Waste Disposition Methodology at the Portsmouth Gaseous Diffusion Plant-16469

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ABSTRACT

Cost-effective and sustainable remedial design is a prudent and required approach for dealing with legacy wastes at the U.S. Department of Energy (DOE) sites. The concept of using contaminated soils as engineered fill for waste disposal facilities is a sustainable remediation process that warrants investigation.

Options for cost-effective site-wide remediation were evaluated by DOE and its site contractor, including completion of evaluations for excavation of certain closed landfills and the excavation of contaminated soil in areas of known groundwater plumes to be used as engineered fill for the operation of an On-Site Waste Disposal Facility (OSWDF) at Portsmouth. The evaluations concluded that excavating select landfills and significant volumes of soil associated with the groundwater plumes considering Portsmouth site specific geology would mitigate the project lifecycle risk. As a result of this evaluation, the excavation of the landfills and soils associated with the groundwater plumes is being incorporated into the project's lifecycle baseline.

On-site independent Headquarters review of this sustainable design approach and evaluation was performed in 2013 by the U.S. Army Corps of Engineers. Extensive presentations, background information, and data were provided to the independent review team along with tours of the affected areas. The review team agreed with the approach, and the Final Waste Disposition Record of Decision (ROD) for the OSWDF at the Portsmouth Site issued in June 2015, provides for the use of contaminated fill as an option provided that additional regulatory authorization/approval is obtained to use contaminated fill.

Stakeholder and regulatory support is evidenced by the issuance of resolutions advocating this sustainable approach. The Commissioners of each of the four surrounding counties and the Portsmouth Site Specific Advisory Board have issued resolutions advocating this approach. They, along with other local leaders and Ohio's congressional delegation, are continuing to pursue implementation of this approach that they believe will enhance the attractiveness of the site for future reindustrialization.

This approach at the Portsmouth Gaseous Diffusion Plant (PORTS) in Piketon, Ohio, is estimated to save more than $200 million over the lifecycle of the decontamination and decommissioning (D&D) project. This strategy has merit not only at Portsmouth, but perhaps other sites within the U.S. Department of Energy's Office of Environmental (EM) Management - and beyond.

INTRODUCTION

The Portsmouth site in south-central Ohio was first used to produce enriched uranium for national defense programs. Located south of Piketon, on 3,714 acres, the DOE site continued to produce enriched uranium to fuel commercial nuclear power plants until operations ceased in 2001.

The gaseous diffusion plant (GDP) went into a Cold Standby Status in 2001, then Cold Shutdown in 2006 with D&D operations beginning in 2011. BWXT Conversion Services operates the depleted uranium hexafluoride (DUF_6) conversion facility at the site and is converting more than 800,000 metric tons of DUF_6 into uranium oxide. The American Centrifuge Project is an advanced uranium enrichment facility leased on the reservation by Centrus Energy. Centrus planned to produce low-enriched uranium for commercial nuclear reactors at the facility, but the project stalled based on a lack of funding. DOE-EM and the Ohio Environmental Protection Agency (EPA) oversee cleanup activities at the site.

PORTS has more than two million cubic yards of hazardous wastes and more than 400 contaminated facilities and structures. Aboveground, 1.5 million cubic meters of solid waste and 88 million gallons of liquid waste exist on-site. Underground, five trichloroethylene (TCE) contaminated plumes have been identified causing contamination of on-site groundwater and surface water. Roughly 21,000 DUF_6 cylinders and 160 solid waste management units exist on-site.

The DOE-EM's mission at PORTS is to restore the land value for future beneficial use. DOE is accomplishing this through environmental remediation, D&D, and waste management, specifically:

- Soil and Groundwater Remediation. The five groundwater plumes identified on-site are receiving remedial pump-and-treat actions. Subsurface barrier walls and extraction wells have been installed to mitigate plume migration.
- D&D. DOE is removing inactive facilities' contents and equipment and then demolishing the facilities. Wastes from D&D are either disposed, recycled, or reused.
- Waste Management. DOE manages the safe disposal of wastes generated from the cleanup and the uranium enrichment plant operations. DOE issued a

ROD for waste disposition of D&D waste in 2015, calling for a combination of on-site and off-site waste disposition remedies.

