# Technical Memorandum

**To:** EPA and Ecology

**From:** AECOM

**Subject:** Errata for the Lower Duwamish Waterway Draft Final Feasibility Study submitted on October 15, 2010

**Date:** November 23, 2010

On behalf of the Lower Duwamish Waterway Group, this correspondence documents technical corrections (errata) of the Draft Final Feasibility Study (FS) for the Lower Duwamish Waterway. The FS was submitted to the U.S. Environmental Protection Agency and Washington Department of Ecology on October 15, 2010. This errata memorandum addresses important technical corrections and the attached file contains revised Table and Figures. These and specific technical corrections in the narrative are described below by section. Additional minor (e.g. editorial) errata may be issued, as needed, during the FS review period.

Executive Summary

(Note: the following corrections are minor and do not change the relative rankings of the alternatives)

- The base cost for Remedial Alternative 6R provided in Figure ES-5 should be $1,300 million instead of $1,350 million.
- The lower bound cost for Alternative 2R provided in Figure ES-5 should be $120 million instead of $90 million.
- The numeric values for natural background reported in Table ES-1 should be 2, 7, 9 and 2 for total PCBs, arsenic, cPAH and dioxins/furans respectively. The units remain the same.
- Figures ES-8 and ES-11 have minor errors in total benefits displayed due to an error in Table 11-7 noted below.
- Text on page ES-36 (range of benefits) should be “5.8 to 6.6” instead of “5.7 to 6.4” and the benefit “4.9” should be “5.1”.

Sections 3 and 4

- Tables 3-7 and 4-4 report old total PCB sediment risk based threshold concentrations (RBTCs) for the three reasonable maximum exposure seafood consumption scenarios. RBTCs displayed in these two tables of the Draft Final FS are from the 2008 Draft Final and 2007 Draft versions of the Remedial Investigation reports, respectively. The correct RBTCs, as reported in the 2010 Final Remedial Investigation Report, are shown below. These minor errors affect neither the preliminary remediation goals (PRGs) nor the analyses presented in the FS.
    - Adult Tribal RME (Tulalip data) = 7.3 µg/kg dw
    - Child Tribal RME (Tulalip data) = 185 µg/kg dw
    - Adult API RME = 100 µg/kg dw
    - The range reported in Table 4-4 should be 7.3 to 185 µg/kg dw.

Section 11

- A formula in Table 11-7, which computed Effectiveness Over the Long Term, did not update correctly. This computation caused small errors in the metrics displayed in Tables 11-3, 11-6, and 11-7 and in Figures 11-1 to 11-4 and in the range of benefits described on Page 11-22. However, this error does not change the relative rankings of the alternatives. In fact, the correction results in a tighter range of net environmental benefits among the alternatives.

| MTCA Metric | 2R | 2R-CAD | 3C | 3R | 4C | 4R | 5C | 5R | 5R-T | 6C | 6R |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall Rank (in Oct 15 submittal) | 6.1 | 5.7 | 6.2 | 6.2 | 6.4 | 6.3 | 6.4 | 6.3 | 5.9 | 5.6 | 4.8 |
| Overall Rank corrected | 6.3 | 5.8 | 6.4 | 6.3 | 6.6 | 6.5 | 6.6 | 6.5 | 6.2 | 5.8 | 5.1 |

Section 12

- Figure 12-2 of benefits for long-term effectiveness is incorrect (see discussion for Table 11-7 above). The figure was revised to reflect the correct benefits for each remedial alternative in accordance with the revision to the formula in Table 11-7, noted above.

## Table ES-1: Preliminary Remediation Goals for Total PCBs, Arsenic, cPAHs, and Dioxins/Furans in LDW Surface Sediment

| Risk-Driver Chemical | Natural Background (UCL95) | Preliminary Remediation Goals (PRGs) | | | | |
|---|---|---|---|---|---|---|
| | | Spatial Scale of Exposure[a] | RAO 1: Human Seafood Consumption | RAO 2: Human Direct Contact | RAO 3: Benthic Organisms | RAO 4: Ecological (River Otter) |
| Total PCBs (µg/kg dw) | 2 | LDW-wide | background | 1,300[b] | n/a | 128 |
| | | Clamming | n/a | 500 | n/a | n/a |
| | | Beach Play | n/a | 1,700 | n/a | n/a |
| | | Point | n/a | n/a | SQS | n/a |
| Arsenic (mg/kg dw) | 7 | LDW-wide | tbd[c] | background[b] | n/a | n/a |
| | | Clamming | n/a | background | n/a | n/a |
| | | Beach Play | n/a | background | n/a | n/a |
| | | Point | n/a | n/a | 57 | n/a |
| cPAHs (µg TEQ/kg dw) | 9 | LDW-wide | tbd[c] | 380[b] | n/a | n/a |
| | | Clamming | n/a | 150[d] | n/a | n/a |
| | | Beach Play | n/a | 90 | n/a | n/a |
| | | Point | n/a | n/a | n/a[e] | n/a |
| Dioxins/Furans (ng TEQ /kg dw) | 2 | LDW-wide | background | 37[b] | n/a | n/a |
| | | Clamming | n/a | 13 | n/a | n/a |
| | | Beach Play | n/a | 28 | n/a | n/a |
| | | Point | n/a | n/a | n/a | n/a |
| Other SMS Chemicals | n/a | Point | n/a | n/a | SQS[f] | n/a |

Notes:

a The spatial scale of site-wide exposure is RAO-specific. The statistical metric for LDW-wide, clamming, and beach play areas is the spatially weighted average concentration (SWAC) for the evaluation of alternatives (compliance monitoring will be based on upper confidence limit on the mean or SWAC).

b LDW-wide PRG based on netfishing scenario.

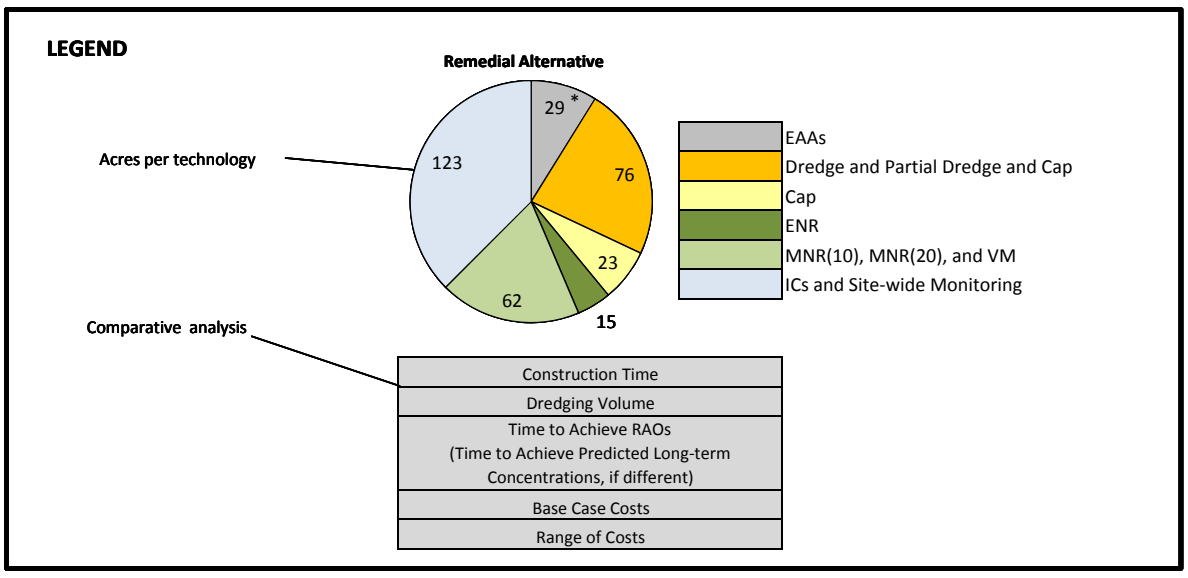
c There is no credible relationship, based on site data, relating cPAH or arsenic concentrations in sediment to concentrations in clam tissue. Cleanup goals are to be determined based on future investigations.

d PRG based on tribal clamming scenario.

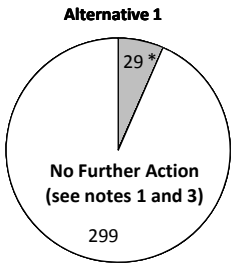
e Low- and high-molecular weight PAHs are addressed by the SMS criteria. Criteria are set for both groupings and for individual compounds.

f Under the SMS, sediment cleanup standards are established on a site-specific basis within an allowable range. The SQS and CSL define this range. For this FS, the PRG has been set at the lowest end of this range (i.e., SQS). However, the final cleanup standard will be set in consideration of the net environmental effects, cost, and technical feasibility of different cleanup alternatives (WAC 173-204-570(4)).

# Figure ES-5
# Summary of Alternatives

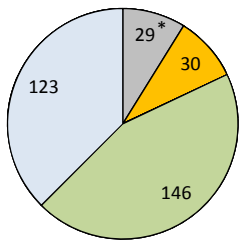



**Alternative 1**
Actively Remediated Area: 29 acres

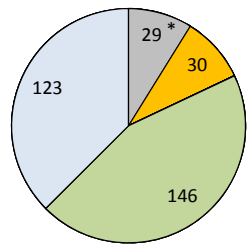



| |
|---|
| n/a |
| n/a |
| n/a |
| See note 1 |

**Alternative 2**
Actively Remediated Area: 59 acres

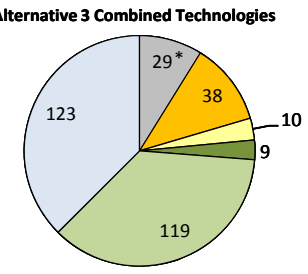



| |
|---|
| 4 years |
| 620,000 cy |
| 19 years (24 years) |
| $210 Million |
| $93 to $330 Million |

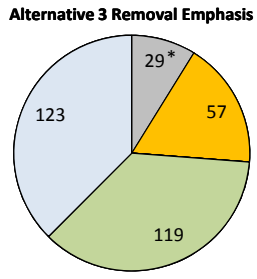



| |
|---|
| 4 years |
| 620,000 cy |
| 19 years (24 years) |
| $230 Million |
| $120 to $360 Million |

**Alternative 3**
Actively Remediated Area: 86 acres

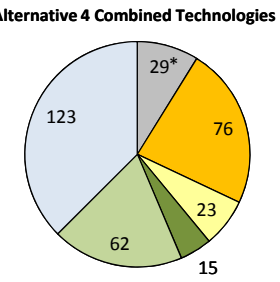



| |
|---|
| 4 years |
| 570,000 cy |
| 14 years (24 years) |
| $220 Million |
| $120 to $360 Million |

