DNAPL Classification, Distribution, and Preliminary Volume Assessment

August 10, 2023

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Draft

Agenda

- Residuals mapping and DNAPL volumes calculation process
- Results of sensitivity analysis
- Theoretically recoverable DNAPL

All results presented herein are preliminary, for discussion purposes.

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Residuals Mapping and DNAPL Volumes Process

Delineation

- Delineate residuals in the Fill and Alluvium WBZ depth intervals
  - Tar (Fill WBZ only)
  - Lampblack/Pitch (Fill WBZ only)
  - Spent Oxide (Fill WBZ only)
  - Residual DNAPL
  - Potentially Mobile DNAPL

Vertical Thickness

Determine the average vertical thickness of residual and potentially mobile DNAPL at each depth interval in each GSA

DNAPL-Containing Soil Volumes

Calculate residual and potentially mobile DNAPL-containing soil volumes for each depth interval and GSA based on DEQ and NW Natural transition points

DNAPL Volumes

Calculate residual and potentially mobile DNAPL volumes for each depth interval and GSA based on the DEQ and NW Natural transition points

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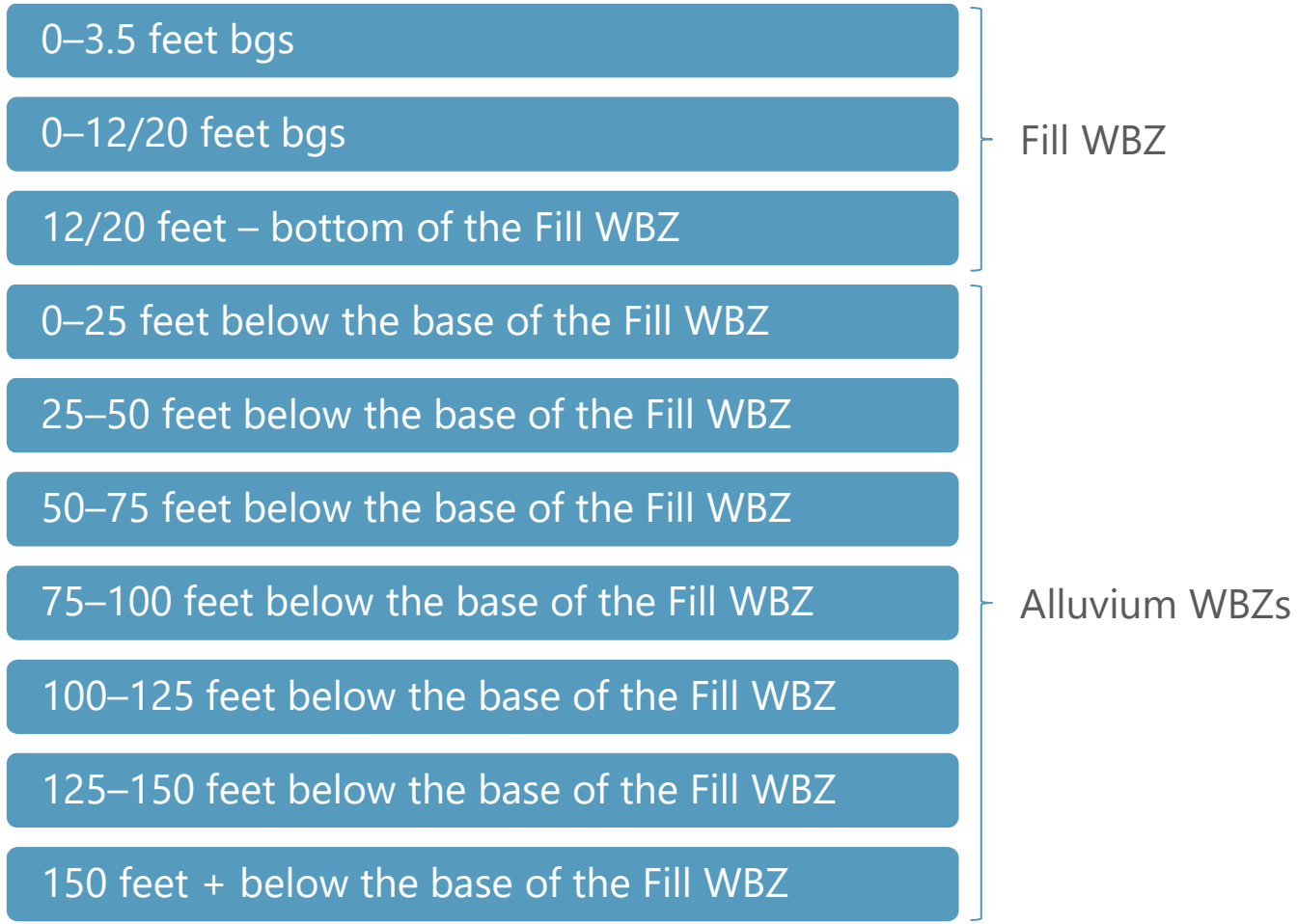
Delineation of Residuals – General Depth Intervals



