CAPITOL LAKE ALTERNATIVES ANALYSIS
DREDGING AND DISPOSAL
ADDENDUM

Prepared for:

General Administration
STATE OF WASHINGTON

Source: City of Olympia

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Executive Summary

Background

Washington State Department of General Administration and the CLAMP Steering Committee are developing an understanding of the different future management alternatives for Capitol Lake. The CLAMP Steering Committee has defined a consistent set of criteria to compare the alternatives. As one piece of this analysis, this report describes the costs, methods, and schedules associated with the dredging elements of the different possible future management alternatives: continued management of the lake as a lake, and restoration of the Deschutes Estuary with or without a separate reflecting pool.

Disposal of Dredged Material

The disposal sites have the most significant impacts to the project cost. Disposal sites also affect construction methods: mechanical dredging is generally most cost-effective for upland disposal or beneficial reuse, while hydraulic dredging is often more cost-effective for offshore disposal. The most cost-effective option for material transported off-site – open-water disposal at Anderson-Ketron Island – is available only for clean material, and may not be available for the Capitol Lake sediments because of the presence of purple loosestrife seeds. Anderson-Ketron Island is particularly sensitive to purple loosestrife because of the near proximity of the Nisqually National Wildlife Refuge. The most expensive option – upland disposal at a landfill site – is certain to be available for all but the most contaminated sediments, which are not believed to be present in Capitol Lake or in Budd Inlet. Intermediate options include the following:

- Open-water disposal at Commencement Bay. This site is more distant than Anderson-Ketron Island but it may accept materials containing purple loosestrife seeds.
- Beneficial reuse for mine reclamation at the Lakeside Industries Central Aggregate Pit and the TransAlta mine, both near Centralia. At either site, it would be necessary to construct a new rail spur for efficient off-loading; this is included in the costs presented here.
- Beneficial reuse for shoreline or nearshore restoration in lower Budd Inlet. While purple loosestrife would be an issue, it could be managed in this relatively urbanized environment. The quantity of dredged material may be greater than lower Budd Inlet projects could accept, so other options would also be needed.
- Beneficial reuse as construction fill. This would only be available for a subset of the dredged material.

It is likely but not certain that one of these intermediate options will be available. Chemical, biological, and physical testing (including the drainage characteristics of the sediment) will be needed to establish the available disposal sites and costs with any certainty.

Another possibility might be to site and permit a new open-water or confined aquatic disposal site in Budd Inlet. There are stringent requirements for siting and permitting a new disposal site, and it is far from possible that a suitable site could be located. Consequently, the costs presented here do not assume that such a site will be available. However, given the need for ongoing dredging by several entities in the vicinity of lower Budd Inlet, a new site would have great value.

Approach to Cost Evaluation

Dredging costs are evaluated based on the most likely dredging quantities, and with the range of possible unit costs considered. All costs shown here are construction costs only, and exclude such costs as engineering, permitting, and construction administration. Future costs are evaluated based on a 50-year project lifetime: costs with and without escalation of construction costs, at 3.5 percent annually, are given. In addition, future costs are given as a net present value (NPV), using the current (2008) U.S. Army Corps of Engineers (USACE) interest rate of 4.875 percent. The NPV takes into account the time value of money. The actual dollar values can vary dramatically over a 50-year project lifetime if construction cost inflation differs from the assumed 3.5 percent.

A typical three-point construction estimate gives a low, medium, and high cost. Because the costs associated with disposal at a landfill are so much higher than other costs, this report additionally includes a worst-case cost.

Lake Alternative

For the Lake Alternative, the following cases are considered:

- Low-cost: Initial and maintenance dredging with a combination of beneficial reuse of the dredged material at a lower Budd Inlet restoration site and an upland reclamation site. The costs given here assume three lower Budd Inlet restoration projects accepting 100,000 cubic yards each will be constructed during the 50-year project lifetime.
- Medium-cost: Initial and maintenance dredging with placement of the dredged material at an upland reclamation site.
- High-cost: Initial and maintenance dredging with placement of the dredged material at an upland reclamation site, except that 5 percent of all material is transported to an upland landfill. Costs for the reclamation site are 25 percent higher than in the medium-cost case.
- Worst-case: All dredged material transported to a landfill site.

These assumptions give the following initial and maintenance dredging costs for the Lake Alternative. All costs shown here are construction costs only, and exclude such costs as engineering, permitting, and construction administration.

Table ES-1. Initial and Maintenance Dredging Costs for the Lake Alternative

Element	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
2008 Dollars (no escalation)				
Initial Dredging	$51.9	$57.9	$102.2	$119.8
Maintenance	$100.2	$112.2	$148.2	$242.2
Total Cost	**$152.2**	**$170.1**	**$250.3**	**$362.0**
Escalation at 3.5% annually with a 2015 start date				
Initial Dredging	$66.1	$73.7	$130.0	$152.5
Maintenance	$402.0	$449.8	$587.1	$970.6
Total Cost	**$468.1**	**$523.4**	**$717.1**	**$1,123.0**
Net Present Value in 2008 with interest rate 4.875%				
Initial Dredging	$47.3	$52.8	$93.1	$109.3
Maintenance	$62.6	$70.1	$93.0	$151.2
NPV of Total Cost	**$109.9**	**$122.9**	**$186.2**	**$260.5**

Note: Numbers may not sum exactly due to rounding

Estuary Alternatives

Two separate Estuary Alternatives have been defined. The Dual Basin Alternative divides the North Basin of Capitol Lake along a north-south line, into a reflecting pool to the east and a free flowing estuary to the west. The Single Basin Alternative would restore the entire lake basin to a free flowing estuary. Costs associated with dredging for the two Estuary Alternatives are similar. In the long-term, Budd Inlet would undergo more sedimentation under the Dual Basin Alternative, because the available sediment storage in the eastern part of the North Basin of Capitol Lake is lost. However, the modeling work carried out by USGS suggests that this will be observed over a scale of decades or more: the difference between the sedimentation rates for the two alternatives is much smaller than the uncertainty in the sedimentation rates.

During initial estuary construction, approximately 394,000 cubic yards will be dredged from the main channels and shoulders of the new tidal channel and placed along Deschutes Parkway on the west shoreline of the lake. This Addendum considers the possibility of moving some material off-site during the initial estuary construction: this will increase the initial costs, but will decrease the quantity of maintenance dredging needed in lower Budd Inlet (marinas and the Port of Olympia's navigation facilities). The results suggest that the costs will be similar in either case. The costs below assume that all of the material dredged in the initial construction will be placed along Deschutes Parkway, with the possible exception of some contaminated materials. However, this should be reviewed with additional modeling prior to final design.

Four cost cases are considered for the Estuary Alternatives:

- Low-cost: Initial estuary dredging and placement along Deschutes Parkway. Maintenance dredging at the marinas with a combination of beneficial reuse at a lower Budd Inlet restoration site and (after 30 years, when purple loosestrife is assumed to be eradicated) to open-water disposal at Anderson-Ketron Island. Maintenance dredging at the Port with open-water disposal at Commencement Bay and then Anderson-Ketron Island.
- Medium-cost: Initial estuary dredging and placement along Deschutes Parkway. Maintenance dredging at the marinas in Budd Inlet and the Port of Olympia facilities with disposal at an upland reclamation site, except that 10 percent of the maintenance dredged material is disposed of at a landfill.
- High-cost: Initial estuary dredging and placement requires 5 percent of the material to be disposed of at a landfill, with the remainder placed along Deschutes Parkway at a cost 25 percent higher than the estimated cost. Maintenance dredging at the marinas in Budd Inlet and the Port of Olympia facilities with disposal at an upland reclamation site, except that between 40 percent of the maintenance dredged material in the first decade dropping to 10 percent in the third decade is disposed of at a landfill. Unit costs to move the maintenance dredged material to the upland restoration site are 25 percent higher than the estimated cost.
- Worst-case: Initial estuary dredging and placement requires 5 percent of the material to be disposed of at a landfill, with the remainder placed along Deschutes Parkway at a cost 25 percent higher than the most likely estimated cost. All maintenance dredged material is moved to a landfill site.

These assumptions give the following initial and maintenance dredging costs for the Estuary Alternatives. These costs do not include effects on marina and port operations. As with the Lake Alternative, the costs assume the most likely sedimentation rate for maintenance dredging – the cost variation results from the unit costs, not from quantities. All costs shown here are construction costs only, and exclude such costs as engineering, permitting, and construction administration.

Table ES-2. Initial and Maintenance Dredging Costs for the Estuary Alternatives

Element	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
2008 Dollars (no escalation)				
Initial Dredging	$10.8	$10.8	$16.4	$16.4
Maintenance	$35.2	$101.7	$119.1	$195.4
Total Cost	**$46.0**	**$112.5**	**$135.5**	**$211.8**
Escalation at 3.5% annually with a 2015 start date				
Initial Dredging	$13.7	$13.7	$20.9	$20.9
Maintenance	$132.7	$369.7	$434.2	$729.3
Total Cost	**$146.4**	**$383.4**	**$455.2**	**$750.2**
Net Present Value in 2008 with interest rate 4.875%				
Initial Dredging	$9.8	$9.8	$15.0	$15.0
Maintenance	$22.6	$66.2	$77.4	$125.5
NPV of Total Cost	**$32.4**	**$76.0**	**$92.4**	**$140.4**

Note: Numbers may not sum exactly due to rounding

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1. Introduction

1.1 Background

Washington State Department of General Administration and the CLAMP Steering Committee are developing an understanding of the different future management alternatives for Capitol Lake (GA 2002). The CLAMP Steering Committee has defined a consistent set of criteria to compare the alternatives.

As one piece of this analysis, this report describes the costs, methods, and schedules associated with the dredging elements of three different possible future management alternatives:

- Dredging for a Managed Lake. This alternative would continue the lake in essentially its current configuration. An initial dredging project would remove nearly one million cubic yards of material from the lake basin; periodic future dredging within the lake would clear out several tens of thousands of annual sediment input from the Deschutes River.
- Dredging for a Single Basin Estuary. This alternative would restore the Deschutes Estuary by removing the Capitol Dam. Among the actions included in the estuary restoration are: a pre-dredge of the lake, to create the anticipated main estuary channel; and placement of the dredged materials to create intertidal habitat along the western shoreline, adjacent to Deschutes Parkway.
- Dredging for a Dual Basin Estuary. This alternative would restore the Deschutes Estuary by removing the Capitol Dam. The difference between the Single Basin and Dual Basin alternatives is that a separate reflecting pool will be constructed in the eastern part of the North Basin. The analysis concluded that the difference between the dredging costs for the Single Basin and Dual Basin Alternatives would be small compared to the overall uncertainties in the costs.

The previous report (Moffatt & Nichol 2008) is here referred to as the *2008 Dredging and Disposal Analysis.*

1.2 Purpose of this Addendum

Washington State Department of General Administration (GA) has requested that M&N revisit three of the assumptions made in the *2008 Dredging and Disposal Analysis*.

1. It was assumed that materials dredged from Capitol Lake could not be placed in Budd Inlet, because of the presence of the noxious weed purple loosestrife in the Lake. Subsequent discussions between General Administration and the Washington State Department of Agriculture (WSDA) have determined that WSDA does not have regulatory authority over purple loosestrife seeds. Within the context of General Administration's ongoing management of purple loosestrife in the Lake, it now appears that the materials dredged from Capitol Lake may be available for beneficial reuse in lower Budd Inlet. This is a possibility for both the Lake Alternative and the Estuary Alternatives.
2. It was assumed that materials dredged from the Port of Olympia's deep draft berth and from the marinas in lower Budd Inlet would not be contaminated by dioxins, furans, or other contaminants. Consequently, it was assumed that open-water disposal of this material would be feasible. This was based on the assumption that existing contaminated sediments in those areas would be removed before any estuary restoration is constructed. This may not, in fact, take place. This assumption affects only the Estuary Alternatives.

3. It was assumed that all material pre-dredged under the Estuary Alternatives will be placed along the western shoreline of Capitol Lake. If some of the material were placed off-site then less material would eventually settle in Lower Budd Inlet. The cost-effectiveness of moving dredged material off-site depends on the cost of doing so versus the cost of later maintenance dredging in lower Budd Inlet. Under the assumptions of the *2008 Dredging and Disposal Analysis*, it was most cost-effective to keep the material within lower Budd Inlet. This may no longer be the case. This affects only the Estuary Alternatives.

This addendum reviews and modifies these assumptions. Based on these modifications, this addendum updates the range of costs for dredging under the Lake Alternative and the Estuary Alternatives.

1.3 Content

Sections 2, 4, and 5 of this addendum investigate the consequences for dredging costs and feasibility of relaxing the assumptions just described.

Sections 3 and 6 update the overall dredging costs – including initial and maintenance dredging – for the Lake Alternatives and Estuary Alternatives respectively.

1.4 Existing Conditions

Figure 1 illustrates the existing condition of the lake, including the current bathymetry. The lake is divided into three main basins by the BNSF Railroad Trestle and the I-5 Bridge, as shown. Deschutes Parkway runs along the west side of the North and Middle Basins; Percival Cove is a freshwater wetland connected to the Middle Basin by a bridge under Deschutes Parkway.

Figure 2 shows the areas of lower Budd Inlet that may be affected by sediment deposition under the Estuary Alternatives. This figure also shows historical industrial uses in the area.

