Mercury Source Tracing and Mechanistic Studies Update

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Unique Environmental

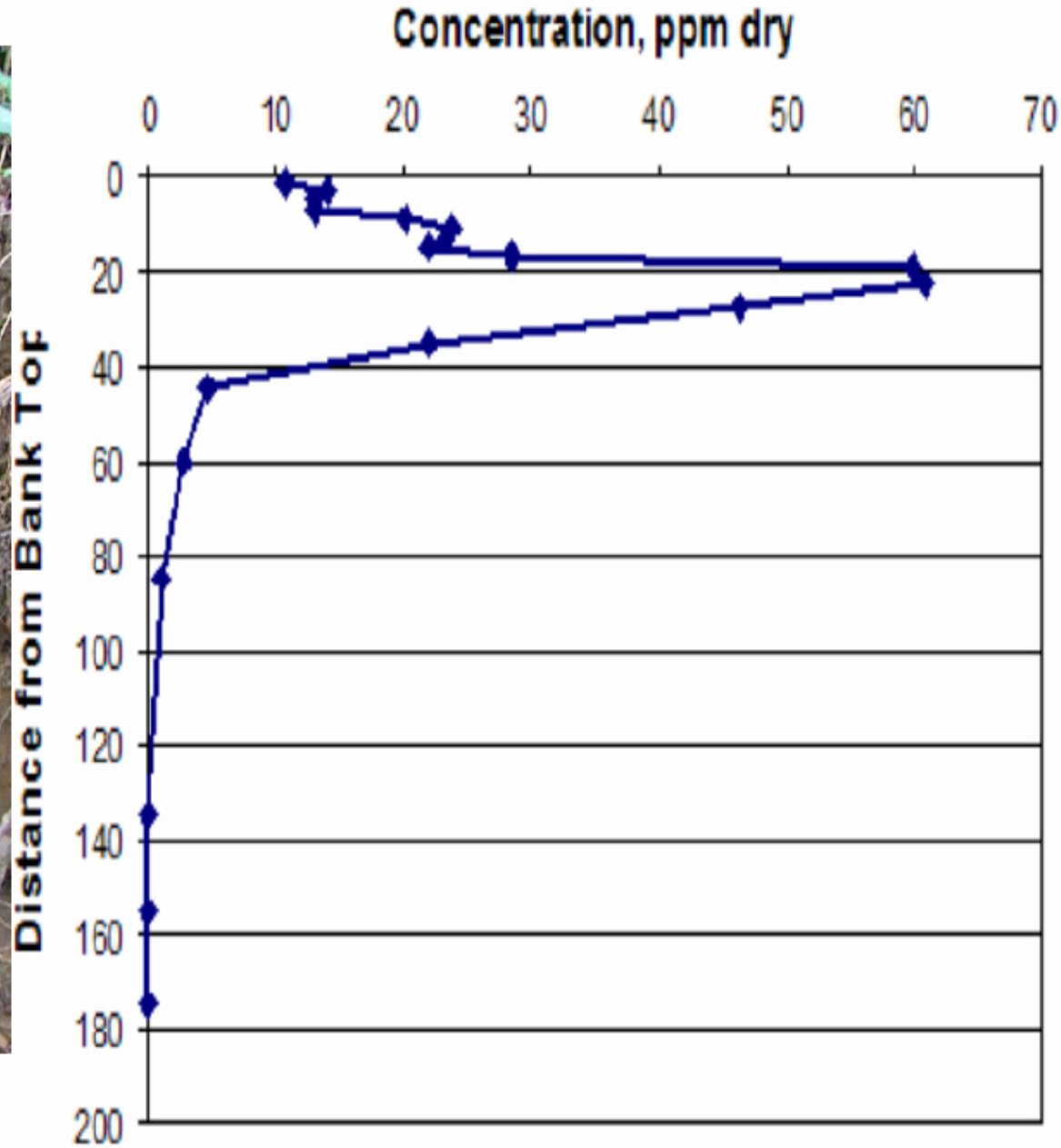
Synopsis from October

- Getting closer to answering the question “How is Hg getting into the South River in bioavailable form?”
  - Very likely not from point source(s)
  - Likely related to presence of Hg in floodplain/bank/bed solids in form(s) that can be released continuously into surface water
  - Role of shallow alluvial groundwater still being quantified

