

OAK RIDGE WASTE DISPOSITION: WHAT TO DO WHEN YOU HAVE NO PLACE TO GO*

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ABSTRACT

The U.S. Department of Energy's (DOE) Oak Ridge Reservation has conducted leading research in a number of areas, including neutron science, genetics, and environmental sciences. Oak Ridge is also a leader in a more dubious category — it is the home of DOE's largest inventory of stored low-level, mixed low-level, and remote-handled transuranic waste. Without accelerated and innovative waste disposition strategies, this inventory will only increase. The volume of stored low-level waste, for instance, is projected to exceed 95,000 m³ within ten years.

Oak Ridge is pursuing a multi-pronged approach to accelerate the disposal of mixed and low-level waste:

- getting several waste streams "road ready" for disposal while awaiting programmatic decisions on disposal outlets;
- pursuing alternate disposal at Subtitle C or D landfills and other recent regulatory avenues;
- reclassifying waste where analytical data supports reclassification; and
- establishing a single, reservation-wide waste acceptance and certification program that is based on treatment and disposal requirements, and not on storage requirements.

These efforts will support Oak Ridge's goal of accelerating legacy waste disposition by at least ten years over the baseline in the *Accelerated Cleanup Plan: Paths to Closure*. An infrastructure will remain to support direct shipment of newly generated waste for treatment and disposal so that no new legacy waste is ever generated.

HISTORY OF WASTE GENERATION AND DISPOSAL AT OAK RIDGE

The Oak Ridge Reservation, which encompasses approximately 140 km² in eastern Tennessee, is the home of three major facilities: Oak Ridge Y-12 Plant, Oak Ridge National Laboratory (ORNL), and East Tennessee Technology Park (ETTP), formerly the K-25 Site. The three primary facilities were hurriedly constructed in the 1940s as part of the Manhattan Project. Their original mission was large-scale production of fissionable materials for the first nuclear weapons. Plants at the K-25 Site and the Y-12 Plant separated and enriched uranium, respectively, while ORNL produced the first gram quantities of plutonium.

More recently, ORNL has pursued a variety of missions and research projects involving a broad range of radionuclides. The Y-12 Plant's mission has shifted to dismantling nuclear weapons components and other production support for DOE. The primary Y-12 operation was suspended in 1993 and the facility is currently undergoing restart. It is expected to return to full operation (and waste production) in 1999. The

K-25 gaseous diffusion plant operations were permanently shut down in 1987. Since that time, plant activities have shifted to environmental restoration, decontamination and decommissioning, waste treatment, and reindustrialization. This diversification is leading to a diversification of wastes being generated.

In addition to solid wastes generated at all three sites from ongoing operations, significant volumes of process residues are produced. The sources of these residues are several waste treatment facilities being operated at the three sites. The majority of these facilities are designed to treat large volumes of wastewaters contaminated with radionuclides and hazardous constituents. In FY 1998, the combined throughput of these facilities was 1.1 billion liters. Other treatment facilities include the Uranium Chip Oxidation Facility at the Y-12 Plant and the Toxic Substances Control Act Incinerator at ETPP.

The High Flux Isotope Reactor continues to operate at ORNL and is the source of solid low-level waste typical of operating reactors. Routine retrofits of the reactor produce much of the special case low-level waste being generated. In FY 1999, approximately 0.7 m³ waste containing an estimated 8000 Ci will be accepted from the facility for storage and ultimate disposal.

ORNL is also the home of the Radiochemical Engineering Development Center whose primary mission is special isotopes production of berkelium, californium, einsteinium, and fermium for medical uses. This facility is the source of most of the highly radioactive transuranic sludge and debris waste currently being generated on the reservation.

On-site Waste Disposal

Historically, waste generated on the Oak Ridge Reservation was disposed of primarily via shallow land burial. In total, Oak Ridge has 57 hectares of burial grounds containing 18,000 metric tons of uranium and over 6 million Ci of radionuclides.

