Conf-950216--83

PNL-SA-25063

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February 1995

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Presented at the
Waste Management 1995 Conference
February 26 - March 2, 1995
Tucson, Arizona

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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A SYSTEMATIC APPROACH FOR FUTURE SOLID WASTE CLEANUP ACTIVITIES AT THE HANFORD SITE

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ABSTRACT

The Hanford Site, an area of approximately 560 square miles in south central Washington State, was a major producer of plutonium beginning in the 1940's and lasting for nearly half a century. The production of plutonium generated large volumes of radioactive and hazardous wastes in both solid and liquid forms. Today, the U.S. Department of Energy (DOE) is in the process of restoring the Hanford Site. As defined in the *Hanford Mission Plan* (DOE 1993), "The primary Hanford mission is to clean up the Hanford Site, eliminate potential risks to the public and our workers, and serve as the DOE model in environmental restoration."

This paper describes the systematic approach to the treatment, storage, and disposal system (TSD) planning and management that has been developed and implemented by Hanford's Solid Waste Program.

The systematic approach includes:

- collecting the forecast and waste inventory data
- defining Hanford's TSD system
- studying and refining the TSD system by using analysis tools
- documenting analysis results.

The customers responsible for planning, funding, and managing future solid waste activities have driven the evolution of the solid waste system.

Currently, all treatment facilities are several years from operating. As these facilities become closer to reality, more detailed systems analysis and modeling will be necessary to successfully remediate solid waste at the Site. The tools will continue to be developed in detail to address the complexities of the system as they become better defined. The tools will help determine which facility lay-outs are most optimal, will help determine what types of equipment should be used to optimize the transport of materials to and from each TSD facility, and will be used for performing life-cycle analysis. It is envisioned that in addition to developing the tools to be adapted to the more specific facility design issues, this approach will also be used as an example for other waste installations across the DOE complex.

INTRODUCTION

The Hanford Site, located in south central Washington State, was a major producer of plutonium beginning in the 1940's and lasting for nearly half a century. The production of plutonium generated large volumes of radioactive and hazardous wastes in both solid and liquid forms. Today, the U.S. Department of Energy (DOE) is in the process of restoring the Hanford Site. As defined in the *Hanford Mission Plan*, "The primary Hanford mission is to clean up the Hanford Site, eliminate potential risks to the public and our workers, and serve as the DOE model in environmental restoration" (DOE 1993).

As part of the restoration mission, the Westinghouse Hanford Company (WHC) Solid Waste Program is responsible for the management and final disposition of the solid wastes generated or received at Hanford.[a] The purpose of this paper is to present an overview of the Program's approach to managing this waste.

As described in this paper, there are three major components to the Solid Waste Program approach: data collection; a treatment, storage, and disposal (TSD) system; and analysis tools. The results from development and use of these components are used by "customers" and Westinghouse Hanford Company (WHC), which operates the Program, to successfully manage solid waste at Hanford and integrate system planning with other DOE installations.

As part of this overview, Section 2.0 outlines the types of customers that use this information and describes how these customers have influenced the analysis process. Section 3.0 provides an overview of the solid waste planning and management concept, including:

- collecting the forecast and waste inventory data
- defining Hanford's TSD system
- studying and refining the TSD system by using analysis tools
- documenting analysis results.

Section 4.0 discusses the plans at Hanford for improving the understanding of the solid waste management system.

CUSTOMERS OF THE DATA

The customers responsible for planning, funding, and managing future solid waste activities have driven the evolution of the solid waste system. The current customers represent a wide array of individuals from different programs, ranging from representatives of the DOE-Headquarters to specific Hanford cognizant engineers who are documenting the design requirements for the future solid waste TSD facilities. As new customers are identified and additional requirements are recognized, new analysis techniques and tools will be applied to develop innovative solutions. A summary of the main customers and their data requirements follows:

- **DOE-Headquarters and DOE-Richland Operations Office.** DOE program managers request information from each DOE installation on the types of radioactive waste that is currently stored at the Site and how much is anticipated to be generated at, and/or shipped to, the Site in future years. This information

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[a] WHC is assisted in this effort by Pacific Northwest Laboratory (PNL), which is operated for DOE by Battelle Memorial Institute under Contract DE-AC06-76RLO.

is requested to determine how large the DOE waste management system is and the magnitude of waste volumes being generated at each installation. The information is transmitted through formal data requests, personal visits, and on an ad hoc basis.

