APPROACH FOR SYSTEMATIC EVALUATION OF TRANSURANIC WASTE MANAGEMENT ALTERNATIVES*

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ABSTRACT

This paper describes an approach for systematic evaluation of management alternatives that are being considered for the treatment, storage, and disposal of transuranic waste (TRUW) at U.S. Department of Energy sites. The approach, which is currently under development, would apply WASTE_MGMT, a database application model developed at Argonne National Laboratory, to estimate projected environmental releases and would evaluate impact measures such as health risk and costs associated with each of the waste management alternatives.

The customized application would combine site-specific TRUW inventory and characterization data with treatment and transportation parameters to estimate the quantities and characteristics of the wastes to be treated, emissions of hazardous substances from the treatment facilities, and the quantities and characteristics of the wastes to be shipped between sites. These data would then be used to estimate for several TRUW management scenarios the costs and health risks of constructing and operating the required treatment facilities and of transporting TRUW for treatment and final disposal.

Treatment, storage, and disposal of TRUW at DOE sites is composed of many variables and options at each stage. The approach described in this paper would provide for efficient consideration of all of these facets when evaluating potentially feasible TRUW management alternatives. By expanding existing databases, this model could eventually be adapted to accommodate the introduction of new treatment technologies, updated TRUW characterization data, and/or revised waste acceptance criteria.

INTRODUCTION

This paper presents an approach for systematic evaluation of alternatives that are being considered in the Department of Energy (DOE) Environmental Restoration and Waste Management (EM) Programmatic Environmental Impact Statement (PEIS) for the treatment, storage, and disposal of transuranic waste (TRUW) at DOE sites. The approach, which is currently under development, would apply WASTE_MGMT, a database application developed at Argonne National Laboratory and described in Reference 1, to evaluate the environmental releases and would evaluate impact measures such as health risk and costs associated with each of the management alternatives.

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DOE generates approximately 1,500 m^3 of TRUW per year. Produced as a by-product of nuclear research and weapons production, TRUW has a radioactivity level greater than 100 nanocuries per gram of alpha-emitting radionuclides with half-lives of more than 20 years. Approximately 60% of TRUW is defined as "mixed hazardous waste" because it contains hazardous chemical constituents. TRUW can occur as contaminated process equipment; laboratory waste such as metal, glassware, paper products, clothing, filters, rubber aprons and gloves, and ion-exchange resins; and contaminated concrete, asphalt, and soil in areas where TRUW has been stored.

COMPONENTS OF TRUW MANAGEMENT

Figure 1 shows the flow of a generic TRUW management system from the point of generation through final disposal. The system consists of seven major components: (1) TRUW source, (2) operations required for retrieving stored TRUW, (3) characterization of TRUW, (4) treatment, (5) packaging and certification for shipment, (6) interim storage of certified TRUW packages, and (7) disposal of certified TRUW packages.

PLACE FIGURE 1 HERE

TRUW MANAGEMENT ALTERNATIVES

For the purpose of the PEIS, the socioeconomic and environmental impacts of several alternatives for TRUW management will be evaluated. Most of the alternatives proposed involve some combination of treatment technology and treatment/interim storage configuration (centralized, decentralized, or regional), followed by disposal of the waste at a geologic repository known as the Waste Isolation Pilot Plant (WIPP). WIPP is an excavation 2,150 feet below the Earth's surface in a bedded-salt formation near Carlsbad, New Mexico.

Numerous options are available for both the treatment technology and the treatment/interim storage configuration. For example, depending on whether the TRUW is a mixed hazardous waste (and therefore regulated by the Resource Conservation and Recovery Act [RCRA]), treatment technology options may range from simple packaging/repacking to meet WIPP acceptance criteria, to exhaustive thermal destruction to meet RCRA land disposal restrictions. This TRUW may be sent to a regional center for treatment/interim storage (regional configuration) or treated and stored on the site where it was generated (decentralized configuration).

A spectrum of representative technologies for the treatment of TRUW is shown in Figure 1. Three levels of treatment are considered in the PEIS to accommodate a range of waste characteristics and PEIS program objectives. The low level of treatment would process and package TRUW to meet current WIPP waste acceptance criteria. The mid-level of treatment would treat TRUW to reduce the rate or the potential of gas generation in the WIPP, in addition to meeting the waste acceptance criteria. The high level of treatment would robustly treat all hazardous constituents in TRUW to meet RCRA land disposal restrictions.