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Distribution of Data Points

>600 data points

Lateral Extents of DNAPL – Lines of Evidence

Boring Log Descriptions

- Residual DNAPL – Blebs, dots, staining, trace oil
- Potentially Mobile DNAPL – Saturated, oozing, flowing, significant, oily

DNAPL Accumulation in Wells

- Measurable (>= 0.01 foot) DNAPL entry = potentially mobile

Measured DNAPL Saturation Values

- DNAPL saturation values exceeding the transition point (22.6% or 35%) indicates potentially mobile DNAPL

TarGOST % RE Data

- % RE values greater than the transition point (52% RE or 80% RE) indicates potentially mobile DNAPL
- % RE values less than the transition points but greater than background (5% RE) indicate residual DNAPL

Data points that do not indicate DNAPL also used to delineate DNAPL

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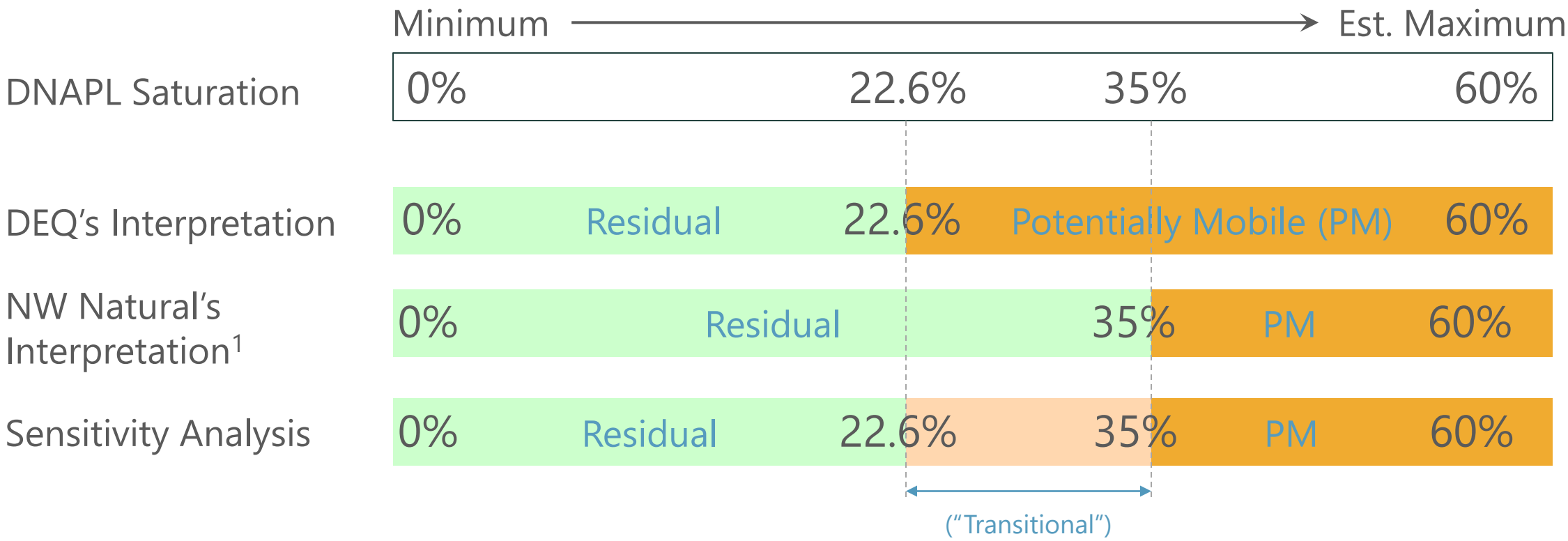
Residual Saturation Value Affects DNAPL Delineation and Volume Estimates