While shallow land burial was a typical practice at most DOE facilities, Oak Ridge is not the best location in the DOE system, hydrogeologically, for such a practice. The region receives over 140 cm of precipitation annually and the reservation is surrounded by extensive surface water systems. Over 160 km of contaminated streams have been mapped and detectable contamination extends downstream at least 110 km to the Watts Bar Dam. The reservation is underlain by complex (principally karst) geologic formations and the water table is generally encountered at depths of 0 to 6 m.

Shallow land burial of radioactive and mixed wastes ceased on the reservation in 1991 and several of the burial grounds have been capped and seep collection systems installed. The inactive burial grounds are the subject of remedial investigation and remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

As below-grade disposal was phased out at Oak Ridge, it was replaced with above-grade tumulus pad disposal. The currently active Interim Waste Management Facility consists of six 500-m² pads, each with associated ventilation and runoff control systems. The facility, which is scheduled to cease operations in FY 1999, has very restrictive waste acceptance criteria. Typically, <15% of the solid low-level waste generated annually on the reservation can be disposed at the Interim Waste Management Facility. The reservation's hydrogeologic conditions dictated this highly engineered method of disposal and the resultant disposal cost—approximately \$5000/m³—has been the highest in the DOE system.

Off-site Waste Disposal

Concurrent with operation of the Interim Waste Management Facility, Oak Ridge began pursuing off-site disposal locations for its low-level waste. In 1992, DOE-Headquarters (HQ) designated the Nevada Test Site as the receiving facility for Oak Ridge waste. By 1994, an audit of the ORNL certification program was completed and the first waste stream approved for shipment to the Nevada Test Site. DOE suspended this first shipment for off-site disposal while the agency negotiated resolution of the state of Nevada lawsuit over National Environmental Policy Act issues at the Nevada Test Site. In subsequent negotiations, DOE-HQ placed Oak Ridge in a group of “new” generators that could not ship waste to the Nevada Test Site until the Programmatic Environmental Impact Statement Record of Decision was signed.

While Oak Ridge has routinely shipped some solid low-level waste off-site for commercial compaction and incineration, until very recently all residues were required to be returned to the reservation for disposal. In early 1998, the first volume of Oak Ridge legacy low-level waste was scheduled for shipment off-site to a commercial facility for disposal. This shipment was suspended in response to a lawsuit contesting the award of a DOE commercial low-level waste disposal contract. The lawsuit was subsequently settled, but shipments remained suspended pending a DOE policy analysis on the use of commercial facilities for waste disposal. This policy analysis is anticipated to be released in mid-1999.

As a consequence of these events and decisions, by mid-FY 1998 Oak Ridge had no off-site outlets for low-level waste disposal and only very limited and expensive on-site disposal capability. At the end of FY 1998, Oak Ridge's inventory of legacy low-level waste had grown to more than 40,000 m³, representing 40% of the entire DOE complex inventory of stored low-level waste (Fig. 1).

OAK RIDGE LEGACY WASTE INVENTORIES

It should be noted that the Oak Ridge Reservation is one of the few DOE installations still generating significant quantities of waste from non-Environmental Management sources. More than 6000 m³ of low-level waste was generated last year from operations sources and this volume is projected to grow to 8000 m³ annually when the Y-12 Plant resumes full operation. Considering the planned low-level waste disposal rates reflected in the *Accelerated Cleanup Plan: Paths to Closure*, the volume of stored low-level waste is projected to approach 100,000 m³ over the next decade (Fig. 2). This projection does not include waste from environmental restoration or decontamination and decommissioning activities.

