GEODESIGN INC

October 24, 2005

Oregon Department of Environmental Quality
Northwest Region
2020 SW Fourth Avenue, Suite 400
Portland, Oregon 97201-4987

Attention: Ms. Jennifer Sutter

Addendum 1
Feasibility Study Addendum
Ross Island Sand & Gravel Company
Portland, Oregon
GeoDesign Project: PerkinsCoi-8-01-01

INTRODUCTION

On behalf of the Ross Island Sand & Gravel Company, GeoDesign, Inc. is pleased to submit this addendum to our August 2, 2005 Feasibility Study as requested in the Oregon Department of Environmental Quality's (DEQ) September 27, 2005 comment letter. In the September 27 letter, DEQ approves the Feasibility Study, but requests additional detail on how the proposed remedial actions described in the Feasibility Study will be integrated with the existing Reclamation Plan for the site. Additionally, the letter requests clarification regarding select remedial action areas and other minor clarifications to the text. The additional detail and clarifications that DEQ requested are presented in numerical order and correlate with each DEQ comment.

ADDENDUM DETAILS

1. Figure 6 (attached) presents the identified remedial action/management areas presented in the Feasibility Study. Hot spots have been identified for portions of Area D and all of Areas B and F. We utilized AutoCAD 2006 to calculate the aerial extents of each of the in-water areas planned to be capped (Areas D and E). The volume of impacted surface sediment was calculated by multiplying the aerial extent by the vertical depth of the impacted surface sediment (0.3 foot). The volume of required cap material was calculated by multiplying the aerial extent by the minimum thickness of the proposed cap (3 feet). Based on the aerial extents, the total calculated volume of impacted surface sediment at Areas D and E are approximately 4,600 and 3,500 cubic yards, respectively.

Based on the aerial extents, a total of approximately 47,000 cubic yards of material is required to construct a 3-foot-thick cap in Area D and a total of approximately 35,000 cubic yards of material is required to construct a 3-foot-thick cap in Area E. However, portions of the cap planned for Areas D and E will be provided by reclamation. Approximately 35,000 of the 47,000 cubic yards of material required for Area D will be provided by reclamation. Approximately 27,000 of the 35,000 cubic yards of material required for Area E will be provided by reclamation. The September 30, 2002 approved reclamation plan calls for a total of approximately 4.5 million cubic yards of clean fill.

Topographic surveys of the uplands and bathymetric surveys of the lagoon portions of the site were completed by Minister-Glaeser Surveying, Inc. of Vancouver, Washington, in the fall of 2001 and 2003. Ross Island Sand & Gravel Company plans to complete an additional topographic and bathymetric survey of the uplands and lagoon in fall 2005. In addition to the 2001 and 2003 survey data, Minister-Glaeser Surveying, Inc. also surveyed the topographic elevations at four upland locations along shoreline areas during recent continuous multi-channel tubing monitoring well installation activities in October 2005. Further, GeoDesign measured the depth to the surface sediment along near-shore areas in four zones during our April and November 2004 pH assessment activities.

The surveyed data and the depth to surface sediment measurements were used to create a total of four cross sections (A-A', B-B', C-C', and D-D'), the locations of which are shown on Figure 1. These cross sections graphically indicate how much of the required cap thickness has already been achieved through existing reclamation fill, how much additional cap thickness will be achieved with planned reclamation fill, and how much material will need to be imported in addition to this to meet the estimated minimum cap thickness of 3 feet.

As shown on Cross Section A-A' (Figure 2), some minor fill has accumulated in certain areas, but in general, this area appears very similar to the conditions that existed at the time of the 2001 bathymetric and topographic survey data. The proposed fill will provide at least a 3-foot cap over the remedial action areas (Figure 6).

As shown on Cross Sections B-B' (Figure 3) and C-C' (Figure 4), as much as 15 and 50 feet of fill, respectively, has been placed along the shoreline in these areas based on the 2001, 2003, and 2005 topographic and bathymetric survey data. In general, the conditions toward the lagoon in these areas are very similar to the conditions that existed at the time of the 2001 bathymetric and topographic survey data. The proposed fill will provide at least a 3-foot cap over the remedial action areas (Figure 6).

As shown on Cross Section D-D' (Figure 5), some minor fill has accumulated in certain areas, but in general, this area appears very similar to the conditions that existed at the time of the 2001 bathymetric and topographic survey data. There are no proposed remedial action areas in this area (Figure 6).

According to the approved 2002 Reclamation Plan, an aquitard is recommended at or beneath the surface of the proposed fill slopes to change the drainage within the substrate from mainly vertical to more horizontal. The thickness of the aquitard will depend on the contrast in hydraulic properties between the aquitard and the underlying coarser material. Ideally, the aquitard would be constructed with a silty clay loam, or other equivalent material with a saturated hydraulic conductivity of less than 0.5 inch per hour (less than 12 inches per day). In fine-grained material (such as a silty clay loam) the daily water surface fluctuations will create slower fluctuations in soil-water pressure, which will enhance the ability of the plants to transport water and survive.

Coarse in-place material is currently being assessed at select areas to evaluate the effectiveness and protectiveness of the material as an engineering control (cap). While we expect the coarse in-place material to mitigate the elevated pH and prevent exposure to contaminants, the fine-grained material may also enhance the caps performance by reducing the vertical flow of water.

Under Alternative 3 for Area D, the hot spots in the sediment would be removed via dredging and transported off site to a licensed and approved disposal facility. Once removed, capping would not be required as part of a remedial action in these areas. The estimated total volume of sediment in Area D that does not constitute a hot spot is approximately 350 cubic yards. As shown on Figure 6, this isolated non-hot spot area is located within the proposed fill area presented in the 2002 reclamation plan. The volume of fill required to construct a 3-foot cap over this isolated non-hot spot area is approximately 3,500 cubic yards.

2. As mentioned previously, portions of in-water Areas D and E will be capped by material provided by reclamation. Additionally, portions of upland Area A2 will be capped by material provided by reclamation. The planned capping along portions of Area A2 will also stabilize the slopes at these areas. Area A1 will also be capped, none of which will be provided by reclamation. The estimated costs associated with the areas to be capped are presented in the following table. The costs in addition to reclamation also include various other tasks in support of the cleanup, including but not limited to, monitoring and sampling, institutional controls, and technical management.

Remedial Action Area	Proposed Cleanup	Volume of Capping Material Required (cubic yards)	Volume Provided by Reclamation (cubic yards)	Total Cost	Cost in Addition to Reclamation
Upland					
Area A1	cap	7,000	0	$191,000	$191,000
Area A2	cap/slope stabilization	0	3,500	$251,000	$50,000

Remedial Action Area	Proposed Cleanup	Volume of Capping Material Required (cubic yards)	Volume Provided by Reclamation (cubic yards)	Total Cost	Cost in Addition to Reclamation
In-Water					
Area D	cap	47,000	35,000	$430,000	$323,000
Area E	cap	35,000	27,000	$320,000	$206,000

3. Figure 6 (attached) has been revised to indicate that there are no cleanup areas in the central lagoon.

4. Tables 16 and 17 (attached) have been revised as requested in DEQ's September 27 letter. Also attached is the revised cost table for Area F that takes into account the total volume of material that would need to be removed above the confined aquatic disposal (CAD) cells (estimated at approximately 250,000 cubic yards) prior to removing the impacted material. The volume estimate takes into account the varying thickness of clean material existing over the CAD cells and the amount of material required to be removed to maintain a 1 horizontal to 1 vertical slope from the surface of the sediment to the base of the impacted CAD cell.

CLARIFICATIONS

1. The text in Sections 3 and 4 of the Feasibility Study has been revised to reflect the correct designations of remedial action Areas D, E, and F, consistent with Section 5 and illustrated on Figure 6. We have attached revised Sections 3 and 4.
2. We acknowledge that additional information will need to be provided (beyond that provided in Section 5.1.3 of the Feasibility Study) in determining the necessary additional characterization needed to determine the extent of elevated contaminant levels in this area (Area A1). This additional information will be provided in a forthcoming Remedial Action Work Plan. Some of this information may include the future 2005 survey data, confirmation of the source of apparent fill material placed in the area, and additional soil characterization activities.
3. We have added the addition of fill material to provide slope stability under Alternative 2 for Area F (CAD cells) in Section 5.7 of the Feasibility Study. We have attached revised Section 5.7.
4. The schedule outlined in Section 6.9 of the Feasibility Study does not include contingency monitoring. However, under Section 6.10 of the Feasibility Study, inspection of the engineered caps would be conducted in the event of a seismic event to verify the integrity of the caps and document that significant alternation of capped areas, particularly slopes, has not occurred. Contingent monitoring would also be implemented if other extraordinary events, such as an extreme storm or flood event, were to occur. If

the engineered controls were to be damaged by any extraordinary event, the engineered controls would be repaired, and adequate monitoring and/or sampling would be conducted to ensure the repair was adequately preventing unacceptable risk to human health or the environment.

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Please call if you have questions regarding this information.

Sincerely,

GeoDesign, Inc.

Kyle R. Sattler
Project Manager

Craig W. Ware, R.G.
Principal Geologist

cc: Mr. Aaron Courtney, Perkins Coie, LLP
Mr. Jim Rue, Ross Island Sand & Gravel Company

KRS:CWW:sms
Attachments
Two copies submitted
Document ID: PerkinsCoi-8-01-01-102405-enva1-FS.doc

ATTACHMENT

available data and the modeling results, it appears that the capped material in the eastern portion of the settling pond and within each of the CAD cells in the lagoon are reliably contained hot spots (Figure 6).

2.4 TREATMENT OF HOT SPOTS

According to DEQ (1998b) guidance, hot spots are given special consideration in the Feasibility Study. A higher cost threshold is applied to the cost reasonableness of treatment or removal of hot spots in the balancing of other remedy evaluation criteria (i.e., effectiveness, long-term reliability, implementability, and implementation risk). For example, a non-treatment alternative such as sediment capping may be justified for hot spots if this alternative would result in equal or better effectiveness, long-term reliability, implementability, and implementation risk, but at a significantly lower cost.

3.0 REMEDIAL AREA IDENTIFICATION

The objective of this section is to summarize those locations at the site where COPCs or COPECs exceed the RBCs or other sample characteristics potentially detrimental to human health or the environment (such as surface sediment toxicity related to elevated pH). These data, combined with the site conceptual model developed in the RI, provide the basis for identification of areas at the site that warrant additional remedial evaluation. These areas, presented by area and media, are described in the following sections.

3.1 UPLANDS SURFACE SOIL

The aerial extent of the uplands surface soil requiring remedial action have been identified as the following areas:

- Area A1: Isolated areas where surface soil exceeds RBCs based on exposure to uplands human or ecological receptors
- Area A2: Isolated areas where surface soil represents a potential threat to the lagoon via erosion and in turn, would exceed RBCs based on exposure to human or ecological receptors

For the purposes of this Feasibility Study, the aerial extent of the uplands surface areas requiring remedial action have been defined by an approximate 100-foot-diameter radii around each impacted surface soil sample or where bound by site facilities (Figure 6). The 100-foot-diameter radii are presented as conservative assumptions of extent, so that volume estimates can be calculated and alternatives compared. The 100-foot-diameter radii may not represent the actual aerial extent of contamination; the actual extent is anticipated to be significantly less. The results of confirmation samples that would be collected during remedy implementation would determine the actual aerial extent. The vertical depth of impact in these areas, based on the results of the RI sampling, ranges from the surface to 1 foot BGS for Area A1 and from the surface to 1.5 feet BGS for Area A2. Based on these limits, the calculated total volume of uplands surface soil requiring remedial action is approximately 11,000 cubic yards (in-place volume). The remedial action limits will be refined during development of the remedial action plan.

Surface Areas A1 appear limited in extent, and based on the hydraulics and sediment transport model, Areas A2 are in not subject to erosion (even under conditions of high water); however, these isolated areas of uplands surface soil are carried forward for further remedial action analysis. Areas A1 and A2 are shown on Figure 6.

3.2 UPLANDS SUBSURFACE SOIL

Area B is identified as former eastern portion of the main process settling pond that is currently capped and would exceed RBCs based on exposure to human or ecological receptors if the cap is removed. The capped material consists of breached material from CAD Cell No. 5, including clean cap material, adjacent non-contaminated fill material, and approximately 6,300 cubic yards of impacted, confined material. Area B is shown on Figure 6.

3.3 UPLANDS SURFACE WATER

Since there is no identified site-related source for arsenic in the settling ponds and the concentrations detected are generally consistent with the background concentration for the Willamette River, remedial action does not appear to be warranted for the settling ponds.

3.4 GROUNDWATER

For Area C, the estimated volume of the impacted groundwater represented by a sample collected from boring LB213 predicted to migrate and pose unacceptable risk to human receptors along the lagoon shoreline is unknown. However, based on review of data collected from MW-02 in the general area of boring LB213, benzo(a)pyrene has not been detected during several recent sampling events. These data suggest that the occurrence of benzo(a)pyrene at boring LB213 is limited in aerial extent. The entire migration pathway area, identified on Figure 6 as Area C, will be carried forward for further analysis.

3.5 LAGOON SURFACE SEDIMENT

Areas D and E include surface sediment in the lagoon that exceeds RBCs and background/ambient concentrations, based on exposure to human or ecological receptors, or with toxicity to ecological receptors related to elevated pH.