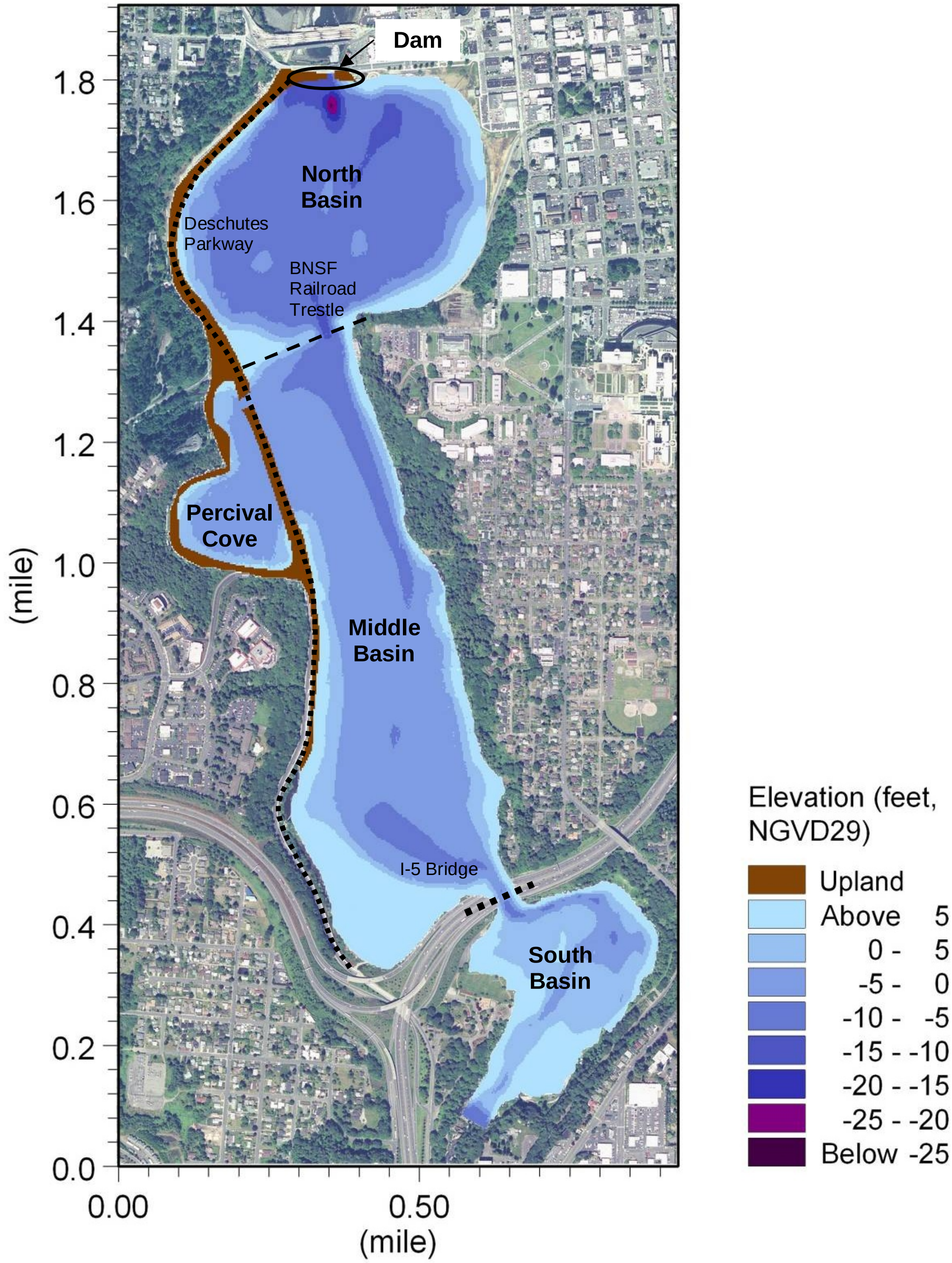

Figure 1. Existing Conditions

Figure 2. Budd Inlet and Capitol Lake

2. Beneficial Reuse of Dredged Sediments

2.1 Background

Beneficial reuse includes a wide variety of opportunities to use dredged material/sediments for a productive purpose. The objective of beneficial reuse is to make the traditional in-water or upland disposal of dredged material unnecessary or reduce the required volume of disposal. Many disposal sites are heavily used and there is increasing pressure to find more productive uses of dredged material including beach/nearshore nourishment, habitat restoration, construction fill, cover for cleanup sites or landfills, etc.

Beneficial reuse has the potential for providing a low-cost solution for the management of dredged material that is environmentally responsible and publicly acceptable by using dredged material as a resource instead of disposing of it as a waste.

This Addendum discusses two additional beneficial reuse options that were not considered in the *2008 Dredging and Disposal Analysis*: placement in lower Budd Inlet for habitat restoration or similar goals, and placement at the TransAlta Mine in Centralia for mine reclamation. The first of these was previously understood to be unacceptable due to the potential presence of purple loosestrife seeds. The second was suggested by the Port of Olympia after the previous analysis was completed.

2.2 Potential for Beneficial Reuse in lower Budd Inlet

The 2008 Dredging and Disposal Analysis assumed that beneficial use of lake sediments in Budd Inlet was not an option because of the potential to spread the noxious weed purple loosestrife. It was then understood that Thurston County Noxious Weed Control Board and the Washington Department of Agriculture had permit authority over the movement of sediments from Capitol Lake. Both entities have since clarified that they both lack legal authority to regulate movement of sediments. Purple loosestrife can be managed in relatively populated areas such as Budd Inlet. Therefore, beneficial reuse of lake sediment is a potential consideration.

Lower Budd Inlet has lost much of its shallow water habitats because of dredging, filling, armoring and sediment impoundment. Identifying potential habitat restoration sites in the West and East Bays that could incorporate clean dredged materials could benefit the ecological processes, structures, functions and aesthetics of lower Budd Inlet.

On February 25, 2009, General Administration (GA) and Thurston Regional Planning Council held a meeting to identify local opportunities for beneficial reuse of dredged material along the shorelines, intertidal areas, and nearshore of lower Budd Inlet (General Administration 2009). The City of Olympia, Port of Olympia, Squaxin Island Tribe, Thurston County, Thurston Conservation District (as the lead entity coordinator for WRIA 13), People for Puget Sound, Washington State Department of Fish and Wildlife (WDFW), and the Washington State Department of Ecology (Ecology) were invited to attend.

A number of potential opportunities to reuse dredged material from Capitol Lake or maintenance dredged material from lower Budd Inlet were discussed at this meeting. These opportunities, which are available for both the Lake Alternative and the Estuary Alternatives, include the following:

- Habitat restoration/enhancement;
- Parks and recreation;
- Cover or capping material for cleanup sites.

The discussion below is based on this meeting together with subsequent conversations and review of information. Specific discussions were with the following:

- The Corps of Engineers (Arden, 2009, personal communication);
- The Squaxin Island Tribe (Steltzner, 2009, personal communication);
- People for Puget Sound (Grosboll, 2009, personal communication);
- The City of Olympia (Hanna, 2009, personal communication).

With two exceptions (see Figure 3), these are examples of potential opportunities rather than plans. Any quantities or dates are estimates and are subject to change and modification. Issues that must be resolved include ownership, geotechnical suitability of the material, and how they would reflect the many interests (commercial, industrial, recreational, environmental, tourism) by government agencies, the Port, tribes, other organizations, and the community in Budd Inlet.

2.2.1 Habitat Restoration and Enhancement

Dredged material from Capitol Lake could be considered for beneficial reuse in shoreline, intertidal, or nearshore aquatic habitat restoration or enhancement. For example, if hard armoring in Budd Inlet were proposed for replacement, Capitol Lake sediments could be utilized as fill to construct softer more gradual shoreline protection and slopes. There would be a risk of purple loosestrife infestation: however, given the localized nature of the placement, this risk could be managed through monitoring.

The Squaxin Island Tribe (Tribe) has recently completed a shoreline survey of Budd Inlet and identified habitat important for salmonid feeding and refuge, forage fish spawning, salmonid stream mouths, etc. Budd Inlet mudflats and shorelines provide important habitat for South Puget Sound juvenile salmon. The Tribe has also started to identify different shoreline segments which could use restoration or protection actions within Budd Inlet. This data is preliminary and is intended as an information database. However, it may provide other organizations with valuable shoreline information on Budd Inlet. Some possible activities include:

- Restore lost sediment to west side beaches through input restoration and enhancement;
- Preserve and enhance riparian vegetation along forage fish spawning beaches;
- Restore sediment delivery to salt marshes;
- Restore creek mouth estuaries for streams and rivers; and
- Protect and restore pocket estuaries.

This Addendum focuses on lower Budd Inlet, south of West Bay Marina and Priest Point Park: however, there are opportunities for shoreline restoration and protection along the remainder of Budd Inlet. The majority of the activities suggested by the Squaxin Island Tribe occur in generally intertidal areas.

Another potential project would restore a previously dredged navigation channel south of West Bay Marina to the surrounding elevations. This had been proposed as a possible receiving site for some of the material to be dredged from the navigation channel and berthing area at the Port of Olympia (Arden 2009, personal communication).

A third potential project would create salt marsh habitat at the north end of the Port peninsula, in the area created as part of the Cascade Pole Cleanup Action under the Model Toxics Control Act (MTCA).

Figure 3 illustrates areas of lower Budd Inlet that have the potential for shoreline or nearshore restoration. Two relatively near-term identified projects are also shown. It is stressed that no specific plans or agreements are in place. For example, the site identified for a possible salt marsh restoration has other potential uses such as an expansion of the Port of Olympia's upland terminal capacity through land reclamation.

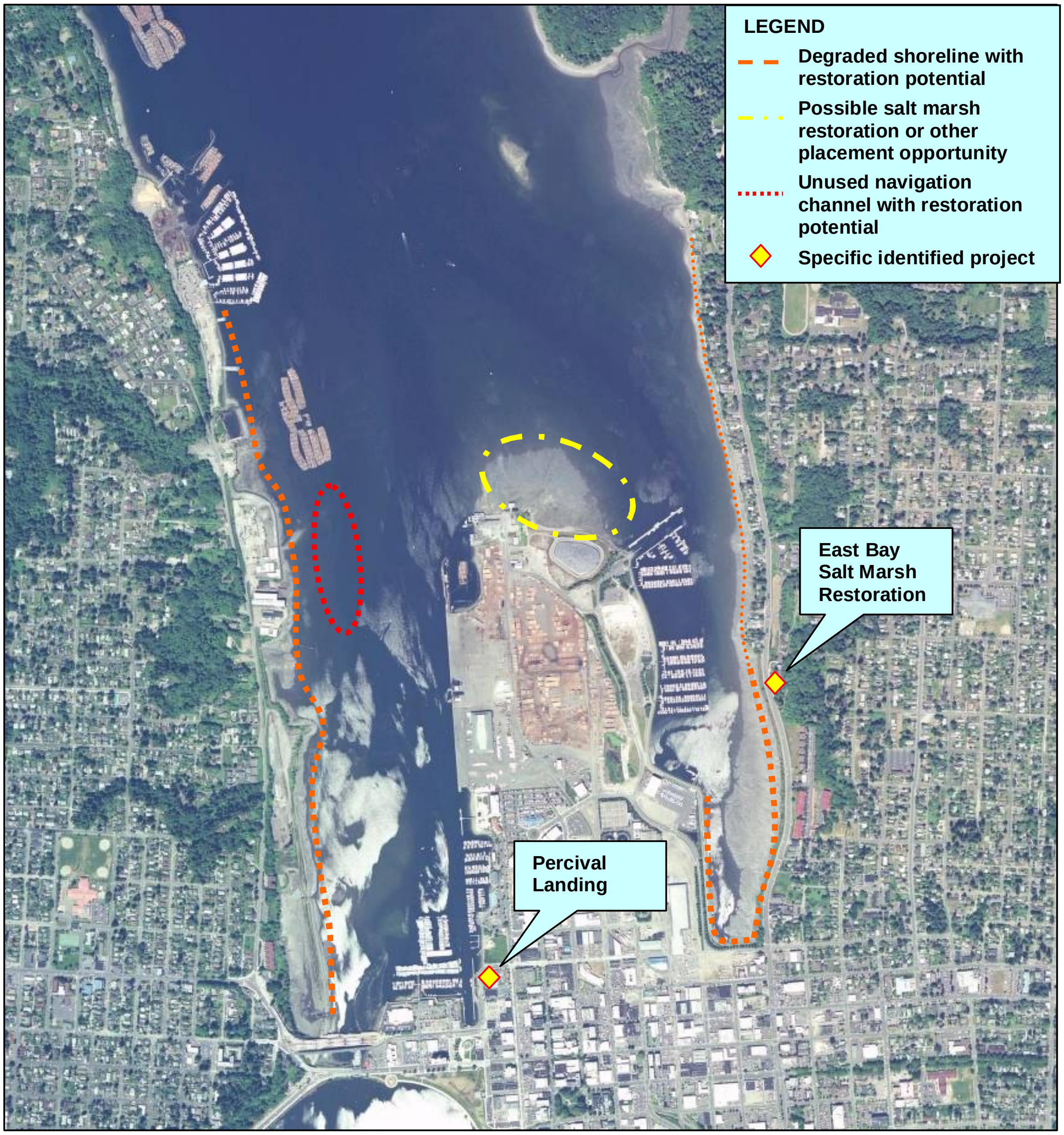

Figure 3. Areas of Lower Budd Inlet with Restoration Potential

Two specific projects are called out in Figure 3.

<u>East Bay Salt Marsh Restoration Project</u>

People for Puget Sound (PPS) has proposed a local shoreline restoration project for Budd Inlet (General Administration 2009). The East Bay Salt Marsh Restoration Project will incorporate beach nourishment (material placement) along a section of East Bay shore to improve shoreline and aquatic habitat. Permitting is anticipated to begin in the fall of 2009. Depending on the final extent of the project, the need for sediment could be less than 10,000 cubic yards. GA and PPS are discussing the possibility of partnering in a pilot project. If successful, similar shoreline and intertidal habitat restoration efforts could be proposed by PPS.

