HALLIBURTON NUS
Environmental Corporation

ROCKY FLATS PLANT PONDCRETE/SALTCRETE REMEDIATION PROGRAM DESCRIPTION

"PONDCRETE AND SALTCRETE WHITE PAPER"

for

EG&G ROCKY FLATS

prepared by

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

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**STABILIZATION OF PONDCRETE/SALTCRETE:
PROCESSING PLAN AND CURRENT STATUS**

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STABILIZATION OF PONDCRETE/SALTCRETE: PROCESSING PLAN AND CURRENT STATUS

1.0 OVERVIEW

The Pondcrete blocks that require reprocessing were produced as a result of combining the contents of Pond 207A with pozzolans. Saltcrete is a similar material produced using the inorganic salt residue produced by the spray dryer associated with the liquid waste treatment facility. Production of saltcrete is an on-going activity.

Halliburton NUS is of the opinion that the problems associated with the previous pondcrete/saltcrete production were two-fold:

- The lack of proper formulations that could produce quality products and

- The lack of an effective mode of process control to ensure output product quality.

This document outlines the current processing concepts for stabilization and the plan for the Pondcrete/Saltcrete Treatability Study.

2.0 BACKGROUND

2.1 Initial Pond Sludge Stabilization Operation

In June 1985, remediation of the sludge contained in Pond 207A commenced. Pond 207A is the largest of five solar evaporation ponds which were used to treat and store much of the waste water generated at the Rocky Flats Plant.

The remediation process at that time consisted of pumping the clear decant water on top of the pond sediments/sludge to Building 374 for evaporation and treatment. The remaining sludge was then slurried and pumped into a Clarifier at the Pondcrete Processing Facility at Building 788 for further dewatering and thickening. The thickened sludge was then pumped intermittently to a pug mill for blending with Portland Type I cement for stabilization. The resultant material, Pondcrete, was cast into lined cardboard boxes which are referred to as tri-wall containers. The Pondcrete was allowed to solidify in the tri-wall containers and then prepared for off-site shipment to permanent storage (Rockwell International, 1989)

This treatment process was essentially a batch operation. A given volume of clarifier underflow sludge/water (slurry) mixture was pumped into the pug mill. A measured quantity of cement was mixed with the slurry in the pug mill mixer. A target Pondcrete formula consisted of using a water to cement ratio of 1.5/1. The input sludge slurry waste stream from the Clarifier was expected to be controlled in a range of approximately 20% solids by weight. The target waste loading (defined as the dry pond solids percentage in the waste form) was about 9.0%. A minimum mixing time for the sludge mixture with the dry ingredients of approximately one-half hour was also the target operating criteria.

Obtaining and controlling these criteria (even though they were not optimal for a cement-stabilized waste form) was, at best, difficult with this processing plant. The feed slurry density (i.e. weight percent solids) in the Clarifier was difficult to maintain and control. The settling rate for the pond sludge solids was very slow and variable. Typically, this Clarifier was operated on a batch basis. Slurry was pumped from the pond into the Clarifier upon completion of pondcrete mixing operations. This reclaimed sludge was allowed to settle overnight to a condition approaching the target terminal density (of about 18 weight percent solids). No flocculant, coagulating agent or other liquid/solids separation promoter was used.

Early in the Pondcrete Process operation, a relatively-low production rate was the target. This allowed sufficient settling time in the Clarifier to be maintained to achieve a more-constant terminal density. At higher production rates, which were targeted later in the program, the Clarifier underflow slurry varied in slurry density depending on the settling time provided. Likewise, as the settled sludge layer in the Clarifier was depleted, there were variations in slurry density between the initial batches of slurry feed to the pug mill and the later batches during an operating cycle.

The combination of variable settling time and non-homogeneous settling characteristics of the solids being reclaimed from different areas of the pond resulted in considerable, uncontrolled variation in the feed slurry density to the stabilization mixer. This, in turn, caused a variable requirement for cement addition to the mixer. The resultant stabilized mixture, therefore, varied not only in the quantity of water, cement, solids, etc. but also in physical properties. Some product had too much water and too little cement; thus resulting in high-water ratio product which were only partially solidified and had low solid strength. Mixtures with higher sludge solids contents or with higher cement to water ratios sometimes were difficult to mix or discharge from the pug mill. In particular, sometimes the residual material from the previous batch had started to gel; thus making a more viscous material in the mixer and making the mixing operation of the pug mill as a batch mixer less efficient.

The operating volume of the pug mill mixer was approximately 16-18 cubic feet, depending on degree of filling. The volume of product which could be contained within the tri-wall container is about 13.7 cubic feet. Therefore, typically, some residual stabilized material was left within the pug mill mixer or one tri-wall container was only partially filled with the residual batch of stabilized waste. If operated partially filled, poor and incomplete mixing occurred in the pug mill.

The pouring arrangement from the pug mill allowed diversion of the cement-stabilized product through a chute into either of two tri-wall containers placed at the discharge. This too resulted in variations in character of the product produced and stratification of product within a tri-wall container.

The Pondcrete produced was routinely disposed of at the Nevada Test Site (NTS) until the fall of 1986 when the Pondcrete was identified as low level mixed waste. From 1986 until May 1988, a total of approximately 18,000 Pondcrete tri-walls were produced. These Pondcrete tri-walls were subsequently stored outside on two storage pads (904 Pad and 750 Pad) while awaiting shipment to permanent storage.

In late May 1988, site operations personnel discovered that several of the Pondcrete tri-walls had deformed. This was, in part, due to weather exposure and also due to the incomplete hardening and solidification of the Pondcrete product which made the tri-wall containers vulnerable when handled or stacked on top of each other. Inspection of the deformed tri-wall containers indicated that the Pondcrete contents had deteriorated, crumbled and cracked. Many of the containers themselves had slumped or lost their integrity and strength. At least one tri-wall was observed to have split and spilled its contents.

After the discovery of the deteriorated Pondcrete and degradation of the tri-wall containers, temporary, tent-like structures were installed on the pad to house the material and to protect it from exposure to the elements. A sorting process was initiated to identify suitable Pondcrete tri-walls which could be disposed of under then existing regulations. The Pondcrete was analyzed to determine if the Land Disposal Restrictions (LDR) were complied with, indicating that the material was acceptable for disposal. This process resulted in the disposal of approximately 11,200 tri-walls at NTS. The remaining 8,800 tri-walls currently are in temporary storage on site and require retreatment prior to ultimate permanent disposal. It is these tri-wall containers and contents which are the primary feed to the proposed Pondcrete/Saltcrete Reprocessing Facility.

2.2 Saltcrete Production

Saltcrete was generated by solidifying the salt residue produced by the Liquid Waste Treatment Facility located at Building 374 at the Rocky Flats Plant. This waste water, which predominately contained nitrate salts, was produced by the evaporation of plant waste water from a variety of sources. Liquid wastes from extraction and leaching processes, electroplating operations, laboratory wastes and metal machining/manufacturing operations were primary sources during plant operation. In addition, laundry waste liquids, organic cleaning solutions and solvents and acidic or caustic cleaning solutions were periodically added to the liquid wastes.

The mixtures of these source solutions and their contained components varied with the varying level of plant operations during at least three different operating periods: normal plant operation, transition during plant shut-down and solutions generated during operations shut-down are represented in the Building 374 feed liquids. As a consequence, the chemical composition of the evaporator salt and brines being stabilized for the existing Saltcrete have changed with time. In addition, primarily due to observed failures of the stabilization mix formulations as these transitions occurred, the cementaceous stabilization mix formulations have also been changed over time. Therefore, the physical and chemical nature of the Saltcrete requiring reprocessing also is variable, reflecting the changing source materials.

In simplified terms, the 374 waste water treatment operation can be categorized as three main processes. Depending on the liquid waste radiological contamination and point of origin, waste water can be fed directly to any one of the three treatment processes. However, recycles and cross-connections within the facility ultimately result in commingling of the streams and production of a combined salt residue, a saturated brine solution and purified condensate.

The three basic processes are:

- Flocculation/precipitation
- Sludge dewatering
- Evaporation

The Flocculation/precipitation activity is designed to remove most of the radioactivity by precipitation and agglomeration of the nuclear components. The settled and dewatered sludge from this process goes to a sludge handling step and the clarified decant solution reports to the evaporator. In addition, waste water feeds with low contamination levels may report directly to the evaporator.

The saturated salt brine and some salt crystal residue produced by the evaporator are further processed in a spray dryer to produce a dry salt residue. These spray dryer salts and some saturated brine solution are mixed with cement in the Saltcrete stabilization process. Primarily, this treatment is performed to immobilize the salts and any other solid particles and to significantly reduce the oxidizing and corrosive characteristics of the predominately nitrate salts and solutions.

Due to a variety of limitations (i.e. mixer type and power, materials handling systems, restriction to Type I cement only, etc.) the Building 374 Saltcrete process cannot produce a certifiable cement stabilized waste form. Thus, the inventory Saltcrete and the small number of Saltcrete half crates being currently produced need to be reprocessed into a certifiable waste form.

2.3 Previous Pondcrete Remix Operations

A development project was initiated by EG&G in 1990 to evaluate the reprocessing (or Remix) of inventory Pondcrete to a certifiable waste product suitable for permanent disposal. A pilot Pondcrete Reprocessing or Remix Operation was set up in containments located in tents on the 904 Pad Area. Laboratory test work was undertaken to define new mix formulations for the Remixed Pondcrete which would satisfy the long-term storage requirements and to define the operating conditions.

The essentials of the Remix Operations were:

- A tri-wall container unwrapping station located on an elevated platform above the pumping hopper on which the wrapped Pondcrete waste was manually unwrapped. The platform was equipped with a sliding ramp to facilitate dumping into the pump hopper.

- A slurry pump and hopper (Morgen Pumper) into which the contents of the unwrapped tri-wall containers and dilution water were dumped. The piston-type pump transferred the slurry (Pondcrete and water) to a cement mixer.

- Manual methods (picks, hammers, shovels, etc.) were used to break up the harder Pondcrete blocks to a small enough size to fit through a grizzly grate on top of the hopper.

- The Pondcrete being reprocessed was very variable in physical characteristics. Some material was hard and crumbly, other material was like wet sand or clayey, and some containers still had portions of the contents which were unsolidified slurry.

- The cement mixer used was a drum-type rotary mixer similar to those used by cement mixer/transport trucks. It was a low-shear batch mixer in which the liquid Pondcrete slurry was introduced and mixed with dry, Type I Portland cement and other additives and mixed until homogenized.

- The Remixed Pondcrete product was then cast, as a batch, into wooden half crate containers to constitute a new waste form.

A number of problems were encountered with this approach. Some were mechanical, some were related to the chemistry and physical nature of the material and others were related to the mode of operation and health and safety considerations.

These included:

- Unwrapping the Pondcrete which was inside a PVC liner bag within the tri-wall containers which, in turn, were banded, wrapped inside another PVC bag with a pallet and taped shut, was at best difficult. A crew of from two to four people took up to two hours handling, unwrapping and emptying the Pondcrete contents into the pumper's hopper.

- The manual handling and unwrapping operation was not only tedious and slow, but had many potential risks for personnel injury or exposure to hazardous material.

- Personnel could only work a limited time within the containment due to the protective gear required and other working conditions. This necessitated a number of back-up crews and effectively reduced operating throughput levels.

- The variable nature of the partially-solidified Pondcrete waste material (which would not be known until the waste was almost entirely unwrapped) required a number of contingency plans and operating practices for handling.

- Some of the material was not easily handled or transported by the piston-type pumping system. Size reduction capability, if required, was not provided for in the Remix system.

- The batch drum-type mixer varied in its performance as the character of the feed slurry mixture and the cement stabilization ingredients varied. Adding to these problems were periodic difficulties in obtaining the right amounts of waste, pozzolans and water. This, in part, was due to wide variations in the Pondcrete waste feed moisture content.

- The Remix product, thus obtained, often had variations in physical characteristics which impeded efficient mixing and made it more fluid or less fluid than desired for casting into the half crates. Adding more water to clean out the drum further aggravated these problems.

However, several very important lessons and information about the characteristics of the inventory Pondcrete material resulted from these Remix Operations. These lessons and information about the physical and chemical nature of the Pondcrete waste subsequently learned during sampling programs of the Pondcrete, waste characterization and treatability study programs in the laboratory have served as a basis for the design of the proposed Pondcrete Reprocessing Facility.

In addition, the proposed facility must also be capable of handling and reprocessing the inventory Saltcrete into a certifiable waste form with only minor additional equipment or operational changes. The flexibility required to effectively handle both of these types of waste feeds (as well as other, as yet undefined, waste materials) has been factored into the proposed design concept.

2.4 Physical Nature of The Material

2.4.1 Pondcrete

The evidence of the deformed and leaking tri-wall containers indicated that some of the inventory Pondcrete had not fully solidified. On the other hand, some of the breached containers were dusty, thus showing evidence of some dry and crumbly Pondcrete.

During the Pondcrete Remix Operation in 1990, the full spectrum of Pondcrete material from almost fluid slurry, to a wet, sticky, clay-like paste, to a wet, granular sand consistency up to a hard, dry cement mortar was seen. This extreme variability and unpredictable physical nature of the inventory Pondcrete waste material gave some concerns for defining and operating a Reprocessing Facility.

Also of concern was the possible variability of chemical components which could exceed waste disposal limits. In order to better understand the physical and chemical character of the inventory Pondcrete, a sampling and analysis program was initiated in late 1990. A total of nineteen tri-wall containers were unwrapped and sampled (out of over 8,000 in inventory). Of these, fourteen tri-walls which did not have any apparent damage were sampled and 5 tri-walls which had observable damage and thus were stored within sealed metal containers.

The variability of the physical nature of the Pondcrete and the possibility of high contained moisture content (over 60% by gravimetric methods) was confirmed. In addition, some of the chemical components tested higher than the Land Disposal Restrictions (LDR) in a few of the samples. The variability of these chemical analyses for some components also gave some concerns.
Another Pondcrete sampling program was undertaken in late 1991 to obtain additional samples to define the chemical component population variability and to provide composite Pondcrete samples for characterization, process development testing and treatability studies. A similar physical appearance variation from the wet and sticky to the apparently dry cement monolith was noted. Some containers had free water or water which collected in the void left by the core-type sampling device. Other material was solid and had to be broken with hammers and chisels. The average gravimetric moisture content was 63% with a range from 46% to 74%.

