CHARACTERIZATION AND REMEDIATION OF PAST-PRACTICE WASTE UNITS AT THE HANFORD SITE AN ENGINEERING PERSPECTIVE

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ABSTRACT

The Hanford Site contains 1,501 identified waste management units that are to be characterized and remediated and/or permitted over the next 30 years. These units include various types of liquid and solid waste disposal sites, underground tanks, and unplanned releases consisting of nonhazardous, hazardous, radioactive, and mixed wastes. To deal with this number of waste units, the Hanford Site has been subdivided into four aggregate areas, each of which is included on the U.S. Environmental Protection Agency's National Priorities List. The collective aggregate areas have been further subdivided into 78 operable units. A discussion of progress made to date on the first six operable units is provided in this report.

INTRODUCTION

The Hanford Site (currently owned by the U.S. Department of Energy [DOE]) was acquired initially by the Federal Government in 1943 to house facilities for the World War II production of plutonium. For more than 20 years, the facilities were dedicated primarily to plutonium production and management of associated wastes. In later years, programs were diversified to include advanced reactor research and development of renewable energy technologies. Westinghouse Hanford Company is the present Operations and Engineering Contractor of the Hanford Site, which comprises approximately 1,450 km^2 of semiarid land in southeastern Washington.

Hanford Site facilities are centralized in numerically designated areas. (See Fig. 1.) Reactor facilities are situated in the 100 Areas along the Columbia River. Reactor fuel processing and facilities for waste management are located in the 200 Areas on a plateau about 11 km from the river. The 300 Area, just north of the city of Richland, contains reactor fuel fabrication facilities and research and development laboratories. The 1100 Area, at the north end of the city of Richland, contains maintenance and transportation facilities. These areas contain 1,501 identified waste management units, as defined in the Preliminary Operable Units Designation Project (1) and the Hanford Site Information Data System (2).

The waste management units include liquid waste disposal sites (e.g., cribs, ponds, ditches, reverse wells, French drains, and tile fields), solid waste burial grounds (disposal trenches), underground tanks, and unplanned releases. The wastes disposed of in these units include nonhazardous, hazardous, radioactive, and mixed wastes. Selected units were evaluated and scored using the U.S. Environmental Protection Agency (EPA) Hazard Ranking System. Based on these scores, aggregate areas (the 100, 200, 300 and 1100 Areas) were listed by the EPA on the National Priorities List. Each aggregate area was further subdivided into groups, called operable units (OU), based on similar history and characteristics. A total of 78 operable units have been designated; seventy four are source OUs and four are groundwater OUs.

Within the next 30 years, each OU will be investigated and remediated under the Resource Conservation and Recovery Act of 1976 (RCRA) (3) or the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (4), and the State of Washington Hazardous Waste Management Act (5) as delineated in the Hanford Federal Facility Agreement and Consent Order (6), referred to hereinafter as the Tri-Party Agreement. For units addressed under RCRA, the investigation will be documented in a RCRA facility investigation/corrective measures study (RFI/CMS); for units under CERCLA, the investigation will be documented in a remedial investigation/feasibility study (RI/FS). Although some differences exist between the processes, they are functionally equivalent.

Either the EPA or the Washington State Department of Ecology (Ecology) will serve as the lead agency for each OU; the determination will be a joint decision between the two. The designated lead agency will then oversee actions at the specified OU, while the other agency will assume a supporting role.

WASTE MANAGEMENT UNIT GROUPING INTOOPERABLE UNITS

Each OU at the Hanford Site may be designated as either a source only unit, a groundwater only unit, or a source and groundwater unit. The grouping was based on analysis of the following eight common factors between individual waste management units:

- Waste characteristics and volume
- Proximity to other waste units

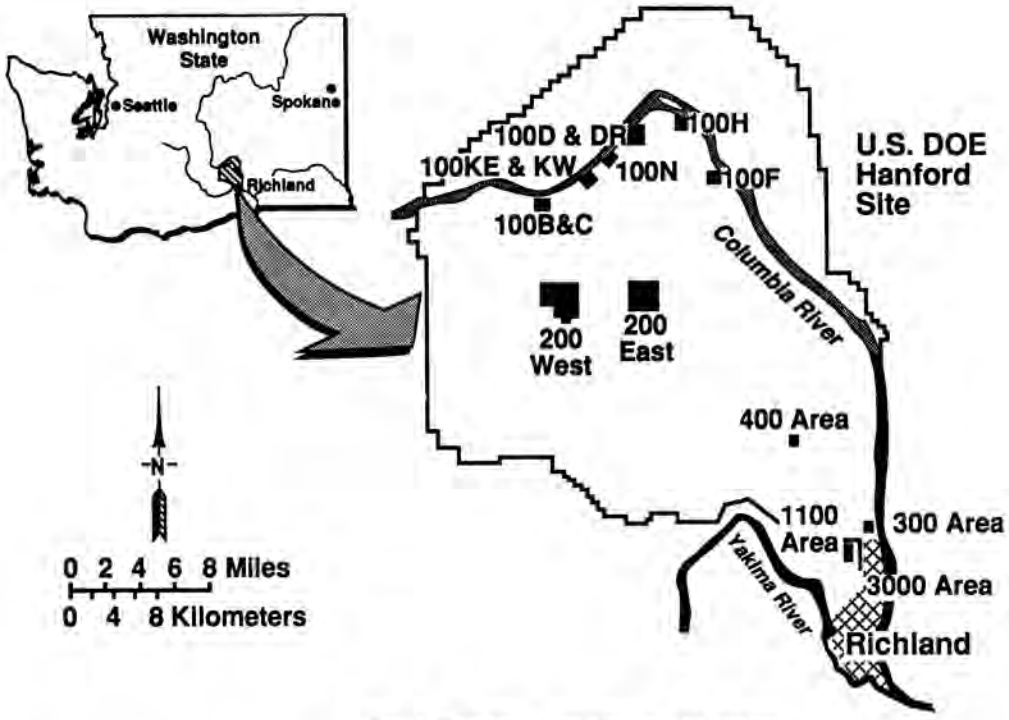

Fig. 1. The Hanford Site, Washington.

- Relationship to contaminants from other waste units
- Site characterization strategy
- Remedial action strategy
- Type of facility (e.g., crib, burial ground, tank)
- Number of waste units
- Presence of priority waste units.

The first three are the most important factors. The waste source indicates possible contaminant concentrations and waste chemistry. The waste chemistry, waste form, and type of contaminants present give an indication of waste mobility and potential impacts.

For economies of scale, each OU should contain as many complementary waste sites as possible. However, if the number of sites is too large, the scope of the RI/FS or RFI/CMS becomes too unwieldy and inefficiencies in organization and operation outweigh economies of scale.

The methodology used to group waste sites into OUs and the designation and prioritization of an individual OU are documented in the Preliminary Operable Units Designation Project (1). In addition, the Tri-Party Agreement establishes the priorities and milestones for performing an RI/FS or RFI/CMS for each OU and specifies the processes that are to be followed in conducting and documenting this work.

PROGRESS TO DATE

In support of the Tri-Party Agreement, signed on May 15, 1989, the DOE has initiated the RI/FS or RFI/CMS processes on six OUs. The following sections describe the progress to date on these OUs.

1100-EM-1 Operable Unit

The 1100-EM-1 OU contains seven waste management units in the 1100 Area. They are associated mostly with vehicle maintenance operations and do not contain radioactive material. The waste management units include the following.

- An abandoned battery acid pit into which an estimated maximum quantity of 56,775 L of battery acid was deposited over the period 1954-1977.
- Two abandoned gravel pits used primarily for disposal of construction debris until 1985. These pits may also have received paints, paint thinners, solvents, antifreeze, degreasers, and wash water from vehicle cleaning operations.
- A waste antifreeze tank, removed in 1986, which may have leaked.
- The site of a minor radioactive water leak from a shipping cask.
- An area of discolored soil that appears to be the result of surface disposal of an unknown liquid.

- An abandoned landfill used before 1970 for disposal of office and construction waste.

This OU has a relatively high priority because of the lack of definitive data available and the presence of water supply wells approximately 0.8 km to the east.

The RI/FS work plan for the 1100-EM-1 OU was approved by EPA in August 1989 (the first to be approved under the Tri-Party Agreement). The goal of initial remedial investigation (RI) activities is to provide initial site characterization and to determine the nature of contamination. Activities include geophysical and soil gas surveys, surface soil and vadose zone sampling, and installation of groundwater monitoring wells. Disparity in the types of sites included in the OU caused the initial RI program to be different for each site. Because little was known about most of the sites, a phased approach was emphasized in the work plan. The RI Phase 1 was subdivided into Phase 1A, which included the nonintrusive work, and Phase 1B, which included the vadose sampling and groundwater monitoring wells. Results of Phase 1A were used to finalize the Phase 1B program. As allowed under Tri-Party Agreement, nonintrusive work, such as surveying and mapping, geophysical surveys, and soil gas sampling, began before work plan approval. Vadose zone drilling was allowed to start after submittal of the work plan and after resolution of initial comments. Groundwater wells were delayed until the work plan was approved.