For the purposes of this FS, the aerial extent of the lagoon surface sediment requiring remedial action in Areas D and E have been defined by an approximate 100-foot-diameter radii around each impacted surface sediment sample (Figure 6). As with the uplands surface soil, the 100-foot-diameter radii are presented as conservative estimates of extent, so that volume estimates can be calculated and to allow for comparison of alternatives. The 100-foot-diameter radii may not represent the actual aerial extent of contamination. The results of confirmation samples will determine the actual aerial extent. The vertical depth of impact in these areas ranges from the surface to a depth of 0.3 foot. Based on the aerial and vertical limits, the total volume of sediment impacted by elevated concentrations of contaminants (Area D) is estimated at approximately 4,500 cubic yards (in-place volume), of which, approximately 3,800 cubic yards (in-place volume) is considered a hot spot. The total volume of sediment impacted by elevated pH (Area E) is estimated at approximately 3,500 cubic yards (in-place volume). The remedial action limits will be refined during development of the remedial action plan. These isolated areas of lagoon surface sediment are carried forward for further remedial action analysis. Areas D and E are shown on Figure 6.

3.6 LAGOON SUBSURFACE SEDIMENT

As previously described, there are five CAD cells in the lagoon, identified as Area F on Figure 6. Concentrations of TBT, heavy metals, and SVOCs (including PAHs, VOCs and PCBs) may present a risk to human and/or ecological receptors should the caps be removed. One subsurface sediment sample collected from a boring within CAD Cell No. 1 was predicted by Landau to pose unacceptable risk to human receptors in the lagoon surface water in less than 1,000 years. However, as previously mentioned, the Port concluded through fate and transport modeling of the migration of contaminants from the CAD cells that migration would not result in unacceptable levels of hazardous substances at the likely exposure points for human or ecological receptors. Nonetheless, since the CAD cells have been identified as reliably contained hot spots, all of the CAD cells will be carried forward for further remedial action analysis. The total volume of confined material for all of the CAD cells is approximately 162,000 cubic yards.

3.7 REMEDIAL AREA SUMMARY

In summary, the following areas and associated impacted volumes of site media that currently or potentially could represent unacceptable risk to human or ecological receptors and require remedial evaluation or action are presented in the following sections.

3.7.1 Uplands Areas

Areas A1 and A2: A total of approximately 11,000 cubic yards of surface soil where:

- benzo(a)pyrene, arsenic, and zinc exceed RBCs based on exposure to potential human and/or ecological receptors.
- PCBs (aroclor 1254 and 1260), several PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene), and two metals (nickel and silver) could result in unacceptable impacts to surface sediment in the lagoon if significant erosion of soil represented by these samples and subsequent transport into the lagoon were to occur.

3.7.2 Uplands Subsurface Areas

Area B: Approximately 6,300 cubic yards of capped material east of the main settling pond where concentrations of TBT and TPH may present a risk to human and/or ecological receptors should the cap be removed.

3.7.3 Groundwater Area

Area C: An unknown volume of groundwater in the vicinity of Geoprobe® boring LB213 where fate and transport modeling predicted that benzo(a)pyrene may pose unacceptable risk to human receptors in surface water along the lagoon shoreline via migration through groundwater.

3.7.4 Lagoon Areas

Area D: Approximately 4,500 cubic yards of surface sediment in the lagoon where:

- PAHs, PCBs, pesticides, and metals exceed RBCs based on exposure to human and/or ecological receptors.

Area E: Approximately 3,500 cubic yards of surface sediment in the lagoon where:

- levels of pH are toxic to benthic organisms.
- select surface sediment samples failed direct toxicity testing.

3.7.5 Lagoon Subsurface Areas:

Area F: A total of approximately 162,000 cubic yards of subsurface sediment contained in CAD Cells No. 1 through 5, where concentrations of TBT, heavy metals, and SVOCs (including PAHs, VOCs, and PCBs) may present a risk to human and/or ecological receptors should the caps be removed.

4.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

4.1 REMEDIAL ACTION OBJECTIVES

The objective of remedial action for the site is to provide cost-effective remedial alternatives that effectively mitigate and minimize threats to, and provide adequate protection of, public health and welfare and the environment. The RAOs described below are based, in part, on regulatory criteria and site-specific information in the RI report and the baseline risk assessment (Landau, 2002a) and meet the following two primary criteria:

- Remedial actions must achieve the standards for "protectiveness" specified in OAR 340-122-040(2). These standards are the acceptable risk levels defined in OAR 340-122-115. Furthermore, as specified in OAR 340-122-040(4), remedial actions shall prevent or minimize future releases and migration of hazardous substances in the environment.
- Remedial actions must treat hot spots (OAR 340-122-115) of contamination to the extent feasible based on the remedy selection balancing factors.

RAOs are medium-specific goals for protecting human health and the environment and specify the following for each impacted medium:

- The COPCs/COPECs
- Exposure routes and receptors for the current and reasonably likely anticipated future land and water use(s)

The RAOs for the site are relevant only to the specific points or areas described in Section 3.0 of this report where the particular exposure pathway is applicable. The RAOs for each impacted media are described below.

4.1.1 Uplands Soil

4.1.1.1 Surface Soil - Areas A1

The RAO for the uplands surface soil in Area A1 is to reduce risk to occupational workers, recreational visitors, and/or ecological receptors to exposure of uplands surface soils impacted with the PAH benzo(a)pyrene, arsenic and zinc.

4.1.1.2 Surface Soil - Areas A2

The RAO for the uplands surface soil in Area A2 is to reduce exposure to potential human receptors (consumers of fish) and ecological receptors (aquatic life) in the lagoon by preventing the soil impacted with concentrations of PAHs, PCBs, and metals from eroding into the lagoon.

4.1.1.3 Subsurface Soil Area B – Capped Pond Material

The RAO for subsurface Area B (capped pond material identified as a reliably contained hot spot) is to prevent exposure of the capped material impacted with TBT and TPH to occupational and potential future recreational visitors and prevent migration of the contaminants from the capped areas.

4.1.2. Groundwater

4.1.2.1 Groundwater - Area C

The RAO for groundwater represented by a sample collected from boring LB213 (identified as a potential hot spot at the discharge location) is to mitigate the potential risk to human health as a result of the potential modeled exceedance of benzo(a)pyrene in groundwater discharging to surface water in the lagoon after 400 years.

4.1.3 Lagoon Sediment

4.1.3.1 Surface Sediment - Areas D and E

The RAO for the lagoon surface sediment, in which some samples were identified as hot spots, is to reduce risk to human health via consumption of fish (based on the assumption that a certain level of chemical uptake will occur from the contaminated sediments in the lagoon to fish tissue), and to benthic invertebrates from exposure to PAHs, PCBs, metals, and elevated pH in the surface sediments in the lagoon.

4.1.3.2 Subsurface Material Capped - Area F (CAD Cells No. 1 through 5)

The RAO for the capped subsurface material in Area F (CAD Cells No. 1 through 5, identified as reliably contained hot spots) is to prevent human and ecological exposure to material impacted with TBT, heavy metals, SVOCs, VOCs, and PCBs and the spread of the contaminants from the capped areas.

4.2 IDENTIFICATION OF GENERAL RESPONSE ACTIONS

General response actions are measures that are implemented to manage and/or control a specific contamination problem to meet the RAOs. In accordance with DEQ's *Final Guidance for Feasibility Studies,* dated July 1, 1998, and specified in OAR 340-122-085(2), these include: 1) no action, 2) engineering and/or institutional controls, 3) treatment, 4) excavation and off-site disposal without treatment, and 5) any combination of the aforementioned, as appropriate. These general response actions are briefly summarized as follows.

4.2.1 No Action

The "no action" alternative serves at the baseline for comparison of other potential remedial alternatives, and no remedial action or monitoring would be performed.

4.2.2 Engineering and/or Institutional Controls

Engineering controls (such as capping, fencing, or hydraulic barriers) are physical measures implemented to prevent or minimize exposure or to reduce mobility of contaminants. Institutional controls (such as land, water use, or property access restrictions) are legal or administrative actions implemented to reduce exposure to contaminants.

4.2.3 Treatment

Treatment alternatives include various in-situ or ex-situ technologies to permanently and substantially eliminate or reduce toxicity, mobility, or volume of contaminants. In general terms, treatment may be performed by chemical, thermal, physical, or biological methods and can be completed either on site or off site.

4.2.4 Excavation and Off-Site Disposal Without Treatment

This alternative involves excavation of soil, solid waste, or hazardous waste and subsequent transportation to and management of the material at a permitted off-site facility.

4.2.5 Any Combination of the Aforementioned General Response Actions

One or more of the above general response actions may be combined to achieve the RAOs. For example, engineering and/or institutional controls will not achieve the RAO by themselves, but will be implemented in conjunction with another remedial technology as part of the final remedial action for the site. Sites that permanently incorporate institutional controls into their remedial action will remain on DEQ's "Inventory of Sites Requiring Further Action."

Specific remedial technologies for the applicable general response actions are identified and further evaluated in Section 4.3 of this report.

4.3 IDENTIFICATION AND SCREENING OF REMEDIAL ALTERNATIVES

This section describes the focused remedial action technologies that are aligned with the focused general response actions identified in Section 4.2 of this report. A screening is presented to assess if the technologies warrant further consideration. These potential remedial action technologies are screened based on the RAOs and data obtained during the RI and RA. The remedy selection criteria, or balancing factors (as specified in OAR 340-122-090), used for the initial screening process are presented in Table 16 and summarized as follows:

Effectiveness: Evaluates the overall effectiveness of the remedy in achieving protection considering the magnitude of risk from untreated waste or treatment residuals, adequacy of engineering or institutional controls, extent to which the action restores or protects existing and reasonably likely future beneficial water uses, and time until the RAOs would be achieved.

Long-Term Reliability: Evaluates the reliability of the treatment technology to meet objectives, reliability of engineering and institutional controls to manage risk, and the nature and degree of uncertainty of any necessary long-term management.

Implementability: Evaluates the ease or difficulty of implementing the remedial action considering practical, technical, and legal difficulties, and unknowns associated with the technology; ability to monitor effectiveness; consistency with federal, state, and local requirements; and availability of necessary services, materials, and specialists.

Implementation Risk: Evaluates the potential impacts on the community, workers, and the environment during implementation of the remedial action and estimated completion time for the remedy.

Reasonableness of Cost: Considers the reasonableness of cost considering capital, annual operation, and review costs; the degree to which the cost of the remedial action are proportionate to the benefits to human health and the environment; degree to which the costs are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial uses of water; and the degree of sensitivity and uncertainty of the costs.

4.3.1 Identification of Potential Remedial Alternatives

The following remedial alternatives for the general response actions were identified as potentially suitable for the impacted media that currently pose unacceptable risks or potential unacceptable future risks to human and ecological receptors.

- Removal Actions, including:
  - Excavation/Dredging and Off-Site Disposal/Treatment
  - Excavation/Dredging and On-Site Disposal/Treatment
- Physical Treatment, including:
  - Solidification/Stabilization
  - Neutralization
  - Air Sparging/Chemical Treatment
- MNA
- Institutional Controls
- Engineering Controls, including:
  - Caps
  - Slope Stabilization
  - Hydraulic Containment

Each of the above remedial technologies was screened based on the criteria described in Section 4.3 of this report.

4.3.2 Description and Initial Screening of Potential Remedial Technologies

The results of the technology screening for each impacted media currently posing or potentially posing unacceptable risks to human and/or ecological receptors are presented in Table 16. Table 16 identifies each remedial technology applicable to the specific media, presents a qualitative rating of the balancing factors described in Section 4.3 of this report, briefly describes each technologies advantages and disadvantages, and whether or not the technology was retained and carried forward for detailed analysis. Each remedial alternative screened is briefly described in Sections 4.3.2.1 through 4.3.2.11 of this report.

4.3.2.1 *No Action*

The "No Action" alternative assumes that no remediation activities occur at the site. The "No Action" alternative is generally carried forward as a baseline for purposes of cost/benefit comparison; however, it has been screened out from further consideration (and not included in Table 16) because it does not achieve any of the RAOs identified in Section 4.1.1 of this report.

4.3.2.2 *Excavation/Dredging and Off-Site Disposal/Treatment*

The excavation/dredging and off-site disposal/treatment technology is a stand-alone removal technology that could be implemented at the site to prevent exposure to human and ecological receptors. This removal technology involves excavating the surface and subsurface soil or dredging the surface and subsurface sediment containing the contaminants and/or elevated pH and transporting it off site for landfill disposal or treatment in accordance with applicable regulations. Both the soil and sediment can be loaded onto barges and transported to a RCRA Subtitle D landfill (Roosevelt Landfill in Roosevelt, Washington) or trucked to the Hillsboro Landfill in Hillsboro, Oregon. Based on the results of the screening presented in Table 16, excavation/ dredging of surface and subsurface soil/sediment and off-site disposal/treatment was retained for consideration in the detailed analysis.

4.3.2.3 *Excavation/Dredging and On-Site Disposal/Treatment*

The excavation/dredging and on-site disposal/treatment removal technology involves excavating the surface and subsurface soil in the uplands or dredging the surface and subsurface sediment in the lagoon that contain contaminants or elevated pH and transporting the impacted material to a single on-site location for disposal or treatment (such as adjacent to the main settling pond) where the current cap could be extended to cover newly placed material. This technology would be combined with other technologies where appropriate, such as solidification/stabilization, engineering cap and institutional controls to achieve the RAOs. Based on the results of the screening presented in Table 16, excavation/dredging of surface and subsurface soil/sediment and on-site disposal/treatment was retained for consideration in the detailed analysis.

4.3.2.4 *Solidification/Stabilization*

This technology is a treatment technology that would be combined with another technology (such as excavation) that involves mixing the contaminants with a binder or mixture of binders, which solidify and contain the contaminants. Stabilization makes the contaminants less soluble, immobile, and in a state that is less toxic. Solidification encapsulates the waste. Solidification/ stabilization (in combination with another technology) was retained for consideration in the detailed analysis.

4.3.2.5 *Neutralization*

This treatment technology would also be combined with another technology (such as a removal technology or engineering control) and would neutralize the elevated pH to levels that would not pose unacceptable risk to benthic invertebrates. Sediment, whether imported fill material to be used as a cap or removed from the lagoon, would be amended with another substance (such as sulfur) to lower the pH to levels less than 8.5. Based on our research, this treatment technology is unproven in submerged environments and would require further evaluation. Neutralization, however, is carried forward for further consideration in the detailed analysis.