Activity Since October

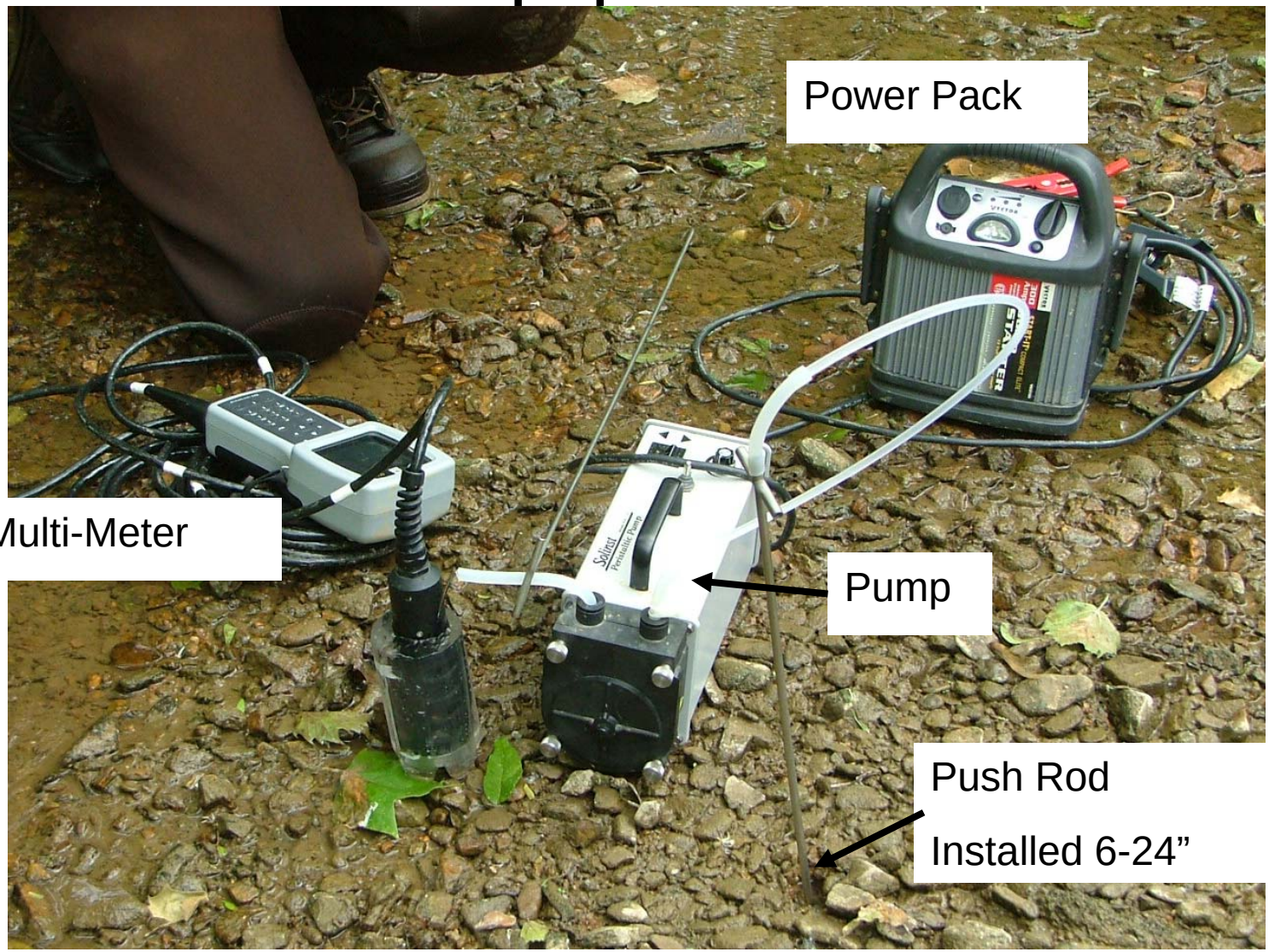
- Storm (large) sampled in river near plant site (results not presented here)
- Additional hyporheic water sampling at BP
- Analysis/interpretation of additional “diffusion bucket” data.
- Additional results for soil leaching study.
- Planning and equipment acquisition.