Percival Landing Redevelopment

The City of Olympia is proposing to redevelop Percival Landing. The proposed project includes maintenance dredging, boardwalk redevelopment, and creation of increased intertidal areas and restoration of estuarine marsh. Phase I demolition is scheduled to begin in late 2009. The creation of increased intertidal and estuary areas could potentially require clean fill material.

2.2.2 Ongoing Planning Programs

Two specific programs that may generate additional opportunities for sediment placement in the vicinity of lower Budd Inlet have been identified.

Budd Inlet Restoration Partnership

The Cities of Olympia and Tumwater, Thurston County, the Port of Olympia, and the LOTT Alliance have formed the Budd Inlet Restoration Partnership. One goal of this Partnership is to identify complementary planning and project efforts. Their Phase I Report (Hoffman and Ross 2008) incorporates planning studies and proposed projects for Budd Inlet which could incorporate restoration opportunities. These include some identified projects that could require local material for beneficial reuse.

Shoreline Master Plan Updates in Thurston County

Thurston County and the Cities of Olympia, Tumwater, and Lacey are updating their Shoreline Master Programs (SMPs). SMP updates are mandated by the State of Washington for areas surrounding large water bodies. The SMP updates are due by 2011. The SMPs will reflect updated shoreline regulations and policies and will address restoration and *no net loss of ecological function* along shorelines.

Shoreline restoration or enhancement opportunities may be identified in this process that could support or benefit the use of dredged material from Capitol Lake. As the County and the City of Olympia work through these updates, potential beneficial reuse opportunities could be identified and listed as a possible partnering opportunity for GA.

2.3 Quantities

There are significant uncertainties surrounding the feasibility of using this material in restoration. These include technical questions such as the geotechnical feasibility as well as regulatory, ownership, and other issues. As a result, it is difficult to estimate the quantity of material that could successfully be placed in lower Budd Inlet for habitat restoration and similar purposes. Some initial quantities can be discussed.

- Based on preliminary designs provided by People for Puget Sound, the East Bay Salt Marsh Restoration Project might require as little as 3,000 cubic yards of material. While the use of small sediment quantities for shoreline restoration would not significantly decrease the costs associated with lake management, they would serve as pilot projects for use of Capitol Lake material in addition to the general ecological benefits provided by the restoration.
- The unused portion of the navigation channel south of West Bay Marina might require approximately 100,000 cubic yards of material, based on a length of 1,000 feet, width of

300 feet, and a depth of 8 to 10 feet below the surrounding grade. More could be placed in the channel north of the marina.

- A salt marsh restoration 10 acres in extent at the north end of the Port Peninsula might require approximately 100,000 cubic yards of material, based on an average increase of 6 feet in bottom elevation.

Other projects along the shoreline could accept anything from a few thousand cubic yards to 100,000 cubic yards or more, depending on whether they are isolated pocket projects (such as the East Bay Salt Marsh Restoration Project) or reach-length projects.

2.4 Dredging Methods and Unit Costs

This Addendum assumes that a shoreline or nearshore restoration might accept between 100,000 and 200,000 cubic yards. This relatively large quantity would justify the use of relatively large (16-inch) hydraulic dredges. Smaller projects are certainly worthwhile. However, a small dredging project would not have the potential to greatly decrease the overall cost of lake management.

Hydraulic dredging is an attractive alternative for dredging from the lake. The dredged sediment would be delivered to the shoreline or channel by pipeline from a portable 16-inch hydraulic dredge. With an average production rate dredge of 170 cubic yards per hour, the overall daily production rate will be 1,200 cubic yards based on an 8-hour shift with 7 hours of effective dredging.

The slurry has a water content by volume of about 80 to 85 percent, so the volume of slurry will be in the range of 6,000 to 8,000 cubic yards per day. This slurry is pumped through a pipeline that is routed through the earthen levee under 5th Avenue in a bored casing, and then onto the deposition site by pipeline laid on the bottom or along the shoreline of lower Budd Inlet. Additional booster pumps will be needed to move the material to the final placement site.

If the placement site is intertidal, the sediment must be allowed to settle and dewater before it is finally graded to the desired elevation. The dewatering method used will depend on the material characteristics. If the sediment is relatively coarse-grained and can settle rapidly, it may be adequate to use silt curtains around the discharge area. A more likely possibility would be to construct dikes from native beach sand. The slurry would be pumped into a containment settling area isolated from Budd Inlet by the dikes. A silt curtain would be used to manage any overflow.

If the placement site is subtidal (e.g., restoring the unused navigation channel to its surrounding grade), two small tugs would be used: one to patrol the silt curtain and the other to control the discharge end of the pipeline. An equipment barge would also be needed.

Daily operational costs, based on relatively large projects, are given in Table 1. This table separates out the dredging costs and the costs at the placement site. The placement costs are very similar for the two alternatives. The placement costs for the intertidal restoration alternative do not include sculpting the sediment to the final desired grade – this cost is assumed to be associated with the restoration project, not the dredging project. Total project costs, based on a placement of 100,000 cubic yards, are given in Table 2. With a daily production of 1,200 cubic yards per day, the project would taken 80 to 90 working days to complete.

Consistent with the *2008 Dredging and Disposal Analysis*, this Addendum assumes that the in-water work window work window lasts for seven months from mid-July to mid-February each year. This is based on the assumption that only the Chinook salmon and bull trout windows will be observed, with minor restrictions at other times. A project of 80 to 90 working days would fit comfortably into a 7-month in-water work window.

Table 1. Daily Operations Cost – Dredging to Lower Budd Inlet Restoration Site: Lake Alternative

	Daily Cost per Unit	Units	Total Daily Cost
Dredging Costs			
Hydraulic dredge, 16-inch	$5,200	1	$10,400
Tender tug, 710 hp	$3,500	1	$7,000
Booster pump	$1,600	2	$3,200
Total daily dredging cost			**$20,600**
Costs at Intertidal Placement Site			
Font-end loader to control discharge	$2,000	1	$2,000
Tug to manage silt curtain	$1,500	1	$1,900
Bulldozers to manage settling areas	$2,200	3	$6,600
Total daily intertidal placement cost			**$10,500**
Costs at Subtidal Placement Site			
Tender tug, 710 hp	$3,500	2	$7,000
Equipment barge	$2,000	1	$2,000
Total daily subtidal placement cost			**$9,000**

Table 2. Cost of Hydraulic Dredging to Lower Budd Inlet Restoration Site: Lake Alternative

Item	Unit	Qty	Unit Cost	Extended Cost (millions)
Mobilization/Demobilization	LS	1	$250,000	$0.3
Pipeline, Booster Pumps, and Tunneling	LS	1	$200,000	$0.2
Daily operation costs (Table 1)	DAY	85	$31,100	$2.6
Purple loosestrife mitigation	ALL	1	$500,000	$0.5
Construction Cost				**$3.6**
Contingency (30%)				$1.1
WSST (8.5%)				$0.3
Total Cost				**$5.0**

Based on a placement volume of 100,000 cubic yards, this corresponds to an overall cost of $50 per cubic yard. This compares very favorably with other costs identified for dredging from Capitol Lake: the *2008 Dredging and Disposal Analysis* presented costs for initial lake dredging that varied between $74 and $138 per cubic yard.

If the material were dredged from the marinas in lower Budd Inlet, a similar process would be used. Given the need to navigate between the slips, a smaller dredge would likely be used – a single 12-inch dredge is assumed in the costs provided in Section 6.

For material dredged from the Port of Olympia's navigation facilities, mechanical dredging would likely be the most cost-effective. The material could be moved to a subtidal restoration site by bottom-dump scow, and placed directly at the site. For an intertidal restoration site, the material could be placed on a shallow draft barge and moved into the water close to the shoreline or into containment areas using earthmoving equipment.

2.5 Reclamation at the TransAlta Mine Pit

The TransAlta mine pit has the capacity to take up to 50 million cubic yards of dredged material, based on discussions between Moffatt & Nichol staff and representatives of TransAlta. Considerations for material placement at the TransAlta mine pit are similar to those for the Lakeside Industries quarry in Centralia, which was discussed in the *2008 Dredging and Disposal Analysis.* Material to be used for mine reclamation would be mechanically dredged from Capitol Lake, transported onto gondolas, and transported by rail to the placement site. Two differences between the TransAlta mine and the Lakeside Industries quarry have been identified:

- The Lakeside Industries quarry reclamation site only accepts material capable of being reworked by bulldozer. This limits the acceptable water content of the material: the *2008 Dredging and Disposal Analysis* assumes cement-based solidification / stabilization. This is not a requirement for the TransAlta mine pit.
- A rail spur must be constructed for both sites to allow direct unloading of the gondolas. This rail spur would be longer, and therefore more costly, at the TransAlta mine (10,000 feet versus 5,000 feet at Lakeside Industries, at a cost of $2.2 million versus $1.1 million).

Disposal costs are similar for the two sites. The cost differences are relatively minor: approximately 10 percent difference for initial lake dredging, with the TransAlta mine pit being less costly. Table 3 provides a cost breakdown for this case, based on a dredge volume of 875,000 cubic yards.

Table 3. Cost of Mechanical Dredging to TransAlta Mine Site: Lake Alternative

Item	Unit	Qty	Unit Cost	Extended Cost (millions)
Mobilization/Demobilization	LS	1	$1.3M	$1.3
Temporary transfer docks	SF	3,000	$200	$0.6
Rail spur	LS	1	$2.2M	$2.2
Daily operation costs	DAY	550	$46,400	$25.5
Disposal, reclamation site, includes rail haul	CY	875,000	$14	$12.3
Construction Cost				**$41.9**
Contingency (30%)				$12.6
WSST (8.5%)				$3.6
Total Cost				**$58.0**

This corresponds to a unit cost of $66 per yard – which again compares favorably with the units costs for other options considered in the *2008 Dredging and Disposal Analysis*.

3. Lake Alternative: Updated Costs

3.1 Introduction

3.1.1 Initial Dredging

Under the Lake Alternative, a significant initial dredging project will be performed to regain much of the water volume lost over the half-century since construction of the Capitol Dam in 1951. Initial dredging is assumed to take place in the North and Middle Basins (a relatively small amount will be dredged from the South Basin: this is included with the Middle Basin for this discussion). The lake will be dredged to a uniform elevation of -7.2 feet NGVD29, which is the sill elevation of the Capitol Dam. This corresponds to a lake depth of about 13 feet during the summer months, based on the summer lake level of +6.22 feet NGVD29, consistent with the Managed Lake Alternative defined by the CLAMP Technical Work Group (CLAMP Technical Work Group 2007).

Table 4 gives the initial dredge areas and volumes for the Lake Alternative.

Table 4. Dredge Areas and Volumes for the Lake Dredging

Basin	Area (acres)	Volume (cy)
North Basin – dredge to a distance 100-feet from the shoreline	48.8	158,000
Middle Basin – dredge to a distance 100-feet from the shoreline	94.9	717,000
Total Dredge Area and Volume	**143.7**	**875,000**

3.1.2 Maintenance Dredging

The quantity of material deposited in the lake by the Deschutes River has averaged 35,000 cubic yards annually (CLAMP Steering Committee 1999). This is assumed the average quantity for future maintenance dredging.

Part of the maintenance dredging could be accomplished by constructing and maintaining sediment traps. Sediment traps are formed by excavating or dredging a depression in the bottom of a waterway. Sediment-laden runoff encounters the larger cross-sectional area created by the depression, the flow velocity decreases, and the sediment settles into the sediment trap. The *2008 Dredging and Disposal Analysis* showed that, while sediment traps may provide a useful contribution to the maintenance dredging program, they are unlikely to affect the cost of maintenance dredging dramatically. This Addendum therefore does not consider the sediment traps further.

The lake as a whole is assumed to be dredged on a regular basis, every ten years. This is more frequent than historical dredging events (CLAMP Steering Committee 1999): historical dredging has not kept up with sedimentation. The methods for maintenance dredging would be similar to those assumed for initial lake dredging. The material resulting from this overall lake dredging will be largely the finer materials – silty sand to sandy silt with a slight admixture of clay.

The length of time required to dredge the 350,000 cubic yards assumed to settle in the lake in a ten-year period depends on the dredging method. All schedules in the *2008 Dredging and Disposal Analysis* and this Addendum assume a 7-month in-water work window.

- With two 16-inch hydraulic dredges, the overall production rate is 2,400 cubic yards per day. This would allow the material to be dredged in a single, 7-month, in-water work window, assuming 6-day weeks or 10-hour working days are allowed.

- With mechanical dredges to landfill or upland reclamation site, the overall production rate is 1,600 cubic yards per day. This is limited by the ability to load the material onto railcars or gondolas, and cannot be increased by adding more dredges. This would require two in-water work windows to complete the operation.
- If a restoration project in lower Budd Inlet were able to accept approximately 100,000 cubic yards of material, it would be feasible for one in-water work window to be assigned to this beneficial reuse and the second to mechanical dredging of the remainder.

Figure 4 illustrates the assumed sediment accumulation at 35,000 cubic yards per year (brown triangles) and the corresponding accumulated dredging quantities (green squares) under the assumption of mechanical dredging.