While low-level waste is the largest of the legacy waste streams on the Oak Ridge Reservation, the volumes of mixed low-level waste and remote-handled transuranic waste also represent a significant share of DOE's entire inventory of those waste types (Fig. 1). Disposition of mixed low-level waste is driven by compliance requirements and schedules in the Oak Ridge Reservation Site Treatment Plan. With the placement of the Broad Spectrum treatment subcontracts in 1998, treatment capability is available for all identified mixed waste streams on the reservation. While Oak Ridge's share of mixed low-level waste is 40% of DOE's inventory, this legacy is being worked off at a rate of 4000 to 8000 m³ annually.

More than one-third of the reservation's inventory of transuranic waste is remote-handled sludge from the liquid waste systems and tanks at ORNL. Treatment of this material, as well as containerized transuranic waste, is included in a privatization contract awarded by DOE in late FY 1998. Transuranic waste treatment and shipments to the Waste Isolation Pilot Plant are scheduled to begin in 2003. This waste type is projected to be at steady state by 2009.

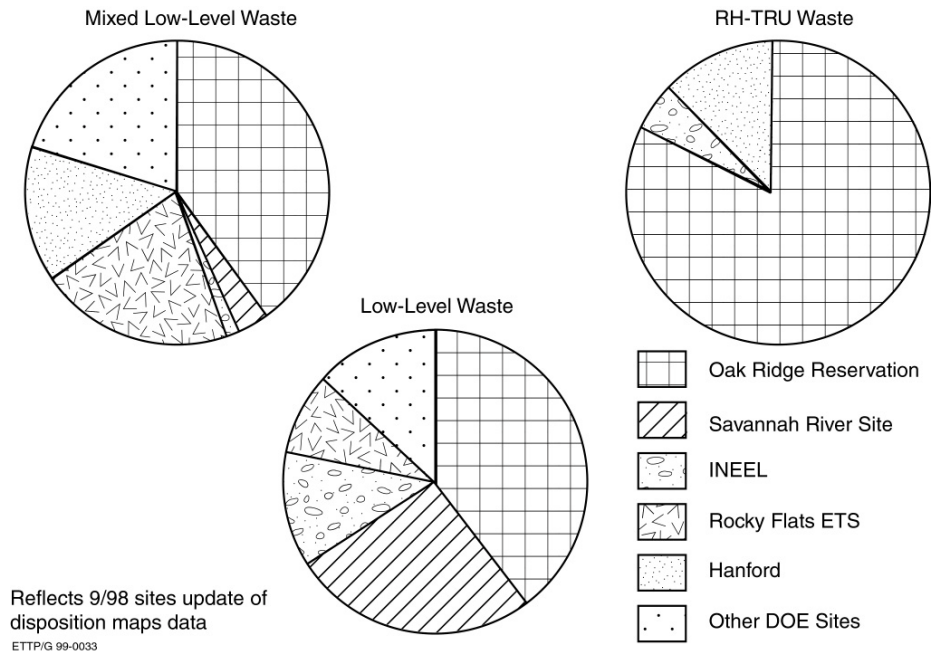


Fig. 1. Comparison of Legacy Waste Inventories Across the DOE Complex (% of total volume)

