Gasco OU FS Site Wide and GSA Alternative Feedback

January 29, 2026

Expectation Setting

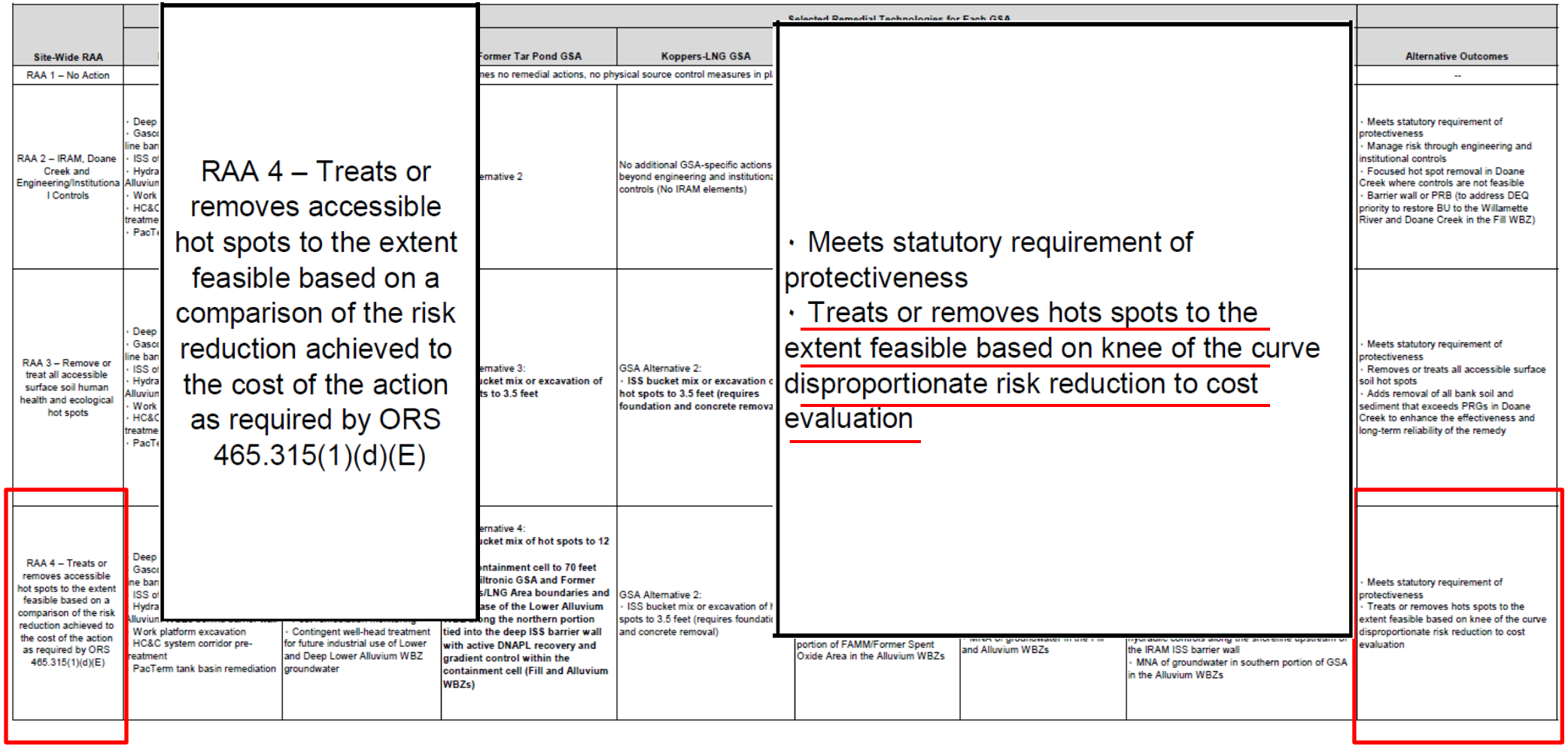
- DEQ is providing high-level and general feedback on the pre-meeting materials provided on January 20th.
- Our feedback is not comprehensive. We have had limited time to review the information and prepare these slides.
- Our feedback will be provided primarily via a series of examples intended to illustrate concepts. Where one GSA is used as an example, the feedback also applies to other GSAs.
- We have ~ 40 slides. DEQ will try to get as far as possible. If time allows, clarifying questions may be asked at the end.

Fundamental Shortcomings

DEQ has removed Site Wide Alts 2 and 3

- Consistent with OAR, DEQ may eliminate development or evaluation of remedial action alternatives in the FS.
- DEQ's comments on the draft FS required NW Natural to remove alternatives 2 and 3.
- Site wide alternatives 2 and 3 are not substantively different than alternatives 2 and 3 presented in the draft FS.
- Feedback: Remove site wide alternatives 2 and 3.

Statutory hot spot requirements



Site-Wide RAA				Former Tar Pond GSA	Koppers-LNG GSA	Selected Remedial Technologies for Each GSA			Alternative Outcomes
RAA 1 – No Action				nes no remedial actions, no physical source control measures in pl					--
RAA 2 – IRAM, Doane Creek and Engineering/Institutional Controls	· Deep · Gasc line ban · ISS o · Hydra Alluviun · Work · HC&C treatme · PacT			ernative 2	No additional GSA-specific actions beyond engineering and institutiona controls (No IRAM elements)				· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane Creek where controls are not feasible · Barrier wall or PRB (to address DEQ priority to restore BU to the Willamette River and Doane Creek in the Fill WBZ)
RAA 3 – Remove or treat all accessible surface soil human health and ecological hot spots	· Deep · Gasc line ban · ISS o · Hydra Alluviun · Work · HC&C treatme · PacT			ernative 3: ucket mix or excavation of ts to 3.5 feet	GSA Alternative 2: · **ISS bucket mix or excavation c hot spots to 3.5 feet (requires foundation and concrete remova**				· Meets statutory requirement of protectiveness · Removes or treats all accessible surface soil hot spots · Adds removal of all bank soil and sediment that exceeds PRGs in Doane Creek to enhance the effectiveness and long-term reliability of the remedy
RAA 4 – Treats or removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	Deep Gasc ne ban ISS o Hydra Alluviun Work platform excavation HC&C system corridor pre-treatment PacTerm tank basin remediation	· Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	**ntainment cell to 70 feet iltronic GSA and Former s/LNG Area boundaries and ase of the Lower Alluvium ong the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	ernative 4: ucket mix of hot spots to 12 GSA Alternative 2: · ISS bucket mix or excavation of spots to 3.5 feet (requires foundati and concrete removal)	portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs	and Alluvium WBZs	the IRAM ISS barrier wall · MNA of groundwater in southern portion of GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Treats or removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

RAA 4 – Treats or removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)

· Meets statutory requirement of protectiveness
· Treats or removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

Knee of a curve - defined

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Knee of a curve

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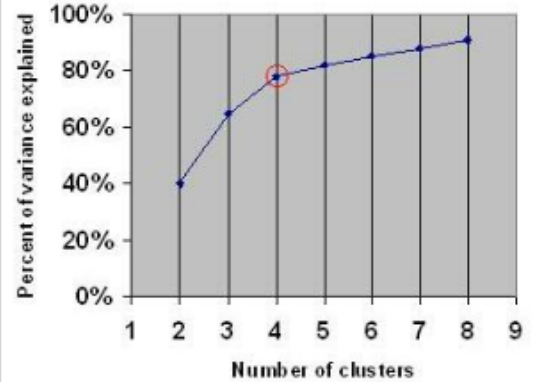
In mathematics, a **knee of a curve** (or **elbow of a curve**) is a point where the curve visibly bends, specifically from high slope to low slope (flat or close to flat), or in the other direction. This is particularly used in optimization, where a knee point is the optimum point for some decision, for example when there is an increasing function and a trade-off between the benefit (vertical *y* axis) and the cost (horizontal *x* axis): the knee is where the benefit is no longer increasing rapidly, and is no longer worth the cost of further increases – a cutoff point of diminishing returns.

In heuristic use, the term may be used informally, and a knee point identified visually, but in more formal use an explicit objective function is used, and depends on the particular optimization problem. A knee may also be defined purely geometrically, in terms of the curvature or the second derivative.



Explained variance. The "elbow" is indicated by the red circle. The number of clusters chosen should therefore be 4.

