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Options To Cleanup Sitewide Vadose Zone Contamination At The Hanford Site, WA, State

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ABSTRACT

The U.S. Department of Energy (DOE) Hanford Site in south central Washington State lies along the Columbia River and is one of DOE's largest legacy waste management sites. Enormous radionuclide and chemical inventories exist below-ground. These include Resource Conservation and Recovery Act (RCRA) [1] storage facilities where hazardous and radioactive contaminants were discharged and leaked to the soil surface and to the deep vadose zone and groundwater. The vadose zone is also contaminated from facilities regulated by the RCRA and Comprehensive Environmental Response Compensation and Liability Act (CERCLA) [2] Act. Hanford now contains as much as 28,300 cubic meters of soil contaminated with radionuclides from liquid wastes released near processing facilities. The Hanford Federal Facility Agreement and Consent Order, Tri-Party Agreement (TPA) [3] has set the completion of the cleanup of these sites by 2024.

There are numerous technical and regulatory challenges to cleanup of the vadose zone at the Hanford site. This paper attempts to identify the categories of deep vadose zone problem and identifies a few possible regulatory options to clean up the site under the mix of state and federal regulatory authorities.

There are four major categories of vadose contamination areas at the Hanford Site. The first is laterally extensive with intermediate depth (ground surface to about 45 meters depth) mostly related to high volume effluent discharge into cribs, ponds and ditches of designated CERCLA facilities. The second is dominated by laterally less extensive mostly related to leaks from RCRA tank farms. The later contamination is often commingled at depth with wastes from adjacent CERCLA facilities. The third category is from the high volume CERCLA facilities extending from the surface to more than 60 meters below ground. Contamination from the later category crosses the entire thickness of the vadose zone and reached groundwater. The fourth category is the lower volume waste sites.

There are multiple management options to clean up the above four categories of vadose zones sites. The following are some of the options considered for detailed evaluation:

- Maintain separate decision processes for each RCRA and CERCLA units/waste sites with a more accommodating schedule.
- Create new vadose zone operable units with limited geographical boundaries regardless of site category/origin and make an integrated decision.

- Expand the existing CERCLA groundwater operable units to include the deep vadose zone
- Use a combination of the above.

Each option has pros and cons and regulatory limitations. Detailed evaluation of these options is required to support a cost effective expedited cleanup.

INTRODUCTION

The Hanford Site encompasses approximately 1450 square kilometers northwest of the city of Richland along the Columbia River in southwest Washington State. The site is divided into several distinct areas: the 100 Areas along the Columbia River, the 300 Area along the Columbia River just north of Richland, and the 200 area east and west area covering the central portion of the site and popularly known as the “central plateau”. All nine reactors are located along the river corridor. Until 1980s, the site was dedicated primarily to the production of plutonium for national defense. Beginning in the 1990s, DOE has focused on cleaning up the site. DOE, EPA and the Department of Ecology (Ecology) signed a comprehensive cleanup and compliance agreement on May 15, 1989. The Hanford Federal Facility Agreement and Consent Order, or Tri-Party Agreement [3], is an agreement for achieving compliance with the CERCLA and RCRA treatment, storage, and disposal unit regulations and corrective action provisions. This paper attempts to identify the categories of deep vadose zone problem in the 200 Area and identifies a few possible options to clean up the site using state and federal authorities.