The D&D Project at Portsmouth is scheduled for completion in 2052.

BACKGROUND

The Ohio EPA and DOE entered into a formal agreement regarding the decision-making process for the D&D of PORTS and for the associated waste management. The terms of the agreement between Ohio EPA and DOE are contained in *The April 13, 2010 Director's Final Findings and Orders for Removal Action and Remedial Investigation and Feasibility Study and Remedial Design and Remedial Action, including the July 16, 2012 Modification thereto* (DFF&O). [1]

The waste disposition remedy chosen for the Portsmouth site called for a combination of on-site and off-site disposal. DOE issued a Proposed Plan on the remedy in November 2014 and, after a formal Public Comment Period, issued the *Record of Decision for the Site-Wide Waste Disposition Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio,* [2] in June 2015. The business case for the waste disposition approach, which was developed in 2013, aimed to answer two questions that were central to a strategic approach to the Portsmouth D&D Project. The key strategic questions to be answered were:

- *If an OSWDF is built for the D&D and other cleanup wastes, what are the optimal sources of cost-effective engineered fill soil to accommodate debris waste placement?*
- *If contaminated soil is identified as a viable source of engineered fill, can its use also reduce or eliminate other long-term environmental liabilities and help minimize lifecycle surveillance and maintenance (S&M) costs for other PORTS cleanup remedies?*

The path forward, in conjunction with the decision for the construction and operation of an OSWDF for the disposition of the site's low-level radioactive waste from D&D and soil remediation, the consolidation of select existing landfills, and the excavation of the site's contaminated soil associated with the groundwater plumes will result in greater than $1.2 billion of combined cost avoidances to the government. [3]

By executing this path forward, DOE's long-term environmental liability will be minimized and the overall demolition and remediation strategy will be streamlined. Additionally, there is an added benefit of having a post-cleanup PORTS site with an open and contiguous land area poised for redevelopment by private industry, giving the community leaders a long-range asset rather than a continued environmental burden.

The debris placement requirements of an OSWDF would create the need for approximately 1.43 million cubic meters (m^3) or more of soil or soil-like material to serve as engineered fill after using waste soils generated from the D&D project and the soil remediation program. This amount of engineered fill required is needed for the proper disposal of debris to ensure the long-term integrity of the capping system. Three options for the source of engineered fill were evaluated: purchase clean fill from an off-site location, generate clean fill from an on-site location, or use contaminated site soil as engineered fill.

Analysis of the options for the sourcing of the required fill materials to support cell waste placement concluded that an additional lifecycle savings of more than $217 million occurs by the excavation of contaminated soil from impacted groundwater areas and selected landfills immediately adjacent and actively contributing to these plumes. Removing this environmental contamination significantly reduces and potentially eliminates DOE’s ongoing groundwater restoration obligations as well as minimizes the S&M requirements on closed landfills.

There is considerable information, including information about site conditions (Figure 1), that must be collected before a final decision on whether to excavate the landfills and use contaminated soil associated with groundwater plumes as engineered fill. Each decision regarding the excavation of an individual landfill or using an individual plume as a source of engineered fill will be done on a case-by-case basis with more detailed cost and environmental-specific information and with careful consideration of those details.

If future information or funding availability limits the ability of DOE to successfully use contaminated soil as engineered fill in an OSWDF, clean soil would likely be used instead, either temporarily or for the remainder of the project.