Tar Ponds GSA Treatment vs Cost Graph

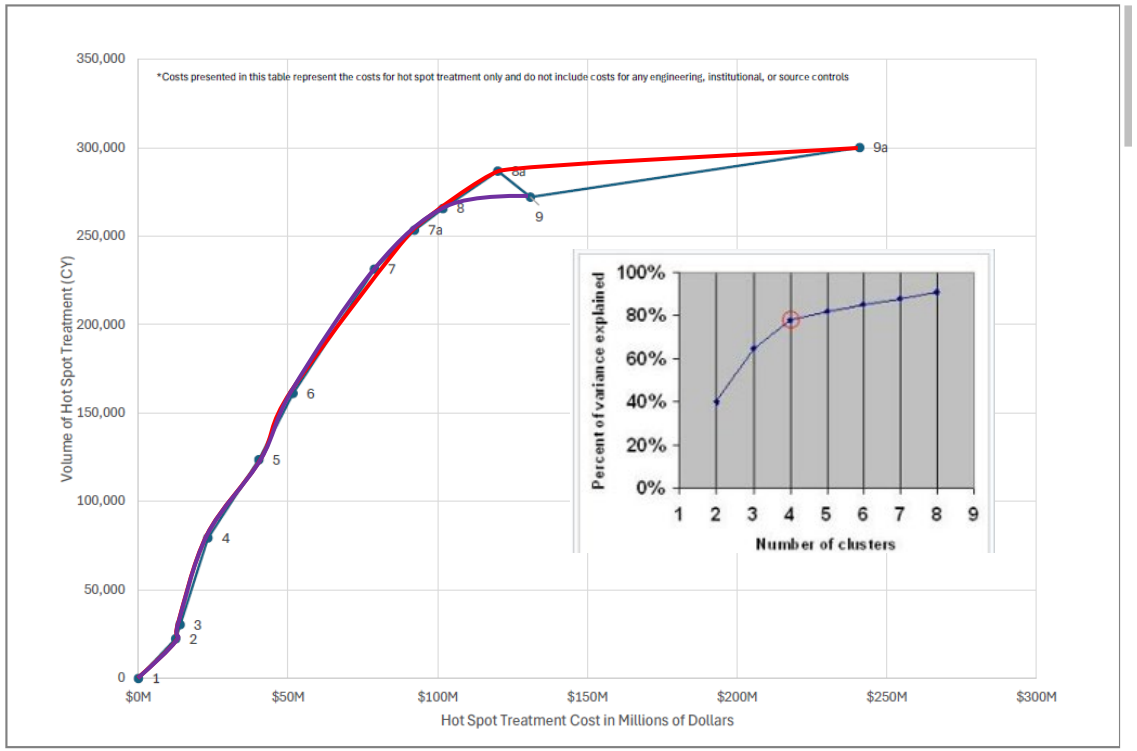


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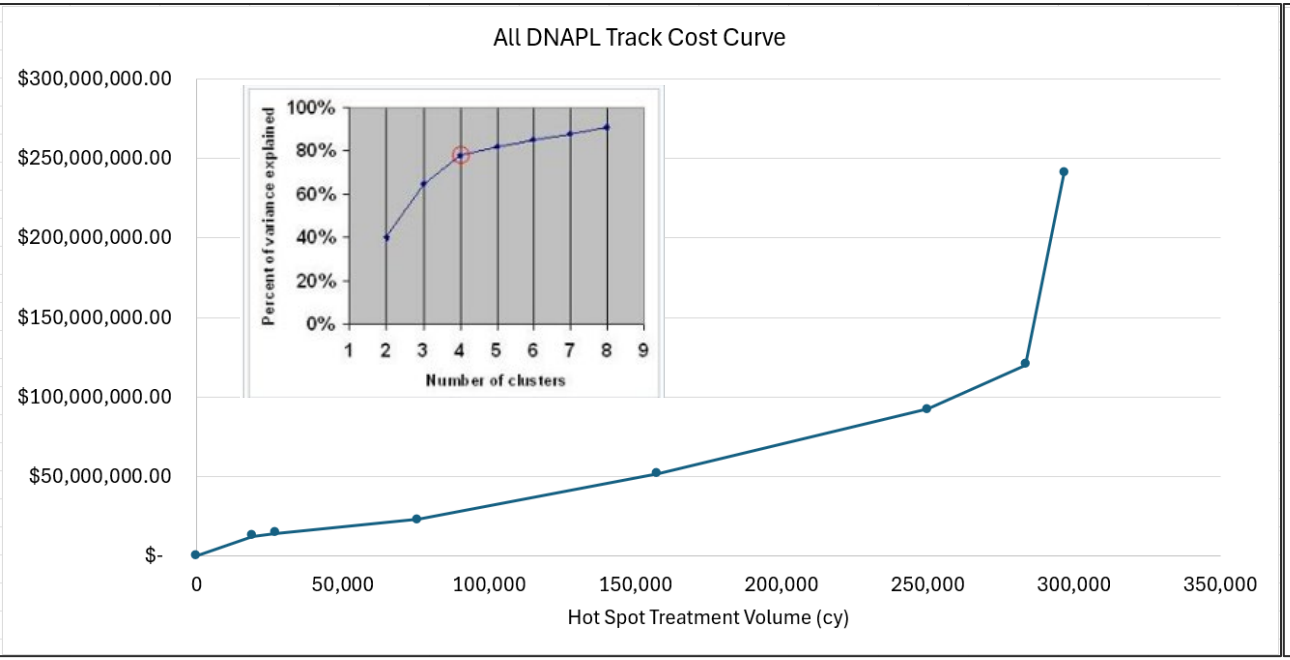
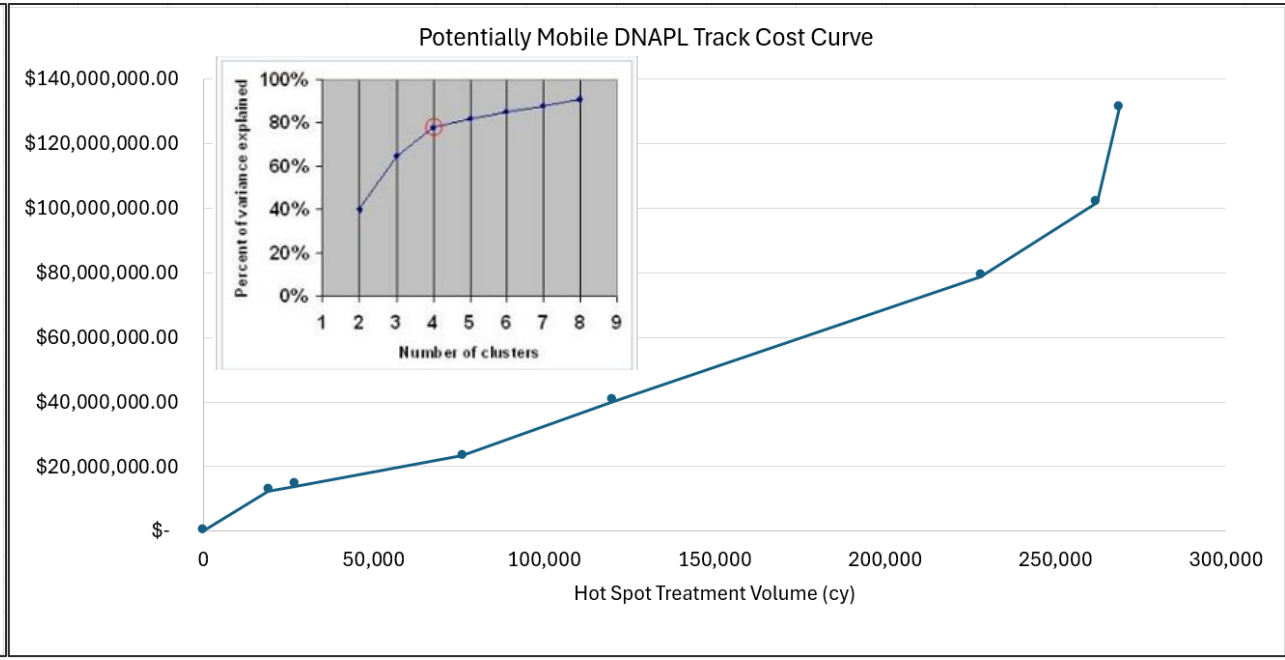
Figure C-2
Volume of Hot Spot Treatment vs. Cost – Former Tar Pond Area
Feasibility Study Report
Gasco OU

- Graph implies that alternatives are progressive. They are not.
- DEQ previously commented that:
  - The Tar Ponds alternatives follow different tracks – one that focuses on all DNAPL treatment, the other that focuses on potentially mobile/transitional DNAPL treatment.
  - NW Natural should display the hot spot treatment volume vs cost graphs on the two separate tracks. Our comments were not addressed.

Tar Ponds Curves – Separated by Track





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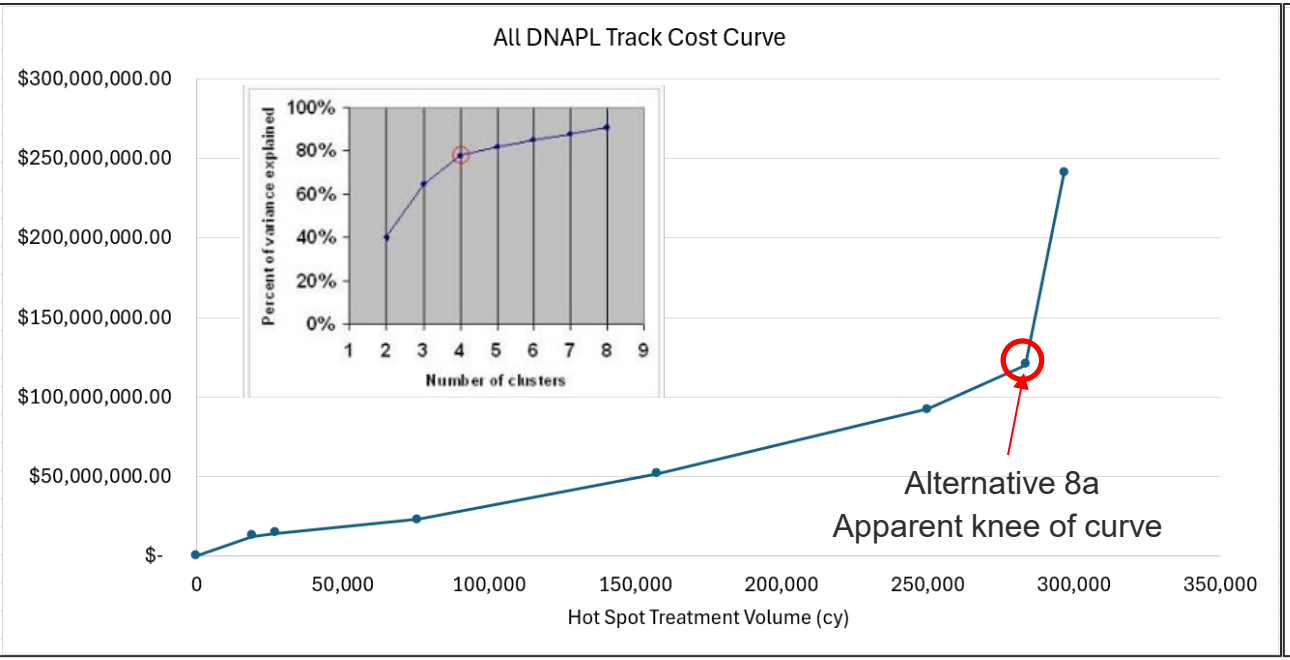
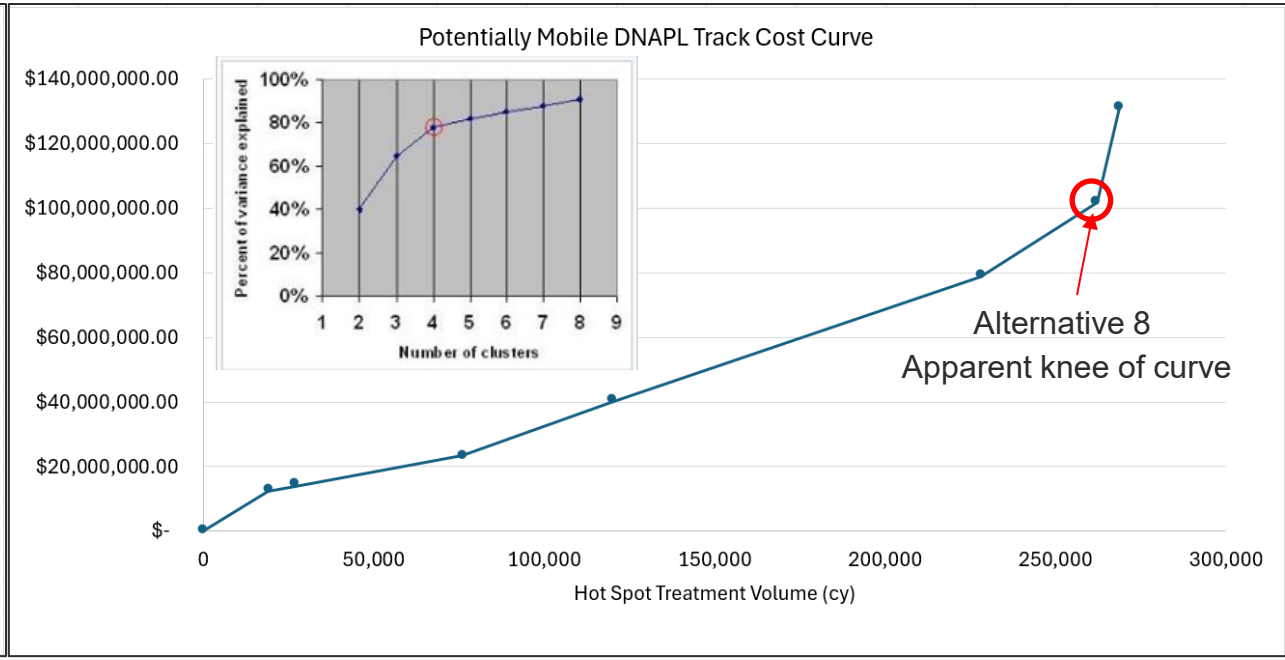




