Remediation of 130 mSv/hr. Soil Contamination Under a Hot Cell-17301

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ABSTRACT

Department of Energy (DOE) contractor CH2M HILL Plateau Remediation Company (CH2M) is currently engineering a system to safely remove and dispose of highly contaminated soil underneath Building 324 located adjacent to the Columbia River on the Hanford Site in Washington State. Cleaning up the waste site will allow for the eventual demolition of the building, which is a top priority for DOE and CH2M due to the proximity of the Columbia River and City of Richland.

Building 324 at Hanford was originally constructed in 1966 and was operated for a number of years serving various missions. One of the missions involved development of treatment processes for liquid high activity waste. As of result of one particular mission, liquid high activity waste was spilled in one of the building's hot cells (known as "B" Cell) and the liquid leaked from a breach in a sump and through construction joints in the hot cell floor and into the soil. Sampling efforts using borehole technology revealed significant under-building contamination with dose rates measuring has high as 130 mSv/hr (13,000 R/hr.).

The Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) between the Washington State, Department of Ecology (Ecology), the U.S. Environmental Protection Agency and the DOE has established a 2021 milestone for demolition and removal of the Building 324. Before building demolition can be undertaken, the highly contaminated soil must be removed from beneath the hot cell while the hot cell structure remains in place to provide shielding and containment during the soil remediation.

CH2M will fabricate and install remotely operated equipment that will remove debris and grout in the cell, the floor of the hot cell, and the contaminated soil beneath the hot cell and package that soil for disposal. To ensure that the structure remains intact and does not shift during soil removal, support for the building structure must also be constructed as a prerequisite for the planned work. CH2M will use a full-scale mock-up of the Building 324 B Cell and airlock area to assist in the testing of the remotely operated equipment and the training of the soil removal team in a contamination-free environment to ensure efficient and safe performance of the challenging work of the project.

INTRODUCTION

The Building 324, or the Chemical Materials Engineering Laboratory, provided office and laboratory space for scientific and engineering staff who conducted research in the areas of waste immobilization, liquid metal sodium coolant testing, non-destructive examination of irradiated nuclear fuel elements and other structural

materials, reprocessing irradiated nuclear fuel and the manufacture of cesium-137 and strontium-90 heat sources for the Federal Republic of Germany repository program.

There are five, stainless steel lined hot cells within the Building 324 that were used to allow workers to safely work without being exposed to dangerous levels of radiation. The most highly contaminated of these hot cells is B Cell. Reports from Pacific Northwest National Laboratory, who performed research within the facility during operations, reference numerous spills of contaminated materials within the facility, including a large spill of concentrated cesium-137 and strontium-90 in the B Cell.
The building is in Hanford's 300 Area, which was home to the fuel manufacturing operations at the Site as well as the experimental and laboratory facilities. Radiological and non-radiological laboratories, support facilities, and administrative areas are found within the structure. The site is located on the Columbia River, just north of the Richland, Washington, city limits.
Between 2004 and 2016 more than 170 buildings were demolished in the 300 Area (Figure 1).

Figure 1: Hanford's 300 Area in 2004 (top) and in 2016 (above).

Demolition preparations for Building 324 (Figure 2) were progressing in 2009, when the potential for contamination under the B Cell (Figure 3) structure was discovered

during decontamination of the trench and sump. A breach in the sump stainless steel liner was visible via cameras in B Cell. Crews began further investigation activities to determine extent of condition. Closed-ended steel tubes were driven under B Cell in 2010 and dose probes inserted which provided the indication of radiological dose under the B-Cell structure.

Figure 2: An aerial view of the 324 Building shows its close proximity to the Columbia River.

Figure 3: Looking through lead-shielded windows into B Cell.

A large spill in B Cell that occurred in 1986 during production of the cesium-137 and strontium-90 heat sources is assumed to be the source of the majority of the inventory and is the main contributor to the radiological dose levels indicated below the cell structure. Significant clean-up activities were attempted to reduce the levels of contamination and dose in B Cell after the spill, which likely attributed to the spread of the spill under B Cell.

