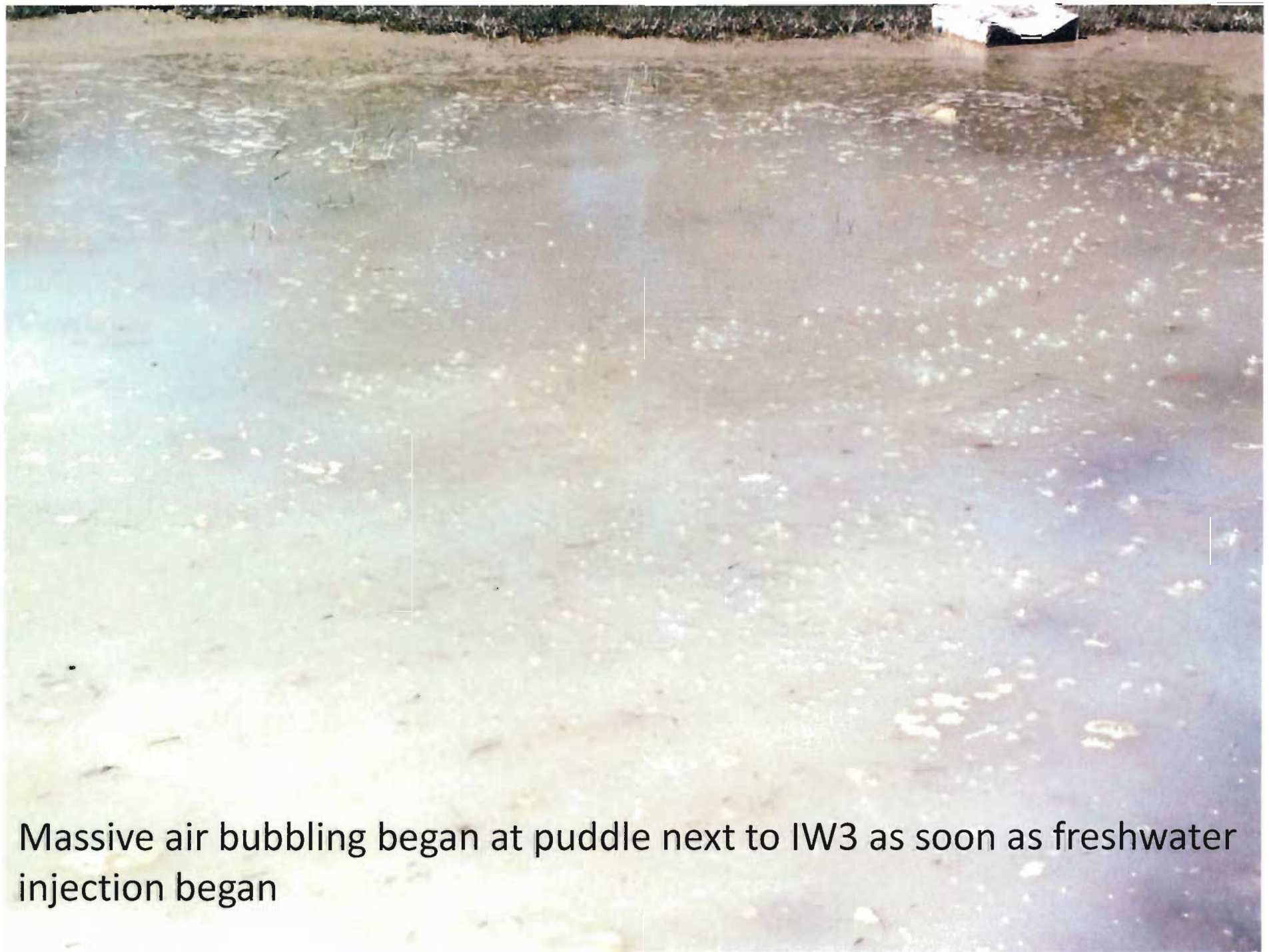
Injected tap water finds a path across the aquitard and moves upward to the unconfined surface aquifer