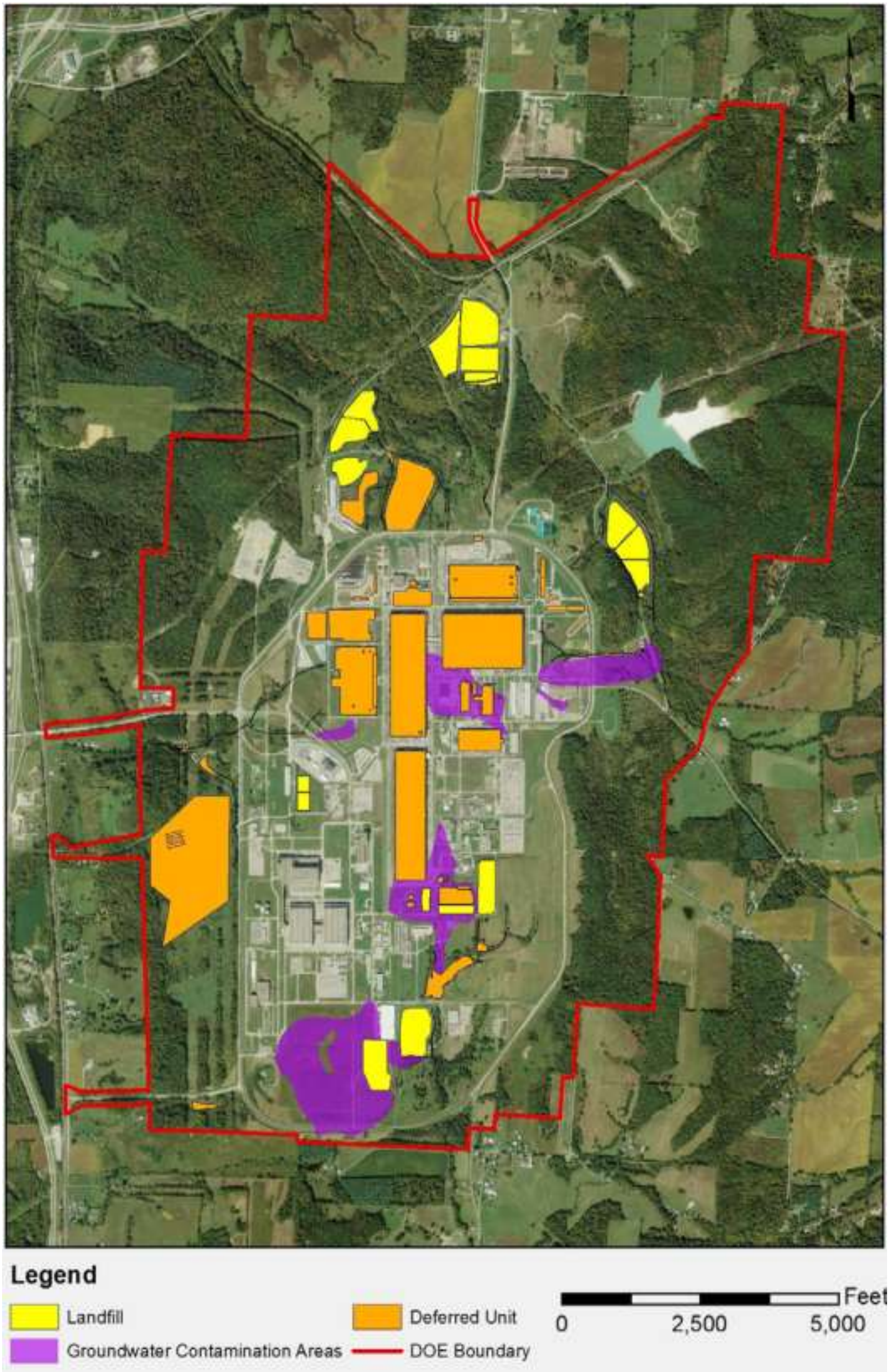


Fig. 1. PORTS Landfills, Groundwater Plumes, and Deferred Units

Regulatory Framework

There are a number of regulatory decisions necessary to support the PORTS site remediation strategy. These regulatory decisions will be made under primary regulatory drivers: the DFF&O (three decisions), the 1989 Ohio Consent Decree, and the 1997 U.S. Environmental Protection Agency (EPA) Administrative Consent Order (two decisions). Table 1 summarizes the decision-making framework at PORTS and describes how the decisions under the three primary regulatory drivers

TABLE I. PORTS Regulatory Framework Summary

fit together to deliver the site remediation strategy.

