Increasing Effectiveness of Reviews and Communications at the U.S. Nuclear Regulatory Commission

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Abstract –*Because the U.S. Nuclear Regulatory Commission (NRC) recognizes efficiency is important to stakeholders, it is striving to increase the efficacy with which staff reviews license termination and decommissioning plans. Co-location of staff review team members is necessary efficient communication, c. To effectively communicate among all internal and external stakeholders, additional tools are needed. One tool that has proven effective at the NRC is three-dimensional (3D) geospatial modeling. This paper presents four cases illustrating the uses of 3D modeling to improve efficiency of reviews and communications with stakeholders.*

I. INTRODUCTION

An important goal in the Strategic Plan of the U.S. Nuclear Regulatory Commission (NRC) is to ensure that actions of the Agency are effective, efficient, realistic, and timely. This focus on performance and increasing demands on NRC's finite resources clearly indicate a need for NRC staff to become more efficient in their regulatory review activities in order to increase productivity and quality while reducing cost.

When an operating facility reaches the end of its useful life, the licensee generally wishes to decommission it and terminate any existing NRC licenses. To do so, the licensee must submit a license termination plan (LTP) for a nuclear power plant or a decommissioning plan (DP) for a materials facility. In addition to describing proposed remediation activities, a basic requirement of these plans is that they contain an adequate description of site conditions. This information, known as site characterization data, is obtained in large part by extensive surveys of the site with a variety of instruments. The outcome includes large quantities of data about radiological and chemical status, and physical characteristics of the site. Survey results are often presented in numerical form in lengthy tables that may contain numerous columns and several different sets of units for measured contaminants (e.g., counts per minute for building surveys, millisieverts per gram for soils, and milligrams per liter for water).

II. DISCUSSION OF WORK

A primary purpose of staff review of LTPs and DPs is to determine if the activities proposed in the plans will, in fact, remediate existing contamination to levels required for license termination. Therefore, staff must thoroughly understand current contaminant concentrations, distributions and potential migration pathways. The staff review team includes members with diverse technical specialties such as health physics, hydrology, geology, and dose pathway analysis. Because the NRC recognizes efficiency is important to stakeholders, including Federal, State, and local agencies and the public, the Agency is striving to increase the efficacy with which staff reviews these plans. It is a challenge, therefore, to present the characterization data in a format such that experts can evaluate this information from their particular technical perspective. At sites where contaminants have been released to the subsurface, NRC staff must determine the current extent of the contamination and evaluate past and potential future contaminant transport, including rate, direction, and concentrations.

II.A. Background

Since the 1996 change to NRC decommissioning regulations, license termination is based on calculated dose to the public from residual contamination. Therefore, another outcome of staff review is verification of residual concentrations (i.e., derived concentration guidelines, or DCGLs). The first step is to define acceptable DCGL values based on pathway analysis, taking into account residual isotopes, future land use, and appropriate uptake pathways. In this paper we focus on the second step, to verify that, at completion of remediation activities, the site will meet regulatory limits. The licensee conducts a survey of the site after remediation is complete and submits a report of residual contamination, known as the final status survey report (FSSR). As with the site characterization data, this information is often in the form of lengthy tables. Format of these reports may vary widely from site to site. For example, one licensee may be removing everything from the site, so the FSSR will contain only data on soils and ground water; another may be leaving many buildings, so that report will include data on building surveys. The technical challenge is to determine if the data demonstrate compliance with the specified criteria.

Thorough understanding of site-specific characteristics is necessary to assess potential dose to the public. Effective review and analysis by a multi-disciplinary team of experts requires resources to perform individual tasks for addressing all important aspects of the site and integrating results. Additionally, staff must explain to concerned stakeholders, including the public, how it reached the conclusion that a site is available for unrestricted use. Because each stakeholder group has different types of expertise and perspectives, exchanging technical data alone may not fully communicate information required to address pertinent questions.

As depicted in Figure 1, several levels of interaction exist among people of widely varying technical backgrounds (e.g., staff to staff, staff to NRC management, NRC to licensee, NRC to the public). To enhance internal communication at the NRC, co-location of team members is one key to efficient reviews. To effectively communicate among all internal and external stakeholders, additional tools are necessary.