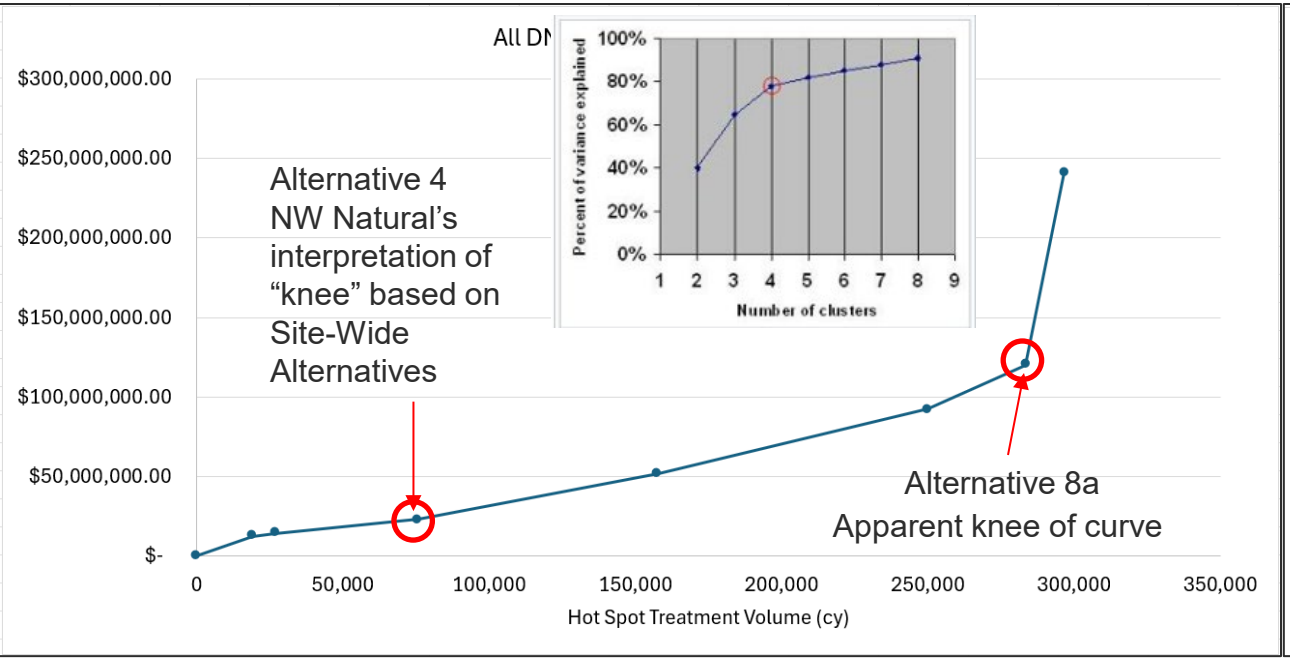
NW Natural's knee of curve

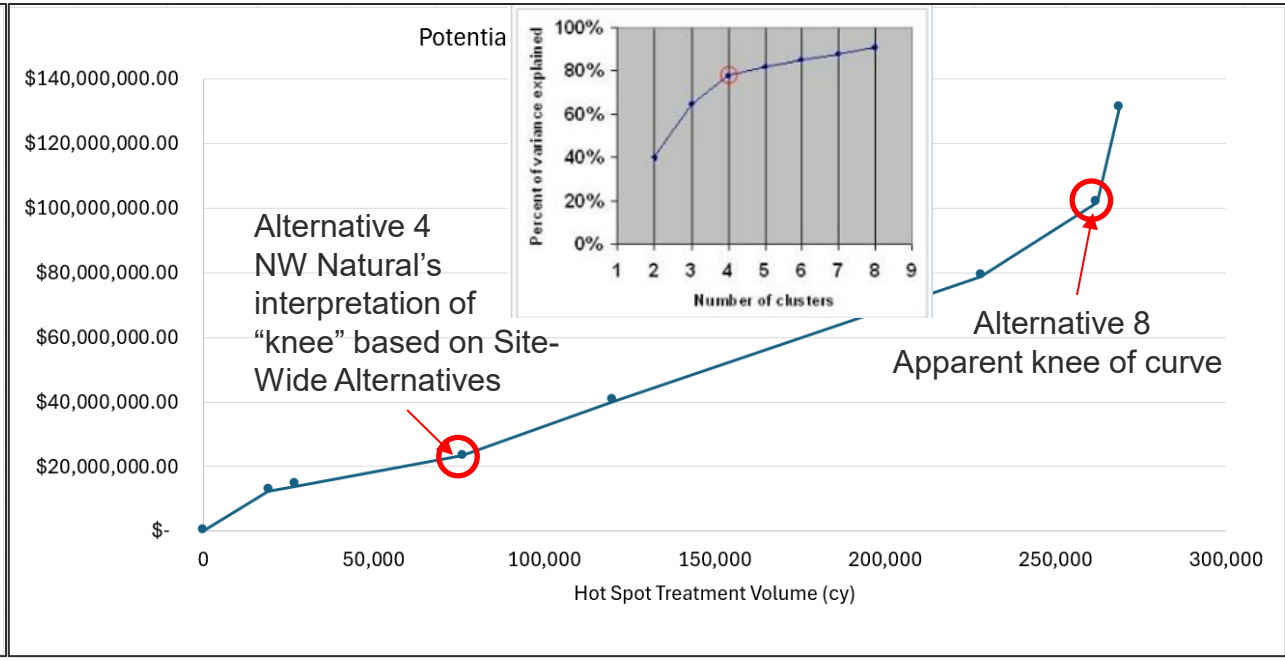
Site-Wide RAA	Selected Site-Wide Remedial Technologies				Alternative Outcomes
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LN	
RAA 1 – No Action	Assumes no remedial actions, no physical source control m				--
RAA 2 – IRAM, Doane Creek and Engineering/Institutional Controls	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 2	No additional GSA-sp beyond engineering a controls (No IRAM ele	· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane Creek where controls are not feasible · Barrier wall or PRB (to address DEQ priority to restore BU to the Willamette River and Doane Creek in the Fill WBZ)
RAA 3 – Remove or treat all accessible surface soil human health and ecological hot spots	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet**	GSA Alternative 2: · **ISS bucket mix or hot spots to 3.5 feet foundation and conc**	· Meets statutory requirement of protectiveness · Removes or treats all accessible surface soil hot spots · Adds removal of all bank soil and sediment that exceeds PRGs in Doane Creek to enhance the effectiveness and long-term reliability of the remedy
RAA 4 – Treats or removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 4: · **ISS bucket mix of hot spots to 12 feet** · **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	GSA Alternative 2: · ISS bucket mix or e spots to 3.5 feet (requ and concrete removal	· Meets statutory requirement of protectiveness · Treats or removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

GSA Alternative 4:

- **ISS bucket mix of hot spots to 12 feet**
- **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**

Tar Ponds Curves – Separated by Track





Another Example – Former FAMM/SO GSA

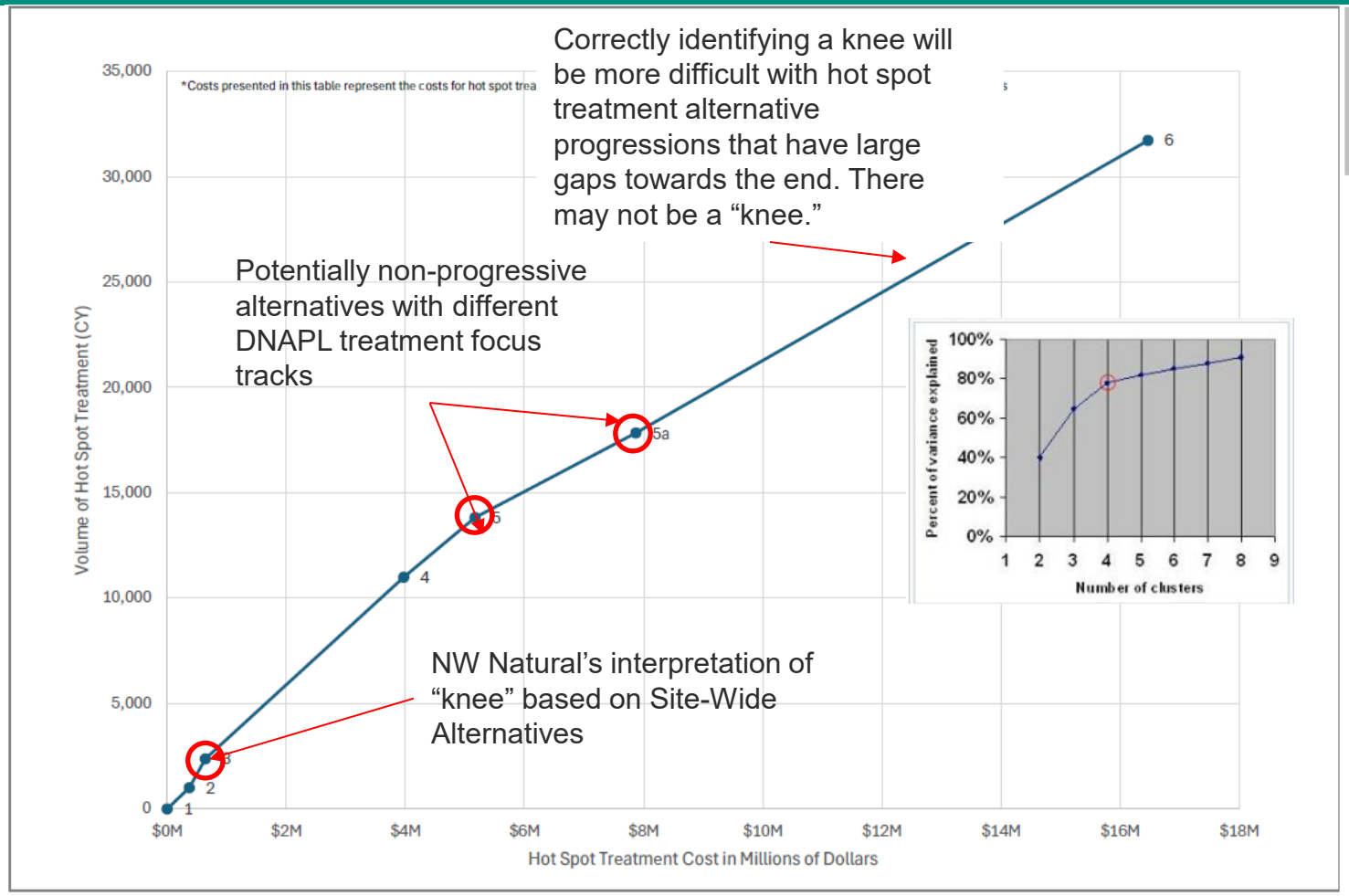


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Figure B-2
Volume of Hot Spot Treatment vs. Cost – FAMM/Former Spent Oxide Area
Feasibility Study Report
Gasco OU

DEQ

Knee of Curve Feedback

The knee of the curve that provides a line of evidence for assessing ‘disproportionate’ costs for risk reduction was incorrectly identified for all GSAs.