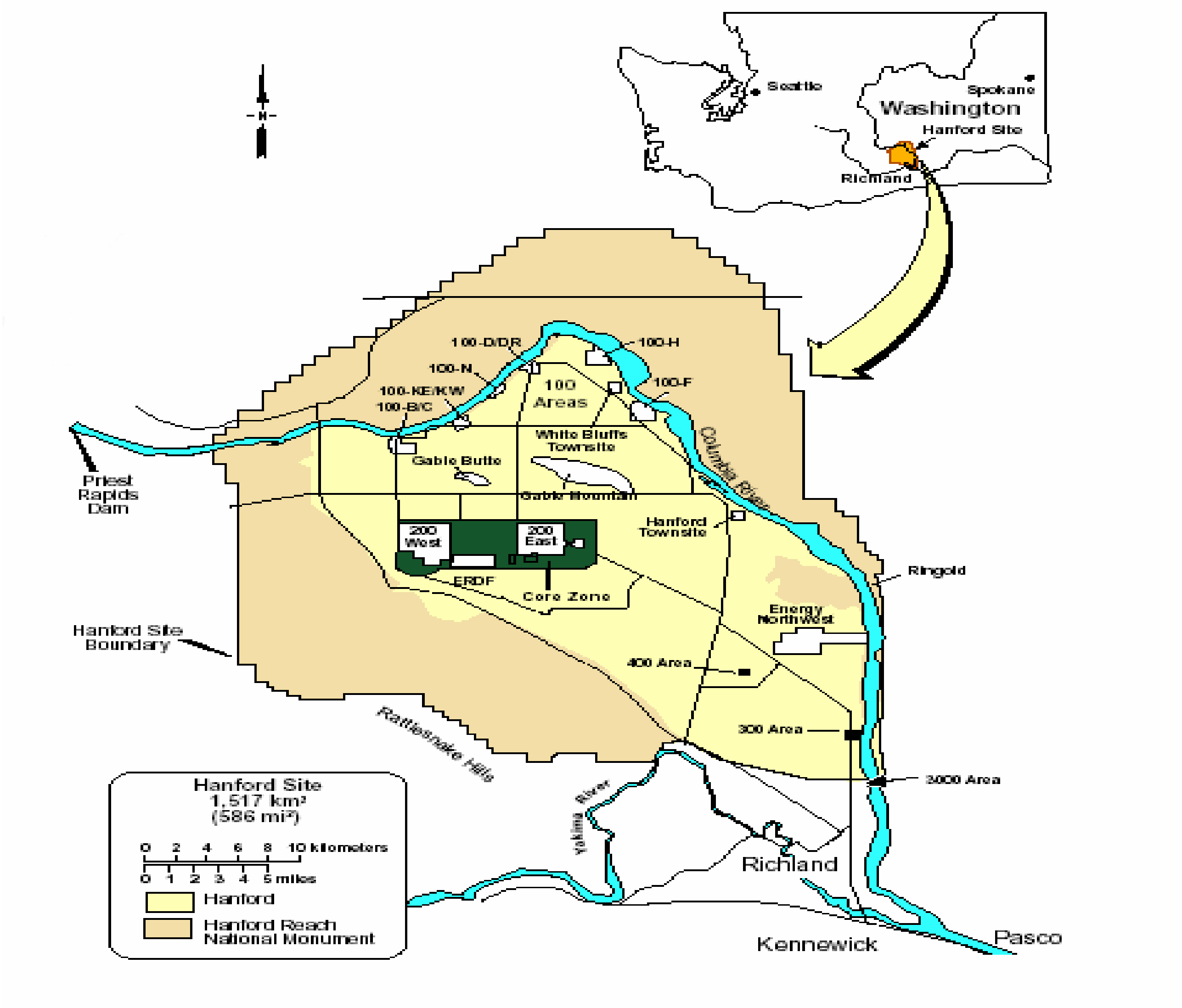
NATURE AND EXTENT OF VADOSE ZONE CONTAMINATION

The production of plutonium generated a huge amount of solid and liquid wastes. In total, site records show that 1.7 trillion liters of contaminated liquids were intentionally discharged to the soil and groundwater. Furthermore, about 1 million gallons of highly radioactive wastes from storage tanks leaked to the soils. As a result, a huge amount of these contaminants of both radioactive and hazardous waste are present in the vadose zone. Hanford now contains about 28,300 cubic meters of contaminated soil. Liquids that reached the groundwater created groundwater plumes of over 440 square kilometers. In the 200 area, the known vadose zone contaminants include mainly uranium, technetium-99, cesium-137, strontium-90, cobalt-60, iodine-129, chromium and chlorinated hydrocarbons. Several contaminant plumes overlap because of either merging separate plumes from different RCRA and CERCLA sources, or because they were released as co-contaminants.

There are four major categories of vadose contamination at the Hanford Site:

1. The laterally extensive contamination related to high volume effluent discharge areas of cribs, ponds, and ditches of CERCLA facilities covers the highest number of sites up to about 150 feet deep below the surface. Monitoring data show that these contaminants are still hanging at intermediate depth at around 45 meters below the ground surface and approximately 25 meters above the water table. The

contaminants include both hazardous chemicals and radioactive waste. One of the sites is expected contain more than 400 curies of technetium-99. A preliminary modeling study shows that if the site is not remediated, technetium-99 has the potential to reach the Columbia River through groundwater migration.



Location of the Hanford Site.

Figure 1: Location of the Hanford Site

2. The second category is comprised of severely contaminated vadose zone with co-mingled plumes from the RCRA tank farms and with releases from the nearby CERCLA liquid disposal sites. Thus, the contaminant plumes include hazardous chemicals and radioactive waste from both RCRA and CERCLA sources. The radionuclide inventory of these sites includes hundreds of curies of technetium-99, and several thousand kilograms of uranium along with other radionuclides such as

cesium-137, iodine-129, strontium, etc. The major chemicals are chromium and nitrate, and chlorinated hydrocarbons. In most cases, these plumes have reached the groundwater.

