**Idaho
National
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Enhanced Integrated Nonthermal Treatment System Study

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**Charles Biagi
Bill Schwinkendorf
Ben Teheranian**

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Integrated Nonthermal Treatment System Study**

**Charles Biagi
Bill Schwinkendorf
Ben Teheranian**

February 1997

**Idaho National Engineering Laboratory
Lockheed Martin Idaho Technologies Company
Idaho Falls, ID 83415**

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ACRONYMS AND ABBREVIATIONS

APC	air pollution control
CEM	continuous emissions monitoring
CWO	catalytic wet oxidation
DAF	dissolved air flotation
DOE	U.S. Department of Energy
EA	environmental assessment
EIS	environmental impact statement
ENTS	enhanced nonthermal treatment system
EPA	U.S. Environmental Protection Agency
F&OR	functional and operational requirements
FTE	full-time equivalent
GPCR	gas phase corona reactor
gpm	gallons per minute
HEPA	high-efficiency particulate air (filter)
INEL	Idaho National Engineering Laboratory
INTS	integrated nonthermal treatment system
ITTS	integrated thermal treatment system
LDPE	low density polyethylene
M	moles
MCC	motor control center
MEO	mediated electrochemical oxidation
MLLW	mixed low-level (radioactive) waste
OH•	hydroxyl radical
O&M	operations and maintenance
PAN	passive/active neutron
PFD	process flow diagram
psi	pounds per square inch
psig	pounds per square inch, gage pressure
R&D	research and development
RCRA	Resource Conservation and Recovery Act
ROM	rough order of magnitude
RTR	real-time radiography
SCC	secondary combustion chamber
SCM	system cost model
SGS	segmented gamma scanning
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TLCC	total life cycle cost
TOC	total organic carbon
TRU	transuranic
UV	ultraviolet light
WBS	work breakdown structure
°	degree
°C	degree Centigrade
°F	degree Fahrenheit
°K	degree Kelvin

EXECUTIVE SUMMARY

The purpose of the Enhanced Nonthermal Treatment Systems (ENTS) study is to evaluate alternative configurations of one of the five systems evaluated in the Integrated Nonthermal Treatment Systems (INTS) study. Five alternative configurations are evaluated. Each is designed to enhance the final waste form performance by replacing grout with improved stabilization technologies, or to improve system performance by improving the destruction efficiency for organic contaminants. All enhanced systems are alternative configurations of System NT-5, which has the following characteristics:

Nonthermal System NT-5:

- catalytic wet oxidation (CWO) to treat organic material including organic liquids, sludges, and soft (or combustible) debris
- thermal desorption of inorganic sludge and process residue
- washing of soil and inorganic debris with treatment by CWO of removed organic material
- metal decontamination by abrasive blasting
- stabilization of treated sludge, soil, debris, and untreated debris with entrained contamination in grout
- stabilization of inorganic sludge, salts and secondary waste in polymer.

System NT-5 was chosen because it was designed to treat combustible debris thereby minimizing the final waste form volume, and because it uses grout for primary stabilization. The enhanced nonthermal systems were studied to determine the cost and performance impact of replacing grout (a commonly used stabilization agent in the DOE complex) with improved waste stabilization methods such as vitrification and polymer.

Two of the five enhanced nonthermal systems consist of a hybrid between two systems (nonthermal organic destruction is combined with thermal stabilization and metal recycling processes). In these two systems, grout is replaced with vitrification and metals with entrained contamination are melted into ingots for recycle. Two nonthermal enhanced systems were developed, in which grout is replaced with enhanced nonthermal stabilization processes. In the fifth system, the organic destruction rate is assumed to be increased by a factor of ten.

The characteristics of these enhanced nonthermal systems are as follows:

ENTS-1:

- catalytic wet oxidation of organic wastes and soft (combustible) debris
- washing of surface contaminated inorganic debris and soil and vitrification of treated debris and soil
- vacuum thermal desorption of inorganic sludges and polymer stabilization of treated sludges and secondary wastes
- melting of metal with entrained contamination and decontamination of surface contaminated metal for recycle
- decontamination or melting of lead for recycle
- retorting of mercury contaminated waste and amalgamation of mercury metal

ENTS-2: Same as ENTS-1 except

- vacuum thermal desorption is eliminated
- untreated inorganic sludge and process residue are sent directly to a vitrifier

ENTS-3: Same as Nonthermal System NT-5 except

- stabilization of all treated wastes is by polymer; no grout stabilization is used.

ENTS-4: Same as Nonthermal System NT-5 except

- stabilization of all treated wastes is by compaction and sintering into pellets, with macroencapsulation of the pellets in polymer.

ENTS-5: Same as Nonthermal System NT-5 except

- the reaction rate for the CWO process that treats all organic wastes and soft debris is assumed to be increased by a factor of ten.

Mass balances, effluent, and cost data were developed for these systems based on conceptual system designs, process flow diagrams, and equipment layouts. The results of the enhanced nonthermal systems study were compared with the results of previous nonthermal and thermal systems studies. The results of these studies indicate the following:

- Nonthermal and enhanced nonthermal systems cost approximately \$1 billion to \$1.5 billion more than thermal systems
- The mass of the offgas of nonthermal systems is one-third to one-tenth the mass of the offgas from thermal systems
- The final waste form volume of systems using vitrification is about one-third the volume of systems using nonthermal stabilization processes

Thus, there is no economic incentive to use nonthermal or enhanced nonthermal systems in place of thermal systems in a centralized treatment facility. However, decreased offgas and low final waste form volumes for hybrid systems may make these systems attractive from the standpoint of stakeholder acceptance.

Operating and maintenance costs are between 50 to 60 percent of the total life cycle cost for all systems. The major drivers for the higher treatment costs for nonthermal and enhanced nonthermal systems are the higher O&M costs associated with more sorting and segregating of waste, higher volumes of waste passing through the certification and shipping subsystem, and more unit operations required to treat the waste.

System ENTS-2 has one-third the offgas from a system using a plasma furnace and one-tenth the offgas from a system using a rotary kiln with air for combustion, producing approximately the same final waste form volume at a life cycle cost of \$1 billion more than these thermal systems.

The costs for System ENTS-2 might be decreased by eliminating the washing process (\$153 million) and treating all inorganic waste in the vitrifier. This should also decrease the front-end handling costs as less sorting will be required. However, a vitrification system must be demonstrated to reliably and efficiently destroy the organic contaminants in these inorganic matrices.

The more waste that can be vitrified, the lower the final waste form volume and the lower the disposal cost. Final waste form performance characteristics are enhanced with a vitrified product.

The use of polymer to stabilize all waste (ENTS-3) decreases the final waste form volume slightly from that produced by System NT-5 which uses grout and polymer. Although there is little cost incentive to use all polymer, a waste form with better performance characteristics than grout may be produced.

Using hybrid waste forms (pellets macroencapsulated in polymer as in ENTS-4) may improve performance relative to System ENTS-3, which uses only polymer for stabilization, but at a cost of \$550 million. If the compressed and sintered pellets can pass TCLP without macroencapsulation, then the stabilization and disposal costs should decrease and be closer to those of System ENTS-3.

There is no cost incentive to perform R&D to increase the reaction rate of nonthermal organic destruction processes. Increasing the reaction rate will allow treatment of all organic wastes in the same reaction vessel, and in a shorter period of time, thereby decreasing the capital and operating costs of treatment. However, this savings is offset by the increase in material handling and maintenance costs associated with equipment and personnel required to handle the increased throughput, and the cost of equipment required to attain the increased reaction rate. However, an advantage of an increased reaction rate may be to increase the destruction efficiency if the residence time were kept the same as the original residence time used at the lower reaction rate (i.e., the throughput remains the same).

Nonthermal systems might be made more competitive with thermal systems by enhancing them through the use of vitrification for all inorganic wastes (except metals and secondary waste salts), and by eliminating the organic separation processes (thermal desorption and washing). This would decrease the capital and O&M costs required to operate and maintain this equipment. Also, sorting requirements, and therefore the front-end handling costs, should decrease. The final waste form volume, and therefore certification and shipping costs and disposal costs, should also decrease. If these enhancements were implemented, the only nonthermal process would be destruction of organic waste, including soft (combustible) debris. Detailed evaluation of a hybrid system such as this, and comparison with selected thermal systems, would quantify how competitive a hybrid system can become.

1. INTRODUCTION

The purpose of the Enhanced Nonthermal Treatment Systems (ENTS) study is to evaluate alternative configurations of the five systems evaluated in the Integrated Nonthermal Treatment Systems (INTS) study (Biagi, 1997). The configurations of alternatives that are evaluated are designed to improve the final waste form performance by replacing grout with improved stabilization technologies, or to improve system performance by improving the destruction efficiency for organic contaminants. All enhanced nonthermal systems are alternative configurations of a single nonthermal system to allow comparison of these alternative configurations.

Nonthermal system NT-5, which has the following characteristics, was chosen as the baseline for evaluation and against which comparisons would be made:

- catalytic wet oxidation (CWO) to treat organic material including organic liquids, sludges, and soft (or combustible) debris
- thermal desorption of inorganic sludge and process residue
- washing of soil and inorganic debris with CWO treatment of the removed organic material
- metal decontamination by abrasive blasting
- stabilization of treated sludge, soil, debris, and untreated debris with entrained contamination in grout
- stabilization of inorganic sludge, salts and secondary waste in polymer

System NT-5 was chosen over Systems NT-1, NT-2 and NT-3 because these three systems were not designed to break down combustible debris. System NT-2 treats combustible debris by vacuum thermal desorption, which does not destroy the combustible matrix. The mediated electrochemical oxidation (MEO) process (Systems NT-1 and NT-3) can treat ion exchange resins and soluble cellulose, but it cannot destroy plastics, wood, and other insoluble combustible debris. System NT-5 with CWO was chosen because CWO destroys combustible debris and minimizes the stabilized waste volume sent to disposal. Detailed descriptions of the nonthermal systems are contained in the INTS report (Biagi, 1997).

System NT-5 with CWO was selected over NT-4. System NT-4 uses acid digestion to treat organic contaminants and combustible debris, and uses phosphate bonded ceramic instead of grout as a stabilization material for the final waste form. The ENTS study was designed in part to replace grout with improved final waste forms. System NT-4 could have been used as the baseline or as another enhanced nonthermal system alternative. However, the cost differences would be slight, and a single baseline system used throughout the ENTS study provides continuity for cost and performance comparisons.

For each ENTS configuration, documents were developed that include process flow diagrams (PFDs), layouts, system characteristics (such as throughput, effluent, and volume reductions) and life-cycle cost estimates. Layouts were not developed for Systems ENTS-3 and ENTS-5, because they are so similar to System INTS-5.

Section 2 describes the systems evaluated in this report and provides the rationale for selecting these systems for evaluation. Sections 3 and 4 present the results of the ENTS evaluations. In Section 5 the results of this study are compared to the results for representative thermal systems from the Integrated Thermal Treatment System (ITTS) study (Feizollahi, 1995) and nonthermal systems from the INTS study. Design figures, including PFDs and layouts, are presented in Section 2 and Appendix A.

2. SYSTEM DESCRIPTIONS

All ENTS systems are variations of INTS System 5, Catalytic Wet Oxidation (CWO). Table 2-1 presents a summary of the five ENTS systems.

All ENTS systems evaluated require (1) the use of extensive characterization and sorting, (2) a Gas Phase Corona Reactor (GPCR) for the destruction of residual organic vapors passing through the offgas treatment, (3) surface decontamination of bulk metals and recyclables, and (4) photo-oxidation destruction of any residual organic materials in the aqueous treatment subsystem.

Each system consists of either 16 or 17 subsystems. Most of the subsystems are identical, or only slightly modified in each of the five system configurations. These subsystems are listed below. It should be noted that not all subsystems are used in each ENTS systems.

The following subsystems are used in all ENTS systems:

- Administration Subsystem
- Receiving and Preparation Subsystem
- Aqueous Waste Treatment Subsystem
- Catalytic Wet Oxidation Organic Destruction Subsystem
- Bulk Soil Treatment Subsystem
- Soft Debris Treatment Subsystem
- Open Debris Treatment Subsystem
- Mercury Amalgamation Subsystem
- Lead Recovery Subsystem
- Metal Decontamination Subsystem
- Special Waste Treatment Subsystem
- Air Pollution Control Subsystem
- Certification and Shipping Subsystem
- Support Subsystem

The following subsystems are used in some ENTS systems:

- Vitrification Subsystem
- Metal Melting Subsystem
- Process Residue and Inorganic Sludge Treatment Subsystem
- Polymer Stabilization Subsystem
- Claytec Subsystem
- Grout Stabilization Subsystem

Table 2-1. Summary System Descriptions for Enhanced Nonthermal Treatment System

Designation	System Description
ENTS System 1: CWO, Desorption and Vitrification	Catalytic wet oxidation of soft debris and organics
	Washing of open debris and soil
	Vacuum thermal desorption of inorganic sludges and process residue
	Vitrification of treated non-metallic debris and treated soil
	Polymer stabilization of inorganic salt waste, treated inorganic sludges and process residue
	Metal melting of complex metal debris
	Decontamination of open metal debris
	Mercury retort of mercury contaminated debris and mercury amalgamation of elemental mercury
	Lead decontamination or melting and casting of lead contaminated debris
ENTS System 2: CWO and Vitrification	Catalytic wet oxidation of soft debris and organics
	Washing of open debris and soil
	Vitrification of treated non-metallic debris, treated soil, untreated process residues and inorganic sludge, and some secondary waste streams
	Polymer stabilization of inorganic salt waste and some secondary waste streams
	Metal melting of complex metal debris
	Decontamination of open metal debris
	Mercury retort of mercury contaminated debris and mercury amalgamation of elemental mercury
	Lead decontamination or melting and casting of lead contaminated debris
ENTS System 3: CWO, Desorption and Polymer Stabilization	Catalytic wet oxidation of soft debris and organics
	Washing of open debris and soil
	Vacuum thermal desorption of inorganic sludges and process residue
	Polymer stabilization of treated debris, treated soil, complex debris, inorganic salt waste, treated inorganic sludge and secondary waste streams
	Decontamination of open metal debris
	Mercury amalgamation of elemental mercury
	Lead decontamination of lead contaminated debris

Table 2-1. (continued) Summary System Descriptions for Enhanced Nonthermal Treatment System

Designation	System Description
ENTS System 4: CWO, Desorption, Compaction and Polymer Stabilization	Catalytic wet oxidation of soft debris and organics
	Washing of open debris and soil
	Vacuum thermal desorption of inorganic sludges and process residue
	Compaction, pelletizing, and polymer stabilization using the Claytec process of complex debris, treated soil, inorganic salt waste, treated inorganic sludge and secondary waste streams
	Decontamination of open metal debris
	Mercury amalgamation of elemental mercury
	Lead decontamination of lead contaminated debris
ENTS System 5: CWO, Desorption, Compaction and Polymer Stabilization	Catalytic wet oxidation of soft debris and organics, at ten times the INTS reaction rates
	Washing of open debris and soil
	Vacuum thermal desorption of inorganic sludges and process residue
	Mercury amalgamation of elemental mercury
	Lead decontamination of lead contaminated debris
	Polymer stabilization of inorganic salt waste, treated inorganic sludge and secondary waste streams
	Grout stabilization of treated debris, and treated soil

2.1 System ENTS-1: Catalytic Wet Oxidation, Desorption and Vitrification

Figure 2-1 presents the overall PFD. Figure 2-2 presents the plan view layout of System ENTS-1. The system consists of all structures, buildings, and equipment needed to accomplish the functional and operational requirements (F&ORs). The organic destruction subsystem is catalytic wet oxidation. The process residue and inorganic sludge treatment subsystem uses vacuum desorption to remove organics prior to stabilization. Bulk soil is treated by aqueous wash. Soft debris is treated by catalytic wet oxidation. Open debris is treated by high pressure wash. Non-metallic complex debris is treated by vitrification. Metallic complex debris is treated by metal melting. Mercury contaminated debris is sent to a mercury retort, where mercury is removed from the debris. Elemental mercury from receiving and preparation and the separated mercury from the retort are amalgamated. The mercury free debris is sent to vitrification. The Air Pollution Control (APC) subsystem is based on dry filtration, wet offgas scrubbing and organic destruction in a GPCR. The vitrification subsystem replaces the grout subsystem used in the INTS systems, and is equipped with an APC subsystem that includes dry and wet offgas treatment trains. System ENTS-1 consists of sixteen subsystems which are described below.

2.1.1 Administrative Subsystem

The administrative subsystem includes all administrative and analytical laboratory buildings required for waste management support functions. The administration subsystem is essentially the same for all five systems.

The administration subsystem incorporates all technical and administrative support functions needed to manage the operation of a waste management facility. These functions include: (1) security, (2) access control, including personnel decontamination (radioactive and hazardous), (3) maintenance of uncontaminated areas and equipment, (4) health physics and radiation badges, (5) facility access control, (6) sanitary facilities, (7) work control and personnel support, (8) internal and external (public relations) communications, (9) spill or emergency response provisions (hazardous and radioactive), (10) analytical laboratory, (11) environmental field sampling, and (12) environmental regulatory reporting, records management and overall site management.

The administrative subsystem maintains general interfaces with all treatment subsystems. Operation and Maintenance (O&M) consumables include analytical supplies, office supplies, sanitary supplies, drums, and personal protective equipment.

2.1.2 Receiving and Preparation Subsystem

Figure 2-3 presents the PFD for the receiving and preparation subsystem. Figures 2-4 and 2-5 present the subsystem's perspective view of this subsystem, which is the same for all systems.

This subsystem utilizes cranes and forklift trucks to unload waste containers from incoming vehicles. The physical state of the waste in the containers is identified by a real-time radiography (RTR) unit. A passive/active neutron (PAN) assay unit determines the level of transuranic (TRU) contamination of the waste. A segmented gamma scanning (SGS) unit is used to assay beta and gamma radioactivity. A computer software and bar code scanning unit records and tracks the wastes.

The wastes are classified either as those requiring or not requiring sorting. Containers of wastes not requiring sorting are moved directly to the appropriate treatment subsystem. For purposes of this study, approximately 75 percent of the waste was assumed to require sorting.

Waste containers requiring sorting are grouped into two categories: homogeneous waste (e.g. sludge) and heterogeneous waste (e.g. debris). For both categories, the container is decapped by a saw mounted on a gantry robot. After decapping, homogeneous waste not requiring size reduction is dumped into transport hoppers. Heterogeneous waste containers are emptied on a sorting table equipped with master-slave and hydraulic manipulators which are used for segregating materials into treatment types, including open debris, soft debris, complex debris, cemented process residue, soil, lead, ferrous metals, and special wastes.

Various sorting technologies, such as robotic assisted sorting tables, vibratory screens, and air classifiers, may be used in the sorting area. Waste identified by manifest or other documentation as contaminated with mercury compounds will be isolated from other debris. Waste classified as debris under the EPA Debris Rule (40 CFR 268.45) must be segregated from other wastes. To be classified as debris a minimum size is required. However, EPA does allow size reduction of debris if it is first cleaned of other material such as soil. The regulations state that cleaning must be performed until the debris appears free of non-debris material. The sorted waste material is size reduced by saw cutting and/or mechanical auger shredding, as required, for the treatment subsystem. Prepared sorted waste is placed in transfer bins and moved to the treatment subsystems. Nonmetallic containers are cut or shredded into smaller pieces.

2.1.3 Aqueous Waste Treatment Subsystem

Figure 2-6 presents the PFD for the aqueous waste treatment subsystem. Figure 2-7 presents the subsystem's perspective view. This subsystem collects and treats input aqueous waste, which could include wastewater with corrosive properties, dissolved solids, suspended solids, radionuclides, and a broad range of RCRA-controlled toxic, heavy-metal, and organic contaminants. Waste is treated to meet the facilities recycling needs and/or discharge conditions.

This subsystem also treats secondary aqueous wastes such as (1) salt solutions from organic destruction, (2) filtrate from the aqueous wash and high pressure wash subsystems, (3) the aqueous waste from APC subsystem condensate and scrubber blowdown, (4) sludge from abrasive blasting in the metal decontamination subsystem, (5) rinse water from container wash down, and (6) water from equipment and floor drains.

The unit operations of the aqueous waste treatment subsystem are designed for maximum flexibility and can be used in series, in parallel, or as stand alone units. The selection of specific unit operations will be based on waste characterization from the receiving and preparation subsystem, as well as in-process evaluations. Operations staff will select the appropriate unit operations. Based on characterization, incoming waste will be segregated and stored in four batch tanks classified as having (1) high levels of total organic carbon (TOC), (2) high TDS levels, (3) low TDS levels, or (4) heavy metals/mercury containing liquids.

For high TOC waste, the primary approach is processing in the organic destruction subsystem. Alternatively, a treatment train is included in the aqueous waste treatment subsystem as a backup. Gross organic removal is accomplished in an oil/water separator or other flotation thickener. Suspended solids filtration is performed using back-flushable filters. Calcium removal prior to organic treatment is performed in a mixing reactor by the addition of sulfuric acid to achieve precipitation of calcium sulfate.

For low concentrations of dissolved organics, removal is accomplished in an ultraviolet (UV) reactor. The destruction of organics by oxidation to carbon dioxide and water is accomplished by exposing the aqueous solution to the light. The reactor design allows the addition of both ozone (O_3) and hydrogen peroxide (H_2O_2). The UV light reacts with hydrogen peroxide or ozone to create hydroxyl radicals ($OH^\bullet$) which attack and break down the organics. Waste characterization prior to transfer to the reactor optimizes the use of ozone, UV, and hydrogen peroxide because treatment effectiveness varies by chemical species. Polishing to remove trace quantities of organic from the treated water is done by activated carbon filtration. Dissolved solids removal is accomplished in an ion exchanger. Aqueous liquids with high concentrations of dissolved organics are subjected to distillation to remove the organics. The distilled organics are sent to the organic destruction subsystem and the aqueous stream with low organic concentration is treated as outlined above.

For liquids with low levels of TDS the same treatments as discussed for high TOC waste are appropriate, with the exception of gross organic removal. Again, waste characterization will dictate which unit operations are necessary for each batch tank.

For liquids with high levels of TDS or contaminated with metals, the treatment train involves precipitation and settling steps for TDS and metal removal. Neutralization with appropriate chemicals such as sodium hydroxide is performed in an agitated tank. Depending on the waste characterization, metals precipitation from the waste followed by settling is performed to convert the dissolved and particulate metals to insoluble salts. The sludge is collected in a sludge settling tank and the clarified aqueous layer is transferred to suspended solids removal and ion exchange equipment. Ion exchange vessels are supplied with

mercury selective resins. Further polishing is available by filtration with sulfur impregnated carbon filters. The sludge is concentrated in an evaporator and sent to the polymer stabilization subsystem.

In addition to the primary treatment trains, each waste type can be routed to, or can bypass, a specific treatment. The aqueous waste treatment subsystem concentrates all sludge waste produced by the various treatment trains prior to stabilization. Spent ion exchange resin from treatment processes is dewatered and sent to the organic destruction subsystem.

The unit operations remove radionuclides and RCRA-regulated metal, and to reduce trace organic concentrations to regulatory discharge levels, thus allowing the treated water to be either recycled or discharged.

2.1.4 Catalytic Wet Oxidation Organic Destruction Subsystem

Figure 2-8 presents the PFD for the organic destruction subsystem. Figure 2-9 presents the subsystem's perspective view. The organic destruction subsystem is based on a catalytic wet oxidation process which uses an oxidant in a catalyzed solution to enhance the destruction of organic wastes. The waste feed is shredded and continuously added to the reaction vessel through a solid or liquid-feed assembly. Because organic destruction involves exothermic reactions, the waste is metered into the reactor to prevent a runaway reaction. Active cooling is provided for temperature control.

The catalytic wet oxidation process is a method of catalytically oxidizing waste organic compounds to destruction using an iron oxidant which is regenerated by oxygen. Iron or Fe(III) in a hydrochloric acid solution oxidizes organics to carbon dioxide (CO_2) and hydrogen ion (H^+). The iron is reduced during this process to Fe(II). Oxygen (O_2) is added to oxidize the Fe(II) back to Fe(III). The oxygen also reacts with the H^+ to produce H_2O . A set of homogenous co-catalysts influences these reactions. Typically, these co-catalysts are copper ions and one or more of the ions platinum(IV), palladium(II), and ruthenium(III). Mercury, radioactive metals, and heavy metals are dissolved and concentrated in the acidic catalyst solution.

The process conditions are expected to be pressures of 20 pounds per square inch gauge (psig) and temperatures of between 300°F and 400°F (150°C to 200°C), depending on the waste form and composition. The 1000 gallon reactor can be operated at pressures of up to 200 psig. The standard solution consists of 60 percent by weight (wt percent) ferric chloride, approximately 3.6 wt percent hydrogen chloride (HCl), with the remainder being water. Catalyst concentration is approximately 0.001 M (the number of moles of catalyst ion in 1 liter of solution). The reactor solution is agitated by recirculated headspace gases and by a mechanical agitator.

Oxidation of organics occurs principally at the surface of contact between the organics and the reagent solution. Carbon dioxide generated by the oxidation reaction is removed from the oxidation vessel with the headspace gases, which are primarily water vapor, CO_2 , O_2 and HCl. Offgas is passed through a condenser to remove most of the water vapor and HCl. A portion of the condensed acidic water is recycled to the reagent storage and feed tank. The remainder of the acid is neutralized using caustic. The neutralized salt solution is routed to the aqueous waste treatment subsystem for further treatment.

As the inorganic residues build up in the reaction vessel, a side stream of reactor solution is removed from the bottom of the vessel and passed through a filter to remove residual solids. The acid filtrate is recycled to the reactor. Solids collected at the filter are rinsed in a wash tank with a mild hydrochloric acid solution, and sent to the polymer stabilization subsystem.

Periodically, the concentration of dissolved metals and radionuclides build up to a level that affects the acid concentration. When this occurs, the feed to the reactor is stopped, organics are allowed to react until

gone, and the reactor solution is cooled. In the precipitator, the solution is neutralized and the metals are precipitated from the reactor solution as hydroxides or oxides by the addition of caustic. Following filtration, the filtrate salt solution is transferred to the aqueous waste treatment subsystem and the metal precipitates are routed to the polymer stabilization subsystem.

2.1.5 Process Residue and Inorganic Sludge Treatment Subsystem

Figure 2-10 presents the overall PFD for the process residue and inorganic sludge treatment subsystem. Figure 2-11 presents the subsystem's perspective view. This subsystem employs an indirectly heated vacuum desorption dryer to remove volatile organics and volatile inorganic compounds from the process residue and inorganic sludge prior to leaching/washing operations for mercury removal.

The waste sent to the process residue treatment subsystem has been size reduced to less than one-inch particles in the receiving and preparation subsystem. The vacuum desorption unit, which is operated in the batch mode, separates organic contaminants from inert solids under low pressure at moderate temperatures. Volatile organics and mercury are condensed and recovered as a liquid.

The waste is fed into the vacuum desorber in batches through a vacuum valve at the top of the desorption unit. In the first step of the process, the waste stream is charged through an inlet flange located on top of the jacketed vacuum desorption vessel. The desorption vessel is sealed and nitrogen is used to purge the desorption vessel and gas equipment of air, removing the potential for combustion of waste material or desorbed gas. The purge stream also assists in the desorption of contaminated vapors.

The second step involves slowly heating the nitrogen to desorb the organic components from the waste. The vapors exit the vessel by passing through a chamber equipped with a filter for removal of entrained particulate. Particulate is subsequently returned to the desorption unit and is removed with the processed waste solids.

The waste is also heated indirectly using a hot oil heating unit. The hot oil is circulated through a baffled external jacket which surrounds the desorption vessel. For homogenous feed such as soil or sludge, a top mounted agitator is used to stir the waste. The agitator shaft and impeller contain annular spaces into which the hot oil can be circulated. Heat is circulated through the waste for one to two hours increasing the waste temperatures to 500°F. As the waste is heated, vacuum (as low as 25 mm mercury [Hg]) is applied for periods of from 15 minutes to several hours, depending on the feed. When treatment is complete the vacuum is released, the unit is opened, and the treated material is discharged to a transportable hopper at the bottom of the desorption vessel.

The bottom solids removed from the vacuum dryer are collected and processed for mercury removal by leaching. The solids are first washed with a potassium iodide and iodine leaching solution in an agitated mixing tank and then rinsed with fresh water. In Solid Wash Stage 2, the solids are washed with a hydrogen peroxide and sulfuric acid solution. The wet solids are filtered, collected in hoppers, and routed to the polymer stabilization subsystem.

The leaching solution and subsequent rinse water are collected and passed through a column containing steel wool which removes mercury. In the column, the mercury is precipitated from solution and captured by the steel wool. The mercury contaminated steel wool is routed to mercury amalgamation. The mercury amalgamation process is sufficiently adaptable to handle this waste. The remaining solution is processed further in a metal precipitation/settling tank to remove dissolved metals. Metals and settled solids are sent to polymer stabilization. The aqueous phase from the precipitation is treated to recover the iodine by the use of a hydrogen peroxide and sulfuric acid mixture. The recovered iodine and the iodide solutions are recycled to the leaching tank while the spent acid and peroxide are recycled to the final acid rinse tank.

Desorber offgas passes through three condensers connected in series. The primary cooler/condenser reduces temperature to ambient conditions. Condensate, which may include aqueous mercury solution, elemental mercury, as well as some organics, is collected and allowed to settle. The condensed aqueous mercury solution, is routed to the aqueous waste treatment subsystem and any organic phase is sent to organic destruction subsystem. The dense lower elemental mercury layer is sent to the mercury amalgamation subsystem.

In the second condenser chilled water reduces the offgas temperature to near 45°F. In the third condenser chilled brine further reduces the offgas temperature to near 0°F for effective condensation of organics and water. The condensed organic liquid is captured and sent to the organic destruction subsystem. The remaining offgas from the dryer is routed to the air pollution control subsystem.

2.1.6 Bulk Soil Treatment Subsystem

Figure 2-12 presents the PFD for the Bulk Soil Treatment subsystem. Figure 2-13 presents the subsystem's perspective view. The bulk soil treatment subsystem uses aqueous wash technology which employs water and surfactants for contaminant removal, with subsequent recycling of the water and surfactants. The aqueous wash process of the bulk soil treatment subsystem is composed of :

- feed preparation equipment
- a surfactant/wash water tank
- an agitated wash tank
- vibrating screen and hydrocyclone separators
- a solid/liquid rinse contractor vessel
- a solubility reduction process to separate surfactant/contaminant from wash water
- ultrafiltration
- soluble metals removal by precipitation followed by dissolved air flotation (DAF)
- surfactant/contaminant separation
- a surfactant preparation tank.

The process is operated in a continuous mode. Costs and design are based on a one shift operation, to minimize operations costs.

Several unit operations that utilize conventional equipment are required. Recycling occurs within most unit operations, minimizing the need for makeup water or surfactant, and reducing the final output volume. The wastes are first processed in an attrition mill to size reduce the waste stream. Wastes are transferred to an agitated wash tank for primary organic removal. A wash water solution containing surfactants and other additives is continuously fed to the wash tank along with the wastes. A 45 degree pitch turbine agitator stirs the tank contents. For soil treatment, four tons of wash solution are used for each ton of soil. The water in the wash tank is maintained between 140°F to 176°F (60°C to 80°C).

Organics and metals will be removed from the soil or residue by the surfactants, additives, and agitation. A slurry of soil and wash water are continuously removed from the bottom of the wash tank and sent to the two step solid/liquid separation equipment. Vapors from the wash tank are vented to two heat exchangers in series. Air is released and the small volume of collected liquids, volatiles and water are sent to the solubility reduction separator discussed below.

The wash tank discharge passes through a two step solid/liquid separation system. The stream is passed over a rotating screen which filters out solids. The filtrate is sent through one or more small bore hydrocyclones for further solids separation. The solids from the screening process, which include the

contaminant, surfactants and water, are sent to a countercurrent soil/liquid contactor. The filtrate is sent to the solubility reduction separator.

Rinse water is added to the rinse contactor at a rate of six tons of water to one ton of soil. The contactor is a trough-like vessel with paddles in which the soil is rinsed clean of the contaminants and surfactant. Following this step, the treated waste is dried and transferred to stabilization. Soil is vitrified while process residue is stabilized with polymer. Both the contaminated contactor rinse water and filtrate from the solid/liquid separation are sent to the solubility reduction separator described below.

The solubility reduction separator uses an approach that is proprietary to the vendor. In this step, temperature and pH effects are used to alter the solubility of the surfactant dramatically. The surfactant forms a dense lower phase, usually containing the contaminant. Colloidal matter such as humic components of soil also collect in the surfactant layer. The surfactant can be described as an adsorption agent, a "liquid active carbon", which holds the contaminant. The top layer of liquid, about 40 percent of the wash/rinse liquid, is recycled to the wash water storage tank. The remaining water layer is sent to ultrafiltration. The surfactant layer, containing the contaminant, is sent to a splitter process to separate the surfactant for reuse.

Ultrafiltration, also referred to as inertial separation, separates the incoming liquid into two liquid streams: the first containing a high level of particulate, and the second, the filtrate containing essentially no particulate. The liquid feed is pumped through parallel porous metal tubes manifolded together. The feed stream, stored in a tank, is continuously recirculated through the ultrafiltration tubes at high speed. The principle of ultrafiltration utilizes inertia whereby a particulate in a stream moving quickly through a porous metal tube remains with the stream while clear water passes through the porous metal. Thus, the filtrate is free of particulate and the particulate stream becomes more concentrated. Periodically, a back pulse of pressurized air is injected into the clear side of the tubes to remove particulate that may clog the tube pores. The concentrate from ultrafiltration is returned to the solubility reduction stage. The filtrate is transferred to a rinse water storage tank at the solid/liquid contactor for reuse. The concentrated particulate can also be removed as a sludge and sent directly to polymer stabilization.

When soluble metals are present, they may remain with the rinse water following ultrafiltration. A process similar to DAF is used to precipitate the metals in a froth. The froth is skimmed off the top of the flotation unit. The collected waste is sent to the polymer stabilization subsystem.

The separation of the surfactant and contaminant "complex" is performed in the splitter. Surfactant is separated by a proprietary process which includes steam stripping, followed by solvent extraction. The solvent is distilled and recycled. The extracted surfactant is recycled to the wash tank. Condensed organics from the stripping and nonvolatiles from the extraction process are sampled and sent to an appropriate subsystem for further treatment. If the waste is highly organic, it will be sent to organic destruction. If the waste contains high levels of mercury or other metals, it will be transferred to aqueous waste treatment.

Although this is a wash process, the only output to aqueous waste treatment is during shutdown or cleanup. All water, except that which exits with the wet treated waste, the metal froth or the organic contaminants, is recycled.

2.1.7 Debris Treatment Subsystem

The soft debris, and the open debris waste streams are subjected to treatment prior to vitrification. The complex debris waste stream is separated into metals and mercury contaminated debris.

2.1.7.1 Soft Debris Treatment Subsystem by Catalytic Wet Oxidation. Figure 2-14 presents the PFD for the soft debris treatment subsystem. Figure 2-15 presents the subsystem's perspective

view. Soft debris is received for treatment from the receiving and preparation subsystem. The debris is passed through a tertiary shredder to reduce the debris to pieces that are less than a half-inch in size. The debris is then sent to a CWO subsystem where it is fed into a stirred reactor containing the same acid solution used for organic liquid destruction. A slower reaction rate is expected for soft debris compared to organic liquids. A larger vessel (2500 gallons) with a longer residence time is required. The soft debris reacts with the hot acid medium to form water vapor, CO_2 , O_2 , and HCl . Most inorganic components in the soft debris are converted to insoluble salts which are removed from the acid mixture by the filtration stabilization subsystem.

2.1.7.2 Complex Debris Treatment. The complex metal debris is sent to a metal melter. The mercury contaminated debris is sent to the mercury amalgamation subsystem where it is retorted to remove the mercury prior to vitrification. The remaining non-metallic complex debris is vitrified. The vitrification subsystem is described in Section 2.1.14 below. The metal melter is described in Section 2.1.15 below.

2.1.7.3 Open Debris Treatment by High Pressure Wash. Figure 2-16 presents the PFD for the open debris treatment subsystem. Figure 2-17 presents the subsystem's perspective view. This subsystem collects and treats open debris whose internal and external surfaces are contaminated with organics and heavy metals which can be removed using surfactants delivered by a high pressure spray wash. The debris treatment subsystem is composed of a shredder, a spray/rinse chamber, a particulate filter, and a surfactant preparation tank. The subsystem is operated in batch mode.

The feed material is placed inside a 12 feet long, 7 feet wide, 8 feet deep spray/rinse chamber using a crane. Monolithic pieces (11 feet long, 7 feet wide, 7 feet high) and 55-gallon drums are placed in the chamber (Dosani, 1995). Smaller loose pieces with a minimum size of 1-inch in any dimension are placed in 4-feet diameter by 4-feet high metal baskets which are lowered into the chamber by crane. The size of the basket openings determines the size range of the loose pieces. Each basket weighs 1,200 pounds and is capable of containing 1 to 2 tons of debris. The debris is placed in the cleaning chamber which is closed to prevent the release of fugitive volatile emissions (Taylor, 1994).

Three stages of high pressure wash occur in the cleaning chamber. In the first stage, the chamber is flooded with approximately 2,000 gallons of 160 °F surfactant solution from the detergent holding tank. The surfactant is industrial grade and biodegradable. The optimum cleaning solution concentration is 5 percent. The optimum solution temperature is 140 °F (EPA, August 1991).

A 600 gpm pump coupled with an educator creates the turbulence for this first stage of washing. Baskets that hold the debris are rotated in the turbulent solution. Monolithic pieces are simply immersed in the turbulent solution. This cycle loosens surface contaminants and provides some superficial cleaning. After this first wash stage, the surfactant solution is pumped from the cleaning chamber into the detergent holding tank.

In the second wash stage, which achieves most of the cleaning, the detergent solution is delivered at a rate of 500 gpm through spray nozzles generating 100 psi of pressure. Nozzles are located inside the basket and throughout the chamber sides and bottom, and the inner surface of the cover. The surfactant solution returns to the detergent holding tank after passing through an oil/water separator to remove oil and solids. The water separator in the aqueous waste treatment system is used for this purpose. Reconditioning the surfactant solution reduces the volume of water consumed in this subsystem.

In the third wash stage, clean water is applied through the spray nozzles to remove residual contaminated liquid from the surfaces of the debris. The washed, non-metallic debris is then sent to the vitrification stabilization subsystem for further processing.

Oil, solids, and paper solubilized in the wash are collected in the oil/water separator and then sent to the organic destruction subsystem for further processing. Excess rinse water and the spent surfactant solution are transferred to the aqueous waste treatment subsystem. The treated water from the aqueous waste treatment subsystem is recycled back to the water holding tank.

2.1.8 Metal Melting Subsystem

Figure 2-18 presents the PFD for the metal melting subsystem. Figure 2-19 presents the subsystem's perspective view. Metals that cannot be decontaminated by mechanical means (surface blasting, grinding, etc.) are sent to this subsystem. These are primarily complex metal items such as pumps, valves, etc, and also drums that have deteriorated such that they cannot be decontaminated. Major functions provided by this subsystem include size reduction function, and metal melting function. Size reduction is accomplished by cutting or by disassembly of large metallic waste items.

The metal melter is an induction type melter. The melting process is designed to separate the molten product into a metal and a non-metal (slag) streams. Most radioactive material is removed in the molten slag, which is containerized and sent to the vitrification process for stabilization and subsequent disposal. Clean molten metal is poured into an ingot, cooled, and recycled within the DOE complex. Off-gas from the induction melter is sent to the APC subsystem for treatment.

2.1.9 Metal Decontamination Subsystem.

Figure 2-20 presents the PFD for the metal decontamination subsystem. Figure 2-21 presents the subsystem's perspective view. The decontamination subsystem has size reduction tools (cutting torch, saw and shears) and an inspection assay area. Decontamination is accomplished by using grit blasting and high pressure wash sprays within blasting booths designed to entrain blasting material and contaminants. Decontaminated metal is assayed, and approved metals are recycled within the DOE complex. Contaminated liquid is separated from the grit and recycled within the subsystem. Excess liquid is sent to the aqueous treatment subsystem. Contaminated grit is sent to the process residue treatment subsystem. Fugitive dust is captured in a prefilter and high-efficiency particulate air (HEPA) filters.

2.1.10 Lead Recovery Subsystem.

Figure 2-22 presents the PFD for the lead recovery subsystem. Figure 2-23 presents the subsystem's perspective view. This subsystem has a decontamination train and an electrically heated roasting oven. The decontamination train has mechanical devices, including saws, shears, and sanders, to cut and remove metal cladding from lead. Decontamination of lead takes place in scarring and abrasive blasting booths where a liquid abrasive solution is used to remove a thin layer of contaminant. Lead which is decontaminated can be recycled within the DOE complex. Drums containing cleaned material are washed and transferred to the certification and shipping subsystem. Lead that cannot be decontaminated due to entrained contamination (gloves, aprons, etc.) is sent to the melter equipment where the lead is melted and cast. The oven is used to melt lead that is not suited for decontamination by mechanical means. The oven includes dry gas filtration for particulate removal from the offgas, prior to the offgas being transferred to the APC subsystem.

2.1.11 Mercury Amalgamation Subsystem.

Figure 2-22 presents the PFD for the mercury amalgamation subsystem. Figure 2-24 presents the subsystem's perspective view. This subsystem uses a retort, followed by a condenser, to reclaim mercury from contaminated solids. After mercury removal, the solids are sent to the primary stabilization subsystem. Offgas from the mercury condenser is treated in a secondary combustion chamber followed by a wet-dry APC.

Recovered elemental mercury is either recycled or amalgamated with zinc or copper in an amalgamation reactor. The mercury amalgamation reactor treats elemental mercury and any steel wool impregnated with mercury from the process residue treatment subsystem leaching process. The mercury is transferred to an amalgamation operation where the mercury is combined with copper (or zinc) powder, steel shot (for proper mixing), and nitric acid. This combination is mixed to form a copper-mercury amalgam, eliminating free mercury. The amalgam is packaged for assay and inspection to ensure that it meets TCLP standards.

2.1.12 Special Waste Treatment Subsystem

It is assumed that there are special wastes that will require capabilities not included in the basic system design concept. The treatment subsystem for special waste is located in a room equipped with a crane and all utilities needed for installing treatment equipment to process special wastes. Special treatment equipment will be identified and provided on a case-by-case basis during facility operation. The cost estimate for all ENTS systems includes the space in the building, but not processing equipment. Equipment and operation costs have not been estimated for special treatment processes.

2.1.13 Polymer Stabilization Subsystem

Figure 2-25 presents the PFD for the polymer stabilization subsystem. Figure 2-26 presents the subsystem's perspective view. The polymer stabilization subsystem receives (1) salt waste from the receiving and preparation subsystem, (2) salts, fines and concentrated scrubber liquid waste from aqueous waste treatment and the air pollution control subsystems, (3) treated process residue solids and desorbed solids from the process residue and inorganic sludge treatment subsystem, and (4) sludges from the soil and debris washing subsystems.

Stabilization of wastes involves polymer encapsulation using polyethylene. The subsystem has a dryer which removes water from the incoming waste. A tertiary shredder is available to reduce the waste size prior to an extrusion operation. The dried, shredded waste and polymer are metered into a mixer or extruder which heats and mixes the polymer with the waste at a ratio of one part polymer to one part waste by weight. The extruder feeds the mixture directly into a drum.

When the filling operation is complete, the drum is automatically capped and sent to a wiping and decontamination station. If surface contamination is detected, the container is washed by high-pressure water jets or blasts of dry ice. The inspected container is sent for assay, certification, and shipment to storage or disposal facilities.

2.1.14 Air Pollution Control (APC) Subsystem

Figure 2-27 presents the PFD for the air pollution control subsystem. Figure 2-28 presents the subsystem's perspective view. The APC subsystem receives offgas from other subsystems that produce offgas requiring treatment. This offgas may include gaseous reaction products from organic destruction (mainly carbon dioxide), desorber offgas, aqueous waste treatment offgas, and offgas from washing operations. Several unit operations are provided in this subsystem.

The APC subsystem is composed of (1) a metal filter, (2) pre-filter, (3) GPCR unit, (4) a wet gas scrubber, (5) mist eliminator, (6) activated carbon for trace organics removal, (7) sulfur impregnated activated carbon for mercury vapor removal, and (8) a system for continuous emissions monitoring (CEM). Treatment occurs near room temperature and pressure.

Gross particulate is removed from the gas stream by a metal filter. The gas is also passed through a HEPA filter to remove fine gas particulate. Once the particulate is removed from the gas stream, the gas enters the GPCR. Unlike carbon adsorption, the gas delivered to the GPCR does not require any temperature reduction or moisture removal. The relative humidity of the inlet gas can be as low as 0 percent and as high as 90 percent. The GPCR is a cylindrical quartz vessel with an inner high voltage electrode and a grounded electrode on its outer surface. The annulus of the vessel is filled with dielectric pellets. A strong alternating electric field placed across the packed bed of dielectric particles creates a corona that causes the gas to partially ionize and to form a plasma in the voids between the particles. In the plasma, electrons are heated to extremely high temperatures while the bulk of the gas remains cool. The high-energy electrons in the plasma cause organic contaminant destruction through direct interaction with the contaminant molecules. Destruction also occurs through secondary ion and radical reactions.

The treated gas exits the GPCR and enters the acid gas scrubber. The gas scrubber includes a hydrosonic scrubber and a packed tower scrubber. The neutralized offgas passes through a mist eliminator. Final polishing is provided by granular activated carbon and sulfur impregnated activated carbon for mercury vapor removal. The treated offgas is monitored continuously before release to the atmosphere.

2.1.15 Vitrification Subsystem

Figure 2-29 presents the PFD for the vitrification subsystem. Figure 2-30 presents the subsystem's perspective view. In this subsystem, waste and soil or chemical additives such as SiO_2 , Al_2O_3 , and Fe_2O_3 are metered into a mixer. The additives, which act as glass formers, are added in quantities proportional to the waste, which consists of treated soil and inorganic debris. The mixer combines the additives with the waste. From the mixer, the waste is discharged into a storage hopper. The mixture is metered from the hopper into a Joule heated melter. The melter vitrifies the waste and soil mixture by heating it to temperatures exceeding 2000 °F, and discharges the molten mass into a crucible.

The melter is equipped with a secondary combustion chamber (SCC). The vitrification process requires a minimal feed preparation. It uses air as the combustion gas in the SCC. This furnace can perform thermal treatment and vitrification. Solid residues from the melter, including radionuclides, are drawn off in two streamlines: a molten glass stream containing the vitrified waste, and a molten metal stream that contains residual metals contained in the pretreated waste. The molten product from the vitrifier is poured into crucibles placed in disposal containers. The containers are cooled, capped, and wipe tested. If surface contamination is found, the container are decontaminated by high-pressure water equipment. The inspected containers are sent for assay, certification, and shipment to storage or disposal facilities.

The APC subsystem is composed of dry and wet filtration equipment. The dry APC equipment includes quench cooling, baghouse filtration, charcoal filters, pre-filters, and a HEPA filtration system. The wet APC includes wet gas scrubbers, mist eliminator, and a NO_x abatement system. The APC system discharge is subject to continuous emissions monitoring (CEM).

2.1.16 Certification and Shipping Subsystem

Figure 2-31 presents the PFD for the certification and shipping subsystem. Figure 2-32 presents the subsystem's perspective view. In this subsystem, the physical and radiological properties of the packaged waste are characterized to allow certification in accordance with transportation, storage, and disposal requirements. Equipment utilized is similar to that in the receiving and preparation subsystem. The containers of packaged waste for shipment are weighed. An RTR unit examines the container to ensure that the matrix is homogeneous and does not contain free water. If TRU or alpha contaminated waste is processed, the TRU concentration is measured by a PAN assay unit. An SGS unit is used to assay the beta

and gamma radioactivity. After inspection, the waste is either sent to a temporary storage area or loaded onto a truck for offsite or onsite shipment.

2.1.17 Support Subsystem

The support subsystem includes the facilities necessary to ensure continuous functioning of the treatment facility. These include (1) the auxiliary operating and maintenance galleries, (2) retrieval and transfer areas, (3) maintenance shop, (4) mechanical equipment room, (5) heating, ventilation and air conditioning (HVAC) equipment room, (6) motor control center (MCC), and (7) electrical rooms. Lighting, drainage, piping, fire protection, heating, and closed circuit television cameras are also provided as part of this subsystem. All of this equipment incorporates proven technologies. Costs for maintenance and equipment galleries are included for each treatment subsystem.

A main control room is provided for the control of process operations. The control room contains monitoring and control instrumentation, remote video monitors, communications devices and other equipment used to operate the facility. Costs for monitors are included in each treatment subsystem.

For maintenance needs, the treatment facility provides large corridors or galleries for equipment pull-out and maintenance next to each cell. To minimize the consequences of equipment failure, the equipment layout is designed to allow the removal of equipment by crane. Equipment requiring repair is removed from its location and staged on a cart next to the maintenance gallery airlock. The equipment can then be transferred to the maintenance gallery. Repairs can be made in the maintenance gallery or, if necessary, removed to an offsite shop via the shipping or receiving subsystems. The gallery also has space to set up duplicate equipment outside the hot cell, and to assist in the remote repair of equipment using robotic or manipulator devices. Cell isolation minimizes the amount of process equipment that must be idled when a mechanical failure shuts down an operation.

The support subsystem includes the equipment to maintain three zones necessary for facility operation. One of them is a non-confinement zone. The zones are:

- Zone 1 - primary confinement. This zone encompasses process enclosures.
- Zone 2 - secondary confinement. This zone encompasses process areas immediately surrounding Zone 1 areas, including maintenance galleries.
- Zone 3 - non-confinement areas. This zone encompasses shipping, receiving, transfer corridors, control rooms, and administration and support areas.

Zone 1 confinement is achieved by drawing air into process enclosures through adjustable dampers and openings from Zone 2. Zone 2 confinement is achieved by drawing air from non-confinement areas in Zone 3. Zone 1 is maintained at negative pressure with respect to Zone 2, while Zone 2 is maintained at negative pressure with respect to Zone 3. Air drawn from Zones 1 and 2 is passed through air handling units comprised of prefilter, HEPA filter and charcoal filter banks. Zone 3 is serviced by an air supply unit equipped with temperature control and air filtration devices that are used to provide fresh conditioned air to the facility from outside.

The confinement system consists of dust collection, process ventilation, building ventilation, and HEPA filtration units. The combination of these units ensures confinement of airborne radioactive and chemical contaminants within the equipment and process area boundaries. The system removes airborne contaminants from the process areas and filters the air before exhaust.

Dust control unit. Waste expected to generate dust will be handled within enclosures. Local vents and dust collection/filtration units are installed in areas where dust generation potential exists. After removal of dust, the filters exhaust the unit to the building ventilation and HEPA filter unit.

Process vent unit. Chemical vapors and fumes generated by processes are collected by a vapor collection system. Vented vapors are treated by filtration units designed to remove vapor, fumes and particulate before being exhausted to the vent system. Treated vapors are then sent to the building ventilation and HEPA filtration units prior to release to atmosphere.

Building ventilation and HEPA filtration system. This system ensures safe operating conditions by maintaining air flow from non-contaminated areas to areas of progressively higher potential contamination. A zoned approach is used, based on a cascade pressure differential principle.

The support subsystem includes the HVAC equipment. The functions of this equipment are (1) to provide heating and cooling requirements for the facility, (2) to provide air confinement barriers by removing air from the facility and recharging it with conditioned air from outside, (3) to remove airborne contaminants from the facility and to treat them prior to discharging treated and conditioned air to the atmosphere, and (4) to monitor radioactivity of treated air released to the atmosphere.

Ventilation air will be introduced into the building after passing through 85 percent efficient pre-filters and nuclear grade HEPA filters. Air will be exhausted from Zone 1 by industrial exhaust fans through a galvanized steel duct system. The exhaust fans will be located adjacent to the stack. Exhaust air will pass through the air treatment system. The air treatment system consists of a dust collection system, a fume abatement system, vapor filters, charcoal filters and nuclear grade HEPA filters. Treated air will be exhausted to the atmosphere through the stack. Intermediate sections will be provided with system redundancies to permit maintenance, testing or replacement of the abatement systems and filters.

The exhaust and makeup air systems operate continuously 24 hours a day, seven days a week. A redundant exhaust fan and filter train will be included to permit fan maintenance, filter change, and repairs.

Air volume measuring stations located in the makeup and exhaust ducting will continuously monitor the air flow rates and send signals to a digital controller. The controller will adjust the variable frequency drive of the exhaust fans to maintain a constant exhaust rate. This feature will automatically compensate for fluctuations in flow rates across the HVAC filters.

Atmospheric and room static pressure probes will send pressure measurement signals to the digital controller. The controller will adjust the variable frequency drive of the makeup air fan to control the volume of air entering processing area zones, and thus will maintain the negative to atmosphere pressure relationships required. A digital controller will be provided for all fans.

Air volume measuring stations will continuously monitor the exhaust air flow rate from each zone. A digital controller will adjust the position of a modulating damper located in the room exhaust ducts to maintain the desired air change rate for that zone. This feature will automatically compensate for pressure adjustment needs during events such as opening and closing doors of controlled spaces.

2.2 System ENTS-2: Catalytic Wet Oxidation and Vitrification for Process Residues

Figure 2-33 presents the overall PFD for System ENTS-2. Figure 2-34 presents the plan view layout. In this system vitrification replaces the grout stabilization used to treat waste streams in INTS System 5. In

this system the vitrification subsystem rather than the vacuum desorption subsystem is used to treat the process residue and inorganic sludge.

The vitrification technology employed by this system is identical to the vitrification subsystem used in ENTS-1. The vitrification reactor employed by the ENTS-1 and ENTS-2 systems has a throughput capacity in excess of 3,000 lbs/hr for waste streams with less than 8000 Btu/lb heat content. All other subsystems of ENTS-2 are identical to the subsystems of ENTS-1.

2.3 System ENTS-3: Catalytic Wet Oxidation and Polymer Stabilization

Figure 2-35 presents the overall PFD of System ENTS-3. A plan view was not developed for the overall system because of its similarity to INTS System 5. In the ENTS-3 configuration the grout stabilization function of NT-5 is replaced by polymer stabilization which provides the only stabilization function for all waste streams, including all secondary waste streams generated by ENTS-3 subsystems. Figure 2-36 presents the polymer stabilization subsystem's perspective view. The polymer stabilization employed by ENTS-3 is capable of providing microencapsulation, and macroencapsulation stabilization functions. Extrudable waste such as process residue and dried sludge may be co-extruded in the polymer extruder. Co-extrusion is accomplished by feeding waste and Low Density Polyethylene (LDPE) simultaneously and co-extruding the product into waste disposal containers. Macroencapsulation is used for non-extrudable waste items which may qualify for treatment under the "EPA Debris Rule". Items such as metal debris are placed in disposal containers and LDPE is extruded through the polymer extruder and discharged into the disposal containers.

2.4 System ENTS-4: Catalytic Wet Oxidation, Desorption, Compaction and Polymer Stabilization

Figure 2-37 presents the overall PFD for System ENTS-4. Figure 2-38 presents the plan view layout. In the ENTS-4 configuration polymer stabilization provides the only stabilization function for all waste streams including all secondary waste streams generated by ENTS-4 subsystems. The polymer stabilization technology employed by ENTS-4 is a macroencapsulation process in which LDPE is extruded through a plastic extruder. The molten LDPE is discharged from the extruder into a container that holds compacted waste pellets. The waste pellets consist of process residue, soil, salts, secondary wastes, and size-reduced debris that is pretreated by screw compaction and sintering prior to polymer macroencapsulation. The sintering and polymer macroencapsulation process used as the basis for this system is the Claytec process.

2.4.1 Claytec Subsystem

Figure 2-39 presents the PFD for the Claytec subsystem. Figure 2-40 presents the subsystem's perspective view. Screw compactors with internal barrel pressures of 10,000 psi are used to compact waste and additives. The compaction force provides the bonding energy required to bind waste and the additives. Screw compactors are equipped with dies and cutters that are used to pelletize the waste. The pellets are then sintered at 2,200 °F to form a dense crystalline ceramic structure with greater than 30,000 psi strength.

Clay or other natural materials may be used as additives. The ratio of additive to waste is 1:1 by weight. Waste after screening and size reduction is added to pre-screened additives in a ribbon blender and is fed through a volumetric feeder to the screw compactor. The compacted waste is pelletized through a die cutter mechanism and is discharged into waste transfer bins.

The waste transfer bins containing raw pellets are taken to the sintering oven. The sintering oven uses a shaker mechanism to transfer the compacted pellets through the oven heat zones and to minimize mechanical force experienced by pellets, thus minimizing breakage during sintering.

The sintering oven has three heat zones. Zone 1 allows the pellet temperatures to rise from ambient temperature to 2,200 °F. Zone 2 provides a residence time of one half hour at 2,200° F to allow for complete curing. Zone 3 provides gradual cooling to avoid cooling shock which might compromise the structural integrity of the sintered pellets. It is estimated that a pellet discharge temperature of 200°F is desirable.

The sintered pellets are discharged into half full 64 cubic feet containers which are cooled to ambient temperatures by forced air in the cool down chamber prior to transfer to the polymer macroencapsulation process.

During the polymer macroencapsulation process sintered pellet containers are placed inside the polymer fill chamber and filled with melted Low Density Polyethylene (LDPE). LDPE is the macroencapsulation medium. The macroencapsulated containers are then allowed to cure and cool in a forced draft cooling chamber prior to being capped and discharged from the subsystem.

2.5 System ENTS-5: Catalytic Wet Oxidation with Increased Reaction Rates

Figure 2-41 presents the overall PFD for System ENTS-5. Because this system is so similar to the INTS System 5, a perspective view was not developed. The aim of the ENTS-5 evaluation was to investigate the effects of processing rates on the life cycle cost of a facility. This system is identical to NT-5 except that the reaction rate through the catalytic wet oxidation process is assumed to be an order of magnitude (ten times) higher than the throughput for the CWO of INTS System 5. In performing this study it was assumed that the faster treatment rates would be accomplished by using a more advanced and more efficient version of the CWO process. It was further assumed that this process will maintain the processing logic and configurations of the CWO process identified in the INTS System 5. It should be noted that no such technology was actually identified, but preliminary results by the vendor indicate that faster reaction rates of two to three times may be possible. Also, application of external energy sources such as microwaves or ultrasonics may enhance the reaction rate.

