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SOIL WASHING
PILOT STUDY REPORT ADDENDUM
SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

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Pilot Study Report
South Cavalcade Superfund Site
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Beazer East, Inc.

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Pilot Study Report

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1.0 Introduction

1.1 Pilot Study Scope

Beazer contracted SWACO-Geolograph to perform pilot soil washing services at the South Cavalcade Superfund site. As part of SWACO's contract, they performed bench tests to characterize the soils to be treated and to identify preferred surfactants to be used in the pilot tests. Dames & Moore observed these tests and also provided technical oversight of the soil washing bench tests and pilot activities. SWACO provided laborers, technicians, senior operators, and site engineering personnel as required to perform the pilot test.

Approximately 100 tons of soils were excavated at the site and processed by SWACO on-site. Beazer hired operators and equipment to perform minor earthwork during the pilot soil washing activities. This minor earthwork included moving untreated soils into the SWACO process area and moving washed soils from the discharge areas of the process unit to the soil staging areas.

Dames & Moore performed the sampling of the untreated soil prior to washing and also sampled wash water and soils discharged from the process after washing. Dames & Moore maintained all records associated with sampling and monitoring performed during these operations. Sampling was performed in accordance with the previously approved Pilot Soil Washing-Sampling and Analysis Plan (PSW-SAP).

SWACO performed all activities related to operating their process unit. These activities included preparing daily operating logs, recording all pertinent process data, and maintaining these records for use in preparing the SWACO Pilot Test Report. SWACO also monitored conditions to ensure compliance with health and safety plans. SWACO's Pilot Test Report is provided in Appendix A. Dames & Moore provided input related to overall site conditions and the contractor was responsible for ensuring safe operations of the process system.

During the course of the bench tests, the presence of particulate pieces of pitch and tar were observed in the soils. Preliminary bench tests of gravity separation processes were performed by Hazen Research in Golden, Colorado. These preliminary tests were successful in removing the particulate matter. Consequently, at the close of SWACO's field pilot tests, portions of the treated soil were containerized and forwarded to Hazen Research for further pilot testing of the gravity separation processes. The selection of which treated

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soils to send to Hazen was made jointly by SWACO's site supervisor and Dames & Moore. Hazen performed gravity separation tests on the various washed fractions and their Pilot Test Report is provided in Appendix B.

1.2 Pilot Study Organization and Execution

During the execution of pilot test activities at the South Cavalcade site there were several service companies involved. The companies and their responsibilities are shown briefly below and are described further in this Pilot Study Report.

Beazer East, Inc.	Project Lead
Dames & Moore	Site Preparation Engineer Construction Oversight Engineer Soil Washing Technical Consultant Site Representative Health and Safety Oversight QA Officer
Sizemore	Site Preparation Contractor
SWACO Geolograph	Soil Washing Contractor
Trucking Properties	Property Owner
Palletized Trucking	Property Owner
Hazen Research	Soil Washing Pilot Test Laboratory

From the list above it can be seen that Dames & Moore provided multiple services during the course of the project. Briefly, the involvement of Dames & Moore in pilot soil washing efforts has included solicitation and evaluation of pilot test bids, bench test oversight and evaluation, site design, operations plan development, site construction oversight, on-site pilot test oversight and evaluation, selection and oversight of off-site pilot tests at Hazen, and evaluation, reporting, and interpretation of the pilot soil washing test results.

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The tasks performed at the South Cavalcade Superfund site related to the soil washing pilot tests included three phases of activity. These three phases include the tasks shown below:

- Site Construction
  - Clear the site, erect fencing, install utilities, and prepare site for pilot operations;
  - Construct process equipment pads and soil staging pads;
  - Excavate and stockpile pilot test soils; and
  - Mobilize pilot soil washing equipment.

- Pilot Operations
  - Perform on-site pilot soil washing tests.

- Post Pilot Operations
  - Demobilize soil washing process equipment; and
  - Initiate off-site pilot soil washing tests.

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2.0 Pilot Study Objective

The primary objective of the pilot soil washing study for the Beazer South Cavalcade Superfund site is to provide the data necessary for the full-scale soil washing remedial design. Specifically:

- characterize the feed soils at the site;
- determine the optimum flow scheme and process conditions for the soil washing process; and
- characterize residual streams generated by the soil washing process.

This study was performed in accordance with the EPA approved Pilot Study Design Report (PSD, Dames & Moore, October, 1992), and those requirements set forth in the EPA approved Remedial Design Work Plan (RDWP, Bechtel, March, 1992).

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3.0 On-Site Pilot Study Procedures

3.1 Pilot Study Site Construction

The pilot study site was constructed in the Spring of 1993. The test site was located and configured as shown on Figures 1 and 2.[1] The site was constructed by Sizemore under contract to Beazer and managed by Dames & Moore. The key features of the test site layout included:

- one curbed concrete process pad;
- two curbed concrete soil staging pads; and
- one curbed concrete decontamination pad.

The traffic areas of the test site were prepared with 8" of crushed limestone to provide a stable working area. Security fencing was installed at the perimeter of the site.

3.2 Test Soil Excavation

Dames & Moore selected and staked the excavation locations for test soils based on Figures 3-1 and 3-2 and pertinent soil boring logs presented in the August 1992 Soil Delineation Report by Keystone Environmental Resources, Incorporated.[2] Sizemore provided labor and equipment to excavate soils to use during the pilot test soil washing operations. Dames & Moore provided oversight of these activities as well as the sampling of the excavated soils.

Approximately 70 cubic yards were excavated from Area A shown on Figure 1 (approximately 15 ft by 20 ft by 6 ft deep). Approximately 30 yards were excavated from Area B to a depth of 2 feet below ground surface. Dames & Moore coordinated with Trucking Property, Inc. and Palletized Trucking representatives to ensure access to the excavation areas. At all times, the contractor took precautions to minimize contact of the surrounding properties with potentially impacted soil.

The floor of the excavation at Area A was not sampled since the excavation extended to six feet below ground surface, the limit of the subsurface soil remediation specified by

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[1] See Response to EPA Comments, December 16, 1993, Appendix G - Item TNRCC #6

[2] See Response to EPA Comments, December 16, 1993, Appendix G - Item TNRCC #1

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the Record of Decision (ROD). Because the depth specified in the ROD is attained in this area, the excavation location was surveyed, documented, and backfilled with approved clean borrow material. Therefore, this area will not be re-excavated during full scale remediation. The shallow excavation at Area B was not sampled during pilot test operations. This small excavation was backfilled with a coarse fill and will be re-excavated during full scale operations. The re-excavated material will be washed in the soil washing unit and the excavation tested at that time.

The dump truck loads of excavated soil were covered and the covering was secured prior to transport to the soil storage pads within the fenced treatment area. Each dump truck was decontaminated prior to leaving the fenced treatment area. The decontamination procedures for the excavation and hauling equipment were performed on the concrete decontamination pad within the fenced treatment area. The procedures included:

- cleaning and scraping in the excavation area to remove caked soils from the pertinent portions of the equipment prior to moving the equipment to the site decontamination pad (As necessary, the excavation bucket was wrapped in visqueen prior to transport to the decontamination area.);
- pressure washing with water at the site decontamination pad and air drying; and
- collecting all rinseate and transferring it to an on-site frac tank for treatment in the groundwater treatment plant.