Based on the information provided in the pre-meeting materials, site wide alternative 4 does not meet statutory or regulatory requirements for hot spot treatment.

A knee of the curve may not be apparent in all GSAs. There may not be any clear inflection point, suggesting that full hot spot treatment is not disproportionate to risk reduction.

A knee of the curve may not necessarily translate to infeasibility.

Assessment of Risk Reduction

- Recap from September 2nd meeting:

Relationship between Risk Reduction (Residual Risk) and Balancing Factors

Residual Risk Assessments
OAR 340-122-0084(4):

- Assessment of risk posed by untreated hazardous substances or treatment residuals using the same exposure assumptions used in the baseline risk assessment (in the absence of any engineering or institutional controls)
- Assessment of adequacy and reliability of any institutional or engineering controls used to manage untreated hazardous substances or treatment residuals

Effectiveness
OAR 340-122-0090(3)(a):

(A) Magnitude of risk from untreated waste or treatment residuals remaining at the facility absent any risk reduction achieved through onsite management of exposure pathways, as determined in OAR 340-122-0084 (Risk Assessment)(4)(a). The characteristics of the residuals shall be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bioaccumulate, and propensity to degrade;

(B) Adequacy of any engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances remaining at the facility, as determined in OAR 340-122-0084 (Risk Assessment)(4)(b);

The “number of risk pathways” information

Risk Pathway[1]	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 7a	Alternative 8	Alternative 8a	Alternative 9	Alternative 9a
HH – Surface Soil	0%	8%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Eco – Surface Soil	0%						99%	99%	99%	99%	99%	99%
HH – Subsurface Soil	0%						99%	99%	99%	99%	99%	99%
HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization[2]	0%						88%	94%	91%	94%	91%	95%
HH – Fill WBZ Groundwater (excavation worker)[2]	0%						88%	94%	91%	94%	91%	95%
Eco – Fill WBZ Groundwater[2]	0%						88%	94%	91%	94%	91%	95%
Eco – Alluvium WBZ Groundwater[3]	0%						57%	65%	76%	86%	80%	94%
HH – Alluvium WBZ Groundwater (industrial use)[3]	0%						57%	65%	76%	86%	80%	94%
Number of Pathways Either Partially or Completely Addressed Through Hot Spot Treatment or Removal:	**0.0**						**8.0**	**8.0**	**8.0**	**8.0**	**8.0**	**8.0**
Fraction of All Pathways Addressed Through Hot Spot Treatment:	**0.0**						**6.7/8**	**7.1/8**	**7.2/8**	**7.5/8**	**7.3/8**	**7.7/8**

The magnitude of risk associated with each pathway is not equal. Risk reduction for each pathway can not be compared with another pathway of different magnitude.

For example: Addressing 50% of the HH Surface Soil pathway is not equivalent to the magnitude of risk reduction associated with addressing 50% of the Eco – Alluvium WBZ Groundwater pathway.

Therefore, the magnitude of residual risk, or risk reduction is not proportional to the “number of pathways addressed” by each alternative.

DEQ's FS Comments regarding risk reduction

b) The draft Gasco OU FS does not establish the feasible limit for hot spot removal and/or treatment. To establish the feasible limit for hot spot removal and/or treatment, Gasco OU FS must apply DEQ's feasibility balancing factors to gradations of RAAs that provide increasing levels of hot spot removal and/or treatment. Since cost may control the feasible limit of hot spot removal and/or treatment in many circumstances, the Gasco OU FS must assess hot spot cost feasibility by 1) quantifying the hot spot removal/treatment (and quantifying untreated hot spots left in-place) for each RAA, and 2) estimating the cost associated with the removal and/or treatment of the hot spots described in each RAA. Revise the draft Gasco OU FS to include charts comparing hot spot removal/treatment quantities versus the associated cost to establish where costs become significantly disproportionate to the hot spot removal and/or treatment quantity.

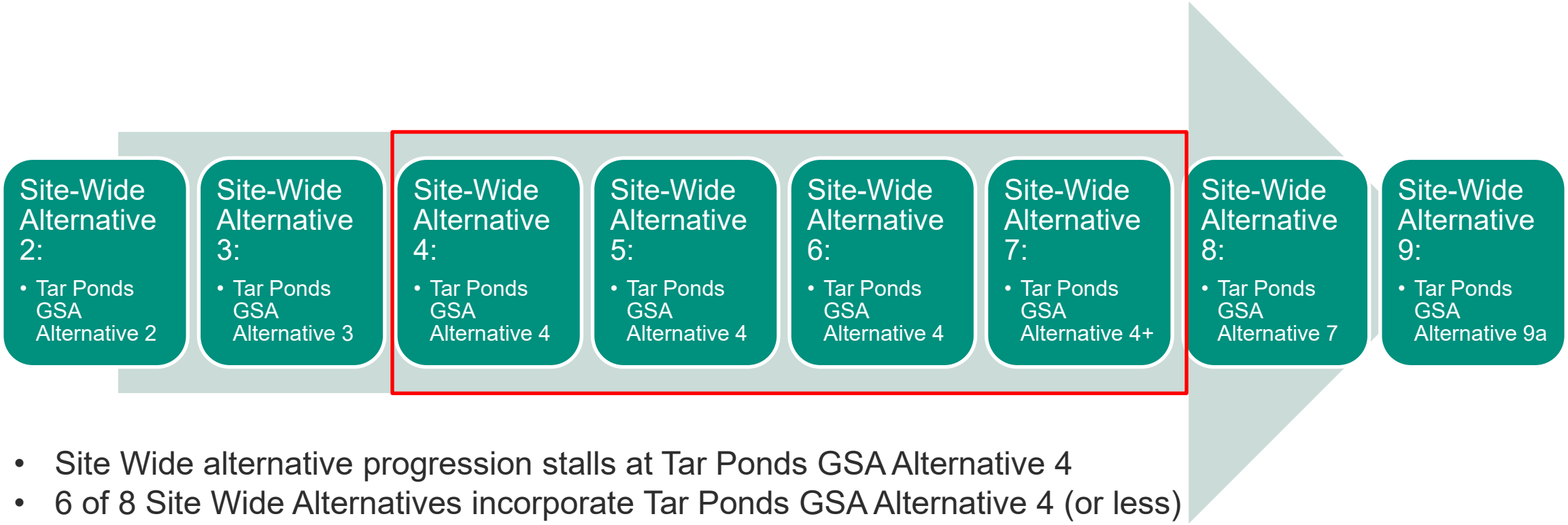
Risk Reduction Feedback

The number of risk pathways treated is not a measure of risk reduction relevant to hot spot feasibility assessment. DEQ does not approve using this metric to support an assessment of the “feasible extent” of hot spot treatment in the FS.

DEQ is not opposed to NW Natural including such analysis in the FS as long as it is correctly and appropriately discussed.

Assessment of the feasible extent of hot spot treatment must align with our FS comments.

Progression of Site Wide Alternatives



- Site Wide alternative progression stalls at Tar Ponds GSA Alternative 4
- 6 of 8 Site Wide Alternatives incorporate Tar Ponds GSA Alternative 4 (or less)
- 7 of 8 Site Wide Alternatives incorporate Tar Ponds GSA Alternatives BELOW the apparent knee of the curve – Alternative 8 or 8a, depending on track –
- None of the Site Wide Alternatives incorporate Tar Ponds GSA apparent knee of curve

Progression of Site Wide Alternatives

Site-Wide RAA	Selected Site-Wide Remedial Technologies		Selected Remedial Technologies for Each GSA					
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LNG GSA	FAMM-Former Spent Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	Alternative Outcomes
RAA 1 – No Action	Assumes no remedial actions, no physical source control measures in place (i.e., no barrier wall), and no HC&C system operation.							--
RAA 2 – IRAM, Doane Creek and Engineering/Institutional Controls	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTe	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2: · **Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed** · **PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek** · **Continued EIB** · **PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall** · **MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs**	· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane Creek where controls are not feasible · Barrier wall or PRB (to address DEQ priority to restore BU to the Willamette River and Doane Creek in the Fill WBZ)
RAA 3 – Remove or treat all accessible surface soil human health and ecological hot spots	· Deep · Gasco line barr · ISS of · Hydra Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	hot spots to 3.5 feet	or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins)** · **MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs**	GSA Alternative 2: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins)** · **MNA of groundwater in the Fill and Alluvium WBZs**	GSA Alternative 3: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · **Removal of surface soil exceeding PRGs in Doane Creek to the extent necessary for SW to meet PRGs** · Continued EIB · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade** · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM area · MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Removes or treats all accessible surface hot spots · Removal of all bank soil and sediments that exceeds PRGs in Doane Creek to enhance effectiveness and long-term reliability of the remedy
RAA 4 – Treats or removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 4: · **ISS bucket mix of hot spots to 12 feet** · **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)	GSA Alternative 3: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in the Fill and Alluvium WBZs	GSA Alternative 2: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · Continued EIB · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall · MNA of groundwater in southern portion of GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

The site wide alternatives include a regression of Siltronic GSA-specific alternatives without an apparent commensurate trade off or justification. Was this intentional? Regressions must be justified.

Site Wide Alternatives are Biased Low

Except for RAA 1 (no action), none of the site wide alternatives should entirely exclude hot spot treatment in any GSA

The concept of limiting hot spot removal/treatment to 3.5 feet bgs (or less) persists through RAA 4 in 4 out of 5 GSAs.

This concept should have been screened out of further consideration on the GSA-scale hot spot analysis.

