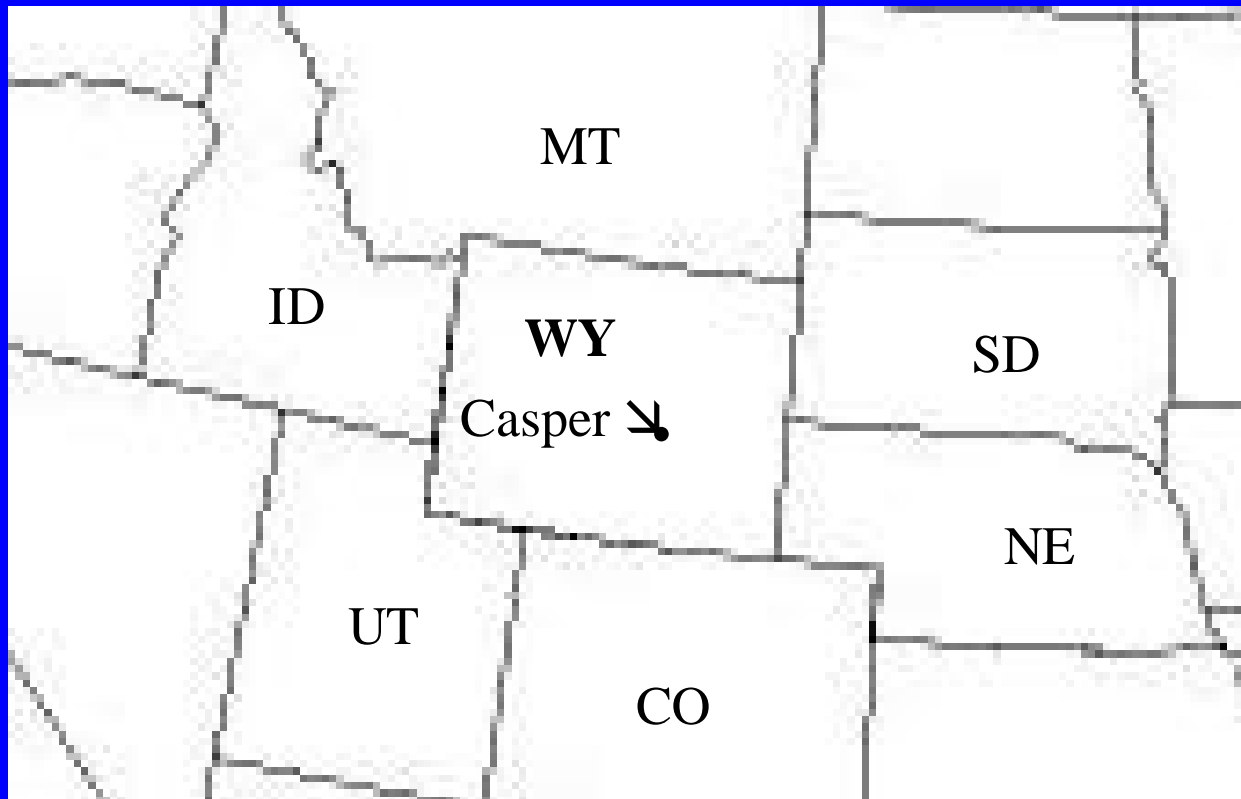


Soda Lake, WY - Capping Case Study

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Soda Lake, Casper Vicinity



Geologic Setting

- Soda Lake is a natural playa basin historically about 100 acres in size.
- Formed in a shale/sandstone depression.
 - Prehistoric sand dunes on about 1/3 of the uplands
- Natural salinity over 50,000 ppm.
 - Some low amounts of natural high TDS groundwater inflow and surface runoff.
 - Historically the lake formed in the winter and mostly evaporated in the summer.
 - WY has 11 inches of rain/snowfall, 40 inches of evaporation

