Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
Slipway Reach Station -2+00 to Station 3+00 (500 LF)	Standard Sediment Cap or Armored Thin Sand Cap	Eastern cap boundary to -22	3:1 to 50:1	2 feet min. sand for standard cap (10 inch min. sand for thin cap); 6 inches filter gravel; 2 feet Type D Rock Armor; additional gravel to fill rock armor voids	1.47*	1.12*	Small rock armor, voids filled with gravel	The slope of the sediment cap and slipway ramp will generally match the existing slope. Rock armor is necessary based on potential scour from tugboat propeller wash during low water; gravel to provide resistance to sand washing through rock armor voids.	Generally flat (flatter than 5:1), mostly surface gravels with some sand immediately in front of slipway ramp. High-energy area.
	Low-Profile Sediment Cap	-22 to 5*	2:1	1 cm RCM, a geotextile cushion, and 3 feet Type E rock armor used in steeper areas; 12 inches Type C Rock Armor used in slipway embayment/rail area			Large rock armor (700 pound max rock size) in steeper areas; Small rock armor (100 pound max rock size) in slipway embayment rail area	Type E rock armor is necessary for scour protection from tugboat propeller wash. The thicker rock armor layer is required for the 2:1 slope and also provides additional weight, which improves the overall slope stability. Smaller Type C rock armor is used in the slipway rail area, where the rock armor will be confined by the rails for the slipway and slopes are flatter. An inspection of the armoring will be completed following each barge launch, and rock armor will be maintained as necessary. Following barge construction operations, Type C rock armor will provide adequate armoring for the wave and propeller wash forces expected in the slipway embayment rail area.	Very steep (2:1 to 1.5:1) outside of rail area, primarily sand and gravel. Silt is present in the rail area.
	Bank Excavation and Armor Replacement Cap on Lower Bank or Repair of Existing Lower Bank Armor	3* to 12	2:1	9 inches filter gravel and 3 feet Type E Rock Armor north of the slipway embayment; Existing engineered rock armor south of the slipway embayment			Large rock armor (700 pound max rock size) with existing medium rock armor south of the slipway embayment	The existing unclassified armor north of the slipway embayment is replaced with Type E Rock Armor, which is necessary based on the maximum vessel generated waves and the 2:1 bank slope.	Very steep slope (varies 2:1 to 1:1), non-classified armor north of the slipway with some bare soil gaps, top elevation of nonclassified armor ranges between 10 and 15 feet.
	Bank Excavation and Armor Replacement Cap on Lower Bank	12 to 15	3:1	6 inches filter gravel, 2 feet Type D Rock Armor north of slipway embayment; TRM with hydroseed and plantings south of the slipway embayment			Medium rock armor (200 pound max. rock size) north of the slipway embayment. Planting of armor is being considered. Shrubs and grasses on a soil slope with TRM obscured by plantings south of the slipway embayment	Type D rock armor has been sized to provide adequate protection for wave forces. Because the river velocities are aligned more directly into the north side of the slipway, rock armor was specified to provide extra protection for debris that may be mobilized in the river during extreme high flow events. Existing armor south of slipway embayment that is above elevation 12 feet (COP) will be replaced with a bioengineering technique that incorporates TRM and heavily planted vegetation. The TRM is necessary to provide protection from river velocities and wave forces during initial establishment and to prevent long-term soil erosion of the cap.	Very steep slope (varies 2:1 to 1:1), non-classified armor north of the slipway with some bare soil gaps, top elevation of non-classified armor ranges between 10 and 15 feet.
	Bank Cut and Soil Cap on Upper Bank	15 to 18	3:1	2 feet min. soil and TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.	TRM is necessary to provide long-term certainty of adequate erosion control to the soil bioengineering techniques proposed for areas below OHW.	Very steep slope (varies 2:1 to 1:1), bare soil and vegetation