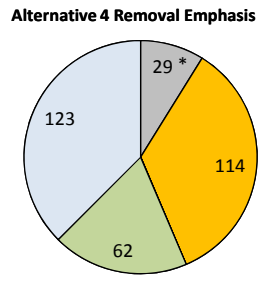



| |
|---|
| 6 years |
| 790,000 cy |
| 16 years (26 years) |
| $290 Million |
| $190 to $460 Million |

**Alternative 4**
Actively Remediated Area: 143 acres

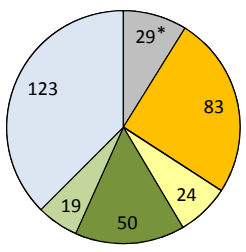



| |
|---|
| 7 years |
| 740,000 cy |
| 12 years (22 years) |
| $290 Million |
| $210 to $410 Million |

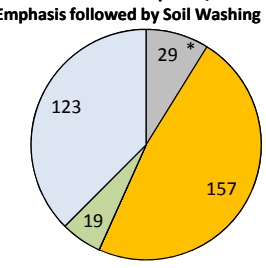



| |
|---|
| 13 years |
| 1,200,000 cy |
| 18 years |
| $440 Million |
| $350 to $630 Million |

**Alternative 5**
Actively Remediated Area: 186 acres

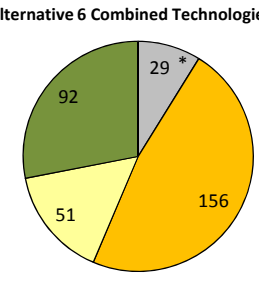



| |
|---|
| 8 years |
| 770,000 cy |
| 13 years (18 years) |
| $310 Million |
| $230 to $450 Million |

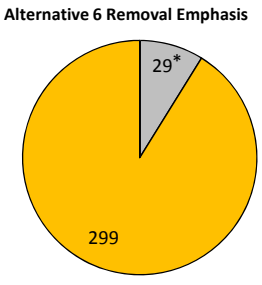



| |
|---|
| 19 years |
| 1,500,000 cy |
| 24 years |
| $550 Million / $600 Million |
| $460 to $940 Million |

**Alternative 6**
Actively Remediated Area: 328 acres




| |
|---|
| 18 years |
| 1,700,000 cy |
| 23 years |
| $650 Million |
| $450 to $820 Million |




| |
|---|
| 38 years |
| 3,600,000 cy |
| 43 years |
| $1,300 Million |
| $970 to $1,500 Million |

**Notes:**

1) Acreages for early action areas (EAAs) are shown here for completeness; they are common to all the alternatives (marked with asterisk). Decisions on those cleanups have been made and are not part of the decision process represented by this FS. EAA in-water work is estimated at $66 million. Substantial additional costs are expected for upland cleanups and source control. For example, at T-117 the in-water costs are approximately $6 million, and the upland costs are approximately $27 million. The EAA costs and the costs of upland cleanup and source control are not included in cost estimates shown for Alternatives 2 through 6.

2) Two cost estimates are shown for each alternative. The first represents a single-point estimate for simply comparing alternatives. The second, a range, reflects high and low sensitivity of costs to actual field design conditions. Actual costs are estimated to fall within the ranges. Costs are rounded to the nearest $10 million.

3) The pie represents 328 acres, i.e., the area where alternatives differ in the types of technologies evaluated. The total area of the FS study area 441 acres. The costs of monitoring and maintaining institutional controls over the entire LDW study area are included in the remedial alternative costs.

4) MNR(10) applies to Alternatives 2 and 4 where the goal is to reach the CSL or SQS, respectively, within 10 years after active remediation. MNR(20) applies to Alternatives 2 and 3, where the goal is to achieve the SQS over a time frame longer than 10 years.

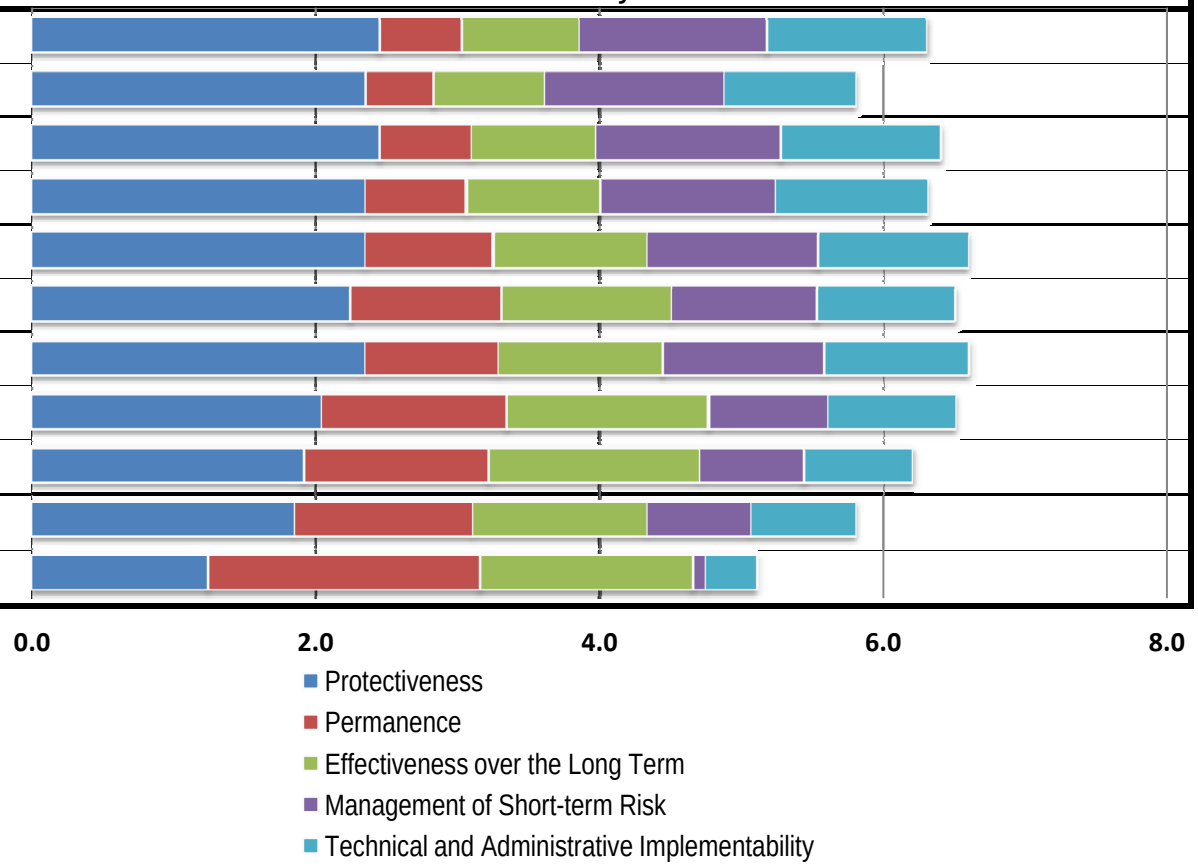
5) Total time is for achievement of all RAOs.

6) Long-term model predicted range of concentrations applies to RAO 1.

CSL = cleanup screening level; cy = cubic yards; EAAs = early action areas;
ENR = enhanced natural recovery; ICs = institutional controls;
MNR = monitored natural recovery; n/a = not applicable;
RAL = remedial action level; RAO = remedial action objective
SQS = sediment quality standard; VM = verification monitoring

**Figure ES-8 MTCA DCA Weighted Benefits for Individual Evaluation Criteria**

| Remedial Alternative | Actively Managed Area (acres)[b] | Weighted Ratings Under MTCA[a] |
|---|---|---|
| | | Total Benefits by Criteria |
| 2R | 59 | |
| 2R-CAD | 59 | |
| 3C | 86 | |
| 3R | 86 | |
| 4C | 143 | |
| 4R | 143 | |
| 5C | 186 | |
| 5R | 186 | |
| 5R-T | 186 | |
| 6C | 328 | |
| 6R | 328 | |




**Notes:**

1. See Section 11 for details.

a Ratings based on rankings shown in Table 10-1.

b Includes 29 EAA acres.

C = combined technologies alternative; CAD = contained aquatic disposal; DCA = disproportionate cost analysis; MTCA = Model Toxics Control Act; R = removal emphasis.

## Figure ES-11 Benefits and Costs for Remedial Alternatives

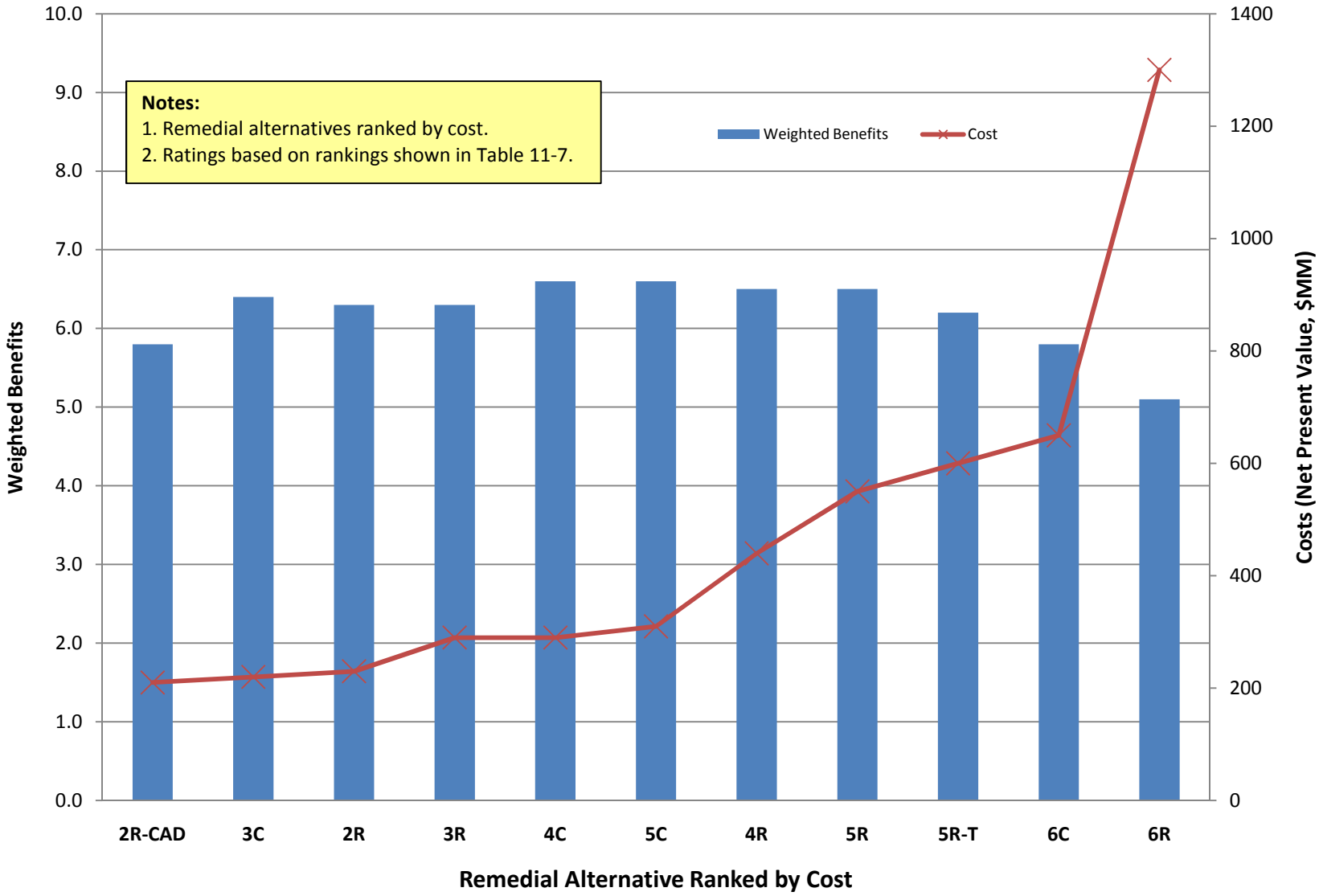


**Table 3-7 Sediment RBTCs for Total PCBs Based on the Human Health RME Seafood Consumption Scenarios and on Seafood Consumption by River Otters**