The wide spectrum of Pondcrete physical character was confirmed by analyses performed in the HNUS Pittsburgh Laboratory. In addition, the populations of the tri-wall containers in temporary storage and those deteriorated containers stored in metal containers did not significantly differ. For the samples from the metal containers only methanol, cadmium, and nickel LDR standards were exceeded by the average values of the samples. The LDR for chromium was exceeded for a few of the samples. For the general tri-wall population, the LDR requirements for cadmium, nickel and chromium was exceeded by the average concentration. Therefore, it has been concluded that the stabilization process must not only be one which addresses the physical stabilization of the waste into a solidified waste form but also one which chemically stabilizes these heavy-metal components.

2.4.2 Saltcrete

As discussed earlier, Saltcrete is a waste form which has been produced at the Rocky Flats Plant from evaporator salts and saturated brines from the waste water evaporation operations in the 374 Building. These salts historically were predominately nitrate salts derived from the waste water solutions from the various sources during the RFP operation. However, as some operations were decreased and ceased entirely, the compositions of the salts changed in character as other waste water sources, such a laundry wastes, etc., increased in proportion. Although the Saltcrete formulations have been shown to reduce the oxidizing potential of the nitrate salts and produce a product suitable for shipping (DOT MTB test RFP-3919), in no cases have the Saltcrete product been deemed acceptable for long-term disposal from a physical property standpoint. Thus, all inventory Saltcrete must be reprocessed to a certifiable waste form.

The feed salt compositions to the inventory Saltcrete have changed at least three times during its production. In addition, attempts to change and adjust the Saltcrete stabilization mix formulation to compensate for the changes in feeds material were made. Limitations in the production equipment's capabilities, the stabilization mix ingredients and the waste loading have also resulted in different and changing physical characteristics in the inventory Saltcrete with time. Consequently, the physical nature and potentially the chemical nature of the inventory Saltcrete has been variable with time and operational changes.

Generally, during the operation of the Saltcrete process, changes in the feed composition resulted in problems with the existing mix

formulation. The original, predominately-nitrate salt mixture cast in tri-wall containers showed significant swelling and expansion of the solidified product. This often resulted in breaching of the inner liner, deterioration of the outer, cardboard tri-wall and splitting of the container. In addition, a phenomenon called effervescence in which salt crystals seemed to grow on the surface of the stabilized waste and on the container where breached was observed. Some of the Saltcrete blocks fragmented, either spontaneously or as a result of handling, into chunks (roughly 1" or less) of semi-crystalline solids. This aggravates the potential dust problem due to the effervescence.
In changing the formulation for the transitional changes in feed composition, higher cement loadings and lower water content seemed, temporarily, to produce acceptable waste forms for temporary storage. However, after two to three months, some of the cast Saltcrete blocks began to show effervescence and others had standing free water on their surface. A laboratory study indicated that less water, less salt waste loading and more cement could improve the physical characteristics somewhat. However, the existing mixing and handling system in the 374 building could not accommodate the best laboratory mix formulations.

A Saltcrete sampling, waste characterization and treatability formula development program was initiated in late 1991. Random samples for testing were drawn in proportion from three populations: tri-wall containers, tri-walls in metal containers and half crates. The half-crates were the more recently cast Saltcrete. The tri-walls in metal containers were, in part, the transition Saltcrete and other container failures. The remaining tri-walls included the earlier, high-nitrate salt and some transition Saltcrete. In addition, Saltcrete is stored in two RFP locations, Pad 904 and Pad 750.

Samples were drawn from the three populations and distributed proportionately between Saltcrete stored on the 904 Pad and the 750 pad and randomized to uniformly cover the time periods during which they were produced. In total 42 tri-wall samples, 6 tri-wall samples from the metal containers and 12 half crate samples were taken for a total of 60 samples. These samples were analyzed for chemical components and preliminary physical characterization data obtained in the HNUS Pittsburgh Laboratory. Composites of the Saltcrete samples from these populations will also be used for treatability study tests and waste formulation mix development.

In the analyses of the tri-wall Saltcrete, eight individual volatile organic analytes were detected in one or more samples. The compounds 2-

butanone, toluene and acetone were the most frequent components detected. In the tri-walls in the metal containers, three volatile organic compounds: 2-butanone, toluene and total xylenes were detected in one or more samples. In the half crate samples, only 2-butanone, toluene and freon 113 were detected. None of the volatile organic analytes were at concentrations which could exceed their respective LDR standards in the TCLP ZHE leachate in any of the Saltcrete samples.

None of the target semi-volatile organics and alcohols were detected in any of the samples.

In the Saltcrete samples, in general, all of the target RCRA toxic metal components were detected. Some variation in concentration and components detected was seen between the three chosen populations. Of these metals, cadmium, nickel, silver were detected in one or more TCLP leachates at levels above the LDR disposal requirements for the tri-wall and metal container populations.

For the half crate samples, none of the components exceeded the LDR requirements. The lower variation and levels of metal components in the more recent Saltcrete samples in half crates is consistent with lower waste loading, higher cement and reduced metals in waste waters from the shut-down operations.

Concentrations of the major salt component, nitrate, in the ASTM TCLP extract for the tri-wall samples averaged 2900 mg/l and 2700 mg/l respectively for tri-walls and tri-walls in metal containers. For the half crate samples, the mean nitrate content of the TCLP extract averaged 1360 mg/l; thus reflecting the significant reduction of the input nitrate salts and higher dilution in the recent Saltcrete mix formulation.

Gravimetric moisture contents ranged from 15.6 to 31.3% for the tri-wall samples, 18.9 to 27.9% for the metal container samples and 18.8 to 25.6% for the half crate samples. An overall average gravimetric moisture of the 60 samples would be about 22.9% which is significantly dryer than the Pondcrete samples.

During the sampling program, the Saltcrete material was characterized as being:

- Hard, solid, cement-like.

- Solid, monolithic block with a tendency to crumble and form dust when sampled.

- Hard and flaky.

- Fine-grained with clay-like properties.

- Slightly damp and sticky.

- Crystalline texture, crumbly with flour-like dust particles.

- Hard interior, soft exterior.

While not as wet and fluid as the Pondcrete, some of the Saltcrete sampled had associated free water and a soft, putty-like character. Other samples were dry and crumbly and readily disintegrated into granular crystallites or dust. The variable nature and character of the inventory Saltcrete does not lend itself to unwrapping or unpackaging. Like the inventory Pondcrete, the reprocessing of the Saltcrete to a certifiable waste form for disposal will be done in a facility which accommodates the container and the wrapping material without exposing the environment or personnel to any hazards relating to manual handling or unwrapping. To the greatest extent possible, the reprocessing of the Saltcrete will utilize the same processing circuit, the same unit operations and the same handling equipment as the Pondcrete Reprocessing facility.

2.5 Reprocessing Options

A number of reprocessing options for Pondcrete and Saltcrete were analyzed and evaluated to define the circuit requirements and to select the appropriate equipment. As discussed earlier, some of the criteria used to define the process flowsheet for the Pondcrete Reprocessing plant were:

- Have the ability to accommodate the inventory Saltcrete with minimal modification or additional Saltcrete-specific equipment required.

- Minimize the potential for environmental contamination or personnel health and safety exposure.

- Eliminate the operating bottleneck which manual unwrapping and handling of the waste form and container material would cause.

- Minimize output waste volume consistent with the mix formulation requirements to produce a certifiable product.

- Provide the process handling and control systems to maintain the operation within the certification limits given the extremely variable physical character of the feed materials.

- Operate at a sufficient capacity to accommodate the inventory waste material within a reasonable time.

2.5.1 Health & Safety Concerns

A primary consideration in the process design is to eliminate many sources of potential environmental concern in reprocessing the inventory Pondcrete and Saltcrete wastes. Furthermore, this philosophy translates itself in the process design to minimize the potential for exposure of operating and other personnel to the waste or in-process solutions or materials.
In addition to the classical approaches of containment of potential sources of emissions and designing the operation to be remotely operated and controlled, the selection of the processing philosophy and the specific equipment utilized were designed to reduce the personnel and environmental exposure.

2.5.2 Wet Process Selection

A number of factors entered into the decision to develop and propose a "wet" materials handling and size reduction process for the Pondcrete and Saltcrete Reprocessing Facility at RFP. The relative benefits of the wet process are contrasted to a dry process below. Primary to the process selection is to define a process which uses unit operations or equipment which are known or conventional (in waste stabilization or other similar application) and which can be readily designed and sized without extensive testing requirements. The nature of the Pondcrete and Saltcrete wastes at RFP precludes all but very small scale laboratory characterization testing. These tests must be adequate for design and sizing.

Surrogate materials representing the waste forms in tri-wall and half crate containers were used to screen and test potential processing strategies and specific equipment. Full-size waste forms using a spectrum of surrogate materials from hard, high-compressive strength cement grout, hard brick clay to soft, plastic brick clay allowed testing and selection of the Primary Size Reduction system which could accommodate the spectrum of waste feeds expected.

Products of surrogate testing of Primary Size Reduction systems (i.e. coarse-crushed surrogate waste and shredded trash) were used to test potential secondary size reduction systems. In addition, the impacts of the trash component on the materials handling and size reduction systems could be evaluated. Testing with such surrogates was conducted at full size or with scaleable pilot-scale equipment.

Dewatering system tests could not be adequately conducted using only surrogate materials. Although the character of the surrogate materials was used to screen potential options for dewatering, laboratory tests at a small scale were needed to provide the design and performance information required for the dewatering system selection and sizing.

Likewise pumping and materials handling considerations could only in part defined by the use of surrogate materials. Laboratory-scale rheological tests and mixing tests of the actual heterogeneous waste and trash slurries also provided design data for pump, pipeline, agitator and mixer design.

2.5.3 Benefits of Wet Process

The positive aspects or benefits of the "wet" processing system include:

- The obvious reduction in the potential for airborne dust or vapors from handling "dry" waste materials. The use of an aqueous media (or slurry) for the waste processing not only eliminates any potential dust emissions but reduces any tendency for volatile or semi-volatile organic components to become airborne.

- Enclosure or venting of all required systems through HEPA filtration systems also eliminates any mist emissions.

- HNUS experience in the chemical stabilization of wastes which need to satisfy a TCLP or other leachability requirement with a cementaceous stabilization formulation indicates that reducing the top size waste particle to minus 10 mesh (<2000 microns) provides the best potential for successful chemical treatment and encapsulation stabilization.

- The wet process not only eases waste handling and transport but facilitates the size reduction requirements of the waste solids using conventional milling technology.

- Accommodates the extreme variability of the feed waste material in the various containers, homogenizes it by blending with a number of the other feed containers and reduces it to a uniform consistency (by dilution with water) in a slurry form prior to further processing.

- The dilute aqueous slurry form facilitates any chemical reductive (or oxidative) treatments required for chemical fixation of components prior to stabilization.

- Obtains a nearly uniform feed (in terms of moisture content) to the cement stabilization mixer by dewatering the waste to the optimal moisture required for the stabilization mix formulation. Thus a minimized waste volume is also obtained.

- The dewatering step (e.g. continuous pressure filtration) also provides a key control for the moisture range in the waste product. The impact of variances in the feed moisture of the inventory wastes are virtually eliminated. The dewatering step also generates filtrate which is recycled back to milling and slurry transport systems and is reused.

- Can be designed to accommodate the size-reduced components of the container and wrapping materials (called "trash") and produce a composite certifiable waste form with the trash components incorporated. This further reduces the waste volume generated by eliminating a separate container and wrapping waste stream as well as eliminating the potential for personnel exposure to adhered wastes upon handling these materials.

2.5.4 Dry Process

The negative aspects of a "dry" processing system include:

- To insure a uniform (and optimal) moisture content a drying system on the feed material or on partially size-reduced material would be necessary. The heat burden required for drying the waste to a desired moisture content consistent with dry size reduction systems would be significant. The by-product of this heat generation and transfer would, itself, cause personnel health & safety problems in the working environment.

- In addition, the potential for emissions of airborne waste dust would be significantly higher than for the wet process.

- Drying, materials handling and size reduction with the trash material would be significantly more difficult.

- To achieve the same degree of feed material blending, large dry mixing and storage equipment would be needed.

- Control of a heterogenous, dry waste feed material (including trash) to the cement stabilization mixing system would be more difficult.

- The drying and dry handling systems potentially would release volatile and semi-volatile organic components to the gas phase. Therefore, in addition to particulate emission control the HEPA filtration systems would also have to accommodate vapor-phase organics or their break-down products. This could considerably increase the complexity and size requirements for such systems.
- The target "tonnage" goal or product production of from 15 to 20 tons per hour of stabilized product, while relatively easy to achieve using the wet processing scenario, would require extremely large dryers and dry bulk solids handling systems for the waste considering the containment requirements. At the projected current waste formulations, one ton of dry waste feed would result in over five tons of stabilized product.

3.0 REMEDIATION OBJECTIVE/DESIGN CRITERIA

The primary objective of the proposed pondcrete/saltcrete waste stabilization effort is to reprocess these existing waste forms using a cement based process into an acceptable and certifiable waste form for storage, transportation and disposal. The process design will attempt to minimize the amount of personnel and equipment exposure to contamination by the wastes, minimize the waste output volumes and consider the ability to effectively decontaminate the processing equipment at the conclusion of remediation.

The existing inventory waste form; either pondcrete in tri-walls or saltcrete in tri-walls (or half crates) will be fed to the reprocessing system in toto. That is, the entire waste form; including the plastic wrapping and liners, the cardboard or wooden box, metal or plastic strapping, and the wooden pallets, will be reprocessed. This type of processing system is necessary due to the lack of space on the 904 Pad to unwrap the containers including excessive personnel costs for manual unwrapping and would prevent any dangerous unwrapping and handling operation of the existing wastes prior to entering the sealed reprocessing system. Incorporation of the shredded, fibrous container and wrapping materials into the final cement-stabilized waste form will have minimal impact on final waste volume or properties.