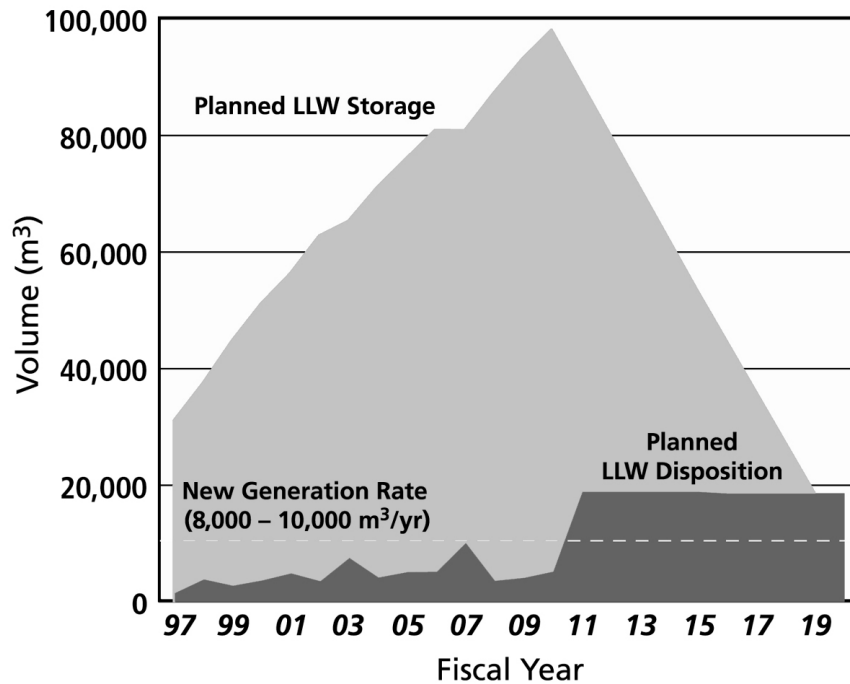


Fig. 2. Projected Oak Ridge Reservation Low-Level Waste Inventory.

ACCELERATING THE DISPOSITION OF OAK RIDGE LEGACY WASTE

For all intents and purposes, the Oak Ridge Reservation can be considered “awash” in legacy waste. Over 90 storage facilities are maintained on the reservation, not including 90-day storage areas, satellite accumulation areas, or underground storage tanks. Nearly 40% of the low-level waste is stored outdoors.

A number of factors have driven Oak Ridge to identify and implement strategies to dramatically accelerate the disposition of legacy waste. Two of the more obvious factors are the cost to store legacy waste volumes and the fact that the reservation does not have unlimited storage space.

Three additional drivers of note are:

- conflicts with required remedial actions,
- health and safety issues associated with one of the largest storage facilities, and
- anticipated requirements of DOE Order 435.1.

Legacy waste storage facilities and the waste they contain are directly in the way of planned CERCLA remedial actions. The most significant of these conflicts is the 4500 m³ of low-level waste stored in the footprint of the proposed on-site disposal cell for remediation waste. This disposal facility, an abovegrade earthen cell with a composite cap, is scheduled to be operational in 2001. Legacy waste, waste from off-site generators, and non-CERCLA waste are specifically excluded from the facility. While the legacy waste in the footprint could be moved, the cost of such a move would be significant and such relocation would not put the waste any closer to final disposition.

Over 9000 m³ of mixed and low-level waste is stored in 34 vaults in the K-25 building. This 50-year-old facility is the largest building on the site (170,000 m²) making it an attractive facility to house waste awaiting treatment and disposal. The building is also an attractive location for bacteria and fungi and these agents are suspected to be the cause of a series of worker illnesses reported in recent years. A “for cause” review conducted by DOE in 1998 led to a moratorium on placing new waste volumes in the building and a plan to remove all waste from the facility in two years. As with waste impeding remediation, the expenditure of funds to simply relocate the waste is considered neither cost-effective nor wise. Similarly, DOE’s implementation of Order 435.1 will significantly increase the cost of waste storage on the Oak Ridge Reservation, funds that could be better spent for waste treatment and disposal where sufficient outlets are available.

ACCELERATING LEGACY WASTE DISPOSITION

A series of initiatives being implemented by DOE and Bechtel Jacobs Company LLC at Oak Ridge are designed to accelerate the disposition of legacy waste and to reduce the time and cost to dispose of waste generated in the future. These initiatives include:

- alternate disposal,
- implementation of regulatory revisions,
- resolution of equity issues,
- waste reclassification, and
- reservation-wide waste certification and acceptance programs.