3.3 Test Soil Characterization

Prior to wrapping the test soil piles in visqueen, they were sampled in accordance with the Pilot Soil Washing SAP (Dames & Moore, January 1993). The samples were sent to Chester LabNet to be sieved into three particle size fractions and each fraction was analyzed for potentially carcinogenic polynuclear aromatic hydrocarbons (cPAHs). The weight distribution of each particle size fraction was used to calculate the composite potentially cPAH concentration of each of the test soil piles. Results are presented in Section 5.2.

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3.4 Soil Washing Pilot Tests

3.4.1 Site Operations

The site operations were executed jointly by the SWACO team and Dames & Moore. The SWACO team handled the soil washing equipment and monitored health and safety conditions. Dames & Moore, supported by the equipment operators, performed pile management, soil loading, site housekeeping, and additional health and safety monitoring.[3]

3.4.2 Material Handling

Approximately one hundred cubic yards of excavated material were divided into ten piles of ten cubic yards each, which were placed separately on two curbed concrete soil staging pads. The piles were covered and segregated by visqueen. After treatment, each washed soil batch was re-placed on the concrete staging pad. The batches were processed separately and an attempt was made to maintain batch segregation throughout the test period.

The soils were washed in batches of 10 to 15 tons each with selected process parameters varied for each test. The test matrix is shown in Appendix A, Section 8.2. The SWACO soil washing process is described briefly below and is illustrated in Figure 3. The ten test soil piles were used to run seven soil washing tests as follows:[4]

- Run A was performed on Piles 3 and 6;
- Run B was performed on Pile 5;
- Run C was performed on Pile 9;
- Run D was performed on Pile 7;
- Run E was performed on Pile 8;
- Run F was performed on Piles 1 and 10; and
- Run G was performed on Piles 2 and 4.

3.4.3 Description of the Soil Washing Process and Equipment Train

The SWACO soil washing process included the primary unit operations described below. The process is depicted in Figure 3, and photographs of the operation are provided in Appendix D. SWACO's equipment terminology is shown in parentheses.

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[3] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #13

[4] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #4

Equipment Description	Process Function
Static bar screen (Grizzly)	Remove +8" debris from the test soil.
Pug mill with spray bars (Hydrojet mill)	Break up soil agglomerations and initiate soil/water slurrying.
One inch vibratory screen with spray bars (Classifier)	Remove rinsed -8", +1" material from the soil.
Mix tank (Attrition scrubber)	Mix the soil and water into a slurry and impart scrubbing action to the soil particles.
Batch slurry circulation tank (Floatation cell/float chamber)	Continue to mix the slurry with circulation pumps for a specified time while 600 CFM of air is introduced in a fine bubble mist to help float vegetative matter and particulates and emulsified constituents of concern (COC's).
Slurry tank skimmer (Vacuum skimmer)	Remove floated matter from the surface of the batch slurry tank in a quiescent area of the tank.
10 mesh Vibratory Screens with spray bars (Scalping Shaker)	Removed washed -1", +10 mesh particles from the soil washing unit.
Hydrocyclone (Desander)	Remove excess water and fine particles (-305 mesh) from the flow stream to improve separation on the downstream vibratory screens (added during test progress).
175 mesh Vibratory Screen with spray bars (Super shaker)	Remove washed -10 mesh, +175 mesh particles from the soil washing unit. Screen sizes ranged from 150 mesh to 210 mesh.
Hydrocyclone and Vibratory Screen with spray bars (Mud screens)	Remove washed fine sands from the flow stream. Screen sizes ranged from 175 to 210 mesh.
Horizontal bowl centrifuges (Centrifuges)	Remove washed silts and clays from the flow stream. Solids discharged as a stiff pancake batter consistency. Two centrifuges operated in parallel.

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Flocculation system (Floc box)	Inject flocculant into the wash water to cause the suspended fine particles to agglomerate into a flox.
Inclined plate clarifier (Clarifier)	Settle the floc from the wash water.
Horizontal bowl centrifuges (Dewatering centrifuges)	Remove excess water from the settled floc. Solids discharged as a cottage cheese consistency.
Wash water recirculation tank (Surge tank)	Holding tank for the recycled wash water.

3.4.4 Operational Difficulties

The pilot test operations went smoothly with minor difficulties as noted below. The Proposed Full Scale Site Layout (Figure 4) and Proposed Process Flow Diagram (Figure 5) reflect modifications to reduce the operational difficulties.[5] The most pervasive problem encountered was related to the tarry, adhesive nature of the soil.

Debris: Extensive debris was found in the soils to be tested, which passed through the "grizzly"and tended to clog pumps. The debris included treated timbers, sticks, roots, tie plates, oyster shells, barstock, spikes, and wire. The debris tended to plug the classifier screen and the attrition scrubber pump, and settled on the bottom of the flotation cell, blocking pump suction. The accumulation of solids in the flotation cell skimmer blocked the skimmer suction. It was necessary to remove grass and roots from the bottom of the clarifier frequently.

Screen Blinding: The tarry nature of the soil particulate and its propensity to blind screens was the most pervasive problem encountered. Screen blinding was problematic for the scalping shaker, super shakers, and mud cleaner screens. High pressure washes were used to clean the screens repeatedly.

[5] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #7

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Wash Water: The wash water produced during the pilot testing was commingled with stormwater and decontamination water and stored on-site in three 20,000 gallon frac tanks. The surfactants added to enhance the soils washing process would tend to coat the groundwater treatment system carbon adsorbers. Treatment for removal of surfactants will be required before the soil wash water passes through these units. Excessive rainfall made stormwater management time consuming and greatly contributed to the quantity of water requiring treatment and discharge.

Pad Configuration: The use of the 20' wide x 100' long concrete soil pads was difficult because of the tendency of the bobcat to push the soil out of the pad during loading. Due to the tarry nature of the test soils, the soil staging pads had to be washed with high pressure washers prior to placing washed soils back on the pads.

Traffic Pattern: Congestion due to equipment operation and pedestrian traffic caused problems during the pilot operations. The washed soils should be conveyed to a point away from the process area to relieve congestion and reduce equipment traffic where there is high pedestrian traffic.

Security: Theft problems were encountered during the operations. Site security will be increased to prevent equipment thefts.

3.5 Performance Sampling

The washed soil fractions smaller than 1" were sampled in accordance with the PSW-SAP. The 1" reject and 8" reject were not sampled due to the impracticality of analyzing these larger particles.

Because of the batch mode of operation, variations in the discharged fractions were observed over the course of each test run. As a rule, the samples were collected in the last two hours of each test run. Further, because of the size of the SWACO equipment, it was difficult to draw definitive lines between what was washed soil from the current test run, and what was residual washed soil from the previous test run.

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Lastly, the estimation of the volume of each washed soil fraction proved to be very difficult. Consequently, the accuracy of the calculated composite washed soil concentrations has an estimated accuracy of ±25 percent. The washed soil potentially cPAH test results are discussed in Section 5.2 and are summarized in Table 2.[6]

3.6 Water Management

Collection of stormwater at the site became a time consuming task due to the numerous storms that occurred during the pilot test period. The stormwater was pumped into 20,000 gallon frac tanks where it was commingled with wash water. The commingled stormwater and wash water were subsequently recycled to the soil washing process. The wash waters were treated by SWACO to remove fine solids as they were generated, before being placed in the frac tanks for recycling. Decontamination waters were stored there without being treated.

At the end of the test period SWACO treated all of the contents of the frac tanks to remove fine solids. The commingled and treated waters are currently stored in three frac tanks on-site. The estimated volume of stored water is 60,000 gallons. The water was sampled and the results are presented in Table 3. It is anticipated that treatment in the groundwater treatment plant for emulsified and dissolved organics, and possible further solids reduction, will be required before disposal. Alternately, the pilot wash waters may be sent off-site for treatment in an approved facility.