There are a wide variety of tools and techniques available to enhance communication among peers. One tool that has proven effective at the NRC is three-dimensional (3D) geospatial modeling, a unique technique for assessment and analysis of sites. Converting numerical data to 3D displays provides

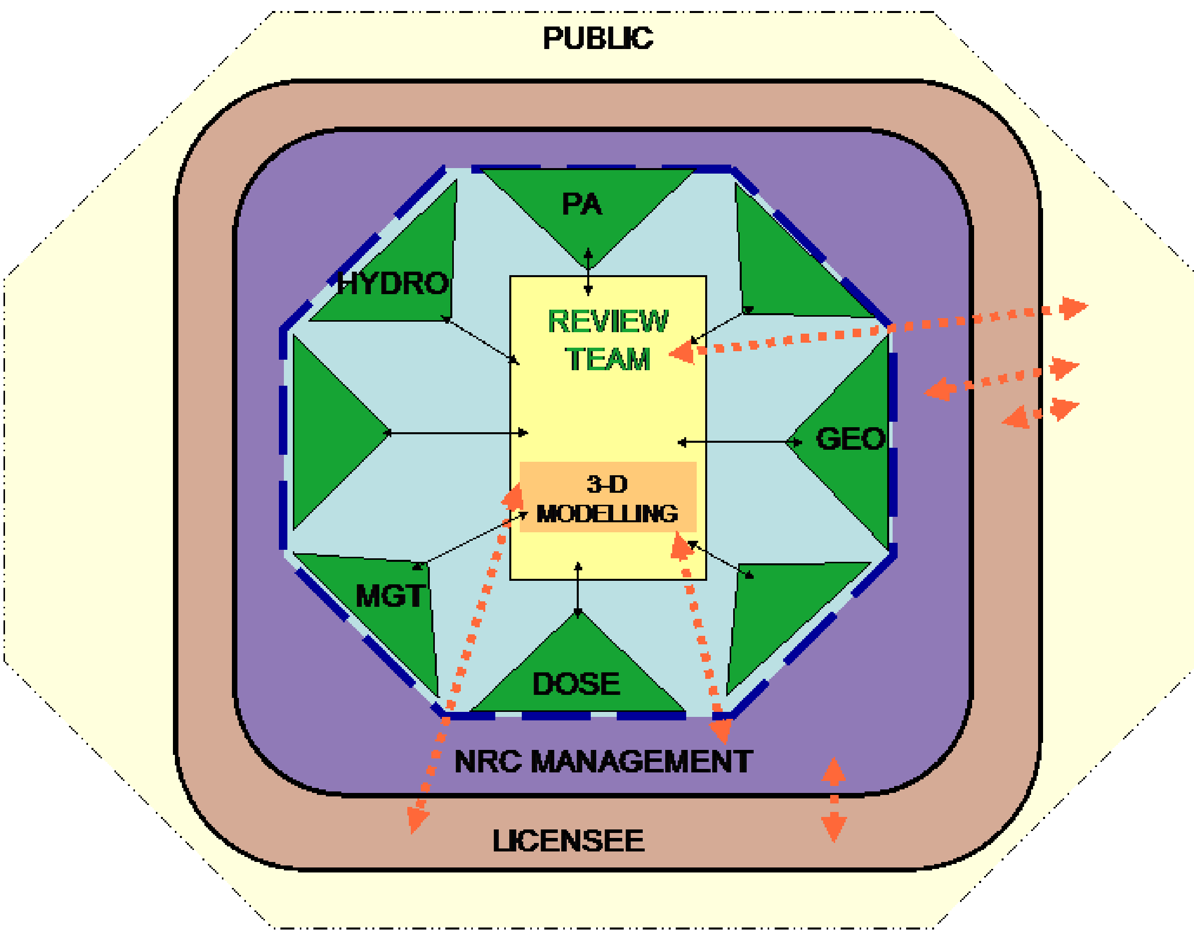

Figure 1. Schematic Diagram of Stakeholder Interactions.

perspectives not possible to achieve with two-dimensional (2D) representations of data. 3D geospatial models can readily be constructed to illustrate site geology and hydrostratigraphy, enabling both internal and external communications about results. These models provide the framework for analyzing and displaying spatial and temporal variations in contaminant plumes which help define potential groundwater flow and transport pathways. Because 3D geospatial models can be employed to display multiple combinations of physical properties and attributes, they can depict complex data in a form comprehendible by experts and non-experts alike. Therefore, this tool is useful for both analysis of site-specific data and conveying results.

