MAUL FOSTER ALONGI
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December 6, 2017
Project No. 8014.01.60

Madi Novak
Oregon Department of Environmental Quality
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232

Re: Annual Site Activity Summary Report—2016
Zidell Waterfront Property, 3121 SW Moody Avenue, Portland, OR
ECSI No. 689

Dear Ms. Novak:

On behalf of ZRZ Realty Company, Zidell Marine Corporation, and Tube Forgings of America, Inc. (collectively referred to in this document as Zidell), Maul Foster & Alongi, Inc. (MFA) has completed an assessment of the overall condition of the Zidell Waterfront Property referenced above. The assessment included a compilation of information, contained in multiple inspection reports, provided by various inspection parties. The reporting period for this submittal is the 2016 calendar year.

SITE CONSTRUCTION

Construction on the site in 2016 is detailed in the Upland Cap Construction Completion Report[1] and consisted of the following:

- Asphalt and gravel caps were placed over remaining uncapped areas south of the Ross Island Bridge (in the Zidell operational area and inside the barge building).
- Zidell completed the cap located in the former TriMet staging area, in the northwest corner of the upland cap, with an additional one foot of gravel.
- Upland remedial construction is now complete.

INSPECTIONS AND MONITORING

Site inspections and monitoring were completed in 2016 to record conditions of the bank, sediment, and upland caps, and to comply with regulatory requirements. The following events were completed in 2016:

[1] MFA. Upland Cap Construction Final Completion Report, Zidell waterfront property, Portland, Oregon. Maul Foster & Alongi, Inc., Portland, Oregon. December 14, 2016.

- A bank and sediment cap topographic survey was completed in the spring and summer of 2016 to collect data for the Year 5 Cap Physical Integrity Monitoring, as described in the OMMP[2] and detailed in the Year 5 (2016) Sediment Cap Bathymetric Monitoring Report.[3] DEQ approval was received March 9. 2017.

- Natural Recovery Monitoring was completed in spring 2016 and is described in the 2016 Natural Recovery Monitoring Report.[4] Sediment conditions are in compliance with the ROD requirements. DEQ approval with comments pertinent to future monitoring events was received May 23, 2017.

- MFA completed site inspections during Cavalia USA's (a short-term lessee at the Site) structure setup and take-down at the Site, including tent construction; fill import; site grading; and demobilization. MFA observed site operations for one to two hours each day and prepared daily reports (with photographs) to document the inspection. Daily reports are available upon request.

- In-water (toe of riverbank to eastern edge of cap) substrate monitoring of the sediment cap was conducted, as required by the Corps of Engineers permit (Year 5) (Attachment B). Substrate conditions, related to the ratios of silt, gravel and rock, are in compliance with the permit conditions. The report was submitted to the Corps of Engineers in December 2016. Consistent with the DEQ approved Substrate Monitoring Plan, the Corps and NMFS have not noted disagreement with the findings of the Substrate Monitoring Report within the permit's specified 30-day timeframe and therefore the report has been accepted as submitted.

- MFA met with DEQ at the Site on January 4th, 2017 to discuss the status of the remediation, preliminary results of monitoring efforts, and a reduction in the inspection and reporting requirements. DEQ designated Paul Seidel as the interim project manager and approved Zidell's request to reduce the inspection and reporting frequency to an annual requirement.

- An annual vegetation monitoring event (Year 4 of 5 required years), required by the City of Portland and the Corps of Engineers, was conducted by Pacific Habitat Services, Inc., with observations recorded in July, August, and September. A technical memorandum describing the methods and results of the monitoring event is attached to this document (Attachment A). The memorandum concludes that

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[2] MFA. Bank and Sediment Remedy Operations, Maintenance, and Monitoring plan, Zidell waterfront property, Portland, Oregon. Maul Foster & Alongi, Inc., Portland, Oregon. June 12, 2013.

[3] MFA. Year 5 (2016) Sediment Cap Bathymetric Monitoring Report, Zidell waterfront property, Portland, Oregon. Maul Foster & Alongi, Inc., Portland, Oregon. December 19, 2016.

[4] MFA. 2016 Natural Recovery Monitoring Report, Zidell waterfront property, Portland, Oregon. Maul Foster & Alongi, Inc., Portland, Oregon. November 21, 2016.

invasive species management and tree/shrub survival are in compliance with permit requirements. Vegetative cover and overall survival are also in compliance with City of Portland monitoring criteria and Corps of Engineers permit condition criteria. The City of Portland acknowledged receipt of the report. A courtesy copy of the report was sent to the Corps of Engineers; the Corps permit only requires a report at the end of the 5-year monitoring period.

- Riverbank vegetation general condition was inspected by the landscape contractor to prepare for growing-season landscape-management planning.

- MFA completed quarterly site inspections during 2016. A detailed annual inspection was conducted during the third-quarter event, consistent with previous years. Conditions encountered during the annual inspection were compared to the 2013, 2014, and 2015 monitoring report conditions to identify changes and progress at the site. Inspections and reporting were completed consistent with the requirements of the site OMMP and the Interim Site Management Plan (ISMP).[5] The inspections generally noted the following:

  - Bank vegetation was dense and consistent in the upper bank areas during 2015.
  - Vegetation on the greenway cap in the slipway and downstream reaches is mostly dense. Vegetation on the greenway cap for the bridge reach is short and sparse with bare patches. Minor areas of ruts and low spots along the greenway cap are recommended for repair and reseeding, however these areas are not at risk of eroding.
  - The bank cap and vegetation are generally in good condition. Some erosion was observed in the downstream reach on the lower part of the bank. Vegetation has increased in density and height. Most of the bank at the North Bridge reach is no longer accessible because of increased dense vegetation growth.
  - The former TriMet work bridge area soil-cap grass plantings are tall and dense.
  - The upland gravel cap is in good condition, with no erosion observed.
  - Three clean gravel stockpiles remain in the northwest portion of the site following the Cavalia production teardown; stockpiled material will be used for fill during future construction on the site.
  - The asphalt cap in the barge-construction operations area is in good condition.

[5] MFA. Zidell interim site management plan, 3121 SW Moody Avenue, Portland, Oregon, ECSI 689. Maul Foster & Alongi, Inc., Portland, Oregon. May 2, 2013.

- Some minor erosion of the cover gravel was noted on the slipway ramp adjacent to the downstream rail. The reactive core mat was not visible in the eroded areas. Gravel in the lower slipway ramp was smoothed out as part of general site-maintenance activities.

SITE MAINTENANCE & REPAIR

Maintenance and repair activities on the Zidell site consisted of the following:

- Routine maintenance was conducted for riverbank vegetation (weed control, irrigation); additional coir logs (60) were installed for erosion control; and supplemental plants (native rushes and sedges) were planted in the lower riverbank transition zone of the downstream reach.

- Weeds and invasive vegetative species on the riverbank cap were managed by pulling and by spraying of herbicide appropriate for this location. Additional details on vegetation management are described in the 2016 Year 4 Vegetative-Monitoring technical memorandum prepared by Pacific Habitat Services (Attachment A).

- The lower bank plantings were irrigated from June through September.

- Routine maintenance was conducted on the gravel layer within the slipway to level displaced gravel.

- Riverbank erosion maintenance in 2016 was limited to landscaping techniques (placement of coir logs and planting of native riparian vegetation) on the lower bank in the downstream reach.

- Slipway maintenance in 2016 consisted of smoothing the existing gravel to the edge of riprap; filling stormwater rills with rock; and backfilling low/bare spots with rock and compacting the materials.

SAMPLING

Samples were taken for import fill to be used in upland gravel-cap placement. Sample test results are summarized in the Upland Cap Construction Completion Report and met site import criteria.

Zidell performed Year 5 incremental sediment sampling outside the sediment cap boundary for required natural recovery monitoring. Results are summarized above (Inspections and Monitoring)

INSTITUTIONAL CONTROLS

No work related to institutional controls was performed at the site in 2016.

OTHER SITE ACTIVITY

In addition to normal barge-construction operations to the south of the Ross Island Bridge, Zidell has hosted several public events (outdoor festivals, concerts, and movie showings) in the northern property area upland and greenway, which has been capped. No damage to the cap in these areas has been observed.

5-YEAR REMEDY REVIEW

The Consent Judgement requires that DEQ review the remedy at least once every five years to ensure that the site remains protective of public health, safety, and welfare and the environment. The review includes evaluation of monitoring data; progress reports; inspection and maintenance reports; land and water uses; compliance with institutional controls; and any other relevant information. Based on the completion of the hotspot removals and construction of the riverbank and sediment caps in 2011, Zidell is providing the following information to support DEQ's review of the site remedy.

<u>Upland</u>

- The remedial action involving the removal of upland hotspot soil (human health and ecological), and construction of comprehensive upland caps over remaining contaminated soils, was completed between 2010 and 2016.
- Institutional controls have been developed and are consistent with the Record of Decision (ROD) and Consent Judgment requirements, and are addressed in the following
  - Easement and Equitable Servitudes
  - Interim Site Management Plan
  - Inspection and Maintenance Plan
- Ongoing annual inspection of the upland caps verify that the caps remain intact and are effective at preventing direct contact with non-hotspot soil.
- Use of the upland property is transitioning into a redevelopment phase where commercial, residential, open space and Greenway future uses are anticipated. Residential use of the upland property was assumed in the development of site cleanup levels that are documented in the ROD, and are therefore protective of the future use when considering the direct-contact pathway.

<u>Sediment</u>

- The sediment remedial action, completed in 2011, involved: the selective removal of sediment within the slipway and construction of a low-profile sediment cap;

stabilization of the riverbank; capping of riverbank soils; and capping of contaminated sediment.

- Institutional controls have been developed and are consistent with the Record of Decision (ROD) and Consent Judgment requirements, and are addressed in the following:
    - Operation Monitoring and Maintenance Plan
    - Restricted Navigation Area and buoy placement at cap limits
    - Oregon State Submerged and Submersible Land Lease
- Site inspection activities conclude that erosion controls remain effective at protecting the physical integrity of the sediment and riverbank caps.
- Bathymetric monitoring demonstrates that the sediment-cap constructed configuration remains consistent with the design basis and compliant with the conditions required in the OMMP.
- Natural-recovery monitoring demonstrates that the sediment bed adjacent to the sediment cap is consistent with background conditions.
- Vegetation monitoring and sediment cap substrate monitoring demonstrate that the sediment remedy remains compliant with federal permit requirements.
- The ROD-required evaluation of the sediment cleanup levels for fish ingestion (Attachment C) indicates that site conditions remain protective of the fish-ingestion pathway.

<u>Groundwater</u>

- The DEQ-requested evaluation of the groundwater discharge to surface-water pathway (Attachment D) indicates that groundwater conditions remain protective of potential receptors in the Willamette River.

2017 PLANNED ACTIVITIES

The following activities are planned for 2017:

- Annual bank and upland cap inspection by MFA (Fall)
- Vegetation-establishment monitoring by Pacific Habitat Services (Year 5 of 5) (Summer)
- Vegetation-maintenance activities by Native Ecosystems Northwest, LLC (Year-Round)

SUMMARY

The bank, sediment, and upland caps are in good condition and are further stabilized, with slightly denser vegetation than that of 2015. Bank-stabilization measures implemented in 2015 and 2016 are effective at the end of the monitoring year. Monitoring of these measures will continue in 2017, and additional efforts to increase and maintain vegetation across the site will be conducted as necessary in 2017.

Sincerely,

Maul Foster & Alongi, Inc.

Jacob Faust, PE
Project Engineer

Erik Bakkom, PE
Senior Engineer

Attachments: Limitations
Attachment A—Year 4 (2016) Vegetation-Monitoring Memorandum
Attachment B—Year 5 (2016) In-water Substrate Monitoring Report
Attachment C—Sediment Cleanup Level Protectiveness Review
Attachment D—Groundwater to Sediment Pathway Evaluation

cc: Kathryn Silva, Zidell Companies
Alan Park, Zidell Companies
Paul Fishman, NorthWest Ecosystem Services, Inc.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

ATTACHMENT A

YEAR 4 (2016) VEGETATION-MONITORING MEMORANDUM

PACIFIC HABITAT SERVICES, INC.
9450 SW Commerce Circle, Suite 180
Wilsonville, OR 97070
(800) 871-9333 ● (503) 570-0800 ● Fax (503) 570-0855

TECHNICAL MEMORANDUM

Date: December 5, 2016

To: Paul Fishman
NorthWest Ecosystem Services, Inc.
ZRZ Realty Company Remediation Project Manager

From: Christie Galen, Senior Ecologist

SUBJECT: ZRZ Realty Company Waterfront Remediation Project
City of Portland PR 11-100684; USACE NWP-2007-962
Year 4 (2016) Vegetation Monitoring
ZRZ Job 423; PHS Project Number: 5106

PROJECT OVERVIEW

The ZRZ remediation project involved in-water dredging and capping of contaminated sediments, removal of debris and structures, bank excavation, stabilization and capping, removal of noxious vegetation (i.e. blackberry monoculture), soil supplementation, and planting native vegetation in riparian and upland areas. Native plants were installed to provide additional erosion controls as well as improve fish and wildlife habitat complexity and diversity.

The remediation project had three major design reaches; Slipway, Bridge, and Downstream. The Slipway and Bridge Reaches, occupying approximately 1,200 linear feet (LF) at the south end of the project site, have rock armor on the riverbank up to the +15 foot elevation (City of Portland datum)[1] and a vegetated soil cap from the top of armor to the top of bank (approximately +30 feet elevation). The landscaping for this soil cap consists of groundcover and shrubs. The Downstream Reach riverbank, extending approximately 1,500 LF to the north end of the project site, was constructed using a bioengineering design from the bank toe (at approximately elevation +11 feet) to the top of bank (elevation +30 feet). Trees, shrubs and groundcover species were planted on the entire bank of this reach.

Construction and planting of the remediation project was completed in spring 2012. Additional coir logs to protect the riverbank from erosion have been installed every year due to erosion caused by inundation and boat waves breaking on the lower riverbank. In the winter of 2015/2016 the river eroded portions of the lower riverbank again. During the spring/summer coir logs were restaked or replaced and additional willow and red-osier cuttings were planted to help protect the coir logs from erosion. In September, after new coir logs were installed, 250 1-gallon herbaceous plants were planted in bare soil areas. An additional 250 1-gallon plants were added to the lower bank in November. The annual management/maintenance of the site has reduced the extent of erosion at the toe of slope each year and increased lower bank stability.

[1] The line of ordinary high water (OHW) at the site is elevation +18ft (City of Portland datum).

The U.S. Army Corps of Engineers (USACE) permit requires monitoring riparian vegetation in the Downstream Reach below the line of OHW. Performance criteria for permit compliance include a minimum of 80% areal coverage by plants, a maximum of 10% non-native or invasive species cover, and a 5-year status report (2017). The City of Portland (CoP) requires annual reports detailing site conditions for 5 years. Monitoring performance criteria for CoP include 75% survival for trees and shrubs, 90% ground coverage (as viewed from above including herbaceous, shrub and tree cover), and less than 10% invasive species cover. The USACE issued a permit modification in June 2014 that required additional enhancement of riparian vegetation (i.e. 112 trees, 465 cuttings) but no additional monitoring was required.

SITE MANAGEMENT AND MAINTENANCE ACTIVITIES

Paul Fishman, consulting Project Manager, coordinated site management and maintenance activities. He inspected the site regularly in 2016; inspections typically included walking the entire project site riverbank, noting the condition of landscaping, weed infestations, plant damage, and erosion, and documenting site conditions. Paul coordinated with all project sub-contractors including Native Ecosystems Northwest, Treecology, Sound Native Plants, Ludlow Landscaping, Geese Guys, and Pacific Habitat Services. Native Ecosystems Northwest is contracted to provide and oversee landscape management services for the 5-year monitoring period.

Silt fences that were installed at the toe of slope in 2014 to deter geese were removed in the fall of 2015 since herbaceous vegetation was taller and dense enough to dissuade geese from foraging and nesting on site. The removal of the fences permitted beaver easy access to riverbank vegetation where they foraged on willow (Photo 1). However, the willow regrew in the spring and there were no adverse effects on cover.

High water in the winter of 2015/16 inundated the lower riparian area and caused minor bank erosion and washouts of coir logs at the base of the slope (Photo 2). In July the coir logs that were still in place were re-anchored with crossed stakes to secure them, and in August and September 70 new coir logs were installed. In late September, 250 1-gallon containers (125 slough sedge, 95 swordleaf rush, 30 poverty rush) were planted below the coir logs; each planting was circled with rocks for protection from erosion. An additional 250 1-gallon emergent plants were added in remaining bare areas during November.

Native Ecosystems Northwest controlled invasive weeds and noxious plants from March through September. They hand-pulled smaller Armenian blackberry, Scotch broom, and butterfly bush to minimize the use of chemical treatments and disturbance to site soils. Morning glory, thistle and larger blackberry, Scotch broom, and butterfly bush were cut and spot sprayed with herbicide. Additionally, over a dozen purple loosestrife plants were sprayed with herbicide or hand-pulled from the gravel flat below the toe of slope in the downstream reach.

Plantings were watered from June through September. Ludlow Landscaping managed the irrigation system for the downstream reach and irrigated the lower slopes. Trees and shrubs on the upper slopes were hand-watered by Treecology during the same time period.

COMPLIANCE MONITORING METHODOLOGY

Christie Galen, Pacific Habitat Services Inc. Senior Ecologist, evaluated vegetation survival and cover on the remediation site for permit compliance. She evaluated plant survival and cover in the permanent block transects on July 29, August 10, September 8, and October 6, 2016.

In 2012 sixteen permanent block transects were installed in every reach and habitat type (Figure 1) to evaluate survival and cover of plantings. Ten were located in uplands above the Ordinary High Water Mark (OHWM) (+18 feet; all design reaches) and six were located in the riparian community below OHWM (downstream design reach). Transects vary in shape and size; most transects are square and approximately 15 feet -20 feet x 15 feet -20 feet, but one is approximately 4 feet x 35 feet. All of the corners of the block transects were surveyed and staked. All dead and live trees and shrubs were recorded for each transect. Cover was estimated visually and survival was based on counting the number of live trees and shrubs in each transect and comparing numbers to plants observed in 2013 (after replant) and in the planting plan.

RESULTS

This is the fourth year of monitoring. Site assessment focused on tree and shrub survival/mortality, and woody plant and herbaceous cover in order to provide vegetation management recommendations and to evaluate CoP and USACE performance criteria. Transect data, including scientific and common names, height, vigor, and cover, for each transect are attached.

In addition to the performance criteria evaluation, wildlife utilization was recorded during monitoring. The project site is providing wildlife habitat for a variety of avian species. Osprey, common mergansers, and great blue heron fish near shore or from the banks. Canada goose, California gull, glaucous-winged gull, mallard, American crow, and spotted sandpiper also forage along the riverbank. The diverse slope vegetation that was planted for mitigation is providing food and cover for white-crowned sparrow, song sparrow, savannah sparrow, dark-eyed junco, Anna’s hummingbird, common yellowthroat, cedar waxwing, and bushtit. Rock pigeons were also observed on site beneath the Ross Island Bridge and beaver sign was common near the river.

Woody Plant Survival and Cover

Woody plant survival and cover were evaluated in each block transect by counting all live and dead trees and shrubs and estimating canopy cover. Height and vigor were also recorded to document plant growth. The number and species of each woody plant was compared to the number of plantings observed in 2013 and the planting plan to evaluate survival.

<u>Upland Shrub Transects</u>

Upland shrub transects (T1, T2, T3, T4) are located on the slopes in the south end of the remediation area where only shrubs were planted (Slipway and Bridge Reaches). The most common shrubs planted included Douglas spirea, kinnikinnick, tall Oregon grape, snowberry, baldhip rose, pea-fruit rose, and twinberry; other species planted on the lower slopes of T1 included red-osier dogwood and willow. Most shrubs showed high vigor. Three twinberry died in 2015 due to the drought even with frequent irrigation; remaining twinberry showed improved vigor in 2016. Shrub survival on upland shrub transects averaged >100% (113 observed/91 required based on 8 square feet/shrub) since transects were overplanted. Shrub cover ranged from 85% to 95% and averaged 91% cover (Photo 3, T3 looking north).

Upland Tree/Shrub Transects

Upland Transects planted with trees and shrubs (T5, T7, T10, T12, T14, T16) are located in the Downstream Reach above the OHWM. Trees averaged approximately 13 feet apart with 1 to 5 trees on each transect. Trees included big leaf maple, Oregon ash, Pacific crabapple, chokecherry, Oregon white oak, and Pacific willow. One Pacific crabapple and 2 western red cedars died on transects in 2015 due to the drought; there was no mortality in 2016. Tree survival on upland slope transects was 73%. Trees range in height from 2 to 11 feet tall and are spread throughout the planting area. Besides the trees mentioned above that were found on transects, madrone (3) and western red cedar (2) were also observed. Shrubs averaged approximately 3 feet apart. Common shrubs included tall Oregon grape, red-osier dogwood, mockorange, baldhip rose, pea-fruit rose, Douglas spirea, and snowberry; serviceberry, oceanspray, red-flowering currant, twinberry, Pacific ninebark, and willow were also present. Shrub survival was 100% with some slight mortality offset by colonization of snowberry and rose. Tree and shrub cover ranged from 60% to 98% and averaged 70% on upland transects (Photo 4, T14).

Riparian Transects

Riparian transects (T6, T8, T9, T11, T13, T15) are located in the Downstream Reach below OHWM. Willow and red-osier cuttings showed vigorous growth and required pruning to enable the sprinklers to operate (Photos 5 & 6). The dominant tree in the riparian community transects was Pacific willow that was planted as cuttings; Oregon ash, black hawthorn, and black cottonwood were also present. Trees averaged approximately 7.8 feet apart and shrubs averaged approximately 3.8 feet apart. Common shrubs in riparian transects included red-osier dogwood, Columbia River willow, Piper's willow, and Sitka willow. Tree and shrub cover ranged from 45% to 95% and averaged 80% on riparian transects. The lowest cover was observed on T6 where the coir logs washed out in 2015 and again last winter. With supplemental cuttings (i.e. willow, red-osier dogwood) planted adjacent to the new logs, cover should improve.