3.7 Health and Safety Procedures

SWACO performed health and safety monitoring and maintained logs for their operations. Dames & Moore performed supplemental health and safety monitoring on Beazer's behalf. The general tasks performed at the site included:

- daily Health and Safety briefings with key site personnel;
- dust monitoring and dust control;
- VOC monitoring at the soil piles and on the process equipment; and

[6] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #1

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- perimeter monitoring.

In addition to the routine events, the following special circumstances arose and were handled in accordance with the Health and Safety Plan:

- Respirators were donned during soil loading operations on one occasion when VOC levels at the soil pile exceeded action levels.

- Respirators were donned on several occasions by operators in the vicinity of the attrition scrubber tank. The elevated VOC readings were a result of the alcohol-based defoamer used by SWACO.

- A confined space entry was made into the slurry tank to remove settled solids. Oxygen levels were monitored, safety harnesses were worn and a safety watch was maintained. Workers were relieved every 15 minutes to avoid heat stress.

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4.0 Off-Site Pilot Studies

Beazer and Dames & Moore determined during bench testing that additional process treatment options would be investigated upon completion of the SWACO soil washing pilot test. Investigation into the process options for separating the particulate matter revealed several gravity separation techniques used in the mining industry (i.e., separation by differences in specific gravity of the soil particles and the particulate COCs. Could enhance the soil washing performance. Hazen Research, Inc. was contracted to perform bench scale and pilot scale tests on washed soil samples from SWACO runs E, F and G to evaluate methods of gravity separation.[7] The separation methods/devices evaluated were heavy medium separation, spiral concentrator, ellutriation column, and froth floatation. Wash soil fractions from roughly -8" to +325 mesh were evaluated in Hazen's tests. The evaluation and selection of the preferred process was based on the following four criteria:

- ability to reduce potentially cPAH concentrations;
- weight of clean soil produced versus weight of waste streams generated;
- process complexity; and
- water consumption of the selected process.

Samples of the -8", +1" SWACO discards for runs E, F, and G were received by Hazen and prepared for heavy medium separation tests by placing them in a rotary scrubber to further remove finer sands and clays from the larger particles. Samples of the scrubbed material were placed in separation tanks containing fluids of varying specific gravities (2.0 and 2.2). The fluid is a suspension of water and finely ground magnetite adjusted to the desired specific gravity. The particulate pitch and organic matter floats to the surface and the soils, sands, gravels, and shells remain on the bottom of the separation tank.

Spiral concentrator tests were performed on the washed sand fractions from SWACO runs E, F, and G. A spiral concentrator is typically a 6" to 8" diameter trough that spirals from 10 ft. high down to floor level in a 2 to 4 ft. diameter spiral. The water and soil slurry is pumped to the top of the spiral and as it flows to the bottom, the lighter COC's move to

[7] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #1 and TNRCC #4

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the outside of the trough and the sands stay to the inside (similar to stream bed gradations at a bend). Diverter blades divert the segregated streams to separate locations at the base of the spiral.

Ellutriation columns are similar to a fluidized bed column. Slurried sands and water were placed in the column and an upflow of water is introduced at the bottom of the column. The upflow carries lighter particles to a spillover weir at the top of the column and sands are drawn off the bottom of the column.

Froth floatation is a dual function operation tested on the washed sands and fines. Agitation is imparted to the slurry in a floatation cell by an agitator while a fine air bubble mist is simultaneously dispersed into the slurry. The lighter particles attach to the fine bubbles and float to the surface where they are skimmed off as froth. The sands and fines remain in the suspended slurry and are drawn from the floatation cell.

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5.0 Test Results

5.1 Physical Soil Characterization

5.1.1 Particle Size Distribution

Particle-size distribution curves for washed soils were prepared by calculating the dry weight fraction of each process stream discarded from the SWACO washing operation. The tarry nature of the untreated test soils also made sieving the material difficult. The soil had a tendency to agglomerate, which skewed the results to indicate less fine material than actually present.[8] The particle size distribution of the pre-washed soils are compared with the wash soil distributions in Figures 8, 9 and 10 for each of the seven test runs (A through G).

Figure 8 shows the percent weight of particles larger than 10 mesh. For the washed soils these were the scalper screen discards (SD). The washed +10 mesh soils contained surprisingly high fractions of coarse solids (primarily oyster shells and gravel), and were obviously fill type materials. Figure 9 shows the weight percent of particles between 10 mesh and roughly 200 mesh, which were the combined quantity of super shaker discards (SSD) and mud cleaner discards (MCD) for washed soils. Figure 10 shows the percent weight of particles smaller than roughly 200 mesh. For the washed soils these were the combined dewatering centrifuge (DWC), C1 and C2 centrifuge discharges.

5.1.2 Density and Moisture of Washed Soils

The washed sand fraction of the test soil was subjected to density tests as specified in the amended PSW-SAP (Dames & Moore, January 1993). The detailed results of these tests are presented in Hazen's Pilot Test Report (Appendix B). The average bulk density for the samples tested was 98.7 pounds per cubic foot (lb./ft.^{3}) wet and 82.8 lb./ft.^{3} dry. The weight percent water averaged 15.3 percent for these same samples.

[8] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #5

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5.2 Chemical Soil Characterization

5.2.1 Pre-Washed Soil

The feed soil samples were sieved and analyzed as described in Section 3.3. The potentially cPAH levels determined by this method are presented in Table 1.[9] [10] The pre-washed soil concentrations reported are lower than the reported concentrations of many of the washed soil fractions.[11] The primary reason for the seemingly low potentially cPAH values reported for the pre-washed soils is believed to be prejudicial handling of the samples in the lab. The lab technician handling the pilot test samples may have tested what physically appeared to be soil particles and excluded the particulate contaminants from the extraction sample. This is believed to have occurred because the size of some particulates would have prohibited them from being placed in the extraction container without being sub-divided.

Secondarily, there may have been poor dissolution of the constituents of concern in the prewashed soils during the lab extraction due to the adhesive nature of the soil. The dark stained pre-washed soils contain enough adhesive-type material to bind them into tight agglomerations. These agglomerations may have inhibited dissolution of the COC's into the extractant, thus giving false, low test results.

Consequently, the feed soil starting concentrations of Table 1 are not useful for determining the removal efficiency of the SWACO soil washing process. However, the achievable potentially cPAH levels in the washed soil can be determined with confidence. The achievable potentially cPAH levels are repeatedly confirmed by the analytical results of the Hazen separation tests described in this study.

The physical properties of the washed soil fractions generated by SWACO were much improved over the pre-washed soils. In contrast to the pre-washed soils, the washed soils had the appearance of friable, unstained soil, and were well graded and homogeneous. Consequently, the laboratory sample preparation for the washed samples was not prone to the prejudicial handling that may have occurred with the pre-washed samples.

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[9] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #3

[10] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #10

[11] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #6a.