Alternate Disposal

Alternate disposal at Subtitle C or D landfills is being pursued under DOE’s policy for the release of materials with residual radioactivity. DOE requirements for the release of real and non-real property, including waste, are specified in DOE Order 5400.5, “Requirements for Release and Control of Property

Containing Residual Radioactive Material.” DOE has issued two primary guidance documents related to this Order—one issued by DOE-Environmental Safety and Health in 1995 clarifying application of the Order’s requirements, and a 1997 guidance document, “Establishment and Coordination of Authorized Limits for Release of Hazardous Waste Containing Residual Radioactive Material.”

These guidance documents address the disposal of DOE wastes at DOE facilities, as well as disposal at non-DOE landfills which are not authorized for disposal of radioactive waste. Requirements that must be satisfied prior to disposal include:

- an evaluation to demonstrate that potential radiation doses to the public will not exceed 25 mrem/year, with an “as low as reasonably achievable” goal of a few mrem/year,
- an evaluation of compliance with groundwater protection requirements,
- reasonable assurance that the proposed disposal will not result in a future remediation requirement, and
- concurrence from the owner/operator of the facility and associated regulators.

DOE has indicated that this policy provides an alternative to the “no-rad added” standard by allowing release limits on a case-by-case basis. The Department has concluded that the policy does not establish a *de minimis* for radioactivity, in that the releases of such materials will continue to be controlled by DOE Field Office personnel. Releases of material having dose rates above 1 mrem/year requiring DOE-HQ approval. DOE’s guidance further clarifies that material released under this policy, while no longer subject to regulation under the Atomic Energy Act, should not be termed “non-radioactive,” but should be referred to as “waste containing residual radioactive materials.”

Oak Ridge completed the first such alternate disposal action in 1998 with the shipment of sediments from Basin 9822. These sediments contained polychlorinated biphenyls (PCBs) ranging from 52 to 450 parts per million, mercury at concentrations below Resource Conservation and Recovery Act (RCRA) regulated levels, and total uranium ranging from 4 to 8 pCi/g. Calculations using uranium concentrations a factor of 2 higher than the highest concentration measured in the sediments yielded a dose to the hypothetical maximally exposed worker at the disposal site of $< 6 \times 10^{-4}$ mrem. The stabilized sediments have been disposed at a RCRA and TSCA-permitted facility in New York at estimated cost savings of nearly \$550,000 over other feasible treatment and disposal alternatives. In its approval of the request for disposal, the New York State Department of Environmental Quality indicated that the total uranium concentrations in the material are considered to be trace concentrations and consistent with the disposal facility’s acceptance criteria.

In a similar initiative, Oak Ridge has submitted special waste requests to the state of Tennessee to approve disposal of waste with low concentrations of radionuclides in the Oak Ridge Reservation sanitary landfill. The permit for this facility allows it to accept solid waste with < 35 pCi/g total uranium. Tennessee approved the non-destructive assay system at ETTP for use to screen waste for this acceptance criterion. Further internal review has established operational criteria for the assay system of computed activity < 15 pCi/g total uranium ($\pm 50\%$ error) on boxes that do not exceed 800 kg.

It is estimated that as much as 10% of the legacy low-level waste could be disposed using alternate disposal criteria. In September, Bechtel Jacobs Company issued a multi-incremental screening process for candidate waste streams. The screening process operates within the limits of 1 to 25 mrem/year established in DOE guidance. For dose estimates between the two limits, specific activity dose calculations for hypothetical dose receptors at the actual disposal facility are made. For doses < 1 mrem/year, additional CERCLA-based screening can be performed against industrial soil and residential groundwater risk criteria of 1×10^{-4} .

Implementation of Regulatory Revisions

Oak Ridge is also pursuing disposal under Environmental Protection Agency's (EPA's) regulations issued June 29, 1998, regarding disposal of PCBs. Such regulations would allow several of Oak Ridge's incinerable solid mixed wastes to be land disposed without treatment at commercial facilities rather than to be treated at the TSCA Incinerator. While the TSCA Incinerator is designed and permitted to take solid wastes, much of the remaining incinerable solid waste streams must be fed at low rates and create accelerated wear on the incinerator's kiln brick. The disposal cost for the untreated waste is less than or, at worst, equal to the cost for the disposal for the residues from the incinerator. This is significant since most of the solid material awaiting treatment is contaminated soils and other inorganics that will yield very little weight or volume reduction when processed through the incinerator.