The increased reaction rates of CWO in System ENTS-5 reduce the processing time for soft debris and organic waste. System ENTS-5 combines the two CWO subsystems into one, reducing the building space required. The reaction rate is so fast that only one shift of operation is necessary to process all the soft debris and organic waste. The reactor is kept to the size needed for treatment of only organics as depicted in the INTS System NT-5. However, a larger material handling system is now needed to prepare waste for treatment in the shorter time period. The APC subsystem is larger than that of System NT-5 to accommodate a higher gas flow when the CWO process is running. As discussed in Section 4.4, this system has an increase in equipment capacity and cost compared with INTS System 5.

2.6 Rationale for System Selection and Design

The first two systems (ENTS-1 and ENTS-2) were chosen to identify the impact on cost and performance of using a hybrid nonthermal/thermal system by replacing grout stabilization with vitrification. In both systems, thermal processes were also used for metal treatment as follows:

- a metal melter for the complex, internally contaminated metal items
- a metal melter for lead waste with entrained contamination (e.g., lead gloves, aprons, etc.)
- a mercury retort and amalgamation for the mercury contaminated waste

The metal melting process increases the destruction of organic contaminants. The ingots produced from these metal melting operations are recycled instead of being stabilized in grout in both these ENTS systems. Thus, the amount of waste and total contaminants sent to disposal is decreased.

Replacing the mercury leaching process used in the nonthermal systems with a mercury retort increases the potential for removing mercury and mercury compounds from inorganic wastes. Mercury associated with organic wastes (including combustible debris) will be solubilized in the CWO solution. Subsequently, the mercury is precipitated as an insoluble sulfide and stabilized in polymer.

In ENTS-1, vitrification only replaces grout. Thus the only difference between NT-5 and ENTS-1 (except for the metal melters and mercury treatment identified above) is that treated debris and soils are vitrified in ENTS-1. As in NT-5, inorganic sludge and process residue are still treated in a vacuum thermal desorber and stabilized in polymer. This provides information on the cost and performance, and the processes required, if grout were replaced with vitrification.

ENTS-2 takes the concept one step further by eliminating the vacuum thermal desorber and treating the inorganic sludge in the vitrifier. Sludge is a difficult waste stream to treat. The efficacy of desorption or washing to remove organic contaminants from sludge is uncertain. Thus, ENTS-2 provides an enhanced waste form, improved system operational performance and more reliable destruction of organic contaminants in the sludge.

In both ENTS-1 and ENTS-2, polymer was used to stabilize (1) salt/sludge waste from aqueous waste treatment, (2) solids and fines from organic destruction, and (3) the primary salt waste. As in the thermal systems evaluated in the ITTS study and in the nonthermal systems evaluated in the INTS study, these waste streams were stabilized in polymer. All salts and sludges from the thermal APC quench and scrubber solutions were stabilized also in polymer. Thus, using polymer for stabilization of these waste streams in the ENTS study provides some continuity between systems for comparison. The primary reason for using polymer instead of vitrification for these waste streams is that many of these salts are chlorides that will volatilize in a vitrifier, end up in the offgas equipment, and will still need to be stabilized in polymer because they cannot be retained in a high temperature melter. Other salts, in particular sulfur based salts, affect electrical conductivity and may cause corrosion of electrodes and refractory. Vitrification of these secondary salt wastes is not a viable alternative.

In Systems ENTS-1 and ENTS-2 residue from CWO organic destruction is sent to polymer, and residue from CWO soft debris treatment is sent to vitrification. In System NT-5 residue from CWO organic destruction is sent to polymer, and residue from CWO soft debris treatment is sent to grout. Residue from organic destruction (organic liquids and sludges) consists primarily of salts from the spent CWO solution. The residue from CWO soft debris treatment consists of large amounts of alumina and silica (as per the mass balance on the debris elemental makeup in the INTS and ITTS reports) that can

be vitrified or stabilized in grout. While this waste stream could be sent to polymer for stabilization, stabilization by vitrification was chosen to minimize disposal volumes.

ENTS-3 and ENTS-4 were evaluated to determine the impact on a nonthermal system of potentially improved waste forms. The stabilization methods used to achieve improved waste forms are:

- polymer stabilization only (ENTS-3)
- pelletizing and sintering the waste, then macroencapsulating it in polymer (ENTS-4)

As indicated previously, System NT-5 was used in these enhanced nonthermal systems for continuity so that we could compare the costs and performance of vitrification, polymer, and compacted pellets macroencapsulated in polymer against a baseline system using grout. System NT-5 was used as the basis for ENTS-5, again for continuity and comparison purposes, and because some reaction rate data were available to allow equipment sizing for an increased reaction rate and subsequent costing.

ENTS-5 was evaluated to determine the benefits, if any, of pursuing R&D to increase the reaction rate of nonthermal chemical oxidation processes. The initially perceived potential advantages of increasing the reaction rate are (1) an increased destruction efficiency if the same throughput and residence time are used as in the case of the slower reaction rate, and (2) decreased cost resulting from shorter operating time, fewer personnel, and smaller processing equipment if the residence time and equipment are scaled down.

If the same throughput and residence time are assumed to provide an increased destruction efficiency, then the personnel numbers or equipment required would not change from that used in a system with a slower reaction rate (e.g., System NT-5). In this case the life-cycle cost would be the same as that for NT-5, except for the additional capital and operating costs to achieve the higher reaction rate. The only option evaluated for System ENTS-5 was the decrease in the number of operating personnel and equipment to match the increased reaction rate.

Figure 2-1. ENT System 1: PFD for Overall System.

Figure 2-3. ENTS System 1: PFD for Receiving and Preparation Subsystem.

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Figure 2-4. ENTS System 1: Perspective View of Receiving and Unloading Area of the Receiving and Preparation Subsystem.

Figure 2-5. ENT S System 1: Perspective View of Decap, Sort, and Dump Cell of the Receiving and Preparation subsystem.

Figure 2-6. ENTS System 1: PFD for Aqueous Waste Treatment Subsystem.

Figure 2-7. ENTs System 1: Perspective View of Aqueous Waste Treatment Subsystem.

Figure 2-8. ENTS System 1: PFD for the CWO Organic Destruction Subsystem.

Figure 2-9. ENTs System 1: Perspective View of the CWO Organic Destruction Subsystem.

Figure 2-10. ENTS System 1: PFD for Process Residue and Inorganic Sludge Treatment Subsystem.

Figure 2-11. ENT System 1: Process Residue and Inorganic Sludge Treatment Subsystem.

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Figure 2-12. ENTS System 1: PFD for Bulk Soil Treatment Subsystem.

NOTE: WALLS NOT SHOWN FOR CLARITY

EQUIPMENT LIST

- ① TRANSPORTABLE WASTE BINS
- ② BIN DUMPER
- ③ FEED HOPPER AND AUGER
- ④ CLEAR RINSE WATER TANK
- ⑤ WASH WATER MAKEUP
- ⑥ MAKE UP WATER TANK
- ⑦ AGITATED WASH TANK
- ⑧ DISSOLVED AIR FLOTATION TANK
- ⑨ HYDROCYCLONES
- ⑩ ROTATING SCREENS
- ⑪ ULTRAFILTRATION
- ⑫ RINSE CONTACTOR TANK
- ⑬ CONCENTRATE TANK
- ⑭ SOLUBILITY REDUCTION TANK
- ⑮ STEAM STRIPPING
- ⑯ SURFACTANT RECOVERY TANK
- ⑰ WASH TANK CONDENSER
- ⑱ OVERHEAD CRANE

NOT TO SCALE

Figure 2-13. ENTS System 1: Perspective View of Bulk Soil Treatment Subsystem.

Figure 2-14. ENTS System 1: PFD for Soft Debris Treatment Subsystem.

Figure 2-15. ENTS System 1: Perspective View of Soft Debris Treatment Subsystem.

Figure 2-16. ENTS System 1: PFD for Open Debris Treatment Subsystem.

NODES	FLOW RATE (LB/HR)
① OPEN DEBRIS	80
② AQUEOUS WASTE	9
③ SURFACTANT	(SEE NOTE)
④ SURFACTANT SOLUTION	422
⑤ HEATED WATER	(SEE NOTE)
⑥ SPRAY WATER	(SEE NOTE)
⑦ MAKE-UP WATER	12
⑧ RECYCLE SURFACTANT SOLUTION	402
⑨ WASHED DEBRIS	83

NOTE: THESE DATA IS NOT AVAILABLE FROM ASPEN MASS BALANCE.

NOT TO SCALE

Figure 2-17. ENT System 1: Perspective View of Open Debris Treatment Subsystem.

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Figure 2-18. ENTS System 1: PFD for Metal Melting Subsystem.

NOTE. WALLS NOT SHOWN FOR CLARITY

EQUIPMENT LIST

- ① SIZE REDUCTION TABLE
- ② SIZED METAL FEED HOPPER
- ③ MELTER
- ④ CASTING/COOLING CHAMBER
- ⑤ ROLLER CONVEYOR
- ⑥ CAPPING/WASHING
- ⑦ INSPECT/ASSY
- ⑧ OVERHEAD CRANE
- ⑨ GANTRY ROBOT
- ⑩ REMOTE MANIPULATORS AND CUTTING TOOLS

SCALE : 1"= 10'-0"

Figure 2-19. ENT System 1: Perspective View of Metal Melting Subsystem.

Figure 2-20. ENTS System 1: PFD for Metal Decontamination Subsystem.

NOTE: WALLS NOT SHOWN FOR CLARITY

EQUIPMENT LIST

- ① TRANSPORTABLE WASTE BINS
- ② GANTRY ROBOT
- ③ SIZE REDUCTION TABLE
- ④ HYDRAULIC MANIPULATOR
- ⑤ MASTER SLAVE MANIPULATOR
- ⑥ DECON CHAMBER
- ⑦ ASSAY CHAMBER
- ⑧ EXIT AIRLOCK
- ⑨ DUST COLLECTION
- ⑩ DECON CHAMBER
- ⑪ INSPECTION/PACKAGING TABLES

NOT TO SCALE

Figure 2-21. ENT System 1: Perspective View of Metal Decontamination Subsystem.

Figure 2-22. ENTS System 1: PFD for Mercury Amalgamation and Lead Recovery Subsystems.

NOTE. WALLS NOT SHOWN FOR CLARITY

EQUIPMENT LIST

- ① POWERED ROLLER CONVEYOR
- ② BARREL DECAPPING
- ③ AUTOMATIC DRUM DUMPER
- ④ DRUM PUSHER
- ⑤ SORT TABLE GLOVE BOX
- ⑥ DECONTAMINATION BOOTH
- ⑦ CLEAN METALS SORT TABLE
- ⑧ INGOT INSPECT SORT TABLE
- ⑨ BARREL CAPPING
- ⑩ ASSAY AND INSPECT STATION
- ⑪ BARREL DECON STATION
- ⑫ BATTERY SORT & SIZING TABLE
- ⑬ SHREDDER
- ⑭ MIXER
- ⑮ MONORAIL
- ⑯ OVERHEAD CRANE
- ⑰ FURNACE WITH HOOD
- ⑱ LEAD CASTING MACHINE
- ⑲ SECONDARY COMBUSTION CHAMBER
- ⑳ QUENCHER
- ㉑ DRY FILTER
- ㉒ CARBON FILTER
- ㉓ HEPA FILTER

NOT TO SCALE

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Figure 2-23. ENTS System 1: Perspective View of Lead Recovery Subsystem.

NOTE: WALLS NOT SHOWN FOR CLARITY

EQUIPMENT LIST

- ① FEED HOPPER AND SHREDDER
- ② ELECTRIC RETORT
- ③ CONDENSER
- ④ SEPARATOR
- ⑤ VACUUM PUMP
- ⑥ OFFGAS COMBUSTION CHAMBER
- ⑦ QUENCH COLUMN
- ⑧ FILTER BAGHOUSE
- ⑨ ACTIVATED CARBON ADSORBERS
- ⑩ HEPA FILTERS
- ⑪ FAN AND STACK

- ⑫ LIQUID MERCURY TANK
- ⑬ SOLIDS MIXER (PEBBLE MILL)
- ⑭ NITRIC ACID TANK
- ⑮ STEEL SHOT BIN
- ⑯ COPPER BIN
- ⑰ SCREW FEEDER
- ⑱ GANTRY ROBOT

NOT TO SCALE

Figure 2-24. ENTS System 1: Perspective View of Mercury Amalgamation Subsystem.

Figure 2-25. ENTS System 1: PFD for Polymer Stabilization Subsystem.

Figure 2-26. ENTS System 1: Perspective View of Polymer Stabilization Subsystem.

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Figure 2-27. ENTS System 1: PFD for Air Pollution Control Subsystem.

Figure 2-28. ENTS System 1: Perspective View of Air Pollution Control Subsystem.

NOTE: WALLS NOT SHOWN FOR CLARITY

EQUIPMENT LIST

- ① TRANSPORTABLE WASTE BINS
- ② WASTE FEED AIRLOCK
- ③ WASTE BIN FEED SYSTEM
- ④ PLASMA FURNACE
- ⑤ ELECTRODE ASSY
- ⑥ SPARE ELECTRODE ASSY
- ⑦ DRY FILTER BAGHOUSE
- ⑧ CARBON FILTERS
- ⑨ HEPA FILTERS
- ⑩ HYDROSONIC SCRUBBER
- ⑪ PACKED TOWER SCRUBBER
- ⑫ FANS
- ⑬ STACK
- ⑭ INSPECT AND ASSAY
- ⑮ DECON BOOTH
- ⑯ COOLING CHAMBER
- ⑰ SLAG COLLECTION CHAMBER
- ⑱ SECONDARY COMBUSTION CHAMBER
- ⑲ OVERHEAD CRANE

NOT TO SCALE

Figure 2-30. ENTS System 1: Perspective View of Vitrification Subsystem.

Figure 2-31. ENTS System 1: PFD for Certification and Shipping Subsystem.

Figure 2-32. ENTSCS System 1: Perspective View of Certification and Shipping Subsystem.

Figure 2-33. ENT System 2: PFD for Overall System.

Figure 2-35. ENT System 3: PFD for Overall System.

Figure 2-36. ENTS System 3: PFD for Polymer Stabilization Subsystem.

Figure 2-37. ENT System 4: PFD for Overall System.

Figure 2-38. ENTs System 4: Plan View of Overall System.

Figure 2-39. ENTS System 4: PFD for Claytec Subsystem.

NOTE: WALLS NOT SHOWN FOR CLARITY

3 SYSTEMS TYP.

EQUIPMENT LIST

- ① TRANSPORTABLE SOIL/WASTE BINS
- ② WASTE BIN HOIST TYP. 3
- ③ SOIL/WASTE WEIGH BINS TYP. 3
- ④ WASTE MIXER TYP. 3
- ⑤ WASTE EXTRUDER TYP. 3
- ⑥ EXTRUDED WASTE BIN DUMPER
- ⑦ SINTERING OVEN
- ⑧ OVEN DISCHARGE
- ⑨ STABILIZED WASTE CURRING ROOM
- ⑩ INSPECT/ASSAY CHAMBER
- ⑪ OVERHEAD CRANE
- ⑫ POLYMER POURING CHAMBER
- ⑬ POLYMER EXTRUDER
- ⑭ POLYMER FEED HOPPER
- ⑮ COMPACT WASTE STAGING AREA
- ⑯ DUST COLLECTION

NOT TO SCALE

Figure 2-40. ENTS System 4: Perspective View of Claytec Subsystem.

Figure 2-41. ENTS System 5: PFD for Overall System.

3. SYSTEM FLOW RATES

This section contains a summary of mass flow rates of the major inputs and outputs of the five ENTS systems and the methods used to make these calculations. This information is presented in several figures in this section. Detailed information on mass flow rates is presented in the process flow diagrams (see Appendix A).

The mass flow rate data used in this preconceptual design study are based on many assumptions. These assumptions, discussed below, must be validated before commencing more detailed design activities.

Mass flow rates for key subsystems of the five ENTS flow sheets were used to size the systems. These flow rates were calculated by modeling the flow sheets with ASPEN PLUS (ASPEN) (Aspen Technology, 1994). The ASPEN model used in the modeling of INTS System 5 was used as the basis for modeling the five ENTS systems.

3.1 System Input Feed Rates

As in the ITTS and INTS studies, the feed rates for the ENTS systems are uniformly calculated based on 4,032 hours of operation per year for 20 years. The calculations are based on a feed rate of 2,927 pounds per hour (lb/hr) to the system. The input to the various subsystems may vary, but the total feed rate to systems in these studies (ENTS, INTS and ITTS) is always 2,927 lb/hr. The chemical composition of the input waste to each of the subsystems is identical to that of System 5 of the INTS study. Feed input rate tables are presented in Section 3 of the INTS study report. Waste input data in Table 3-1 (below) show the input waste plus major secondary waste streams that have been calculated in the mass balance studies.

3.2 System Secondary Waste

Secondary waste produced within the facility includes APC scrubber salts, decontamination subsystem sludge, sludge from the CWO process, and organic liquids from vacuum desorption condensed offgas.

3.3 Key Assumptions for Mass Flow Calculations

Detailed assumptions for mass flow calculations are presented in the INTS report. Densities and other key assumptions used in the calculations are as follows:

- Density of waste input and output (pounds per cubic foot [lb/cu.ft]):
 - Input waste = 64 lb/ft³
 - Metal = 480 lb/ft³
 - Aqueous liquid = 62 lb/ft³
 - Soil = 67 lb/ft³
 - Polymer stabilized salts = 80 lb/ft³
 - Polymer stabilized salts/residues/waste = 94 lb/ft³
 - Screw compacted waste pellets = 94 lb/ft³
 - Grout stabilized waste = 126.6 lb/ft³
 - Stabilized mercury amalgam = 733 lb/ft³

- Density of reagents and additives:
 - Caustic (NaOH) = 133 lb/ft³
 - Acid solution = 62 lb/ft³
 - Ammonia = 45 lb/ft³
 - Nitric acid = 94 lb/ft³
 - Silver nitrate = 271 lb/ft³
 - Hydrogen peroxide = 91 lb/ft³
 - Polyethylene = 80 lb/ft³
 - Clay = 80 lb/ft³
 - Copper for mercury amalgamation = 557 lb/ft³
- Mercury content:
 - Elemental mercury (100 percent Hg) comprises 5 percent of the waste designated as mercury-contaminated.
 - Mercury concentration in the remaining 95 percent of the mercury-contaminated stream is 5 percent.
- Stabilization formulas (all on a mass basis):
 - Polymer = One part polymer to one part waste.
 - Grout = Two parts grout to one part waste.
 - Polymer/Pellet = 0.35 parts polymer to one part pellets
 - Pellets = One part additive to one part waste

3.4 System Output

Output calculations are presented for the five ENTS systems, allowing comparison of the offgas volumes and waste volume reduction for the different systems. System offgas, water and metal recycling outputs are presented in Table 3-2. Waste volume outputs from the five ENTS systems are presented in Table 3-3.

3.5 Energy Balance Calculation Results

Energy requirements for ENTS Systems 1 through 4 were calculated using ASPEN. These results are presented in Table 3-4.

3.6 Mass Balance Calculation Results

Simplified block diagrams showing the key system input and output products from the five ENTS systems are shown in Figures 3-1 through 3-5. The major input and output products of the subsystems are shown in the figures. These simplified figures do not include additives or all secondary streams and therefore do not contain the complete numerical balance. Detailed mass balances that were generated using ASPEN are presented in Table 3-5. Additional mass balance information is presented in the PFDs presented in Section 2. A comparison of the mass balance results with INTS and ITTS systems is presented in Section 5.

Table 3-1. Input feed rates to ENTS subsystems (lb/hr).

Subsystem ^a	ENTS System 1	ENTS System 2	ENTS System 3	ENTS System 4	ENTS System 5
Administration	2,927	2,927	2,927	2,927	2,927
Receiving and preparation	2,927	2,927	2,927	2,927	2,927
Aqueous waste treatment	1,945	1,653	1,914	1,914	1,956
Organic destruction	256	233	256	256	256
Process residue and inorganic sludge treatment	1,007		1,007	1,007	1,020
Bulk soil treatment	329	329	329	329	329
Soft debris treatment	435	435	435	435	435
Open debris treatment	80	80	80	80	80
Complex debris treatment ^c	177	177			
Metal decontamination	462	462	462	462	462
Mercury amalgamation	4.0	3.8	2.7	2.7	2.7
Lead recovery	26	26	26	26	26
Polymer stabilization	1,128	176	1,772		1,127
Claytec Process	Not Used	Not Used	Not Used	1,772	Not Used
Air pollution control	1,507	1,731	1,433	1,433	1,433
Vitrification	495	1,502	Not Used	Not Used	Not Used
Grout Stabilization	Not Used	Not Used	Not Used	Not Used	650
Special treatment	155	155	155	155	155
Certification and shipping	3,227	2,701	3,687	4,762	4,271

Notes:

- (a) Input to all subsystems includes only the primary and the secondary waste streams
- (b) Treated by vitrification subsystem
- (c) Includes mercury contaminated complex debris.
- (d) Complex debris is treated by polymer stabilization
- (e) Complex debris is treated by grout stabilization
- (f) Claytec and polymer macro-encapsulation are used in ENTS-4

Table 3-2. Offgas, water and metal recycle outputs from the five ENTS systems (lb/hr).

Subsystem	ENTS System 1	ENTS System 2	ENTS System 3	ENTS System 4	ENTS System 5
Offgas from APC	1703.493	2,541	1,433	1,433	1,433
Water Discharge	1,262	941	1,233	1,233	564
Metal/ lead Recycle	605	605	456	456	451

Table 3-3. Waste volume outputs from the five ENTS systems (ft³/hr)

Subsystem	ENTS System 1	ENTS System 2	ENTS System 3	ENTS System 4	ENTS System 5
Polymer stabilization	18.3	3.7	32.7	-	18.3
Claytec	-	-	-	44.1	-
Vitrification	3.9	8.5	-	-	-
Grout stabilization	-	-	-	-	15.3
Mercury amalgamation	0.01	0.01	0.01	0.01	0.01
Metal to recycle	1.3	1.3	1.0	1.0	0.9
Special waste	2.4	2.4	2.4	2.4	2.4
All subsystems waste to disposal	24.7	14.6	35.1	46.5	36.0
Volume reduction factor (vol in/vol out)	1.82	3.08	1.28	0.97	1.25

Table 3-4. Energy Requirement for ENTS Systems (BTU/hr)

Subsystem	Unit Operation	Temperature (F)	Energy Type	System 1 Vitrification	System 2 Vitrification	System 3 Polymer	System 4 Claytec
APC	GPCR temp.		electricity	1,268	2,237	404	408
	GPCR power		electricity	50,162	105,244	39,450	39,448
	scrubber	100	cooling water	(481,764)	(2,230,000)	(99,031)	(98,898)
	HEPA heater	300	electricity	78,163	121,382	63,794	63,788
Aqueous Waste Treatment	OH generator	100	electricity	2,801	(4,700)	3,534	3,539
	Photolytic UV	100	cooling water	(22,604)	(21,671)	(22,618)	(22,621)
	scrubber	100	cooling water	(22,063)	(6,761)	(22,126)	(22,126)
	concentrator	150	natural gas	158	95	112	112
Bulk Soil	dryer	200	natural gas	54,566	54,566	54,566	54,566
Hg Amalgamation	reactor	2,000	electricity	1,102	1,062	751	1,102
Organic Destruction	CWO	302	cooling water	(3,653,274)	(3,192,410)	(3,653,269)	(3,662,835)
	equilibration	302	c. water, elect if >0	(11,337)	989	(11,337)	(11,776)
	scrubber	100	cooling water	(351,250)	(315,217)	(351,250)	(352,204)
Pb Melter	melter	2,000	natural gas	1,602	1,602	1,602	1,602
Polymer	dryer	200	nat gas, cw if <0	16,130	(1,914)	73,768	73,766
Debris	vacuum desorp.	550	natural gas	499,722		499,722	499,722
	CWO	302	cooling water	(4,625,297)	(4,625,308)	(4,625,297)	(4,625,297)
	equilibration	302	electricity	808	804	808	808
	scrubber	100	cooling water	(388,142)	(387,732)	(387,732)	(387,732)
	metal melter	3,000	electricity	516,151	516,151		
	Hg retort	500	natural gas	31,951	31,951		31,951
Vitrification	vitrifier	3,000	electricity	1,918,000	2,430,000		
Total Energy Consumption (BTU)			electricity	2,567,187	3,170,932	108,337	108,685
			natural gas	604,129	88,214	629,770	661,719
			cooling water	(9,555,731)	(10,781,013)	(9,172,660)	(9,183,489)
Hourly Energy Costs (\$/hr)			electricity unit cost = \$0.05/k	38	46	2	2
			gas unit cost = \$2.00/MMBtu	1	0	1	1
			Total Hourly Energy Costs (\$/hr)	39	47	3	3

NOTE:

1. Energy balances presented are based on 2927 lb/hr of waste input.
2. Energy balance for ENTS System 5 is the same as for INTS System 5.

Table 3-5. ASPEN Mass Balance Data

SUBSYSTEM	System 1 Vitrification	System 2 Vitrification	System 3 Polymer	System 4 Claytec	System 5 INTS
SUBSYSTEM INPUTS FROM GENERATOR					
Aqueous Waste (1000)	60.8	60.8	60.8	60.8	60.8
Organic Liquids, Sludges (2000/3000)	185.4	185.4	185.4	185.4	185.4
Residue, Inorg. Sludge (3000)	1007.2	1007.2	1007.2	1007.2	1007.2
Salt Waste (3000)	6.6	6.6	6.6	6.6	6.6
Bulk Soils (4000)	328.5	328.5	328.5	328.5	328.5
Debris - Soft (5000)	434.8	434.8	434.8	434.8	434.8
Debris - Complex (5000)	177.4	177.4	177.4	177.4	177.4
Debris - Open (5000)	80.4	80.4	80.4	80.4	80.4
Bulk Metal (5000)	462.1	462.1	462.1	462.1	462.1
Special (6000)	154.9	154.9	154.9	154.9	154.9
Mercury waste (7000)	2.5	2.5	2.5	2.5	2.5
Lead Waste (7000)	26.0	26.0	26.0	26.0	26.0
Total Input Waste	2926.6	2926.6	2926.6	2926.6	2926.6
TOTAL SUBSYSTEM INPUTS					
Hg Amalgamation Subsystem					
Waste Input					
Mercury waste (7000)	2.50	2.50	2.50	2.50	2.50
Process Inputs					
additives (copper)	2.76	2.66	1.85	1.85	1.85
Input from other subsystems					
Hg retort - debris treatment	1.30	1.30			
process residue/inorganic sludge	0.15		0.15	0.15	0.15
Total Subsystem Input	6.71	6.46	4.50	4.50	4.50
Air Pollution Control Subsystem					
Waste Input					
Process Inputs					
Air: O2	45.60	264.77	0.00	0.00	0.00
N2	150.17	871.98	0.00	0.00	0.00
NaOH	3.66	11.68	2.87	2.87	2.86
H2O	3.66	11.68	2.87	2.87	2.86
Input from other subsystems					
aqueous waste treatment	9.40	13.76	9.33	9.54	9.47
organic destruction - offgases	561.75	490.71	561.75	561.75	561.64
process residue/inorganic sludge	79.87		79.87	79.87	79.87
debris treatment	781.80	781.80	781.80	781.80	781.80
bulk soil treatment					
vitrification subsystem	74.24	445.08			
Total Subsystem Input	1710.16	2891.46	1438.49	1438.70	1438.50
Aqueous Waste Treatment Subsystem					
Waste Input					
Aqueous Waste (1000)	60.80	60.80	60.80	60.80	60.80
Process Inputs					
Air (for ozone generation)	3.82	3.75	3.73	4.00	3.91
H2O2	0.63	0.62	0.62	0.66	0.64
H2O	8.97	1.30	8.97	8.97	8.97
NaOH	8.97	1.30	8.97	8.97	8.97
Input from other subsystems					
APC - moisture		328.90			
APC - concentrate	6.67	21.26	5.22	5.22	5.22
process residue/inorganic sludge	336.57		336.57	336.57	349.57
debris treatment	406.89	406.89	406.89	406.89	406.89
bulk soil treatment	355.35	355.35	355.35	355.35	355.35
polymer stabilization	265.73		235.97	235.97	265.50
metal decontamination	126.18	126.18	126.18	126.18	126.18
organic destruction - liquids	386.73	353.43	386.73	386.73	386.15
Total Subsystem Input	1967.29	1659.77	1935.98	1936.29	1978.13
Process Residue and Inorganic Sludge Treatment Subsystem					
Waste Input					
Residue, Inorg. Sludge (3000)	1007.20		1007.20	1007.20	1007.20
Process Inputs					
H2O	306.00		306.00	306.00	306.00
N2 sweep gas	79.87		79.87	79.87	79.87
Input from other subsystems					
Pb recovery	0.01		0.01	0.01	13.01
Total Subsystem Input	1393.08		1393.08	1393.08	1406.08

Table 3-5. (continued) ASPEN Mass Balance Data

SUBSYSTEM	System 1 Vitrification	System 2 Vitrification	System 3 Polymer	System 4 Claytec	System 5 INTS
Debris Treatment Subsystem					
Waste Input					
Debris - Soft (5000)	434.76	434.76	434.76	434.76	434.76
Debris - Complex (5000)	177.41	177.41			
Debris - Open (5000)	80.40	80.40	80.40	80.40	80.40
Process Inputs					
HNO3	15.21	15.21	15.21	15.21	15.21
oxygen	766.67	766.67	766.67	766.67	766.67
H2O	42.94	42.94	42.94	42.94	42.94
NaOH	30.94	30.94	30.94	30.94	30.94
Input from other subsystems					
Total Subsystem Input	1548.33	1548.33	1370.92	1370.92	1370.92
Vitrification / Grout Subsystem					
Waste Input					
Debris - Soft (5000)					
Debris - Complex (5000)					177.41
Debris - Open (5000)					
Residue, Inorg. Sludge (3000)		1007.20			
Process Inputs					
fluxing material (soil)	315.00	528.55			
dry grout material (cement & sand)					904.32
water required for grout					383.37
Input from other subsystems					
bulk soil treatment	285.51	285.51			285.51
Pb recovery					4.99
process residue/inorganic sludge					
debris treatment	209.46	209.46			182.24
Total Subsystem Input	809.96	2030.71			1937.83
Metal Decontamination Subsystem					
Waste Input					
Bulk Metal (5000)	462.11	462.11	462.11	462.11	462.11
Process Inputs					
H2O	94.33	94.33	94.33	94.33	94.33
Input from other subsystems					
Total Subsystem Input	556.44	556.44	556.44	556.44	556.44
Organic Destruction Subsystem					
Waste Input					
Organic Liquids, Sludges (2000/3000)	185.40	185.40	185.40	185.40	185.40
Process Inputs					
O2	604.77	524.26	604.77	604.77	604.62
H2O	50.67	50.18	50.67	50.67	50.67
NaOH - gas scrubbing	50.67	50.18	50.67	50.67	50.67
Acid-in (FeCl3, H2O, HCl)	9.29	8.47	9.29	9.29	9.29
Input from other subsystems					
aqueous waste treatment - decanted orgs	31.95	31.95	31.95	31.95	31.95
process residue/inorganic sludge	22.62		22.62	22.62	22.57
bulk soil treatment	16.14	16.14	16.14	16.14	16.14
Total Subsystem Input	971.52	866.58	971.52	971.52	971.32
Lead Recovery Subsystem					
Waste Input					
Lead Waste (7000)	25.99	25.99	25.99	25.99	25.99
Process Inputs					
H2O					13.00
Input from other subsystems					
Total Subsystem Input	25.99	25.99	25.99	25.99	38.99
Polymer Stabilization Subsystem					
Waste Input					
Salt Waste (3000)	6.60	6.60	6.60	6.60	6.60
Debris - Complex (5000)			177.41	177.41	
Process Inputs					
polyethylene	862.21	174.71	1535.67	1074.97	861.01
clay				1535.67	
Input from other subsystems					
mercury retort					
process residue/inorganic sludge	953.87		953.87	953.87	953.91
aqueous waste treatment - sludge	137.75	125.86	137.75	137.75	137.75
aqueous waste treatment - concentrate	6.67	21.26	5.22	5.22	5.22
organic destruction	23.04	22.44	23.04	23.04	23.03
APC	0.00	0.04			
bulk soil treatment			285.51	285.51	
debris treatment			182.24	182.24	
Total Subsystem Input	1990.14	350.90	3307.31	4382.27	1987.53

Table 3-5. (continued) ASPEN Mass Balance Data

SUBSYSTEM	System 1 Vitrification	System 2 Vitrification	System 3 Polymer	System 4 Claytec	System 5 INTS
Bulk Soil Treatment Subsystem					
Waste Input					
Bulk Soils (4000)	328.50	328.50	328.50	328.50	328.50
Process Inputs					
H2O	328.50	328.50	328.50	328.50	328.50
Input from other subsystems					
Total Subsystem Input	657.00	657.00	657.00	657.00	657.00
Special Waste Treatment Subsystem					
Waste Input					
Special (6000)	154.90	154.90	154.90	154.90	154.90
Process Inputs					
Input from other subsystems					
Total Subsystem Input	154.90	154.90	154.90	154.90	154.90
SUBSYSTEM OUTPUTS					
Hg Amalgamation Subsystem					
Process Outputs	6.71	6.46	4.50	4.50	4.50
Output to other subsystems					
Total Subsystem Output	6.71	6.46	4.50	4.50	4.50
Air Pollution Control Subsystem					
Process Outputs					
Offgas					
O2	37.95	146.73	30.84	30.84	30.85
N2	234.31	876.19	84.07	84.28	84.21
NO	0.67	0.67	0.67	0.67	0.67
H2O	37.13	85.18	3.79	3.78	3.77
CO2	1391.10	1427.73	1313.75	1313.75	1313.64
total offgas	1703.49	2541.32	1433.27	1433.48	1433.29
Output to other subsystems					
aqueous waste treatment - salts	6.67	21.26	5.22	5.22	5.22
aqueous waste treatment - moisture		328.90			
polymer stabilization - metals	0.00	0.04			
Total Subsystem Output	1710.17	2891.52	1438.49	1438.70	1438.50
Aqueous Waste Treatment Subsystem					
Process Outputs					
aqueous recycle	1781.80	1468.78	1752.01	1752.11	1794.53
Output to other subsystems					
organic destruction - decanted orgs	31.95	31.95	31.95	31.95	31.95
polymer stabilization	137.75	125.86	137.75	137.75	137.75
polymer stabilization - concentrate	6.67	21.26	5.22	5.22	5.22
APC	9.40	13.76	9.33	9.54	9.47
Total Subsystem Output	1967.57	1661.60	1936.26	1936.57	1978.91
Process Residue and Inorganic Sludge Treatment Subsystem					
Process Outputs					
Output to other subsystems					
polymer stabilization	953.87		953.87	953.87	953.91
organic destruction	22.62		22.62	22.62	22.57
aqueous waste treatment	336.57		336.57	336.57	349.57
APC	79.87		79.87	79.87	79.87
grout stabilization					
Hg amalgamation					0.15
Total Subsystem Output	1392.93		1392.93	1392.93	1406.08
Debris Treatment Subsystem					
Process Outputs					
metal	148.89	148.89			
Output to other subsystems					
aqueous waste treatment	406.89	406.89	406.89	406.89	406.89
APC	781.80	781.80	781.80	781.80	781.80
Hg amalgamation	1.30	1.30			
vitrification	209.46	209.46			
polymer stabilization			182.24	182.24	
output from Hg retort to vit/poly	27.22	27.22			
output from HP wash to vit/poly	82.82	82.82	82.82	82.82	82.82
output from CWO to vit/poly	99.42	99.42	99.42	99.42	
output from vac. to poly					
output from CWO to grout					99.42
Total Subsystem Output	1548.33	1548.34	1370.92	1370.92	1370.92

Table 3-5. (continued) ASPEN Mass Balance Data

SUBSYSTEM	System 1 Vitrification	System 2 Vitrification	System 3 Polymer	System 4 Claytec	System 5 INTS
Vitrification / Grout Subsystem					
Process Outputs					
vitrified product	735.72	1585.64			
grouted product					1937.83
Output to other subsystems					
APC	74.24	445.08			
Total Subsystem Output	809.96	2030.71			1937.83
Metal Decontamination Subsystem					
Process Outputs					
decontaminated metal	430.26	430.26	430.26	430.26	430.26
Output to other subsystems					
aqueous waste treatment	126.18	126.18	126.18	126.18	126.18
Total Subsystem Output	556.44	556.44	556.44	556.44	556.44
Organic Destruction Subsystem					
Process Outputs					
Output to other subsystems					
aqueous waste treatment - water	386.73	353.43	386.73	386.73	386.15
APC - gases	561.75	490.71	561.75	561.75	561.64
polymer stabilization	23.04	22.44	23.04	23.04	23.03
Total Subsystem Output	971.52	866.58	971.52	971.52	970.82
Lead Recovery Subsystem					
Process Outputs					
lead out	25.99	25.99	25.99	25.99	21.00
Output to other subsystems					
process residue/inorganic sludge					13.00
grout - gloves					4.99
Total Subsystem Output	25.99	25.99	25.99	25.99	38.99
Polymer Stabilization Subsystem					
Process Outputs					
polymer or clay stabilized waste	1724.41	349.35	3071.34	4146.30	1722.02
Output to other subsystems					
aqueous waste treatment	265.73		235.97	235.97	265.50
Total Subsystem Output	1990.14	349.35	3307.31	4382.27	1987.53
Bulk Soil Treatment Subsystem					
Process Outputs					
Output to other subsystems					
APC					
aqueous waste treatment	355.35	355.35	355.35	355.35	355.35
vitrification	285.51	285.51			
grout					285.51
polymer / clay stabilization			285.51	285.51	
organic destruction	16.14	16.14	16.14	16.14	16.14
Total Subsystem Output	657.00	657.00	657.00	657.00	657.00
Special Waste Treatment Subsystem					
Process Outputs					
Output to other subsystems	154.90	154.90	154.90	154.90	154.90
Total Subsystem Output	154.90	154.90	154.90	154.90	154.90

Reagents Input to Process (density, lb/ft3)					
Cu for Hg amalgamation (557)					
NaOH (133)	94.24	94.10	93.45	93.45	93.44
acid solution (FeCl3, H2O, HCl) (~62)	24.50	23.68	24.50	24.50	24.50
NH3 (45)					
HNO3 (94)					
H2O2 (91)	0.63	0.62	0.62	0.66	0.64
grout material (126)					904.32
water required for grout (62)					383.37
fluxing material (126)	315.00	528.55			
polyethylene/clay (~80)	862.21	174.71	1535.67	1535.67	861.01
vitrification fluxing agent (soil) (67)	315.00	528.55			

Table 3-5. (continued) ASPEN Mass Balance Data

SUBSYSTEM	System 1 Vitrification	System 2 Vitrification	System 3 Polymer	System 4 Claytec	System 5 INTS
Densities (lb/ft³)					
Input Waste	64.00	64.00	64.00	64.00	64.00
Soil	67.00	67.00	67.00	67.00	67.00
Metal (Input)	480.00	480.00	480.00	480.00	480.00
Metal (Output)	480.00	480.00	480.00	480.00	480.00
Aqueous Liquid	62.00	62.00	62.00	62.00	62.00
Slag, Vitrified Debris	187.00	187.00	187.00	187.00	187.00
Polymerized Salt	80.00	80.00	80.00	80.00	80.00
Polymerized Ash/Metal/Salt	94.00	94.00	94.00	94.00	94.00
Polymerized Lime	96.50	96.50	96.50	96.50	96.50
Grouted Debris	126.60	126.60	126.60	126.60	126.60
Stabilized Hg Amalgam	732.96	732.96	732.96	732.96	732.96
Mass Flow Rate Calculation					
Mass Solids In (lb/hr, no aqueous)	2865.78	2865.78	2865.78	2865.78	2865.78
Mass Vitrified Waste Out (lb/hr)	735.72	1585.64			
Mass Grouted Waste Out (lb/hr)					1937.83
Mass Special Waste (not stabilized)	154.90	154.90	154.90	154.90	154.90
Mass Metal & Pb Out (lb/hr) clean	605.14	605.14	456.25	456.25	451.26
Mass Polymerized Waste Out (lb/hr)	1724.41	349.35	3071.34	4146.30	1722.02
Mass Stabilized Hg Amalgam Out	6.71	6.46	4.50	4.50	4.50
Total Mass Processed Wastes Out (lb/hr, no metals)	2621.75	2096.35	3230.74	4305.71	3819.26
Waste Mass Reduction Ratio (In/Out)	1.09	1.37	0.89	0.67	0.75
Volumetric Flow Rate Calculation					
Volume Solids In (ft ³ /hr)	44.78	44.78	44.78	44.78	44.78
Volume Vitrified Waste Out (ft ³ /hr)	3.93	8.48			
Volume Grouted Waste Out (ft ³ /hr)					15.31
Volume Special Wastes (not stabilized) (ft ³ /hr)	2.42	2.42	2.42	2.42	2.42
Volume Metal/Pb Out (ft ³ /hr)	1.26	1.26	0.95	0.95	0.94
Volume Polymerized Waste Out (ft ³ /hr)	18.34	3.72	32.67	44.11	18.32
Vol Stabilized Hg Amalgam Out	0.01	0.01	0.01	0.01	0.01
Total Volume Solids Out to Disposal (ft ³ /hr, no metals)	24.71	14.62	35.10	46.54	36.05
Volume Metal to Recycle (ft ³ /hr)	1.26	1.26	0.95	0.95	0.94
Waste Volume Reduction Ratio (In/Out)	1.81	3.06	1.28	0.96	1.24
Total Water Requirements					
Aqueous Waste Treatment					8.97
Inorganic Sludge Washing / Hg Leaching					306.00
Lead Recovery					13.00
Debris Treatment	42.94	42.94	42.94	42.94	42.94
Metal Decontamination	94.33	94.33	94.33	94.33	94.33
Organic Destruction	50.67	50.18	50.67	50.67	50.67
Soil Washing	328.50	328.50	328.50	328.50	328.50
Air Pollution Control - scrubber water	3.66	11.68	2.87	2.87	2.86
Water for grout (30 weight %)					383.37
Total	520.10	527.63	519.31	519.31	1230.64
Total Water Available for Recycle	1781.80	1468.78	1752.01	1752.11	1794.53
Net Water Generation Rate (recycle - required)	1261.70	941.15	1232.70	1232.80	563.89

Figure 3-1. General mass flow rates (lb/hr) for system ENTS-1: Catalytic Wet Oxidation, Desorption and Vitrification.

Figure 3-2. General mass flow rates (lb/hr) for system ENTS-2: Catalytic Wet Oxidation and Vitrification for Process Residues.

Figure 3-3. General mass flow rates (lb/hr) for system ENTS-3: Catalytic Wet Oxidation and Polymer Stabilization.

Figure 3-4. General mass flow rates (lb/hr) for system ENTS-4: Catalytic Wet Oxidation, Desorption, Compaction and Polymer Stabilization.

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Figure 3-5. General mass flow rates (lb/hr) for system ENTS-5 : Catalytic Wet Oxidation with Increased Reaction Rates.

4. TOTAL LIFE CYCLE COST ESTIMATES

This section contains a summary of planning level Total Life Cycle Costs (TLCC) estimates for the five ENTS systems. In this report TLCC estimates are expressed as either "with disposal" or "without disposal".

4.1 Estimating Methods, Basis, and Assumptions

Estimating methodology and assumptions previously documented in the ITTS and INTS were used to develop the ENTS TLCC estimates. Cost estimates are presented at the end of this section.

Treatment systems reviewed in ENTS are sized at the nominal capacity of 2,927 lb/hr used in the ITTS and INTS studies to allow direct comparison. It is assumed that the facility will process both alpha and nonalpha MLLW. The sizing of the ENTS systems will permit treatment of the stored alpha and nonalpha MLLW for a 20-year period.

4.2 Treatment Facility TLCC (with Disposal) Estimate Summaries

Similar to previous ITTS and INTS studies, the TLCC estimate for each facility is divided into seven component Work Breakdown Structure (WBS) elements and disposal categories. These are:

- Studies and Bench Scale Tests and Demonstration
- Demonstration Costs
- Facility Capital Costs
- Preconstruction and Preoperational Activities
- Operations and Maintenance
- Decontamination and Decommissioning
- Disposal Cost Summaries

For information on the scope of these WBS elements and cost estimating methods, the reader is referred to previously published INTS (Biagi, 1997) and ITTS (Feizollahi, 1995) study reports.

4.3 TLCC Estimates (without Disposal) for ENTS-1, ENTS-2, ENTS-3 and ENTS-4

TLCC estimates (without disposal) were developed and prepared using the same methodology used to develop the cost estimate for INTS-5 and are documented in Tables 4-1 through 4-4.

4.4 TLCC (without Disposal) Estimates for ENTS-5

The TLCC estimate for ENTS-5 includes the same WBS elements listed in Section 4.2 above. Table 4-5 presents the TLCC without disposal. The methodology used to estimate effects of increased reaction rates on TLCC are listed below.

4.4.1 Reaction Rate Calculations

ENTS-5 is designed to show the effect of a ten-fold increase in reaction rate in the CWO process. Experimental reaction rate data for a variety of organic compounds was provided by the vendor (Dhooge, 1996). Table 4-11 lists the compounds, the reaction rates and the waste by category sent to the CWO process. The reaction rates are assigned to INTS waste stream categories. Two weighted average reaction rates are calculated: one for the oxidation of organic liquids and the other for soft debris. The average reaction rates are 1.6 lbs/gal-hr for organic liquids, and 0.86 lbs/gal-hr for soft debris. These rates were then multiplied by ten for this system.

4.4.2 Equipment Requirements

At ten times the reaction rate of the INTS system 5 CWO reactor, a much smaller CWO vessel is required for processing. The size of a reactor which would be able to treat both organic liquids and soft debris was calculated. The minimum reactor volume is approximately 200 gallons. However, the reactor size could be optimized to treat a single day's waste in a single shift. This would require a reactor volume of between 600 and 900 gallons. A one shift operation would provide labor and operations efficiencies, although a larger APC would be needed to treat the offgas. A 1000 gallon reactor, sized for organic liquids in INTS-5, would be able to accommodate both liquids and soft debris with this higher reaction rate with a single shift per day operation.

The soft debris and organic destruction subsystems were combined, since a single reactor and peripherals is adequate for both. Material handling, a major cost for all processes, would require additional equipment in the single subsystem. Also, the feeding system to the reactor would need to be adapted for a faster feed rate, and for both liquid and soft debris feeds. The capacity of feed preparation, filtration and neutralization equipment would be increased for single shift operation and to accommodate the waste volume of both liquids and soft debris. Costs for these items were increased from the System NT-5 baseline using the following equation (Peters and Timmerhaus, 1968):

$$C_2 = C_1 (Q_2 / Q_1)^n$$

Cost at capacity 2 (C_2) equals cost at capacity 1 (C_1) times the ratio of equipment capacities (Q_2 / Q_1) taken to an exponent n . The capacity of the ENTS-5 CWO subsystem is the hourly capacity of both soft debris and organic destruction multiplied by 3, because the treatment occurs in one-third the time. The cost exponent (n) is less than one, because equipment costs increase slower than capacity. For ITTS and INTS, exponents of 0.6 and 0.7 were employed respectively. The 0.7 exponent, which has been commonly used in these studies, was used in this analysis. Vendor information provided for costing the INTS organic destruction and soft debris subsystems indicated an exponent somewhat higher than 0.7.

Cost for the reactor system using this factor also increased. Although the reactor itself would not be larger, the peripheral handling equipment would be designed to accommodate the larger mass flow rate. The equipment cost increase for a tenfold increase in reaction rate cannot be definitively predicted. A faster reaction rate will require well developed process controls. The reactor cost is increased to include either equipment or supplies (e.g. catalyst) needed to increase the reaction rate. The exact equipment needed to increase the reaction rate cannot be determined, because it is not known what kind of devices would be necessary. Therefore, the estimating method using the above capacity equation was selected.

The APC subsystem would also see an increase in capacity. These equipment costs were scaled using the combined capacity of the one shift CWO subsystem, compared to a three shift operation.

4.4.3 Labor Requirements

The time and motion study presented in a separate report (Biagi, 1997) provided data on the labor requirements for the CWO subsystems. As part of this study, the labor for the improved reaction rate case was developed. The major cost of labor in both cases is related to material handling. For the increased reaction rate analysis, full time equivalent employees (FTEs) were calculated for material handling and process control. Less than four FTEs per day were required for process monitoring. Over eleven FTEs per day were necessary for material handling (15 FTEs total). The labor for ENTS-5 for this one shift operation is significantly reduced compared with NT-5 (26 FTEs for CWO combined soft debris and organic destruction subsystems).

4.4.4 Building Requirements

The building space for the soft debris subsystem was deleted. An additional 900 square feet for soft debris handling equipment was added to the building space for the combined CWO subsystem. The reduced building size provides reductions in both facility capital costs and decontamination and decommissioning costs.

4.4.5 Results of the ENTS-5 Cost Analysis

The costs for ENTS System 5 are presented in Table 4-5. The life cycle cost for a system with an order of magnitude increase in CWO reaction rates is one percent less than the INTS System 5 cost. Savings in operating labor, building and decontamination and decommissioning are offset by increases in equipment cost and maintenance labor. Research and development costs were kept the same as for INTS System 5, although additional research and development could be expected to result in the equipment and/or process by which the reaction rate would be increased.

The cost differential between NT-5 and ENTS-5 is sensitive to the equipment costs. Maintenance equipment and labor are a function of equipment costs. As in INTS, annual maintenance equipment costs are calculated at 10 percent of the total equipment cost and annual maintenance labor is 250 percent of the maintenance equipment cost. Thus, annual costs of 35 percent of the equipment costs are incurred. Over 20 years, a \$100 increase in equipment will be accompanied by a \$700 increase in maintenance and operations. Every dollar of increase in capital cost increases eightfold over the lifetime. This is why the increases in maintenance labor and equipment for ENTS-5 organic destruction subsystem more than offset the decrease in operating labor.

Because of the equipment costs effect on the subsystem costs, two sensitivity analyses were performed:

- (1) the cost exponent at 0.6 instead of 0.7
- (2) the capacity of the subsystem for a three shift operation, instead of a one shift operation

The results of the first analysis are as follows:

- a 0.7 exponent in the above capacity equation yields a decrease of TLCC relative to NT-5 of 1 percent
- a 0.6 exponent yields a decrease of TLCC relative to NT-5 of 2 percent

The results of the second analysis show the following:

- processing all the waste in a single shift provides a 1 percent decrease of TLCC relative to NT-5
- processing all the waste in a three shifts provides a 3 percent decrease of TLCC relative to NT-5

These analyses indicate that the effect of CWO reaction rates on life cycle cost is slight, if any. Decreases in the TLCC without disposal of between one and three percent over the life time of the facility are not significant. This result is not unexpected since CWO processes less than 25 percent of the waste. Adjustments to CWO costs will have little effect on the cost of processing the majority of the waste. CWO processing costs are driven by material handling which is little changed by adjusting reaction rates. Waste treated by CWO must first be received, inspected and sorted. Following CWO, the residuals will be stabilized, packaged and shipped. These costs are not affected by rate increases.

4.5 Additional TLCC Information

TLCC estimates with disposal are shown in Table 4-6. Unit costs are also presented on these tables. System ENTS-2 (CWO and vitrification), with the lowest volume of waste to disposal, has the lowest cost. System ENTS-4 (CWO and polymer stabilization) has the highest cost. Table 4-7 compares the TLCC with disposal by WBS element for the five ENTS systems. Operating and maintenance costs and disposal costs are the most significant discriminators between the systems.

Table 4-8 presents the normalized TLCC (without disposal) comparison, using INTS System NT-5 as the baseline. System ENTS-2 has the lowest costs. Table 4-9 presents the TLCC without disposal by subsystem. Table 4-10 presents the operating FTE Estimates for the ENTS systems and for NT-5.

Table 4-1. TLCC (without Disposal) Estimate for ENTS-1 (in millions of dollars).

Work Breakdown Structure Total System Cost		CWO ENTS - 1 (\$ 000,000)
1.0	Studies and bench scale test costs	
1.1	Manpower costs during research	\$30.3
1.2	Equipment costs	\$3.2
1.3	Installation costs	\$1.2
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$3.5
1.5	Contingency (25 % of 1.1 through 1.4)	\$9.5
	Subtotal 1.0	\$47.7
2.0	Demonstration costs	
2.1	Manpower costs during demonstration	\$28.5
2.2	Design cost (30 % of 2.5)	\$11.5
2.3	Inspection cost (7 % of 2.5)	\$2.7
2.4	Project management (10 % of 2.5)	\$3.8
2.5	Construction cost	
2.5.1	Building structure costs	\$5.3
2.5.2	Equipment costs	\$24.5
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$8.6
	Subtotal of 2.5	\$38.4
2.6	Construction management costs (17.1 % of 2.5)	\$6.6
2.7	Management Reserve (10 % of 2.5)	\$3.8
2.8	Contingency (25 % of 2.1 through 2.7)	\$23.9
	Subtotal 2.0	\$119.3
3.0	Production facility construction costs	
3.1	Design cost (25 % of 3.4)	\$95.1
3.2	Inspection cost (7 % of 3.4)	\$26.6
3.3	Project management (10 % of 3.4)	\$38.0
3.4	Construction cost	
3.4.1	Building structure costs	\$161.1
3.4.2	Equipment costs	\$133.8
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$85.5
	Subtotal of 3.4	\$380.4
3.5	Construction management (17.1 % of 3.4)	\$65.0
3.6	Management Reserve (10 % of 3.4)	\$38.0
3.7	Contingency (25 % of 3.1 through 3.5)	\$151.3
	Subtotal 3.0	\$794.5
4.0	Operations Budget Funded Activities (See Sect. 7)	
4.1	Conceptual design (1.5 % of 3.0)	\$11.9
4.2	Safety assurance (1 % of 3.0)	\$7.9
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7.0
4.4	Preparation for operations (100 % of 5.0)	\$106.7
4.5	Project Management (10 % of 4.1 through 4.4)	\$13.4
	Subtotal 4.0	\$146.9
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$1,108.4
5.0	Operating and maintenance costs	
5.1	Annual operating costs	\$56.6
5.2	Annual utility costs	\$1.9
5.3	Annual material costs	\$6.6
5.4	Annual maintenance costs	\$20.1
5.5	Contingency (25 % of 5.1 through 5.4)	\$21.3
	Subtotal 5.0	\$106.7
	5.7 Total 20 year O & M cost (20 times Subtotal 5.0)	\$2,133.5
6.0	Decontamination & Decommissioning	\$84.2
7.0	ROM Life cycle costs (20 years operation)	\$3,326.0

Table 4-2. TLCC (without Disposal) Estimate for ENTS-2 (in millions of dollars).

Work Breakdown Structure Total System Cost		ENTS - 2 (\$ 000,000)
1.0	Studies and bench scale test costs	
1.1	Manpower costs during research	\$26.6
1.2	Equipment costs	\$2.7
1.3	Installation costs	\$1.0
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$3.0
1.5	Contingency (25 % of 1.1 through 1.4)	\$8.3
	Subtotal 1.0	\$41.6
2.0	Demonstration costs	
2.1	Manpower costs during demonstration	\$24.0
2.2	Design cost (30 % of 2.5)	\$10.6
2.3	Inspection cost (7 % of 2.5)	\$2.5
2.4	Project management (10 % of 2.5)	\$3.5
2.5	Construction cost	
2.5.1	Building structure costs	\$4.8
2.5.2	Equipment costs	\$22.5
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$7.9
	Subtotal of 2.5	\$35.2
2.6	Construction management costs (17.1 % of 2.5)	\$6.0
2.7	Management Reserve (10 % of 2.5)	\$3.5
2.8	Contingency (25 % of 2.1 through 2.7)	\$21.3
	Subtotal 2.0	\$106.6
3.0	Production facility construction costs	
3.1	Design cost (25 % of 3.4)	\$91.2
3.2	Inspection cost (7 % of 3.4)	\$25.5
3.3	Project management (10 % of 3.4)	\$36.5
3.4	Construction cost	
3.4.1	Building structure costs	\$153.5
3.4.2	Equipment costs	\$129.3
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$82.0
	Subtotal of 3.4	\$364.8
3.5	Construction management (17.1 % of 3.4)	\$62.4
3.6	Management Reserve (10 % of 3.4)	\$36.5
3.7	Contingency (25 % of 3.1 through 3.5)	\$145.1
	Subtotal 3.0	\$761.9
4.0	Operations Budget Funded Activities (See Sect. 7)	
4.1	Conceptual design (1.5 % of 3.0)	\$11.4
4.2	Safety assurance (1 % of 3.0)	\$7.6
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7.0
4.4	Preparation for operations (100 % of 5.0)	\$93.9
4.5	Project Management (10 % of 4.1 through 4.4)	\$12.0
	Subtotal 4.0	\$131.9
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$1,042.2
5.0	Operating and maintenance costs	
5.1	Annual operating costs	\$47.5
5.2	Annual utility costs	\$2.0
5.3	Annual material costs	\$6.5
5.4	Annual maintenance costs	\$19.2
5.5	Contingency (25 % of 5.1 through 5.4)	\$18.8
5.6	Subtotal 5.0	\$93.9
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$1,878.0
6.0	Decontamination & Decommissioning	\$81.3
7.0	ROM Life cycle costs (20 years operation)	\$3,001.4

Table 4-3. TLCC (without Disposal) Estimate for ENTS-3 (in millions of dollars).

Work Breakdown Structure Total System Cost		ENTS - 3 (\$ 000,000)
1.0	Studies and bench scale test costs	
1.1	Manpower costs during research	\$28.2
1.2	Equipment costs	\$2.9
1.3	Installation costs	\$1.1
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$3.2
1.5	Contingency (25 % of 1.1 through 1.4)	\$8.9
	Subtotal 1.0	\$44.3
2.0	Demonstration costs	
2.1	Manpower costs during demonstration	\$26.3
2.2	Design cost (30 % of 2.5)	\$11.0
2.3	Inspection cost (7 % of 2.5)	\$2.6
2.4	Project management (10 % of 2.5)	\$3.7
2.5	Construction cost	
2.5.1	Building structure costs	\$4.9
2.5.2	Equipment costs	\$23.5
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$8.2
	Subtotal of 2.5	\$36.6
2.6	Construction management costs (17.1 % of 2.5)	\$6.3
2.7	Management Reserve (10 % of 2.5)	\$3.7
2.8	Contingency (25 % of 2.1 through 2.7)	\$22.5
	Subtotal 2.0	\$112.5
3.0	Production facility construction costs	
3.1	Design cost (25 % of 3.4)	\$79.0
3.2	Inspection cost (7 % of 3.4)	\$22.1
3.3	Project management (10 % of 3.4)	\$31.6
3.4	Construction cost	
3.4.1	Building structure costs	\$141.8
3.4.2	Equipment costs	\$103.1
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$71.0
	Subtotal of 3.4	\$315.8
3.5	Construction management (17.1 % of 3.4)	\$54.0
3.6	Management Reserve (10 % of 3.4)	\$31.6
3.7	Contingency (25 % of 3.1 through 3.5)	\$125.6
	Subtotal 3.0	\$659.7
4.0	Operations Budget Funded Activities (See Sect. 7)	
4.1	Conceptual design (1.5 % of 3.0)	\$9.9
4.2	Safety assurance (1 % of 3.0)	\$6.6
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7.0
4.4	Preparation for operations (100 % of 5.0)	\$105.4
4.5	Project Management (10 % of 4.1 through 4.4)	\$12.9
	Subtotal 4.0	\$141.8
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$958.3
5.0	Operating and maintenance costs	
5.1	Annual operating costs	\$58.1
5.2	Annual utility costs	\$1.9
5.3	Annual material costs	\$7.4
5.4	Annual maintenance costs	\$16.9
5.5	Contingency (25 % of 5.1 through 5.4)	\$21.1
5.6	Subtotal 5.0	\$105.4
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$2,108.3
6.0	Decontamination & Decommissioning	\$77.6
7.0	ROM Life cycle costs (20 years operation)	\$3,144.2

Table 4-4. TLCC (without Disposal) Estimate for ENTS-4 (in millions of dollars).