| Seafood Consumption Scenario | Sediment RBTCs for Total PCBs (µg/kg dw) | | | |
|---|---|---|---|---|
| | 1 in 1,000,000 Risk Level ($1 \times 10^{-6}$) | 1 in 100,000 Risk Level ($1 \times 10^{-5}$) | 1 in 10,000 Risk Level ($1 \times 10^{-4}$) | HQ = 1 |
| *Human* | | | | |
| Adult Tribal RME (Tulalip data) | <1[a] | <1[a] | 7.3 | <1 |
| Child Tribal RME (Tulalip data) | <1[a] | <1[a] | 185 | <1 |
| Adult API RME | <1[a] | <1[a] | 100 | <1 |
| *Ecological* | | | | |
| River otter | n/a | n/a | n/a | 128 – 159[b] |

Notes:

a For RBTCs presented as <1 µg/kg dw, a sediment RBTC could not be calculated because even if the total PCB concentration in sediment was set equal to 0 µg/kg dw, food web model-estimated total PCB concentrations in tissue were greater than the RBTC for the applicable risk level. These estimates result from a combination of the contribution from water, even at concentrations similar to those in upstream water (i.e., 0.3 ng/L) and key risk assumptions (e.g., seafood consumption rate).

b Represents best-fit estimates for two different fish consumption scenarios as presented in the ERA (Windward 2007a).

API = Asian and Pacific Islander; dw = dry weight; ERA – ecological risk assessment; HQ = hazard quotient; n/a = not applicable; PCB = polychlorinated biphenyl; RBTC = risk-based threshold concentration; RME = reasonable maximum exposure

**Table 4-4 Preliminary Remediation Goals for Total PCBs, Arsenic, cPAH TEQ, and Dioxin/ Furan TEQ in Lower Duwamish Waterway Sediment**

| Analyte | Practical Quantitation Limits | | | Natural Background[b] | Risk-Based Threshold Concentrations | | | | | Preliminary Remediation Goals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EPA Method | RI QAPP RLs[a] | Range of RLs from undetected values | | Spatial Scale of Exposure[c] | RAO 1: Human Seafood Consumption | RAO 2: Human Direct Contact | RAO 3: Benthic Organisms | RAO 4: Ecological (River Otter) | Value | Basis | Statistical Metric for Application | Spatial Scale of PRG Application |
| Total PCBs (µg/kg dw) | 8082 | 4[d] | 0.56 – 50[d] | 2, 3 | Site-wide | nc (7.3 - 185)[e] | 1,300 | n/a | (128 - 159)[f] | 2 (RAO 1)/1,300 (RAO 2) | bg/RBTC | SWAC | Site-wide |
| | | | | | Tribal Clamming | n/a | 500 | n/a | n/a | 500 | RBTC | SWAC | Clamming Areas |
| | | | | | Beach Play | n/a | 1,700 | n/a | n/a | 1,700 | RBTC | SWAC | Individual Beaches |
| | | | | | Point | n/a | n/a | 12/65[g] | n/a | 12 (mg/kg oc) | RBTC (SMS) | Point Concentration or Toxicity Test Pass | Point |
| Arsenic (mg/kg dw) | 6010B | 5 | 3.1 – 31 | 7, 11[h] | Site-wide | n/c[i] | 3.7 | n/a | n/a | 7[i] (RAO 2) | bg | SWAC | Site-wide |
| | | | | | Tribal Clamming | n/a | 1.3 | n/a | n/a | 7 | bg | SWAC | Clamming Areas |
| | | | | | Beach Play | n/a | 2.8 | n/a | n/a | 7 | bg | SWAC | Individual Beaches |
| | | | | | Point | n/a | n/a | 57/93[g] | n/a | 57 | RBTC (SMS) | Point Concentration or Toxicity Test Pass | Point |
| cPAH (µg TEQ/kg dw) | 8270D | 6.3 – 20[j] | 9.0 – 130[j] | 9, 15 | Site-wide | n/c[i] | 380 | n/a | n/a | 380[j] (RAO 2) | RBTC | SWAC | Site-wide |
| | | | | | Tribal Clamming | n/a | 150 | n/a | n/a | 150 | RBTC | SWAC | Clamming Areas |
| | | | | | Beach Play | n/a | 90 | n/a | n/a | 90 | RBTC | SWAC | Individual Beaches |
| | | | | | Point | n/a | n/a | n/a[k] | n/a | n/a | n/a | n/a | n/a |
| Dioxins/Furans (ng TEQ/kg dw) | 1613B | 1 – 10[l] | 0.12 – 7.7[l] | 2, 2 | Site-wide | nc (bg) | 37 | n/a | n/a | 2 (RAO 1) 37 (RAO 2) | bg/RBTC | SWAC | Site-wide |
| | | | | | Tribal Clamming | n/a | 13 | n/a | n/a | 13 | RBTC | SWAC | Clamming Areas |
| | | | | | Beach Play | n/a | 28 | n/a | n/a | 28 | RBTC | SWAC | Individual Beaches |
| | | | | | Point | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |

Notes:

a Reporting limits from Table A-1, Round 3 Surface Sediment QAPP Addendum (Windward 2006) in dry weight units on untransformed data.

b Two values are shown for natural background for each risk driver (x, x): the first is the UCL95 value and the second is the 90th percentile, both calculated from the EPA OSV *Bold* Survey dataset using ProUCL.

c The spatial scale of site-wide exposure is RAO-specific: (seafood consumption for RAO 1 and RAO 4; netfishing for RAO 2)

d PCB RLs reported in Table A-1, Round 3 Surface Sediment QAPP Addendum (Windward 2006) are for individual Aroclors. Range of RLs for undetected values were queried from the RI database and represent RLs for undetected total PCBs, not undetected values of individual Aroclors. Individual undetected Aroclors were not reported because they are not included in the calculation of total PCBs when other Aroclors are detected in the sample.

e RBTC <1 µg/kg dw at risk levels of $10^{-5}$ and $10^{-6}$, and RBTC range of 19 to 320 µg/kg dw for the three RME seafood consumption scenarios at the $10^{-4}$ risk level.

f Values represent best-fit estimates for two different dietary scenarios as reported in the RI (Windward 2010).

g Total PCB concentration units are mg/kg oc and the two values are SQS/CSL. Arsenic concentration units are mg/kg dw and the two values are SQS/CSL.

h Using MTCAStat software, the 90th percentile for arsenic is 11.9 mg/kg dw (assuming 70 samples, averaged duplicates, and log-normal distribution).

i Arsenic and cPAH PRGs are undefined for the human health seafood consumption pathway (RAO 1). Seafood consumption excess cancer risks for these two risk drivers were largely attributable to the consumption of clams There is no credible relationship, based on site data, relating cPAH or arsenic concentrations in sediment to concentrations in clam tissue (Section 8 of the RI, Windward 2010). Section 8 of the FS discusses the need for future investigations of the sediment/tissue relationships for arsenic and cPAHs.

j All individual PAH compounds used in the cPAH calculation have an RL of 20 except for dibenzo[a,h]anthracene, which has an RL of 6.3. RLs reported for undetected values are based on calculated cPAHs and can be found in Table A-1, of Round 3 Surface Sediment QAPP Addendum (Windward 2006).

k Low- and high-molecular weight PAHs are addressed by the SMS. Criteria are set for both groupings and for individual PAH compounds.

l Dioxin/furan TEQ RLs are based on those for the individual congeners used in the TEQ calculation. RLs for undetected values are in Table A-1, Round 3 Surface Sediment QAPP Addendum (Windward 2006).

bg = natural background; cPAH = carcinogenic polycyclic aromatic hydrocarbon; CSL = cleanup screening level; dw = dry weight; EPA = U.S. Environmental Protection Agency; LDW = Lower Duwamish Waterway; µg/kg = micrograms per kilogram; mg/kg = milligrams per kilogram; n/a = not applicable; nc = no value calculated; nc (bg) = not calculated, RBTC value expected to be below background; ng/kg = nanograms per kilogram; oc = organic carbon; PCB = polychlorinated biphenyl; PRG = preliminary remediation goal; QAPP = quality assurance project plan; RAO = remedial action objective; RBTC = risk-based threshold concentration; RL = reporting limit; SMS = Sediment Management Standards; SQS = sediment quality standard; SWAC = spatially-weighted average concentration; TEQ = toxic equivalent