Basic Park Intensive Study Site



Sampled by University of Delaware-2005

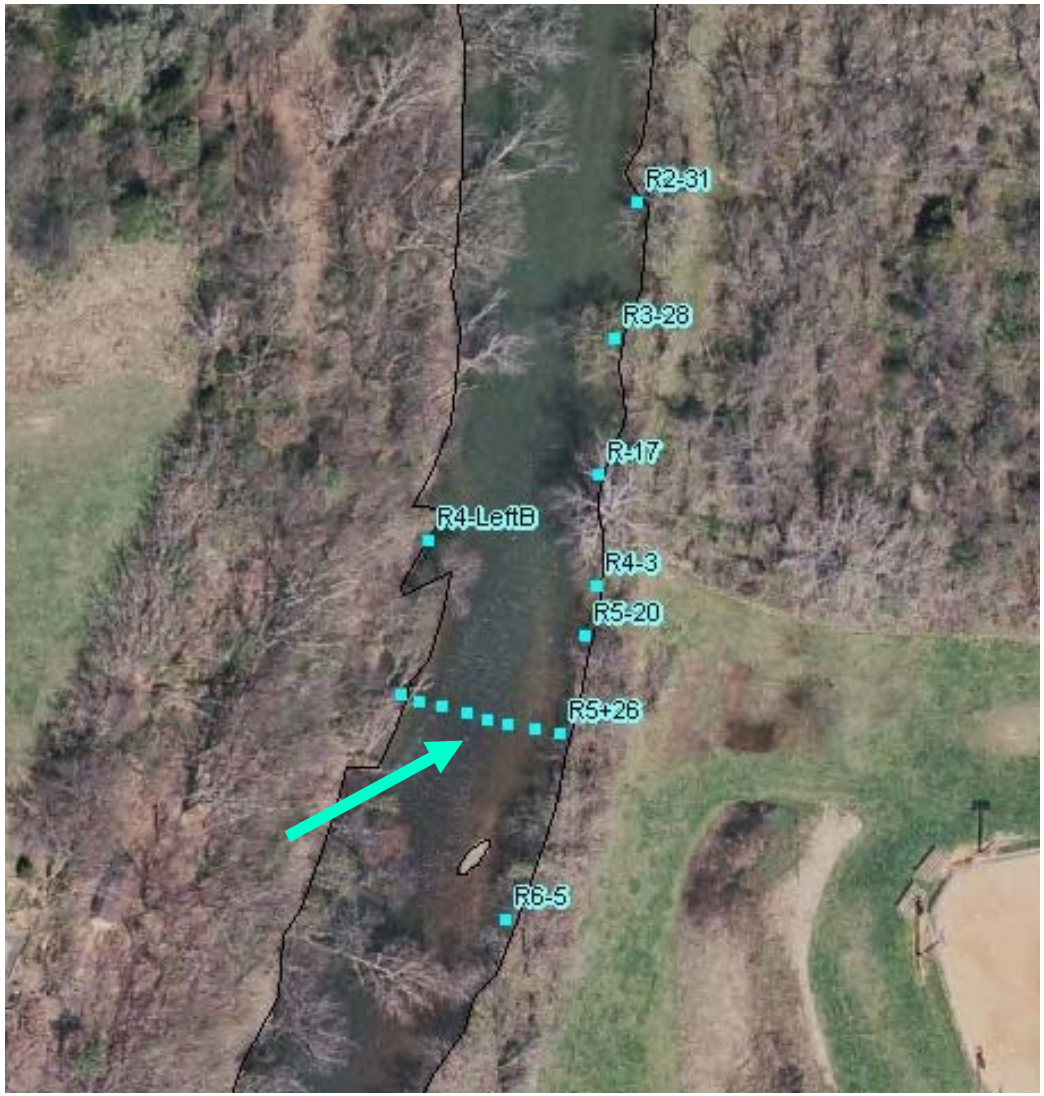
Pore/Hyporheic Water Sampling Equipment



Also measure water level in manometer relative to river water level

Hyporheic Water Stations

July 2006, Including one SW

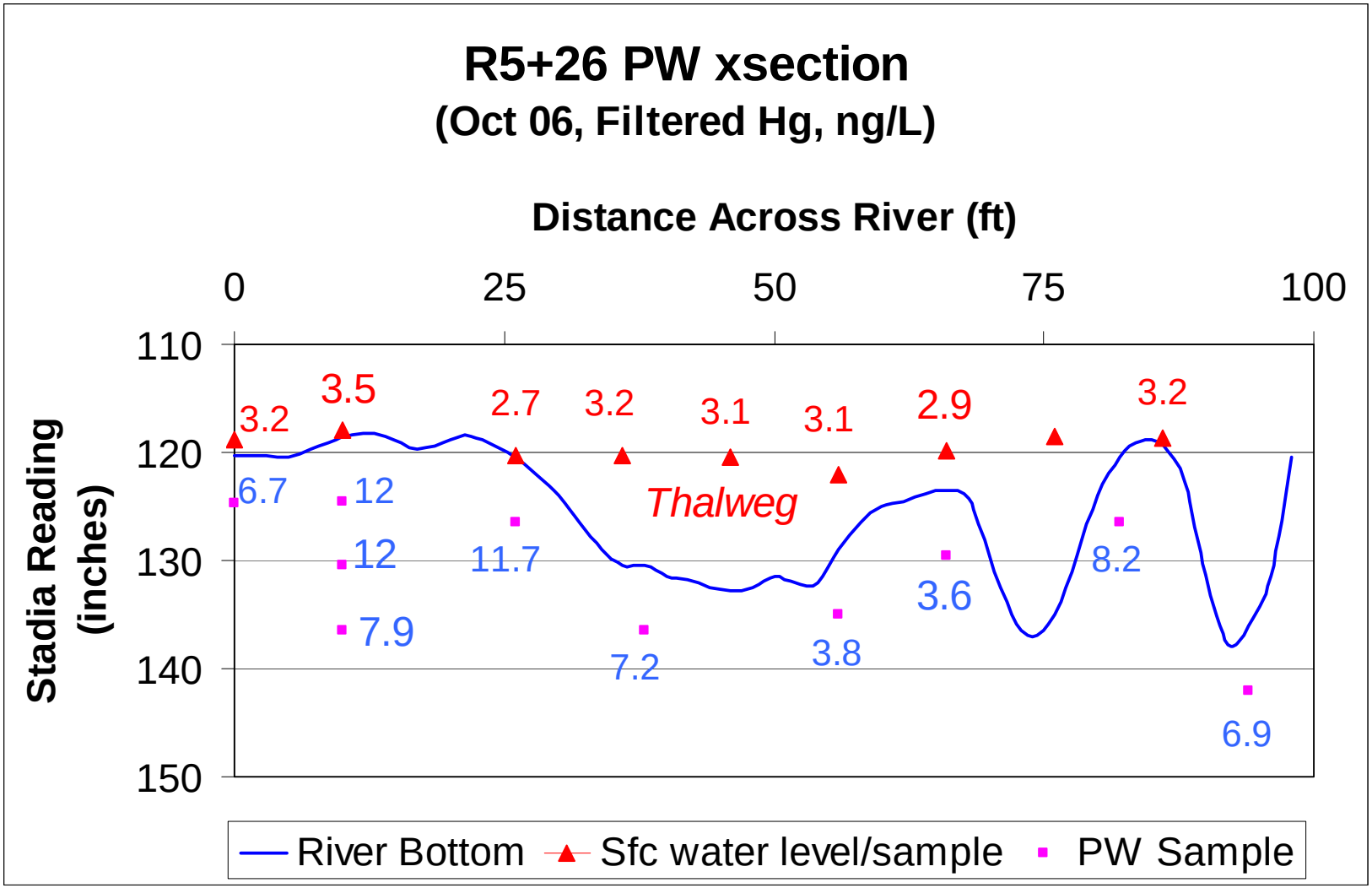


Hyporheic Water Transect

Dissolved THg (ng/L)-July 2006

[Hg] in streambed hyporheic zone generally 2x to 3x surface water (SW) value

Repeat In October 06



Other Gravel Bar Observations

- If you can partly accept higher electrical conductivities as groundwater indicator…
  - Conductivities suggest SW-related, not GW
- Pressure differentials suggest downward movement of water into gravel in study location.