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5.2.2 Washed Soil

After discharge from the SWACO process, the various washed soil fractions from each test run were analyzed for potentially cPAHs.[12] This included the scalper discharge (minus 1 inch, plus 10 mesh), the super shaker and mud cleaner discharges (roughly minus 10 mesh, plus 150 mesh), centrifuge discharges C1 and C2 (roughly minus 150 mesh, plus 325 mesh); and dewatering centrifuge discharge (roughly minus 325 mesh). The potentially cPAH values for each of these streams are shown on Table 2. The analytical data from the pilot testing demonstrates that many of the washed soils meet ROD goals when the weighted composite concentration is calculated.[13]

The seven SWACO test runs produced mixed results in relation to the ROD goal of 700 ppm potentially cPAH, as shown in Table 2. Observations which can be made from that table are as follows:

- gravels (-1 inch, +10 mesh) - one run under 700 ppm, five runs over 700 ppm, and one run not sampled;
- sands (roughly -10 mesh, plus 150 mesh) - four runs under 700 ppm, two runs over 700 ppm, and one part of one run not sampled (this is based on both the SSD and MCD samples being either under or over 700 ppm); and
- fines (roughly -150 mesh) - two runs under 700 ppm, four runs over 700 ppm, and one run not sampled.

5.3 Wash Water

5.3.1 Characterization

The wash waters were sampled five times during the pilot tests. The samples were analyzed for potentially cPAHs, BTEX, pH, total suspended solids (TSS), total dissolved solids (TDS), chemical oxygen demand (COD) and total organic carbon (TOC). The results of the analyses are presented in Table 3. The wash waters are currently being tested for surfactant levels and surfactant removal treatability tests by Chester Environmental. Results of these tests will be presented when available.

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[12] See Response to EPA Comments, December 16, 1993, Appendix G - Item TNRCC #2 and EPA #10

[13] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #6b.

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The water currently stored in the frac tanks on-site cannot be considered fully representative of the wash water which will be produced by the full scale soil washing process. The stored water is commingled batches of stormwater, wash water and decontamination water. An attempt will be made during full scale operation to prevent storm water from coming in contact with the process or from entering the process containment pads. Further the full scale process will vary somewhat from the pilot test process as described in Section 6.3.

5.3.2 Surfactant Performance

Two surfactants, Dowfax 8390 and Triton X-100, were tested in various concentrations and at various wash water pH's. The details of the test and the test matrix are provided by SWACO in Sections 7.1 and 8.2 of Appendix A. The pilot tests indicate that the Triton X-100 exhibited excessive foaming problems and performed no better than the Dowfax 8390. The Dowfax 8390 provided acceptable performance at concentrations of 0.5 to 1.0 weight percent of the wash water at a ph of 11 to 12.

5.4 SWACO Soil Washing Equipment Performance

The SWACO equipment encountered numerous solids handling difficulties. These difficulties and others are discussed in detail in SWACO's Pilot Test Report (Appendix A) and include:

- slow feed rate capability of the grizzly;
- high water usage and poor dispersion in the pug mill;
- insufficient particle abrasion in the attrition scrubber;
- coarse solids settling in the attrition scrubber and slurry tank;
- low percent solids in the slurry tank;
- excessive foaming if defoamer is not used;
- numerous pump and line plugging problems; and
- low screen efficiencies due to blinding of the screens with tar.

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These difficulties necessitate significant departure from the pilot test unit for full scale application. SWACO's recommended modifications to their equipment are discussed in detail in Section 13 of the SWACO report (Appendix A). The recommended full scale process, based on the SWACO and Hazen results, is discussed in Section 6.3.

5.5 Hazen Equipment Performance

Of the Hazen test runs which were performed during the evaluation of separation methods (see Hazen Appendices C, D, E and F), ten produced clean (i.e. less than 700 ppm) sands, ten produced clean fines, two produced clean gravel, and one produced clean rocks.[14] The Hazen tests indicated effective performance of froth floatation, heavy media separation and spiral concentrators. Ellutriation column testing did not indicate effective separation of the particulate COCs from the soil.

Of the gravity separation processes tested by Hazen, froth floatation afforded the best removal of COC's, consumed a relatively low volume of wash water, and produced the maximum quantity of clean soil. The integration of froth floatation into the overall soil washing process is presented in Figure 5 and discussed in Section 6.3.

These and other process specific parameters are summarized for the various gravity separation processes in Hazen's Test Report (Appendix B). The results of Hazen's tests are of such a nature that the test results cannot be summarized in a single table without reference to the Hazen text.

5.6 Lab Data Correlations

Approximately 165 soil samples and 8 water samples were analyzed as part of the pilot soil washing tests. The total PAH levels of the pilot test samples were compared to the total potentially cPAH levels. The results are presented in Tables 5 and 6, and Figures 6 and 7. No specific correlation was found; however, a ratio of about 10 to 1 total PAH to totally potential cPAHs was observed for the washed soils and a 3 to 1 ratio was observed for the pre-washed soils. This correlation was investigated because it may assist in the use of field test kits in the full scale RA.

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[14] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #1 and TNRCC #4

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6.0 Conclusions and Recommendations

6.1 Summary of Pilot Test Performance

Approximately 78 cubic yards of soil were washed in seven on-site pilot soil washing runs. The potentially cPAH concentrations of the test soils prior to treatment, as shown in Table 1, varied from 22.30 ppm to 1271.51 ppm. The accuracy of this data is discussed in Section 5.2.1. The washed soils discharged from the SWACO process had potentially cPAH levels of 117 ppm to 6882 ppm as shown in Table 2.

The data which most clearly indicates the reduction of potentially cPAH in soils at the site is the Hazen froth floatation separation tests.[15] For inlet feed concentrations of 1,420 ppm and 256 ppm, clean soils ranging from non-detectable to 324 ppm were produced.

6.2 The Basis of the Conceptual Design

The results of the SWACO pilot tests and Hazen bench scale and pilot tests were used to develop a conceptual design for the full scale soil washing process. The conceptual design is founded on the premise that the goal of the ROD can be met with a soil washing process as described in this report.[16] The predicted success of the soil washing process is based on the test soils being representative of the remaining soils at the site.

The proposed full scale soil washing process will include scrubbing and particle size separation operations (such as those performed by SWACO during the pilot tests on site), combined with gravity separation steps (such as those tested by Hazen). The proposed full scale flow diagram is based on the following assumptions:

- The soils to be treated will be similar in particle size distribution to those processed during the pilot test.
- The soils to be treated will contain a similarly high quantity of particulate tar and pitch as was identified in the pilot test soils.

[15] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #1

[16] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #12

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6.3 Proposed Soil Washing Equipment Train

The proposed full scale soil washing process is illustrated in Figure 5 and discussed below.[17]

Grizzly: The excavated soil will be fed into the soil washing process through a 6-inch static dry screen also known as a "grizzly". The grizzly will remove plus 6-inch material. The grizzly rejects will be stockpiled.

Two-Stage Rotary Dry Screen: The material passing the grizzly will move to the two-stage rotary dry screen. This screen will discharge a plus 2-1/2 inch material, a minus 2-1/2 inch, plus 1/2 inch material, and a minus 1/2 inch material. Plus 1/2 inch material is rejected and minus 1/2 inch material passes to the wet rotary scrubber. The plus 2-1/2 inch rejects will be stockpiled. The plus 1/2 inch rejects will be stored separately.

Wet Rotary Scrubber: The minus 1/2 inch material will be discharged to a wet rotary scrubber with a 10 mesh trommel. The oversize materials passing through the trommel (minus 1/2 inch, plus 10 mesh) will be free draining. They will be stockpiled in a manner that permits them to drain. The minus 10 mesh material passing the trommel will be in the form of a water and soil slurry. It will be discharged to an 80 mesh vibratory screen.