After the discovery, demolition activities stopped. By that time, crews had already demolished some of the adjoining structures to Building 324, installed temporary power and were in the process of stepping out of the ventilation system, to support eventual demolition. Even though soil contamination remains above groundwater, work to demolish Building 324 was placed on hold until the contamination below the B Cell can be cleaned up.

During the period from the discovery of the contamination until 2015, the intended strategy for soil remediation was formulated and analysis and design activities were conducted to prepare for soil removal. The project was placed on hold in 2015 in advance of a planned contract transition. In April 2016, the Building 324 scope transitioned to CH2M from Washington Closure Hanford, LLC (WCH), as WCH's contract ended. From that point, CH2M conducted an initial design assessment and established a project team and plan to complete the design and progress the project into procurement and prerequisite activities for soil removal, which are now in progress.

CHALLENGES

There are many challenges inherent in a project such as this, including:

- Radiological hazards: Soil under B Cell is highly contaminated resulting in radiation levels of up to approximately 130 mSv/hr (13,000 R/hr). Contamination levels and radiation levels inside of the B Cell will require all work to be done remotely. Due to the hazards inside the adjacent airlock cell, workers must wear multiple layers of protection and breathe supplied air, which will limit stay times.
- Maintaining building structural integrity during demolition: Removing the highly contaminated soil may require the excavation of ten feet of soil beneath the facility's B Cell. Extensive structural support to the exterior of the cell is required before excavation can begin. This will require work in areas that are difficult to access.
- Maintaining building support systems for demolition: Portions of Building 324 will be required to function throughout soil removal activities, including ventilation, cranes, crane and cell shield-doors, lights, etc. These systems are old and will have to be carefully managed throughout the project to minimize the risk of failure during critical phases of the project.

STRATEGY

CH2M will use remote operated tools to dig through the debris on the B Cell floor, the grout on the floor, steel liner, concrete and into the soil itself (Figure 4). Soil excavation will focus around the perimeter of the hot cell, as that is where the mostly highly-contaminated soil is believed to be, due to leaks in the seams around the perimeter of the stainless steel liner.

