CHPRC-02377
Revision 0

Three-Dimensional Modeling: Communicating Risk to Inform Site Cleanup Priorities-15238

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
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Three-Dimensional Modeling: Communicating Risk to Inform Site Cleanup Priorities – 15238

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ABSTRACT

Three-dimensional waste site models are being created at the Department of Energy's Hanford Site in southeastern Washington State as an important visualization tool for risk communication and remediation planning. When concluded, the user will have a detailed, three-dimensional subsurface view of waste sites, pipelines and facilities located in the Central Plateau portion of the site with respect to a hydrogeologic solids model of the area. This will enhance communication between the site contractor and primary points of contact, such as the government and the public. It will also allow users to plan for future projects to be completed on-site.

INTRODUCTION

The cleanup of several hundred hazardous waste sites is ongoing at the U.S. Department of Energy's Hanford Site located in southeastern Washington State. Plutonium production for the nation's defense left behind more than 56 million gallons of radioactive tank waste, 25 million ft^3 of solid radioactive waste, and groundwater contaminated above drinking water standards at the site. Cleanup decisions for contaminated soil resulting from most of the liquid discharge sites in the Central Plateau, such as cribs, ponds, and ditches remain to be made. Public and government (local, state, and federal) participation continues to be vital to the success of the environmental cleanup efforts as those cleanup efforts progress. A clear understanding of where the waste and contamination is located and what processes will be put in place for remediation are important to facilitate technical and budgetary decisions regarding Hanford environmental cleanup. The DOE Contractor CH2M HILL Plateau Remediation Company (CHPRC) is using innovative computer modeling technology to construct three-dimensional (3-D) models of the Central Plateau waste sites and facilities to cultivate that understanding and facilitate waste site remedial actions.

METHODS

The waste site models were created using AutoCAD® Maps 3-D (1) and Leapfrog® Hydro (2) computer software. The individual waste site models were generated in AutoCAD® using data (including coordinates and mapping information) taken from the original 2-dimensional (2-D) maps, sections, and engineering drawings of the waste sites that were generated for construction. These documents dated back to the 1940s in some cases. Data was also extrapolated from QMAP® (3), a 2-D virtual mapping application developed for the Hanford site, and other available data sources. These sources enabled conformance to published waste site dimensions and location coordinates, allowing accurate model depictions relative to size and location. The waste site data may also be taken from previously created electronically available 2-D shape files by copying and pasting the available individual waste sites into a new electronic map and using the software “extrude” tool to construct the third dimension (i.e., vertical extent) (Fig. 1.).

Fig.1.-Extruding a Rectangular Waste Site Shape File.

Once the waste site framework was mapped out, details were added to show the tangible features within each waste site in order to provide the user with a representative view of the site’s interior, including piping and other engineered features. In addition to the liquid discharge sites, a complex network of underground piping is located on the Central Plateau connecting facilities, waste tanks, and waste sites. AutoCAD Map 3D files are also currently being developed for a substantial part of the pipeline network. Infrastructure elements, such as underground water, sewer, and power lines are being incorporated into specific areas where detailed remediation planning is underway.

The individual waste site 3-D representations were then transferred to the Leapfrog 3-D modeling software for insertion into the properly scaled and sized hydrogeologic solid model. The solids model was created using spatial information obtained from boreholes and other geophysical investigation techniques as well as previous knowledge about Hanford Site geology.

A log is currently being kept detailing the maps and drawings used, assumptions made, quality assurance notes and any other vital information associated with the creation of that specific map layer or 3-D waste site (Table 1). The log is also being used to track progress towards completion of the full inventory of waste sites that need AutoCAD files. This data will be documented in an engineering calculation file to ensure reproducibility and traceability of this process.

Site Code	Site Type	Outline	Solid	Details	Comments
218-E-12B	Burial Ground	Sasa	Sasa		
216-T-4A	Pond	Yes	Yes	Complete	Shape file was used to draw the pond. Elevation (670 ft) and depth (4ft) were taken from "Notes on 216-T-4A" in the WIDS library.
216-T-4B	Pond	Yes	Yes	Complete	Shape file was used to draw the pond. Elevation (670 ft) and depth (4ft) were taken from "Notes on 216-T-4A" in the WIDS library since 4B did not have any specific documentation referancing the elevation or depth.
216-T-4-2	Ditch				
218-E-4	Burial Ground	Yes	Yes	Complete	Assumed elevation based off 200-E-188-PL which is located right next to the site.
218-E-5	Burial Ground	Yes	Yes	Complete	Found coordinates using map "H-2-55534".
218-E-2A	Burial Ground	Heather	Heather	Complete	Wrong coordinates