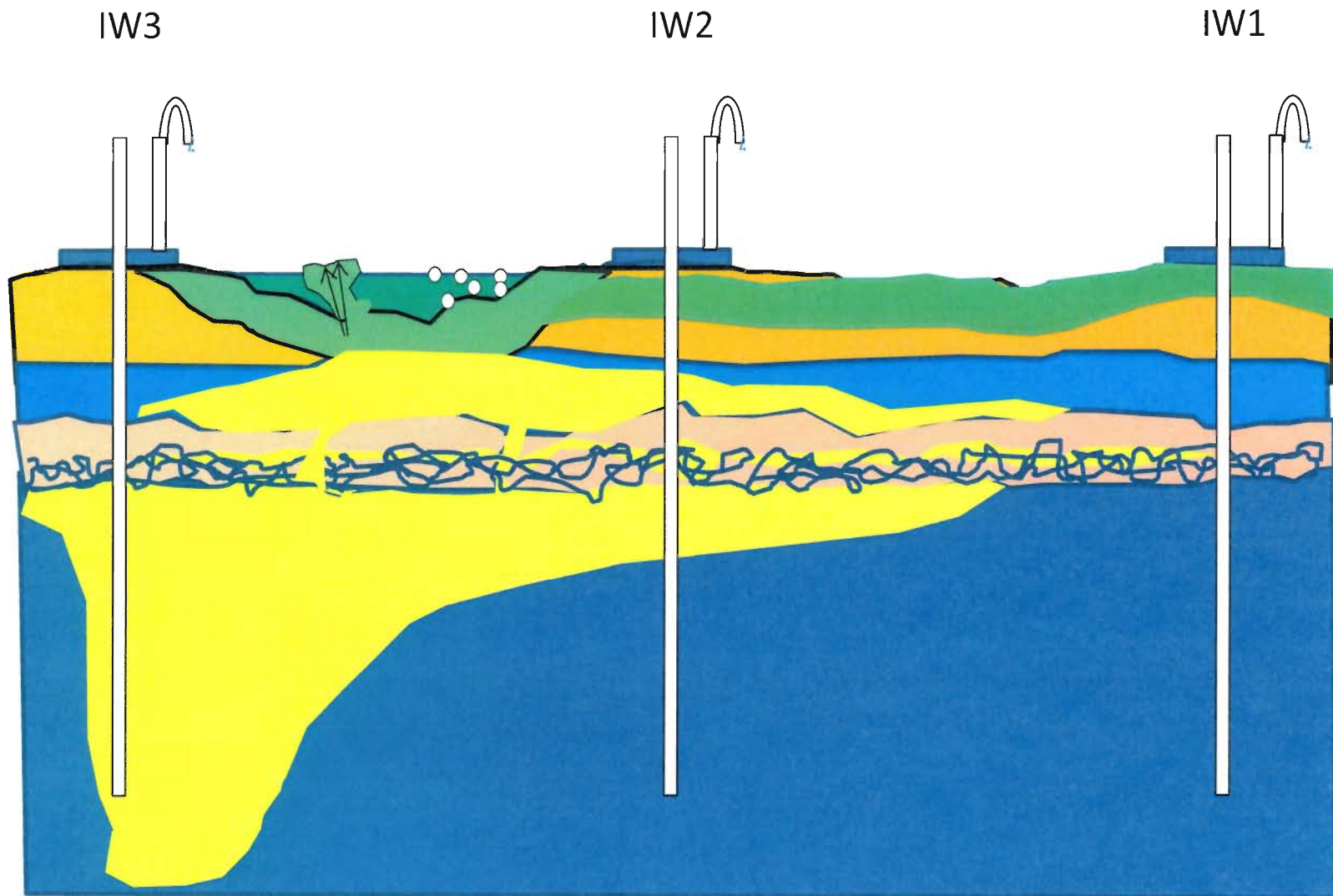
Injected tap water continues to move across the aquitard and moves upward to the unconfined surface aquifer. Pore space is filled with water and air moves to surface bubbling at pond