Table 11-3 Compliance with Minimum Requirements

| Analysis Parameters | | | Remedial Alternative | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2R | 2R-CAD | 3C | 3R | 4C | 4R | 5C | 5R | 5R-T | 6C | 6R |
| *Threshold Requirements* | Protect human health and the environment, and compliance with cleanup standards | | | | | | | | | | | | | |
| | Risk Pathway Category | Preliminary Cleanup Standard [a] | Compliance | | | | | | | | | | | |
| | Human Health – RAO 1: Human Health – Seafood Consumption | Preliminary CULs = PRGs (possible adjustment upward due to natural background calculation) with a POC of the upper 10 cm of sediment site-wide | Not achieved | PRGs are not achieved for any alternative; however, the RAO is achieved through a combination of active remediation, natural recovery, and institutional controls. See Section 9. | | | | | | | | | | |
| | Human Health – RAO 2: Human Health – Direct Contact | Preliminary CULs = PRGs (except 11 mg/kg dw for arsenic[b]) with a POC of the upper 45 cm of sediment in beaches and potential clamming areas, and upper 10 cm of sediment site-wide | Not achieved | Predicted to achieve within 15 years following the beginning of construction based on BCM predictions in Table 9-2a [c] | | Predicted to achieve following construction completion [a] | | | | | | | | |
| | Environment – RAO 3: Ecological Health – Benthic | Preliminary CULS = PRGs (SQS) with a POC upper 10 cm of sediment site-wide | Not achieved | Predicted to achieve SQS within 10 years following construction, based on BCM predictions in Table 9-2b | | Predicted to achieve SQS within 5 years following construction, based on BCM predictions in Table 9-2b | | Predicted to achieve SQS immediately following construction, based on BCM predictions in Table 9-2b | | | | | | |
| | Environment – RAO4: Ecological Health – Seafood Consumption – River Otter | Preliminary CULS = PRGs with a POC upper 10 cm of sediment site-wide | Not achieved | Predicted to achieve immediately following construction based on BCM predictions in Table 9-6b | | | | | | | | | | |
| | Compliance with applicable local, state and federal laws | | Not achieved | Complies with all applicable local, state, and federal laws; see Section 9 for discussion. | | | | | | | | | | |
| | Provide for compliance monitoring | | Not achieved | Conceptual monitoring plan for Remedial Alternatives 2 through 6 is provided in Appendix K. | | | | | | | | | | |
| | Achieves threshold requirements? | | No | Yes | | | | | | | | | | |
| *Other Requirements* | *Restoration Time Frames (RTF – years)* [d] | | | | | | | | | | | | | |
| | Duration of construction period | | n/a | 4 | 4 | 4 | 6 | 7 | 13 | 8 | 19 | 19 | 18 | 38 |
| | Implementation period from issuance of the final decision document (construction period plus 5 yrs) | | | 9 | 9 | 9 | 11 | 12 | 18 | 13 | 24 | 24 | 23 | 43 |
| | RAO 1 | Predicted years to complete construction and implement institutional controls [e] | | 9 | 9 | 9 | 11 | 12 | 18 | 13 | 24 | 24 | 23 | 43 |
| | RAO 2 | Predicted years to achieve cumulative risk $\leq 1 \times 10^{-5}$ (all exposure scenarios)[f] | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | RAO 3 | Predicted years to achieve >98% of area remediated to <SQS [g] | | 19 | 19 | 14 | 16 | 12 | 15 | 12 | 15 | 15 | 12 | 15 |
| | RAO 4 | Predicted years to reach ecological HQ<1 for all scenarios [h] | | 9 | 9 | 9 | 11 | 12 | 18 | 13 | 24 | 24 | 23 | 43 |
| | Additional risk reduction (RAO 1) | Time for risk drivers to reach modeled long-term concentration range in surface sediment, which provides nominal incremental risk reduction | | 24 | 24 | 24 | 26 | 22 | 18 | 18 | 24 | 24 | 23 | 43 |
| | *Consideration of public concerns* | | n/a | Determined during development of final decision document | | | | | | | | | | |
| *Additional Minimum Requirements* | *Groundwater cleanup actions* | | n/a | Not applicable to FS | | | | | | | | | | |
| | *Soil at residential areas, schools, and child care centers* | | | Not applicable to FS | | | | | | | | | | |
| | *Institutional controls* | | | Achieved | | | | | | | | | | |
| | *Releases and migration* | | | Achieved | | | | | | | | | | |
| | *Dilution and dispersion* | | | Achieved | | | | | | | | | | |
| | *Remediation levels* | | | Achieved | | | | | | | | | | |
| *DCA* | Weighted Benefit Points (score from Table 11-6) [i] | | n/a | 6.3 | 5.8 | 6.4 | 6.3 | 6.6 | 6.5 | 6.6 | 6.5 | 6.2 | 5.8 | 5.1 |
| | Cost ($millions net present value) | | | 230 | 210 | 220 | 290 | 290 | 440 | 310 | 550 | 600 | 650 | 1,300 |
| | Benefit points/cost ($billions) | | | 27 | 28 | 29 | 22 | 23 | 15 | 21 | 12 | 10 | 9 | 4 |

Notes:

a Preliminary cleanup levels are considered to be equivalent with PRGs with the exception of those based on natural background, as discussed in Section 11.2.

b A value of 11 mg/kg dw was calculated as the 90th percentile of the EPA OSV *Bold* survey dataset using ProUCL. Using MTCAStat, the 90th percentile of the EPA OSV Bold survey dataset is 12 mg/kg dw

c Achieves cumulative direct contact risk of 1 x $10^{-5}$ for all scenarios. PCBs and dioxins/furans achieve direct contact excess cancer risk of $10^{-6}$ for all scenarios. Arsenic achieves MTCA background concentrations. cPAH exceed 1 x$10^{-6}$ for Beach 3 due to lateral loads.

d Estimated RTF is time from the issuance of the final decision documents; 5 years are added to the construction time to estimate the time to complete the EAAs, baseline monitoring, and remedial design.

e Two time frames are considered for RAO 1. First is the remedial alternative's implementation time, at which point all alternatives reduce the Adult Tribal RME seafood consumption risk to the lowest risk magnitude (10) achievable in the long term. The multi-layered program of monitoring and ICs (advisories, outreach, and education) is required at this point for all alternatives to further reduce seafood consumption exposures (see Section 10.2.1.2). The second time component is the predicted time for risk-driver concentrations to achieve long-term modeled concentration ranges. The food web model relationship between sediment and fish tissue concentrations is assumed to not apply during construction. Fish tissue concentrations are assumed to remain elevated as a result of resuspension and release of total PCBs into the water column. None of the alternatives reduce the human non-cancer seafood consumption HQ to less than 1.

f Alternatives 3C and 3R specifically address direct contact risks and achieve a cumulative direct contact risk of≤1 x $10^{-5}$ for all exposure scenarios. It is assumed that the Alternative 3 actions occur in the first 5 years of Alternatives 4, 5, and 6, and therefore the same rounded time frame to achieve RAO 2 (10 years) is applied to Alternatives 3 through 6. Alternative 2 does not specifically address direct contact risks through active remediation. However, surface sediments in potential clamming and assumed beach play areas are expected to recover naturally over time.

g The RAO 3 RTF is assumed to range between when the MCUL is met (<1 acre associated with remaining point exceedances) and when remaining SQS points correspond to fewer than 2% of the LDW surface area. Within this range, conditions are reached when it is no longer technically practicable to manage isolated point exceedances with any certainty of a net environmental benefit.

h RTF for RAO 4 is based on the longer of: 1) wildlife seafood consumption non-cancer risks to HQ <1 based on the site-wide total PCB SWAC, and 2) end of construction. The food web model relationship between sediment and fish tissue concentrations is assumed not to apply during construction. Fish tissue concentrations are assumed to remain elevated above equilibrium values as a result of and release of total PCBs into the water column.

I Weighted benefit points are based on Table 11-7.

C = combined technology alternatives; CUL = cleanup level; HQ = hazard quotient; MCUL = minimum cleanup level; MTCA = Model Toxics Control Act; n/a = not applicable; POC = point of compliance; PRGs = preliminary remediation goals; R = removal-emphasis alternatives with upland disposal; RAO = remedial action objective; R-CAD = removal-emphasis alternative with contained aquatic disposal; RME = reasonable maximum exposure; R-T = removal-emphasis alternative with soil washing; RTF = restoration time frame; SMS = sediment management standards; SQS = sediment quality standards; TBD = to be determined

**Table 11-6 Summary of Disproportionate Cost Analysis – Alternative Benefits Scores**

| | Evaluation Criteria | Remedial Alternatives and Scores[a] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2R | 2R–CAD | 3C | 3R | 4C | 4R | 5C | 5R | 5R– T | 6C | 6R |
| **1** | **Protectiveness – total weighting factor: 30%[b]** | **8.1** | **7.8** | **8.1** | **7.9** | **7.8** | **7.4** | **7.7** | **6.8** | **6.3** | **6.2** | **4.1** |
| 1a | Degree to which existing risks are reduced | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.9 | 7.9 |
| 1b | Time required to reduce risk | 7.7 | 7.7 | 8.0 | 7.6 | 7.9 | 7.3 | 8.0 | 6.4 | 6.4 | 6.7 | 3.6 |
| 1c | On-site and off-site risks from implementation | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 1d | Improvement of the overall environmental quality | 8.3 | 7.9 | 8.2 | 8.0 | 7.8 | 7.4 | 7.6 | 7.0 | 6.2 | 6.1 | 4.3 |
| **2** | Permanence – total weighting factor: 20%[b] | 2.9 | 2.4 | 3.2 | 3.6 | 4.4 | 5.3 | 4.7 | 6.5 | 6.5 | 6.3 | 9.5 |
| 2a | Reduction in volume of contaminated sediment | 1.6 | 0.8 | 1.4 | 2.0 | 1.9 | 3.0 | 1.9 | 3.8 | 3.8 | 4.3 | 9.0 |
| 2b | Reduction in mobility of contaminants | 4.2 | 4.0 | 4.9 | 5.2 | 6.8 | 7.5 | 7.5 | 9.2 | 9.2 | 8.3 | 9.9 |
| 2c | Reduction in toxicity, adequacy of alternative in destroying hazardous substances, reduction or elimination of hazardous substance releases and sources or releases, the degree of irreversibility of waste treatment processes, and the characteristics and quantity of treatment residuals generated – MTCA criteria not used | | | | | | | | | | | |
| **3** | Effectiveness Over the Long Term – total weighting factor: 20%[b] | 4.1 | 3.9 | 4.4 | 4.7 | 5.4 | 6.0 | 5.8 | 7.1 | 7.4 | 6.2 | 7.5 |
| 3a | Degree of certainty that remedy will be successful | 4.0 | 4.0 | 4.7 | 4.9 | 6.5 | 6.9 | 7.2 | 8.4 | 8.4 | 7.9 | 9.0 |
| 3b | Reliability of the alternatives during the time that sediment above PRGs remain on site | 4.0 | 4.0 | 4.7 | 4.9 | 6.5 | 6.9 | 7.2 | 8.4 | 8.4 | 7.9 | 9.0 |
| 3c | Magnitude of residual risk | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.9 | 7.9 |
| 3d | Reliability of ICs and engineering controls used to manage risk | 0.8 | 0.1 | 0.9 | 1.5 | 1.5 | 3.0 | 1.6 | 4.1 | 4.1 | 1.9 | 4.6 |
| 3e | Hierarchy of cleanup and disposal technologies used | 3.6 | 3.4 | 3.9 | 4.2 | 4.7 | 5.4 | 4.8 | 6.4 | 8.3 | 5.2 | 6.8 |
| **4** | Management of Short-term Risk – total weighting factor: 15%[b] | 8.8 | 8.4 | 8.7 | 8.2 | 7.9 | 6.8 | 7.6 | 5.6 | 4.9 | 4.9 | 0.6 |
| 4a | Implementation risks | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 4b | Effectiveness of protective measures to manage short-term risks | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| **5** | Technical and Administrative Implementability – total weighting factor: 15%[b] | 7.5 | 6.2 | 7.5 | 7.2 | 7.1 | 6.5 | 6.8 | 6.0 | 5.1 | 5.0 | 2.4 |
| 5a | Technical feasibility | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 5b | Availability of necessary off-site facilities, services and materials | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| 5c | Administrative and regulatory requirements | 8.0 | 2.0 | 8.0 | 7.0 | 7.0 | 5.0 | 6.0 | 5.0 | 2.0 | 5.0 | 2.0 |
| 5d | Scheduling, size, and complexity | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 5e | Monitoring requirements | 1.6 | 0.2 | 1.7 | 3.0 | 2.9 | 5.9 | 3.1 | 8.2 | 8.2 | 3.7 | 9.1 |
| 5f | Access for construction operations and monitoring | 7.7 | 7.7 | 8.0 | 7.6 | 7.9 | 7.3 | 8.0 | 6.4 | 6.4 | 6.7 | 3.6 |
| 5g | Integration with existing facility operations and other remedial actions | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| **6** | Consideration of Public Concerns (not factored into the cost benefit analysis) – to be decided in the final decision documents | | | | | | | | | | | |
| **7** | Total Weighted Benefits | 6.3 | 5.8 | 6.4 | 6.3 | 6.6 | 6.5 | 6.6 | 6.5 | 6.2 | 5.8 | 5.1 |
| **8** | Cost ($millions) | 230 | 210 | 220 | 290 | 290 | 440 | 310 | 550 | 600 | 650 | 1300 |
| **9** | Benefit/cost (Benefit /$billions) | 27 | 28 | 29 | 22 | 23 | 15 | 21 | 12 | 10 | 9 | 4 |