Feasible options for the technology, level, and configuration of TRUW treatment/interim storage will be combined into approximately 15 cases for evaluation in the PEIS. Some examples of these combinations are (2):

Decentralized/Mid-Level. Treat to intermediate level via shredding, grouting, and upgrading containers to exceed WIPP waste acceptance criteria and reduce gas generation (upgrade existing facilities and/or construct new facilities for packaging and processing TRUW). Treat/interim store at same site as generation. Transport to WIPP for disposal.

Regionalized/High Level. Transport TRUW from small-generator DOE sites only to five regional sites for treatment and interim storage. Treat to meet land disposal restrictions (construct necessary treatment facilities at five sites). (See Figure 1 for possible high-level treatment technologies.) Ship from the five sites to WIPP for disposal.

Centralized/High Level. Transport all TRUW to WIPP and treat to meet land disposal restrictions (construct necessary treatment facilities at WIPP). (See Figure 1 for possible high-level treatment technologies.) Dispose at WIPP.

APPLICATION OF THE PROPOSED METHODOLOGY FOR EVALUATION OF TRUW MANAGEMENT ALTERNATIVES

Figure 2 shows the databases and dynamics of the proposed conceptualized approach to modeling TRUW management alternatives. As shown, the conceptualized TRUW model would include a release module (WASTE_MGMT). The release module would combine site-specific TRUW inventory and characterization data with the treatment and transportation parameters of each case to evaluate the quantities and characteristics of the wastes treated at the facilities and shipped between sites. It would also project radionuclide and hazardous chemical releases to the atmosphere during routine operations. A separate accident evaluation module as part of the release module would estimate the air releases of radionuclides and hazardous chemicals under postulated accident conditions.

These data would then be evaluated in the impact module to estimate for each case impact measures such as the costs and health risks of constructing and operating the required treatment facilities and transporting TRUW to the facilities and WIPP

PLACE FIGURE 2 HERE

Figure 3 presents abbreviated layouts of the database files. Shaded areas in Figure 3 indicate key fields that, when combined, would be unique to each record and would be used to link or retrieve associated data in external files.

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Case definition files would specify for each site potential treatment options for treatment, storage, and disposal of TRUW. Site configuration would also be defined.

Waste inventory and characterization files would contain the current TRUW inventory and projected generation rates for each site by treatability class derived from the "Integrated Data Base" and the "Interim Mixed Waste Inventory Report" (3,4). The radionuclide distribution and activity of the waste and its chemical profile would also be included. The treatability classes for TRUW can be specified as the following: aqueous

liquids, organic liquids, solid process residues, soils, debris, special waste (such as lab packs and explosives), inherently hazardous waste (such as liquid mercury and beryllium dust), and unknown.

Treatment, storage, and disposal files would contain the unit operations parameters for treatment facilities. Parameters would include the throughput volume and mass concentration/distribution of the output product, liquid residual and solid residual, and radionuclide and chemical partitioning factors among the output quantities and air releases.

Impact analysis files would include (1) unit risk factors for the evaluation of health risks to workers and the general public that could result from facility operation and transportation of TRUW under both normal and accident conditions; and (2) transportation costs and facility costs associated with demonstration, construction, operations and maintenance, and decontamination and decommissioning.

The facility risk factors are being developed at DOE's Oak Ridge National Laboratory; Argonne National Laboratory is developing the transportation risk factors; facility and transportation cost estimates are being developed by EG&G Idaho, Inc.

Release module output would include quantities and characteristics of facility throughputs and releases to the environment. Output files identify the source of the material entering a given treatment facility and site, the mass and volume of TRUW treated, and the radionuclide distribution/activity and chemical profile of releases.

Impact module output from the impact module would include impact measures such as health risks and costs for each TRUW management alternative under evaluation. In the impact module, calculated throughput and release quantities would be combined with proper unit risk factors and cost estimates for evaluating the health risks and costs.

CONCLUSION

Treatment, storage, and disposal of TRUW at DOE sites is composed of many variables and options at each stage. The conceptual model described in this paper would provide an efficient means of allowing all of these facets to be considered when evaluating feasible TRUW management alternatives for DOE sites. By expanding existing databases, this model can be adapted to accommodate the introduction of new treatment technologies, updated TRUW characterization data, and/or revised waste acceptance criteria.