Work Breakdown Structure Total System Cost		ENTS - 4 (\$ 000,000)
1.0	Studies and bench scale test costs	
1.1	Manpower costs during research	\$28.2
1.2	Equipment costs	\$2.9
1.3	Installation costs	\$1.1
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$3.2
1.5	Contingency (25 % of 1.1 through 1.4)	\$8.9
	Subtotal 1.0	\$44.3
2.0	Demonstration costs	
2.1	Manpower costs during demonstration	\$26.3
2.2	Design cost (30 % of 2.5)	\$11.0
2.3	Inspection cost (7 % of 2.5)	\$2.6
2.4	Project management (10 % of 2.5)	\$3.7
2.5	Construction cost	
2.5.1	Building structure costs	\$4.9
2.5.2	Equipment costs	\$23.5
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$8.2
	Subtotal of 2.5	\$36.6
2.6	Construction management costs (17.1 % of 2.5)	\$6.3
2.7	Management Reserve (10 % of 2.5)	\$3.7
2.8	Contingency (25 % of 2.1 through 2.7)	\$22.5
	Subtotal 2.0	\$112.5
3.0	Production facility construction costs	
3.1	Design cost (25 % of 3.4)	\$80.0
3.2	Inspection cost (7 % of 3.4)	\$22.4
3.3	Project management (10 % of 3.4)	\$32.0
3.4	Construction cost	
3.4.1	Building structure costs	\$141.8
3.4.2	Equipment costs	\$106.4
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$72.0
	Subtotal of 3.4	\$320.1
3.5	Construction management (17.1 % of 3.4)	\$54.7
3.6	Management Reserve (10 % of 3.4)	\$32.0
3.7	Contingency (25 % of 3.1 through 3.5)	\$127.3
	Subtotal 3.0	\$668.6
4.0	Operations Budget Funded Activities (See Sect. 7)	
4.1	Conceptual design (1.5 % of 3.0)	\$10.0
4.2	Safety assurance (1 % of 3.0)	\$6.7
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7.0
4.4	Preparation for operations (100 % of 5.0)	\$122.5
4.5	Project Management (10 % of 4.1 through 4.4)	\$14.6
	Subtotal 4.0	\$160.9
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$986.3
5.0	Operating and maintenance costs	
5.1	Annual operating costs	\$68.7
5.2	Annual utility costs	\$2.0
5.3	Annual material costs	\$10.1
5.4	Annual maintenance costs	\$17.2
5.5	Contingency (25 % of 5.1 through 5.4)	\$24.5
5.6	Subtotal 5.0	\$122.5
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$2,450.3
6.0	Decontamination & Decommissioning	\$77.6
7.0	ROM Life cycle costs (20 years operation)	\$3,514.1

Table 4-5. TLCC (without Disposal) Estimate for ENTS-5 (in millions of dollars).

Work Breakdown Structure Total System Cost		ENTS 5 (\$ 000,000)
1.0	Studies and bench scale test costs	
1.1	Manpower costs during research	\$30.3
1.2	Equipment costs	\$3.2
1.3	Installation costs	\$1.2
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$3.5
1.5	Contingency (25 % of 1.1 through 1.4)	\$9.5
	Subtotal 1.0	\$47.7
2.0	Demonstration costs	
2.1	Manpower costs during demonstration	\$28.5
2.2	Design cost (30 % of 2.5)	\$11.5
2.3	Inspection cost (7 % of 2.5)	\$2.7
2.4	Project management (10 % of 2.5)	\$3.8
2.5	Construction cost	
2.5.1	Building structure costs	\$5.3
2.5.2	Equipment costs	\$24.5
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$8.6
	Subtotal of 2.5	\$38.4
2.6	Construction management costs (17.1 % of 2.5)	\$6.6
2.7	Management Reserve (10 % of 2.5)	\$3.8
2.8	Contingency (25 % of 2.1 through 2.7)	\$23.9
	Subtotal 2.0	\$119.3
3.0	Production facility construction costs	
3.1	Design cost (25 % of 3.4)	\$80.7
3.2	Inspection cost (7 % of 3.4)	\$22.6
3.3	Project management (10 % of 3.4)	\$32.3
3.4	Construction cost	
3.4.1	Building structure costs	\$136.2
3.4.2	Equipment costs	\$114.2
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$72.6
	Subtotal of 3.4	\$323.0
3.5	Construction management (17.1 % of 3.4)	\$55.2
3.6	Management Reserve (10 % of 3.4)	\$32.3
3.7	Contingency (25 % of 3.1 through 3.5)	\$128.5
	Subtotal 3.0	\$674.6
4.0	Operations Budget Funded Activities (See Sect. 7)	
4.1	Conceptual design (1.5 % of 3.0)	\$10.1
4.2	Safety assurance (1 % of 3.0)	\$6.7
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7.0
4.4	Preparation for operations (100 % of 5.0)	\$101.2
4.5	Project Management (10 % of 4.1 through 4.4)	\$12.5
	Subtotal 4.0	\$137.5
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$979.1
5.0	Operating and maintenance costs	
5.1	Annual operating costs	\$55.1
5.2	Annual utility costs	\$1.2
5.3	Annual material costs	\$6.1
5.4	Annual maintenance costs	\$18.6
5.5	Contingency (25 % of 5.1 through 5.4)	\$20.2
5.6	Subtotal 5.0	\$101.2
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$2,023.3
6.0	Decontamination & Decommissioning	\$75.6
7.0	Life cycle costs (20 years operation)	\$3,078.1

Table 4-6. ENTS TLCC Estimates with Disposal.

	units	ENTS System 1	ENTS System 2	ENTS System 3	ENTS System 4	ENTS System 5	INTS System 5
Treatment Cost	\$/lb	\$14.09	\$12.72	\$13.32	\$14.89	\$13.04	\$13.17
Output Volumetric Flow Rate	ft ³ /hr	24.7	14.6	35.1	46.5	36.0	36.04
Total treatment cost	millions of dollars	\$3,326	\$3,001	\$3,144	\$3,514	\$3,078	\$3,110
Final Waste Volume	ft ³	1,992,507	1,179,357	2,830,486	3,752,669	2,906,784	2,906,266
Disposal Cost	millions of dollars	\$484	\$287	\$688	\$912	\$706	\$706
Total Life Cycle Cost	millions of dollars	\$3,810	\$3,288	\$3,832	\$4,426	\$3,784	\$3,816
Total Life Cycle Unit Cost	\$/lb	\$16.14	\$13.93	\$16.23	\$18.75	\$16.03	\$16.17
Disposal Unit Cost	\$/lb	\$2.05	\$1.21	\$2.91	\$3.86	\$2.99	\$2.99

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Note: The treatment cost unit rate is calculated by dividing the treatment cost by the total waste input to the ENTS facility for 20 years of operation (236 million pounds).

Table 4-7. TLCC Comparisons of the five ENTS systems (in millions of dollars).

WBS Element Costs (a)	ENTS System 1	ENTS System 2	ENTS System 3	ENTS System 4	ENTS System 5	INTS System 5
TREATMENT						
Item 1.0, 2.0, and 4.0	\$314	\$280	\$299	\$318	\$305	\$306
Item 3.0	\$794	\$762	\$660	\$669	\$675	\$668
Item 5.0	\$2,133	\$1,878	\$2,108	\$2,450	\$2,023	\$2,058
Item 6.0	\$84	\$81	\$78	\$78	\$76	\$78
Total Treatment PLCC	\$3,326	\$3,001	\$3,144	\$3,514	\$3,078	\$3,110
DISPOSAL (b)						
Disposal PLCC	\$484	\$287	\$688	\$912	\$706	\$706
TOTAL TREATMENT & DISPOSAL PLCC	\$3,810	\$3,288	\$3,832	\$4,426	\$3,784	\$3,816

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(a) Work breakdown structure elements used in developing treatment PLCC are:

1 Studies and Bench Scale Tests	4 Operating Budget Funded Activities
2 Demonstration Costs	5 Operating & Maintenance Costs
3 Production Facility Construction Costs	6 Decontamination & Decommissioning Costs

(b) The disposal cost has been calculated using a unit disposal cost rate of \$243/ ft³.

Table 4-8. Normalized Lifecycle Cost Comparison of the Five ENTS system (normalized with respect to INTS System 5) (in millions of dollars).

		Actual Cost	Normalized Costs				
Cost Component		INTS System 5	ENTS 1	ENTS 2	ENTS 3	ENTS 4	ENTS 5
1.0	Studies and bench scale test costs	\$47.7	1.00	0.87	0.93	0.93	1.00
2.0	Demonstration costs	\$119.3	1.00	0.89	0.94	0.94	1.00
3.0	Production facility construction costs	\$667.8	1.19	1.14	0.99	1.00	1.01
4.0	Operations Budget Funded Activities	\$139.3	1.05	0.95	1.02	1.16	0.99
5.0	Operating and maintenance costs	\$2,058.1	1.04	0.91	1.02	1.19	0.98
6.0	Decontamination & Decommissioning	\$77.6	1.09	1.05	1.00	1.00	0.97
7.0	Planning life cycle costs (20 years operation)	\$3,109.7	1.07	0.97	1.01	1.13	0.99

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Notes:

1. INTS System 5 costs are taken as the normalizing cost basis.
2. Actual Costs are in millions of dollars.

Table 4-9. TLCC Comparison (without disposal) by Subsystem for the Five ENTS systems (in millions of dollars).

SUBSYSTEM	ENTS 1 (\$M)	ENTS 2 (\$M)	ENTS 3 (\$M)	ENTS 4 (\$M)	ENTS 5 (\$M)
Administration Building Subsystem	169.9	169.9	169.9	169.9	169.9
Receiving & Inspection Subsystem	940.5	940.5	940.5	940.5	940.5
Aqueous Waste Treatment Subsystem	149.7	149.7	149.7	149.7	149.7
Organic Destruction Subsystem	177.0	177.0	177.0	177.0	358.9
Residue & Sludge Treatment Subsystem	126.7	Treated by other subsystems	126.7	126.7	126.7
Soft Debris Treatment Subsystem	219.3	219.3	219.3	219.3	
Complex Debris Treatment Subsystem	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems
Open Debris Treatment Subsystem	98.5	98.5	98.5	98.5	98.5
Bulk Soil Treatment Subsystem	54.8	54.8	54.8	54.8	54.8
Metal Decontamination Subsystem	64.2	64.2	64.2	64.2	64.2
Special Waste	45.9	45.9	45.9	45.9	45.9
Mercury Amalgamation Subsystem	58.0	58.0	34.7	34.7	34.7
Lead Recovery Subsystem	89.0	89.0	41.1	41.1	41.1
Air Pollution Control Subsystem	70.4	70.4	70.4	70.4	76.0
Polymer Stabilization Subsystem	289.2	163.5	443.8	479.8	289.2
Vitrification	252.4	303.1			
Grout Stabilization Subsystem					120.1
Certification & Shipping Subsystem	346.4	223.5	423.9	757.8	423.9
Support Subsystem	83.8	83.8	83.8	83.8	83.8
Metal Melting Subsystem	90.4	90.4			
TOTAL	3,326.1	3,001.5	3,144.2	3,514.1	3,078.1

Table 4-10. Operating FTE Estimates for ENTS Systems.

SUBSYSTEM	ENTS 1	ENTS 2	ENTS 3	ENTS 4	ENTS 5	INTS 5
Administration Building Subsystem	32	32	32	32	32	32
Receiving & Inspection Subsystem	170	170	170	170	170	170
Aqueous Waste Treatment Subsystem	5	5	5	5	5	5
Organic Destruction Subsystem	12	12	12	12	15	12
Residue & Sludge Treatment Subsystem	8	0	8	8	8	8
Soft Debris Treatment Subsystem	14	14	14	14	0	14
Complex Debris Treatment Subsystem	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems	Treated by other subsystems
Open Debris Treatment Subsystem	8	8	8	8	8	8
Bulk Soil Treatment Subsystem	2	2	2	2	2	2
Metal Decontamination Subsystem	4	4	4	4	4	4
Special Waste	3	3	3	3	3	3
Mercury Amalgamation Subsystem	4	4	1	1	1	1
Lead Recovery Subsystem	8	8	3	3	3	3
Air Pollution Control Subsystem	4	4	4	4	4	4
Polymer Stabilization Subsystem	38	8	56	45	38	37.5
Vitrification	16	18				
Grout Stabilization Subsystem					8	8
Certification & Shipping Subsystem	67	37	88	175	88	88
Support Subsystem	5	5	5	5	5	5
Metal Melting Subsystem	5	5				
TOTAL	405	339	415	491	394	405

Table 4-11. Reaction Rates for CWO.

COMPOUND	DELPHI REACTION RATE AT 200° C kg/l-hr	EQUIVALENT INTS WASTE CATEGORY
VAPORS:		
Acetone	0.39	Nonhalogenated Organic Liquids
MEK	0.487	Nonhalogenated Organic Liquids
Hexane	0.585	Nonhalogenated Organic Liquids
TCE	0.885	Halogenated Organic Liquids
Chloroform	0.8025	Halogenated Organic Liquids
Methylene chloride	0.57	Halogenated Organic Liquids
Carbon tetrachloride	1.035	Halogenated Organic Liquids
1,1,1 TCA	0.9	Halogenated Organic Liquids
Methanol	0.3	Nonhalogenated Organic Liquids
LIQUIDS:		
oil	0.041	oil
Weighted Average Reaction Rate for Liquids and Vapors	0.191	
Reaction Rate at 10 times actual	1.91	
SOLIDS:		
paper	0.12	paper, cardboard
cotton	0.18	cloth
wood	0.16	wood
latex rubber	0.033	rubber
butyl rubber	0.0066	rubber
PVC	0.14	PVC
Polyethylene	0.0049	PE/PP
activated carbon	0.0009	graphite
ion exchange resin	0.0065	all other nonplastic
Weighted Average Rate for Solids	0.102	
Reaction Rate at 10 times actual	1.02	

Notes:

1. Rates based on Delphi Research, Inc data (Dhooge, 1996). Delphi representatives stated that a 7.5 times increase was appropriate to adjust the test data from 150 to 200° C. This adjustment is included in this table.
2. Weighted average rates were calculated by
 - a) calculating the percent distribution of each of the identified waste types in INTS organic liquids and soft debris
 - b) multiplying the percent distribution by the reaction rate for that waste
 - c) summing the product of the percent distribution by the reaction rate to get the total reaction rate.
3. To convert from kg/l-hr to lb/gal-hr, multiply by 8.38.

5. SYSTEM COMPARISON

This section summarizes the results for representative thermal systems evaluated in the ITTS study and nonthermal systems evaluated in the INTS study, and compares these results with the results for the enhanced nonthermal systems evaluated in this study.

The thermal systems compared include the following:

System A-1

- rotary kiln with air for combustion for organic destruction
- vitrification of ash
- polymer stabilization of secondary wastes
- decontamination of surface contaminated metals
- melting of metals with entrained contamination, and
- retorting of mercury contaminated waste

System C-1

- plasma furnace with air for combustion for organic destruction
- polymer stabilization of secondary wastes
- decontamination of surface contaminated metals
- melting of metals with entrained contamination, and
- retorting of mercury contaminated waste

System H-1

- steam reforming of combustible waste for organic destruction
- vitrification of ash and inorganic waste
- polymer stabilization of secondary wastes
- decontamination of surface contaminated metals
- melting of metals with entrained contamination, and
- retorting of mercury contaminated waste

The nonthermal systems compared include the following:

System NT-1

- mediated electrochemical oxidation for organic destruction
- thermal desorption of soil and process residue
- decontamination of surface contaminated metals
- polymer stabilization of treated sludge and secondary waste
- grout stabilization of treated soil and untreated debris
- amalgamation of mercury contaminated waste

System NT-2

- catalytic wet oxidation for organic destruction
- thermal desorption of soil, process residue and debris
- decontamination of surface contaminated metals
- polymer stabilization of treated sludge and secondary waste
- grout stabilization of treated soil and treated debris
- amalgamation of mercury contaminated waste

System NT-3

- mediated electrochemical oxidation for organic destruction
- washing of soil, process residue and debris
- decontamination of surface contaminated metals
- polymer stabilization of treated sludge and secondary waste
- grout stabilization of treated soil and treated debris
- amalgamation of mercury contaminated waste

System NT-4

- acid digestion for organic destruction of liquids and soft (combustible debris)
- thermal desorption of process residue
- washing of soil and debris
- decontamination of surface contaminated metals
- stabilization of treated waste in phosphate bonded ceramic
- stabilization of secondary waste in polymer or phosphate bonded ceramic
- amalgamation of mercury contaminated waste

System NT-5

- catalytic wet oxidation for organic destruction of liquids and soft (combustible debris)
- thermal desorption of process residue
- washing of soil and debris
- decontamination of surface contaminated metals
- polymer stabilization of treated sludge and secondary wastes
- primary stabilization of treated soil and treated debris in grout
- amalgamation of mercury contaminated waste

5.1 Feed Rates

The waste feed rates to the various subsystems for the systems being compared are shown in Table 5-1. The administration and receiving and preparation subsystems must handle the same amount of material (2927 lbs/hr) for all systems.

Aqueous waste treatment for INTS or ENTS systems treats approximately the same amount of wastewater, whereas ITTS systems treat 3 to 10 times more wastewater than INTS or ENTS systems. Most of the wastewater treated in thermal systems is scrubber liquor from the air pollution control subsystem. This

wastewater stream has few or no organic contaminants and is therefore evaporated rather than being passed through a complex treatment process. Thus, as will be seen later, the cost of the aqueous waste treatment subsystem for all systems is approximately the same.

The organic destruction subsystem for thermal systems treats most of the incoming waste (organic wastes, soil, sludge and all debris), whereas in nonthermal systems only organic material (organic liquid and organic sludge) is treated in the organic destruction process. In nonthermal systems soft (or combustible) debris is treated by stabilization (System NT-1), thermal desorption (System NT-2) or washing (System NT-3), followed by stabilization. In Systems NT-4 and NT-5 soft debris is destroyed using the same chemical reagents used to destroy organic liquids and sludges, but different reaction vessels are used. In the nonthermal systems only acid digestion and catalyzed wet oxidation (CWO) can treat all organic waste including soft debris. Noncombustible waste requires processes to separate organic contaminants from the inorganic matrix. The separated organics are then sent to the destruction process.

Metal debris with entrained contamination (complex debris) is melted in a metal melter in most thermal systems. However, in System C-1 the plasma furnace can accept this waste stream and separate the metal from the slag to form ingots. In nonthermal systems the EPA Debris Rule is invoked and metal items that fall into this category are macroencapsulated in grout or polymer. In hybrid systems ENTS-1 and ENTS-2 metal with entrained contamination is also melted into ingots.

The enhanced nonthermal systems are similar to System NT-5 in which CWO is used to treat organic waste and combustible debris. In all systems, except ENTS-5, organic waste and soft debris are treated in separate reaction vessels. In system ENTS-5 the assumed reaction rate is fast enough that a single reaction vessel of reasonable size (1,000 gallons) can be used to treat all organic material, including soft debris.

All enhanced nonthermal systems except System ENTS-2 require separation of organics from noncombustible waste in the same manner as the nonthermal systems. In ENTS-2 inorganic sludge (~34 percent of the incoming waste) is sent directly to a vitrifier which destroys the organic contaminants and vitrifies the sludge. However, in this case organics are still separated from soils and inorganic debris by being washed prior to vitrification of the inorganic waste streams. System H-1 is similar to ENTS-2 in that the steam reformer can treat only combustible material while all noncombustible material (except metals) is sent directly to the vitrifier.

Thermal systems (except System H-1 which requires a steam reformer and a vitrifier) can treat most of the waste in a single process. Nonthermal systems require separate processes for organic waste and soft debris, and require additional processes for inorganic waste streams to separate the organic contaminants from the inorganic matrix.

Enhanced nonthermal systems require separate processes for organic waste and soft debris unless the feed system, reactor size, and process controls can be designed such that all combustible waste can be treated in the same reaction vessel. Enhanced nonthermal systems also require separation of organics from inorganic waste matrices unless a vitrifier can be demonstrated to reliably treat organically contaminated soils, sludge and debris.

Because most thermal systems use excess air to oxidize combustible material, they have significantly more offgas requiring treatment in the air pollution control subsystem than do nonthermal or enhanced nonthermal systems. The offgas entering the APC subsystem for System H-1 is a combustible gas from the steam reformer. This gas is oxidized with excess air in a thermal oxidizer so that the total gaseous emissions from System H-1 are significantly higher than the input shown for the APC system.

5.2 Effluent

Effluent volumes for the thermal, nonthermal and enhanced nonthermal systems is shown in Table 5-2. The offgas emissions are shown in Figure 5-1. The offgas from nonthermal and enhanced nonthermal systems is about one-tenth to one-third the offgas from thermal systems. This is due to the need for excess air for combustion in the thermal systems where the major component of the offgas is nitrogen as shown in Table 5-3. The undefined portion of the offgas from thermal systems is the offgas from ancillary operations such as metal decontamination and should have essentially the same composition as the other sources.

In condensed phase (or liquid phase) organic destruction used in nonthermal systems, organics are converted to carbon dioxide and water without the additional air or oxygen for combustion. Thus, the primary component of the offgas from these systems is carbon dioxide. More CO₂ is produced in Systems NT-4 and NT-5 and the enhanced nonthermal systems, compared to NT-1, NT-2, and NT-3. This is because soft debris, in addition to organic liquid and sludge, is oxidized by acid digestion or CWO in these systems. The other nonthermal systems only oxidize organic liquid and sludge.

The enhanced nonthermal systems that use vitrification have slightly more offgas than do the other enhanced nonthermal or nonthermal systems. This is because excess air is used in the vitrifier's secondary combustion chamber to oxidize any organics volatilized in the vitrifier. System ENTS-2 has the most offgas because of the organics in the untreated sludge sent to the vitrifier. However, this offgas is still an order-of-magnitude less than the offgas from System A-1 and one-third the offgas from System C-1.

The wastewater discharged from the four enhanced nonthermal systems that use polymer or vitrification for stabilization is greater than NT-5 or ENTS-5 which use grout. This is because some wastewater is used in the grouting process and is tied up in the grout rather than discharged.

Hybrid systems ENTS-1 and ENTS-2 have about the same amount of clean metal going to recycling as do the thermal systems, whereas nonthermal systems have less metal to be recycled. This is because thermal and hybrid systems melt metals with entrained contamination and produce ingots that are assumed to be recycled within the DOE complex. Nonthermal systems macroencapsulate these metal debris items and dispose of them.

Systems that produce a vitrified final waste form have significantly less mass sent to disposal than systems that use a nonthermal stabilization material such as grout or polymer. Production of a glass/ceramic waste form in a vitrifier requires addition of one part glass former for every two parts waste. Polymer requires one part polymer to one part waste, while grout requires two parts grout material to one part waste. Thus, nonthermal stabilization requires significantly more stabilizing material to be added to the waste than does vitrification. Systems NT-4 and NT-5 have less final waste form mass than the other nonthermal systems because soft debris is destroyed instead of being stabilized.

System ENTS-1 has a greater amount of solids sent to disposal than thermal systems because in ENTS-1 treated inorganic sludge (or process residue) is stabilized in polymer. However, replacing grout in System NT-5 with vitrification produces less final waste form volume for disposal. System ENTS-2 has nearly the same amount of stabilized waste as do the thermal systems because most of the solid waste is vitrified in both cases. Replacing grout with polymer (ENTS-3) also slightly decreases the mass and volume of waste sent to disposal. System ENTS-4 has the highest final waste form volume because the sintering (or Claytec) process requires a one-to-one mixture of clay and waste followed by the addition of polymer at 35 percent of the waste plus clay on a mass basis.

5.3 Waste Sent to Disposal

The mass of the solid waste sent to disposal as a stabilized final waste form is shown in Table 5-4 and Table 5-5. Figure 5-2 presents the volume of solid waste sent to disposal. Replacing grout in NT-5 with vitrification as in ENTS-1 produces a decrease in the final waste form volume from 36.1 cu. ft to 24.7 cu. ft and thus reduces the disposal cost from \$707 million to \$484 million. System ENTS-2 extends the trend of volume reduction by the vitrification of untreated inorganic sludge. For System ENTS-2, the waste form volume is reduced to 14.6 cu. ft and the disposal cost to \$286 million. Stabilizing the waste in polymer only (ENTS-3) decreases the final waste form volume slightly from 36.1 cu. ft in NT-5 to 35.1 cu. ft.

System ENTS-4 has the most mass and volume sent to disposal because of the combined stabilization process. If the pellets produced by the Claytec process can be shown to pass the TCLP tests then macroencapsulation may not be required. In this case, the volume sent to disposal would be reduced from 46.5 cu. ft to 35.1 cu. ft, the same as ENTS-3 that uses polymer stabilization. This is because both the polymer and Claytec processes use a 1:1 ratio of stabilizing agent to waste and the same assumed density of the stabilized waste (94 lbs/cu. ft) for both cases. If the density of the pellets is greater than the density of the polymer stabilized waste, then the volume of disposed waste may be less, although the void fraction of containerized pellets would need to be considered in calculating the total volume.

Vitrified waste has a lower total mass than waste stabilized by nonthermal means. This is because fewer additives are required to produce the final waste form. Vitrified waste has a higher density than grout or polymer so the volume of waste is significantly less (by approximately a factor of three). Thus, hybrid systems, such as ENTS-2 in which all primary inorganic waste is vitrified, minimize both the offgas and the volume of waste sent to disposal. However, not all waste can be vitrified because there are some secondary waste salts that will either cause problems with the vitrifier or will volatilize and therefore cannot be contained in the glass. These secondary wastes will require a nonthermal stabilization such as polymer.

The volume reduction factor (volume in/volume out) is shown in Table 5-6 where the density of incoming waste is assumed to be 64 lbs/ft³. The percent of the volume of waste entering the facility that leaves the facility as a final waste form (output/input expressed as a percent) is presented in Table 5-6 and Figure 5-3. For systems that use nonthermal stabilization the volume of waste is reduced by 5 to 10 percent for those systems that do not destroy soft debris, and by 20 percent for those systems that do destroy soft debris (Systems NT-4 and NT-5).

The waste volume is reduced by 70 percent for thermal systems. The volume reduction for System ENTS-3 which uses polymer is also 20 percent, about the same as NT-5 which uses grout and polymer. There is a volume increase for System ENTS-4 which uses an enhanced hybrid final waste form. Volume reduction for System ENTS-2 is about the same as for thermal systems (~70 percent).

5.4 Resources Used

Table 5-7 illustrates the energy use for the systems being compared. The highest costs for electrical energy are associated with those systems that use electrical energy for organic destruction (plasma furnace), or to regenerate the oxidizer in the organic destruction process (mediated electrochemical oxidation in Systems NT-1 and NT-3).

Systems that vitrify treated waste use an intermediate amount of electrical energy. Systems that have the highest natural gas cost are those that use combustion for organic destruction (e.g., System A-1). In all cases, energy costs are less than one percent of the treatment costs (i.e., TLCC without disposal).

The reagent use by these systems is shown in Table 5-8. The enhanced nonthermal systems use approximately the same quantity of reagents as System NT-5 since the enhanced nonthermal systems use the same organic destruction process.

The major reagent used in all systems is sodium hydroxide. This is used for acid neutralization in nonthermal systems, and for scrubber water and acid gas neutralization in thermal systems.

Truck traffic to transport reagents to the treatment facility is minimal at 14 to 27 trucks per year as shown in Table 5-9. The major source of truck traffic is incoming waste, which is the same for all systems, and stabilizing agents. Systems that use vitrification have the least number of incoming trucks (340 to 350 trucks/year) and the least number of outgoing trucks taking vitrified waste to disposal and metals to storage (230 to 250 trucks/year). Systems that use nonthermal stabilization have more incoming traffic (450 to 520 trucks/year) to deliver stabilizing agent, and more outgoing traffic to dispose of the greater volume of stabilized waste.

The FTE requirements for these systems is shown in Table 5-10 for each subsystem. The major requirements are in the front-end handling subsystem to receive, characterize, sort and size reduce the incoming waste.

Nonthermal systems (including the enhanced nonthermal systems) require much more sorting than thermal systems so that the FTEs required for front-end handling are significantly greater. A large number of personnel are required in the certification and shipping subsystem for nonthermal systems because the volume of waste passing through this subsystem is greater for nonthermal than for thermal systems. The personnel required in certification and shipping for the enhanced nonthermal systems is also a function of the volume of stabilized waste passing through the subsystem. The personnel required for System ENTS-2 is approximately equal to the personnel required for thermal systems.

The personnel required for organic destruction in Systems NT-5 and ENTS-5 include personnel to treat organic liquid, sludge and soft debris. Because of the increased reaction rate in ENTS-5, these waste streams can be treated in one reaction vessel and in one shift, so fewer operating personnel are required for ENTS-5.

5.5 Life Cycle Cost Comparison

Life cycle costs are shown by work breakdown element in Table 5-11 and Figure 5-4. In all cases operating and maintenance (O&M) costs are 50 to 60 percent and capital costs are 15 to 25 percent of the TLCC. Disposal costs depend on the volume of the final waste form and range from about 10 percent of the TLCC for systems that use vitrification to 20 percent of the TLCC for systems that use nonthermal stabilization technologies.

Treatment costs (i.e., life cycle cost without disposal) for nonthermal systems and three of the enhanced nonthermal systems (ENTS-1, ENTS-3 and ENTS-4) are about \$1 billion more than for thermal systems. Treatment costs for System ENTS-1 is about \$1.2 billion and System ENTS-4 is about \$1.4 billion more than the thermal systems. These two ENTS systems require two stabilization processes. Their costs reflect the higher costs associated with vitrification and the Claytec processes, respectively.

The major driver for these higher treatment costs is the higher O&M costs associated with nonthermal and enhanced nonthermal systems due to more sorting and segregating of waste, higher volumes of waste passing through the certification and shipping subsystem, and more unit operations required to treat the waste.

Disposal costs for systems that use vitrification are a factor of 2.5 to 3.5 less than for systems that use nonthermal stabilization. Disposal costs for System ENTS-2 are about the same as for thermal systems and

considerably less than nonthermal systems. Disposal costs for System ENTS-1 are less than those for nonthermal systems, but higher than those for thermal systems since a significant portion of the waste (inorganic sludge at 34 percent of the incoming waste) is stabilized in polymer.

Life cycle costs broken down by subsystem are shown in Table 5-12. The major cost driver for all systems is the front-end handling subsystem at 20 to 30 percent of the TLCC. Stabilization costs are 12 to 15 percent of the TLCC for all systems, and metal recovery costs are higher for systems using metal melting. It costs \$90 million (Table 4-9) over 20 years to melt 149 lbs/hr of ferrous metal with entrained contamination and to produce ingots for possible recycling within the DOE complex. However, stabilization of the same internally contaminated metal in polymer produces 2.17 cubic feet per hour of stabilized waste that costs \$43 million for disposal.

Primary treatment costs are about the same for all nonthermal and enhanced nonthermal systems that destroy soft debris, but these costs are about three times the primary treatment costs of thermal systems due to the multiple subsystems required.

5.6 Conclusions

Several conclusions can be drawn from this comparison of systems. There is no economic incentive to use nonthermal or enhanced nonthermal systems in place of thermal systems in a centralized treatment facility. However, reduced offgas and low final waste form volumes may make hybrid systems attractive.

System ENTS-2 has one-third the offgas from the plasma furnace (System C-1) and one-tenth the offgas from the rotary kiln (System A-1), with approximately the same final waste form volume at a cost of \$1 billion more than these two thermal systems.

The costs for System ENTS-2 may be reduced by eliminating the washing process (\$153 million) and treating all inorganic waste in the vitrifier as in System H-1. This should also reduce the front-end handling costs somewhat, as less sorting will be required. However, a vitrification subsystem must be demonstrated to reliably and efficiently destroy the organic contaminants in these inorganic matrices.

The more waste that can be vitrified, the lower the final waste form volume, and, thus, the lower the disposal cost.

The use of polymer to stabilize all waste (ENTS-3) reduces the final waste form volume slightly from that produced by System NT-5 which uses grout and polymer. Although there is little cost incentive to use all polymer, a waste form with better performance characteristics than grout may be produced.

Using hybrid waste forms (pellets macroencapsulated in polymer as in ENTS-4) may have improved performance but at a cost of \$550 million more than System ENTS-3 which uses only polymer for stabilization. If the compressed and sintered pellets can pass TCLP without macroencapsulation, then the stabilization and disposal costs should decrease and be closer to those of System ENTS-3.

There is no cost incentive to perform R&D to increase the reaction rate of nonthermal organic destruction processes. Increasing the reaction rate will allow treatment of all organic wastes in a single subsystem and in a shorter period of time. This decreases the capital and operating cost for treatment. However, this savings is offset by the increase in maintenance costs associated with equipment and personnel required to handle the increased throughput, and the cost of equipment required to produce the increased reaction rate. An advantage of an increased reaction rate may be an increase in the destruction efficiency if the residence time were to be kept the same as the original residence time with the lower reaction rate (i.e., the throughput remains the same).

Nonthermal systems may be made more competitive with thermal systems by enhancing them through the use of vitrification for all inorganic wastes (except metals and secondary waste salts) and by eliminating the organic separation processes (thermal desorption and washing). This should reduce the capital costs and O&M costs required to operate and maintain this equipment. Sorting requirements, and therefore the front-end handling costs, should decrease. In addition, the final waste form volume and therefore certification and shipping costs and disposal costs should also decrease. Thus, the most competitive enhanced nonthermal system includes only one nonthermal process (destruction of organic waste, including combustible debris). Detailed evaluation of a hybrid system such as its comparison with selected thermal systems would quantify how competitive a hybrid system can become.

Table 5-1 Subsystem Waste Feed Rates (lbs/hr)

Subsystems ^a	Rotary Kiln/Air (A-1)	Plasma Furnace (C-1)	Steam Reforming (H-1)	Grout Debris (NT-1)	Thermal Desorption (NT-2)	Wash (NT-3)	Acid Digestion (NT-4)	Catalytic Wet Oxidation (NT-5)
Administration	2927	2927	2927	2927	2927	2927	2927	2927
Receiving and Preparation	2927	2927	2927	2927	2927	2927	2927	2927
Aqueous Waste Treatment	13658	6568	3266	1193	1258	1632	1983	1956
Organic Destruction	2000	2237	660	237	268	326	256	256
Process Residue	^b	^b	^c	1020	1020	1020	1020	1020
Bulk Soil Treatment	^b	^b	^c	329	329	329	329	329
Soft Debris Treatment	^b	^b	^b	^d	435	435	435	435
Open Debris Treatment	^b	^b	^c	^d	80	80	80	80
Complex Debris Treatment	^b	^b	^c	^d	177	177	^e	^e
Metal Decontamination	468	468	468	462	462	462	462	462
Mercury Amalgamation	50	50	50	2.6	2.6	2.5	2.6	2.6
Lead Recovery	21	21	21	26	26	26	26	26
Metal Melting	154	5	154	Not Used	Not Used	Not Used	Not Used	Not Used
Polymer Stabilization	123	123	123	1067	1110	1246	6.6	1126
Phosphate Bonded Ceramic	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	1592	Not Used
Claytec Process	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
Vitrification	1495	Not Used	1490	Not Used	Not Used	Not Used	Not Used	Not Used
Grout Stabilization	0.3	0.3	0.3	1082	1228	958	265	650
Air Pollution Control	21420	7339	957	695	823	827	1396	1433
Special Waste	153	153	153	155	155	155	155	155
Certification & Shipping	2551	2519	2549	5126	5067	4919	4115	4270

Notes:

^a Input to all systems includes only primary and secondary waste streams^b These waste streams are sent to organic destruction^c These waste streams are sent to vitrification.^d These waste streams are sent to grout stabilization^e Complex debris is treated by grout stabilization^f Soft debris is treated by organic destruction^g Complex debris is treated by polymer stabilization.^h Claytec and polymer macroencapsulation are used in ENTS-4.

Table 5-1 (continued) Subsystem Waste Feed Rates (lbs/hr)

Subsystems	Replace Grout with Vitrification (ENTS-1)	Vitrify Untreated Sludge (ENTS-2)	Polymer Stabilization (ENTS-3)	Pelletization with Polymer (ENTS-4)	Increased Reaction Rate (ENTS-5)
Administration	2927	2927	2927	2927	2927
Receiving and Preparation	2927	2927	2927	2927	2927
Aqueous Waste Treatment	1945	1653	1914	1914	1956
Organic Destruction	256	233	256	256	691
Process Residue	1007	^c	1007	1007	1020
Bulk Soil Treatment	329	329	329	329	329
Soft Debris Treatment	435	435	435	435	^e
Open Debris Treatment	80	80	80	80	80
Complex Debris Treatment	177	177	^g	^g	^e
Metal Decontamination	462	462	462	462	462
Mercury Amalgamation	3.9	3.8	2.6	2.6	2.6
Lead Recovery	21	21	26	26	26
Metal Melting	154	154	Not Used	Not Used	Not Used
Polymer Stabilization	1128	176	1772	^h	1126
Phosphate Bonded Ceramic	Not Used	Not Used	Not Used	Not Used	Not Used
Claytec Process	Not Used	Not Used	Not Used	1772	Not Used
Vitrification	495	1502	Not Used	Not Used	Not Used
Grout Stabilization	Not Used	Not Used	Not Used	Not Used	650
Air Pollution Control	1507	1731	1433	1433	1433
Special Waste	155	155	155	155	155
Certification & Shipping	3227	2701	3687	4762	4270

Notes:

^a Input to all systems includes only primary and secondary waste streams^b These waste streams are sent to organic destruction^c These waste streams are sent to vitrification.^d These waste streams are sent to grout stabilization^e Complex debris is treated by grout stabilization^f Soft debris is treated by organic destruction^g Complex debris is treated by polymer stabilization.^h Claytec and polymer macroencapsulation are used in ENTS-4.

Table 5-2 System Effluents (lbs/hr)

Effluent (lbs/hr)	Rotary Kiln /Air (A-1)	Plasma Furnace (C-1)	Steam Reforming (H-1)	Grout Debris (NT-1)	Thermal Desorption (NT-2)	Wash (NT-3)	Acid Digestion (NT-4)	Catalytic Wet Oxidation (NT-5)
Offgas	20697	6895	11648	696	823	827	1441	1433
Wastewater	399	463	-487	59	135	176	780	564
Clean Metal to Recycle	622	658	622	451	451	451	451	451
Clean Lead	24.5	24.5	24.5	21	21	21	21	21
Clean Metal	597	633	597	430	430	430	430	430
Solids to Disposal	1929	1861	1927	4675	4616	4468	3664	3819
Mercury Amalgam	10.5	10.5	10.5	4.5	8.8	4.3	4.5	4.5
Grout	0.9	0.9	0.9	2913	2764	2731	783	1938
Polymer	246	246	246	1602	1688	1578	13.2	1722
Ceramic	0	0	0	0	0	0	2708	0
Slag/Glass	1519	1451	1517	0	0	0	0	0
Special Waste	153	153	153	155	155	155	155	155
Total Effluent (excluding clean metal)	23025	9219	13088	5429	5574	5471	5885	5817

Table 5-2 (continued) System Effluents (lbs/hr)

Effluent (lbs/hr)	Replace Grout with Vitrification (ENTS-1)	Vitrify Untreated Sludge (ENTS-2)	Polymer Stabilization (ENTS-3)	Pelletization with Polymer (ENTS-4)	Increased Reaction Rate (ENTS-5)
Offgas	1701	2537	1433	1433	1433
Wastewater	1262	941	1233	1233	564
Clean Metal to Recycle	605	605	456	456	451
Clean Lead	26	26	26	26	21
Clean Metal	579	579	430	430	430
Solids to Disposal	2622	2096	3231	4306	3819
Mercury Amalgam	6.7	6.5	4.5	4.5	4.5
Grout	0	0	0	0	1938
Polymer	1724	349	3071	4146	1722
Ceramic	0	0	0	0	0
Slag/Glass	736	1586	0	0	0
Special Waste	155	155	155	155	155
Total Effluent (excluding clean metal)	5585	5574	5897	6972	5816

Table 5-3 Offgas Composition (lbs/hr)

Offgas Components (lbs/hr)	Rotary Kiln / Air (A-1)	Plasma Furnace (C-1)	Steam Reforming (H-1)	Grout Debris (NT-1)	Thermal Desorption (NT-2)	Wash (NT-3)	Acid Digestion (NT-4)	Catalytic Wet Oxidation (NT-5)
Oxygen	1625	1387	1489	29	36	55	10	31
Nitrogen	14730	2062	19523	118	165	19	132	84
Nitrogen Oxide	0	0	0	0.8	0.7	0.8	0.2	0.7
Water Vapor	1478	357	1923	10	2	15	11	4
Carbon Dioxide	2364	1569	3366	538	620	737	1288	1314
Undefined	497	497	133	0	0	0	0	0
Sulfur Dioxide	3	2	3	0	0	0	0	0
Total	20197	5375	26301	696	823	827	1441	1422

Offgas Components (lbs/hr)	Replace Grout with Vitrification (ENTS-1)	Vitrify Untreated Sludge (ENTS-2)	Polymer Stabilization (ENTS-3)	Pelletization with Polymer (ENTS-4)	Increased Reaction Rate (ENTS-5)
Oxygen	38	147	31	31	31
Nitrogen	234	876	84	84	84
Nitrogen Oxide	0.7	0.7	0.7	0.7	0.7
Water Vapor	37	85	4	4	4
Carbon Dioxide	1391	1428	1314	1314	1314
Other	2	4	0	0	0
Total	1701	2537	1433	1433	1433

Table 5-4 Final Waste Form Mass sent to Disposal (lbs/hr)

System	Primary Residue ^a	Secondary Residue ^b	Mercury Amalgam	Grout	Polymer or Ceramic ^c	Slag	Special Waste
Rotary Kiln Air (A-1)	1519	247	11	1	246	1519	153
Plasma Furnace (C-1)	1451	247	11	1	246	1451	153
Steam Reforming (H-1)	1517	247	11	1	246	1517	153
Grout Debris (NT-1)	4297	218	4.5	2913	1602	0	155
Thermal Desorption (NT-2)	4141	311	9	2764	1688	0	155
Wash (NT-3)	4069	239	4	2731	1578	0	155
Acid Digestion (NT-4)	3107	397	5	783	2721	0	155
Catalyzed Wet Ox (NT-5)	3315	345	5	1938	1722	0	155
Replace Grout with Vit. (ENTS-1)	2112	348	7	0	1724	736	155
Vitrify Untreated Sludge (ENTS-2)	1586	349	7	0	349	1586	155
Polymer Stabilization (ENTS-3)	2727	345	5	0	3071	0	155
Pelletization with Polymer (ENTS-4)	3680	466	5	0	4146	0	155
Increased Reaction Rate (ENTS-5)	3315	345	5	1938	1722	0	155

Notes:

^a Primary residue equals all primary waste stabilized in grout, polymer, or vitrified^b Secondary residue equals the salt and sludge wastes generated by the processes and stabilized in polymer or phosphate bonded ceramic.^c Only system NT-4 uses phosphate bonded ceramic.

Table 5-5 Final Waste Form Volume Sent to Disposal (ft³/hr)

System	Primary Residue ^a	Secondary Residue ^b	Mercury Amalgam	Grout	Polymer or Ceramic ^c	Slag	Special Waste	Total Volume
Rotary Kiln / Air (A-1)	8.1	3.1	0.01	0.01	3.1	8.1	2.4	13.6
Plasma Furnace (C-1)	7.8	3.1	0.01	0.01	3.1	7.8	2.4	13.2
Steam Reforming (H-1)	8.1	3.1	0.01	0.01	3.1	8.1	2.4	13.6
Grout Debris (NT-1)	37.7	2.3	0.006	23	17	0	2.4	42.5
Thermal Desorption (NT-2)	36.5	3.3	0.012	21.8	18	0	2.4	42.2
Wash (NT-3)	35.8	2.6	0.001	21.6	16.8	0	2.4	40.8
Acid Digestion (NT-4)	30.9	4.3	0.006	6.2	28.9	0	2.4	37.5
Catalyzed Wet Ox (NT-5)	30	3.7	0.006	15.3	18.3	0	2.4	36
Replace Grout with Vit. (ENTS-1)	18.6	3.7	0.01	0	18.3	3.9	2.4	24.7
Vitrify Untreated Sludge (ENTS-2)	8.5	3.7	0.01	0	3.7	8.5	2.4	14.6
Polymer Stabilization (ENTS-3)	29	3.7	0.01	0	32.7	0	2.4	35.1
Pelletization with Polymer (ENTS-4)	39.2	5	0.01	0	44.1	0	2.4	46.5
Increased Reaction Rate (ENTS-5)	30	3.7	0.01	15.3	18.3	0	2.4	36

Notes:

^a Primary residue equals all primary waste stabilized in grout, polymer, or vitrified.^b Secondary residue equals the salt and sludge wastes generated by the processes and stabilized in polymer or phosphate bonded ceramic.^c Only system NT-4 uses phosphate bonded ceramic.

Table 5-6 **Waste Volume Reduction**

System	Volume In/Volume Out	Volume Out as a Percent of Volume In
Rotary Kiln /Air (A-1)	3.37	30%
Plasma Furnace (C-1)	3.46	29%
Steam Reforming (H-1)	3.437	30%
Grout Debris (NT-1)	1.05	95%
Thermal Desorption (NT-2)	1.06	94%
Wash (NT-3)	1.1	91%
Acid Digestion (NT-4)	1.19	84%
Catalyzed Wet Ox (NT-5)	1.24	81%
Replace Grout with Vit. (ENTS-1)	1.81	55%
Vitrify Untreated Sludge (ENTS-2)	3.06	33%
Polymer Stabilization (ENTS-3)	1.28	78%
Pelletization with Polymer (ENTS-4)	0.96	104%
Increased Reaction Rate (ENTS-5)	1.24	81%

Table 5-7 Treatment System Energy Cost

System	Energy Costs per Hour			Fraction of Treatment Cost
	Electrical Energy	Natural Gas	Total Energy Cost	
Rotary Kiln / Air (A-1)	\$29.36	\$17.97	\$47.33	0.00176
Plasma Furnace (C-1)	\$163.54	\$0.00	\$163.54	0.00666
Steam Reforming (H-1)	\$42.59	\$7.83	\$50.42	0.00185
Grout Debris (NT-1)	\$67.98	\$1.25	\$69.23	0.00193
Thermal Desorption (NT-2)	\$0.38	\$2.41	\$2.79	0.00008
Wash (NT-3)	\$93.52	\$0.37	\$93.89	0.00253
Acid Digestion (NT-4)	\$0.61	\$1.48	\$2.09	0.00005
Catalyzed Wet Ox (NT-5)	\$0.59	\$1.30	\$1.89	0.00005
Replace Grout with Vit. (ENTS-1)	\$37.60	\$1.21	\$38.81	0.00094
Vitrify Untreated Sludge (ENTS-2)	\$46.44	\$0.18	\$46.62	0.00125
Polymer Stabilization (ENTS-3)	\$1.59	\$1.26	\$2.85	0.00007
Pelletization with Polymer (ENTS-4)	\$1.59	\$1.32	\$2.91	0.00007
Increased Reaction Rate (ENTS-5)	\$0.59	\$1.30	\$1.89	0.00005

Table 5-8 Reagent Use (lbs/hr)

Reagents (lbs/hr)	All Thermal Systems	Grout Debris (NT-1)	Thermal Desorption (NT-2)	Wash (NT-3)	Acid Digestion (NT-4)	Catalytic Wet Oxidation (NT-5)
Copper	5	1.9	3.6	1.8	1.8	1.9
Sodium Hydroxide	78	58	84.7	58.5	104	93.4
CWO Acid Solution	0	0	9.7	0	0	24.5
Ferric Chloride			5.8			14.7
Hydrochloric Acid			1.1			2.8
Water			2.8			7.0
Ammonia	0	4	0	5.5	6.8	0
Nitric Acid	0	21.4	0	28.8	73.7	0
Silver Nitrate	0	2.9	0	4.7	0	0
Hydrogen Peroxide	0	29.2	0.6	48.6	0.6	0.6

Reagents (lbs/hr)	Replace Grout with Vitrification (ENTS-1)	Vitrify Untreated Sludge (ENTS-2)	Polymer Stabilization (ENTS-3)	Pelletization with Polymer (ENTS-4)	Increased Reaction Rate (ENTS-5)
Copper	2.8	2.7	1.9	1.9	1.9
Sodium Hydroxide	94.2	94.1	93.4	93.4	93.4
CWO Acid Solution	24.5	23.7	24.5	24.5	24.5
Ferric Chloride	14.7	14.7	14.2	14.7	14.7
Hydrochloric Acid	2.8	2.8	2.8	2.8	2.8
Water	7.0	7.0	6.7	7.0	7.0
Ammonia	0	0	0	0	0
Nitric Acid	0	0	0	0	0
Silver Nitrate	0	0	0	0	0
Hydrogen Peroxide	0.6	0.6	0.6	0.7	0.6

Table 5-9 Truck Traffic (trucks per year)

System	Incoming Waste	Incoming Reagent	Stabilizing Agents	Total Incoming Truck Traffic	Waste to Disposal	Metals/Lead to Storage	Total Outgoing Loaded Trucks
Rotary Kiln / Air (A-1)	269	14	58	341	177	57	234
Plasma Furnace (C-1)	269	14	56	339	171	60	231
Steam Reforming (H-1)	269	14	58	341	177	57	234
Grout Debris (NT-1)	269	17	198	484	428	41	470
Thermal Desorption (NT-2)	269	16	196	480	423	41	464
Wash (NT-3)	269	21	189	479	409	41	451
Acid Digestion (NT-4)	269	27	158	454	336	41	377
Catalyzed Wet Ox (NT-5)	269	18	162	449	350	41	391
Replace Grout with Vit. (ENTS-1)	269	19	108	395	240	55	296
Vitrify Untreated Sludge (ENTS-2)	269	18	64	352	192	55	248
Polymer Stabilization (ENTS-3)	269	18	141	428	296	42	338
Pelletization with Polymer (ENTS-4)	269	18	239	526	395	42	436
Increased Reaction Rate (ENTS-5)	269	18	162	449	350	41	391

Notes:

- Primary residue equals all primary waste stabilized in grout, polymer, or vitrified.
- Secondary residue equals the salt and sludge wastes generated by the processes and stabilized in polymer or phosphate bonded ceramic.
- Only system NT-4 uses phosphate bonded ceramic.