Decision Category	Regulatory Driver	Regulatory Decision Type	Scope of the Decision	Anticipated Date
1. Soil Remediation Decision	1989 Ohio Consent Decree, 1997 EPA Administrative Consent Order	Decision Document; issued by Ohio EPA	Final cleanup levels for soil protective of human health and the environment; final soil volumes and cleanup locations; disposal locations for excavated soil; closeout of remaining RCRA solid waste management units; final land use/end state and institutional controls.	TBD
2. Groundwater Remediation Decision	1989 Ohio Consent Decree, 1997 EPA Administrative Consent Order	Decision Document; issued by Ohio EPA	Final cleanup levels for groundwater; remedial technologies and cleanup locations; disposal locations for associated cleanup wastes.	TBD
3. D&D of 46 Support Buildings	2010 DFF&O	CERCLA Removal Action; Action Memorandum issued by DOE	Early D&D of 46 buildings listed in Attachment G of the DFF&O. Referred to as the "Balance of Plant" D&D Decision. Waste disposed off site until DFF&O Waste Disposition Decision, then will be managed consistent with that decision.	Action Memorandum was issued March 2012
4. D&D of Main Process Facilities and All Other Support Facilities	2010 DFF&O	CERCLA Remedial Action; ROD issued by DOE	Final D&D of all remaining PORTS buildings and structures listed in Attachment H of the DFF&O. Waste will be managed consistent with the DFF&O Waste Disposition Decision.	2014
5. Waste Disposition Decision	2010 DFF&O	CERCLA Remedial Action; ROD issued by DOE	Site-wide on-site or off-site waste disposal decision; disposition of DFF&O D&D wastes; planning for other site-wide cleanup wastes.	2014

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D = decontamination and decommissioning
DFF&O = *The April 13, 2010 Director's Final Findings and Orders for Removal Action and Remedial Investigation and Feasibility Study and Remedial Design and Remedial Action, including the July 16, 2012 Modification thereto*
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
Ohio EPA = Ohio Environmental Protection Agency
PORTS = Portsmouth Gaseous Diffusion Plant
RCRA = Resource Conservation and Recovery Act of 1976, as amended
ROD = Record of Decision
TBD = to be determined

Working together, these regulatory decisions will remove the threats to future human health and the environment and provide the best opportunity to support the footprint reduction and the future vision for the site.

While formally making the disposal decision for the DFF&O D&D waste volumes, as part of its scope and role, the waste disposition decision creates a platform to evaluate other waste streams expected to be generated through the cleanup of the GDP under other regulatory processes. These waste streams include the expected generation of contaminated soil associated with the cleanup of uncharacterized solid waste management units underlying former GDP processing facilities.

Cost of Engineered Fill Options for the OSWDF

Several viable options for obtaining engineered fill are available. They consist of: (1) buying clean engineered fill from off-site sources, (2) generating clean engineered fill from on-site source areas (e.g., developing a new borrow area), and (3) using contaminated soil from various locations across the PORTS reservation. This third option brings with it the potential of reducing future operating costs associated with previous or upcoming RCRA decisions for groundwater and landfills.

The costs in this section are only for finding or creating the engineered fill and transporting it to the OSWDF. All of the estimates assume that placement in the OSWDF is part of the OSWDF operations costs. The estimates in this section are only the short-term costs of obtaining engineered fill. The cost bases are from the *Remedial Investigation and Feasibility Study Report for the Site-Wide Waste Disposition Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio*, [4] dated February 27, 2014, for obtaining contaminated soil and from historical project baseline estimates for purchasing or generating clean engineered fill. These estimates are roughly +50/-30 percent accurate.

All engineered fill options are assumed to occur on the same schedule, with the last engineered fill placed in 2038.

Buying Clean Engineered Fill from Off-site Sources

Buying clean engineered fill from off-site sources is generally accepted as the lowest cost option in the short-term. This option includes not only the purchase of the soil from off-site sources, but the stockpiling in a clean area and on-site transfer of this material to the OSWDF. Key assumptions for the cost estimate include:

- The fill will be purchased from an off-site local vendor and delivered to an on-site stockpile.
- Stockpile management is included.

- The clean engineered fill from the on-site stockpile will be transported to the OSWDF, as needed.

The present value cost for the use of purchased clean soil as engineered fill material in the OSWDF is $28 million.

Generating Clean Engineered Fill from On-site Sources

Generating clean soil from on-site sources is similar in cost to buying soil. For this option, it is assumed that a new borrow area can be generated from outside of Perimeter Road and provide the required 1.4 million cy.

The soil would be transported to the OSWDF on an as-needed basis. The development of this borrow area, as well as transportation, are included in this estimate. Key estimate assumptions include the following:

- There is at least 1.07 million m^3 of clean soil at one location.
- The soil is of sufficient quality that no processing is needed.
- Soil will be transported to the OSWDF as needed. There will be no intermediate stockpile or second transportation trip.