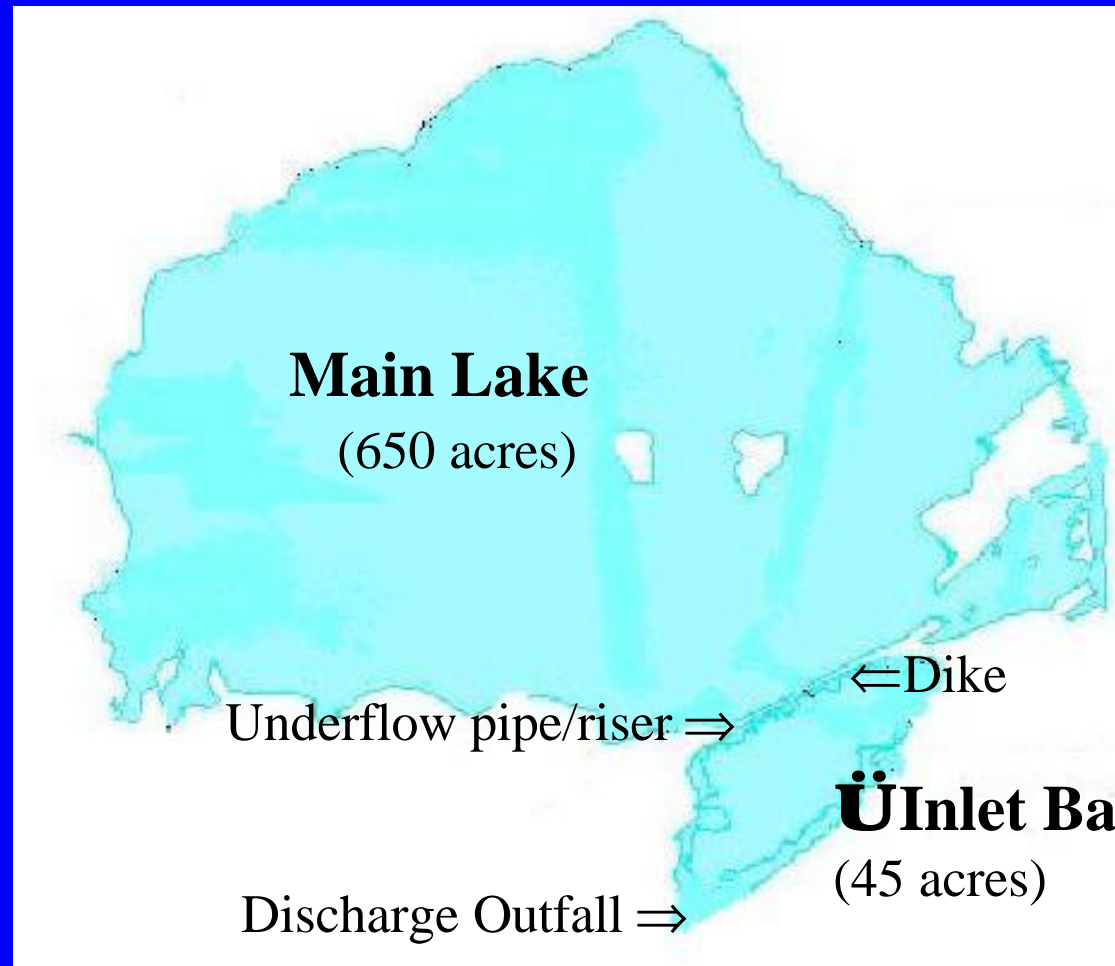
Pre-1957 playa basin



Usage History

- Amoco's Casper refinery rerouted process water to the lake in 1957 to avoid discharges to the North Platte River
 - River used for drinking water. No sewer treatment in Casper at the time.
 - Lake size increased from 100 acres to over 650
- Primary settling was through separators
 - “Inlet Basin” was a final settling pond.
 - Built by diking a natural ridge and installing an underflow pipe with riser.
- Refinery Closed in 1991

Soda Lake Today



Soda Lake Habitat

- The pumping of freshwater to Soda Lake and exclusion of human activity has created a significant wildlife habitat
 - Nominated for 'Partners In Flight' refuge
 - Over 320 bird species observed
 - Used regularly by Local Audubon and school groups for wildlife observation
 - River water pumping continues to maintain habitat pending remedy decisions
- Known exposure of birds to PAHs in Inlet Basin prompted remediation

Inlet Basin Water/Sediment Characteristic

- Water depth ranges from 2-12 feet
 - Low salinity
- Soft sediment thickness ranges from 1-9 feet
 - Total volume about 350,000 yd³
- Coring determined:
 - Surface (<4”) solids content about 29%
 - Very plastic, low liquid limits and low to non-existent shear and compressive strength
 - Atterberg limit ≈ 116
 - Solids content increases to 87% at depth