Tentative Gravel Bar Thoughts

- Are gravel bars important Hg storage compartments?
- Are gravel bars high-surface area sources, acting like “packed columns”?
- Are gravel bars acting somewhat like flux chambers? Retarded flow, rising concentration, etc...
- Any way to use a gravel bar as an investigative tool? For non-mud locations.

Diffusion Buckets

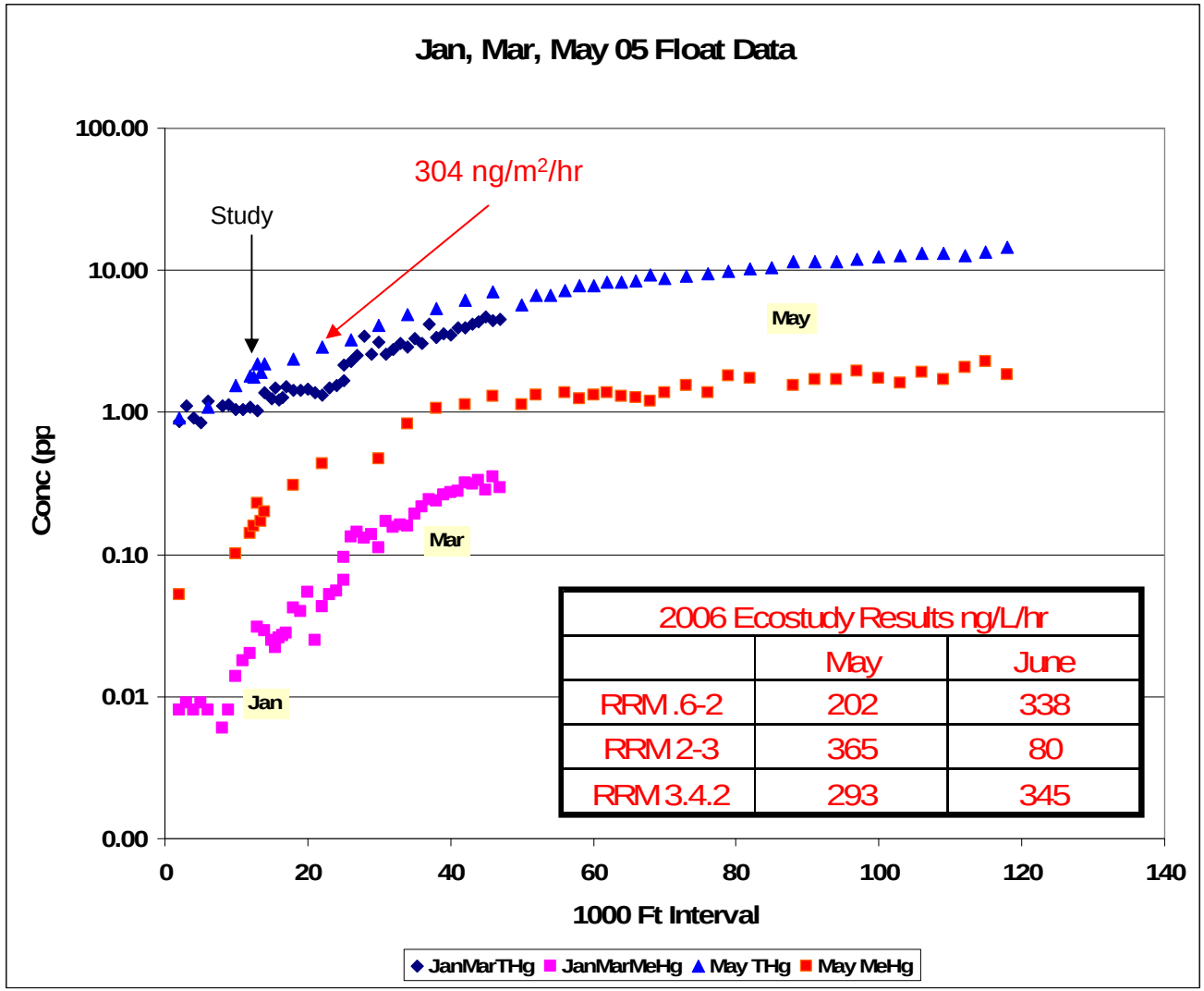
Intended as a device to isolate a section of near-bank sediment from continuous "flushing" by upstream surface water, i.e., a simplified benthic flux chamber