1. ASTM, 2022. Standard E3282-22: Standard Guide for NAPL Mobility and Migration in Sediments – Evaluation Metrics. West Conshohocken, Pennsylvania: ASTM International. DOI: 10.1520/E3282-21A.

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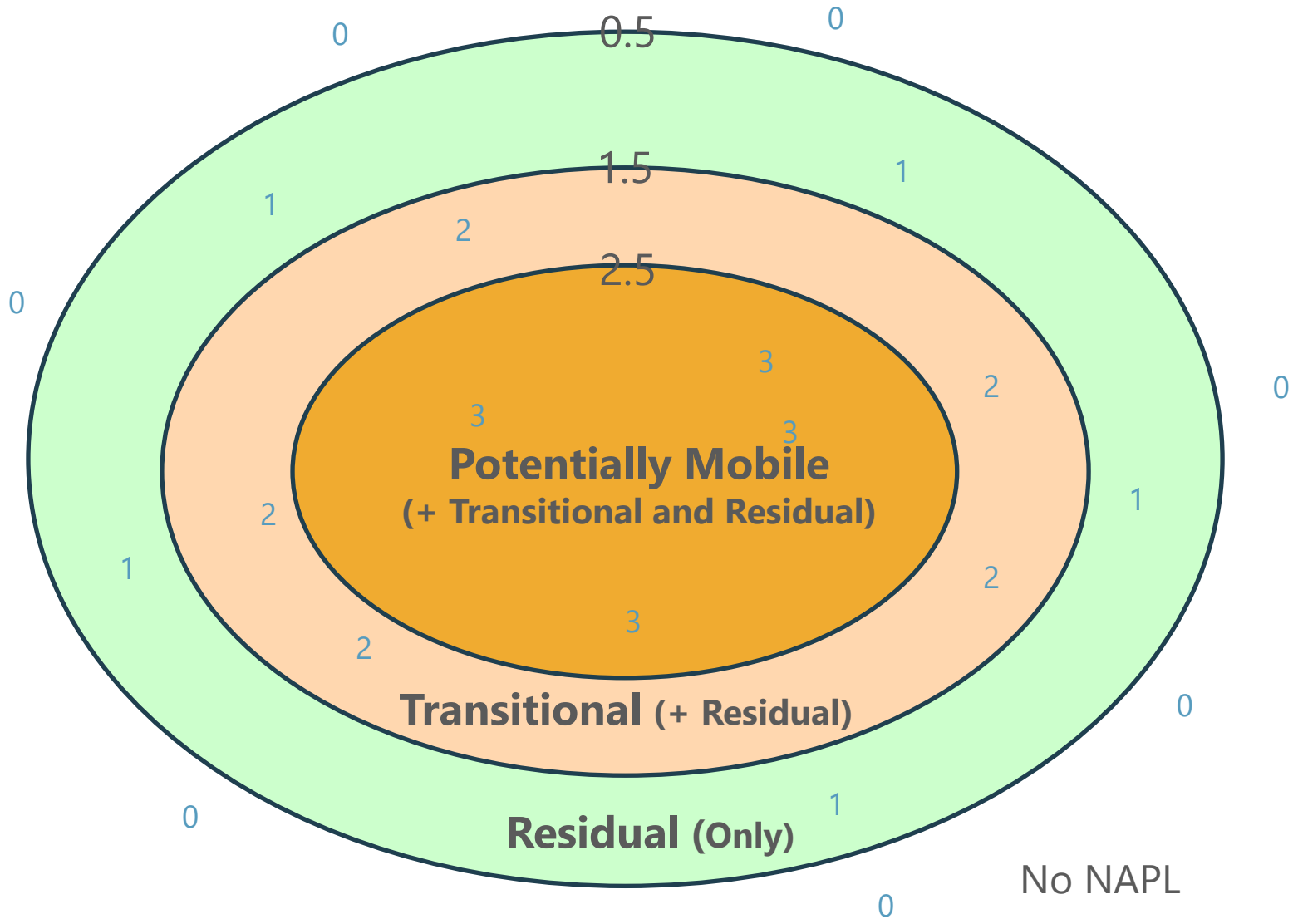
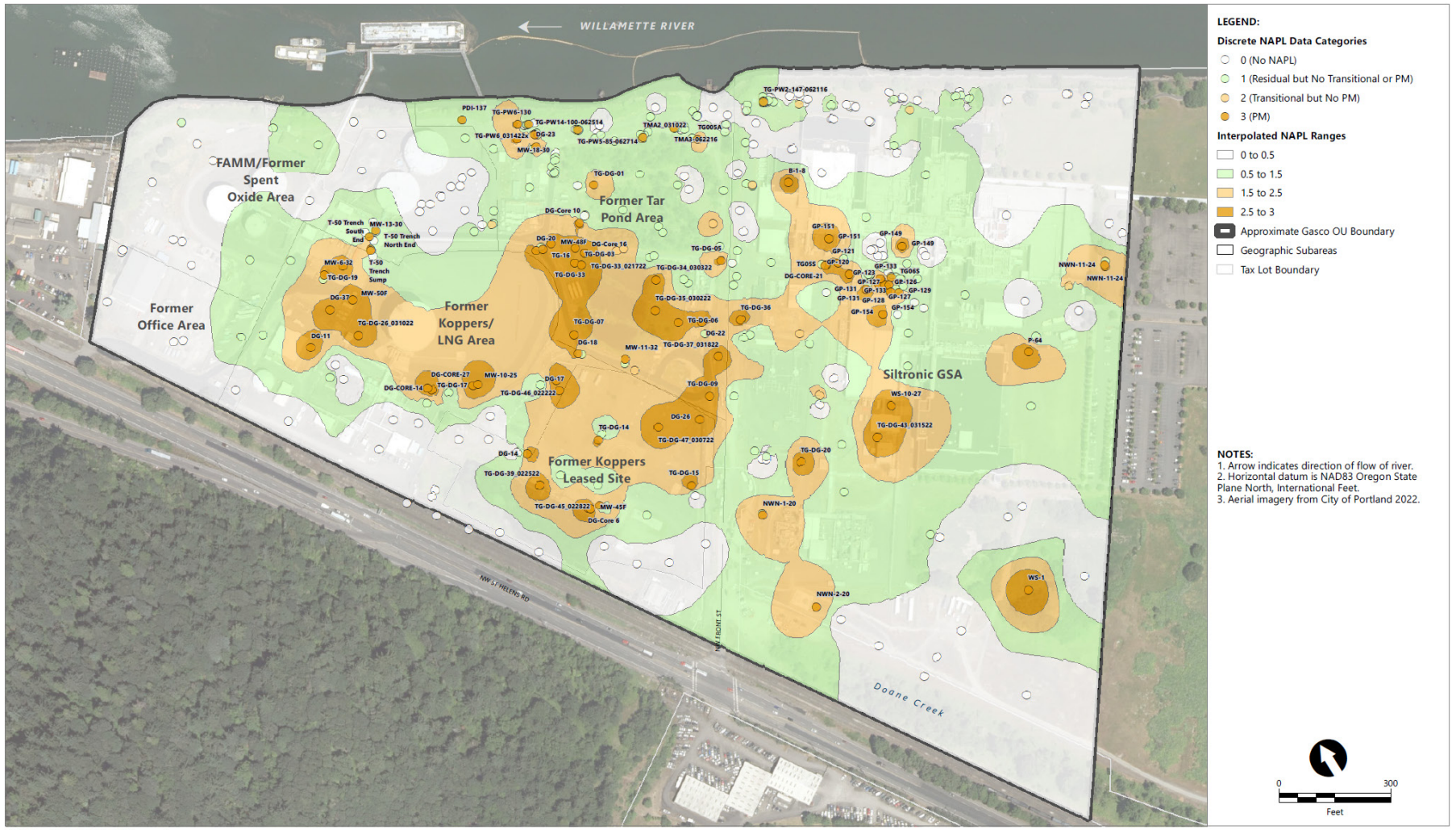
Contouring to Delineate DNAPL Categories