Herbaceous Cover

Herbaceous cover was evaluated in 16 block transects to evaluate seeding success and herbaceous weed cover. Upland herbaceous cover was evaluated in 10 block transects (T1, T2, T3, T4, T5, T7, T10, T12, T14, T16) and riparian herbaceous cover was evaluated in 6 block transects (T6, T8, T9, T11, T13, T15).

Upland Herbaceous Cover

Herbaceous cover on the upland slopes averaged 100% cover on transects (0.4% bare ground). Cover was dominated by native species (97% cover) that were planted in the seedmix and include blue wild rye (45%), meadow barley (42%), and Alaska brome (10%). Non-native species cover averaged 1% and included oxeye daisy, sheep sorrel, and sweetpea. Invasive species cover averaged 2% and included Himalayan blackberry, thistle, Scotch broom, sweetbriar rose, and St. John's wort.

Riparian Herbaceous Cover

Herbaceous cover in the riparian zone (below the OHWM) averaged 93% cover and ranged from 85-100% cover in the block transects. Vegetation included native and non-native species. Native species (87% cover) were dominated by slough sedge, soft rush, and blue wildrye with smaller amounts of swamp smartweed, blue skullcap, witchgrass, common yellow oxalis, peppermint, and willowherb. Non-native species cover (5%) included lady's thumb, scarlet pimpernel, oxeye daisy, crabgrass, centaury, pennyroyal, wall bedstraw, and white campion. Weedy species (1%) included teasel, toadflax, St. John's wort, and morning glory.

Invasive / Noxious / Weedy Species Cover

Invasive, noxious and other weedy species that have been observed and managed on site are listed above in the site management and maintenance section. Weedy species cover averaged 2% in upland transects (sweetbriar rose, St. John's wort, Himalayan blackberry, Scotch broom, thistle) and 1% in riparian transects (butterfly bush, teasel). Morning glory and purple loosestrife are increasing on site in the beach gravels below the transects/planting area. Sweetbriar rose is colonizing the upper slopes of the site and needs to be managed to prevent it from spreading further on the site.

CONCLUSION

Woody Plant Performance Criterion (CoP): 75% survival rate for trees and shrubs (including volunteers); plants that do not survive will be replaced to reach an amount equal to 75% of the originally installed plants (Photos 7 & 8).

Tree Survival

There was no new mortality on transects in 2016. Since monitoring began 2 western red cedar trees and 1 crabapple died in 2015, and 1 madrone died in 2013. Transect data show that trees are diverse and well distributed throughout the planting areas and show moderate to high vigor; on upland slopes trees averaged approximately 13 feet apart and trees in the riparian community averaged 7.8 feet apart.

The original number of trees assumed to be in each upland block transect was based on the number of trees observed on each transect in 2013. Tree survival on transects in 2016 was 73%. Tree survival was not evaluated in riparian transects since cuttings were used to replace red alder and ash that died due to beaver. However, trees are robust (2-8 feet tall), average 7.8 feet apart and are vigorous throughout the riparian community.

Shrub Survival

Shrub survival is estimated to be approximately 100%. Most shrubs showed high vigor and growth and many bore fruit. Shrubs are diverse and well distributed throughout the site. No additional shrub planting is warranted at this time.

CoP Permit Compliance based on Overall Survival of Trees and Shrubs

Tree and shrub survival averages over 86% and no additional tree or shrub planting is required at this time. The project is in compliance with CoP requirements.

Areal Coverage Performance Criterion: 90% Ground Coverage (CoP); 80% Ground Coverage in Downstream Reach (USACE); Photos 7 & 8.

Upland Cover

Areal cover on upland transects averaged 100% and is greater than the 90% cover performance criterion required by CoP and the 80% cover performance criterion required by the USACE. Upland cover meets CoP an USACE performance criteria.

Riparian Cover

Areal cover on riparian transects averaged 93% cover including 80% woody plant cover and 13% herbaceous cover, and 7% bare ground. Areal cover continues to improve in the riparian community. Areal cover meets CoP and USACE performance criteria.

Invasive Species Cover Performance Criterion: Less than 10% Invasive Species Cover (CoP); Less than 10% Non-native or Invasive Species Cover (USACE).

Invasive Species Cover is approximately 1% in riparian transects and 2% in upland transects and meets the CoP and USACE invasive species cover performance criterion at this time. The maintenance crew should continue to monitor and control weeds on site: field bindweed, butterfly bush, Himalayan blackberry, nightshade, purple loosestrife, reed canarygrass, Scotch broom, St. John's wort, sweetbriar rose, teasel, and thistle.

Appendix

Transect Data

Figure 1

Photos 1-8

ZRZ Mitigation Monitoring - Plant Survival and Cover 2016

T1: Shrub Slope; 225 sq ft (15X15); August 10, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Cornus sericea	red-osier dogwood	1	1	1	1	3	2		
Lonicera involucrata	twinberry	2	2	2	2	1.5	4		crowded out by dense veg
Mahonia aquifolium	tall Oregon grape	1	1	1	1	3	5		grew 2'; fruiting
Rosa pisocarpus	pea-fruit rose	5	5	5	5	3	6		grew 1.5'; fruiting
Salix exigua var. columbiana	Columbia River willow	0	0	1	1	3			
Salix lasiandra	Pacific red willow	2	2	1	1	3	3		just below transect
Spiraea douglasii	Douglas spirea	10	10	10	10	3	5		up to 7'
Symphoricarpos albus	snowberry	2	2	2	2	3	4.5		fruiting
TOTAL		23	23	23	23			0	

Notes: shrubs taller than corner stakes and too dense to count individuals; no mortality observed; assumed same as 2015

Shrub Cover: 90%; Ground Cover: 100%, native: 98% w/ 95% meadow barley, 1% bluewildrye, 1% willowherb, 1% Can. horseweed; 2% inv. Blackberry, common tansy

T2: Shrub Slope; south end; 225 sq ft (15X15); August 10, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Arctostaphylos uva-ursi	kinnikinnick	1	0	0	0	3	NA		9 sq ft
Lonicera involucrata	twinberry	6	7	8	7	2	4.5	1	2-5'; 4 w/low vigor due to drought; new leaves
Mahonia aquifolium	tall Oregon grape	10	10	10	8	3	5		3-7'
Rosa gymnocarpa	baldhip rose	0	0	1	2			2	
Symphoricarpos albus	snowberry	13	13	9	11	3	4		fruiting
TOTAL		29	30	28	28			3	

Shrub Cover: 95%; Ground Cover: 100%, native: 98% w/78% meadow barley, 15% wildrye, 5% brome, and 2% non-nat.: 1% sweetpea, 1% blackberry

T3: Shrub Slope; long and skinny transect perpendicular to slope; 132 sq ft (4X33); August 10, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Arctostaphylos uva-ursi	kinnikinnick	2	2	3	0	3	NA	1	~550 sq ft
Lonicera involucrata	twinberry	6	6	6	6	2	4		2.5-4'
Mahonia aquifolium	tall Oregon grape	4	4	4	4	3	4		fruiting
Rosa gymnocarpa	baldhip rose	6	6	6	6	2	3.5		
Rosa pisocarpus	pea-fruit rose	3	3	3	3	3	5		fruiting
Salix sitchensis	Sitka willow	2	2	1	2	3	10		
Spiraea douglasii	Douglas spirea	2	2	3	4	3	5.5	2	fruiting
Symphoricarpos albus	snowberry	8	8	9	9	3	4	1	fruiting
TOTAL		33	33	35	34			3	

Note: shrubs to dense to walk inside transect

Shrub Cover: 95%; Ground Cover: 100%, native: 99% w/50% meadow barley, 49% blue wildrye, and 1% non-native sweetpea

T4: Shrub slope by gravel road;144 sq ft (12X12); August 10, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Arctostaphylos uva-ursi	kinnikinnick	5	5	5	5	3	NA		30 sq ft
Lonicera involucrata	twinberry	2	4	6	6	2	3.5	4	
Mahonia aquifolium	tall Oregon grape	2	2	3	3	3	3.75	1	up to 5'
Rubus parviflorus	thimbleberry	0	0	1	1			1	
Spiraea douglasii	Douglas spirea	1	1	1	0	3	3.5		grew 1'
Symphoricarpos albus	snowberry	18	18	18	19	3	2.5	3	2-4' tall
TOTAL		28	30	34	34			9	

Shrub Cover: 85%; Ground Cover: 96%, Native: 92%: 61% blue wildrye, 31% brome, and 4% Inv.: 2% rose, 1% blackberry, 1% St. John's wort

ZRZ Mitigation Monitoring - Plant Survival and Cover 2016

T5: Tree slope; adjacent to T6; 240 sq ft (16X15); September 8, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Amelancier alnifolia	serviceberry	2	2	2	4	2	3.5	2	grew 1'
Cornus sericea	red-osier dogwood	1	1	2	2	3	8	1	grew 2.5'
Malus fusca	Pacific crabapple	1	1	2	2	3	2	1	improved vigor
Ribes sanguineum	red-flowering currant	1	1	1	1	3	5		in NW corner
Rosa pisocarpa	clustered rose	7	7	6	8	2.5	3	1	1-5'; spreading
Spiraea douglasii	Douglas spirea	5	5	5	5	3	3		up to 5'
Symphoricarpos albus	snowberry	2	2	1	1	3	2.5		fruiting
TOTAL		19	19	19	23			5	

Tree/Shrub Cover: 60%; Ground Cover: 100%: Native 99%: w/50% blue wildrye, 34% brome, 15% meadow barley; and 1% invasive Scotch broom (pulled)

T6 Riparian: past years Canada geese and erosion; 315 sq ft (21X15); September 8, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Alnus rubra	red alder	0	0	0	0			1	
Cornus sericea	red-osier dogwood	8	6	8	9	3	6	1	some pruned
Crataegus douglasii	black hawthorn	0	1	1	0				was 4' last year
Fraxinus latifolia	Oregon ash	0	0	0	0			1	
Salix exigua var. columbiana	Columbia River willow	1	1	1	1	3	3	NA	
Salix lucida ssp. lasiandra	Pacific willow	4	4	4	4	3	5	NA	
Salix hookeriana	dune willow	5	4	0	0	3	2	NA	
Salix sitchensis	Sitka willow	2	2	3	6	3	7	NA	red bark
TOTAL		20	18	17	20			3	

Tree/Shrub Cover: 45%; Ground Cover: 90%: 82% native: 10% sedge, 35% meadow barley, 35% blue wildrye, 2% yellow oxalis; 7% non-native: 2% oxeye daisy, 2% vetch, 2% scarlet pipernel, 1% sorrel, 1% invasive toadflax & 10% bare soil; Note: lower transect washed out in 2014 and 2015

T7: Tree slope; south of Tri-Met; 165 sq ft (15X11); July 29, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Amelancier alnifolia	serviceberry	1	1	1	1	3	2.5		
Holodiscus discolor	oceanspray	1	1	1	1	3	3.5		grew 0.5'
Mahonia aquifolium	tall Oregon grape	7	7	7	7	3	4.5		grew 1'; up to 5.5'
Philadelphus lewisii	mock orange	5	6	4	4	3	3.5		grew 1'
Quercus garryana	Oregon white oak	1	1	1	1	3	4.5		
Rosa gymnocarpa	baldhip rose	4	4	3	2	3	4		grew 1'; up to 6'
Symphoricarpos albus	snowberry	5	5	5	5	3	3		grew 0.5'
TOTAL		24	25	22	21			0	

Tree/Shrub Cover: 60%; Ground Cover: 100% native: blue wildrye (10%), brome (10%), and meadow barley (80%)

T8: Riparian beneath Tilicum bridge; 324 sq ft (18X18); July 29, 2016 (gps 307-310)

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Cornus sericea	red-osier dogwood	12	12	11	17	3	7	5	some pruned to ~4'
Crataegus douglasi	black hawthorn	1	1	1	0	3	3		grew 2'
Physocarpus capitatus	Pacific ninebark	1	1	1	1	3	6.5		grew 2.5'; in seed
Salix exigua var. columbiana	Columbia River willow	0	0	0	1	3		NA	
Salix lucida ssp. lasiandra	Pacific willow	5	4	7	15	3	3.5	NA	up to 5.6'
Salix hookeriana	dune willow	2	2	0	2	3	6.5	NA	
Salix sitchensis	Sitka willow	6	6	7	11	3	8	NA	
TOTAL		27	26	27	47			5	

Tree/Shrub Cover: 80%; Ground Cover: 85% (15% bareground) w/ 75% native: 35% meadow barley, 15% blue wildrye, 5% tufted hairgrass, 5% slough sedge, 5% yellow oxalis, 1% smartweed, 4% willowherb, 5% Mentha piperata; 8% non-native: 4% crabgrass, 1% violet, 1% oxeye daisy, 1% silene, 1% scarlet pimpernel; 2% invasive butterfly bush and teasel; Note: base of slope washed out but no new coir; 1 2' ash below transect

T9 Riparian: north of Tri-Met; 120 sq ft (10X12); July 29, 2016 (gps 303-306)

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Cornus sericea	red-osier dogwood	5	5	5	5	3	7		grew 2'
Salix exigua var. columbiana	Columbia River willow	0	0	0	2			NA	
Salix lucida ssp. lasiandra	Pacific willow	2	2	3	6	2	2	NA	just below transect
Salix sitchensis	Sitka willow	9	9	9	15	3	6	NA	grew 2.5'
TOTAL		16	16	17	28			0	

Tree/Shrub Cover: 85%; Ground Cover: 90%: 89% native: tufted hairgrass, meadow barley, wildrye, soft rush, slough sedge, willowherb, & trailing bb; 10% bare soil
No new coir or plantings installed on transect but a lot to the north; 1 red-osier dogwood and 2 willow below transect; large patch of morning glory in gravel below

T10: Forested slope; adjacent to T9; 144 sq ft (12X12); July 29, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Cornus sericea	red-osier dogwood	3	2	3	3	3	7	1	1 on line; grew 2'
Malus fusca	Pacific crabapple	1	1	1	1	2.5	9		grew 0.5'
Philadelphus lewisii	mock orange	0	1	0	1				could not find in dense veg
Rosa pisocarpos	peafruit rose	8	8	7	3	3	5		spreading
Salix exigua var. columbiana	Columbia River willow	0	1	1	1				could not find in dense veg
Salix piperi	Piper's willow	1	1	1	1	3	10		grew 4'
Salix sitchensis	Sitka willow	6	6	6	6	3	11		grew 4'; up to 15'
Spiraea douglasii	Douglas spirea	2	2	2	2	3	5		grew 1'
Symphoricarpos albus	snowberry	5	3	4	4	3	4		
TOTAL		26	25	25	22			1	

Tree/Shrub Cover: 98%; Ground Cover: 100% native: 47% blue wildrye, 6% brome, 47% meadow barley; plantings very dense

T11 Riparian: bottom of slope above Paul's cage; 300 sq ft (15X20); July 29, 2016

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Cornus sericea	red-osier dogwood	6	6	5	6	3	5		up to 7'
Fraxinus latifolius	Oregon ash	1	1	0	0	3	5		grew 1'
Physocarpos capitatus	Pacific ninebark	4	4	4	4	3	6		grew 1.5'
Salix exigua var. columbiana	Columbia River willow	2	2	2	3	2	4	NA	
Salix lucida ssp. lasiandra	Pacific willow	9	9	0	11	3	6	NA	grew 0.5'
Salix sitchensis	Sitka willow	4	4	5	5	3	9.5	NA	grew 2.5'; up to 12'
TOTAL		26	26	16	29			0	

Shrub Cover: 80%; Ground Cover: 98% (2% bare) w/93% soft rush, blue wildrye, meadow barley, willowherb and yellow oxalis; 4% non-native wall bedstraw, centaury and vetch and 1% inv. St. John's wort

T12: Forested slope; adjacent to T11; 368 sq ft (16X23); August 10, 2016; located above Paul's cage

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Arbutus menziesii	madrone	0	0	0	0			1	
Cornus sericea	red-osier dogwood	2	2	2	2	3	7		grew 2.5'
Fraxinus latifolius	Oregon ash	1	1	1	1	3	7		grew 4'
Mahonia aquifolium	tall Oregon grape	1	1	1	1	3	5		
Philadelphus lewisii	mock orange	9	9	9	9	3	3		up to 5'
Physocarpos capitatus	Pacific ninebark	1	1	1	1	3	6.5		grew 1.5'
Rosa pisocarpos	peafruit rose	12	12	12	12	3	3.5		thicket; didn't count
Salix exigua var. columbiana	Columbia River willow	0	0	1	1	3	5		
Salix piperi	Piper's willow	3	3	3	3	3	7		grew 1'
Spiraea douglasii	Douglas spirea	5	5	5	5	3	4		
Symphoricarpos albus	snowberry	7	5	4	3	3	3		spreading
TOTAL		41	39	39	38			1	

Tree/Shrub Cover: 70%; Ground Cover: 100%: Native 98%: blue wildrye, meadow barley, and willowherb; non-nat. 1% oxeye daisy, and 1% inv. blackberry

ZRZ Mitigation Monitoring - Plant Survival and Cover 2016

T13 Riparian: 340 sq ft (20X17); August 10, 2016 (gps 288-291)

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Alnus rubra	red alder	0	0	0	0	0		1	cut by beaver
Cornus sericea	red-osier dogwood	9	10	12	9	3	5	1	some pruned to 3'; up to 8'
Crataegus douglasi	black hawthorn	1	1	1	0	3	4		grew 0.5'
Fraxinus latifolia	Oregon ash	1	0	0	0	0	4		pruned
Physocarpos capitatus	Pacific ninebark	0	0	0	1	0		1	
Populus trichocarpa balsamif	black cottonwood	1	1	0	0	3	8		
Salix exigua var. columbiana	Columbia River willow	4	4	7	5	3	6	NA	up to 7'
Salix lucida ssp. lasiandra	Pacific willow	5	5	10	8	3	6	NA	up to 9'
Salix sitchensis	Sitka willow	7	7	11	10	3	8.5	NA	up to 11'
TOTAL		28	28	41	33			3	

Tree/Shrub Cover: 95%; Ground Cover: 100% native: soft rush, slough sedge, meadow barley, willowherb, and tufted hairgrass

T14: Forested slope; 396 sq ft (22X18); August 10, 2016; GPS pts 285-288

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Acer macrophyllum	big leaf maple	1	1	1	1	3	11		grew 2.5'
Fraxinus latifolius	Oregon ash	1	1	1	1	3	5		grew 2'
Holodiscus discolor	oceanspray	4	4	4	4	2.5	4.5		
Lonicera involucrata	twinberry	1	1	1	1	2	4		1/2 green
Mahonia aquifolium	tall Oregon grape	8	8	8	8	3	4		grew 0.5'; berries
Philadelphus lewisii	mock orange	5	5	5	5	3	4		up to 6'
Ribes sanguineum	red-flowering currant	7	7	7	8	3	5.5	1	up to 8'
Rosa gymnocarpa	baldhip rose	2	2	1	1	3	4.75		
Rosa pisocarpos	peafruit rose	5	5	5	7	3	2.5	2	
Spiraea douglasii	Douglas spirea	1	1	1	1	3	4		
Symphoricarpos albus	snowberry	8	8	8	8	3	4		1 w/ vigor 1.5
TOTAL		43	43	42	45			3	

Tree/Shrub Cover: 70%; Ground Cover: 100%: Native: 99% w/ 88% blue wildrye, 5% brome, 5% meadow barley, and 1% willowherb; non-native 1% sorrel

T15 Riparian: 500 sq ft (20X25); August 10, 2016; transect does not have tall brown stakes (gps 278-282)

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Alnus rubra	red alder	0	0	0	1	3	3	1	
Cornus sericea	red-osier dogwood	29	29	26	35	3	3	6	pruned to 4; up to 8"
Crataegus douglasii	black hawthorn	1	0	1	0	3	6	1	planted 2014
Populus balsamifera	black cottonwood	0	0	1	1	NA		NA	
Salix exigua var. columbiana	Columbia River willow	1	0	1	1	3	5	NA	
Salix lucida ssp. lasiandra	Pacific willow	1	6	7	6	3	6	NA	
Salix sitchensis	Sitka willow	15	15	13	42	3	9	NA	5-10'
TOTAL		47	50	49	85			7	

Tree/Shrub Cover: 95%; Ground Cov.:95% w/ 92% native (meadow barley, sedge, rush, scullcap, smartweed, witchgrass, yellow oxalis) & 3% non-native pennyroyal, campion

ZRZ Mitigation Monitoring - Plant Survival and Cover 2016

T16: Forested slope; 550 sq ft (25X22); August 10, 2016; no brown stakes (gps 282-285)

SPECIES	Common Name	2016	2015	2014	2013	AVG. VIG. (1-3)	AVG. HT. (ft)	DEAD/ VIG 1	COMMENTS
Acer macrophyllum	big leaf maple	1	0	0	0	3	5		
Cornus sericea	red-osier dogwood	5	4	4	5	3	7		
Lonicera involucrata	twinberry	4	3	5	5	2	3.5	2	
Mahonia aquifolium	tall Oregon grape	7	7	7	7	3	4		up to 5'
Malus fusca	Pacific crabapple	2	2	2	2	3	6		
Philadelphus lewisii	mock orange	6	6	11	14	2	2	8	stepped on by maintenance
Prunus emarginata	chokecherry	1	1	1	1	3	8		grew 2.5'
Rosa gymnocarpa	baldhhip rose	2	2	1	1	3	5.5'		grew 0.5'
Rosa pisocarpos	peafruit rose	17	17	13	10	3	3.5		
Salix lucida ssp. lasiandra	Pacific willow	1	1	1	2	3	6.5	1	grew 0.5'
Spiraea douglasii	Douglas spirea	7	7	7	7	3	5		up to 6'
Symphoricarpos albus	snowberry	8	8	8	8	3	3		spreading additional seedlings
Thuja plicata	western red cedar	0	0	2	2			2	
TOTAL		61	58	62	59			13	

Tree/Shrub Cover: 60%; Ground Cover: 92% native w/ 65% blue wildrye, 17% meadow barley, 10% brome; 6% non-native: 5% oxeye daisy & 1% sorrel, and 2% invasive blackberry and thistle