Flux Bucket Locations

May, July, Sept 06

Close Interval Filtered SW Results

Fairly Steady Rise in Dissolved



2006 Ecostudy Results ng/L/hr		
	May	June
RRM .6-2	202	338
RRM 2-3	365	80
RRM 3.4.2	293	345

Diffusion Bucket Results
May/July/September 06

Location	Time = 0	Time = 3	Time = 6	Time = 23	Avg Flux
May	**(hr)**	**(hr)**	**(hr)**	**(hr)**	**(ng/m^2/hr)**
B3					323
July					
B3					Negative
B4					295
Sept					
B1	2.8 ng/L	3.2	3.2	3.6	4.8
B2	2.8	2.5	2.6	3.4	6.1
B3	2.9	10.3	17.6	30.9	208.8
B4	2.9	3.8	2.8	23.7	201.5
B5	3.2	2.5	2.7	4.3	7.6

Soil added

“New” Near Bank Results
Sep/Oct 06

- Sediments perhaps more “localized” than previously expected? Flux buckets now confirm.
- Near-bank sediments sometimes appear to release Hg at rates comparable to apparent “whole” river releases.
- But in many cases, release rates are much lower than river average.
- This might point to the other substrates as important contributors: sand, gravel, cobble, etc.

Soil/Sediment Leaching Studies - Continuing

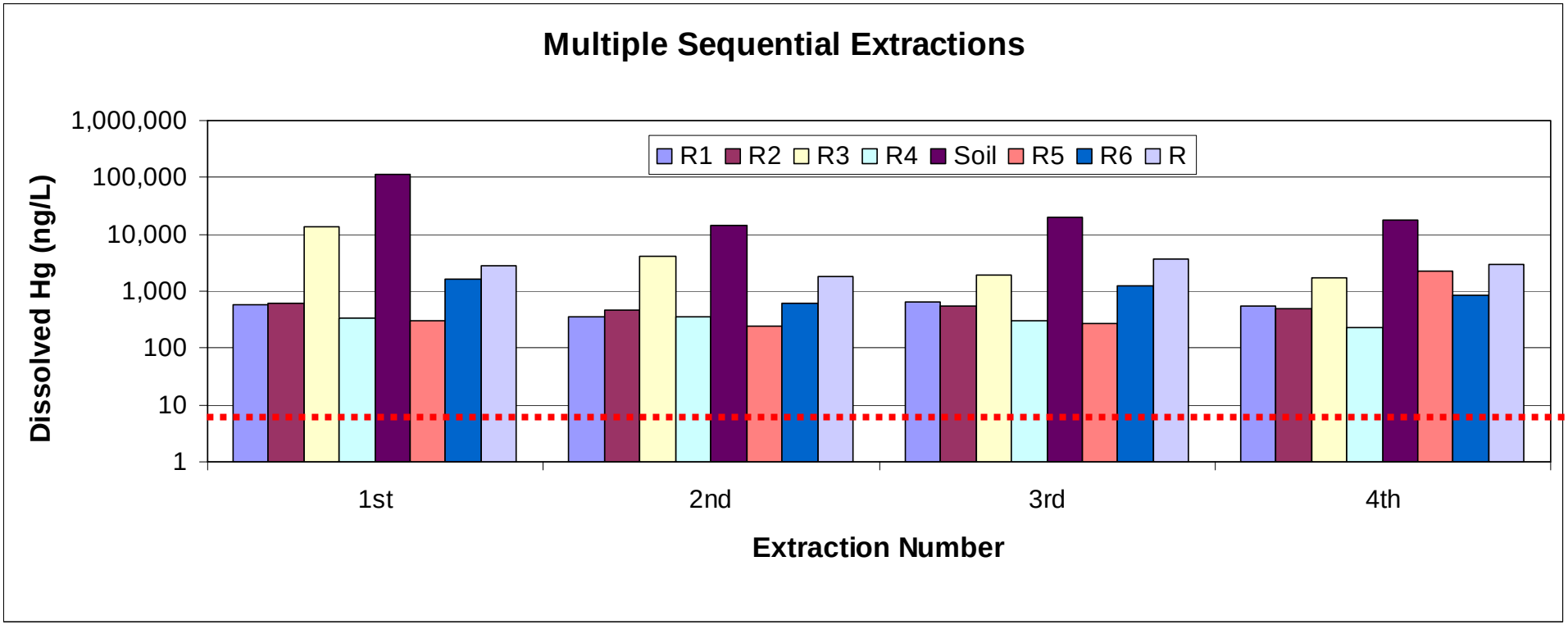
Objective: Determine whether Hg release from bank soils and near-bank sediments follows a “simple” desorption equilibrium.