80 Mesh Vibratory Screen: The minus 10 mesh underflow material from the wet rotary scrubber will fall onto an 80 mesh wet vibratory screen. The -10 mesh, +80 mesh screened material will be stockpiled and allowed to drain. After draining, these clean sands will be mixed with the dewatered sands and fines from the mechanical floatation cell, and a soil amendment in a pug mill, and then returned to the excavation. The material that passes through the screen will be discharged to the mechanical floatation cell.

Mechanical Flotation Cell: The -80 mesh underflow material from the 80 mesh vibratory screen composed of soil, weathered creosote, pitch and tar, and undersized debris will enter

[17] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #8

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the floatation cell. Approximately 43 wt% of the feed soil will enter the floatation cell. Water will be added to the mixture to operate the process at a 35 wt% solids slurry. In the floatation cell, micro-fine bubbles of air are introduced at the bottom of compartment, where they will attach to the lighter particulate, causing it to float to the surface as a froth. The washed soil discharges from the mechanical flotation cell as a slurry to a 200 mesh vibratory screen for dewatering.

Approximately 6 wt% of the feed soil will be skimmed off as froth at an estimated 25 wt% solids slurry. Two 500-gallon cone bottom tanks, each providing a retention time of approximately 60 minutes, will receive the froth discharge. After the addition of a foam breaker and flocculant, one tank will be used to settle the solids while the other tank fills. The tank bottom solid slurry, expected to contain the majority of the froth solids in a 50 wt% solids slurry, will be discharged into 55-gallon drums for reuse, or further treatment or disposal off-site at an approved TSD facility.[18] The treated water will be either recycled back to the process or will be blown down to the groundwater treatment plant.

<u>200 Mesh Vibratory Screen</u>: The material from the bottom of the floatation chamber will drop onto a 200 mesh vibratory screen. The minus 200 mesh undersize material, which will contain a significant portion of the process water, will be dewatered using horizontal bowl centrifuges. The water removed will be recycled to the soil washing process.

<u>Pug Mill</u>: In the pug mill, the -80, +200 fine sands from the floatation cell, the minus 200 mesh fines from the dewatering centrifuges, coarse sands (minus 10, plus 80 mesh) from the vibratory screen, and a clean sand soil amendment will be mixed and blended, before being returned to the excavation as clean fill.

6.4 Anticipated Full Scale Plant Performance

The revised process is predicted to wash soils with initial potentially, cPAH concentrations of 1500 ppm or less to levels below the 700 ppm total potentially cPAH criteria. Process performance for soil in excess of 1500 ppm CPAH, will be monitored in

[18] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #9

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the field. Based on concentrations of COC's identified during the Remedial Investigation, it is probable that hot spots above 1500 ppm potentially cPAH will be homogenized to below 1500 ppm during the excavation and pre-screening/feed preparation operations. Based on the physical characteristics of the test soils, the washed soil will represent approximately 67 weight percent of the soil excavated.

6.5 Backfill Requirements

The full scale process will require that the washed soils (minus 10 mesh) be amended to restore the soil to its original volume and to provide a geotechnically sound fill material for backfill into the excavations.

Approximately 27 weight percent of the feedstock is soil particles larger than 10 mesh. It is proposed that the minus 2-1/2 inch, plus 10 mesh materials, separated from the feedstock, comprising approximately 17 wt% of the feed, be used as asphalt aggregate as described in Section 6.10. Further, the froth discharged from mechanical flotation will contain approximately 6 weight percent of the feedstock and will not be recombined with the washed soils. The removal of this combined 33 weight percent (aggregate plus froth solids) of the impacted soil feedstock will require an equal amount of soil amendment to return an adequate volume of fill to the excavation. Therefore, 33 weight percent of the feedstock will be replaced with clean borrow sand as a soil amendment.

The soil amendment, when combined with the washed soils, must provide a stable fill. The in-situ water content of the excavated soils was estimated to be in the range of 20 to 25 weight percent and stable prior to removal. The target water content for the washed soil fill should be in the range of 20 to 25 weight percent to provide similar stability.

Clean sand will be used as the soil amendment. A clean well-graded sand has an optimum moisture content of 9 to 16 weight percent. Several soil material suppliers in the Houston area have indicated an average delivered moisture content, weather dependent, will range from 8 to 14 weight percent. During periods of rain and high humidity, no guarantee of moisture content on delivered amendment is normally offered. A normal delivered amendment moisture content of 14 weight percent will be assumed.

Washed soil from the 80 mesh vibratory screen (minus 10 mesh, plus 80 mesh), dewatered floatation tailings (minus 200 mesh) and screened flotation tailings (minus 80

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mesh, plus 200 mesh) will be combined with the soil amendment in the pug mill. The mixed soil will be segregated in approximately 50-ton piles and marshalled in a constructed staging area. Free draining liquids will be collected and pumped to the on-site groundwater treatment facility. The concrete pad will serve to further dewater the mixed soils prior to return to excavation.

Material balance calculations for the averaged soils tested indicate that the combined materials should achieve a water content of 25 weight percent. Fly ash or similar material will be added in the staging area, as required, to obtain desired compaction properties.

6.6 Wash Water Pretreatment

Wash water will be discharged from the process at several points. Water from the centrifuge will be commingled with water separated from the froth. Free draining water from the washed soil staging area will also be routed to the wash water storage area. These waters will likely require further treatment to remove fine suspended solids. Dissolved organics are not expected to be a problem due to the low solubility of the COC's in water. A blowdown of 10% of the wash water recirculation rate (approximately 10 to 20 gpm of blowdown) is suggested to prevent buildup of surfactant and solids in the wash water.

At the end of soil washing operations, the wash water will be discharged to the ground water treatment plant for final treatment.

6.7 Site Configuration

The site configuration used for the pilot soil washing tests is illustrated in Figures 1 and 2. The configuration was effective but several improvements and revisions will be required for full scale operations. A modified conceptual full scale site layout is provided in Figure 4. This layout will be finalized when the RA contractor is selected.

6.8 Sampling and Analysis Procedures

Improved and simplified sampling and analysis procedures will be developed for full scale operations. Several key features will be incorporated as noted below.

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- Feed soils will be screened by visual means noting clay content, moisture content, and presence of tar and pitch.

- Washed soils will be tested using an on-site lab or other approved field test kit methods to expedite returning clean soils to the excavation.

6.9 Waste Streams

As currently planned, the soil remediation will generate minimal process residual streams for off-site disposal. Wash water will be recycled, except for a small amount of blowdown, which will be discharged to the on-site groundwater treatment plant. The froth solids slurry described in Section 6.3 will be reused or disposed of at a TSD facility. The remediation will generate personnel protection equipment (PPE) wastes, sampling wastes, and miscellaneous solid wastes such as oversize debris, visqueen, etc. This material will be managed onsite and disposed of at a TSD facility.

Coarse aggregate and aggregate will be recycled into a beneficial use product made and used on-site. The process will discharge two aggregate fractions (minus 2-1/2 inch, plus 1/2 inch and minus 1/2 inch, plus 10 mesh) that will be recycled in an on-site asphalt batch plant. The aggregate is intermixed with particulate tars and pitch and is suitable for asphalt mixes. The proposed disposition of these materials is discussed further in Section 6.10.

Management of debris larger than 2-1/2 inches will be addressed in the RA planning phase of the project. Based on the visual characterization of this large debris during the pilot tests, it is probable that high pressure hydroblasting of the material is the appropriate treatment method. The material would then be managed as specified in the approved RA Work Plan.[19]

6.10 Recycle of Beneficial Use Constituents

The test soil contained approximately 17 weight percent aggregate larger than 10 mesh and smaller than 2-1/2 inch. Approximately 50 to 60 weight percent of this aggregate is tar- and pitch-like material. In addition, a quantity of the aggregate present in the soils is covered with a hard coating of the tar material.