4.3.2.6 Air Sparging/Aeration

This technology is an in-situ treatment technology that involves volatilizing organic compounds absorbed onto soil and dissolved in groundwater via forced air. For a site where groundwater is impacted by organic compounds, air would be injected below the water table via vertical slotted piping, adding oxygen to the aquifer, and facilitating biodegradation. Volatile contaminants could be collected in the vadose zone by vapor extraction. Based on the results of the screening presented in Table 16, air sparging/aeration was not retained for consideration in the detailed analysis.

4.3.2.7 Groundwater Extraction and Treatment

This technology involves extraction of groundwater from recovery wells or trenches with aboveground treatment using either activated carbon or air stripping methods, or both. Based on the results of the screening presented in Table 16, groundwater extraction and treatment was not retained for consideration in the detailed analysis.

4.3.2.8 Chemical Treatment

This technology is a stand-alone treatment technology that involves injecting chemical oxidants or magnesium peroxide to contaminated media in order to destroy the contaminants by converting them to innocuous compounds commonly found in nature. Chemical treatment technologies have been shown to be very effective at treating organic compounds in soil and groundwater. Based on the results of the screening presented in Table 16, chemical treatment was not retained for consideration in the detailed analysis.

4.3.2.9 MNA and MNR

These technologies involve the reliance of naturally occurring physical, chemical, or biological processes to reduce the concentration and/or mobility of organic contaminants in soil, sediment or groundwater. Natural attenuation and natural recovery processes include adsorption, dilution, dispersion, and biological transformation of contaminants. These technologies would be combined with a monitoring program to document their effect on the contaminant mass. Based on the results of the screening presented in Table 16, MNA and MNR were retained for consideration in the detailed analysis

4.3.2.10 Institutional Controls

Institutional controls (such as land use restrictions) are legal or administrative measures or actions that will be implemented to prevent and/or minimize exposure to the impacted media either currently or potentially posing unacceptable risk to human receptors. Institutional controls will not achieve the RAOs by themselves, but will be implemented in combination with another technology as part of the final remedial action for the specific impacted media. Sites that permanently incorporate institutional controls into their remedial action will remain on DEQ's "Inventory of Sites Requiring Further Action." Based on the results of the screening presented in Table 16, institutional controls will be considered as critical components in combination with other select alternatives (such as capping and MNR), but since they are not stand-alone technologies for a given general response action, they are not included in the detailed analysis.

4.3.2.11 Engineering Controls

Engineering controls will not achieve the RAOs by themselves, but would be combined with other alternatives (such as institutional controls) as part of the final remedial action for the site. The engineering control technologies considered and screened are intended to physically prevent exposure of contaminants to human and ecological receptors. Based on the results of the screening presented in Table 16, some engineering controls were retained for consideration in the detailed analysis. The retained engineering controls include caps constructed of soil, concrete, or sediment. To achieve the RAOs outlined in Section 4.1 of this report, we have defined uplands soil and lagoon sediment caps at least 3 feet thick and uplands concrete caps at least 0.5-foot thick. Actual cap thicknesses would be determined during further site-specific analysis.

4.4 SUMMARY OF RETAINED REMEDIAL TECHNOLOGIES

Based on the initial screening, certain technologies were retained for further consideration based on the balancing criteria. The retained remedial technologies for the impacted media currently posing or potentially posing unacceptable risk to human and/or ecological receptors are as follows:

- Excavation/Dredging and Off-Site Disposal
- Excavation/Dredging and On-Site Disposal
- Combination Dredging and Sediment Cap
- Solidification/Stabilization
- MNA and MNR as part of monitoring programs
- Institutional Controls
- Engineering Controls

4.5 ASSEMBLY OF REMEDIAL ALTERNATIVES

From the initial screening, the retained potential remedial technologies were assembled into viable remedial alternatives for further analysis. For each general response action, at least one stand-alone remedial technology was carried forward from the screening analysis. For those general response actions with only one stand-alone remedial technology, a comparative analysis was not completed.

According to DEQ guidance, sites containing hot spots of contamination must include an evaluation of treatment- or removal-based alternatives. Current hot spots have been identified as Area B, select Areas D, and Areas F, as shown on Figure 6. Partial removal of hot spots combined with other alternatives (such as capping remaining residual contamination) are also evaluated. Fate and transport modeling predicts a potential future hot spot in the surface water along a portion of the lagoon shoreline (Area C) as shown on Figure 6. As shown in Table 16, the removal technologies that include off-site treatment for Areas B, D, and E were retained for quantitative evaluation and are described below. However, since groundwater is identified as only a potential hot spot in the future (should the previously detected concentration at boring LB213 migrate north and discharge to the lagoon in 400 years), none of the treatment technologies identified in Table 16 for this area were retained for quantitative evaluation, based on a combination of all five remedy selection criteria. Area C is identified as a potential concern and will be addressed via monitoring.

5.6.3 Implementability

Alternative 2 ranked the highest for this criterion (most implementable), since some of Area D has already received fill in accordance with the approved reclamation plan and provisions set forth in the DSL Removal/Fill permit. The widespread and dispersed nature of the likely source material for the elevated pH in the lagoon poses an implementation challenge for Alternatives 1A and 1B, as well as potentially exacerbating existing contamination confined in the CAD cells.

5.6.4 Implementation Risk

Alternative 2 ranked the highest for this criterion, primarily due to its conformance with typical on-going filling activities. This alternative only poses minor risks to on-site workers and potential recreational visitors. Alternatives 1A and 1B rank lowest for this criterion, since significant implementation risks associated with dredging and transportation of contaminated media exist near the CAD cells.

5.6.5 Reasonableness of Cost

Alternative 2 ranked the highest for this criterion (least expensive), followed by Alternative 1B, and Alternative 1A (most expensive). Alternative 2 (a non-treatment alternative) is more easily implemented, has low implementation risk, and significantly lower cost than Alternative 1A (treatment technology) to achieve the RAOs.

5.6.6 Extent of Treatment of Hot Spots

There were no hot spots identified in Area E.

5.7 LAGOON SUBSURFACE SEDIMENT - AREA F

Two remedial alternatives were retained for comparison in Table 17 for the material in the existing CAD cells in the southern portion of the lagoon where TBT, heavy metals, and SVOCs (including PAHs, VOCs, and PCBs) may cause an unacceptable risk to human and ecological receptors should the current cap material be compromised. The retained alternatives include the following:

- Alternative 1: Dredging and Off-Site Disposal
- Alternative 2: Implement a Management/Maintenance Plan to Maintain the Existing Cap and stabilize the slopes adjacent to the CAD cells, where appropriate

5.7.1 Effectiveness

Each alternative ranked equally high (equally as effective) for this criterion. Currently, the CAD cells are considered reliably contained hot spots, as modeling and site data have demonstrated.

5.7.2 Long-Term Reliability

Alternative 1 ranked the highest for this criterion primarily since it removes the contaminants from the site and would reduce the hot spots to non-hot spot levels by removing the source of the contaminants. Alternative 2 ranked only slightly lower than Alternative 1 because it would require an institutional control.

5.7.3 Implementability

Alternative 2 ranked the highest for this criterion, primarily because a cap is already in place and a maintenance/management program could be prepared and implemented any time. On-going reclamation fill adjacent to the capped areas will be placed in a manner that ensures slope stability. The depth of the CAD cells beneath the fill material in the lagoon adds a significant implementation challenge to Alternative 1.

5.7.4 Implementation Risk

Alternative 2 ranked the highest for this criterion, as there is no anticipated implementation risk associated with this alternative. There is a significant implementation risk associated with Alternative 1, and implementing this alternative may potentially exacerbate contamination in the lagoon and would inherently include increased risks associated with the excavation and transportation of contaminated media.

5.7.5 Reasonableness of Cost

Alternative 2 (the non-treatment alternative) ranked the highest for this criterion, followed by Alternative 1 (the treatment alternative). Alternative 2 results in equal effectiveness, is more easily implemented, and has less implementation risk, yet at a significantly lower cost.

5.7.6 Extent of Treatment of Hot Spots

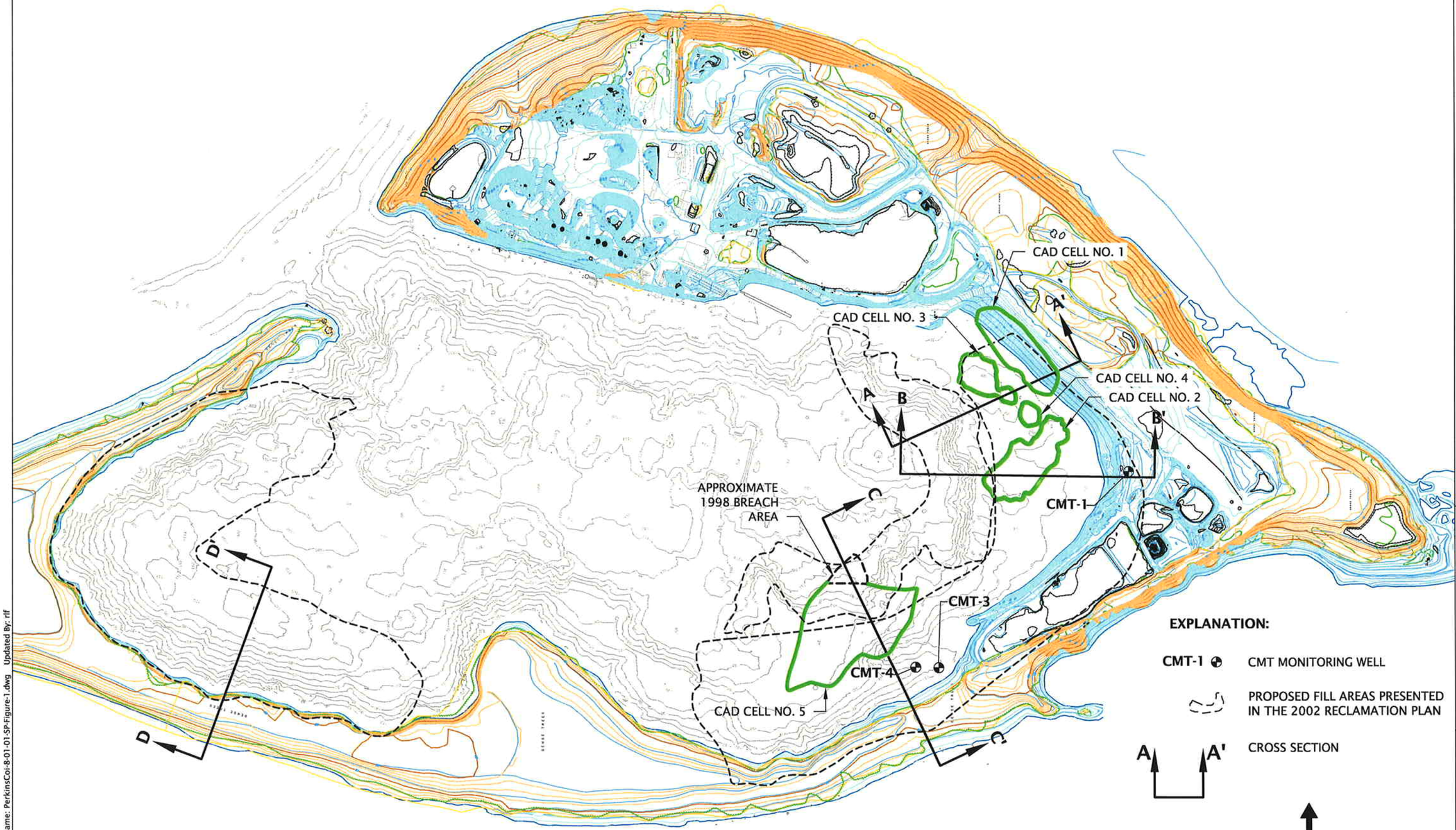
Alternatives 1 and 2 would both achieve the RAO; however, Alternative 1 would result in the removal of the hot spot and, therefore, is ranked slightly higher. Alternative 2 is currently reliably containing the hot spot and will continue to do so as long as the existing cap is maintained.

6.0 RECOMMENDED REMEDIAL ALTERNATIVES

Recommended alternatives for each remedial area identified in Section 3.0 of this report are presented below and are based on the results of the comparative evaluation of each alternative summarized in Table 17 and discussed in Section 5.0 of this report.

6.1 UPLANDS SURFACE SOIL - AREA A1

On the basis of the detailed analysis of each of the alternatives presented in Section 5.0 and Table 17 of this report, Alternative 3A received the highest total rankings (46 points). Considering a combination of all five remedy selection criteria, Alternative 3A is recommended for implementation at the site to achieve the RAO. Implementation of the recommended remedy would include soil import and placement over the affected area at a thickness of approximately 3 feet. Prior to implementing the remedy, supplemental sampling and analysis would be conducted to more accurately define the extent of benzo(a)pyrene, arsenic, and zinc in surface soil requiring a soil cap. Estimated costs for the soil cap have been initially developed on the conservative assumption that all surface soils within the 100-foot radius would require capping. The capping alternative for Area A1 is consistent with the overall reclamation plan goals for the facility.



SITE PLAN

FIGURE 1

ROSS ISLAND SAND & GRAVEL
PORTLAND, OR

PERKINSCOI-8-01-01

OCTOBER 2005

SITE PLAN BASED ON DRAWING PROVIDED BY LANDAU ASSOCIATES, INC.