- Assign data values and contour
  - No DNAPL = 0
    - Contour 0.5 splits No DNAPL from Residual DNAPL
  - Residual, but no Transitional or Potentially Mobile DNAPL = 1
    - Contour 1.5 splits Residual DNAPL from Transitional
  - Transitional, but no Potentially Mobile DNAPL = 2
    - Contour 2.5 splits Transitional from Potentially Mobile DNAPL
  - Potentially Mobile DNAPL = 3
- Objective, unbiased approach
- Many more data available than during Interim FS


0.5
1.5
2.5
Potentially Mobile
(+ Transitional and Residual)
Transitional (+ Residual)
Residual (Only)
No NAPL

Preliminary Example (12/20 Feet to Base of Fill)



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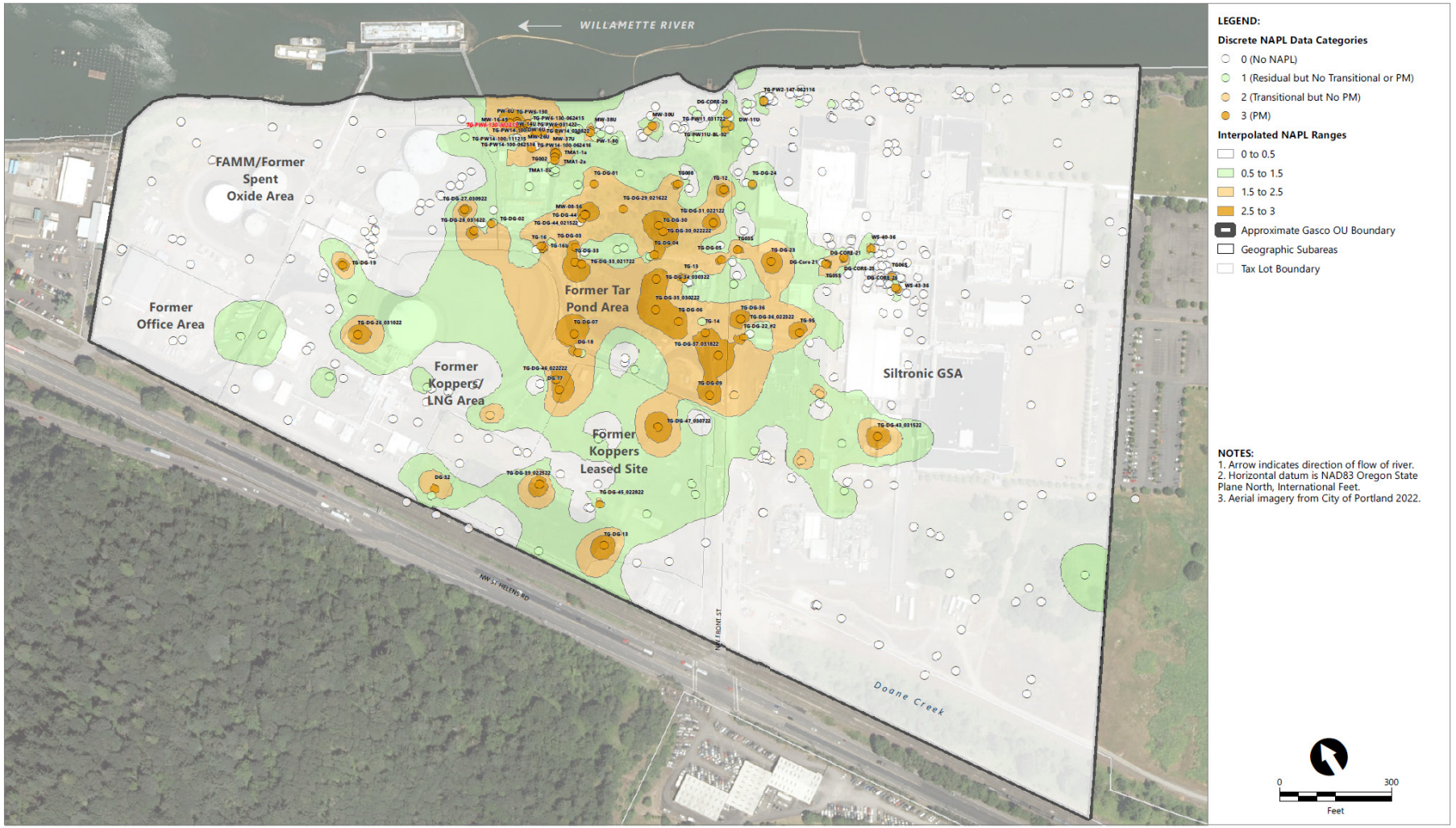
Preliminary Example (0–25 Feet Below Base of Fill)