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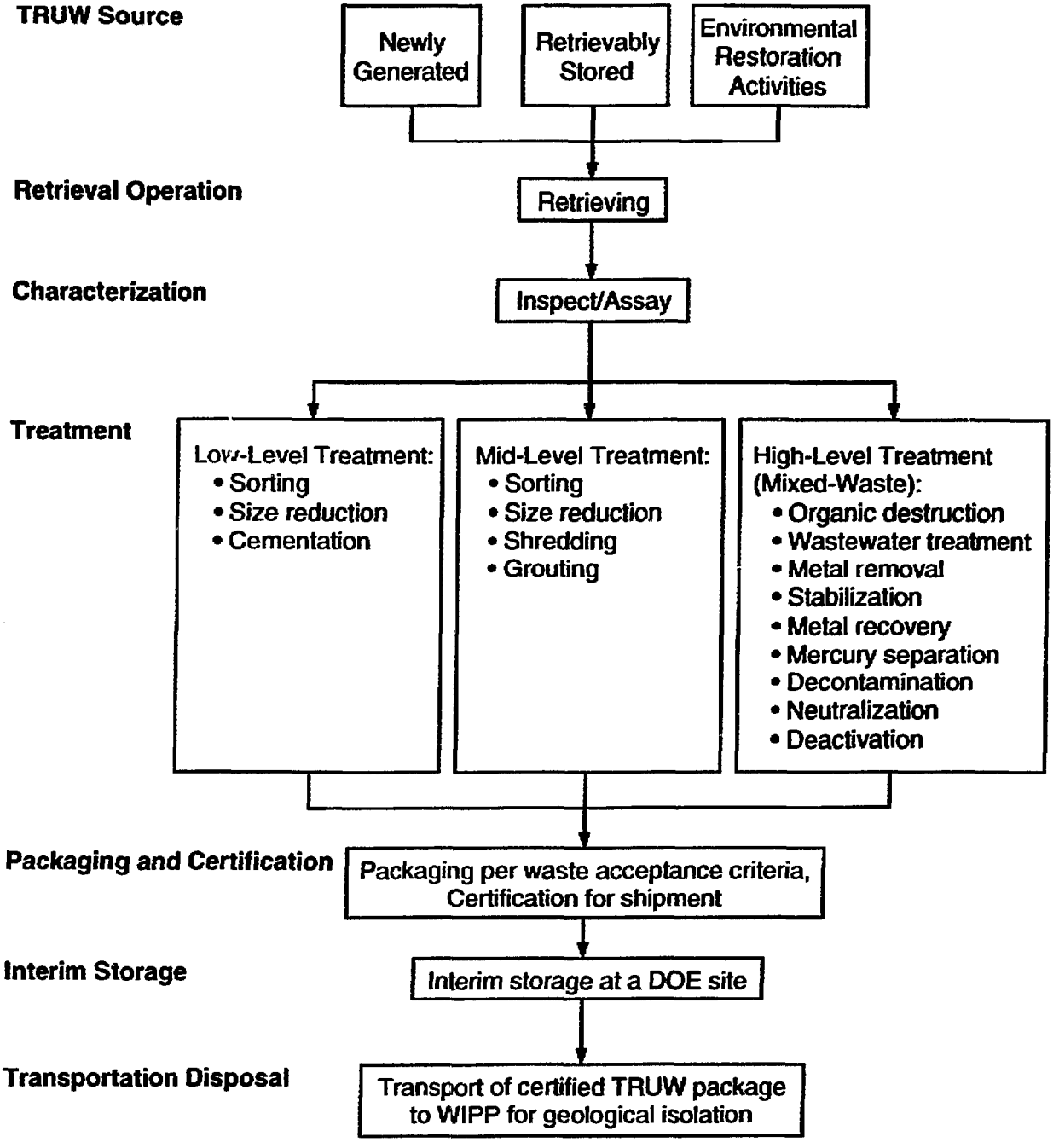
TRUW Source
Newly Generated
Retrievably Stored
Environmental Restoration Activities
Retrieval Operation
Retrieving
Characterization
Inspect/Assay
Treatment
Low-Level Treatment:
• Sorting
• Size reduction
• Cementation
Mid-Level Treatment:
• Sorting
• Size reduction
• Shredding
• Grouting
High-Level Treatment (Mixed-Waste):
• Organic destruction
• Wastewater treatment
• Metal removal
• Stabilization
• Metal recovery
• Mercury separation
• Decontamination
• Neutralization
• Deactivation
Packaging and Certification
Packaging per waste acceptance criteria, Certification for shipment
Interim Storage
Interim storage at a DOE site
Transportation Disposal
Transport of certified TRUW package to WIPP for geological isolation