Notes:

a A score of 0 represents the lowest benefit, or a poor performing alternative for the given metric. A score of 10 represents the highest benefit, or an excellent performing alternative for the given metric. Scores of 0 and 10 do not represent the lowest and highest alternatives in the suite of alternatives, but represent the high and low values shown in the Scale of Benefit columns on Table 11-7. The alternatives are scored on a linear scale between these end points.

b Categorical ratings for each alternative are averaged scores from each of the subcriteria listed underneath the shaded headings.

AOPC = area of potential concern; BPJ = best professional judgement; C = combined technology; cy = cubic yards; EAA = early action area; ENR = enhanced natural recovery; ICs = institutional controls; MNR = monitored natural recovery; MTCA = Model Toxics Control Act; R = removal focused; RAO = remedial action objective; R-CAD = removal-emphasis alternative with contained aquatic disposal; R-T = removal-emphasis alternative with treatment (soil washing)

Table 11-7 Disproportionate Cost Analysis – Alternative Benefits Metrics and Scores

| MTCA Evaluation Criteria | | | Units | Scale of Benefit (Scoring Basis)[a] | | Remedial Alternatives and Scores[b] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Score 0 | Score 10 | 2R | 2R-CAD | 3C | 3R | 4C | 4R | 5C | 5R | 5R-T | 6C | 6R |
| 1 | Protectiveness – total weighting factor: 30% | | Benefit | Average score of 1a, 1b, 1c, 1d | | 8.1 | 7.8 | 8.1 | 7.9 | 7.8 | 7.4 | 7.7 | 6.8 | 6.3 | 6.2 | 4.1 |
| 1a | Degree to which existing risks are reduced | Average benefit score of all RAOs weighted equally | benefit | Average score of RAOs | | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.9 | 7.9 |
| | RAO 1[c,d] | Excess residual cancer risk from total PCBs – Adult Tribal RME | benefit | $9 \times 10^{-4}$ (baseline) | $1 \times 10^{-5}$ | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| | | | risk at end of the model period | | | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ |
| | | Non-cancer risk (HQ) – Adult Tribal RME | benefit | 24 (baseline) | 1 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.3 | 1.3 |
| | | | HQ at end of the model period | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 |
| | RAO 2[e] | Residual Direct Contact Risk – Cumulative (for net fishing, clamming, and beach play scenarios) | benefit | $1 \times 10^{-4}$ | $1 \times 10^{-5}$ for all areas | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | total risk at the end of the model period | | | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas | ≤1 x $10^{-5}$ for all areas |
| | RAO 3 | SQS exceedances remediated as percentage of total FS surface sediment dataset stations (n=1,395; see Table 9-2b) | benefit | Approx. 65% (baseline) | 98% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | % of points remediated 10 years after construction | | | 98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% |
| | | LDW area associated with SQS exceedances as percent of total study area (441 acres; see Table 9-2b) | benefit | Approx. 65% (baseline) | 98% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | % of area remediated 10 years after construction | | | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% | >98% |
| | RAO 4 | HQ for consumption of seafood (without juvenile fish) by the river otter | benefit | 2 (baseline) | 1 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | | | HQ at the end of the model period | | | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1b | Time required to reduce risk[f] | Average benefit score of all RAOs weighted equally | benefit | Average score of RAOs and additional risk reduction | | 7.7 | 7.7 | 8.0 | 7.6 | 7.9 | 7.3 | 8.0 | 6.4 | 6.4 | 6.7 | 3.6 |
| | RAO 1[g] | Years to complete construction and implement of institutional controls | benefit | 45 years | 5 years | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| | | | years from issuance of final decision documents | | | 9 | 9 | 9 | 11 | 12 | 18 | 13 | 24 | 24 | 23 | 43 |
| | RAO 2[h] | Years to achieve cumulative risk ≤1 x $10^{-5}$ (all exposure scenarios) | benefit | 45 years | 5 years | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 |
| | | | years from issuance of final decision documents | | | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| | RAO 3[i] | Years to achieve >98% of area remediated to <SQS | benefit | 45 years | 5 years | 6.5 | 6.5 | 7.8 | 7.3 | 8.3 | 7.5 | 8.3 | 7.5 | 7.5 | 8.3 | 7.5 |
| | | | years from issuance of final decision documents | | | 19 | 19 | 14 | 16 | 12 | 15 | 12 | 15 | 15 | 12 | 15 |
| | RAO 4 | Years to reach ecological HQ <1 for all scenarios | benefit | 45 years | 5 years | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| | | | years from issuance of final decision documents | | | 9 | 9 | 9 | 11 | 12 | 18 | 13 | 24 | 24 | 23 | 43 |
| | Additional risk reduction for RAO 1 | Time for risk drivers to reach long-term model-predicted concentration ranges in surface sediment | benefit | 45 years | 5 years | 5.3 | 5.3 | 5.3 | 4.8 | 5.8 | 6.8 | 6.8 | 5.3 | 5.3 | 5.5 | 0.5 |
| | | | years from issuance of final decision documents | | | 24 | 24 | 24 | 26 | 22 | 18 | 18 | 24 | 24 | 23 | 43 |
| 1c | On-site and off-site risks from implementation | Assume implementation risks are proportional to volume of material handled[j] | benefit | 5 million cy | 0 cy | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| | Total volume of material handled including dredging (base-case performance volume), CAD construction (2R–CAD) (0.37 MM cy), treatment (5R–T) (50% of performance volume), backfill, ENR, residuals management, and capping volume (total placement volume). | | million cy | | | 0.73 | 1.2 | 0.83 | 1.03 | 1.3 | 1.6 | 1.4 | 2.1 | 2.8 | 2.9 | 4.7 |
| 1d | Improvement of the overall environmental quality | Overall improvement is assumed to be proportional to risk reduction benefit minus implementation risks (average #1a and #1c above) | benefit | see #1a and #1c above | | 8.3 | 7.9 | 8.2 | 8.0 | 7.8 | 7.4 | 7.6 | 7.0 | 6.2 | 6.1 | 4.3 |

Table 11-7 Disproportionate Cost Analysis – Alternative Benefits Metrics and Scores