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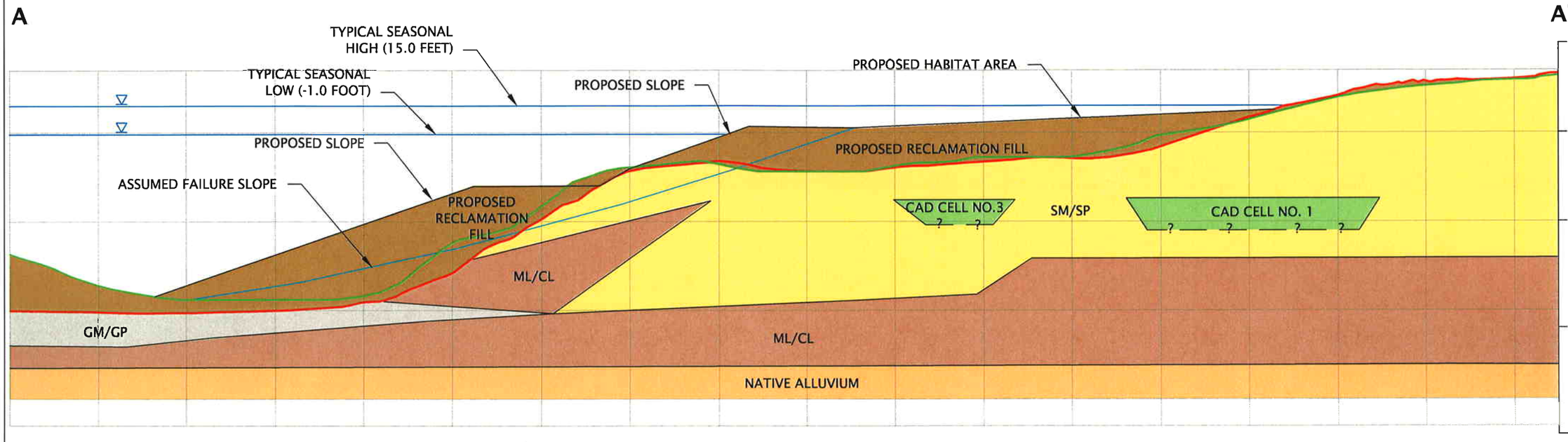
Dec 21, 2005 - 12:39:26 DWG Name: PerkinsCoi-8-01-01-SP-Figure-1.dwg Updated By: rlf



EXPLANATION:

EXISTING SURFACE AS OF NOVEMBER 2001	GM/GP — SANDY GRAVEL
EXISTING SURFACE AS OF NOVEMBER 2003	ML/CL — SILT WITH FINE SAND AND CLAYEY SILT
ASSUMED FAILURE SLOPE AS DETERMINED DURING THE SLOPE STABILITY EVALUATION BY LANDAU ASSOCIATES, INC.	SM/SP — FINE SAND WITH SILT
GROUNDWATER	CAD CELL — CONFINED AQUATIC DISPOSAL CELL
	NATIVE ALLUVIUM WITH DENSE, SANDY GRAVEL
	PROPOSED RECLAMATION FILL

NOTE:

THIS SUBSURFACE PROFILE IS GENERALIZED FROM DRAWING PROVIDED BY LANDAU ASSOCIATES, INC. AND SURVEY DATA FROM MINISTER-GLAESER SURVEYING, INC., AND (3D)I, LLC.

0 60 120
(IN FEET)

CROSS SECTION A-A'

ROSS ISLAND SAND & GRAVEL
PORTLAND, OR

FIGURE 2

PERKINSCOI-8-01-01

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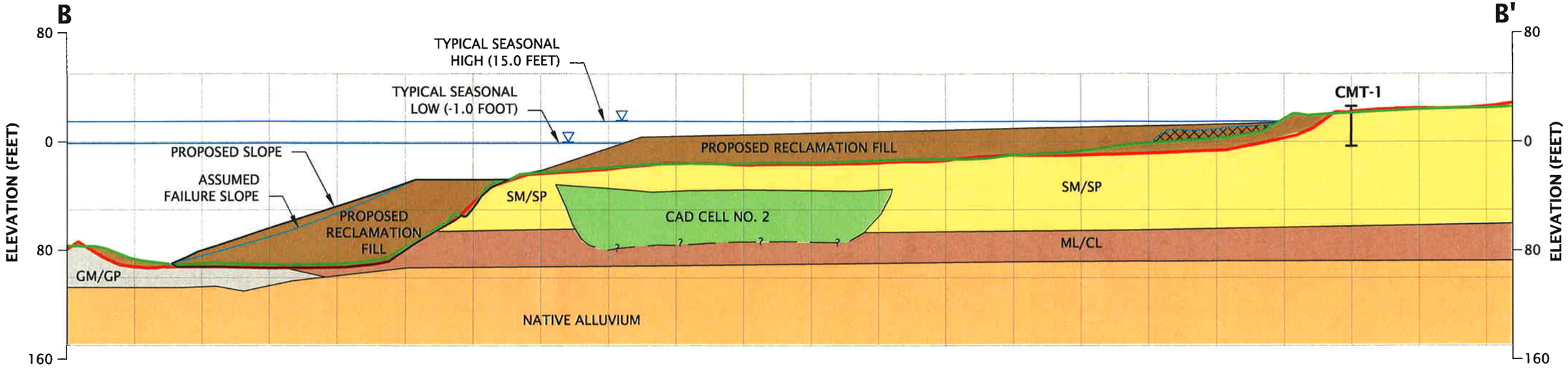
Dec 21, 2005 - 12:41:33 DWG Name: PerkinsCoi-8-01-01-SEC-Figure-2-5.dwg Updated By: rlf



EXPLANATION:

CMT-1 MONITORING WELL

EXISTING SURFACE AS OF NOVEMBER 2001

EXISTING SURFACE AS OF NOVEMBER 2003

ASSUMED FAILURE SLOPE AS DETERMINED DURING THE SLOPE STABILITY EVALUATION BY LANDAU ASSOCIATES, INC.

GROUNDWATER

GM/GP	SANDY GRAVEL
ML/CL	SILT WITH FINE SAND AND CLAYEY SILT
SM/SP	FINE SAND WITH SILT
CAD CELL	CONFINED AQUATIC DISPOSAL CELL
	NATIVE ALLUVIUM WITH DENSE, SANDY GRAVEL
	PROPOSED RECLAMATION FILL
	FILL PLACED BETWEEN FALL 2003 AND FALL 2005

0 80 160
(IN FEET)

THIS SUBSURFACE PROFILE IS GENERALIZED FROM DRAWING PROVIDED BY LANDAU ASSOCIATES, INC. AND SURVEY DATA FROM MINISTER-GLAESER SURVEYING, INC., AND (3D)I, LLC.

CROSS SECTION B-B'

FIGURE 3

ROSS ISLAND SAND & GRAVEL
PORTLAND, OR

PERKINSCOI-8-01-01

OCTOBER 2005

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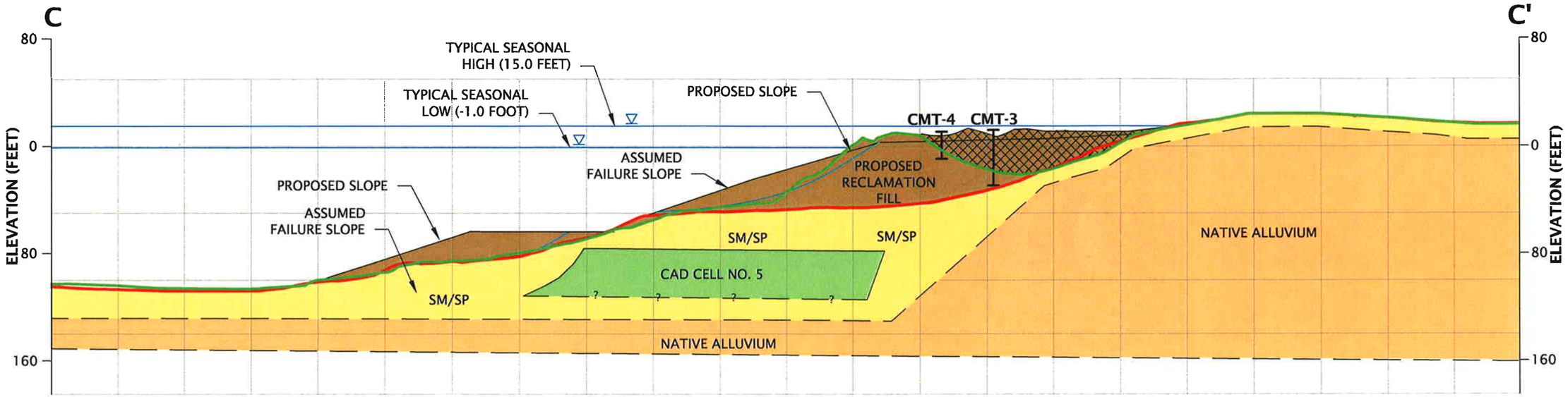
Sept 29, 2005 - 13:10:50 DWG Name: Drawing2.dwg Updated By: rlf



EXPLANATION:

CMT-3
MONITORING WELL

EXISTING SURFACE AS OF NOVEMBER 2001

EXISTING SURFACE AS OF NOVEMBER 2003

ASSUMED FAILURE SLOPE AS DETERMINED DURING THE SLOPE STABILITY EVALUATION BY LANDAU ASSOCIATES, INC.

GROUNDWATER

SM/SP	FINE SAND WITH SILT
CAD CELL	CONFINED AUQUATIC DISPOSAL CELL
	NATIVE ALLUVIUM WITH DENSE, SANDY GRAVEL
	PROPOSED RECLAMATION FILL
	AREAS OF FILL PLACED BETWEEN FALL 2003 AND FALL 2005

NOTE:
THIS SUBSURFACE PROFILE IS GENERALIZED FROM DRAWING PROVIDED BY LANDAU ASSOCIATES, INC. AND SURVEY DATA FROM MINISTER-GLAESER SURVEYING, INC., AND (3D)I, LLC.

0 80 160
(IN FEET)

CROSS SECTION C-C'

FIGURE 4

ROSS ISLAND SAND & GRAVEL
PORTLAND, OR

PERKINSCOI-8-01-01

OCTOBER 2005

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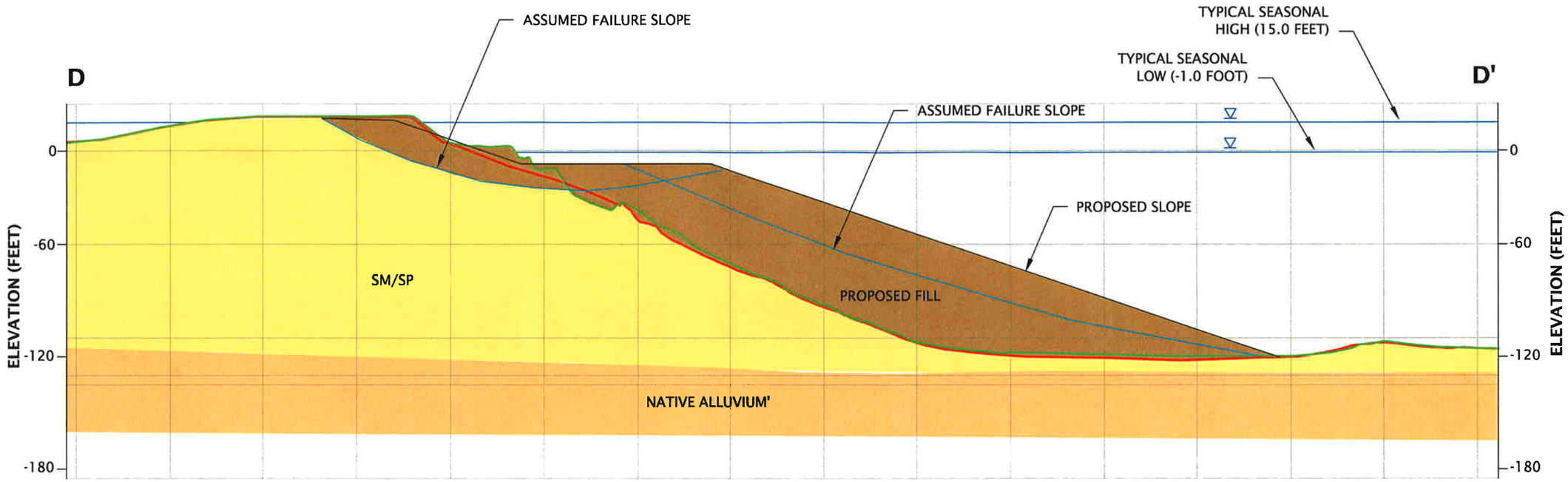
Sept 29, 2005 - 13:10:50 DWG Name: Drawing2.dwg Updated By: rlf



EXPLANATION:

EXISTING SURFACE AS OF NOVEMBER 2001

EXISTING SURFACE AS OF NOVEMBER 2003

ASSUMED FAILURE SLOPE AS DETERMINED DURING THE SLOPE STABILITY EVALUATION BY LANDAU ASSOCIATES, INC.

GROUNDWATER

SM/SP — FINE SAND WITH SILT

NATIVE ALLUVIUM WITH DENSE, SANDY GRAVEL

PROPOSED RECLAMATION FILL

NOTE:

THIS SUBSURFACE PROFILE IS GENERALIZED FROM DRAWING PROVIDED BY LANDAU ASSOCIATES, INC. AND SURVEY DATA FROM MINISTER-GLAESER SURVEYING, INC., AND (3D)I, LLC.