Secondary processing criteria include:

- Minimize waste volume

  The major impact on the stabilized product waste volume results from the free water to pozzolan ratio requirements of the stabilization mix formulation. Free water available for pozzolan hydration is defined as the mass of the liquid phase which is not dissolved solids. Techniques have been developed to process at higher dissolved solids, in order to reduce the final waste volumes.

- Minimize Footprint of Equipment

  Suitable space available for locating processing equipment within the Plant boundaries is at a premium. In addition, attempts have been made to reduce interference with other plant activities.

- Minimize On-site Erection Labor

  The Rocky Flats Plant, due to high security requirements, environmental sensitivity, and radiation health and safety requirements, requires a number of extraordinary work rules, practices and procedures which are not typical for most industrial environments.

Therefore, off-site fabrication, assembly and operational testing have been maximized for all equipment and systems utilized in the stabilization process.

- Minimize Plant Interface

  The process has been designed to minimize the interface with the rest of the Plant. Almost all utilities, including power, compressed air, fuel, and reagents have been provided independent of the existing systems at the Rocky Flats Plant.

4.0 CURRENT PROCESSING CONCEPTS

Current equipment proposed for the Pondcrete/Saltcrete reprocessing train is from a variety of sources:

- Equipment demonstrated as part of the Pondsludge equipment selection process
- Equipment proven in the field in similar applications
- Engineering experience of HNUS and subcontractors

Preliminary testing must be conducted on several types of equipment early in the Treatability Study to verify the adequacy of the proposed process train to handle these materials. The present key to equipment selection is the dewatering device (e.g. filter, centrifuge, etc.) and the cement stabilization mixer.

The process planned for Pondcrete/Saltcrete reprocessing is known as the COMIX process due to the commingling of container and wrapping wastes with the Pondcrete/Saltcrete material being processed. Flowsheet schematics are shown in the attached Block Flow Diagrams (BFD's) (ATTACHMENTS 1 and 2) for Pondcrete and Saltcrete reprocessing. A key feature of the process strategy is to feed the entire wrapped waste form into the circuit for stabilization. The wrapping and container materials are referred to as "trash" in the processing description.

The process consists of:

- Feed system and a size reduction circuit
- Additive addition
- Trash separation
- Handling and size reduction
- Remix of the size-reduced trash and waste
- Dewatering
- Cement mixing and casting circuits

Water is added to the Pondcrete/Saltcrete blocks to permit wet grinding, wet slurry handling, transport, and to facilitate trash separation and size reduction. The excess water above that required for the stabilization mixture is removed prior to pozzolan mixing and is recycled back to the wet grinding and slurry handling systems and reused. Each of these operations is described in detail below.

4.1 Primary Size Reduction

The waste containers range in size from heavy-wall cardboard about 40" x 40" x 24" (tri-walls) to wooden boxes 4' x 7' x 2' (half crates). The task of handling these initial feed sizes presents a unique problem in the equipment selection and design for the primary size reduction. In addition, the physical character of the waste within the containers ranges from hard and dry, like cement, to wet and slushy, like wet sand or soft clay. The primary size reduction must produce a -6" material(including the container and wrapping materials) to feed the SAG mill secondary size reduction system.

The primary size reduction system for the COMIX process needs to accommodate input tri-wall containers with the full wrapping (plastic bags, tape, strapping, pallets, etc.). In addition the feed and size reduction systems need to handle:

- Leaking or ruptured tri-walls in metal containers
- Half crates with pondcrete or saltcrete requiring reprocessing
- Bulk oversize and trash materials in dumpster boxes (or full crates) scalped from the 207 area pond sludge operations weighing up to 4,700 pounds.

Regardless of the type of system used for the size reduction, the feed to the system will be by a hopper and hoist system with a negative draft vent system pulling air into the enclosure. The feed opening will use wind curtains as air barriers. The hopper will be sized and designed to accommodate all of the contents of a metal (up to three tri-walls) including any liquid drainage. Thus, a half crate or full crate will easily be handled in the hopper.

The skip hopper, with feed material, would be elevated up to the enclosed tracks to the feed chamber of the primary size reduction unit. There it would dump into an enclosure covering the primary size reduction feed hopper. This feed hopper for the crusher/shredder would also be fully contained, either independent of, or as part of the primary size reduction system.

The primary size reduction system currently under consideration is a hydraulically-driven screw auger/shredding system (manufactured by Komar Industries) which provides all of the required features in an existing design.

4.2 Secondary Size Reduction

The size of the material leaving the primary auger/shredder is expected to be approximately -6". This has to be reduced to a 2.0 mm material (approximately 10 mesh) before stabilization to minimize the potential for metal leaching from the stabilized waste product. A wet ball mill secondary size reduction system is being considered due to its ability to size reduce the trash and the physical nature of the feed material.

As a practical matter, the large feed size dictates that a Semi-Autogenous Grinding mill (SAG) be used. It is designed with a lifter/liner system to permit the use of larger size steel balls ($\phi \geq 3"$). The larger balls and the high-lift mill liner segments combine to produce a larger proportion of the size reduction action by impact breakage. This is the desired mechanism to produce a -2mm product.

The mill will be configured as an overflow mill. That is, it will not have a grate on the discharge to prevent or retard oversize material being discharged. This is because of the trash material. It will have a discharge spout with a spiral ball catcher to return ejected balls and some oversize back to the mill. In addition, a magnetic tramp iron trap will be provided to remove some of the metallic trash and ball fragments from the mill discharge. This tramp iron will be removed from the stabilization processing system on a periodic basis as a normal maintenance procedure.

The character of the trash (plastic bags, tape, cardboard and wood) upon discharge from the SAG mill is expected to be handled within the normal slurry handling system. Surrogate testing was conducted in a SAG mill with wood fragments that were chopped and shredded into fibers from 1/2" to 2" long and $\approx$1/8" diameter. The cardboard seemed to be completely disaggregated and was almost not observable. The plastic was predominately in ¼" to ½" pieces, although some ½" wide ribbons up to 2" long were observed. This type of trash product will present no problems in transport and can be readily separated from the ground undersize in a slotted urethane vibrating screen deck.

The SAG mill also generally has less percentage of the total charge weight in the mill as balls (15% or less) while the ball mill charge is typically 40-45% balls. This facilitates the balls being lifted and dropped; thus promoting breakage and fracturing of the materials charged. With the expected generally soft character of the pondcrete, the mill will also act as a disaggregation mixing unit or washing drum. This will promote good mixing and homogenization of the pondcrete material as feed to the downstream unit operations.

The milling system will be fed continuously or semi-continuously by the transport auger of the auger/shredder system. The SAG mill will operate on a continuous basis. Small changes in circulating load density and quantity of oversize material will be seen due to the somewhat intermittent solids feed nature; but should present no problems in operation of the mill or associated systems.

The volume of slurry resident in the mill, sumps, etc. is about 200 cubic feet. At a nominal 20% solids slurry, about 3 to 3.5 tons of solids are circulating at one time in the milling system with an approximate residence time of 2-3 minutes/ charging cycle. This circulating load is being continuously mixed with the new feed material. This enables significant blending of the Pondcrete/Saltcrete feed materials during processing.

4.3 Classification/Trash Separation System

The SAG mill produces predominantly -10 mesh trash but leaves larger pieces of plastic and wood. The classification/trash separation system separates the larger trash materials and grinds them down to a -10 mesh material. This is done by first screening the oversize material, then elutriating it with water to separate the trash from the oversize pondcrete/saltcrete, and finally using a disc pulverizer to reduce the wet trash to -10 mesh material.

4.3.1 Screen Classifier

The SAG mill secondary size reduction system will be operated in closed circuit with a classification screen to produce the target -10 mesh (U.S. Sieve Series) or -2.0 mm product. A screen is used for the following reasons:

- It provides a positive, high-efficiency separation of the oversize waste material from the finer, already-ground material.

- It is relatively insensitive to feed slurry density or viscosity. Supplemental water sprays on the screen or dilution water added to the screen feed can be used to assist in obtaining a high separation efficiency.

- A screen is also relatively insensitive to feed flow rate. This is important when the design circulating load in the milling circuit (ratio of oversize material on the screen to the new feed into the mill) is unknown or higher than expected.

- Any screen oversize (or excess feed which cannot be handled) would overflow the screen to trash separation and return to the milling circuit after trash separation. This will allow an adjustment in the feed rate to be made and the mill circuit to catch up.

- It is relatively compact, and can be elevated to permit gravity flow of products. The screen deck and discharge is also totally contained and is a low maintenance item.

- The trash and oversize material reports to the trash separator and the screen underflow flows to the slurry sump and pumps feeding the ground slurry holding/filter feed tank.

In addition, the classifying screen serves as the trash removal system for the milling circuit. Testing conducted with the trash from crushed surrogate material consisting of tri-wall containers, shredded pallets and plastic liner and wrapper bags, etc. through a SAG mill were highly successful. Both clay and cementaceous feeds with trash were used for this test. The trash material continued to be reduced in size and a nearly uniform size distribution of the different kinds of trash materials was produced.

4.3.2 Hydroseparator

The separation of the trash from the oversize pondcrete solids is to be accomplished in a hydroseparator elutriation device. The wet trash and solids oversize from the screen are mixed with water (in the screen discharge chute or launder) and fed by gravity to the hydroseparator. This device is commonly used to separate lighter density materials from heavier density materials. In addition, this device has the capability of separating smaller particles from larger particles and material with a high drag coefficient from material with lower drag coefficient.

The design envisioned has the following features:

- It has a cylindrical or cone shape similar to cyclone size separators.

- The heavies are removed from the bottom and the lights are removed from the top.

- Supplemental water for elutriation is generally introduced near the bottom of the cone and flows counter-current to the feed materials.

- The sizing of the unit (diameter at the overflow, discharge diameter, height, etc.) is based on the flow range necessary to effect the density (or size) discrimination and the material input flow rate.

- The separation efficiency of the unit is easily controlled by increasing or decreasing the supplemental water flow to the unit. The excess water overflowing with the trash is dewatered from the trash and reports to the dirty water separator and subsequently to the process water tank where it is recycled.

The process is designed to be fail-safe. That is, typically only fine solids will overflow with the trash and generally only coarse trash will migrate to the underflow. The underflow returns to the milling circuit where it is further reduced in size. Thus, oversize trash will eventually find its way out of the system when it is reduced in size sufficiently.

Each Tri-wall container fed to the processing system would have approximately 102 pounds of container, wrapping, liner, pallets, etc. as "trash" associated with approximately 1,200 lbs of wet pondcrete material.

4.3.3 Dewatering/Trash Grinding

The trash material overflowing the hydroseparator would proceed to a dewatering screen where the excess, free-draining water and any fine pondcrete solids report to the screen underflow and the partially-dewatered trash would proceed into a horizontal screw conveyor which feeds a disc pulverizer in which the size of the wet trash is reduced to approximately a -10 mesh size. Used extensively for size reduction of wood pulp (known as a refiner in that industry), the disc pulverizer will produce a trash product which will mix with the other solids slurry and produce a fluid, composite pulp feed to the dewatering filter. Leaving the pulverizer, the ground trash pulp will fall into the Stirred Holding Tank. It would be mixed with the screen underflow slurry and fed to the dewatering filter.

4.4 Production of Stabilized Waste Form

The processing circuit as envisioned at present, would store the -10 mesh material in a Stirred Holding Tank before being filtered to remove the excess water. The filtered waste would be mixed with the pozzolans in a controlled fashion to produce a slurry which would be cast into half crates at the casting station.

The production facilities for reprocessing the existing Pondcrete/Saltcrete would use as many of the equipment components used for stabilization processing of the 207 area pond sludges as possible.

4.4.1 Stirred Holding Tank

A holding/feed tank provides surge capacity for the cementing operation, serves as the slurry filter feed tanks and would be the mix tanks for any additives required to adjust pH, oxidation state or slurry character prior to filtration and cementation. It will be equipped with variable-speed pumping type of agitators in order to sustain a well-blended slurry feed to filtration.

4.4.2 Filtration System

To control the cementing area water balance, the ground slurry would be filtered prior to feeding the cement mixing unit. This would provide the means to achieve an optimum cementing feed cake moisture content (45 to 55 wt.% free water). This secondary water balance control also allows a slurry-based size-reduction and transport strategy to be considered even though the Pondcrete/Saltcrete blocks being reprocessed contain variable feed moisture contents. The filtration system would also provide makeup liquid for use in the cementing circuit, for equipment flushing and for additive blending while minimizing the amount of fresh water makeup required. Use of the filtration step prior to the cementing operation will also allow more consistent control of the moisture contents in the cement-stabilized product.

The filtration equipment being considered for dewatering of the Pondcrete/Saltcrete solids being reprocessed are pressure belt filters and hybrid screen centrifuge systems. Although these dewatering processes are expensive, they are essential to the process operation, control and waste minimization.

The presence of the fibrous trash materials in the pulp being filtered improves the filterability of the pulp. Some increase in cake moisture occurs, but would be offset by the ease of handling and disposal of the contaminated trash.

The dewatered filter cake is discharged to enclosed, horizontal screw transport conveyors which move it to the cement mixing unit. The semi-continuous operation of the filter is converted to a relatively continuous feed in the conveyor system. The screw conveyors are constructed of smooth plastic-coated steel to minimize sticking.

> (Note: Saltcrete slurries may not need filtration due to their fluidity at relatively-high solids content and to a necessity of maintaining a relatively-high free water, thus pozzolan/solids ratio. In that case, the ground saltcrete and trash slurry would bypass the filter and be fed directly into the high-intensity stabilization mixer.)

4.4.3 Pozzolan Mixing

Pozzolan mixing for the cementaceous stabilization mix would be accomplished in a high-shear mixer. Continuous operation of the mixer is achieved with efficient mixing of the dewatered filter cake, chemical treatment additives, pozzolans and liquid. Feed rate control of any additional water, other additives, and the pozzolan mix is accomplished in feeding of the mixers to control the product density, free moisture content, pH and physical properties.

Primary solid feed control to the stabilization process is provided by a control system which interlocks the filter feed pump flow rate, slurry density and the speed of the transport screw conveyor. Additional monitoring of the filter cake discharge moisture (in the transport screw) for moisture content will define a dry solids mass flow, the free water mass flow and will provide the basis for control of the pozzolan addition rate and any additional makeup water needed. The optimum filter cake moisture will be a key issue of the Treatability Study. The filtrate flows into a sump from which it is pumped to the dirty water separator for recycle to the process water storage and distribution system.