| MTCA Evaluation Criteria | | | Units | Scale of Benefit (Scoring Basis)[a] Score 0 | Score 10 | Remedial Alternatives and Scores[b] 2R | 2R-CAD | 3C | 3R | 4C | 4R | 5C | 5R | 5R-T | 6C | 6R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Permanence – total weighting factor: 20% | | benefit | Average score of 2a, 2b | | 2.9 | 2.4 | 3.2 | 3.6 | 4.4 | 5.3 | 4.7 | 6.5 | 6.5 | 6.3 | 9.5 |
| 2a | Reduction in volume of contaminated sediment | | benefit | 0 cy | 4 million cy | 1.6 | 0.8 | 1.4 | 2.0 | 1.9 | 3.0 | 1.9 | 3.8 | 3.8 | 4.3 | 9.0 |
| | | Volume removed from LDW (base case performance volume estimate)[k] | million cy | | | 0.62 | 0.31 | 0.57 | 0.79 | 0.74 | 1.20 | 0.77 | 1.50 | 1.50 | 1.70 | 3.60 |
| 2b | Reduction in mobility of contaminants | Immobility rating based on the weighted benefit of areas and type of technology applied in AOPC 1 | benefit | score total of weighted average: (acres of technology) * (weighting) / (total acres (176 = AOPC 1)) | | 4.2 | 4.0 | 4.9 | 5.2 | 6.8 | 7.5 | 7.5 | 9.2 | 9.2 | 8.3 | 9.9 |
| | | dredge | acres of AOPC 1 | weighting: 10 | | 27 | 3 | 29 | 52 | 51 | 103 | 54 | 145 | 145 | 64 | 160 |
| | | cap/ partial dredge and cap (Alternative 2R–CAD includes 24 acres of CAD area; that acreage is subtracted from the dredge area) | acres of AOPC 1 | weighting: 9 | | 3 | 27 | 19 | 5 | 48 | 11 | 53 | 12 | 12 | 65 | 16 |
| | | ENR | acres of AOPC 1 | weighting: 5 | | 0 | 0 | 9 | 0 | 15 | 0 | 50 | 0 | 0 | 47 | 0 |
| | | MNR and VM | acres of AOPC 1 | weighting: 3 | | 146 | 146 | 119 | 119 | 62 | 62 | 19 | 19 | 19 | 0 | 0 |
| 2c | Reduction in toxicity, adequacy of alternative in destroying hazardous substances, reduction or elimination of hazardous substance releases and sources or releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated – MTCA criteria not used | | | | | | | | | | | | | | | |
| 3 | Effectiveness Over the Long Term – total weighting factor: 20% | | benefit | Average score of 3a, 3b, 3c, 3d, 3e | | 4.1 | 3.9 | 4.4 | 4.7 | 5.4 | 6.0 | 5.8 | 7.1 | 7.4 | 6.2 | 7.5 |
| 3a | Degree of certainty that remedy will be successful[l] | Degree of certainty rating based on weighted benefit of remedial technologies below | benefit | score total of weighted average: (acres of technology) * (weighting) / (total acres (176 = AOPC 1)) | | 4.0 | 4.0 | 4.7 | 4.9 | 6.5 | 6.9 | 7.2 | 8.4 | 8.4 | 7.9 | 9.0 |
| | | dredge | acres of AOPC 1 | weighting: 9 | | 27 | 3 | 29 | 52 | 51 | 103 | 54 | 145 | 145 | 64 | 160 |
| | | cap/ partial dredge and cap (Alternative 2R–CAD includes 24 acres of CAD area; that acreage is subtracted from the dredge area) | acres of AOPC 1 | weighting: 9 | | 3 | 27 | 19 | 5 | 48 | 11 | 53 | 12 | 12 | 65 | 16 |
| | | ENR | acres of AOPC 1 | weighting: 5 | | 0 | 0 | 9 | 0 | 15 | 0 | 50 | 0 | 0 | 47 | 0 |
| | | MNR and VM | acres of AOPC 1 | weighting: 3 | | 146 | 146 | 119 | 119 | 62 | 62 | 19 | 19 | 19 | 0 | 0 |
| 3b | Reliability of the alternatives during the time that sediment above PRGs remain on site | Reliability rating based on weighted benefit of remedial technologies | benefit | see #3a above | | 4.0 | 4.0 | 4.7 | 4.9 | 6.5 | 6.9 | 7.2 | 8.4 | 8.4 | 7.9 | 9.0 |
| 3c | Magnitude of residual risk | Proportional to the degree to which existing risks are reduced (see #1a above) | benefit | see #1a above | | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.9 | 7.9 |
| 3d | Reliability of ICs and engineering controls used to manage risk | Assume that the reliability of controls is proportional to the degree to which they are used | benefit | | | 0.8 | 0.1 | 0.9 | 1.5 | 1.5 | 3.0 | 1.6 | 4.1 | 4.1 | 1.9 | 4.6 |
| | Seafood consumption advisory | Assume reliability is based on the degree of seafood advisories in effect | benefit | no | yes | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | fish advisory remains in effect? | | | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes | yes |
| | Reliability of O&M monitoring, relative amounts of maintenance required, relative monitoring and notification of waterway users | Assume reliability is inversely proportional to acres of caps, ENR, MNR, VM in AOPC 1. Alternative 2R–CAD includes 24 acres of CAD area | benefit | 176 acres (AOPC 1) | 0 acres | 1.6 | 0.2 | 1.7 | 3.0 | 2.9 | 5.9 | 3.1 | 8.2 | 8.2 | 3.7 | 9.1 |
| | | | acres of AOPC 1 | | | 149 | 173 | 147 | 124 | 125 | 73 | 122 | 31 | 31 | 112 | 16 |
| 3e | Hierarchy of cleanup and disposal technologies used | Weighted average of acres for each achieved (assume acres remediated is a proxy for volume remediated) | benefit | score total of weighted average: (acres of technology) * (weighting) / (total acres (176 = AOPC 1)) | | 3.6 | 3.4 | 3.9 | 4.2 | 4.7 | 5.4 | 4.8 | 6.4 | 8.3 | 5.2 | 6.8 |
| | | Reuse and recycle (assume 25% of acres of dredging for Alternative 5RT is reused sediment) | acres of AOPC 1 | weighting: 9 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 0 | 0 |
| | | Destruction and detoxification | acres of AOPC 1 | weighting: n/a | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Immobilization and solidification | acres of AOPC 1 | weighting: n/a | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | On-site or off-site disposal (dredge) | acres of AOPC 1 | weighting: 7 | | 27 | 3 | 29 | 52 | 51 | 103 | 54 | 145 | 145 | 64 | 160 |
| | | On-site isolation or containment (cap + PDC) (Alternative 2R–CAD includes 24 acres of CAD area; that acreage is subtracted from the dredge area) | acres of AOPC 1 | weighting: 5 | | 3 | 27 | 19 | 5 | 48 | 11 | 53 | 12 | 12 | 65 | 16 |
| | | Institutional controls and monitoring (ENR, MNR, VM) | acres of AOPC 1 | weighting: 3 | | 146 | 146 | 128 | 119 | 77 | 62 | 69 | 19 | 19 | 47 | 0 |

Table 11-7 Disproportionate Cost Analysis – Alternative Benefits Metrics and Scores

| | MTCA Evaluation Criteria | | Units | Scale of Benefit (Scoring Basis)[a] Score 0 | Scale of Benefit (Scoring Basis)[a] Score 10 | Remedial Alternatives and Scores[b] 2R | 2R-CAD | 3C | 3R | 4C | 4R | 5C | 5R | 5R-T | 6C | 6R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Management of Short-term Risk – total weighting factor: 15% | | benefit | Average score of 4a, 4b | | 8.8 | 8.4 | 8.7 | 8.2 | 7.9 | 6.8 | 7.6 | 5.6 | 4.9 | 4.9 | 0.6 |
| 4a | Implementation risks | Implementation risks are assumed to be equivalent to on-site and off-site risks due to implementation (see #1c above) | benefit | see #1c above | | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 4b | Effectiveness of protective measures to manage short-term risks | Proportional to the construction time frame | benefit | 40 years | 0 years | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| | | Construction time frame | years | | | 4 | 4 | 4 | 6 | 7 | 13 | 8 | 19 | 19 | 18 | 38 |
| 5 | Technical and Administrative Implementability – total weighting factor: 15% | | benefit | Average score of 5a, 5b, 5c, 5d, 5e, 5f, 5g | | 7.5 | 6.2 | 7.5 | 7.2 | 7.1 | 6.5 | 6.8 | 6.0 | 5.1 | 5.0 | 2.4 |
| 5a | Technical feasibility | All alternatives are assumed be technically feasible. Treatment (5RT) is scored lower because of additional technical challenges. | benefit | see #1c above | | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 5b | Availability of necessary off-site facilities, services and materials | Assume off-site resources are available; they are used in proportion to the construction time frame (see #4b above) | benefit | see #4b above | | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| 5c | Administrative and regulatory requirements | Evaluated using BPJ assuming that alternatives with longer construction time frames will have additional requirements, and CAD and treatment | benefit | BPJ | | 8.0 | 2.0 | 8.0 | 7.0 | 7.0 | 5.0 | 6.0 | 5.0 | 2.0 | 5.0 | 2.0 |
| 5d | Scheduling, size, and complexity | Assume size is proportional to removal and handling volume (see #1c above) | benefit | see #1c above | | 8.5 | 7.7 | 8.3 | 7.9 | 7.5 | 6.8 | 7.2 | 5.9 | 4.4 | 4.2 | 0.6 |
| 5e | Monitoring requirements | Assume monitoring is proportional to cap, ENR, and MNR area (see #3d above) | benefit | see #3d above | | 1.6 | 0.2 | 1.7 | 3.0 | 2.9 | 5.9 | 3.1 | 8.2 | 8.2 | 3.7 | 9.1 |
| 5f | Access for construction operations and monitoring | Assume access is available; and access is needed in proportion to the restoration time frame (see #1b above) | benefit | see #1b above | | 7.7 | 7.7 | 8.0 | 7.6 | 7.9 | 7.3 | 8.0 | 6.4 | 6.4 | 6.7 | 3.6 |
| 5g | Integration with existing facility operations and other remedial actions | Assume integration is possible, and integration challenges are in proportion to the construction time frame (see #4b above) | benefit | see #4b above | | 9.0 | 9.0 | 9.0 | 8.5 | 8.3 | 6.8 | 8.0 | 5.3 | 5.3 | 5.5 | 0.5 |
| 6 | Consideration of Public Concerns | Not factored into the cost benefit analysis – TBD in the final decision documents | | | | | | | | | | | | | | |
| 7 | Total Weighted Benefits | | | | | 6.3 | 5.8 | 6.4 | 6.3 | 6.6 | 6.5 | 6.6 | 6.5 | 6.2 | 5.8 | 5.1 |
| 8 | Cost ($millions) | | | | | 230 | 210 | 220 | 290 | 290 | 440 | 310 | 550 | 600 | 650 | 1,300 |
| 9 | Benefit/cost (Benefit /$billions) | | | | | 27 | 28 | 29 | 22 | 23 | 15 | 21 | 12 | 10 | 9 | 4 |

Notes:

a A score of 0 represents the lowest benefit, or a poor performing alternative for the given metric. A score of 10 represents the highest benefit, or an excellent performing alternative for the given metric. Scores of 0 and 10 do not represent the lowest and highest alternatives in the suite of alternatives, but represent the high and low values shown in the Scale of Benefit columns. The alternatives are scored on a linear scale between these end points.

b Categorical ratings for each alternative are averaged scores from each of the subcriteria listed underneath the shaded headings.

c Risk estimate based on use of the total PCB SWAC (using base case [mid input values] BCM output) in the food web model. Total excess cancer risks (all carcinogens combined) are expected to be similar to total PCB risks for the consumption of resident fish and crab because most of the seafood consumption risk for these seafood types is from PCBs.

d See Table 9-6a for other RME risk scenarios and site-related risk reduction calculations.

e Base case (mid input values) BCM output used for cumulative (i.e., contributions of all four risk-driver chemicals) risk estimation. Cumulative risks lower than $1 \times 10^{5}$ comply with one component of MTCA cleanup standards. Clamming risk is selected as baseline because it is the highest baseline risk of the direct contact scenarios.

f The estimated time frames to achieve RAOs start at the issuance of final remedy decision documents. Final remedy decision documents are estimated to precede the beginning of remedial construction by 5 years.

g Restoration time frame for RAO 1 is based on the longer of: 1) reducing seafood consumption risks to the $10^{4}$ risk magnitude based on the site-wide total PCB SWAC, and 2) end of construction. The food web model relationship between sediment and fish tissue concentrations is assumed not to apply during construction. Fish tissue concentrations are assumed to remain elevated above equilibrium values as a result of construction-stimulated releases of total PCBs into the water column.

h Alternatives 3C and 3R specifically address direct contact risks and attain a cumulative direct contact risk of ≤$1 \times 10^{-5}$ for all exposure scenarios. It is assumed that the Alternative 3 actions occur in the first 5 years of Alternatives 4, 5, and 6 and therefore the same rounded time frame to achieve RAO 2 (10 years) is applied to Alternatives 3 through 6. Alternative 2 does not specifically address direct contact risks. However, surface sediments in potential clamming and assumed beach play areas are expected to recover because of remediation of sediment above the site-wide RALs and naturally over time.

i The RAO 3 restoration time frame is assumed to range between when the MCUL is achieved (<1 acre associated with remaining point exceedances) and when remaining SQS points correspond to fewer than 2% of the LDW surface area. Within this range, conditions are reached when it is no longer technically practicable to manage isolated point exceedances with any certainty of a net environmental benefit.