II.B. Examples of Applications

To further address technical communication, following are four examples of application of 3D modeling to site analysis performed at the NRC. For a reactor site undergoing decommissioning, information provided by the licensee indicated a relatively complex subsurface stratigraphy which included three water-bearing zones. The middle zone was thin, typically less than 0.5 m (1.5 ft), and at variable depth from the ground surface. The licensee had drilled several wells to monitor contamination in the unit. NRC staff experts in hydrology and geology reviewed the data and determined that a model of this unit different from the one presented by the licensee was credible. Because there was a known release of radioactivity to the subsurface, staff required an accurate description of all possible transport pathways. Staff constructed 3D geospatial models using the licensee's data employing Earthvision software from Dynamic Graphic Inc, in Alameda, CA, to illustrate the location of subsurface hydrostratigraphic units relative to screened intervals of wells at the site. This model indicated a tilt to the unit that was not captured in the model developed by the licensee. By displaying the hydrostratigraphic unit of interest and the screened intervals of existing wells as represented in the NRC model, staff demonstrated the unit was not completely characterized or monitored. This information was presented to the licensee in a timely fashion and, as a result, the licensee drilled three additional wells to better characterize and monitor the unit concurrently with others already planned.

In another case, the site was composed of three aquifers systems separated by aquitards, and the two upper aquifer systems were contaminated by both radionuclides and processing chemicals. The data further indicated vertical communication between the two uppermost aquifer systems. Staff reviewed the data and concluded that models presented by the licensse did not adequately explain the change in subsurface radioactive concentrations over time. Accurate assessment was essential to developing a site model upon which to base a dose analysis. It was also necessary to determine if radionuclides could migrate beyond the site boundaries in concentrations above criteria. Therefore, NRC staff developed 3D geospatial models using a simplified conceptual site model made up of three aquifer systems: terrace (uppermost), shallow, and deep (lowest). The model of the terrace aquifer system showed preferential flow pathways for contaminants that had not been previously defined (Figure 2). The licensee used information on groundwater flow and transport pathways derived from the 3D geospatial models to design monitoring wells and locate characterization trenches and geophysical survey lines at the site. This 3D model resulted in modification of groundwater flow and transport models to reasonably approximate the data. Staff discussed the models with the licensee, its consultants, and local tribal representatives. The models were also presented to peers at technical conferences.

In a third case, after review of a licensee's site characterization data and inspecting 2D maps of survey results, staff concluded that it did not adequately describe portions of the site and should not be accepted for detailled review. NRC management were not fully persuaded by the staff's arguments, and believed that sufficient supplemental data could be obtained through requests for additional information. Staff then constructed 3D models of several distinct areas of the site. The limited data from the licensee did not well constrain extrapolation of the properties in the model. Consequently, unreasonable projections of contaminant concentrations and locations resulted. The model illustrated to NRC management that limitations of the existing site characterization data were significant, and additional characterization was required to accurately evaluate the condition of the site. As a result, NRC elicited a commitment by the licensee to conduct additional characterization, and remediation, as necessary.

Finally, a 3D geospatial property model illustrating surface and subsurface distribution of total uranium was constructed for a sludge storage lagoon excavated into silty clay floodplain deposits at a wastewater treatment plant. Facility operators had disposed of sewage sludge ash by mixing it with