In addition to the new rules for PCB disposal, EPA promulgated a new rule for the disposal of contaminated soils on May 26, 1998. This rule affects the Land Disposal Restrictions for waste and allows for soils exceeding the treatment standards to be directly land disposed. This rule is referred to as the 90/10 rule in that it requires the mobility of the hazardous constituent be reduced by 90% or down to 10 times the current treatment standard, whichever is higher. This rule, which only applies to soil matrices, will aid in the disposition of some Oak Ridge remediation waste streams.

Waste Reclassification

In conjunction with alternative disposal initiatives, a review of the classification of selected legacy waste streams is being held. In response to 1991 congressional and states' attorneys general investigations regarding the disposal of radioactive material at an unlicensed facility in Alabama, Oak Ridge established one of the most conservative "no-rad added" policies in the DOE system. Over time, most hazardous and suspect waste was classified as "policy mixed" rather than applying the exhaustive process established to certify it contained no added radioactivity. The use of "policy mixed" as a waste classification has been suspended, and process knowledge and carefully designed analytical protocols are being used to clarify whether waste should continue to be classified and managed as mixed waste or "downgraded" to a hazardous classification. An estimated 10% of the legacy mixed waste could be reclassified in this process.

Resolving Equity Issues

State equity issues continue to play a significant role in several DOE decisions regarding the treatment and disposal of wastes from DOE facilities. Although several proposals have been considered and numerous forums have been held with stakeholders and state governments during the past several years, no comprehensive resolution of this issue has been forthcoming.

In early 1998, Oak Ridge began pursuing an alternate strategy. While the national debate over state equity has been somewhat at a stalemate, Oak Ridge has identified possible waste "exchanges" with other DOE sites that may be viewed as equitable by the two states involved. The Oak Ridge Reservation is one of the least suitable DOE sites for waste disposal and thus is not in a good position to receive wastes from other DOE sites for disposal. However, the unique treatment capabilities of the TSCA Incinerator play a critical role in such exchanges.

A key element of these waste exchanges is that they represent a permanent solution to a waste problem. Wastes are exchanged for treatment and/or disposal, not simply for continued storage. A proposed exchange between Nevada and Tennessee currently under consideration may be a near-term solution to the lack of off-site disposal for Oak Ridge low-level waste. In this proposed exchange, mixed waste from the Nevada Test Site would be treated at the TSCA Incinerator in return for disposal of Oak Ridge low-

level waste at the Nevada Test Site. The proposal has received initial support from both states and is currently being discussed with stakeholders.

Reservation-wide Waste Acceptance and Certification

With limited disposal outlets and the backlog of mixed waste to be treated, most of the newly generated mixed and low-level waste in effect becomes legacy waste as soon as it is generated because it must be sent to storage for an indefinite period. Oak Ridge is examining waste certification and acceptance criteria to reduce the cost and to facilitate the disposal of such waste once outlets are available. Historically, with the absence of outlets for Oak Ridge waste, acceptance criteria were based on storage facility requirements. This practice meant that most waste streams required additional characterization and some required repackaging prior to treatment and disposal. As a consequence, both costs and worker risks increased. To further complicate the issue, separate waste acceptance, tracking, container labeling, and certification programs were developed at the three major facilities on the Oak Ridge Reservation.