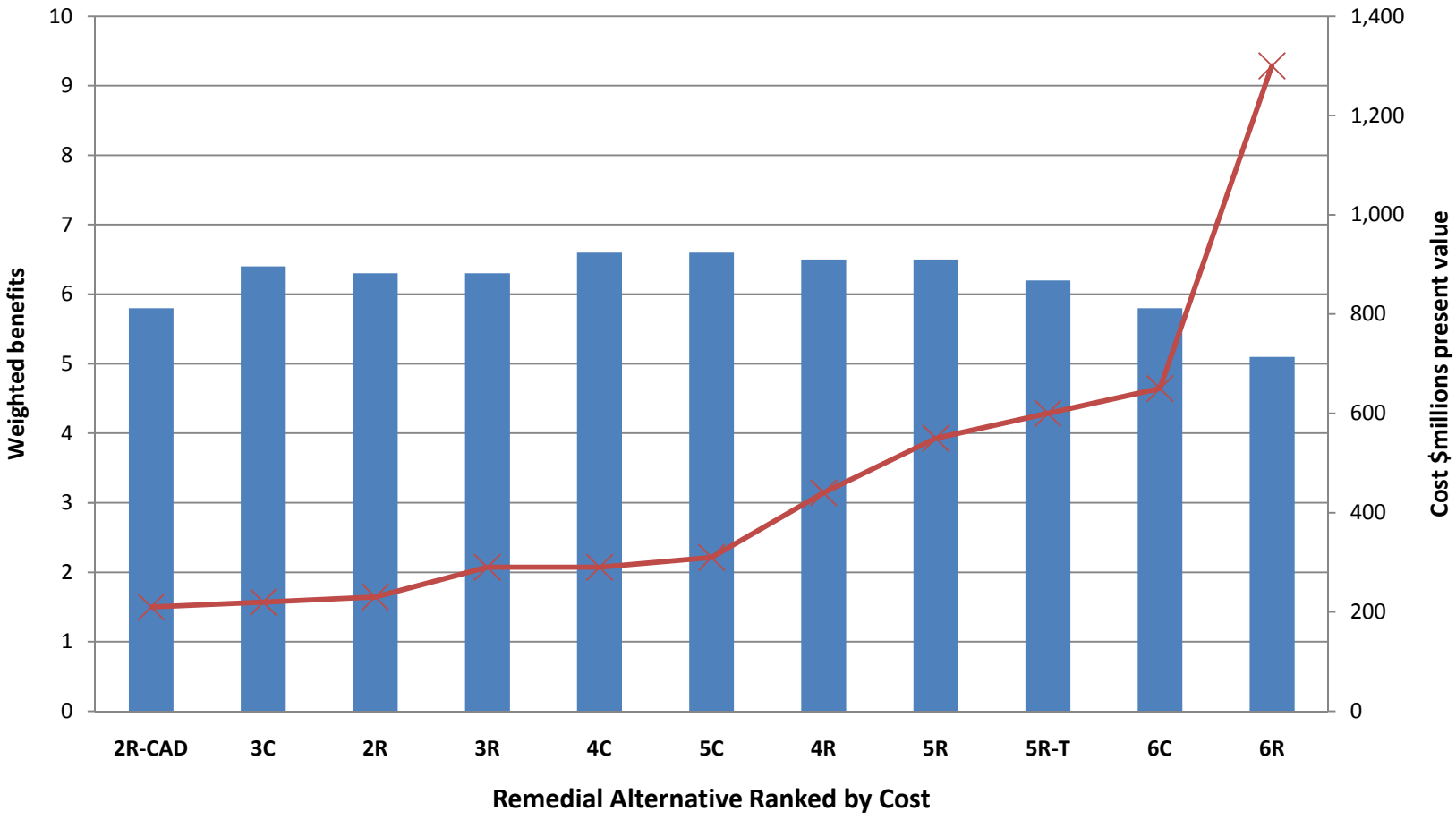
j On-site and off-site risks due to implementation include release of residual contamination into the water column during dredging, landfill usage, environmental impacts due to transportation of material and mining of sand, worker safety, greenhouse gas emissions, particulate emissions, and others such as landfill space and carbon footprint. For the purpose of this metric, the volume of material handled is used as a proxy for these risks.

k CAD volumes for Alternative 2R-CAD are assumed to remain in the LDW.

l The remediation of all risk-driver chemicals is subject to uncertainty. PCBs are used as a surrogate for uncertainty for all risk-driver chemicals. HHH stands for high lateral, bed replacement, and upstream values, MMM stands for mid lateral, bed replacement, and upstream values, and LLL stands for low lateral, bed replacement, and upstream values.

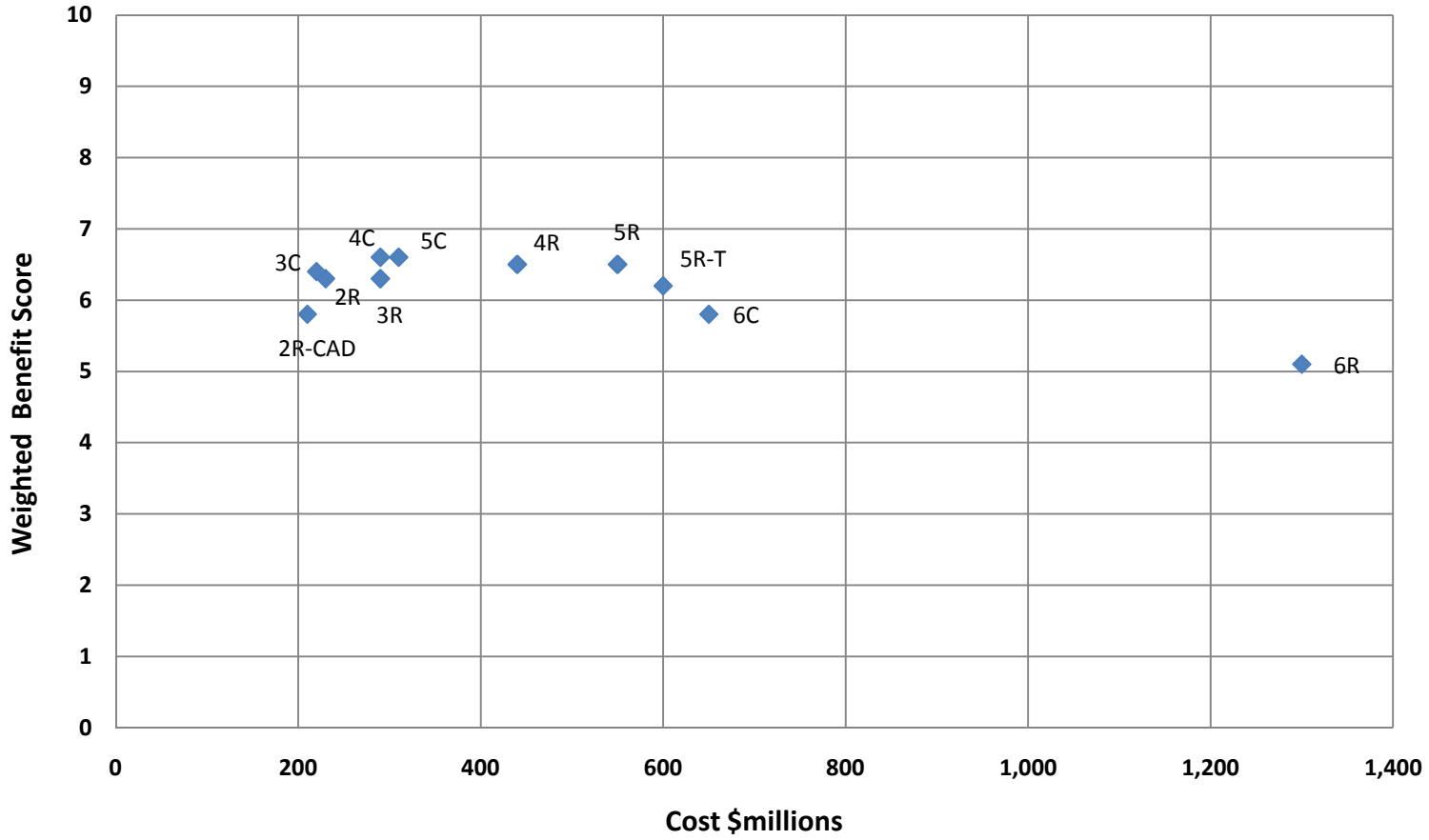
AOPC = area of potential concern; BCM = bed composition nodel; BPJ = best professional judgment; C = combined technology; CAD = contained aquatic disposal; cy = cubic yards; EAA = early action area; ENR = enhanced natural recovery; HQ = hazard quotient; ICs = institutional controls; MCUL = minimum cleanup level; MNR = monitored natural recovery; MTCA = Model Toxics Control Act; O&M = operations and maintenance; PDC = partial dredge and cap; PRGs = preliminary remediation goals; R = removal focused; RAO = remedial action objective; R-CAD = removal-emphasis alternative with contained aquatic disposal; RME = reasonable maximum exposure; R–T = removal-emphasis alternative with treatment (soil washing); SQS = sediment quality standard; SWAC = spatially-weighted average concentration; TBD = to be decided; VM = verification monitoring.

## Figure 11-1 Benefits and Costs for Remedial Alternatives (Ranked by Cost)




Notes:
C = combined technology alternatives
R = removal-emphasis alternatives with upland disposal
R-CAD = removal-emphasis alternative with contained aquatic disposal
R-T = removal-emphasis alternative with soil washing treatment