- **Facility Planners.** Facility planners are outlining the requirements of future TSD facilities. To perform this work, these planners require insights into how much waste is currently at the Site and how much will be generated in the future. In addition, these planners need specific waste characteristic information to help determine the types of examination equipment, treatment technologies, and disposal grounds that will be necessary for waste characterization and final disposition.

- **System Analysts and Solid Waste Program Managers.** Hanford solid waste system analysts use the data to support system-wide TSD planning and to ensure all waste forms have a defined waste management path, eventually reaching onsite or offsite disposal. These data are also used to test the system sensitivity to alternative planning options. By understanding future TSD requirements, the information is also used by the Program to justify funding for facilities that are required to safely and expeditiously manage solid waste.

- **Financial Analysts.** The financial system uses the data to set billing rates for onsite and offsite waste generators who will be sending waste to Hanford's Solid Waste Management System over the next year.

A SOLID WASTE PLANNING AND MANAGEMENT CONCEPT

Remediation of Hanford's solid waste is a complex mission. Many factors impact the success of this mission: complying with all laws and regulations; identifying technologies that are feasible and available; identifying future waste types and volumes that will be managed at the Site; ensuring worker and public health and safety; ensuring funding is available to carryout the mission; and identifying and planning for uncertainties associated with future program missions, waste volumes, and funding appropriations. This section describes the systematic approach that has been implemented to address design and planning issues associated with Hanford's complex solid waste TSD system. Figure 1 illustrates the primary system components that constitute the solid waste management approach. Each of these components is described in the following subsections.

Waste Volumes

Each year information is collected on how much solid waste will be sent to Hanford in the future. This information is requested from the specific waste generating sites and is maintained in an evolving electronic database. Hanford also has large volumes of solid waste that were generated in the past and are currently being stored in trenches, caissons, and buildings. Waste characteristic information for the waste currently stored at the Site has been maintained in a separate electronic database.

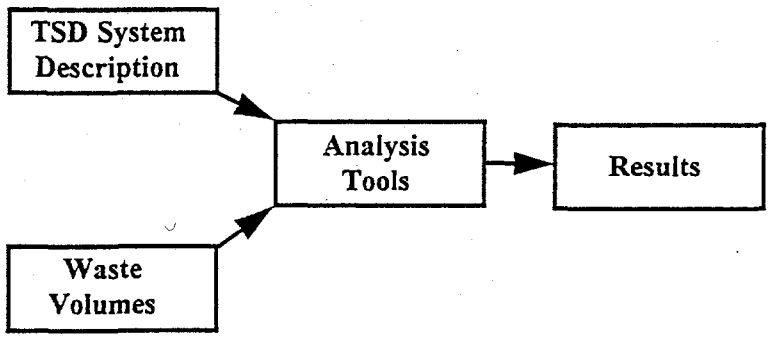

Fig. 1. System concept for waste management planning.

The information that is collected and maintained for both the forecasted waste and the stored waste is driven by the needs of the data users. The types of information currently available include the generating source, level of radioactivity, date of generation or shipment to the Site, volume of waste, the container types used for shipping and storing the waste, the physical matrix of the waste contents, and the hazardous constituents within each container.

The waste characteristic information serves several purposes. The information aids in determining waste management handling requirements. For example, large odd-shaped containers may require special devices to load the material to and from storage, disposal, and treatment. The specific container types also allow a planner to determine how many packages can be placed in a building and how the material can be stacked and organized. Containers that contain specific waste characteristics may need to be stored in special designated areas within a building. The radioactivity level, physical matrix, and hazardous constituents present within a waste package will also dictate the treatment and disposal requirements. In some cases, the waste may need to be shipped offsite for final disposition.

Treatment, Storage, and Disposal (TSD) System Description

A written description of Hanford's TSD system has been developed to narratively capture the future plans for TSD. This information is obtained from technical documentation, facility planners, program managers, and system analysts working within the Solid Waste Program. Consensus meetings are held to ensure that the system description adequately reflects all participants' points of view and documents a technical baseline from which sensitivity analyses can be performed.

The latest system description contains multiple storage buildings, several treatment facilities, and both onsite and offsite disposal sites. Figure 2 illustrates the current state of the planned system, while Figure 3 portrays Hanford's vision for the solid waste management system in the future. The vertical columns in the figures identify the waste sources, storage areas, characterization and treatment facilities, and disposal sites. Many of these components of the TSD system do not yet exist but will be constructed in phases, with the first major treatment facility (WRAP Module 1) planned to be on-line in 1997 and the last treatment facility scheduled for operations by 2013.