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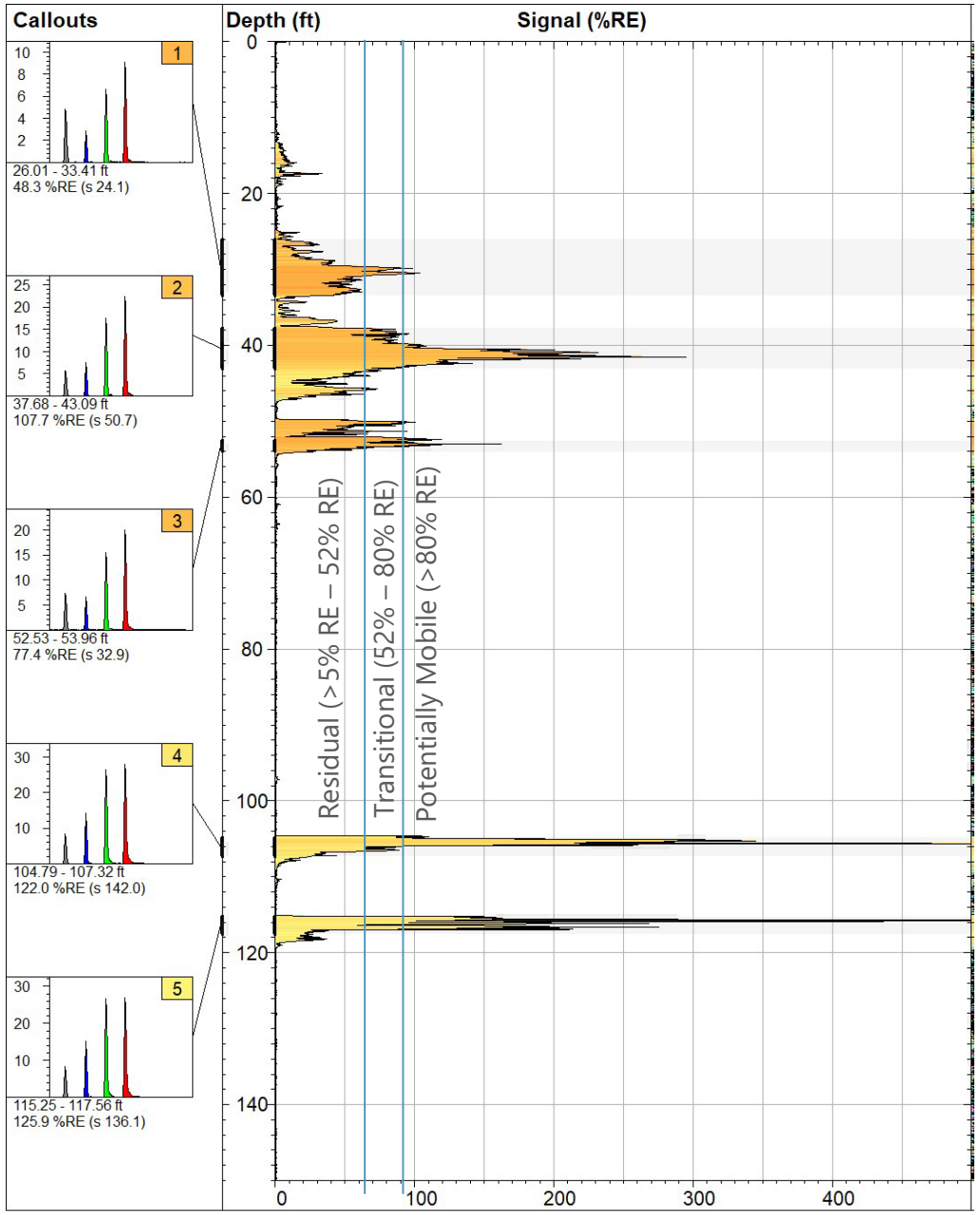