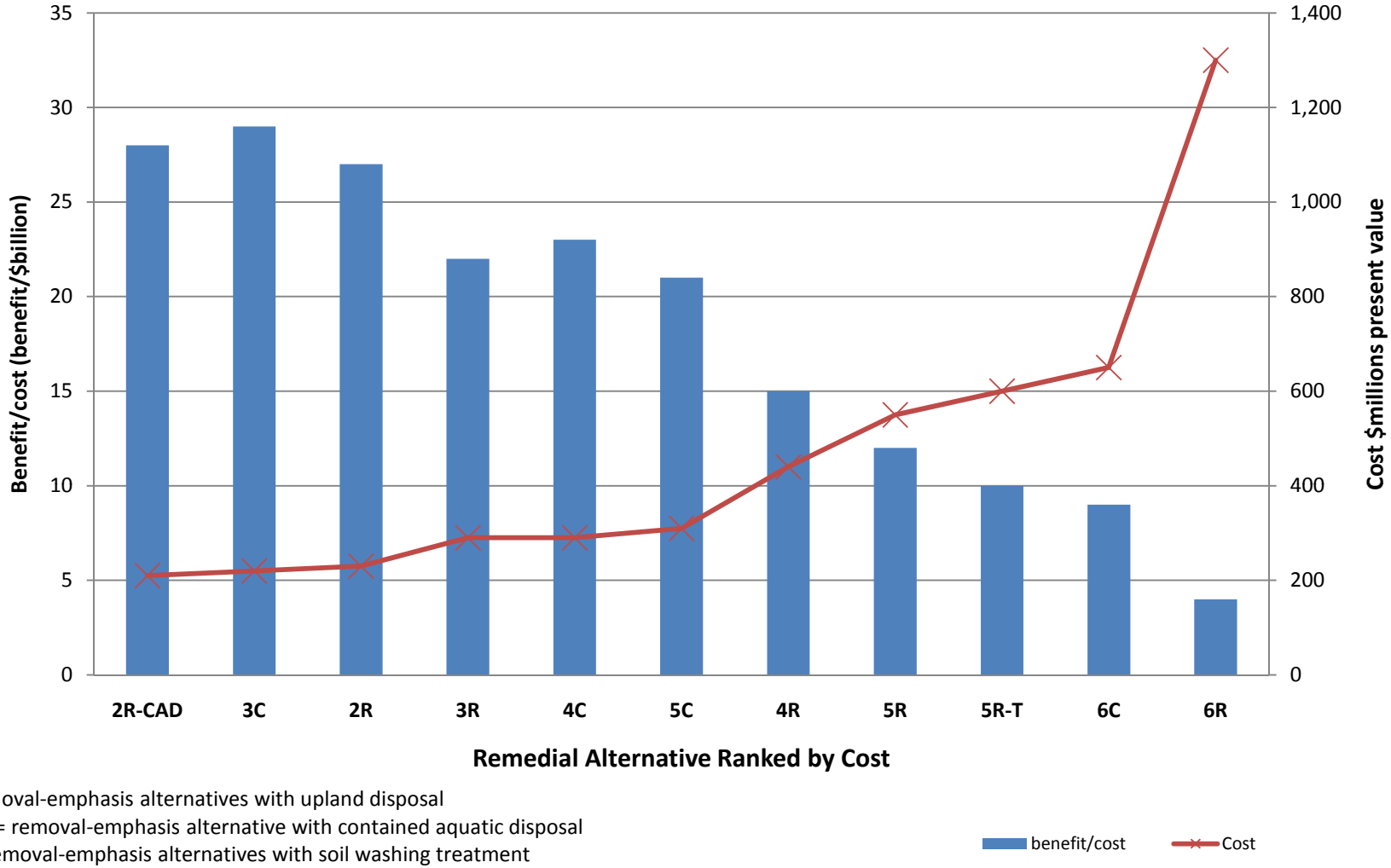
## Figure 11-2 Benefits vs. Costs for Remedial Alternatives




Notes:

C = combined technology alternative; R = removal-emphasis alternatives with upland disposal; R-CAD = removal-emphasis alternative with contained aquatic disposal; R-T = removal-emphasis alternative with soil washing treatment.

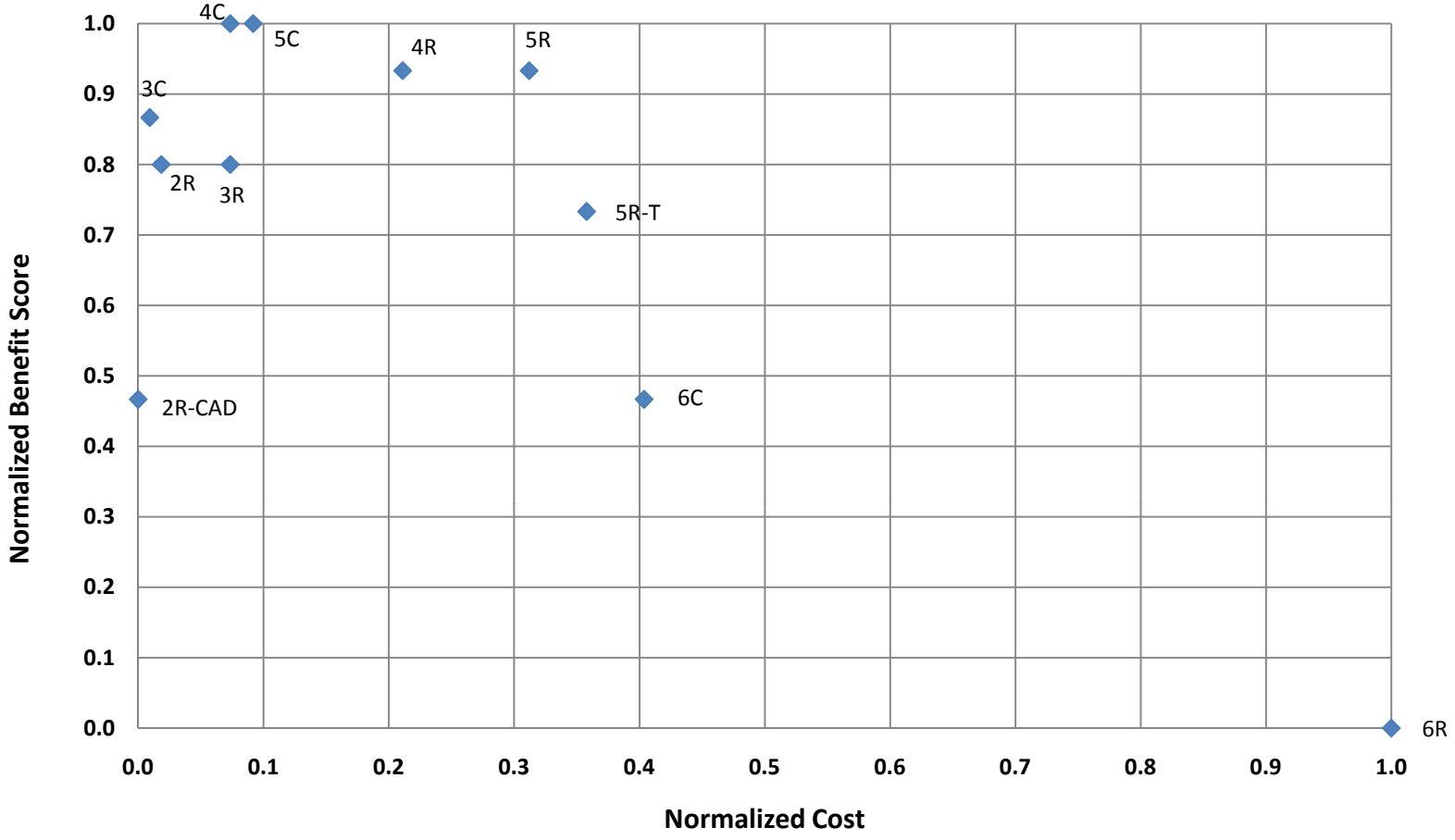
## Figure 11-3 Benefits per Unit Cost for Remedial Alternatives (Ranked by Cost)




Notes:
R = removal-emphasis alternatives with upland disposal
R-CAD = removal-emphasis alternative with contained aquatic disposal
R-T = removal-emphasis alternatives with soil washing treatment
C = combined technology alternatives

MM - millions

## Figure 11-4 Normalized Benefits vs. Normalized Costs for Remedial Alternatives

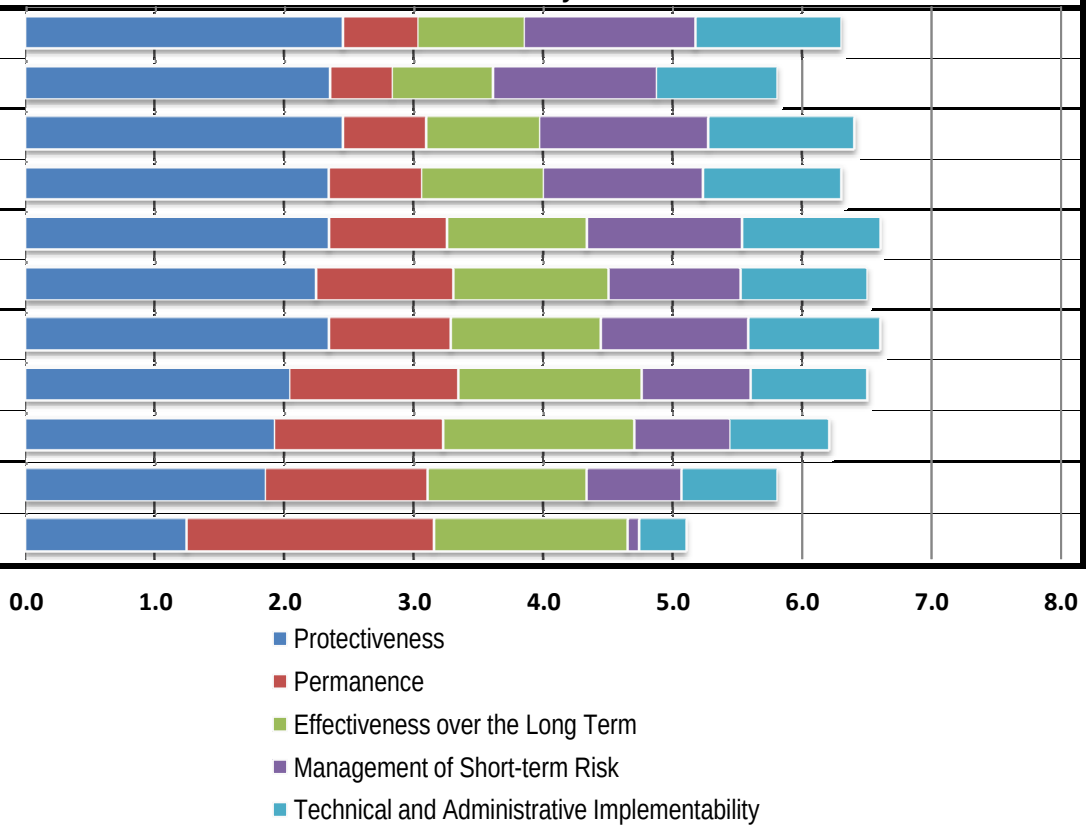



Notes:
Costs and benefits were normalized from the lowest score or value of all the alternatives to the highest score or value of all the alternatives.
R = removal-emphasis alternatives with upland disposal; R-CAD = removal-emphasis alternative with contained aquatic disposal; R-T = removal-emphasis alternative with soil washing treatment; C = combined technology alternatives

Normalized value = ((value)-(min alt))/((max alt)-(min alt))

**Figure 12-2 MTCA DCA Weighted Benefits for Individual Evaluation Criteria**

| Remedial Alternative | Actively Managed Area (acres)[b] | Weighted Ratings Under MTCA[a] |
|---|---|---|
| | | Total Benefits by Criteria |
| 2R | 59 | |
| 2R-CAD | 59 | |
| 3C | 86 | |
| 3R | 86 | |
| 4C | 143 | |
| 4R | 143 | |
| 5C | 186 | |
| 5R | 186 | |
| 5R-T | 186 | |
| 6C | 328 | |
| 6R | 328 | |




**Notes:**

1. See Section 11 for details.

a Ratings based on rankings shown in Table 10-1.

b Includes 29 EAA acres.

C = combined technologies alternative; CAD = contained aquatic disposal; DCA = disproportionate cost analysis; MTCA = Model Toxics Control Act; R = removal emphasis.