The estimated present value cost using this clean soil as the engineered fill for the placement of the D&D and landfill debris is $34 million.

Using Contaminated Soil as Engineered Fill from On-site Sources

If an OSWDF is present at PORTS, there is the opportunity to optimize previous cleanup decisions at PORTS involving significant volumes of contaminated media. These cleanup decisions, summarized in the previous subsections, involved capping multiple legacy landfills and relying on long-duration groundwater extraction and treatment technologies to restore affected groundwater in the low-yield, discontinuous groundwater system underlying PORTS.

It has been forecasted that groundwater remediation via extraction and treatment could take up to 300 years to fully restore the affected groundwater because of the low-yield properties of the system. Minimizing active groundwater restoration is projected to significantly decrease the lifecycle costs at PORTS. For this reason, the impacted soil associated with the groundwater is viewed as a viable and preferred source of the engineered fill for the OSWDF.

When determining the available volumes of contaminated soil associated with groundwater plumes to satisfy the engineered fill demands, an assumption had to be made. The volume assumption, to minimize future costs, is based on removing sufficient secondary source material that groundwater drinking water levels could be achieved within 10 years after excavation using Monitored Natural Attenuation (MNA). Plume remediation is assumed to transform from active extraction and treatment to MNA once the impacted soil associated with groundwater concentrations greater than approximately 50 ppb (a low and conservative value) has been removed.

The volumes in Table 2 are based on excavating remaining soil in the groundwater plume after landfill excavation to the 50 ppb contour.

TABLE II. Contaminated Soil from Groundwater Plumes as Sources of Engineered Soil Requirements

AREAS	CONTAMINATED SOIL (USED AS FILL) (m^3)
X-701B	284,000
X-740 AREA	10,700
X-749/120 AREA	433,000
7-UNIT AREA	220,000
5-UNIT AREA	191,000
TOTAL	1,138,700

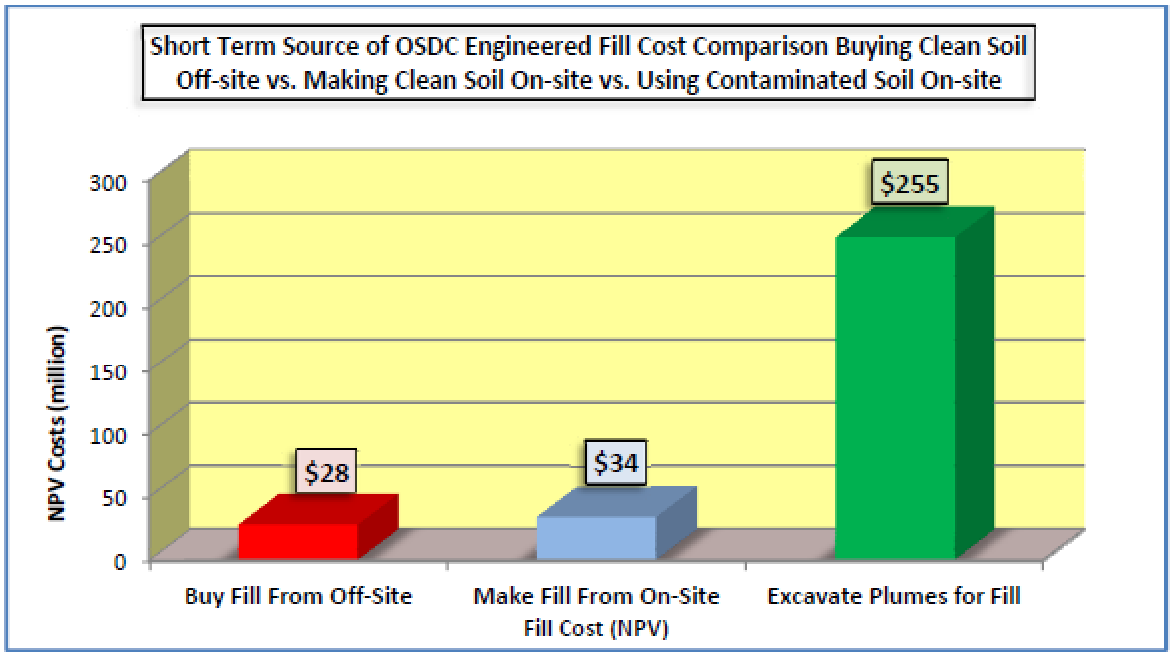
The scope of this action and estimate includes characterization, excavation of remaining contaminated soil associated with groundwater contamination (after landfill excavation), treatment (as needed), water management, transportation, stockpile management, and 10 years of groundwater monitoring after excavation.