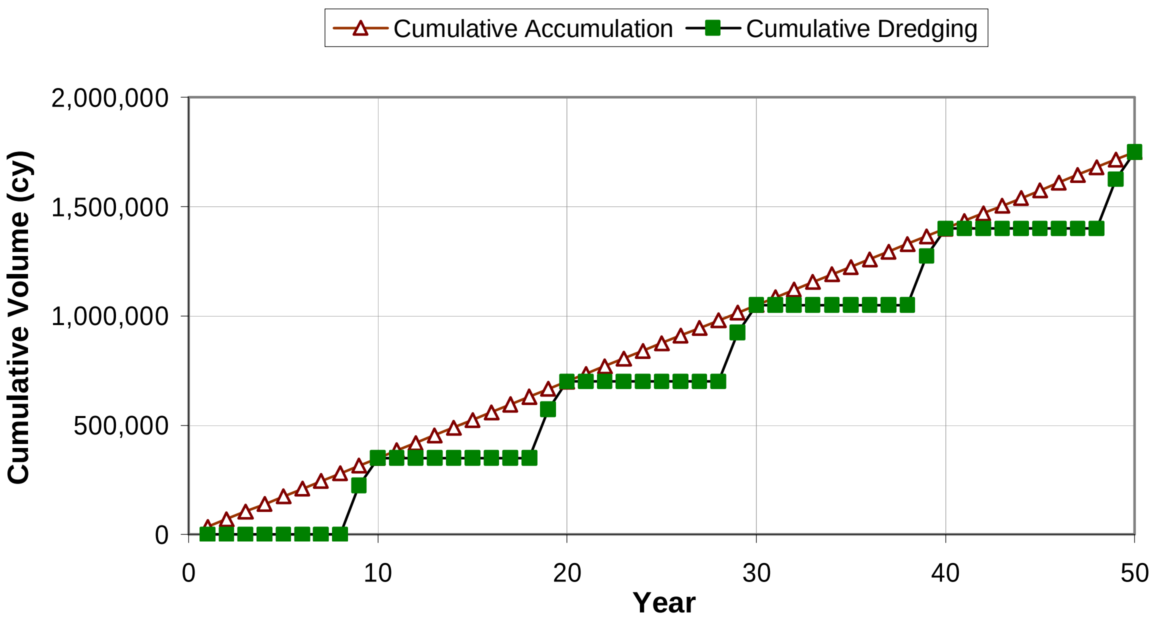

Figure 4. Sediment Accumulation and Maintenance Dredging Quantities for the Lake Alternative

3.2 Fixed and Variable Costs for Lake Dredging

This section summarizes the fixed and variable construction costs for lake dredging, based on the *2008 Dredging and Disposal Analysis* and the additional options discussed in Section 2 of this report. The construction costs are driven by the disposal options, which are closely tied in to the dredging method. Costs include a 30 percent contingency (15 percent for landfill tipping fees) and Washington State Sales Tax at 8.9 percent (valid after April 1, 2009).

All unit costs in this Addendum include only construction costs – engineering, permitting, construction administration, etc., are excluded.

Table 5 breaks down the costs into up to three components:

- One-off fixed costs, such as construction of a new rail spur or mooring dolphins.
- Fixed costs for each operation, such as construction of a temporary dock or pipelines.
- Variable costs that scale with the volume. Variable costs include mobilization / demobilization. The mobilized equipment is in use for one or more full in-water work windows in all cases. Since the equipment will be remobilized at the start of each in-

water work window, the costs of mob / demob are essentially proportional to the length of time the equipment is in use – and so to the volume of dredging.

Table 5. Unit Costs for Lake Dredging

Cost Component	Amount	Comment
Mechanical Dredging to Landfill		
Fixed Cost per Operation	\$831,000	Temporary docks at Deschutes Parkway
Variable Costs	\$136.00 / cy	Includes mob/demob and tipping fees
Mechanical Dredging to Reclamation Site		
One-Off Fixed Cost	\$3,047,000	Rail spur at TransAlta mine
Fixed Cost per Operation	\$831,000	Temporary docks at Deschutes Parkway
Variable Costs	\$61.75 / cy	Includes mob/demob and tipping fees
Hydraulic Dredging to Commencement Bay Open-Water Disposal Site		
One-Off Fixed Cost	\$1,939,000	Mooring piles in lower Budd Inlet
Fixed Cost per Operation	\$4,709,000	Purple loosestrife mitigation (\$3M), pipeline past 5th Avenue Dam, mooring pile rehabilitation
Variable Costs	\$85.50 / cy	Includes mob/demob and DNR disposal fees
Hydraulic Dredging to Anderson / Ketron Island Open-Water Disposal Site		
One-Off Fixed Cost	\$1,939,000	Mooring piles in lower Budd Inlet
Fixed Cost per Operation	\$554,000	Pipeline past 5th Avenue Dam, mooring pile rehabilitation
Variable Costs	\$63.50 / cy	Includes mob/demob and DNR disposal fees
Hydraulic Dredging to Nearshore Restoration Site		
Fixed Cost per Operation	\$970,000	Purple loosestrife mitigation (\$500k), pipeline
Variable Costs	\$40.00 / cy	Includes mob/demob

One potential alternative not included in this table is a possible new disposal site in Budd Inlet. The costs associated with disposal at a new open-water or confined aquatic disposal site are heavily dependent on the location of the new site. However, they are likely to lie between the costs associated with hydraulic dredging to the Anderson-Ketron Island open-water disposal site, and those associated with hydraulic dredging to a nearshore restoration site.

3.3 Low, Medium, High, and Worst-Case Costs

Table 6 describes a 50-year dredging cycle for four cost cases: low-cost, medium-cost, high-cost, and worst-case. The table assumes the lake will be dredged once every ten years. Dredging costs associated with placement in Anderson-Ketron Island are very similar those associated with placement in a reclamation site, so this table only considers the latter. Open-water disposal of material dredged from the lake is not particularly cost-effective because of the need to move the material around the 5th Avenue Dam.

Nearshore restoration is shown as an option only for the low-cost case. It is assumed that three relatively large restoration projects, each capable of receiving 100,000 cubic yards of sediment, are constructed during the 50-year project lifetime.

The medium-cost scenario assumes only placement at the reclamation site.

Table 6. Assumptions and 2008 Costs for Lake Dredging over 50 Years

Project	Low-Cost		Medium-Cost		High-Cost		Worst-Case	
	Assumption	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**
Initial	100,000 cy to nearshore restoration 775,000 cy to reclamation site	$51.9	875,000 cy to reclamation site	$57.9	835,000 cy to Commencement Bay 40,000 to landfill	$102.2	875,000 to landfill	$119.8
Year 10	350,000 to reclamation site	$20.3	350,000 cy to reclamation site	$22.4	330,000 to reclamation site 20,000 to landfill	$32.0	350,000 to landfill	$48.4
Year 20	100,000 cy to nearshore restoration 250,000 cy to reclamation site	$19.7	350,000 cy to reclamation site	$22.4	330,000 to reclamation site 20,000 to landfill	$29.0	350,000 to landfill	$48.4
Year 30	350,000 to reclamation site	$20.3	350,000 cy to reclamation site	$22.4	330,000 to reclamation site 20,000 to landfill	$29.0	350,000 to landfill	$48.4
Year 40	100,000 cy to nearshore restoration reclamation site 250,000 cy to reclamation site	$19.7	350,000 cy to reclamation site	$22.4	330,000 to reclamation site 20,000 to landfill	$29.0	350,000 to landfill	$48.4
Year 50	350,000 to reclamation site	$20.3	350,000 cy to reclamation site	$22.4	330,000 to reclamation site 20,000 to landfill	$29.0	350,000 to landfill	$48.4
Notes	Unit costs for reclamation site 10% lower than in Table 5.		Unit costs for reclamation site as shown in Table 5.		Unit costs for reclamation site 25% higher than in Table 5.		Unlikely case.	

The table considers placement at the Commencement Bay open-water disposal site for the high-cost scenario for the initial dredging, under the assumption that a reclamation site becomes available in the subsequent ten years. Dredging costs associated with placement in Commencement Bay are higher than those associated with a reclamation site. The high-cost case also assumes that approximately 5 percent of material is moved to an upland landfill throughout the project lifetime.

The worst-case – with all material transported to an upland landfill site – is considered very unlikely. It is shown to bracket the possibilities.

3.4 Cost Summary

Table 7 gives a cost timeline for the four cases, in 2008 dollars. As described in the *2008 Dredging and Disposal Analysis*, the use of sediment traps does not significantly affect the overall costs (difference less than 5 percent). Consequently, this Addendum makes the simplification that no sediment traps are used.

Table 7. Cost timelines for the Lake Alternative: 2008 Costs, No Escalation

Year	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
Initial	$51.9	$57.9	$102.2	$119.8
Year 10	$20.3	$22.4	$32.1	$48.4
Year 20	$19.7	$22.4	$29.0	$48.4
Year 30	$20.3	$22.4	$29.0	$48.4
Year 40	$19.7	$22.4	$29.0	$48.4
Year 50	$20.3	$22.4	$29.0	$48.4
Total Cost	**$152.2**	**$170.1**	**$250.3**	**$362.0**

Note: Numbers may not sum exactly due to rounding.

Table 8 gives the cost timelines assuming initial construction in 2015 and escalation of construction costs at 3.5 percent annually. The Net Present Value (NPV) of the total project cost is also given, based on the 2008 Federal interest rate of 4.875 percent.

Table 8. Cost timelines for the Lake Alternative: escalation at 3.5 percent annually, interest rate at 4.875 percent annually

Year	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
Initial	$66.1	$73.7	$130.0	$152.5
Year 10	$36.4	$40.3	$57.6	$86.9
Year 20	$49.9	$56.8	$73.5	$122.6
Year 30	$72.4	$80.1	$103.6	$172.9
Year 40	$99.2	$113.1	$146.2	$244.0
Year 50	$144.1	$159.5	$206.2	$344.1
Total Cost	**$468.1**	**$523.4**	**$717.1**	**$1,123.0**
NPV Cost	**$109.9**	**$122.9**	**$186.2**	**$260.5**

Note: Numbers may not sum exactly due to rounding.

These tables do not show the lowest conceivable costs. First, this report assumes that lower Budd Inlet has a limited capacity to accept dredged material for habitat restoration. It assumes there will be three projects, each 100,000 cubic yards in size, over the next 50 years. It seems unlikely that restoration projects in lower Budd Inlet can usefully accept more than 2.6 million cubic yards that will be dredged from Capitol Lake during the 50-year project lifetime.

To bracket the potential costs: if all material were placed in a nearshore restoration project, the total cost in 2008 dollars would be $110.8 million; the total inflated cost would be $345.8 million; and the net present value would be $79.5 million.

Another possibility that could reduce project costs below the low-cost case shown here would be a new open-water disposal site or confined aquatic disposal site in Budd Inlet, able to accept material potentially contaminated with purple loosestrife. The construction costs associated with placement at such a new disposal site would be similar to those just given for a nearshore restoration project. However, it is far from certain that a new disposal site could be successfully permitted. Consequently, while such a site should be investigated, it cannot be relied upon.

4. Sediment Contamination in Lower Budd Inlet

4.1 Review of Earlier Assumptions

4.1.1 Lower Budd Inlet Cleanup

The *2008 Dredging and Disposal Analysis* assumed the following with respect to existing dredging needs and future maintenance dredging associated with the Estuary Alternatives:

- Existing contaminated sediment in the marina areas and the Port of Olympia West Bay Berth will be dredged prior to estuary restoration.
- “Clean” sediment from the restored estuary will be transported and deposited in the vicinity of the marinas and the West Bay Berth.

The dredging costs were investigated based on a 50-year project lifetime.

4.1.2 Maintenance Dredging in Lower Budd Inlet

The *2008 Dredging and Disposal Analysis* considered four cost cases for the Estuary Alternatives. The following assumptions were made for the maintenance dredging portion:

- Low-cost: All maintenance dredge material is disposed of at the Anderson-Ketron Island open-water disposal site.
- Medium-cost: Almost all of the maintenance dredge material is disposed of at the Anderson-Ketron Island open-water disposal site; 5 percent of the material is disposed of at a landfill in the first maintenance dredging cycle.
- High-cost: The same assumptions were made as for the medium-cost option (dredging efficiency was assumed to be lower).
- Worst-case: In the first two maintenance dredging cycles, all of the material must be transported to a landfill. In the third dredging cycle one-half of the material must be transported to a landfill. Subsequent dredging costs are the same as the high-cost case.

4.2 Discussion of Earlier Assumptions

4.2.1 Issues

The Port of Olympia (the Port) has questioned the assumption that any portion of the maintenance dredging material would be suitable for open-water disposal because of the following:

- It cannot be assumed that the dredging of existing contaminated sediment from the marinas and West Bay Berth will be completed prior to estuary restoration in association with needed maintenance dredging. The Port has proposed dredging of about 460,000 cubic yards from the West Berth Area, the navigational channel and the turning basin. Dredge material characterization results indicate that dioxin is present at concentrations greater than open-water disposal criteria (USACE 2006) in approximately 240,000 cubic yards of the proposed dredge materials. In the absence of an alternative upland use, those materials will need to be disposed at an upland landfill. The Port of Olympia believes that the disposal costs will likely be prohibitive and the dredging will not be completed.
- Maintenance dredging material will not be suitable for open-water disposal at the Anderson-Ketron Island open-water disposal site because of likely mixing with existing

contaminated sediment and the presence of purple loosestrife seeds. The costs for maintenance dredging will therefore also be prohibitive, especially for the marinas.

The Port also noted that the cost scenarios do not include economic impacts related to eventual loss of the marinas and West Bay Berth due to sedimentation if maintenance dredging is not feasible.