The waste sources shown in Figure 3 include 22 offsite and 68 onsite waste generators who will be sending waste to Hanford over the next 30 years. Several storage areas are planned to store the waste arriving from these waste generators as well as the work-in-process waste that is awaiting additional treatment or shipment to disposal. Six treatment facilities are planned to treat the waste, and several disposal sites have been identified to receive the waste for final disposal. Each TSD component is subject to environmental regulations and treatment requirements that dictate what type of activities and functions will be performed.

Once this system has been described to the level of detail required by the customer, the information is documented in flow diagrams. An example of a flow diagram is shown in Figure 4. These flow diagrams depict the system description in a more structured, analytical method, tracking each waste stream from point of generation to its final disposition. These diagrams provide a flow diagram model of the solid waste management baseline. The flow diagram model is imported into a computer model so that the system can be analyzed and sensitivity studies can be performed.

Analysis Tools

Several analysis tools are used to understand and refine Hanford's solid waste management system. Because of the large quantities of data that are collected, databases have been used to maintain and store the forecasted waste information and waste currently in inventory. The databases are updated as volume information is collected. Because this information is maintained electronically, specific information can be extracted to respond to data requests, to provide information to the financial department, and to create an electronic file to be used during modeling activities.

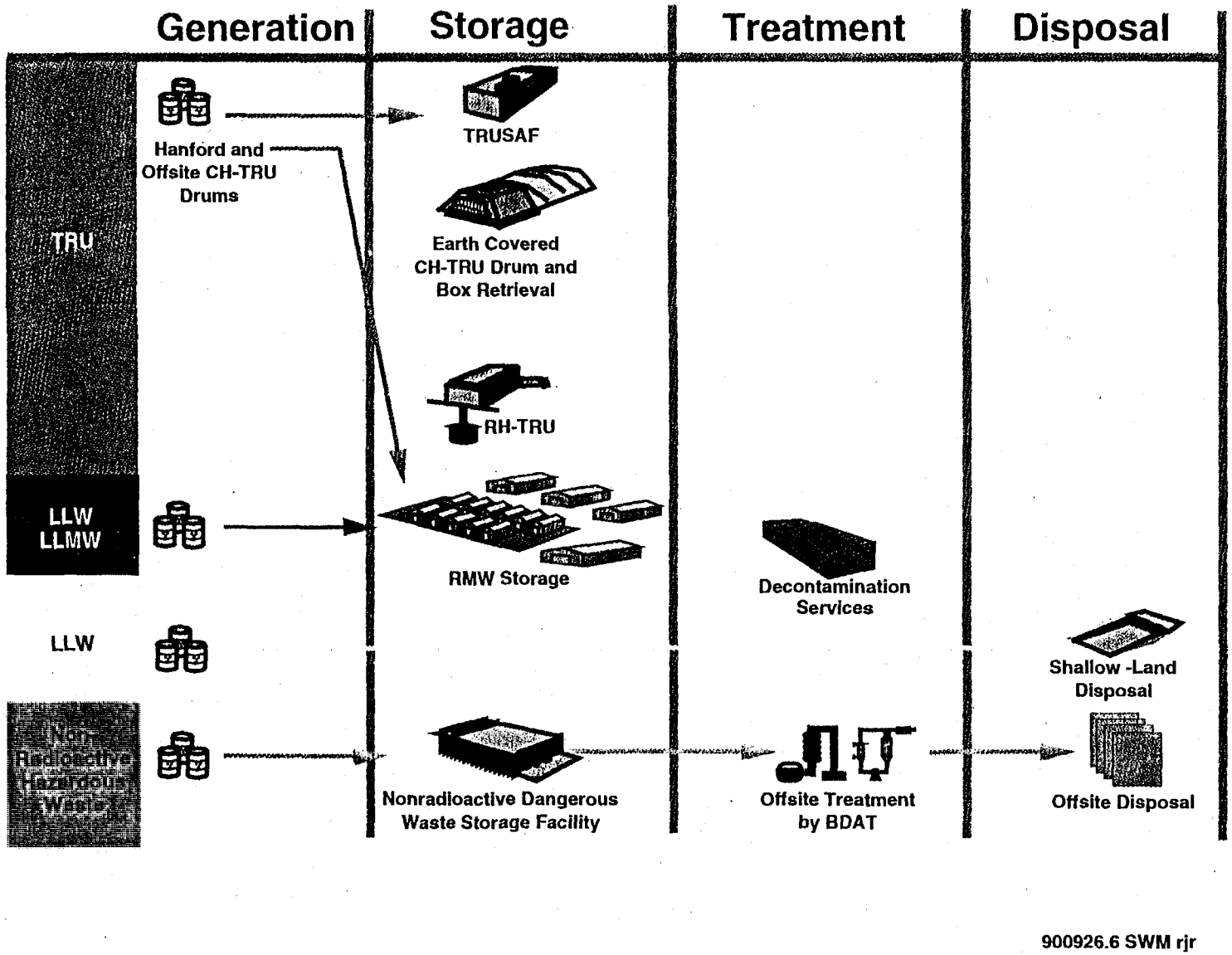

Fig. 2. Hanford's solid waste management system 1994.

