Integration between Performance Assessments Does Not Equal Duplication – 14577

Kent Rosenberger, Savannah River Remediation

ABSTRACT

Performance Assessments (PAs) with the U.S. Department of Energy (DOE) complex are performance-based, risk-informed analyses of the fate and transport of contaminants used to support decision making. Within the DOE complex there exist similar facilities at various operations sites. For example, liquid waste storage tanks exist at the Savannah River Site, Hanford Site and the Idaho Site. Because the facilities are all liquid waste tanks in the DOE complex there is a tendency to believe that parameters associated with all PAs developed for decision making purposes should be the same. This is especially true regarding modeling assumptions associated with engineered features and barriers. Hence a generalization that integration between sites might equate to duplication of some key modeling parameters.

INTRODUCTION

As PAs are performance-based, risk-informed analyses of the fate and transport of contaminants, modeling must utilize numerous inputs regarding the nature of the contaminants, the engineered barriers surrounding the contaminants and the natural system (see Figure 1). The nature of these inputs can vary not only from site to site but also at various facilities at an individual site. The specifics of a site's natural system can dictate the level of reliance on engineered barriers and thus the amount of model support for the modeling parameters. The three categories of modeling inputs will be discussed as they relate to integration of modeling activities and how integration does not equal duplication.

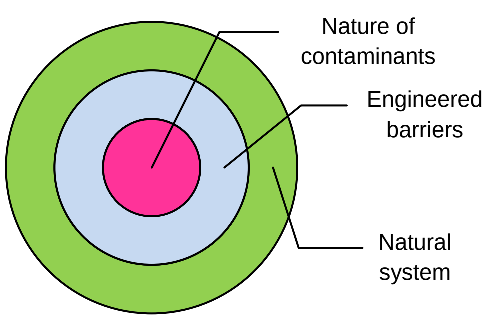


Fig. 1. Modeling Integration.

DISCUSSION

Nature of Contaminants

The nature of the contaminants being modeled will vary between facilities. As an example, in the closure of liquid waste storage tanks cleaning is typically accomplished with the use of large volumes of water and/or chemicals. Therefore the residual material under evaluation in the closed tanks are solids that are modeled as having releases that are solubility controlled, as the soluble fractions have been removed during cleaning. In facilities that dispose of low-level liquid wastes the contaminants are typically soluble due to the nature of waste processing prior to disposal. Due to the nature of the contaminants, the amount of uncertainty, and thus the amount of necessary model support, varies as modeling a solubility controlled release requires a solubility limit input that requires knowledge or assumptions as to the form and chemistry of the residual solids.

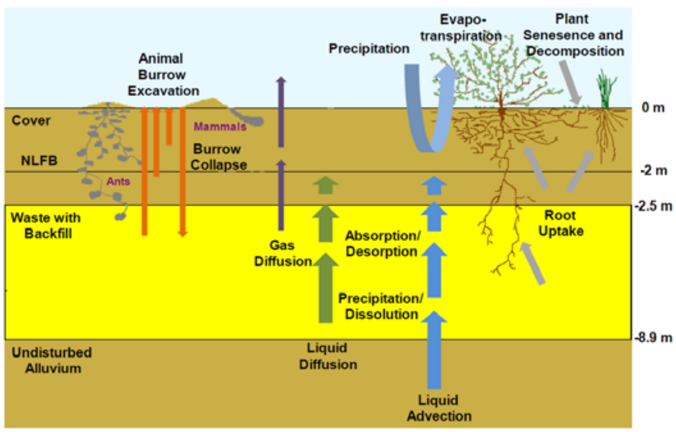
The long term behavior of the contaminants is also important to the conceptual model. The radionuclides being modeled could include those with short half-lives relative to the modeling times (i.e., Cs-137 or Sr-90), long half-lives (i.e., Pu-239, Tc-99 or I-129) and/or could include radionuclides that produce risk-significant decay products over time (i.e., depleted uranium). The level of model support may be driven by the time period over which the contaminants are in risk-significant quantities. Understanding the nature of the contaminants as it relates to releases from the system over time is a foundation for the overall conceptual model and can vary greatly between PAs.

Engineered Barriers

Engineered barriers may exist that can delay the transport of the residual contaminants from their location at the time of closure to the natural system. These barriers could include materials such as cementitious materials used to stabilize the closed system or as the waste form itself, a steel tank liner that had the operating purpose of containing liquids or a concrete enclosure surrounding a tank or cementitious waste form. The level of necessary reliance on these barriers can be driven by either the nature of the contaminants or the natural system conditions or both. The considerations in modeling engineered barriers has to include not only their initial conditions and properties at the time of closure but also how these conditions and properties can change over time, which may include many thousands of years. If the barriers are not critical to a risk decision due to the nature of the contaminants or the natural system, then models can either ignore the barriers completely or assume they are not present after a certain time period such as 500 years. If the barriers are important to making a risk decision, the amount of model support and therefore the complexity of input parameter development may increase significantly.

For example, if the modeling of closed tank systems includes the steel tank liners as an engineered barrier, one must consider initial conditions of the liner such as any discontinuities/ penetrations that can influence flow and transport. The modeling over time must consider the initial conditions such as liner thickness, materials of construction and system chemistry to determine degradation rates that can be influenced by changing system chemistry. [1] As tank liners may be constructed of either carbon steel or stainless steel the nature of degradation rates over time may be significantly different. This level of input parameter development is much more complicated than assuming a barrier does not exist and requires a higher commitment of time and resources.