4.2.2 Discussion

We concur that costs for existing and future maintenance dredging could prohibit dredging if upland landfill disposal of all the dredged material is required. However, alternatives to landfill disposal for sediments containing dioxin and/or purple loose strife seed could include the following:

- The dioxin concentrations reported for most of the dredge material characterized for the Port of Olympia maintenance dredging are less than Model Toxics Control Act Method B criteria for upland conditions. MTCA Method B Criteria for upland uses is 1,100 ng/kg (parts per trillion). As such, even if materials must be moved to an upland disposal site, this could be for a beneficial reuse such as mine and quarry reclamation.
- If the potential presence of purple loosestrife seeds is sufficient to rule out open-water disposal at Anderson-Ketron Island, open-water disposal may still be possible at Commencement Bay. This conclusion is based on discussions with the DMMP Committee and others reported in the *2008 Dredging and Disposal Analysis*. The presence of purple loosestrife seeds would likely not rule out the use of the sediment for habitat restoration in lower Budd Inlet.
- Almost 50 percent (220,000 out of 460,000 cubic yards) of the dredge material characterized for the Port of Olympia maintenance dredging has dioxin concentrations low enough to meet open-water criteria. Even with mixing between existing contaminated sediment and newer, clean material from the restored Deschutes Estuary, there is no reason to suppose that all of the material will be contaminated. Over time, the fraction of clean material dredged from the marinas and West Bay Berth will likely increase.

4.2.3 Possible New Disposal Site

Another possibility might be to site and permit a new disposal site in Budd Inlet that could accept the material. At a meeting held to discuss future dredging needs (General Administration 2008), the operators of the East Bay marinas and the Port of Olympia discussed the need for a Budd Inlet disposal site that could be used to dispose of their dredged sediments. If a nondispersive disposal site were permitted within Budd Inlet, the clean portions of the maintenance dredged material could be used as cover or capping material.

It is far from certain that this is possible: a new open-water disposal site or confined aquatic disposal site would require siting studies, environmental impact studies, and considerable coordination and negotiations with regulatory agencies. However, the costs of disposal at such a site could be similar to the costs currently assumed for open-water disposal at Anderson-Ketron Island and significantly less than assumed upland landfill disposal costs.

5. Pre-Dredge for Estuary Alternatives

5.1 Background

Under the Estuary Alternatives, Capitol Lake will be dredged before the establishment of tidal flow. Material will be dredged from those areas of the lake due to become the main channel of the restored estuary, and will be placed along Deschutes Parkway to provide intertidal habitat. In addition to the habitat benefits, this will decrease the quantity of maintenance dredging required at the marinas in the south end of Budd Inlet and at the Port of Olympia in the years immediately following reintroduction of tidal flow into Capitol Lake.

The *2008 Dredging and Disposal Analysis* proposed a balanced dredge and placement operation, in which all of the material dredged from the main channel would be placed along the west shoreline of the lake. Modeling performed by the United States Geological Survey (USGS 2008) showed that this would decrease the quantity of maintenance dredging in lower Budd Inlet by more than 50 percent in the first three years.

The *2008 Dredging and Disposal Analysis* noted that, depending on the relative costs of removing material from the lake versus navigation dredging, it might be cost-effective to remove material from the lake during initial construction of the estuary. Based on discussions and new information obtained since that analysis was completed, this now appears more likely. This section analyzes the likely effects on maintenance dredging.

5.2 Proposed Dredge and Placement Alternatives

Figure 5 illustrates the proposed bathymetry after the dredge and placement have occurred together with outlines of the dredge and placement areas. The illustration on the left side shows the proposed bathymetry with balanced cut and placement, in which case there is no net export of material: this was the design provided in the *2008 Dredging and Disposal Analysis*. The illustration on the right side shows the proposed bathymetry with minimal placement within Capitol Lake: only the amount of material required to provide an approximate 1V:12H slope along Deschutes Parkway is placed. The remainder of the material in this case is assumed to be moved off-site.

The most visible difference between the two designs is in the North Basin. Figure 6 gives a close-up view of the proposed North Basin bathymetry along Deschutes Parkway. Sections across the initial and dredged/filled bathymetry are shown in Figure 7, and dredge and placement quantities are shown in Table 9.

Table 9. Dredge and Placement Quantities for Estuary Alternatives

Basin	**Volume (cy)**	
	No Net Export	**Minimal Placement**
North Basin – dredge in channel	42,000	42,000
Middle Basin – dredge in channel and shoulders	352,000	352,000
Total Dredge Volume	**394,000**	**394,000**
North Basin – place along Deschutes Parkway	182,000	69,000
Middle Basin – place along Deschutes Parkway	212,000	107,000
Placed Offsite	None	218,000
Total Placement Volume	**394,000**	**394,000**

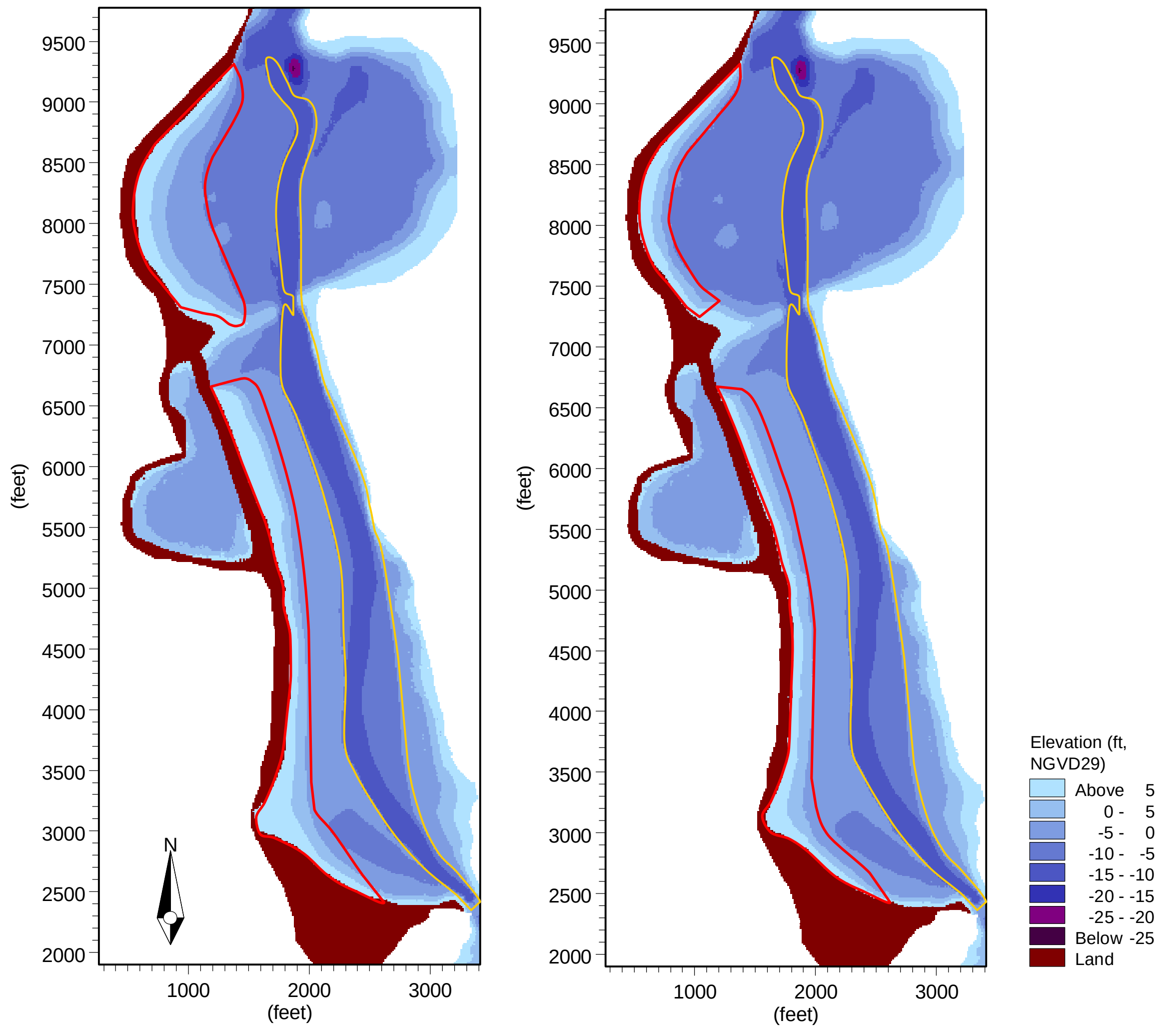

Figure 5. Proposed Dredged Bathymetry with Dredge Footprint (Yellow Line) and Fill Footprint (Red Line): No Net Export (Left Figure) and Minimal Placement (Right Figure)

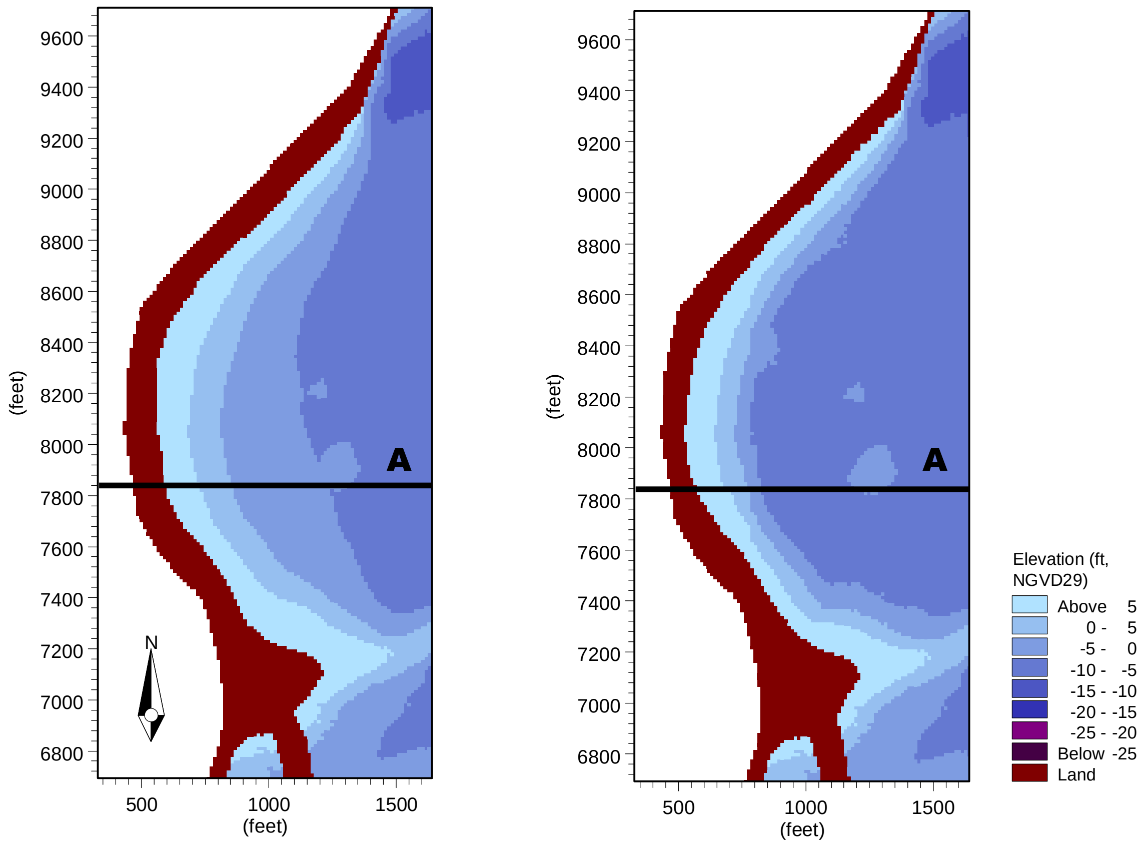

Figure 6. Proposed Bathymetry in the North Basin along Deschutes Parkway: No Net Export (Left Figure) and Minimal Placement (Right Figure)

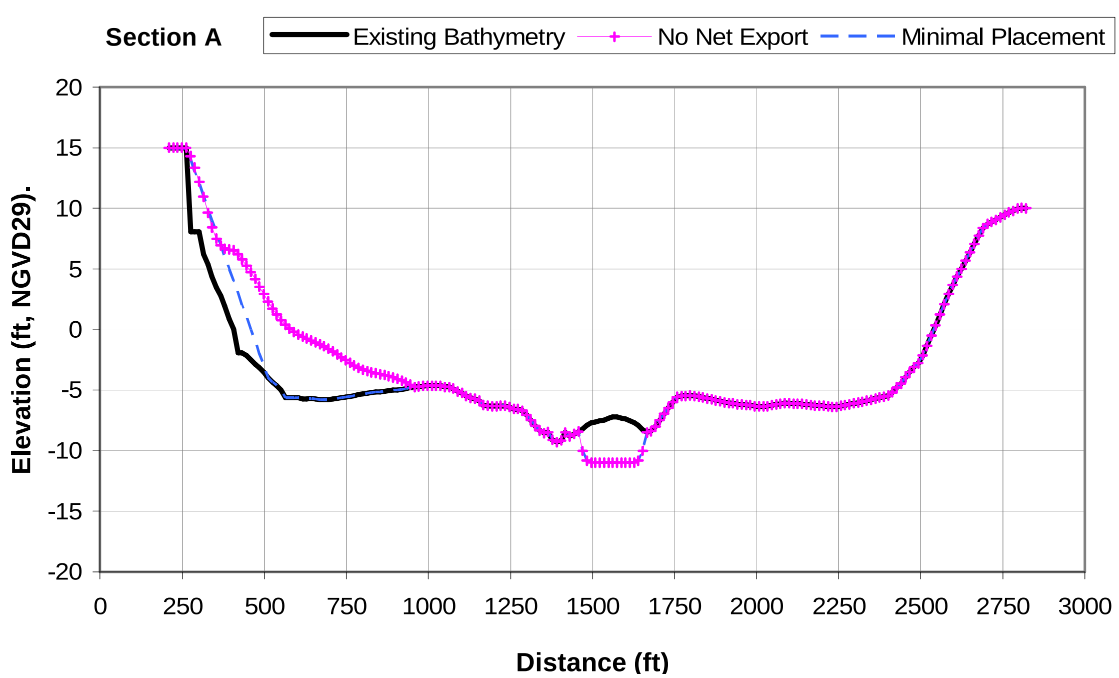

Figure 7. Existing and Proposed Sections

5.3 Estimates of Material Deposition in the Marina and Port Areas

5.3.1 Overview

The purpose of pre-dredging is to decrease the quantity of material that will settle in the marinas in the West Bay of lower Budd Inlet and the deep draft navigation areas of the Port of Olympia. The affected Port facilities include the berth, turning basin, and the southern end of the Federal navigation channel.