3. The third category is from the high volume CERCLA discharge sites covering the entire vadose zone exceeding more than 200 feet in thickness down to the depth of groundwater. These high volume discharges have not only impacted the vadose zone but also created huge groundwater plumes. About 70 percent of the total approximate discharges of 440 billion gallons at the Hanford Site were discharged at these facilities. Due to large discharge volume and very dilute nature of the effluent, we are not seeing any significant contamination left in the vadose zone.

4. The last category is the miscellaneous isolated less extensive waste discharges in the including a few reverse/injection wells. These injection wells were used for the direct disposal into the aquifer. Only the highly immobile contaminants such as plutonium, strontium, cesium, etc. were present in this low volume discharge. Preliminary studies from the inventory, nature, and monitoring data indicate that these contaminants have not migrated in the recent years and may not be a threat to the human health and the environment.

OPTIONS FOR THE VADOSE ZONE CLEAN UP

There are numerous technical and regulatory challenges to cleanup of the vadose zone at the Hanford site. The remoteness of the deep vadose zone causes characterization difficulties and limits our ability to demonstration of protectiveness of groundwater with limited technical approaches. The available surface remedies seem to provide only a limited protectiveness. It will take a while to find appropriate remediation technologies to address various types of vadose zone problems at the Hanford Site. In order to move forward the three parties need to evaluate the pros and cons of various options for a meaningful, cost effective process using both state and federal regulations. The current TPA framework and the applicable regulation would allow us to move forward in a variety of different ways.

Clean Up Approaches

One way to clean up various deep vadose zone sites is to have a separate decision process for each RCRA and CERCLA waste unit. The approach of keeping separate decision processes maintains current practices of Hanford cleanup following separate RCRA and CERCLA paths.

Another path is to make an integrated decision for sites within a given geographic boundary regardless of site category by creating separate vadose zone operable units. Under this framework, we would be able to combine the tank farm vadose zone and the nearby CERCLA site together. Thus, the creation of new deep vadose zone units covering both RCRA and CERCLA sites would require developing an appropriate integrated regulatory path. It appears that the proposed consolidation would improve the opportunities for consistency in investigations and decision-making. It is also expected to allow the priorities for deep vadose zone clean up efforts to be balanced across the 200 Area needs, e.g., which tank farm first. This may allow us to move forward with tank farm deep vadose zone remedies well ahead of tank retrieval and closure enabling the effectiveness of those remedies to be assessed at the time of final tank closure. The current cleanup/closure milestone dates of various tank farms are supposed to take place later than the current CERCLA site clean up. Thus, major adjustments of current TPA milestones of CERCLA clean up and RCRA closures are anticipated in this option. Detailed analysis must be completed over impact on other issues such as budget, site's overall priorities etc. prior to implementing such an option.

Another clean up option is to include/expand the current CERCLA groundwater operable units to include the deep vadose zone. The investigation and remedy selection for deep vadose zone contaminants will be conducted using an appropriate integrated RCRA/CERCLA or CERCLA authority. This would enable physical integration of groundwater and deep vadose zone decisions. However, it might delay some of groundwater clean up decisions due to lack of information or available remedies for the deep vadose zone. A number of groundwater remedy decisions are already in place. Other impacts on TPA milestone, budget, etc. need to be evaluated before we make any decision to move forward.

Another theoretical approach would be the combination of the above options and apply it where it is meaningful and cost effective. However, use of different alternatives for similar problems may cause unintended regulatory challenges, management problems, affect stakeholder relations and drive sitewide inconsistency which is one of the things we are trying to avoid.

CONCLUSION

There are several clean up options to address the deep vadose contamination at the Hanford Site. Each has pros and cons. Some of them may impact the current TPA milestones and the site's overall priorities. Our decision analysis should be broad enough to address impact on the current TPA milestones, budget, and the site's overall priorities.

REFERENCES

1. Resource Conservation and Recovery Act, 1976. 42 United States Code s/s 321 et seq.
2. Comprehensive Environmental Response, Compensation and Liability Act, 1980. 42 United States Code.
3. Washington State Department of Ecology, United States Environmental Protection Agency and United State Department of Energy,1989. Hanford Federal Facility Agreement and Consent Order, Revision 6. US DOE/RL-89-1, EPA Docket Number: 1089-03-04-120, and Ecology Docket Number: 89-54.