By the time the work plan was approved, geophysical and soil gas surveys had been completed, and vadose zone drilling had been initiated. At present, the RI field work is essentially complete, and Phase 1 of the feasibility study (FS) is well under way. To expedite schedules, the Tri-Party Agreement Action Plan calls for FS Phases 1 and 2 to be combined in a single task. Accordingly, remedial alternatives for each waste site will be identified and screened to produce a recommendation of candidate remedial alternatives in the FS Phase 1 and 2 report. Evaluation of the results of RI Phase 1, plus data needs associated with candidate remedial alternatives identified in FS Phase 2, will provide the necessary input to plan additional field work for RI Phase 2. It is too early to draw conclusions regarding the need for additional investigative activities or remedial action at each site.

200-BP-1 Operable Unit

The 200-BP-1 OU occupies approximately 10 ha within the 200 East Area and includes 13 waste management units (approximately 1.6 ha). The 200-BP-1 OU waste disposal activities were associated with the management of waste from U Plant uranium reclamation and 241-BY Tank Farm operations. There are no data on the exact concentrations and quantities of radionuclides or other contaminants of concern remaining within 200-BP-1. The primary known contaminants are radionuclides (hydrogen-3, technetium-99, strontium-90, cesium-137, cobalt-60, plutonium-238/239/240, total uranium, and ruthenium-106) and nonmetallic ions (nitrate, selenium, total cyanide, ferrocyanide, and free cyanide). The 200-BP-1-OU includes the following waste management units.

- Nine inactive cribs (underground drain fields) that were filled with an estimated cumulative quantity of 173,000,000 L of liquid waste. Waste disposed in seven of the cribs (operated from 1954 to 1957) was generated in a uranium metal recovery process. Waste disposed in the other two cribs (between 1965 and 1973) consisted of storage tank condensate generated from an in-tank solidification process performed on 241-BY Tank Farm tanks.
- Three unplanned releases (UPR) that have little or no document history. One release involved 41,635 L of uranium metal recovery process waste. One release involved waste from the 241-BY Tank Farm and impacted an area of approximately 2,300 m^2. No information is available on the third release.
- One inactive crib that has no documented history of past waste disposal operations.

The 200-BP-1 OU was ranked third in priority (1) because of a recently identified cyanide plume that was found in the groundwater north of the OU. The plume is believed to be attributed to past crib operations in 200-BP-1.

The 200-BP-1 RI/FS work plan was submitted to EPA in November 1989 and was the second to be submitted for approval under the Tri-Party Agreement. Remedial investigation nonintrusive site characterization activities were initiated in early summer 1989 and were completed by the end of fiscal year 1989. Activities included surface radiation, biota and ground-penetrating radar (GPR) surveys, and topographic mapping.

Approximately 4 ha were land-surface surveyed for dose rate and contamination levels using hand-held alpha and beta/gamma radiation detection equipment. A number of "hot spot" specks were found that may require removal to prevent near-term migration via saltation beyond the OU boundary. The biota survey consisted of a site inspection by biologists. There were no visible signs of any endangered plant or animal species residing at the site or any signs of plant or animal stress. Due to the late-summer survey, another cursory survey will be conducted in the spring to inspect plants in their growing cycle and to see if any migratory bird species use the site for spring nesting or foraging. A GPR survey was conducted for the purpose of identifying potential unknown underground piping or structures. One unidentified pipe was located that appears to begin and end within the OU. A topographic map was prepared at a 0.5-m contour interval extending approximately 100 m beyond the

OU boundary. All surface features and anomalies were mapped during the survey.

Two other field activities included:

- The use of seismic refraction/reflection methods to determine the top-of-basalt under the OU
- Developmental work on a high resolution spectral gamma radionuclide logging system.

Site geologic and lithologic conditions are such that seismic techniques failed to determine the top-of-basalt. Laboratory activities included the development of special analytical methods to achieve lower detection limits for ruthenium-106 in groundwater and to reduce interferences in the measurement of total, free, and complexed cyanide in soil and groundwater.