Air bubbles

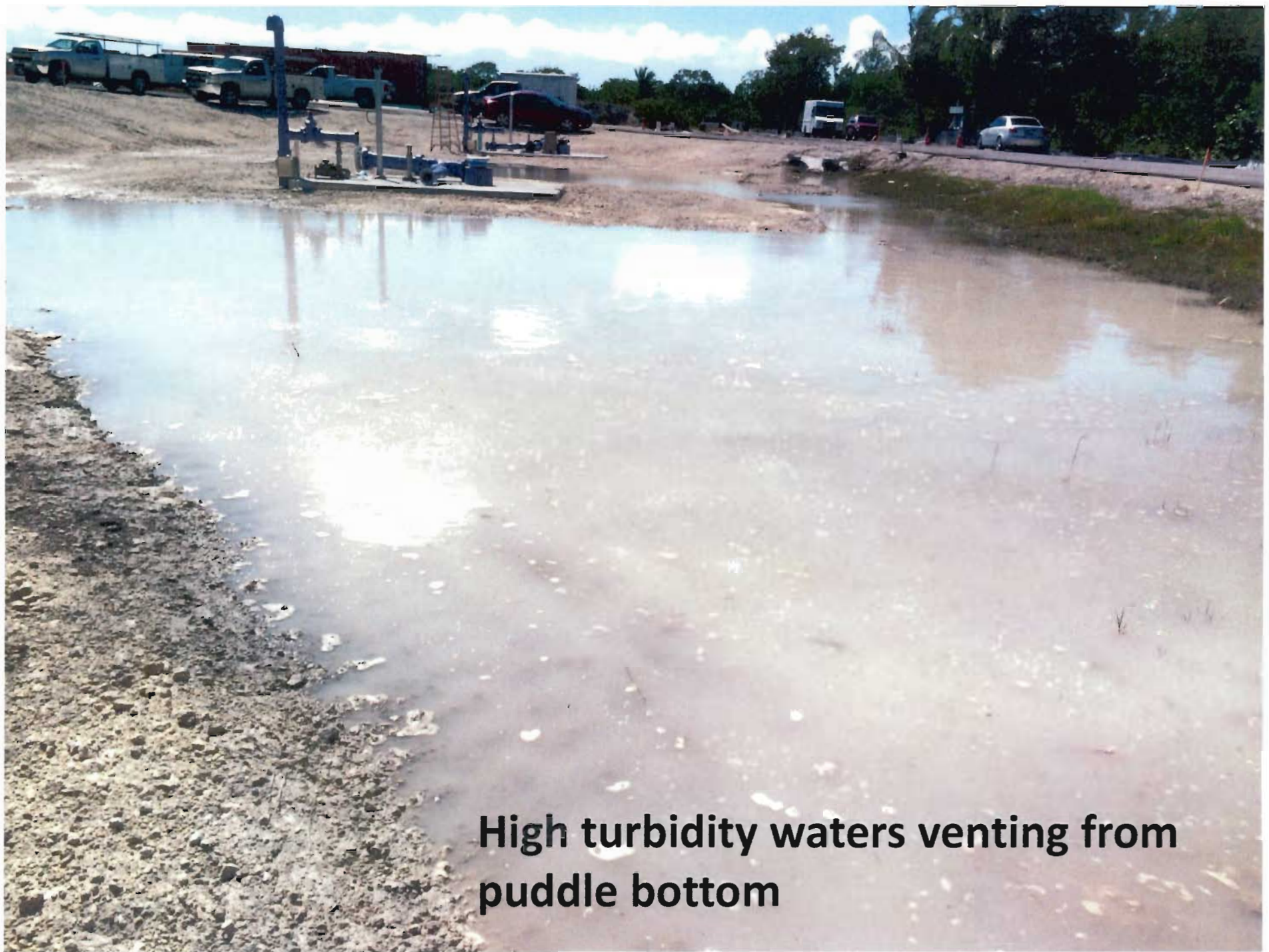


Massive air bubbling began at puddle next to IW3 as soon as freshwater injection began