DNAPL Average Thicknesses

- Raw TarGOST % RE data sorted using Python based on DNAPL type (residual, transitional, potentially mobile)
- Thickness for each DNAPL type calculated by summing TarGOST data points at each boring location
- Average thickness calculated for each DNAPL type in each general depth interval in each GSA
- Only TarGOST borings that contained the specific DNAPL type at each depth interval and GSA were used in averaging
- Average thickness calculated using data within the lateral areas discussed previously

DNAPL Volume Calculations

- DEQ Method
  - Residual DNAPL Volume
    - (residual DNAPL area + transitional area + PM area)[1] x (average residual DNAPL thickness) x (porosity)[2] x (0.113)[3]
  - Potentially Mobile DNAPL Volume
    - (transitional area + PM area)[4] x average transitional thickness) + (PM area x average PM thickness) x (porosity)[2] x (0.413)[3]

Notes:
1. Entire area inside 0.5 contour.
2. Porosity values for the Fill WBZ and Alluvium WBZs were determined by averaging the laboratory porosity values from the DNAPL Mobility analysis.
3. Blue numbers represent midpoints of DNAPL saturation for residual and potentially mobile DNAPL, respectively.
4. Entire area inside 1.5 contour.

DNAPL Volume Calculations

- NW Natural Method
  - Residual DNAPL Volume
    - (residual DNAPL area + transitional area + PM area)[1] x (average residual DNAPL thickness + average transitional thickness) x (porosity)[2] x (0.175)[3]
  - Potentially Mobile DNAPL Volume
    - (PM area)[4] x (average PM thickness) x (porosity)[2] x (0.475)[3]

Notes:
1. Entire area inside 0.5 contour.
2. Porosity values for the Fill WBZ and Alluvium WBZs were determined by averaging the laboratory porosity values from the DNAPL Mobility analysis.
3. Blue numbers represent midpoints of DNAPL saturation for residual and potentially mobile DNAPL, respectively.
4. Entire area inside 2.5 contour.

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DNAPL Volume Estimates (Preliminary Examples, Gallons)

DNAPL Type	Geographic Subarea	Depth Intervals			
		Fill WBZ		Alluvium WBZs	
		DEQ (gallons)	NW Natural (gallons)	DEQ (gallons)	NW Natural (gallons)
Residual DNAPL	Former Office Area	86,914	134,601	67,964	105,254
	FAMM/Former Spent Oxide Area	158,506	251,996	72,306	85,579
	Former Tar Pond Area	1,694,379	3,192,746	2,159,510	4,347,101
	Former Koppers/LNG Area	1,274,476	2,443,088	985,127	1,747,325
	Siltronic	5,068,218	10,841,409	2,914,872	6,357,305
Potentially Mobile DNAPL	Former Office Area	0	0	0	0
	FAMM/Former Spent Oxide Area	126	0	14,334	2,690
	Former Tar Pond Area	403,271	139,602	1,735,214	435,137
	Former Koppers/LNG Area	682,116	212,612	162,404	43,689
	Siltronic	921,400	148,839	1,526,645	445,877
	Total Residual:	**8,282,493**	**16,863,840**	**6,199,779**	**12,642,564**
	Total Potentially Mobile:	**2,006,914**	**501,053**	**3,438,597**	**927,393**