Table 5-10 Personnel Requirements by Subsystem (Full Time Equivalents)

Subsystems	Rotary Kiln / Air (A-1)	Plasma Furnace (C-1)	Steam Reforming (H-1)	Grout Debris (NT-1)	Thermal Desorption (NT-2)	Wash (NT-3)	Acid Digestion (NT-4)	Catalytic Wet Oxidation (NT-5)
Administration	27	27	27	32	32	32	32	32
Receiving and Preparation	112	112	132	170	170	170	170	170
Organic Destruction	16	16	20	12	12	12	30	26
Air Pollution Control	4	4	4	4	4	4	4	4
Primary Stabilization	16	16	16	8	8	8	45	8
Secondary Stabilization	8	8	8	38	38	40	5	38
Metal Melting	5	^a	5	^b	^b	^b	^b	^b
Metal Decontamination	5	5	5	4	4	4	4	4
Lead Recovery	8	8	8	3	3	3	3	3
Mercury Amalgamation	4	4	4	1	1	1	1	1
Process Residue/Soil	^c	^c	^d	10	16	3	10	10
Debris Treatment	^e	^e	^d	^e	^f	16	8	8
Aqueous Waste Treatment	16	16	16	5	5	5	5	5
Special Waste Treatment	2	2	2	3	3	3	3	3
Certification & Shipping	32	32	32	106	105	110	87	88
Support	5	5	5	5	5	5	5	5
Total	260	255	284	401	406	416	412	405

Notes:^aInternally contaminated ferrous metal is treated in the plasma furnace.^bThis subsystem is not provided in this system.^cThese waste streams are treated in the thermal organic destruction subsystem^dThese waste streams are treated in primary stabilization (vitrifier).^eUntreated debris is stabilized.^fDebris is thermally desorbed with process residue/soil.^gOnly one method of stabilization is provided in this system

Table 5-10 (continued) Personnel Requirements by Subsystem (Full Time Equivalents)

Subsystems	Replace Grout with Vitrification (ENTS-1)	Vitrify Untreated Sludge (ENTS-2)	Polymer Stabilization (ENTS-3)	Pelletization with Polymer (ENTS-4)	Increased Reaction Rate (ENTS-5)
Administration	32	32	32	32	32
Receiving and Preparation	170	170	170	170	170
Organic Destruction	26	26	26	26	15
Air Pollution Control	4	4	4	4	4
Primary Stabilization	16	18	56	45	8
Secondary Stabilization	38	8	^a	^a	38
Metal Melting	5	5	^b	^b	^b
Metal Decontamination	4	4	4	4	4
Lead Recovery	8	8	3	3	3
Mercury Amalgamation	4	4	1	1	1
Process Residue/Soil	10	2	10	10	10
Debris Treatment	8	8	8	8	8
Aqueous Waste Treatment	5	5	5	5	5
Special Waste Treatment	3	3	3	3	3
Certification & Shipping	67	37	88	175	88
Support Systems	5	5	5	5	5
Total	405	339	415	491	394

Notes:

^aInternally contaminated ferrous metal is treated in the plasma furnace.^bThis subsystem is not provided in this system.^cThese waste streams are treated in the thermal organic destruction subsystem^dThese waste streams are treated in primary stabilization (vitrifier).^eUntreated debris is stabilized.^fDebris is thermally desorbed with process residue/soil.^gOnly one method of stabilization is provided in this system

Table 5-11 Total Life-Cycle Costs (\$ million)

Cost Component	Rotary Kiln /Air (A-1)		Plasma Furnace (C-1)		Steam Reforming (H-1)		Grout Debris (NT-1)		Thermal Desorption (NT-2)		Wash (NT-3)		Acid Digestion (NT-4)		Catalytic Wet Oxidation (NT-5)	
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%
Test & Demonstration	\$100	4%	\$99	4%	\$62	3%	\$134	4%	\$142	4%	\$143	4%	\$208	5%	\$167	4%
Operations Budget	\$97	4%	\$90	4%	\$99	4%	\$131	4%	\$129	4%	\$135	4%	\$138	4%	\$139	4%
Capital	\$554	23%	\$459	20%	\$588	24%	\$600	16%	\$561	15%	\$632	17%	\$673	17%	\$668	18%
O&M	\$1,362	56%	\$1,283	57%	\$1,390	57%	\$1,950	52%	\$1,930	53%	\$2,005	53%	\$2,040	53%	\$2,058	54%
D&D	\$54	2%	\$50	2%	\$54	2%	\$74	2%	\$69	2%	\$77	2%	\$80	2%	\$78	2%
Disposal	\$266	11%	\$259	12%	\$266	11%	\$833	22%	\$827	23%	\$799	21%	\$736	19%	\$707	19%
Total	\$2,433		\$2,240		\$2,459		\$3,722		\$3,658		\$3,792		\$3,875		\$3,817	
Total Without Disposal	\$2,167		\$1,981		\$2,193		\$2,889		\$2,831		\$2,993		\$3,139		\$3,110	
Unit Treatment Costs With Disposal	\$7.85		\$7.17		\$8.90		\$15.77		\$15.50		\$16.06		\$16.42		\$16.17	
Unit Treatment Costs Without Disposal	\$9.18		\$8.39		\$9.29		\$12.24		\$11.99		\$12.68		\$13.30		13.18	

Table 5-11 (continued) Total Life-Cycle Costs (\$ million)

Cost Component	Replace Grout with Vitrification (ENTS-1)		Vitrify Untreated Sludge (ENTS-2)		Polymer Stabilization (ENTS-3)		Pelletization with Polymer (ENTS-4)		Increased Reaction Rate (ENTS-5)	
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%
Test & Demonstration	\$167	4%	\$148	5%	\$157	4%	\$157	4%	\$167	4%
Operations Budget	\$147	4%	\$132	4%	\$142	4%	\$161	4%	\$138	4%
Capital	\$795	21%	\$762	23%	\$660	17%	\$669	15%	\$675	18%
O&M	\$2,134	56%	\$1,878	57%	\$2,108	55%	\$2450	55%	2023	53%
D&D	\$84	2%	\$81	2%	\$78	2%	\$78	2%	\$76	2%
Disposal	\$484	13%	\$286	9%	\$688	18%	\$911	21%	\$707	19%
Total	\$3,810		\$3,287		\$3,832		\$4,425		\$3,785	
Total Without Disposal	\$3,326		\$3,001		\$3,144		\$3,514		\$3,078	
Unit Treatment Costs With Disposal	\$16.14		\$13.93		\$16.24		\$18.75		\$16.04	
Unit Treatment Costs Without Disposal	\$14.09		\$12.72		\$13.32		\$14.89		\$13.04	

Table 5-12 Subsystem Life-Cycle Cost (\$ million)

Subsystem	Rotary Kiln /Air (A-1)		Plasma Furnace (C-1)		Steam Reforming (H-1)		Grout Debris (NT-1)		Thermal Desorption (NT-2)		Wash (NT-3)		Acid Digestion (NT-4)		Catalytic Wet Oxidation (NT-5)	
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%
Front-End Handling	\$667	27%	\$660	29%	\$783	32%	\$941	25%	\$941	26%	\$941	25%	\$941	24%	\$941	25%
Organic Destruction	\$162	7%	\$202	9%	\$185	8%	\$246	7%	\$177	5%	\$246	6%	\$391	10%	\$396	10%
Thermal Desorption							\$134	4%	\$157	4%			\$127	3%	\$127	3%
Wash											\$214	6%	\$153	4%	\$153	4%
Primary Treatment	\$162	7%	\$202	9%	\$185	8%	\$380	10%	\$334	9%	\$460	12%	\$670	17%	\$676	18%
Aqueous Waste	\$149	6%	\$149	7%	\$54	2%	\$150	4%	\$150	4%	\$150	4%	\$150	4%	\$150	4%
APC	\$115	5%	\$80	4%	\$88	4%	\$70	2%	\$70	2%	\$70	2%	\$70	2%	\$70	2%
Stabilization	\$377	15%	\$284	13%	\$377	15%	\$444	12%	\$444	12%	\$452	12%	\$480	12%	\$444	12%
Metal Recovery	\$235	10%	\$143	6%	\$235	10%	\$105	3%	\$105	3%	\$105	3%	\$105	3%	\$105	3%
Special Waste	\$29	1%	\$29	1%	\$29	1%	\$46	1%	\$46	1%	\$46	1%	\$46	1%	\$46	1%
Certify & Ship	\$193	8%	\$193	9%	\$193	8%	\$499	13%	\$491	13%	\$514	14%	\$420	11%	\$424	11%
Admin & Support	\$240	10%	\$240	11%	\$249	10%	\$254	7%	\$250	7%	\$254	7%	\$256	7%	\$254	7%
Disposal	\$266	11%	\$259	12%	\$266	11%	\$833	22%	\$827	23%	\$799	21%	\$736	19%	\$707	19%
Total	\$2,434		\$2,239		\$2,460		\$3,721		\$3,657		\$3,790		\$3,874		\$3,816	

Table 5-12 (continued) Subsystem Life-Cycle Costs (\$millions)

Cost Component	Replace Grout with Vitrification (ENTS-1)		Vitrify Untreated Sludge (ENTS-2)		Polymer Stabilization (ENTS-3)		Pelletization with Polymer (ENTS-4)		Increased Reaction Rate (ENTS-5)	
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%
Front-End Handling	\$941	25%	\$941	29%	\$941	24%	\$941	21%	\$941	25%
Organic Destruction	\$396	10%	\$396	12%	\$396	10%	\$396	9%	\$359	9%
Thermal Desorption	\$127	3%			\$127	3%	\$127	3%	\$127	3%
Wash	\$153	4%	\$153	5%	\$153	4%	\$153	3%	\$153	4%
Primary Treatment	\$676	18%	\$550	17%	\$676	17%	\$676	15%	\$639	17%
Aqueous Waste	\$150	4%	\$150	5%	\$150	4%	\$150	3%	\$150	4%
APC	\$70	2%	\$70	2%	\$70	2%	\$70	2%	\$76	2%
Stabilization	\$600	16%	\$525	16%	\$479	12%	\$515	12%	\$444	12%
Metal Recovery	\$244	6%	\$244	7%	\$105	3%	\$105	2%	\$105	3%
Special Waste	\$46	1%	\$46	1%	\$46	1%	\$46	1%	\$46	1%
Certify & Ship	\$346	9%	\$224	7%	\$424	12%	\$758	17%	\$424	11%
Admin & Support	\$254	7%	\$254	8%	\$254	7%	\$254	6%	\$254	7%
Disposal	\$484	13%	\$286	9%	\$688	18%	\$911	21%	\$707	19%
Total	\$3,810		\$3,288		\$3,832		\$4,425		\$3,785

Figure 5-1 Offgas Emissions

Figure 5-2 Final Waste Form Volume

Figure 5-3 Volume Reduction

Figure 5-4 Total Life Cycle Cost

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APPENDIX A

Figures

Presented under a separate cover

APPENDIX B

Cost Data

B-1 ENTS-1 Cost Tables

- B-1.1. Equipment Purchase and Installation Budget Estimates
- B-1.2. Development, Testing and Evaluation Cost Estimate
- B-1.3. Building, Equipment and Installation Cost Summary
- B-1.4. Annual Operating and Maintenance Costs
- B-1.5. Decontamination and Decommissioning Costs
- B-1.6 Total Life-Cycle Cost (without Disposal) Estimate Summary for Enhanced Integrated Nonthermal Treatment Systems

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC. CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
1 Administration Building Subsystem	III							
- Administration Office								
- Office Furniture - EMPLOYEE	E		49	7.0	343	1.0	49	392
- Computers	E		Lot	500.0	500	50.0	50	550
- Communication	E		Lot	250.0	250	35.0	35	285
- Testing Laboratory								
- ICP-Mass Spectrometer	D		1					
- Gas Chromatography - Mass Spec.	D		1					
- Scintillation Counter - Alpha	D		1					
- Scintillation Counter - Gamma	D		1					
- Geiger - Muller Counter	D		1					
- Fume Hood	A		2					
- Centrifuge	A		2					
- Autoclave	A		1					
- Scrubber/Blower	C		1					
- Hood/HEPA Filtration	C		1					
- Glovebox	D		1					
- Wet Chemistry Equipment	D		1					
- Refrigeration / Storage	A		1					
- Computer & Data Communication	D		2					
- Atomic Absorption Spectrography	D		1					
- Soil / Physical Testing Equipment	D		Lot					
- Complete Package per Above Detail	E		Lot	1,500.0	1500	300.0	300	1800
- Office Equipment & Furnishing	E		Lot	80.0	80	7.0	7	87
- Allowance for Mechanical/Piping	E		Lot		26.7		132.3	159
- Allowance for Electrical/Control	E		Lot		401.0		264.6	665.6
- Calibration, Testing & Startup	E		Lot		62.0		50.3	112.3
-								
-								
Total Administration Building Subsystem					3162.7		888.2	4050.9
2 Receiving & Inspection Subsystem	I							
- Unloading, Staging & Storage (A-RCINS)								
- O/H Bridge Crane & Rigging - 20 TN	E		1	625.0	625	125.0	125	750
- Forklift - 10 TN	E		2	65.0	130	10.0	20	150
- Airlock	E		1	124.0	124	39.0	39	163
- Inspect & Assay (A-RCINS)								
- Transfer Cart - 2 TN	B							
- Gamma Spectroscopy (GS)	D							
- Passive Active Neutron Assay (PAN)	D							
- Real Time Radiography (RTR)	D							
- Load Cell	D							
- Closed Circuit TV	D							
- RHMMS Barrel Monitor including above	E		1	2,000.0	2000	400.0	400	2400
- Personnel Contamination Monitor	E		1	35.0	35	5.0	5	40
- Container Decontamination Enclosure	E		1	140.0	140	15.0	15	155
- Open, Dump, & Sort								
- Self Guided Vehicle	E		2	425.0	850	64.0	128	978
- Decap Device	E		3	50.0	150	9.0	27	177
- Sort Hopper	E		5	40.0	200	4.0	20	220
- Sort/Rotating Table	E		5	200.0	1000	30.0	150	1150
- Special Waste Glove Box	E		1	400.0	400	48.0	48	448

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Dump Hopper	E		6	40.0	240	4.0	24	264
- Maintenance Crane	E		1	800.0	800	120.0	120	920
- Bins	E		80	5.0	400	1.0	80	480
- Bin Conveyor 8 ft long	E		20	10.0	200	4.0	80	280
- Bin Conveyor 70 ft long	E		2	70.0	140	28.0	56	196
- Bin Pusher	E		34	10.0	340	4.0	136	476
- Main Cell Gantry Robot	E		1	2,000.0	2000	400.0	400	2400
- Sorting Table Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Sorting Master Slave Manipulator	E		5	100.0	500	40.0	200	700
- Box Size Reduction Unit	E		1	1,500.0	1500	400.0	400	1900
- Drum Opening Gantry Robot	E		2	400.0	800	80.0	160	960
- Glovebox Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Container Grapppler	E		4	50.0	200	8.0	32	232
- Decap Enclosure	E		3	100.0	300	30.0	90	390
- Bin Hoist / Pusher	B	5	1	33	66	8	8	74
- Discharge. & Oversize Load Hopper (100 CF)	B	1	1	25	50	7	7	57
- Primary Shredder (.25, 1.5, 2 Tons/hr)	E	250	1	375	375	75	75	450
- Secondary Shredder (.5, 1.5, 3 Tons/hr)	E	60	1	160	160	32	32	192
- Live Bottom Bulk Storage	B	1	1	25	50	7	7	57
- Conveyor / Canister Handler	B	5	1	40	80	10	10	90
- Dust Collection System w/ Blower	E		Lot	108	108	17	17	125
- HEPA Filter	E		2	25	50	5	10	60
- Closed Circuit TV	E		8	10.0	80	2.0	16	96
- Airlock	E		4	124.0	496	39.0	156	652
- Roll up Door (CA)	E		2	20.0	40	2.0	4	44
- Allowance for Mechanical/Piping	E		Lot		755.5		1,628.5	2384
- Allowance for Electrical/Control	E		Lot		2,266.4		1,628.5	3894.9
- Calibration, Testing & Startup	E		Lot		362.6		260.6	623.2
Total Receiving & Inspection Subsystem					18493.5		6774.6	25268.1
3 Aqueous Waste Treatment Subsystem	II							
- Batch Liquid Waste (A-AQWTR)								
- High TOC Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TOC Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Low TDS Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Low TDS Batch Tank Pump	E		1	5.0	5	1.0	1	6
- High TDS/ Heavy Metals Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TDS/ Heavy Metals Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Hg Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Hg Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Airlocks	E		2	124.0	248	39.0	78	326
- Closed Circuit TV	E		5	10.0	50	2.0	10	60
- Crane	E		1	525.0	525	105.0	105	630
- Shield Window	E		1	130	130	44	44	174
- Gross Organics Removal (A-AQWTR)								
- Oil/ Water Separator	E		1	18.0	18	2.5	2.5	20.5
- Neutralization / Settling (A-AQWTR)								
- Neutralization System	E		1	95.0	95	19.0	19	114
- Neutralization Overflow Pump	E		1	5.0	5	1.0	1	6
- Sludge Transfer Pump	E		1	5.0	5	1.0	1	6

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Sludge Settler	E		1	27.0	27	5.0	5	32
- Sludge Settler Pump	E		1	5.0	5	1.0	1	6
- Suspended Solids Filtration (A-AQWTR)								
- Suspended Solids Filter	E		1	125.0	125	25.0	25	150
- Concentration (A-AQWTR)								
- Evaporator with Condenser	E		2	300.0	600	75.0	150	750
- Evaporator Liquids Pump	E		2	5.0	10	1.0	2	12
- Calcium Carbonate Removal								
- Tank with Agitator	E		1	27.0	27	5.0	5	32
- Transfer Pump	E		4	5.0	20	1.0	4	24
- Decanter Centrifuge	E		1	450.0	450	60.0	60	510
- Holding Tank	E		1	7.0	7	1.5	1.5	8.5
- Slurry Pump	E		1	5.0	5	1.0	1	6
- Filter	E		2	2.5	5	0.5	1	6
- Dissolved Organics Removal								
- Ozone Generator System	E							
- UV/Peroxide System	E							
- Ozone Decomposer	E							
- Complete Package per Above Detail	E		Lot	125.0	125	25.0	25	150
- Liquid-Phase Carbon (55-gal drum)	F		4	0.8	3.2	0.1	0.4	3.6
- Concentrator								
- Vapor Phase Carbon	F		2	16.0	32	3.0	6	38
- Evaporator with Condenser	E		1	500.0	500	75.0	75	575
- Condenser Liquids Pump	E		1	5.0	5	1.0	1	6
- Dissolved Solids Removal								
- Ion Exchanger	E		1	61.0	61	9.0	9	70
- Treated Water Sampling								
- Treated Water Tanks	E		2	45.0	90	12.0	24	114
- Treated Water Pumps	E		2	5.0	10	1.0	2	12
- Chemical Distribution								
- Chemical Addition Pump (Acid)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Caustic)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Sulfide)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Floc/ Polymer)	E		1	1.0	1	0.3	0.3	1.3
- Chemical Storage Tanks	E		4	7.0	28	1.5	6	34
- Chemical Addition Pump (Peroxide)	E		1	5.0	5	1.0	1	6
- Peroxide Storage Tank	E		1	7.0	7	1.5	1.5	8.5
- Allowance for Mechanical/Piping	E		Lot		1,010.2		416.5	1426.7
- Allowance for Electrical/Control	E		Lot		505.1		347.1	852.2
- Calibration, Testing & Startup	E		Lot		97.7		58.3	156
Total Aqueous Waste Treatment Subsystem					4980.2		1516.1	6496.3
4 Organic Destruction Subsystem								
- Prepare and Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		Lot	50	50	8	8	58
- Discharge and Loading Hoppers	E		Lot	45	45	8	8	53
- Feed Blender	E		Lot	45	45	8	8	53
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost For Above Package	E		Lot	2400	2400	300	300	2700
- Miscellaneous								
- Neutralization System	E		1	95	95	19	19	114
- Neutralization Overflow Pump	E		1	5	5	1	1	6
- Sludge Transfer Pump	E		1	5	5	1	1	6
- Crane	E		1	525	525	105	105	630
- Closed Circuit TV	E		8	10	80	2	16	96
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	132	522
- Allowance for Mechanical/Piping	E		Lot		1,166.4		405.6	1572
- Allowance for Electrical/Control	E		Lot		583.2		338.0	921.2
- Calibration, Testing & Startup	E		Lot		112.8		56.8	169.6
Total Organic Destruction Subsystem					5750.4		1476.4	7226.8
5 Residue & Sludge Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	50	50	8	8	58
- Discharge. & Oversize Load Hopper (100 CF)	E		1	45	45	8	8	53
- Manipulate Crane 10 TN	E	15	1	525	525	105	105	630
- Shield Window	E		1	130.0	130	44.0	44	174
- Airlock	E		2	124	248	39	78	326
- Closed Circuit TV	E		10	10	100	2	20	120
- Feed Blender	E		1	45	45	8	8	53
- Dewatering System	E		1					
- THERMAL DESORPTION								
- High Vacuum Dryer			1					
- Nitrogen gas storage and feed tank	E		1					
- Vacuum Pump	E		1					
- Filter	E		1					
- Hot Oil System								
- Oil Storage and Feed Tank	E		1					
- Oil Heater	E		1					
- Fuel Storage and Feed Tank	E		1					
- Condensers								
- HEPA Filter for particulates	E		1					
- Induced Air Fan	E		1					
- Primary Condensers (Air Cooler)	E		1					
- Secondary Condensers (Water Chiller)	E		2					
- Total per Package Above	E		Lot	1700	1700	170	170	1870
- Mercury Removal System								
- Mercury Precipitation Tank	E		1	95	95	19	19	114
- Iodine Recovery Tank	E		1	27	27	5	5	32

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- KI/I2 Storage and Feed	E		1	27	27	5	5	32
- Metal Precipitation Tank	E		1	27	27	5	5	32
- Mercury Reduction Tank	E		1	27	27	5	5	32
- Solids Wash Tank	E		1	27	27	5	5	32
- Water Holding Tank	E		1	12	12	3	3	15
- Acid Holding and Feed Tank	E		1	12	12	3	3	15
- H2O2 Holding and Feed Tank	E		1	12	12	3	3	15
- Lime Holding Tank	E		1	12	12	3	3	15
- Rinse Tank	E		1	12	12	3	3	15
- Filter	E		1	125	125	25	25	150
- Pump	E		10	5	50	1	10	60
- Allowance for Mechanical/Control/Instrumentation	E		Lot		992.4		321.0	1313.4
- Allowance For Electrical/Control	E		Lot		496.2		267.5	763.7
- Calibration, Testing & Startup	E		Lot		95.9		44.9	140.8
Total Residue & Sludge Treatment Subsystem					4892.5		1168.4	6060.9
6 Soft Debris Treatment Subsystem	II							
- Prepare & Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		1	50	50	8	8	58
- Discharge and Loading Hoppers	E		1	45	45	8	8	53
- Feed Blender	E		1	45	45	8	8	53
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost for Above Package	E		Lot	4300	4300	430	430	4730
- Miscellaneous								
- Neutralization System	E		1	95	95	19	19	114
- Neutralization Overflow Pump	E		1	5	5	1	1	6
- Sludge Transfer Pump	E		1	5	5	1	1	6
- Crane	E		1	525	525	105	105	630
- Closed Circuit TV	E		10	10	100	2	20	120
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	44	434
- Allowance for Mechanical/Control/Instrumentation	E		Lot		1,742.4		216.6	1959
- Allowance For Electrical/Control	E		Lot		871.2		433.2	1304
- Calibration, Testing & Startup	E		Lot		168.4		82.3	251
Total Soft Debris Treatment Subsystem					8590		1454.1	10,044

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
7 Complex Debris Treatment Subsystem								
- Costs included with Grout								
- Total Complex Debris Treatment Subsystem								
8 Open Debris Treatment Subsystem	II							
- Feed Preparation and Separation								
- Bulk Solids Dump Hopper	F		1	40	40	4	4	44
- Bin Hoist/Pusher	E		2	33	66	8	16	82
- Drum/Bin Conveyor	E		6	10	60	4	24	84
- OH Crane	E		1	525	525	105	105	630
- Closed Circuit TV	E		7	10	70	2	14	84
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		1	130	130	44	44	174
- Dust Collection Assembly	E		Lot	108	108	17	17	125
- High Pressure Wash								
- Receptacle Basket								
- Water Pump								
- Agitation Pump								
- Surfactant Preparation								
- Surfactant Pump								
- Surfactant Holding Tank								
- Mixing Tank with Agitator								
- Solution High Pressure Pump								
- Water Heater								
- Water Holding Tank								
- Water Pump								
- Gross Organic Removal								
- Oil/Water Separator								
- Recycle Pump								
- Oil Pump								
- Water Treatment								
- Bag Filter								
- Solids Bin								
- Neutralization Tank								
- Chemical Addition Pump (Acid)								
- Chemical Storage Tank								
- Liquid-Phase Carbon								
- Ion Exchange Unit								
- Treated Water Holding Tank								
- Treated Water Pump								
- Total Per Wash Package Above	A		Lot	47	141	5	5	146
- Allowance for Mechanical/Control/Instrumentation	E		Lot		416.4		184.2	600.6
- Allowance For Electrical/Control	E		Lot		208.2		153.5	361.7
- Calibration, Testing & Startup	E		Lot		40.3		25.8	66.1
- Total Open Debris Treatment Subsystem					2052.9		670.5	2723.4
9 Bulk Soil Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	30	30	6	6	36
- Discharge. & Oversize Load Hopper	E		1	11	11	2	2	13
- Slurry Mix Tank	E		1	20	20	4	4	24
- Feed Pump	E		1	5	5	1	1	6

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Water Pump	E		1	5	5	1	1	6
- Airlock	E		2	124	248	39	78	326
- Closed Circuit TV	E		7	10	70	2	14	84
- Shield Window	E		1	130	130	44	44	174
- Wash System								
- Attrition Mill	D		1	25	37.5	5	5	42.5
- Extraction Tank with Agitator	D		1	50	74.4	10	9.9	84.3
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Off-Gas Control								
- Heat Exchanger	E		2	6	12	0.4	0.8	12.8
- Solid/ Liquid Separation System	E							
- Vibrating Screen	E		1	6	6	1	1	7
- Hydrocyclone	D		2	4.5	13.5	0.4	0.8	14.3
- Countercurrent Solid/ Liquid Contactor	B		1	160	320	32	32	352
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Diaphragm Pump	E		1	1	1	0.2	0.2	1.2
- Solids Bin	E		1	5	5	1	1	6
- Overhead Crane	E		1	525	525	105	105	630
- Solubility Reduction Separator								
- Phase Separator	B		1	4.8	9.6	1	1	10.6
- Additive Addition Pump	E		1	1	1	0.3	0.3	1.3
- Surfactant Phase Pump	E		1	5	5	1	1	6
- Water Phase Pump	E		1	5	5	1	1	6
- Storage Tanks (Water and Concentrate)	E		2	2	4	0.4	0.8	4.8
- Ultrafiltration Unit	E		1	50	50	10	10	60
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Dissolved Air Floatation Unit	E		1	50	50	7.5	7.5	57.5
- Surfactant Preparation								
- Water Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Heater	E		1	0.6	0.6	0.1	0.1	0.7
- Surfactant Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Pump	E		1	5	5	1	1	6
- Surfactant Pump	E		1	5	5	1	1	6
- Dilution Tank Agitator	E		1	1.5	1.5	0.2	0.2	1.7
- Dilution Tank Pump	E		1	5	5	1	1	6
- Surfactant Dilution Tank	E		1	2.0	2	0.4	0.4	2.4
- Dryer	E		1	100.0	100	30.0	30	130
- Surfactant Separation								
- Additive Pump	E		4	1	4	0.3	1.2	5.2
- Additive Tanks	E		1	3.2	3.2	0.5	0.5	3.7
- Surfactant Separation Unit	B		1	50	100	10	10	110
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Allowance for Mechanical/Control/Instrumentation	E		Lot		572.5		228.7	801.2
- Allowance For Electrical/Control	E		Lot		286.2		190.6	476.8
- Calibration, Testing & Startup	E		Lot		55.3		32.0	87.3
-								
-								
Total Bulk Soil Treatment Subsystem					2822.3		832.4	3654.7

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
10 Metal Decontamination Subsystem	I							
- Pretreatment (GTCC-II)								
- High Pressure Water Rinse Station								
- Hot Air Dryer Station								
- Chemical Storage Tank								
- Chemical Mixing Tank								
- Chemical Metering Pump								
- Solution Pump								
- Complete Package per Above Detail	E		Lot	150.0	150	50.0	50	200
- Shield Window	E		1	130	130	44	44	174
- Closed Circuit TV	E		5	10.0	50	2.0	10	60
- Size Reduction (GTCC-II)								
- Hydraulic Manipulator	E		1	120.0	120	50.0	50	170
- Gantry Robot	E		1	800.0	800	160.0	160	960
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245
- Fugitive Dust Collection System	E		2	100.0	200	15.0	30	230
- Master Slave Manipulator	E		1	65.0	65	15.0	15	80
- Airlock	E		2	124.0	248	39.0	78	326
- Assay/Inspection (GTCC-II)								
- Assay Unit - Mini	E		1	500.0	500	100.0	100	600
- Roller Conveyor	E		10	6.0	60	1.0	10	70
- Shielding Window	E		3	130.0	390	44.0	132	522
- Allowance for Mechanical/Piping	E		Lot		145.9		359.5	505.4
- Allowance for Electrical/Control	E		Lot		437.7		359.5	797.2
- Calibration, Testing & Startup	E		Lot		70.0		57.5	127.5
-								
-								
Total Metal Decontamination Subsystem					3571.6		1495.5	5067.1
11 Special Waste	II							
-								
- Allowance for Mechanical/Piping	E		Lot					
- Allowance for Electrical/Control	E		Lot					
- Calibration, Testing & Startup	E		Lot					
-								
-								
Total Special Waste								
12 Mercury Amalgamation Subsystem	II							
- Feed Storage & Preparation (A-RMERC)								
- Mercury Waste Feed Bin (60 ft³)	F		1	20.0	20.0	4.0	4.0	24.0
- Shredder/ Feeder	F		1	90.0	90.0	15.0	15.0	105.0
- Airlock	E		1	124.0	124.0	39.0	39.0	163.0
- Crane	F		1	525.0	525.0	105.0	105.0	630.0
- Closed Circuit TV	E		2	10.0	20.0	10.0	20.0	40.0
- Mercury Recovery (A-RMERC)								
- Mercury Retort	F		1					
- Mercury Condenser	E		1					
- Mercury Separator	E		1					
- Total Retort System	E		1	300.0	300.0	80.0	80.0	380.0
- Off-Gas Treatment (A-RMERC)								
- Offgas Combustion Chamber	E		1	130.0	130.0	10.0	10.0	140.0
- Quencher	E		1	57.0	57.0	12.0	12.0	69.0
- Dry Gas Filter	E		1	160.0	160.0	25.0	25.0	185.0

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Carbon Adsorbers	E		2	10.0	20.0	1.0	2.0	22.0
- HEPA Filters	E		1	52.0	52.0	7.0	7.0	59.0
- Vacuum Pump	E		1	15.0	15.0	3.0	3.0	18.0
- ID Blower	E		1	15.0	15.0	3.0	3.0	18.0
- Stack (3' ø x 30')	E		1	20.0	20.0	5.0	5.0	25.0
- Stack Monitor	E		Lot	350.0	350.0	140.0	140.0	490.0
- Mercury Amalgamation & Packaging (A-RMERC)								
- Liquid Mercury Storage Tank	E		1	7.0	7.0	1.0	1.0	8.0
- Liquid Mercury Pump	E		1	5.0	5.0	1.0	1.0	6.0
- Copper Powder Bin (1 ft³)	E		1	5.0	5.0	0.6	0.6	5.6
- Steel Shot Bin (0.5 ft³)	E		1	5.0	5.0	0.6	0.6	5.6
- Nitric Acid Tank (1 GAL)	E		1	5.0	5.0	0.5	0.5	5.5
- Nitric Acid Pump (1 Gal/hr)	E		1	5.0	5.0	1.0	1.0	6.0
- Amalgam Mixer (5 GAL)	F		1	26.0	26.0	5.0	5.0	31.0
- Amalgam packager	F		1	2.0	2.0	0.4	0.4	2.4
- Allowance for Mechanical/Piping	E		Lot		587.4		288.1	875.5
- Allowance for Electrical/Control	E		Lot		293.7		240.1	533.8
- Calibration, Testing & Startup	E		Lot		56.8		40.3	97.1
Total Mercury Amalgamation Subsystem					2895.9		1048.6	3944.5
13 Lead Recovery Subsystem	II							
- Battery Disassembly (A-PBRCR)								
- Roller Conveyors (ft)	F		50	4.0	200.0	1.0	50.0	250.0
- Shredder	F		1	42.0	42.0	7.0	7.0	49.0
- Hydraulic Drum Dumper	F		1	3.0	3.0	1.0	1.0	4.0
- Hydraulic Drum Dumper w/ Spout	F		1	10.0	10.0	2.0	2.0	12.0
- Acid Resist Sorting Table	E		1	5.0	5.0	1.0	1.0	6.0
- Acid Drain Tank	E		1	5.0	5.0	1.0	1.0	6.0
- Battery Cutting Saw	F		1	2.0	2.0	1.0	1.0	3.0
- Airlock	E		1	124.0	124.0	39.0	39.0	163.0
- Crane	E		1	525.0	525.0	105.0	105.0	630.0
- Closed Circuit TV	E		2	10.0	20.0	2.0	4.0	24.0
- Decontamination (A-PBRCR)								
- Drum Lid Detacher	F		1	4.0	4.0	1.0	1.0	5.0
- Roller Conveyors (Straight)	F		12	5.0	60.0	1.0	12.0	72.0
- Decon Booth	F		1	175.0	175.0	25.0	25.0	200.0
- Hydraulic Drum Dumper	F		1	4.0	4.0	2.0	2.0	6.0
- Sorting Table (1 Hole)	E		2	4.0	8.0	1.0	2.0	10.0
- Sorting Table (4 Holes)	E		1	6.0	6.0	1.0	1.0	7.0
- Rolling Conveyor (L-Shaped)	F		1	5.0	5.0	2.0	2.0	7.0
- Drum Pusher	F		1	1.0	1.0	1.0	1.0	2.0
- Aqueous Waste Tank	E		1	5.0	5.0	2.0	2.0	7.0
- Aqueous Waste Pump	E		1	3.0	3.0	2.0	2.0	5.0
- Lead Melter (A-PBRCR)								
- Melting Furnace w/ Hood	F		1	100.0	100.0	30.0	30.0	130.0
- Crucibles	E		1	1.0	1.0	0.2	0.2	1.2
- Sodium Carbonate Tank	E		1	5.0	5.0	0.2	0.2	5.2
- Sodium Carbonate Pump	E		1	5.0	5.0	0.2	0.2	5.2
- Stirrer	E		1	15.0	15.0	2.5	2.5	17.5
- Casting (A-PBRCR)								
- Lead Casting	F		1	88.0	88.0	10.0	10.0	98.0

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Cast Lead Cooling Bin	F		4	5.0	20.0	0.3	1.2	21.2
- Assay/Drumming (A-PBRCR)								
- Drum Pusher	F		1	10.0	10.0	0.2	0.2	10.2
- Lid Attacher	F		1	2.0	2.0	0.3	0.3	2.3
- Assay Station	F		1	500.0	500.0	3.0	3.0	503.0
- Drum Washer	E		1	70.0	70.0	10.0	10.0	80.0
- Miscellaneous Equipment								
- Transfer Cart (CA)	E		1	100.0	100.0	20.0	20.0	120.0
- Air Pollution Control								
- Quencher System	E		1	100.0	100.0	20.0	20.0	120.0
- Baghouse	E		1	30.0	30.0	6.0	6.0	36.0
- Activate Carbon	E		1	50.0	50.0	10.0	10.0	60.0
- HEPA Filter	E		1	50.0	50.0	10.0	10.0	60.0
- Stack	E		1	20.0	20.0	4.0	4.0	24.0
- Stack Monitor (Radioactive)	E		Lot	200.0	200.0	80.0	80.0	280.0
- Stack Monitor (Non-Radioactive)	E		Lot	150.0	150.0	60.0	60.0	210.0
- Allowance for Mechanical/Piping	E		Lot		816.9		317.3	1134.2
- Allowance for Electrical/Control	E		Lot		408.5		264.4	672.9
- Calibration, Testing & Startup	E		Lot		79.0		44.4	123.4
-								
-								
Total Lead Recovery Subsystem					4027.4		1154.9	5182.3
14 Air Pollution Control Subsystem	II							
- Particulate Filter								
- Baghouse Assembly	E		1	240.0	240	48.0	48	288
- Prefilter	E		2	26.0	52	12.0	24	76
- Inter Connection Ducts.	E		Lot	2.0	2	10.0	10	12
- Corona Reactor								
- Reactor								
- Skid & Instrumentation								
- Power Supply								
- Cost per Package Above	E		Lot	73.0	73	7.0	7	80
- Acid Gas Scrubber								
- Packing Tower	E		1	45.0	45	13.0	13	58
- Induced Fan	E		2	4.5	9	0.5	1	10
- Recycle Pump	E		2	1.8	3.6	0.2	0.4	4
- Sludge Discharge Pump	E		2	2.7	5.4	0.5	1	6.4
- Caustic Feed Pump	E		2	0.9	1.8	0.2	0.4	2.2
- NaOH Transfer Pump	E		2	0.9	1.8	0.2	0.4	2.2
- Caustic Storage Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Slurry Pump	E		2	2.7	5.4	0.5	1	6.4
- Condensate Tank	E		1	0.9	0.9	0.2	0.2	1.1
- NaOH Day Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Scrubber Solution Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Evaporator System	E		1	54.0	54	16.2	16.2	70.2
- Hydrosonic Scrubber	E		1	27.0	27	5.4	5.4	32.4
- Liquid/ Solid Separator	E		1	18.0	18	3.6	3.6	21.6
- Mist Eliminator	E		1	1.6	1.6	0.4	0.4	2
- Heat Exchanger	E		2	5.4	10.8	1.8	3.6	14.4
- Carbon Adsorption								
- Carbon Filter (GAC)	F		2	9.0	18	1.8	3.6	21.6

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC. CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Carbon Filter (Sublimated GAC)	F		2	9.0	18	1.8	3.6	21.6
- Support System								
- Stack	E		1	7.2	7.2	1.4	1.4	8.6
- Stack Monitors - Radioactive	E		Lot	56.0	56	14.4	14.4	70.4
- Stack Monitors - Non Radioactive	E		Lot	27.0	27	10.8	10.8	37.8
- OH Crane	E		1	525.0	525	105.0	105	630
- Airlock	E		2	124.0	248	39.0	78	326
- Closed Circuit TV	E		4	10.0	40	2.0	8	48
- Shield Window	E		1	130	130	44	44	174
- Allowance for Mechanical/Piping	E		Lot		487.0		243.0	730
- Allowance for Electrical/Control	E		Lot		243.5		202.5	446
- Calibration, Testing & Startup	E		Lot		47.1		34.0	81.1
Total Air Pollution Control Subsystem					2400.8		884.5	3285.3
15 Polymer Stabilization Subsystem	I							
- Prepare & Feed Incoming Waste (A-PLYMR)								
- Bin Hoist / Pusher	F	5	1	100.0	100	8.0	8	108
- Discharge. & Oversize Load Hopper (100 CF)	F	1	1	60.0	60	9.0	9	69
- Tertiary Shredder	B	50	1	50.0	100	10.0	10	110
- Live Bottom Bulk Storage	F	1	1	60.0	60	9.0	9	69
- Conveyor / Canister Handler	F	5	1	80.0	80	10.0	10	90
- Manipulation Crane - 5 TON	E	10	1	525.0	525	105.0	105	630
- Dust Collection System w/ Blower	F		1	108.0	108	17.0	17	125
- HEPA Filter	F		8	25.0	200	5.0	40	240
- Closed Circuit TV	E		13	10.0	130	2.0	26	156
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		2	130	260	44	88	348
- Drying (A-PLYMR)								
- Drier	F		1	585.0	585	88.0	88	673
- Conveyor	F	5	5	6.0	30	1.0	5	35
- Proportioning and Blending (A-PLYMR)								
- Polymer Pellets Storage Silo	E		4	25.0	100	7.0	28	128
- Weigh Station	E		2	20.0	40	2.0	4	44
- Blender	F	2	1	53.0	53	5.0	5	58
- Conveyor	F	5	11	6.0	66	1.0	11	77
- Encapsulation (A-PLYMR)								
- Extruder	F	100	1	630.0	630	22.7	22.7	652.7
- Activated Carbon	F		4	10.0	40	1.0	4	44
- Drum Cooling (A-PLYMR)								
- Induced Draft Fan/ Ducting	F		8	16.0	128	2.0	16	144
- Enclosure	F		1	121.0	121	8.0	8	129
- Drum Capping and Washing (A-PLYMR)								
- Drum Wash/ Cap	E		4	70.0	280	15.0	60	340
- Flush Water Collection and Conveying	E		2	30.0	60	18.0	36	96
- Conveyor	F	5	39	6.0	234	1.0	39	273
- Allowance for Mechanical/Piping	E		Lot		211.9		363.4	575.3
- Allowance for Electrical/Control	E		Lot		635.7		363.4	999.1
- Calibration, Testing & Startup	E		Lot		101.7		58.1	159.8
Total Polymer Stabilization Subsystem					5187.3		1511.6	6698.9

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
16 Vitrification	II							
- Prepare and Feed Incoming Waste (A-VITRF)								
- Bulk Solids Dump Hopper	F		1	60.0	60.0	15.0	15.0	75.0
- Shredding System	E		1	1,320.0	1,320.0	260.0	260.0	1,580.0
- Waste Prep Crane	F		1	525.0	525.0	105.0	105.0	630.0
- Drum/Bin Conveyor	E		20	6.0	120.0	1.0	20.0	140.0
- Closed Circuit TV	E		2	10.0	20.0	2.0	4.0	24.0
- Airlock	E		2	124.0	248.0	39.0	78.0	326.0
- Dust Collection Assembly	E		1	120.0	120.0	20.0	20.0	140.0
- Melter (A-VITRF)								
- Melter			1					
- Melter Feed Assembly			1					
- Melter Oxygen Feed Controller			1					
- Melter Inlet Air Blower			1					
- Melter Discharge System			1					
- Melter Room Temperature Monitoring & Cooling			1					
- Melter Vacuum Pumps			1					
- Melter Slag/ Ingot Vacuum Chamber			1					
- Melter Hearth Removal System			2					
- Cost Per Package Above	F		Lot	4,000.0	4,000.0	800.0	800.0	4,800.0
- Maintenance Crane (5 TN)	E		1	525.0	525.0	105.0	105.0	630.0
- Monorail Hoist (5 TN)	F		1	85.0	85.0	20.0	20.0	105.0
- Cool Melter (A-VITRF)								
- Melter Cooling Water Unit								
- Cooling Water Pump 150 Gal/min								
- Cooling Water Pump 200 gal/min								
- Cooling Water Pump 2500 GAL								
- Elevated Water Tank								
- Cooling Tower								
- Circulation pump								
- Complete Package per Above Detail	E		Lot	300.0	300.0	70.0	70.0	370.0
- Prepare and Feed Soil (A-VITRF)								
- Melter Soil Feeder	E		1	150.0	150.0	30.0	30.0	180.0
- Dryer	E		Lot	180.0	180.0	36.0	36.0	216.0
- Soil Day Tank	E		1	30.0	30.0	8.0	8.0	38.0
- Soil Storage Silos	E		2	65.0	130.0	20.0	40.0	170.0
- Soil Transfer Pump	E		1	30.0	30.0	10.0	10.0	40.0
- Slag Cooling & Packaging (A-VITRF)								
- Metal Canister Capper	F		1	150.0	150.0	30.0	30.0	180.0
- Canister Decon Unit	F		1	70.0	70.0	9.0	9.0	79.0
- Canister Cooling System	F		2	75.0	150.0	40.0	80.0	230.0
- Canister Conveyor	E		30	4.0	120.0	1.0	30.0	150.0
- Grouting Unit	E		1	150.0	150.0	25.0	25.0	175.0
- Air Pollution Control								
- Quencher	E		1	200.0	200.0	4.0	4.0	204.0
- Ceramic Filters	E		2	240.0	480.0	48.0	96.0	576.0
- Primary Activated Carbon Filter	E		Lot	50.0	50.0	1.0	1.0	51.0
- Hepa Filter	E		2	170.0	340.0	65.0	130.0	470.0
- Induced Fan	E		2	15.0	30.0	3.0	6.0	36.0
- Baghouse	E							
- Stack	E		1	20.0	20.0	4.0	4.0	24.0

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1 CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
- Stack Monitor (Radioactive)	E		1	200.0	200.0	80.0	80.0	280.0
- Stack Monitor (Non-Radioactive)	E		1	150.0	150.0	60.0	60.0	210.0
- Allowance for Mechanical/Piping	E		Lot		2,985.9		1,305.6	4291.5
- Allowance for Electrical/Control	E		Lot		1,493.0		1,088.0	2581
- Calibration, Testing & Startup	E		Lot		288.6		182.8	471.4
Total Vitrification					14720.5		4752.4	19472.9
17 Certification & Shipping Subsystem	III							
- Incoming Material Storage (B-CSHIP)								
- Overhead Bridge Crane 20 TN	E		1	625.0	625	125.0	125	750
- Forklift 10 TN	E		1	65.0	65	10.0	10	75
- Inspect & Assay (B-CSHIP)								
- Transfer Cart 2 TN	E							
- Real Time Radiography (ND)								
- Passive Active Neutron (ND)								
- Segmented Gamma Spectroscopy (ND)								
- Complete Package per Above	E		2	1,500.0	3000	150.0	300	3300
- Self Guided Vehicle (ND)	E		1	425.0	425	850.0	850	1275
- Truck Loading (B-CSHIP)								
- Forklift 10 TN	E		10	65.0	650	10.0	100	750
- Roll-up Door	E		2	20.0	40	2.0	4	44
- Bridge Crane	E		1	525.0	525	105.0	105	630
- Roller Conveyor (CA)	E		20	2.0	40	1.0	20	60
- Allowance for Mechanical/Piping	E		Lot		268.5		757.0	1025.5
- Allowance for Electrical/Control	E		Lot		805.5		757.0	1562.5
- Calibration, Testing & Startup	E		Lot		128.9		121.1	250
Total Certification & Shipping Subsystem					6572.9		3149.1	9722
18 Support Subsystem	III							
- Electrical Distribution and MCC								
- Control Panel - FT	E		110	10.0	1100	2.0	220	1320
- Emergency Power Generator	E		1	500.0	500	100.0	100	600
- Main Control Panel	E		20	10.0	200	2.0	40	240
- Motor Control Center	E		100	1.5	150	0.5	50	200
- Stand by Emergency Power	E		1	230.0	230	80.0	80	310
- Utilities and Mechanical								
- Breathing Air Package	E		Lot	70.0	70	30.0	30	100
- Compressed Air Package	E		Lot	100.0	100	25.0	25	125
- Instrument Air	E		1	70.0	70	30.0	30	100
- Instrument Air Package	E		Lot	90.0	90	25.0	25	115
- Plant Steam/Boiler	E		1	75.0	75	25.0	25	100
- Service Water	E		1	130.0	130	40.0	40	170
- Sump Pump	E	3	10	5.0	50	2.0	20	70
- Cooling Tower	E		1	200.0	200	10.0	10	210
- Cooling Water Pumps	E	3	2	15.0	30	3.0	6	36
- Heating, Ventilation & Exhaust								
- Included with Building Cost								
- Radiation Monitoring								
- Air Monitors	E		44	10.0	440	2.0	88	528
- Area Monitoring	E		44	4.5	198	1.0	44	242
- Personnel Monitoring Portals	E		6	35.0	210	5.0	30	240

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Portal Monitors	E		6	35.0	210	5.0	30	240
- Allowance for Mechanical/Piping	E		Lot		40.5		8.9	49.4
- Allowance for Electrical/Control	E		Lot		608.0		134.0	742
- Calibration, Testing & Startup	E		Lot		94.0		20.7	114.7
Total Support Subsystem					4795.5		1056.6	5852.1
19 Metal Melting Subsystem	II							
- Prepare and Feed Incoming Waste (A-MMELT)								
- Bulk Solids Dump Hopper	F		1	45.0	45	10.0	10.0	55.0
- Gantry Robot	F		1	525.0	525	105.0	105.0	630.0
- Master Slave Manipulator	E		1	65.0	65	15.0	15.0	80.0
- Size Reduction Table with Tools	E		1	120.0	120	24.0	24.0	144.0
- Drum/Bin Conveyor	F		20	6.0	120	1.0	20.0	140.0
- Closed Circuit TV	E		2	10.0	20	4.0	8.0	28.0
- Airlock	E		2	124.0	248	39.0	78.0	326.0
- Dust Collection Assembly	E		1	100.0	100	15.0	15.0	115.0
- Melter (A-MMELT)								
- Melter								
- Melter Feed Assembly								
- Melter Secondary Combustion Chamber								
- Melter Oxygen Feed Controller								
- Melter Inlet Air Blower								
- Melter Discharge System								
- Melter Room Temperature Monitoring & Cooling								
- Melter Vacuum Pumps								
- Melter Slag/ Ingot Vacuum Chamber								
- Melter Hearth Removal System								
- Cost Per Package Above	F		Lot	1,200.0	1200	500.0	500.0	1,700.0
- Maintenance Crane	E		1	450.0	450	100.0	100.0	550.0
- Monorail Hoist	F		1	85.0	85	20.0	20.0	105.0
- Cool Melter (A-MMELT)								
- Melter Cooling Water Unit								
- Cooling Water Pump 150 gal/min								
- Cooling Water Pump 200 gal/min								
- Cooling Water Pump 2500 GAL								
- Elevated Water Tank								
- Cooling Tower								
- Circulation pump	E							
- Complete Package per Above Detail	E		Lot	150.0	150	60.0	60.0	210.0
- Metal Cooling & Packaging (A-MMELT)								
- Metal Canister Capper	F		1	150.0	150	50.0	50.0	200.0
- Canister Decon Unit	F		1	70.0	70	20.0	20.0	90.0
- Canister Cooling System	F		1	200.0	200	60.0	60.0	260.0
- Canister Conveyor	F		15	4.0	60	1.0	15.0	75.0
- Air Pollution Control System								
- Quench System	E		1	100	100	20	20.0	120.0
- Filter Baghouse	E		1	30	30	6	6.0	36.0
- Activated Carbon Filters	E		1	50	50	10	10.0	60.0
- HEPA Filters	E		1	50	50	10	10.0	60.0
- Stack	E		1	20	20	4	4.0	24.0

Table B-1.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 1 CWO, Desorption and Vitrification

DESCRIPTION	ENTS - 1							
	CWO, Desorption and Vitrification Case							
	FAC CAT	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Stack Monitor (Radioactive)	E		1	200	200	80	80.0	280.0
- Stack Monitor (Non-Radioactive)	E		1	150	150	60	60.0	210.0
- Allowance for Mechanical/Piping	E		Lot		1,262.4		774.0	2036.4
- Allowance for Electrical/Control	E		Lot		631.2		645.0	1276.2
- Calibration, Testing & Startup	E		Lot		122.0		108.4	230.4
-								
-								
Total Metal Melting Subsystem					6,223.6		2,817.4	9,041.0

Table B-1.2 : Development, Testing & Evaluation Cost Estimate
ENTS - 1 CWO, Desorption and Vitrification

UNIT OPERATION		ENTS - 1 CWO, Desorption and Vitrification								
		Primary Paper Evaluation Research Manpower	Bench Scale Studies Research Manpower	Sec. Paper Evaluation Research Manpower	Total Research Manpower	Bench Scale Studies Equipment \$1000	Bench Scale Studies Installation \$1000	Pilot Plant Mock-up Test Demo. Manpower	Pilot Plant Mock-up Test Bldg. \$1000	Pilot Plant Mock-up Test Equip. \$1000
1	Administration Building Subsystem									
2	Receiving & Inspection Subsystem	12			12			25	1,200	6,000
3	Aqueous Waste Treatment Subsystem	5	3	3	11	100	300	10	400	2,000
4	Organic Destruction Subsystem	18	20	4	42	500	150	30	400	4,000
5	Residue & Sludge Treatment Subsystem	13	8	4	25	500	150	30	500	2,000
6	Soft Debris Treatment Subsystem									
7	Complex Debris Treatment Subsystem									
8	Open Debris Treatment Subsystem	2	6	2	10	300	50	20	1,000	3,000
9	Bulk Soil Treatment Subsystem	10	6	2	18	200	50	10	200	500
10	Metal Decontamination Subsystem									
11	Special Waste	8	20	5	33	600	250	20	400	2,000
12	Mercury Amalgamation Subsystem	1	3		4	100	50			
13	Lead Recovery Subsystem	2	2		4	100	30			
14	Air Pollution Control Subsystem	5	3	2	10	200	50	15	400	2,000
15	Polymer Stabilization Subsystem	2	8	4	14	300	50	15	400	2,000
16	Vitrification	2	8	4	14	300	50	15	400	1,000
17	Certification & Shipping Subsystem									
18	Support Subsystem	5			5					
19	Metal Melting Subsystem									
	Unit Cost (\$/Unit)				\$150,000			\$150,000		
	Total Cost				30,300	3,200	1,180	28,500	5,300	24,500
	Post Totals To Table 4-1, Item				1.1	1.2	1.3	2.1	2.5.1	2.5.2

Table B-1.3 : Building, Equipment and Installation Cost Summary
ENTS - 1 CWO, Desorption and Vitrification

UNIT OPERATION		ENTS - 1 CWO, Desorption and Vitrification								
		Building Area					Material & Equipment Costs			Total Cost per Unit Oprtn. \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	Total Area Cost \$1000	Purchase Cost \$1000	Installation Cost \$1000	Total Cost \$1000	
1.0	Administration Building Subsystem	12,440	3,000			3,499.0	3,162.7	888.2	4,051.0	7,550.0
2.0	Receiving & Inspection Subsystem		24,227	2,970	14,839	38,966.0	18,493.5	6,774.6	25,268.0	64,234.0
3.0	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	5,287.0	4,980.2	1,516.1	6,496.0	11,783.0
4.0	Organic Destruction Subsystem		1,128	1,717	1,560	5,187.0	5,750.4	1,476.4	7,227.0	12,414.0
5.0	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	9,376.0	4,892.5	1,168.4	6,061.0	15,437.0
6.0	Soft Debris Treatment Subsystem		1,606	2,444	2,220	7,381.0	8,590.0	1,454.1	10,044.0	17,425.0
7.0	Complex Debris Treatment Subsystem									
8.0	Open Debris Treatment Subsystem		1,888	2,873	2,610	8,678.0	2,052.9	670.5	2,723.0	11,401.0
9.0	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	7,381.0	2,822.3	832.4	3,655.0	11,036.0
10.0	Metal Decontamination Subsystem		641	169	1,904	3,709.0	3,571.6	1,495.5	5,067.0	8,776.0
11.0	Special Waste		604	159	1,792	3,491.0				3,491.0
12.0	Mercury Amalgamation Subsystem		679	179	2,016	3,928.0	2,895.9	1,048.6	3,945.0	7,873.0
13.0	Lead Recovery Subsystem		830	219	2,464	4,800.0	4,027.4	1,154.9	5,182.0	9,982.0
14.0	Air Pollution Control Subsystem		955	1,453	1,320	4,389.0	2,400.8	884.5	3,285.0	7,674.0
15.0	Polymer Stabilization Subsystem		2,322	3,534	3,210	10,673.0	5,187.3	1,511.6	6,699.0	17,372.0
16.0	Vitrification		2,614	8,209	4,140	17,987.0	14,720.5	4,752.4	19,473.0	37,460.0
17.0	Certification & Shipping Subsystem		28,277			11,876.0	6,572.9	3,149.1	9,722.0	21,598.0
18.0	Support Subsystem	3,360	16,883			7,696.0	4,795.5	1,056.6	5,852.0	13,548.0
19.0	Metal Melting Subsystem		1,169	309	3,472	6,764.0	6,223.6	2,817.4	9,041.0	15,805.0
	Total Cost					161,068.0			133,791.0	294,859.0
		Post Totals To Table 4-1, Item				3.4.1			3.4.2	

Table B-1.4 : Annual Operating & Maintenance Costs
ENTS - 1 CWO, Desorption and Vitrification

UNIT OPERATION		ENTS - 1					
		CWO, Desorption and Vitrification					Totals
		Operating FTE	Utilities \$1000	Materials \$1000	Maintenance Labor (1) \$1000	Maintenance Materials (2) \$1000	
1	Administration Building Subsystem	32	5	164	318	127	445
2	Receiving & Inspection Subsystem	170	159	612	1,850	740	2,590
3	Aqueous Waste Treatment Subsystem	5	300	1,705	873	349	1,222
4	Organic Destruction Subsystem	12	298	297	1,438	575	2,013
5	Residue & Sludge Treatment Subsystem	8	21	1	855	342	1,197
6	Soft Debris Treatment Subsystem	14	708	704	2,148	859	3,007
7	Complex Debris Treatment Subsystem						
8	Open Debris Treatment Subsystem	8	25	100	360	144	504
9	Bulk Soil Treatment Subsystem	2	22	14	140	56	196
10	Metal Decontamination Subsystem	4	5	25	625	250	875
11	Special Waste	3	12	200			
12	Mercury Amalgamation Subsystem	4	2	10	508	203	711
13	Lead Recovery Subsystem	8	73	50	705	282	987
14	Air Pollution Control Subsystem	4	67	130	420	168	588
15	Polymer Stabilization Subsystem	38	118	1,858	908	363	1,271
16	Vitrification	16	37	661	1,473	589	2,062
17	Certification & Shipping Subsystem	67	12	70	658	263	921
18	Support Subsystem	5			480	192	672
19	Metal Melting Subsystem	5	79	33	623	249	872
	Unit cost (\$/unit)	\$140,000					
	Total Cost	56,630	1943	6,634			20,133
Post Totals To Table 4-1, Item		5.1	5.2	5.3			5.4

Notes:

1. Annual Maintenance Labor is 250 % of maintenance material cost.
2. Maintenance Material is assumed to be 2 % of equipment capital cost for the Bulk Soil Treatment subsystem, because the capital equipment is based on one shift operation.
3. Maintenance Material is assumed to be 10 % of equipment capital cost for organic destruction and soft debris.
4. Maintenance Material is assumed to be 4 % of equipment capital cost for Administration, Receiving & Inspection, Grout Stabilization, Certification & Shipping, and Support subsystems.
5. Maintenance Material is assumed to be 7 % of equipment capital cost for all other subsystems

Table B-1.5 : Decontamination & Decommissioning Costs
ENTS - 1 CWO, Desorption and Vitrification

UNIT OPERATION		ENTS - 1 CWO, Desorption and Vitrification				
		Building Area				Total Area Cost \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	
1	Administration Building Subsystem	12,440	3,000			6,948
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	18,916
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	2,021
4	Organic Destruction Subsystem		1,128	1,717	1,560	1,983
5	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	3,584
6	Soft Debris Treatment Subsystem		1,606	2,444	2,220	2,822
7	Complex Debris Treatment Subsystem					
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	3,317
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	2,822
10	Metal Decontamination Subsystem		641	169	1,904	1,221
11	Special Waste		604	159	1,792	1,150
12	Mercury Amalgamation Subsystem		679	179	2,016	1,293
13	Lead Recovery Subsystem		830	219	2,464	1,581
14	Air Pollution Control Subsystem		955	1,453	1,320	1,678
15	Polymer Stabilization Subsystem		2,322	3,534	3,210	4,080
16	Vitrification		2,614	8,209	4,140	6,733
17	Certification & Shipping Subsystem		28,277			12,725
18	Support Subsystem	3,360	16,883			9,109
19	Metal Melting Subsystem		1,169	309	3,472	2,228
	Total Cost					84,211
		Post Totals To Table 4-1, Item				7.0

Table B-1.6: Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Non Thermal Treatment Systems (cost module ENTS-1)

Cost component	Cost Items	ENTS - 1										
		Administration Building Subsystem	Receiving & Inspection Subsystem	Aqueous Waste Treatment Subsystem	Organic Destruction Subsystem	Residue & Sludge Treatment Subsystem	Soft Debris Treatment Subsystem	Complex Debris Treatment Subsystem	Open Debris Treatment Subsystem	Bulk Soil Treatment Subsystem	Metal Decontamination Subsystem	Special Waste
1.0	Studies and bench scale test costs											
1.1	Manpower costs during research	\$0	\$1,800	\$1,650	\$6,300	\$3,750	\$0	\$0	\$1,500	\$2,700	\$0	\$4,950
1.2	Equipment costs	\$0	\$0	\$100	\$500	\$500	\$0	\$0	\$300	\$200	\$0	\$600
1.3	Installation costs	\$0	\$0	\$300	\$150	\$150	\$0	\$0	\$50	\$50	\$0	\$250
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$0	\$180	\$205	\$695	\$440	\$0	\$0	\$185	\$295	\$0	\$580
1.5	Contingency (25 % of 1.1 through 1.4)	\$0	\$495	\$564	\$1,911	\$1,210	\$0	\$0	\$509	\$811	\$0	\$1,595
	Subtotal 1.0	\$0	\$2,475	\$2,819	\$9,556	\$6,050	\$0	\$0	\$2,544	\$4,056	\$0	\$7,975
2.0	Demonstration costs											
2.1	Manpower costs during demonstration	\$0	\$3,750	\$1,500	\$4,500	\$4,500	\$0	\$0	\$3,000	\$1,500	\$0	\$3,000
2.2	Design cost (30 % of 2.5)	\$0	\$2,786	\$929	\$1,703	\$968	\$0	\$0	\$1,548	\$271	\$0	\$929
2.3	Inspection cost (7 % of 2.5)	\$0	\$650	\$217	\$397	\$226	\$0	\$0	\$361	\$63	\$0	\$217
2.4	Project management (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90	\$0	\$310
2.5	Construction cost											
2.5.1	Building structure costs	\$0	\$1,200	\$400	\$400	\$500	\$0	\$0	\$1,000	\$200	\$0	\$400
2.5.2	Equipment costs	\$0	\$6,000	\$2,000	\$4,000	\$2,000	\$0	\$0	\$3,000	\$500	\$0	\$2,000
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$2,088	\$696	\$1,276	\$725	\$0	\$0	\$1,160	\$203	\$0	\$696
	Subtotal of 2.5	\$0	\$9,288	\$3,096	\$5,676	\$3,225	\$0	\$0	\$5,160	\$903	\$0	\$3,096
2.6	Construction management costs (17 % of 2.5)	\$0	\$1,588	\$529	\$971	\$551	\$0	\$0	\$882	\$154	\$0	\$529
2.7	Management Reserve (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90	\$0	\$310
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$4,980	\$1,723	\$3,596	\$2,529	\$0	\$0	\$2,996	\$768	\$0	\$2,098
	Subtotal 2.0	\$0	\$24,900	\$8,614	\$17,979	\$12,645	\$0	\$0	\$14,979	\$3,839	\$0	\$10,489
3.0	Production facility construction costs											
3.1	Design cost (25 % of 3.4)	\$2,435	\$20,716	\$3,800	\$4,004	\$4,979	\$5,620	\$0	\$3,677	\$3,559	\$2,830	\$1,126
3.2	Inspection cost (7 % of 3.4)	\$682	\$5,800	\$1,064	\$1,121	\$1,394	\$1,573	\$0	\$1,029	\$997	\$792	\$315
3.3	Project management (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$1,991	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450
3.4	Construction cost											
3.4.1	Building structure costs	\$3,499	\$38,966	\$5,287	\$5,187	\$9,376	\$7,381	\$0	\$8,678	\$7,381	\$3,709	\$3,491
3.4.2	Equipment costs	\$4,051	\$25,268	\$6,496	\$7,227	\$6,061	\$10,044	\$0	\$2,723	\$3,655	\$5,067	\$0
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$2,190	\$18,628	\$3,417	\$3,600	\$4,477	\$5,053	\$0	\$3,306	\$3,200	\$2,545	\$1,012
	Subtotal of 3.4	\$9,740	\$82,862	\$15,200	\$16,014	\$19,914	\$22,478	\$0	\$14,707	\$14,236	\$11,321	\$4,503
3.5	Construction management (17 % of 3.4)	\$1,666	\$14,169	\$2,599	\$2,738	\$3,405	\$3,844	\$0	\$2,515	\$2,434	\$1,936	\$770
3.6	Management Reserve (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$1,991	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450
3.7	Contingency (25 % of 3.1 through 3.5)	\$3,874	\$32,958	\$6,046	\$6,370	\$7,921	\$8,941	\$0	\$5,850	\$5,663	\$4,503	\$1,791
	Subtotal 3.0	\$20,345	\$173,077	\$31,749	\$33,449	\$41,595	\$46,952	\$0	\$30,720	\$29,737	\$23,646	\$9,405
4.0	Operations Budget Funded Activities (See Sect. 7)											
4.1	Conceptual design (1.5 % of 3.0)	\$305	\$2,596	\$476	\$502	\$624	\$704	\$0	\$461	\$446	\$355	\$141
4.2	Safety assurance (1 % of 3.0)	\$203	\$1,731	\$317	\$334	\$416	\$470	\$0	\$307	\$297	\$236	\$94
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
4.4	Preparation for operations (100 % of 5.0)	\$6,368	\$33,951	\$4,909	\$5,360	\$2,924	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790
4.5	Project Management (10 % of 4.1 through 4.4)	\$1,388	\$3,828	\$570	\$620	\$396	\$915	\$0	\$295	\$138	\$242	\$103
	Subtotal 4.0	\$15,264	\$42,106	\$6,272	\$6,816	\$4,360	\$10,063	\$0	\$3,249	\$1,521	\$2,664	\$1,128
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$35,609	\$242,558	\$49,454	\$67,800	\$64,650	\$57,015	\$0	\$51,492	\$39,153	\$26,310	\$28,997
5.0	Operating and maintenance costs											
5.1	Annual operating costs	\$4,480	\$23,800	\$700	\$1,680	\$1,120	\$1,960	\$0	\$1,120	\$280	\$560	\$420
5.2	Annual utility costs	\$5	\$159	\$300	\$298	\$21	\$708	\$0	\$25	\$22	\$5	\$12
5.3	Annual material costs	\$164	\$612	\$1,705	\$297	\$1	\$704	\$0	\$100	\$14	\$25	\$200
5.4	Annual maintenance costs	\$445	\$2,590	\$1,222	\$2,013	\$1,197	\$3,007	\$0	\$504	\$196	\$875	\$0
5.5	Contingency (25 % of 5.1 through 5.4)	\$1,274	\$6,790	\$982	\$1,072	\$585	\$1,595	\$0	\$437	\$128	\$366	\$158
5.6	Subtotal 5.0	\$6,368	\$33,951	\$4,909	\$5,360	\$2,924	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$127,360	\$679,020	\$98,180	\$107,200	\$58,480	\$159,480	\$0	\$43,720	\$12,800	\$36,620	\$15,800
6.0	Decontamination & Decommissioning	\$6,948	\$18,916	\$2,021	\$1,983	\$3,584	\$2,822	\$0	\$3,317	\$2,822	\$1,221	\$1,150
7.0	ROM Life cycle costs (20 year operation)	\$169,917	\$940,494	\$149,655	\$176,983	\$126,714	\$219,317	\$0	\$98,529	\$54,775	\$64,151	\$45,947