The bulk dry pozzolan mix storage will be outside of the tents in storage hopper tanks. Periodically the dry bulk mix will be conveyed in batches to small, storage and weigh hoppers located near the cement mixing unit.

The feed rate of the dry ingredients to the mixing systems will be controlled by the mix computer control system and loss-in-weight feeder control. Positive control of the cement stabilization formulation (i.e. water to pozzolan ratio and pozzolan to solids ratio) will be exercised.

This can also be varied manually while operating based on the physical character of the cast product and other observable variables.

4.4.4 Casting

The mixed pondcrete product will be cast into half crates using a pressure pumping system to pump the concrete to the casting station. This type of product delivery system will permit the use of a lower slump material (less free water) in the cement mix than required for a pourable mix, thus providing an additional component for controlling the potential for free liquid formation in the cast product. Provisions for sampling the product are also accommodated. The pouring rate, final delivered weight and cast product volume will be controlled in the pouring operation. The casting system will be equipped with an water flush purge to flush the transport line and pouring nozzle for end-of-operation or emergency cleanout. The pouring station will be covered by a hood system vented through a HEPA air filtering system.

The cast product will be weighed, labeled and delivered to the curing station by others after the pouring operation is complete. The casting station and chain-type conveyors for half crate handling will be moved from the 750 pad processing area upon completion of pond sludge processing and will be utilized in the Pondcrete/Saltcrete reprocessing circuit at the 904 pad.

Drains from the equipment and from the casting discharge nozzle will be provided to a central sump inside of the containment where a slurry sump pump on level control returns the flush liquid and solids to the dirty water separator system for reclaim and reprocessing back through the stabilization system. This flush system can also be utilized for intermittent or emergency production interruptions which last longer than the maximum hold time (about 20 minutes) of the material in the cement mixing system.

4.5 Water Handling Systems

The trash separation and filtration systems currently envisioned as being part of the process, require the handling of large amounts of water during processing. The dirty water separator is a simple, cone-bottomed thickener/settling tank into which turbid liquids (e.g. filtrate, if necessary) or liquids containing significant solids (e.g. flush water return slurry) are introduced. This allows most of the solids to settle in the cone area and densify. This equipment would be removed from the pond sludge processing area for Ponds A/B for this purpose. The clarified liquids overflow the lip of the tank into the process water storage tank and the solids slurry is periodically pumped to the holding tank or directly to the cement mixing system for stabilization. This system consists of a cone-bottomed tank with cover and overflow lip fabricated out of steel plate. A positive-displacement, progressive cavity pump returns the solids from the underflow of the cone to the holding tank.

5.0 CURRENT STATUS

The stabilization process for Pondcrete/Saltcrete outlined in the previous section form the general guidelines for the Treatability Study, and the design and engineering effort that will be implemented.

5.1 Waste Characterization

As the preliminary phase, Pondcrete and Saltcrete wastes have been characterized by Halliburton NUS. As of this writing, the Waste Characterization Reports for Saltcrete and Pondcrete have been published. The data does seem to indicate that there is not much diversity in the chemical compositions of the various Saltcrete and Pondcrete populations and out initial assessment is that the characterization data does not present any overwhelming problems for processing. Additional investigation of the Pondcrete population stored in metals will be required during the Treatability Study to determine whether methanol leaches above the LDR Standard.

5.2 Treatability Studies

Halliburton NUS has commenced the Treatability Study phase for Pondcrete/Saltcrete. This will be conducted in a step-wise fashion. Each of these phases is discussed below with a more detailed description included as ATTACHMENT 3.

<u>Phase I - Physical Handling Studies</u>

This phase is primarily intended to obtain data for design and selection of equipment of the portion of the processing circuit leading up to the mixing of the waste with the pozzolans. This has been broken into two sub phases.

<u>Phase IA - Physical Properties Testing</u>

The waste characterization data obtained already is primarily composed of chemical composition data. During this phase, the physical properties of the different Saltcrete and Pondcrete populations will be examined to ascertain whether they must be treated separately and undergo different pre-treatment steps. Additionally, waste loading studies will be conducted in this phase to determine the maximum percent solids of pondcrete and saltcrete that can be solidified.

<u>Phase IB - Equipment Design Studies</u>

Based on the data obtained in Phase IA, the unit operations outlined in SECTION 5.0 will be re-examined and finalized following the results of the tests to be conducted in this phase. The tests would include dewatering tests and to determine the optimum dewatering process. This phase of the Treatability Study will likely include vendor testing. A trash study will also be conducted which will evaluate the impact of trash on the CSS formulation. The goal of this testing will be to eliminate trash as a variable in the process formulation development.

Phase II - Preliminary CSS Testing

After the physical nature of the sized waste has been established, a series of tests will be conducted to screen the variables in the stabilization process. Since a considerable amount of information on the waste from which Pondcrete and Saltcrete was created has been obtained during the course of the Pondsludge Treatability Study, this phase is not expected to be very lengthy. Clarifier and C Pond Crystal Studies should provide useful information for the process formulations. Formulations for the 207 A/B and 207C/Clarifier process will provide initial starting points to develop the Pondcrete/Saltcrete formulation.

Phase III - Regulatory CSS Testing

After the key variables for stabilization have been identified, a series of factorial experiments will be conducted to bound the limits of the process formulation which would yield a certifiable product. The product would be subjected to all the tests that are required to pass certification. The results of the Treatability Studies will be consolidated in a report that would also define the process operating envelope.

5.3 Design and Engineering

Separate design basis memos for Pondcrete and Saltcrete have been generated which define the criteria for design and processing as it was visualized in the Fall of 1991. The results of Phase I of the treatability studies will provide much of the information for design of the grinding and sizing circuit. This and other information from the treatability studies will be used to prepare the Design Criteria deliverable document. This will be followed by the preparation of Process Flow Sheets with Mass Balance, Equipment Selection, preparation of a preliminary Equipment list. The Process Control philosophy and P&ID's (Piping and Instrument Diagrams) would be defined before proceeding to perform long lead time equipment procurement. These items include the Crusher, the SAG Mill, and Filters. This would be followed by the General Arrangement drawings, Plot Plans, and the detailed design.

6.0 LONG-TERM APPLICATIONS FOR FACILITY

6.1 Other Applications

The facility for reprocessing the existing inventory Pondcrete and Saltcrete, which has been previously been described, has been conceived and designed to be a temporary facility with focus toward that limited goal. This does not mean, however, that this basic stabilization and remediation system cannot be utilized for other types of wastes at the RFP. With some slight modifications in the circuit design and with adherence to more rigid set of specifications for a semi-permanent facility, the same process flowsheet and equipment have the capability and flexibility to accommodate a wide variety of other feed materials other than Pondcrete and Saltcrete.

Key to acceptance of alternative materials as feed material to the stabilization process is the already-existing flexibility to handle the anticipated wide spectrum of Pondcrete and Saltcrete waste forms. This not only relates to the physical state of the material (i.e. slurries, sticky plastic material, hard cementaceous blocks, etc.), but also to the wide range of feed sizes which can be accommodated.

The Primary Size Reduction unit, an auger-shredder, has a hopper and feed throat such that it can accommodate up to a 4' x 4' x 7' full crate and has been demonstrated as being able to handle 2' x 4' x 7' half crates of solid, 10,000 psi cement grout. For less solid or soft materials, i.e. soils, masonry walls, boxes of fabric waste, etc., this machine is capable of handling up to the 4' x 4' x 8' feed size with little problems. The scissoring action of the counter-rotating tapered screw augers will draw in this large, monolithic box shape. Irregularly-shaped materials such as telephone poles, railroad ties, steel beams, etc. can also be fed with the proper hopper arrangement.

The current hopper design is completely enclosed, under negative pressure to prevent dust emissions and vented through HEPA filtration to provide environmental containment. Provisions have been made, however, for bulk dumping of metal containers (approximately 4' x 4' x 8'), which in the case of Pondcrete or Saltcrete contain 2 or 3 tri-wall containers. This same bulk dumping capability, using a similar metal container or substituting a skip hopper dumping arrangement, can be used to handle and feed bulk waste material to the hopper. In this manner, solid material like bulk asphalt or concrete paving, pond liner material, masonry or steel sheet building materials, broken reinforced concrete slab or pillars, dirt or soils, etc. can be fed to the first stage of the Reprocessing Facility.

The Primary Size Reduction system product is transported to the Secondary Size Reduction system (i.e. SAG mill) by a hydraulically-driven screw auger system. This hydraulic screw conveyor is heavy-duty and originally designed for pressurized feeding of shredded material to combustion incinerators, kilns or digestors. Not only can it handle broken -6" solid materials but also semi-plastic or compacted fibrous materials such as oil-bearing clays, plastic bottles, wet newspapers and rags. Cut metal pieces such as rebars, shredded sheet metal, angles or beams can also be handled. The transport auger and the casing itself has some taper and force multiplication which provides additional cutting action during transport. The microprocessor-controlled hydraulic drive automatically reverses and cycles to alleviate blockage.

The SAG mill Secondary Size Reduction system is commonly used in minerals processing to size reduce hard mineral rocks to a coarse-ground (down to -20 mesh or -850 micron) product. Feed sizes (depending on the mill size) can be up to 4' cubic rocks from some types of quarry-mining operations (limestone, phosphate rock, etc.). Typically, -18" to -6" material from surface or underground mining operations are the feed sizes. Depending on the material hardness, breakage characteristics and the design allowances for recycle or circulating load back to the mill, the target product grind typically is from -¼" to -20 mesh. The nominal target grind for the Pondcrete Reprocessing circuit is -10 mesh (-2,000 microns) and thus is well within the feasible limit.

The SAG mill design, which in North America has a 2 to 2½ times diameter to length ratio, primarily serves as a crusher and grain-boundary breakage milling device. This is due to the use of a relatively low steel ball charge (5 to 15 volume % of the milling volume), larger (3" to 4" diameter) balls and a liner design with lifters which lifts the solids and balls and drops them, resulting in impact breakage. Fine or attrition grinding is more typically accomplished in conventional ball mills which have larger ball loads (35 to 40%), a rationed ball charge with a spectrum of steel ball sizes (½" to 3½") and usually have a diameter to length ratio of 1:1 or less. In conventional ball mills for fine grinding, the breakage mechanism is primarily attrition grinding and the charge typically is not falling off the sides of the mill but rolling with the balls.

The SAG mills can also effectively operate at lower percent solids (minimum 10-20 wt.%) while ball mills typically require 50% solids or higher. Viscosity effects of the slurry play an important role in governing the mill performance.

The SAG mill typically is not sensitive to tramp material (wood, metal wire, tramp iron) or trash (leaves, roots, etc.) in the feed. The hammering action of the balls reduces the heavy material to a size such that it eventually leaves the mill and does not accumulate. The lighter material (wood, plastic, etc.) is also reduced in size to fibers or small-sized sheets ($\approx$4-6" squares) by the milling action. This was confirmed for the Surrogate Pondcrete waste material containing up to 30% by volume of trash material in pilot SAG mill and classification system tests.

The major problems encountered in the circuit due to the light-density, fibrous or flat material in conjunction with size reduction of the solids wastes are: maintaining a well-mixed discharge sump, pumping the material and separating the oversize trash and waste from the already-ground waste slurry. The handling and pumping is accomplished in the Reprocessing Facility by the use of a live-bottomed sump and pump combination for pumping the trash-laden mill discharge slurry. This pump has a recessed or high-clearance open impeller which provides the required clearance for the trash materials.

A vibrating slotted polyurethane deck trash separating screen and hydraulic elutriator are used to separate the heavier waste solids from the lighter trash and ground waste slurry. The oversize light waste (wood chips, plastic, paper, etc.) in the mill discharge upon separation from the circulating load is size-reduced in a disc pulverizer typically used in the pulp and paper industry for making wood pulp. Therefore, the light waste does not build up in the mill circuit or circulating load, is removed after one trip through the SAG mill, and is separately size-reduced for inclusion in the feed slurry to the dewatering and stabilization systems.

This type of size reduction system would have the flexibility to handle a wide range of material feeds and physical characteristics. The SAG mill can serve effectively as a simple washing drum or dilution device for clayey or sticky materials which require disaggregation or dilution and not necessarily size reduction. It can also serve as an effective mixer and homogenizing device since the mill volume is several times larger than any of the discrete waste forms (i.e. half crates, tri-walls, etc.) which could be fed. The circulating load (which may be up to 400% of the new feed) also serves to homogenize and blend the feed material.

SAG mills have also been used and proposed for soil washing applications (complex organic chemicals, oils and heavy metals) where the washing, mixing/blending and size reduction components are all required. Applications with organic liquid solvents or water/organic emulsions as the liquid phase have also been developed.

Once the feed materials are size reduced to whatever is the desired feed size to the dewatering or stabilization unit operations (this size can be finer or coarser depending on the screen size opening or the disc pulverizer clearance setting), the slurries can be fed to dewatering or directly to the stabilization mixer depending on the stabilization or disposal requirements. The product from dewatering, i.e. the filter cake, could also be directly packaged for disposal if cement stabilization is not required. Any chemical pretreatment which can be done in the slurry phase could be done in the slurry holding tank or in a separate system, if required.

The stabilization mixer can mix other dry solid or liquid additives with the waste other than the cementaceous or pozzolanic ingredients. Depending on the specific waste disposal requirements, the mixer can be used for adding lime, chlorinating agents, peroxides, reducing agents, polymers, emulsifiers, etc. The product from the mixer can be a relatively-dry solid, a plastic material, a liquid slurry or a blended liquid. Therefore, the disposition of the stabilization mixer product can be anything the material requires. It is not limited to disposal by casting into a half crate container for long-term storage or disposal. Flushing systems can be designed into the stabilization system components to allow rapid conversion for use involving non-radiologically contaminated materials.

Slurry materials or liquid wastes requiring chemical treatment and stabilization can be pumped or fed directly into the SAG mill and by-pass the Primary Size Reduction system.