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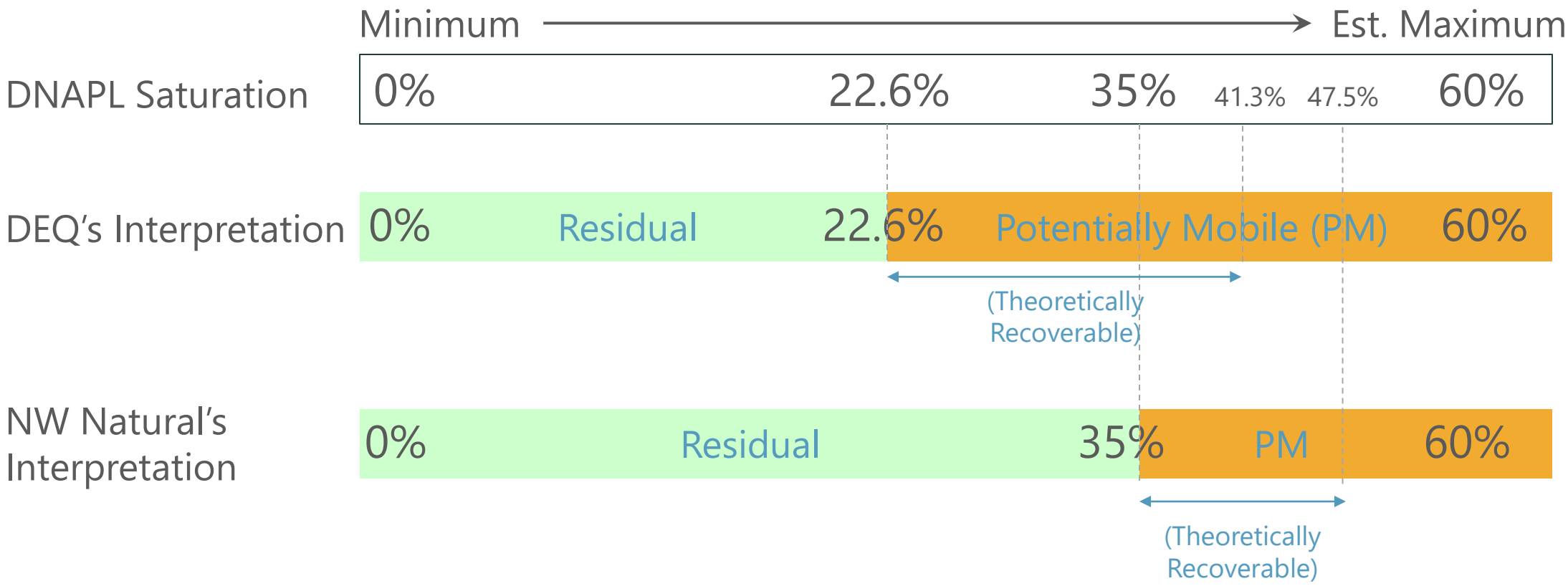
Theoretically Recoverable DNAPL Volume Calculation



Theoretically Recoverable Volume Estimates (Preliminary)

	Geographic Subarea	Depth Interval			
		Fill WBZ		Alluvium WBZs	
		DEQ (gallons)	NW Natural (gallons)	DEQ (gallons)	NW Natural (gallons)
Potentially Mobile DNAPL	Former Office Area	0	0	0	0
	FAMM/Former Spent Oxide Area	126	0	14,334	2,690
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	Former Koppers/LNG Area	682,116	212,612	162,404	43,689
	Siltronic	921,400	148,839	1,526,645	445,877
Total Potentially Mobile:		**2,006,914**	**501,053**	**3,438,597**	**927,393**
Theoretically Recoverable Volumes:		**908,699**	**131,856**	**1,556,944**	**244,051**

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Preliminary Findings from DNAPL Mapping

- Sporadic distribution of potentially mobile DNAPL
- NW Natural method suggests large number of separate “targets”
- DEQ method has similar results, but “targets” are larger and appear to be more coalesced

Preliminary Findings from Sensitivity Analysis

- NW Natural and DEQ methods produce significantly different results
- DEQ method suggests approximately 4x more potentially mobile DNAPL volume than indicated by NW Natural method
- Locations with highest saturation most likely to produce DNAPL
- Pre-design pilot testing may be necessary to field verify DNAPL entry and potential for recovery within transitional areas vs. potentially mobile areas

What questions do you have?