0 60 120
(IN FEET)

CROSS SECTION D-D'

ROSS ISLAND SAND & GRAVEL
PORTLAND, OR

FIGURE 5

PERKINSCOI-8-01-01

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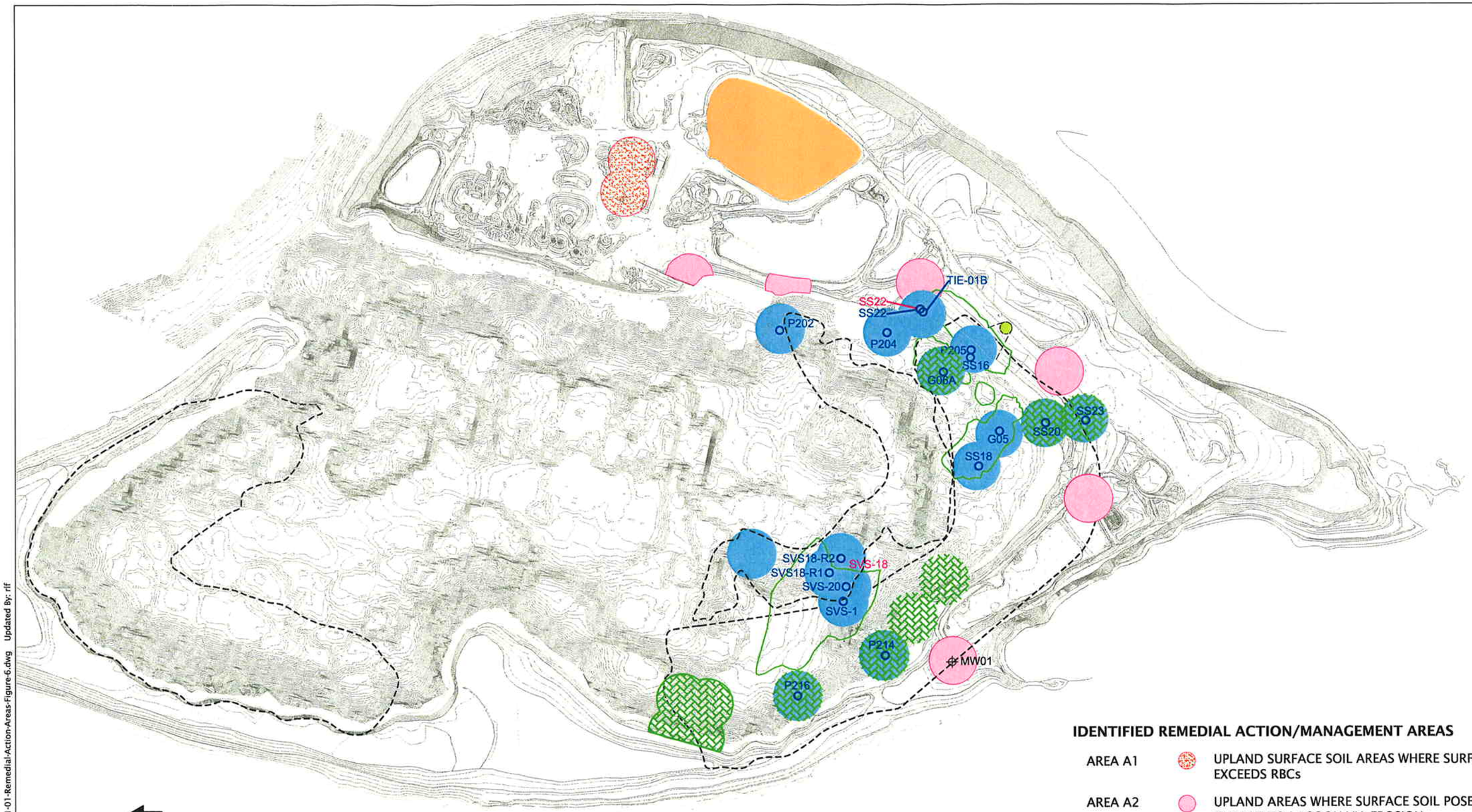
Sept 29, 2005 - 13:10:50 DWG Name: Drawing2.dwg Updated By: rlf



REMEDIAL ACTION AREAS AND IDENTIFIED HOT SPOTS

ROSS ISLAND SAND & GRAVEL
PORTLAND, OR

FIGURE 6

PERKINSCOI-8-01-01

OCTOBER 2005

N

0 400 800
(IN FEET)

SITE PLAN BASED ON DRAWING PROVIDED BY LANDAU ASSOCIATES, INC.

NOTES:

1. BATHYMETRY FROM MINISTER-GLAESER SURVEYING, INC., VANCOUVER, WA - NOVEMBER 2003
2. TOPOGRAPHY FROM (3D)I, LLC, EUGENE, OR - DECEMBER 2003

IDENTIFIED HOT SPOTS

- SELECT AREA D, INCLUDING:
  - LAGOON SURFACE SEDIMENT SAMPLES THAT REPRESENT POTENTIAL HUMAN HEALTH HOT SPOTS ABOVE BACKGROUND/AMBIENT CONCENTRATIONS (ER > 10.0 FOR NON-CARCINOGENS AND/OR > 100.0 FOR CARCINOGENS)
  - LAGOON SURFACE SEDIMENT SAMPLES THAT REPRESENT POTENTIAL ECOLOGICAL HOT SPOTS ABOVE BACKGROUND/AMBIENT CONCENTRATIONS (ER >10.0)
- CAPPED POND MATERIAL (AREA B)
- CONFINED AQUATIC DISPOSAL CELLS (AREA F)

IDENTIFIED REMEDIAL ACTION/MANAGEMENT AREAS

AREA A1	UPLAND SURFACE SOIL AREAS WHERE SURFACE SOIL EXCEEDS RBCs
AREA A2	UPLAND AREAS WHERE SURFACE SOIL POSES A THREAT TO LAGOON VIA EROSION
AREA B	CAPPED POND MATERIAL
AREA C	SOURCE AND PREDICTED BENZO(A)PYRENE MIGRATION AREA
AREA D	SURFACE SEDIMENT AREAS IMPACTED WITH CONTAMINANTS
AREA E	SURFACE SEDIMENT AREAS WITH ELEVATED pH
AREA F	CONFINED AQUATIC DISPOSAL CELLS
	PROPOSED FILL AREAS PRESENTED IN THE 2002 RECLAMATION PLAN

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Portland OR 97224
Off 503.968.8787 Fax 503.968.3068

Dec 21, 2005 - 12:41:56 DWG Name: PerkinsCoi-8-01-01-Remedial-Action-Areas-Figure-6.dwg Updated By: rlf

TABLE 16
Identified Technology Screening Results
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor(s) at Risk	General Response Actions	Identified Remedial Technologies	Relevant Screening Criteria					Comments	Retained (Yes/No)	Identified Hot Spot (Yes/No)
					Effectiveness (L/M/H)	Long-Term Reliability (L/M/H)	Implementability (E/M/D)	Implementation Risk (L/M/H)	Cost (L/M/H)			
Impacted Media: Uplands Surface Soil												
Area A1	PAHs, Metals	Human and Ecological	Removal	Excavation and Off-Site Disposal/Treatment	H	H	M	M	H	A relatively small volume of impacted surface soil in this area makes this option feasible. This alternative is an effective and reliable method to achieve the RAO. Excavated soil would be transported to off-site treatment or disposal facility. This alternative would meet the RAO in a relatively short time frame (less than one year). Excavated soil greater than 1 foot in depth would require replacement with import material. Would be easy to implement, as equipment to excavate and load (presumably onto a barge) is readily accessible. Low to moderate implementation risk due to excavation equipment.	Yes	No
				Excavation and On-Site Treatment/Containment	H	H	M	M	M	Same as above comment, except that excavated soil would be treated and/or contained on site. If contained on site, this option would require other technologies, such as solidification (to treat soil) or a cap (to prevent future exposure to human and ecological receptors). This option would also achieve the RAO in a relatively short time frame (less than one year), depending on the treatment method. Would require management and possibly monitoring. Excavated soil greater than 1 foot in depth would require replacement with import material. Would be easy to implement, as equipment to excavate, load and transport is readily accessible. Low to moderate implementation risk due to excavation and transportation equipment.	Yes	
			Physical Treatment	Solidification	H	H	E/M	L/M	M	This alternative is an effective and reliable method to achieve the RAO. A relatively small volume of surface soil could be treated by ex-situ stabilization methods. Stabilization would solidify and contain the contaminants, making them less soluble, immobile, and less toxic. Would be relatively easy to implement, but may require a bench scale test prior to implementation. Low to moderate implementation risk due to mixing process and equipment.	Yes	
			Institutional Control	Limit Future Access to Impacted Area	M	M	E	L	L	Legally restrict or control certain activities in the vicinity of Area A1 (such as excavation, grading or landscaping) that could potentially result in exposure to workers or recreational visitors. Some of the areas are located near the processing facility and are currently restricted to access by RIS&G employees. This alternative would not achieve the RAO by itself, but would be combined with another technology, such as an engineering control to mitigate potential exposure to workers and recreational visitors.	Yes[1]	
			Engineering Control	Construct Cap	H	M/H	E/M	L/M	M/H	Will achieve RAO if the cap is constructed with at least 3 feet of soil, or constructed of concrete. It appears that between 1 and 3 feet of fill has been placed in the operations area since the surface soil samples were collected in 1999 and 2001. Imported soil material would be in accordance with the approved reclamation plan. Would be easy to implement, with slight implementation risk near the processing facility due to ongoing operations. Would need to be implemented with an institutional control restricting future excavation in the area, and would require periodic maintenance and monitoring. Conforms more closely to planned activities in the approved reclamation plan than other technologies.	Yes	
Impacted Media: Uplands Surface Soil												
Area A2	PAHs, Metals, and PCBs	Human and Ecological	Removal	Excavation and Off-Site Disposal/Treatment	H	H	E	L/M	H	A relatively small volume of impacted surface soil in this area makes this option feasible. Most effective and reliable method to achieve the RAO, as it completely removes the source prior to potential erosion into the lagoon. Excavated soil would be transported to off-site disposal facility. This alternative would meet the RAO in a relatively short time frame (less than one year). Excavated soil may require replacement with import material to maintain slope stability (in conjunction with approved reclamation plan). Would be easy to implement, as equipment to excavate and load (presumably onto a barge) is readily accessible. Low to moderate implementation risk due to excavation equipment.	Yes	No

TABLE 16
Identified Technology Screening Results
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor(s) at Risk	General Response Actions	Identified Remedial Technologies	Relevant Screening Criteria					Comments	Retained (Yes/No)	Identified Hot Spot (Yes/No)
					Effectiveness (L/M/H)	Long-Term Reliability (L/M/H)	Implementability (E/M/D)	Implementation Risk (L/M/H)	Cost (L/M/H)			
Area A2 (continued)	PAHs, metals, and PCBs	Human and Ecological	Removal	Excavation and On-Site Disposal	H	H	E	L/M	H	Same comment as above, but, rather than transport the excavated material off-site for disposal, this alternative only considers transporting it to an area of the uplands that will not be susceptible to erosion. This alternative could also meet the RAO in a relatively short time frame (less than one year). Excavated soil may require replacement with import material to maintain slope stability (in conjunction with approved reclamation plan). Would be easy to implement, as equipment to excavate and transport the soil is readily accessible. Would require management and maintenance. Low to moderate implementation risk due to excavation equipment.	Yes	No
			Institutional Control	Limit Future Access to Impacted Areas	L	L	E	L	L	This alternative would not achieve the RAO, as it would not prevent erosion from potentially occurring. However, institutional controls may be required in conjunction with alternatives that contain comtaminated material on site.	No	
			Engineering Control	Stabilize Slopes	H	H	E	L	L/M	Would achieve the RAO if the cap is constructed at a designed slope in order to prevent future erosion. The cap/slope would be constructed with materials in accordance with the approved reclamation plan. Locations not currently proposed for fill material under the approved reclamation plan would be included. Based on 2001 and 2003 topographic data, it appears that some fill has been placed in the vicinity of Area A2 since December 1999 and April 2001. Would require maintenance of slopes. Conforms more closely to planned activities in the approved reclamation plan than the other technologies.	Yes	
Impacted Media: Uplands Subsurface Soil												
Area B	TBT and TPH	Human and Ecological	Removal	Excavation and Off-Site Disposal/Treatment	H	H	D	H	H	Would achieve RAO; however, volume of impacted soil and significant volume of current cap material (serving as an engineering control) make this alternative less feasible. Implementation risk is high relative to other options, as deep, open excavation poses risk to excavation equipment, on-site workers, and recreational visitors. Would be difficult to implement, since significant volume of cap material would be difficult to handle and manage. However, since this area has been identified as a hot spot, this alternative has been carried forward.	Yes	Capped pond material is currently a reliably contained hot spot and will remain so as long as cap is maintained.
			Institutional Control	Restrict Future Access/Excavation	H	M	E	L	L	Legally restrict or control certain activities in the vicinity of Area C (such as excavation, grading, or landscaping) that could potentially result in exposure to workers or recreational visitors. The capped pond material is located near the processing facility just east of the main active processing settling pond, and is currently restricted to access by RIS&G employees. This alternative would not achieve the RAO by itself, but would be combined with another technology such as ongoing management and maintenance of the existing engineering control, to mitigate potential exposure to workers and recreational visitors.	Yes[1]	
			Engineering Control	Maintain Existing Cap	H	H	E	L	L	An engineering control (clean soil cap) currently mitigates potential exposure to human and ecological receptors. Modeling has indicated that contained contaminants do not pose a potential unacceptable risk to human health or the environment, including the surface water of Holgate Slough or Ross Island Lagoon. Management and maintenance of the cap would be conducted to ensure the cap maintains structural integrity. The management/maintenance would be easily implemented and combined with an institutional control to restrict future excavation in the area. Monitoring would be conducted to confirm the modeling results.	Yes	
Impacted Media: Groundwater												
Area C	Benzo(a)pyrene	Human	Removal	Interceptor Trench	L/M	L/M	M	M/H	H	May achieve RAO, but would best be utilized in combination with another technology, such as a hydraulic barrier system. Would require excavation and installation of extraction wells and equipment. High capital costs and uncertain effectiveness make this alternative unfavorable.	No	Groundwater only identified as potential hot spot in future, should concentration at discharge point to lagoon constitute a hot spot
				Extraction and On- or Off-Site Treatment/Disposal	L/M	M	M/D	M	H	Numerous extraction technologies are available, at moderate to high cost, that may achieve the RAO after many years of operation. Monitoring would be required. Off-site disposal would require periodic and regular transportation off site. On-site treatment would require this alternative to be combined with a treatment technology and then discharged on site via reinjection or other means. High capital costs make this alternative unfavorable.	No	

