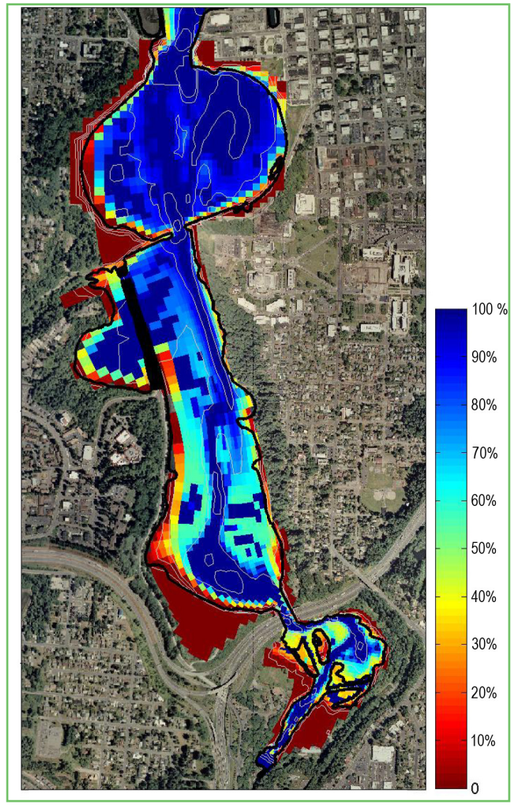
Results
continued

Tidal Inundation

All four restoration alternatives show little to no difference in the amount of submerged or exposed lake bottom. The model predicts that the North Basin, much of the Middle Basin, and the main channel, which would reform quickly after dam removal, would be under water 80% of the time.

The main difference between the pre-dam estuary (pre-1951) and the restored estuary is that the pre-dam estuary was deeper and much of it was inundated more of the time, especially in the South Basin. About 57% of the sediment that has become stored in the lake since 1951 will remain within the three basins, leading to a restored estuary that is somewhat shallower than pre-dam conditions. Modeling also showed that full tidal inundation would be expected throughout the basin, a critical finding for estuary restoration.



Predicted mean annual tidal innundation for Alternative A. [Report Figure 3.18]

Salinity

As noted in the Reference Estuary Study - Fact Sheet #3, salinity would be one the most important biological conditions within a restored estuary. Freshwater from the Deschutes River and salt water from the tides of southern Budd Inlet both play a part in predicting the water circulation and salinities within the restored estuary. Salinity in southern Puget Sound is as high as 32 parts per thousand (ppt), and estuarine conditions are considered to be present at salinities above 0.5 ppt.

The intensity of the estuarine circulation differs between the pre-dam and the restored estuary but still produces similar vertical and horizontal density gradients. Near-bed salinities (bottom portion of the water column) in the pre-dam estuary were 3 to 5 ppt saltier than in any of the restored estuary alternatives shortly after dam removal. The likely difference is that the pre-dam estuary was deeper and would have allowed a larger volume of marine water into the basin.

The study predicts a gradient of annual mean salinity from 0 ppt at Deschutes Falls to around 20 ppt in the North Basin. A low river flow during the dry season would result in a slightly wider range of salinity (from 0 ppt at the falls to above 25 ppt in the North Basin). The seasonal variation in salinity as a result of varying river discharge may be important to the biological response of the restored estuary.

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CAPITOL LAKE
Adaptive Management Plan

Hydrodynamics and Sediment Transport Modeling Report

Study Background

This Fact Sheet is a summary of major findings from the Deschutes Estuary Feasibility Study. It presents information from the 2nd in a series of technical reports. The report on Hydrodynamics and Sediment Transport Modeling was prepared by the United States Geological Survey (USGS).

The full report can be downloaded from the Washington Department of General Administration website at: www.ga.wa.gov/CLAMP/EstuaryStudy.htm.

Capitol Lake is part of the Washington State Capitol Campus and is located in Olympia and Tumwater, Washington. Sediment accumulation in Capitol Lake since the damming of the Deschutes River in 1951 is now about 1.7 million cubic yards. The sediment has made the lake more shallow which has affected flooding, weed management, and resulted in the loss of some recreational opportunities.

When designing the **D**eschutes **E**stuary **F**easibility **S**tudy **(DEFS)**, one important question was … **What might happen to all the accumulated sediment in the lake - if the Capitol Lake dam was removed?** This technical report describes model predictions of how tidal and storm processes will influence the river, lake and lower Budd Inlet should estuary restoration occur.

North Basin of Capitol Lake, downtown Olympia and Budd Inlet, looking north. Image courtesy of The Olympian

This study also helps describe the future physical conditions of a potential restored Deschutes River estuary. Factors such as salinity, speed of currents, depth of tidal waters, and sediment characteristics (mud vs. sand vs. gravel) all have important effects on what types of habitat for fish, wildlife, and plants might develop. This information is also useful to other researchers as they conduct additional reports as part of the feasibility Study.