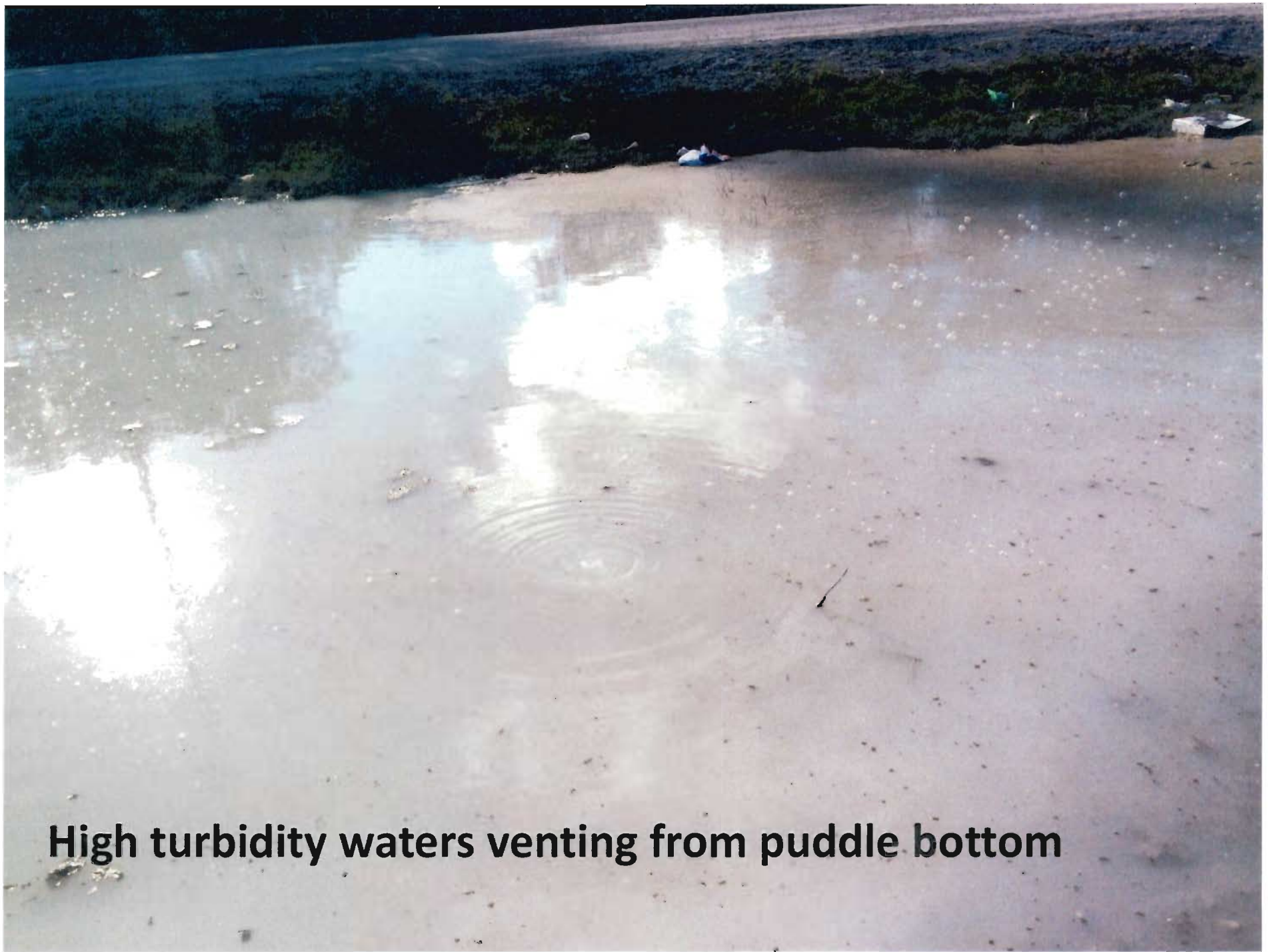


Injected tap water continues to move across the aquitard and moves upward to the unconfined surface aquifer. Pressure building due to hydraulic head makes water vent at puddle bottom and boil in surface