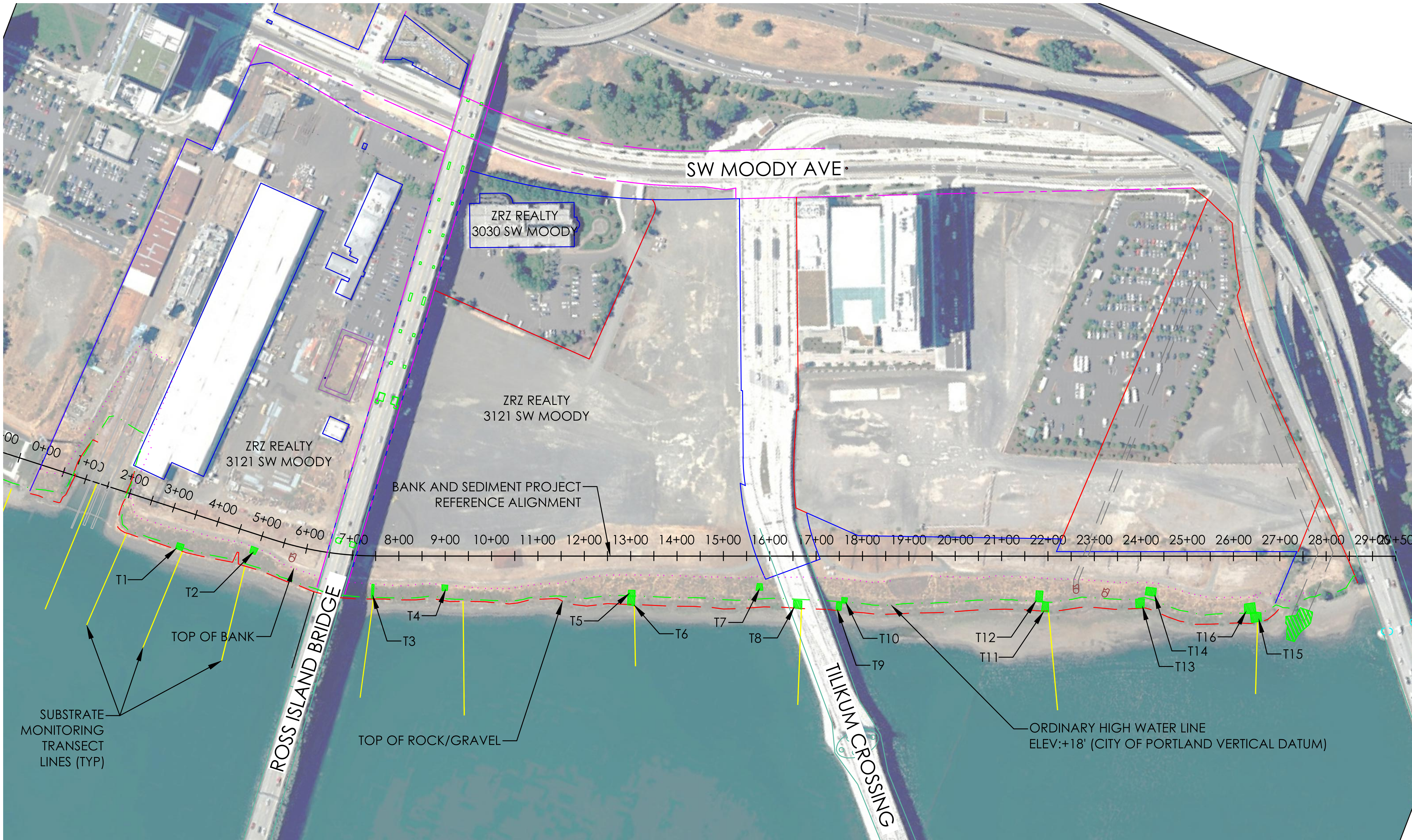

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Figure 1
Vegetative Monitoring Transects - Overview

ZRZ Realty
Portland, Oregon

Photo 1:

Beaver pruned willows

(Paul Fishman, February 26, 2016)

Photo 2:

Winter high water again moved coir logs in the downstream reach

(Paul Fishman, February 26, 2016)

Pacific Habitat Services, Inc.
9450 SW Commerce Circle, Suite 180
Wilsonville, OR 97070

Photo 3:

Upland Shrub Transect T-3.
(August 10, 2016)

Photo 4:

Tree-Shrub Transect T-14.

(August 10, 2016)

Project #5106
11/2/2016

Pacific Habitat Services, Inc.
9450 SW Commerce Circle, Suite 180
Wilsonville, OR 97070

Photo 5:

Riparian community beneath the Tilikum Bridge
(T8, September 9, 2016)

Photo 6:

Riparian community Downstream Reach between the Marquam and Tilikum Bridges North of T9

(September 9, 2016)

Photo 7:

Site overview looking south from the Tilikum Bridge.
(September 9, 2016)

Photo 8:

Site overview looking north from the Tilikum Bridge
(September 9, 2016)

ATTACHMENT B

YEAR 5 (2016) IN-WATER SUBSTRATE MONITORING REPORT

ZRZ REALTY COMPANY WATERFRONT REMEDIATION PROJECT
USACE NWP-2007-962

YEAR 5 (2016) SUBSTRATE MONITORING REPORT

Submitted to

U.S. Army Corps of Engineers
Portland District, Regulatory Branch
P.O. Box 2946
Portland, Oregon 97208-2946

Prepared for

ZRZ Realty Company
3121 SW Moody Avenue
Portland, Oregon 97239

Prepared by

SWCA ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

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December 2016

SWCA Project No. 17563

submitted to U. S. Army Corps of Engineers
January 16, 2017
Paul A. Fishman, ZRZ Remediation Project Manager
copy to Oregon DEQ

CONTENTS

APPENDICES

TABLES

FIGURES

1. COMPLIANCE STATEMENT

The results from the Year 5 (2016) survey indicate that the rock-armored sediment cap in the study area is in compliance with the U.S. Army Corps of Engineers (USACE) Nationwide Permit 2007-962.

2. INTRODUCTION AND BACKGROUND

The ZRZ Realty Company (ZRZ) completed the in-water and riverbank portions of the ZRZ Waterfront Remediation Project in late October 2011. As part of the initial design, ZRZ placed rounded gravel substrate over portions of the in-water rock-armored sediment cap, as requested by the National Marine Fisheries Service (NMFS), in order to minimize impacts to habitat for Endangered Species Act (ESA)–listed fish. The purpose of the gravel substrate layer was to achieve the permit-required zero net increase in exposed rock armor substrate in the rock-armored sediment cap area below the ordinary high water (OHW) line between pre- and post-construction (as-built) conditions (Figure 1).

The terms and conditions in NMFS's *Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations* (BiOp; NMFS 2011) specify that to achieve a zero net increase in rock armor, the extent of gravel and/or fine-grain substrate (substrate smaller than gravel) must remain covering the rock armor. The BiOp also requires ZRZ to conduct substrate monitoring and reporting to document substrate conditions over the 10 years following construction. NMFS's concern is that erosion forces over time may shift the gravel substrate and expose rock armor, which they do not consider to be habitat for ESA-listed salmonids, but do consider to be habitat for predatory fish. Alternatively, silt deposits may accumulate with time over the rock armor and gravel substrate, which would decrease potential predatory habitat cover and provide what is considered acceptable habitat for salmonids. Dominance of ≤ gravel and an absence of potential predator cover are the primary parameters for meeting compliance. SWCA Environmental Consultants (SWCA) prepared a substrate monitoring plan to document changes in substrate. This plan was submitted to the USACE on April 28, 2011, and approved by NMFS. The plan outlines methods, monitoring intervals, performance criteria, and reporting goals of monitoring (SWCA 2011). Based on the Monitoring Plan, substrate monitoring surveys are to be completed during project years 1, 2, 3, 5 and 10 (2012 was Year 1).

Specifically, the Year 5 survey's objectives are to determine the following:

1. Dominance of gravel and/or smaller fine-grain substrate (substrate smaller than gravel, e.g., silt), evidence of erosion or sedimentation, and the extent to which conditions have changed within and between the monitoring transects and within and between the reaches since the as-built survey.
2. Absence or presence of rock armor within the gravel substrate, the extent to which these rocks protrude above the surrounding substrate, and the extent to which conditions have changed within and between the monitoring transects and within and between the reaches since the as-built survey.

SWCA performed an as-built substrate survey from October 24 to 27, 2011, to establish a baseline from which to measure future changes in the extent and type of substrate within the rock-armored sediment cap area. Following this baseline survey, SWCA conducted a Year 1 survey from August 3 to 9, 2012, a Year 2 survey from September 9 to 11, 2013, and a Year 3 survey from October 3 to 31, 2014. The Year 5 survey reported here, conducted on September 20 and 21 and October 10 and 11, 2016, and future surveys will document substrate changes from depositional or erosional forces that may occur in the study area during the high water period (November through June). The next data collection will occur in the summer months of 2021 (Year 10), during a period of favorable water clarity and river stage conditions. An additional summer survey will be conducted if a 20-year or larger flood event occurs between 2017 and 2021.

This Year 5 substrate monitoring report presents the data collected along 12 monitoring transects within three reaches. These reaches, Slipway, Bridge, and Downstream (south to north), were included in the project design and in the as-built, Year 1, 2, and 3 reports. Transects within these reaches were developed to encompass the range of physical conditions (slope, depth, velocity, substrate type, etc.) present throughout the rock-armored sediment cap area. All future substrate monitoring will use the same target number of data collection points along these transects, which is required for compliance. The monitoring plan does not require the data collected on data collection transects to be extrapolated to total surface area coverage (i.e., square feet or acres) for the entire rock-armored sediment cap area.

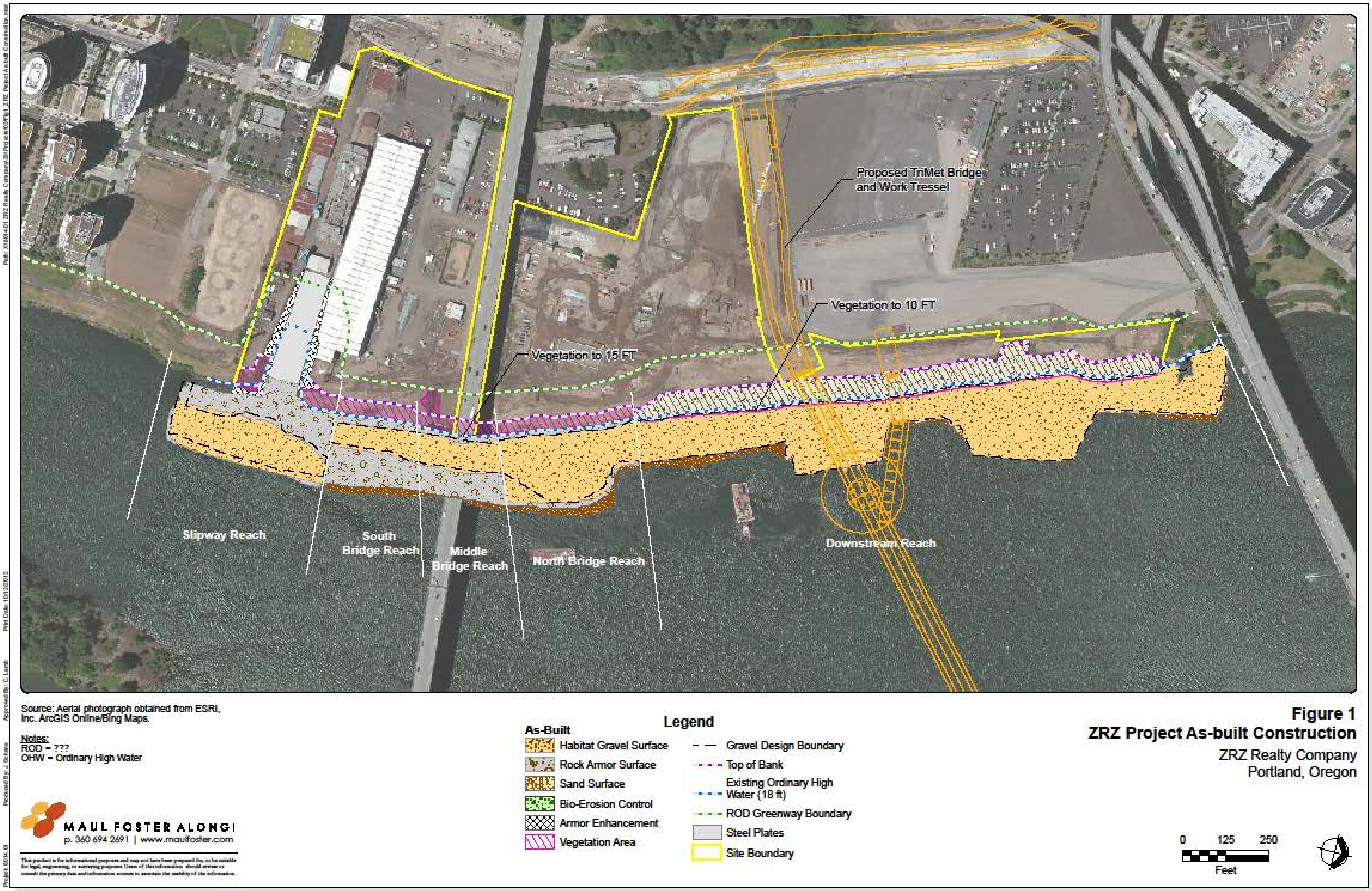

Figure 1. ZRZ Realty Company design plan map approved by National Marine Fisheries Service.

3. METHODS

Monitoring was conducted using methods described in the substrate monitoring plan (SWCA 2011). Transects were oriented perpendicularly to the shoreline and thalweg of the river and extended from the toe of the bank slope riverward (Figure 2). Transect lengths varied depending on the distances of the rock-armored sediment cap edge from shore; however, all transects extended beyond the cap edge determined by the 2011 as-built survey. Using a Trimble global positioning system (GPS) unit with submeter accuracy, transect locations at the riverbank were established before the as-built survey. Metal posts were driven into the ground at those locations as a benchmark/monument. All past and future transect data collection will begin at these markers. These locations were also tied into the overall project baseline alignment system used in the original engineering survey to identify land features. Data points (stations) were established at 1-meter (3.3-foot) intervals along each transect and given a unique identification number (Table 1).

Table 1. Substrate Monitoring Transect Locations and Distances Surveyed in As-Built Survey

Reach	Transect (station)	Transect Length (meters)	Start Location		End Location	
			X	Y	X	Y
Slipway	1 (−0+47)	57.0	−122.667265	45.499023	−122.666536	45.499033
	2 (1+24)	89.0	−122.667672	45.499476	−122.666533	45.499478
	3 (2+19)	60.0	−122.66731	45.499751	−122.666543	45.499741
Bridge	4 (3+45)	63.0	−122.667349	45.500098	−122.666542	45.500099
	5 (4+87)	56.9	−122.66742	45.500483	−122.666701	45.500559
	6 (6+29)	48.0	−122.667482	45.500911	−122.666872	45.500959
	7 (7+45)	61.0	−122.667616	45.501259	−122.666862	45.5014
	8 (9+37)	72.0	−122.667907	45.501755	−122.667059	45.502008
Downstream	9 (13+08)	39.9	−122.668462	45.502689	−122.667993	45.502833
	10 (16+68)	63.0	−122.668972	45.50361	−122.668216	45.503807
	11 (22+01)	65.0	−122.669749	45.504966	−122.669012	45.505239
	12 (26+50)	47.0	−122.670339	45.506132	−122.669777	45.506284

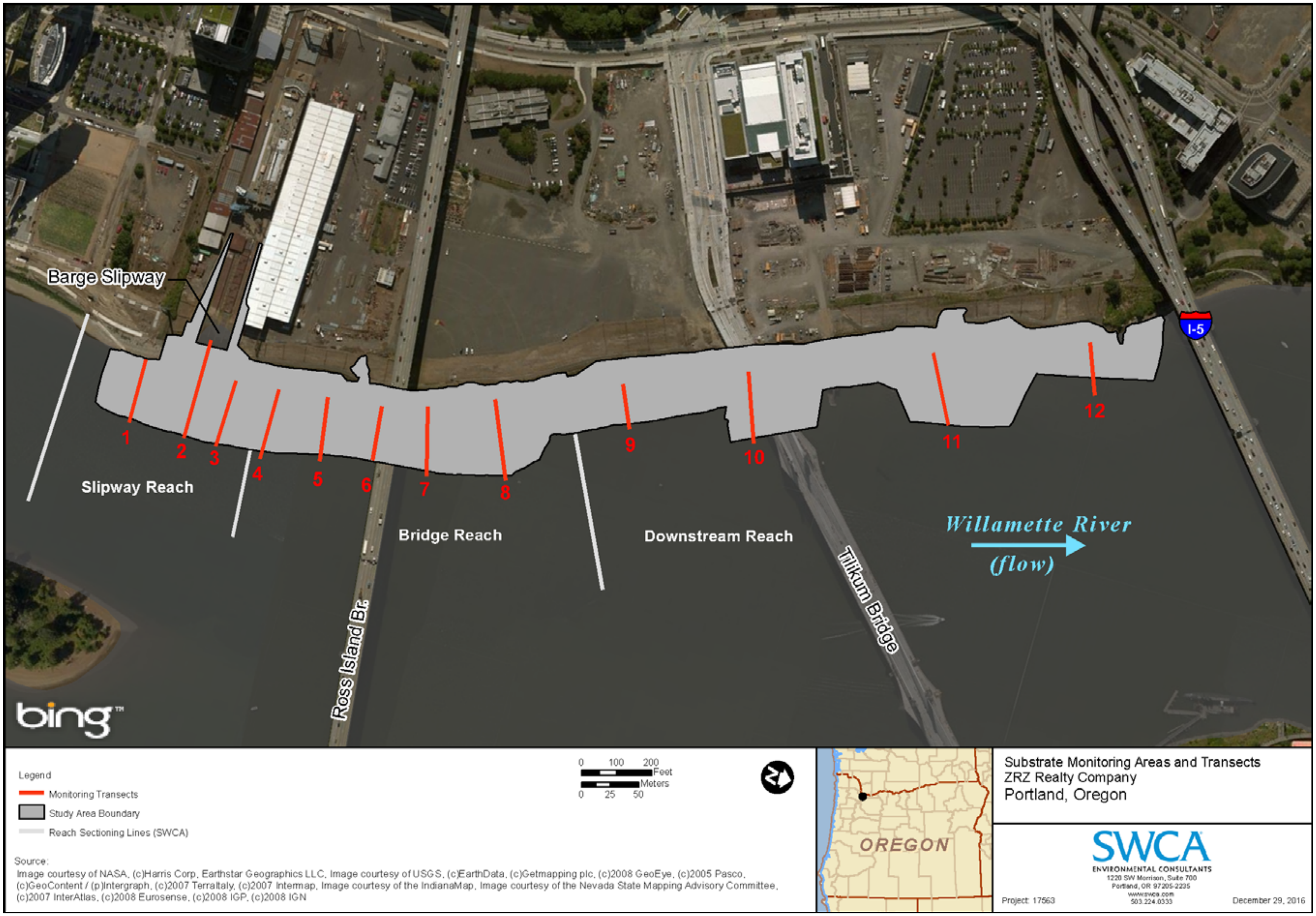

Figure 2. Transect locations and study area boundary for ZRZ Waterfront Remediation Project. Transects begin at the toe of bank slope.

The exposed shoreline end of each transect was surveyed at low tide in order to observe as much of the exposed transect as possible in-the-dry. At each exposed station, a digital photograph was taken, and substrate type, substrate category (Table 2), and percentage cover were recorded along with additional pertinent information. Silt and gravel substrate were combined into one single category (≤ gravel) because both are given a similar habitat value according to the NMFS BiOp and because any substrate consisting of gravel substrate or smaller material constitutes a compliant condition. Substrates B, C, D, and E are types of rock armor. Photographs of substrate types are provided in Appendix A.

Table 2. Definition of Substrate Types in the Study Area

Substrate Category	Substrate Type: Description	Diameter of Rock (inches)			Maximum Weight (lbs)	Gradation: Percentage by Weight (lbs)			
		Maximum	**Minimum**	**Mean**		**20%**	**30%**	**40%**	**10%**
≤ Gravel	Silt	0.38	0	N/A	N/A	N/A			
	Gravel: 2.52 inches minus rounded to subrounded	2.52	0.38	N/A	N/A	N/A			
Rock armor	Type B: 8 inches minus rounded to subrounded (cobble)	8	0.38	4	N/A	Well graded			
	Type C armor rock (100 lbs[*])	12[†]	2 lbs: 2.75[‡]	N/A	100	60–100	25–60	2–25	0–2
	Type D armor rock (200 lbs[*])	16[†]	8 lbs: 4.50[‡]	N/A	200	140–200	80–140	8–80	0–8
	Type E armor rock (700 lbs[*])	24[†]	20 lbs: 6.00[‡]	N/A	700	500–700	200–500	20–200	0–20

[*] Oregon Department of Transportation classification
[†] Approximate diameters
[‡] Approximate diameters of smallest rock in gradation

While surveying each transect, the in-water end of the transect was established using a tag-line attached to an anchored buoy placed at the riverward end of the transect (Figure 3). The tag-line was strung from the buoy to the shoreward end of the transect and attached to the metal benchmark post (Figure 4). The boat was attached to the tag-line using a bow clip to maintain its position along the transect (Figure 5).

Figure 3. Transect 4 (upstream of the Ross Island Bridge) looking east from the shoreline, showing the anchor buoy located at the in-water end of the transect and a secondary line buoy attached to the tag-line. Gravel substrate and a few pieces of rock armor are shown in the foreground above the water line.

Figure 4. Transcent 6 (under the Ross Island Bridge), looking south along the shoreline, showing the tag-line and metal benchmark post. Rock armor is visible above the water line.

Figure 5. Boat attached to a transect tag-line using a bow clip at Transect 10. Gravel substrate is shown in the foreground above the water line.

To document the portions of transects below the water line, an underwater video camera was lowered from the boat and manually pulled along the transect line. Methods followed those described in the substrate monitoring plan (SWCA 2011), with the exception of the camera frame configuration. To satisfy NMFS requirements to assess the vertical profile of rock armor protruding above the surface, an oblique camera angle was needed, which precluded the use of the camera frame design described in the plan. Data were recorded with the camera and GPS unit, and the video was recorded to digital video disk (DVD). The video feed was monitored in real-time to ensure seamless data capture. Video time and general substrate description were noted at each desired station point. When conditions became windy or if the current caused a bow in the transect line, the boat motor was used to hold the boat over the desired station point long enough to obtain a video image. Light-emitting diode (LED) lights mounted to the camera were used in low-light, deep-water areas (> 20 feet) to increase visibility.