300-FF-1/300-FF-5 Operable Units

The 300-FF-1 is a source OU which occupies approximately 57 ha along the Columbia River in the northeast corner of the 300 Area. The 300-FF-5 is a groundwater OU that underlies and is potentially affected by 300-FF-1 and two adjacent 300 Area source OUs. The 300-FF-1 waste disposal activities are associated with radioactive fuel fabrication process wastes and research laboratory wastes. The 300-FF-1 OU includes all of the major past and present liquid waste disposal units in the 300 Area. The 300-FF-2 and 300-FF-3 source OUs that may affect the 300-FF-5 groundwater OU consist of waste management units that received solid waste and contaminated equipment from fuel fabrication operations; sanitary waste facilities; a plutonium test reactor; life science research and development activities; and support facilities. The following specific waste management units are included in the 300-FF-1 OU:

- Six process liquid waste disposal and transfer facilities that include the process sewer system, two ponds, one retention basin, and two sets of trenches (one set of which remains active)
- Four other liquid waste disposal and transfer facilities that include a sanitary sewer system, ash pits, and retired and operational filter backwash ponds
- Three burial grounds, two of which contain uranium-contaminated miscellaneous materials. The third site is a process pond scraping disposal area that consists of pond sediments and coal flyash.
- Three radioactive liquid waste transfer and storage facilities that include a retired radioactive sewer system, an active radioactive sewer system, and radioactive sewage storage tanks
- Two hazardous waste staging facilities, one of which contains drummed waste oil and empty hazardous waste drums. The second facility contains small containers of hazardous waste.
- No radiological inventories are available. Nonradiological chemical waste inventories can only be estimated. Contaminants of concern for 300-FF-1 include:
- Metals (aluminum, antimony, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc)
- Volatile organics (tetrachloroethylene, trichloroethylene, methylene chloride, Arochlor 1248, and trans 1,2-dichloroethylene)
- Radionuclides (cesium-137, cobalt-60, hydrogen-3, strontium-90, and uranium-235/238)
- Nonmetallic ions (ammonium, fluoride, nitrate, nitrite, and sulfate).

The 300-FF-5 OU has an identical list of contaminants of concern except for several radionuclides that have not been detected in the groundwater.

The draft 300-FF-1 and 300-FF-5 work plans are undergoing regulatory review and will be submitted for regulatory approval in early 1990. Surface radiation and GPR surveys have been initiated for 300-FF-1. As a result of the surface radiation surveys, a previously unknown burial ground (landfill), numerous surface hot spots, and some slightly contaminated vegetation sites have been identified. Only limited GPR work has been conducted, and no results are yet available.

100-HR-1/100-HR-3 Operable Units

The 100-HR-1 is a source OU that occupies approximately 130 ha adjacent to the Columbia River in the northeast portion of the 100-H Area. The OU includes the site of the retired 100-H reactor and adjacent support facilities. Many of the aboveground structures have been partially or fully decommissioned. The 100-HR-3 is a groundwater OU that underlies and is potentially affected by 100-HR-1, 100-HR-2, 100-DR-1, 100-DR-2, and 100-DR-3 source OUs (and possibly by other sources). The RFI/CMS for 100-HR-1 and 100-HR-3 OUs have been submitted for regulatory review. No field activities have been conducted to date. The 100-HR-1 OU consists of the following 19 waste management units:

- One reactor exhaust stack that received reactor confinement air emissions
- One radioactive solid waste disposal trench that received sludge from a nearby retention basin
- Three sanitary sewage transfer, treatment, and disposal facilities that include sanitary sewer pipelines and two sanitary septic systems

- One solar evaporation basin that received liquid process wastes from N reactor fuel fabrication activities in the 300 Area
- Ten process effluent, transfer, treatment and disposal facilities that include a reactor building, process effluent pipelines, an outfall structure, a retention basin, two disposal trenches, a pumping station, a French drain, and two cribs. These disposal facilities received process effluents from contaminated and noncontaminated reactor cooling water, decontamination wastes, and reactor confinement seal pit drainage.

The waste management units were used from 1949 to 1965 except for the solar evaporation basin, which was operated between 1973 and 1985. Primarily due to the presence of the solar evaporative basins, which will be closed under RCRA as a disposal facility, these OUs have been designated as RCRA past-practice sites and will be investigated under the RFI/CMS process. Several contaminants of concern for 100-HR-1 and 100-HR-3 are common to both OUs and are marked in the following list with an asterisk. The contaminants of concern are:

- Metals (aluminum, barium, chromium*, copper, iron, and lead*)
- Nonmetallic ions (fluoride*, nitrate*, nitrite, and sulfate)
- Volatile organics (chloroform*, tetrachloroethylene, and 1,1,1-trichloroethane*)
- Radionuclides (carbon-14, cesium-137, cobalt-60, europium-152/154/155, hydrogen-3*, nickel-63*, plutonium-238/239/240, ruthenium-106*, strontium-90, technetium-99, and uranium-235/238*).