Site-Wide R…	…ponents	Selected Remedial Technologies for Each GSA					Alternative Outcomes
		Former Tar Pond GSA	Koppers-LNG GSA	FAMM-Former Spent Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	
RAA 1 – No A…	Assumes no remedial actions, no physical source control measures in place (i.e., no barrier wall), and no HC&C system operation.						--
RAA 2 – IRAM, …Creek an… Engineering/Ins… l Controls	…ols …ols …ered cap …Lower …monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2: · **Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed** · **PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek** · **Continued EIB** · **PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall** · **MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs**	· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane Creek where controls are not feasible · Barrier wall or PRB (to address DEQ priority to restore BU to the Willamette River and Doane Creek in the Fill WBZ)
	…r wall …erty …ll and …er wall …diation · Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet**	GSA Alternative 2: · **ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)**	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins)** · **MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs**	GSA Alternative 2: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins)** · **MNA of groundwater in the Fill and Alluvium WBZs**	GSA Alternative 3: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · **Removal of surface soil exceeding PRGs in Doane Creek to the extent necessary for SW…** · Continued EIB · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade** · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM area · MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Removes or treats all accessible surface …spots · …l of all bank soil and sedim… …eeds PRGs in Doane Creek to e… …e effectiveness and long-term reliab… …the remedy
comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	…ill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation · Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 4: · **ISS bucket mix of hot spots to 12 feet** · **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)	GSA Alternative 3: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in the Fill and Alluvium WBZs	GSA Alternative 2: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · Continued EIB · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall · MNA of groundwater in southern portion of GSA in the Alluvium WBZs	…requirement of …removes hots spots to the …ent feasible based on knee of the curve …disproportionate risk reduction to cost evaluation

Alignment with Hot Spot Treatment Goals

- DEQ previously commented (in comments and previous meetings) that maximizing groundwater beneficial use restoration and reduction in engineering control reliance should be strategic goals for site wide alternatives.
- Only 2 of the 9 site wide remedial alternatives propose groundwater beneficial use restoration via hot spot treatment.
- Only 2 of the 9 site wide alternatives reduce reliance on engineering controls (i.e., a critical metric for assessing risk reduction)

Progression of Site Wide Alternatives

- Progression of site wide alternatives are biased too low.
- Alternatives that represent the “knee” of the hot spot treatment curve are only introduced late in the progression.
- Alternatives that represent the “knee” of the hot spot treatment curve are not sufficiently or appropriately bracketed by other alternatives.
- The progression of Site Wide Alternatives is unsuitable for informing remedy selection.

Other Comments, Critiques, Questions, and Suggestions

DNAPL Treatment Track Feedback

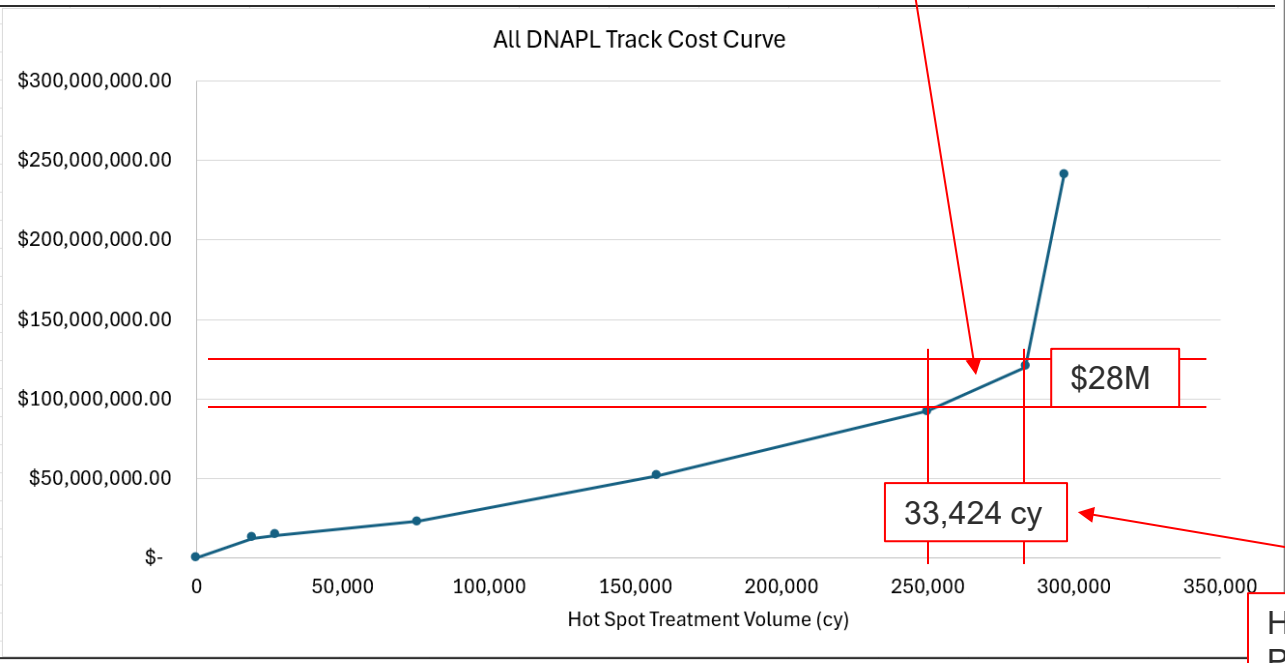
- Multiple GSAs incorporate separate tracks for DNAPL hot spot treatment:
  - One that focuses on all DNAPL
  - Another that focuses on potentially mobile/transitional DNAPL.
- The FS must present rationale for determining why and how these two tracks are represented in site-wide alternatives.
  - Strong rationale will be centered around restoration of groundwater beneficial uses
  - Weak rationale will be centered around engineering controls, like containment cells and hydraulic controls.

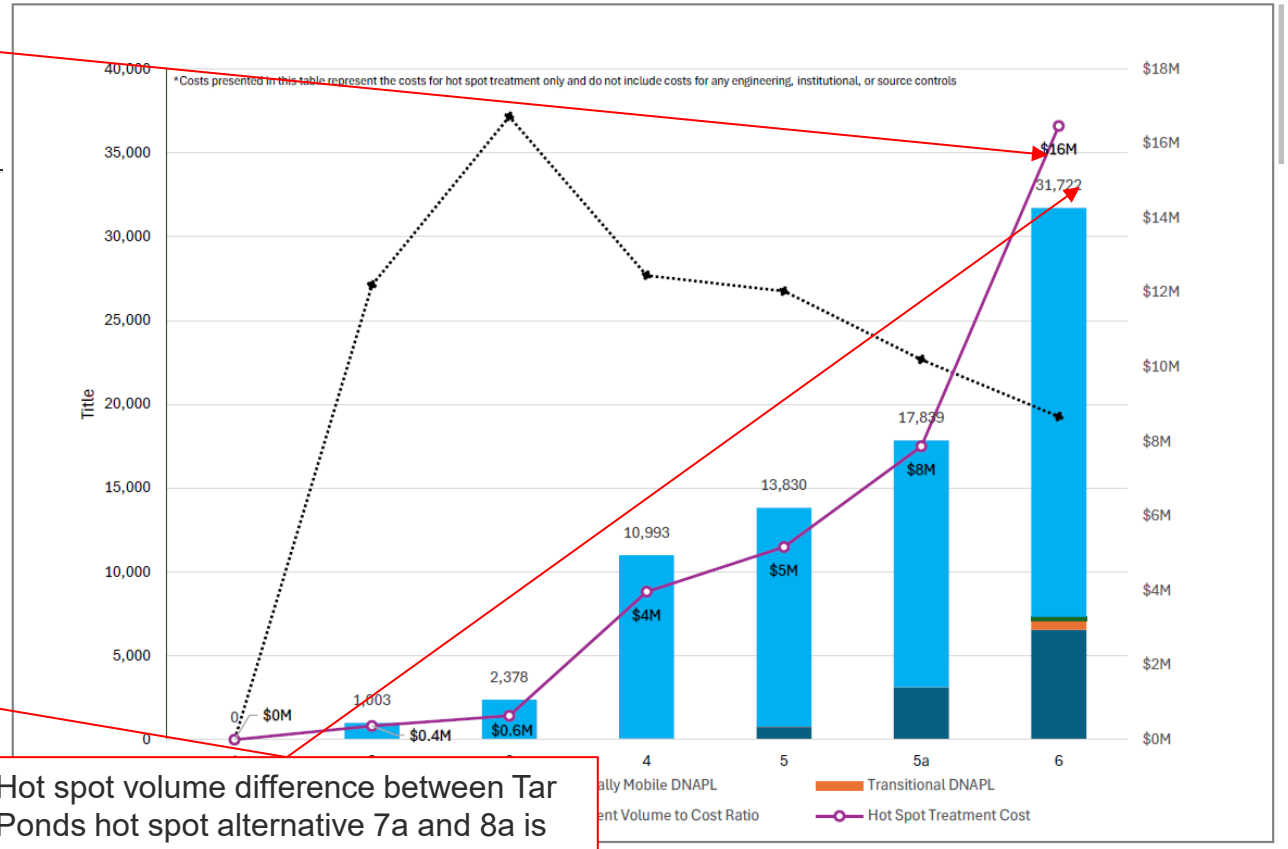
Layer Cake Approach Feedback

- The Tar Ponds GSA (and other GSAs) present a “layer cake” approach to developing GSA-specific hot spot alternatives, where alternatives progressively extend treatment from the ground surface to the deepest depths.
- During the November 20th meeting, DEQ commented that the “layer cake” approach for the Tar Ponds GSA alternatives was limiting and that site wide alternatives would need to consider other configurations for DNAPL treatment within GSAs (not just by depth) to better address risk reduction and groundwater restoration goals.
- Only 1 site wide alternative appears to consider our November 20th comment.
- We recommend NW Natural consider the trade offs between the “layer cake” approach versus targeting deeper DNAPL in earlier alternatives in a more strategic manner. For example: The Siltronic GSA.
- Layer cake approach is less useful for GSAs where fill is less than 12 feet thick (e.g., LNG/Koppers GSA, Former Office GSA) and the various risk pathway depth intervals overlap. For example, where 12 feet bgs intersects the fill and portions of the alluvium below the fill.

Hot Spot Budgets Across GSAs (concept)

Cost difference between Tar Ponds hot spot alternative 7a and 8a is higher than the cost to treat all hot spots in the FAMM/Spent Oxide Area





Hot spot volume difference between Tar Ponds hot spot alternative 7a and 8a is higher (but close to) than all treatable hot spots in the FAMM/Spent Oxide Area

Figure B-3
Treatment Volume and Cost Summary – FAMM/Former Spent Oxide Area
Feasibility Study Report
Gasco OU

GSA-Scale Alternative Progression

Table D-2
Hot Spot Volume and Risk Pathway Su
(assumes risk reduction through hot s

Preliminary

The only difference between LNG/Koppers GSA-scale alternatives 3 and 4 is an engineering control (downgradient barrier wall). Alternative 4 does not include progressively more hot spot treatment. This approach skews the "knee of the curve" interpretations.

Why would adding a downgradient barrier wall address more risk pathways?