Video images and field data were reviewed to determine the most common (dominant) and second-most common (subdominant) substrate types (see Table 2) and percentage cover of each station within a transect. Percentage cover was estimated based on the amount of each substrate type within a 0.5-square-meter (5.4-square-foot) area at each station. Where cover was 50% of one type and 50% of another type, the dominant substrate classification was assigned to the nearest dominant substrate type immediately surrounding the station. Additional observations that were noted included the presence of periphyton/algal growth and organisms. All data were entered into a geographic information system (GIS) database to ensure ease of future monitoring data comparisons.

In this and future monitoring events, the location of the riverward edge of the cap will be reevaluated using video observations. The distance from the metal post to the substrate rock (gravel substrate or rock armor) observed farthest from shore during the as-built survey cap was considered the extent of the cap and is referred to as the “cap transect.” The Year 3 transects were deliberately extended beyond the last station with rock armor observed in the Year 2 survey in order to confirm these findings.

Pinpointing the exact edge of the rock-armored sediment cap is difficult because of the increased hydraulic forces possibly found at the end of each transect where the water is deep and close to the thalweg. This substrate environment is therefore possibly more dynamic than that close to shore and may result in increased movement of silt and possibly habitat gravel. In addition, visibility is often poor, and the ability to control the underwater camera is affected by higher current velocities. It should also be noted that the sediment cap rock armor was designed with a “self-launching” toe to fill any undercutting with armor rock. Therefore, the additional lengths of some substrate transects is the result of either 1) substrate rock moving riverward, 2) silt movement exposing previously covered substrate rock, or 3) finding existing rock previously not observed. Cap transect length may increase if more substrate rock is observed beyond the existing edge; however, it will be assumed that observed silt is covering substrate rock in stations in which substrate rock was observed in previous years but only silt is observed in the current year of survey. Therefore, stations may be added to the cap transect but not removed. Because of this potential difference in number of stations within a transect, reach, and overall cap between the surveys, percentages of substrate types will be compared rather than totals.

When rock armor was present within stations dominated by gravel substrate or by silt-covered gravel substrate observed in the as-built survey (hereafter referred to as “HG/silt”), the rock armor was assessed to determine if individual pieces were protruding more than 2.5 inches above the substrate and creating a vertical face. The NMFS BiOp states that rocks exceeding these criteria constitute potential predator habitat (personal communication, Genevieve Angle, NMFS, March 29, 2011). Rock armor protruding from substrate was not assessed at stations that were either 1) dominated by silt but not identified as being gravel substrate–dominant in the as-built survey, or 2) not dominated by gravel substrate in the Year 5 survey. Gravel substrate was not placed at these stations, and assessing them would falsely inflate the amount of potential predator habitat; therefore, this criterion is assessed using HG/silt rather than ≤ gravel.

To achieve the Year 5 survey objectives, results and discussion in this report focus on the findings for the current Year 5 survey and how they compare to the as-built baseline survey. Trends throughout the years are explored, but conclusions are still difficult to make considering only 4 survey years of data have been collected since the as-built survey and considering that parameters varied in many transects and reaches between survey years.

4. RESULTS

4.1. Survey Conditions

During the survey days of September 20 and 21 and October 10 and 11, 2016, the daily mean gage height from the U.S. Geological Survey (USGS) gage located on the Willamette River approximately 1 mile downstream from the study area at the Morrison Bridge (river mile [RM] 12.8) ranged from 0.86 to 4.52 feet (adjusted to the City of Portland [CoP] datum). Daily mean discharge ranged from 8,140 to 19,800 cubic feet per second (USGS 2016). Small tidal amplitude (-1 foot 5 inches to 1 foot 2 inches; ProTides 2016) during the survey period did not result in currents flowing upstream during incoming tides.

Mean turbidity at the USGS Willamette River gage ranged from 2.3 to 4.3 formazin nephelometric units (FTUs). Mean total chlorophyll measured at the USGS gage ranged from 0.6 to 3.0 micrograms per liter (USGS 2016). These moderately clear water conditions during the survey resulted in visibility for the underwater video camera of approximately 3 feet.

4.2. Dominant Substrates

Cap transect length varied by location during the 2016 survey (38–82 meters [125–269 feet]).

Percentage coverage by ≤ gravel substrate increased in seven cap transects between the as-built and Year 5 surveys and was more dominant than rock armor in all cap transects and reaches observed during the Year 5 survey except for one transect that was equal parts ≤ gravel and rock armor (ranging from 50.0% to 97.0%). These percentages are similar to the as-built survey in which ≤ gravel was dominant in all but one cap transect (52.3%–96.9%). The Year 5 mean percentage coverage by ≤ gravel substrate was also greater than rock armor in the overall Slipway (60.9%), Bridge (65.7%), and Downstream reaches (84.6%) and in the overall rock-armored sediment cap area (70.1%). These findings are slightly higher than those observed in the as-built survey (54.9% in Slipway; 62.2% in Bridge; 67.8% in overall rock-armored sediment cap area) except for the Downstream reach, which was slightly higher (88.3%; Table 3).

Table 3. Percentage of Stations within Cap Transects Area Dominated by Substrate Category

Reach	Cap Transect	≤ Gravel				Rock Armor			
		As-Built		Year 5		As-Built		Year 5	
Slipway	1	61.5%	(32)	56.3%	(27)	38.5%	(20)	43.8%	(21)
	2	52.3%	(45)	70.7%	(58)	47.7%	(41)	29.3%	(24)
	3	52.6%	(30)	50.0%	(27)	47.4%	(27)	50.0%	(27)
	Mean	54.9%	(107)	60.9%	(112)	45.1%	(88)	39.1%	(72)

Table 3. Percentage of Stations within Cap Transects Area Dominated by Substrate Category

Reach	Cap Transect	≤ Gravel				Rock Armor			
		As-Built		Year 5		As-Built		Year 5	
Bridge	4	46.7%	(28)	53.3%	(32)	53.3%	(32)	46.7%	(28)
	5	61.4%	(35)	64.9%	(37)	38.6%	(22)	35.1%	(20)
	6	55.1%	(27)	63.3%	(31)	44.9%	(22)	36.7%	(18)
	7	58.6%	(34)	59.3%	(35)	41.4%	(24)	40.7%	(24)
	8	83.3%	(60)	83.3%	(60)	16.7%	(12)	16.7%	(12)
	Mean	62.2%	(184)	65.7%	(195)	37.8%	(112)	34.3%	(102)
Downstream	9	81.1%	(30)	60.5%	(23)	18.9%	(7)	39.5%	(15)
	10	95.3%	(61)	90.3%	(56)	4.7%	(3)	9.7%	(6)
	11	96.9%	(62)	97.0%	(64)	3.1%	(2)	3.0%	(2)
	12	70.0%	(28)	78.6%	(33)	30.0%	(12)	21.4%	(9)
	Mean	88.3%	(181)	84.6%	(176)	11.7%	(24)	15.4%	(32)
Grand mean		67.8%	(472)	70.1%	(483)	32.2%	(224)	29.9%	(206)

Note: *n* values are presented in parentheses.

The percentage of cap transects dominated by gravel substrate decreased between the as-built and Year 5 surveys in all but one transect; however, gravel substrate was still greater than silt in eight cap transects (35.1%–61.2%) in Year 5. This differs from the as-built survey in which gravel substrate was greater in all cap transects (43.9%–96.9%). The mean percentage coverage by gravel substrate continued to slightly decrease in the Slipways reach from the as-built (49.7%) to the Year 5 (38.0%) survey while reducing by roughly half in the Bridge (from 60.5% to 36.0%) and Downstream (from 85.9% to 38.5%) reaches and the overall rock armored sediment cap (from 64.9% to 37.3%; Table 4; Figure 6).

Table 4. Percentage of Stations within Cap Transects Area Dominated by Substrate Type

Reach	Cap Transect	Silt				Gravel Substrate				Type B				Type C				Type D				Type E			
		As-Built		Year 5		As-Built		Year 5		As-Built		Year 5		As-Built		Year 5		As-Built		Year 5		As-Built		Year 5	
Slipway	1	0.0%	(0)	0.0%	(0)	61.5%	(32)	56.3%	(27)	0.0%	(0)	2.1%	(1)	0.0%	(0)	8.3%	(4)	1.9%	(1)	29.2%	(14)	36.5%	(19)	4.2%	(2)
	2	5.8%	(5)	42.7%	(35)	46.5%	(40)	28.0%	(23)	0.0%	(0)	3.7%	(3)	30.2%	(26)	8.5%	(7)	0.0%	(0)	14.6%	(12)	17.4%	(15)	2.4%	(2)
	3	8.8%	(5)	13.0%	(7)	43.9%	(25)	37.0%	(20)	0.0%	(0)	0.0%	(0)	0.0%	(0)	5.6%	(3)	0.0%	(0)	33.3%	(18)	47.4%	(27)	11.1%	(6)
	Mean	5.1%	(10)	22.8%	(42)	49.7%	(97)	38.0%	(70)	0.0%	(0)	2.2%	(4)	13.3%	(26)	7.6%	(14)	0.5%	(1)	23.9%	(44)	31.3%	(61)	5.4%	(10)
Bridge	4	1.7%	(1)	11.7%	(7)	45.0%	(27)	41.7%	(25)	51.7%	(31)	36.7%	(22)	0.0%	(0)	8.3%	(5)	0.0%	(0)	1.7%	(1)	1.7%	(1)	0.0%	(0)
	5	1.8%	(1)	29.8%	(17)	59.6%	(34)	35.1%	(20)	35.1%	(20)	29.8%	(17)	0.0%	(0)	3.5%	(2)	1.8%	(1)	1.8%	(1)	1.8%	(1)	0.0%	(0)
	6	0.0%	(0)	2.0%	(1)	55.1%	(27)	61.2%	(30)	36.7%	(18)	32.7%	(16)	6.1%	(3)	2.0%	(1)	0.0%	(0)	0.0%	(0)	2.0%	(1)	2.0%	(1)
	7	0.0%	(0)	11.9%	(7)	58.6%	(34)	47.5%	(28)	39.7%	(23)	37.3%	(22)	0.0%	(0)	1.7%	(1)	0.0%	(0)	1.7%	(1)	1.7%	(1)	0.0%	(0)
	8	4.2%	(3)	77.8%	(56)	79.2%	(57)	5.6%	(4)	12.5%	(9)	1.4%	(1)	2.8%	(2)	9.7%	(7)	1.4%	(1)	4.2%	(3)	0.0%	(0)	1.4%	(1)
	Mean	1.7%	(5)	29.6%	(88)	60.5%	(179)	36.0%	(107)	34.1%	(101)	26.3%	(78)	1.7%	(5)	5.4%	(16)	0.7%	(2)	2.0%	(6)	1.4%	(4)	0.7%	(2)
Downstream	9	2.7%	(1)	39.5%	(15)	78.4%	(29)	21.1%	(8)	18.9%	(7)	18.4%	(7)	0.0%	(0)	21.1%	(8)	0.0%	(0)	0.0%	(0)	0.0%	(0)	0.0%	(0)
	10	4.7%	(3)	59.7%	(37)	90.6%	(58)	30.6%	(19)	4.7%	(3)	3.2%	(2)	0.0%	(0)	6.5%	(4)	0.0%	(0)	0.0%	(0)	0.0%	(0)	0.0%	(0)
	11	0.0%	(0)	45.5%	(30)	96.9%	(62)	51.5%	(34)	3.1%	(2)	3.0%	(2)	0.0%	(0)	0.0%	(0)	0.0%	(0)	0.0%	(0)	0.0%	(0)	0.0%	(0)
	12	2.5%	(1)	33.3%	(14)	67.5%	(27)	45.2%	(19)	7.5%	(3)	11.9%	(5)	0.0%	(0)	9.5%	(4)	22.5%	(9)	0.0%	(0)	0.0%	(0)	0.0%	(0)
	Mean	2.4%	(5)	46.2%	(96)	85.9%	(176)	38.5%	(80)	7.3%	(15)	7.7%	(16)	0.0%	(0)	7.7%	(16)	4.4%	(9)	0.0%	(0)	0.0%	(0)	0.0%	(0)
Grand mean		2.9%	(20)	32.8%	(226)	64.9%	(452)	37.3%	(257)	16.7%	(116)	14.2%	(98)	4.5%	(31)	6.7%	(46)	1.7%	(12)	7.3%	(50)	9.3%	(65)	1.7%	(12)

Note: n values are presented in parentheses.

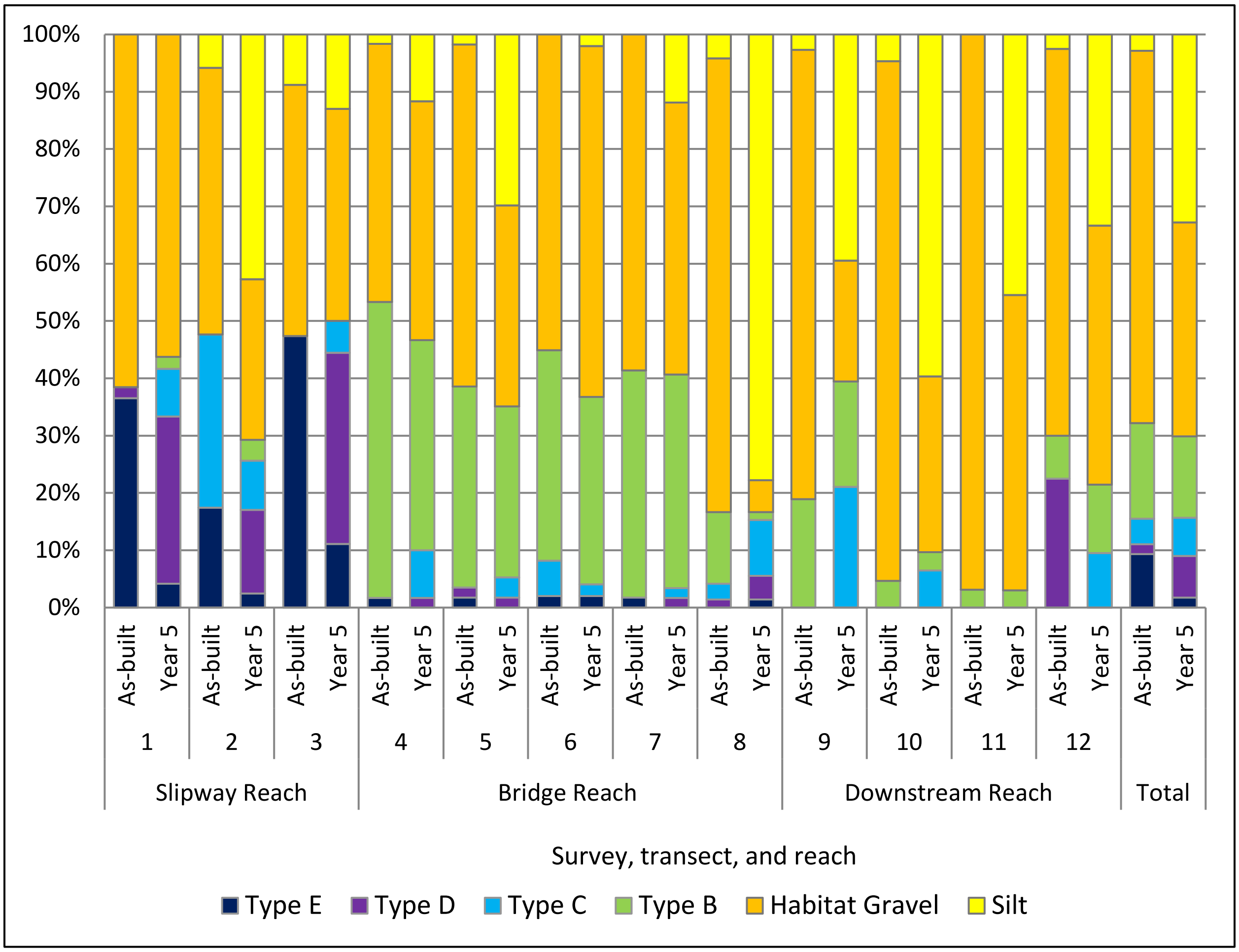

Figure 6. Substrate type and composition within the cap transects.

Between the as-built and Year 5 surveys, the percentage coverage by rock armor decreased in seven cap transects, in the Slipway and Bridge reaches, and in the overall rock-armored sediment cap. More specifically, the mean percentage change of Types B, C, D, and E in each cap transect varied drastically between the as-built and Year 5 surveys. Large rock armor decreases were observed in Type B in the Bridge reach (from 34.1% to 26.3%) and in Type C and E in the Slipway reach (from 13.3% to 7.6% and from 31.3% to 5.4%, respectively). A large mean increase in Type D was observed in the Slipway reach (from 0.5% to 23.9%). Changes in all other rock armor types by reach were minimal except for a few exceptions by cap transect (Type B in Transects 4 and 8, Type C in Transects 2 and 9, and Type D in Transect 12). In Year 5, Type B was greater than other rock armor in six cap transects (3.0%–37.3%) all within the Bridge and Downstream reaches. Type D was the most common in the Slipway reach cap transects (14.6%–33.3%). This is similar to the as-built survey in which Type B was the most prevalent rock armor in eight cap transects all within the Bridge and Downstream reaches (3.1%–51.7%), and Type E was most or second-most common in the Slipway reach (17.4%–47.4%; see Table 4 and Figure 6).

4.3. Sedimentation/Deposition

Silt was observed in all but one cap transect (0.0%–77.8%) and at a much greater amount than in the as-built survey (0.0%–8.8%). Mean silt dominance also increased considerably in the reaches (from 5.1% to 22.8% in Slipway, from 1.7% to 29.6% in Bridge, and from 2.4% to 46.2% in Downstream), and in the overall rock-armored sediment cap (from 2.9% to 32.8%). Silt was not observed in Transect 1, which is equal to the as-built survey (0.0%; see Table 4 and Figure 6).

4.4. Potential Predator Cover

In all, 405 HG/silt-dominant stations were assessed for the presence and size of rock armor (Table 5). In the as-built survey, 452 were assessed, and this decrease is a result of changes in observed dominant substrate. The number of HG/silt-dominant stations in each cap transect in which rock armor was present varied between years. The percentage in which a rock armor vertical face protruded more than 2.5 inches above HG/silt did not increase in any cap transects, decreased in ten, and stayed the same in two, between the as-built and Year 5 surveys. The percentage in which rock armor was present but did not protrude over 2.5 inches above substrate or did not have a vertical face increased in four cap transects and decreased in eight, when compared to the as-built survey. HG/silt-dominant stations in the Slipway reach contained the highest mean percentage of stations with vertical rock armor face protruding more than 2.5 inches above the surrounding substrate (14.8%) when compared to the Bridge (1.8%) and Downstream (0.0%) reaches. The Slipway reach also contained the highest mean percentages in the as-built survey (27.8%). The Bridge and Downstream reaches both decreased between the surveys. The Bridge reach contained the highest mean percentage of stations with rock armor that did not protrude more than 2.5 inches above the surrounding substrate or did not have a vertical face (25.5%). This was followed by the Slipway reach (18.5%) and then by the Downstream reach (8.8%). The Bridge reach also contained the highest mean percentages in the as-built survey (32.4%).

Overall, a small portion of stations dominated by HG/silt contained rock armor with a vertical face protruding more than 2.5 inches above the surrounding substrate (3.7%). This amount is less than the mean in the as-built survey (9.5%). A greater mean percentage of stations in all years contained rock armor that did not protrude more than 2.5 inches above the surrounding substrate or did not have a vertical face (Year 5: 17.5%, as-built: 21.9%).

Table 5. Protruding Rock Armor in Year 5 Gravel Substrate–Dominant Stations and Silt-Dominant Stations that were Gravel Substrate–Dominant in the As-Built Survey

Reach	Cap Transect	Rock Armor With Vertical Face Present and Protruding > 2.5 Inches Above Substrate				Rock Armor Present But Does Not Have a Vertical Face Protruding > 2.5 Inches Above Substrate			
		As-Built		Year 5		As-Built		Year 5	
Slipway	1	25.0%	(8)	7.4%	(2)	25.0%	(8)	18.5%	(5)
	2	25.0%	(10)	12.9%	(4)	15.0%	(6)	9.7%	(3)
	3	36.0%	(9)	26.1%	(6)	20.0%	(5)	30.4%	(7)
	Mean	27.8%	(27)	14.8%	(12)	19.6%	(19)	18.5%	(15)
Bridge	4	7.4%	(2)	0.0%	(0)	55.6%	(15)	28.0%	(7)
	5	11.8%	(4)	3.7%	(1)	47.1%	(16)	48.1%	(13)
	6	3.7%	(1)	3.3%	(1)	37.0%	(10)	30.0%	(9)
	7	8.8%	(3)	3.3%	(1)	20.6%	(7)	30.0%	(9)
	8	0.0%	(0)	0.0%	(0)	17.5%	(10)	7.5%	(4)
	Mean	5.6%	(10)	1.8%	(3)	32.4%	(58)	25.5%	(42)
Downstream	9	0.0%	(0)	0.0%	(0)	31.0%	(9)	19.0%	(4)
	10	1.7%	(1)	0.0%	(0)	10.3%	(6)	5.5%	(3)
	11	3.2%	(2)	0.0%	(0)	4.8%	(3)	3.2%	(2)
	12	11.1%	(3)	0.0%	(0)	14.8%	(4)	23.8%	(5)
	Mean	3.4%	(6)	0.0%	(0)	12.5%	(22)	8.8%	(14)
Grand Mean		9.5%	(43)	3.7%	(15)	21.9%	(99)	17.5%	(71)

Note: n values are presented in parentheses.

4.5. Substrate Trends

Generally, less ≤ gravel was observed in the as-built survey (46.7%–96.9%) than in the Year 1 through 5 surveys (49.1%–98.4%). Eight transects, the Slipway and Bridge reaches, and the overall study area contained a low (lowest or second lowest of all years) percentage of observed ≤ gravel in the as-built survey. Overall, the percentage of observed ≤ gravel tended to increase from the as-built survey and then fluctuate in the following years. No obvious trends are apparent between the Year 1, 2, 3, and 5 surveys; however, mean observed ≤ gravel per reach and in the overall study area appears to be decreasing slightly over time but was generally similar between years (Slipway: 60.9%–70.0%, Bridge: 65.7%–77.1%, Downstream: 84.6%–91.7%, overall: 70.1%–78.3%) and remained higher than in the as-built survey.