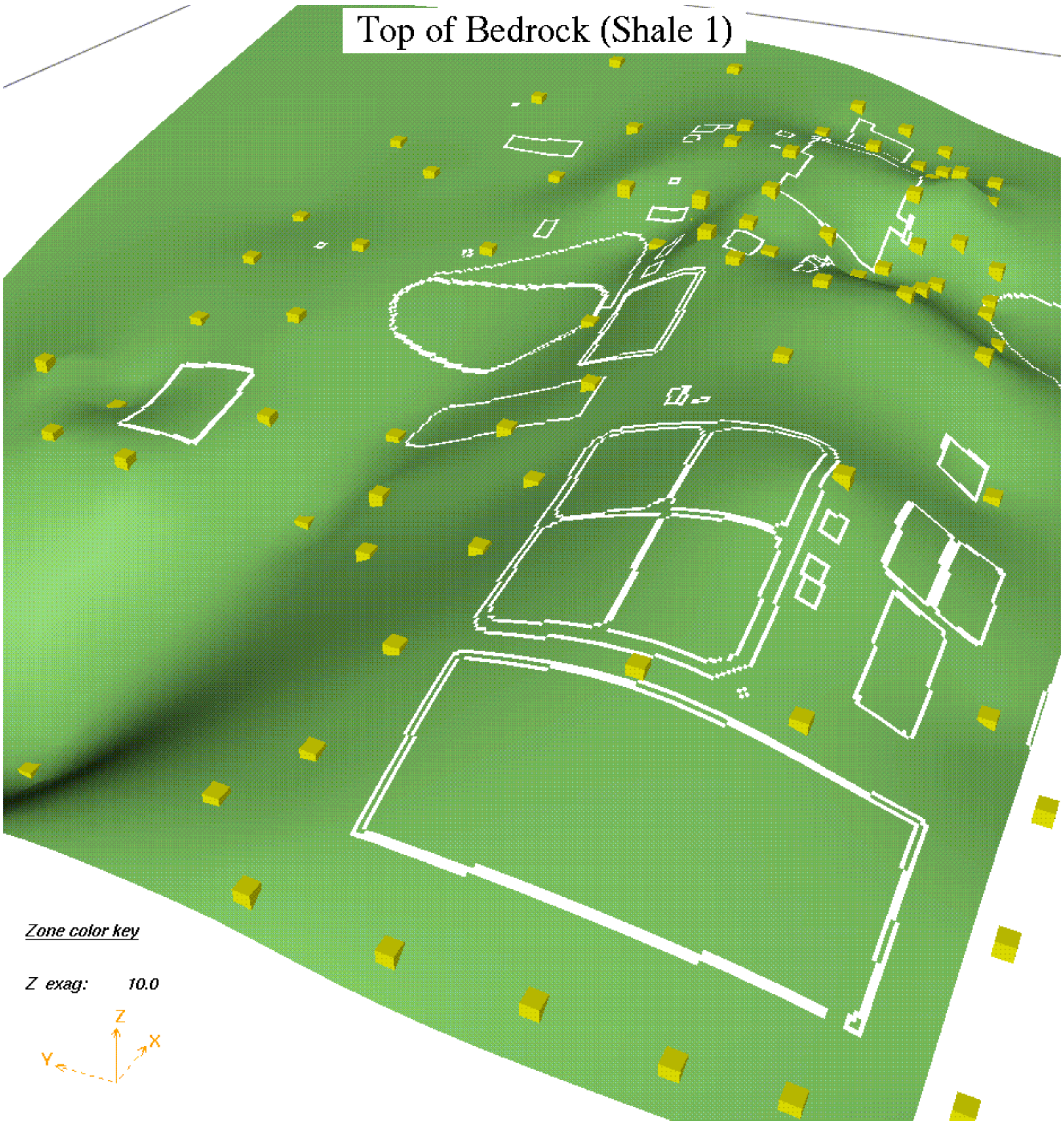

Figure 2. 3D Model Illustrating Two Preferential Ground Water Flow Pathways.

water to form a liquid slurry and pumping this material into the lagoon. Discharges to the lagoon ceased in 1993. One sample collected exhibited a maximum radioactivity level of 922.85 pCi/g at a depth between 1.2-1.3 m. Based on NRC regulatory guidelines, an activity greater than 30 pCi/g was considered to be of potential concern for public health and safety. Activity levels for total uranium >30 pCi/g were found to commonly occur beneath surficial materials having activities <30 pCi/g, suggesting that a relatively large volume of material at depth in the lagoon exhibited radioactivity levels higher than 30 pCi/g. Samples collected on a sampling grid provided excellent horizontal and vertical control for development of the 3D geospatial property model of the lagoon (Figure 3). Property data and lagoon boundary files were combined to develop a property model realistically constrained by shape, size, and volume of the lagoon. The model enabled visualization of 3D distribution of total