GSA Alternative	Treatment/Removal Technologies	Risk Path				Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
						All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
1	None	None				0	0	0	0	0	0	0	0	0	0%	0%	$0M
2	• ISS bucket mix or excavation of hot spots to 3.5 feet	• HH – Sur • HH – Fill • Eco – Fill • Eco – Sur • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (5%)				5,662	5,607	55	0	0	5,662	55	653	0	4%	3%	$1M
3	• ISS bucket mix of hot spots to 12 feet • Dual phase extraction in elevated benzene area and DNAPL recovery where accessible	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (excavation worker) (25%) • Eco – Fill WBZ Groundwater (25%) • Eco – Surface Soil (77%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (25%)	3.0/8			70,431	22,359	40,257	5,196	2,619	58,540	48,072	762,599	0	55%	35%	$18M
4	• ISS bucket mix of hot spots to 12 feet • Dual phase extraction in elevated benzene area and DNAPL recovery where accessible as well as hydraulic/DNAPL recovery • Downgradient barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (excavation worker) (59%) • Eco – Fill WBZ Groundwater (59%) • Eco – Surface Soil (77%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (59%)	4.0/8	200,673	127,581	170,5[illegible]2	70,431	22,359	40,257	5,196	2,619	58,540	48,072	762,599	0	55%	35%	$18M
5	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (excavation worker) (49%) • Eco – Fill WBZ Groundwater (49%) • Eco – Surface Soil (77%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (49%)	3.7/8			58,540	20,944	32,122	3,756	1,718	58,540	37,596	578,252	0	46%	29%	$30M

GSA-Scale Alternative Progression

Table D-2
Hot Spot Volume and Risk Pathway Summary Table – Former Koppers/LNG Area
(assumes risk reduction through hot spot treatment or removal only)

Preliminary

A		ed by Treatment/Removal of Hot Spots Only	Fraction of Risk Pathways Addressed by Hot Spot Treatment	Soil Hot Spot* Volume in GSA (cy)			Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
				All[1]	Accessible	DNAPL[2]	All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
			0.0/8				0	0	0	0	0	0	0	0	0	0%	0%	$0M
		ater (excavation worker) (5%) ater (5%) urface Soil and Fill WBZ Groundwater	1.7/8				5,662	5,607	55	0	0	5,662	55	653	0	4%	3%	$1M
		70%) ater (excavation worker) (25%) ater (25%) urface Soil and Fill WBZ Groundwater	3.0/8				70,431	22,359	40,257	5,196	2,619					35%	35%	$18M
4	• ISS bucket mix of hot spots to 12 feet • Dual phase extraction in elevated benzene area and DNAPL recovery where accessible as well as hydraulic/DNAPL recovery • Downgradient barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (excavation worker) (59%) • Eco – Fill WBZ Groundwater (59%) • Eco – Surface Soil (77%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (59%)	4.0/8	200,673	127,581	170,582	70,431	22,359	40,257	5,196	2,619	58,540	48,072	762,599	0	55%	35%	$18M
5	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (excavation worker) (49%) • Eco – Fill WBZ Groundwater (49%) • Eco – Surface Soil (77%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (49%)	3.7/8				58,540	20,944	32,122	3,756	1,718	58,540	37,596	578,252	0	46%	29%	$30M

Engineering controls, like barrier wall should not be included in the cost of hot spot treatment.

Adding engineering controls to the costs biases the "knee of curve" interpretation when compared to alternatives that do not include engineering controls.

Alternatives should not regress with respect to hot spot treatment quantities.

GSA-Scale Alternative Progression

Table D-2
Hot Spot Volume and Risk Pathway Summary Table – Former Koppers/LNG Area
(assumes risk reduction through hot spot treatment or removal only)

Preliminary

GSA Alternative	Treatment/Removal Technologies	Risk Pathways Addressed by Treatment/Removal of Hot Spots Only	Fraction of Risk Pathways Addressed by Hot Spot Treatment	Soil Hot Spot* Volume in GSA (cy)			Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
				All[1]	Accessible	DNAPL[2]	All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
5	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (• Eco – Fill WBZ Groundwater (• Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (49%)								3,756	1,718	58,540	37,596	578,252	0	46%	29%	$30M
5a	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area with amendment to reduce benzene concentrations • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (• Eco – Fill WBZ Groundwater (• Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (49%)								3,756	1,718	58,540	37,596	578,252	0	46%	29%	$43M

The only difference between Koppers GSA alternatives 5 and 5a is use of amendments in the ISS mix design.

We are unaware of any testing at Gasco to inform decision making about the need for specific amendments. Use of amendments will be determined during RD.

Including versions of essentially the same alternative will skew the “knee of the curve” interpretations. If NW Natural believes an amendment is necessary for ISS to be effective, then include alterative 5a, if not then include alternative 5.

Treatment Train

Table D-2
Hot Spot Volume and Risk Pathway Summary Table – Former Koppers/LNG Area
(assumes risk reduction through hot spot treatment or removal only)

Preliminary

GSA Alternative	Treatment/Removal Technologies	Risk Pathways Addressed by Treatment/Removal of Hot Spots Only	Fraction of Risk Pathways Addressed by Hot Spot Treatment	Soil Hot Spot* Volume in GSA (cy)			Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
				All[1]	Accessible	DNAPL[2]	All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
5	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (• Eco – Fill WBZ Groundwater (• Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (49%)								3,756	1,718	58,540	37,596	578,252	0	46%	29%	$30M
5a	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area with amendment to reduce benzene concentrations • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater (• Eco – Fill WBZ Groundwater (• Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (49%)								3,756	1,718	58,540	37,596	578,252	0	46%	29%	$43M

- DEQ has previously commented (Interim FS, draft FS, meetings) about the need to consider a treatment train approach.
- A treatment train approach seems most suitable for the former LNG/Koppers GSA. For example, to reduce dissolved benzene concentrations via AS/SVE prior to ISS to improve ISS effectiveness. A treatment train approach may be more cost effective than the cost difference between adding an amendment vs not ($13M)
- DEQ continues to recommend a treatment train approach.

LNG/Koppers Hot Spot Quantity Calculations

Table D-2
Hot Spot Volume and Risk Pathway Summary Table – Former Koppers/LNG Area
(assumes risk reduction through hot spot treatment or removal only)

Preliminary

GSA Alternative	Treatment/Removal Technologies	Risk Pathways Addressed by Treatment/Removal of Hot Spots Only	Fraction of Risk Pathways Addressed by Hot Spot Treatment	Soil Hot Spot* Volume in GSA (cy)			Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
				All[1]	Accessible	DNAPL[2]	All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
1	None	None	0.0/8				0	0	0	0	0	0	0	0	0	0%	0%	$0M
2	• ISS bucket mix or excavation of hot spots to 3.5 feet	• HH – Surface Soil (77%) • HH – Fill WBZ Groundwater (excavation worker) (5%) • Eco – Fill WBZ Groundwater (5%) • Eco – Surface Soil (77%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (5%)	1.7/8				5,662	5,607	55	0	0	5,662	55	653	0	4%	3%	$1M
3	• ISS bucket mix of hot spots to 12 feet • Dual phase extraction in elevated benzene area and DNAPL recovery where accessible	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater • Eco – Fill WBZ Groundwater • Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (25%)					70,431	22,359	40,257	5,196	2,619	58,540	48,072	762,599	0	5%	35%	$18M
4	• ISS bucket mix of hot spots to 12 feet • Dual phase extraction in elevated benzene area and DNAPL recovery where accessible as well as hydraulic/DNAPL recovery • Downgradient barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater • Eco – Fill WBZ Groundwater • Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (59%)				170,582	70,431	22,359	40,257	5,196	2,619	58,540	48,072	762,599	0	5%	35%	$18M
5	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall	• HH – Surface Soil (77%) • HH – Subsurface Soil (70%) • HH – Fill WBZ Groundwater • Eco – Fill WBZ Groundwater • Eco – Surface Soil (77%) • HH – Surface and Subsurface Volatilization (49%)					58,540	20,944	32,122	3,756	1,718	58,540	37,596	578,252	0	46%	29%	$30M

How is it possible to treat potentially mobile DNAPL, but not treat recoverable DNAPL?

Are the hot spot treatment volumes shown just associated with ISS in the top 12 feet?

How much hot spot treatment is attributed to DNAPL recovery via dual phase extraction? Co-incident DNAPL recovery with dual phase extraction (GWE/SVE) would not address unrecoverable DNAPL.

New Terminology

5	• ISS bucket mix of hot spots to 12 feet • ISS hot spots in elevated benzene area • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall

What is the elevated benzene area? How does it compare to the presence of DNAPL or other source materials in the fill?
How does the distinction align with RAOs? Or groundwater restoration goals?

6a	• ISS bucket mix of hot spots to 12 feet • ISS all DNAPL from 12 feet bgs to the base of the Fill WBZ • Downgradient barrier wall with hydraulic/DNAPL recovery upgradient of barrier wall

Site Wide Alternative Contradictions

Table 14-1
Site-Wide Remedial Action Alternative Selected Technologies

Preliminary Draft Discussion Document
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Site-Wide RAA	Selected Site-Wide Remedial Technologies		Selected Remedial Technologies for Each GSA					Alternative Outcomes
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LNG GSA	FAMM-Former Spent Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	
RAA 1 – No Action				measures in place (i.e., no barrier wall), and no HC&C system operation.				--
RAA 2 – IRAM, Doane Creek and Engineering/Institutional Controls	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation			pecific actions and institutional lements)	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2:	quirement of gh engineering and emoval in Doane s are not feasible (to address DEQ to the Willamette eek in the Fill WBZ)
RAA 3 – Remove or treat all accessible surface soil human health and ecological hot spots	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation			r excavation of t (requires ncrete removal)	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the**	GSA Alternative 2: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved**	GSA Alternative 3: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · **Removal of surface soil exceeding PRGs in Doane Creek to the extent necessary for SWAC to meet PRGs** · Continued EIB · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade** · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM area · MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Removes or treats all accessible surface soil hot spots · Adds removal of all bank soil and sediment that exceeds PRGs in Doane Creek to enhance the effectiveness and long-term reliability of the remedy
RAA 4 – Treats or removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	· **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)	GSA Alternative 3: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in the Fill and Alluvium WBZs	GSA Alternative 2: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · Continued EIB · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall · MNA of groundwater in southern portion of GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Treats or removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

- Deep shoreline ISS barrier wall
- Gasco/US Moorings property line barrier wall
- ISS of nearshore DNAPL
- Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall
- Work platform excavation
- HC&C system corridor pre-treatment
- PacTerm tank basin remediation

Treating DNAPL hot spots in the PacTerm tank basin are only included in FAMM/Spent Oxide GSA Alternative 6.

What does PacTerm tank basin remediation mean?

Engineering Control Objectives

Table 14-1
Site-Wide Remedial Action Alternative Selected Technologies

Preliminary Draft Discussion Document
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Site-Wide RAA	Selected Site-Wide Remedial Technologies		Selected Remedial Technologies for Each GSA					Alternative Outcomes
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LNG GSA	FAMM-Former Spent Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	
RAA 1 – No Action	Assumes no remedial actions, no physical source control measures in place (i.e., no barrier wall), and no HC&C system operation.							--
RAA 2 – IRAM, Doane Creek and Engineering/Institutional Controls	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2: · **Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed** · **PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek** · **Continued EIB** · **PR… hydr… upstr…** · **MN… Siltro…**	· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane
RAA 3 – Remove or treat all accessible surface soil human health and ecological hot spots	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet**			**: 2: ix or excavation of 5 feet from final other approved placed in the ndwater in the Fill WBZs**	GSA · Foc… spots · PR… contr… · **Re… Doan… to m…** · Con… · **ISS… 3.5 fe…** · PR… hydra… the IF… · MN… Siltro…	
RAA 4 – Treats or removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 4: · **ISS bucket mix of hot spots to 12 feet** · **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**			**: 2: x or excavation of feet from final other approved placed in the tank dwater in the Fill BZs**	GSA · Foc… spots · PR… contr… · Con… · PR… hydra… the IF… · MN… in the…	

GSA Alternative 4:
· **ISS bucket mix of hot spots to 12 feet**
· **ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**

What does active DNAPL recovery mean? Is it recovering DNAPL coincident with hydraulic gradient control? DEQ would consider that passive and not active. Passive or coincident DNAPL recovery may not address ongoing DNAPL migration risks.