TABLE 16
Identified Technology Screening Results
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor(s) at Risk	General Response Actions	Identified Remedial Technologies	Relevant Screening Criteria: Effectiveness (L/M/H)	Long-Term Reliability (L/M/H)	Implementability (E/M/D)	Implementation Risk (L/M/H)	Cost (L/M/H)	Comments	Retained (Yes/No)	Identified Hot Spot (Yes/No)
Area C (continued)	Benzo(a)pyrene	Human	Physical/ Chemical Treatment	Air Sparging System	L	M	M/D	L/M	H	This technology would include installation of injection wells and air delivery equipment to remediate impacted groundwater. An in-situ system would require higher capital costs and would be less effective in achieving the RAO, since the contaminant is not readily conducive to volatilization. System could be designed for biosparging to degrade the contaminant, and would include monitoring and O&M. High capital cost and low effectiveness make this alternative unfavorable.	No	Groundwater only identified as potential hot spot in future, should concentration at discharge point to lagoon constitute a hot spot
				Chemical Oxidation	M	L/M	M	M	H	May achieve the RAO, but methods of delivery and the volumes needed for treatment are likely to be significant. May require multiple applications. Significant treatment costs make this alternative unfavorable.	No	
			Engineering Control	Extend Shoreline and Implement Monitoring Program	M	M	E/M	L	L/M	May achieve the RAO by extending the distance groundwater would migrate to the shoreline, thereby increasing the attenuation time of the contaminant. This alternative conforms to the approved reclamation plan and would be combined with a monitoring program.	Yes	
				Hydraulic Containment	L/M	L/M	M	L	H	May achieve the RAO by preventing the impacted groundwater from reaching the lagoon and potentially presenting a risk to human health. This alternative would likely require an extraction/reinfiltration system to control groundwater migration. This technology has high cost to implement and, therefore, is considered unfavorable.	No	
Impacted Media: Lagoon Surface Sediment												
Area D	PAHs, PCBs, Pesticides, and Metals	Human and Ecological	Removal	Dredging and Off-Site Disposal/Treatment	H	H	D	H	H	This alternative would be an effective and reliable method to achieve the RAO. Dredged sediment would be transported to off-site disposal facility. This alternative could meet the RAO in a relatively moderate time frame (10 years or less). Implementation may be very difficult, due to the dispersed nature of the source material. Implementation risk is high relative to other options, especially near CAD cells. However, since portions of this area have been identified as a hot spot, this alternative is carried forward.	Yes	Some contaminant concentrations in some of the surface sediments in Area D constitute current and future hot spots.
				Dredging and On-Site Disposal/Treatment	H	H	D	H	H	This alternative would be an effective and reliable method to achieve the RAO. Dredged sediment would be transported to a single uplands location for containment and treatment. On-site containment and treatment would require another technology, such as an engineering control (containment) or physical treatment (solidification). This alternative could meet the RAO in a relatively moderate time frame (10 years or less). Implementation may be very difficult due to the dispersed nature of the source material. Implementation risk is high relative to other options, especially near CAD cells. However, since portions of this area have been identified as a hot spot, this alternative is carried forward.	Yes	
			Partial Removal and Engineering Control	Dredging and On- or Off-Site Disposal/Treament of Hot Spots and Construction of Sediment Cap	H	H	D	H	H	This alternative combines a removal action with an engineering control and would be an effective and reliable method to achieve the RAO. Dredged "hot spots" in the sediment would be transported to an off-site disposal facility or to a single uplands location for containment and treatment. Residual contamination after removal of the hot spots would be capped. Since the majority of the impacted surface sediment is considered a hot spot, implementation would be difficult, especially near the CAD cells. However, this alternative is carried forward.	Yes	
			Institutional Control	Limit Access to Lagoon	M	M	E	L	L	This alternative would not achieve the RAO by itself, but would be combined with another technology, such as an engineering control to physically prevent exposure to benthic invertebrates inhabiting the sediment. Legal or administrative restrictions on certain activities in the vicinity of Area D, such as future dredging, would be implemented to help prevent future exposure of the capped material.	Yes[1]	

TABLE 16
Identified Technology Screening Results
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor(s) at Risk	General Response Actions	Identified Remedial Technologies	Relevant Screening Criteria					Comments	Retained (Yes/No)	Identified Hot Spot (Yes/No)
					Effectiveness (L/M/H)	Long-Term Reliability (L/M/H)	Implementability (E/M/D)	Implementation Risk (L/M/H)	Cost (L/M/H)			
Area D (continued)	PAHs, PCBs, Pesticides, and Metals	Human and Ecological	Engineering Control	Construct Sediment Cap	H	H	E	L/M	L/M	Would achieve the RAO for human health and for the benthic invertebrates. Would be easy to implement. Material used for the cap would be in accordance with the approved reclamation plan. Would be combined with an institutional control. Conforms more closely to the reclamation plan than other technologies.	Yes	Some contaminant concentrations in some of the surface sediments in Area D constitute current and future hot spots.
			Intrinsic Remediation	Monitored Natural Reduction	M	M/H	E	L	L	This alternative may achieve the RAO by natural processes that may be occuring at the site. A monitoring program would be implemented to verify decreasing contaminant concentrations over time. However, this alternative would not correspond to the plans and goals of the reclamation plan or the DSL permit requirements and is, therefore, considered unfavorable.	No	
Area E	Elevated pH	Ecological	Removal	Dredging and Off-Site Disposal/Treatment	H	H	D	H	H	This alternative would be an effective and reliable method to achieve the RAO. Dredged sediment would be transported to off-site disposal facility. This alternative could meet the RAO in a relatively moderate time frame (10 years or less). Implementation may be very difficult, due to the dispersed nature of the source material.	Yes	No
				Dredging and On-Site Disposal/Treatment	H	H	D	H	H	This alternative would be an effective and reliable method to achieve the RAO. Dredged sediment would be transported to a single uplands location for containment and treatment. On-site containment and treatment would require another technology, such as an engineering control (containment). This alternative could meet the RAO in a relatively moderate time frame (10 years or less). Implementation may be very difficult due to the dispersed nature of the source material.	Yes	
			Institutional Control	Limit Access to Lagoon	M	M	E	L	L	This alternative would not achieve the RAO by itself, but would be combined with another technology, such as an engineering control to physically prevent exposure to benthic invertebrates inhabiting the sediment. Legal or administrative restrictions on certain activities in the vicinity of Area E, such as future dredging, would be implemented to help prevent future exposure of the capped material.	Yes[1]	
			Engineering Control	Construct Sediment Cap	H	H	E	L/M	L/M	Would achieve the RAO for the benthic invertebrates. Would be easy to implement. Material used for the cap would be in accordance with the approved reclamation plan. Would be combined with an institutional control. Conforms more closely to the reclamation plan than other technologies.	Yes	
			Physical Treatment	Neutralization of Elevated pH	L[1]	H	E	L/M	M/H	This alternative is unproven and would have uncertain effectiveness in achieving the RAO. Surface sediment with elevated pH could be capped with amended material to neutralize elevated pH. Neutralization could lower the elevated pH to levels less than 8.5. Since this area has been identified as a hot spot, this alternative is carried forward.	Yes	
			Intrinsic Remediation	Monitored Natural Reduction	M	M/H	E	L	L	This alternative may achieve the RAO by natural processes that may be occuring at the site. A monitoring program would be implemented to verify pH reduction over time. However, this alternative would not correspond to the plans and goals of the reclamation plan or the DSL permit requirements and is, therefore, considered unfavorable.	No	

TABLE 16
Identified Technology Screening Results
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor(s) at Risk	General Response Actions	Identified Remedial Technologies	Relevant Screening Criteria					Comments	Retained (Yes/No)	Identified Hot Spot (Yes/No)
					Effectiveness (L/M/H)	Long-Term Reliability (L/M/H)	Implementability (E/M/D)	Implementation Risk (L/M/H)	Cost (L/M/H)			
Impacted Media: Lagoon Subsurface Sediment												
Area F	TBT, Metals, PAHs, VOCs, and PCBs	Human and Ecological	Removal	Excavation and Off-Site Disposal/Treatment	H	H	D	H	H	Will achieve RAO; however, clean fill material and current engineering cap would first need to be removed. Volume and depth of confined material add significant implementation challenge. Confined material would be transported off-site to a permitted disposal facility. This alternative could meet the RAO in a relatively moderate time frame (10 years or less). Since this area has been identified as a hot spot, this alternative is carried forward.	Yes	Currently, CAD cells are reliably contained hot spots and will remain so as long as caps are maintained.
			Institutional Control	Restrict Future Access/Excavation	H	M	E	L	L	This alternative must be combined with the existing engineering control (cap) and would achieve the RAO by legally restricting access to all future workers, recreational visitors, and future excavation in the vicinity of the capped CAD cells.	Yes[1]	
			Engineering Control	Maintain Existing Cap	H	M	E	L	M	This alternative has already been implemented and is effectively achieving the RAO. Management and monitoring of the cap would be implemented to verify the cap's structural integrity. An institutional control would be implemented in conjunction with this alternative to restrict future excavation in the area.	Yes	

Notes:

1. Institutional controls in the form of administrative or legal measures to restrict specific activities in select areas are carried forward as a component that may be used in combination with select final remedial alternatives. Since this is not a stand-alone technology that can be compared with other similar technologies for a given general response action, it is not presented in the comparative analysis (Table 17).

E/M/D: Qualitative rating of easy, moderately easy, or difficult for the implementation balancing factor.

L/M/H: Qualitative rating of low, medium, or high for each of the balancing factors.

TABLE 17
Comparative Analysis of Remedial Alternatives
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor at Risk	Approximate Depth of Contamination (feet)	Approximate Volume of Impacted Media (cubic yards)	Identified Remedial Alternative	Description	Relevant Screening Criteria												Total Score	
							Effectiveness		Long-Term Reliability		Implementability		Implementation Risk		Reasonableness of Cost		Extent of Treatment of Hot Spots		Score	Rank
							Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score		
Impacted Media: Uplands Soil																				
Area A1	PAHs, Metals	Human and Ecological	0 to 1	2,300	Alternative 1A - Excavation and On-Site Disposal/Containment	Surface soil in Area A1 would be excavated, transported, and treated or contained on site at a single location within the uplands. This alternative would be combined with other technologies, such as solidification (to treat soil) or a cap (to contain and prevent future exposure to human and ecological receptors), and an institutional control to restrict future activities (such as excavation) in the vicinity of the containment area. Would require imported backfill material and re-vegetation to meet the approved reclamation plan.	Excavation (source removal) and on-site disposal by containment and/or stabilization is considered an effective technology to achieve the RAO. Combining this alternative with institutional controls (legal restrictions) would further benefit effectiveness of this disposal alternative.	10	This alternative requires the use of other alternatives to provide long-term reliability with respect to the RAO. Effectiveness could be documented by sampling excavation limits and a management/ maintenance program to ensure engineering control is maintained or treatment is effective. Periodic sampling may be required to demonstrate containment or treatment performance at the disposal location.	6	Primary implementation challenge relates to on-site facilities and operations in the vicinity of Area A1. Additionally, it appears some clean fill material has been placed in the vicinity of Area A1, and would require removal prior to excavating and removing contaminated material.	6	Some uncertainty with disposing impacted material on-site; however, if used in combination with other alternatives, implementation risk is low. Excavation would pose risks (manageable) to on-site workers and potential recreational visitors.	8	$243,000	8	No hot spots are identified in Area A1	NA	38	4th
					Alternative 1B - Excavation and Off-Site Disposal	Surface soil in Area A1 would be excavated and transported off site to a licensed and approved disposal facility. Would require imported backfill material and re-vegetation to meet the approved reclamation plan.	Excavation (source removal) and off-site disposal is considered a very effective technology to achieve the RAO. Landfill disposal is considered an effective method for managing impacted soil.	10	Source removal and off-site disposal would provide long term reliability with respect to the RAO. Effectiveness could easily be documented by sampling excavation limits.	10	Primary implementation challenge relates to facilities and operations in the vicinity of Area A1, clean overburden, and necessary multiple handling of impacted soil. Although transport equipment (barge) is readily available, loading and off-loading barge and loading and unloading on-road truck adds implementation challenge.	6	Excavation would pose risk (manageable) to on-site workers and potential recreational visitors. Multiple handling of impacted soil also adds implementation risk to workers.	8	$406,000	6			40	Tied for 3rd
					Alternative 2 - Solidification and Stabilization	This treatment technology would be implemented in combination with Alternative 1A. The contaminated soil would be mixed with a binding agent to solidify and contain the contaminants. This technology makes the contaminants less soluble, immobile, and in a state that is less toxic.	Solidification and stabilization is considered a very effective technology to achieve the RAO. Combining this alternative with institutional controls (legal restrictions) would further benefit effectiveness of this alternative. This alternative scores slightly less for this category than off-site disposal, because the source has not been removed from the site.	10	This alternative requires the use of other alternatives to provide long-term reliability with respect to the RAO. Effectiveness could be documented by periodic monitoring to demonstrate treatment performance at the disposal location.	6	Since this technology would be combined with Alternative 1A, the contaminated material could be mixed with the binder agent prior to on-site disposal. Primary implementation challenge relates to locating an area to mix the materials and place the solidified material.	4	Mixing would pose slight risk (manageable) to on-site workers and potential recreational visitors. Multiple handling of impacted soil during excavation and mixing process also adds implementation risk to workers.	8	$295,175	8			36	5th
					Alternative 3A - Construct Soil Cap	This technology could be implemented as a stand-alone technology or in combination with Alternative 1A. At least 3 feet of clean soil would be placed in Area A1 (or another disposal area if combined with Alternative 1A) to prevent exposure to current and future site workers, recreational visitors, and ecological receptors. Clean soil meeting RIS&G's criterion of "Class A" fill would be used as capping material in accordance with the approved reclamation plan. This alternative conforms to the reclamation plan.	Capping is considered a very effective technology to achieve the RAO. The soil cap would effectively prohibit exposure to human and ecological receptors, as long as the cap is maintained. Vegetating the clean soil cap in accordance with the reclamation plan would minimize disturbance of the cap.	10	The soil cap would be a reliable alternative, as long as the cap is not disturbed due to erosion, excavation, or other activity. Combining this alternative with institutional control increases long-term reliability. Periodic maintenance may be required.	6	Based on 2003 topography data, it appears that between 1 and 3 feet of material has been placed in the operations area in the vicinity of Area A1. Additional cap material could easily be placed in these areas at a consistent thickness of 3 feet.	10	Capping would pose slight risk (manageable) to on-site workers and potential recreational visitors.	10	$191,100	10			46	1st