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
Slipway Reach Station -2+00 to Station 3+00 (500 LF) ***continued***	Bank Cut and Upper Bank Soil Cap	18 to top of bank	3:1	2 feet min. soil; hydroseed and planting	1.47*	1.12*	Shrubs and grasses on a soil slope.	Soil bioengineering techniques provide adequate stability and erosion control above OHW.	Very steep slope (varies 2:1 to 1:1), bare soil and vegetation
Inner Slipway—South Slope	Repair of Existing Bank Armor	Varies; ramp to top of armor (~15)	2:1	Existing engineered rock armor	NA	NA	Medium rock armor	Geotechnical stability modeling was not deemed necessary by the geotechnical engineer because of the relatively short slope height down to the slipway ramp. The 2:1 slope is expected to be stable. A flatter slope would compromise the barge construction operations at the top of the slope. The size of the existing rock armor was previously engineered and will not be modified.	2:1 to 1.75:1 slope, existing engineered rock armor and vegetated soil slope
	Bank Excavation with Soil Cap	Varies; top of armor (~15) to top of bank	2:1	2 feet min. soil; TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.		1.75:1 vegetated slope
Inner Slipway—North Slope	Repair of Existing Bank Armor	Varies; slipway ramp to building foundation	2:1	6 inches filter gravel; 2 feet Type C and Type D	NA	NA	Small rock armor	Geotechnical stability modeling was not deemed necessary by the geotechnical engineer because of the relatively short slope height down to the slipway ramp. The 2:1 slope is expected to be stable. A flatter slope is not possible because of the presence of the barge construction building at the top of the slope. The rock armor provides bank erosion control and stability, but is not meant to support the building, which is supported by existing piles. The proposed Type C and D rock armor is expected to be sufficient because the existing building piles should help increase stability and shield the rock armor from waves. Class C Rock Armor is the largest size expected to be possible to place by hand under the building and is expected to be sufficient since there should not be any significant wave action at these locations.	2:1 slope, bare soil and nonclassified armor
South Bridge Reach Station 3+00 to Station 7+50 (450 LF)	Standard Sediment Cap	Eastern cap boundary to 5*	5:1	2 foot min. sand (thickness varies); 16 inches of Type B Rock Armor	1.51	1.24	Angular cobbles with gravel	5:1 slope is assumed by the geotechnical engineer to be the maximum slope that can be hydraulically placed in water to allow for spreading of the sand and to avoid cutting and trimming. Variables contributing to the amount of spreading include variations in the grain size distribution, specific gravity of the sand, and river velocities during placement. Type B rock armor is required because of close proximity of main river channel and higher potential for vessel-generated waves.	Very steep nearshore slope (2:1 to 1:1), flattening at depth (5:1 to <25:1), primarily sand and gravel with some silt

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
South Bridge Reach Station 3+00 to Station 7+50 (450 LF) ***continued***	Bank Excavation and Armor Replacement Cap on Lower Bank	3* to 15	2:1	Filter fabric or 9 inches filter gravel, 3 feet Type E Rock Armor	1.51	1.24	Large rock armor	The 2:1 cut slope provides a stable slope configuration as determined by stability modeling by the geotechnical engineer. Discontinuous existing unclassified armor is replaced with Type E rock armor, which is required based on vessel-generated waves.	Very steep slope (generally 2:1 to 1:1), nonclassified armor with some bare soil gaps, top elevation of nonclassified armor ranges from 10 to 20 feet COP
	Bank Excavation and Soil Cap on Upper Bank	15 to top of bank	2:1	2 feet min. soil; TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.	The 2:1 cut slope provides a stable slope configuration as determined by stability modeling by the geotechnical engineer. TRM is necessary to provide long-term erosion control certainty for the required soil cap.	Very steep slope (generally 2:1 to 1:1); vegetation, nonclassified armor, and some bare soil gaps; top elevation of nonclassified armor ranges from 10 to 20 feet COP
North Bridge Reach Station 7+50 to Station 11+50 (400 LF)	Standard Sediment Cap	Eastern cap boundary to 5*	5:1	2 foot min. sand (thickness varies); 16 inches of Type B Rock Armor	1.51	1.20	Angular cobbles with gravel	5:1 slope is assumed by the geotechnical engineer to be the maximum slope that can be hydraulically placed in water to allow for spreading of the sand and to avoid cutting and trimming. Variables contributing to the amount of spreading include variations in the grain size distribution, specific gravity of the sand, and river velocities during placement. Type B rock armor is required because of close proximity of main river channel and higher potential for vessel-generated waves.	Steep nearshore slope (5:1 to 2:1), flattening at depth (5:1 to flatter than 25:1); primarily silt and sand with some gravel, transitional energy area
	Repair of Existing Bank Armor on Lower Bank	3* to 15	2:1 to 1:1	Existing armor			Large rock armor	Existing unclassified armor slope is consistent with ROD remedy and provides a stable slope configuration if the bank above an elevation of 15 feet is cut at a 2H:1V as determined by stability modeling by the geotechnical engineer. The armor will be repaired as necessary.	Very steep slope (generally 2:1 to 1:1), nonclassified armor with some bare soil gaps, top elevation of nonclassified armor ranges from 13 to 28 feet COP
	Bank Excavation and Soil Cap on Upper Bank	15 to top of bank	2:1	2 feet min. soil; TRM with hydroseed and planting			Shrubs and grasses on a soil slope. The TRM is obscured by the plantings.	The 2:1 cut slope provides a stable slope configuration as determined by stability modeling by the geotechnical engineer. Any existing armor will be replaced with bioengineering techniques that incorporate TRM. TRM is necessary to provide long-term certainty of adequate erosion control to the soil bioengineering techniques proposed.	Very steep slope (generally 2:1 to 1:1); vegetation, nonclassified armor, and some bare soil gaps; top elevation of nonclassified armor ranges from 13 to 28 feet COP