Silt accumulation followed a similar pattern and percentage of silt in cap transects during the as-built survey (0.0%–8.8%) and was generally much lower than subsequent years (0.0%–82.8%). The percentage in each cap transect in the Slipway reach tended to decrease every year from Year 1 to Year 5. The percentage in each cap transect in the Bridge reach tended to decrease from Year 1 to Year 2, increase from Year 2 to Year 3, and decrease again from Year 3 to Year 5; however, the magnitude of percentage fluctuations tended to decrease over time. The percentage in each cap transect in the Downstream reach tended to increase from Year 1 to Year 3, with a slight decrease in Year 5. Year 1 through 5 mean silt appears to be decreasing in the Slipway reach (decreases ranging from 22.8% to 43.4%) and increasing in the Downstream reach (increases ranging from 35.6% to 50.0%).

The percentage of gravel substrate in cap transects was generally high (highest or second highest of all years) in the as-built survey (ranging from 43.9% to 96.9%). The percentage in each cap transect in the Slipway reach tended to increase from Year 1 to Year 3 and decrease slightly from Year 3 to Year 5. The percentage in each cap transect in the Bridge reach tended to increase from Year 1 to Year 2, decrease from Year 2 to Year 3, and increase again from Year 3 to Year 5. The percentage in each cap transect in the Downstream reach tended to decrease from Year 1 to Year 3 and increase slightly from Year 3 to Year 5. Year 1 through Year 5 mean gravel substrate appears to be increasing in the Slipway reach (increases ranging from 22.7% to 42.4%) and decreasing in the Downstream reach (decreases ranging from 36.1% to 56.1%). This trend is inverse to that for silt.

During the as-built survey, the percentage of Type B in cap transects was low (lowest of all years) in the Slipway reach (0.0%–0.0%) and high (highest or second highest of all years) in the Bridge reach (12.5%–51.7%). In general, the percentage in each cap transect in the Slipway and Downstream reaches tended to increase from Year 1 to Year 2 and decrease from Year 2 to Year 5. The percentage in each cap transect in the Bridge reach tended to increase from Year 1 to Year 2, decrease from Year 2 to Year 3, and increase from Year 3 to Year 5.

The percentage of Type C in cap transects was relatively nonexistent in the Downstream reach throughout the years (0.0%–21.1%).

The percentage of Type D in cap transects was low (lowest of all years) during the as-built survey in the Slipway reach (0.0%–1.9%). The percentage in each cap transect in the Slipway reach tended to decrease from Year 1 to Year 2 and increase from Year 2 to Year 5. Type D was not observed in Transects 6, 9, 10, and 11 throughout the years (0.0%–0.0%). Year 1 through Year 5 mean Type D appears to be increasing slightly in the Bridge reach (1.0%–2.0%).

The percentage of Type E in cap transects was high (highest or second highest of all years) during the as-built survey in the Slipway reach (36.5%–47.4%). The percentage in each cap transect in the Slipway reaches tended to decrease from Year 1 to Year 2, increase from Year 2 to Year 3, and decrease again from Year 3 to Year 5. Type E has been relatively nonexistent in the Downstream reach throughout the four surveys (0.0%–2.5%).

The percentage of HG/silt stations in which rock armor vertical faces protruded more than 2.5 inches above the substrate tended to decrease from Year 1 to Year 2 in the Bridge reach, increase from Year 2 to Year 3, and decrease again from Year 3 to Year 5. Year 1 through Year 5 mean vertical faces appear to be decreasing in the Slipway (10.7%–24.4%) and Downstream reaches (0.0%–4.6%) and overall rock armored sediment cap (3.7%–9.6%).

The percentage of HG/silt stations in which rock armor did not have a vertical face or protrude 2.5 inches above the substrate was high (highest or second highest of all years) during the as-built survey in the Bridge and Downstream reaches (4.8%–55.6%). The percentage in each cap transects in the Slipway and Bridge reaches tended to increase from Year 1 to Year 2, decrease from Year 2 to Year 3, and increase again from Year 3 to Year 5. The percentage in each cap transects in the Downstream reach tended to decrease from Year 1 to Year 2, increase from Year 2 to Year 3, and decrease again from Year 3 to Year 5.

See Appendix B for all substrate trend data from the as-built and Years 1, 2, 3, and 5 surveys.

4.6. Fish and Invertebrate Observations

Several species of fish were documented during the Year 5 survey, including carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and largescale sucker (*Catostomus macrocheilus*). Documented fish were observed in all three transects of the Slipway reach, Transects 7 and 8 of the Bridge reach, and Transects 9 and 11 of the Downstream reach. This observation is similar to the number of fish observations in eight cap transects in the as-built survey.

4.7. Periphyton and Algae Growth

Periphyton growth was apparent on rock surfaces throughout the study area, primarily below the low water mark to depths of 10 to 15 feet (at the time of survey), where sunlight penetration becomes diminished.

4.8. Bank Repair

No signs of erosion were apparent in areas of new bank repair (see Figure 7 as example). Coir matting or logs remain in place, and rooted vegetation is present at all sites at which bank stabilization repair work occurred (i.e., Transects 1, 3, 6, 7, and 8).

Figure 7. Bank restoration (area above armor) at Transect 3.

5. DISCUSSION

5.1. Sedimentation and Deposition

Survey conditions (daily mean gage height, daily mean discharge, tidal amplitude, stream flows, turbidity, surface turbidity, total chlorophyll, and visibility) were all within normal and acceptable ranges during the Year 5 survey.

Overall, ≤ gravel was the dominant substrate type in the Year 5 survey and was 2.3% greater than the amount observed in the as-built survey. This shift in ≤ gravel was observed in all reaches. In terms of specific substrate type, the stations within the Slipway reach changed between the as-built and Year 5 surveys more than the other reaches. In fact, only Transect 8 of the Bridge reach did not have a change in gravel substrate or rock armor-type percentage composition between the surveys. Gravel substrate and Type B both decreased significantly in the Bridge reach stations, but Types C, D, and E generally had little variation. Gravel substrate composition significantly decreased in the Downstream reach, whereas rock armor only slightly increased, and ≤ gravel overall remained relatively consistent between the as-built and Year 5 surveys.

Movement and deposition of silt were most likely the primary contributing factors to the changes seen between the as-built and Year 5 surveys. Considering that silt increased and gravel substrate decreased in almost all cap transects, it can be inferred that silt additional to that already in the cap transects settled on and covered gravel substrate in almost all cap transects.

Displaced substrate may explain the instances where overall gravel substrate decreased (Transects 1, 3, 9, and 10) more than silt increased. These scenarios resulted in an overall decrease in ≤ gravel in four transects and may be the result of hydraulic forces moving gravel substrate elsewhere. Hydraulic forces may have also dispersed Types B and C over gravel substrate, and anecdotal evidence suggests that Types B and C placed along the toe of the bank have been dispersed riverward by wave action. In fact, an increase in Types B and C in all four transects accounts for most or all of the difference between silt and gravel substrate changes. The loss or maintenance in the amount of gravel substrate appears to be partially because of Types B and C covering existing or newly exposed gravel substrate. However, these erosion forces are likely limited and localized considering that silt was found in most Year 5 cap transects in significant amounts. Overall, however, the amount of silt is currently greater than what was observed in the as-built survey.

5.2. Potential Predator Cover

Changes in the presence and size of rock armor observed within HG/silt-dominant stations are also likely because of the movement of silt. Between the as-built and Year 5 surveys, the percentage of HG/silt-dominant stations containing rock armor (of any size with or without vertical faces) decreased in most cap transects. These data suggest that hydraulic conditions moved silt to cover all sizes (> and < 2.5 inches) of protruding rock armor in many locations in the reaches. Overall, the mean percentage of observed protruding rock armor of any size, i.e., potential predator habitat, in Year 5 was less than that observed in the as-built survey.

5.3. Substrate Trends

With only the as-built data and 4 years of subsequent data over the course of 5 years, conclusions regarding trends or rate of change can still not be substantiated. Data can indicate differences over time; however, the inferred causes of these differences are based on limited data and should be interpreted with caution.

The western pier of the Tilikum Crossing Bridge, located adjacent to the cap, was completed in September 2015, 4 years after the as-built survey was completed in October 2011. The western pier and the temporary work trestle, present during the as-built survey and removed prior to the 2014 (Year 3) survey, may influence long term patterns of scour and deposition in the Downstream reach.

With that being said, movement of silt has been a common trend throughout the study, and as expected, the largest change was observed between the as-built and Year 1 surveys, which is likely because of the initial siltation on relatively silt-free substrate. Silt was then observed in Year 1 through Year 5 in almost every cap transect, but changes varied, sometimes greatly, between cap transect and year. ≤ gravel also increased from the as-built survey and then varied in the subsequent surveys but to a lesser degree than silt. The percentage of observed gravel substrate and rock armor types has also changed throughout the study and was likely affected by the silt. Degrees of change between years varied greatly by transect and reach; however, patterns have emerged in certain area for certain substrates. Again, the largest changes tended to be between the as-built and Year 1 surveys.

Silt has also caused a change in the rock armor protruding in HG/silt-dominant stations. However, unlike gravel substrate in which large changes tended to be observed between the as-built and Year 1 surveys, mean reach percentages of vertical faces greater than 2.5 inches tended to stay relatively similar between these years. Alternatively, mean reach percentages of rock armor without a vertical face or not protruding greater than 2.5 inches above substrate tended to decrease. The large amount of silt that accumulated between the as-built and Year 1 surveys apparently did not cover large protruding rock armor (> 2.5 inches) but did cover smaller rock armor (< 2.5 inches). Changes in percentage of HG/silt-dominant stations with vertical faces in subsequent years were variable between most years and transects; however, a decreasing mean trend in protruding vertical faces greater than 2.5 inches was observed in all reaches. Overall, siltation may not have initially caused a decrease in potential predator habitat but appears to slowly be covering the rock armor through the years.

5.4. Bank Repair

New bank restoration measures have been effective, and vegetation is becoming well established in all transects in which restoration measures were applied (see Figure 7).

6. CONCLUSIONS

The NMFS-approved substrate monitoring plan for the study area defines substrate compliance as monitoring results indicating that "the area of gravel or finer substrate observed in the representative [data collection] cap transects is not less than the as-built condition as measured on an annual basis" (SWCA 2011). Specifically, compliance is based on the following three factors in the NMFS-approved substrate monitoring plan:

- Dominance of gravel or smaller substrate: The Year 5 survey indicates a 3.37% increase in stations dominated by ≤ gravel from the 472 observed in the as-built survey; this meets condition compliance.

- Absence/presence of large angular rocks (> 2.5 inches) with vertical faces: The Year 5 survey indicates a 65.12% decrease in stations containing protruding, visible rock faces from the 43 observed in the as-built survey; this meets condition compliance.
- Exposed large angular rock may constitute a compliant condition if oriented in such a way that it creates a flat surface relative to other substrate, is covered or surrounded by a dominant composition of gravel or smaller substrates, and does not protrude above the surrounding substrate level: The Year 5 survey indicates a 28.28% decrease in the percentage of stations with rock armor not protruding greater than 2.5 inches from the silt or not having a vertical face. This percentage was not converted to protruding rock armor faces over 2.5 inches as this percentage also decreased. This meets condition compliance.

Overall, because of an increase in siltation, the percentage cover of ≤ gravel has increased, whereas rock armor protruding from silt and gravel substrate has decreased since the as-built survey. According to the findings of the Year 5 survey, the rock-armored sediment cap area is currently in compliance.

7. LITERATURE CITED

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Appendix A

Images of Substrate Types

Figure A1. Underwater image of silt substrate.

Figure A2. Underwater image of gravel substrate.

Figure A3. Underwater image of Type B size rock armor.

Figure A4. Underwater image of Type C size rock armor and silt.

Figure A5. Underwater image of Type D size rock armor.

Figure A6. Underwater image of Type E size rock armor and a small amount of silt.

Figure A7. Underwater image of silt on gravel substrate with a > 2.5-inch rock armor face protruding through.

Figure A8. Underwater image of silt over Type C size rock armor.

Figure A9. Underwater image of gravel substrate in shallow water showing periphyton growth.

Figure A10. Underwater image of a large mouth bass.

Figure A11. Underwater image of bluegill.

Figure A12. Underwater image of a largescale sucker.

Appendix B

Yearly Survey Data

Table B1. Percentage of Stations within Cap Transects Area Dominated by Substrate Category

Reach	Cap Transect	≤ Gravel										Rock Armor									
		As-Built		Year 1		Year 2		Year 3		Year 5		As-Built		Year 1		Year 2		Year 3		Year 5	
Slipway	1	61.5%	(32)	54.5%	(30)	60.0%	(33)	61.8%	(34)	56.3%	(27)	38.5%	(20)	45.5%	(25)	40.0%	(22)	38.2%	(21)	43.8%	(21)
	2	52.3%	(45)	84.9%	(73)	86.0%	(74)	84.4%	(76)	70.7%	(58)	47.7%	(41)	15.1%	(13)	14.0%	(12)	15.6%	(14)	29.3%	(24)
	3	52.6%	(30)	49.1%	(28)	55.9%	(33)	51.7%	(31)	50.0%	(27)	47.4%	(27)	50.9%	(29)	44.1%	(26)	48.3%	(29)	50.0%	(27)
	Mean	54.9%	(107)	66.2%	(131)	70.0%	(140)	68.8%	(141)	60.9%	(112)	45.1%	(88)	33.8%	(67)	30.0%	(60)	31.2%	(64)	39.1%	(72)
Bridge	4	46.7%	(28)	68.3%	(41)	73.3%	(44)	65.6%	(40)	53.3%	(32)	53.3%	(32)	31.7%	(19)	26.7%	(16)	34.4%	(21)	46.7%	(28)
	5	61.4%	(35)	77.2%	(44)	64.9%	(37)	66.7%	(38)	64.9%	(37)	38.6%	(22)	22.8%	(13)	35.1%	(20)	33.3%	(19)	35.1%	(20)
	6	55.1%	(27)	69.4%	(34)	59.2%	(29)	57.7%	(30)	63.3%	(31)	44.9%	(22)	30.6%	(15)	40.8%	(20)	42.3%	(22)	36.7%	(18)
	7	58.6%	(34)	71.2%	(42)	50.0%	(31)	79.0%	(49)	59.3%	(35)	41.4%	(24)	28.8%	(17)	50.0%	(31)	21.0%	(13)	40.7%	(24)
	8	83.3%	(60)	94.4%	(68)	81.9%	(59)	88.9%	(64)	83.3%	(60)	16.7%	(12)	5.6%	(4)	18.1%	(13)	11.1%	(8)	16.7%	(12)
	Mean	62.2%	(184)	77.1%	(229)	66.7%	(200)	72.7%	(221)	65.7%	(195)	37.8%	(112)	22.9%	(68)	33.3%	(100)	27.3%	(83)	34.3%	(102)
Downstream	9	81.1%	(30)	86.5%	(32)	70.3%	(26)	73.7%	(28)	60.5%	(23)	18.9%	(7)	13.5%	(5)	29.7%	(11)	26.3%	(10)	39.5%	(15)
	10	95.3%	(61)	95.3%	(61)	95.3%	(61)	93.8%	(60)	90.3%	(56)	4.7%	(3)	4.7%	(3)	4.7%	(3)	6.3%	(4)	9.7%	(6)
	11	96.9%	(62)	98.4%	(63)	96.9%	(62)	97.0%	(64)	97.0%	(64)	3.1%	(2)	1.6%	(1)	3.1%	(2)	3.0%	(2)	3.0%	(2)
	12	70.0%	(28)	80.0%	(32)	85.0%	(34)	67.5%	(27)	78.6%	(33)	30.0%	(12)	20.0%	(8)	15.0%	(6)	32.5%	(13)	21.4%	(9)
	Mean	88.3%	(181)	91.7%	(188)	89.3%	(183)	86.1%	(179)	84.6%	(176)	11.7%	(24)	8.3%	(17)	10.7%	(22)	13.9%	(29)	15.4%	(32)
Grand mean		67.8%	(472)	78.3%	(548)	74.2%	(523)	75.5%	(541)	70.1%	(483)	32.2%	(224)	21.7%	(152)	25.8%	(182)	24.5%	(176)	29.9%	(206)

Table B2. Percentage of Stations within Cap Transects Area Dominated by Substrate Type

Silt

Reach	Cap Transect	As-Built	Year 1	Year 2	Year 3	Year 5
Slipway	1	0.0% (0)	18.2% (10)	5.5% (3)	1.8% (1)	0.0% (0)
	2	5.8% (5)	69.8% (60)	51.2% (44)	45.6% (41)	42.7% (35)
	3	8.8% (5)	28.1% (16)	18.6% (11)	20.0% (12)	13.0% (7)
	Mean	5.1% (10)	43.4% (86)	29.0% (58)	26.3% (54)	22.8% (42)
Bridge	4	1.7% (1)	21.7% (13)	6.7% (4)	21.3% (13)	11.7% (7)
	5	1.8% (1)	45.6% (26)	1.8% (1)	24.6% (14)	29.8% (17)
	6	0.0% (0)	26.5% (13)	0.0% (0)	13.5% (7)	2.0% (1)
	7	0.0% (0)	27.1% (16)	1.6% (1)	51.6% (32)	11.9% (7)
	8	4.2% (3)	76.4% (55)	68.1% (49)	68.1% (49)	77.8% (56)
	Mean	1.7% (5)	41.4% (123)	18.3% (55)	37.8% (115)	29.6% (88)
Downstream	9	2.7% (1)	48.6% (18)	35.1% (13)	47.4% (18)	39.5% (15)
	10	4.7% (3)	68.8% (44)	82.8% (53)	75.0% (48)	59.7% (37)
	11	0.0% (0)	6.3% (4)	34.4% (22)	57.6% (38)	45.5% (30)
	12	2.5% (1)	17.5% (7)	12.5% (5)	0.0% (0)	33.3% (14)
	Mean	2.4% (5)	35.6% (73)	45.4% (93)	50.0% (104)	46.2% (96)
Grand mean		2.9% (20)	40.3% (282)	29.2% (206)	38.1% (273)	32.8% (226)

Habitat Gravel

Reach	Cap Transect	As-Built	Year 1	Year 2	Year 3	Year 5
Slipway	1	61.5% (32)	36.4% (20)	54.5% (30)	60.0% (33)	56.3% (27)
	2	46.5% (40)	15.1% (13)	34.9% (30)	38.9% (35)	28.0% (23)
	3	43.9% (25)	21.1% (12)	37.3% (22)	31.7% (19)	37.0% (20)
	Mean	49.7% (97)	22.7% (45)	41.0% (82)	42.4% (87)	38.0% (70)
Bridge	4	45.0% (27)	46.7% (28)	66.7% (40)	44.3% (27)	41.7% (25)
	5	59.6% (34)	31.6% (18)	63.2% (36)	42.1% (24)	35.1% (20)
	6	55.1% (27)	42.9% (21)	59.2% (29)	44.2% (23)	61.2% (30)
	7	58.6% (34)	44.1% (26)	48.4% (30)	27.4% (17)	47.5% (28)
	8	79.2% (57)	18.1% (13)	13.9% (10)	20.8% (15)	5.6% (4)
	Mean	60.5% (179)	35.7% (106)	48.3% (145)	34.9% (106)	36.0% (107)
Downstream	9	78.4% (29)	37.8% (14)	35.1% (13)	26.3% (10)	21.1% (8)
	10	90.6% (58)	26.6% (17)	12.5% (8)	18.8% (12)	30.6% (19)
	11	96.9% (62)	92.2% (59)	62.5% (40)	39.4% (26)	51.5% (34)
	12	67.5% (27)	62.5% (25)	72.5% (29)	67.5% (27)	45.2% (19)
	Mean	85.9% (176)	56.1% (115)	43.9% (90)	36.1% (75)	38.5% (80)
Grand mean		64.9% (452)	38.0% (266)	45.0% (317)	37.4% (268)	37.3% (257)

Type B

Reach	Cap Transect	As-Built	Year 1	Year 2	Year 3	Year 5
Slipway	1	0.0% (0)	0.0% (0)	7.3% (4)	1.8% (1)	2.1% (1)
	2	0.0% (0)	0.0% (0)	3.5% (3)	1.1% (1)	3.7% (3)
	3	0.0% (0)	3.5% (2)	8.5% (5)	5.0% (3)	0.0% (0)
	Mean	0.0% (0)	1.0% (2)	6.0% (12)	2.4% (5)	2.2% (4)
Bridge	4	51.7% (31)	23.3% (14)	25.0% (15)	24.6% (15)	36.7% (22)
	5	35.1% (20)	19.3% (11)	29.8% (17)	22.8% (13)	29.8% (17)
	6	36.7% (18)	24.5% (12)	38.8% (19)	34.6% (18)	32.7% (16)
	7	39.7% (23)	27.1% (16)	25.8% (16)	14.5% (9)	37.3% (22)
	8	12.5% (9)	1.4% (1)	16.7% (12)	9.7% (7)	1.4% (1)
	Mean	34.1% (101)	18.2% (54)	26.3% (79)	20.4% (62)	26.3% (78)
Downstream	9	18.9% (7)	13.5% (5)	29.7% (11)	26.3% (10)	18.4% (7)
	10	4.7% (3)	4.7% (3)	4.7% (3)	6.3% (4)	3.2% (2)
	11	3.1% (2)	1.6% (1)	3.1% (2)	3.0% (2)	3.0% (2)
	12	7.5% (3)	10.0% (4)	10.0% (4)	10.0% (4)	11.9% (5)
	Mean	7.3% (15)	6.3% (13)	9.8% (20)	9.6% (20)	7.7% (16)
Grand mean		16.7% (116)	9.9% (69)	15.7% (111)	12.1% (87)	14.2% (98)

