Real-Time Monitoring Capability for Performance Assessment
Corrective Action Management Unit Containment Cell
Sandia National Laboratories, New Mexico

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Abstract: Sandia National Laboratories in Albuquerque, New Mexico, operates a Corrective Action Management Unit (CAMU) for the DOE. The CAMU containment cell has a capacity to permanently store up to one million cubic feet of treated soil. The containment cell is situated approximately 500 feet above groundwater in a region with low rainfall and infiltration. These site conditions required a unique approach to monitoring cell integrity and protecting groundwater. To satisfy RCRA groundwater monitoring requirements, a Vadose Zone Monitoring System (VZMS) for detecting leaks was incorporated into the containment cell design. One component of the VZMS, the Primary Subliner (PSL) monitoring subsystem, utilizes the containment cell subliner to focus potential leakage into five longitudinal trenches, which are filled with a wicking material surrounding vitrified clay piping. The vitrified clay piping provides access for neutron probes to measure soil moisture content directly under the containment cell. The other component of the VZMS, the Vertical Sensor Array (VSA), consists of 22 time-domain reflectometers that provide a backup to the PSL. These two vadose zone monitoring subsystems allow for real-time leak detection, as well as long-term assessment and assurance of containment cell performance.

In September 1997, following significant public and regulatory interaction, Sandia Corporation (Sandia) was granted a RCRA and HSWA permit modification that allowed construction and operation of a CAMU. The CAMU follows regulatory guidance that allows for expedient and cost-effective cleanup and management of hazardous remediation wastes. The CAMU was designed to store, treat, and provide long-term management for Sandia's environmental restoration (ER)-derived wastes. The 20-acre CAMU site includes facilities for storing bulk soils and containerized wastes, treating bulk soils, and a containment cell for long-term disposition of waste. Proposed treatment operations include soil washing/soil stabilization for metals contamination and low-temperature thermal desorption for removal of volatile organics.

Sandia's CAMU is the only such facility within the DOE complex that implements this innovative approach to ER waste management. Gaining approval to operate the CAMU has required successful coordination with community representatives, state and federal regulators, DOE, and Sandia's corporate management. A significant cost savings to taxpayers for on-site waste treatment and containment versus off-site disposal is anticipated. The CAMU's life-cycle cost is currently projected to be approximately $14 million.

In January 1999, the first waste was accepted into the CAMU for temporary storage. Phase I Construction of the CAMU was completed in March 1999. Environmental monitoring of the containment cell prior to waste emplacement commenced in December 1998. Placement of

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treated waste into the containment cell is scheduled to begin in the summer of 2002. At completion of waste management operations, the facility will be closed, the containment cell will be capped, and long-term post-closure monitoring will begin.

The liner components of the containment cell greatly minimize the possibility of leaks (either liquid- or vapor-phase) from the containment cell to the vadose zone and, subsequently, to groundwater. At final closure, the containment cell will be capped to prevent precipitation from infiltrating the cell. The final cover design incorporates a capillary barrier and a vegetative cover for primary hydraulic control, and a liner at the base of the cover to provide secondary hydraulic control. The containment cell measures approximately 200 feet wide by 300 feet long and is designed to accommodate up to 1 million cubic feet of treated waste.

The high desert environment, hydrogeologic setting and the prohibition on liquids in the containment cell lead to monitoring for leaks within the vadose zone versus in groundwater. The principle factors that support leak detection monitoring in the vadose zone versus groundwater monitoring include: a semi-arid climate with less than 9 inches of precipitation per year; a depth to groundwater of approximately 500 feet; insufficient infiltration at the site for migration of liquids to groundwater; and extensive engineered barriers in the cell design to mitigate potential fluid migration.

Vadose zone monitoring of the CAMU containment cell was accepted by EPA Region VI regulators because of its high probability for early detection of leakage if it were to occur, as well as enabling timely implementation of a corrective action to mitigate the possibility of any impacts to groundwater. In many respects, the CAMU VZMS exceeds the intent of the RCRA regulations, which require that groundwater be protected in association with placement of waste into a containment cell, and that the monitoring system be sufficient to detect and subsequently characterize releases of hazardous constituents to groundwater.

The CAMU VZMS provides a superior methodology for the detection and subsequent characterization of any potential leaks emanating from waste contained in the cell versus the use of groundwater monitoring wells. Innovative vadose zone monitoring technology was incorporated into the VZMS. One of the main advantages offered by the VZMS is its ability to provide real-time data on containment cell performance. Because of the layout, aerial coverage, and the multiple monitoring parameters incorporated into the VZMS, the specific location of a leak from the cell can be defined, as well as the nature of the contaminant source (volatile organic versus inorganic compounds).

Figure 1 illustrates the spatial distribution of the two monitoring subsystems that comprise the containment cell VZMS. The PSL monitoring subsystem is located approximately 5 feet beneath the bottom of the containment cell liner and is the primary leak detection component of the VZMS. The PSL consists of five subhorizontal access tubes lying within shallow trenches filled with a wicking material. The five access tubes are spaced 17 to 27 feet apart and oriented parallel to the length of the containment cell. The tubes are used for deploying a neutron probe to collect data for determining moisture content. The access tubes are constructed of high-strength vitrified clay pipe to minimize interference to the neutron probe, while providing sufficient porosity for moisture detection as well as soil gas sampling. The vitrified clay pipes could also be breached if necessary to extract or contain a leak. A neutron probe can be deployed at any time that there is a requirement for gathering soil moisture data in the PSL. The probe reports “counts” at any selected point along the PSL pipe run. Neutron counts can be translated into soil moisture data by using an empirical formula relating count values to soil moisture content. Data from the probe can be directly input into a personal computer for logging, storage, and later acquisition, or can be read locally on a digital readout. Currently, these data are collected monthly; however, if liner integrity was in question or other system performance concerns existed, new data could be obtained in a matter of minutes.