Table 3-1
Sediment and Bank Cap Design Summary
Zidell Waterfront Property
Portland, Oregon

	Final Conditions								
Reach and Stationing	**Description of Cap Component (from east to west)**	**Elevation Range (feet COP)**	**Final Slope**	**Cap Layers and Thickness**	**Stability FOS**	**Seismic FOS**	**Final Surface Appearance**	**Factors Determining Slope and Armoring Requirements**	**Existing Conditions**
Downstream Reach Station 11+50 to Station 28+59 (1709 LF)	Standard Sediment Cap	eastern cap boundary to 10	5:1	2 foot min. sand (thickness varies); 12 inches of Type A Rock Armor	1.61	1.14	Round river rock (cobbles and gravel)	5:1 slope is assumed by the geotechnical engineer to be the maximum slope that can be hydraulically placed in water to allow for spreading of the sand and to avoid cutting and trimming. Variables contributing to the amount of spreading include variations in the grain size distribution, specific gravity of the sand, and river velocities during placement. The geotechnical engineer's analysis indicates that Class C rock armor would be required for the resistance to waves on the bank down to an elevation of -1 foot, and Type B rock armor would be required for resistance to propeller wash from -1 down to an elevation of -5 feet. However, the armor size was reduced to Class A because the thickness of the cap is generally much more than 2 feet (which allows for some erosion), because the area is generally depositional in nature, and because of the low likelihood of pleasure craft operating over the wetland planting area.	Generally flat shallow area near shore (25:1 to 5:1); mostly silt with some sand; low-energy area
	Fill and Cap	10 to 18	3:1	2 foot min. soil (thickness varies); 12 inches of Type A Rock Armor			Dense vegetation consisting of grass, shrubs, and trees that obscure the view of round river rock (cobbles and gravels)	3:1 slope is used for the fill placed above water, based on a stable slope configuration as determined by stability modeling by the geotechnical engineer. The geotechnical engineer 's analysis indicates that Type C rock armoring is required because of wave forces, but the armoring size was reduced to Type A since the maximum wave forces will be very infrequent, the thickness of the cap is generally much more than 2 feet (which allows for some erosion), and because the area is generally depositional in nature.	Generally steep slope (3:1 to 1:1); vegetation, non-classified armor, and some bare soil gaps; top elevation of non-classified armor ranges from 10 to 20 feet COP
	Fill and Cap	18 to top of bank	3:1	2 foot min. soil (thickness varies); hydroseed and planting			Shrubs and grasses on a soil slope.	3:1 slope is used for the fill placed above water based on a stable slope configuration as determined by stability modeling by the geotechnical engineer. No rock is placed above 18 feet (OHW), as vegetation alone will provide adequate stability and erosion control.	Generally steep slope (3:1 to 1:1); vegetation, nonclassified armor, and some bare soil gaps; top elevation of nonclassified armor ranges from 10 to 20 feet COP

cm = centimeter.
COP = City of Portland Datum.
FOS = minimum calculated factor of safety for reach, as determined by geotechnical stability analysis for worst-case cross section within the reach (GeoDesign, 2009).
LF = linear feet.
min = minimum.
OHW = ordinary high water.
RCM = reactive core mat.
TRM = turf reinforced mat.
xx:1 = slope in feet horizontal to feet vertical.
*The sediment cap overlaps the bank cap in these areas. Bank armor generally extends down to elevation 3 feet, and the sediment cap extends up to elevation 5 feet.