TABLE 17
Comparative Analysis of Remedial Alternatives
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Area of Concern	Contaminant or Issue of Concern	Receptor at Risk	Approximate Depth of Contamination (feet)	Approximate Volume of Impacted Media (cubic yards)	Identified Remedial Alternative	Description	Relevant Screening Criteria										Total Score	
							Effectiveness		Long-Term Reliability		Implementability		Implementation Risk		Reasonableness of Cost		Extent of Treatment of Hot Spots		Score	Rank
							Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score		
Area A1 (continued)	PAHs, Metals	Human and Ecological	0 to 1	2,300	Alternative 3B - Construct Concrete Cap	A 3- to 6-inch-thick asphalt or concrete cap would be constructed at the location of Area A1 to prevent exposure to current and future site workers, recreational visitors, and ecological receptors. However, this technology would not conform with the approved reclamation plan and would inhibit future ecological development.	Capping is considered a very effective technology to achieve the RAO. A concrete cap would effectively prevent human and ecological exposure to the impacted surface soils.	10	A concrete cap would be a very reliable long-term cap technology. Periodic inspection and maintenance would be required to ensure structural integrity.	8	Primary implementation challenge relates to constructing the cap in the vicinity of site facilities and during ongoing operations. Subgrade would require preparation prior to cap construction.	8	Capping could pose a slight risk (manageable) to on-site workers and potential recreational visitors.	10	$410,700	6	No hot spots are identified in Area A1	NA	42	2nd
Area A2	PAHs, Metals, and PCBs	Human and Ecological	0 to 1.5	8,700	Alternative 1 - Excavation and Off-Site Disposal/Treatment	Surface soil in Area A2 should be excavated and transported off-site to a licensed and approved disposal facility. Would require imported backfill material and re-vegetation to meet the approved reclamation plan.	Excavation (source removal) is considered a very effective technology to achieve the RAO. Landfill disposal is considered an effective method for managing impacted soil. Source is removed from the site.	10	Source removal and off-site disposal would provide long term reliability with respect to the RAO. Effectiveness could easily be documented by sampling excavation limits.	10	This alternative could easily be implemented, as excavation and transport equipment is readily accessible and Area A2 is not heavily vegetated. Although transport equipment (barge) is readily available, loading and off-loading barge and loading and unloading on-road truck adds implementation challenge, although manageable. Additionally, it appears some clean fill material has been placed in some areas of Area A2, and would require removal prior to excavating and removing contaminated material.	8	Excavation would pose risk (manageable) to on-site workers and potential recreational visitors. Multiple handling of impacted soil also adds implementation risk to workers.	8	$814,700	8	No hot spots are identified in Area A2	NA	44	2nd
					Alternative 2 - Slope Stabilization	Additional imported fill material that complies with the approved reclamation plan would be placed along the lagoon shorelines in the Area A2 at a designed slope and vegetated to prevent erosion of the contaminants into the lagoon. This alternative conforms with the approved reclamation plan in Area A2 outside the plant operations. Area inside plant operations may also receive fill at a designed slope and vegetated as to prevent erosion of the contaminants into the lagoon. Periodic monitoring of the slope conditions would ensure stability is maintained.	The designed slope and vegetation would effectively prevent erosion of the contaminants into the lagoon. Periodic monitoring would be required to ensure that slope stability is maintained.	10	Slope stabilization and would provide good long-term reliability if designed properly, maintained and periodically monitored to ensure stability. Vegetation would further benefit the effectiveness of this alternative. This alternative scores slightly less for this category since the source is not removed.	8	This alternative could easily be implemented in accordance with the approved reclamation plan. Some clean fill material has been placed in Area A2. Also, the current northern bank along the southern portion of the plant operations area is an engineered slope that contains rip-rap material that prevents erosion in this area. Once plant operations cease and facilities are dismantled, the designed slope will be re-evaulated and additional fill material would be placed along the remaining shoreline areas at a designed slope, and vegetated to prevent erosion of contaminants from these areas into the lagoon.	10	There is no anticipated risk to implement this alternative.	10	$201,400	10		NA	48	1st
Impacted Media: Uplands Subsurface Soil																				
Area B	TBT and TPH	Human and Ecological	Up to 30	66,300[1]	Alternative 1 - Excavation and Off-Site Disposal/Treatment	Subsurface soil in Area B (capped pond material) would be excavated and transported off-site to a licensed and approved disposal facility. Would require imported backfill material and re-vegetation to meet the approved reclamation plan.	Excavation (source removal) is considered a very effective technology to achieve the RAO. Landfill disposal is considered an effective method for managing impacted soil. Source is removed from the site.	10	Source removal and off-site disposal would provide long term reliability with respect to the RAO. Effectiveness could easily be documented by sampling excavation limits.	10	This alternative would be difficult to implement, as significant volume of clean overburden (cap material) would first need to be removed. Handling significant volume of clean overburden would be difficult.	8	Deep, open excavation would pose a risk (manageable) to on-site workers and potential recreational visitors.	8	$947,300	8	The hot spot would be reduced to non-hot spot levels by removing the source of TBT and TPH.	10	54	2nd

TABLE 17
Comparative Analysis of Remedial Alternatives
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor at Risk	Approximate Depth of Contamination (feet)	Approximate Volume of Impacted Media (cubic yards)	Identified Remedial Alternative	Description	Relevant Screening Criteria										Total Score	
							Effectiveness		Long-Term Reliability		Implementability		Implementation Risk		Reasonableness of Cost		Extent of Treatment of Hot Spots		Score	Rank
							Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score		
Area B (continued)	TBT and TPH	Human and Ecological	Up to 30	66,300[1]	Alternative 2 - Maintain Existing Cap	A maintenance plan would be prepared to provide information regarding proper procedures and protocol to ensure the existing cap is maintained. Also, monitoring would be conducted to confirm modeling results.	The existing soil cap is currently preventing exposure to current and future site workers, **recreational visitors and** ecological receptors and will continue to be protective of human health and the environment as long as the cap is maintained.	10	The existing soil cap will continue to be a reliable Alternative as long as the cap is not disturbed due to erosion, excavation, or other activity. Implementing this alternative with an institutional control will ensure long-term reliability. This technology scores slightly less than Alternative 1 since the source remains on-site.	8	The maintenance plan could be prepared and easily implemented at any time to ensure that the existing cap is not disturbed.	10	There is no anticipated implementation risk to this alternative, as long as the cap is designed to prevent erosion and an institutional control prevents future excavation in the area.	10	$54,000	10	Currently, the capped pond material is reliably contained, and modeling has demonstrated contaminants will not migrate to other **media and present** unacceptable risk. Maintaining the existing cap will ensure future receptors are not exposed to the hot spot.	10	58	1st
Impacted Media: Groundwater																				
Area C	Benzo(a)pyrene	Human	24 to 28	Unknown	Alternative 1 - Extend Shoreline and Implement Monitoring Program	This alternative involves placing additional clean soil along the lagoon shoreline at the location the model predicted an exceedance from migrating groundwater. This alternative conforms with the planned reclamation activities. Extending the shoreline will extend the migration distance of the groundwater, thereby potentially reducing the contaminant concentration to an acceptable level to be protective of human health. Groundwater at the location of Boring LB213 and along the modeled migration pathway will be resampled to verify that the concentration of Benzo(a)pyrene is consistent with earlier concentrations used to predict the modeled exceedance. If groundwater conditions are similar to the previous conditions, a permanent monitoring well will be constructed at the location of Boring LB213 to verify groundwater conditions over time. If necessary, surface water samples will be collected at the predicted discharge location to confirm groundwater is not entering the lagoon at concentrations posing a risk to human health.	This alternative, combined with future monitoring, would likely be effective in reducing the contaminant concentration in the groundwater to an acceptable concentration at the surface water interface, since the model used to predict the exceedance (during year 400) along the lagoon shoreline was conservative was based on a potentially biased high groundwater result collected from a temporary boring, as opposed to a properly installed groundwater monitoring well. Any exceedances at compliance points would require additional action.	NA	Extending the shoreline and the migration distance of the groundwater to the shoreline is anticipated to have good long-term reliability. However, exceedances at compliance points would require additional remedial action to ensure protection to human health. Monitored attenuation along the predicted migration pathway would provide a measure of reliability for overall protectiveness.	NA	This alternative could easily be implemented in conjunction with the proposed fill plan (according to the approved reclamation plan). According to the reclamation plan, the area of the shoreline at the predicted exceedance point will be extended approximately 200 feet. If installation of the monitoring points using machine equipment proves difficult, they could be installed by hand equipment near the final shoreline.	NA	Some uncertainty as to overall reduction, but low implementation risk since there would be monitoring to assess any potential exceedances of protective criteria. Extending the shoreline and installing monitoring points would pose slight risks (manageable) to on-site workers and potential recreational visitors.	NA	$130,700	NA	Extending the shoreline would increase natural attenuation processes and reduce potential for discharge to the lagoon via groundwater migration (which would constitute a hot spot). Additional action would be triggered by the monitoring program, if warranted.	NA	NA	NA

TABLE 17
Comparative Analysis of Remedial Alternatives
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Area of Concern	Contaminant or Issue of Concern	Receptor at Risk	Approximate Depth of Contamination (feet)	Approximate Volume of Impacted Media (cubic yards)	Identified Remedial Alternative	Description	Relevant Screening Criteria												Total Score	
							Effectiveness		Long-Term Reliability		Implementability		Implementation Risk		Reasonableness of Cost		Extent of Treatment of Hot Spots		Score	Rank
							Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score		
Impacted Media: Lagoon Surface Sediment																				
Area D	PAHs, PCBs, Pesticides and Metals	Human and Ecological	0 to 0.3	4,500	Alternative 1A - Dredging and Off-Site Disposal/Treatment	Surface sediment in Area D would be dredged and transported off site to a licensed and approved disposal or treatment facility. Would require imported backfill material in addition to the proposed fill material for reclamation.	Dredging (source removal) is considered a very effective technology to prevent exposure of organic contaminants to human and ecological receptors. Landfill disposal or treatment is considered an effective method for managing impacted sediment.	10	Source removal and off-site disposal or treatment would provide long-term reliability with respect to the RAO. Effectiveness could easily be documented by sampling, dredging limits, and periodic monitoring.	10	Primary implementation challenge relates to the dispersed nature of the likely source material for the PAHs, PCBs, pesticides and metals. Although transport equipment (barge) is available, multiple handling events (loading and off-loading barge, then loading and unloading truck) add implementation challenge. A significant volume of clean sediment would first need to be removed.	2	Dredging would pose a risk (manageable) to on-site workers and potential recreational visitors; however, there is a significant implementation risk associated with dredging near CAD cells. Dredging may exacerbate contamination.	8	$1,045,000	4	The hot spots would be reduced to non-hot spot levels by removing the source of the contaminants.	10	44	2nd
					Alternative 1B - Dredging and On-Site Disposal/Containment	Surface sediment in Area D would be dredged and transported to a single on-site location for containment and disposal. Would require imported backfill material in addition to the proposed fill material for reclamation. This alternative would be combined with another technology, such as an engineering cap and monitoring, to help prevent exposure of contained material.	Dredging (source removal) would be a very effective technology to achieve the RAO. Containment and monitoring would be an effective method for managing impacted sediment.	10	Source removal and on-site containment would provide long-term reliability with respect to the RAO. Effectiveness could easily be documented by sampling dredging limits, and management/monitoring. This alternative ranks slightly less than Alternative 1A, since contaminants would remain on site.	8	Primary implementation challenge relates to the dispersed nature of the likely source material for the PAHs, PCBs, pesticides and metals. Although transport equipment (barge) is available, multiple handling events (loading and off-loading barge, then loading and unloading truck) also add implementation challenge. A significant volume of clean sediment would first need to be removed.	2	Dredging would pose a risk (manageable) to on-site workers and potential recreational visitors; however, there is a significant implementation risk associated with dredging near the CAD cells.	8	$800,000	6	The hot spots would be reduced to non-hot spot levels by removing the source of the contaminants. However, on-site disposal may potentially create a hot spot elsewhere on site.	8	42	3rd
					Alternative 2 - Construct Sediment Cap/Monitoring	Clean soil meeting RIS&G's criterion of "Class A" fill material would be placed in portions of the lagoon over the locations of elevated contaminant concentrations and elevated pH levels, to prevent exposure to benthic invertebrates inhabiting the surface sediment and fish inhabiting the lagoon. If necessary, the capping material could be amended to neutralize the elevated pH levels. This alternative would conform with the approved reclamation plan and be combined with institutional controls to restrict future dredging and a long-term management/monitoring program. For the purpose of this FS, the assumed minimum cap thickness is 3 feet. This alternative conforms to the approved reclamation plan.	The sediment cap may be a very effective technology to achieve the RAO, as long as the cap is maintained. The effectiveness of capping surface sediment in the lagoon is currently being evaluated. Restricting future dredging within the lagoon via an institutional control would further benefit effectiveness.	10	The cap would provide long-term reliability with respect to the RAO, as long as the cap is not disturbed due to dredging. This alternative would require institutional controls to increase long-term reliability. Effectiveness could easily be documented through a management and monitoring program. Periodic sampling may be required to demonstrate cap effectiveness over time.	6	The sediment cap could easily be implemented in conjunction with the proposed fill plan (according to the approved reclamation plan). Isolated areas not planned to receive fill according to the reclamation plan would be capped, as well.	10	Capping would pose a minor risk (manageable) to on-site workers and potential recreational visitors.	10	$323,000	10	The hot spots would be reliably contained by capping the contaminants causing the hot spots.	10	56	1st