Key	
(green)	Corrections Needed
(yellow)	In Progress
(blue)	Completed
(red)	Incomplete

TABLE 1-Sample Tracking Log for Waste Site AutoCAD files

Data entered into the 3-D solids models will provide for accurate spatial relationships between the waste sites, surrounding waste sites and other infrastructure, vadose zone lithology, and the deeper unconfined aquifer. All data and relationships will be available for use in remedial activities. Data available on subsurface contaminant distribution is also being incorporated directly into the Leapfrog model. The initial models can be expanded to include a greater level of detail as time and resources allow. The evolving 3-D model provides a highly accurate visual depiction of subsurface waste sites and their relationships to other Hanford Site facilities.

DISCUSSION

1. Risk Communication Tool

The model will provide a unique tool for communicating waste site spatial information (both extent and relationship to geologic media and facilities), simplifying the difficulties related to presenting large data sets to local, state, and federal governments, tribal nations, stakeholders, and members of the public. The utility of this innovative approach is that it will enable DOE to communicate the problems visually, and comprehensively, using the data's 3-D spatial relationships to explain, easily understand, and address the problems, and to develop the appropriate remedial solutions. This 3-D model will provide a communication tool to allow for more timely and effective presentation of complex waste site datasets and issues. This tool will facilitate more effective participation by regulators and stakeholders, enabling more informed decision making to achieve cleanup priorities by providing involved parties with a better understanding of the waste sites and related hydro-geologic complexities that control potential contaminant migration and offsite impacts. The model can be updated as needed to maintain its relevance as a visualization device as more characterization and remediation is accomplished in future years.

2. Other Uses

The 3-D model will allow for several alternative uses, one of the most important of these being support to remediation planning. The user will be able to evaluate several different remediation plans and alternatives considering the spatial relationship of waste sites to each other and to nearby facilities and infrastructure elements, helping them to weigh different options and solutions. This visualization capability will enable more complete analysis of plans, and interactions associated with implementation of each potential approach. It will also give a clearer insight on the impact a specific remediation approach could have on surrounding sites. This will allow cognizant personnel to make informed decisions about future actions to take.

One current use of the model exists as a visualization tool for construction planning for the Remedial Design/Remedial Action Work Plan being developed for the 200-PW-1/3/6 and 200-CW-5 operable unit on the Hanford Site. In order to properly prepare for potential excavation of contaminated soil required by the Record of Decision (ROD), the team must be aware of potential hazards and objects that could interfere with construction. The model is being used as an instrument to preview excavation sites and plan for any obstacles that could occur within that footprint. It is also enabling the team to visualize and plan remedial activities defined in the ROD, allowing potential issues to be clearly identified ahead of executing work in the field. Remediation approaches can be adjusted as necessary to minimize potentially large financial impacts from the execution of such work.

Several useful analytical tools are being developed as part of the 3-D model that will make use of the extensive software capabilities. A volume calculation tool will allow the user to calculate volumes of soil added or removed from various excavations or fill configurations. The user will be able to evaluate excavation configurations to identify concentrations of specific constituents in the excavated soil supporting waste handling disposition where contaminant distribution data is available and incorporated into the model. Utilizing the model to define zones of contamination allows the user to forecast waste management demands that may come up during remediation. It will also allow for an enhanced financial analysis because volume of soil and the type of transportation needed can be determined using the model.

Figure 2 shows several screenshots from the current version of the 3-D model depicting the spatial relationship of selected key features.