When completed, it is anticipated that drinking water standards will be met in the groundwater and there will be no remaining groundwater environmental liability to DOE, thus all extraction and treatment operations can cease. The required amount of engineered fill soil for the OSWDF is met with remediation of all five plumes. Key assumptions used to develop these estimates are as follows:

- The landfills and soils associated with capturing contamination to depth and providing for a safe excavation are not considered in these volumes or estimates.
- The volumes are based on removing all soil contaminated with TCE above the 50 ppb level (excluding the volume above). Capturing the TCE contamination will also capture any other contamination.
- The clean overburden from the plume excavation is set aside for eventual use in restoring the site.
- Sampling and water management costs through the purchase and operation of a mobile treatment unit are included.
- Some of the contaminated soil requires treatment prior to use in the OSWDF to meet assumed Applicable or Relevant and Appropriate Requirements (ARAR)-based Waste Acceptance Criteria (to be set in future regulatory documents).
- No mobilization of excavation equipment is included. Once the landfill soil or deferred unit soil has been excavated, excavation for soils associated with plumes will continue with no re-start of the project.

- The staged plume clean overburden will be replaced in the excavated areas and the area restored to allow drainage. Only recontouring is assumed to be needed; no clean fill will need to be brought to the site.
- The schedule of each plume excavation is integrated with the demand of engineered fill caused by debris waste generation.
- Drinking water standards can be met in each plume within 10 years of the time excavation is complete. Monitoring of groundwater conditions will use the remaining existing monitoring well network and will conclude after 10 years.

The total net present value cost of using soil associated with contaminated groundwater plumes as engineered fill is estimated to be $255 million. Figure 2 presents a short-term cost comparison between the three engineered fill options.



OSDC = on-site disposal cell NPV = net present value

Fig. 2. Short-Term Costs of Engineered Fill Options in Net Present Value

Impacts on Lifecycle Costs for Engineered Fill Options

Although the short-term costs of using contaminated soil as engineered fill are greater than buying or making clean engineered fill, intuitively removing contamination from the environment would introduce cost savings in the long-term elsewhere in the program.

For the ‘use contaminated site soil’ option, the long-term costs will be developed below, as these long-term costs are impacted positively by this third option to obtain engineered fill.

Life-cycle Costs of Buying Clean Engineered Fill

The cost of buying engineered fill from a local off-site vendor is $28 million. However, as this option does not impact the existing cost profile for the groundwater treatment operations and maintenance for the site's groundwater plumes, the long-term cost impact associated with this option is $604 million.

Therefore, the total lifecycle net present value cost associated with this option is $632 million ($28 million + $604 million).

Lifecycle Costs of Generating Clean Engineered Fill

The cost of making engineered fill from a location on the PORTS site is $34 million. However, as this option does not impact the existing cost profile for the groundwater treatment operations and maintenance for the site's groundwater plumes, the long-term cost impact associated with this option is the $604 million.

Therefore, the total life-cycle net present value cost associated with this option is $638 million ($34 million + $604 million).