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[19] See Response to EPA Comments, December 16, 1993, Appendix G - Item TNRCC #5

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The aggregate is ideally suited for use in an asphalt mix.[20] The basis for this conclusion is review of Asphalt Institute literature and ASTM specifications for asphalt mixes and discussions with asphalt recycle contractors. These rock fractions will be made into a cold-mixed asphalt pavement which will be used to pave a portion of the site. This asphalt produced on-site will be used to pave the backfilled excavations areas to allow trucks to be parked in the remediated areas. The proposed recycled aggregate will produce approximately 48,000 square foot of 6-inch thick asphalt suitable for paving purposes. The recycle of aggregate into asphalt is discussed in detail in Appendix C.

[20] See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #2 and EPA #12

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Figures

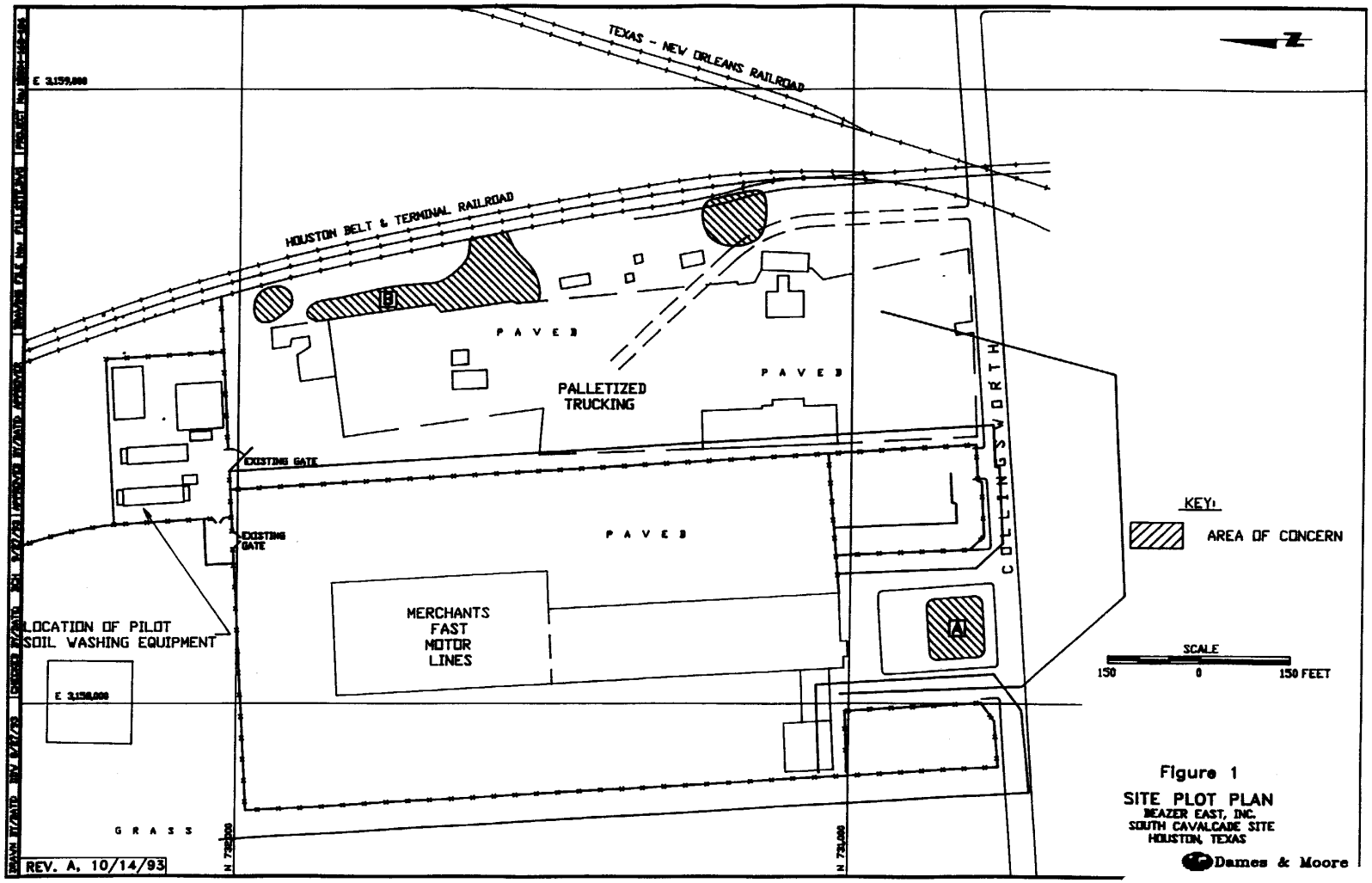

Figure 1
SITE PLOT PLAN
BEAZER EAST, INC.
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

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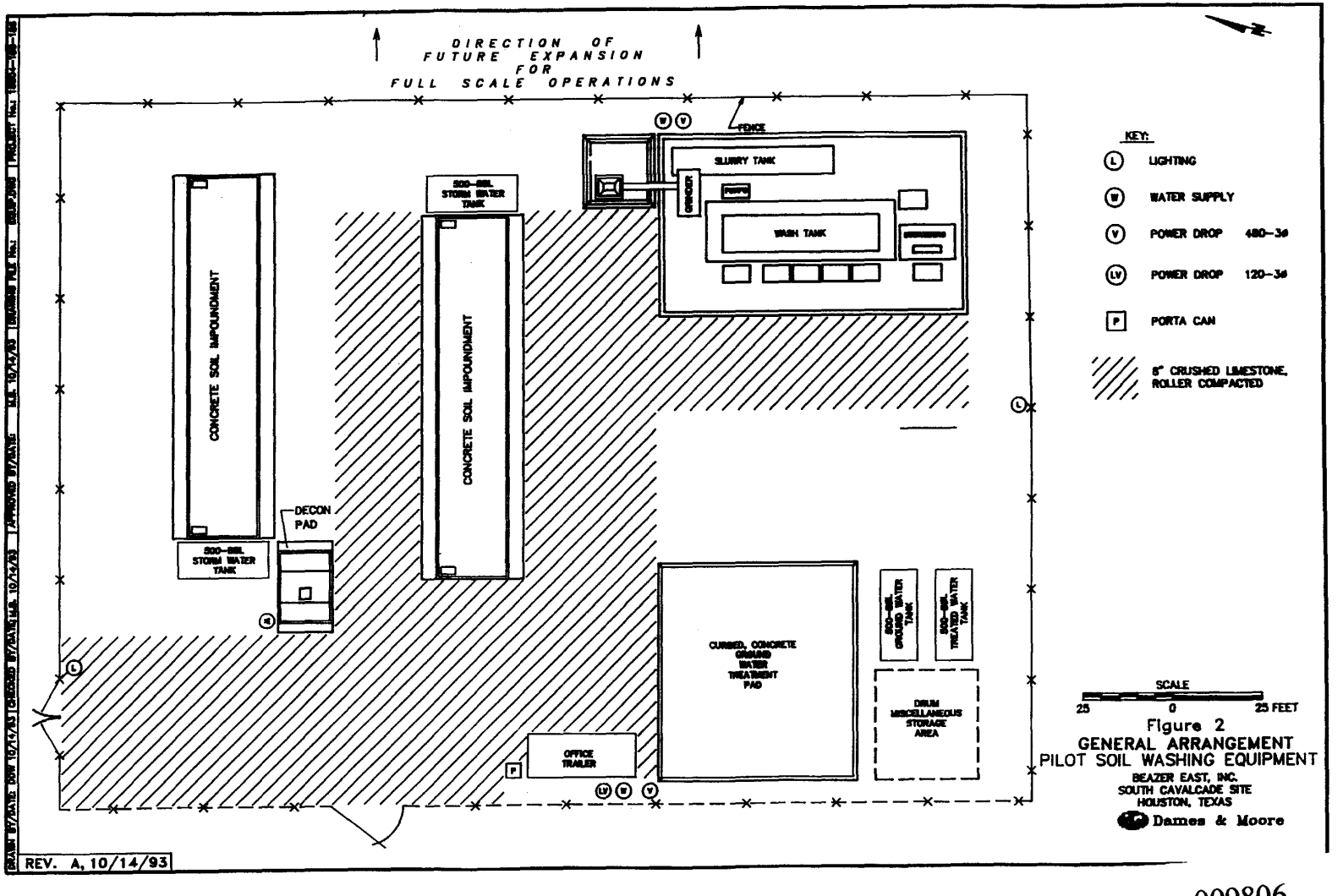