Is active DNAPL recovery an intentional effort to remove recoverable DNAPL from the subsurface? Active DNAPL recovery was not included in the Tar Ponds GSA hot spot alternatives.

Engineering Control Objectives

Table 14-1
Site-Wide Remedial Action Alternative Selected Technologies

Preliminary Draft Discussion Document
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Site-Wide RAA	Selected Site-Wide Remedial Technologies		Selected Remedial Technologies for Each GSA					Alternative Outcomes
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LNG GSA	FAMM Former Sport Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	
RAA 5 – Treats or removes all accessible soil human health or ecological direct contact hot spots; focused treatment of elevated benzene area	· Deep s · Gasco/ line barri · ISS of · Hydrau Alluvium · Work p · HC&C treatmen · PacTer		2 d to BZ o the ntrol d	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 12 feet (requires foundation and concrete removal)** · **GWE/SVE (dual phase) to address elevated benzene (>1,000 µg/L in the Fill WBZ) and recover DNAPL**	GSA Alt · **ISS b** **of hot s** **grade (** **materia** **tank ba** · MNA portion Oxide A			liment hot needed ydraulic oane Creek **f soil cover** **ct risk** **the Fill and** **feet from** ll and n of the IRAM ortion of GSA	· Meets statutory requirement of protectiveness · Treats or removes hot spots beyond the extent indicated by knee of the curve risk reduction to cost evaluation · Addresses DEQ request for treatment or removal of all HH and ecological direct contact soil hot spots, reducing reliance on engineering and institutional controls and improving the long-term reliability of the remedy · Addresses DEQ priorities for reducing vapor intrusion risk pathway and leaching to groundwater pathway in the elevated benzene area, reducing reliance on engineering and institutional controls and improving the long-term reliability of the remedy · Eliminates ecological exposure pathway in Doane Creek to maximize the effectiveness and long-term reliability of the remedy in Doane Creek · Reduces the mobility and toxicity of DNAPL on the Siltronic GSA, reducing reliance on engineering and institutional controls and improving the long-term reliability of the remedy
RAA 6 – Optimize potential for restoration of groundwater in northern portion of shoreline	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 4: · ISS bucket mix of hot spots to 12 feet · ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and t the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient contro within the containment cell (Fill and Alluvium WBZs)	GSA Alternative 4: · ISS bucket mix or excavation of hot spots to 12 feet (requires foundation and concrete removal) · GWE/SVE (dual phase) to address elevated benzene (>1,000 µg/L in the Fill WBZ) and recover DNAPL · **Downgradient barrier wall to the bottom of the Fill WBZ along GSA boundary connecting with Former Tar Pond Area barrier wall** · **Hydraulic/DNAPL recovery upgradient of barrier wall**	GSA Alt · ISS b hot spot (swell o will be p · **ISS o** **DNAPL** **(MW-21** · **Barrie** **Lower /** **the For** **wall, to** **alluviu** **of the S** · MNA portion Oxide A			liment hot needed ydraulic oane Creek oil cover to e Alluvium spots to 20 ll and n of the IRAM ortion of	· Meets statutory requirement of protectiveness · Treats or removes hot spots beyond the extent indicated by knee of the curve risk reduction to cost evaluation · Barrier walls address DEQ's request to enhance the potential to restore BU of groundwater in the Fill and Alluvium WBZs in the northern portion of the Gasco OU · Additional focused ISS near MW-21U treats the remaining DNAPL not contained by a barrier wall and addresses DEQ's request to enhance the potential to restore BU on the northern portion of the Gasco OU

Dual phase extraction of groundwater and DNAPL overlaps with hydraulic control/DNAPL recovery upgradient of the barrier wall. How do these work together?

GSA Alternative 4:
· ISS bucket mix or excavation of hot spots to 12 feet (requires foundation and concrete removal)
· GWE/SVE (dual phase) to address elevated benzene (>1,000 µg/L in the Fill WBZ) and recover DNAPL
· **Downgradient barrier wall to the bottom of the Fill WBZ along GSA boundary connecting with Former Tar Pond Area barrier wall**
· **Hydraulic/DNAPL recovery upgradient of barrier wall**

Confusing Cross GSA Controls

How is the barrier wall to the base of the Fill WBZ downgradient of the LNG/Koppers GSA (Introduced in site wide alternative 6) different from the 70-foot barrier wall for the Tar Ponds GSA (introduced in site wide alternative 4)?

Table 14-1
Site-Wide Remedial A

Preliminary Draft Discussion Document
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Site-Wide RAA	Selected Remedial Technologies for Each GSA							Alternative Outcomes
				Koppers-LNG GSA	FAMM			
RAA 5 – Treats or removes all accessible soil human health or ecological direct contact hot spots; focused treatment of elevated benzene area	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	· ISS bucket mix of hot spots to 12 feet · ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 12 feet (requires foundation and concrete removal)** · **GWE/SVE (dual phase) to address elevated benzene (>1,000 µg/L in the Fill WBZ) and recover DNAPL**	GSA Alt · **ISS b** **of hot s** **grade (** **materia** **tank ba** · MNA portion Oxide A		liment hot needed ydraulic oane Creek **f soil cover ct risk** **the Fill and** **feet from** ll and n of the IRAM ortion of GSA	· Meets statutory requirement of protectiveness · Treats or removes hot spots beyond the extent indicated by knee of the curve risk reduction to cost evaluation · Addresses DEQ request for treatment or removal of all HH and ecological direct contact soil hot spots, reducing reliance on engineering and institutional controls and improving the long-term reliability of the remedy · Addresses DEQ priorities for reducing vapor intrusion risk pathway and leaching to groundwater pathway in the elevated benzene area, reducing reliance on engineering and institutional controls and improving the long-term reliability of the remedy · Eliminates ecological exposure pathway in Doane Creek to maximize the effectiveness and long-term reliability of the remedy in Doane Creek · Reduces the mobility and toxicity of DNAPL on the Siltronic GSA, reducing reliance on engineering and institutional controls and improving the long-term reliability of the remedy
RAA 6 – Optimize potential for restoration of groundwater in northern portion of shoreline	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	GSA Alternative 4: · ISS bucket mix of hot spots to 12 feet · ISS containment cell to 70 feet along Siltronic GSA and Former Koppers/LNG Area boundaries and t the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient contro within the containment cell (Fill and Alluvium WBZs)	GSA Alternative 4: · ISS bucket mix or excavation of hot spots to 12 feet (requires foundation and concrete removal) · GWE/SVE (dual phase) to address elevated benzene (>1,000 µg/L in the Fill WBZ) and recover DNAPL · **Downgradient barrier wall to the bottom of the Fill WBZ along GSA boundary connecting with Former Tar Pond Area barrier wall** · **Hydraulic/DNAPL recovery upgradient of barrier wall**	GSA Alt · ISS b hot spot (swell o will be p · **ISS o** **DNAPL** **(MW-21** · **Barri** **Lower /** **the For** **wall, to** **alluviu** **of the S** · MNA portion Oxide A		liment hot needed ydraulic oane Creek oil cover to e Alluvium spots to 20 ll and n of the IRAM ortion of	· Meets statutory requirement of protectiveness · Treats or removes hot spots beyond the extent indicated by knee of the curve risk reduction to cost evaluation · Barrier walls address DEQ's request to enhance the potential to restore BU of groundwater in the Fill and Alluvium WBZs in the northern portion of the Gasco OU · Additional focused ISS near MW-21U treats the remaining DNAPL not contained by a barrier wall and addresses DEQ's request to enhance the potential to restore BU on the northern portion of the Gasco OU

GSA Alternative 4:
· ISS bucket mix or excavation of hot spots to 12 feet (requires foundation and concrete removal)
· GWE/SVE (dual phase) to address elevated benzene (>1,000 µg/L in the Fill WBZ) and recover DNAPL
· **Downgradient barrier wall to the bottom of the Fill WBZ along GSA boundary connecting with Former Tar Pond Area barrier wall**
· **Hydraulic/DNAPL recovery upgradient of barrier wall**

Including RAO compliance into alternatives

Table 14-1
Site-Wide Remedial Action Alternative Selected Technologies

Preliminary Draft Discussion Document
Do Not Quote or Cite

Site-Wide RAA	Selected Site-Wide Remedial Technologies		Selected Remedial Technologies for Each GSA					Alternative Outcomes
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LNG GSA	FAMM-Former Spent Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	
RAA 1 – No Action	Assumes no remedial actions, no physical source control measures in place (i.e., no barrier wall), and no HC&C system operation.							--
RAA 2 – IRAM, Doane	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower	2	No additiona beyond engi controls (No			GSA Alternative 2: · **Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed** · **PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek** · **Continued EIB** · **PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall** · **MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs**	· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane Creek where controls are not feasible · Barrier wall or PRB (to address DEQ priority to restore BU to the Willamette River and Doane Creek in the Fill WBZ)
			3: ix or excavation of feet	GSA Alterna · **ISS bucke hot spots to foundation**			GSA Alternative 3: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · **Removal of surface soil exceeding PRGs in Doane Creek to the extent necessary for SWAC to meet PRGs** · Continued EIB · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade** · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM area · MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Removes or treats all accessible surface soil hot spots · Adds removal of all bank soil and sediment that exceeds PRGs in Doane Creek to enhance the effectiveness and long-term reliability of the remedy
removes accessible hot spots to the extent feasible based on a comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	line barrier wall · ISS of nearshore DNAPL · Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	· Site-wide engineered cap · MNA in the Deep Lower Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	4: ix of hot spots to 12 ent cell to 70 feet **along Siltronic GSA and Former Koppers/LNG Area boundaries and to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	GSA Alterna · ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)	material will be placed in the tank basins) · MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs	material will be placed in the tank basins) · MNA of groundwater in the Fill and Alluvium WBZs	GSA Alternative 2: · Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · Continued EIB · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall · MNA of groundwater in southern portion of GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Treats or removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

Use of SWACs has not been previously discussed. DEQ does not approve baking RAO compliance metrics into the site wide alternatives.

RAO compliance should be evaluated based on the exposure point concentration calculation methodology in the risk assessment.

DEQ is open to discussing alternative RAO compliance methods, but only after remedy selection. Such discussions should include development of DQOs and a sampling design.