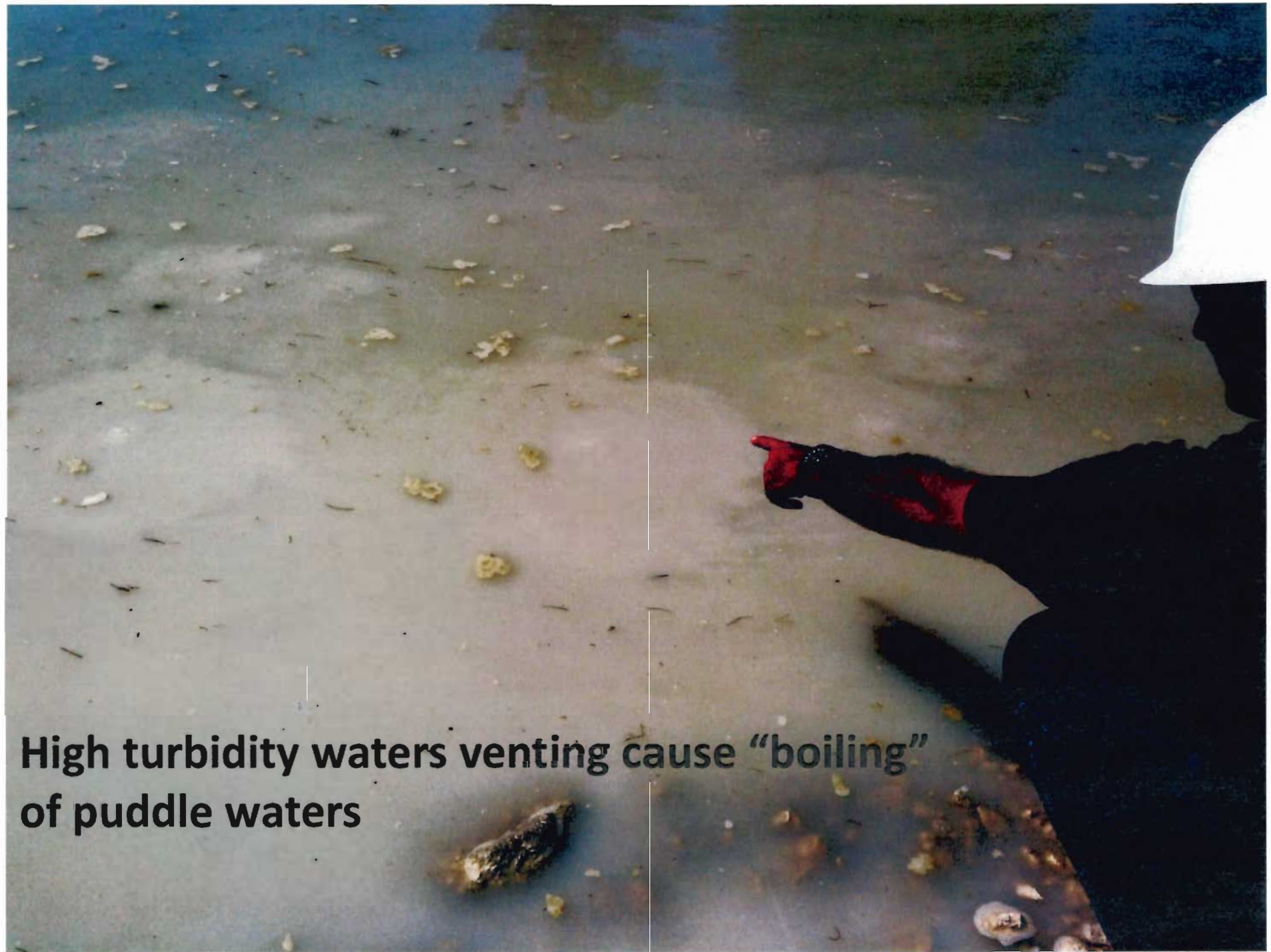




**High turbidity waters venting from  
puddle bottom**



**High turbidity waters venting from puddle bottom**

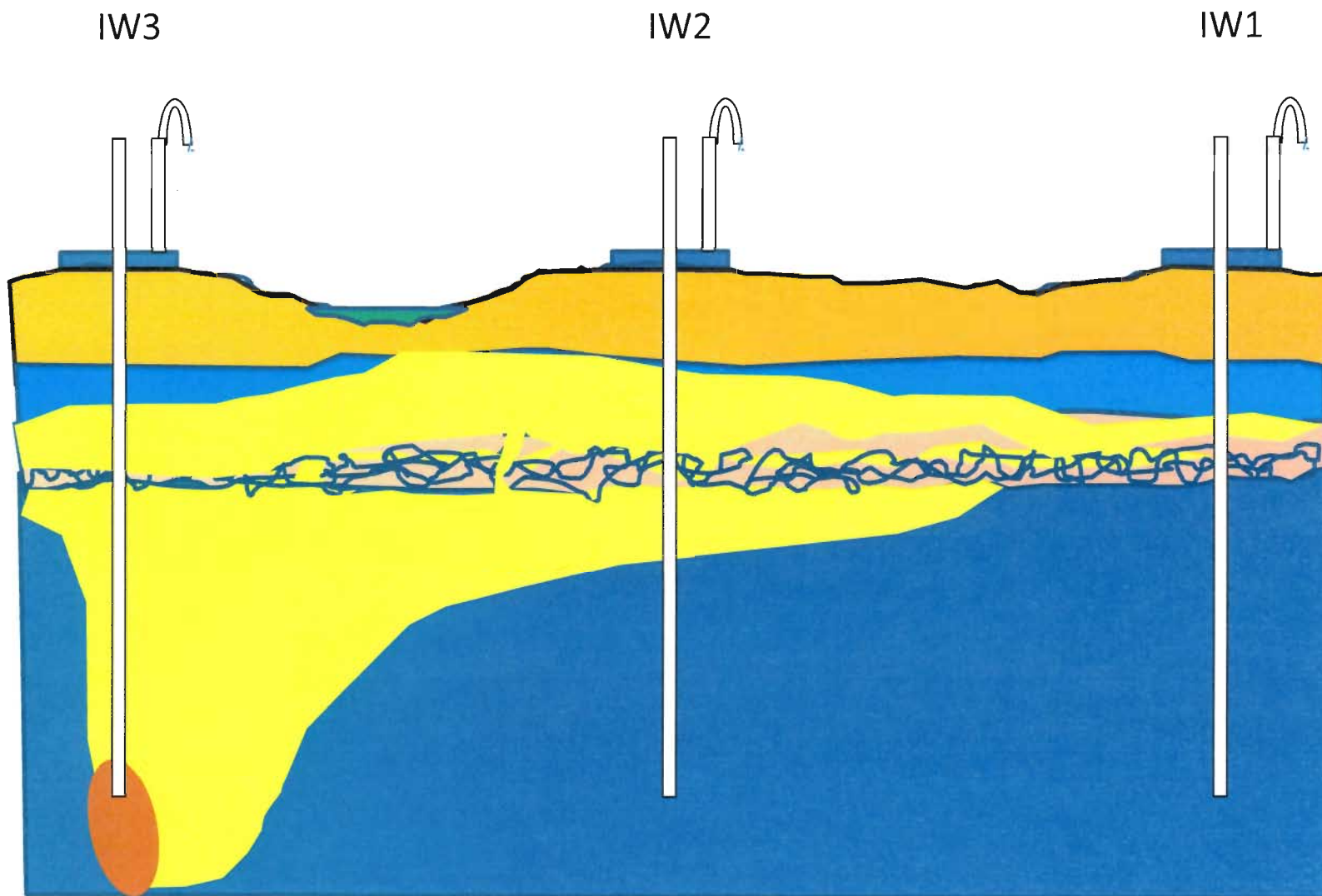


**High turbidity waters venting cause “boiling”  
of puddle waters**

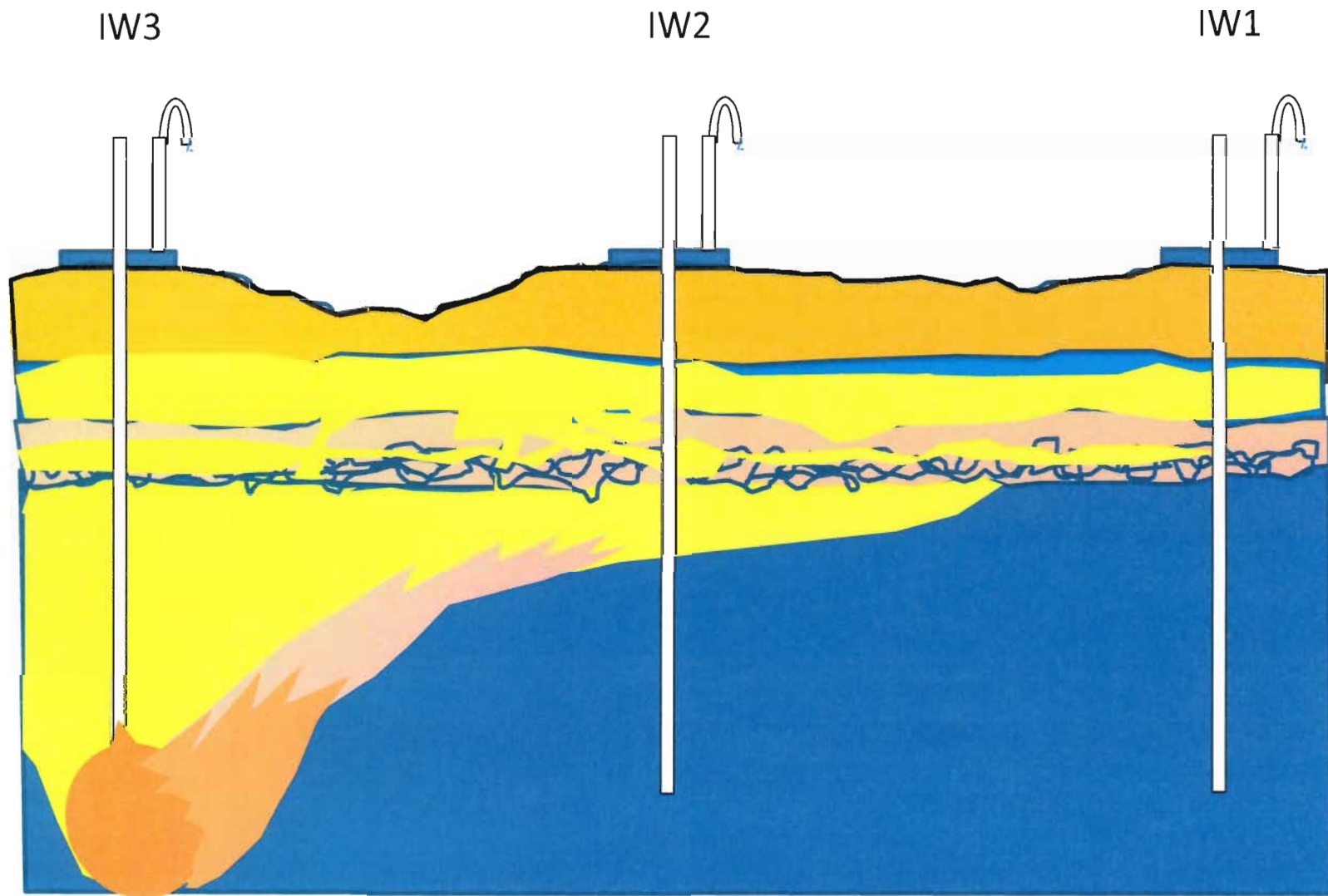
# Results of Freshwater Injection

- A connection between injection depth and surface waters may exist at the injection site
- A decline in “dye-like substance” signal was observed after freshwater injection in OW4 and OW5. This may be a result of the freshwater flooding of the area.
- No changes in salinity were detected in IWs or OWs following freshwater injection

# Dye Injection



After freshwater injection was halted. The puddle dried out rather fast (1-2 day). Sixty gallons of dye were poured into well IW3 on March 5<sup>th</sup>. Well pipes were reinstalled and freshwater injection was resumed at an average rate close to 420 gpm (~600,000 gpd)