Table B-1.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Non Thermal Treatment Systems (cost module ENT-1)

Cost component	Cost Items	ENTS - 1	ENTS - 1	ENTS - 1	ENTS - 1	ENTS - 1	ENTS - 1	ENTS - 1	ENTS - 1	ENTS - 1
		Mercury Amalgamation Subsystem	Lead Recovery Subsystem	Air Pollution Control Subsystem	Polymer Stabilization Subsystem	Vitrification	Certification & Shipping Subsystem	Support Subsystem	Metal Melting Subsystem	Total System
1.0	Studies and bench scale test costs									
1.1	Manpower costs during research	\$600	\$600	\$1,500	\$2,100	\$2,100	\$0	\$750	\$0	\$30,300
1.2	Equipment costs	\$100	\$100	\$200	\$300	\$300	\$0	\$0	\$0	\$3,200
1.3	Installation costs	\$50	\$30	\$50	\$50	\$50	\$0	\$0	\$0	\$1,180
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$75	\$73	\$175	\$245	\$245	\$0	\$75	\$0	\$3,468
1.5	Contingency (25 % of 1.1 through 1.4)	\$206	\$201	\$481	\$674	\$674	\$0	\$206	\$0	\$9,537
	Subtotal 1.0	\$1,031	\$1,004	\$2,406	\$3,369	\$3,369	\$0	\$1,031	\$0	\$47,685
2.0	Demonstration costs									
2.1	Manpower costs during demonstration	\$0	\$0	\$2,250	\$2,250	\$2,250	\$0	\$0	\$0	\$28,500
2.2	Design cost (30 % of 2.5)	\$0	\$0	\$929	\$929	\$542	\$0	\$0	\$0	\$11,533
2.3	Inspection cost (7 % of 2.5)	\$0	\$0	\$217	\$217	\$126	\$0	\$0	\$0	\$2,691
2.4	Project management (10 % of 2.5)	\$0	\$0	\$310	\$310	\$181	\$0	\$0	\$0	\$3,844
2.5	Construction cost									
	2.5.1 Building structure costs	\$0	\$0	\$400	\$400	\$400	\$0	\$0	\$0	\$5,300
	2.5.2 Equipment costs	\$0	\$0	\$2,000	\$2,000	\$1,000	\$0	\$0	\$0	\$24,500
	2.5.3 Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$0	\$696	\$696	\$406	\$0	\$0	\$0	\$8,642
	Subtotal of 2.5	\$0	\$0	\$3,096	\$3,096	\$1,806	\$0	\$0	\$0	\$38,442
2.6	Construction management costs (17 % of 2.5)	\$0	\$0	\$529	\$529	\$309	\$0	\$0	\$0	\$6,574
2.7	Management Reserve (10 % of 2.5)	\$0	\$0	\$310	\$310	\$181	\$0	\$0	\$0	\$3,844
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$0	\$1,910	\$1,910	\$1,349	\$0	\$0	\$0	\$23,857
	Subtotal 2.0	\$0	\$0	\$9,551	\$9,551	\$6,744	\$0	\$0	\$0	\$119,285
3.0	Production facility construction costs									
3.1	Design cost (25 % of 3.4)	\$2,539	\$3,219	\$2,475	\$5,603	\$12,081	\$6,965	\$4,369	\$5,097	\$95,092
3.2	Inspection cost (7 % of 3.4)	\$711	\$901	\$693	\$1,569	\$3,383	\$1,950	\$1,223	\$1,427	\$26,626
3.3	Project management (10 % of 3.4)	\$1,016	\$1,288	\$990	\$2,241	\$4,832	\$2,786	\$1,748	\$2,039	\$38,037
3.4	Construction cost									
	3.4.1 Building structure costs	\$3,928	\$4,800	\$4,389	\$10,673	\$17,987	\$11,876	\$7,696	\$6,764	\$161,068
	3.4.2 Equipment costs	\$3,945	\$5,182	\$3,285	\$6,699	\$19,473	\$9,722	\$5,852	\$9,041	\$133,791
	3.4.3 Indirect (29 % of 3.4.1 & 3.4.2)	\$2,283	\$2,895	\$2,225	\$5,038	\$10,863	\$6,263	\$3,929	\$4,583	\$85,509
	Subtotal of 3.4	\$10,156	\$12,877	\$9,899	\$22,410	\$48,323	\$27,861	\$17,477	\$20,388	\$380,368
3.5	Construction management (17 % of 3.4)	\$1,737	\$2,202	\$1,693	\$3,832	\$8,263	\$4,764	\$2,989	\$3,486	\$65,043
3.6	Management Reserve (10 % of 3.4)	\$1,016	\$1,288	\$990	\$2,241	\$4,832	\$2,786	\$1,748	\$2,039	\$38,037
3.7	Contingency (25 % of 3.1 through 3.5)	\$4,040	\$5,122	\$3,938	\$8,914	\$19,221	\$11,082	\$6,952	\$8,109	\$151,292
	Subtotal 3.0	\$21,215	\$26,897	\$20,678	\$46,810	\$100,935	\$58,194	\$36,506	\$42,585	\$794,495
4.0	Operations Budget Funded Activities (See Sect. 7)									
4.1	Conceptual design (1.5 % of 3.0)	\$318	\$403	\$310	\$702	\$1,514	\$873	\$548	\$639	\$11,917
4.2	Safety assurance (1 % of 3.0)	\$212	\$269	\$207	\$468	\$1,009	\$582	\$365	\$426	\$7,945
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$7,000
4.4	Preparation for operations (100 % of 5.0)	\$1,604	\$2,788	\$1,681	\$10,621	\$6,250	\$12,979	\$1,715	\$2,105	\$106,675
4.5	Project Management (10 % of 4.1 through 4.4)	\$213	\$346	\$220	\$1,179	\$877	\$1,443	\$263	\$317	\$13,354
	Subtotal 4.0	\$2,347	\$3,806	\$2,418	\$12,970	\$9,650	\$15,877	\$2,891	\$3,487	\$146,891
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$24,593	\$31,707	\$35,053	\$72,700	\$120,698	\$74,071	\$40,428	\$46,072	\$1,108,356
5.0	Operating and maintenance costs									
5.1	Annual operating costs	\$560	\$1,120	\$560	\$5,250	\$2,240	\$9,380	\$700	\$700	\$56,630
5.2	Annual utility costs	\$2	\$73	\$67	\$118	\$37	\$12	\$0	\$79	\$1,943
5.3	Annual material costs	\$10	\$50	\$130	\$1,858	\$661	\$70	\$0	\$33	\$6,634
5.4	Annual maintenance costs	\$711	\$987	\$588	\$1,271	\$2,062	\$921	\$672	\$872	\$20,133
5.5	Contingency (25 % of 5.1 through 5.4)	\$321	\$558	\$336	\$2,124	\$1,250	\$2,596	\$343	\$421	\$21,335
5.6	Subtotal 5.0	\$1,604	\$2,788	\$1,681	\$10,621	\$6,250	\$12,979	\$1,715	\$2,105	\$106,675
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$32,080	\$55,760	\$33,620	\$212,420	\$125,000	\$259,580	\$34,300	\$42,100	\$2,133,500
6.0	Decontamination & Decommissioning	\$1,293	\$1,581	\$1,678	\$4,080	\$6,733	\$12,725	\$9,109	\$2,228	\$84,211
7.0	ROM Life cycle costs (20 years operation)	\$57,966	\$89,048	\$70,351	\$289,200	\$252,431	\$346,376	\$83,837	\$90,400	\$3,326,067

B-2 ENTS-2 Cost Tables

- B-2.1. Equipment Purchase and Installation Budget Estimates
- B-2.2. Development, Testing and Evaluation Cost Estimate
- B-2.3. Building, Equipment and Installation Cost Summary
- B-2.4. Annual Operating and Maintenance Costs
- B-2.5. Decontamination and Decommissioning Costs
- B-2.6. Total Life-Cycle Cost (without Disposal) Estimate Summary for Enhanced Integrated Nonthermal Treatment Systems

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2 CWO and Vitrification								
	FAC. CAT.	HP	MATLS. & EQUIP.			INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's		
1 Administration Building Subsystem	III								
- Administration Office									
- Office Furniture - EMPLOYEE	E		49	49	7.0	343	1.0	49	392
- Computers	E		Lot	1	500.0	500	50.0	50	550
- Communication	E		Lot	1	250.0	250	35.0	35	285
- Testing Laboratory									
- ICP-Mass Spectrometer	D		1	1					
- Gas Chromatography - Mass Spec.	D		1	1					
- Scintillation Counter - Alpha	D		1	1					
- Scintillation Counter - Gamma	D		1	1					
- Geiger - Muller Counter	D		1	1					
- Fume Hood	A		2	2					
- Centrifuge	A		2	2					
- Autoclave	A		1	1					
- Scrubber/Blower	C		1	1					
- Hood/HEPA Filtration	C		1	1					
- Glovebox	D		1	1					
- Wet Chemistry Equipment	D		1	1					
- Refrigeration / Storage	A		1	1					
- Computer & Data Communication	D		2	2					
- Atomic Absorption Spectrography	D		1	1					
- Soil / Physical Testing Equipment	D		Lot	1					
- Complete Package per Above Detail	E		Lot	1	1,500.0	1500	300.0	300	1800
- Office Equipment & Furnishing	E		Lot	1	80.0	80	7.0	7	87
- Allowance for Mechanical/Piping	E		Lot	1	26.7	26.7	132.3	132.3	159
- Allowance for Electrical/Control	E		Lot	1	401.0	401	264.6	264.6	665.6
- Calibration, Testing & Startup	E		Lot	1	62.0	62	50.3	50.3	112.3
-									
-									
-									
- Total Administration Building Subsystem						3162.7		888.2	4050.9
2 Receiving & Inspection Subsystem	I								
- Unloading, Staging & Storage (A-RCINS)									
- O/H Bridge Crane & Rigging - 20 TN	E		1	1	625.0	625	125.0	125	750
- Forklift - 10 TN	E		2	2	65.0	130	10.0	20	150
- Airlock	E		1	1	124.0	124	39.0	39	163
- Inspect & Assay (A-RCINS)									
- Transfer Cart - 2 TN	B								
- Gamma Spectroscopy (GS)	D								
- Passive Active Neutron Assay (PAN)	D								
- Real Time Radiography (RTR)	D								
- Load Cell	D								
- Closed Circuit TV	D								
- RHMMS Barrel Monitor including above	E		1	1	2,000.0	2000	400.0	400	2400
- Personnel Contamination Monitor	E		1	1	35.0	35	5.0	5	40
- Container Decontamination Enclosure	E		1	1	140.0	140	15.0	15	155
- Open, Dump, & Sort									
- Self Guided Vehicle	E		2	2	425.0	850	64.0	128	978
- Decap Device	E		3	3	50.0	150	9.0	27	177
- Sort Hopper	E		5	5	40.0	200	4.0	20	220
- Sort/Rotating Table	E		5	5	200.0	1000	30.0	150	1150
- Special Waste Glove Box	E		1	1	400.0	400	48.0	48	448
- Dump Hopper	E		6	6	40.0	240	4.0	24	264
- Maintenance Crane	E		1	1	800.0	800	120.0	120	920
- Bins	E		80	80	5.0	400	1.0	80	480
- Bin Conveyor 8 ft long	E		20	20	10.0	200	4.0	80	280
- Bin Conveyor 70 ft long	E		2	2	70.0	140	28.0	56	196
- Bin Pusher	E		34	34	10.0	340	4.0	136	476
- Main Cell Gantry Robot	E		1	1	2,000.0	2000	400.0	400	2400

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2 CWO and Vitrification							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Sorting Table Hydraulic Manipulator	E		2	2	120.0	240	40.0	320
- Sorting Master Slave Manipulator	E		5	5	100.0	500	40.0	700
- Box Size Reduction Unit	E		1	1	1,500.0	1500	400.0	1900
- Drum Opening Gantry Robot	E		2	2	400.0	800	80.0	960
- Glovebox Hydraulic Manipulator	E		2	2	120.0	240	40.0	320
- Container Grapppler	E		4	4	50.0	200	8.0	232
- Decap Enclosure	E		3	3	100.0	300	30.0	390
- Bin Hoist / Pusher	B	5	1	1	33	66	8	74
- Discharge. & Oversize Load Hopper (100 CF)	B	1	1	1	25	50	7	57
- Primary Shredder (.25, 1.5, 2 Tons/hr)	E	250	1	1	375	375	75	450
- Secondary Shredder (.5, 1.5, 3 Tons/hr)	E	60	1	1	160	160	32	192
- Live Bottom Bulk Storage	B	1	1	1	25	50	7	57
- Conveyor / Canister Handler	B	5	1	1	40	80	10	90
- Dust Collection System w/ Blower	E		Lot	1	108	108	17	125
- HEPA Filter	E		2	2	25	50	5	60
- Closed Circuit TV	E		8	8	10.0	80	2.0	96
- Airlock	E		4	4	124.0	496	39.0	652
- Roll up Door (CA)	E		2	2	20.0	40	2.0	44
- Allowance for Mechanical/Piping	E		Lot	1	755.5	755.5	1,628.5	2384
- Allowance for Electrical/Control	E		Lot	1	2,266.4	2266.4	1,628.5	3894.9
- Calibration, Testing & Startup	E		Lot	1	362.6	362.6	260.6	623.2
Total Receiving & Inspection Subsystem						18493.5	6774.6	25268.1
3 Aqueous Waste Treatment Subsystem	II							
- Batch Liquid Waste (A-AQWTR)								
- High TOC Batch Tank with Agitator	E		1	1	27.0	27	5.0	32
- High TOC Batch Tank Pump	E		1	1	5.0	5	1.0	6
- Low TDS Batch Tank with Agitator	E		1	1	27.0	27	5.0	32
- Low TDS Batch Tank Pump	E		1	1	5.0	5	1.0	6
- High TDS/ Heavy Metals Batch Tank with Agitator	E		1	1	27.0	27	5.0	32
- High TDS/ Heavy Metals Batch Tank Pump	E		1	1	5.0	5	1.0	6
- Hg Batch Tank with Agitator	E		1	1	27.0	27	5.0	32
- Hg Batch Tank Pump	E		1	1	5.0	5	1.0	6
- Airlocks	E		2	2	124.0	248	39.0	326
- Closed Circuit TV	E		5	5	10.0	50	2.0	60
- Crane	E		1	1	525.0	525	105.0	630
- Shield Window	E		1	1	130	130	44	174
- Gross Organics Removal (A-AQWTR)								
- Oil/ Water Separator	E		1	1	18.0	18	2.5	20.5
- Neutralization / Settling (A-AQWTR)								
- Neutralization System	E		1	1	95.0	95	19.0	114
- Neutralization Overflow Pump	E		1	1	5.0	5	1.0	6
- Sludge Transfer Pump	E		1	1	5.0	5	1.0	6
- Sludge Settler	E		1	1	27.0	27	5.0	32
- Sludge Settler Pump	E		1	1	5.0	5	1.0	6
- Suspended Solids Filtration (A-AQWTR)								
- Suspended Solids Filter	E		1	1	125.0	125	25.0	150
- Concentration (A-AQWTR)								
- Evaporator with Condenser	E		2	2	300.0	600	75.0	750
- Evaporator Liquids Pump	E		2	2	5.0	10	1.0	12
- Calcium Carbonate Removal								
- Tank with Agitator	E		1	1	27.0	27	5.0	32
- Transfer Pump	E		4	4	5.0	20	1.0	24
- Decanter Centrifuge	E		1	1	450.0	450	60.0	510
- Holding Tank	E		1	1	7.0	7	1.5	8.5
- Slurry Pump	E		1	1	5.0	5	1.0	6
- Filter	E		2	2	2.5	5	0.5	6
- Dissolved Organics Removal								

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2								
	CWO and Vitrification								
	FAC. CAT.	HP	MATLS. & EQUIP.				INST. COSTS		
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.	
- Ozone Generator System	E								
- UV/Peroxide System	E								
- Ozone Decomposer	E								
- Complete Package per Above Detail	E		Lot	1	125.0	125	25.0	25	150
- Liquid-Phase Carbon (55-gal drum)	F		4	4	0.8	3.2	0.1	0.4	3.6
- Concentrator									
- Vapor Phase Carbon	F		2	2	16.0	32	3.0	6	38
- Evaporator with Condenser	E		1	1	500.0	500	75.0	75	575
- Condenser Liquids Pump	E		1	1	5.0	5	1.0	1	6
- Dissolved Solids Removal									
- Ion Exchanger	E		1	1	61.0	61	9.0	9	70
- Treated Water Sampling									
- Treated Water Tanks	E		2	2	45.0	90	12.0	24	114
- Treated Water Pumps	E		2	2	5.0	10	1.0	2	12
- Chemical Distribution									
- Chemical Addition Pump (Acid)	E		1	1	5.0	5	1.0	1	6
- Chemical Addition Pump (Caustic)	E		1	1	5.0	5	1.0	1	6
- Chemical Addition Pump (Sulfide)	E		1	1	5.0	5	1.0	1	6
- Chemical Addition Pump (Floc/ Polymer)	E		1	1	1.0	1	0.3	0.3	1.3
- Chemical Storage Tanks	E		4	4	7.0	28	1.5	6	34
- Chemical Addition Pump (Peroxide)	E		1	1	5.0	5	1.0	1	6
- Peroxide Storage Tank	E		1	1	7.0	7	1.5	1.5	8.5
- Allowance for Mechanical/Piping	E		Lot	1	1,010.2	1010.2	416.5	416.5	1426.7
- Allowance for Electrical/Control	E		Lot	1	505.1	505.1	347.1	347.1	852.2
- Calibration, Testing & Startup	E		Lot	1	97.7	97.7	58.3	58.3	156
Total Aqueous Waste Treatment Subsystem						4980.2		1516.1	6496.3
4 Organic Destruction Subsystem	II								
- Prepare and Feed Incoming Waste									
- Feed Conveyor Lift/ Hoist/ Bins	E		Lot	1	50	50	8	8	58
- Discharge and Loading Hoppers	E		Lot	1	45	45	8	8	53
- Feed Blender	E		Lot	1	45	45	8	8	53
- Detox Process									
- Reaction Vessel	E								
- Reflux Condenser	E								
- Filter	E								
- Solids Feeder	E								
- Solution Cooler	E								
- Overhead Condenser	E								
- Pumps	E								
- Condensate Catch	E								
- Neutralization Tanks	E								
- Filtered Solids Rinse Tanks	E								
- Oil Heating and Cooling System	E								
- Total Cost For Above Package	E		Lot	1	2400	2400	300	300	2700
- Miscellaneous									
- Neutralization System	E		1	1	95	95	19	19	114
- Neutralization Overflow Pump	E		1	1	5	5	1	1	6
- Sludge Transfer Pump	E		1	1	5	5	1	1	6
- Crane	E		1	1	525	525	105	105	630
- Closed Circuit TV	E		8	8	10	80	2	16	96
- Airlock	E		2	2	124	248	39	78	326
- Shield Window	E		3	3	130	390	44	132	522
- Allowance for Mechanical/Piping	E		Lot	1	1,166.4	1166.4	405.6	405.6	1572
- Allowance for Electrical/Control	E		Lot	1	583.2	583.2	338.0	338	921.2
- Calibration, Testing & Startup	E		Lot	1	112.8	112.8	56.8	56.8	169.6
Total Organic Destruction Subsystem						5750.4		1476.4	7226.8

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION		ENTS 2 CWO and Vitrification							
		FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			
				QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
5	Residue & Sludge Treatment Subsystem	II							
	- Feed Preparation and Size Reduction								
	- Feed Conveyor Lift/Hoist/Bins	E		1	1				
	- Discharge, & Oversize Load Hopper (100 CF)	E		1	1				
	- Manipulate Crane 10 TN	E	15	1	1				
	- Shield Window	E		1	1				
	- Airlock	E		2	2				
	- Closed Circuit TV	E		10	10				
	- Feed Blender	E		1	1				
	- Dewatering System	E		1	1				
	- THERMAL DESORPTION								
	- High Vacuum Dryer			1	1				
	- Nitrogen gas storage and feed tank	E		1	1				
	- Vacuum Pump	E		1	1				
	- Filter	E		1	1				
	- Hot Oil System								
	- Oil Storage and Feed Tank	E		1	1				
	- Oil Heater	E		1	1				
	- Fuel Storage and Feed Tank	E		1	1				
	- Condensers								
	- HEPA Filter for particulates	E		1	1				
	- Induced Air Fan	E		1	1				
	- Primary Condensers (Air Cooler)	E		1	1				
	- Secondary Condensers (Water Chiller)	E		2	2				
	- Total per Package Above	E		Lot	1				
	-								
	- Mercury Removal System								
	- Mercury Precipitation Tank	E		1	1				
	- Iodine Recovery Tank	E		1	1				
	- KI/I2 Storage and Feed	E		1	1				
	- Metal Precipitation Tank	E		1	1				
	- Mercury Reduction Tank	E		1	1				
	- Solids Wash Tank	E		1	1				
	- Water Holding Tank	E		1	1				
	- Acid Holding and Feed Tank	E		1	1				
	- H2O2 Holding and Feed Tank	E		1	1				
	- Lime Holding Tank	E		1	1				
	- Rinse Tank	E		1	1				
	- Filter	E		1	1				
	- Pump	E		10	10				
	-								
	- Allowance for Mechanical/Control/Instrumentation	E		Lot	1				
	- Allowance For Electrical/Control	E		Lot	1				
	- Calibration, Testing & Startup	E		Lot	1				
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Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2 CWO and Vitrification							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost for Above Package	E		Lot	1	4300	4300	430	430
- Miscellaneous								
- Neutralization System	E		1	1	95	95	19	19
- Neutralization Overflow Pump	E		1	1	5	5	1	1
- Sludge Transfer Pump	E		1	1	5	5	1	1
- Crane	E		1	1	525	525	105	105
- Closed Circuit TV	E		10	10	10	100	2	20
- Airlock	E		2	2	124	248	39	78
- Shield Window	E		3	3	130	390	44	44
- Allowance for Mechanical/Control/Instrumentation	E		Lot	1	1,742.4	1742.4	216.6	216.6
- Allowance For Electrical/Control	E		Lot	1	871.2	871.2	433.2	433.2
- Calibration, Testing & Startup	E		Lot	1	168.4	168.4	82.3	82.3
-								
-								
Total Soft Debris Treatment Subsystem						8590		1454.1
7. Complex Debris Treatment Subsystem								
- Costs included with Grout								
-								
-								
Total Complex Debris Treatment Subsystem								
8. Open Debris Treatment Subsystem	II							
- Feed Preparation and Separation								
- Bulk Solids Dump Hopper	F		1	1	40	40	4	4
- Bin Hoist/Pusher	E		2	2	33	66	8	16
- Drum/Bin Conveyor	E		6	6	10	60	4	24
- OH Crane	E		1	1	525	525	105	105
- Closed Circuit TV	E		7	7	10	70	2	14
- Airlock	E		2	2	124	248	39	78
- Shield Window	E		1	1	130	130	44	44
- Dust Collection Assembly	E		Lot	1	108	108	17	17
- High Pressure Wash								
- Receptacle Basket								
- Water Pump								
- Agitation Pump								
- Surfactant Preparation								
- Surfactant Pump								
- Surfactant Holding Tank								
- Mixing Tank with Agitator								
- Solution High Pressure Pump								
- Water Heater								
- Water Holding Tank								
- Water Pump								
- Gross Organic Removal								
- Oil/Water Separator								
- Recycle Pump								
- Oil Pump								
- Water Treatment								
- Bag Filter								
- Solids Bin								
- Neutralization Tank								
- Chemical Addition Pump (Acid)								
- Chemical Storage Tank								
- Liquid-Phase Carbon								
- Ion Exchange Unit								

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2								
	CWO and Vitrification								
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS				Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's		
- Treated Water Holding Tank									
- Treated Water Pump									
- Total Per Wash Package Above	A		Lot	1	47	141	5	5	146
- Allowance for Mechanical/Control/Instrumentation	E		Lot	1	416.4	416.4	184.2	184.2	600.6
- Allowance For Electrical/Control	E		Lot	1	208.2	208.2	153.5	153.5	361.7
- Calibration, Testing & Startup	E		Lot	1	40.3	40.3	25.8	25.8	66.1
Total Open Debris Treatment Subsystem						2052.9		670.5	2723.4
9 Bulk Soil Treatment Subsystem	II								
- Feed Preparation and Size Reduction									
- Feed Conveyor Lift/Hoist/Bins	E		1	1	30	30	6	6	36
- Discharge. & Oversize Load Hopper	E		1	1	11	11	2	2	13
- Slurry Mix Tank	E		1	1	20	20	4	4	24
- Feed Pump	E		1	1	5	5	1	1	6
- Water Pump	E		1	1	5	5	1	1	6
- Airlock	E		2	2	124	248	39	78	326
- Closed Circuit TV	E		7	7	10	70	2	14	84
- Shield Window	E		1	1	130	130	44	44	174
- Wash System									
- Attrition Mill	D		1	1	25	37.5	5	5	42.5
- Extraction Tank with Agitator	D		1	1	50	74.4	10	9.9	84.3
- Water Pump	E		1	1	5	5	1	1	6
- Slurry Pump	E		1	1	5	5	1	1	6
- Off-Gas Control									
- Heat Exchanger	E		2	2	6	12	0.4	0.8	12.8
- Solid/ Liquid Separation System	E								
- Vibrating Screen	E		1	1	6	6	1	1	7
- Hydrocyclone	D		2	2	4.5	13.5	0.4	0.8	14.3
- Countercurrent Solid/ Liquid Contactor	B		1	1	160	320	32	32	352
- Water Pump	E		1	1	5	5	1	1	6
- Slurry Pump	E		1	1	5	5	1	1	6
- Diaphragm Pump	E		1	1	1	1	0.2	0.2	1.2
- Solids Bin	E		1	1	5	5	1	1	6
- Overhead Crane	E		1	1	525	525	105	105	630
- Solubility Reduction Separator									
- Phase Separator	B		1	1	4.8	9.6	1	1	10.6
- Additive Addition Pump	E		1	1	1	1	0.3	0.3	1.3
- Surfactant Phase Pump	E		1	1	5	5	1	1	6
- Water Phase Pump	E		1	1	5	5	1	1	6
- Storage Tanks (Water and Concentrate)	E		2	2	2	4	0.4	0.8	4.8
- UltraFiltration Unit	E		1	1	50	50	10	10	60
- Recycle Pump	E		1	1	5	5	1	1	6
- Water Pump	E		1	1	5	5	1	1	6
- Dissolved Air Floatation Unit	E		1	1	50	50	7.5	7.5	57.5
- Surfactant Preparation									
- Water Hold Tank	E		1	1	2	2	0.2	0.2	2.2
- Water Heater	E		1	1	0.6	0.6	0.1	0.1	0.7
- Surfactant Hold Tank	E		1	1	2	2	0.2	0.2	2.2
- Water Pump	E		1	1	5	5	1	1	6
- Surfactant Pump	E		1	1	5	5	1	1	6
- Dilution Tank Agitator	E		1	1	1.5	1.5	0.2	0.2	1.7
- Dilution Tank Pump	E		1	1	5	5	1	1	6
- Surfactant Dilution Tank	E		1	1	2.0	2	0.4	0.4	2.4
- Drier	E		1	1	100.0	100	30.0	30	130
- Surfactant Separation									
- Additive Pump	E		4	4	1	4	0.3	1.2	5.2
- Additive Tanks	E		1	1	3.2	3.2	0.5	0.5	3.7

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION		ENTS 2							
		CWO and Vitrification							
		FAC. CAT.	HP	MATLS. & EQUIP.			INST. COSTS		
				QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Surfactant Separation Unit	B		1	1	50	100	10	10	110
- Recycle Pump	E		1	1	5	5	1	1	6
- Water Pump	E		1	1	5	5	1	1	6
- Allowance for Mechanical/Control/Instrumentation	E		Lot	1	572.5	572.5	228.7	228.7	801.2
- Allowance For Electrical/Control	E		Lot	1	286.2	286.2	190.6	190.6	476.8
- Calibration, Testing & Startup	E		Lot	1	55.3	55.3	32.0	32	87.3
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Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2								
	CWO and Vitrification								
	FAC. CAT.	HP	MATLS. & EQUIP.				INST. COSTS		
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.	
- Quencher	E		1	1	57.0	57.0	12.0	12.0	69.0
- Dry Gas Filter	E		1	1	160.0	160.0	25.0	25.0	185.0
- Carbon Adsorbers	E		2	2	10.0	20.0	1.0	2.0	22.0
- HEPA Filters	E		1	1	52.0	52.0	7.0	7.0	59.0
- Vacuum Pump	E		1	1	15.0	15.0	3.0	3.0	18.0
- ID Blower	E		1	1	15.0	15.0	3.0	3.0	18.0
- Stack (3' ø x 30')	E		1	1	20.0	20.0	5.0	5.0	25.0
- Stack Monitor	E		Lot	1	350.0	350.0	140.0	140.0	490.0
- Mercury Amalgamation & Packaging (A-RMERC)									
- Liquid Mercury Storage Tank	E		1	1	7.0	7.0	1.0	1.0	8.0
- Liquid Mercury Pump	E		1	1	5.0	5.0	1.0	1.0	6.0
- Copper Powder Bin (1 ft³)	E		1	1	5.0	5.0	0.6	0.6	5.6
- Steel Shot Bin (0.5 ft³)	E		1	1	5.0	5.0	0.6	0.6	5.6
- Nitric Acid Tank (1 GAL)	E		1	1	5.0	5.0	0.5	0.5	5.5
- Nitric Acid Pump (1 gal/hr)	E		1	1	5.0	5.0	1.0	1.0	6.0
- Amalgam Mixer (5 GAL)	F		1	1	26.0	26.0	5.0	5.0	31.0
- Amalgam packager	F		1	1	2.0	2.0	0.4	0.4	2.4
- Allowance for Mechanical/Piping	E		Lot	1	587.4	587.4	288.1	288.1	875.5
- Allowance for Electrical/Control	E		Lot	1	293.7	293.7	240.1	240.1	533.8
- Calibration, Testing & Startup	E		Lot	1	56.8	56.8	40.3	40.3	97.1
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Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION		ENTS 2								
		CWO and Vitrification								
		FAC. CAT.	HP	MATLS. & EQUIP.			INST. COSTS			
QTY	Unit Cost \$1000's			Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.			
-	Assay Station	F		1	1	500.0	500.0	3.0	3.0	503.0
-	Drum Washer	E		1	1	70.0	70.0	10.0	10.0	80.0
-	Miscellaneous Equipment									
-	Transfer Cart (CA)	E		1	1	100.0	100.0	20.0	20.0	120.0
-	Air Pollution Control									
-	Quencher System	E		1	1	100.0	100.0	20.0	20.0	120.0
-	Baghouse	E		1	1	30.0	30.0	6.0	6.0	36.0
-	Activate Carbon	E		1	1	50.0	50.0	10.0	10.0	60.0
-	HEPA Filter	E		1	1	50.0	50.0	10.0	10.0	60.0
-	Stack	E		1	1	20.0	20.0	4.0	4.0	24.0
-	Stack Monitor (Radioactive)	E		Lot	1	200.0	200.0	80.0	80.0	280.0
-	Stack Monitor (Non-Radioactive)	E		Lot	1	150.0	150.0	60.0	60.0	210.0
-	Allowance for Mechanical/Piping	E		Lot	1	816.9	816.9	317.3	317.3	1134.2
-	Allowance for Electrical/Control	E		Lot	1	408.5	408.5	264.4	264.4	672.9
-	Calibration, Testing & Startup	E		Lot	1	79.0	79	44.4	44.4	123.4
-										
-										
-	Total Lead Recovery Subsystem						4027.4		1154.9	5182.3
14	Air Pollution Control Subsystem	II								
-	Particulate Filter									
-	Baghouse Assembly	E		1	1	240.0	240	48.0	48	288
-	Prefilter	E		2	2	26.0	52	12.0	24	76
-	Inter Connection Ducts.	E		Lot	1	2.0	2	10.0	10	12
-	Corona Reactor									
-	Reactor									
-	Skid & Instrumentation									
-	Power Supply									
-	Cost per Package Above	E		Lot	1	73.0	73	7.0	7	80
-	Acid Gas Scrubber									
-	Packing Tower	E		1	1	45.0	45	13.0	13	58
-	Induced Fan	E		2	2	4.5	9	0.5	1	10
-	Recycle Pump	E		2	2	1.8	3.6	0.2	0.4	4
-	Sludge Discharge Pump	E		2	2	2.7	5.4	0.5	1	6.4
-	Caustic Feed Pump	E		2	2	0.9	1.8	0.2	0.4	2.2
-	NaOH Transfer Pump	E		2	2	0.9	1.8	0.2	0.4	2.2
-	Caustic Storage Tank	E		1	1	0.9	0.9	0.2	0.2	1.1
-	Slurry Pump	E		2	2	2.7	5.4	0.5	1	6.4
-	Condensate Tank	E		1	1	0.9	0.9	0.2	0.2	1.1
-	NaOH Day Tank	E		1	1	0.9	0.9	0.2	0.2	1.1
-	Scrubber Solution Tank	E		1	1	0.9	0.9	0.2	0.2	1.1
-	Evaporator System	E		1	1	54.0	54	16.2	16.2	70.2
-	Hydrosonic Scrubber	E		1	1	27.0	27	5.4	5.4	32.4
-	Liquid/ Solid Separator	E		1	1	18.0	18	3.6	3.6	21.6
-	Mist Eliminator	E		1	1	1.6	1.6	0.4	0.4	2
-	Heat Exchanger	E		2	2	5.4	10.8	1.8	3.6	14.4
-	Carbon Adsorption									
-	Carbon Filter (GAC)	F		2	2	9.0	18	1.8	3.6	21.6
-	Carbon Filter (Sublimated GAC)	F		2	2	9.0	18	1.8	3.6	21.6

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION		ENTS 2							
		CWO and Vitrification							
		FAC. CAT.	HP	MATLS. & EQUIP.			INST. COSTS		
				QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Support System									
- Stack	E		1	1	7.2	7.2	1.4	1.4	8.6
- Stack Monitors - Radioactive	E		Lot	1	56.0	56	14.4	14.4	70.4
- Stack Monitors - Non Radioactive	E		Lot	1	27.0	27	10.8	10.8	37.8
- OH Crane	E		1	1	525.0	525	105.0	105	630
- Airlock	E		2	2	124.0	248	39.0	78	326
- Closed Circuit TV	E		4	4	10.0	40	2.0	8	48
- Shield Window	E		1	1	130	130	44	44	174
- Allowance for Mechanical/Piping	E		Lot	1	487.0	487	243.0	243	730
- Allowance for Electrical/Control	E		Lot	1	243.5	243.5	202.5	202.5	446
- Calibration, Testing & Startup	E		Lot	1	47.1	47.1	34.0	34	81.1
-									
- Total Air Pollution Control Subsystem						2400.8		884.5	3285.3
15 Polymer Stabilization Subsystem	I								
- Prepare & Feed Incoming Waste (A-PLYMR)									
- Bin Hoist / Pusher	F	5	1	1	100.0	100	8.0	8	108
- Discharge. & Oversize Load Hopper (100 CF)	F	1	1	1	60.0	60	9.0	9	69
- Tertiary Shredder	B	50	1	1	50.0	100	10.0	10	110
- Live Bottom Bulk Storage	F	1	1	1	60.0	60	9.0	9	69
- Conveyor / Canister Handler	F	5	1	1	80.0	80	10.0	10	90
- Manipulation Crane - 5 TON	E	10	1	1	525.0	525	105.0	105	630
- Dust Collection System w/ Blower	F		1	1	108.0	108	17.0	17	125
- HEPA Filter	F		8	8	25.0	200	5.0	40	240
- Closed Circuit TV	E		13	13	10.0	130	2.0	26	156
- Airlock	E		2	2	124.0	248	39.0	78	326
- Shield Window	E		2	2	130	260	44	88	348
- Drying (A-PLYMR)									
- Drier	F		1	1	585.0	585	88.0	88	673
- Conveyor	F	5	5	5	6.0	30	1.0	5	35
- Proportioning and Blending (A-PLYMR)									
- Polymer Pellets Storage Silo	E		4	4	25.0	100	7.0	28	128
- Weigh Station	E		2	2	20.0	40	2.0	4	44
- Blender	F	2	1	1	53.0	53	5.0	5	58
- Conveyor	F	5	11	11	6.0	66	1.0	11	77
- Encapsulation (A-PLYMR)									
- Extruder	F	100	1	1	630.0	630	22.7	22.7	652.7
- Activated Carbon	F		4	4	10.0	40	1.0	4	44
- Drum Cooling (A-PLYMR)									
- Induced Draft Fan/ Ducting	F		8	8	16.0	128	2.0	16	144
- Enclosure	F		1	1	121.0	121	8.0	8	129
- Drum Capping and Washing (A-PLYMR)									
- Drum Wash/ Cap	E		4	4	70.0	280	15.0	60	340
- Flush Water Collection and Conveying	E		2	2	30.0	60	18.0	36	96
- Conveyor	F	5	39	39	6.0	234	1.0	39	273
- Allowance for Mechanical/Piping	E		Lot	1	211.9	211.9	363.4	363.4	575.3
- Allowance for Electrical/Control	E		Lot	1	635.7	635.7	363.4	363.4	999.1
- Calibration, Testing & Startup	E		Lot	1	101.7	101.7	58.1	58.1	159.8
-									
- Total Polymer Stabilization Subsystem						5187.3		1511.6	6698.9
16 Vitrification	II								
- Prepare and Feed Incoming Waste (A-VITRF)									
- Bulk Solids Dump Hopper	F		1	1	60.0	60.0	15.0	15.0	75.0
- Shredding System	E		1	1	1,320.0	1,320.0	260.0	260.0	1,580.0
- Waste Prep Crane	F		1	1	525.0	525.0	105.0	105.0	630.0
- Drum/Bin Conveyor	E		20	20	6.0	120.0	1.0	20.0	140.0
- Closed Circuit TV	E		2	2	10.0	20.0	2.0	4.0	24.0
- Airlock	E		2	2	124.0	248.0	39.0	78.0	326.0

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION		ENTS 2							
		CWO and Vitrification							
		FAC. CAT.	HP	MATLS. & EQUIP.			INST. COSTS		
				QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Dust Collection Assembly	E		1	1	120.0	120.0	20.0	20.0	140.0
- Melter (A-VITRF)									
- Melter			1	1					
- Melter Feed Assembly			1	1					
- Melter Oxygen Feed Controller			1	1					
- Melter Inlet Air Blower			1	1					
- Melter Discharge System			1	1					
- Melter Room Temperature Monitoring & Cooling			1	1					
- Melter Vacuum Pumps			1	1					
- Melter Slag/ Ingot Vacuum Chamber			1	1					
- Melter Hearth Removal System			2	2					
- Cost Per Package Above	F		Lot	1	5,560.0	5,560.0	800.0	800.0	6,360.0
- Maintenance Crane (5 TN)	E		1	1	525.0	525.0	105.0	105.0	630.0
- Monorail Hoist (5 TN)	F		1	1	85.0	85.0	20.0	20.0	105.0
- Cool Melter (A-VITRF)									
- Melter Cooling Water Unit									
- Cooling Water Pump 150 gal/min									
- Cooling Water Pump 200 gal/min									
- Cooling Water Pump 2500 GAL									
- Elevated Water Tank									
- Cooling Tower									
- Circulation pump									
- Complete Package per Above Detail	E		Lot	1	300.0	300.0	70.0	70.0	370.0
- Prepare and Feed Soil (A-VITRF)									
- Melter Soil Feeder	E		1	1	208.5	208.5	30.0	30.0	238.5
- Dryer	E		Lot	1	250.2	250.2	36.0	36.0	286.2
- Soil Day Tank	E		1	1	41.7	41.7	8.0	8.0	49.7
- Soil Storage Silos	E		2	2	90.4	180.7	20.0	40.0	220.7
- Soil Transfer Pump	E		1	1	41.7	41.7	10.0	10.0	51.7
- Slag Cooling & Packaging (A-VITRF)									
- Metal Canister Capper	F		1	1	208.5	208.5	30.0	30.0	238.5
- Canister Decon Unit	F		1	1	97.3	97.3	9.0	9.0	106.3
- Canister Cooling System	F		2	2	104.3	208.5	40.0	80.0	288.5
- Canister Conveyor	E		30	30	5.6	166.8	1.0	30.0	196.8
- Grouting Unit	E		1	1	208.5	208.5	25.0	25.0	233.5
- Air Pollution Control									
- Quencher	E		1	1	278.0	278.0	4.0	4.0	282.0
- Ceramic Filters	E		2	2	333.6	667.2	48.0	96.0	763.2
- Primary Activated Carbon Filter	E		Lot	1	69.5	69.5	1.0	1.0	70.5
- Hepa Filter	E		2	2	236.3	472.6	65.0	130.0	602.6
- Induced Fan	E		2	2	20.9	41.7	3.0	6.0	47.7
- Baghouse	E								
- Stack	E		1	1	20.0	20.0	4.0	4.0	24.0
- Stack Monitor (Radioactive)	E		1	1	200.0	200.0	80.0	80.0	280.0
- Stack Monitor (Non-Radioactive)	E		1	1	150.0	150.0	60.0	60.0	210.0
- Allowance for Mechanical/Piping	E		Lot	1	3,718.3	3718.3	1,305.6	1305.6	5023.9
- Allowance for Electrical/Control	E		Lot	1	1,859.2	1859.2	1,088.0	1088	2947.2
- Calibration, Testing & Startup	E		Lot	1	359.4	359.4	182.8	182.8	542.2
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Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2 CWO and Vitrification							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
17 Certification & Shipping Subsystem	I							
- Incoming Material Storage (B-CSHIP)								
- Overhead Bridge Crane 20 TN	E		1	625.0	625	125.0	125	750
- Forklift 10 TN	E		1	65.0	65	10.0	10	75
- Inspect & Assay (B-CSHIP)								
- Transfer Cart 2 TN	E							
- Real Time Radiography (ND)								
- Passive Active Neutron (ND)								
- Segmented Gamma Spectroscopy (ND)								
- Complete Package per Above	E		1	1,575.0	1575	150.0	150	1725
- Self Guided Vehicle (ND)	E		1	425.0	425	850.0	850	1275
- Truck Loading (B-CSHIP)								
- Forklift 10 TN	E		10	65.0	650	10.0	100	750
- Roll-up Door	E		2	20.0	40	2.0	4	44
- Bridge Crane	E		1	525.0	525	105.0	105	630
- Roller Conveyor (CA)	E		20	2.0	40	1.0	20	60
- Allowance for Mechanical/Piping	E		Lot	197.3	197.3	682.0	682	879.3
- Allowance for Electrical/Control	E		Lot	591.8	591.8	682.0	682	1273.8
- Calibration, Testing & Startup	E		Lot	94.7	94.7	109.1	109.1	203.8
Total Certification & Shipping Subsystem					4828.8		2837.1	7665.9
18 Support Subsystem	III							
- Electrical Distribution and MCC								
- Control Panel - FT	E		110	10.0	1100	2.0	220	1320
- Emergency Power Generator	E		1	500.0	500	100.0	100	600
- Main Control Panel	E		20	10.0	200	2.0	40	240
- Motor Control Center	E		100	1.5	150	0.5	50	200
- Stand by Emergency Power	E		1	230.0	230	80.0	80	310
- Utilities and Mechanical								
- Breathing Air Package	E		Lot	70.0	70	30.0	30	100
- Compressed Air Package	E		Lot	100.0	100	25.0	25	125
- Instrument Air	E		1	70.0	70	30.0	30	100
- Instrument Air Package	E		Lot	90.0	90	25.0	25	115
- Plant Steam/Boiler	E		1	75.0	75	25.0	25	100
- Service Water	E		1	130.0	130	40.0	40	170
- Sump Pump	E	3	10	5.0	50	2.0	20	70
- Cooling Tower	E		1	200.0	200	10.0	10	210
- Cooling Water Pumps	E	3	2	15.0	30	3.0	6	36
- Heating, Ventilation & Exhaust								
- Included with Building Cost								
- Radiation Monitoring								
- Air Monitors	E		44	10.0	440	2.0	88	528
- Area Monitoring	E		44	4.5	198	1.0	44	242
- Personnel Monitoring Portals	E		6	35.0	210	5.0	30	240
- Portal Monitors	E		6	35.0	210	5.0	30	240
- Allowance for Mechanical/Piping	E		Lot	40.5	40.5	8.9	8.9	49.4
- Allowance for Electrical/Control	E		Lot	608.0	608	134.0	134	742
- Calibration, Testing & Startup	E		Lot	94.0	94	20.7	20.7	114.7
Total Support Subsystem					4795.5		1056.6	5852.1

Table B-2.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 2 CWO and Vitrification

DESCRIPTION	ENTS 2 CWO and Vitrification							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
19 Metal Melting Subsystem	II							
- Prepare and Feed Incoming Waste (A-MMELT)								
- Bulk Solids Dump Hopper	F		1	45.0	45	10.0	10.0	55.0
- Gantry Robot	F		1	525.0	525	105.0	105.0	630.0
- Master Slave Manipulator	E		1	65.0	65	15.0	15.0	80.0
- Size Reduction Table with Tools	E		1	120.0	120	24.0	24.0	144.0
- Drum/Bin Conveyor	F		20	6.0	120	1.0	20.0	140.0
- Closed Circuit TV	E		2	10.0	20	4.0	8.0	28.0
- Airlock	E		2	124.0	248	39.0	78.0	326.0
- Dust Collection Assembly	E		1	100.0	100	15.0	15.0	115.0
- Melter (A-MMELT)								
- Melter								
- Melter Feed Assembly								
- Melter Secondary Combustion Chamber								
- Melter Oxygen Feed Controller								
- Melter Inlet Air Blower								
- Melter Discharge System								
- Melter Room Temperature Monitoring & Cooling								
- Melter Vacuum Pumps								
- Melter Slag/ Ingot Vacuum Chamber								
- Melter Hearth Removal System								
- Cost Per Package Above	F		Lot	1,200.0	1200	500.0	500.0	1,700.0
- Maintenance Crane	E		1	450.0	450	100.0	100.0	550.0
- Monorail Hoist	F		1	85.0	85	20.0	20.0	105.0
- Cool Melter (A-MMELT)								
- Melter Cooling Water Unit								
- Cooling Water Pump 150 gal/min								
- Cooling Water Pump 200 gal/min								
- Cooling Water Pump 2500 GAL								
- Elevated Water Tank								
- Cooling Tower								
- Circulation pump	E							
- Complete Package per Above Detail	E		Lot	150.0	150	60.0	60.0	210.0
- Metal Cooling & Packaging (A-MMELT)								
- Metal Canister Capper	F		1	150.0	150	50.0	50.0	200.0
- Canister Decon Unit	F		1	70.0	70	20.0	20.0	90.0
- Canister Cooling System	F		1	200.0	200	60.0	60.0	260.0
- Canister Conveyor	F		15	4.0	60	1.0	15.0	75.0
- Air Pollution Control System								
- Quench System	E		1	100	100	20	20.0	120.0
- Filter Baghouse	E		1	30	30	6	6.0	36.0
- Activated Carbon Filters	E		1	50	50	10	10.0	60.0
- HEPA Filters	E		1	50	50	10	10.0	60.0
- Stack	E		1	20	20	4	4.0	24.0
- Stack Monitor (Radioactive)	E		1	200	200	80	80.0	280.0
- Stack Monitor (Non-Radioactive)	E		1	150	150	60	60.0	210.0
-	E							
- Allowance for Mechanical/Piping	E		Lot	1,262.4	1262.4	774.0	774	2036.4
- Allowance for Electrical/Control	E		Lot	631.2	631.2	645.0	645	1276.2
- Calibration, Testing & Startup	E		Lot	122.0	122	108.4	108.4	230.4
-								
Total Metal Melting Subsystem					6,223.6		2,817.4	9,041.0

Table B-2.2 : Development, Testing & Evaluation Cost Estimates

ENTS - 2 CWO and Vitrification

UNIT OPERATION		ENTS - 2 CWO and Vitrification								
		Primary Paper Evaluation Research Manpower	Bench Scale Studies Research Manpower	Sec. Paper Evaluation Research Manpower	Total Research Manpower	Bench Scale Studies Equipment \$1000	Bench Scale Studies Installation \$1000	Pilot Plant Mock-up Test Demo. Manpower	Pilot Plant Mock-up Test Bldg. \$1000	Pilot Plant Mock-up Test Equip. \$1000
1	Administration Building Subsystem									
2	Receiving & Inspection Subsystem	12			12			25	1,200	6,000
3	Aqueous Waste Treatment Subsystem	5	3	3	11	100	300	10	400	2,000
4	Organic Destruction Subsystem	18	20	4	42	500	150	30	400	4,000
5	Residue & Sludge Treatment Subsystem									
6	Soft Debris Treatment Subsystem									
7	Complex Debris Treatment Subsystem									
8	Open Debris Treatment Subsystem	2	6	2	10	300	50	20	1,000	3,000
9	Bulk Soil Treatment Subsystem	10	6	2	18	200	50	10	200	500
10	Metal Decontamination Subsystem									
11	Special Waste	8	20	5	33	600	250	20	400	2,000
12	Mercury Amalgamation Subsystem	1	3		4	100	50			
13	Lead Recovery Subsystem	2	2		4	100	30			
14	Air Pollution Control Subsystem	5	3	2	10	200	50	15	400	2,000
15	Polymer Stabilization Subsystem	2	8	4	14	300	50	15	400	2,000
16	Vitrification	2	8	4	14	300	50	15	400	1,000
17	Certification & Shipping Subsystem									
18	Support Subsystem	5			5					
19	Metal Melting Subsystem									
	Unit Cost (\$/Unit)				\$150,000			\$150,000		
	Total Cost				26,550	2,700	1,030	24,000	4,800	22,500
	Post Totals To Table 4-2 Item				1.1	1.2	1.3	2.1	2.5.1	2.5.2

Table B-2.3 :Building, Equipment and Installation Cost Summary
ENTS - 2 CWO and Vitrification

UNIT OPERATION		ENTS - 2 CWO and Vitrification								
		Building Area					Material & Equipment Costs			Total Cost per Unit Oprtn. \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	Total Area Cost \$1000	Purchase Cost \$1000	Installation Cost \$1000	Total Cost \$1000	
1	Administration Building Subsystem	12,440	3,000			3,499	3,163	888	4,051	7,550
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	38,966	18,494	6,775	25,268	64,234
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	5,287	4,980	1,516	6,496	11,783
4	Organic Destruction Subsystem		1,128	1,717	1,560	5,187	5,750	1,476	7,227	12,414
5	Residue & Sludge Treatment Subsystem									
6	Soft Debris Treatment Subsystem		1,606	2,444	2,220	7,381	8,590	1,454	10,044	17,425
7	Complex Debris Treatment Subsystem									
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	8,678	2,053	671	2,723	11,401
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	7,381	2,822	832	3,655	11,036
10	Metal Decontamination Subsystem		641	169	1904	3,709	3,572	1,496	5,067	8,776
11	Special Waste		604	159	1792	3,491				3,491
12	Mercury Amalgamation Subsystem		679	179	2,016	3,928	2,896	1,049	3,945	7,873
13	Lead Recovery Subsystem		830	219	2,464	4,800	4,027	1,155	5,182	9,982
14	Air Pollution Control Subsystem		955	1,453	1,320	4,389	2,401	885	3,285	7,674
15	Polymer Stabilization Subsystem		2,322	3,534	3,210	10,673	5,187	1,512	6,699	17,372
16	Vitrification		2,875	9,030	4,554	19,785	18,331	4,752	23,084	42,869
17	Certification & Shipping Subsystem		28,277			11,876	4,829	2,837	7,666	19,542
18	Support Subsystem	3360	16,883			7,696	4,796	1,057	5,852	13,548
19	Metal Melting Subsystem		1,169	309	3,472	6,764	6,224	2,817	9,041	15,805
	Total Cost					153,490			129,285	282,775
		Post Totals To Table 4-2 Item				3.4.1			3.4.2	

Table B-2.4 : Annual Operating & Maintenance Costs
ENTS - 2 CWO and Vitrification

UNIT OPERATION		ENTS - 2 CWO and Vitrification					
		Operating FTE	Utilities	Materials	Maintenance Labor (1)	Maintenance Materials (2)	Totals
			\$1000	\$1000	\$1000	\$1000	\$1000
1	Administration Building Subsystem	32	5	164	318	127	445
2	Receiving & Inspection Subsystem	170	159	612	1,850	740	2,590
3	Aqueous Waste Treatment Subsystem	5	300	1,705	873	349	1,222
4	Organic Destruction Subsystem	12	298	297	1,438	575	2,013
5	Residue & Sludge Treatment Subsystem						
6	Soft Debris Treatment Subsystem	14	708	704	2,148	859	3,007
7	Complex Debris Treatment Subsystem						
8	Open Debris Treatment Subsystem	8	25	100	360	144	504
9	Bulk Soil Treatment Subsystem	2	22	14	140	56	196
10	Metal Decontamination Subsystem	4	5	25	625	250	875
11	Special Waste	3	12	200			
12	Mercury Amalgamation Subsystem	4	2	10	508	203	711
13	Lead Recovery Subsystem	8	73	50	705	282	987
14	Air Pollution Control Subsystem	4	67	130	420	168	588
15	Polymer Stabilization Subsystem	8	118	1,223	908	363	1,271
16	Vitrification	18	65	1,177	1,833	733	2,566
17	Certification & Shipping Subsystem	37	12	70	483	193	676
18	Support Subsystem	5			480	192	672
19	Metal Melting Subsystem	5	79	33	623	249	872
	Unit cost (\$/unit)	\$140,000					
	Total Cost	47,460	1950	6,514			19,195
	Post Totals To Table 4-2, Item	5.1	5.2	5.3			5.4

Notes:

1. Annual Maintenance Labor is 250 % of maintenance material cost.
2. Maintenance Material is assumed to be 2 % of equipment capital cost for the Bulk Soil Treatment subsystem, because the capital equipment is based on one shift operation.
3. Maintenance Material is assumed to be 10 % of equipment capital cost for organic destruction and soft debris.
4. Maintenance Material is assumed to be 4 % of equipment capital cost for Administration, Receiving & Inspection, Grout Stabilization, Certification & Shipping, and Support subsystems.
5. Maintenance Material is assumed to be 7 % of equipment capital cost for all other subsystems

Table B-2.5 : Decontamination & Decommissioning Costs
ENTS - 2 CWO and Vitrification

UNIT OPERATION		ENTS - 2 CWO and Vitrification				
		Building Area				Total Area Cost \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	
1	Administration Building Subsystem	12,440	3,000			6,948
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	18,916
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	2,021
4	Organic Destruction Subsystem		1,128	1,717	1,560	1,983
5	Residue & Sludge Treatment Subsystem					
6	Soft Debris Treatment Subsystem		1,606	2,444	2,220	2,822
7	Complex Debris Treatment Subsystem					
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	3,317
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	2,822
10	Metal Decontamination Subsystem		641	169	1,904	1,222
11	Special Waste		604	159	1,792	1,150
12	Mercury Amalgamation Subsystem		679	179	2,016	1,293
13	Lead Recovery Subsystem		830	219	2,464	1,581
14	Air Pollution Control Subsystem		955	1,453	1,320	1,678
15	Polymer Stabilization Subsystem		2,322	3,534	3,210	4,080
16	Vitrification		2,875	9,030	4,554	7,407
17	Certification & Shipping Subsystem		28,277			12,725
18	Support Subsystem	3,360	16,883			9,109
19	Metal Melting Subsystem		1,169	309	3,472	2,228
	Total Cost					81,302
		Post Totals To Table 4-2 Item				7.0

Table B-2.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Non Thermal Treatment Systems (cost module ENTS-2)