Specific types of alternative materials which may require some sort of stabilization or chemical treatment at the RFP include:

- Contaminated soils or dirt.
- Asphalt or macadam pond liner (including any geotextile or membrane liner cut into appropriate size)
- Concrete or asphalt pad material.
- Brick, plaster, block or other masonry building demolition materials.
- Broken chunks of concrete foundation material (including rebar or steel mesh sections).
- Metal building sidewall panels (with or without insulation, wiring, fixtures, etc.)
- Roofing materials (asphalt shingles, tar & gravel sections, beams, etc.)

- Cabinets, desks, furniture, laboratory equipment, ductwork, etc. which may be contaminated.

- Drums, thin-wall metal containers, un-plugged gas cylinders, rubber hose, plastic (HDPE, PVC) piping, etc.

- Bagged, drummed or boxed coveralls, masks, gloves, uniforms, lab coats, booties, etc. which could be stabilized into cementaceous waste forms for more effective disposal.

- Laboratory wastes, waste samples, glass jars, bottles, plastic bottles, etc. which can be fed intact into the

- Contaminated pallets, boxes, half crates, etc. which may or may not have waste material in them.

- Half crates or metal containers full of oversize pond solids and organic slimes.

- Contaminated ion-exchange resins, incinerator ash or slag, absorbent materials containing hazardous materials, etc. which would require stabilization prior to disposal or storage.

- Salt brines or salt crystals (particularly nitrates) from evaporators which require stabilization prior to shipment to reduce oxidation potential to satisfy DOT shipping standards.

In these cases, not only can the bulk materials be fed to the process, but in many cases the containers can also be fed and integrated into the desired waste form product for efficient disposal.

6.2 Separate Processing Facilities

The processing and materials handling systems of the Pondcrete and Saltcrete Reprocessing Facility, currently configured as a temporary operation, are of modular construction with each unit operation contained within its own stand-alone skid or module. Environmental controls, containment and filtration systems for any venting are provided on each module. Flow connections between modules are by double-containment piping. This piping may be rigid or flexible. Electrical connections within a module are hard-wired but between modules may be flexible cable. Each module is separately grounded. Typically, few specific pipe racks or electrical cable conduits or trays are provided for the short-term facility. Such design considerations reflect the

Specifications and Design Criteria for a sub-contractor operated temporary facility at the RFP.

Given the modular design, any modifications or additional equipment required to accommodate different feed material or to provide a more sophisticated in-process treatment can be easily added to the current process flowsheet and to the basic processing circuit. To alter the design or to make the Reprocessing Facility a semi-permanent installation or to have the flexibility to accommodate a wider variety of feed materials would be a relatively simple task.

The Specifications, Design Criteria and the Operating Guidelines in use for the facility would need to be reviewed, updated and modified to accommodate the engineering requirements for the longer-duration, more-permanent installation. In addition, the RFP requirements and Criteria for such an installation would have to be included and comprehended in the process design and equipment selection criteria. For a semi-permanent installation, more care and attention would need to be expended during the detailed design engineering phase to define the equipment layout, piping design, electrical design, building requirements and considerations such as HVAC, environmental containment, facilities for operating personnel, instrumentation and controls, etc.

The integration of the elements and unit operations of the Pondcrete Reprocessing Facility into a more-permanent installation would be facilitated by locating the process equipment and ancillaries within its own enclosure. Whether this be within a separate building or temporary structure, the operation of the process and the increased flexibility to handle a wide variety of feed material would be enhanced by providing the proper-sized enclosures and local containment for the unit operations. This would also facilitate the design for operation on a year-round basis.

The temporary facility for Pondcrete and Saltcrete could be designed for year-round, all-weather operation. This, however, would add considerably to the cost, reduce flexibility of operation and, perhaps, require reduced levels of operation. Difficulties for the operating personnel could also be significant. If the proper space for the longer-term facility was allocated, a building provided with sufficient height to locate the equipment inside and space to marshall feed material and to store the product material were available, then many of the difficulties with year-round operation could be easily overcome. The 903 pad area could be considered for such a facility.

An integrated facility could provide more efficient equipment location and containment. Critical spares (for pumps, surge tanks, etc.) could also be provided to sustain a more uniform operation. This not only would reduce the amount of down-time as a result of operational spills or equipment failure, but the systems to maintain safe containment (drain channels, holding tanks for flush water, emergency sumps, etc.) and facilitate cleanup could be more easily provided. Piping and electrical connections could be more efficiently arranged, thus providing more access to the equipment and process.

The material flow paths could be more efficiently laid out. The waste material to be processed, the processing equipment, ancillary support, process materials storage and the product disposition facilities could be better arranged to facilitate efficient and safe operation.

6.3 Equipment Criteria

The general design criteria for a temporary facility are documented in Section 3.0. These criteria would change for a permanent facility. Other considerations are discussed below.

6.3.1. Service Life of Unit

The temporary facility design has few provisions for long-term durability or operation. The goal for the Pondcrete and Saltcrete Reprocessing Operation is to minimize the time for installation, pre-operational testing and operational training. The time estimated to reprocess the existing inventory Pondcrete and Saltcrete plus any reject or processing wastes is between three and six months based on maintenance of a "normal" operating schedule and material throughput.

The process design has not provided for: permanent piping, durable electrical connections, Winter operation, allowances for extraordinary corrosion or erosion in the materials of construction, critical installed spares, extraordinary warehoused spares for many items, containment systems which would facilitate emergency cleanup, and performance of routine maintenance. These and a number of other system design changes would be made for a facility designed for longer-term operation.

Few changes would be made, however, to the specific equipment selected for the Reprocessing Facility. These equipment have been selected primarily on a performance requirement basis. Few other alternatives are available for some of the unit operations of the process. Specifications consistent with the longer-term operation and periodic maintenance requirements would be utilized, however, to insure the required durability was obtained. For example, little is known about the long-term corrosivity of some of the waste materials. Lacking such information, a more conservative approach to materials of construction criteria would be taken for a longer-term facility design.

There should be few problems, however, in developing a equipment selection criteria and specifications for the basic process design consistent with longer-term operation or to provide additional flexibility to handle alternative feeds materials. Provisions for alternate waste product forms can be also made in the design. A five to ten-year life plant design should present few problems since the equipment being used is typically being used in industrial applications for similar or longer-duration services. The SAG mill, for example, can typically be expected to last twenty years or more with proper maintenance and wear-part replacement.

Other types of equipment in the flowsheet: pumps, agitators, screens, tanks, piping, etc. should also be capable of long-term service with the proper materials of construction selection, installed spares where appropriate and periodic maintenance and wear-part replacement. Similar components in materials handling plant applications such as in minerals processing typically have a minimum of five years and up to ten years service life projections.

6.3.2 Maintenance

Two key elements are involved in the maintenance of a facility for long-term service:

- The process design must comprehend the design service life and provide for the appropriate equipment durability and facilitate the routine and emergency maintenance.

- The operating philosophy and practices should comprehend the necessity for routine preventive maintenance, inspection and repair to minimize emergency failures and repairs.

The design considerations: equipment and material specifications, the general utility specifications, equipment and facility layout, enclosure and containment provisions, etc. all contribute toward facilitating the maintenance requirements of the plant. Having proper access to the equipment for maintenance, available replacement equipment or parts and systems for containment or control of in-process waste material during maintenance are some design-related factors. In addition, the success in maintaining a plant directly impacts on the operability and durability of the plant. These can be comprehended and addressed in the design philosophy.

The philosophy under which the plant will be operated contributes (positively and negatively) to the operating availability and durability of the plant. Planned, routine and preventive maintenance reduces the potential for emergency events. This in turn reduces the potential for sympathetic equipment failures (those caused by the catastrophic failure of one piece of equipment which, in turn, causes damage to another piece of equipment). In addition, personnel safety and environmental safety are significantly improved when emergency failures are minimized.

Operational scheduling, planned maintenance scheduling, and adequately training of both operating and designated maintenance personnel all have an impact on the success of sustaining plant maintenance, operability and the durability of the plant. A commitment by the operating management to a successful maintenance philosophy is key to its success.

6.3.3 Site Conditions Criteria

The site-related criteria used for development of the design for the temporary Reprocessing Facility are also provided in the Process and Project Design Criteria. Many of the pertinent rules, regulations, guidelines, etc. for a sub-contractor operated, temporary facility, however, are different and have a different basis than those which could be in effect or required for a longer-term facility.

In addition, criteria for a processing facility which could accommodate a wider variety of feed materials and possibly have the ability to produce alternative product waste forms are also likely to be different. These new criteria would have to be defined and the appropriate modifications made to the equipment design criteria, general design criteria, specifications and site-related considerations. These differences would then have to be comprehended into the engineering design.

It is likely that the site-related criteria required for the longer-term plant will not only require a more detailed engineering effort for process design, but also would require greater attention to definition of the site-related factors such as soil bearing pressure, requirements for foundations, vibrational considerations, building criteria, etc.

7.0 PROJECT SCHEDULE/LOOK AHEAD

The engineering of Pondcrete and Saltcrete is dependent upon the finalization of the Process Design Criteria. This Process Design Criteria includes basic information required for design ranging from physical and chemical properties of the waste through the mix design for stabilization processing.

In order to finalize part of the Process Design Criteria, PHASES I A and B of the Treatability Study need to be completed. At this time, it is anticipated that PHASE IA should be complete by the end of January, 1993 and PHASE IB should be complete by the end of February, 1993 (See Attachment 4).

Once the PHASE I of the Treatability Study is complete and if assumptions can be made regarding the mix design and characteristics of the stabilized product prior to pouring, then conceptual design can proceed. This is also based on the presumption that all required equipment testing can be completed during PHASE IB of the Treatability Study.

The first activity would be the production of Block Flow Diagram's (BFD's) to confirm the unit operations required for the process. The BFDs would be followed by Process Flow Diagram's (PFDs) and mass/heat balances. Equipment lists would then be produced as equipment selection is finalized.

Specification preparation and procurement would then begin on long lead equipment items. After approval of the PFD's, a process control philosophy would be developed followed by developing the Piping & Instrument Drawing's (P&ID's). Specifications would also be produced for other process equipment during P&ID development, as required. Plot plans and general arrangement drawings (preliminary) would also be developed during this period of time.

After conceptual design is completed, the detailed design criteria would be initiated. Procurement will need to be completed prior to staffing up for the bulk of the detailed design effort in order to have vendor data available for design.

The above scenario is based on the some guidelines as those for Pondsludge – temporary facility, no Rocky Flats Plant study required, no title II reviews, etc.

As part of the Treatability Study, temperature changes in the Pondcrete and Saltcrete blocks will have to be monitored during the period November 92 - January 93 to determine the length of time blocks will have to be relocated to a heated tent to ensure a 50°F slurry temperature prior to processing. With the current loading situation on the 904 Pad, this issue may prove critical as to whether winter processing is practicable.

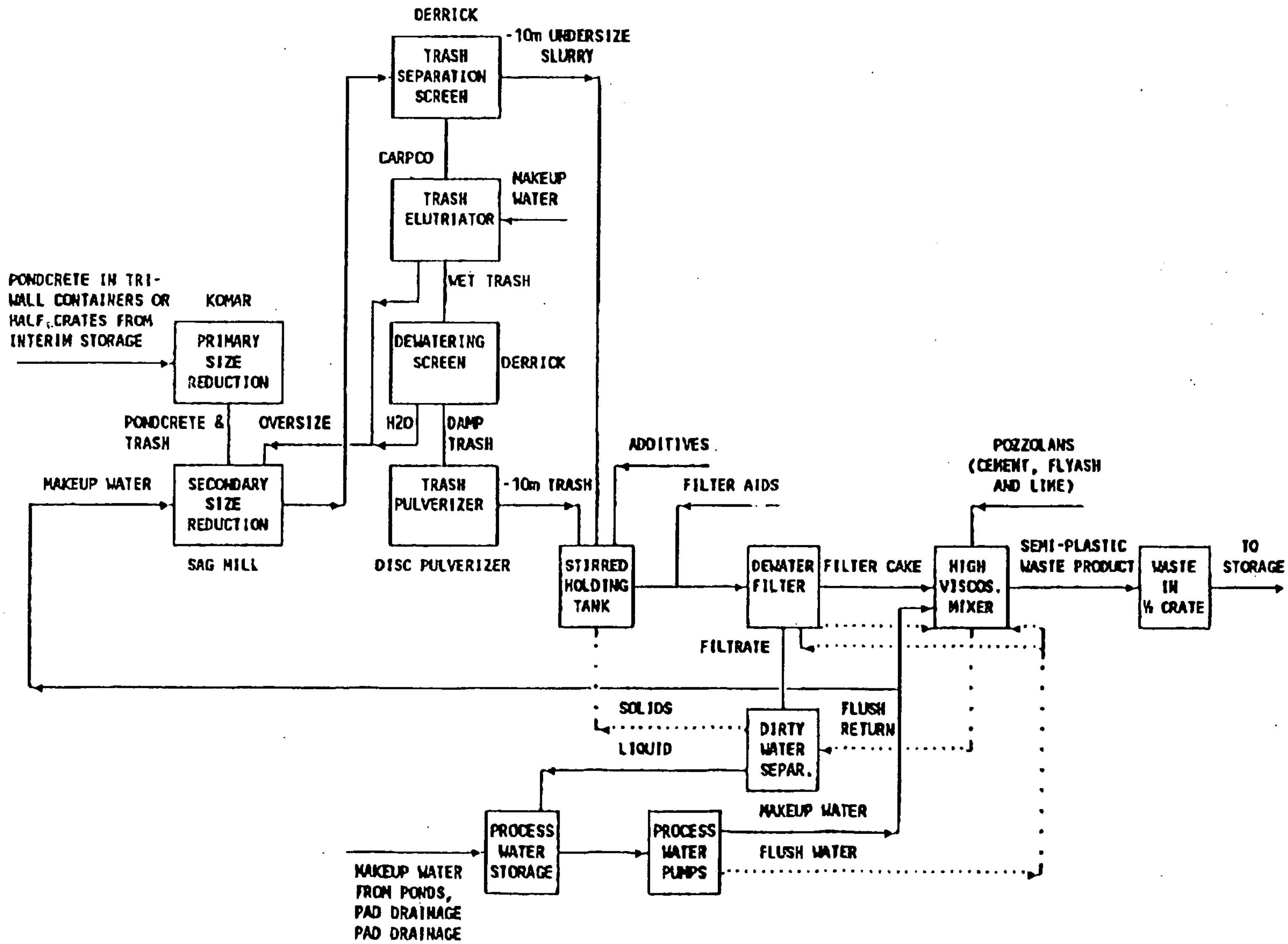
There are several major decisions to be made to proceed expeditiously.