Table 3-2
Rock Armor Descriptions
Zidell Waterfront Site
Portland, Oregon

Rock Armor Type	Description	Maximum Diameter of Rock (inches)	Mean Diameter	Gradation
Type A Rock Armor	6" Minus Rounded to Subrounded	6	3	Well Graded
Type B Rock Armor	8" Minus Angular to Subangular	8	4	Well Graded

Rock Armor Type	Description	Approximate Maximum Diameter of Rock (inches)	Maximum Weight of Rock (Pounds)	Gradation—Percent by Weight			
				20%	30%	40%	10%
Type C Rock Armor	ODOT Class 100 Riprap	10	100	100-60	60-25	25-2	2-0
Type D Rock Armor	ODOT Class 200 Riprap	15?	200	200-140	140-80	80-8	8-0
Type E Rock Armor	ODOT Class 700 Riprap	24?	700	700-500	500-200	200-20	20-0

Table 3-3
Material Quantities Summary
Zidell Waterfront Property
Portland, Oregon

Material	Location				
	Slipway Reach	South Bridge Reach	North Bridge Reach	Downstream Reach	Upland Greenway (Phase II)
Volume Calculations (Cubic Yards)					
Hotspot Backfill[a]	30	50	80	700	12,000
General Fill (Soil Cap and Bank Fill)	900	1,200	1,400	60,400	13,200
Clean Sand (for standard sand cap	4,200	28,800	10,600	17,000	- -
Type A Rock Armor (New)	- -	- -	- -	8,100	- -
Type B Rock Armor (New)	- -	4,200	3,500	- -	- -
Type C Rock Armor (New)	300	- -	- -	- -	- -
Type D Rock Armor (New)	8,300	- -	- -	- -	- -
Type E Rock Armor (New)	2,600	1,600	- -	- -	- -
Type C or D Rock Armor (Repair)	300	- -	100	- -	- -
Area Measurements (Square Feet)[b]					
Hotspot Backfill	2,000	4,400	6,900	0	112,000
General Fill (Soil Cap and Bank Fill)	10,800	16,100	15,100	197,500	173,800
Sediment Cap (Total)	69,200	82,200	67,400	209,600	- -
Clean Sand (for standard sand cap)	34,100	83,600	70,600	98,700	- -
Thin Cap (Armored and Standard)	23,400	- -	- -	50,100	- -
Type A Rock Armor (New)	- -	- -	- -	221,400	- -
Type B Rock Armor (New)	- -	84,900	71,900	- -	- -
Type C Rock Armor (New)	8,400	- -	- -	- -	- -
Type D Rock Armor (New)	87,400	- -	- -	- -	- -
Type E Rock Armor (New)	18,500	8,300	- -	- -	- -
Type C or D Rock Armor (Repair)	15,700	- -	5,000	- -	- -
Reactive Core Mat	18,500	- -	- -	- -	- -

NOTES:

- - not applicable.

[a]Hot spot backfill does not represent total hot spot disposal volume, only that portion requiring backfill.

[b]Area measurements were obtained from plan view dimensions.

Table 4-1
Maximum Daily Willamette River Stage
ZRZ Realty Company
Portland, Oregon

River Stage	Approximate Number of Days Exceeding River Stage	Approximate Number of Events Exceeding River Stage	Approximate Number of Water Years Exceeding River Stage
12 feet	2,064	182	32
15 feet	662	84	23
18 feet	174	32	11
20 feet	78	13	8
25 feet	6	1	1
30 feet	2	1	1
Total on Record	**12,236**	**NA**	**37**

Daily maximum Willamette River stage values obtained from the U.S. Army Corps of Engineers Morrison Bridge gauge (USGS ID: 14211720) database and converted to the City of Portland elevation datum.
http://www.nwd-wc.usace.army.mil/perl/dataquery.pl?k=id:prto

The dataset included river stages well above the February 1996 flood elevations. The U.S. Army Corps lists the February 1996 flood elevations as the highest river stage on record; therefore, all river stage elevations above the 1996 flood were considered suspect and excluded from analysis.

An event was defined as a continuous number of days during which a particular river stage was exceeded.

Table 4-2
Preliminary Construction Schedule
Zidell Waterfront Property
Portland, Oregon

Item	Schedule
Final Design, Permitting, and Preconstruction	August 2009 through early 2011
Site Preparation and Erosion Control	Early 2011 for work below OHW; July 1, 2011 for work below OHW
Construction above OHW	Early 2011 through late 2011
Construction below OHW	July 1, 2011 through October 31, 2011
Planting	Late spring 2011 through fall 2011

NOTE:
OHW = ordinary high water.