Cost component	Cost Items	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2
		Administration Building Subsystem	Receiving & Inspection Subsystem	Aqueous Waste Treatment Subsystem	Organic Destruction Subsystem	Residue & Sludge Treatment Subsystem	Soft Debris Treatment Subsystem	Complex Debris Treatment Subsystem	Open Debris Treatment Subsystem	Bulk Soil Treatment Subsystem	Metal Decontamination Subsystem	Special Waste
1.0	Studies and bench scale test costs											
1.1	Manpower costs during research	\$0	\$1,800	\$1,650	\$6,300	\$0	\$0	\$0	\$1,500	\$2,700	\$0	\$4,950
1.2	Equipment costs	\$0	\$0	\$100	\$500	\$0	\$0	\$0	\$300	\$200	\$0	\$600
1.3	Installation costs	\$0	\$0	\$300	\$150	\$0	\$0	\$0	\$50	\$50	\$0	\$250
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$0	\$180	\$205	\$695	\$0	\$0	\$0	\$185	\$295	\$0	\$580
1.5	Contingency (25 % of 1.1 through 1.4)	\$0	\$495	\$564	\$1,911	\$0	\$0	\$0	\$509	\$811	\$0	\$1,595
	Subtotal 1.0	\$0	\$2,475	\$2,819	\$9,556	\$0	\$0	\$0	\$2,544	\$4,056	\$0	\$7,975
2.0	Demonstration costs											
2.1	Manpower costs during demonstration	\$0	\$3,750	\$1,500	\$4,500	\$0	\$0	\$0	\$3,000	\$1,500	\$0	\$3,000
2.2	Design cost (30 % of 2.5)	\$0	\$2,786	\$929	\$1,703	\$0	\$0	\$0	\$1,548	\$271	\$0	\$929
2.3	Inspection cost (7 % of 2.5)	\$0	\$650	\$217	\$397	\$0	\$0	\$0	\$361	\$63	\$0	\$217
2.4	Project management (10 % of 2.5)	\$0	\$929	\$310	\$568	\$0	\$0	\$0	\$516	\$90	\$0	\$310
2.5	Construction cost											
2.5.1	Building structure costs	\$0	\$1,200	\$400	\$400	\$0	\$0	\$0	\$1,000	\$200	\$0	\$400
2.5.2	Equipment costs	\$0	\$6,000	\$2,000	\$4,000	\$0	\$0	\$0	\$3,000	\$500	\$0	\$2,000
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$2,088	\$696	\$1,276	\$0	\$0	\$0	\$1,160	\$203	\$0	\$696
	Subtotal of 2.5	\$0	\$9,288	\$3,096	\$5,676	\$0	\$0	\$0	\$5,160	\$903	\$0	\$3,096
2.6	Construction management costs (17.1 % of 2.5)	\$0	\$1,588	\$529	\$971	\$0	\$0	\$0	\$882	\$154	\$0	\$529
2.7	Management Reserve (10 % of 2.5)	\$0	\$929	\$310	\$568	\$0	\$0	\$0	\$516	\$90	\$0	\$310
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$4,980	\$1,723	\$3,596	\$0	\$0	\$0	\$2,996	\$768	\$0	\$2,098
	Subtotal 2.0	\$0	\$24,900	\$8,614	\$17,979	\$0	\$0	\$0	\$14,979	\$3,839	\$0	\$10,489
3.0	Production facility construction costs											
3.1	Design cost (25 % of 3.4)	\$2,435	\$20,716	\$3,800	\$4,004	\$0	\$5,620	\$0	\$3,677	\$3,559	\$2,830	\$1,126
3.2	Inspection cost (7 % of 3.4)	\$682	\$5,800	\$1,064	\$1,121	\$0	\$1,573	\$0	\$1,029	\$997	\$792	\$315
3.3	Project management (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$0	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450
3.4	Construction cost											
3.4.1	Building structure costs	\$3,499	\$38,966	\$5,287	\$5,187	\$0	\$7,381	\$0	\$8,678	\$7,381	\$3,709	\$3,491
3.4.2	Equipment costs	\$4,051	\$25,268	\$6,496	\$7,227	\$0	\$10,044	\$0	\$2,723	\$3,655	\$5,067	\$0
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$2,190	\$18,628	\$3,417	\$3,600	\$0	\$5,053	\$0	\$3,306	\$3,200	\$2,545	\$1,012
	Subtotal of 3.4	\$9,740	\$82,862	\$15,200	\$16,014	\$0	\$22,478	\$0	\$14,707	\$14,236	\$11,321	\$4,503
3.5	Construction management (17.1 % of 3.4)	\$1,666	\$14,169	\$2,599	\$2,738	\$0	\$3,844	\$0	\$2,515	\$2,434	\$1,936	\$770
3.6	Management Reserve (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$0	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450
3.7	Contingency (25 % of 3.1 through 3.5)	\$3,874	\$32,958	\$6,046	\$6,370	\$0	\$8,941	\$0	\$5,850	\$5,663	\$4,503	\$1,791
	Subtotal 3.0	\$20,345	\$173,077	\$31,749	\$33,449	\$0	\$46,952	\$0	\$30,720	\$29,737	\$23,646	\$9,405
4.0	Operations Budget Funded Activities (See Sect. 7)											
4.1	Conceptual design (1.5 % of 3.0)	\$305	\$2,596	\$476	\$502	\$0	\$704	\$0	\$461	\$446	\$355	\$141
4.2	Safety assurance (1 % of 3.0)	\$203	\$1,731	\$317	\$334	\$0	\$470	\$0	\$307	\$297	\$236	\$94
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
4.4	Preparation for operations (100 % of 5.0)	\$6,368	\$33,951	\$4,909	\$5,360	\$0	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790
4.5	Project Management (10 % of 4.1 through 4.4)	\$1,388	\$3,828	\$570	\$620	\$0	\$915	\$0	\$295	\$138	\$242	\$103
	Subtotal 4.0	\$15,264	\$42,106	\$6,272	\$6,816	\$0	\$10,063	\$0	\$3,249	\$1,521	\$2,664	\$1,128
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$35,609	\$242,558	\$49,454	\$67,800	\$0	\$57,015	\$0	\$51,492	\$39,153	\$26,310	\$28,997
5.0	Operating and maintenance costs											
5.1	Annual operating costs	\$4,480	\$23,800	\$700	\$1,680	\$0	\$1,960	\$0	\$1,120	\$280	\$560	\$420
5.2	Annual utility costs	\$5	\$159	\$300	\$298	\$0	\$708	\$0	\$25	\$22	\$5	\$12
5.3	Annual material costs	\$164	\$612	\$1,705	\$297	\$0	\$704	\$0	\$100	\$14	\$25	\$200
5.4	Annual maintenance costs	\$445	\$2,590	\$1,222	\$2,013	\$0	\$3,007	\$0	\$504	\$196	\$875	\$0
5.5	Contingency (25 % of 5.1 through 5.4)	\$1,274	\$6,790	\$982	\$1,072	\$0	\$1,595	\$0	\$437	\$128	\$366	\$158
5.6	Subtotal 5.0	\$6,368	\$33,951	\$4,909	\$5,360	\$0	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$127,360	\$679,020	\$98,180	\$107,200	\$0	\$159,480	\$0	\$43,720	\$12,800	\$36,620	\$15,800
6.0	Decontamination & Decommissioning	\$6,948	\$18,916	\$2,021	\$1,983	\$0	\$2,822	\$0	\$3,317	\$2,822	\$1,222	\$1,150
7.0	ROM Life cycle costs (20 years operation)	\$169,917	\$940,494	\$149,655	\$176,983	\$0	\$219,317	\$0	\$98,529	\$54,775	\$64,152	\$45,947

Table B-2.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Non Thermal Treatment Systems (cost module ENTS-2)

Cost component	Cost Items	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2	ENTS-2
		Mercury Amalgamation Subsystem	Lead Recovery Subsystem	Air Pollution Control Subsystem	Polymer Stabilization Subsystem	Vitrification	Certification & Shipping Subsystem	Support Subsystem	Metal Melting Subsystem	Total System
1.0	Studies and bench scale test costs									
1.1	Manpower costs during research	\$600	\$600	\$1,500	\$2,100	\$2,100	\$0	\$750	\$0	\$26,550
1.2	Equipment costs	\$100	\$100	\$200	\$300	\$300	\$0	\$0	\$0	\$2,700
1.3	Installation costs	\$50	\$30	\$50	\$50	\$50	\$0	\$0	\$0	\$1,030
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$75	\$73	\$175	\$245	\$245	\$0	\$75	\$0	\$3,028
1.5	Contingency (25 % of 1.1 through 1.4)	\$206	\$201	\$481	\$674	\$674	\$0	\$206	\$0	\$8,327
	Subtotal 1.0	\$1,031	\$1,004	\$2,406	\$3,369	\$3,369	\$0	\$1,031	\$0	\$41,635
2.0	Demonstration costs									
2.1	Manpower costs during demonstration	\$0	\$0	\$2,250	\$2,250	\$2,250	\$0	\$0	\$0	\$24,000
2.2	Design cost (30 % of 2.5)	\$0	\$0	\$929	\$929	\$542	\$0	\$0	\$0	\$10,565
2.3	Inspection cost (7 % of 2.5)	\$0	\$0	\$217	\$217	\$126	\$0	\$0	\$0	\$2,465
2.4	Project management (10 % of 2.5)	\$0	\$0	\$310	\$310	\$181	\$0	\$0	\$0	\$3,522
2.5	Construction cost									
2.5.1	Building structure costs	\$0	\$0	\$400	\$400	\$400	\$0	\$0	\$0	\$4,800
2.5.2	Equipment costs	\$0	\$0	\$2,000	\$2,000	\$1,000	\$0	\$0	\$0	\$22,500
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$0	\$696	\$696	\$406	\$0	\$0	\$0	\$7,917
	Subtotal of 2.5	\$0	\$0	\$3,096	\$3,096	\$1,806	\$0	\$0	\$0	\$35,217
2.6	Construction management costs (17.1 % of 2.5)	\$0	\$0	\$529	\$529	\$309	\$0	\$0	\$0	\$6,022
2.7	Management Reserve (10 % of 2.5)	\$0	\$0	\$310	\$310	\$181	\$0	\$0	\$0	\$3,522
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$0	\$1,910	\$1,910	\$1,349	\$0	\$0	\$0	\$21,328
	Subtotal 2.0	\$0	\$0	\$9,551	\$9,551	\$6,744	\$0	\$0	\$0	\$106,641
3.0	Production facility construction costs									
3.1	Design cost (25 % of 3.4)	\$2,539	\$3,219	\$2,475	\$5,603	\$13,825	\$6,302	\$4,369	\$5,097	\$91,195
3.2	Inspection cost (7 % of 3.4)	\$711	\$901	\$693	\$1,569	\$3,871	\$1,765	\$1,223	\$1,427	\$25,535
3.3	Project management (10 % of 3.4)	\$1,016	\$1,288	\$990	\$2,241	\$5,530	\$2,521	\$1,748	\$2,039	\$36,478
3.4	Construction cost									
3.4.1	Building structure costs	\$3,928	\$4,800	\$4,389	\$10,673	\$19,785	\$11,876	\$7,696	\$6,764	\$153,490
3.4.2	Equipment costs	\$3,945	\$5,182	\$3,285	\$6,699	\$23,084	\$7,666	\$5,852	\$9,041	\$129,285
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$2,283	\$2,895	\$2,225	\$5,038	\$12,432	\$5,667	\$3,929	\$4,583	\$82,005
	Subtotal of 3.4	\$10,156	\$12,877	\$9,899	\$22,410	\$55,301	\$25,209	\$17,477	\$20,388	\$364,780
3.5	Construction management (17.1 % of 3.4)	\$1,737	\$2,202	\$1,693	\$3,832	\$9,456	\$4,311	\$2,989	\$3,486	\$62,377
3.6	Management Reserve (10 % of 3.4)	\$1,016	\$1,288	\$990	\$2,241	\$5,530	\$2,521	\$1,748	\$2,039	\$36,478
3.7	Contingency (25 % of 3.1 through 3.5)	\$4,040	\$5,122	\$3,938	\$8,914	\$21,996	\$10,027	\$6,952	\$8,109	\$145,091
	Subtotal 3.0	\$21,215	\$26,897	\$20,678	\$46,810	\$115,509	\$52,656	\$36,506	\$42,585	\$761,934
4.0	Operations Budget Funded Activities (See Sect. 7)									
4.1	Conceptual design (1.5 % of 3.0)	\$318	\$403	\$310	\$702	\$1,733	\$790	\$548	\$639	\$11,429
4.2	Safety assurance (1 % of 3.0)	\$212	\$269	\$207	\$468	\$1,155	\$527	\$365	\$426	\$7,619
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$7,000
4.4	Preparation for operations (100 % of 5.0)	\$1,604	\$2,788	\$1,681	\$4,665	\$7,910	\$7,423	\$1,715	\$2,105	\$93,899
4.5	Project Management (10 % of 4.1 through 4.4)	\$213	\$346	\$220	\$584	\$1,080	\$874	\$263	\$317	\$11,995
	Subtotal 4.0	\$2,347	\$3,806	\$2,418	\$6,419	\$11,878	\$9,614	\$2,891	\$3,487	\$131,942
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$24,593	\$31,707	\$35,053	\$66,149	\$137,500	\$62,270	\$40,428	\$46,072	\$1,042,152
5.0	Operating and maintenance costs									
5.1	Annual operating costs	\$560	\$1,120	\$560	\$1,120	\$2,520	\$5,180	\$700	\$700	\$47,460
5.2	Annual utility costs	\$2	\$73	\$67	\$118	\$65	\$12	\$0	\$79	\$1,950
5.3	Annual material costs	\$10	\$50	\$130	\$1,223	\$1,177	\$70	\$0	\$33	\$6,514
5.4	Annual maintenance costs	\$711	\$987	\$588	\$1,271	\$2,566	\$676	\$672	\$872	\$19,195
5.5	Contingency (25 % of 5.1 through 5.4)	\$321	\$558	\$336	\$933	\$1,582	\$1,485	\$343	\$421	\$18,780
5.6	Subtotal 5.0	\$1,604	\$2,788	\$1,681	\$4,665	\$7,910	\$7,423	\$1,715	\$2,105	\$93,899
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$32,080	\$55,760	\$33,620	\$93,300	\$158,200	\$148,460	\$34,300	\$42,100	\$1,877,980
6.0	Decontamination & Decommissioning	\$1,293	\$1,581	\$1,678	\$4,080	\$7,407	\$12,725	\$9,109	\$2,228	\$81,302
7.0	ROM Life cycle costs (20 years operation)	\$57,966	\$89,048	\$70,351	\$163,529	\$303,107	\$223,455	\$83,837	\$90,400	\$3,001,434

B-3 ENTS-3 Cost Tables

- B-3.1. Equipment Purchase and Installation Budget Estimates
- B-3.2. Development, Testing and Evaluation Cost Estimate
- B-3.3. Building, Equipment and Installation Cost Summary
- B-3.4. Annual Operating and Maintenance Costs
- B-3.5. Decontamination and Decommissioning Costs
- B-3.6 Total Life-Cycle Cost (without Disposal) Estimate for Enhanced Integrated Nonthermal Treatment Systems

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
1 Administration Building Subsystem	III							
- Administration Office								
- Office Furniture - EMPLOYEE	E		49	7.0	343	1.0	49	392
- Computers	E		Lot	500.0	500	50.0	50	550
- Communication	E		Lot	250.0	250	35.0	35	285
- Testing Laboratory								
- ICP-Mass Spectrometer	D		1					
- Gas Chromatography - Mass Spec.	D		1					
- Scintillation Counter - Alpha	D		1					
- Scintillation Counter - Gamma	D		1					
- Geiger - Muller Counter	D		1					
- Fume Hood	A		2					
- Centrifuge	A		2					
- Autoclave	A		1					
- Scrubber/Blower	C		1					
- Hood/HEPA Filtration	C		1					
- Glovebox	D		1					
- Wet Chemistry Equipment	D		1					
- Refrigeration / Storage	A		1					
- Computer & Data Communication	D		2					
- Atomic Absorption Spectrography	D		1					
- Soil / Physical Testing Equipment	D		Lot					
- Complete Package per Above Detail	E		Lot	1,500.0	1500	300.0	300	1800
- Office Equipment & Furnishing	E		Lot	80.0	80	7.0	7	87
- Allowance for Mechanical/Piping	E		Lot	26.7	26.7	132.3	132.3	159
- Allowance for Electrical/Control	E		Lot	401.0	401	264.6	264.6	665.6
- Calibration, Testing & Startup	E		Lot	62.0	62	50.3	50.3	112.3
-								
Total Administration Building Subsystem					3162.7		888.2	4050.9
2 Receiving & Inspection Subsystem	I							
- Unloading, Staging & Storage (A-RCINS)								
- O/H Bridge Crane & Rigging - 20 TN	E		1	625.0	625	125.0	125	750
- Forklift - 10 TN	E		2	65.0	130	10.0	20	150
- Airlock	E		1	124.0	124	39.0	39	163
- Inspect & Assay (A-RCINS)								
- Transfer Cart - 2 TN	B							
- Gamma Spectroscopy (GS)	D							
- Passive Active Neutron Assay (PAN)	D							
- Real Time Radiography (RTR)	D							
- Load Cell	D							
- Closed Circuit TV	D							
- RHMMS Barrel Monitor including above	E		1	2,000.0	2000	400.0	400	2400
- Personnel Contamination Monitor	E		1	35.0	35	5.0	5	40
- Container Decontamination Enclosure	E		1	140.0	140	15.0	15	155
- Open, Dump, & Sort								
- Self Guided Vehicle	E		2	425.0	850	64.0	128	978
- Decap Device	E		3	50.0	150	9.0	27	177
- Sort Hopper	E		5	40.0	200	4.0	20	220
- Sort/Rotating Table	E		5	200.0	1000	30.0	150	1150
- Special Waste Glove Box	E		1	400.0	400	48.0	48	448
- Dump Hopper	E		6	40.0	240	4.0	24	264
- Maintenance Crane	E		1	800.0	800	120.0	120	920
- Bins	E		80	5.0	400	1.0	80	480
- Bin Conveyor 8 ft long	E		20	10.0	200	4.0	80	280
- Bin Conveyor 70 ft long	E		2	70.0	140	28.0	56	196
- Bin Pusher	E		34	10.0	340	4.0	136	476
- Main Cell Gantry Robot	E		1	2,000.0	2000	400.0	400	2400
- Sorting Table Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Sorting Master Slave Manipulator	E		5	100.0	500	40.0	200	700
- Box Size Reduction Unit	E		1	1,500.0	1500	400.0	400	1900
- Drum Opening Gantry Robot	E		2	400.0	800	80.0	160	960
- Glovebox Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Container Grapppler	E		4	50.0	200	8.0	32	232

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3							
	CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Decap Enclosure	E		3	100.0	300	30.0	90	390
- Bin Hoist / Pusher	B	5	1	33	66	8	8	74
- Discharge, & Oversize Load Hopper (100 CF)	B	1	1	25	50	7	7	57
- Primary Shredder (.25, 1.5, 2 Tons/hr)	E	250	1	375	375	75	75	450
- Secondary Shredder (.5, 1.5, 3 tons/hr)	E	60	1	160	160	32	32	192
- Live Bottom Bulk Storage	B	1	1	25	50	7	7	57
- Conveyor / Canister Handler	B	5	1	40	80	10	10	90
- Dust Collection System w/ Blower	E		Lot	108	108	17	17	125
- HEPA Filter	E		2	25	50	5	10	60
- Closed Circuit TV	E		8	10.0	80	2.0	16	96
- Airlock	E		4	124.0	496	39.0	156	652
- Roller up Door (CA)	E		2	20.0	40	2.0	4	44
- Allowance for Mechanical/Piping	E		Lot	755.5	755.5	1,628.5	1628.5	2384
- Allowance for Electrical/Control	E		Lot	2,266.4	2266.4	1,628.5	1628.5	3894.9
- Calibration, Testing & Startup	E		Lot	362.6	362.6	260.6	260.6	623.2
-								
Total Receiving & Inspection Subsystem					18493.5		6774.6	25268.1
3 Aqueous Waste Treatment Subsystem	II							
- Batch Liquid Waste (A-AQWTR)								
- High TOC Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TOC Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Low TDS Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Low TDS Batch Tank Pump	E		1	5.0	5	1.0	1	6
- High TDS/ Heavy Metals Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TDS/ Heavy Metals Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Hg Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Hg Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Airlocks	E		2	124.0	248	39.0	78	326
- Closed Circuit TV	E		5	10.0	50	2.0	10	60
- Crane	E		1	525.0	525	105.0	105	630
- Shield Window	E		1	130	130	44	44	174
- Gross Organics Removal (A-AQWTR)								
- Oil/ Water Separator	E		1	18.0	18	2.5	2.5	20.5
- Neutralization / Settling (A-AQWTR)								
- Neutralization System	E		1	95.0	95	19.0	19	114
- Neutralization Overflow Pump	E		1	5.0	5	1.0	1	6
- Sludge Transfer Pump	E		1	5.0	5	1.0	1	6
- Sludge Settler	E		1	27.0	27	5.0	5	32
- Sludge Settler Pump	E		1	5.0	5	1.0	1	6
- Suspended Solids Filtration (A-AQWTR)								
- Suspended Solids Filter	E		1	125.0	125	25.0	25	150
- Concentration (A-AQWTR)								
- Evaporator with Condenser	E		2	300.0	600	75.0	150	750
- Evaporator Liquids Pump	E		2	5.0	10	1.0	2	12
- Calcium Carbonate Removal								
- Tank with Agitator	E		1	27.0	27	5.0	5	32
- Transfer Pump	E		4	5.0	20	1.0	4	24
- Decanter Centrifuge	E		1	450.0	450	60.0	60	510
- Holding Tank	E		1	7.0	7	1.5	1.5	8.5
- Slurry Pump	E		1	5.0	5	1.0	1	6
- Filter	E		2	2.5	5	0.5	1	6
- Dissolved Organics Removal								
- Ozone Generator System	E							
- UV/Peroxide System	E							
- Ozone Decomposer	E							
- Complete Package per Above Detail	E		Lot	125.0	125	25.0	25	150
- Liquid-Phase Carbon (55-gal drum)	F		4	0.8	3.2	0.1	0.4	3.6
- Concentrator								
- Vapor Phase Carbon	F		2	16.0	32	3.0	6	38
- Evaporator with Condenser	E		1	500.0	500	75.0	75	575
- Condenser Liquids Pump	E		1	5.0	5	1.0	1	6
- Dissolved Solids Removal								
- Ion Exchanger	E		1	61.0	61	9.0	9	70

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3							
	CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Treated Water Sampling								
- Treated Water Tanks	E		2	45.0	90	12.0	24	114
- Treated Water Pumps	E		2	5.0	10	1.0	2	12
- Chemical Distribution								
- Chemical Addition Pump (Acid)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Caustic)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Sulfide)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Floc/ Polymer)	E		1	1.0	1	0.3	0.3	1.3
- Chemical Storage Tanks	E		4	7.0	28	1.5	6	34
- Chemical Addition Pump (Peroxide)	E		1	5.0	5	1.0	1	6
- Peroxide Storage Tank	E		1	7.0	7	1.5	1.5	8.5
- Allowance for Mechanical/Piping	E		Lot	1,010.2	1010.2	416.5	416.5	1426.7
- Allowance for Electrical/Control	E		Lot	505.1	505.1	347.1	347.1	852.2
- Calibration, Testing & Startup	E		Lot	97.7	97.7	58.3	58.3	156
-								
-								
Total Aqueous Waste Treatment Subsystem					4980.2		1516.1	6496.3
4 Organic Destruction Subsystem	II							
- Prepare and Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		Lot	50	50	8	8	58
- Discharge and Loading Hoppers	E		Lot	45	45	8	8	53
- Feed Blender	E		Lot	45	45	8	8	53
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost For Above Package	E		Lot	2400	2400	300	300	2700
- Miscellaneous								
- Neutralization System	E		1	95	95	19	19	114
- Neutralization Overflow Pump	E		1	5	5	1	1	6
- Sludge Transfer Pump	E		1	5	5	1	1	6
- Crane	E		1	525	525	105	105	630
- Closed Circuit TV	E		8	10	80	2	16	96
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	132	522
- Allowance for Mechanical/Piping	E		Lot	1,166.4	1166.4	405.6	405.6	1572
- Allowance for Electrical/Control	E		Lot	583.2	583.2	338.0	338	921.2
- Calibration, Testing & Startup	E		Lot	112.8	112.8	56.8	56.8	169.6
-								
-								
Total Organic Destruction Subsystem					5750.4		1476.4	7226.8
5 Residue & Sludge Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	50	50	8	8	58
- Discharge, & Oversize Load Hopper (100 CF)	E		1	45	45	8	8	53
- Manipulate Crane 10 TN	E	15	1	525	525	105	105	630
- Shield Window	E		1	130.0	130	44.0	44	174
- Airlock	E		2	124	248	39	78	326
- Closed Circuit TV	E		10	10	100	2	20	120
- Feed Blender	E		1	45	45	8	8	53
- Dewatering System	E		1					
- THERMAL DESORPTION								
- High Vacuum Dryer			1					
- Nitrogen gas storage and feed tank	E		1					
- Vacuum Pump	E		1					

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
- Filter	E		1					
- Hot Oil System								
- Oil Storage and Feed Tank	E		1					
- Oil Heater	E		1					
- Fuel Storage and Feed Tank	E		1					
- Condensers								
- HEPA Filter for particulates	E		1					
- Induced Air Fan	E		1					
- Primary Condensers (Air Cooler)	E		1					
- Secondary Condensers (Water Chiller)	E		2					
- Total per Package Above	E		Lot	1700	1700	170	170	1870
- Mercury Removal System								
- Mercury Precipitation Tank	E		1	95	95	19	19	114
- Iodine Recovery Tank	E		1	27	27	5	5	32
- KI/I2 Storage and Feed	E		1	27	27	5	5	32
- Metal Precipitation Tank	E		1	27	27	5	5	32
- Mercury Reduction Tank	E		1	27	27	5	5	32
- Solids Wash Tank	E		1	27	27	5	5	32
- Water Holding Tank	E		1	12	12	3	3	15
- Acid Holding and Feed Tank	E		1	12	12	3	3	15
- H2O2 Holding and Feed Tank	E		1	12	12	3	3	15
- Lime Holding Tank	E		1	12	12	3	3	15
- Rinse Tank	E		1	12	12	3	3	15
- Filter	E		1	125	125	25	25	150
- Pump	E		10	5	50	1	10	60
- Allowance for Mechanical/Control/Instrumentation	E		Lot	992.4	992.4	321.0	321	1313.4
- Allowance For Electrical/Control	E		Lot	496.2	496.2	267.5	267.5	763.7
- Calibration, Testing & Startup	E		Lot	95.9	95.9	44.9	44.9	140.8
-								
- Total Residue & Sludge Treatment Subsystem					4892.5		1168.4	6060.9
6 Soft Debris Treatment Subsystem	II							
- Prepare & Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		1	50	50	8	8	58
- Discharge and Loading Hoppers	E		1	45	45	8	8	53
- Feed Blender	E		1	45	45	8	8	53
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost for Above Package	E		Lot	4300	4300	430	430	4730
- Miscellaneous								
- Neutralization System	E		1	95	95	19	19	
- Neutralization Overflow Pump	E		1	5	5	1	1	
- Sludge Transfer Pump	E		1	5	5	1	1	
- Crane	E		1	525	525	105	105	630
- Close Circuit TV	E		10	10	100	2	20	216
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	44	174
- Allowance for Mechanical/Control/Instrumentation	E		Lot	1,742.4	1742.4	216.6	216.6	1959
- Allowance For Electrical/Control	E		Lot	871.2	871.2	433.2	433.2	1304.4
- Calibration, Testing & Startup	E		Lot	168.4	168.4	82.3	82.3	250.7
-								
- Total Soft Debris Treatment Subsystem					8590		1454.1	9754.1

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
7 Complex Debris Treatment Subsystem								
- Costs included with Grout								
-								
Total Complex Debris Treatment Subsystem								
8 Open Debris Treatment Subsystem	II							
- Feed Preparation and Separation								
- Bulk Solids Dump Hopper	F		1	40	40	4	4	44
- Bin Hoist/Pusher	E		2	33	66	8	16	82
- Drum/Bin Conveyor	E		6	10	60	4	24	84
- OH Crane	E		1	525	525	105	105	630
- Closed Circuit TV	E		7	10	70	2	14	84
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		1	130	130	44	44	174
- Dust Collection Assembly	E		Lot	108	108	17	17	125
- High Pressure Wash								
- Receptacle Basket								
- Water Pump								
- Agitation Pump								
- Surfactant Preparation								
- Surfactant Pump								
- Surfactant Holding Tank								
- Mixing Tank with Agitator								
- Solution High Pressure Pump								
- Water Heater								
- Water Holding Tank								
- Water Pump								
- Gross Organic Removal								
- Oil/Water Separator								
- Recycle Pump								
- Oil Pump								
- Water Treatment								
- Bag Filter								
- Solids Bin								
- Neutralization Tank								
- Chemical Addition Pump (Acid)								
- Chemical Storage Tank								
- Liquid-Phase Carbon								
- Ion Exchange Unit								
- Treated Water Holding Tank								
- Treated Water Pump								
- Total Per Wash Package Above	A		Lot	47	141	5	5	146
- Allowance for Mechanical/Control/Instrumentation	E		Lot	416.4	416.4	184.2	184.2	600.6
- Allowance For Electrical/Control	E		Lot	208.2	208.2	153.5	153.5	361.7
- Calibration, Testing & Startup	E		Lot	40.3	40.3	25.8	25.8	66.1
Total Open Debris Treatment Subsystem					2052.9		670.5	2723.4
9 Bulk Soil Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	30	30	6	6	36
- Discharge. & Oversize Load Hopper	E		1	11	11	2	2	13
- Slurry Mix Tank	E		1	20	20	4	4	24
- Feed Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Airlock	E		2	124	248	39	78	326
- Closed Circuit TV	E		7	10	70	2	14	84
- Shield Window	E		1	130	130	44	44	174
- Wash System								
- Attrition Mill	D		1	25	37.2	5	5	42.2
- Extraction Tank with Agitator	D		1	50	74.4	10	9.9	84.3
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Off-Gas Control								
- Heat Exchanger	E		2	6	12	0.4	0.8	12.8

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3							
	CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Solid/ Liquid Separation System	E							
- Vibrating Screen	E		1	6	6	1	1	7
- Hydrocyclone	D		2	4.5	13.5	0.4	0.8	14.3
- Countercurrent Solid/ Liquid Contactor	B		1	160	320	32	32	352
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Diaphragm Pump	E		1	1	1	0.2	0.2	1.2
- Solids Bin	E		1	5	5	1	1	6
- Overhead Crane	E		1	525	525	105	105	630
- Solubility Reduction Separator								
- Phase Separator	B		1	4.8	9.6	1	1	10.6
- Additive Addition Pump	E		1	1	1	0.3	0.3	1.3
- Surfactant Phase Pump	E		1	5	5	1	1	6
- Water Phase Pump	E		1	5	5	1	1	6
- Storage Tanks (Water and Concentrate)	E		2	2	4	0.4	0.8	4.8
- UltraFiltration Unit	E		1	50	50	10	10	60
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Dissolved Air Floatation Unit	E		1	50	50	7.5	7.5	57.5
- Surfactant Preparation								
- Water Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Heater	E		1	0.6	0.6	0.1	0.1	0.7
- Surfactant Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Pump	E		1	5	5	1	1	6
- Surfactant Pump	E		1	5	5	1	1	6
- Dilution Tank Agitator	E		1	1.5	1.5	0.2	0.2	1.7
- Dilution Tank Pump	E		1	5	5	1	1	6
- Surfactant Dilution Tank	E		1	2.0	2	0.4	0.4	2.4
- Drier	E		1	100.0	100	30.0	30	130
- Surfactant Separation								
- Additive Pump	E		4	1	4	0.3	1.2	5.2
- Additive Tanks	E		1	3.2	3.2	0.5	0.5	3.7
- Surfactant Separation Unit	B		1	50	100	1	10	110
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Allowance for Mechanical/Control/Instrumentation	E		Lot	572.4	572.4	228.7	228.7	801.1
- Allowance For Electrical/Control	E		Lot	286.2	286.2	190.6	190.6	476.8
- Calibration, Testing & Startup	E		Lot	55.3	55.3	32.0	32	87.3
-								
-								
Total Bulk Soil Treatment Subsystem					2821.9		832.4	3654.3
10: Metal Decontamination Subsystem								
- Pretreatment (GTCC-II)								
- High Pressure Water Rinse Station								
- Hot Air Dryer Station								
- Chemical Storage Tank								
- Chemical Mixing Tank								
- Chemical Metering Pump								
- Solution Pump								
- Complete Package per Above Detail	E		Lot	150.0	150	50.0	50	200
- Shield Window	E		1	130	130	44	44	174
- Closed Circuit TV	E		5	10.0	50	2.0	10	60
- Size Reduction (GTCC-II)								
- Hydraulic Manipulator	E		1	120.0	120	50.0	50	170
- Gantry Robot	E		1	800.0	800	160.0	160	960
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245
- Fugitive Dust Collection System	E		2	100.0	200	15.0	30	230
- Master Slave Manipulator	E		1	65.0	65	15.0	15	80
- Airlock	E		2	124.0	248	39.0	78	326
- Assay/Inspection (GTCC-II)								
- Assay Unit - Mini	E		1	500.0	500	100.0	100	600
- Roller Conveyor	E		10	6.0	60	1.0	10	70
- Shielding Window	E		3	130.0	390	44.0	132	522

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
- Allowance for Mechanical/Piping	E		Lot	145.9	145.9	359.5	359.5	505.4
- Allowance for Electrical/Control	E		Lot	437.7	437.7	359.5	359.5	797.2
- Calibration, Testing & Startup	E		Lot	70.0	70	57.5	57.5	127.5
-								
Total Metal Decontamination Subsystem					3571.6		1495.5	5067.1
11 Special Waste	II							
-								
- Allowance for Mechanical/Piping	E		Lot					
- Allowance for Electrical/Control	E		Lot					
- Calibration, Testing & Startup	E		Lot					
-								
Total Special Waste								
12 Mercury Amalgamation Subsystem	II							
- Mercury Amalgamation & Packaging (A-RMERC)								
- Liquid Mercury Storage Tank	E		1	7.0	7	1.0	1	8
- Liquid Mercury Pump	E		1	5.0	5	1.0	1	6
- Copper Powder Bin (1 ft³)	E		1	5.0	5	0.6	0.6	5.6
- Steel Shot Bin (0.5 ft³)	E		1	5.0	5	0.6	0.6	5.6
- Nitric Acid Tank (1 GAL)	E		1	5.0	5	0.5	0.5	5.5
- Nitric Acid Pump (1 Gal/hr)	E		1	5.0	5	1.0	1	6
- Amalgam Mixer (5 GAL)	F		1	26.0	26	5.0	5	31
- Amalgam packager	F		1	2.0	2	0.4	0.4	2.4
- Crane	E		1	525.0	525	105.0	105	630
- Closed Circuit TV	E		2	10.0	20	2.0	4	24
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		1	130.0	130	44.0	44	174
- Allowance for Mechanical/Piping	E		Lot	294.9	294.9	144.7	144.7	439.6
- Allowance for Electrical/Control	E		Lot	147.5	147.5	120.6	120.6	268.1
- Calibration, Testing & Startup	E		Lot	28.5	28.5	20.3	20.3	48.8
-								
Total Mercury Amalgamation Subsystem					1453.9		526.7	1980.6
13 Lead Recovery Subsystem	I							
- Decontamination (A-PBRCR)								
- Drum Lid Detacher	F		1	4.0	4	1.0	1	5
- Roller Conveyors (Straight)	F		12	5.0	60	1.0	12	72
- Decon Booth	F		1	175.0	175	25.0	25	200
- Hydraulic Drum Dumper	F		1	4.0	4	2.0	2	6
- Sorting Table (1 Hole)	E		2	4.0	8	1.0	2	10
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245
- Sorting Table (4 Holes)	E		1	6.0	6	1.0	1	7
- Rolling Conveyor (L-Shaped)	F		1	5.0	5	2.0	2	7
- Drum Pusher	F		1	1.0	1	1.0	1	2
- Aqueous Waste Tank	E		1	5.0	5	2.0	2	7
- Aqueous Waste Pump	E		1	3.0	3	2.0	2	5
- Assay/Drumming (A-PBRCR)								
- Drum Pusher	F		1	10.0	10	0.2	0.2	10.2
- Lid Attacher	F		1	2.0	2	0.3	0.3	2.3
- Assay Station	F		1	500.0	500	3.0	3	503
- Drum Washer	E		1	70.0	70	10.0	10	80
- Miscellaneous Equipment								
- Transfer Cart (CA)	E		1	100.0	100	20.0	20	120
- Crane	E		1	525.0	525	105.0	105	630
- Closed Circuit TV	E		4	10.0	40	2.0	8	48
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		1	130.0	130	44.0	44	174
- Allowance for Mechanical/Piping	E		Lot	105.1	105.1	179.3	179.3	284.4
- Allowance for Electrical/Control	E		Lot	315.2	315.2	179.3	179.3	494.5
- Calibration, Testing & Startup	E		Lot	50.4	50.4	28.7	28.7	79.1
-								
Total Lead Recovery Subsystem					2571.7		745.8	3317.5

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
14. Air Pollution Control Subsystem	H							
- Particulate Filter								
- Baghouse Assembly	E		1	240.0	240	48.0	48	288
- Prefilter	E		2	26.0	52	12.0	24	76
- Inter Connection Ducts.	E		Lot	2.0	2	10.0	10	12
- Corona Reactor								
- Reactor								
- Skid & Instrumentation								
- Power Supply								
- Cost per Package Above	E		Lot	73.0	73	7.0	7	80
- Acid Gas Scrubber								
- Packing Tower	E		1	45.0	45	13.0	13	58
- Induced Fan	E		2	4.5	9	0.5	1	10
- Recycle Pump	E		2	1.8	3.6	0.2	0.4	4
- Sludge Discharge Pump	E		2	2.7	5.4	0.5	1	6.4
- Caustic Feed Pump	E		2	0.9	1.8	0.2	0.4	2.2
- NaOH Transfer Pump	E		2	0.9	1.8	0.2	0.4	2.2
- Caustic Storage Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Slurry Pump	E		2	2.7	5.4	0.5	1	6.4
- Condensate Tank	E		1	0.9	0.9	0.2	0.2	1.1
- NaOH Day Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Scrubber Solution Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Evaporator System	E		1	54.0	54	16.2	16.2	70.2
- Hydrosonic Scrubber	E		1	27.0	27	5.4	5.4	32.4
- Liquid/ Solid Separator	E		1	18.0	18	3.6	3.6	21.6
- Mist Eliminator	E		1	1.6	1.6	0.4	0.4	2
- Heat Exchanger	E		2	5.4	10.8	1.8	3.6	14.4
- Carbon Adsorption								
- Carbon Filter (GAC)	F		2	9.0	18	1.8	3.6	21.6
- Carbon Filter (Sublimated GAC)	F		2	9.0	18	1.8	3.6	21.6
- Support System								
- Stack	E		1	7.2	7.2	1.4	1.4	8.6
- Stack Monitors - Radioactive	E		Lot	56.0	56	14.4	14.4	70.4
- Stack Monitors - Non Radioactive	E		Lot	27.0	27	10.8	10.8	37.8
- OH Crane	E		1	525.0	525	105.0	105	630
- Airlock	E		2	124.0	248	39.0	78	326
- Closed Circuit TV	E		4	10.0	40	2.0	8	48
- Shield Window	E		1	130	130	44	44	174
- Allowance for Mechanical/Piping	E		Lot	487.0	487	243.0	243	730
- Allowance for Electrical/Control	E		Lot	243.5	243.5	202.5	202.5	446
- Calibration, Testing & Startup	E		Lot	47.1	47.1	34.0	34	81.1
Total Air Pollution Control Subsystem					2400.8		884.5	3285.3
15. Polymer Stabilization Subsystem	I							
- Prepare & Feed Incoming Waste (A-PLYMR)								
- Bin Hoist / Pusher	F		5	100.0	100	8.0	8	108
- Discharge. & Oversize Load Hopper (100 CF)	F		1	90.0	90	9.0	9	99
- Tertiary Shredder	B		50	1	75.0	150	10.0	160
- Live Bottom Bulk Storage	F		1	1	90.0	90	9.0	99
- Conveyor / Canister Handler	F		5	1	120.0	120	10.0	130
- Manipulation Crane - 5 TON	E		10	1	525.0	525	105.0	630
- Dust Collection System w/ Blower	F		1	162.0	162	17.0	17	179
- HEPA Filter	F		8	37.5	300	5.0	40	340
- Closed Circuit TV	E		13	10.0	130	2.0	26	156
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		2	130	260	44	88	348
- Drying (A-PLYMR)								
- Drier	F		1	877.5	877.5	88.0	88	965.5
- Conveyor	F		5	5	6.0	30	1.0	35
- Proportioning and Blending (A-PLYMR)								
- Polymer Pellets Storage Silo	E		4	37.5	150	7.0	28	178
- Weigh Station	E		2	30.0	60	2.0	4	64
- Blender	F		2	1	79.5	79.5	5.0	84.5

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
- Conveyor	F	5	11	6.0	66	1.0	11	77
- Encapsulation (A-PLYMR)								
- Extruder	F	100	1	945.0	945	22.7	22.7	967.7
- Activated Carbon	F		4	15.0	60	1.0	4	64
- Drum Cooling (A-PLYMR)								
- Induced Draft Fan/ Ducting	F		8	24.0	192	2.0	16	208
- Enclosure	F		1	181.5	181.5	8.0	8	189.5
- Drum Capping and Washing (A-PLYMR)								
- Drum Wash/ Cap	E		4	105.0	420	15.0	60	480
- Flush Water Collection and Conveying	E		2	45.0	90	18.0	36	126
- Conveyor	F	5	39	6.0	234	1.0	39	273
- Allowance for Mechanical/Piping	E		Lot	278.0	278	363.4	363.4	641.4
- Allowance for Electrical/Control	E		Lot	834.1	834.1	363.4	363.4	1197.5
- Calibration, Testing & Startup	E		Lot	133.5	133.5	58.1	58.1	191.6
Total Polymer Stabilization Subsystem					6806.1		1511.6	8317.7
16 Certification & Shipping Subsystem	I							
- Incoming Material Storage (B-CSHIP)								
- Overhead Bridge Crane 20 TN	E		1	625.0	625	125.0	125	750
- Forklift 10 TN	E		1	65.0	65	10.0	10	75
- Inspect & Assay (B-CSHIP)								
- Transfer Cart 2 TN	E							
- Real Time Radiography (ND)								
- Passive Active Neutron (ND)								
- Segmented Gamma Spectroscopy (ND)								
- Complete Package per Above	E		2	1,500.0	3000	150.0	300	3300
- Self Guided Vehicle (ND)	E		1	425.0	425	850.0	850	1275
- Truck Loading (B-CSHIP)								
- Forklift 10 TN	E		10	65.0	650	10.0	100	750
- Roll-up Door	E		2	20.0	40	2.0	4	44
- Bridge Crane	E		1	525.0	525	105.0	105	630
- Roller Conveyor (CA)	E		20	2.0	40	1.0	20	60
- Allowance for Mechanical/Piping	E		Lot	268.5	268.5	757.0	757	1025.5
- Allowance for Electrical/Control	E		Lot	805.5	805.5	757.0	757	1562.5
- Calibration, Testing & Startup	E		Lot	128.9	128.9	121.1	121.1	250
Total Certification & Shipping Subsystem					6572.9		3149.1	9722

Table B-3.1: Equipment Purchase & Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 3 CWO and Polymer Stabilization

DESCRIPTION	ENTS - 3 CWO and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			
			QTY	Unit Cost	Amount	Unit Cost	Amount	Total U.O.
				\$1000's	\$1000's	\$1000's	\$1000's	
17 Support Subsystem	III							
- Electrical Distribution and MCC								
- Control Panel - FT	E		110	10.0	1100	2.0	220	1320
- Emergency Power Generator	E		1	500.0	500	100.0	100	600
- Main Control Panel	E		20	10.0	200	2.0	40	240
- Motor Control Center	E		100	1.5	150	0.5	50	200
- Stand by Emergency Power	E		1	230.0	230	80.0	80	310
- Utilities and Mechanical								
- Breathing Air Package	E		Lot	70.0	70	30.0	30	100
- Compressed Air Package	E		Lot	100.0	100	25.0	25	125
- Instrument Air	E		1	70.0	70	30.0	30	100
- Instrument Air Package	E		Lot	90.0	90	25.0	25	115
- Plant Steam/Boiler	E		1	75.0	75	25.0	25	100
- Service Water	E		1	130.0	130	40.0	40	170
- Sump Pump	E	3	10	5.0	50	2.0	20	70
- Cooling Tower	E		1	200.0	200	10.0	10	210
- Cooling Water Pumps	E	3	2	15.0	30	3.0	6	36
- Heating, Ventilation & Exhaust								
- Included with Building Cost								
- Radiation Monitoring								
- Air Monitors	E		44	10.0	440	2.0	88	528
- Area Monitoring	E		44	4.5	198	1.0	44	242
- Personnel Monitoring Portals	E		6	35.0	210	5.0	30	240
- Portal Monitors	E		6	35.0	210	5.0	30	240
- Allowance for Mechanical/Piping	E		Lot	40.5	40.5	8.9	8.9	49.4
- Allowance for Electrical/Control	E		Lot	608.0	608	134.0	134	742
- Calibration, Testing & Startup	E		Lot	94.0	94	20.7	20.7	114.7
-								
Total Support Subsystem					4795.5		1056.6	5852.1

Table B-3.2 : Development, Testing & Evaluation Cost Estimates
ENTS - 3 CWO and Polymer Stabilization

UNIT OPERATION		ENTS - 3 CWO and Polymer Stabilization								
		Primary Paper Evaluation Research Manpower	Bench Scale Studies Research Manpower	Sec. Paper Evaluation Research Manpower	Total Research Manpower	Bench Scale Studies Equipment \$1000	Bench Scale Studies Installation \$1000	Pilot Plant Mock-up Test Demo. Manpower	Pilot Plant Mock-up Test Bldg. \$1000	Pilot Plant Mock-up Test Equip. \$1000
1	Administration Building Subsystem									
2	Receiving & Inspection Subsystem	12			12			25	1200	6000
3	Aqueous Waste Treatment Subsystem	5	3	3	11	100	300	10	400	2000
4	Organic Destruction Subsystem	18	20	4	42	500	150	30	400	4000
5	Residue & Sludge Treatment Subsystem	13	8	4	25	500	150	30	500	2000
6	Soft Debris Treatment Subsystem									
7	Complex Debris Treatment Subsystem									
8	Open Debris Treatment Subsystem	2	6	2	10	300	50	20	1000	3000
9	Bulk Soil Treatment Subsystem	10	6	2	18	200	50	10	200	500
10	Metal Decontamination Subsystem									
11	Special Waste	8	20	5	33	600	250	20	400	2000
12	Mercury Amalgamation Subsystem	1	3		4	100	50			
13	Lead Recovery Subsystem	2	2		4	100	30			
14	Air Pollution Control Subsystem	5	3	2	10	200	50	15	400	2000
15	Polymer Stabilization Subsystem	2	8	4	14	300	50	15	400	2000
16	Certification & Shipping Subsystem									
17	Support Subsystem	5			5					
	Unit Cost (\$/Unit)				\$150,000			\$150,000		
	Total Cost				28,200	2,900	1,130	26,250	4,900	23,500
	Post Totals To Table 4-3, Item				1.1	1.2	1.3	2.1	2.5.1	2.5.2

Table B-3.3 : Building, Equipment & Installation Cost Summary
ENTS - 3 CWO and Polymer Stabilization

UNIT OPERATION		ENTS - 3 CWO and Polymer Stabilization								
		Building Area					Material & Equipment Costs			Total Cost per Unit Oprtn. \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	Total Area Cost \$1000	Purchase Cost \$1000	Installation Cost \$1000	Total Cost \$1000	
1	Administration Building Subsystem	12,440	3,000			3499	3162.7	888.2	4051	7550
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	38966	18493.5	6774.6	25268	64234
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	5287	4980.2	1516.1	6496	11783
4	Organic Destruction Subsystem		1,128	1,717	1,560	5187	5750.4	1476.4	7227	12414
5	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	9376	4892.5	1168.4	6061	15437
6	Soft Debris Treatment Subsystem		1,606	2,444	2,220	7381	8590	1454.1	10044	17425
7	Complex Debris Treatment Subsystem									
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	8678	2052.9	670.5	2723	11401
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	7381	2821.9	832.4	3654	11035
10	Metal Decontamination Subsystem		641	169	1904	3709	3571.6	1495.5	5067	8776
11	Special Waste		604	159	1792	3491				3491
12	Mercury Amalgamation Subsystem		1020	1552	1410	4688	1453.9	526.7	1981	6669
13	Lead Recovery Subsystem						2571.7	745.8	3318	3318
14	Air Pollution Control Subsystem		955	1,453	1,320	4389	2400.8	884.5	3285	7674
15	Polymer Stabilization Subsystem		3,097	8,278	5,250	20159	6806.1	1511.6	8318	28477
16	Certification & Shipping Subsystem		28,277			11876	6572.9	3149.1	9722	21598
17	Support Subsystem	3360	16,883			7696	4795.5	1056.6	5852	13548
	Total Cost					141,763			103,067	244,830
		Post Totals To Table 4-3, Item				3.4.1			3.4.2	

Table B-3.4 : Annual Operating & Maintenance Costs
ENTS - 3 CWO and Polymer Stabilization

UNIT OPERATION		ENTS - 3					
		CWO and Polymer Stabilization					Totals
		Operating FTE	Utilities \$1000	Materials \$1000	Maintenance Labor (1) \$1000	Maintenance Materials (2) \$1000	
1	Administration Building Subsystem	32	5	164	318	127	445
2	Receiving & Inspection Subsystem	170	159	612	1,850	740	2,590
3	Aqueous Waste Treatment Subsystem	5	300	1,705	873	349	1,222
4	Organic Destruction Subsystem	12	298	297	1,438	575	2,013
5	Residue & Sludge Treatment Subsystem	8	21	1	855	342	1,197
6	Soft Debris Treatment Subsystem	14	708	704	2,148	859	3,007
7	Complex Debris Treatment Subsystem						
8	Open Debris Treatment Subsystem	8	25	100	360	144	504
9	Bulk Soil Treatment Subsystem	2	22	14	140	56	196
10	Metal Decontamination Subsystem	4	5	25	625	250	875
11	Special Waste	3	12	200			
12	Mercury Amalgamation Subsystem	1	2	10	255	102	357
13	Lead Recovery Subsystem	3	73	50	450	180	630
14	Air Pollution Control Subsystem	4	67	130	420	168	588
15	Polymer Stabilization Subsystem	56	177	3,344	1,190	476	1,666
16	Certification & Shipping Subsystem	88	12	70	658	263	921
17	Support Subsystem	5			480	192	672
	Unit cost (\$/unit)	\$140,000					
	Total Cost	58,135	1886	7,426			16,883
	Post Totals To Table 4-3, Item	5.1	5.2	5.3			5.4

Notes:

1. Annual Maintenance Labor is 250 % of maintenance material cost.
2. Maintenance Material is assumed to be 2 % of equipment capital cost for the Bulk Soil Treatment subsystem, because the capital equipment is based on one shift operation.
3. Maintenance Material is assumed to be 10 % of equipment capital cost for organic destruction and soft debris.
4. Maintenance Material is assumed to be 4 % of equipment capital cost for Administration, Receiving & Inspection, Grout Stabilization, Certification & Shipping, and Support subsystems.
5. Maintenance Material is assumed to be 7 % of equipment capital cost for all other subsystems

Table B-3.5 : Decontamination & Decommissioning Costs
ENTS - 3 CWO and Polymer Stabilization

UNIT OPERATION		ENTS - 3 CWO and Polymer Stabilization				
		Building Area				Total Area Cost \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	
1	Administration Building Subsystem	12,440	3,000			6,948
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	18,916
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	2,021
4	Organic Destruction Subsystem		1,128	1,717	1,560	1,983
5	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	3,584
6	Soft Debris Treatment Subsystem		1,606	2,444	2,220	2,822
7	Complex Debris Treatment Subsystem					
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	3,317
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	2,822
10	Metal Decontamination Subsystem		641	169	1,904	1,222
11	Special Waste		604	159	1,792	1,150
12	Mercury Amalgamation Subsystem		1,020	1,552	1,410	1,792
13	Lead Recovery Subsystem					
14	Air Pollution Control Subsystem		955	1,453	1,320	1,678
15	Polymer Stabilization Subsystem		3,097	8,278	5,250	7,481
16	Certification & Shipping Subsystem		28,277			12,725
17	Support Subsystem	3,360	16,883			9,109
	Total Cost					77,570
		Post Totals To Table 4-3, Item				7.0

Table B-3.6: Total Life-Cycle Cost (without Disposal) Estimate for
Enhanced Integrated Non Thermal Treatment Systems (cost module ENTS-3)

Cost component	Cost Items	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3
		Administration Building Subsystem	Receiving & Inspection Subsystem	Aqueous Waste Treatment Subsystem	Organic Destruction Subsystem	Residue & Sludge Treatment Subsystem	Soft Debris Treatment Subsystem	Complex Debris Treatment Subsystem	Open Debris Treatment Subsystem	Bulk Soil Treatment Subsystem	Metal Decontamination Subsystem	Special Waste	
1.0	Studies and bench scale test costs												
1.1	Manpower costs during research	\$0	\$1,800	\$1,650	\$6,300	\$3,750	\$0	\$0	\$1,500	\$2,700	\$0	\$4,950	
1.2	Equipment costs	\$0	\$0	\$100	\$500	\$500	\$0	\$0	\$300	\$200	\$0	\$600	
1.3	Installation costs	\$0	\$0	\$300	\$150	\$150	\$0	\$0	\$50	\$50	\$0	\$250	
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$0	\$180	\$205	\$695	\$440	\$0	\$0	\$185	\$295	\$0	\$580	
1.5	Contingency (25 % of 1.1 through 1.4)	\$0	\$495	\$564	\$1,911	\$1,210	\$0	\$0	\$509	\$811	\$0	\$1,595	
	Subtotal 1.0	\$0	\$2,475	\$2,819	\$9,556	\$6,050	\$0	\$0	\$2,544	\$4,056	\$0	\$7,975	
2.0	Demonstration costs												
2.1	Manpower costs during demonstration	\$0	\$3,750	\$1,500	\$4,500	\$4,500	\$0	\$0	\$3,000	\$1,500	\$0	\$3,000	
2.2	Design cost (30 % of 2.5)	\$0	\$2,786	\$929	\$1,703	\$968	\$0	\$0	\$1,548	\$271	\$0	\$929	
2.3	Inspection cost (7 % of 2.5)	\$0	\$650	\$217	\$397	\$226	\$0	\$0	\$361	\$63	\$0	\$217	
2.4	Project management (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90	\$0	\$310	
2.5	Construction cost												
2.5.1	Building structure costs	\$0	\$1,200	\$400	\$400	\$500	\$0	\$0	\$1,000	\$200	\$0	\$400	
2.5.2	Equipment costs	\$0	\$6,000	\$2,000	\$4,000	\$2,000	\$0	\$0	\$3,000	\$500	\$0	\$2,000	
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$2,088	\$696	\$1,276	\$725	\$0	\$0	\$1,160	\$203	\$0	\$696	
	Subtotal of 2.5	\$0	\$9,288	\$3,096	\$5,676	\$3,225	\$0	\$0	\$5,160	\$903	\$0	\$3,096	
2.6	Construction management costs (17 % of 2.5)	\$0	\$1,588	\$529	\$971	\$551	\$0	\$0	\$882	\$154	\$0	\$529	
2.7	Management Reserve (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90	\$0	\$310	
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$4,980	\$1,723	\$3,596	\$2,529	\$0	\$0	\$2,996	\$768	\$0	\$2,098	
	Subtotal 2.0	\$0	\$24,900	\$8,614	\$17,979	\$12,645	\$0	\$0	\$14,979	\$3,839	\$0	\$10,489	
3.0	Production facility construction costs												
3.1	Design cost (25 % of 3.4)	\$2,435	\$20,716	\$3,800	\$4,004	\$4,979	\$5,620	\$0	\$3,677	\$3,559	\$2,830	\$1,126	
3.2	Inspection cost (7 % of 3.4)	\$682	\$5,800	\$1,064	\$1,121	\$1,394	\$1,573	\$0	\$1,029	\$996	\$792	\$315	
3.3	Project management (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$1,991	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450	
3.4	Construction cost												
3.4.1	Building structure costs	\$3,499	\$38,966	\$5,287	\$5,187	\$9,376	\$7,381	\$0	\$8,678	\$7,381	\$3,709	\$3,491	
3.4.2	Equipment costs	\$4,051	\$25,268	\$6,496	\$7,227	\$6,061	\$10,044	\$0	\$2,723	\$3,654	\$5,067	\$0	
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$2,190	\$18,628	\$3,417	\$3,600	\$4,477	\$5,053	\$0	\$3,306	\$3,200	\$2,545	\$1,012	
	Subtotal of 3.4	\$9,740	\$82,862	\$15,200	\$16,014	\$19,914	\$22,478	\$0	\$14,707	\$14,235	\$11,321	\$4,503	
3.5	Construction management (17 % of 3.4)	\$1,666	\$14,169	\$2,599	\$2,738	\$3,405	\$3,844	\$0	\$2,515	\$2,434	\$1,936	\$770	
3.6	Management Reserve (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$1,991	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450	
3.7	Contingency (25 % of 3.1 through 3.5)	\$3,874	\$32,958	\$6,046	\$6,370	\$7,921	\$8,941	\$0	\$5,850	\$5,662	\$4,503	\$1,791	
	Subtotal 3.0	\$20,345	\$173,077	\$31,749	\$33,449	\$41,595	\$46,952	\$0	\$30,720	\$29,734	\$23,646	\$9,405	
4.0	Operations Budget Funded Activities (See Sect. 7)												
4.1	Conceptual design (1.5 % of 3.0)	\$305	\$2,596	\$476	\$502	\$624	\$704	\$0	\$461	\$446	\$355	\$141	
4.2	Safety assurance (1 % of 3.0)	\$203	\$1,731	\$317	\$334	\$416	\$470	\$0	\$307	\$297	\$236	\$94	
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	
4.4	Preparation for operations (100 % of 5.0)	\$6,368	\$33,951	\$4,909	\$5,360	\$2,924	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790	
4.5	Project Management (10 % of 4.1 through 4.4)	\$1,388	\$13,828	\$570	\$620	\$396	\$915	\$0	\$295	\$138	\$242	\$103	
	Subtotal 4.0	\$15,264	\$42,106	\$6,272	\$6,816	\$4,360	\$10,063	\$0	\$3,249	\$1,521	\$2,664	\$1,128	
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$35,609	\$242,558	\$49,454	\$67,800	\$64,650	\$57,015	\$0	\$51,492	\$39,150	\$26,310	\$28,997	
5.0	Operating and maintenance costs												
5.1	Annual operating costs	\$4,480	\$23,800	\$700	\$1,680	\$1,120	\$1,960	\$0	\$1,120	\$280	\$560	\$420	
5.2	Annual utility costs	\$5	\$159	\$300	\$298	\$21	\$708	\$0	\$25	\$22	\$5	\$12	
5.3	Annual material costs	\$164	\$612	\$1,705	\$297	\$1	\$704	\$0	\$100	\$14	\$25	\$200	
5.4	Annual maintenance costs	\$445	\$2,590	\$1,222	\$2,013	\$1,197	\$3,007	\$0	\$504	\$196	\$875	\$0	
5.5	Contingency (25 % of 5.1 through 5.4)	\$1,274	\$6,790	\$982	\$1,072	\$585	\$1,595	\$0	\$437	\$128	\$366	\$158	
5.6	Subtotal 5.0	\$6,368	\$33,951	\$4,909	\$5,360	\$2,924	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790	
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$127,360	\$679,020	\$98,180	\$107,200	\$58,480	\$159,480	\$0	\$43,720	\$12,800	\$36,620	\$15,800	
6.0	Decontamination & Decommissioning	\$6,948	\$18,916	\$2,021	\$1,983	\$3,584	\$2,822	\$0	\$3,317	\$2,822	\$1,222	\$1,150	
7.0	ROM Life cycle costs (20 years operation)	\$169,917	\$940,494	\$149,655	\$176,983	\$126,714	\$219,317	\$0	\$98,529	\$54,772	\$64,152	\$45,947	