USGS (2006 and 2008) has developed a numerical model of hydrodynamics and sediment transport for the restored estuary, including the *No Net Export* pre-dredge and material placement as one case. Model forecasts covered a 10-year time-frame with no pre-dredge, and 3 years with the *No Net Export* pre-dredge. Numerical modeling of the *Minimal Placement* option has not been performed. Since the dredging quantities and costs are required over a 50-year time-frame, it is necessary to extrapolate further from these results.

5.3.2 Sediment Deposition

USGS (2006, 2008) used the DELFT-3D model to predict the quantity of sediment that would be deposited in the marinas and Port facilities under the Estuary Alternatives. The DELFT-3D model calculates sediment transport in terms of mass rather than volume. The modeling by USGS (2006) used a sediment input equivalent to 33,000 cubic yards annually, assuming a bulk density for the sediment of 1,137 kilograms per cubic meter (kg/m^3). This bulk density is appropriate for sediment that has accumulated in the lake over decades, and has consolidated during that time. As such, it is consistent with past measurements of sediment deposition in Capitol Lake, which have used long-term changes in the lake bed bathymetry to estimate sediment deposition. (The sediment deposition is not necessarily the same as the volume of sediment that enters Capitol Lake from upstream sources: some fraction of that sediment must reach Budd Inlet through the tide gates. The fraction of material that passes into Budd Inlet is not known, but based on the limited historical deposition in the deeper areas of West Bay it is unlikely to be large).

Recently deposited sediments, that have not had a chance to consolidate, are less dense. USGS (2008) described field measurements of the bulk density of the lake bed sediments. They found a typical value of 455 kg/m^3, averaged over the upper 30 cm (12 inches) of the bed. The density typically increases with depth: the bulk density at a depth of 25 to 30 cm (10 to 12 inches) below the lake bed averages to about 680 kg/m^3. Sediment deposits a few years old with thickness greater than 50 cm (18 inches) might have a bulk density between 600 and 800 kg/m^3; and that a muddy deposit many years older and with a thickness substantially greater than this would have a higher bulk density, perhaps 800 to 1000 kg/m^3 (Gelfenbaum 2009, personal communication).

The DELFT-3D model does not have the capability to account for sediment consolidation. Therefore, the sediment deposition reported in USGS (2008) assumed completely unconsolidated sediments, with a bulk density of 455 kg/m^3. Given that maintenance dredging in lower Budd Inlet would not be performed every year, the sediment would actually consolidate before being dredged. This Addendum adjusts the dredge volumes to account for this sediment consolidation. Specifically, it assumes that maintenance dredging occurs every 5 years, and that a bulk density of 750 kg/m^3 is appropriate for the dredged material.

For example, USGS (2008) predicted that, under the Estuary Alternatives with no pre-dredging, the long-term sedimentation rate in the marinas and the Port facilities would be 43,000 cubic yards annually. If this material were dredged every year, the dredge volume would be just 43,000 cubic yards. However, if the material is dredged every 5 years, and consolidates to an average bulk density of 750 kg/m^3, the dredge volume would be equivalent to $43{,}000 \times (455 \div 750) =$ 26,100 cubic yards annually. This Addendum adjusts the dredge volumes in lower Budd Inlet in this way. The result of this is that this Addendum uses sedimentation volumes in the marinas and Port facilities that are lower than those given in USGS (2008).

5.3.3 Extrapolation to 50-Year Timeframe

The extrapolation to a 50-year timeframe is based on the length of time it takes the estuary to reach approximate equilibrium after the estuary construction is completed. Estuaries are intrinsically dynamic systems: the concept of a final estuary equilibrium – particularly in the presence of ongoing sea level rise – is questionable at best. Nevertheless, the modeling results do predict that the majority of the morphological changes in the restored estuary will occur in the first few years after restoration. The estuary appears to be approaching a near-equilibrium condition within the first 10 years: the predicted erosion and accumulation in different basins is still changing from year to year, but only slightly.

For the purposes of estimating likely dredging quantities over a 50-year time-frame, this Addendum assumes that full equilibrium is reached 15 years after the estuary is restored. At this stage, for the *No Net Export* case, 100 percent of the sediment load from the Deschutes Estuary – 35,000 cubic yards annually – bypasses the Capitol Lake basins. 70 percent of this load, or 24,500 cubic yards annually, settles in the marinas and the Port facilities. A smooth curve is drawn to connect the sedimentation rates predicted for the first three years with the fixed rate after 15 years. Figure 8 illustrates the extrapolated annual sediment load. The partition between the different basis is typical of that given by the USGS results: 20 percent to each of the Olympia Yacht Club and the Percival Landing marinas, and 60 percent to the Port of Olympia facilities. The sedimentation rates are assumed steady for the remainder of the 50-year project lifetime. Figure 9 illustrates the sediment accumulation for the different basins.

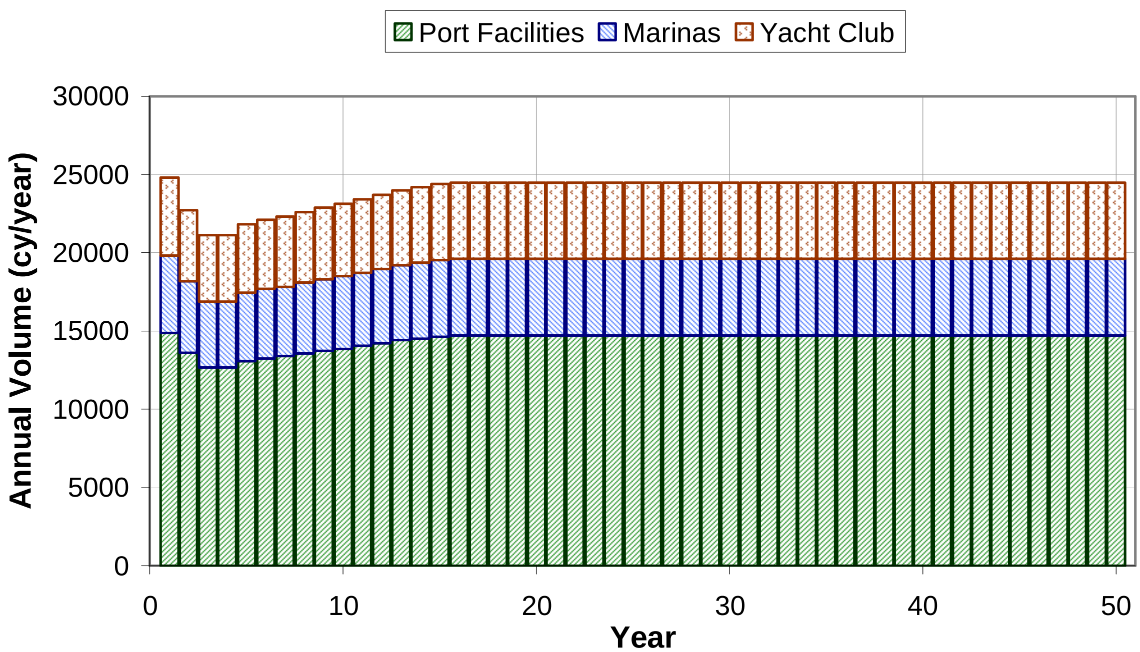

Figure 8. Extrapolated Annual Sedimentation in the Marinas and Port Facilities for the No Net Export Case

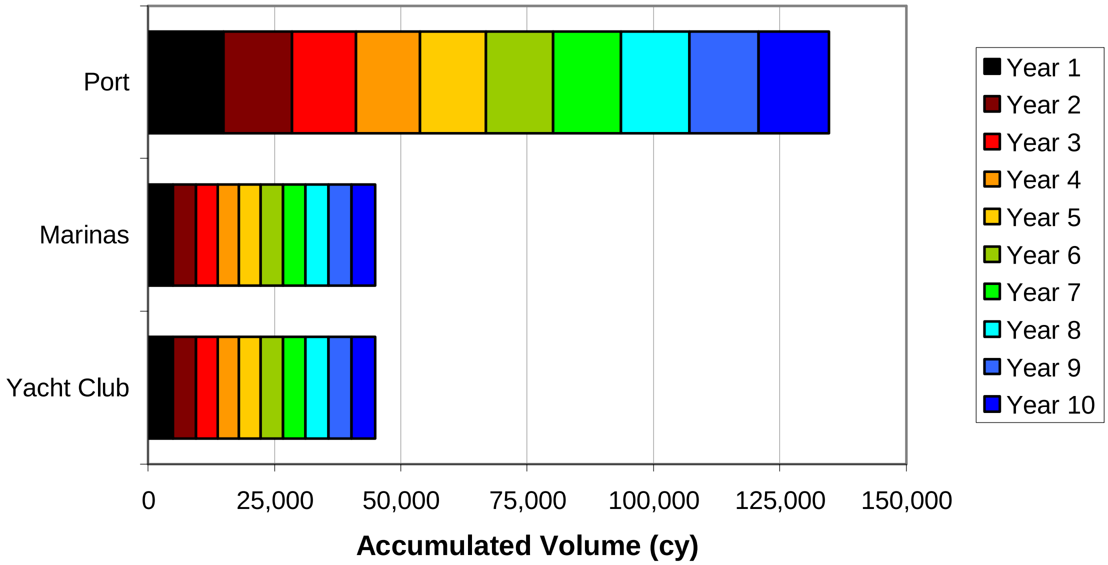

Figure 9. Extrapolated Cumulative Sedimentation in the Marinas and Port Facilities for the No Net Export Case

With the *Minimal Placement* case, the North Basin has a much greater volume available for sediment deposition – similar to the volume available with no pre-dredging (see Figure 7). This Addendum assumes that, after the first year, sediment settles in the North Basin at a rate two-thirds that predicted with no pre-dredging. (The amount of settlement must be less in the first year, since this approach would unrealistically predict that no sediment whatsoever reaches the marinas and Port facilities in the first year). The volumes of sediment accumulation are shown in Figure 10 and Figure 11.

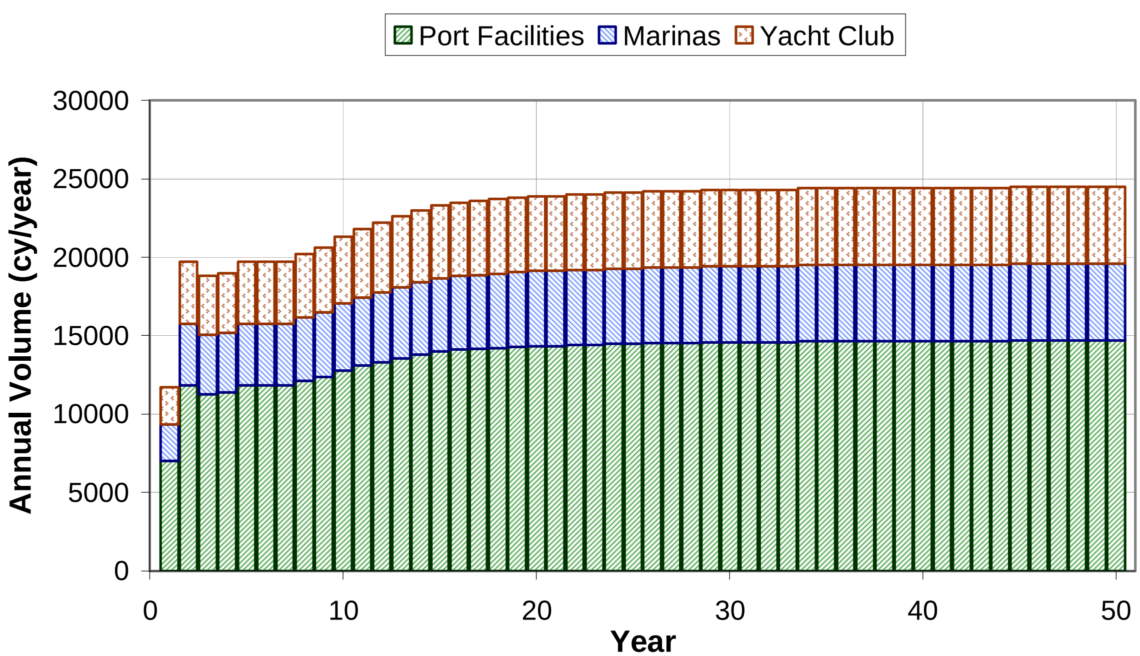

Figure 10. Extrapolated Annual Sedimentation in the Marinas and Port Facilities for the Minimal Placement Case