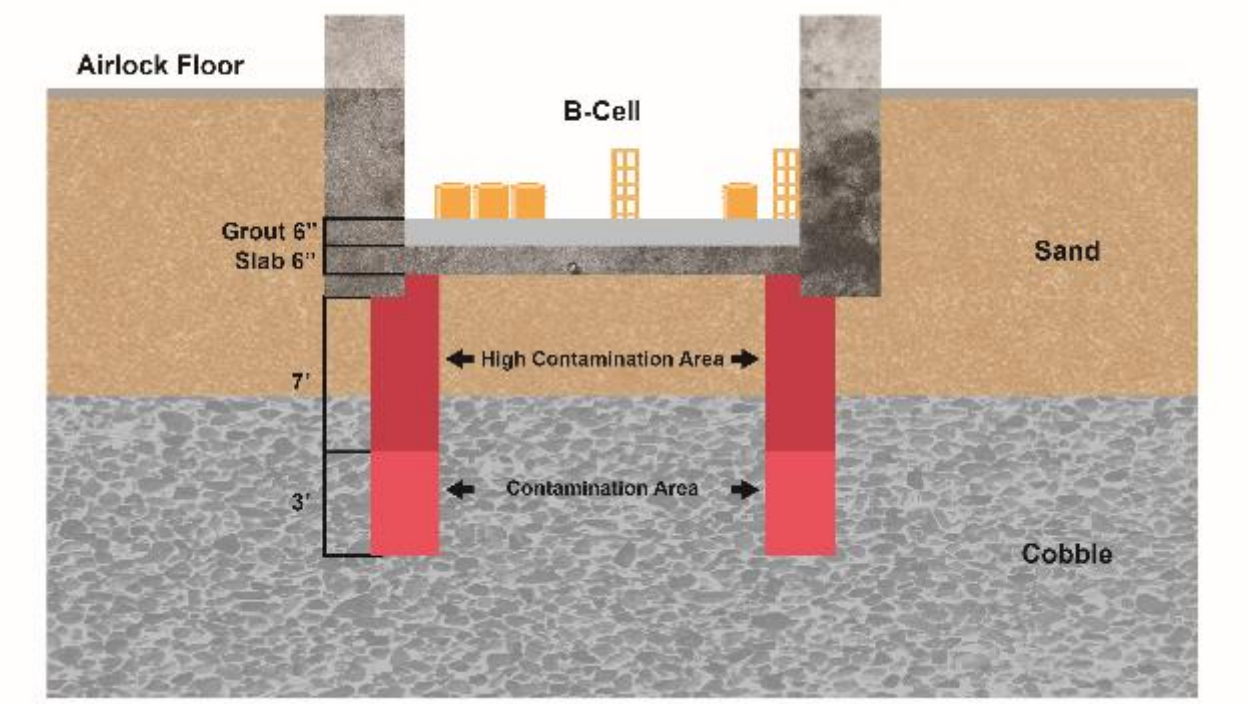

Figure 4: Illustrative cross section of B Cell, grout, concrete slab and the levels of contamination beneath B Cell.

A remote excavator arm (REA), attached to the side of B Cell, will load debris or soil into a waste bin. A transfer mechanism will move that waste bin out of B Cell and into the airlock where it will be measured to determine radiological contamination levels (Figure 5). The most highly contaminated debris will be transferred into adjacent hot cells where it will be grouted in place for eventual removal during building demolition. Lower level debris and soil will be placed in a container and grout added to stabilize the waste for transport to the Hanford Site's regulated landfill.

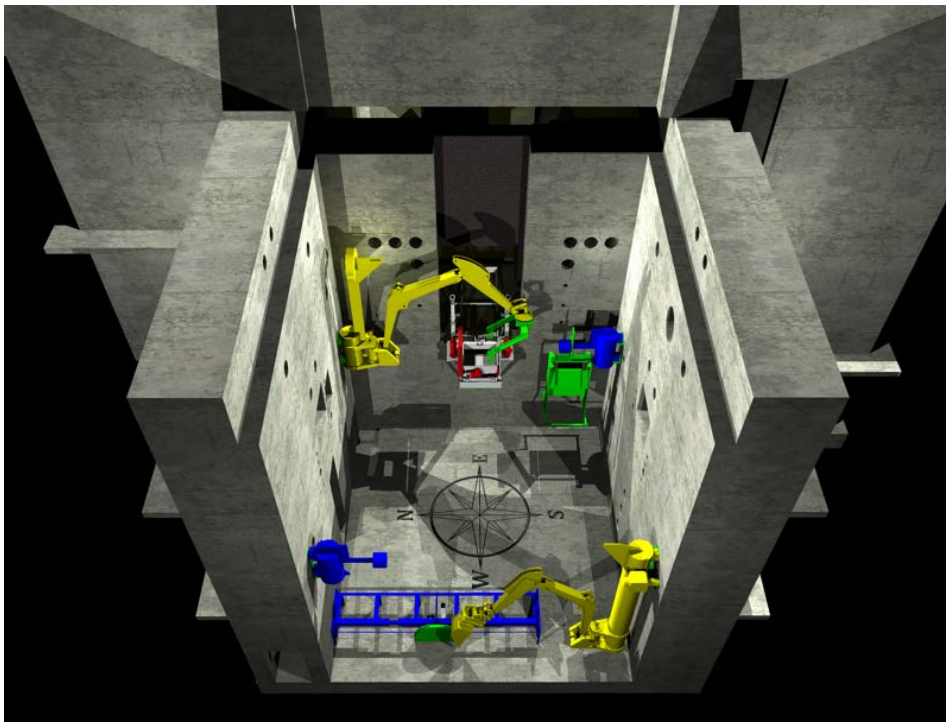

Figure 5: Illustration inside B Cell of remote excavator arms (yellow) and saw system for cutting through the stainless steel lined floor (blue).

Structural modifications are necessary to support Building 324 during the excavation of soil from beneath the building (Figure 6). Ultimately, the structural modifications will eliminate the risk that the structure will shift during soil removal to prevent impacts to the operability of building systems (cell shield-doors, cranes, etc.) required throughout the project.