Type C

Reach	Cap Transect	As-Built	Year 1	Year 2	Year 3	Year 5
Slipway	1	0.0% (0)	3.6% (2)	5.5% (3)	1.8% (1)	8.3% (4)
	2	30.2% (26)	5.8% (5)	5.8% (5)	3.3% (3)	8.5% (7)
	3	0.0% (0)	5.3% (3)	5.1% (3)	3.3% (2)	5.6% (3)
	Mean	13.3% (26)	5.1% (10)	5.5% (11)	2.9% (6)	7.6% (14)
Bridge	4	0.0% (0)	6.7% (4)	0.0% (0)	1.6% (1)	8.3% (5)
	5	0.0% (0)	0.0% (0)	3.5% (2)	7.0% (4)	3.5% (2)
	6	6.1% (3)	4.1% (2)	0.0% (0)	3.8% (2)	2.0% (1)
	7	0.0% (0)	0.0% (0)	9.7% (6)	1.6% (1)	1.7% (1)
	8	2.8% (2)	2.8% (2)	0.0% (0)	0.0% (0)	9.7% (7)
	Mean	1.7% (5)	2.7% (8)	2.7% (8)	2.6% (8)	5.4% (16)
Downstream	9	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	21.1% (8)
	10	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	6.5% (4)
	11	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	12	0.0% (0)	0.0% (0)	0.0% (0)	10.0% (4)	9.5% (4)
	Mean	0.0% (0)	0.0% (0)	0.0% (0)	1.9% (4)	7.7% (16)
Grand mean		4.5% (31)	2.6% (18)	2.7% (19)	2.5% (18)	6.7% (46)

Type D

Reach	Cap Transect	As-Built	Year 1	Year 2	Year 3	Year 5
Slipway	1	1.9% (1)	21.8% (12)	9.1% (5)	9.1% (5)	29.2% (14)
	2	0.0% (0)	3.5% (3)	2.3% (2)	8.9% (8)	14.6% (12)
	3	0.0% (0)	22.8% (13)	18.6% (11)	20.0% (12)	33.3% (18)
	Mean	0.5% (1)	14.1% (28)	9.0% (18)	12.2% (25)	23.9% (44)
Bridge	4	0.0% (0)	0.0% (0)	0.0% (0)	1.6% (1)	1.7% (1)
	5	1.8% (1)	1.8% (1)	0.0% (0)	1.8% (1)	1.8% (1)
	6	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	7	0.0% (0)	1.7% (1)	6.5% (4)	3.2% (2)	1.7% (1)
	8	1.4% (1)	1.4% (1)	0.0% (0)	1.4% (1)	4.2% (3)
	Mean	0.7% (2)	1.0% (3)	1.3% (4)	1.6% (5)	2.0% (6)
Downstream	9	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	10	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	11	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	12	22.5% (9)	7.5% (3)	2.5% (1)	12.5% (5)	0.0% (0)
	Mean	4.4% (9)	1.5% (3)	0.5% (1)	2.4% (5)	0.0% (0)
Grand mean		1.7% (12)	4.9% (34)	3.3% (23)	4.9% (35)	7.3% (50)

Type E

Reach	Cap Transect	As-Built	Year 1	Year 2	Year 3	Year 5
Slipway	1	36.5% (19)	20.0% (11)	18.2% (10)	25.5% (14)	4.2% (2)
	2	17.4% (15)	5.8% (5)	2.3% (2)	2.2% (2)	2.4% (2)
	3	47.4% (27)	19.3% (11)	11.9% (7)	20.0% (12)	11.1% (6)
	Mean	31.3% (61)	13.6% (27)	9.5% (19)	13.7% (28)	5.4% (10)
Bridge	4	1.7% (1)	1.7% (1)	1.7% (1)	6.6% (4)	0.0% (0)
	5	1.8% (1)	1.8% (1)	1.8% (1)	1.8% (1)	0.0% (0)
	6	2.0% (1)	2.0% (1)	2.0% (1)	3.8% (2)	2.0% (1)
	7	1.7% (1)	0.0% (0)	8.1% (5)	1.6% (1)	0.0% (0)
	8	0.0% (0)	0.0% (0)	1.4% (1)	0.0% (0)	1.4% (1)
	Mean	1.4% (4)	1.0% (3)	3.0% (9)	2.6% (8)	0.7% (2)
Downstream	9	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	10	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	11	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
	12	0.0% (0)	2.5% (1)	2.5% (1)	0.0% (0)	0.0% (0)
	Mean	0.0% (0)	0.5% (1)	0.5% (1)	0.0% (0)	0.0% (0)
Grand mean		9.3% (65)	4.4% (31)	4.1% (29)	5.0% (36)	1.7% (12)

Note: n values are presented in parentheses.

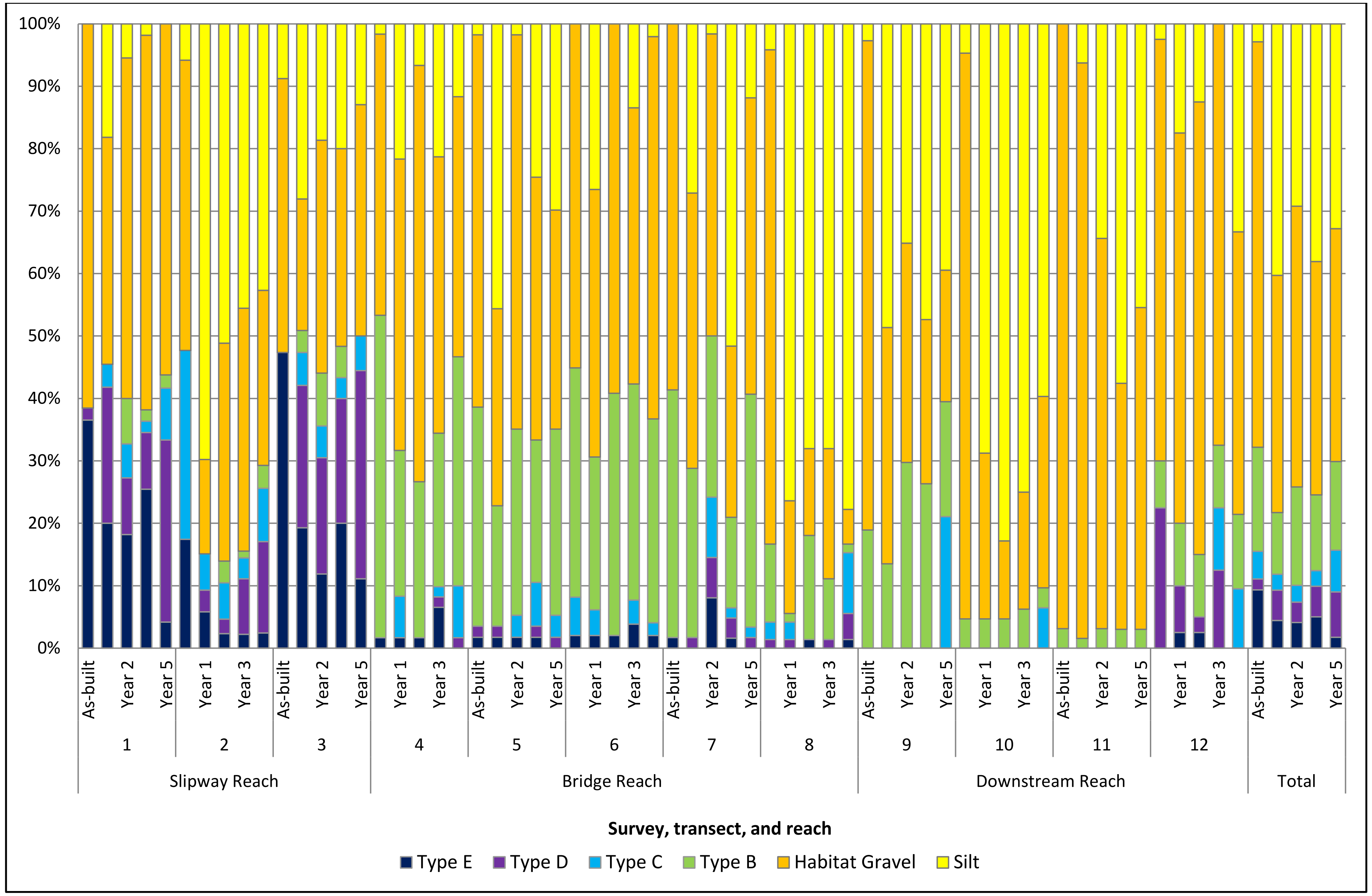

Figure B1. Substrate type and composition within the cap transects.

Table B3. Protruding Rock Armor in Year 5 Gravel Substrate-dominant Stations and Silt-Dominant Stations that were Gravel Substrate–Dominant in the As-Built Survey

Reach	Cap Transect	Rock Armor With Vertical Face Present and Protruding > 2.5 Inches Above Substrate										Rock Armor Present But Does Not Have a Vertical Face Protruding > 2.5 Inches Above Substrate									
		As-Built		Year 1		Year 2		Year 3		Year 5		As-Built		Year 1		Year 2		Year 3		Year 5	
Slipway	1	25.0%	(8)	21.4%	(6)	30.0%	(9)	15.2%	(5)	7.4%	(2)	25.0%	(8)	3.6%	(1)	26.7%	(8)	18.2%	(6)	18.5%	(5)
	2	25.0%	(10)	35.9%	(14)	20.5%	(9)	4.4%	(2)	12.9%	(4)	15.0%	(6)	5.1%	(2)	22.7%	(10)	11.1%	(5)	9.7%	(3)
	3	36.0%	(9)	8.7%	(2)	11.1%	(3)	16.0%	(4)	26.1%	(6)	20.0%	(5)	8.7%	(2)	22.2%	(6)	16.0%	(4)	30.4%	(7)
	Mean	27.8%	(27)	24.4%	(22)	20.8%	(21)	10.7%	(11)	14.8%	(12)	19.6%	(19)	5.6%	(5)	23.8%	(24)	14.6%	(15)	18.5%	(15)
Bridge	4	7.4%	(2)	14.3%	(4)	5.0%	(2)	9.4%	(3)	0.0%	(0)	55.6%	(15)	39.3%	(11)	32.5%	(13)	56.3%	(18)	28.0%	(7)
	5	11.8%	(4)	6.3%	(2)	0.0%	(0)	8.8%	(3)	3.7%	(1)	47.1%	(16)	43.8%	(14)	54.1%	(20)	47.1%	(16)	48.1%	(13)
	6	3.7%	(1)	12.9%	(4)	0.0%	(0)	7.7%	(2)	3.3%	(1)	37.0%	(10)	29.0%	(9)	31.0%	(9)	11.5%	(3)	30.0%	(9)
	7	8.8%	(3)	8.6%	(3)	6.7%	(2)	6.3%	(2)	3.3%	(1)	20.6%	(7)	17.1%	(6)	40.0%	(12)	6.3%	(2)	30.0%	(9)
	8	0.0%	(0)	0.0%	(0)	1.9%	(1)	0.0%	(0)	0.0%	(0)	17.5%	(10)	7.1%	(4)	5.8%	(3)	7.5%	(4)	7.5%	(4)
	Mean	5.6%	(10)	7.1%	(13)	2.7%	(5)	5.6%	(10)	1.8%	(3)	32.4%	(58)	24.2%	(44)	30.3%	(57)	24.3%	(43)	25.5%	(42)
Downstream	9	0.0%	(0)	10.7%	(3)	0.0%	(0)	0.0%	(0)	0.0%	(0)	31.0%	(9)	10.7%	(3)	9.1%	(2)	20.8%	(5)	19.0%	(4)
	10	1.7%	(1)	0.0%	(0)	0.0%	(0)	0.0%	(0)	0.0%	(0)	10.3%	(6)	0.0%	(0)	3.4%	(2)	1.8%	(1)	5.5%	(3)
	11	3.2%	(2)	1.6%	(1)	6.5%	(4)	0.0%	(0)	0.0%	(0)	4.8%	(3)	8.1%	(5)	4.8%	(3)	11.3%	(7)	3.2%	(2)
	12	11.1%	(3)	15.4%	(4)	6.9%	(2)	0.0%	(0)	0.0%	(0)	14.8%	(4)	15.4%	(4)	6.9%	(2)	11.1%	(3)	23.8%	(5)
	Mean	3.4%	(6)	4.6%	(8)	3.5%	(6)	0.0%	(0)	0.0%	(0)	12.5%	(22)	6.9%	(12)	5.3%	(9)	9.4%	(16)	8.8%	(14)
Grand Mean		9.5%	(43)	9.6%	(43)	7.0%	(32)	4.7%	(21)	3.7%	(15)	21.9%	(99)	13.7%	(61)	19.6%	(90)	16.4%	(74)	17.5%	(71)

Note: n values are presented in parentheses.

ATTACHMENT C

SEDIMENT CLEANUP LEVEL PROTECTIVENESS REVIEW

MEMORANDUM

To:	File	Date:	November 28, 2017
From:	Phil Wiescher, PhD	Project:	8014.01.60

RE: Zidell Record of Decision Sediment Cleanup Level Protectiveness Review

The Oregon Department of Environmental Quality (DEQ) issued the Remedial Action Record of Decision for the Zidell Waterfront Property (ECSI No. 689) in June 2005 (the ROD). As stated in Section 7.4.1 (titled "Protectiveness"), Oregon Administrative Rule 340-122-0040 requires that all remedies be protective of human health and the environment. As part of the five-year review of remedy protectiveness,[1] the ROD requires reevaluation of sediment cleanup levels for the fish-ingestion pathway. At the time of the ROD (2005), evaluations of polychlorinated biphenyls (PCBs) and other contaminants in Willamette River sediment were being conducted as part of ongoing remedial investigation (RI) and feasibility study (FS) activities for the Portland Harbor Superfund Site (PHSS), which is approximately 2 miles downstream of the Zidell site. DEQ anticipated that the PHSS findings, which are now available, could inform "more reliable sediment cleanup levels for the fish ingestion exposure pathway," per the ROD.

This memorandum evaluates the ROD fish-ingestion cleanup levels in the context of the PHSS study results. The current approach used at the Zidell site, assessing sediment PCB concentrations relative to background concentrations, is considered protective of the fish-ingestion pathway. In addition, the ROD polycyclic aromatic hydrocarbon (PAH) cleanup levels are sufficiently protective when compared with the PHSS screening levels. Information supporting these conclusions is provided below.

CLEANUP LEVELS

The ROD Table 4-2 provides the Zidell sediment cleanup levels for fish ingestion. The cleanup levels are 2 micrograms per kilogram (ug/kg) for PCB Aroclors 1254 and 1260. Cleanup levels ranging from 21 ug/kg to 21,062 ug/kg are also provided for seven carcinogenic PAH (cPAH) compounds. The cleanup levels were derived for a recreational fisher scenario, using standard U.S. Environmental Protection Agency (USEPA) bioaccumulation models.

[1] The first 5-year review is for 2011 through 2016.

The PHSS RI evaluated potential total PCB (as congeners or Aroclors) and cPAH exposure for subsistence, tribal, and recreational fisher scenarios to develop risk estimates (LWG, 2016). Sediment risk-based criteria (i.e., preliminary remediation goals [PRGs]) based on target tissue concentrations were subsequently developed using food web (e.g., for PCBs) and bioaccumulation (e.g., for polycyclic aromatic hydrocarbons [PAHs]) models informed by site-specific considerations as described in Appendix B of the PHSS FS. The most protective sediment PRGs for fish ingestion are reported as 0 ug/kg (for both cancer and noncancer risks) for total PCBs and as 3,950 ug/kg for cPAHs (see Tables 2.2-5 and B3-5 of the PHSS FS [USEPA, 2016]). It is noted that the food web model (FWM) predicted that negative total PCB sediment concentrations were required to meet risk-based targets.[2] The most protective PCB sediment PRG developed for the PHSS site (0 ug/kg) is therefore lower than the ROD sediment cleanup level of 2 ug/kg for the nearby Zidell site. However, the ROD and USEPA recognize that PCBs are ubiquitous in Willamette River sediments because of anthropogenic background sources. Achieving the ROD cleanup level of 2 ug/kg or the PHSS sediment PRG of zero is therefore not feasible. The current approach used at the Zidell site to determine protectiveness of the fish-ingestion pathway—assessing sediment PCB concentrations relative to background concentrations—is consistent with the PHSS approach. Since PCB sediment concentrations at the Zidell site are consistent with background concentrations, site conditions are sufficiently protective of the fish-ingestion pathway.

The ROD PAH cleanup levels are sufficiently protective when compared with the PHSS screening level of 3,950 ug/kg for cPAHs. To make a direct comparison of the ROD cleanup level to this screening level, the ROD PAH cleanup levels were converted to a benzo(a)pyrene equivalent (BaPEq) cPAH concentration. This BaPEq was calculated using the benzo(a)pyrene potency equivalent factors provided in the PHSS RI. The resulting BaPEq cPAH concentration of the ROD cleanup levels is 147 ug/kg, more than an order of magnitude lower than the PHSS screening level.

REFERENCES

LWG. 2016. Portland Harbor RI/FS Remedial Investigation Report. Prepared by: Lower Willamette Group. February.

USEPA. 2016. Portland Harbor RI/FS Feasibility Study. Prepared by: U.S. Environmental Protection Agency and CDM Smith. June.

[2] Oregon ambient water quality criteria for PCBs were used to represent target post-remedial surface water concentrations in the FWM. The FWM applied predicted that the target dissolved PCB surface water concentrations alone would result in estimated PCB tissue concentrations greater than the risk-based target. This resulted in a calculation of a PCB sediment PRG of less than zero. The sediment PRG was therefore set to zero.

ATTACHMENT D

GROUNDWATER TO SEDIMENT PATHWAY EVALUATION

MAUL FOSTER ALONGI

MEMORANDUM

To:	File	Date:	December 6, 2017
From:	Phil Wiescher, PhD	Project:	8014.01.60

RE: Zidell Record of Decision Groundwater Discharge Protectiveness Review

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The Oregon Department of Environmental Quality (DEQ) issued the Remedial Action Record of Decision for the Zidell Waterfront Property (ECSI No. 689) in June 2005 (the ROD). As stated in Section 7.4.1 (titled "Protectiveness"), Oregon Administrative Rule 340-122-0040 requires that all remedies be protective of human health and the environment. As part of the five-year review of remedy protectiveness,[1] DEQ requested review of the groundwater discharge to surface-water pathway.

This memorandum evaluates the groundwater-discharge pathway for the Zidell site. Groundwater concentrations in riverbank monitoring wells (see the attached Figure) were compared with applicable screening criteria. The screening approach conservatively assumes groundwater discharges to surface water or porewater at the concentrations measured in groundwater (without consideration of the distance traveled through soil to arrive at the sediment surface). The results show that detected groundwater concentrations at the site are typically below the screening criteria. A few analytes show sporadic exceedances that are usually limited to one or two of the eight wells that comprise the riverbank monitoring well network. Based on the infrequent exceedances and other site- and chemical-specific factors (e.g., presence of sediment isolation cap and armor), the overall site groundwater conditions are protective of potential receptors in the Willamette River (river). Information supporting this conclusion is provided below.

SCREENING APPROACH

Groundwater concentrations in eight riverbank monitoring wells were compared with criteria developed for the groundwater migration pathway as part of Portland Harbor Superfund Site (PHSS) activities. These include the groundwater cleanup levels (CULs) provided in Table 17 of the PHSS Record of Decision. Groundwater concentrations were also compared with the PHSS remedial action objectives (RAOs) 4 (Migration of Contaminated Groundwater, Human Health) and 8 (Migration of Contaminated Groundwater, Direct Contact/Ingestion of Porewater for Ecological Receptors),

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[1] The first five-year review is for 2011 through 2016.

which were developed as part of the PHSS feasibility study (FS). The PHSS groundwater CULs are typically based on either the RAO 4 or 8 values[2]; however, for some chemicals, RAOs are available and CULs are not available. In a few cases, PHSS criteria for analytes evaluated at the site are unavailable, and the Table 3-1 Joint Source Control Strategy (JSCS) criteria were considered. The lowest-available JSCS criteria protective of human health (for fish consumption, assuming 175 grams/day consumption)[3] and ecological receptors (based on the 2004 USEPA and the 2004 DEQ water-quality criteria)[4] were evaluated. The PHSS and JSCS metals criteria are typically based on either the total or dissolved phase and are compared with the corresponding (i.e., total or dissolved) site groundwater concentrations.

The applied groundwater criteria were developed for protection of accessible surface water or porewater. This screening approach therefore conservatively assumes that groundwater discharges to surface water or porewater at the concentrations measured in groundwater.

SCREENING RESULTS AND CONCLUSIONS

The screening results are shown in the attached Tables 1 through 6. Data for upland wells that were not screened are provided in the tables for informational purposes. The results show that detected groundwater concentrations at site riverbank wells are typically below screening criteria. A few analytes show infrequent exceedances and are further discussed:

- PCBs (Aroclor 1260). Two minor exceedances were observed at only one well (MW-9). Based on the low solubility of PCBs and the very limited detections throughout the monitoring well network, PCBs are not considered to be of concern.
- Antimony (total). PHSS criteria are unavailable for antimony. The JSCS criteria (64 ug/L, for total and dissolved phases) based on fish consumption were marginally exceeded at only one well (MW-6) for antimony (total). The mean concentration of all antimony (total) riverbank detections is below the JSCS criteria. Dissolved antimony concentrations, which better represent the bioavailable fraction, do not exceed the criteria at any well. Antimony is not considered to be of concern.
- Arsenic (total). Exceedances of the PHSS CUL of 0.018 ug/L, a human health bioaccumulative criteria based on consumption of organisms and water, were observed at several wells. Arsenic background levels are typically around 5 ug/L and commonly up to 10 ug/L in the Willamette basin (Hinkle and Polette, 1999). Only MW-6 showed detected concentrations above 11 ug/L, and the mean detected concentration calculated for all other wells (5.6 ug/l) is consistent with reported background levels. Fish mobility and presence of

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[2] These can appear to differ in some cases due to the use of different significant figures.

[3] In some cases, the JSCS criteria include values developed for protection of drinking groundwater; this pathway is incomplete at the site.

[4] In some cases, Tier II SCV values are provided in JSCS Table 3-1. These were developed so that aquatic benchmarks could be established with fewer data than are required for USEPA water-quality criteria, and are considered more uncertain.

the sediment isolation cap and armoring would significantly limit their potential exposure to groundwater discharge. Similarly, consumption of water at groundwater discharge areas would not occur since they are not accessible. Arsenic (dissolved) did not exceed the corresponding RAO 8, protective of ecological receptors, at any well. Based on the above, arsenic is not considered to be of concern.