- Purchase of the KOMAR unit. As can be seen from the schedule, there is a 10 month lead time for purchase of the KOMAR, plus a two month installation period. There is a possibility of saving up to $1 million on the KOMAR if certain options are eliminated.

- Will the installation be temporary or permanent? Savings can be realized if skid purchases are eliminated. Long range use of the KOMAR at RFP may require different KOMAR options be purchased. Location must also be considered.

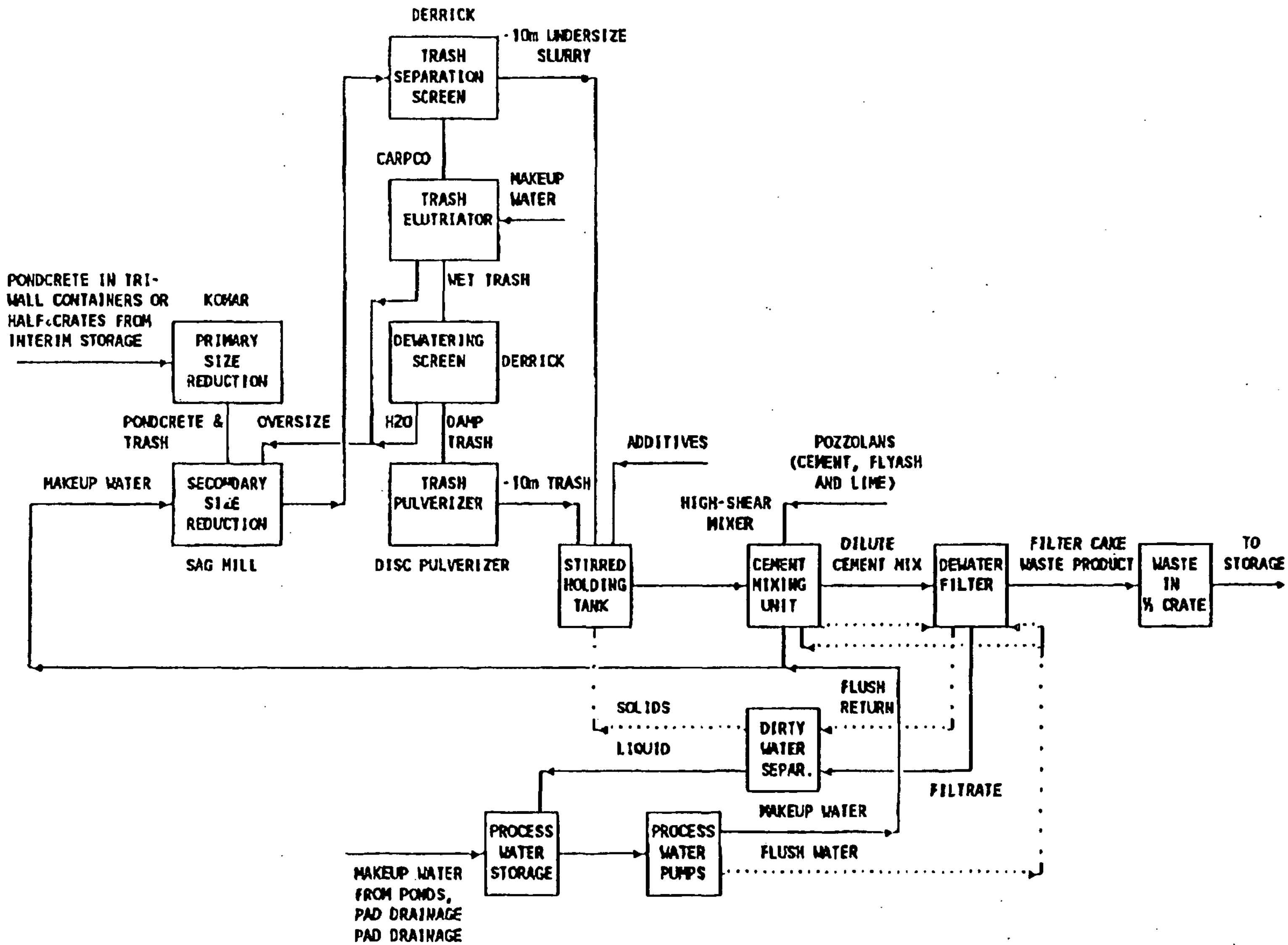
- If funding will not be available for several years to process pondcrete and saltcrete, should the Treatability Study be focused toward producing a certifiable waste from the Building 374 evaporator per Attachment 5?

PONDCRETE/SALTCRETE ON 904 PAD - CEMENT MIXER AFTER FILTER



ATTACHMENT 1

PONDCRETE PROCESSING ON 904 PAD - CEMENT MIXER BEFORE FILTER



ATTACHMENT 2

CONCEPTUAL OUTLINE OF PONDCRETE TREATABILITY STUDY

PONDCRETE PHASE I

This Phase will consist of two subparts, IA and IB. Phase IA will consist of tests to determine the upper limit of the waste loading, and engineering parameters such as viscosity, bulk densities, specific gravities, etc. Phase IB will consist of dewatering studies and trash studies. Additional details are provided below.

Pondcrete Phase IA

Initial Analytical Testing

1. Methanol Study for Triwalls in Metal Containers:

   a. Conduct total methanol analysis with second column confirmation to verify presence of contaminant for triwalls in metal containers.

   b. Conduct zero head space TCLP extraction for methanol. Conduct analysis using a spike sample at the average and 2X the average concentration of methanol as determined by the characterization study.

   Goal: The goal of this study is to determine whether methanol will leach above the LDR standard.

2. Baseline Analysis:

   a. Both triwalls and the triwalls in the metal containers will be analyzed for TCLP metals, total metals, anions and cations.

   Goal: Determine baseline data for bulk samples to compare with characterization data.

3. Engineering Parameters:

   a. Analyze triwalls and triwalls in metal containers for bulk density, specific gravity of the discrete particles, moisture content, and Karl Fisher.

   Goal: Determine baseline for engineering parameters.

Engineering Studies

1. Waste Loading Study: This study will be conducted for triwalls and triwalls in metal containers. The study will consist of mixing the waste forms, at different percent solids, with the same CSS formulation used for the solar ponds. The CSS formulation will consist of portland Type V cement, Type C flyash, and hydrated lime at a ratio of 1.0/2.0/0.075, respectively. The waste loading will vary based on the total solids content of the waste. Mixes will be conducted at 70, 60, 50, 40, 30, and 20 percent solids. The saturated liquid phase of the slurry (concentration determined by the dissolution test) will also be solidified using the same CSS formulation. All mixes will be prepared at a water-to-pozzolan ratio of 0.42. Trash inclusion will not be tested in this phase, but will be evaluated in Phase IB. Testing of the input and output waste streams will be as follows:

    Input: Total solids, total dissolved solids of supernatent, viscosity, specific gravity, and density.

    Output: Density, VG Fann testing, and observation of the ability of the material to be pumped (the testing will be filmed).

    Testing: All of the cylinders will be cured using the 48-hour warm water accelerated cure procedure. Cylinders will be submitted for 48-hour UCS, TCLP metal analysis, and accelerated durability testing. All cylinders will be evaluated for free liquid after curing by visual observation.

    Goal: This testing will determine the upper limit of the waste loading, which will help determine the degree of dewatering which will be necessary (e.g., if 20 percent was the upper waste loading, then it would not be necessary to dewater the waste material to greater than 20 percent solids). The results of this testing should narrow the selection of downstream process options.

2. Dissolution Test of Pondcrete in Water: This test consists of dissolving a known mass of sample in excess water and determining the specific gravity and TDS of the solution. The dry weight of the undissolved portion of the sample will also be determined. The undissolved portion of the sample will be analyzed for specific gravity of the discrete particles.

Another test will consist of dissolving the sample in a small amount of water to make a saturated solution. The TDS and specific gravity of the supernatant will be determined after filtration.

Both these tests will be performed at room temperature and repeated at 100°F.

3. Viscosities and Densities of Samples at Different Percent Solids: Mixtures of the samples with water will be prepared at different total solids concentrations (from 5% to 60%). The viscosities and specific gravities will be determined for each of the samples. The viscosities of the supernatant, up to the saturated point, will also be determined. The experiment will be conducted at room temperature and at 100°F to reflect the expected temperature rise from grinding.

4. Settling Tests: Settling tests will be conducted on sample ground to -10 mesh to determine settling rates and terminal densities. These tests will use a saturated solution for the liquid phase and be conducted at different percent solids and temperatures.

5. Rheology Evaluation of Slurries: Viscosity will be measured over a range of solids (5 to 50 percent) with and without trash included in the slurry. This testing will be conducted in a saturated solution. Trash is defined as the pallet, plastic sheeting, and steel band. The trash makes up approximately 8% of the total weight of the billet on a wet weight basis. When using dry weights, 20% of the billet is considered to be trash. Specific gravities of the slurries will also be measured.

6. Saturation TDS Versus Temperature: The degree of salt dissolution versus temperature will be determined by collecting samples of the supernatant at different temperatures (i.e., 50°F, room temperature and 100°F). The samples will be analyzed for TDS and specific gravity.

Pondcrete Phase IB

This portion of Phase I will consist of evaluating dewatering processes and performing a trash study. The dewatering study will evaluate the selected process option which is believed to be the most practical to achieve the percent solids as determined in the waste loading study. The trash study will evaluate various loadings of trash to determine if there is any impact from different loadings.

1. Dewatering Studies: This testing will evaluate various dewatering processes which are capable of achieving the appropriate percent solids which will be determined in the waste loading study. Vendors will be solicited to conduct the dewatering tests. The dewatering testing will include the appropriate quantities of trash. Further details on these tests will be determined at the completion of the waste loading test.

2. Trash Study: This study will evaluate trash addition with regards to physical parameters and chemical parameters. Testing will be conducted at the percent solids determined to be the maximum waste loading. Trash will be added at 2, 5, 7.5, 10, 12.5, 15, 20, 50, 75, and 100 percent of the waste loading. The objective of this test is to generate data to eliminate trash as a future variable for the CSS formulation development.

   a. Physical testing: Trash will be blended with the triwalls and the triwalls in the metal containers. Testing will consist of the following:

      - Percent solids
      - Bulk density
      - Viscosities
      - Specific gravities
      - Karl Fisher

   b. CSS Testing: CSS testing will be conducted to determine the effect of trash on TCLP criteria and on the stability of the solidified product. The CSS testing will be conducted at three waste loadings; one will be the selected waste loading from the initial waste loading study and the other two will bracket either side of the selected loading (e.g., 40, 50, and 60 percent solids). The water-to-pozzolan ratio will be at 0.42. Testing will consist of 48-hour accelerated cures followed by UCS, TCLP metal analysis, accelerated durability testing, and visual observation for free liquids.

PONDCRETE PHASE II - CSS FORMULATION DEVELOPMENT

This Phase will be conducted using triwalls. Triwalls in metal containers <u>will not</u> be used unless concerns with methanol still exist. Triwalls have the same contaminants as those that exceeded the LDRs for the triwalls in metal containers but at higher concentrations. These studies will be conducted at the selected waste loading using water-to-pozzolan ratios of 0.34, 0.42, and 0.50. The CSS formula will consist of Type V cement, Type C flyash, and hydrated lime at a ratio of 1.0/2.0/0.075. This testing will determine the need for additives to improve the characteristics of the solidified product so that it will pass the TCLP testing criteria.

The first set of tests will be cured for 48 hours and then submitted for TCLP metal analysis. Depending on the results of these test, further testing may be required to evaluate various additives to reduce the leachability of the metal constituents. If the TCLP results pass the LDR criteria then this Phase will be complete.

NOTE: Testing in this phase will be dependent on the results of the waste loading study. Upon completion of the waste loading study, additional information will be available to thoroughly scope the CSS formulation development.

PONDCRETE PHASE III - REGULATORY TESTING PHASE

This Phase will test the CSS formulation to determine if it will pass all regulatory criteria over the proposed operating range. The proposed operating range will be at a water-to-pozzolan ratio of 0.34 to 0.50 with 0.42 being the center point. These water-to-pozzolan ratios will be tested at +/-10 percentage points around the selected waste loading. The test cylinders will be cured for 7 days and 28 days. After 7 days the cylinders will be tested for TCLP metals and UCS. After 28 days the cylinders will be tested for TCLP metals, UCS, paint filter liquids, liquids/solids, and durability testing.

Several additional tests will also be conducted during this Phase of the work. A factorial experiment will be conducted which varies the ratio of pozzolans so that the cement to flyash to lime ratio can be varied from 1/2/0.075 during remediation. Another factorial experiment will be conducted for superplasticizer addition. Curing the test cylinders at different temperatures will also be evaluated. Cylinders from each of these three tests will be tested for all of the pertinent regulatory criteria.

CONCEPTUAL OUTLINE OF SALTCRETE TREATABILITY STUDY

SALTCRETE PHASE I

This Phase will consist of two subparts, IA and IB. Phase IA will consist of tests to determine the upper limit of the waste loading, and engineering parameters such as viscosity, bulk densities, specific gravities, etc. Phase IB will consist of dewatering studies and trash studies. Additional details are provided below.

Saltcrete Phase IA

Initial Analytical Testing

1. Total dissolved solids test:

   This test will be conducted with the triwalls, half crates, and triwalls in metal containers. Each waste form will be dissolved in excess deionized water at different dilutions. The liquid will then be filtered and the filtrate will be analyzed for TDS. The filter cake will be analyzed for TS and specific gravity.

   Goal: To provide an initial baseline of the salt in each of the waste forms.

2. Baseline Analysis:

   Triwalls, half crates, and the triwalls in the metal containers will be analyzed for TCLP metals, total metals, anions, and cations.

   Goal: Determine baseline data for bulk samples and compare it with characterization data.