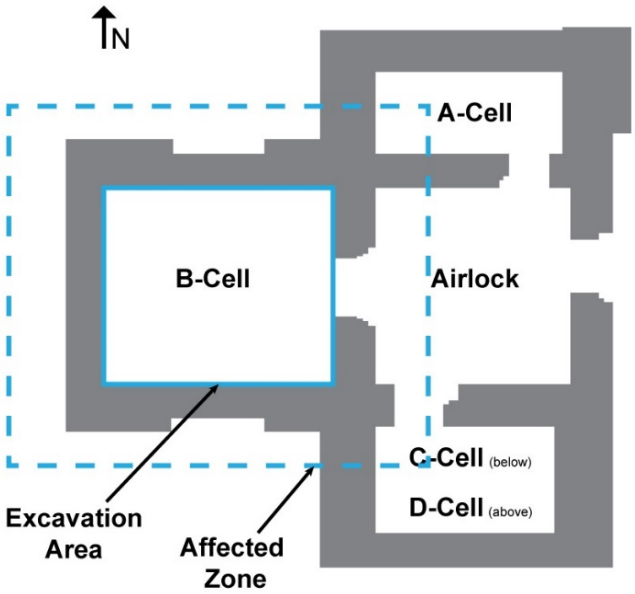

Figure 6: Overhead look of the B Cell area in the 324 Building. The planned soil excavation area is larger than the footprint of B Cell itself.

MOCK-UP TO AID TESTING AND PERSONNEL TRAINING

CH2M will use a full-scale replica of the B Cell area and airlock for the testing of equipment before it is installed in Building 324 B Cell (Figure 7). Employees will also train on the equipment at the mock-up before using it in the actual environment.

Figure 7: Mock up structure located near the 324 Building.

CH2M has successfully used this mock-up strategy before, having creating a mock-up facility to aid in the development of tools and equipment to remove the highly radioactive sludge currently stored underwater at the Hanford site's 100K Area.

The mock-up for the project will allow personnel to practice installation and removal of equipment and verify equipment operability to increase efficient when equipment is installed inside the actual building. It is designed to allow the workforce to practice soil removal and process the soil through the airlock

The mock-up is constructed with windows, doors and ports on the wall, representative of the actual structure of B Cell (Figure 8). The concrete floor of the B Cell mock up, which includes the steel liner, will allow workers to cut the floor and remove soil using the remote excavator arm equipment – the same work evolutions that will take place in the actual B Cell. This will allow crews to practice how to respond to issues or scenarios ahead of time, in a clean environment, to increase safety and efficiency of crews once the actual soil removal work starts.

Figure 8: Interior of B Cell mock-up. The square holes in the wall replicate shielded windows; the circular holes above the windows will allow for the eventual installation of manipulators to allow operators remote access into the B Cell.

CURRENT STATUS

CH2M is advancing the cleanup mission on several fronts:

- Adding employees to the design team and also adding nuclear chemical operators and radiological control technicians to support airlock cleanout and hot cell cleanout which is scheduled to begin in early calendar year 2017.
- Progressing the design to support completion of the mock-up, including adding support trailers, utility service, and the procurement of the REAs and other equipment for the mock-up.
- Preparing to conduct component level testing to support risk mitigation (e.g. floor saw test) in calendar year 2017.
- Adopting safety equipment and tools successfully used at other CH2M projects at Hanford, including external breathing air compressors and fully-encapsulating Level B suits used in highly contaminated environments at the Plutonium Finishing Plant. Level B equipment uses positive pressure, supplied air respirator with escape SCBA (NIOSH approved) along with hooded, chemical resistant overalls. CH2M is evaluating whether components of this personal protective equipment, used to cut up and remove highly-contaminated glove boxes at PFP, is necessary and can be adapted for use in airlock cleanout.

CONCLUSIONS

The work to remove the soil beneath the Building 324 involves careful planning and coordination to safely and compliantly manage the building and prepare and mature the design for tools and techniques to remove the highly contaminated soil beneath

the building to allow for the building's eventual demolition. This project, though faced with a number of unique challenges, is an important priority for DOE, stakeholders and members of the community as the work to protect the Columbia River and the surrounding areas continues.