- Lead (dissolved). One minor exceedance was observed at only one well (MW-9). The lead criterion is based on RAO 8, which considers ecological receptor direct-contact with porewater. Direct exposure to porewater is not expected due to the sediment isolation cap and armoring, and receptor mobility would further limit potential exposure. Based on these considerations, and very limited detections throughout the monitoring well network, lead is not considered to be of concern.

- Zinc (dissolved). Two minor exceedances were observed at only one well (MW-7). The zinc criterion is based on RAO 8, which considers ecological receptor direct-contact with porewater. Direct exposure to porewater is not expected due to the sediment isolation cap and armoring, and ecological receptor mobility would further limit potential exposure from specific discharge areas. Based on these considerations, and non-detects or detections below the criteria throughout the monitoring well network, zinc is not considered to be of concern.

- Naphthalene. One minor exceedance was observed at only one well (MW-6). Based on its low solubility and the very limited detections throughout the monitoring well network, naphthalene is not considered to be of concern.

- Volatile organic compounds (VOCs). Benzene (at MW-6 only) and o-xylene (at MW-7 only) detections marginally exceeded criteria once and twice, respectively. The benzene criterion (0.44 ug/L) is a human health criterion that accounts for consumption of organisms and water.[5] The associated organism-only criterion (1.4 ug/L) is not exceeded and better reflects potential exposure. Consumption of water at groundwater discharge areas is not expected to occur, due to presence of the isolation cap and armoring. The xylene criterion is based on the RAO 8 for xylenes (total), which considers ecological receptor direct-contact with porewater. Direct exposure to porewater is not expected since the sediment isolation cap and armoring and receptor mobility would limit potential exposure. The detected o-xylene concentrations are several orders of magnitude lower than the RAO 4 value protective of human health. Based on these factors, and very limited detections throughout the monitoring well network, VOCs are not considered to be of concern.

- Petroleum hydrocarbons (PHC). For PHC the PHSS ROD provides only a groundwater CUL of 2.6 ug/L specific to the diesel C10-C12 aliphatic fraction. JSCS criteria are unavailable for PHC. Groundwater data specific to the diesel C10-C12 aliphatic fraction are unavailable for the historic Zidell dataset; this diesel fraction is a small subset of hydrocarbons present in the

[5] See Table 2.1-4 in the PHSS FS.

broader aliphatic and aromatic diesel range. However, groundwater modelling conducted for the site in 2003 predicted a PHC[6] isocontour at a concentration of 1 ug/L, which reaches the river at only three of seven discharge zones. PHC concentrations at the other four discharge zones are expected to be less than 1 ug/L (MFA, 2003). Because PHC, which accounts for total diesel concentrations, is predicted to reach the river at 1 ug/L or higher in limited areas and the CUL of 2.6 ug/L applies to just a small subset of PHC (diesel C10-C12 aliphatics), PHCs are not considered to be of concern.

In summary, groundwater concentrations are below screening criteria in the riverbank wells, with a few exceptions. Prior to the installation of the remedy, there was approximately 50 feet of soil between the riverbank wells and the ordinary high-water line. Due to installation of the riverbank and sediment isolation cap and armoring, the lateral groundwater to surface-water pathway has been increased to more than 80 feet. Sediment cap modelling has demonstrated that even for the most mobile chemicals in sediment porewater, a two-foot sand cap will prevent contaminant breakthrough for more than 1,000 years (MFA, 2009). Previous groundwater modelling also demonstrated that groundwater discharge to the river from the site is a small fraction of actual flow in the river (MFA, 2003). Based on these multiple lines of evidence, groundwater concentrations would therefore be expected to attenuate significantly if discharging to river-transition zone water and then to surface water. Furthermore, the presence of the armoring layer of the sediment cap prevents direct exposure of receptors to porewater. Based on the screening results, and the site- and chemical-specific factors described above, groundwater conditions are sufficiently protective and are not expected to pose unacceptable risk to human health and the environment.

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MFA. 2009. Sediment Cap Chemical Isolation Layer Model Report, Zidell Waterfront Property, Portland, Oregon. Prepared for ZRZ Realty Company. July 16.

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USEPA. 2017. Portland Harbor Record of Decision. Prepared by: U.S. Environmental Protection Agency. January.

[6] Modelled as the higher of diesel or motor oil concentration detected in groundwater, and therefore accounts for the highest diesel concentrations detected.

Figure
Monitoring Well Locations

Site Management Plan
ZRZ Realty Company
Portland, Oregon

Legend

- Monitoring Well (Abandoned)
- ROD Greenway Boundary
- Existing Top of Bank
- Existing Ordinary High Water (18 ft)
- Zidell Property Boundary

0 125 250
Feet

Source: Aerial photograph obtained from ArcGIS/Bing Maps; property boundary surveyed by Olson Engineering (2007); top of bank obtained from City of Portland.

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Path: X:\8014.01 ZRZ Realty Company\32\Projects\06\Fig4-1_Monitoring Well Locations.mxd
Print Date: 03/20/2012
Approved By: L. Ovelar
Produced By: J. Schane
Project: 8014.01.32/06CG

Table 1
PCBs-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268
PHSS Record of Decision Groundwater CUL					0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MW-2	Riverbank	ZM 02 W	12/4/1997		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW2	4/14/1998	27	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-37	10/18/1999	23	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
MW-3	Riverbank	ZM 03 W	12/4/1997		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW3	4/18/1998	29	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-10	10/23/1998	30	0.2 U,H	0.2 U,H	0.2 U,H	0.2 U,H	0.2 U,H	0.2 U,H	0.2 U,H	N/A	N/A
		GW-25	2/25/1999	25	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
MW-6	Riverbank	ZD-060995-7	6/9/1995		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		ZD-091195-1	9/11/1995		0.2 U	1 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		ZM 06 W	12/3/1997	27	2 U,B	2 U,B	2 U,B	2 U,B	2 U,B	2 U,B	2 U,B	N/A	N/A
		MW6	4/17/1998	27.5	1.0 U,D	1.0 U,D	1.0 U,D	1.0 U,D	1.0 U,D	1.0 U,D	1.0 U,D	N/A	N/A
MW-7	Riverbank	ZD-060995-4	6/9/1995		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		ZD-091195-2	9/11/1995		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		ZM 07 W	12/3/1997	31	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW7	4/19/1998	39	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
MW-8	Riverbank	GW-14	10/28/1998	31	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-30	3/1/1999	21	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
		GW-36	3/1/1999	21	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
		GW-43	10/18/1999	28	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
MW9	Riverbank	GW-31	2/26/1999	21	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.1	0.095 U	0.095 U
		GW-44	10/19/1999	29	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.19	0.094 U	0.094 U
		GW-64	10/19/2000	28.5	0.08 U	0.16 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	N/A	N/A
		GW-68	10/19/2000	29	0.08 U	0.16 U	0.08 U	0.08 U	0.08 U	0.08 U	0.08 U	N/A	N/A

Table 1
PCBs-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268
PHSS Record of Decision Groundwater CUL					0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MW10	Riverbank	ZM 10 W	12/2/1997		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW10	4/15/1998	30	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-2	7/28/1998	31	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-16	10/28/1998	32	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
MW-4	Upland	ZM 04 W	12/5/1997	16	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW4	4/14/1998	17	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-39	10/19/1999	14	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
		GW-49	10/19/1999	14	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U	0.094 U
MW-5	Upland	ZM 05 W	12/5/1997	17	0.2 U	0.2 U	0.2 U	0.25 U,B	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW5	4/19/1998	17	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-11	10/30/1998	17	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-27	3/1/1999	10	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
MW11	Upland	MW11	4/17/1998	33	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-3	7/28/1998	34	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-17	10/30/1998	35	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-33	2/26/1999	26	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U	0.095 U
MW12	Upland	ZM 12 W	12/5/1997	13.5	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW12	4/15/1998	15	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-4	7/27/1998	15	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-18	10/27/1998	16	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
MW13	Upland	ZM 13 W	12/5/1997	13-14	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW13	4/14/1998	15	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-5	7/27/1998	16	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-19	10/26/1998	16	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A

Table 1
PCBs-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268
PHSS Record of Decision Groundwater CUL					0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MW14	Upland	ZM 14 W	12/5/1997	15	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW14	4/15/1998	15	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-6	7/27/1998	16	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-20	10/26/1998	17	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
MW15	Upland	ZM 15 W	12/4/1997	22	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		MW15	4/14/1998	24	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-7	7/27/1998	24	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A
		GW-21	10/26/1998	25	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	N/A	N/A

Notes:

Criteria used for screening purposes highlighted grey.

Non-detect data are not screened.

Riverbank data are screened against applicable criteria. Upland data are shown for informational purposes only.

B = The MRL/MDL is elevated because of matrix interferences.

D = The MRL is elevated because of matrix interferences and because the sample required diluting.

H = The analysis was performed past the recommended holding time.

NV = No Value.

U = Not detected at or above a specific method reporting limit (MRL).

ug/L = micrograms per liter.

Table 2
Total Metals-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PHSS Record of Decision Groundwater CUL					NV	0.018	DIS	DIS	DIS	DIS	NV	NV	DIS
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	0.02	NV	100	1300	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV	DIS	DIS	DIS	DIS	DIS	NV	NV	DIS
JSCS Table 3.1 Criteria					64	--	--	--	--	--	NV	NV	--
MW-2	Riverbank	ZM 02 W	12/4/1997		50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		MW2	4/14/1998	27	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-9	10/26/1998	27	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-24	2/24/1999	15	2 U	1.6	20 U	10 U	20 U	1 U	0.2 U	0.04 U	20 U
MW-3	Riverbank	GW-10	10/23/1998	30	50 U	8	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-25	2/25/1999	25	2 U	9.8	20 U	10 U	20 U	1 U	0.2 U	0.04 U	20 U
		GW-38	10/20/1999	26	3 U	100 U	20 U	10 U	20 U	1 U	0.81	40 U	20 U
		GW-59	10/19/2000	26	3 U	13 U	0.5 U	1.8	1.3	0.5 U	0.2 U	4.3	12
MW-6	Riverbank	GW-40	10/20/1999	12	100	170	20 U	10 U	150	3.1	0.2 U	200	20 U
		GW-41	10/21/1999	28.5	3 U	100 U	20 U	10 U	20 U	1 U	0.2 U	40 U	31
		GW-60	10/19/2000	17	91	110	0.85	5.6	120	3.7	0.2 U	190	28
		GW-61	10/18/2000	28.5	3 U	13 U	0.5 U	6.1	5.1	0.5 U	0.2 U	15	6.2
MW-7	Riverbank	GW-13	10/28/1998	38	50 U	8	4 U	5 U	10 U	2 U	0.2 U	20 U	40
		GW-29	2/26/1999	25	2 U	11	20 U	10 U	20 U	1 U	0.2 U	0.04 U	46
		GW-42	10/21/1999	37	3 U	100 U	20 U	44	20 U	1 U	0.79	40 U	250
		GW-62	10/19/2000	32	3 U	13 U	0.5 U	6.5	2.7	1.1	0.2 U	7.2	45
MW-8	Riverbank	GW-30	3/1/1999	21	2 U	3.7	20 U	10 U	20 U	1 U	0.2 U	0.04 U	21
		GW-36	3/1/1999	21	2 U	2.7	20 U	10 U	20 U	1 U	0.2 U	0.04 U	20 U
		GW-43	10/18/1999	28	3 U	100 U	20 U	10 U	20 U	1 U	0.39	40 U	41
		GW-63	10/19/2000	29	3 U	13 U	0.5 U	3.6	1.5	0.5 U	0.2 U	4.2	11

Table 2
Total Metals-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PHSS Record of Decision Groundwater CUL					NV	0.018	DIS	DIS	DIS	DIS	NV	NV	DIS
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	0.02	NV	100	1300	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV	DIS	DIS	DIS	DIS	DIS	NV	NV	DIS
JSCS Table 3.1 Criteria					64	--	--	--	--	--	NV	NV	--
MW9	Riverbank	GW-64	10/19/2000	28.5	3.8	13 U	0.5 U	6.8	32	33	0.2 U	4.1	97
		GW-68	10/19/2000	29	3 U	13 U	0.5 U	5.5	18	21	0.2 U	3.4	69
		GW-86	10/11/2001		7.04	1 U	0.133	6.35	71.1	19.7	0.2 U	3.49	104
		GW-91	10/18/2002	31	N/A	3.5	0.5 U	N/A	5.2	8.08	N/A	2.72	N/A
MW10	Riverbank	GW-16	10/28/1998	32	50 U	5 U	4 U	45	40	2 U	0.2 U	20 U	75
		GW-32	2/26/1999	27	2 U	2.2	20 U	10 U	20 U	4.4	0.2 U	0.04 U	23
		GW-45	10/20/1999	31.5	3 U	100 U	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-65	10/18/2000	32	3 U	13 U	0.5 U	3.8	1 U	0.5 U	0.2 U	2.4	13
MW11	Riverbank	GW-17	10/30/1998	35	50 U	5 U	4 U	5 U	10 U	8 U, D	0.2 U	20 U	19
		GW-33	2/26/1999	26	31	1 U	20 U	10 U	20 U	1 U	0.2 U	0.04 U	20 U
		GW-46	10/21/1999	35	3 U	100 U	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-66	10/18/2000	33	3.4	13 U	0.5 U	4.5	4.2	1.9	0.2 U	2.8	20
MW-1	Upland	ZD-060995-1	6/9/1995		50 U	5 U	3 U	8	19 U	30 U	0.5 U	20 U	42 U
		ZD-091395-8	9/13/1995		50 U	9	3 U	53	107	195	1.2	39	262
MW-4	Upland	MW4	4/14/1998	17	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-26	2/25/1999	8	2 U	1 U	20 U	10 U	20 U	1 U	0.2 U	0.04 U	20 U
		GW-39	10/19/1999	14	3 U	100 U	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-49	10/19/1999	14	3 U	100 U	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
MW-5	Upland	GW-11	10/30/1998	17	103	90	4 U	5 U	169	8 U, D	0.2 U	202	10 U
		GW-27	3/1/1999	10	77	110	20 U	10 U	150	3.6	0.2 U	190	20 U
		GW-88	10/11/2001		97.4	101	1.17	9.04	140	6.61	0.2 U	209	57.1
		GW-92	10/18/2002	25	N/A	105	0.717	N/A	146	10.6	N/A	175	N/A
MW12	Upland	ZM 12 W	12/5/1997	13.5	50 U	5 U	4 U	5 U	10 U	2	0.5 U	20 U	10 U
		MW12	4/15/1998	15	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-4	7/27/1998	15	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-18	10/27/1998	16	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U

Table 2
Total Metals-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PHSS Record of Decision Groundwater CUL					NV	0.018	DIS	DIS	DIS	DIS	NV	NV	DIS
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	0.02	NV	100	1300	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV	DIS	DIS	DIS	DIS	DIS	NV	NV	DIS
JSCS Table 3.1 Criteria					64	--	--	--	--	--	NV	NV	--
MW13	Upland	ZM 13 W	12/5/1997	13-14	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		MW13	4/14/1998	15	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-5	7/27/1998	16	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-19	10/26/1998	16	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
MW14	Upland	ZM 14 W	12/5/1997	15	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	11
		MW14	4/15/1998	15	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-6	7/27/1998	16	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-20	10/26/1998	17	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
MW15	Upland	ZM 15 W	12/4/1997	22	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		MW15	4/14/1998	24	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-7	7/27/1998	24	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-21	10/26/1998	25	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U

Notes:

Criteria used for screening purposes highlighted grey.

JSCS criteria are shown only if PHSS ROD CULs and PHSS RAO PRGs are unavailable for both total and dissolved water phases (i.e., for antimony, mercury, and nickel).

JSCS criteria shown is the recommended value for use in initial screenings, unless that value is related to drinking water or the ORNL Tier II SCVs for ecological receptors. In those cases, the other lowest available human health (fish consumption based on 175 g/day) or ecological (2004 NRWQC or 2004 AWQC) criteria are shown.

Non-detect data are not screened.

Only criteria based on the totals water phase are shown.

Riverbank data are screened against applicable criteria. Upland data are shown for informational purposes only.

DIS = dissolved criteria available.

N/A = Not applicable or not analyzed.

NV = No Value.

U = Not detected at or above a specific method reporting limit (MRL).

ug/L = micrograms per liter.

Table 3
Dissolved Metals-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PHSS Record of Decision Groundwater CUL					NV	TOT	0.091	11	2.74	0.54	NV	NV	36.5
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	TOT	NV	TOT	TOT	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV	150	0.091	11	2.74	0.5	NV	NV	36.5
JSCS Table 3.1 Criteria					64	--	--	--	--	--	0.77	16	--
MW-2	Riverbank	ZM 02 W	12/4/1997		50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		MW2	4/14/1998	27	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10
		GW-9	10/26/1998	27	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-24	2/24/1999	15	2 U	1.6	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
MW-3	Riverbank	MW3	4/18/1998	29	50 U	7	4 U	5 U	10 U	2 U	N/A	20 U	10 U
		GW-10	10/23/1998	30	50 U	8	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-25	2/25/1999	25	2 U	8.8	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-38	10/20/1999	26	4 U	12	20U	10 U	20U	1 U	0.63	40 U	20U
MW-6	Riverbank	ZM 06 W	12/3/1997	27	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	25
		MW6	4/17/1998	27.5	50 U	5 U	4 U	5 U	10 U	2 U	N/A	20 U	10 U
		GW-28	2/26/1999	22	2 U	3.1	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-41	10/21/1999	28.5	4 U	21	20U	10 U	20U	1 U	0.2 U	40 U	20U
MW-7	Riverbank	MW7	4/19/1998	39	50 U	8	4 U	5 U	10 U	2 U	N/A	20 U	105
		GW-13	10/28/1998	38	50 U	8	4 U	5 U	10 U	2 U	0.2 U	20 U	27
		GW-29	2/26/1999	25	2 U	10	20 U	10 U	20 U	1 U	0.2 U	40 U	46
		GW-42	10/21/1999	37	4 U	13	20U	10 U	20U	1 U	0.34	40 U	32
MW-8	Riverbank	GW-14	10/28/1998	31	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-30	3/1/1999	21	2 U	3.6	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-36	3/1/1999	21	2 U	2.8	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-43	10/18/1999	28	4 U	1.6	20U	10 U	20U	1 U	0.48	40 U	20U
MW9	Riverbank	GW-1	7/28/1998	32	50 U	5	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-15	10/23/1998	30	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-31	2/26/1999	21	2 U	4.4	20 U	10 U	20 U	1 U	0.2 U	40 U	22
		GW-44	10/19/1999	29	4 U	7	20U	10 U	20U	1.5	0.22	40 U	20U

Table 3
Dissolved Metals-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PHSS Record of Decision Groundwater CUL					NV	TOT	0.091	11	2.74	0.54	NV	NV	36.5
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	TOT	NV	TOT	TOT	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV	150	0.091	11	2.74	0.5	NV	NV	36.5
JSCS Table 3.1 Criteria					64	--	--	--	--	--	0.77	16	--
MW10	Riverbank	GW-16	10/28/1998	32	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		GW-2	7/28/1998	31	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-32	2/26/1999	27	2 U	2.2	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-45	10/20/1999	31.5	4 U	1.9	20U	10 U	20U	1 U	0.2 U	40 U	20U
MW11	Riverbank	GW-17	10/30/1998	35	50 U	5 U	4 U	5 U	10 U	4 U, D	0.2 U	20 U	18
		GW-3	7/28/1998	34	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-33	2/26/1999	26	31	1 U	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-46	10/21/1999	35	4 U	1.9	20 U	10 U	20U	1 U	0.2 U	40 U	22
MW-1	Upland	ZD-060995-1	6/9/1995	N/A	50 U	5 U	3 U	5 U	12 U	2 U	0.5 U	20 U	10 U
		ZD-091395-8	9/13/1995	N/A	50 U	5 U	3 U	5 U	10 U	2 U	0.5 U	20 U	11
MW-4	Upland	MW4	4/14/1998	17	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-26	2/25/1999	8	2 U	1 U	20 U	10 U	20 U	1 U	0.2 U	40 U	20 U
		GW-39	10/19/1999	14	4 U	1 U	20U	10 U	20U	1 U	0.2 U	40 U	20U
		GW-49	10/19/1999	14	4 U	1 U	20U	10 U	20U	1 U	0.2 U	40 U	20U
MW-5	Upland	MW5	4/19/1998	17	78	48	4 U	5 U	195	2 U	N/A	289	10 U
		GW-11	10/30/1998	17	101	91	4 U	5 U	164	4 U, D	0.2 U	206	10 U
		GW-27	3/1/1999	10	75	110	20 U	10 U	140	3.4	0.2 U	170	31
		GW-40	10/20/1999	12	89	110	20U	10 U	150	3	0.2 U	200	20U

Table 3
Dissolved Metals-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
PHSS Record of Decision Groundwater CUL					NV	TOT	0.091	11	2.74	0.54	NV	NV	36.5
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	TOT	NV	TOT	TOT	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV	150	0.091	11	2.74	0.5	NV	NV	36.5
JSCS Table 3.1 Criteria					64	--	--	--	--	--	0.77	16	--
MW12	Upland	ZM 12 W	12/5/1997	13.5	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		MW12	4/15/1998	15	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U
		GW-18	10/27/1998	16	50 U	5 U	4 U	5 U	10 U	2 U	0.2 U	20 U	10 U
		ZM 13 W	12/5/1997	13-14	50 U	5 U	4 U	5 U	10 U	2 U	0.5 U	20 U	10 U

Notes:

Criteria used for screening purposes highlighted grey.

JSCS criteria are shown only if PHSS ROD CULs and PHSS RAO PRGs are unavailable for both total and dissolved water phases (i.e., for antimony, mercury, and nickel).

JSCS criteria shown is the recommended value for use in intital screenings, unless that value is related to drinking water or the ORNL Tier II SCVs for ecological receptors. In those cases, the other lowest available human health (fish consumption based on 175 g/day) or ecological (2004 NRWQC or 2004 AWQC) criteria are shown.

Non-detect data are not screened.

Only criteria based on the dissolved water phase are shown.

Riverbank data are screened against applicable criteria. Upland data are shown for informational purposes only.

D = The MRL is elevated because of matrix interferences and because the sample required diluting.

TOT = total criteria available.

N/A = Not applicable or not analyzed.

NV = No Value.