Figure 2
GENERAL ARRANGEMENT
PILOT SOIL WASHING EQUIPMENT
BEAZER EAST, INC.
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
Dames & Moore

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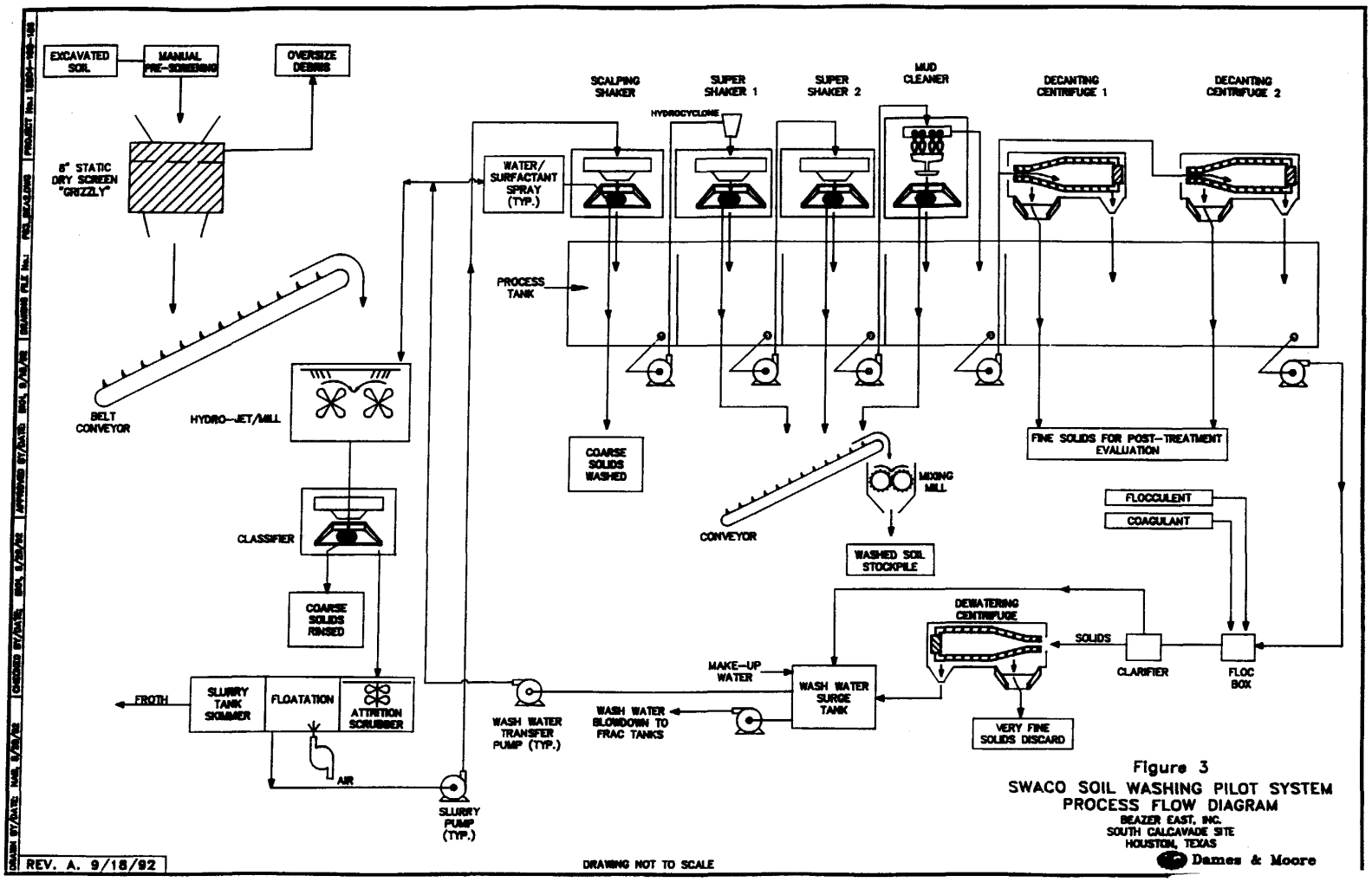