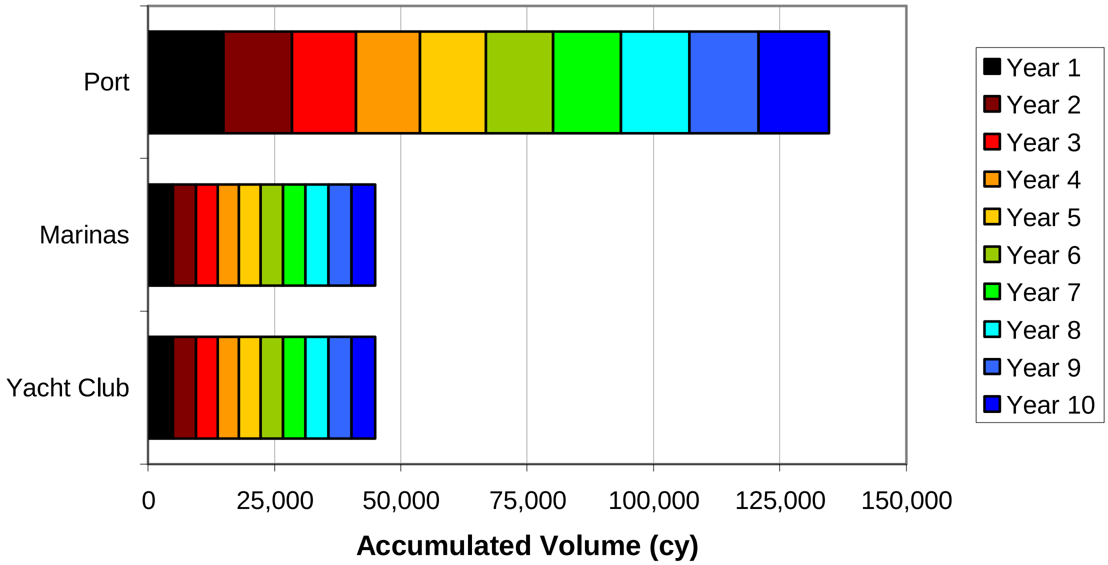

Figure 11. Extrapolated Cumulative Sedimentation in the Marinas and Port Facilities for the Minimal Placement Case

6. Estuary Alternatives: Updated Costs

6.1 Introduction

6.1.1 Initial Estuary Construction

Under the Estuary Alternatives, Capitol Lake will be dredged before the establishment of tidal flow. Material will be dredged from those areas of the lake due to become the main channel of the restored estuary, and will be placed along Deschutes Parkway to provide intertidal habitat. In addition to the habitat benefits, this will decrease the quantity of maintenance dredging required at the marinas in the south end of Budd Inlet and at the Port of Olympia in the years immediately following reintroduction of tidal flow into Capitol Lake.

Initial construction of the estuary will include 394,000 cubic yards of dredging, as described in Table 10. For the *No Net Export* alternative, 394,000 cubic yards will be placed on-site. For the *Minimal Placement* alternative, 176,000 cubic yards will be placed on-site and 218,000 cubic yards will be exported. Alternatives for placement off-site are assumed similar to those for the Lake Alternative.

Table 10. Dredge and Placement Quantities for Estuary Alternatives

Basin	Volume (cy)	
	No Net Export	**Minimal Placement**
North Basin – dredge in channel	42,000	42,000
Middle Basin – dredge in channel and shoulders	352,000	352,000
Total Dredge Volume	**394,000**	**394,000**
North Basin – place along Deschutes Parkway	182,000	69,000
Middle Basin – place along Deschutes Parkway	212,000	107,000
Placed Offsite	None	218,000
Total Placement Volume	**394,000**	**394,000**

6.1.2 Maintenance Dredging

As described by USGS (2006, 2008) and as further discussed in Section 5.3, maintenance dredging for the Estuary Alternatives would be performed in the Olympia Yacht Club, Percival Landing, the marinas along the eastern shoreline of West Bay, and the deep draft navigation channel (maintained to -30 feet MLLW), the turning basin, and the berthing areas at the Port of Olympia.

Figure 12 and Figure 13 illustrate the assumed sediment accumulation (brown triangles) and the corresponding accumulated dredging quantities (green squares) under the assumption of mechanical dredging. The two figures illustrate the sediment accumulation and dredging quantities under the assumption of *No Net Export* and *Minimum Placement* respectively. The results for the *Minimum Placement* case are based on an extrapolation of the USGS modeling results for the *No Net Export* case.

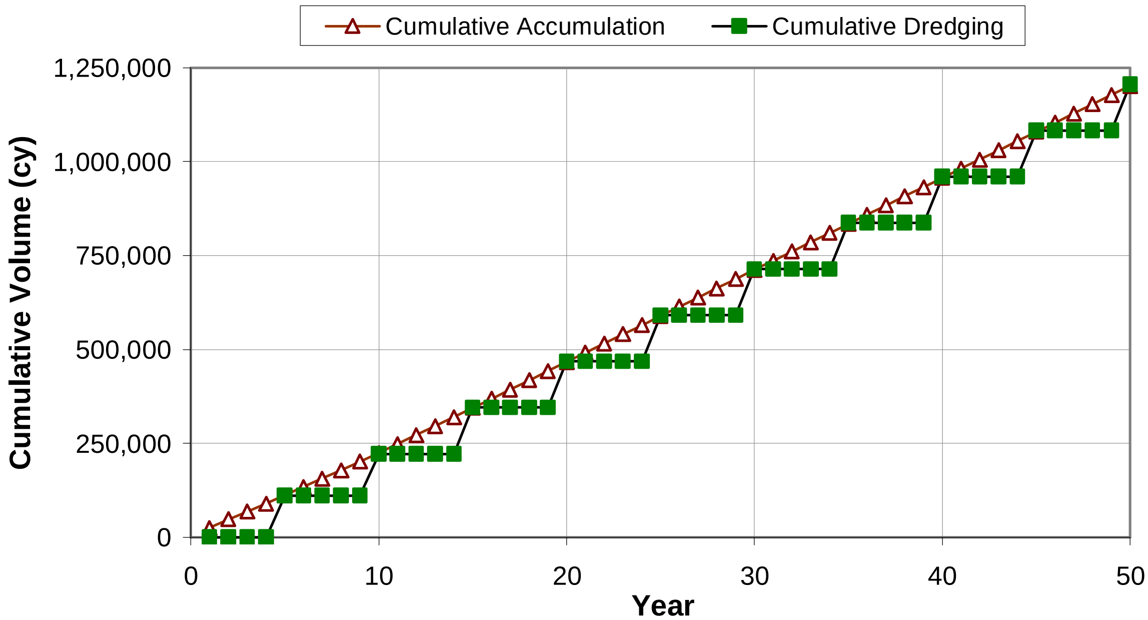

Figure 12. Sediment Accumulation and Maintenance Dredging Quantities for the Estuary Alternatives with No Net Export

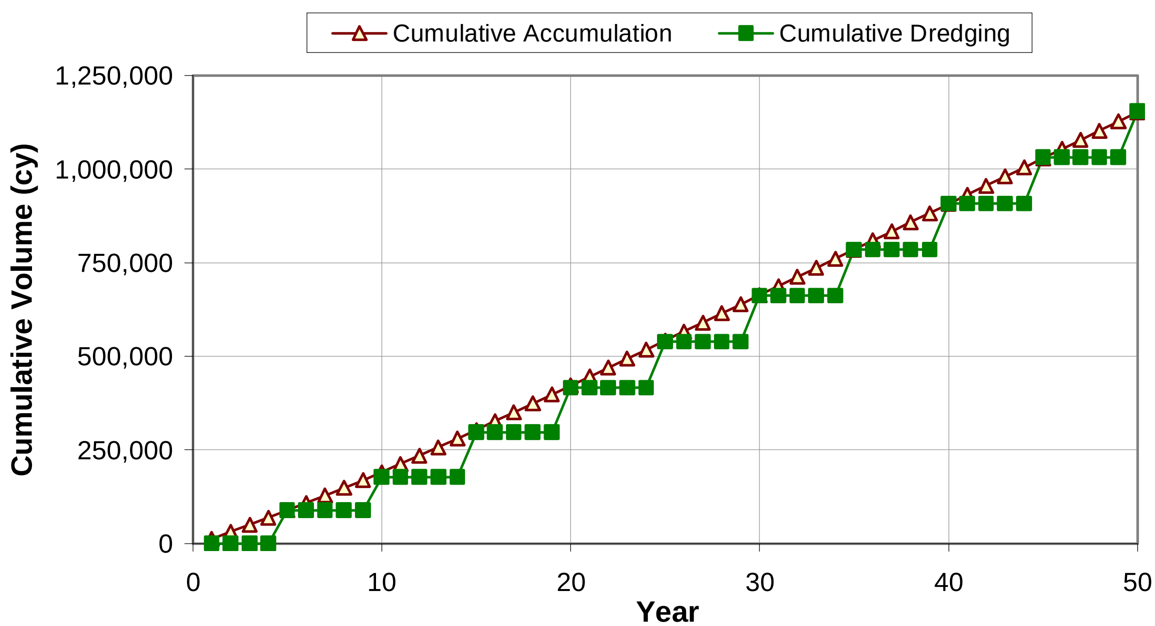

Figure 13. Sediment Accumulation and Maintenance Dredging Quantities for the Estuary Alternatives with Minimal Placement

6.2 Fixed and Variable Costs for Estuary Dredging

Because all pre-dredging for estuary construction will occur before the dam is breached, the methods and costs for the portion of the lake dredging that is moved off-site will be identical to that for initial dredging of the Lake Alternative. Table 11 shows costs for initial dredging. Placement at Anderson-Ketron Island is considered to be ruled out in the near term because of the potential presence of purple loosestrife seeds in the sediment.

All unit costs shown here include only construction costs – engineering, permitting, construction administration, etc., are excluded. Mobilization and demobilization are included with the variable costs.

Table 11. Unit Costs for Initial Estuary Dredging

Cost Component	Amount	Comment
Hydraulic Dredging with Placement along Deschutes Parkway		
Fixed Cost per Operation	$1,615,000	Diking to contain placed sediments, pipelines
Variable Costs	$23.25 / cy	Includes mob/demob
Mechanical Dredging to Landfill		
Fixed Cost per Operation	$831,000	Temporary docks at Deschutes Parkway
Variable Costs	$136.00 / cy	Includes mob/demob, tipping fees
Mechanical Dredging to Reclamation Site		
One-Off Fixed Cost	$3,037,000	Rail spur at TransAlta mine
Fixed Cost per Operation	$831,000	Temporary docks at Deschutes Parkway
Variable Costs	$61.75 / cy	Includes mob/demob, tipping fees
Hydraulic Dredging to Commencement Bay		
One-Off Fixed Cost	$1,939,000	Mooring piles in lower Budd Inlet
Fixed Cost per Operation	$4,709,000	Purple loosestrife mitigation ($3M), pipeline past 5th Avenue Dam, mooring pile rehabilitation
Variable Costs	$85.50 / cy	Includes mob/demob, DNR disposal fees

For the maintenance dredging, costs are similar to those given in the *2008 Dredging and Disposal Analysis*, again with the additional possibilities shown here. With the exception of a one-off cost for a rail spur to the TransAlta mine (or other reclamation site), fixed costs are generally absent for maintenance dredging. Table 12 gives unit costs for maintenance dredging at the Port of Olympia, and Table 13 gives unit costs for maintenance dredging in the marinas.

Table 12. Unit Costs for Maintenance Dredging at the Port

Cost Component	Amount	Comment
Mechanical Dredging to Landfill		
Variable Costs	$142.00 / cy	Includes mob/demob, tipping fees
Mechanical Dredging to Reclamation Site		
One-Off Fixed Cost	$3,047,000	Rail spur at TransAlta mine
Variable Costs	$51.00 / cy	Includes mob/demob, tipping fees
Mechanical Dredging to Commencement Bay		
Variable Costs	$17.75 / cy	Includes mob/demob, DNR disposal fees
Mechanical Dredging to Anderson / Ketron Island		
Variable Costs	$13.75 / cy	Includes mob/demob, DNR disposal fees
Mechanical Dredging to Nearshore Restoration Site		
Variable Costs	$13.25 / cy	Includes mob/demob

Table 13. Unit Costs for Maintenance Dredging at the Marinas

Cost Component	Amount	Comment
Combination Mechanical and Hydraulic Dredging to Landfill		
Fixed Cost per Operation	$623,000	Settling basin for hydraulically dredged portion
Variable Costs	$179.00 / cy	Includes mob/demob, tipping fees
Combination Mechanical and Hydraulic Dredging to Reclamation Site		
One-Off Fixed Cost	$3,056,000	Rail spur at TransAlta mine
Fixed Cost per Operation	$623,000	Settling basin for hydraulically dredged portion
Variable Costs	$99.50 / cy	Includes mob/demob, tipping fees
Combination Mechanical and Hydraulic Dredging to Commencement Bay		
Variable Costs	$70.00 / cy	Includes mob/demob, DNR disposal fees
Combination Mechanical and Hydraulic Dredging to Anderson / Ketron Island		
Variable Costs	$57.00 / cy	Includes mob/demob, DNR disposal fees
Hydraulic Dredging to Nearshore Restoration Site		
Variable Costs	$45.00 / cy	Two 12-inch hydraulic dredges; shoreline restoration at similar cost. Includes mob/demob.

6.3 Low, Medium, High, and Worst-Case Costs

Table 14 and Table 15 respectively provide the information describing a 50-year dredging cycle for the *No Net Export* and the *Minimal Placement* approaches. Each table shows four cost cases: low-cost, medium-cost, high-cost, and worst-case. The *No Net Export* case assumes that, in the initial estuary construction, all material not contaminated is placed along Deschutes Parkway: the Minimal Placement case assumes that 218,000 cubic yards of this material is moved off-site. With this exception, the same assumptions are made in the two tables. Generally similar assumptions are made for the Estuary Alternatives as were made for the Lake Alternative.

The low-cost case assumes that lower Budd Inlet is cleaned up before the restoration of the Deschutes Estuary is constructed – and that open-water disposal is possible for all maintenance dredge material. The Port of Olympia has questioned this assumption. However, it seems reasonable as a best case. The low-cost case also assumes that material from the marinas is used for nearshore restoration, with three large nearshore restoration projects being constructed during the 50-year project lifetime. For the first two dredging cycles, material from the Port of Olympia is placed at the Commencement Bay open-water disposal site. Purple loosestrife is eradicated by year 30, meaning that material (if not chemically contaminated) can be placed at the Anderson-Ketron Island open-water disposal site starting in year 30.