U = Not detected at or above a specific method reporting limit (MRL).

ug/L = micrograms per liter.

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)-anthracene	Benzo(a)-pyrene	Benzo(b)-fluoranthene	Benzo(g,h,i) perylene	Benzo(k)-fluoranthene	Chrysene	Dibenz(a,h) anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)-pyrene	Naphthalene	Phenanthrene	Pyrene
PHSS Record of Decision Groundwater CUL					23	NV	0.73	0.0012	0.00012	0.0012	NV	0.0013	0.0013	0.00012	NV	NV	0.0012	NV	NV	NV
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	0.001	0.0001	0.001	NV	0.001	0.001	0.0001	NV	NV	0.001	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					23	NV	0.7	0.03	0.01	0.7	0.4	0.6	2	0.3	6.2	3.9	0.3	12	6.3	10
JSCS Table 3.1 Criteria					--	NV (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-2	Riverbank	ZD-060995-9	6/9/1995		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
		ZD-091395-9	9/13/1995		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
		ZM 02 W	12/4/1997		1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW2	4/14/1998	27	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW-3	Riverbank	ZD-060995-10	6/9/1995		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
		ZD-091395-10	9/13/1995		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
		ZM 03 W	12/4/1997		1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW3	4/18/1998	29	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW-6	Riverbank	ZD-091195-1	9/11/1995		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	40	10 U	10 U
		ZM 06 W	12/3/1997	27	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW6	4/17/1998	27.5	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-12	10/30/1998	29	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW-7	Riverbank	ZD-060995-4	6/9/1995		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
		ZD-091195-2	9/11/1995		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
		ZM 07 W	12/3/1997	31	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW7	4/19/1998	39	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW-8	Riverbank	MW8	4/18/1998	30	2 U, B	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-14	10/28/1998	31	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-30	3/1/1999	21	0.82	0.093 U	0.046 U	0.046 U	0.046 U	0.046 U	0.069 U	0.046 U	0.046 U	0.069 U	0.046 U	0.046 U	0.069 U	0.093 U	0.046 U	0.078
		GW-36	3/1/1999	21	0.046 U	0.093 U	0.046 U	0.046 U	0.046 U	0.046 U	0.069 U	0.046 U	0.046 U	0.069 U	0.052	0.046 U	0.069 U	0.093 U	0.13	0.12
MW9	Riverbank	ZM 09 W	12/2/1997		1 U	2 U, B	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.3 U, B	0.1 U	0.2 U	0.3	0.1 U	1 U	0.5	0.5 U, B
		MW9	4/18/1998	31	1 U	4 U, B	0.1 U	0.1 U	0.3 U, B	0.2 U	0.2 U	0.1 U, B	0.5 U, B	0.1 U	0.4 U, B	0.5	0.1 U	2 U, B	0.8 U, B	3 U, B
		GW-1	7/28/1998	32	10 U, B	10 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	10 U, B	1 U, B	2 U, B
		GW-15	10/23/1998	30	10 U, B	10 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	10 U, B	1 U, B	3 U, B
MW10	Riverbank	ZM 10 W	12/2/1997		1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1	0.2	0.4
		MW10	4/15/1998	30	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-2	7/28/1998	31	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-16	10/28/1998	32	10 U, B	10 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	10 U, B	1 U, B	2 U, B
MW11	Riverbank	ZM 11 W	12/2/1997		1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.4	0.2 U
		MW11	4/17/1998	33	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-3	7/28/1998	34	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-17	10/30/1998	35	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW-1	Upland	ZD-060995-1	6/9/1995		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
		ZD-091395-8	9/13/1995		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
MW-4	Upland	ZD-060995-5	6/9/1995		0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
		ZD-091195-5	9/11/1995		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
		ZM 04 W	12/5/1997	16	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW4	4/14/1998	17	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)-anthracene	Benzo(a)-pyrene	Benzo(b)-fluoranthene	Benzo(g,h,i) perylene	Benzo(k)-fluoranthene	Chrysene	Dibenz(a,h) anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)-pyrene	Naphthalene	Phenanthrene	Pyrene
PHSS Record of Decision Groundwater CUL					23	NV	0.73	0.0012	0.00012	0.0012	NV	0.0013	0.0013	0.00012	NV	NV	0.0012	NV	NV	NV
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	0.001	0.0001	0.001	NV	0.001	0.001	0.0001	NV	NV	0.001	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					23	NV	0.7	0.03	0.01	0.7	0.4	0.6	2	0.3	6.2	3.9	0.3	12	6.3	10
JSCS Table 3.1 Criteria					--	NV (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-5	Upland	ZM 05 W	12/5/1997	17	10 U, B	10 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	10 U, B	1 U, B	2 U, B
		MW5	4/19/1998	17	1 U	18 U, B	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	3 U, B	0.4 U, B	2 U, B
		GW-11	10/30/1998	17	10 U, B	10 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	1 U, B	1 U, B	2 U, B	2 U, B	1 U, B	10 U, B	1 U, B	2 U, B
		GW-27	3/1/1999	10	4.9	4.6 U	6.7	2.3 U	2.3 U	2.3 U	3.5 U	2.3 U	2.3 U	3.5 U	2.3 U	2.3 U	3.5 U	4.6 U	2.3 U	2.3 U
MW12	Upland	ZM 12 W	12/5/1997	13.5	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.5	0.2 U
		MW12	4/15/1998	15	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.2	0.2 U
		GW-4	7/27/1998	15	1 U, H	1 U, H	0.1 U, H	0.1 U, H	0.1 U, H	0.2 U, H	0.2 U, H	0.1 U, H	0.1 U, H	0.1 U, H	0.2 U, H	0.2 U, H	0.1 U, H	1 U, H	0.3 H	0.2 U, H
		GW-18	10/27/1998	16	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2	0.1 U	1 U	0.7	0.2 U
MW13	Upland	ZM 13 W	12/5/1997	13-14	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.3	0.2 U
		MW13	4/14/1998	15	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-5	7/27/1998	16	1 U, H	1 U, H	0.1 U, H	0.1 U, H	0.1 U, H	0.2 U, H	0.2 U, H	0.1 U, H	0.1 U, H	0.1 U, H	0.2 U, H	0.2 U, H	0.1 U, H	1 U, H	0.1 U, H	0.2 U, H
		GW-19	10/26/1998	16	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW14	Upland	ZM 14 W	12/5/1997	15	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW14	4/15/1998	15	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-6	7/27/1998	16	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-20	10/26/1998	17	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
MW15	Upland	ZM 15 W	12/4/1997	22	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		MW15	4/14/1998	24	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-7	7/27/1998	24	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U
		GW-21	10/26/1998	25	1 U	1 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	0.1 U	0.1 U	0.2 U	0.2 U	0.1 U	1 U	0.1 U	0.2 U

Notes:

Criteria used for screening purposes highlighted grey.

JSCS criteria are shown only if PHSS ROD CULs and PHSS RAO PRGs are unavailable.

JSCS criteria shown is the recommended value for use in initial screenings, unless that value is related to drinking water or the ORNL Tier II SCVs for ecological receptors. In those cases, the other lowest available human health (fish consumption based on 175 g/day) or ecological (2004 NRWQC or 2004 AWQC) criteria are shown.

Non-detect data are not screened.

Riverbank data are screened against applicable criteria. Upland data are shown for informational purposes only.

B = The MRL/MDL is elevated because of matrix interferences.

H = The analysis was performed past the recommended holding time.

NV = No Value.

U = Not detected at or above a specific method reporting limit (MRL).

ug/L = micrograms per liter.

(1) = A drinking water MCL for benzo(a)pyrene is provided and is not considered applicable.

Table 5
VOCs-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	1,1-Dichloro-ethene (1,1-DCE)	1,2,3-Trichloro-propane	1,2,4-Trichloro-benzene	1,2-Dichloro-benzene	1,3-Dichloro-benzene	1,4-Dichloro-benzene	Benzene	Chlorobenzene	Ethylbenzene	Isopropylbenzene (Cumene)	m,p-Xylenes	Naphthalene	o-Xylene	Tetrachloro-ethene (PCE)	Toluene	Xylenes, Total
PHSS Record of Decision Groundwater CUL					7	NV	NV	NV	NV	NV	0.44	64	7.3	NV	13 (2)	NV	13 (2)	0.24	9.8	13
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					7	NV	NV	NV	NV	NV	0.4	74	68	NV	10000 (2)	NV	10000 (2)	0.2	57	10000
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					25	NV	NV	NV	NV	NV	130	64	7.3	NV	13 (2)	12	13 (2)	NV	9.8	13
JSCS Table 3.1 Criteria					--	NV (1)	7	130	96	19	--	--	--	NV (1)	--	--	--	--	--	--
MW-2	Riverbank	ZM 02 W	12/4/1997		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		MW2	4/14/1998	27	0.5 U,H	0.5 U,H	2 U,H	0.5 U,H	0.5 U,H	0.5 U,H	0.5 U,H	0.5 U,H	0.5 U,H	2 U,H	N/A	2 U,H	N/A	0.5 U,H	0.5 U,H	0.5 U,H
		GW-24	2/24/1999	15	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-37	10/18/1999	23	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
MW-3	Riverbank	ZM 03 W	12/4/1997		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	1.4	1.2
		MW3	4/18/1998	29	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	1.8	1.1
		GW-25	2/25/1999	25	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-38	10/20/1999	26	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.12J	N/A
MW-6	Riverbank	GW-28	2/26/1999	22	0.4 U	0.4 U	0.42	0.5	0.4 U	0.45	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-41	10/21/1999	28.5	0.036J	0.037J	1.8	1.6	0.51	1.3	0.12J	0.73	1.2	0.12J	3.3	0.4 U	5.7	0.049J	0.31J	N/A
		GW-82	10/10/2001		0.4 U	0.4 U	0.75	1.27	0.128 J	0.716	0.4 U	0.55	2.36	0.234 J	5.22	0.153 J	17.2	0.4 U	0.159 J	N/A
		GW-96	10/17/2002	29	1 U	1 U	0.691 J	0.998 J	1 U	0.682 J	1 U	0.669 J	1.62	1 U	5.81	1 U	13.6	1 U	0.647 J	N/A
MW-7	Riverbank	ZM 07 W	12/3/1997	31	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	1	1
		MW7	4/19/1998	39	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	1.2	0.5 U	0.5	2 U	N/A	2 U	N/A	0.5 U	5.3	3.1
		GW-29	2/26/1999	25	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-42	10/21/1999	37	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.1J	N/A
MW-8	Riverbank	MW8	4/18/1998	30	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	1.6	0.8
		GW-14	10/28/1998	31	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.6	N/A
		GW-30	3/1/1999	21	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-36	3/1/1999	21	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	1.5	N/A
MW9	Riverbank	ZM 09 W	12/2/1997		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5
		MW9	4/18/1998	31	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.6	0.7
		GW-1	7/28/1998	32	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.6 S	0.5
		GW-15	10/23/1998	30	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	N/A
MW10	Riverbank	ZM 10 W	12/2/1997		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		MW10	4/15/1998	30	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.7	0.5 U
		GW-2	7/28/1998	31	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.7 S	0.5 U
		GW-16	10/28/1998	32	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.5	N/A
MW11	Riverbank	ZM 11 W	12/2/1997		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		MW11	4/17/1998	33	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-3	7/28/1998	34	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.7 S	0.5 U
		GW-17	10/30/1998	35	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	N/A
MW-1	Upland	ZD-060995-1	6/9/1995		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		ZD-091395-8	9/13/1995		0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	4.4	0.5 U
MW-4	Upland	MW4	4/14/1998	17	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.8	0.5 U
		GW-26	2/25/1999	8	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-39	10/19/1999	14	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.13J	N/A
		GW-49	10/19/1999	14	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.16J	N/A
MW-5	Upland	GW-40	10/20/1999	12	0.4 U	0.4 U	0.4 U	0.87	0.4 U	0.4 U	8.6	19	9.4	0.76	24D	1.5	21D	0.07J	3.5	N/A
		GW-60	10/19/2000	17	0.4 U	0.4 U	0.4 U	0.95	0.4 U	0.4 U	8.5	21	10	0.84	29	2	23	0.064	4.8	N/A
		GW-88	10/11/2001		8 U	8 U	8 U	8 U	8 U	8 U	8.89	17.6	9.7	8 U	25.8	2.44 J	21.6	8 U	4.17 J	N/A
		GW-92	10/18/2002	25	10 U	10 U	10 U	10 U	10 U	10 U	10.2	24	12.2	10 U	29.5	10 U	28.6	10 U	10 U	N/A
MW12	Upland	ZM 12 W	12/5/1997	13.5	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		MW12	4/15/1998	15	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-4	7/27/1998	15	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-18	10/27/1998	16	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.6	N/A

Location	Area	Sample	Sampling Date	Depth (Feet bgs)	1,1-Dichloro-ethene (1,1-DCE)	1,2,3-Trichloro-propane	1,2,4-Trichloro-benzene	1,2-Dichloro-benzene	1,3-Dichloro-benzene	1,4-Dichloro-benzene	Benzene	Chlorobenzene	Ethylbenzene	Isopropylbenzene (Cumene)	m,p-Xylenes	Naphthalene	o-Xylene	Tetrachloro-ethene (PCE)	Toluene	Xylenes, Total
PHSS Record of Decision Groundwater CUL					7	NV	NV	NV	NV	NV	0.44	64	7.3	NV	13 (2)	NV	13 (2)	0.24	9.8	13
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					7	NV	NV	NV	NV	NV	0.4	74	68	NV	10000 (2)	NV	10000 (2)	0.2	57	10000
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					25	NV	NV	NV	NV	NV	130	64	7.3	NV	13 (2)	12	13 (2)	NV	9.8	13
JSCS Table 3.1 Criteria					--	NV (1)	7	130	96	19	--	--	--	NV (1)	--	--	--	--	--	--
MW13	Upland	ZM 13 W	12/5/1997	13-14	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	1.2	0.5 U
		MW13	4/14/1998	15	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-5	7/27/1998	16	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-19	10/26/1998	16	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	N/A
MW14	Upland	ZM 14 W	12/5/1997	15	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		MW14	4/15/1998	15	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-6	7/27/1998	16	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	N/A	2 U	N/A	0.5 U	0.5 U	0.5 U
		GW-20	10/26/1998	17	0.5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	2 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	N/A
MW15	Upland	GW-34	2/26/1999	21	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.4 U	N/A
		GW-47	10/20/1999	23	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.13J	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.056J	N/A
		GW-67	10/19/2000	24	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.15 J	N/A
		GW-69	10/19/2000	24	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.8 U	0.4 U	0.4 U	0.4 U	0.2 J	N/A

Notes:

Analytes for which criteria are available and that were detected in riverbank wells are shown.

Criteria used for screening purposes highlighted grey.

JSCS criteria are shown only if PHSS ROD CULs and PHSS RAO PRGs are unavailable.

JSCS criteria shown is the recommended value for use in initial screenings, unless that value is related to drinking water or the ORNL Tier II SCVs for ecological receptors. In those cases, the other lowest available human health (fish consumption based on 175 g/day) or ecological (2004 NRWQC or 2004 AWQC) criteria are shown.

Non-detect data are not screened.

Riverbank data are screened against applicable criteria. Upland data are shown for informational purposes only.

H = The analysis was performed past the recommended holding time.

NV = No Value.

U = Not detected at or above a specific method reporting limit (MRL).

ug/L = micrograms per liter.

J = Estimated concentrations.

S = Suspected laboratory contaminant.

(1) = A drinking water MCL is provided and is not considered applicable.

(2) = Criteria based on total xylenes.

Location	Area	Sample	Sampling Date	Depth (feet bgs)	Diesel	Gasoline	Jet Fuel as Jet A	Jet Fuel as JP-4	Kerosene	Mineral Spirits	Motor Oil	Naphtha Distillate
PHSS Record of Decision Groundwater CUL					NV (1)	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV (1)	NV	NV	NV	NV	NV	NV	NV
JSCS Table 3.1 Criteria					NV	NV	NV	NV	NV	NV	NV	NV
MW-2	Riverbank	GW-24	2/24/1999	15	240 U	95 U,N	95 U	95 U,N	240 U	240 U,N	480 U	240 U,N
MW-3	Riverbank	GW-59	10/19/2000	26	790 X1	N/A	N/A	N/A	N/A	N/A	1300	N/A
		GW-70	5/26/2001		430 X1	N/A	N/A	N/A	N/A	N/A	430	N/A
		GW-84	10/10/2001		767 X2	N/A	N/A	N/A	N/A	N/A	1,020 X2	N/A
		GW-93	10/17/2002		922 X1	N/A	N/A	N/A	N/A	N/A	1600	N/A
MW-6	Riverbank	GW-61	10/18/2000	28.5	380 X1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		GW-72	5/24/2001		250	N/A	N/A	N/A	N/A	N/A	550	N/A
		GW-82	10/10/2001		539 X2	N/A	N/A	N/A	N/A	N/A	698 X2	N/A
		GW-96	10/17/2002		614 X2	N/A	N/A	N/A	N/A	N/A	738	N/A
MW-7	Riverbank	GW-62	10/19/2000	32	1300 X1	N/A	N/A	N/A	N/A	N/A	1800	N/A
		GW-73	5/24/2001		430 X1	N/A	N/A	N/A	N/A	N/A	430	N/A
		GW-87	10/11/2001		1,170 X2	N/A	N/A	N/A	N/A	N/A	1,370 X2	N/A
		GW-90	10/18/2002		1,070 X1	N/A	N/A	N/A	N/A	N/A	1400	N/A
MW-8	Riverbank	GW-63	10/19/2000	29	2800 X2	N/A	N/A	N/A	N/A	N/A	3200	N/A
		GW-74	5/25/2001		470 X1	N/A	N/A	N/A	N/A	N/A	600	N/A
		GW-85	10/10/2001		984 X2	N/A	N/A	N/A	N/A	N/A	1,210 X2	N/A
		GW-97	10/18/2002		866 X1	N/A	N/A	N/A	N/A	N/A	1700	N/A
MW-9	Riverbank	GW-68	10/19/2000	29	1100 X1	N/A	N/A	N/A	N/A	N/A	1300	N/A
		GW-75	5/26/2001		2300	N/A	N/A	N/A	N/A	N/A	9900 X1	N/A
		GW-86	10/11/2001		1,330 X2	N/A	N/A	N/A	N/A	N/A	1,540 X2	N/A
		GW-91	10/18/2002		1,470 X1	N/A	N/A	N/A	N/A	N/A	1680	N/A
MW-10	Riverbank	GW-65	10/18/2000	32	370 X1	N/A	N/A	N/A	N/A	N/A	2100	N/A
		GW-76	5/25/2001		2000	N/A	N/A	N/A	N/A	N/A	10,000 X1	N/A
		GW-81	10/10/2001		810 X2	N/A	N/A	N/A	N/A	N/A	1,080 X2	N/A
		GW-94	10/17/02		1230 X1	N/A	N/A	N/A	N/A	N/A	2520	N/A

Table 6
Petroleum-Groundwater (ug/L)
Zidell Waterfront Property
ZRZ Realty Company

Location	Area	Sample	Sampling Date	Depth (feet bgs)	Diesel	Gasoline	Jet Fuel as Jet A	Jet Fuel as JP-4	Kerosene	Mineral Spirits	Motor Oil	Naphtha Distillate
PHSS Record of Decision Groundwater CUL					NV (1)	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 4 (Migration of Contaminated Groundwater—Human Health)					NV	NV	NV	NV	NV	NV	NV	NV
PHSS RAO 8 (Migration of Contaminated Groundwater—Ecological Direct Porewater Contact)					NV (1)	NV	NV	NV	NV	NV	NV	NV
JSCS Table 3.1 Criteria					NV	NV	NV	NV	NV	NV	NV	NV
MW-11	Riverbank	GW-33	2/26/1999	26	320 X1	95 U,N	95 U	95 U,N	240 U	240 U,N	710	240 U,N
		GW-66	10/18/2000	33	240 U	N/A	N/A	N/A	N/A	N/A	330 J	N/A
		GW-77	5/24/2001		320 X1	N/A	N/A	N/A	N/A	N/A	800	N/A
		GW-83	10/10/01		379 X2	N/A	N/A	N/A	N/A	N/A	587 X2	N/A
MW-5	Upland	GW-71	5/25/2001		12,000 X2	N/A	N/A	N/A	N/A	N/A	13,000 X2	N/A
		GW-88	10/11/2001		37,600 X2	N/A	N/A	N/A	N/A	N/A	25,300 X2	N/A
		GW-92	10/18/2002		37,700 X2	N/A	N/A	N/A	N/A	N/A	37,100 X2	N/A
MW-13	Upland	MW13	4/14/1998	15	100 U	100 U,L	100 U	100 U,L	100 U	100 U	N/A	100 U, L
		GW-5	7/27/1998	16	100 U	100 U,L	100 U	100 U,L	100 U	100 U	N/A	100 U,L
		GW-19	10/28/1998	16	100 U	100 U,L	100 U	100 U,L	100 U	100 U	N/A	100 U,L
MW-15	Upland	GW-67	10/19/2000	24	1000 X1	N/A	N/A	N/A	N/A	N/A	1600	N/A
		GW-79	6/12/2001		680 X1	N/A	N/A	N/A	N/A	N/A	1200	N/A
		GW-80	10/10/2001		606 X2	N/A	N/A	N/A	N/A	N/A	868 X2	N/A
		GW-95	10/17/02		1190 X1	N/A	N/A	N/A	N/A	N/A	2340	N/A

Notes:

Analytes that were analyzed in riverbank wells are shown.

Criteria used for screening purposes highlighted grey.

JSCS criteria are shown only if PHSS ROD CULs and PHSS RAO PRGs are unavailable.

Non-detect data are not screened.

Riverbank data are screened against applicable criteria. Upland data are shown for informational purposes only.

B = The MRL/MDL is elevated because of matrix interferences.

H = The analysis was performed past the recommended holding time.

N/A = Not applicable or not analyzed.

NV = No Value.

U = Not detected at or above a specific method reporting limit (MRL).

ug/L = micrograms per liter.

X1 = Chromatogram suggests heavy oil.

X2 = Contaminant does not appear to be typical product.

(1) = The PHSS ROD and FS provide a diesel C10-C12 aliphatic fraction only criteria. This is a small subset of hydrocarbons present in the broader diesel fraction and the criterion is not applicable for these data.