Experimental Approach

- Collect representative soil and sediments from study area at Basic Park.
- Perform four (4) successive extractions of each sample with DI* water at solution/solid=10 (40 mL/4g)
- Analyze extracts for filtered (0.4 micron) mercury.
- Compare leaching patterns.

*River water for ongoing work!

Extraordinarily High Results
(Using DI Water)



Similar aqueous [Hg] across all four extractions.
Bank soil produced highest aqueous [Hg]

May 2006 Leaching Caveats

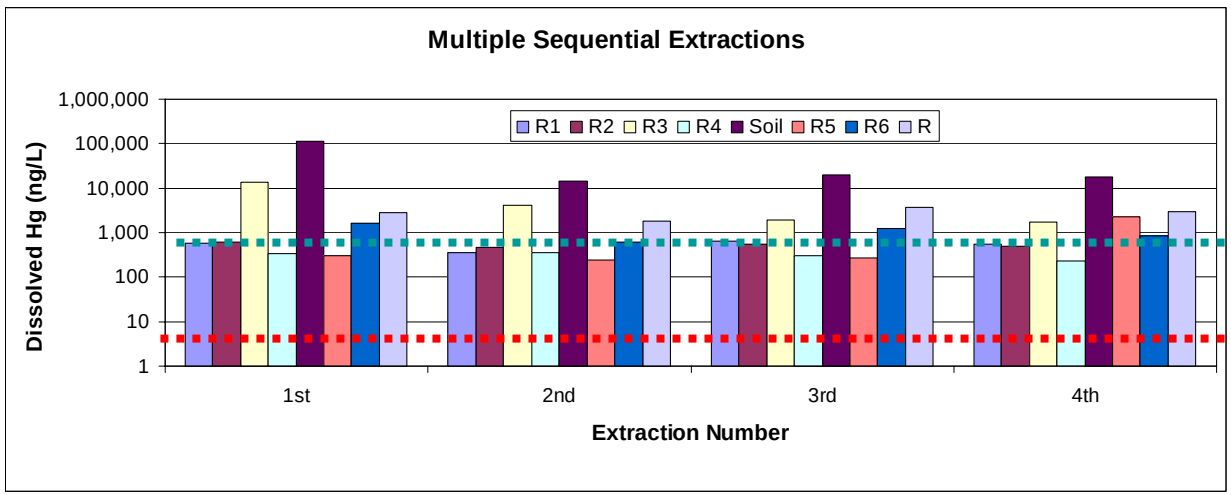
- D.I. Water may be unrealistic extraction fluid. Should compare actual river water.
- All that passes a 0.4 µ filter is not truly bioavailable
  - particulate-attached, colloids
  - DOC bound
- Does extraction routine produce an unrealistic amount of DOC or colloidal particles? What is nature of “Particle Effect”

D.I. vs. River Water

for soil extractions

Extraction Water	Result (ng/L)
D.I.	2500
South River at SR01	936

While much lower, 936 ng/L still represents a strong driving force for mass transfer of Hg.



Centrifuge in SRST Office

Beckman GS-6

Two Main Purposes for Centrifuge

- Ultrafiltration of water samples to remove colloidal particles and give a better measure of “dissolved” - better measure of “bioavailable”
- Rapid removal of pore water samples from fine sediments. Another way to measure “driving force” for mass transfer of Hg to water column.

Millipore Ultra-Filtration Tubes

5000 MWCO

Path Forward-Leaching Study

- Verify high aqueous [Hg] associated with the sediments by spinning porewaters from shallow sediments by centrifuge.
- Repeat selected extractions with filtered river water (high/low spec cond) from SR-01 (Lyndhurst)
- Characterize the physical/chemical nature of Hg in these kinds of leachates (e.g., volatility, molecular weight, reactivity)
- Use centrifuges in SRST office and Seattle to begin characterizing truer “dissolved” samples