Lifecycle Costs of Using Contaminated Soil as Engineered Fill

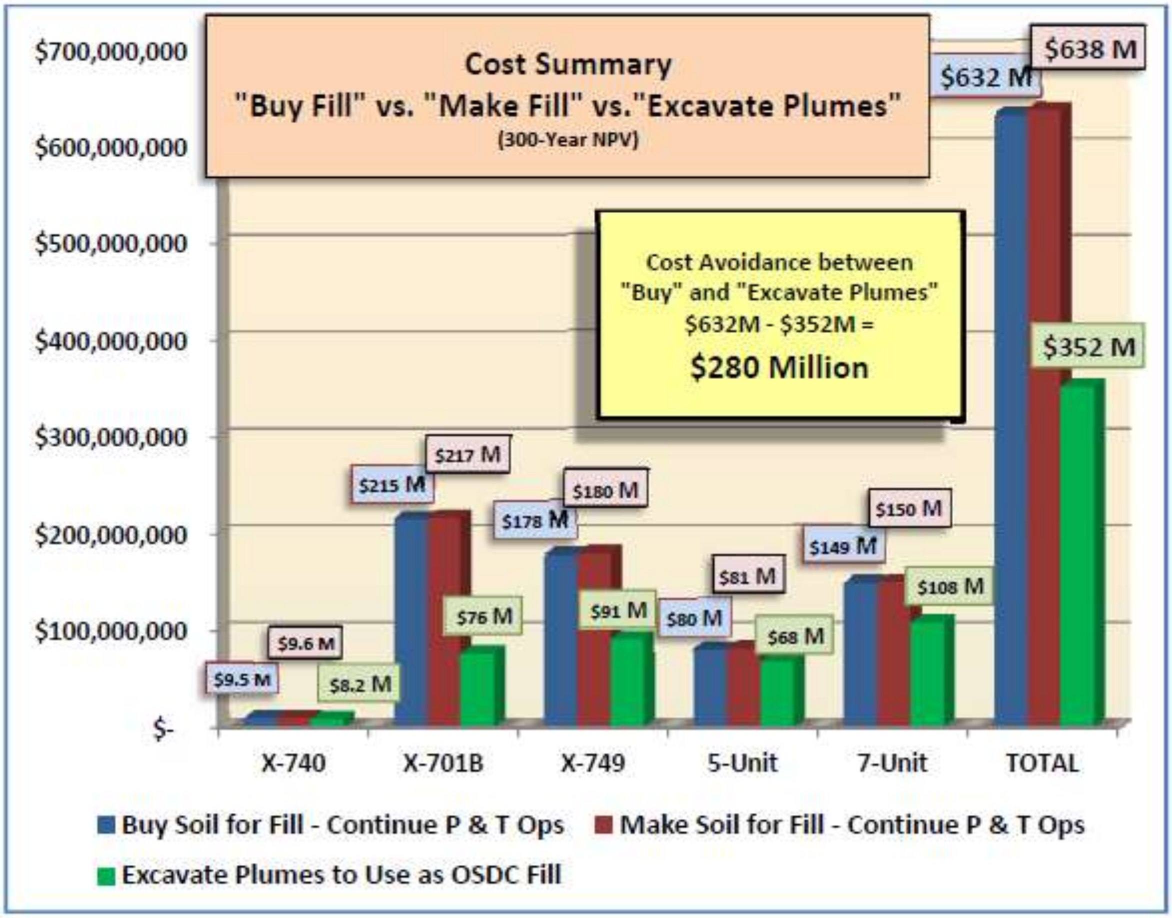
The cost of using contaminated soil from the groundwater plumes on the PORTS site is $255 million. However, this option significantly impacts the long-term groundwater operations and maintenance cost. The current obligations are maintained only until the target contaminated soil has been removed. At that point, monitoring to track MNA success is assumed to occur for 10 years post excavation. Following the 10-year monitoring window, all obligations relative to groundwater are assumed to cease as the contamination is assumed to be gone. The resultant cost for this minimal obligation is $97 million in net present value.

Therefore, the total lifecycle net present value cost associated with this option is $352 million ($255 million + $97 million).

Lifecycle Cost Comparison

Figure 3 shows a comparison of the fill options for each plume and provides an estimate of the cost of obtaining the quantity of fill associated with each plume plus the groundwater remediation costs associated with each fill option. The use of MNA as the groundwater remedy instead of long-term extraction and treatment more than offsets the extra costs associated with excavating the contaminated soil associated with each groundwater plume, with the offset being more significant for some plumes (such as X-701B) than for others (such as X-740).

However, for all plumes, the lifecycle costs associated with using contaminated soil as fill is less. Shown in Figure 3 below, the result of this comparison shows that $280 million can be avoided by using contaminated soil from the groundwater plumes as engineered fill for the OSWDF.