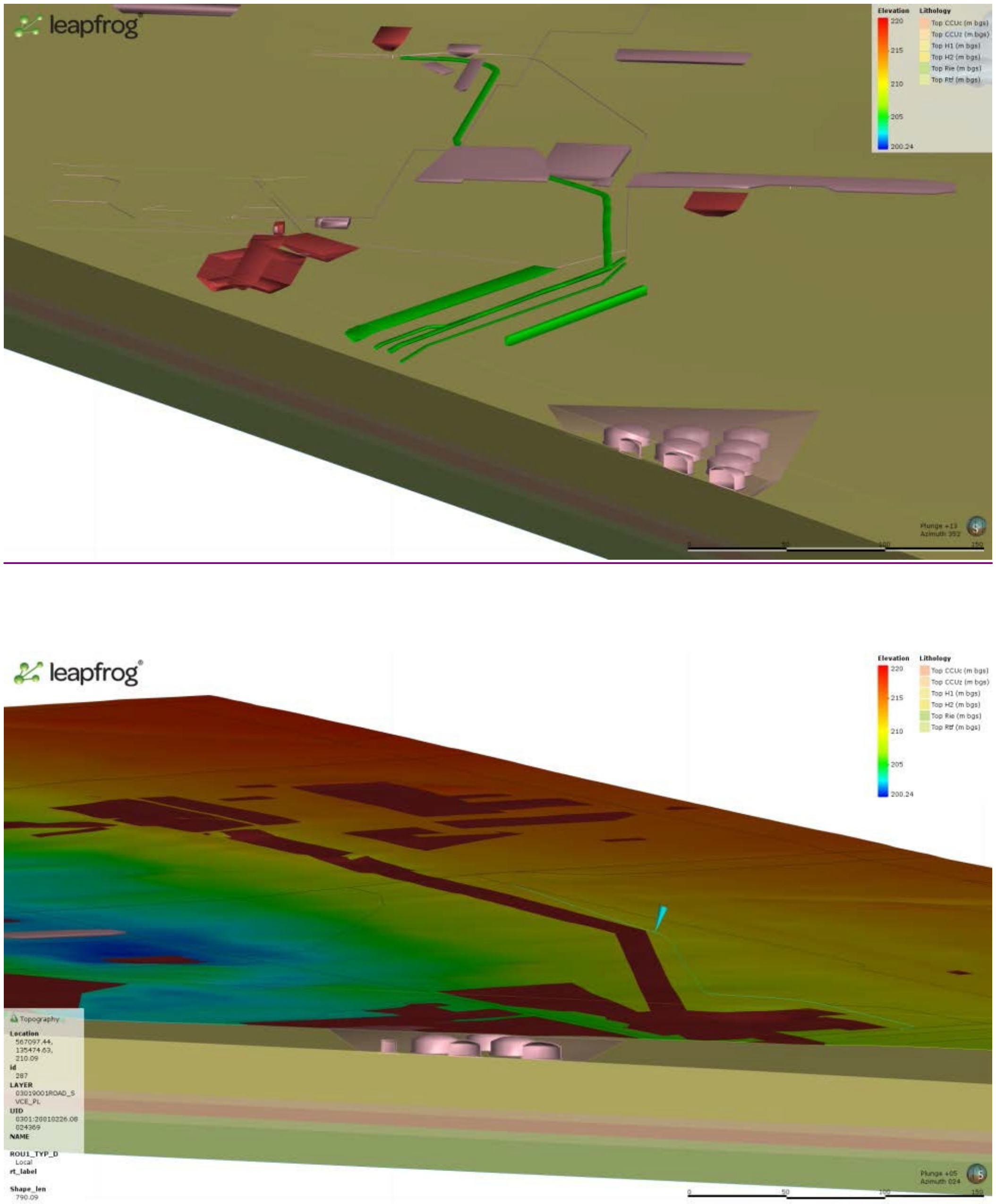

Fig.2.- Two Views of the 3D model Illustrating a Slice Through a Tank Farm and Showing Geologic Layering.

3. Limitations

While this model will allow for a more precise visualization of the Hanford subsurface environment and facilities, it contains several limitations. Inadequacies exist in the solids model because of the difficulties with of the interpretation and depiction of the complex geometry and spatial inconsistency of hydrogeologic materials and structures. Hydrogeologic features are interpolated in some areas as a result of data limitations and simplifications due to a limited number of borehole samples; contaminant distribution data is also limited. Larger data sample sets would contribute to a more accurate contaminant plume representation in the model.

The three-dimensional waste sites also contain data inadequacies resulting from dated or misplaced data. A number of the maps used to generate the elevations and coordinates for the waste sites were original drawings from the 1940’s. This caused discrepancies when comparing the waste sites and the hydrogeologic solids model resulting in certain sites not aligning correctly with surrounding hydrogeologic features and elevation datums in the solids model. Where such misalignments were identified, these were corrected through adjustments made to both the solids surface and the waste site coordinates based on surveying data, surrounding building and ground elevations and a thorough check of assumptions made when models were being created. Adjustments will be made as needed as new data is obtained that can improve the accuracy of the representation.

CONCLUSION

This 3-D modeling approach will provide an improved technique for communicating waste site information including contaminant extent and relationship to geologic setting and facilities and to streamline the presentation of large amounts of information about Central Plateau waste sites. The unique analytical and visualization tools provided by this model will support an array of uses, ranging from remedial planning to defining alternative options, to preparing plans and work scopes, to defining potential environmental and cost impacts.

Communication tools such as this 3-D model will allow for more efficient, timely, and effective presentation of complex waste site issues and improve development of solutions with regulators and stakeholders, enabling informed decision making to achieve cleanup priorities.

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