Table B-3.6 : Total Life-Cycle Cost (without Disposal) Estimate for
Enhanced Integrated Non Thermal Treatment Systems (cost module ENTS-3)

Cost component	Cost Items	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3	ENTS-3
		Mercury Amalgamation Subsystem	Lead Recovery Subsystem	Air Pollution Control Subsystem	Polymer Stabilization Subsystem	Certification & Shipping Subsystem	Support Subsystem	Total System
1.0	Studies and bench scale test costs							
1.1	Manpower costs during research	\$600	\$600	\$1,500	\$2,100	\$0	\$750	\$28,200
1.2	Equipment costs	\$100	\$100	\$200	\$300	\$0	\$0	\$2,900
1.3	Installation costs	\$50	\$30	\$50	\$50	\$0	\$0	\$1,130
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$75	\$73	\$175	\$245	\$0	\$75	\$3,223
1.5	Contingency (25 % of 1.1 through 1.4)	\$206	\$201	\$481	\$674	\$0	\$206	\$8,863
	Subtotal 1.0	\$1,031	\$1,004	\$2,406	\$3,369	\$0	\$1,031	\$44,316
2.0	Demonstration costs							
2.1	Manpower costs during demonstration	\$0	\$0	\$2,250	\$2,250	\$0	\$0	\$26,250
2.2	Design cost (30 % of 2.5)	\$0	\$0	\$929	\$929	\$0	\$0	\$10,991
2.3	Inspection cost (7 % of 2.5)	\$0	\$0	\$217	\$217	\$0	\$0	\$2,565
2.4	Project management (10 % of 2.5)	\$0	\$0	\$310	\$310	\$0	\$0	\$3,664
2.5	Construction cost							
2.5.1	Building structure costs	\$0	\$0	\$400	\$400	\$0	\$0	\$4,900
2.5.2	Equipment costs	\$0	\$0	\$2,000	\$2,000	\$0	\$0	\$23,500
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$0	\$696	\$696	\$0	\$0	\$8,236
	Subtotal of 2.5	\$0	\$0	\$3,096	\$3,096	\$0	\$0	\$36,636
2.6	Construction management costs (17 % of 2.5)	\$0	\$0	\$529	\$529	\$0	\$0	\$6,265
2.7	Management Reserve (10 % of 2.5)	\$0	\$0	\$310	\$310	\$0	\$0	\$3,664
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$0	\$1,910	\$1,910	\$0	\$0	\$22,509
	Subtotal 2.0	\$0	\$0	\$9,551	\$9,551	\$0	\$0	\$112,544
3.0	Production facility construction costs							
3.1	Design cost (25 % of 3.4)	\$2,151	\$1,070	\$2,475	\$9,184	\$6,965	\$4,369	\$78,958
3.2	Inspection cost (7 % of 3.4)	\$602	\$300	\$693	\$2,571	\$1,950	\$1,223	\$22,108
3.3	Project management (10 % of 3.4)	\$860	\$428	\$990	\$3,674	\$2,786	\$1,748	\$31,583
3.4	Construction cost							
3.4.1	Building structure costs	\$4,688	\$0	\$4,389	\$20,159	\$11,876	\$7,696	\$141,763
3.4.2	Equipment costs	\$1,981	\$3,318	\$3,285	\$8,318	\$9,722	\$5,852	\$103,067
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$1,934	\$962	\$2,225	\$8,258	\$6,263	\$3,929	\$71,001
	Subtotal of 3.4	\$8,603	\$4,280	\$9,899	\$36,735	\$27,861	\$17,477	\$315,831
3.5	Construction management (17 % of 3.4)	\$1,471	\$732	\$1,693	\$6,282	\$4,764	\$2,989	\$54,007
3.6	Management Reserve (10 % of 3.4)	\$860	\$428	\$990	\$3,674	\$2,786	\$1,748	\$31,583
3.7	Contingency (25 % of 3.1 through 3.5)	\$3,422	\$1,703	\$3,938	\$14,612	\$11,082	\$6,952	\$125,622
	Subtotal 3.0	\$17,969	\$8,941	\$20,678	\$76,732	\$58,194	\$36,506	\$659,692
4.0	Operations Budget Funded Activities (See Sect. 7)							
4.1	Conceptual design (1.5 % of 3.0)	\$270	\$134	\$310	\$1,151	\$873	\$548	\$9,895
4.2	Safety assurance (1 % of 3.0)	\$180	\$89	\$207	\$767	\$582	\$365	\$6,597
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$0	\$0	\$0	\$0	\$0	\$0	\$7,000
4.4	Preparation for operations (100 % of 5.0)	\$636	\$1,466	\$1,681	\$16,328	\$16,654	\$1,715	\$105,413
4.5	Project Management (10 % of 4.1 through 4.4)	\$109	\$169	\$220	\$1,825	\$1,811	\$263	\$12,891
	Subtotal 4.0	\$1,195	\$1,858	\$2,418	\$20,071	\$19,920	\$2,891	\$141,796
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$20,195	\$11,803	\$35,053	\$109,723	\$78,114	\$40,428	\$958,348
5.0	Operating and maintenance costs							
5.1	Annual operating costs	\$140	\$420	\$560	\$7,875	\$12,320	\$700	\$58,135
5.2	Annual utility costs	\$2	\$73	\$67	\$177	\$12	\$0	\$1,886
5.3	Annual material costs	\$10	\$50	\$130	\$3,344	\$70	\$0	\$7,426
5.4	Annual maintenance costs	\$357	\$630	\$588	\$1,666	\$921	\$672	\$16,883
5.5	Contingency (25 % of 5.1 through 5.4)	\$127	\$293	\$336	\$3,266	\$3,331	\$343	\$21,083
5.6	Subtotal 5.0	\$636	\$1,466	\$1,681	\$16,328	\$16,654	\$1,715	\$105,413
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$12,720	\$29,320	\$33,620	\$326,560	\$333,080	\$34,300	\$2,108,260
6.0	Decontamination & Decommissioning	\$1,792	\$0	\$1,678	\$7,481	\$12,725	\$9,109	\$77,570
7.0	ROM Life cycle costs (20 years operation)	\$34,707	\$41,123	\$70,351	\$443,764	\$423,919	\$83,837	\$3,144,178

B-4 ENTS-4 Cost Tables

- B-4.1. Equipment Purchase and Installation Budget Estimates
- B-4.2. Development, Testing and Evaluation Cost Estimate
- B-4.3. Building, Equipment and Installation Cost Summary
- B-4.4. Annual Operating and Maintenance Costs
- B-4.5. Decontamination and Decommissioning Costs
- B-4.6. Total Life-Cycle Cost (without Disposal) Estimate Summary for Enhanced Integrated Nonthermal Treatment Systems

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4 CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
1 Administration Building Subsystem	HI							
- Administration Office								
- Office Furniture - EMPLOYEE	E		49	7.0	343	1.0	49	392
- Computers	E		Lot	500.0	500	50.0	50	550
- Communication	E		Lot	250.0	250	35.0	35	285
- Testing Laboratory								
- ICP-Mass Spectrometer	D		1					
- Gas Chromatography - Mass Spec.	D		1					
- Scintillation Counter - Alpha	D		1					
- Scintillation Counter - Gamma	D		1					
- Geiger - Muller Counter	D		1					
- Fume Hood	A		2					
- Centrifuge	A		2					
- Autoclave	A		1					
- Scrubber/Blower	C		1					
- Hood/HEPA Filtration	C		1					
- Glovebox	D		1					
- Wet Chemistry Equipment	D		1					
- Refrigeration / Storage	A		1					
- Computer & Data Communication	D		2					
- Atomic Absorption Spectrography	D		1					
- Soil / Physical Testing Equipment	D		Lot					
- Complete Package per Above Detail	E		Lot	1,500.0	1500	300.0	300	1800
- Office Equipment & Furnishing	E		Lot	80.0	80	7.0	7	87
- Allowance for Mechanical/Piping	E		Lot	26.7	26.7	132.3	132.3	159
- Allowance for Electrical/Control	E		Lot	401.0	401	264.6	264.6	665.6
- Calibration, Testing & Startup	E		Lot	62.0	62	50.3	50.3	112.3
Total Administration Building Subsystem					3162.7		888.2	4050.9
2 Receiving & Inspection Subsystem	I							
- Unloading, Staging & Storage (A-RCINS)								
- O/H Bridge Crane & Rigging - 20 TN	E		1	625.0	625	125.0	125	750
- Forklift - 10 TN	E		2	65.0	130	10.0	20	150
- Airlock	E		1	124.0	124	39.0	39	163
- Inspect & Assay (A-RCINS)								
- Transfer Cart - 2 TN	B							
- Gamma Spectroscopy (GS)	D							
- Passive Active Neutron Assay (PAN)	D							
- Real Time Radiography (RTR)	D							
- Load Cell	D							
- CCTV	D							
- RHMMS Barrel Monitor including above	E		1	2,000.0	2000	400.0	400	2400
- Personnel Contamination Monitor	E		1	35.0	35	5.0	5	40
- Container Decontamination Enclosure	E		1	140.0	140	15.0	15	155
- Open, Dump, & Sort								
- Self Guided Vehicle	E		2	425.0	850	64.0	128	978
- Decap Device	E		3	50.0	150	9.0	27	177
- Sort Hopper	E		5	40.0	200	4.0	20	220
- Sort/Rotating Table	E		5	200.0	1000	30.0	150	1150
- Special Waste Glove Box	E		1	400.0	400	48.0	48	448
- Dump Hopper	E		6	40.0	240	4.0	24	264
- Maintenance Crane	E		1	800.0	800	120.0	120	920
- Bins	E		80	5.0	400	1.0	80	480
- Bin Conveyor 8 ft long	E		20	10.0	200	4.0	80	280
- Bin Conveyor 70 ft long	E		2	70.0	140	28.0	56	196
- Bin Pusher	E		34	10.0	340	4.0	136	476
- Main Cell Gantry Robot	E		1	2,000.0	2000	400.0	400	2400
- Sorting Table Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Sorting Master Slave Manipulator	E		5	100.0	500	40.0	200	700
- Box Size Reduction Unit	E		1	1,500.0	1500	400.0	400	1900
- Drum Opening Gantry Robot	E		2	400.0	800	80.0	160	960
- Glovebox Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Container Grappler	E		4	50.0	200	8.0	32	232
- Decap Enclosure	E		3	100.0	300	30.0	90	390

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4							
	CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Bin Hoist / Pusher	B	5	1	33	66	8	8	74
- Discharge. & Oversize Load Hopper (100 CF)	B	1	1	25	50	7	7	57
- Primary Shredder (.25, 1.5, 2 tons/hr)	E	250	1	375	375	75	75	450
- Secondary Shredder (.5, 1.5, 3 tons/hr)	E	60	1	160	160	32	32	192
- Live Bottom Bulk Storage	B	1	1	25	50	7	7	57
- Conveyor / Canister Handler	B	5	1	40	80	10	10	90
- Dust Collection System w/ Blower	E		Lot	108	108	17	17	125
- HEPA Filter	E		2	25	50	5	10	60
- CCTV	E		8	10.0	80	2.0	16	96
- Airlock	E		4	124.0	496	39.0	156	652
- Roller up Door (CA)	E		2	20.0	40	2.0	4	44
- Allowance for Mechanical/Piping	E		Lot	755.5	755.5	1,628.5	1628.5	2384
- Allowance for Electrical/Control	E		Lot	2,266.4	2266.4	1,628.5	1628.5	3894.9
- Calibration, Testing & Startup	E		Lot	362.6	362.6	260.6	260.6	623.2
Total Receiving & Inspection Subsystem					18493.5		6774.6	25268.1
3 Aqueous Waste Treatment Subsystem	II							
- Batch Liquid Waste (A-AQWTR)								
- High TOC Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TOC Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Low TDS Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Low TDS Batch Tank Pump	E		1	5.0	5	1.0	1	6
- High TDS/ Heavy Metals Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TDS/ Heavy Metals Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Hg Batch Tank wth Agitator	E		1	27.0	27	5.0	5	32
- Hg Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Airlocks	E		2	124.0	248	39.0	78	326
- CCTV	E		5	10.0	50	2.0	10	60
- Crane	E		1	525.0	525	105.0	105	630
- Shield Window	E		1	130	130	44	44	174
- Gross Organics Removal (A-AQWTR)								
- Oil/ Water Separator	E		1	18.0	18	2.5	2.5	20.5
- Neutralization / Settling (A-AQWTR)								
- Neutralization System	E		1	95.0	95	19.0	19	114
- Neutralization Overflow Pump	E		1	5.0	5	1.0	1	6
- Sludge Transfer Pump	E		1	5.0	5	1.0	1	6
- Sludge Settler	E		1	27.0	27	5.0	5	32
- Sludge Settler Pump	E		1	5.0	5	1.0	1	6
- Suspended Solids Filtration (A-AQWTR)								
- Suspended Solids Filter	E		1	125.0	125	25.0	25	150
- Concentration (A-AQWTR)								
- Evaporator with Condenser	E		2	300.0	600	75.0	150	750
- Evaporator Liquids Pump	E		2	5.0	10	1.0	2	12
- Calcium Carbonate Removal								
- Tank with Agitator	E		1	27.0	27	5.0	5	32
- Transfer Pump	E		4	5.0	20	1.0	4	24
- Decanter Centrifuge	E		1	450.0	450	60.0	60	510
- Holding Tank	E		1	7.0	7	1.5	1.5	8.5
- Slurry Pump	E		1	5.0	5	1.0	1	6
- Filter	E		2	2.5	5	0.5	1	6
- Dissolved Organics Removal								
- Ozone Generator System	E							
- UV/Peroxide System	E							
- Ozone Decomposer	E							
- Complete Package per Above Detail	E		Lot	125.0	125	25.0	25	150
- Liquid-Phase Carbon (55-gal drum)	F		4	0.8	3.2	0.1	0.4	3.6
- Concentrator								
- Vapor Phase Carbon	F		2	16.0	32	3.0	6	38
- Evaporator with Condenser	E		1	500.0	500	75.0	75	575
- Condenser Liquids Pump	E		1	5.0	5	1.0	1	6
- Dissolved Solids Removal								
- Ion Exchanger	E		1	61.0	61	9.0	9	70
- Treated Water Sampling								
- Treated Water Tanks	E		2	45.0	90	12.0	24	114

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4 CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
- Treated Water Pumps	E		2	5.0	10	1.0	2	12
- Chemical Distribution								
- Chemical Addition Pump (Acid)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Caustic)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Sulfide)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Floc/ Polymer)	E		1	1.0	1	0.3	0.3	1.3
- Chemical Storage Tanks	E		4	7.0	28	1.5	6	34
- Chemical Addition Pump (Peroxide)	E		1	5.0	5	1.0	1	6
- Peroxide Storage Tank	E		1	7.0	7	1.5	1.5	8.5
- Allowance for Mechanical/Piping	E		Lot	1,010.2	1010.2	416.5	416.5	1426.7
- Allowance for Electrical/Control	E		Lot	505.1	505.1	347.1	347.1	852.2
- Calibration, Testing & Startup	E		Lot	97.7	97.7	58.3	58.3	156
Total Aqueous Waste Treatment Subsystem					4980.2		1516.1	6496.3
4 Organic Destruction Subsystem	H							
- Prepare and Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		Lot	50	50	8	8	58
- Discharge and Loading Hoppers	E		Lot	45	45	8	8	53
- Feed Blender	E		Lot	45	45	8	8	53
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost For Above Package	E		Lot	2400	2400	300	300	2700
- Miscellaneous								
- Neutralization System	E		1	95	95	19	19	114
- Neutralization Overflow Pump	E		1	5	5	1	1	6
- Sludge Transfer Pump	E		1	5	5	1	1	6
- Crane	E		1	525	525	105	105	630
- CCTV	E		8	10	80	2	16	96
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	132	522
- Allowance for Mechanical/Piping	E		Lot	1,166.4	1166.4	405.6	405.6	1572
- Allowance for Electrical/Control	E		Lot	583.2	583.2	338.0	338	921.2
- Calibration, Testing & Startup	E		Lot	112.8	112.8	56.8	56.8	169.6
Total Organic Destruction Subsystem					5750.4		1476.4	7226.8
5 Residue & Sludge Treatment Subsystem	H							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	50	50	8	8	58
- Discharge. & Oversize Load Hopper (100 CF)	E		1	45	45	8	8	53
- Manipulate Crane 10 TN	E	15	1	525	525	105	105	630
- Shield Window	E		1	130.0	130	44.0	44	174
- Airlock	E		2	124	248	39	78	326
- CCTV	E		10	10	100	2	20	120
- Feed Blender	E		1	45	45	8	8	53
- Dewatering System	E		1					
- THERMAL DESORPTION								
- High Vacuum Dryer			1					
- Nitrogen gas storage and feed tank	E		1					
- Vacuum Pump	E		1					
- Filter	E		1					
- Hot Oil System								
- Oil Storage and Feed Tank	E		1					
- Oil Heater	E		1					
- Fuel Storage and Feed Tank	E		1					

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4							
	CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Condensers								
- HEPA Filter for particulates	E		1					
- Induced Air Fan	E		1					
- Primary Condensers (Air Cooler)	E		1					
- Secondary Condensers (Water Chiller)	E		2					
- Total per Package Above	E		Lot	1700	1700	170	170	1870
- Mercury Removal System								
- Mercury Precipitation Tank	E		1	95	95	19	19	114
- Iodine Recovery Tank	E		1	27	27	5	5	32
- KI/I2 Storage and Feed	E		1	27	27	5	5	32
- Metal Precipitation Tank	E		1	27	27	5	5	32
- Mercury Reduction Tank	E		1	27	27	5	5	32
- Solids Wash Tank	E		1	27	27	5	5	32
- Water Holding Tank	E		1	12	12	3	3	15
- Acid Holding and Feed Tank	E		1	12	12	3	3	15
- H2O2 Holding and Feed Tank	E		1	12	12	3	3	15
- Lime Holding Tank	E		1	12	12	3	3	15
- Rinse Tank	E		1	12	12	3	3	15
- Filter	E		1	125	125	25	25	150
- Pump	E		10	5	50	1	10	60
- Allowance for Mechanical/Control/Instrumentation	E		Lot	992.4	992.4	321.0	321	1313.4
- Allowance For Electrical/Control	E		Lot	496.2	496.2	267.5	267.5	763.7
- Calibration, Testing & Startup	E		Lot	95.9	95.9	44.9	44.9	140.8
- Total Residue & Sludge Treatment Subsystem					4892.5		1168.4	6060.9
6 Soft Debris Treatment Subsystem	II							
- Prepare & Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		1	50	50	8	8	58
- Discharge and Loading Hoppers	E		1	45	45	8	8	53
- Feed Blender	E		1	45	45	8	8	53
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost for Above Package	E		Lot	4300	4300	430	430	4730
- Miscellaneous								
- Neutralization System	E		1	95	95	19	19	
- Neutralization Overflow Pump	E		1	5	5	1	1	
- Sludge Transfer Pump	E		1	5	5	1	1	
- Crane	E		1	525	525	105	105	630
- CCTV	E		10	10	100	2	20	216
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	44	174
- Allowance for Mechanical/Control/Instrumentation	E		Lot	1,742.4	1742.4	216.6	216.6	1959
- Allowance For Electrical/Control	E		Lot	871.2	871.2	433.2	433.2	1304.4
- Calibration, Testing & Startup	E		Lot	168.4	168.4	82.3	82.3	250.7
- Total Soft Debris Treatment Subsystem					8590		1454.1	9754.1
7 Complex Debris Treatment Subsystem								
- Costs included with Grout								
- Total Complex Debris Treatment Subsystem								

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4							
	CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
8. Open Debris Treatment Subsystem	II							
- Feed Preparation and Separation								
- Bulk Solids Dump Hopper	F		1	40	40	4	4	44
- Bin Hoist/Pusher	E		2	33	66	8	16	82
- Drum/Bin Conveyor	E		6	10	60	4	24	84
- OH Crane	E		1	525	525	105	105	630
- CCTV	E		7	10	70	2	14	84
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		1	130	130	44	44	174
- Dust Collection Assembly	E		Lot	108	108	17	17	125
- High Pressure Wash								
- Receptacle Basket								
- Water Pump								
- Agitation Pump								
- Surfactant Preparation								
- Surfactant Pump								
- Surfactant Holding Tank								
- Mixing Tank with Agitator								
- Solution High Pressure Pump								
- Water Heater								
- Water Holding Tank								
- Water Pump								
- Gross Organic Removal								
- Oil/Water Separator								
- Recycle Pump								
- Oil Pump								
- Water Treatment								
- Bag Filter								
- Solids Bin								
- Neutralization Tank								
- Chemical Addition Pump (Acid)								
- Chemical Storage Tank								
- Liquid-Phase Carbon								
- Ion Exchange Unit								
- Treated Water Holding Tank								
- Treated Water Pump								
- Total Per Wash Package Above	A		Lot	47	141	5	5	146
- Allowance for Mechanical/Control/Instrumentation	E		Lot	416.4	416.4	184.2	184.2	600.6
- Allowance For Electrical/Control	E		Lot	208.2	208.2	153.5	153.5	361.7
- Calibration, Testing & Startup	E		Lot	40.3	40.3	25.8	25.8	66.1
Total Open Debris Treatment Subsystem					2052.9		670.5	2723.4
9. Bulk Soil Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	30	30	6	6	36
- Discharge. & Oversize Load Hopper	E		1	11	11	2	2	13
- Slurry Mix Tank	E		1	20	20	4	4	24
- Feed Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Airlock	E		2	124	248	39	78	326
- CCTV	E		7	10	70	2	14	84
- Shield Window	E		1	130	130	44	44	174
- Wash System								
- Attrition Mill	D		1	25	37.2	5	5	42.2
- Extraction Tank with Agitator	D		1	50	74.4	10	9.9	84.3
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Off-Gas Control								
- Heat Exchanger	E		2	6	12	0.4	0.8	12.8
- Solid/ Liquid Separation System	E							
- Vibrating Screen	E		1	6	6	1	1	7
- Hydrocyclone	D		2	4.5	13.5	0.4	0.8	14.3
- Countercurrent Solid/ Liquid Contactor	B		1	160	320	32	32	352
- Water Pump	E		1	5	5	1	1	6

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4 CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Slurry Pump	E		1	5	5	1	1	6
- Diaphragm Pump	E		1	1	1	0.2	0.2	1.2
- Solids Bin	E		1	5	5	1	1	6
- Overhead Crane	E		1	525	525	105	105	630
- Solubility Reduction Separator								
- Phase Separator	B		1	4.8	9.6	1	1	10.6
- Additive Addition Pump	E		1	1	1	0.3	0.3	1.3
- Surfactant Phase Pump	E		1	5	5	1	1	6
- Water Phase Pump	E		1	5	5	1	1	6
- Storage Tanks (Water and Concentrate)	E		2	2	4	0.4	0.8	4.8
- UltraFiltration Unit	E		1	50	50	10	10	60
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Dissolved Air Floatation Unit	E		1	50	50	7.5	7.5	57.5
- Surfactant Preparation								
- Water Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Heater	E		1	0.6	0.6	0.1	0.1	0.7
- Surfactant Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Pump	E		1	5	5	1	1	6
- Surfactant Pump	E		1	5	5	1	1	6
- Dilution Tank Agitator	E		1	1.5	1.5	0.2	0.2	1.7
- Dilution Tank Pump	E		1	5	5	1	1	6
- Surfactant Dilution Tank	E		1	2.0	2	0.4	0.4	2.4
- Drier	E		1	100.0	100	30.0	30	130
- Surfactant Separation								
- Additive Pump	E		4	1	4	0.3	1.2	5.2
- Additive Tanks	E		1	3.2	3.2	0.5	0.5	3.7
- Surfactant Separation Unit	B		1	50	100	10	10	110
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Allowance for Mechanical/Control/Instrumentation	E		Lot	572.4	572.4	228.7	228.7	801.1
- Allowance For Electrical/Control	E		Lot	286.2	286.2	190.6	190.6	476.8
- Calibration, Testing & Startup	E		Lot	55.3	55.3	32.0	32	87.3
Total Bulk Soil Treatment Subsystem					2821.9		832.4	3654.3
10 Metal Decontamination Subsystem								
- Pretreatment (GTCC-II)								
- High Pressure Water Rinse Station								
- Hot Air Dryer Station								
- Chemical Storage Tank								
- Chemical Mixing Tank								
- Chemical Metering Pump								
- Solution Pump								
- Complete Package per Above Detail	E		Lot	150.0	150	50.0	50	200
- Shield Window	E		1	130	130	44	44	174
- CCTV	E		5	10.0	50	2.0	10	60
- Size Reduction (GTCC-II)								
- Hydraulic Manipulator	E		1	120.0	120	50.0	50	170
- Gantry Robot	E		1	800.0	800	160.0	160	960
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245
- Fugitive Dust Collection System	E		2	100.0	200	15.0	30	230
- Master Slave Manipulator	E		1	65.0	65	15.0	15	80
- Airlock	E		2	124.0	248	39.0	78	326
- Assay/Inspection (GTCC-II)								
- Assay Unit - Mini	E		1	500.0	500	100.0	100	600
- Roller Conveyor	E		10	6.0	60	1.0	10	70
- Shielding Window	E		3	130.0	390	44.0	132	522
- Allowance for Mechanical/Piping	E		Lot	145.9	145.9	359.5	359.5	505.4
- Allowance for Electrical/Control	E		Lot	437.7	437.7	359.5	359.5	797.2
- Calibration, Testing & Startup	E		Lot	70.0	70	57.5	57.5	127.5
Total Metal Decontamination Subsystem					3571.6		1495.5	5067.1

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4 CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
11 Special Waste	II							
- Allowance for Mechanical/Piping	E		Lot					
- Allowance for Electrical/Control	E		Lot					
- Calibration, Testing & Startup	E		Lot					
Total Special Waste								
12 Mercury Amalgamation Subsystem	II							
- Feed Storage & Preparation (A-RMERC)								
- Shield Window	E		1	130.0	130.0	44.0	44.0	174.0
- Airlock	E		2	124.0	248.0	39.0	78.0	326.0
- Crane	F		1	525.0	525.0	105.0	105.0	630.0
- CCTV	E		2	10.0	20.0	2.0	4.0	24.0
- Mercury Amalgamation & Packaging (A-RMERC)								
- Liquid Mercury Storage Tank	E		1	7.0	7.0	1.0	1.0	8.0
- Liquid Mercury Pump	E		1	5.0	5.0	1.0	1.0	6.0
- Copper Powder Bin (1 ft³)	E		1	5.0	5.0	0.6	0.6	5.6
- Steel Shot Bin (0.5 ft³)	E		1	5.0	5.0	0.6	0.6	5.6
- Nitric Acid Tank (1 GAL)	E		1	5.0	5.0	0.5	0.5	5.5
- Nitric Acid Pump (1 GPH)	E		1	5.0	5.0	1.0	1.0	6.0
- Amalgam Mixer (5 GAL)	F		1	26.0	26.0	5.0	5.0	31.0
- Amalgam packager	F		1	2.0	2.0	0.4	0.4	2.4
- Allowance for Mechanical/Piping	E		Lot	294.9	294.9	144.7	144.7	439.6
- Allowance for Electrical/Control	E		Lot	147.5	147.5	120.6	120.6	268.1
- Calibration, Testing & Startup	E		Lot	28.5	28.5	20.3	20.3	48.8
Total Mercury Amalgamation Subsystem					1453.9		526.7	1980.6
13 Lead Recovery Subsystem	II							
- Airlock	E		2	124.0	248.0	39.0	78.0	326.0
- Crane	E		1	525.0	525.0	105.0	105.0	630.0
- Shield Window	E		1	130.0	130.0	44.0	44.0	174.0
- CCTV	E		4	10.0	40.0	2.0	8.0	48.0
- Decontamination (A-PBRCR)								
- Drum Lid Detacher	F		1	4.0	4.0	1.0	1.0	5.0
- Roller Conveyors (Straight)	F		12	5.0	60.0	1.0	12.0	72.0
- Decon Booth	F		1	175.0	175.0	25.0	25.0	200.0
- Hydraulic Drum Dumper	F		1	4.0	4.0	2.0	2.0	6.0
- Sorting Table (1 Hole)	E		2	4.0	8.0	1.0	2.0	10.0
- Size Reduction Table and Tools	E		1	205.0	205.0	40.0	40.0	245.0
- Sorting Table (4 Holes)	E		1	6.0	6.0	1.0	1.0	7.0
- Rolling Conveyor (L-Shaped)	F		1	5.0	5.0	2.0	2.0	7.0
- Drum Pusher	F		1	1.0	1.0	1.0	1.0	2.0
- Aqueous Waste Tank	E		1	5.0	5.0	2.0	2.0	7.0
- Aqueous Waste Pump	E		1	3.0	3.0	2.0	2.0	5.0
- Assay/Drumming (A-PBRCR)								
- Drum Pusher	F		1	10.0	10.0	0.2	0.2	10.2
- Lid Attacher	F		1	2.0	2.0	0.3	0.3	2.3
- Assay Station	F		1	500.0	500.0	3.0	3.0	503.0
- Drum Washer	E		1	70.0	70.0	10.0	10.0	80.0
- Miscellaneous Equipment								
- Transfer Cart (CA)	E		1	100.0	100.0	20.0	20.0	120.0
- Allowance for Mechanical/Piping	E		Lot	105.1	105.1	179.3	179.3	284.4
- Allowance for Electrical/Control	E		Lot	315.2	315.2	179.3	179.3	494.5
- Calibration, Testing & Startup	E		Lot	50.4	50.4	28.7	28.7	79.1
Total Lead Recovery Subsystem					2571.7		745.8	3317.5
14 Air Pollution Control Subsystem	II							
- Particulate Filter								
- Baghouse Assembly	E		1	240.0	240	48.0	48	288
- Prefilter	E		2	26.0	52	12.0	24	76
- Inter Connection Ducts.	E		Lot	2.0	2	10.0	10	12
- Corona Reactor								
- Reactor								
- Skid & Instrumentation								
- Power Supply								

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4 CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
- Cost per Package Above	E		Lot	73.0	73	7.0	7	80
- Acid Gas Scrubber								
- Packing Tower	E		1	45.0	45	13.0	13	58
- Induced Fan	E		2	4.5	9	0.5	1	10
- Recycle Pump	E		2	1.8	3.6	0.2	0.4	4
- Sludge Discharge Pump	E		2	2.7	5.4	0.5	1	6.4
- Caustic Feed Pump	E		2	0.9	1.8	0.2	0.4	2.2
- NaOH Transfer Pump	E		2	0.9	1.8	0.2	0.4	2.2
- Caustic Storage Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Slurry Pump	E		2	2.7	5.4	0.5	1	6.4
- Condensate Tank	E		1	0.9	0.9	0.2	0.2	1.1
- NaOH Day Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Scrubber Solution Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Evaporator System	E		1	54.0	54	16.2	16.2	70.2
- Hydrosonic Scrubber	E		1	27.0	27	5.4	5.4	32.4
- Liquid/ Solid Separator	E		1	18.0	18	3.6	3.6	21.6
- Mist Eliminator	E		1	1.6	1.6	0.4	0.4	2
- Heat Exchanger	E		2	5.4	10.8	1.8	3.6	14.4
- Carbon Adsorption								
- Carbon Filter (GAC)	F		2	9.0	18	1.8	3.6	21.6
- Carbon Filter (Sublimated GAC)	F		2	9.0	18	1.8	3.6	21.6
- Support System								
- Stack	E		1	7.2	7.2	1.4	1.4	8.6
- Stack Monitors - Radioactive	E		Lot	56.0	56	14.4	14.4	70.4
- Stack Monitors - Non Radioactive	E		Lot	27.0	27	10.8	10.8	37.8
- OH Crane	E		1	525.0	525	105.0	105	630
- Airlock	E		2	124.0	248	39.0	78	326
- CCTV	E		4	10.0	40	2.0	8	48
- Shield Window	E		1	130	130	44	44	174
- Allowance for Mechanical/Piping	E		Lot	487.0	487	243.0	243	730
- Allowance for Electrical/Control	E		Lot	243.5	243.5	202.5	202.5	446
- Calibration, Testing & Startup	E		Lot	47.1	47.1	34.0	34	81.1
Total Air Pollution Control Subsystem					2400.8		884.5	3285.3
15 Claytec Subsystem	I							
- Prepare & Feed Incoming Waste								
- Live Bottom Bulk Storage	F	1	1	60.0	60	9.0	9	69
- Conveyor / Canister Handler	F	5	1	80.0	80	10.0	10	90
- Manipulation Crane - 5 TON	E	10	1	525.0	525	105.0	105	630
- Dust Collection System w/ Blower	F		1	108.0	108	17.0	17	125
- HEPA Filter	F		8	25.0	200	5.0	40	240
- CCTV	E		13	10.0	130	2.0	26	156
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		2	130	260	44	88	348
- Proportioning and Blending								
- Storage Silo	E		8	25.0	200	7.0	56	256
- Weigh Station	E		4	20.0	80	2.0	8	88
- Blender	F	2	1	53.0	53	5.0	5	58
- Conveyor	F	5	11	6.0	66	1.0	11	77
- Macro-Encapsulation (A-PLYMR)								
- Extruder	F	100	1	630.0	630	22.7	22.7	652.7
- Activated Carbon	F		4	10.0	40	1.0	4	44
- Screw Compactor								
- Extruder Assembly	F	100	3	465.0	1395	93.0	279	1674
- Sintering Oven System								
- Oven Assembly	F	100	1	700.0	700	140.0	140	840
- Oven Feed and Discharge System	F	20	1	250.0	250	50.0	50	300
- Drum Cooling (A-PLYMR)								
- Induced Draft Fan/ Ducting	F		8	16.0	128	2.0	16	144
- Enclosure	F		1	121.0	121	8.0	8	129
- Drum Capping and Washing (A-PLYMR)								
- Drum Wash/ Cap	E		4	70.0	280	15.0	60	340
- Flush Water Collection and Conveying	E		2	30.0	60	18.0	36	96
- Conveyor	F	5	39	6.0	234	1.0	39	273

Table B-4.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

DESCRIPTION	ENTS 4							
	CWO, Desorption, Compaction and Polymer Stabilization							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Allowance for Mechanical/Piping	E		Lot	292.4	292.4	553.9	553.9	846.3
- Allowance for Electrical/Control	E		Lot	877.2	877.2	553.9	553.9	1431.1
- Calibration, Testing & Startup	E		Lot	140.4	140.4	88.6	88.6	229
Total Claytec Subsystem					7158		2304.1	9462.1
16 Certification & Shipping Subsystem	I							
- Incoming Material Storage (B-CSHIP)								
- Overhead Bridge Crane 20 TN	E		1	625.0	625	125.0	125	750
- Forklift 10 TN	E		1	65.0	65	10.0	10	75
- Inspect & Assay (B-CSHIP)								
- Transfer Cart 2 TN	E							
- Real Time Radiography (ND)								
- Passive Active Neutron (ND)								
- Segmented Gamma Spectroscopy (ND)								
- Complete Package per Above	E		3	1,500.0	4500	150.0	450	4950
- Self Guided Vehicle (ND)	E		1	425.0	425	850.0	850	1275
- Truck Loading (B-CSHIP)								
- Forklift 10 TN	E		10	65.0	650	10.0	100	750
- Roll-up Door	E		2	20.0	40	2.0	4	44
- Bridge Crane	E		1	525.0	525	105.0	105	630
- Roller Conveyor (CA)	E		20	2.0	40	1.0	20	60
- Allowance for Mechanical/Piping	E		Lot	343.5	343.5	832.0	832	1175.5
- Allowance for Electrical/Control	E		Lot	1,030.5	1030.5	832.0	832	1862.5
- Calibration, Testing & Startup	E		Lot	164.9	164.9	133.1	133.1	298
Total Certification & Shipping Subsystem					8408.9		3461.1	11870
17 Support Subsystem	III							
- Electrical Distribution and MCC								
- Control Panel - FT	E		110	10.0	1100	2.0	220	1320
- Emergency Power Generator	E		1	500.0	500	100.0	100	600
- Main Control Panel	E		20	10.0	200	2.0	40	240
- Motor Control Center	E		100	1.5	150	0.5	50	200
- Stand by Emergency Power	E		1	230.0	230	80.0	80	310
- Utilities and Mechanical								
- Breathing Air Package	E		Lot	70.0	70	30.0	30	100
- Compressed Air Package	E		Lot	100.0	100	25.0	25	125
- Instrument Air	E		1	70.0	70	30.0	30	100
- Instrument Air Package	E		Lot	90.0	90	25.0	25	115
- Plant Steam/Boiler	E		1	75.0	75	25.0	25	100
- Service Water	E		1	130.0	130	40.0	40	170
- Sump Pump	E		3	10	50	2.0	20	70
- Cooling Tower	E		1	200.0	200	10.0	10	210
- Cooling Water Pumps	E		3	2	30	3.0	6	36
- Heating, Ventilation & Exhaust								
- Included with Building Cost								
- Radiation Monitoring								
- Air Monitors	E		44	10.0	440	2.0	88	528
- Area Monitoring	E		44	4.5	198	1.0	44	242
- Personnel Monitoring Portals	E		6	35.0	210	5.0	30	240
- Portal Monitors	E		6	35.0	210	5.0	30	240
- Allowance for Mechanical/Piping	E		Lot	40.5	40.5	8.9	8.9	49.4
- Allowance for Electrical/Control	E		Lot	608.0	608	134.0	134	742
- Calibration, Testing & Startup	E		Lot	94.0	94	20.7	20.7	114.7
Total Support Subsystem					4795.5		1056.6	5852.1

Table B-4.2 : Development, Testing & Evaluation Cost Estimates
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

UNIT OPERATION		ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization								
		CWO, Desorption, Compaction and Polymer Stabilization								
		Primary Paper Evaluation Research Manpower	Bench Scale Studies Research Manpower	Sec. Paper Evaluation Research Manpower	Total Research Manpower	Bench Scale Studies Equipment \$1000	Bench Scale Studies Installation \$1000	Pilot Plant Mock-up Test Demo. Manpower	Pilot Plant Mock-up Test Bldg. \$1000	Pilot Plant Mock-up Test Equip. \$1000
1	Administration Building Subsystem									
2	Receiving & Inspection Subsystem	12			12			25	1,200	6,000
3	Aqueous Waste Treatment Subsystem	5	3	3	11	100	300	10	400	2,000
4	Organic Destruction Subsystem	18	20	4	42	500	150	30	400	4,000
5	Residue & Sludge Treatment Subsystem	13	8	4	25	500	150	30	500	2,000
6	Soft Debris Treatment Subsystem									
7	Complex Debris Treatment Subsystem									
8	Open Debris Treatment Subsystem	2	6	2	10	300	50	20	1,000	3,000
9	Bulk Soil Treatment Subsystem	10	6	2	18	200	50	10	200	500
10	Metal Decontamination Subsystem									
11	Special Waste	8	20	5	33	600	250	20	400	2,000
12	Mercury Amalgamation Subsystem	1	3		4	100	50			
13	Lead Recovery Subsystem	2	2		4	100	30			
14	Air Pollution Control Subsystem	5	3	2	10	200	50	15	400	2,000
15	Claytec Subsystem	2	8	4	14	300	50	15	400	2,000
16	Certification & Shipping Subsystem									
17	Support Subsystem	5			5					
	Unit Cost (\$/Unit)				\$150,000			\$150,000		
	Total Cost				28,200	2,900	1,130	26,250	4,900	23,500
	Post Totals To Table 4-4, Item				1.1	1.2	1.3	2.1	2.5.1	2.5.2

Table B-4.3 : Building, Equipment and Installation Cost Summary
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

UNIT OPERATION		ENTS - 4									
		CWO, Desorption, Compaction and Polymer Stabilization									
		Building Area					Material & Equipment Costs			Total Cost per Unit Oprtn. \$1000	
Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	Total Area Cost \$1000	Purchase Cost \$1000	Installation Cost \$1000	Total Cost \$1000				
1	Administration Building Subsystem	12440	3,000			3499	3162.7	888.2	4051	7550	
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	38966	18493.5	6774.6	25268	64234	
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	5287	4980.2	1516.1	6496	11783	
4	Organic Destruction Subsystem		1,128	1,717	1,560	5187	5750.4	1476.4	7227	12414	
5	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	9376	4892.5	1168.4	6061	15437	
6	Soft Debris Treatment Subsystem		1,606	2,444	2,220	7381	8590	1454.1	10044	17425	
7	Complex Debris Treatment Subsystem										
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	8678	2052.9	670.5	2723	11401	
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	7381	2821.9	832.4	3654	11035	
10	Metal Decontamination Subsystem		641	169	1904	3709	3571.6	1495.5	5067	8776	
11	Special Waste		604	159	1792	3491				3491	
12	Mercury Amalgamation Subsystem		1020	1552	1410	4688	1453.9	526.7	1981	6669	
13	Lead Recovery Subsystem						2571.7	745.8	3318	3318	
14	Air Pollution Control Subsystem		955	1,453	1,320	4389	2400.8	884.5	3285	7674	
15	Claytec Subsystem		3,097	8,278	5,250	20159	7158	2304.1	9462	29621	
16	Certification & Shipping Subsystem		28,277			11876	8408.9	3461.1	11870	23746	
17	Support Subsystem	3360	16,883			7696	4795.5	1056.6	5852	13548	
	Total Cost					141,763				106,359	248,122
		Post Totals To Table 4-4, Item				3.4.1				3.4.2	

Table B-4.4 : Annual Operating & Maintenance Costs
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

UNIT OPERATION		ENTS - 4						
		CWO, Desorption, Compaction and Polymer Stabilization						
		Operating FTE	Utilities \$1000	Materials \$1000	Maintenance Labor (1) \$1000	\$1000	Maintenance Materials (2) \$1000	Totals \$1000
1	Administration Building Subsystem	32	5	164	318	3162.7	127	445
2	Receiving & Inspection Subsystem	170	159	612	1,850	18493.5	740	2,590
3	Aqueous Waste Treatment Subsystem	5	300	1,705	873	4980.2	349	1,222
4	Organic Destruction Subsystem	12	298	297	1,438	5750.4	575	2,013
5	Residue & Sludge Treatment Subsystem	8	21	1	855	4892.5	342	1,197
6	Soft Debris Treatment Subsystem	14	708	704	2,148	8590	859	3,007
7	Complex Debris Treatment Subsystem							
8	Open Debris Treatment Subsystem	8	25	100	360	2052.9	144	504
9	Bulk Soil Treatment Subsystem	2	22	14	140	2821.9	56	196
10	Metal Decontamination Subsystem	4	5	25	625	3571.6	250	875
11	Special Waste	3	12	200				
12	Mercury Amalgamation Subsystem	1	2	10	255	1453.9	102	357
13	Lead Recovery Subsystem	3	73	50	450	2571.7	180	630
14	Air Pollution Control Subsystem	4	67	130	420	2400.8	168	588
15	Claytec Subsystem	45	255	6,000	1,253	7158	501	1,754
16	Certification & Shipping Subsystem	175	12	70	840	8408.9	336	1,176
17	Support Subsystem	5			480	4795.5	192	672
	Unit cost (\$/unit)	\$140,000						
	Total Cost	68,740	1964	10,082				17,226
	Post Totals To Table 4-4, Item	5.1	5.2	5.3				5.4

Notes:

1. Annual Maintenance Labor is 250 % of maintenance material cost.
2. Maintenance Material is assumed to be 2 % of equipment capital cost for the Bulk Soil Treatment subsystem, because the capital equipment is based on one shift operation.
3. Maintenance Material is assumed to be 10 % of equipment capital cost for organic destruction and soft debris.
4. Maintenance Material is assumed to be 4 % of equipment capital cost for Administration, Receiving & Inspection, Grout Stabilization, Certification & Shipping, and Support subsystems.
5. Maintenance Material is assumed to be 7 % of equipment capital cost for all other subsystems

Table B-4.5 : Decontamination & Decommissioning Costs
ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization

UNIT OPERATION	ENTS - 4 CWO, Desorption, Compaction and Polymer Stabilization				
	Building Area				Total Area Cost \$1000
	Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	
1 Administration Building Subsystem	12,440	3,000			6,948
2 Receiving & Inspection Subsystem		24,227	2,970	14,839	18,916
3 Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	2,021
4 Organic Destruction Subsystem		1,128	1,717	1,560	1,983
5 Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	3,584
6 Soft Debris Treatment Subsystem		1,606	2,444	2,220	2,822
7 Complex Debris Treatment Subsystem					
8 Open Debris Treatment Subsystem		1,888	2,873	2,610	3,317
9 Bulk Soil Treatment Subsystem		1,606	2,444	2,220	2,822
10 Metal Decontamination Subsystem		641	169	1,904	1,222
11 Special Waste		604	159	1,792	1,150
12 Mercury Amalgamation Subsystem		1,020	1,552	1,410	1,792
13 Lead Recovery Subsystem					
14 Air Pollution Control Subsystem		955	1,453	1,320	1,678
15 Claytec Subsystem		3,097	8,278	5,250	7,481
16 Certification & Shipping Subsystem		28,277			12,725
17 Support Subsystem	3,360	16,883			9,109
Total Cost					77,570
	Post Totals To Table 4-4, Item				7.0

Table B- 4.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Nonthermal Treatment Systems (cost module ENTS-4)

Cost component	Cost Items	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4
		Administration Building Subsystem	Receiving & Inspection Subsystem	Aqueous Waste Treatment Subsystem	Organic Destruction Subsystem	Residue & Sludge Treatment Subsystem	Soft Debris Treatment Subsystem	Complex Debris Treatment Subsystem	Open Debris Treatment Subsystem	Bulk Soil Treatment Subsystem	Metal Decontamination Subsystem	Special Waste
1.0	Studies and bench scale test costs											
	1.1 Manpower costs during research	\$0	\$1,800	\$1,650	\$6,300	\$3,750	\$0	\$0	\$1,500	\$2,700	\$0	\$4,950
	1.2 Equipment costs	\$0	\$0	\$100	\$500	\$500	\$0	\$0	\$300	\$200	\$0	\$600
	1.3 Installation costs	\$0	\$0	\$300	\$150	\$150	\$0	\$0	\$50	\$50	\$0	\$250
	1.4 Project management before title I (10 % of 1.1 through 1.3)	\$0	\$180	\$205	\$695	\$440	\$0	\$0	\$185	\$295	\$0	\$580
	1.5 Contingency (25 % of 1.1 through 1.4)	\$0	\$495	\$564	\$1,911	\$1,210	\$0	\$0	\$509	\$811	\$0	\$1,595
	Subtotal 1.0	\$0	\$2,475	\$2,819	\$9,556	\$6,050	\$0	\$0	\$2,544	\$4,056	\$0	\$7,975
2.0	Demonstration costs											
	2.1 Manpower costs during demonstration	\$0	\$3,750	\$1,500	\$4,500	\$4,500	\$0	\$0	\$3,000	\$1,500	\$0	\$3,000
	2.2 Design cost (30 % of 2.5)	\$0	\$2,786	\$929	\$1,703	\$968	\$0	\$0	\$1,548	\$271	\$0	\$929
	2.3 Inspection cost (7 % of 2.5)	\$0	\$650	\$217	\$397	\$226	\$0	\$0	\$361	\$63	\$0	\$217
	2.4 Project management (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90	\$0	\$310
	2.5 Construction cost											
	2.5.1 Building structure costs	\$0	\$1,200	\$400	\$400	\$500	\$0	\$0	\$1,000	\$200	\$0	\$400
	2.5.2 Equipment costs	\$0	\$6,000	\$2,000	\$4,000	\$2,000	\$0	\$0	\$3,000	\$500	\$0	\$2,000
	2.5.3 Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$2,088	\$696	\$1,276	\$725	\$0	\$0	\$1,160	\$203	\$0	\$696
	Subtotal of 2.5	\$0	\$9,288	\$3,096	\$5,676	\$3,225	\$0	\$0	\$5,160	\$903	\$0	\$3,096
	2.6 Construction management costs (17 % of 2.5)	\$0	\$1,588	\$529	\$971	\$551	\$0	\$0	\$882	\$154	\$0	\$529
	2.7 Management Reserve (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90	\$0	\$310
	2.8 Contingency (25 % of 2.1 through 2.7)	\$0	\$4,980	\$1,723	\$3,596	\$2,529	\$0	\$0	\$2,996	\$768	\$0	\$2,098
	Subtotal 2.0	\$0	\$24,900	\$8,614	\$17,979	\$12,645	\$0	\$0	\$14,979	\$3,839	\$0	\$10,489
3.0	Production facility construction costs											
	3.1 Design cost (25 % of 3.4)	\$2,435	\$20,716	\$3,800	\$4,004	\$4,979	\$5,620	\$0	\$3,677	\$3,559	\$2,830	\$1,126
	3.2 Inspection cost (7 % of 3.4)	\$682	\$5,800	\$1,064	\$1,121	\$1,394	\$1,573	\$0	\$1,029	\$996	\$792	\$315
	3.3 Project management (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$1,991	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450
	3.4 Construction cost											
	3.4.1 Building structure costs	\$3,499	\$38,966	\$5,287	\$5,187	\$9,376	\$7,381	\$0	\$8,678	\$7,381	\$3,709	\$3,491
	3.4.2 Equipment costs	\$4,051	\$25,268	\$6,496	\$7,227	\$6,061	\$10,044	\$0	\$2,723	\$3,654	\$5,067	\$0
	3.4.3 Indirect (29 % of 3.4.1 & 3.4.2)	\$2,190	\$18,628	\$3,417	\$3,600	\$4,477	\$5,053	\$0	\$3,306	\$3,200	\$2,545	\$1,012
	Subtotal of 3.4	\$9,740	\$82,862	\$15,200	\$16,014	\$19,914	\$22,478	\$0	\$14,707	\$14,235	\$11,321	\$4,503
	3.5 Construction management (17 % of 3.4)	\$1,666	\$14,169	\$2,599	\$2,738	\$3,405	\$3,844	\$0	\$2,515	\$2,434	\$1,936	\$770
	3.6 Management Reserve (10 % of 3.4)	\$974	\$8,286	\$1,520	\$1,601	\$1,991	\$2,248	\$0	\$1,471	\$1,424	\$1,132	\$450
	3.7 Contingency (25 % of 3.1 through 3.5)	\$3,874	\$32,958	\$6,046	\$6,370	\$7,921	\$8,941	\$0	\$5,850	\$5,662	\$4,503	\$1,791
	Subtotal 3.0	\$20,345	\$173,077	\$31,749	\$33,449	\$41,595	\$46,952	\$0	\$30,720	\$29,734	\$23,646	\$9,405
4.0	Operations Budget Funded Activities (See Sect. 7)											
	4.1 Conceptual design (1.5 % of 3.0)	\$305	\$2,596	\$476	\$502	\$624	\$704	\$0	\$461	\$446	\$355	\$141
	4.2 Safety assurance (1 % of 3.0)	\$203	\$1,731	\$317	\$334	\$416	\$470	\$0	\$307	\$297	\$236	\$94
	4.3 NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
	4.4 Preparation for operations (100 % of 5.0)	\$6,368	\$33,951	\$4,909	\$5,360	\$2,924	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790
	4.5 Project Management (10 % of 4.1 through 4.4)	\$1,388	\$3,828	\$570	\$620	\$396	\$915	\$0	\$295	\$138	\$242	\$103
	Subtotal 4.0	\$15,264	\$42,106	\$6,272	\$6,816	\$4,360	\$10,063	\$0	\$3,249	\$1,521	\$2,664	\$1,128
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$35,609	\$242,558	\$49,454	\$67,800	\$64,650	\$57,015	\$0	\$51,492	\$39,150	\$26,310	\$28,997
5.0	Operating and maintenance costs											
	5.1 Annual operating costs	\$4,480	\$23,800	\$700	\$1,680	\$1,120	\$1,960	\$0	\$1,120	\$280	\$560	\$420
	5.2 Annual utility costs	\$5	\$159	\$300	\$298	\$21	\$708	\$0	\$25	\$22	\$5	\$12
	5.3 Annual material costs	\$164	\$612	\$1,705	\$297	\$1	\$704	\$0	\$100	\$14	\$25	\$200
	5.4 Annual maintenance costs	\$445	\$2,590	\$1,222	\$2,013	\$1,197	\$3,007	\$0	\$504	\$196	\$875	\$0
	5.5 Contingency (25 % of 5.1 through 5.4)	\$1,274	\$6,790	\$982	\$1,072	\$585	\$1,595	\$0	\$437	\$128	\$366	\$158
	5.6 Subtotal 5.0	\$6,368	\$33,951	\$4,909	\$5,360	\$2,924	\$7,974	\$0	\$2,186	\$640	\$1,831	\$790
	5.7 Total 20 year O & M cost (20 times Subtotal 5.0)	\$127,360	\$679,020	\$98,180	\$107,200	\$58,480	\$159,480	\$0	\$43,720	\$12,800	\$36,620	\$15,800
6.0	Decontamination & Decommissioning	\$6,948	\$18,916	\$2,021	\$1,983	\$3,584	\$2,822	\$0	\$3,317	\$2,822	\$1,222	\$1,150
7.0	ROM Life cycle costs (20 years operation)	\$169,917	\$940,494	\$149,655	\$176,983	\$126,714	\$219,317	\$0	\$98,529	\$54,772	\$64,152	\$45,947

Table B- 4.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Nonthermal Treatment Systems (cost module ENTS-4)

	Cost component	Cost Items	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4	ENTS-4
			Mercury Amalgamation Subsystem	Lead Recovery Subsystem	Air Pollution Control Subsystem	Claytec Subsystem	Certification & Shipping Subsystem	Support Subsystem	Total System
1.0	Studies and bench scale test costs								
	1.1	Manpower costs during research	\$600	\$600	\$1,500	\$2,100	\$0	\$750	\$28,200
	1.2	Equipment costs	\$100	\$100	\$200	\$300	\$0	\$0	\$2,900
	1.3	Installation costs	\$50	\$30	\$50	\$50	\$0	\$0	\$1,130
	1.4	Project management before title I (10 % of 1.1 through 1.3)	\$75	\$73	\$175	\$245	\$0	\$75	\$3,223
	1.5	Contingency (25 % of 1.1 through 1.4)	\$206	\$201	\$481	\$674	\$0	\$206	\$8,863
		Subtotal 1.0	\$1,031	\$1,004	\$2,406	\$3,369	\$0	\$1,031	\$44,316
2.0	Demonstration costs								
	2.1	Manpower costs during demonstration	\$0	\$0	\$2,250	\$2,250	\$0	\$0	\$26,250
	2.2	Design cost (30 % of 2.5)	\$0	\$0	\$929	\$929	\$0	\$0	\$10,991
	2.3	Inspection cost (7 % of 2.5)	\$0	\$0	\$217	\$217	\$0	\$0	\$2,565
	2.4	Project management (10 % of 2.5)	\$0	\$0	\$310	\$310	\$0	\$0	\$3,664
	2.5	Construction cost							
		2.5.1 Building structure costs	\$0	\$0	\$400	\$400	\$0	\$0	\$4,900
		2.5.2 Equipment costs	\$0	\$0	\$2,000	\$2,000	\$0	\$0	\$23,500
		2.5.3 Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$0	\$696	\$696	\$0	\$0	\$8,236
		Subtotal of 2.5	\$0	\$0	\$3,096	\$3,096	\$0	\$0	\$36,636
	2.6	Construction management costs (17 % of 2.5)	\$0	\$0	\$529	\$529	\$0	\$0	\$6,265
	2.7	Management Reserve (10 % of 2.5)	\$0	\$0	\$310	\$310	\$0	\$0	\$3,664
	2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$0	\$1,910	\$1,910	\$0	\$0	\$22,509
		Subtotal 2.0	\$0	\$0	\$9,551	\$9,551	\$0	\$0	\$112,544
3.0	Production facility construction costs								
	3.1	Design cost (25 % of 3.4)	\$2,151	\$1,070	\$2,475	\$9,553	\$7,658	\$4,369	\$80,019
	3.2	Inspection cost (7 % of 3.4)	\$602	\$300	\$693	\$2,675	\$2,144	\$1,223	\$22,405
	3.3	Project management (10 % of 3.4)	\$860	\$428	\$990	\$3,821	\$3,063	\$1,748	\$32,008
	3.4	Construction cost							
		3.4.1 Building structure costs	\$4,688	\$0	\$4,389	\$20,159	\$11,876	\$7,696	\$141,763
		3.4.2 Equipment costs	\$1,981	\$3,318	\$3,285	\$9,462	\$11,870	\$5,852	\$106,359
		3.4.3 Indirect (29 % of 3.4.1 & 3.4.2)	\$1,934	\$962	\$2,225	\$8,590	\$6,886	\$3,929	\$71,955
		Subtotal of 3.4	\$8,603	\$4,280	\$9,899	\$38,211	\$30,632	\$17,477	\$320,077
	3.5	Construction management (17 % of 3.4)	\$1,471	\$732	\$1,693	\$6,534	\$5,238	\$2,989	\$54,733
	3.6	Management Reserve (10 % of 3.4)	\$860	\$428	\$990	\$3,821	\$3,063	\$1,748	\$32,008
	3.7	Contingency (25 % of 3.1 through 3.5)	\$3,422	\$1,703	\$3,938	\$15,199	\$12,184	\$6,952	\$127,311
		Subtotal 3.0	\$17,969	\$8,941	\$20,678	\$79,814	\$63,982	\$36,506	\$668,561
4.0	Operations Budget Funded Activities (See Sect. 7)								
	4.1	Conceptual design (1.5 % of 3.0)	\$270	\$134	\$310	\$1,197	\$960	\$548	\$10,028
	4.2	Safety assurance (1 % of 3.0)	\$180	\$89	\$207	\$798	\$640	\$365	\$6,686
	4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$0	\$0	\$0	\$0	\$0	\$0	\$7,000
	4.4	Preparation for operations (100 % of 5.0)	\$636	\$1,466	\$1,681	\$17,886	\$32,198	\$1,715	\$122,515
	4.5	Project Management (10 % of 4.1 through 4.4)	\$109	\$169	\$220	\$1,988	\$3,380	\$263	\$14,623
		Subtotal 4.0	\$1,195	\$1,858	\$2,418	\$21,869	\$37,178	\$2,891	\$160,852
		Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$20,195	\$11,803	\$35,053	\$114,603	\$101,160	\$40,428	\$986,273
5.0	Operating and maintenance costs								
	5.1	Annual operating costs	\$140	\$420	\$560	\$6,300	\$24,500	\$700	\$68,740
	5.2	Annual utility costs	\$2	\$73	\$67	\$255	\$12	\$0	\$1,964
	5.3	Annual material costs	\$10	\$50	\$130	\$6,000	\$70	\$0	\$10,082
	5.4	Annual maintenance costs	\$357	\$630	\$588	\$1,754	\$1,176	\$672	\$17,226
	5.5	Contingency (25 % of 5.1 through 5.4)	\$127	\$293	\$336	\$3,577	\$6,440	\$343	\$24,503
	5.6	Subtotal 5.0	\$636	\$1,466	\$1,681	\$17,886	\$32,198	\$1,715	\$122,515
	5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$12,720	\$29,320	\$33,620	\$357,720	\$643,960	\$34,300	\$2,450,300
6.0	Decontamination & Decommissioning		\$1,792	\$0	\$1,678	\$7,481	\$12,725	\$9,109	\$77,570
7.0	ROM Life cycle costs (20 years operation)		\$34,707	\$41,123	\$70,351	\$479,804	\$757,845	\$83,837	\$3,514,143