NPV = net present value
OSDC = on-site disposal cell
P&T = pump and treat

Fig. 3. Present Value Costs for Each Fill Option by Plume

RESULTS AND CONCLUSIONS

The reasons for selecting contaminated soil as the engineered fill for planning purposes for the OSWDF are presented below. Also presented is the path forward for obtaining regulatory approval.

Business Case Recommendation for Engineered Fill

The holistic comparison of the options conducted, regardless of regulatory authorities and programs, demonstrates that although the initial cost of using contaminated soil as engineered fill for the OSWDF is well above that of the clean fill options, the long-term benefits are significant. Therefore, the initial investment cost to use contaminated soil as engineered fill is not only recovered, but this action projects a cost avoidance to the government as shown in Figure 4.

This figure shows the cost avoidance from using contaminated soil as engineered fill for the OSWDF is $280 million (net present value). However, there is an incremental cost for consolidating the landfills inside Perimeter Road of $63 million (net present value). Therefore, the net cost avoidance for consolidation of the landfills and using contaminated soil from the groundwater plumes is $217 million.

Fig. 4. Total Cost Avoidance from Landfill Consolidation and Plume Excavation

After evaluating all the information, it is recommended that contaminated site soils associated with the groundwater plumes be used as the preferred source of engineered fill for the OSWDF, which necessitates the removal of five landfills within Perimeter Road as sources to the contamination within the plumes.

Each plume has a different cost benefit associated with the fill decision, as was shown in Figure 3.

Removing landfills and contaminated soils associated with the groundwater plumes to levels that will allow for natural attenuation of contamination levels to drinking water standards within 10 years, DOE will minimize the environmental liability at PORTS, consistent with DOE-EM's mission.

Reaching drinking water standards quickly also supports DOE's commitment to restoring groundwater to beneficial use and addresses one of the greatest environmental threats at PORTS. The use of the contaminated soil as engineered fill maximizes the effectiveness of the OSWDF, as valuable capacity is not used by clean soil. DOE will have the added benefit of being consistent with stakeholder input by providing the community with a site that can be readily redeveloped by private industry.

The decision at this stage is still a planning decision. The removal of the five landfills inside Perimeter Road and the contaminated soil associated with groundwater contamination was used as a representative process option in the waste disposition Remedial Investigation/Feasibility Study (RI/FS), proposed plan, and ROD and has been added to the lifecycle plan. A representative process option means that a technology has been assumed for the purposes of evaluating an alternative against the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) criteria, but that any of the other technologies that it represents (in this case the use of clean engineered fill), can ultimately be used.

Important in this decision is the recognition that the D&D and OSWDF projects are still early in the planning stages. There is considerable information including subsurface contamination and landfill content information that must be collected before this decision to use contaminated soil as engineered fill can be implemented.

There will always be unknowns associated with any subsurface actions, so as the project is implemented, there is still the chance that unexpected conditions could arise. If any condition arises in the future that does not support continued implementation of this recommendation, the option to divert to using clean soil as engineered fill exists, either temporarily or for the rest of the project.

REFERENCES

1. The April 13, 2010 Director's Final Findings and Orders for Removal Action and Remedial Investigation and Feasibility Study and Remedial Design and Remedial Action, including the July 16, 2012 Modification thereto (DFF&O) (Ohio EPA 2012)

2. Record of Decision for the Site-Wide Waste Disposition Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio (DOE/PPPO/03-0513&D2) dated June 30, 2015

3. Business Case for the Excavation of Select Landfills and Impacted Soil Associated with the Groundwater Plumes for Use as Fill in an Engineered On-Site Disposal Facility at the Portsmouth Gaseous Diffusion Plant, Piketon Ohio (FBP-ER-RCRA-WD-RPT-0110, Revision 3) dated October 2013

4. Remedial Investigation and Feasibility Study Report for the Site-Wide Waste Disposition Evaluation Project at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio (DOE/PPPO/03-0246&D3) dated February 27, 2014

5. Supplement to the Remedial Investigation and Feasibility Study Report for the Site-Wide Waste Disposition Evaluation Project: Proposed Corrective Action Management Unit and Area of Contamination Designations for Alternative 2 at the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio (DOE/PPPO/03-0646&D1) dated October 21, 2014

TABLES

FIGURES