An initiative to develop a reservation-wide waste certification program, coupled with a single set of waste acceptance criteria based on waste treatment and disposal facility requirements, is being implemented. Master profiles for most waste streams are being developed and coordinated with candidate receiving facilities at Oak Ridge, at other DOE sites, and at commercial facilities. With few exceptions, master profiles can be developed to guide the waste generator even in instances where the receiving facility has not yet been selected. This approach is particularly useful for environmental remediation projects by establishing definitive requirements prior to completing remedial design. The approach will also streamline Oak Ridge's efforts to work with generators before wastes are generated to ensure waste acceptance criteria can be met. Figure 3 presents a schematic of this process. It also serves to clarify the roles and responsibilities of waste generators versus the DOE-Environmental Management funded waste management program.

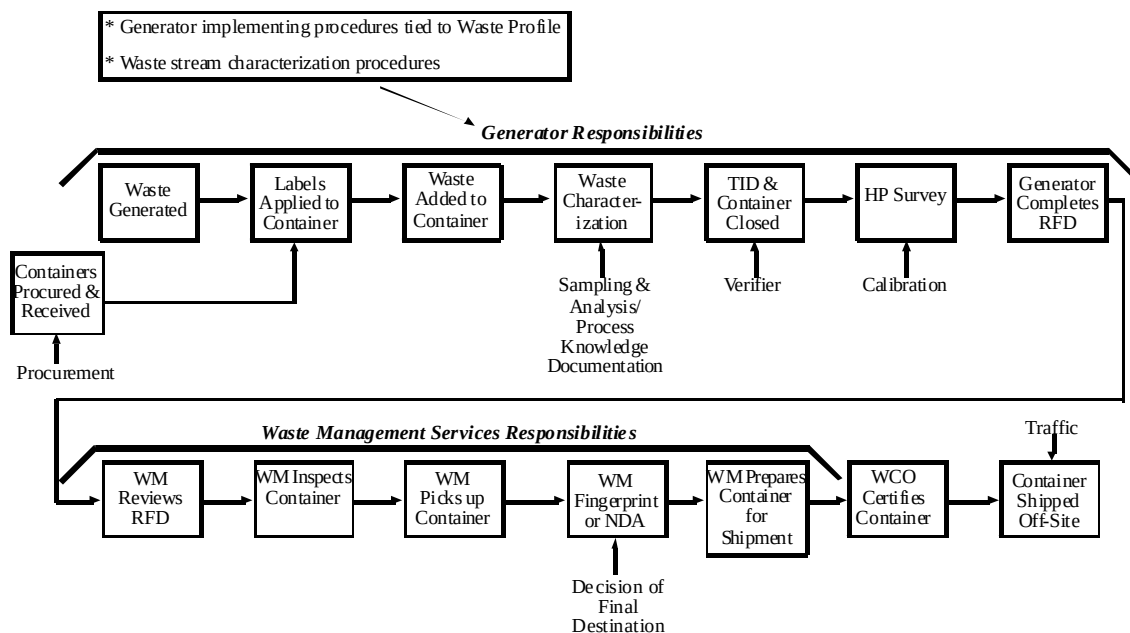


Fig. 3. Schematic of Waste Acceptance and Certification Process.

CONCLUSION

Shifting focus and priorities from simply maintaining compliant waste storage and meeting the requirements of the Oak Ridge Site Treatment Plan to an aggressive waste disposition program is critical to resolving Oak Ridge's legacy waste challenge. Gaining access to off-site disposal outlets and obtaining sufficient funding are mandatory. In late 1998, Oak Ridge completed the first shipment of legacy low-level waste for off-site disposal in the history of the reservation. Under the moratorium on commercial low-level waste disposal pending release of the policy analysis, this shipment of uranium oxide from the Y-12 Plant to Envirocare of Utah was only authorized by DOE-HQ because it was considered an "emergency."

Funding remains extremely limited. Accelerating legacy waste disposal is one of Oak Ridge's highest priorities and savings from other operations will be utilized wherever possible to reduce the inventory. Alternate disposal options have proven to be less expensive in many cases than more conventional disposal. Requiring generators to characterize, package, and certify newly generated waste for treatment/disposal facility acceptance criteria will also facilitate the cost-effective disposition of this waste in the future.

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