The medium-cost case assumes that the majority of dredged material is moved upland, to a reclamation site. Ten percent of maintenance dredged material through year 20, and 5 percent starting in year 30, must be moved to a landfill site. This does not suggest that only 10 percent or 5 percent of the material meets the standards for open-water disposal. As discussed in Section 4, dioxin contamination at levels detected to date in lower Budd Inlet does not generally rule out upland disposal for reclamation and similar purposes.

The high-cost case is similar to the low-cost case, with higher fractions of dredged material requiring landfill disposal.

The worst-case shown – with all material transported to an upland landfill site – is considered very unlikely. However, it is shown to bracket the range of possibilities.

Table 14. Assumptions and 2008 Costs for Estuary Dredging over 50 Years: No Net Export

Project	Low-Cost		Medium-Cost		High-Cost		Worst-Case	
	Assumption	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**
Initial Estuary	394,000 cy to Deschutes Parkway	$10.8	394,000 cy to Deschutes Parkway	$10.8	374,000 cy to Deschutes Parkway and 20,000 cy to landfill	$16.4	374,000 cy to Deschutes Parkway and 20,000 cy to landfill	$16.4
Years 5 and 10								
Marinas	44,000 cy to nearshore restoration	$2.0 each event	40,000 cy to reclamation site and 4,000 cy to landfill	$6.8 then $5.3	26,000 cy to reclamation site and 18,000 cy to landfill	$6.1 then $4.6	44,000 cy to landfill	$8.5 each event
Port	67,000 cy to Commencement Bay	$1.2 each event	60,000 cy to reclamation site and 7,000 cy to landfill	$5.6 then $4.1	40,000 cy to reclamation site and 27,000 cy to landfill	$7.9 then $6.4	67,000 cy to landfill	$9.5 each event
Years 15 and 20								
Marinas	48,000 cy to nearshore restoration	$2.2 each event	43,000 cy to reclamation site and 5,000 cy to landfill	$5.8 each event	38,000 cy to reclamation site and 10,000 cy to landfill	$6.2 each event	48,000 cy to landfill	$9.2 each event
Port	75,000 cy to Commencement Bay	$1.3 each event	67,500 cy to reclamation site and 7,500 cy to landfill	$4.5 each event	60,000 cy to reclamation site and 15,000 cy to landfill	$6.0 each event	75,000 cy to landfill	$10.7 each event
Years 25 and 30								
Marinas	50,000 cy to Anderson – K. Island	$2.9 each event	47,500 cy to reclamation site and 2,500 cy to landfill	$5.8 each event	45,000 cy to reclamation site and 5,000 cy to landfill	$6.7 each event	50,000 cy to landfill	$9.6 each event
Port	73,000 cy to Anderson – K. Island	$1.0 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$4.1 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$5.0 each event	73,000 cy to landfill	$10.4 each event

Project	Low-Cost		Medium-Cost		High-Cost		Worst-Case	
	Assumption	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**
Years 35 and 40								
Marinas	50,000 cy to nearshore restoration	$2.3 each event	47,500 cy to reclamation site and 2,500 cy to landfill	$5.8 each event	45,000 cy to reclamation site and 5,000 cy to landfill	$6.7 each event	50,000 cy to landfill	$9.6 each event
Port	73,000 cy to Anderson - K. Island	$1.0 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$4.1 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$5.0 each event	73,000 cy to landfill	$10.4 each event
Years 45 and 50								
Marinas	50,000 cy to Anderson – K. Island	$2.9 each event	47,500 cy to reclamation site and 2,500 cy to landfill	$5.8 each event	45,000 cy to reclamation site and 5,000 cy to landfill	$6.7 each event	50,000 cy to landfill	$9.6 each event
Port	73,000 cy to Anderson - K. Island	$1.0 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$4.1 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$5.0 each event	73,000 cy to landfill	$10.4 each event
Notes	Assumes purple loosestrife is eradicated by Year 30.		Unit costs for reclamation site as shown in Table 5. One-time costs in Year 5.		Unit costs for initial dredging and the reclamation site 25% higher than in Table 12 and Table 13. One-time costs in Year 5.		Unlikely case.	

Table 15. Assumptions and 2008 Costs for Estuary Dredging over 50 Years: Minimal Placement

Project	Low-Cost		Medium-Cost		High-Cost		Worst-Case	
	Assumption	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**
Initial Estuary	176,000 cy to Deschutes Parkway and 218,000 cy to reclamation site	$21.7	176,000 cy to Deschutes Parkway and 218,000 cy to reclamation site	$23.0	176,000 cy to Deschutes Parkway and 198,000 cy to reclamation site and 20,000 cy to landfill	$29.0	176,000 cy to Deschutes Parkway and 218,000 cy to landfill	$34.9
Years 5 and 10								
Marinas	36,000 cy to nearshore restoration	$1.6 each event	32,500 cy to reclamation site and 3,500 cy to landfill	$6.0 then $4.5	22,000 cy to reclamation site and 14,000 cy to landfill	$5.6 then $4.1	36,000 cy to landfill	$7.1 each event
Port	53,000 cy to Commencement Bay	$0.9 each event	48,000 cy to reclamation site and 5,000 cy to landfill	$4.7 then $3.2	32,000 cy to reclamation site and 21,000 cy to landfill	$6.5 then $5.0	53,000 cy to landfill	$7.5 each event
Years 15 and 20								
Marinas	46,000 cy to nearshore restoration	$2.1 each event	41,000 cy to reclamation site and 5,000 cy to landfill	$5.6 each event	37,000 cy to reclamation site and 9,000 cy to landfill	$6.1 each event	46,000 cy to landfill	$8.9 each event
Port	73,000 cy to Commencement Bay	$1.3 each event	66,000 cy to reclamation site and 7,000 cy to landfill	$4.4 each event	58,000 cy to reclamation site and 15,000 cy to landfill	$5.8 each event	73,000 cy to landfill	$10.4 each event
Years 25 and 30								
Marinas	50,000 cy to Anderson-K. Island	$2.9 each event	47,500 cy to reclamation site and 2,500 cy to landfill	$5.8 each event	45,000 cy to reclamation site and 5,000 cy to landfill	$6.7 each event	50,000 cy to landfill	$9.6 each event
Port	73,000 cy to Anderson-K. Island	$1.0 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$4.1 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$5.0 each event	73,000 cy to landfill	$10.4 each event

Project	Low-Cost		Medium-Cost		High-Cost		Worst-Case	
	Assumption	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**	**Assumption**	**Cost ($M)**
Years 35 and 40								
Marinas	50,000 cy to nearshore restoration	$2.3 each event	47,500 cy to reclamation site and 2,500 cy to landfill	$5.8 each event	45,000 cy to reclamation site and 5,000 cy to landfill	$6.7 each event	50,000 cy to landfill	$9.6 each event
Port	73,000 cy to Anderson-K. Island	$1.0 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$4.1 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$5.0 each event	73,000 cy to landfill	$10.4 each event
Years 45 and 50								
Marinas	50,000 cy to Anderson-K. Island	$2.9 each event	47,500 cy to reclamation site and 2,500 cy to landfill	$5.8 each event	45,000 cy to reclamation site and 5,000 cy to landfill	$6.7 each event	50,000 cy to landfill	$9.6 each event
Port	73,000 cy to Anderson-K. Island	$1.0 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$4.1 each event	69,000 cy to reclamation site and 4,000 cy to landfill	$5.0 each event	73,000 cy to landfill	$10.4 each event
Notes	Assumes purple loosestrife is eradicated by Year 30. Unit costs for reclamation site 10% lower than in Table 12 and Table 13.		Unit costs for reclamation site as shown in Table 12 and Table 13. One-time costs in Year 5.		Unit costs for reclamation site 25% higher than in Table 12 and Table 13. One-time costs in Year 5.		Unlikely case.	

6.4 Cost Summary

Table 16 (*No Net Export*) and Table 17 (*Minimal Placement*) give cost timelines, in 2008 dollars.

Table 16. Cost timelines for the Estuary Alternatives, No Net Export: 2008 costs, no escalation

Year	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
Initial	$10.8	$10.8	$16.4	$16.4
Years 5 - 10	$6.3	$21.8	$24.9	$36.0
Years 15 - 20	$7.0	$20.6	$24.4	$39.7
Years 25 - 30	$7.7	$19.8	$23.3	$39.9
Years 35 - 40	$6.5	$19.8	$23.3	$39.9
Years 45 - 50	$7.7	$19.8	$23.3	$39.9
Total Cost	**$46.0**	**$112.5**	**$135.5**	**$211.8**

Note: Numbers may not sum exactly due to rounding.

Table 17. Cost timelines for the Estuary Alternatives, Minimal Placement: 2008 costs, no escalation

Year	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
Initial	$21.7	$23.0	$29.0	$34.9
Years 5 - 10	$5.1	$18.3	$21.2	$29.2
Years 15 - 20	$6.7	$19.9	$23.9	$38.4
Years 25 - 30	$7.7	$19.8	$23.3	$39.9
Years 35 - 40	$6.5	$19.8	$23.3	$39.9
Years 45 - 50	$7.7	$19.8	$23.3	$39.9
Total Cost	**$55.5**	**$120.6**	**$143.9**	**$222.2**

Note: Numbers may not sum exactly due to rounding.

Table 18 and Table 19 give the cost timelines assuming initial construction in 2015 and escalation of construction costs at 3.5 percent annually. The NPV of the total project cost is also given, based on the 2008 Federal interest rate of 4.875 percent.

Table 18. Cost timelines for the Estuary Alternatives, No Net Export: escalation at 3.5 percent annually, interest rate at 4.875 percent annually

Year	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
Initial	$13.7	$13.7	$20.9	$20.9
Years 5 - 10	$10.5	$35.6	$40.8	$59.5
Years 15 - 20	$16.3	$48.0	$56.8	$92.6
Years 25 - 30	$25.3	$65.0	$76.5	$131.2
Years 35 - 40	$30.2	$91.7	$107.9	$185.0
Years 45 - 50	$50.4	$129.4	$152.2	$261.0
Total Cost	**$146.4**	**$383.4**	**$455.2**	**$750.2**
NPV Cost	**$32.4**	**$76.0**	**$92.4**	**$140.4**

Note: Numbers may not sum exactly due to rounding.

Table 19. Cost timelines for the Estuary Alternatives, Minimal Placement: escalation at 3.5 percent annually, interest rate at 4.875 percent annually

Year	Low-Cost ($millions)	Medium-Cost ($millions)	High-Cost ($millions)	Worst-Case ($millions)
Initial	$27.6	$29.3	$36.9	$44.4
Years 5 - 10	$8.5	$29.9	$34.7	$48.2
Years 15 - 20	$15.7	$46.4	$55.7	$89.6
Years 25 - 30	$25.3	$65.0	$76.5	$131.2
Years 35 - 40	$30.2	$91.7	$107.9	$185.0
Years 45 - 50	$50.4	$129.4	$152.2	$261.0
Total Cost	**$157.7**	**$391.7**	**$463.8**	**$759.4**
NPV Cost	**$41.2**	**$83.8**	**$100.4**	**$150.7**

Note: Numbers may not sum exactly due to rounding.

As with the Lake Alternative, these tables do not show the lowest conceivable costs. The capacity of lower Budd Inlet to accept dredged material for habitat restoration is assumed to be limited.

To bracket the potential costs for the *No Net Export* case: if all material from the initial estuary dredging and maintenance dredging from the marinas and the Port facilities were placed in a nearshore restoration project, the total cost in 2008 dollars would be $42.1 million; the total inflated cost would be $131.0 million; and the net present value would be $29.9 million. Corresponding costs would be similar for the *No Net* Export case.

Another possibility that could reduce project costs below the low-cost case shown here would be a new open-water disposal site in Budd Inlet, able to accept material potentially contaminated with purple loosestrife. The costs associated with placement at such a new disposal site would be similar to those just given for a nearshore restoration project. However, it is far from certain that a new open-water disposal site could be successfully permitted. Consequently, while such a site should be investigated, it cannot be relied upon.

The costs for the *Minimal Placement* case are similar to, and slightly higher than, the costs for the *No Net Export* case. The *Minimal Placement* case should not be ruled out at this stage, however. The costs shown for this case are based on volumes extrapolated from other results by USGS (2006, 2008): sedimentation volumes have not been specifically modeled. As such, the results for the *Minimal Placement* case are less accurately known than for the *No Net Export* case.

The costs for the Estuary Alternatives are lower than the corresponding cases for the Lake Alternatives. This is partly because some of the potential unit costs for dredging are lower for the Estuary Alternatives. The estuary pre-dredging, with placement alongside Deschutes Parkway, is very cost-effective: so is dredging from the Port facilities with open-water disposal. Because equipment dredging in the Lake is confined by the 5th Avenue Dam, equipment size is limited – which in turn decreases possible production rates and increases costs.

Second, even where unit costs are similar or higher for the Estuary Alternatives – e.g., with placement in a landfill or reclamation site – the absolute quantity of material to be dredged long-term is smaller for the Estuary Alternatives. The modeling by USGS (2006, 2008) shows that, in the long term, approximately 30 percent of material that enters lower Budd Inlet bypasses the marinas and Port facilities and moves north into Budd Inlet.

Third, this Addendum does not consider the non-construction costs associated with maintenance dredging in the marinas and the Port facilities: its scope is limited to construction costs. The inconvenience and disruption experienced by the marina operators, boaters, and the Port during dredging operations should be included in the overall project costs.

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