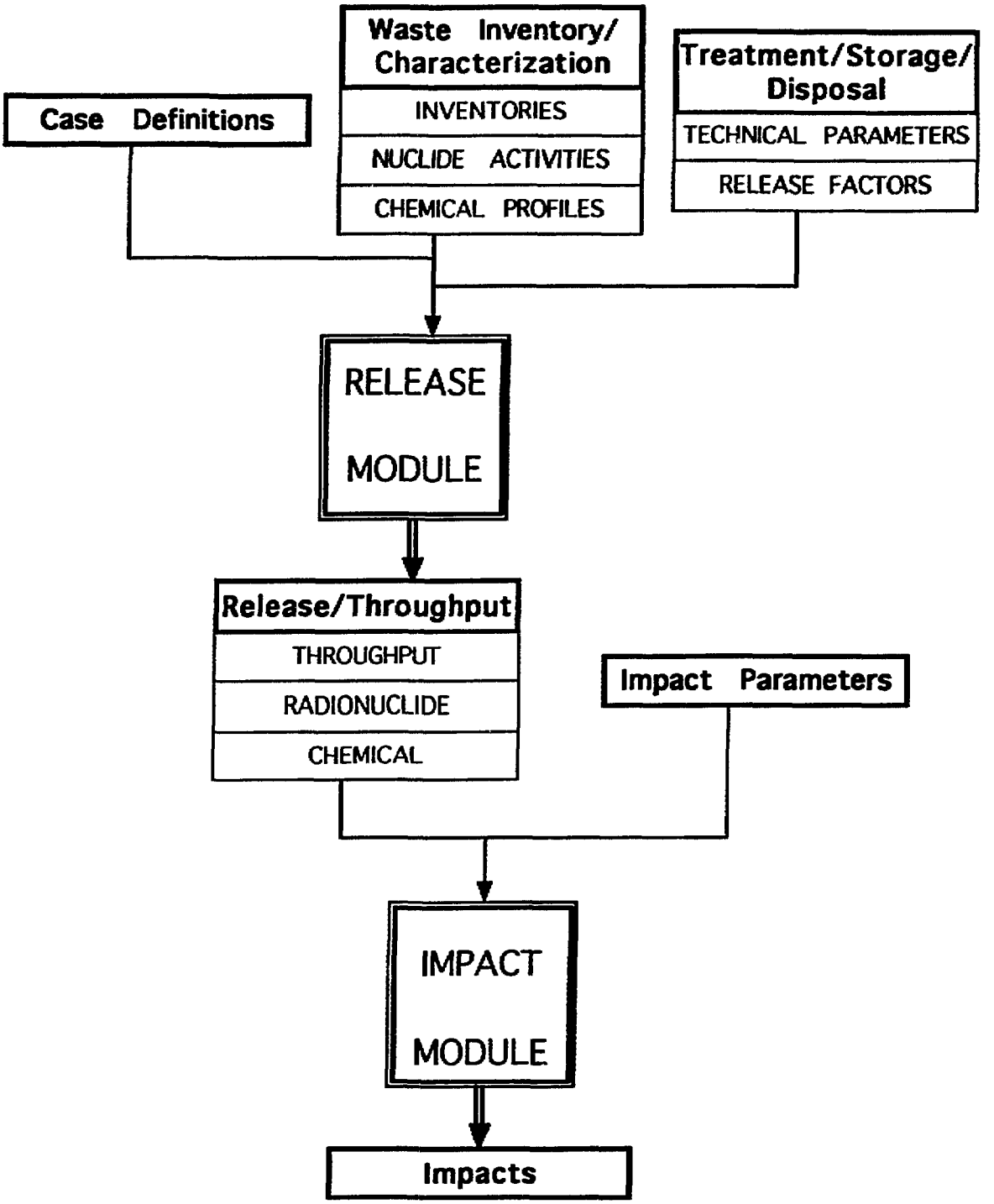

Fig. 2 Conceptual Model for Evaluating TRUW Management Alternatives