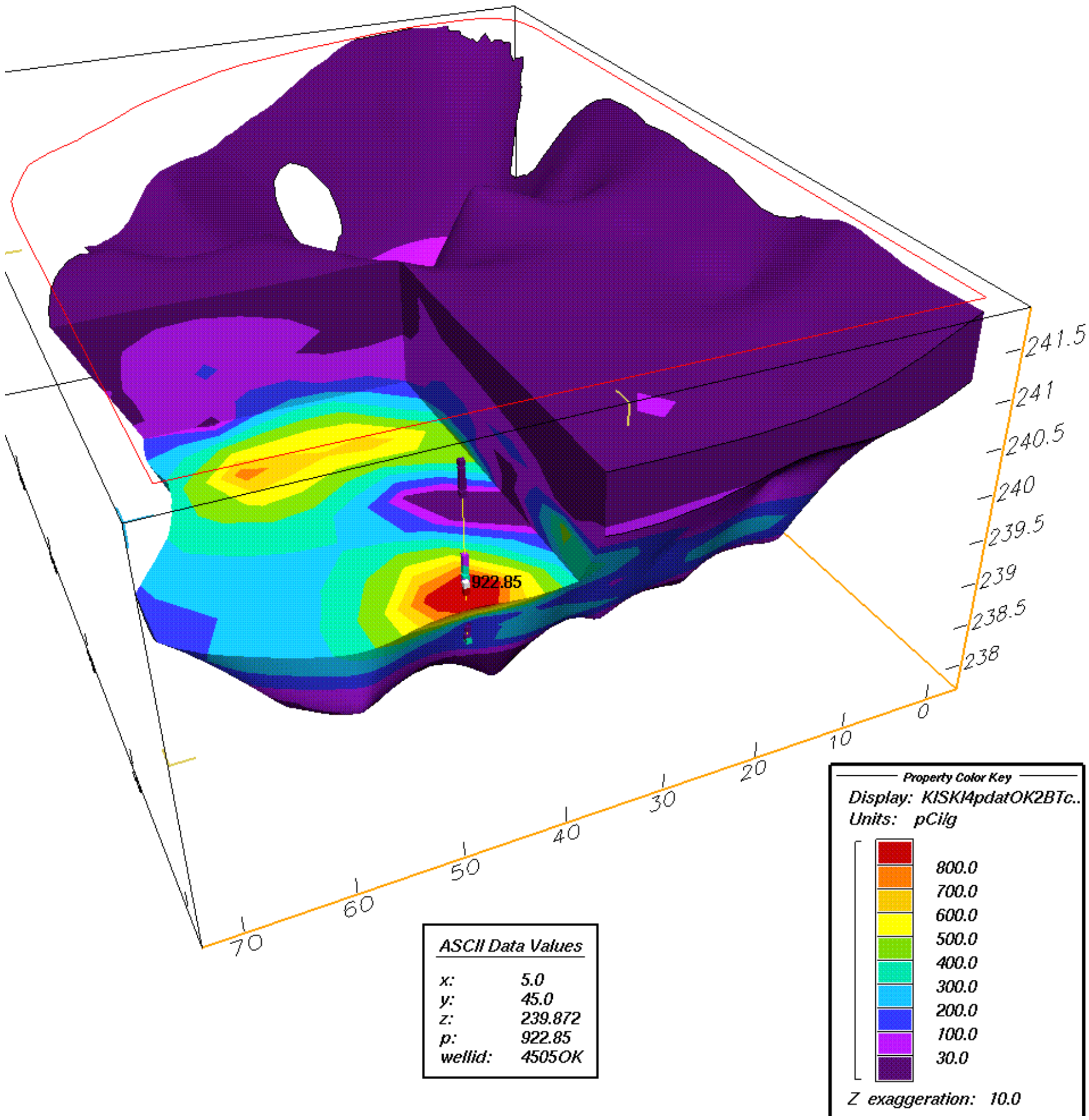

Figure 3. 3D Geospatial Property Model.

uranium in the lagoon; analysis of volumes of materials associated with specific levels of radioactivity; and assessment of potential remediation options for contaminated sludge in the lagoon, including excavation and offsite disposal of the contaminated materials. The model was interactively exhibited for technical and managerial staff of the treatment plant, their consultants, and representatives of involved State agencies. Data on radioactivity levels and associated volumes of material in the lagoon derived from the model were also used by NRC staff as input for preliminary dose assessment calculations. The NRC conducted dose assessments for a range of potential use scenarios, including off-site scenarios where the ash would be removed, and on-site use scenarios with the ash left in place. Based on these assessments, staff determined that the site met the NRC's criteria for unrestricted use under the License Termination Rule, Title 10 of the Code of Federal Regulations (10 CFR) Part 20, Subpart E. Because the ash lagoon met the criteria for unrestricted use, NRC released the site from its jurisdiction without further remedial action.

II.C. Interactive Capabilities

One of the most useful capabilities of 3D modeling software is interactive, real-time manipulation of the model. This aspect is particularly useful for demonstrating surface and subsurface site conditions, including contaminant plumes, to those who are not experts in geology and hydrology. The model can be interactively rotated to show plan and elevation views as well as oblique views. It can be sliced through any plane, and individual stratigraphic layers removed to show only details of particular interest. To illustrate versatility of the software, Figure 2 shows only the bedrock surface of one site-specific model, while Figure 3 shows a complete 3D geospatial property model for another site.

By constructing models using (x,y,z) and property data collected for specific time frames, it is also possible to dynamically illustrate how contaminant plume geometry and concentrations change over time. This capability assists with analysis of flow and transport pathways which must be understood for designing optimal groundwater monitoring systems at contaminated sites.

III. CONCLUSIONS

The effectiveness of communications among stakeholders during review and approval of LTPs and DP is greatly improved by use of 3D modeling software to enhance understanding of site-specific details for technical staff, conveying results of analyses to NRC management, and communicating the bases for decisions to both licensees and the public.