3. Engineering Parameters:

   Analyze triwalls, half crates, and triwalls in metal containers for bulk density, specific gravity of the discrete particles, moisture content, and Karl Fisher.

   Goal: Determine baseline for engineering parameters.

Engineering Studies

1. Waste Loading Study: This study will be conducted for triwalls, half crates, and triwalls in metal containers. The study will consist of mixing the waste forms, at different solids concentrations, with the same CSS formulation used for the solar ponds. The CSS formulation will consist of portland Type V cement, Type C flyash, and hydrated lime at a ratio of 1.0/2.0/0.075, respectively. Batches will also be prepared using lime/cement/flyash and latex. Latex will be evaluated at 5 and 10 percent of the weight of the cement. Mixes will be conducted at 70, 60, 50, 40, 30, and 20 percent total solids. The saturated supernatant will also be solidified using the same CSS formula. All mixes will be prepared at a water-to-pozzolan ratio of 0.42. A corresponding TDS value will also be determined for each waste loading. Trash inclusion will not be tested in this phase but will be evaluated in Phase IB. Testing of the input and output waste streams will be as follows:

   Input: Total solids, total dissolved solids of the supernatant, viscosity, specific gravity, and density.

   Output: Density, VG Fann testing, and observation of the ability of the material to be pumped (the testing will be filmed).

   Testing: All of the cylinders will be cured using the 48-hour warm water accelerated cure procedure. Cylinders will be submitted for 48-hour UCS, TCLP metal analysis, and accelerated durability testing. All cylinders will be evaluated for free liquid after curing by visual observation.

   Goal: This testing will determine the upper limit of the waste loading which will determine the degree of dewatering, if any, which will be necessary (i.e., if 50 percent was the upper waste loading, then it would not be necessary to dewater the waste material to greater than 50 percent solids). The results of this testing should narrow the selection of downstream process options. Additionally, this testing will determine whether latex is beneficial and should be considered further during the CSS formulation development.

2. Dissolution Test of Saltcrete in Water: This test consists of dissolving a known mass of sample in excess water and determining the specific gravity and TDS of the solution. The dry weight of the undissolved

portion of the sample will also be determined. The undissolved portion of the sample will be analyzed for specific gravity of the discrete particles.

Another test will consist of dissolving the sample in a small amount of water to make a saturated solution and the TDS and specific gravity of the supernatant determined after filtration.

Both these tests will be performed at room temperature and repeated at 100°F.

3. Viscosities and Densities of Samples at Different Percent Solids: Mixtures of the samples with water will be prepared at different total solids concentrations (from 5% to 60%). The viscosities and specific gravities will be determined for each of the samples. The viscosities of the supernatant, up to the saturated point, will also be determined. The experiment will be conducted at room temperature and at 100°F to reflect the expected temperature rise from grinding.

4. Settling Tests: Settling tests will be conducted on sample ground to -10 mesh to determine settling rates and terminal densities. These tests will use a saturated solution for the liquid phase and be conducted at different percent solids and temperatures.

5. Rheology Evaluation of Slurries: Viscosity will be measured over a range of solids (5 to 50 percent) with and without trash included in the slurry. This testing will be conducted in a saturated solution. Trash is defined as the pallet, plastic sheeting, and steel band. The trash makes up approximately 8% of the total weight of the billet on a wet weight. When using dry weights, 15% of the billet is considered to be trash. Specific gravities of the slurries will also be measured.

6. Saturation TDS Versus Temperature: The degree of salt dissolution versus temperature will be determined by collecting samples of the supernatant at different temperatures (i.e., 50°F, room temperature, and 100°F). Samples will be analyzed for TDS and specific gravity.

Saltcrete Phase IB

This portion of Phase I will consist of evaluating dewatering processes and conducting a trash study. The dewatering study will evaluate the selected process option which is believed to be the most practical to achieve the target percent solids as determined in the waste loading study. The trash study will evaluate various loadings of trash to determine if there is any impact from different loadings.

1. Dewatering Studies: This testing will evaluate various dewatering processes which are capable of achieving the appropriate percent solids which will be determined in the waste loading study. Vendors will be solicited to conduct the dewatering tests. The dewatering testing will include the appropriate quantities of trash. Further details on these tests will be determined at the completion of the waste loading test.

2. Trash Study: This study will evaluate trash addition with regards to physical parameters and chemical parameters. Testing will be conducted of the TDS concentration determined in the waste loading study. Trash added at 2, 5, 7.5, 10, 12.5, 15, 20, 50, 75, and 100 percent of the waste loading. The objective of this test is to generate data to eliminate trash as a future variable for the CSS formulation development.

   a. Physical testing: Trash will be blended with the triwalls, half crates, and the triwalls in the metal containers. Testing will consist of the following:

      - Percent Solids
      - Percent TDS
      - Bulk Density
      - Viscosities
      - Specific Gravities
      - Karl Fisher

   b. CSS Testing: CSS testing will be conducted to determine the effect of trash on TCLP criteria and on the stability of the solidified product. The CSS testing will be conducted at three waste loadings; one will be the selected waste loading from the initial waste loading study and the other two will bracket either side of the selected loading (e.g., 40, 50, and 60 percent solids). The water-to-pozzolan ratio will be at 0.42. Testing will consist of 48-hour accelerated cures followed by UCS, TCLP metal analysis, accelerated durability testing, and visual observation for free liquids.

SALTCRETE PHASE II - CSS FORMULATION DEVELOPMENT

This Phase will be conducted using triwalls, triwalls in metal containers, and half crates. These studies will be conducted at the selected waste loading using water-to-pozzolan ratios of 0.34, 0.42, and 0.50 for the triwalls in metal containers. The half crates and triwalls will be evaluated using higher water-to-pozzolan ratios because treatment of the chemical constituents is not required (neither population exceeded any LDR standards). Using a higher water-to-pozzolan ratio will reduce the volume of the output. A water-to-pozzolan ratio of 1.0 will be evaluated to determine if a stable waste can be produced. Testing for triwalls and half crates will also include accelerated durability to determine the effect of using higher water-to-pozzolan ratios on long-term durability. The CSS formula will consist of Type V cement, Type C flyash, and hydrated lime at a ratio of 1.0/2.0/0.075. Latex will be evaluated if it was determined to be warranted in the Phase I waste loading study. The testing for triwalls in metal containers will determine the need for additives to improve the characteristics of the solidified product so that it will pass the TCLP testing criteria.

The first set of tests will be cured for 48 hours and then submitted for TCLP metal analysis. Depending on the results of these test, further testing may be required to evaluate various additives to reduce the leachability of the metal constituents. If the TCLP results pass the LDR criteria, then this Phase will be complete.

NOTE: Testing in this phase will be dependent on the results of the waste loading study. Upon completion of the waste loading study, additional information will be available to thoroughly scope the CSS formulation development.

SALTCRETE PHASE III - REGULATORY TESTING PHASE

This Phase will test the CSS formulation to determine if it will pass all regulatory criteria over the proposed operating range. The proposed operating range for metal containers will be at a water-to-pozzolan ratio of 0.34 to 0.50 with 0.42 being the center point. The operating range for triwalls and half crates will be determined in Phase II. These water-to-pozzolan ratios will be tested at +/-10 percentage points around the selected waste loading. The test cylinders will be cured for 7 days and 28 days. After 7 days the cylinders will be tested for TCLP metals and UCS. After 28 days the cylinders will be tested for TCLP metals, UCS, paint filter liquids, liquids/solids, and durability testing.

Several additional tests will also be conducted during this Phase of the work. A factorial experiment will be conducted which varies the ratio of pozzolans so that the cement to flyash to lime can be varied from 1/2/0.075 during remediation. Another factorial experiment will be conducted for superplasticizer addition. Curing the test cylinders at different temperatures will also be evaluated. Cylinders from each of these three tests will be tested for all of the pertinent regulatory criteria.

Attachment 5

PROPOSAL

FOR

CHEMICAL STABILIZATION/SOLIDIFICATION PROCESS DEVELOPMENT FOR BUILDING 374 EVAPORATOR WASTES

FOR

EG&G ROCKY FLATS PLANT

Attachment 5

EXECUTIVE SUMMARY

This proposal has been prepared in response to a request for information regarding the performance of a chemical stabilization/solidification process development program for Building 374. The objectives of this scope of work are:

- to provide a technical approach for the development of one or more chemical stabilization/solidification (CSS) formulations for evaporator solids produced in Building 374, and

- to provide an approach to the development of a conceptual flowsheet and budget cost estimate of the overall facilities needed including the process, raw materials and stabilized waste handling areas.

It is estimated that approximately 2-4 months are required for the completion of the laboratory treatability testing of the evaporator solids. Additionally, it is estimated that an additional month would be required for a field demonstration phase using equipment already available in Building 374. The detailed project schedule is provided in Section 4.0. The cost to complete this work is estimated at **SIXTY FIVE THOUSAND DOLLARS** ($65,000), excluding the Field Demonstration.

Presented herein is a comprehensive Scope of Work for the development of CSS processes that will be applicable for treating Building 374 evaporator solids.

Attachment 5

1.0 INTRODUCTION

In Building 374, certain process waste streams are treated resulting in the generation of evaporator solids which are classified as mixed waste and fall under RCRA Land Disposal Restrictions (LDRs) as published in the June 1, 1990 Federal Register, Vol. 55, No 55, No. 108 (pp. 22520 - 22720). Based on the literature as well as ongoing tests on similar waste streams at the plant, the evaporator solids should be amenable to chemical stabilization/solidification prior to disposal at the Nevada Test Site (NTS). To determine the optimum chemical stabilization/solidification (CSS) process, treatability studies are needed to define the type of stabilization necessary for all these wastes to meet regulatory requirements.

The objectives of this project are:

- to develop a description of processing steps needed to stabilize Building 374 evaporator solids to meet land disposal restrictions and other applicable final waste form certification criteria,
- to provide a list of the source, types and amount of ingredients needed for the stabilization process,
- the effect of key treatment variables on stabilized waste quality as measured by TCLP tests for metals. The effect of variables on the leachability of critical contaminants will specifically be measured,
- to estimate the volume of final waste form product, and
- to prepare a conceptual flowsheet and budget cost estimate of the overall facilities needed including the process, raw materials, and stabilized waste form handling areas.

This information will be a major source of data needed to design a full-scale operational facility to treat Building 374 evaporator solids.

This proposal is presented in seven sections:

1.0 Introduction
2.0 Technical Understanding and Approach
3.0 Scope of Work
4.0 Schedule and Reports
5.0 Project Organization and Staffing
6.0 Contract Costs, Terms and Conditions

The Technical *Understanding section* includes a statement of the problem; assumptions used in the development of this Scope of Work; and the approach.

Section 3.0 addresses the work that is required to meet project objectives. The Scope of Work section includes a total of 10 individual tasks. These tasks are grouped in five phases:

- o Characterization of Waste Feeds
- o Screening of Trial Mixes
- o Design Basis Formula Development
- o *Field Demonstration*
- o Conceptual Process Design Report (CDR)

Section 4.0 of this Scope of Work presents the overall project schedule for Phases I through V. The schedule also identifies key project milestones and reports.

Section 5.0 identifies the project organization and staffing.

Section 6.0 presents the contract costs, terms, and conditions.

Attachment 5

2.0 TECHNICAL UNDERSTANDING AND APPROACH

It is understood that the treatability study portion of this project will be conducted on evaporator solids generated in Building 374. Currently multiple aqueous waste streams enter Building 374 where they are selectively combined and chemically neutralized to a pH around 7.0. After neutralization, wastes are pumped to an evaporator from a feed tank. The evaporator produces pure water condensate (not the subject of this effort) and a highly concentrated brine stream (bottoms). The bottoms are then sent to a spray drier where additional water is evaporated resulting in more pure water condensate and dry salt. Currently the dry salt is blended with brine to produce an acceptable consistency for treatment in an existing CSS process.

EG&G's specific goal is to effectively and efficiently implement a stabilization facility operation within Building 374 for processing evaporator solids that will consistently produce a certifiable final waste form acceptable for disposal at the NTS. Accordingly, the facility should:

1. meet all regulatory requirements,
2. minimize final waste form for disposal,
3. generate a manageable stabilized material,
4. be operable and maintainable,
5. meet EG&G and DOE standards,
6. control dusting, and
7. be operable within as soon as possible.

2.1 PROPOSED APPROACH

The approach will be to conduct the treatability study with evaporator solids prepared at various dilution levels from dry crystal solids through the range to a fully saturated solution. Heavy metals such as cadmium, chromium, and possibly lead are expected to be the most troublesome metals encountered in the evaporator solids waste stream. Pending the results of waste sample characterization and discussions with EG&G personnel, certain salts may also be of concern, namely nitrates.

Because of the potential high variability of contaminants in the waste streams entering Building 374, Contaminant and/or Inorganic salt spiking may be necessary since it is not possible to collect samples that are representative of all wastes and waste codes. Some of the wastes are either too small to handle on a continuous basis or are nor produced continuously. Test samples supplied for the treatability study should be representative of the major waste streams producing evaporator solids in Building 374.

3.0 SCOPE OF WORK

There are four primary goals in the following chemical stabilization/solidification (CSS) treatability study scope of work. These include:

- o Create an impermeable monolith with minimum leaching properties - It is necessary to identify the optimum treatment formulation that will prevent direct contact with leachants such as groundwater and percolating rain. By reducing the permeability of the monolith, leachant contact is confined to the outer boundaries of the treated waste thereby reducing the exposure solublization of the stabilized contaminants.

- o Enhance contaminant binding - This goal is to develop a solid matrix that effectively binds the hazardous constituents of concern. Binding can be accomplished through chemical reactions and or adsorption phenomena. By enhancing constituent binding, the mobility of the hazardous contaminants within the waste form or monolith is reduced, minimizing release to the environment.

- o Achieve durability - Once the monolith has beensuccessfully created, it is important that environmental stresses such as freeze/thaw cycles, groundwater and rain percolation contact and mechanical loads have minimum effect on integrity. Emphasis on each of these stress factors is specific to each particular waste site and its location.

- o Field performance verification - After completion of a successful bench-scale treatability study program with the identification of an appropriate waste/binder/admixture formulation, field verification is necessary. Field verification testing eliminates the possibility of unforeseen variables and fatal flaws that may jeopardize the success of the project.