Neither freshening nor dye has been detected nearby IW because: 1) freshwater is still displacing saline water ; 2) Freshwater found a preferential path (e.g. west?)  
In whatever case, if in fact there is a connection across the aquitard, dye will appear somewhere in surface.



EHTD Modeled distances

# On going test

- According to the Model readings around 5 ppb should begin to appear after 8 days of injection at 90 m of injection site
- After 10 days since beginning of dye injection, no significant dye concentration has been detected in any of the samples except for some isolated higher readings in all wells, excluding IW1.

# Following Work

# Relocation of supporting infrastructure

- The Horiba Spectrofluorometer has been moved to the NPS Ranger Station at Key Largo to optimize operations.
- A Shimadzu Fluorometer will remain operative at Cudjoe for screening of water samples to be sent to Key Largo
- C3 Turner Submersible Fluorometer and YSI sonde remain at Cudjoe Key for transect studies
- We would like to continue using the trailer at Cudjoe Key as field-base for lab operation, office, and parking for boats and trailer
- The USV and boats remain at Cudjoe Key

# Continuation of Operations

- We will continue monitoring the Lake to the north and Pond to the south along transects.
- Additionally we will relocate the ISCO Autosamplers currently in IW1 and IW4 to sites along the trace of a major NW linear feature crossing the injection site.
- Eventually the ISCO at OW2 will also be used for monitoring lake waters
- We will purge all OWs before re-starting Autosamplers to increase circulation and inflow.
- We will inject a second dye on Tuesday March 24<sup>th</sup>
- For this second injection we need the freshwater injection to be suspended on Monday 23<sup>rd</sup>