Another example is the use of an engineered closure cap/cover placed over the facility. Most closure and disposal facilities include a cover but the nature of its performance and thus the complexity of the model support can be markedly different. Figure 2 contrasts the level of engineering associated with closure caps at an arid site versus a humid site. At arid sites the necessary performance property of a closure cap may be simply to provide a barrier to eliminate direct contact with the residual contaminants or provide radiation shielding. If this is the nature of the performance then the model support necessary may be to simply show that the cover thickness will not erode over time due to natural processes. At a humid site the closure cap may provide a distance and shielding function but also is necessary to reduce the amount of infiltrating water over long periods of time. Therefore rather than being simply a soil layer, the closure cap may be a complicated system of various layers that perform various functions such as erosion control, evapotranspiration or drainage over long time periods all with the purpose of minimizing the overall infiltration rate. [2] Again, the level of input parameter development and commitment of time and resources is driven by the necessary reliance on the barrier.



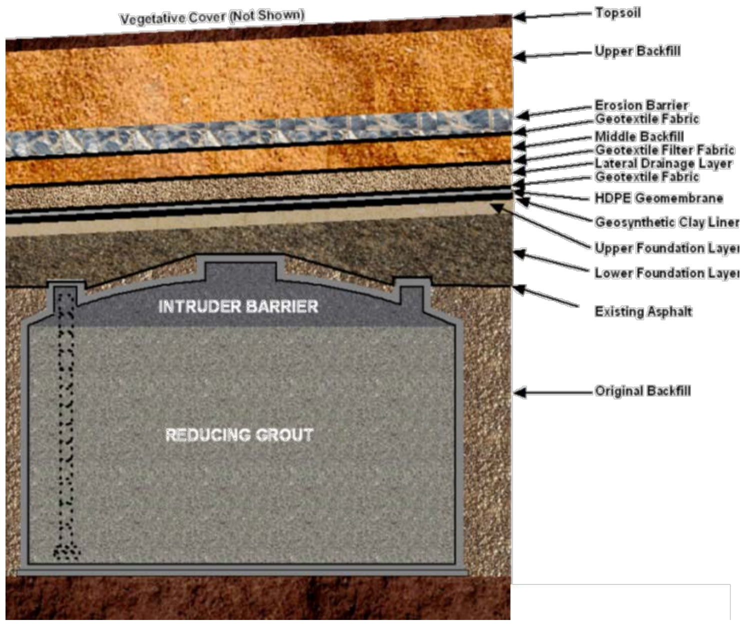


Fig. 2 – Comparison of Arid (Top) Versus Humid (Bottom) Site's Closure Caps

Natural System

While there is effort required to define the natural and input parameters necessary to model a site's natural system, the natural system can have less modeling uncertainty than the long-term nature of the contaminants and the performance of engineered barriers. Therefore, the natural system at a particular site can be the most important parameter to performing PA modeling to arrive at a risk-informed decision and save considerable resources with the reduction in reliance on engineered barriers.

An excellent example of DOE sites with dramatically different natural systems are the Savannah River Site and the Nevada Nuclear Security Site. [3] The Savannah River Site is located in the Southeastern United States and is a humid site. The Nevada Nuclear Security Site is located in the Western United States and is an arid site. Table 1 provides a comparison of some of the key natural system parameters.

Table 1. Comparison of natural systems at the Savannah River Site and Nevada Nuclear Security Site

Natural System Parameter	Savannah River Site	Nevada Nuclear Security Site
Depth to groundwater	Facilities range from within groundwater to < 15 meters (50 feet) above	> 213 meters (700 feet)

Annual rainfall	~ 124 cm (49 inches)	~ 12.7 cm (5 inches)
Natural annual infiltration	~ 41 cm (16 inches)	~ 0 cm
Exposure pathways	Groundwater, intrusion and air pathways	No groundwater pathways, intrusion or air pathways only

As suggested by the natural system comparison, PA modeling at the Savannah River Site tends to take greater credit for engineered barriers as the attributes of the natural system provide less long-term protection than at the Nevada Nuclear Security Site. Without any appreciable water infiltration and a significant depth to groundwater, the Nevada Nuclear Security Site does not have exposure pathways associated with a contaminated groundwater pathway and thus does not require any reliance on engineered barriers from advective contaminant movement. An engineered barrier for protection against intrusion can thus be a relatively simple protective barrier and will not require the level of model support as a barrier to advective movement that is relied upon at the Savannah River Site. Therefore one should expect that the commitment of time and resources for ongoing maintenance activities related to model support would be greater for the Savannah River Site than the Nevada Nuclear Security Site.

CONCLUSIONS

Three key aspects of the PA conceptual modeling at a site include the nature of contaminants, engineered barriers and the natural system. As has been discussed, the nature of these inputs can vary not only from site to site but also at various facilities at an individual site. Examples have been provided that examine how the specifics of a site's natural system can dictate the level of reliance on engineered barriers and thus the amount of model support for the modeling parameters. It is the responsibility of the PA professional to understand how modeling for individual facilities may have similar features as others but may have very different modeling input parameters. Hence, this understanding will enable one to realize that integration between PAs does not equal duplication.

REFERENCES

1. Savannah River Remediation, *Performance Assessment for the F-Tank Farm at the Savannah River Site*, SRS-REG-2007-00002, Revision 1, March 2010.

2. M. A. Phifer, *FTF Closure Cap Concept and Infiltration Estimates*, WSRC-STI-2007-00184, Revision 2, October 2007.

3. U.S. Nuclear Regulatory Commission, *Transcript of the Advisory Committee on Reactor Safeguards Radiation Protection and Nuclear Materials Subcommittee – November 19, 2013*, Accession Number ML13339A891, 2013.