Another important consideration - and possibly a constraint - is the volume expansion of the treated waste. It is possible with certain wastes that the amount of treatment reagents (i.e., binders and admixtures) required to meet the goals listed above can create a volume expansion of the final waste form that is physically and/or economically unacceptable.

With the above in mind, the following phased approach in proposed to meet EG&G's objectives for this project.

3.1 PHASE I - CHARACTERIZATION OF WASTE FEEDS

In the first phase of the CSS treatability program, evaporator solids samples will be physically and chemically characterized to develop a baseline reference point.

Also in this phase, evaporator solids samples will be prepared for testing by spiking them with heavy metal and/or inorganic salts as agreed to in consultation with EG&G.

3.1.1 Task 1 - Project Kickoff Meeting

To formally initiate this project, assigned project personnel will participate in a kickoff meeting at the Rocky Flats plant to establish communications protocol, data sources, and to discuss key aspects of the scope of work. At this same time, the current evaporator solids processing operations in Building 374 will be inspected.

3.1.2 Task 2 - Characterize Building 374 Evaporator Solids Samples

In this task, the three (3) evaporator solids samples will be analyzed for key physical characteristics and specific "before treatment" levels of contaminants.

Physical tests that will be performed include:

- o bulk density (compacted and uncompacted)
- o specific density
- o particle size, distribution, and shape
- o rheological characteristics
- o general physical appearance

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Chemical analyses of samples will include:

- o Appendix IX metals - Al, Sb, As, Ba, Cd, Cr, Co, Cu, Pb, Mg, Hg, Ni, Se, Ag, V, Zn
- o Anions - total chloride, fluoride, sulfate, phosphate, borate
- o Other Constituents - iron, silicon, sulfur, boron, phosphorus
- o Alkalinity/acidity (%)

Chemical analysis of sample extracts (TCLP) will include:

- o Appendix IX metals - Al, Sb, As, Ba, Cd, Cr, Co, Cu, Pb, Mg, Hg, Ni, Se, Ag, V, Zn
- o Anions - total chloride, fluoride, sulfate, phosphate, borate
- o Alkalinity/acidity

In the event it is determined that the reduction of the particle size distribution of crystallized evaporator solids results in a significant improvement of the CSS process, a number of the analyses listed above will be performed on that processed raw sample.

3.1.3 Task 3 - Prepare Spiked Samples

Because it is envisioned that the focus of this project will be on the stabilization of heavy metals and certain inorganic salts (notwithstanding physical stability characteristics), treatability testing will be conducted with spiked samples. Cadmium, chromium, and lead are expected to be the most troublesome metals encountered with the wastes. The metals will be spiked to ten (10) times the EP-Tox level. Highly soluble acetate salts of lead (Pb) and cadmium (Cd) will be used. Chromium (VI) should be spiked as highly soluble oxides (As_2O_5 and CrO_3). The samples may also be spiked with nitrate salts.

Spiking is necessary because it is not possible (or desirable) to supply waste samples that are representative of all wastes and waste-codes.

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3.2 PHASE II - SCREENING OF TRIAL MIXES

In this phase, the stabilization performance of at least three binders and possibly three admixtures are evaluated. Initially, a number of binders and admixtures are mixed with waste samples in general screening tests to observe performance and identify major variables. Fundamental to this phase is the identification of the major CSS variables which affect the treatment of the evaporator solids. Some of the more important variables include:

- o Water content
- o Particle size
- o Temperature
- o Pretreatment (e.g., dilution)
- o Mixing energy
- o Mixing time

At the completion of this phase, one or more formulations will be identified for further testing.

3.2.1 Task 1 - Perform Wide-range Screening Tests

At the onset of this task, a controlled amount of free-form (creative) screening of binder materials should be performed based on previous experience with Pond 207C waste and the reported findings of other researchers in the industry.

A limited series of qualitative and semi-quantitative analyses will be performed of a number of waste/binder/admixture combinations. The intent here is to observe the primarily the physical characteristics of the various formulations. Characteristics such as set time, bleed water or phase separation, and slump or workability will be observed.

3.2.2 Task 2 - Evaluate Major CSS Variables

In this task, a series of qualitative and semi-quantitative analyses will be performed of a number of waste/binder/admixture combinations. The intent here is to observe the primarily the physical characteristics of the various formulations. Characteristics such as set time, phase separation, and workability will be observed.

Quite often the success (or failure) of a CSS project centers around to effective identification of major processing variables such as:

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- o water content,
- o waste particle size,
- o curing temperature,
- o waste pretreatment,
- o inhibitor concentration,
- o mixing energy and,
- o mixing time

There are a number of ways to handle the evaluation of these variables but factorial experimentation has been found to be the most cost effective and timely. Typically, a two level factorial experiment design is used (i.e., 2^n). With the judicious use of replicates, statistical techniques (i.e., ANOVA) can be applied to help identify variables that significantly affect the performance of the CSS process. As an example, if three variables were evaluated in a two-level factorial experiment (excluding replicates), the test matrix would be as follows:

Run Number	Variables A	B	C
1	+	+	+
2	+	+	-
3	+	-	+
4	-	+	+
5	+	-	-
6	-	-	+
7	-	+	-
8	-	-	-

The plus and minus signs represents two levels of concentration (or application) for the variables.

While compressibility testing in accordance with ASTM D-1633-63 and D2166-66, strength tests which are fundamental to this type of testing and selected leaching tests will also be performed. For this project, selected metals leaching tests will be performed using a modification of ASTM D3987-85.

Also, freeze/thaw and wet/dry testing may also be evaluated depending the outcome of further discussions with EG&G.

3.2.3 Task 3 - Evaluate Binder/Admixture Formulations

In this task a multilevel test series will be used to evaluate binder and or admixture materials to choose an optimum blend to (1) minimize cost and volume increase, (2) develop adequate strength and impermeability, and (3) meet site and regulatory performance requirements. The objective will be to quantify the principle binder components and additives to develop initial cost projections and preliminary site operations planning.

Key variables that will be evaluated include set time, bleed water, 7 and 14-day unconfined compressive strength and metals leachability.

3.3 PHASE III - DESIGN BASIS FORMULA DEVELOPMENT

At this point in the test program, one or more candidate CSS formulations should be known. This phase will involve a more comprehensive evaluation of these formulations. This step refines this information and verifies that the physical and regulatory requirements are met (i.e., final waste form certification)..

3.3.1 Task 1 - Evaluate Final or 28-Day Physical Characteristics

In this task, a more comprehensive evaluation of the physical characteristics of the stabilized waste forms will be performed. Testing will include:

- o 28-day unconfined compressive strength
- o 28-day permeability
- o Structural integrity (wet/dry and/or freeze/thaw)

3.3.2 Task 2 - Evaluate Regulatory Compliance

This task will evaluate regulatory compliance based on regulatory statutory tests including:

- o EP Toxicity
- o TCLP

3.3.3 Task 3 - Prepare CSS Treatability Study Report

For this task, a report will be prepared while includes the detailed findings of the treatability study. In addition to providing the raw test data, a preliminary discussion of the recommended CSS formulations as well as recommendations for full scale operations will be made. This report will be the basis of the background

Information for the Conceptual Process Design Report.

3.4 PHASE IV - FIELD DEMONSTRATION

After completion of a successful bench-scale treatability study program with the identification of an appropriate waste/binder/admixture formulation, field verification is necessary. Field verification testing eliminates the possibility of unforeseen variables and fatal flaws that may jeopardize the success of the project.

The scope of work and associated costs for this phase will be developed at or near the completion of the preceding phase.

3.5 PHASE V - CONCEPTUAL PROCESS DESIGN REPORT

The conceptual process design phase of a project is where all concepts are established and basic designs are made on which production engineering will be based. In this phase, options are evaluated and recommendations made. This effort can be defined as a "feasibility" evaluation, but the essence of this engineering effort is its comparative-analysis nature. Typical subjects of evaluation include:

- Source, types and amount of ingredients needed for the stabilization process,
- The effect of key treatment variables on stabilized waste quality as measured by TCLP tests for metals. The effect of variables on the leachability,
- Volume of final waste form as a function of raw waste form input, and
- Processing alternatives
- Preliminary process flowsheets
- Chemical and operational cost
- Type of system-fixed or mobile/portable
- Required redundancy-for backup
- Area operations and Space requirements

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- Labor and personnel required
- Occupational health considerations (dust, noise, toxicity)
- Throughput rate
- Waste feed system
- Mixing system
- Chemical storage requirements
- Chemical feed system(s)
- Utility and power requirements
- Setting and curing times
- Handling of CSS waste after treatment (conveyance/placement)
- Volume increase
- Order-of-Magnitude cost estimates.

Additionally, this report will also serve to identify the status of the project as well as identify additional testing requirements.

4.0 SCHEDULE AND REPORTS

A proposed project schedule is provided in Figure 4-1 which shows that estimates an overall project duration, excluding Phase V, of approximately four (4) calendar months. During the course of the work, the schedule will be revised as necessary to reflect certain aspects of the work or successes not anticipated at this time.

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FIGURE 4-1

PROJECT SCHEDULE

< ... To be provided in final proposal ... >

Attachment 5

5.0 PROJECT ORGANIZATION AND STAFFING

To accomplish the proposed effort, an experienced project team would be assigned that is well qualified in the technical and regulatory areas necessary to bring the project to successful completion.

All laboratory treatability studies will be performed in a laboratory facility licensed to handle mixed wastes.

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6.0 CONTRACT COSTS, TERMS AND CONDITIONS

6.1 CONTRACT COSTS

As discussed in Section 2.0, this work will be conducted in five phases, each with appropriate milestones which allow for effective project monitoring. The costs presented below reflect the work to be performed in the first four phases - the fifth phase will be costed when this milestone is reached.

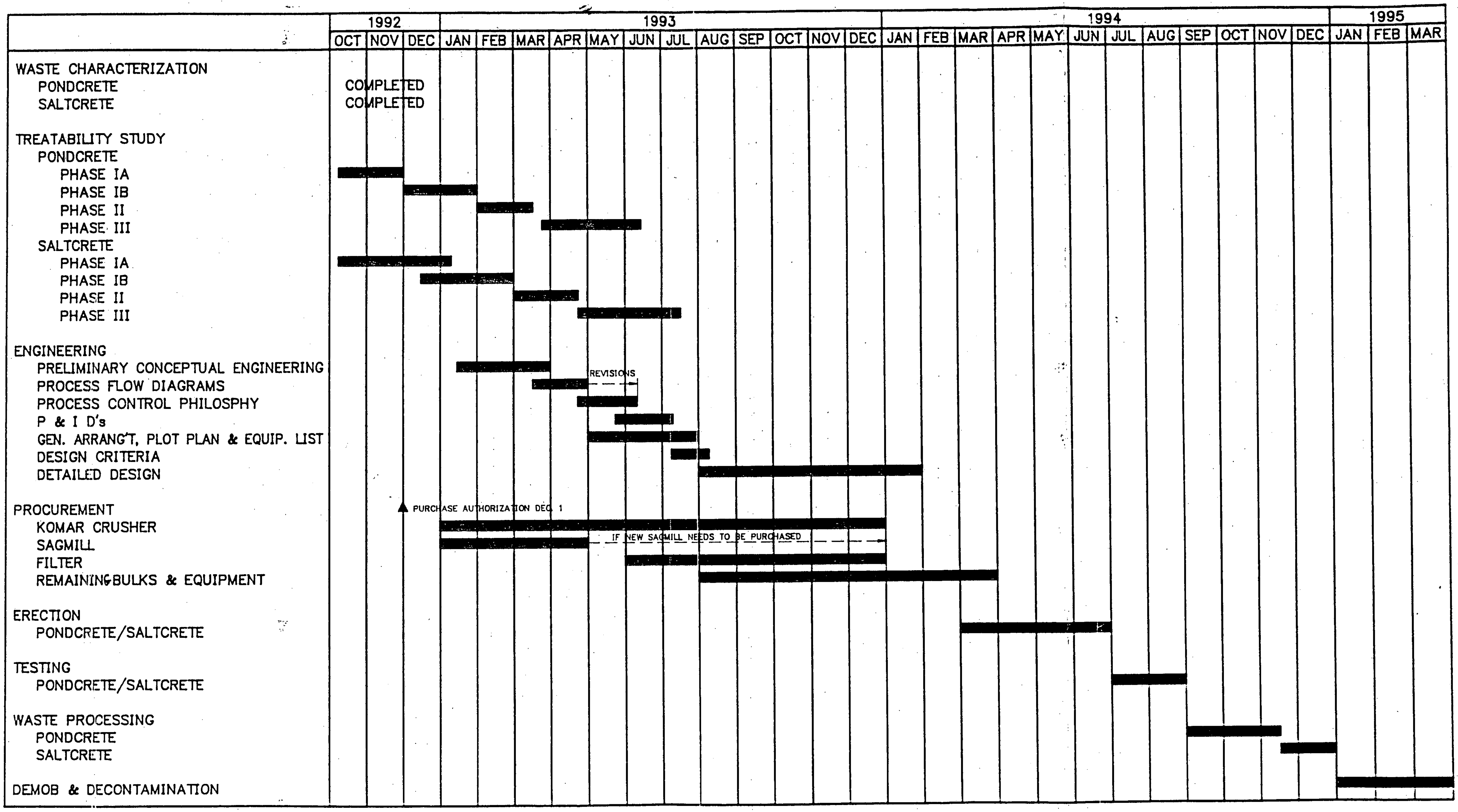
The estimated charges for services broken down by phase are as follows:

Phase I Characterization of Waste Feeds	**$11,000**
Phase II Screening of Trial Mixes	**$9,400**
Phase III Design Basis Formula Development	**$16,600**
Phase IV Field Demonstration	**(optional)**
Phase V Conceptual Process Design Report	**$28,000**

These figures are an estimate only, and are based on estimates of the time and materials necessary to complete the scope of work as suggested.

6.2 CONTRACT TERMS AND CONDITIONS

< ... To be provided in final proposal ... >



PONDCRETE / SALTCRETE SCHEDULE
ROCKY FLATS PLANT, GOLDEN, COLORADO

HALLIBURTON NUS
Environmental Corporation