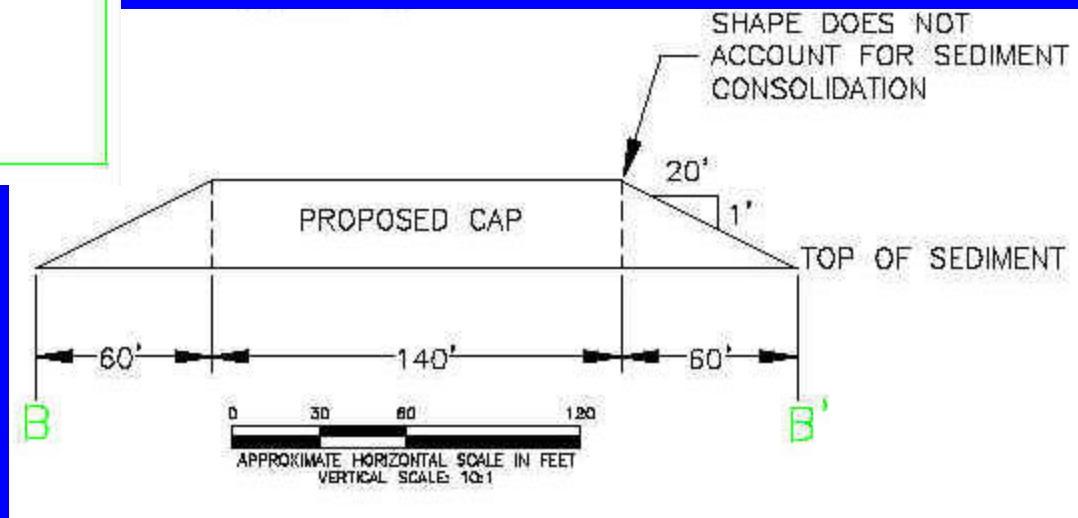
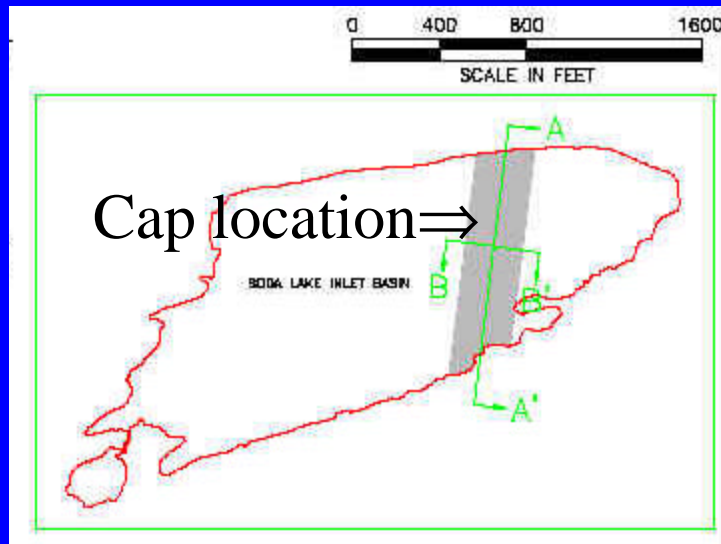
Sediment Contaminants

- Contaminants typical of refinery separator type sludges, e.g
 - Benzene
 - up to 0.5 mg/kg
 - Total PAHs
 - up to 800 mg/kg
 - Chromium
 - up to 2,800 mg/kg
 - And blobs of non-aqueous phase liquids (NAPLs) similar to diesel oils

Cap Purpose

- Demonstration Project used:
 - To determine the viability of isolation capping as a long- term remedy
 - Test placement modeling hypotheses, e.g.
 - potential short-term water quality impacts
 - To ensure effective cap design modeling and engineering though, e.g.
 - settlement plates
 - cap coring
 - pore water collection
 - Data used in Corrective Measures Study to help determine final remedy options

Location and Schematic of Demonstration Cap



Cap Modeling

- Final cap design thickness of 1.5 feet
 - Primary Consolidation Model predicted
 - 0.6' to 1.6' of cap consolidation
 - rapid initial consolidation
 - Cap was designed to embed itself into the soft sediments and the lower sand layers of cap serve as the foundation for upper clean zones to rest upon
 - cap instability if high loads were placed upon the in-situ sediments
 - Cap constructed in 1.5" lifts
 - under conservative advective flux modeling, sediment and water quality criteria would not be exceeded at the cap surface

Some Standards Applied during Placement

- Construction timing
 - Cap placement done after the basin thawed but prior to significant bird nesting activity
- Collection of surface water during and post placement
 - Ambient Water Quality Criteria imposed upon placement
 - Valuable wildlife could be adversely affected by resuspended contaminants

Surface Water Placement Results

- Twice weekly inside and outside of silt curtains
- No organics detected during placement
- Barium was the only metal detected above AWQC
 - The native sand material was high in barium.