Complementing the PSL monitoring subsystem are the 11 fixed monitoring locations that comprise the VSA subsystem (Figure 1). Each VSA location contains two vertically oriented monitoring points positioned at 5 and 15 feet below the cell liner. An instrument package, which contains a time-domain reflectometry (TDR) probe, a temperature sensor, and a soil-gas sampling port, is installed at each monitoring location. As with the neutron probe, the TDR probe determines soil moisture indirectly through use of a correlation relationship. An electrical signal is transmitted from a cable tester to the TDR probe and into the surrounding soil and then measured as a waveform. The waveform length in the soil can be related to soil moisture content. Application of a correlation formula that uses the waveform length permits a quick determination of the equivalent soil moisture value at each monitoring point. The VSA backs up the PSL subsystem and provides both lateral distribution and vertical gradient information on in situ soil moisture, with additional capabilities for measuring temperature and soil-gas concentrations directly below the containment cell.

To monitor the potential impact of moisture and soil gas sources adjacent to the CAMU containment cell from an adjacent sanitary sewer line and a chemical waste landfill, a third monitoring system, referred to as the Chemical Waste Landfill Sanitary Sewer (CSS) subsystem, is also being utilized. Six 20-feet-deep, steel-cased boreholes border the east side of the containment cell and are used to monitor the influence from known and potential moisture and soil gas sources located upgradient of the containment cell. The steel-cased boreholes allow the use of a neutron probe for acquiring data that are used to determine vertical and lateral soil moisture gradients (Figure 1). A slotted screen near the bottom of each borehole permits gathering samples for soil gas analysis.

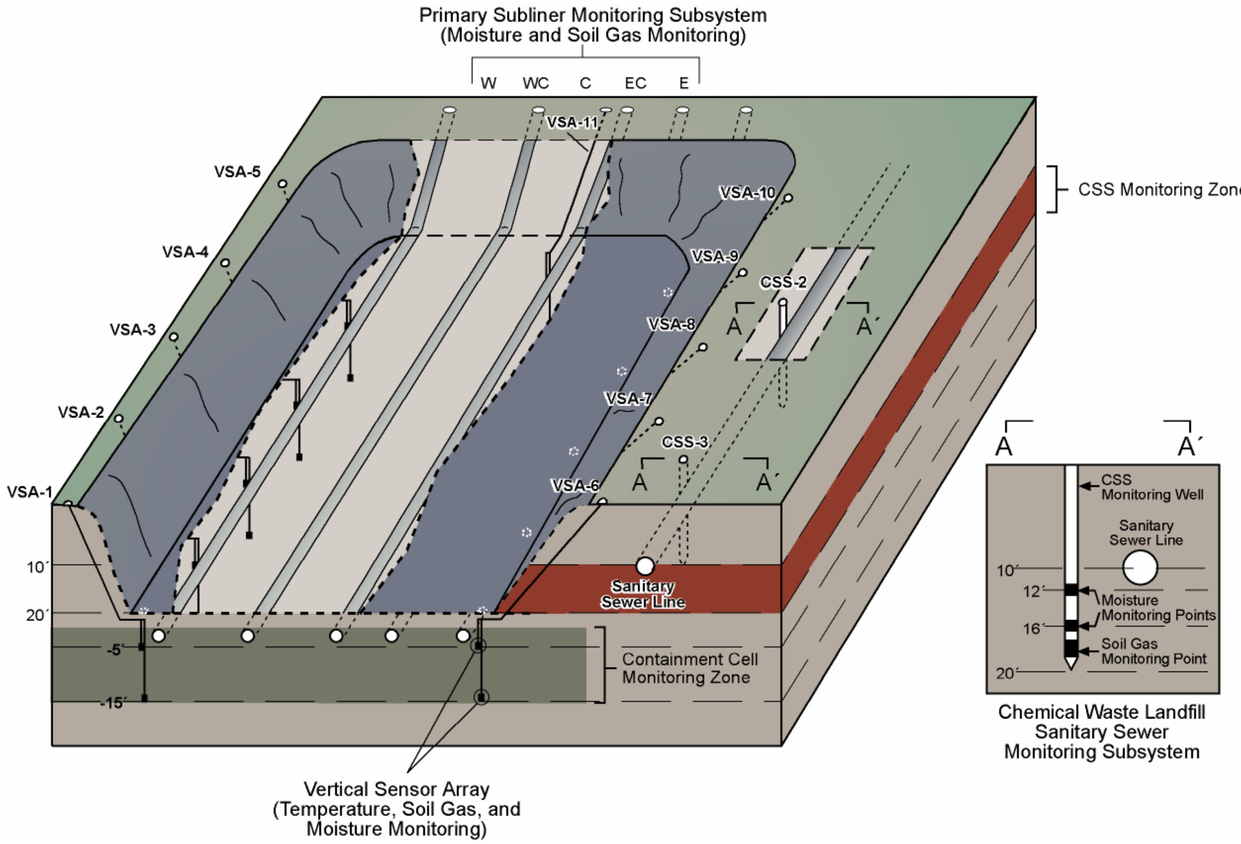

Figure 1 – Schematic Block Diagram Showing the Spacial Distribution of the Vadose Zone Monitoring Subsystems within and Adjacent to the CAMU Containment Cell.