The 100-HR-3 OU also includes perchloroethylene.

LESSONS LEARNED

The size of the Hanford Site and the number and variety of present waste sites offer unique challenges for both characterization and remediation of past-practice units. The experience of implementing the Tri-Party Agreement and working through several OUs have indicated ways in which the remedial process can be improved. Initiatives to do so are under way in several areas.

- Perform scoping studies to evaluate available site data, define site conditions, and develop preliminary conceptual models prior to work plan development activities.
- Create a data quality strategy that addresses unique investigation needs at the Hanford Site and provides for development and implementation of screening methods to reduce the number of samples submitted for laboratory analysis. This strategy will maintain a high overall level of data quality and defensibility.
- Develop a site-wide database for storage and retrieval of remedial investigation data.
- Implement a regional background sampling and analysis effort to provide a basis for development of realistic cleanup standards and to reduce redundancy associated with background sampling for individual sites or OUs.
- Prepare a generic procedures document.
- Prepare generic documents for a community relations plan, a data management plan, a quality assurance project plan, and a health and safety plan.

Scoping Studies

Problems arising from the lack of reliable site data have served to emphasize the importance of site characteristics and facility data in planning an RI/FS or RFI/CMS. Future OUs will include more emphasis on "scoping studies" to evaluate and document site conditions before work plan preparation. The scoping study will consist of a review of all available documents, interviews with present and former facility personnel, and limited nonintrusive field work. The purpose is to provide a detailed site description and a conceptual model of contaminant sources, migration pathways and receptors that will form the basis for work plan preparation and preliminary risk assessment. This work will be carried out by Westinghouse Hanford Company personnel who are familiar with the site and who have access to facility personnel and internal files. Scoping studies are especially important as more outside organizations become involved in the RI/FS or RFI/CMS process.

Data Quality Strategy

Implementation of RI work has resulted in the submittal of relatively large numbers of soil samples for costly and time-consuming laboratory analysis. Many of these samples have been clean. In addition, contaminants of concern at many waste sites are not commonly encountered in "conventional" RI/FS work, and conventional laboratory test methods may not be adequate. Therefore, a data quality strategy is being developed to identify specific contaminants of concern and to provide for greater use of screening methods that focus on the analyses for contaminated samples. This strategy involves the identification of probable contaminants during the scoping study and the development of screening and validated laboratory methods for analysis of these contaminants. The initial sampling and analysis program then applies both screening and validated laboratory methods to background and source areas to establish a correlation and to refine the list of contaminants. Screening methods are subsequently used to define the extent of con-

tamination, with a lesser number of validated laboratory data required for confirmation. Also, the list of contaminants of concern is revised as appropriate to include only those constituents present at elevated levels. Implementation of the data quality strategy is anticipated to result in a significant reduction in analytical costs while still maintaining high standards of data quality and defensibility.

Site-Wide Database

The Hanford Environmental Information System (HEIS) is currently under development. This database will contain all available vadose and groundwater data. As such, the HEIS will serve as a valuable reference for future work at nearby OUs.

Background Sampling

Many contaminants of concern also occur naturally and may be ubiquitous throughout the region. In these cases, cleanup criteria must be based on concentrations relative to background levels observed in areas not affected by waste disposal operations. A coordinated effort is being planned to obtain background samples on a regional basis, such that consistent back-ground data are used for all operable units. This will also eliminate the redundancy associated with individual background sampling for each site or OU.

Generic Documents

A number of generic documents have been or are being generated to standardize, to the highest degree possible, the method of conducting business. This will minimize redundant writing, reviewing, and editing of documents.

CONCLUSIONS

The Hanford Site presents unique challenges for both RI and cleanup. The large number of individual sites and the wide variety of site types, contaminants, and available data are factors that greatly affect the conduct of site remediation activities. Before approval and implementation of the Tri-Party Agreement, it was impossible to develop a coherent strategy for dealing with Hanford Site's waste problems. The Tri-Party Agreement and Action Plan, however, define the regulatory approach. Definition of an OU has helped to reduce the individual number of remedial programs that must be implemented, and the lead regulatory agency concept has alleviated the number of regulatory conflicts. Implementation of more detailed scoping studies before work plan preparation will provide a more consistent basis for work plan preparation, particularly where outside organizations are involved. Implementation of the HEIS, regional background sampling, and adoption of the data quality strategy will further serve to eliminate redundancy. The OUs mentioned in this paper have been a learning experience for everyone. The continued cooperation between DOE, EPA, and Ecology will result in a timely cleanup of all past-practice sites.

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