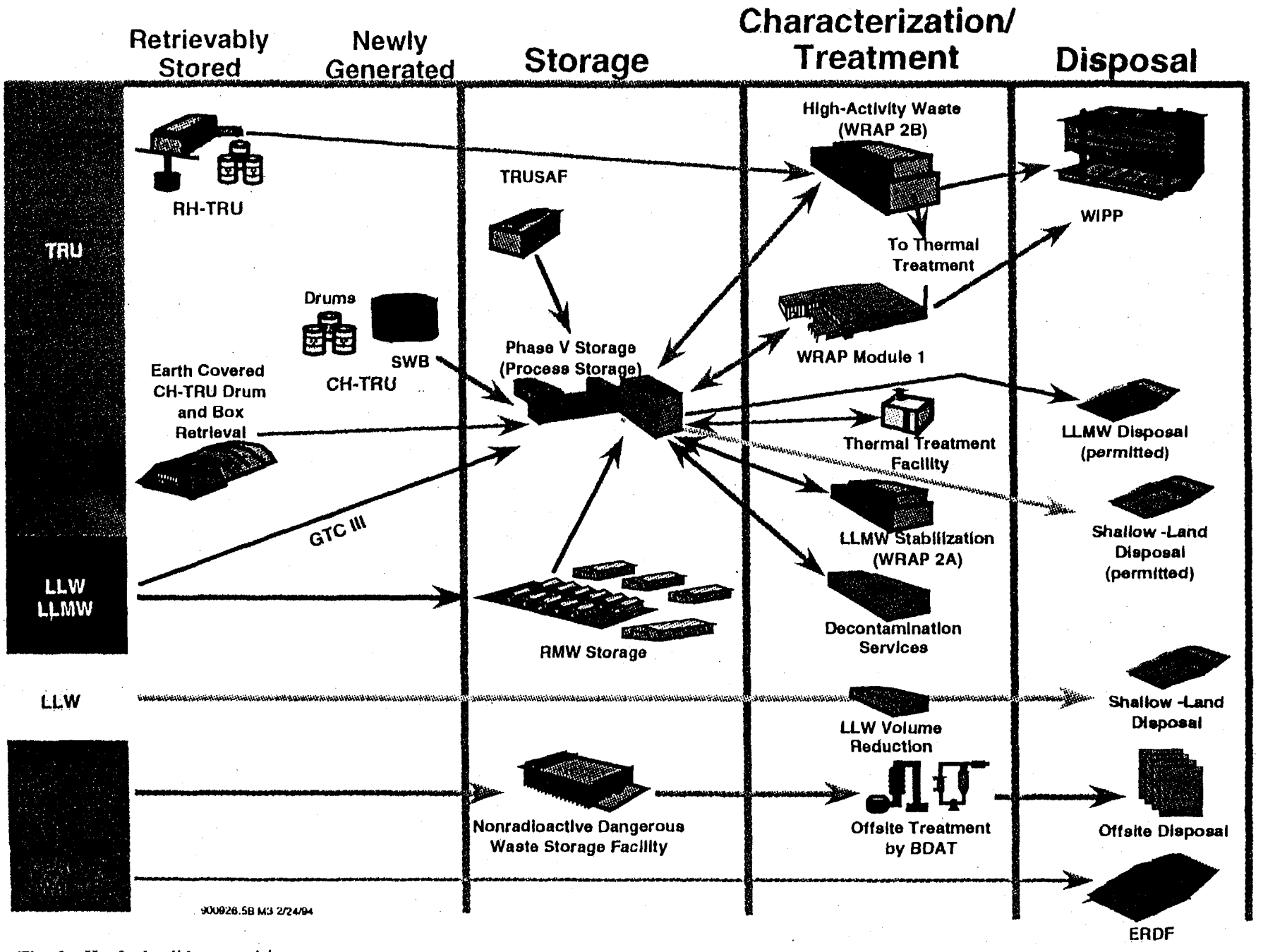

Fig. 3. Hanford solid waste vision.

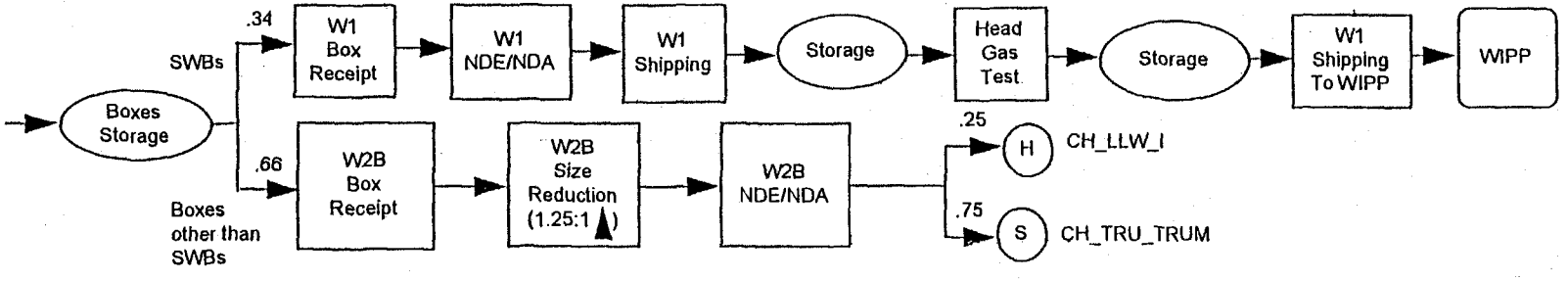

Fig. 4. Example solid waste flow diagram.

A second tool used at the Hanford Site is a simulation model that is based upon Hanford's TSD system description. The TSD functions are coded within the simulation model, and the input data from the forecast and stored waste databases are fed into the model to analyze the baseline system and alternative operating strategies. A baseline is established to gain an understanding of how the system may operate in the future.

Once the baseline is understood, alternatives can be evaluated using the simulation model to determine if other operating strategies are more optimal than the baseline. For example, the baseline system may indicate that shortfalls will exist by the year 2000 in planned storage capacity; therefore, one may want to evaluate alternatives that could alleviate this problem. Model runs could be performed delaying the timing of the waste receipts so that less volume requires storage within a given time period, or increasing the capacity of one of the treatment facilities to process waste volumes waiting in storage more rapidly.

Another reason for investigating alternatives to the baseline system description is to evaluate the system's sensitivity to events not represented in the baseline that have a probability of occurring. For instance, one may want to determine the impacts to the system if the waste volumes received at the Site have the potential to be twice the amount forecasted over the next 10 years. Several alternatives could be analyzed to assess the optimal sizes and startup dates for the TSD facilities. This tool provides the flexibility to easily analyze and study alternatives before designing a full-scale system.

Data obtained from the simulation model are stored in a database that allows a user quick access to the end results. The database allows for model output results of different alternatives to be compared and viewed graphically. Each time an alternative is generated, the new results can be compared to previous results to determine how the TSD system components are impacted.

Results

Several types of formal results from the analysis work are generated and provided to the customers, including results obtained from the collection and organization of the forecast and inventory data and results obtained from the system description and simulation model.

Results From the Forecast and Inventory Data

Due to the large volume of forecast and inventory data currently maintained and the diversity of the customers requesting information, several reports and summaries are issued. The following list identifies a sample of these reports and summaries, and provides a brief description of the information contained in each document.

- **Solid Waste Forecast Volume Summary Report.** The objective of the document is to provide a baseline volume forecast that can be used for standard reporting, preparing input files for modeling Hanford's waste management facilities, establishing a basis for billing rates, and responding to special data requests from solid waste facility planners and system analysts.