The Model

To improve our understanding of the likely future physical environment USGS used a computer model ("Delft3D") to simulate conditions in a restored Deschutes Estuary. To set up the computer model, the current and historical bathymetry (underwater topography) of Capitol Lake and Budd Inlet were used. Other data used to initialize the model included existing lake bottom sediment characteristics, information on Budd Inlet tides, and river flow data from the Deschutes River. The model was then run multiple times to simulate the 1949 pre-dam condition and the different restoration alternatives. Model results were examined to learn what might happen within the first year following restoration when change is most rapid, and then 3, 5, and 10 years later. The model showed an initial period of rapid change in the shape of the bottom, followed by a leveling off. Longer model runs also showed a gradual evolution into "dynamic equilibrium".

Results

The modeling found that after dam removal, tidal and estuarine processes would be immediately restored. Marine water from Budd Inlet would be carried into the lake basins with areas of mud flats, sand flats, and sand channels being exposed during each tide.

Within the first year after dam removal, tidal action, along with the occasional river flood, would redistribute sediment within the lake and southern Budd Inlet. Erosion and deposition of lake bed sediments would be rapid during the first two years. This redistribution is expected to slow between years five and ten as dynamic equilibrium is reached.

By year ten the overall behavior of the estuary is expected to be similar to the pre-dam estuary, with the exception of the South Basin. The South Basin will likely remain very shallow due to the input of Deschutes River sediments.

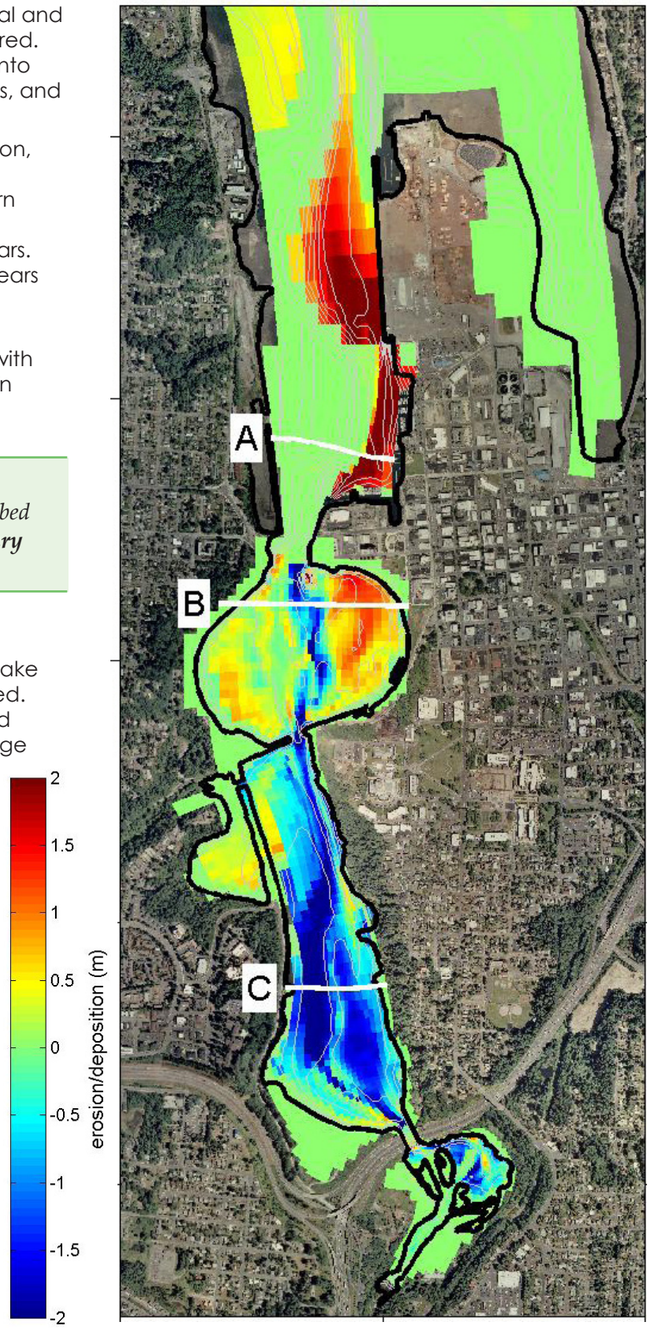
Modeling runs were completed on four estuary restoration Alternatives. Each Alternative is described in the executive summary titled ***"Deschutes Estuary Feasibility Study"*** *(Fact Sheet 2).*

Sediment Transport

Much of the accumulated sediment in Capitol Lake would be mobilized if estuary restoration occurred. It would be both redistributed within the lake and exported into southern Budd Inlet. There is a range of predicted sediment volumes because of uncertainty about the "erodablility" of the lake bed sediments.

Whether the sediments are easily dislodged or are more resistant to erosion results in an estimated range of sediment exported to Budd Inlet between 163,000 and 222,000 cubic yards within the first three years. This represents about 10 to 13% of the sediment that has been deposited in the lake since 1951. The degree of firmness of these lake bed sediments will also alter the shape of the restored estuary.