B-5 ENTS-5 Cost Tables

- B-5.1. Equipment Purchase and Installation Budget Estimates
- B-5.2. Development, Testing and Evaluation Cost Estimate
- B-5.3. Building, Equipment and Installation Cost Summary
- B-5.4. Annual Operating and Maintenance Costs
- B-5.5. Decontamination and Decommissioning Costs
- B-5.6. Total Life-Cycle Cost (without Disposal) Estimate Summary for Enhanced Integrated Nonthermal Treatment Systems

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
1 Administration Building Subsystem	III							
- Administration Office								
- Office Furniture - EMPLOYEE	E		49	7.0	343	1.0	49	392
- Computers	E		Lot	500.0	500	50.0	50	550
- Communication	E		Lot	250.0	250	35.0	35	285
- Testing Laboratory								
- ICP-Mass Spectrometer	D		1					
- Gas Chromatography - Mass Spec.	D		1					
- Scintillation Counter - Alpha	D		1					
- Scintillation Counter - Gamma	D		1					
- Geiger - Muller Counter	D		1					
- Fume Hood	A		2					
- Centrifuge	A		2					
- Autoclave	A		1					
- Scrubber/Blower	C		1					
- Hood/HEPA Filtration	C		1					
- Glovebox	D		1					
- Wet Chemistry Equipment	D		1					
- Refrigeration / Storage	A		1					
- Computer & Data Communication	D		2					
- Atomic Absorption Spectrography	D		1					
- Soil / Physical Testing Equipment	D		Lot					
- Complete Package per Above Detail	E		Lot	1,500.0	1500	300.0	300	1800
- Office Equipment & Furnishing	E		Lot	80.0	80	7.0	7	87
- Allowance for Mechanical/Piping	E		Lot	26.7	26.7	132.3	132.3	159
- Allowance for Electrical/Control	E		Lot	401.0	401	264.6	264.6	665.6
- Calibration, Testing & Startup	E		Lot	62.0	62	50.3	50.3	112.3
Total Administration Building Subsystem					3162.7		888.2	4050.9
2 Receiving & Inspection Subsystem	I							
- Unloading, Staging & Storage (A-RCINS)								
- O/H Bridge Crane & Rigging - 20 TN	E		1	625.0	625	125.0	125	750
- Forklift - 10 TN	E		2	65.0	130	10.0	20	150
- Airlock	E		1	124.0	124	39.0	39	163
- Inspect & Assay (A-RCINS)								
- Transfer Cart - 2 TN	B							
- Gamma Spectroscopy (GS)	D							
- Passive Active Neutron Assay (PAN)	D							
- Real Time Radiography (RTR)	D							
- Load Cell	D							
- CCTV	D							
- RHMMS Barrel Monitor including above	E		1	2,000.0	2000	400.0	400	2400
- Personnel Contamination Monitor	E		1	35.0	35	5.0	5	40
- Container Decontamination Enclosure	E		1	140.0	140	15.0	15	155
- Open, Dump, & Sort								
- Self Guided Vehicle	E		2	425.0	850	64.0	128	978
- Decap Device	E		3	50.0	150	9.0	27	177
- Sort Hopper	E		5	40.0	200	4.0	20	220
- Sort/Rotating Table	E		5	200.0	1000	30.0	150	1150
- Special Waste Glove Box	E		1	400.0	400	48.0	48	448
- Dump Hopper	E		6	40.0	240	4.0	24	264
- Maintenance Crane	E		1	800.0	800	120.0	120	920
- Bins	E		80	5.0	400	1.0	80	480
- Bin Conveyor 8 ft long	E		20	10.0	200	4.0	80	280
- Bin Conveyor 70 ft long	E		2	70.0	140	28.0	56	196
- Bin Pusher	E		34	10.0	340	4.0	136	476
- Main Cell Gantry Robot	E		1	2,000.0	2000	400.0	400	2400
- Sorting Table Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Sorting Master Slave Manipulator	E		5	100.0	500	40.0	200	700
- Box Size Reduction Unit	E		1	1,500.0	1500	400.0	400	1900

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5 CWO with Increased Reaction Rates							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Drum Opening Gantry Robot	E		2	400.0	800	80.0	160	960
- Glovebox Hydraulic Manipulator	E		2	120.0	240	40.0	80	320
- Container Grapppler	E		4	50.0	200	8.0	32	232
- Decap Enclosure	E		3	100.0	300	30.0	90	390
- Bin Hoist / Pusher	B	5	1	33	66	8	8	74
- Disch. & Oversize Load Hopper (100 CF)	B	1	1	25	50	7	7	57
- Primary Shredder (.25, 1.5, 2 tons/hr)	E	250	1	375	375	75	75	450
- Secondary Shredder (.5, 1.5, 3 tons/hr)	E	60	1	160	160	32	32	192
- Live Bottom Bulk Storage	B	1	1	25	50	7	7	57
- Conveyor / Canister Handler	B	5	1	40	80	10	10	90
- Dust Collection System w/ Blower	E		Lot	108	108	17	17	125
- HEPA Filter	E		2	25	50	5	10	60
- CCTV	E		8	10.0	80	2.0	16	96
- Airlock	E		4	124.0	496	39.0	156	652
- Roll up Door (CA)	E		2	20.0	40	2.0	4	44
- Allowance for Mechanical/Piping	E		Lot	755.5	755.5	1,628.5	1628.5	2384
- Allowance for Electrical/Control	E		Lot	2,266.4	2266.4	1,628.5	1628.5	3894.9
- Calibration, Testing & Startup	E		Lot	362.6	362.6	260.6	260.6	623.2
Total Receiving & Inspection Subsystem					18493.5		6774.6	25268.1
3 Aqueous Waste Treatment Subsystem	H							
- Batch Liquid Waste (A-AQWTR)								
- High TOC Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TOC Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Low TDS Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Low TDS Batch Tank Pump	E		1	5.0	5	1.0	1	6
- High TDS/ Heavy Metals Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- High TDS/ Heavy Metals Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Hg Batch Tank with Agitator	E		1	27.0	27	5.0	5	32
- Hg Batch Tank Pump	E		1	5.0	5	1.0	1	6
- Airlocks	E		2	124.0	248	39.0	78	326
- CCTV	E		5	10.0	50	2.0	10	60
- Crane	E		1	525.0	525	105.0	105	630
- Shield Window	E		1	130	130	44	44	174
- Gross Organics Removal (A-AQWTR)								
- Oil/ Water Separator	E		1	18.0	18	2.5	2.5	20.5
- Neutralization / Settling (A-AQWTR)								
- Neutralization System	E		1	95.0	95	19.0	19	114
- Neutralization Overflow Pump	E		1	5.0	5	1.0	1	6
- Sludge Transfer Pump	E		1	5.0	5	1.0	1	6
- Sludge Settler	E		1	27.0	27	5.0	5	32
- Sludge Settler Pump	E		1	5.0	5	1.0	1	6
- Suspended Solids Filtration (A-AQWTR)								
- Suspended Solids Filter	E		1	125.0	125	25.0	25	150
- Concentration (A-AQWTR)								
- Evaporator with Condenser	E		2	300.0	600	75.0	150	750
- Evaporator Liquids Pump	E		2	5.0	10	1.0	2	12
- Calcium Carbonate Removal								
- Tank with Agitator	E		1	27.0	27	5.0	5	32
- Transfer Pump	E		4	5.0	20	1.0	4	24
- Decanter Centrifuge	E		1	450.0	450	60.0	60	510
- Holding Tank	E		1	7.0	7	1.5	1.5	8.5
- Slurry Pump	E		1	5.0	5	1.0	1	6
- Filter	E		2	2.5	5	0.5	1	6
- Dissolved Organics Removal								
- Ozone Generator System	E							
- UV/Peroxide System	E							
- Ozone Decomposer	E							
- Complete Package per Above Detail	E		Lot	125.0	125	25.0	25	150
- Liquid-Phase Carbon (55-gal drum)	F		4	0.8	3.2	0.1	0.4	3.6

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Concentrator								
- Vapor Phase Carbon	F		2	16.0	32	3.0	6	38
- Evaporator with Condenser	E		1	500.0	500	75.0	75	575
- Condenser Liquids Pump	E		1	5.0	5	1.0	1	6
- Dissolved Solids Removal								
- Ion Exchanger	E		1	61.0	61	9.0	9	70
- Treated Water Sampling								
- Treated Water Tanks	E		2	45.0	90	12.0	24	114
- Treated Water Pumps	E		2	5.0	10	1.0	2	12
- Chemical Distribution								
- Chemical Addition Pump (Acid)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Caustic)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Sulfide)	E		1	5.0	5	1.0	1	6
- Chemical Addition Pump (Floc/ Polymer)	E		1	1.0	1	0.3	0.3	1.3
- Chemical Storage Tanks	E		4	7.0	28	1.5	6	34
- Chemical Addition Pump (Peroxide)	E		1	5.0	5	1.0	1	6
- Peroxide Storage Tank	E		1	7.0	7	1.5	1.5	8.5
- Allowance for Mechanical/Piping	E		Lot	1,010.2	1010.2	416.5	416.5	1426.7
- Allowance for Electrical/Control	E		Lot	505.1	505.1	347.1	347.1	852.2
- Calibration, Testing & Startup	E		Lot	97.7	97.7	58.3	58.3	156
Total Aqueous Waste Treatment Subsystem					4980.2		1516.1	6496.3
4 Organic Destruction Subsystem	II							
- Prepare and Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins (increase capacity for liq and solids, 1	E		1	145.462	145.5	29.0923	29.1	174.6
- Discharge and Loading Hoppers	E		1	130.915	130.9	26.1831	26.2	157.1
- Feed Blender	E		1	130.915	130.9	26.1831	26.2	157.1
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Detox Reaction Rate Enhancer (new device- unknown cost)								
- Total Cost For Above Package	E		Lot	10465.5	10465.5	2093.1	2093.1	12558.6
- Miscellaneous								
- Neutralization System (increased cost to account for 6x throughput per	E		1	276.377	276.4	55.2754	55.3	331.7
- Neutralization Overflow Pump	E		1	14.5462	14.5	2.90923	2.9	17.4
- Sludge Transfer Pump	E		1	14.5462	14.5	2.90923	2.9	17.4
- Crane	E		1	525	525	105	105	630
- CCTV (added 2 TVs)	E		10	10	100	2	20	120
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		3	130	390	44	132	522
- Allowance for Mechanical/Piping	E		Lot	3,732.4	3732.4	1,542.4	1542.4	5274.8
- Allowance for Electrical/Control	E		Lot	1,866.2	1866.2	1,285.4	1285.4	3151.6
- Calibration, Testing & Startup	E		Lot	360.8	360.8	215.9	215.9	576.7
Total Organic Destruction Subsystem					18400.6		5614.4	24015

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
5 Residue & Sludge Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	50	50	8	8	58
- Discharge. & Oversize Load Hopper (100 CF)	E		1	45	45	8	8	53
- Manipulate Crane 10 TN	E	15	1	525	525	105	105	630
- Shield Window	E		1	130.0	130	44.0	44	174
- Airlock	E		2	124	248	39	78	326
- CCTV	E		10	10	100	2	20	120
- Feed Blender	E		1	45	45	8	8	53
- Dewatering System	E		1					
- THERMAL DESORPTION								
- High Vacuum Dryer			1					
- Nitrogen gas storage and feed tank	E		1					
- Vacuum Pump	E		1					
- Filter	E		1					
- Hot Oil System								
- Oil Storage and Feed Tank	E		1					
- Oil Heater	E		1					
- Fuel Storage and Feed Tank	E		1					
- Condensers								
- HEPA Filter for particulates	E		1					
- Induced Air Fan	E		1					
- Primary Condensers (Air Cooler)	E		1					
- Secondary Condensers (Water Chiller)	E		2					
- Total per Package Above	E		Lot	1700	1700	170	170	1870
- Mercury Removal System								
- Mercury Precipitation Tank	E		1	95	95	19	19	114
- Iodine Recovery Tank	E		1	27	27	5	5	32
- KI/I2 Storage and Feed	E		1	27	27	5	5	32
- Metal Precipitation Tank	E		1	27	27	5	5	32
- Mercury Reduction Tank	E		1	27	27	5	5	32
- Solids Wash Tank	E		1	27	27	5	5	32
- Water Holding Tank	E		1	12	12	3	3	15
- Acid Holding and Feed Tank	E		1	12	12	3	3	15
- H2O2 Holding and Feed Tank	E		1	12	12	3	3	15
- Lime Holding Tank	E		1	12	12	3	3	15
- Rinse Tank	E		1	12	12	3	3	15
- Filter	E		1	125	125	25	25	150
- Pump	E		10	5	50	1	10	60
- Allowance for Mechanical/Control/Instrumentation	E		Lot	992.4	992.4	321.0	321	1313.4
- Allowance For Electrical/Control	E		Lot	496.2	496.2	267.5	267.5	763.7
- Calibration, Testing & Startup	E		Lot	95.9	95.9	44.9	44.9	140.8
Total Residue & Sludge Treatment Subsystem					4892.5		1168.4	6060.9
6 Soft Debris Treatment Subsystem	II							
- Prepare & Feed Incoming Waste								
- Feed Conveyor Lift/ Hoist/ Bins	E		1					
- Discharge and Loading Hoppers	E		1					
- Feed Blender	E		1					
- Detox Process								
- Reaction Vessel	E							
- Reflux Condenser	E							
- Filter	E							
- Solids Feeder	E							
- Solution Cooler	E							
- Overhead Condenser	E							
- Pumps	E							
- Condensate Catch	E							
- Neutralization Tanks	E							

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Filtered Solids Rinse Tanks	E							
- Oil Heating and Cooling System	E							
- Total Cost for Above Package	E		Lot					
- Miscellaneous								
- Neutralization System	E		1					
- Neutralization Overflow Pump	E		1					
- Sludge Transfer Pump	E		1					
- Crane	E		1					
- CCTV	E		10					
- Airlock	E		2					
- Shield Window	E		3					
- Allowance for Mechanical/Control/Instrumentation	E		Lot					
- Allowance For Electrical/Control	E		Lot					
- Calibration, Testing & Startup	E		Lot					
Total Soft Debris Treatment Subsystem								
7 Complex Debris Treatment Subsystem								
- Costs included with Grout								
Total Complex Debris Treatment Subsystem								
8 Open Debris Treatment Subsystem	H							
- Feed Preparation and Separation								
- Bulk Solids Dump Hopper	F		1	40	40	4	4	44
- Bin Hoist/Pusher	E		2	33	66	8	16	82
- Drum/Bin Conveyor	E		6	10	60	4	24	84
- OH Crane	E		1	525	525	105	105	630
- CCTV	E		7	10	70	2	14	84
- Airlock	E		2	124	248	39	78	326
- Shield Window	E		1	130	130	44	44	174
- Dust Collection Assembly	E		Lot	108	108	17	17	125
- High Pressure Wash								
- Receptacle Basket								
- Water Pump								
- Agitation Pump								
- Surfactant Preparation								
- Surfactant Pump								
- Surfactant Holding Tank								
- Mixing Tank with Agitator								
- Solution High Pressure Pump								
- Water Heater								
- Water Holding Tank								
- Water Pump								
- Gross Organic Removal								
- Oil/Water Separator								
- Recycle Pump								
- Oil Pump								
- Water Treatment								
- Bag Filter								
- Solids Bin								
- Neutralization Tank								
- Chemical Addition Pump (Acid)								
- Chemical Storage Tank								
- Liquid-Phase Carbon								
- Ion Exchange Unit								
- Treated Water Holding Tank								
- Treated Water Pump								
- Total Per Wash Package Above	A		Lot	47	141	5	5	146
- Allowance for Mechanical/Control/Instrumentation	E		Lot	416.4	416.4	184.2	184.2	600.6
- Allowance For Electrical/Control	E		Lot	208.2	208.2	153.5	153.5	361.7
- Calibration, Testing & Startup	E		Lot	40.3	40.3	25.8	25.8	66.1
Total Open Debris Treatment Subsystem					2052.9		670.5	2723.4

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		Total U.O.
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
9 Bulk Soil Treatment Subsystem	II							
- Feed Preparation and Size Reduction								
- Feed Conveyor Lift/Hoist/Bins	E		1	30	30	6	6	36
- Discharge. & Oversize Load Hopper	E		1	11	11	2	2	13
- Slurry Mix Tank	E		1	20	20	4	4	24
- Feed Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Airlock	E		2	124	248	39	78	326
- CCTV	E		7	10	70	2	14	84
- Shield Window	E		1	130	130	44	44	174
- Wash System								
- Attrition Mill	D		1	25	37.2	5	5	42.2
- Extraction Tank with Agitator	D		1	50	74.4	10	9.9	84.3
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Off-Gas Control								
- Heat Exchanger	E		2	6	12	0.4	0.8	12.8
- Solid/ Liquid Separation System	E							
- Vibrating Screen	E		1	6	6	1	1	7
- Hydrocyclone	D		2	4.5	13.5	0.4	0.8	14.3
- Countercurrent Solid/ Liquid Contactor	B		1	160	320	32	32	352
- Water Pump	E		1	5	5	1	1	6
- Slurry Pump	E		1	5	5	1	1	6
- Diaphragm Pump	E		1	1	1	0.2	0.2	1.2
- Solids Bin	E		1	5	5	1	1	6
- Overhead Crane	E		1	525	525	105	105	630
- Solubility Reduction Separator								
- Phase Separator	B		1	4.8	9.6	1	1	10.6
- Additive Addition Pump	E		1	1	1	0.3	0.3	1.3
- Surfactant Phase Pump	E		1	5	5	1	1	6
- Water Phase Pump	E		1	5	5	1	1	6
- Storage Tanks (Water and Concentrate)	E		2	2	4	0.4	0.8	4.8
- UltraFiltration Unit	E		1	50	50	10	10	60
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Dissolved Air Floatation Unit	E		1	50	50	7.5	7.5	57.5
- Surfactant Preparation								
- Water Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Heater	E		1	0.6	0.6	0.1	0.1	0.7
- Surfactant Hold Tank	E		1	2	2	0.2	0.2	2.2
- Water Pump	E		1	5	5	1	1	6
- Surfactant Pump	E		1	5	5	1	1	6
- Dilution Tank Agitator	E		1	1.5	1.5	0.2	0.2	1.7
- Dilution Tank Pump	E		1	5	5	1	1	6
- Surfactant Dilution Tank	E		1	2.0	2	0.4	0.4	2.4
- Drier	E		1	100.0	100	30.0	30	130
- Surfactant Separation								
- Additive Pump	E		4	1	4	0.3	1.2	5.2
- Additive Tanks	E		1	3.2	3.2	0.5	0.5	3.7
- Surfactant Separation Unit	B		1	50	100	10	10	110
- Recycle Pump	E		1	5	5	1	1	6
- Water Pump	E		1	5	5	1	1	6
- Allowance for Mechanical/Control/Instrumentation	E		Lot	572.4	572.4	228.7	228.7	801.1
- Allowance For Electrical/Control	E		Lot	286.2	286.2	190.6	190.6	476.8
- Calibration, Testing & Startup	E		Lot	55.3	55.3	32.0	32	87.3
Total Bulk Soil Treatment Subsystem					2821.9		832.4	3654.3

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5 CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost	Amount	Unit Cost	Amount	
				\$1000's	\$1000's	\$1000's	\$1000's	
10 Metal Decontamination Subsystem	I							
- Pretreatment (GTCC-II)								
- High Pressure Water Rinse Station								
- Hot Air Dryer Station								
- Chemical Storage Tank								
- Chemical Mixing Tank								
- Chemical Metering Pump								
- Solution Pump								
- Complete Package per Above Detail	E		Lot	150.0	150	50.0	50	200
- Shield Window	E		1	130	130	44	44	174
- CCTV	E		5	10.0	50	2.0	10	60
- Size Reduction (GTCC-II)								
- Hydraulic Manipulator	E		1	120.0	120	50.0	50	170
- Gantry Robot	E		1	800.0	800	160.0	160	960
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245
- Fugitive Dust Collection System	E		2	100.0	200	15.0	30	230
- Master Slave Manipulator	E		1	65.0	65	15.0	15	80
- Airlock	E		2	124.0	248	39.0	78	326
- Assay/Inspection (GTCC-II)								
- Assay Unit - Mini	E		1	500.0	500	100.0	100	600
- Roller Conveyor	E		10	6.0	60	1.0	10	70
- Shielding Window	E		3	130.0	390	44.0	132	522
- Allowance for Mechanical/Piping	E		Lot	145.9	145.9	359.5	359.5	505.4
- Allowance for Electrical/Control	E		Lot	437.7	437.7	359.5	359.5	797.2
- Calibration, Testing & Startup	E		Lot	70.0	70	57.5	57.5	127.5
Total Metal Decontamination Subsystem					3571.6		1495.5	5067.1
11 Special Waste	II							
- Allowance for Mechanical/Piping	E		Lot					
- Allowance for Electrical/Control	E		Lot					
- Calibration, Testing & Startup	E		Lot					
Total Special Waste								
12 Mercury Amalgamation Subsystem	II							
- Mercury Amalgamation & Packaging (A-RMERC)								
- Liquid Mercury Storage Tank	E		1	7.0	7	1.0	1	8
- Liquid Mercury Pump	E		1	5.0	5	1.0	1	6
- Copper Powder Bin (1 ft³)	E		1	5.0	5	0.6	0.6	5.6
- Steel Shot Bin (0.5 ft³)	E		1	5.0	5	0.6	0.6	5.6
- Nitric Acid Tank (1 GAL)	E		1	5.0	5	0.5	0.5	5.5
- Nitric Acid Pump (1 gal/hr)	E		1	5.0	5	1.0	1	6
- Amalgam Mixer (5 GAL)	F		1	26.0	26	5.0	5	31
- Amalgam packager	F		1	2.0	2	0.4	0.4	2.4
- Crane	E		1	525.0	525	105.0	105	630
- CCTV	E		2	10.0	20	2.0	4	24
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		1	130.0	130	44.0	44	174
- Allowance for Mechanical/Piping	E		Lot	294.9	294.9	144.7	144.7	439.6
- Allowance for Electrical/Control	E		Lot	147.5	147.5	120.6	120.6	268.1
- Calibration, Testing & Startup	E		Lot	28.5	28.5	20.3	20.3	48.8
Total Mercury Amalgamation Subsystem					1453.9		526.7	1980.6
13 Lead Recovery Subsystem	II							
- Decontamination (A-PBRCR)								
- Drum Lid Detacher	F		1	4.0	4	1.0	1	5
- Roller Conveyors (Straight)	F		12	5.0	60	1.0	12	72
- Decon Booth	F		1	175.0	175	25.0	25	200
- Hydraulic Drum Dumper	F		1	4.0	4	2.0	2	6
- Sorting Table (1 Hole)	E		2	4.0	8	1.0	2	10
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Sorting Table (4 Holes)	E		1	6.0	6	1.0	1	7
- Rolling Conveyor (L-Shaped)	F		1	5.0	5	2.0	2	7
- Drum Pusher	F		1	1.0	1	1.0	1	2
- Aqueous Waste Tank	E		1	5.0	5	2.0	2	7
- Aqueous Waste Pump	E		1	3.0	3	2.0	2	5
- Assay/Drumming (A-PBRCR)								
- Drum Pusher	F		1	10.0	10	0.2	0.2	10.2
- Lid Attacher	F		1	2.0	2	0.3	0.3	2.3
- Assay Station	F		1	500.0	500	3.0	3	503
- Drum Washer	E		1	70.0	70	10.0	10	80
- Miscellaneous Equipment								
- Transfer Cart (CA)	E		1	100.0	100	20.0	20	120
- Crane	E		1	525.0	525	105.0	105	630
- CCTV	E		4	10.0	40	2.0	8	48
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		1	130.0	130	44.0	44	174
- Allowance for Mechanical/Piping	E		Lot	105.1	105.1	179.3	179.3	284.4
- Allowance for Electrical/Control	E		Lot	315.2	315.2	179.3	179.3	494.5
- Calibration, Testing & Startup	E		Lot	50.4	50.4	28.7	28.7	79.1
-								
Total Lead Recovery Subsystem					2571.7		745.8	3317.5
14 Air Pollution Control Subsystem	II							
- Particulate Filter								
- Baghouse Assembly (increased size for 1 shift operation)	E		1	464.0	464	69.6	69.6	533.6
- Prefilter (added 4 filters)	E		4	26.0	104	12.0	48	152
- Inter Connection Ducts. (tripled cost)	E		Lot	6.0	6	30.0	30	36
- Corona Reactor								
- Reactor (no change- no organics expected from CWO)								
- Skid & Instrumentation								
- Power Supply								
- Cost per Package Above (increased size for triple capacity)	E		Lot	141.1	141.1	7.0	7	148.1
- Acid Gas Scrubber								
- Packing Tower (increased cost for triple capacity) using .6 factor	E		1	87.0	87	13.0	13	100
- Induced Fan	E		2	4.5	9	0.5	1	10
- Recycle Pump	E		2	1.8	3.6	0.2	0.4	4
- Sludge Discharge Pump	E		2	2.7	5.4	0.5	1	6.4
- Caustic Feed Pump	E		2	0.9	1.8	0.2	0.4	2.2
- NaOH Transfer Pump	E		2	0.9	1.8	0.2	0.4	2.2
- Caustic Storage Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Slurry Pump	E		2	2.7	5.4	0.5	1	6.4
- Condensate Tank	E		1	0.9	0.9	0.2	0.2	1.1
- NaOH Day Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Scrubber Solution Tank	E		1	0.9	0.9	0.2	0.2	1.1
- Evaporator System	E		1	54.0	54	16.2	16.2	70.2
- Hydrosonic Scrubber	E		1	27.0	27	5.4	5.4	32.4
- Liquid/ Solid Separator	E		1	18.0	18	3.6	3.6	21.6
- Mist Eliminator	E		1	1.6	1.6	0.4	0.4	2
- Heat Exchanger	E		2	5.4	10.8	1.8	3.6	14.4
- Carbon Adsorption								
- Carbon Filter (GAC)	F		2	9.0	18	1.8	3.6	21.6
- Carbon Filter (Sublimated GAC)	F		2	9.0	18	1.8	3.6	21.6
- Support System								
- Stack	E		1	7.2	7.2	1.4	1.4	8.6
- Stack Monitors - Radioactive	E		Lot	56.0	56	14.4	14.4	70.4
- Stack Monitors - Non Radioactive	E		Lot	27.0	27	10.8	10.8	37.8
- OH Crane	E		1	525.0	525	105.0	105	630
- Airlock	E		2	124.0	248	39.0	78	326
- CCTV	E		4	10.0	40	2.0	8	48
- Shield Window	E		1	130	130	44	44	174
- Allowance for Mechanical/Piping	E		Lot	604.0	604	282.4	282.4	886.4

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	QTY	MATLS. & EQUIP.		INST. COSTS		
				Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	Total U.O.
- Allowance for Electrical/Control	E		Lot	302.0	302	235.3	235.3	537.3
- Calibration, Testing & Startup	E		Lot	58.4	58.4	39.5	39.5	97.9
Total Air Pollution Control Subsystem					2977.7		1027.8	4005.5
15 Polymer Stabilization Subsystem	I							
- Prepare & Feed Incoming Waste (A-PLYMR)								
- Bin Hoist / Pusher	F	5	1	100.0	100	8.0	8	108
- Disch. & Oversize Load Hopper (100 CF)	F	1	1	60.0	60	9.0	9	69
- Tertiary Shredder	B	50	1	50.0	100	10.0	10	110
- Live Bottom Bulk Storage	F	1	1	60.0	60	9.0	9	69
- Conveyor / Canister Handler	F	5	1	80.0	80	10.0	10	90
- Manipulation Crane - 5 TON	E	10	1	525.0	525	105.0	105	630
- Dust Collection System w/ Blower	F		1	108.0	108	17.0	17	125
- HEPA Filter	F		8	25.0	200	5.0	40	240
- CCTV	E		13	10.0	130	2.0	26	156
- Airlock	E		2	124.0	248	39.0	78	326
- Shield Window	E		2	130	260	44	88	348
- Drying (A-PLYMR)								
- Drier	F		1	585.0	585	88.0	88	673
- Conveyor	F	5	5	6.0	30	1.0	5	35
- Proportioning and Blending (A-PLYMR)								
- Polymer Pellets Storage Silo	E		4	25.0	100	7.0	28	128
- Weigh Station	E		2	20.0	40	2.0	4	44
- Blender	F	2	1	53.0	53	5.0	5	58
- Conveyor	F	5	11	6.0	66	1.0	11	77
- Encapsulation (A-PLYMR)								
- Extruder	F	100	1	630.0	630	22.7	22.7	652.7
- Activated Carbon	F		4	10.0	40	1.0	4	44
- Drum Cooling (A-PLYMR)								
- Induced Draft Fan/ Ducting	F		8	16.0	128	2.0	16	144
- Enclosure	F		1	121.0	121	8.0	8	129
- Drum Capping and Washing (A-PLYMR)								
- Drum Wash/ Cap	E		4	70.0	280	15.0	60	340
- Flush Water Collection and Conveying	E		2	30.0	60	18.0	36	96
- Conveyor	F	5	39	6.0	234	1.0	39	273
- Allowance for Mechanical/Piping	E		Lot	211.9	211.9	363.4	363.4	575.3
- Allowance for Electrical/Control	E		Lot	635.7	635.7	363.4	363.4	999.1
- Calibration, Testing & Startup	E		Lot	101.7	101.7	58.1	58.1	159.8
Total Polymer Stabilization Subsystem					5187.3		1511.6	6698.9
16 Grout Stabilization Subsystem	I							
- Manipulation Crane - 5 TON	E	10	1	525.0	525	105.0	105	630
- Dust Collection System w/ Blower	F		1	108.0	108	17.0	17	125
- HEPA Filter	F		4	25.0	100	5.0	20	120
- Size Reduction Table and Tools	E		1	205.0	205	40.0	40	245
- Shield Window	E		1	130.0	130	44.0	44	174
- CCTV	E		14	10.0	140	2.0	28	168
- Airlock	E		2	124.0	248	39.0	78	326
- Store & Feed Binder								
- Pneumatic Feed								
- Binder Storage Silo								
- Silo Discharge Feeder								
- Mixing Station								
- Binder Feed Pump								
- Complete Package per Above Detail	E		Lot	250	250	40	40	290
- Micro/ Macro - Solidification								
- Binder Feed Prep								
- Binder Feed Hopper								
- Waste Feeder								
- Drum Tumbler								

Table B-5.1: Equipment Purchase and Installation Budget Estimates
Enhanced Non-Thermal Treatment System
ENTS - 5 CWO with Increased Reaction Rates

DESCRIPTION	ENTS - 5							
	CWO with Increased Reaction Rates							
	FAC. CAT.	HP	MATLS. & EQUIP.		INST. COSTS			Total U.O.
			QTY	Unit Cost \$1000's	Amount \$1000's	Unit Cost \$1000's	Amount \$1000's	
- Grout/Water Mixer								
- Complete Package per Above Detail	E		4	250	1000	38	152	1152
- Drum Capping and Washing								
- Drum Wash /Cap Unit	E		4	70	280	15	60	340
- Flush Water Collection & Conveying	E		2	30	60	18	36	96
- Conveyor	E		24	6	144	1	24	168
- Allowance for Mechanical/Piping	E		Lot	159.5	159.5	322.0	322	481.5
- Allowance for Electrical/Control	E		Lot	478.5	478.5	322.0	322	800.5
- Calibration, Testing & Startup	E		Lot	76.6	76.6	51.5	51.5	128.1
Total Grout Stabilization Subsystem					3904.6		1339.5	5244.1
17 Certification & Shipping Subsystem	I							
- Incoming Material Storage (B-CSHIP)								
- Overhead Bridge Crane 20 TN	E		1	625.0	625	125.0	125	750
- Forklift 10 TN	E		1	65.0	65	10.0	10	75
- Inspect & Assay (B-CSHIP)								
- Transfer Cart 2 TN	E							
- Real Time Radiography (ND)								
- Passive Active Neutron (ND)								
- Segmented Gamma Spectroscopy (ND)								
- Complete Package per Above	E		2	1,500.0	3000	150.0	300	3300
- Self Guided Vehicle (ND)	E		1	425.0	425	850.0	850	1275
- Truck Loading (B-CSHIP)								
- Forklift 10 TN	E		10	65.0	650	10.0	100	750
- Roll-up Door	E		2	20.0	40	2.0	4	44
- Bridge Crane	E		1	525.0	525	105.0	105	630
- Roller Conveyor (CA)	E		20	2.0	40	1.0	20	60
- Allowance for Mechanical/Piping	E		Lot	268.5	268.5	757.0	757	1025.5
- Allowance for Electrical/Control	E		Lot	805.5	805.5	757.0	757	1562.5
- Calibration, Testing & Startup	E		Lot	128.9	128.9	121.1	121.1	250
Total Certification & Shipping Subsystem					6572.9		3149.1	9722
18 Support Subsystem	III							
- Electrical Distribution and MCC								
- Control Panel - FT	E		110	10.0	1100	2.0	220	1320
- Emergency Power Generator	E		1	500.0	500	100.0	100	600
- Main Control Panel	E		20	10.0	200	2.0	40	240
- Motor Control Center	E		100	1.5	150	0.5	50	200
- Stand by Emergency Power	E		1	230.0	230	80.0	80	310
- Utilities and Mechanical								
- Breathing Air Package	E		Lot	70.0	70	30.0	30	100
- Compressed Air Package	E		Lot	100.0	100	25.0	25	125
- Instrument Air	E		1	70.0	70	30.0	30	100
- Instrument Air Package	E		Lot	90.0	90	25.0	25	115
- Plant Steam/Boiler	E		1	75.0	75	25.0	25	100
- Service Water	E		1	130.0	130	40.0	40	170
- Sump Pump	E		3	10	50	2.0	20	70
- Cooling Tower	E		1	200.0	200	10.0	10	210
- Cooling Water Pumps	E		3	2	30	3.0	6	36
- Heating, Ventilation & Exhaust								
- Included with Building Cost								
- Radiation Monitoring								
- Air Monitors	E		44	10.0	440	2.0	88	528
- Area Monitoring	E		44	4.5	198	1.0	44	242
- Personnel Monitoring Portals	E		6	35.0	210	5.0	30	240
- Portal Monitors	E		6	35.0	210	5.0	30	240
- Allowance for Mechanical/Piping	E		Lot	40.5	40.5	8.9	8.9	49.4
- Allowance for Electrical/Control	E		Lot	608.0	608	134.0	134	742
- Calibration, Testing & Startup	E		Lot	94.0	94	20.7	20.7	114.7
Total Support Subsystem					4795.5		1056.6	5852.1

Table B-5.2 : Development, Testing & Evaluation Cost Estimate
ENTS - 5 CWO with Increased Reaction Rates

UNIT OPERATION	ENTS-5 CWO with Increased Reaction Rates								
	Primary Paper Evaluation Research Manpower	Bench Scale Studies Research Manpower	Sec. Paper Evaluation Research Manpower	Total Research Manpower	Bench Scale Studies Equipment \$1000	Bench Scale Studies Installation \$1000	Pilot Plant Mock-up Test Demo. Manpower	Pilot Plant Mock-up Test Bldg. \$1000	Pilot Plant Mock-up Test Equip. \$1000
1 Administration Building Subsystem									
2 Receiving & Inspection Subsystem	12			12			25	1,200	6,000
3 Aqueous Waste Treatment Subsystem	5	3	3	11	100	300	10	400	2,000
4 Organic Destruction Subsystem	18	20	4	42	500	150	30	400	4,000
5 Residue & Sludge Treatment Subsystem	13	8	4	25	500	150	30	500	2,000
6 Soft Debris Treatment Subsystem									
7 Complex Debris Treatment Subsystem									
8 Open Debris Treatment Subsystem	2	6	2	10	300	50	20	1,000	3,000
9 Bulk Soil Treatment Subsystem	10	6	2	18	200	50	10	200	500
10 Metal Decontamination Subsystem									
11 Special Waste	8	20	5	33	600	250	20	400	2,000
12 Mercury Amalgamation Subsystem	1	3		4	100	50			
13 Lead Recovery Subsystem	2	2		4	100	30			
14 Air Pollution Control Subsystem	5	3	2	10	200	50	15	400	2,000
15 Polymer Stabilization Subsystem	2	8	4	14	300	50	15	400	2,000
16 Grout Stabilization Subsystem	2	8	4	14	300	50	15	400	1,000
17 Certification & Shipping Subsystem									
18 Support Subsystem	5			5					
Unit Cost (\$/Unit)				\$150,000			\$150,000		
Total Cost				30,300	3,200	1,180	28,500	5,300	24,500
Post Totals To Table 4-5, Item				1.1	1.2	1.3	2.1	2.5.1	2.5.2

Table B-5.3 : Building, Equipment and Installation Cost Summary
ENTS - 5 CWO with Increased Reaction Rates

UNIT OPERATION		ENTS-5 CWO with Increased Reaction Rates								
		Building Area					Material & Equipment Costs			Total Cost per Unit Oprtn. \$1000
		Cost Category 1 sq.ft	Cost Category 2 sq.ft	Cost Category 3 sq.ft	Cost Category 4 sq.ft	Total Area Cost \$1000	Purchase Cost \$1000	Installation Cost \$1000	Total Cost \$1000	
1.0	Administration Building Subsystem	12,440	3,000			3,499	3,163	888	4,051	7,550
2.0	Receiving & Inspection Subsystem		24,227	2,970	14,839	38,966	18,494	6,775	25,268	64,234
3.0	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	5,287	4,980	1,516	6,496	11,783
4.0	Organic Destruction Subsystem		1,578	2,317	2,460	7,625	18,401	5,614	24,015	31,640
5.0	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	9,377	4,893	1,168	6,061	15,438
6.0	Soft Debris Treatment Subsystem									
7.0	Complex Debris Treatment Subsystem									
8.0	Open Debris Treatment Subsystem		1,888	2,873	2,610	8,678	2,053	671	2,723	11,401
9.0	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	7,381	2,822	832	3,654	11,035
10.0	Metal Decontamination Subsystem		641	169	1904	3,709	3,572	1,496	5,067	8,776
11.0	Special Waste		604	159	1792	3,491				3,491
12.0	Mercury Amalgamation Subsystem		1020	1552	1410	4,688	1,454	527	1,981	6,669
13.0	Lead Recovery Subsystem						2,572	746	3,318	3,318
14.0	Air Pollution Control Subsystem		955	1,453	1,320	4,389	2,978	1,028	4,006	8,395
15.0	Polymer Stabilization Subsystem		2,322	3,534	3,210	10,673	5,187	1,512	6,699	17,372
16.0	Grout Stabilization Subsystem		1,931	2,940	2,670	8,878	3,905	1,340	5,244	14,122
17.0	Certification & Shipping Subsystem		28,277			11,876	6,573	3,149	9,722	21,598
18.0	Support Subsystem	3,360	16,883			7,696	4,796	1,057	5,852	13,548
	Total Cost					136,213			114,157	250,370
						3.4.1			3.4.2	

Table B-5.4 : Annual Operating & Maintenance Costs
ENTS - 5 CWO with Increased Reaction Rates

UNIT OPERATION	ENTS-5 CWO with Increased Reaction Rates						
	Operating FTE	Utilities \$1000	Materials \$1000	Maintenance Labor (1) \$1000		Maintenance Materials (2) \$1000	Totals \$1000
					\$1000		
1 Administration Building Subsystem	32	5	164	318	3162.7	127	445
2 Receiving & Inspection Subsystem	170	159	612	1,850	18493.5	740	2,590
3 Aqueous Waste Treatment Subsystem	5	300	1,705	873	4980.2	349	1,222
4 Organic Destruction Subsystem	15	298	297	4,600	18400.6	1,840	6,440
5 Residue & Sludge Treatment Subsystem	8	21	1	855	4892.5	342	1,197
6 Soft Debris Treatment Subsystem							
7 Complex Debris Treatment Subsystem							
8 Open Debris Treatment Subsystem	8	25	100	360	2052.9	144	504
9 Bulk Soil Treatment Subsystem	2	22	14	140	2821.9	56	196
10 Metal Decontamination Subsystem	4	5	25	625	3571.6	250	875
11 Special Waste	3	12	200				
12 Mercury Amalgamation Subsystem	1	2	10	255	1453.9	102	357
13 Lead Recovery Subsystem	3	73	50	450	2571.7	180	630
14 Air Pollution Control Subsystem	4	67	130	520	2977.7	208	728
15 Polymer Stabilization Subsystem	37.5	118	1,858	908	5187.3	363	1,271
16 Grout Stabilization Subsystem	8	47	847	390	3904.6	156	546
17 Certification & Shipping Subsystem	88	12	70	658	6572.9	263	921
18 Support Subsystem	5			480	4795.5	192	672
Unit cost (\$/unit)	\$140,000						
Total Cost	55,090	1166	6,083				18,594
Post Totals To Table 4-5, Item	5.1	5.2	5.3				5.4

Notes:

1. Annual Maintenance Labor is 250 % of maintenance material cost.
2. Maintenance Material is assumed to be 2 % of equipment capital cost for the Bulk Soil Treatment subsystem, because the capital equipment is based on one shift operation.
3. Maintenance Material is assumed to be 10 % of equipment capital cost for organic destruction and soft debris.
4. Maintenance Material is assumed to be 4 % of equipment capital cost for Administration, Receiving & Inspection, Grout Stabilization, Certification & Shipping, and Support subsystems.
5. Maintenance Material is assumed to be 7 % of equipment capital cost for all other subsystems
6. Organic destruction FTEs include one shift operation of CWO process (3 FTEs), but allow 3 shift FTEs for material handling of soft debris (4 FTE)

Table B-5.5 : Decontamination & Decommissioning Costs
ENTS - 5 CWO with Increased Reaction Rates

UNIT OPERATION		ENTS-5 CWO with Increased Reaction Rates				
		Building Area				Total Area Cost \$1000
		Cost Category 1	Cost Category 2	Cost Category 3	Cost Category 4	
		sq.ft	sq.ft	sq.ft	sq.ft	
1	Administration Building Subsystem	12,440	3,000			6,948
2	Receiving & Inspection Subsystem		24,227	2,970	14,839	18,916
3	Aqueous Waste Treatment Subsystem		1,150	1,751	1,590	2,021
4	Organic Destruction Subsystem		1,578	2,317	2,460	2,860
5	Residue & Sludge Treatment Subsystem		2,040	3,105	2,820	3,584
6	Soft Debris Treatment Subsystem					
7	Complex Debris Treatment Subsystem					
8	Open Debris Treatment Subsystem		1,888	2,873	2,610	3,317
9	Bulk Soil Treatment Subsystem		1,606	2,444	2,220	2,822
10	Metal Decontamination Subsystem		641	169	1,904	1,222
11	Special Waste		604	159	1,792	1,150
12	Mercury Amalgamation Subsystem		1,020	1,552	1,410	1,792
13	Lead Recovery Subsystem					
14	Air Pollution Control Subsystem		955	1,453	1,320	1,678
15	Polymer Stabilization Subsystem		2,322	3,534	3,210	4,080
16	Grout Stabilization Subsystem		1,931	2,940	2,670	3,393
17	Certification & Shipping Subsystem		28,277			12,725
18	Support Subsystem	3,360	16,883			9,109
	Total Cost					75,617
		Post Totals To Table 4-5, Item				7.0

Table B-5.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Nonthermal Treatment Systems (cost module ENTS-5)

Cost component	Cost Items	ENTS 5								
		Administration Building Subsystem	Receiving & Inspection Subsystem	Aqueous Waste Treatment Subsystem	Organic Destruction Subsystem	ENTS 5 Residue & Sludge Treatment Subsystem	Soft Debris Treatment Subsystem	Complex Debris Treatment Subsystem	Open Debris Treatment Subsystem	Bulk Soil Treatment Subsystem
1.0	Studies and bench scale test costs									
1.1	Manpower costs during research	\$0	\$1,800	\$1,650	\$6,300	\$3,750	\$0	\$0	\$1,500	\$2,700
1.2	Equipment costs	\$0	\$0	\$100	\$300	\$500	\$0	\$0	\$300	\$200
1.3	Installation costs	\$0	\$0	\$300	\$150	\$150	\$0	\$0	\$50	\$50
1.4	Project management before title 1 (10 % of 1.1 through 1.3)	\$0	\$180	\$205	\$695	\$440	\$0	\$0	\$185	\$295
1.5	Contingency (25 % of 1.1 through 1.4)	\$0	\$495	\$564	\$1,911	\$1,210	\$0	\$0	\$509	\$811
	Subtotal 1.0	\$0	\$2,475	\$2,819	\$9,556	\$6,050	\$0	\$0	\$2,544	\$4,056
2.0	Demonstration costs									
2.1	Manpower costs during demonstration	\$0	\$3,750	\$1,500	\$4,500	\$4,500	\$0	\$0	\$3,000	\$1,500
2.2	Design cost (30 % of 2.5)	\$0	\$2,786	\$929	\$1,703	\$968	\$0	\$0	\$1,548	\$271
2.3	Inspection cost (7 % of 2.5)	\$0	\$650	\$217	\$397	\$226	\$0	\$0	\$361	\$63
2.4	Project management (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90
2.5	Construction cost									
2.5.1	Building structure costs	\$0	\$1,200	\$400	\$400	\$500	\$0	\$0	\$1,000	\$200
2.5.2	Equipment costs	\$0	\$6,000	\$2,000	\$4,000	\$2,000	\$0	\$0	\$3,000	\$500
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$2,088	\$696	\$1,276	\$725	\$0	\$0	\$1,160	\$203
	Subtotal of 2.5	\$0	\$9,288	\$3,096	\$5,676	\$3,225	\$0	\$0	\$5,160	\$903
2.6	Construction management costs (17.1 % of 2.5)	\$0	\$1,588	\$529	\$971	\$551	\$0	\$0	\$882	\$154
2.7	Management Reserve (10 % of 2.5)	\$0	\$929	\$310	\$568	\$323	\$0	\$0	\$516	\$90
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$4,980	\$1,723	\$3,596	\$2,529	\$0	\$0	\$2,996	\$768
	Subtotal 2.0	\$0	\$24,900	\$8,614	\$17,979	\$12,645	\$0	\$0	\$14,979	\$3,839
3.0	Production facility construction costs									
3.1	Design cost (25 % of 3.4)	\$2,435	\$20,716	\$3,800	\$10,204	\$4,979	\$0	\$0	\$3,677	\$3,559
3.2	Inspection cost (7 % of 3.4)	\$682	\$5,800	\$1,064	\$2,857	\$1,394	\$0	\$0	\$1,029	\$996
3.3	Project management (10 % of 3.4)	\$974	\$8,286	\$1,520	\$4,082	\$1,992	\$0	\$0	\$1,471	\$1,424
3.4	Construction cost									
3.4.1	Building structure costs	\$3,499	\$38,966	\$5,287	\$7,625	\$9,377	\$0	\$0	\$8,678	\$7,381
3.4.2	Equipment costs	\$4,051	\$25,268	\$6,496	\$24,015	\$6,061	\$0	\$0	\$2,723	\$3,654
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$2,190	\$18,628	\$3,417	\$9,176	\$4,477	\$0	\$0	\$3,306	\$3,200
	Subtotal of 3.4	\$9,740	\$82,862	\$15,200	\$40,816	\$19,915	\$0	\$0	\$14,707	\$14,235
3.5	Construction management (17.1 % of 3.4)	\$1,666	\$14,169	\$2,599	\$6,980	\$3,405	\$0	\$0	\$2,515	\$2,434
3.6	Management Reserve (10 % of 3.4)	\$974	\$8,286	\$1,520	\$4,082	\$1,992	\$0	\$0	\$1,471	\$1,424
3.7	Contingency (25 % of 3.1 through 3.5)	\$3,874	\$32,958	\$6,046	\$16,235	\$7,921	\$0	\$0	\$5,850	\$5,662
	Subtotal 3.0	\$20,345	\$173,077	\$31,749	\$85,256	\$41,598	\$0	\$0	\$30,720	\$29,734
4.0	Operations Budget Funded Activities (See Sect. 7)									
4.1	Conceptual design (1.5 % of 3.0)	\$305	\$2,596	\$476	\$1,279	\$624	\$0	\$0	\$461	\$446
4.2	Safety assurance (1 % of 3.0)	\$203	\$1,731	\$317	\$853	\$416	\$0	\$0	\$307	\$297
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$7,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
4.4	Preparation for operations (100 % of 5.0)	\$6,368	\$33,951	\$4,909	\$11,419	\$2,924	\$0	\$0	\$2,186	\$640
4.5	Project Management (10 % of 4.1 through 4.4)	\$1,388	\$3,828	\$570	\$1,355	\$396	\$0	\$0	\$295	\$138
	Subtotal 4.0	\$15,264	\$42,106	\$6,272	\$14,906	\$4,360	\$0	\$0	\$3,249	\$1,521
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$35,609	\$242,558	\$49,454	\$127,697	\$64,653	\$0	\$0	\$51,492	\$39,150
5.0	Operating and maintenance costs									
5.1	Annual operating costs	\$4,480	\$23,800	\$700	\$2,100	\$1,120	\$0	\$0	\$1,120	\$280
5.2	Annual utility costs	\$5	\$159	\$300	\$298	\$21	\$0	\$0	\$25	\$22
5.3	Annual material costs	\$164	\$612	\$1,705	\$297	\$1	\$0	\$0	\$100	\$14
5.4	Annual maintenance costs	\$445	\$2,590	\$1,222	\$6,440	\$1,197	\$0	\$0	\$504	\$196
5.5	Contingency (25 % of 5.1 through 5.4)	\$1,274	\$6,790	\$982	\$2,284	\$583	\$0	\$0	\$437	\$128
5.6	Subtotal 5.0	\$6,368	\$33,951	\$4,909	\$11,419	\$2,924	\$0	\$0	\$2,186	\$640
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$127,360	\$679,020	\$98,180	\$228,380	\$58,480	\$0	\$0	\$43,720	\$12,800
6.0	Decontamination & Decommissioning	\$6,948	\$18,916	\$2,021	\$2,860	\$3,584	\$0	\$0	\$3,317	\$2,822
7.0	ROM Life cycle costs (20 years operation)	\$169,917	\$940,494	\$149,655	\$358,937	\$126,717	\$0	\$0	\$98,529	\$54,772

Table B-5.6 : Total Life-Cycle Cost (without Disposal) Estimate Summary for
Enhanced Integrated Nonthermal Treatment Systems (cost module ENTSS-5)

Cost component	Cost Items	ENTSS 5 Metal Decontamination Subsystem	ENTSS 5 Special Waste	ENTSS 5 Mercury Amalgamation Subsystem	ENTSS 5 Lead Recovery Subsystem	ENTSS 5 Air Pollution Control Subsystem	ENTSS 5 Polymer Stabilization Subsystem	ENTSS 5 Grout Stabilization Subsystem	ENTSS 5 Certification & Shipping Subsystem	ENTSS 5 Support Subsystem
1.0	Studies and bench scale test costs									
1.1	Manpower costs during research	\$0	\$4,950	\$600	\$600	\$1,500	\$2,100	\$2,100	\$0	\$750
1.2	Equipment costs	\$0	\$600	\$100	\$100	\$200	\$300	\$300	\$0	\$0
1.3	Installation costs	\$0	\$250	\$50	\$30	\$50	\$50	\$50	\$0	\$0
1.4	Project management before title I (10 % of 1.1 through 1.3)	\$0	\$580	\$75	\$73	\$175	\$245	\$245	\$0	\$75
1.5	Contingency (25 % of 1.1 through 1.4)	\$0	\$1,595	\$206	\$201	\$481	\$674	\$674	\$0	\$206
	Subtotal 1.0	\$0	\$7,975	\$1,031	\$1,004	\$2,406	\$3,369	\$3,369	\$0	\$1,031
2.0	Demonstration costs									
2.1	Manpower costs during demonstration	\$0	\$3,000	\$0	\$0	\$2,250	\$2,250	\$2,250	\$0	\$0
2.2	Design cost (30 % of 2.3)	\$0	\$929	\$0	\$0	\$929	\$929	\$542	\$0	\$0
2.3	Inspection cost (7 % of 2.3)	\$0	\$217	\$0	\$0	\$217	\$217	\$126	\$0	\$0
2.4	Project management (10 % of 2.3)	\$0	\$310	\$0	\$0	\$310	\$310	\$181	\$0	\$0
2.5	Construction cost									
2.5.1	Building structure costs	\$0	\$400	\$0	\$0	\$400	\$400	\$400	\$0	\$0
2.5.2	Equipment costs	\$0	\$2,000	\$0	\$0	\$2,000	\$2,000	\$1,000	\$0	\$0
2.5.3	Indirect (29 % of 2.5.1 & 2.5.2)	\$0	\$696	\$0	\$0	\$696	\$696	\$406	\$0	\$0
	Subtotal of 2.5	\$0	\$3,096	\$0	\$0	\$3,096	\$3,096	\$1,806	\$0	\$0
2.6	Construction management costs (17.1 % of 2.5)	\$0	\$529	\$0	\$0	\$529	\$529	\$309	\$0	\$0
2.7	Management Reserve (10 % of 2.5)	\$0	\$310	\$0	\$0	\$310	\$310	\$181	\$0	\$0
2.8	Contingency (25 % of 2.1 through 2.7)	\$0	\$2,098	\$0	\$0	\$1,910	\$1,910	\$1,349	\$0	\$0
	Subtotal 2.0	\$0	\$10,489	\$0	\$0	\$9,551	\$9,551	\$6,744	\$0	\$0
3.0	Production facility construction costs									
3.1	Design cost (25 % of 3.4)	\$2,830	\$1,126	\$2,151	\$1,070	\$2,708	\$5,603	\$4,554	\$6,965	\$4,369
3.2	Inspection cost (7 % of 3.4)	\$792	\$315	\$602	\$300	\$758	\$1,569	\$1,275	\$1,950	\$1,223
3.3	Project management (10 % of 3.4)	\$1,132	\$450	\$860	\$428	\$1,083	\$2,241	\$1,822	\$2,786	\$1,748
3.4	Construction cost									
3.4.1	Building structure costs	\$3,709	\$3,491	\$4,688	\$0	\$4,389	\$10,673	\$8,878	\$11,876	\$7,696
3.4.2	Equipment costs	\$5,067	\$0	\$1,981	\$3,318	\$4,006	\$6,699	\$5,244	\$9,722	\$5,852
3.4.3	Indirect (29 % of 3.4.1 & 3.4.2)	\$2,545	\$1,012	\$1,934	\$962	\$2,435	\$5,038	\$4,095	\$6,263	\$3,929
	Subtotal of 3.4	\$11,321	\$4,503	\$8,603	\$4,280	\$10,830	\$22,410	\$18,217	\$27,861	\$17,477
3.5	Construction management (17.1 % of 3.4)	\$1,936	\$770	\$1,471	\$732	\$1,852	\$3,832	\$3,115	\$4,764	\$2,989
3.6	Management Reserve (10 % of 3.4)	\$1,132	\$450	\$860	\$428	\$1,083	\$2,241	\$1,822	\$2,786	\$1,748
3.7	Contingency (25 % of 3.1 through 3.5)	\$4,503	\$1,791	\$3,422	\$1,703	\$4,308	\$8,914	\$7,246	\$11,082	\$6,952
	Subtotal 3.0	\$23,646	\$9,405	\$17,969	\$8,941	\$22,622	\$46,810	\$38,051	\$58,194	\$36,506
4.0	Operations Budget Funded Activities (See Sect. 7)									
4.1	Conceptual design (1.5 % of 3.0)	\$355	\$141	\$270	\$134	\$339	\$702	\$571	\$873	\$548
4.2	Safety assurance (1 % of 3.0)	\$236	\$94	\$180	\$89	\$226	\$468	\$381	\$582	\$365
4.3	NEPA permitting (\$ 6 Mill for EIS, \$1 Mill for EA)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
4.4	Preparation for operations (100 % of 3.0)	\$1,831	\$790	\$636	\$1,466	\$1,856	\$10,621	\$3,200	\$16,654	\$1,715
4.5	Project Management (10 % of 4.1 through 4.4)	\$242	\$103	\$109	\$169	\$242	\$1,179	\$415	\$1,811	\$263
	Subtotal 4.0	\$2,664	\$1,128	\$1,195	\$1,858	\$2,663	\$12,970	\$4,567	\$19,920	\$2,891
	Total Initial Cost (1.0,2.0,3.0 & 4.0)	\$26,310	\$28,997	\$20,195	\$11,803	\$37,242	\$72,700	\$52,731	\$78,114	\$40,428
5.0	Operating and maintenance costs									
5.1	Annual operating costs	\$560	\$420	\$140	\$420	\$560	\$5,250	\$1,120	\$12,320	\$700
5.2	Annual utility costs	\$5	\$12	\$2	\$73	\$67	\$118	\$47	\$12	\$0
5.3	Annual material costs	\$25	\$200	\$10	\$50	\$130	\$1,858	\$847	\$70	\$0
5.4	Annual maintenance costs	\$875	\$0	\$357	\$630	\$728	\$1,271	\$546	\$921	\$672
5.5	Contingency (25 % of 5.1 through 5.4)	\$366	\$158	\$127	\$293	\$371	\$2,124	\$640	\$3,331	\$343
5.6	Subtotal 5.0	\$1,831	\$790	\$636	\$1,466	\$1,856	\$10,621	\$3,200	\$16,654	\$1,715
5.7	Total 20 year O & M cost (20 times Subtotal 5.0)	\$36,620	\$15,800	\$12,720	\$29,320	\$37,120	\$212,420	\$64,000	\$333,080	\$34,300
6.0	Decontamination & Decommissioning	\$1,222	\$1,150	\$1,792	\$0	\$1,678	\$4,080	\$3,393	\$12,725	\$9,109
7.0	ROM Life cycle costs (20 years operation)	\$64,152	\$45,947	\$34,707	\$41,123	\$76,040	\$289,200	\$120,124	\$423,919	\$83,837