Cap Standards

- Selection of multiple numeric criteria for sediment
 - selected through hierarchy, e.g.
 - Great Lakes ARCS,
 - WA LAET,
 - FL LEL
 - Ontario Ministry of Environment Low levels
 - Biologically Active Zone (4”) was required to meet low screening levels
- Collection of pore water
 - Ambient Water Quality Criteria appropriate to evaluate cap isolation success

Cap Placement

- Cap sand was provided on-site
 - Sand dunes
- Sand was slurried with 70% water from the lake

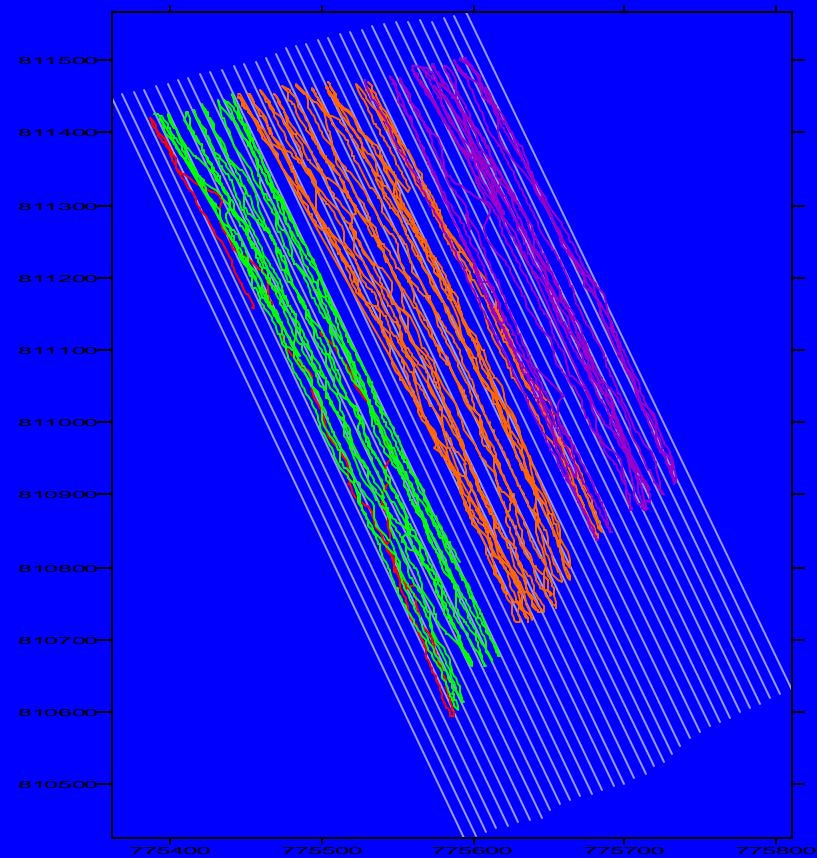
Pumped onto spreader barge for deep water areas or sprayed onto shallower areas with a nozzle



Spraying sand slurry into shallows

Cap Placement

- Spreader barge tracked with GPS - output daily
- Plotted nightly to ensure adequate coverage
- Revisited missed areas over time



Days shown in different colors

Cap monitoring

- Results of only one '3 month' event to date
 - Cap Stability Tested through:
 - bathymetry,
 - settling plates,
 - coring

Cap Monitoring Results

- Bathymetry
 - Some areas of differential settling
- Settling Plates and Coring
 - no areas thinner than designed

Cap Monitoring Results

- Cap Isolation
 - analysis of bulk sediment for contaminants using cores
 - Coring was unsuccessful in gathering pore water
 - » Water drained quickly from sand before sampling
 - Switching to dialysis bag peepers instead
 - No Contaminants detected in bulk sediments from upper 2 feet of cap
 - Lower mixing zones had some detected PAHs

Cap monitoring

- Pore water techniques required modifications
 - Sampling not done yet



Rod with slotted PVC for driving dialysis bag samplers into upper cap.

Summary

- Unique site-specific variables required demonstration project
 - e.g. NAPL blobs
 - project will ground truth model and hopefully allow for more effective final remedy decisions
 - Cap construction appears feasible
- No organic detections and one metal detection in surface water during placement
 - Cap placement would be unlikely to impact wildlife through contaminant releases
- Cap is physically stable despite low strength sediments

Summary

- Results from the 3 month monitoring event show no organic contaminants above screening criteria in the upper 2 feet of cap.
- Cap isolation monitoring will determine if demonstration cap is functioning.
- Long-term integrity is being evaluated.
- On-site sands with capping remedy may allow Soda Lake to continue receiving river water and remain a viable habitat

Conclusion

- The Rockies not only have sediments, but reindeer too.