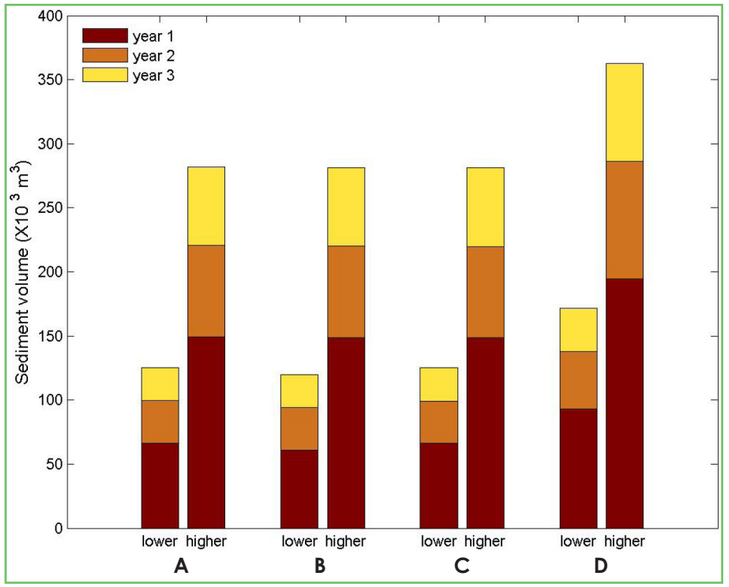
Overall, changes within a restored estuary would occur in two phases. The first phase would be one of rapid change for three to five years after dam removal, regardless of the restoration alternative. A main channel would form down the middle of the estuary within the first year, which would deepen to about 6 feet after three years. Large amounts of sediment would be eroded from the Middle Basin. It would be deposited in the North Basin and in southern Budd Inlet. The Port of Olympia and marinas along Percival Landing would absorb about 80% of those exported sediments.



Predicted areas of erosion (in blue) and deposition (in red), for Alternative A with high erodability in meters (1 meter=3.3 feet). [Report Figure 3.37]

The second phase would be when the restored estuary reaches dynamic equilibrium. Beyond five years after dam removal the rate of change slows, and the net transfer of sediments between basins slows. After that river sediment and possibly previously transported material from the estuary would continue to accumulate in the port and marina region.

The extent of erosion and deposition is similar for all four restoration alternatives. The model predicts that from 98,000 to 291,000 cubic yards of sediment would be exported from the restored estuary during the first year, if the lake is not dredged before the dam is removed.



Predicted sediment volume for the Port and marina region by year and in cubic meters for Alternatives A to D. [Report Figure 4.8]

By year ten for Alternatives A, B, and C the North Basin would accumulate 149,000 cubic yards, with the Port of Olympia and the Percival Landing marinas accumulating 586,000 cubic yards. Sediment accumulation at both locations would be as much as 6.5 feet in depth. Also, 140,000 cubic yards would be dispersed into other parts of southern Budd Inlet. For Alternative D the sediment discharged to the port and marina areas is predicted to be 21% higher, because only the western half of the North Basin would be part of the restored estuary.

Scour

In general, the projected tidal velocities among the four restoration alternatives would be similar. Average velocities within the basins would be low during flood or tidal events and should not affect structures and land use along the shore. However, the restriction points of 5th Avenue, Burlington Northern Santa Fe railroad trestle, and Interstate 5 would need to be reinforced to resist scour during flood or extreme tidal events. At those times, velocities up to 16 feet per second are predicted.

The maximum velocities through the BNSF railroad trestle would decrease by approximately 40% if the trestle was widened (Alternative B). Only a small decrease in maximum velocity is projected if the opening of the Deschutes Parkway bridge at Percival Creek was doubled (Alternative C). Velocities through the entrance to Budd Inlet are not significantly affected when only the western half of North Basin is part of the restored estuary (Alternative D). Fig 4.2

Flooding

The current summer lake elevation is 6.5 feet above Mean Sea Level (MSL) with winter levels a foot lower at 5.5 feet MSL. By comparison the tides within Budd Inlet range from a high tide of 6.8 feet MSL to a low tide of -7.7 feet MSL. The Federal Emergency Management Agency's (FEMA) elevation for a 100-year flood within the current shoreline of Capitol Lake is 11.5 feet MSL. Whereas the FEMA 100-year high tide level in Budd Inlet is 10.6 feet MSL.

In Heritage Park the bulkhead along the Arc of Statehood is below the 100-year flood elevation. Recent landscaping additions to Heritage Park raise the ground elevation behind the bulkhead to 11.5 feet MSL to prevent flooding from the lake into downtown Olympia. In general, tidal elevations within a restored estuary would be below the current elevations in the lake. At Heritage Park saltwater would not be expected to harm existing vegetation behind the bulkhead. In the South Basin, portions of Tumwater Historical Park and some islands would be submerged during spring high tides.

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