- **Treatability Group Summary Report.** This document describes the physical waste forms and hazardous constituents for the waste that will be shipped to Hanford's Solid Waste Complex and how these characteristics enable the mixed waste to be identified by nationally established treatability groups. This information provides insight into the treatments and capacities that will be required at the Site.

- **Container Volume Summary Report.** This document describes the containers that will be used to ship waste to the Hanford Site and the volume of waste associated with each container type. This report is used primarily for planning the handling, storage, and disposal requirements at Hanford's solid waste complex.

- **Stored Waste Data Analysis Summary**. This report analyzes the use of stored waste data to determine if past waste receipts provide insight into future waste shipments. It compares past waste volumes with the forecast volumes to identify trends among onsite and offsite waste generators for each waste generator from year to year and for each waste category. The report includes both the forecast data and stored waste data.

- **Additional Solid Waste Reports**. The specific data requirements of the TSD planners often vary from year to year. For this reason, unscheduled reports are frequently generated to supply these data needs. These reports differ in subject matter and level of detail; however, the objective is to provide a documented data set that may be used consistently for short- and long-term planning.

- **Integrated Database Support**. Every year Hanford is required to provide input to the DOE Integrated Database (IDB). A portion of the required information is extracted from the solid waste forecast database.

Results From the System Description and Simulation Model

Reports are developed that document the baseline system description and the baseline model results. Once the baseline assumptions and results are established, the system is analyzed with the simulation model by investigating "what-if" scenarios. The following list identifies the products delivered to the customers as a result of the system description and modeling activities.

- **TSD (Baseline) System Description**. This document describes a cradle to grave approach for achieving the mission to manage Hanford's solid waste. The report includes detailed definitions about each treatment facility, each storage building, and each onsite or offsite disposal site. In addition, the report identifies the facilities' functional requirements, the system's and facilities' interfaces with other systems or facilities, and the operational constraints of the system.

- **Baseline Model Results and Systems Analysis**. Once the baseline system description is established, the system is modeled using a simulation package to indicate how the current system plan meets the projected waste volume demands over the next 30 years. A report is issued that summarizes the results of this simulation. The results that are summarized include facility throughputs, storage requirements, disposal accumulations, and transporter movements. This information is presented in written descriptions, tables, and interim reports as well as through presentations to provide feedback to management and facility planners on the baseline system results. The analysis of the end results may introduce alternatives to be studied.

- **Alternative Operating Strategies**. Feedback obtained from WHC management and facility planners allows for several alternative studies to be conducted to show how Hanford's system could be impacted and/or improved by varying the system components or input data. Such alternative studies have included increasing/decreasing a treatment facility's capacity, adding waste volumes to the system that have the potential of requiring treatment at Hanford, re-routing waste volumes through other treatment facilities, and never opening a disposal site. The information provided for these studies is specific to the study performed but primarily includes treatment facility throughputs and storage requirements.

- **Integrated Database Support**. The simulation model has also been used to respond to the IDB in the past, as defined in Section 3.4.1.

CONCLUSION AND FUTURE VISION

Hanford has developed a systematic approach to accomplishing its mission to remediate solid waste. The four major activities performed toward achieving this mission are:

- collecting the forecast and waste inventory data

- defining Hanford's TSD system
- studying and refining the TSD system by using analysis tools
- documenting analysis results and communicating these results to the customers.

Over the next year, Hanford will continue to analyze the solid waste management system by performing the above activities. These activities illustrate to system designers which areas need improvement or attention. Also, these activities assist Hanford in quantifying the complex pieces of the solid waste management system and in identifying those components of the system that can greatly impact the system.

Currently, all treatment facilities are several years from operating. As these facilities become closer to reality, more detailed systems analysis and modeling will be necessary to support successful planning of solid waste remediation. The tools will continue to be developed in detail to address the complexities of the system as they become better defined. The tools will help determine which facility lay-outs are most feasible, will help determine what types of equipment should be used to optimize the transport of materials to and from each TSD facility, and will be used for performing life-cycle analysis. It is envisioned that in addition to developing the tools to be adapted to the more specific facility design issues, this approach will also be used as an example for other waste installations across the DOE complex.

REFERENCE

1. U.S. DEPARTMENT OF ENERGY (DOE). *Hanford Mission Plan*. DOE/RL-93-08, Volume 1. DOE, Richland Operations Office (1993).