GSA Alternative 3:
· Focused excavation of soil and sediment hot spots in Doane Creek and backfill as needed
· PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek
· **Removal of surface soil exceeding PRGs in Doane Creek to the extent necessary for SWAC to meet PRGs**
· Continued EIB
· **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade**
· PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM area
· MNA of groundwater in southern portion of Siltronic GSA in the Alluvium WBZs

Off-Site Hot Spot Considerations

- How do alternatives consider the risk that DNAPL has migrated offsite?
- Only site wide alternative 9 appears to treat DNAPL projected across the property boundary in the former Office Area GSA and FAMM/Spent Oxide GSA.

Former Office Area Considerations

Table A-1
Risk Reduction Through Hot Spot Treatment or Removal Only – Former Office Area

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How was this estimated? Does contamination in the Office Area GSA affect the aquatic life pathway in the alluvium?

Risk Pathway[1]	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 4a
	0%	69%	69%	69%	69%
	0%	69%	69%	69%	69%
	0%	0%	75%	75%	75%
HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization[2]	0%	16%	70%	71%	75%
HH – Fill WBZ Groundwater (excavation worker)[2]	0%	16%	70%	71%	75%
Eco – Fill WBZ Groundwater[2]	0%	16%	70%	71%	75%
Eco – Alluvium WBZ Groundwater[3]	0%	0%	0%	23%	48%
HH – Alluvium WBZ Groundwater (industrial use)[3]	0%	0%	0%	23%	48%
Number of Pathways Either Partially or Completely Addressed Through Hot Spot Treatment or Removal:	**0.0**	**5.0**	**6.0**	**8.0**	**8.0**
Fraction of All Pathways Addressed Through Hot Spot Treatment:	**0.0/8**	**1.9/8**	**4.2/8**	**4.7/8**	**5.3/8**

Former Office Area Considerations

Table A-2
Hot Spot Volume and Risk Pathway Summary Table – Former Office Area
(assumes risk reduction through hot spot treatment or removal only)

Prelin

GSA Alternative	Treatment/ Removal Technologies	Risk Pathways Addressed by Treatment/Removal of Hot Spots Only	Fraction of Risk Pathways Addressed by Hot Spot Treatment	Volume of Hot Spot-Containing* Soil in GSA (cy)			Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
				All[1]	Accessible	DNAPL[2]	All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
1	None	None	0.0/8				0	0	0	0	0	0	0	0	0.0	0%	0%	$0.0M
2		• Eco – Fill WBZ Groundwater (16%)					692	93	599	0	0	692	599	7,076	0	6%	6%	$0.1M
3	• ISS bucket mix of hot spots to 12 feet	• HH – Surface Soil (69%) • Eco – Surface Soil (69%) • HH – Subsurface Soil (75%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (70%)	4.2/8				3,057	300	2,757	0	0	3,057	2,757	32,595	0	28%	28%	$0.3M
4	• ISS of hot spots to 12 feet transitional and potentially	• HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (75%)	4.7/8	10,946	6,425	6,121	4,610	304	4,306	0	0	4,610	4,306	0	0	42%	42%	$1.2M
4a	of hot spots all depths	Volatilization (71%) • HH – Fill WBZ Groundwater (excavation worker) (71%) • Eco – Fill WBZ Groundwater (71%) • Eco – Alluvium WBZ Groundwater (23%) • HH – Alluvium WBZ Groundwater (industrial use) (23%)	5.3/8				6,425	305	6,121	0	0	6,425	6,121	53,146	0	59%	59%	$2.3M

The cost to increase hot spot treatment from 692 cy to 3,057 cy (↑ 2,365 cy) increases by $0.2M

Why are treatment costs so disproportional for same technology?

The cost to increase hot spot treatment from 3,057 cy to 4,610 cy (↑ 1,553 cy) increases by $0.9M

Former Office Area Considerations

Table A-2
Hot Spot Volume and Risk Pathway Summary Table – Former Office Area
(assumes risk reduction through hot spot treatment or removal only)

Prelin

GSA Alternative	Treatment/ Removal Technologies	Risk Pathways Addressed by Treatment/Removal of Hot Spots Only	Fraction of Risk Pathways Addressed by Hot Spot Treatment	Volume of Hot Spot-Containing* Soil in GSA (cy)			Volume of Hot Spot-Containing* Soil Treated (cy)							Volume of Treated DNAPL (gallons)		Percent of Soil Hot Spot* Volume Treated (%)		FS Soil Hot Spot Treatment Cost ($M)[5]
				All[1]	Accessible	DNAPL[2]	All	Non-DNAPL Hot Spots	Residual	Transitional	Potentially Mobile	Accessible	DNAPL[2]	Saturation Adjusted DNAPL[3]	Recoverable DNAPL[4]	Accessible	All[1]	
1	None	None	0.0/8				0	0	0	0	0	0	0	0	0.0	0%	0%	$0.0M
2	• ISS bucket mix or excavation of hot spots to 3.5 feet	• HH – Surface Soil (69%) • Eco – Surface Soil (69%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (16%) • HH – Fill WBZ Groundwater (excavation worker) (16%) • Eco – Fill WBZ Groundwater (16%)	1.9/8				692	93	599	0	0	692	599	7,076	0	6%	6%	$0.1M
3	• ISS bucket mix of hot spots to 12 feet	• HH – Surface Soil (69%) • Eco – Surface Soil (69%) • HH – Subsurface Soil (75%) • HH – Surface and Subsurface Soil and Fill WBZ Groundwater Volatilization (70%) • HH – Fill WBZ Groundwater (excavation worker) (70%) • Eco – Fill WBZ Groundwater (70%)	4.2/8				3,057	300	2,757	0	0	3,057	2,757	32,595	0	28%	28%	$0.3M
4	• ISS bucket mix of hot spots to 12 feet and transitional and potentially mobile DNAPL to all depths	• HH – Surface Soil (69%) • Eco – Surface Soil (69%) • HH – Subsurface Soil (75%) • HH – Surface and Subsurface Soil and Fill Volatilization (75%) • HH – Fill WBZ Groundwater (excavation • Eco – Fill WBZ Groundwater (75%)		10,946	6,425	6,121					0	4,610	4,306	0	0	42%	42%	$1.2M
4a	• ISS auger mix of hot spots all depths	• HH – Surface Soil (69%) • Eco – Surface Soil (69%) • HH – Subsurface Soil (75%) • HH – Surface and Subsurface Soil and Fill Volatilization (71%) • HH – Fill WBZ Groundwater (excavation worker) (71%) • Eco – Fill WBZ Groundwater (71%) • Eco – Alluvium WBZ Groundwater (23%) • HH – Alluvium WBZ Groundwater (industrial use) (23%)									0	6,425	6,121	53,146	0	59%	59%	$2.3M

The cost to treat all hot spots in the Office Area is nominal compared to all other GSAs. Especially considering that only the last alternative addresses DNAPL that may extend across the property boundary.

MNA Effectiveness

Table 14-1
Site-Wide Remedial Action Alternative Selected Technologies

Preliminary Draft Discussion Document
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Site-Wide RAA	Selected Site-Wide Remedial Technologies		Selected Remedial Technologies for Each GSA					Alternative Outcomes
	IRAM Components	Other Components	Former Tar Pond GSA	Koppers-LNG GSA	FAMM-Former Spent Oxide GSA	Former Office Area GSA	Siltronic GSA[1]	
RAA 1 – No Action	Assumes no remedial actions, no physical source control measures in place (i.e., no barrier wall), and no HC&C system operation.							--
RAA 2 – IRAM, Doane	· Deep shoreline ISS barrier wall · Gasco/US Moorings property line barrier wall · ISS of nearshore DNAPL	· Engineering controls · Institutional controls · Site-wide engineered cap · MNA in the Deep Lower	2	No additional GSA-specific actions beyond engineering and institutional controls (No IRAM elements)	GSA Alternative 2	No be cor	GSA Alternative 2: nent hot eeded lraulic ane and tion of	· Meets statutory requirement of protectiveness · Manage risk through engineering and institutional controls · Focused hot spot removal in Doane Creek where controls are not feasible · Barrier wall or PRB (to address DEQ priority to restore BU to the Willamette River and Doane Creek in the Fill WBZ)
			3: ix or excavation of feet	GSA Alternative 2: · **ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)**	GSA Alternative 3: · **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins)** · **MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs**	GS I hot gra ma an N an	it hot led ilic Creek RGs in r SWAC pots to tream of of	· Meets statutory requirement of protectiveness · Removes or treats all accessible surface soil hot spots · Adds removal of all bank soil and sediment that exceeds PRGs in Doane Creek to enhance the effectiveness and long-term reliability of the remedy
comparison of the risk reduction achieved to the cost of the action as required by ORS 465.315(1)(d)(E)	· Hydraulic controls in the Fill and Alluvium WBZs behind barrier wall · Work platform excavation · HC&C system corridor pre-treatment · PacTerm tank basin remediation	Alluvium WBZ · Post-remediation monitoring · Contingent well-head treatment for future industrial use of Lower and Deep Lower Alluvium WBZ groundwater	4: ix of hot spots to 12 ent cell to 70 feet GSA and Former rea boundaries and **to the base of the Lower Alluvium WBZ along the northern portion tied into the deep ISS barrier wall with active DNAPL recovery and gradient control within the containment cell (Fill and Alluvium WBZs)**	GSA Alternative 2: · ISS bucket mix or excavation of hot spots to 3.5 feet (requires foundation and concrete removal)	GSA Alternative 3: · ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs	GS · IS hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins) · MNA of groundwater in the Fill and Alluvium WBZs	it hot led · PRB or Fill WBZ barrier wall with hydraulic control of Fill WBZ groundwater to Doane Creek · Continued EIB · PRB or shallow Fill WBZ barrier wall and hydraulic controls along the shoreline upstream of the IRAM ISS barrier wall · MNA of groundwater in southern portion of GSA in the Alluvium WBZs	· Meets statutory requirement of protectiveness · Treats or removes hots spots to the extent feasible based on knee of the curve disproportionate risk reduction to cost evaluation

GSA Alternative 3:
· **ISS bucket mix or excavation of hot spots to 3.5 feet from final grade (swell or other approved material will be placed in the tank basins)**
· **MNA of groundwater in northern portion of FAMM/Former Spent Oxide Area in the Alluvium WBZs**

Treatment of hot spots to restore aquatic life beneficial use is not proposed until site-wide alternative 7 for the FAMM-Spent Oxide GSA (and many other GSAs).

It is not clear whether MNA (proposed in site wide alternative 3) would be an effective groundwater treatment technology in the absence of hot spot treatment.

If MNA will not effectively restore groundwater, where it is feasible to restore groundwater (like the FAMM-Spent Oxide GSA) then another groundwater treatment technology is required.

DEQ's Observations and Path Forward

- The site wide alternatives require a fundamental overhaul
- It is not clear to what extent feedback we have provided in FS comments and/or previous meetings has been incorporated into the pre-meeting tables and figures.
- Ongoing meetings to repeat feedback is not productive.
- Additional meetings are not necessary for NW Natural to understand and satisfactorily address FS comments.
- NW Natural should complete the revised FS for DEQ review.