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							Effectiveness		Long-Term Reliability		Implementability		Implementation Risk		Reasonableness of Cost		Extent of Treatment of Hot Spots		Score	Rank
							Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score		
Area D (continued)	PAHs, PCBs, Pesticides and Metals	Human and Ecological	0 to 0.3	4,500	Alternative 3 - Hot Spot Removal/Cap/Monitoring	Only hot spots identified in the surface sediment of Area D would be dredged and transported off site to a licensed and approved disposal or treatment facility. Would require imported backfill material in addition to the proposed fill material for reclamation. This alternative would be combined with another technology, such as an engineering cap and monitoring, to help prevent exposure of residual material not removed during the hot-spot removal.	Dredging (hot spot removal) would be a very effective technology to partially achieve the RAO. Non-hot spot impacted sediment would be contained with a sediment cap. Combining these two technologies would achieve the RAO, as long as the cap is maintained. Long-term monitoring would be an effective method for managing impacted sediment The effectiveness of capping surface sediment in the lagoon is currently being evaluated. Restricting future dredging within the lagoon via an institutional control would further benefit effectiveness.	10	Hot spot source removal combined with capping residual contamination would provide long-term reliability with respect to the RAO, as long as the cap is not disturbed. Effectiveness could easily be documented by sampling dredging limits, and periodic monitoring/sampling over time. This alternative would require institutional controls to increase long-term reliability.	6	Primary implementation challenge relates to removing the hot spot source material, as a signigifcant volume of clean sediment would first need to be removed. Although transport equipment (barge) is available, multiple handling events (loading and off-loading barge, then loading and unloading truck) add implementation challenge. The sediment cap could easily be implemented in conjunction with the proposed fill plan (according to the approved reclamation plan) once the removal activities are complete. Isolated areas not planned to receive fill according to the reclamation plan would be capped as well.	6	Dredging the hot spots would pose a risk (manageable) to on-site workers and potential recreational visitors; however, there is a significant implementation risk associated with dredging near CAD cells. Dredging in these areas may exacerbate contamination. Capping would pose a minor risk (manageable) to on-site workers and potential recreational visitors after the dreding stage is complete.	6	$904,100	4	The hot spots would be reduced to non-hot spot levels by removing the source of the contaminants. Non-hot spots would be reliably contained by capping the contaminants.	10	42	Tied for 3rd
Area E	Elevated pH	Ecological	0 to 0.3	3,500	Alternative 1A - Dredging and Off-Site Disposal/Treatment	Surface sediment in Area E would be dredged and transported off site to a licensed and approved disposal or treatment facility. Would require imported backfill material in addition to the proposed fill material for reclamation.	Dredging (source removal) is considered a very effective technology to prevent exposure of organic contaminants and elevated pH to human and ecological receptors. Landfill disposal or treatment is considered an effective method for managing impacted sediment.	10	Source removal and off-site disposal or treatment would provide long-term reliability with respect to the RAO. Effectiveness could easily be documented by sampling, dredging limits, and periodic monitoring.	10	Primary implementation challenge relates to the dispersed nature of the likely source material for the elevated pH. Source removal would be very difficult given the potentially heterogeneously distributed source. Although transport equipment (barge) is available, multiple handling events (loading and off-loading barge, then loading and unloading truck) add implementation challenge.	2	Dredging would pose a risk (manageable) to on-site workers and potential recreational visitors.	8	$800,000	4	No	NA	34	Tied for 2nd
					Alternative 1B - Dredging and On-Site Disposal/Containment	Surface sediment in Area E would be dredged and transported to a single on-site location for containment and disposal. Would require imported backfill material in addition to the proposed fill material for reclamation. This alternative would be combined with another technology, such as an engineering cap and monitoring, to help prevent exposure of contained material.	Dredging (source removal) would be a very effective technology to achieve the RAO. Containment and monitoring would be an effective method for managing the elevated pH sediment.	10	Source removal and on-site containment would provide long-term reliability with respect to the RAO. Effectiveness could easily be documented by sampling dredging limits, and management/monitoring. This alternative ranks slightly less than Alternative 1A, since the source of the elevated pH would remain on site.	8	Primary implementation challenge relates to the dispersed nature of the likely source material for the elevated pH. Source removal would be very difficult givent the potentially heterogenously distributed source. Although transport equipment (barge) is available, multiple handling events (loading and off-loading barge, then loading and unloading truck) also add implementation challenge.	2	Dredging would pose a risk (manageable) to on-site workers and potential recreational visitors.	8	$720,000	6			34	Tied for 2nd

TABLE 17
Comparative Analysis of Remedial Alternatives
Ross Island Sand & Gravel

Area of Concern	Contaminant or Issue of Concern	Receptor at Risk	Approximate Depth of Contamination (feet)	Approximate Volume of Impacted Media (cubic yards)	Identified Remedial Alternative	Description	Relevant Screening Criteria										Total Score	
							Effectiveness		Long-Term Reliability		Implementability		Implementation Risk		Reasonableness of Cost		Extent of Treatment of Hot Spots		Score	Rank
							Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score	Comments	Score		
Area E (continued)	Elevated pH	Ecological	0 to 0.3	3,500	Alternative 2 - Construct Sediment Cap/Monitoring	Clean soil meeting RIS&G's criterion of "Class A" fill material would be placed in portions of the lagoon over the locations of elevated pH levels, to prevent exposure to benthic invertebrates inhabiting the surface sediment and fish inhabiting the lagoon. If necessary, the capping material could be amended to neutralize the elevated pH levels. This alternative would conform with the approved reclamation plan and be combined with institutional controls to restrict future dredging and a long-term management/ monitoring program. For the purpose of this FS, the assumed minimum cap thickness is 3 feet. This alternative conforms to the approved reclamation plan.	The sediment cap may be a very effective technology to achieve the RAO, as long as the cap is maintained. The effectiveness of capping surface sediment in the lagoon is currently being evaluated. Restricting future dredging within the lagoon via an institutional control would further benefit effectiveness.	10	The cap would provide long-term reliability with respect to the RAO, as long as the cap is not disturbed due to dredging. This alternative would require institutional controls to increase long-term reliability. Effectiveness could easily be documented through a management and monitoring program. Periodic sampling may be required to demonstrate cap effectiveness over time.	6	The sediment cap could easily be implemented in conjunction with the proposed fill plan (according to the approved reclamation plan). Isolated areas not planned to receive fill according to the reclamation plan would be capped, as well.	10	Capping would pose a minor risk (manageable) to on-site workers and potential recreational visitors.	10	$206,000	10	No	NA	46	1st
Impacted Media: Lagoon Subsurface Sediment																				
Area F	TBT, Metals, PAHs, VOCs, and PCBs	Human and Ecological	Up to 45	162000	Alternative 1 - Dredging and Off-Site Disposal	Subsurface sediment in Area E would be dredged and transported off site to a licensed and approved disposal facility. Would require removal of existing cap material and imported backfill material, in addition to the proposed fill material for reclamation.	Dredging (source removal) is considered a very effective technology to prevent exposure of organic contaminants to human and ecological receptors. Landfill disposal is considered an effective method for managing impacted sediment.	10	Source removal and off-site disposal would provide long term reliability with respect to the RAO. However, this technologies effectiveness may be difficult to document, due to the depth at which the removal action would need to be conducted and the potential for spreading of contamination during the removal activities. Sampling would need to occur to evaulate potential contaminant spreading.	10	This alternative could be implemented, as dredging and transport equipment is accessible; however, the depth of the CAD cells and the volume of clean fill material currently covering them adds a significant implementation challenge and makes this option less feasible.	2	Dredging would pose a risk (manageable) to on-site workers and potential recreational visitors; however, there is a significant implementation risk associated with dredging CAD cells. Dredging may exacerbate contamination.	8	32,800,000	2	The hot spots would be reduced to non-hot spot levels by removing the source of the contaminants.	10	42	2nd
					Alternative 2 - Manage Existing Cap and Stabilize Slopes	A maintenance/management plan would be prepared to provide information regarding proper procedures and protocol within the lagoon, to ensure the existing CAD cells are not compromised. This alternative would be combined with institutional controls restricting future activities that may disturb the capped CAD cells. Additionally, on-going reclamation fill will be placed in a manner that ensures slope stability adjacent to the CAD cells.	This alternative has successfully been implemented and is effectively achieving the RAO. Fate and transport modeling conducted by the Port of Portland concluded that potential migration of contaminants from the CAD cells would not result in unacceptable levels of hazardous substances at the likely exposure points for human or ecological receptors. Future institutional controls would benefit this alternative's effectiveness.	10	The maintenance/management plan would ensure long-term reliability with respect to the RAO. Effectiveness could easily be documented through a monitoring program. This technology scores slightly less than Alternative 1, since the source remains on site.	8	The maintenance/ management plan could be prepared and easily implemented at any time.	10	There is no anticipated implementation risk to this alternative.	10	204,900	10	Currently, the CAD cells are reliably contained, and modeling and site data has demonstrated contaminants will not migrate to other media and present unacceptable risk. Maintaining the existing cap will ensure future receptors are not exposed to the hot spot.	10	58	1st

Note:
1. Approximately 60,000 cubic yards of clean material currently caps approximately 6,300 cubic yards of impacted material.

Present Value Analysis
Ross Island Sand & Gravel Remedial Alternatives Area F, Alternative 1

Cost Type	Year	Total Cost	Total Cost per Year	Discount Factor (@7.5%)	Present Value
Capital Costs	0	$32,807,556.25	$32,807,556.25	1.00	$32,807,556.25
Annual O&M Costs	1 - 30	$0.00	$0.00	11.81	$0.00
Periodic Costs	5	$0.00	$0.00	0.697	$0.00
Periodic Costs	10	$0.00	$0.00	0.485	$0.00
Periodic Costs	15	$0.00	$0.00	0.338	$0.00
Periodic Costs	20	$0.00	$0.00	0.235	$0.00
Periodic Costs	25	$0.00	$0.00	0.164	$0.00
Periodic Costs	30	$0.00	$0.00	0.114	$0.00
			Total Present Value of Alternative		**$32,807,556.25**

Capital Cost Analysis
Ross Island Sand & Gravel Remedial Alternatives - Area F, Alternative 1

Area E	Description	Specifications	Rate	Unit	Qty	Capital Costs: Costs	Capital Costs: Subtotal
Alternative 1 - Dredging and Off-Site Disposal. Includes dredging of approximately 162,000 CY^3 of sediment contained in CAD Cells No. 1 through 5 and transporting the material to an off-site licensed and approved disposal facility. Impacted sediment is as much as 45 feet deep.	**Mobilization/Demobilization**						
	Work plan preparation		$15,000.00	LS	1	$15,000.00	
	Permitting/coordination		$8,500.00	LS	1	$8,500.00	
	Agency communication/correspondence		$10,000.00	LS	1	$10,000.00	
	Post-field work reporting		$20,000.00	LS	1	$20,000.00	
	SUBTOTAL						$53,500.00
	Site Work						
	Dredge clean overburden	Dredge and transport by barge/off-load	$15.00	CY^3	250,000	$3,750,000.00	
	Dredge impacted sediment	Dredge and load barge	$12.00	CY^3	162,000	$1,944,000.00	
	Handle/transport and dispose sediment	Transport (by barge) and dispose at Rooseve	$100.00	CY^3	162,000	$16,200,000.00	
	Subtotal						$21,894,000.00
	Sampling and Analysis						
	Field labor	1 staff at 10 hrs/day	$1,050.00	Day	90	$94,500.00	
	Field equipment	miscellaneous equip., mileage, etc.	$100.00	Day	90	$9,000.00	
	Laboratory analytical	PAHs and pH for 20 samples	$4,500.00	LS	1	$4,500.00	
	SUBTOTAL						$108,000.00
							$22,055,500.00
	Contingency		25.0%				$5,513,875.00
	SUBTOTAL						**$27,569,375.00**
	Project Management		5.0%			$1,378,468.75	$1,378,468.75
	Remedial Design		8.0%			$2,205,550.00	$2,205,550.00
	Construction Management		6.0%			$1,654,162.50	$1,654,162.50
	Institutional Controls						
	SUBTOTAL						$5,238,181.25
	TOTAL CAPITAL COSTS						**$32,807,556.25**

Notes:
1. Average staff rates set at $105 per hour

Operations & Maintenance Cost Analysis
Ross Island Sand & Gravel Remedial Alternatives - Area F, Alternative 1

Operations and Maintenance

Description	Specifications	Rate	Unit	Qty	Costs

No operations and maintenance costs associated with this alternative.

Periodic Cost Analysis
Ross Island Sand & Gravel Remedial Alternatives - Area F, Alternative 1

Periodic Costs

Description	Year	Rate	Unit	Qty	Costs

No periodic costs associated with this alternative.