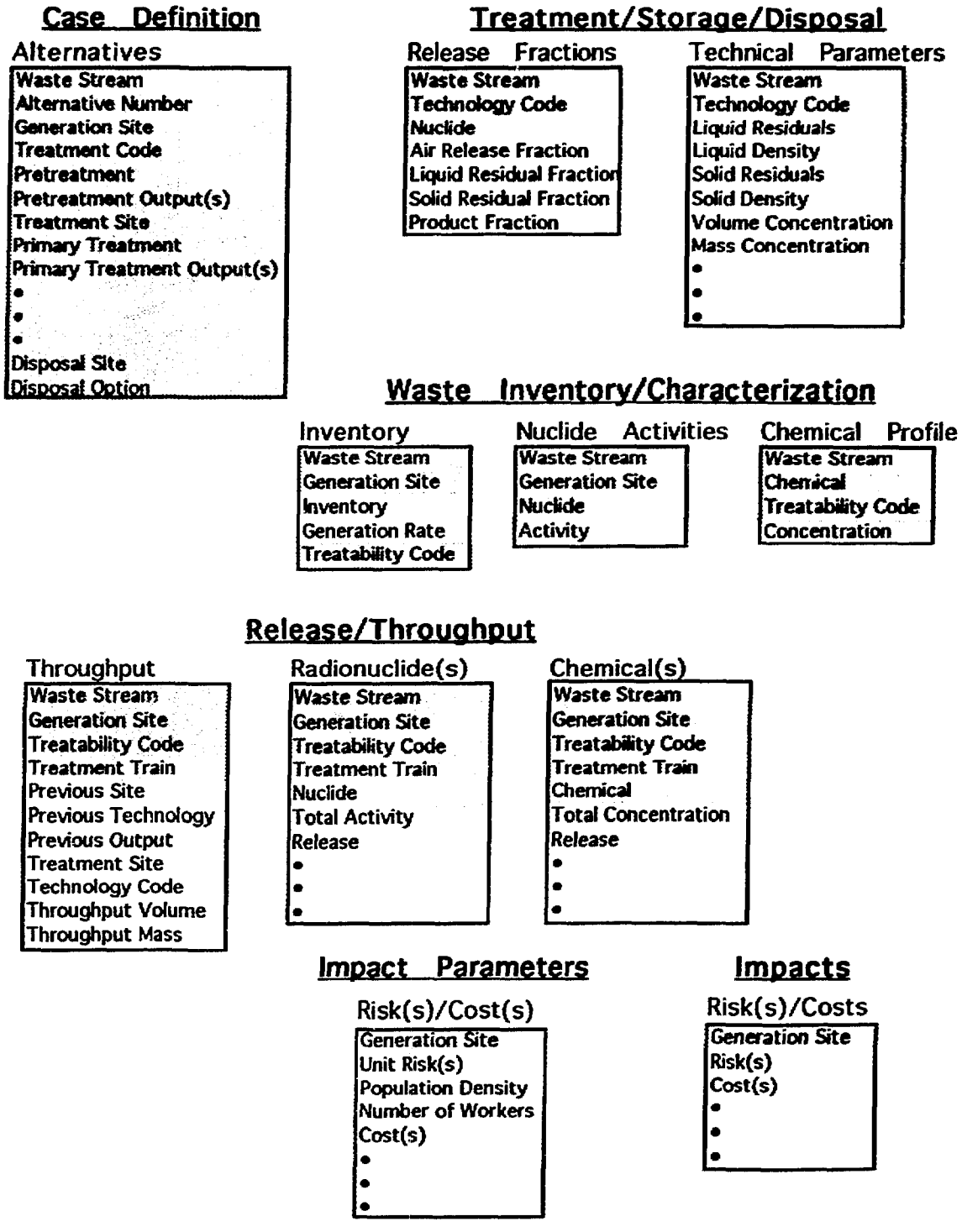

Fig. 3 Databases Used in the Conceptualized TRUW Model