Figure 3
SWACO SOIL WASHING PILOT SYSTEM
PROCESS FLOW DIAGRAM
BEAZER EAST, INC.
SOUTH CALCAVADE SITE
HOUSTON, TEXAS

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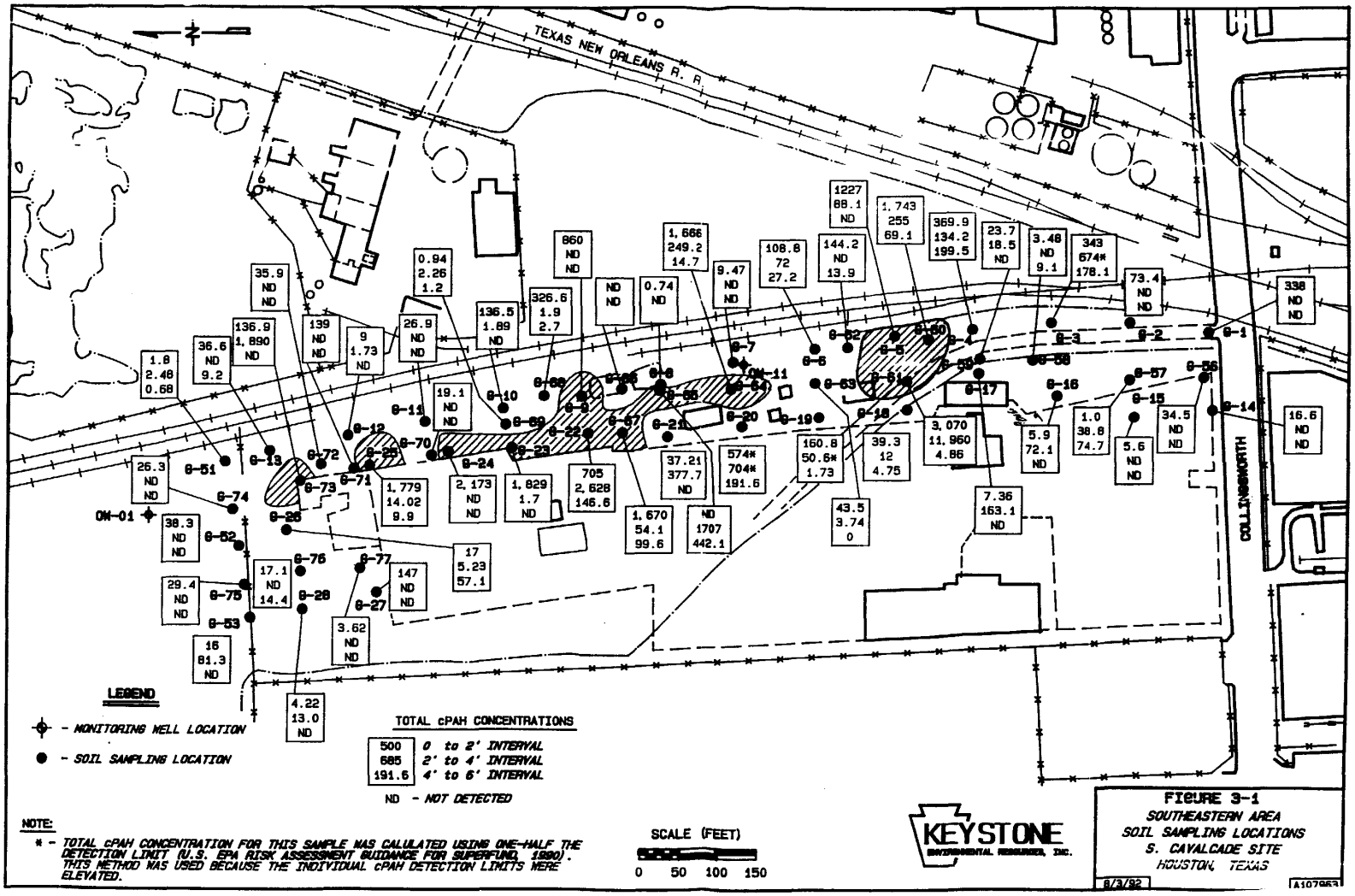
TEXAS NEW ORLEANS R. R.
COLLINGSWORTH
LEGEND
- MONITORING WELL LOCATION
- SOIL SAMPLING LOCATION
TOTAL cPAH CONCENTRATIONS
500 0 to 2' INTERVAL
685 2' to 4' INTERVAL
191.6 4' to 6' INTERVAL
ND - NOT DETECTED
NOTE:
* - TOTAL cPAH CONCENTRATION FOR THIS SAMPLE WAS CALULATED USING ONE-HALF THE DETECTION LIMIT (U.S. EPA RISK ASSESSMENT GUIDANCE FOR SUPERFUND, 1990). THIS METHOD WAS USED BECAUSE THE INDIVIDUAL cPAH DETECTION LIMITS WERE ELEVATED.
SCALE (FEET)
0 50 100 150
KEYSTONE
ENVIRONMENTAL RESOURCES, INC.
FIGURE 3-1
SOUTHEASTERN AREA
SOIL SAMPLING LOCATIONS
S. CAVALCADE SITE
HOUSTON, TEXAS
8/3/92
A107953

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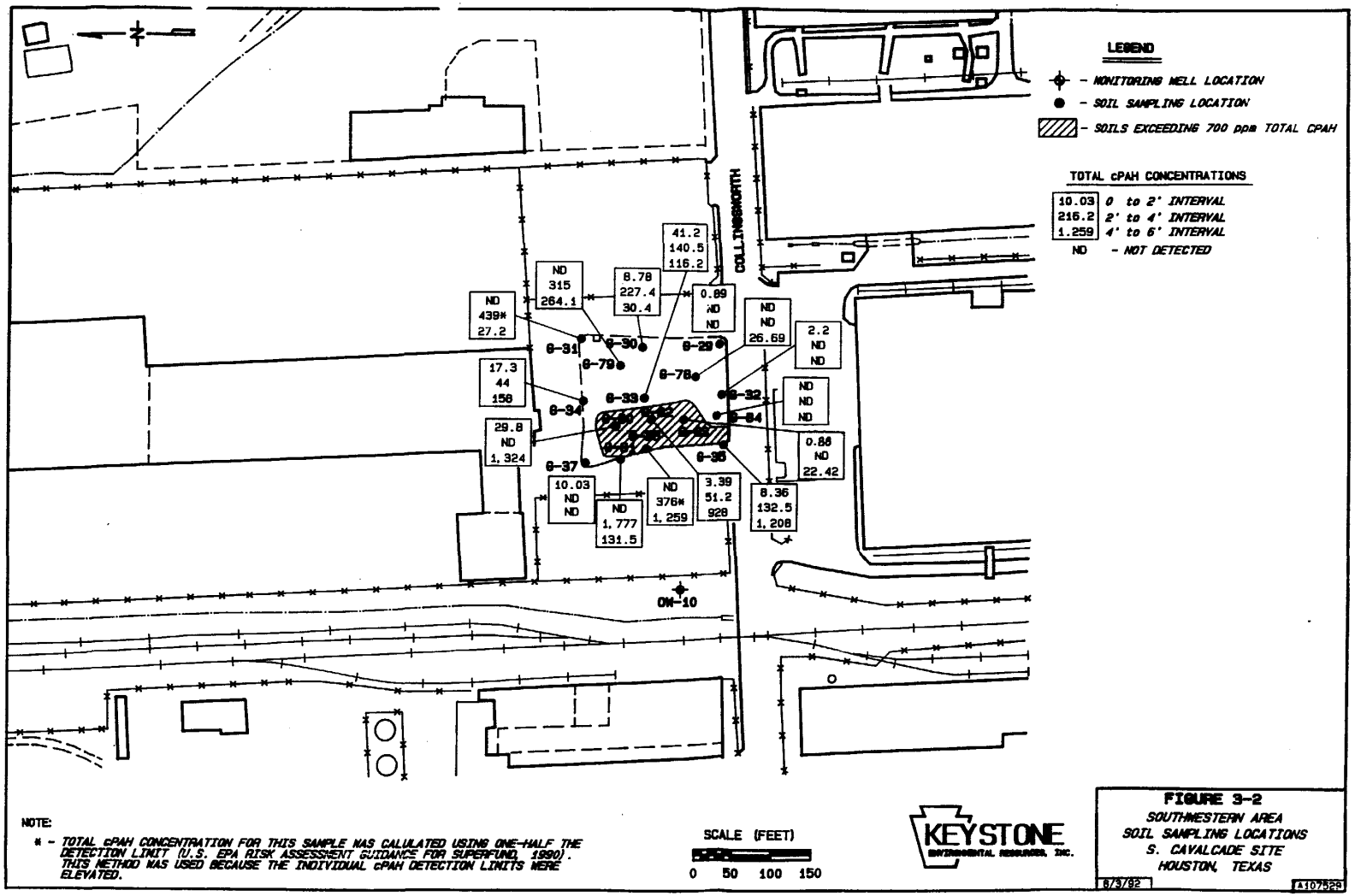

NOTE:

* - TOTAL cPAH CONCENTRATION FOR THIS SAMPLE WAS CALULATED USING ONE-HALF THE DETECTION LIMIT (U.S. EPA RISK ASSESSMENT GUIDANCE FOR SUPERFUND, 1990). THIS METHOD WAS USED BECAUSE THE INDIVIDUAL cPAH DETECTION LIMITS WERE ELEVATED.

FIGURE 3-2
SOUTHWESTERN AREA
SOIL SAMPLING LOCATIONS
S. CAVALCADE SITE
HOUSTON, TEXAS

8/3/92 A107528

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[redacted]

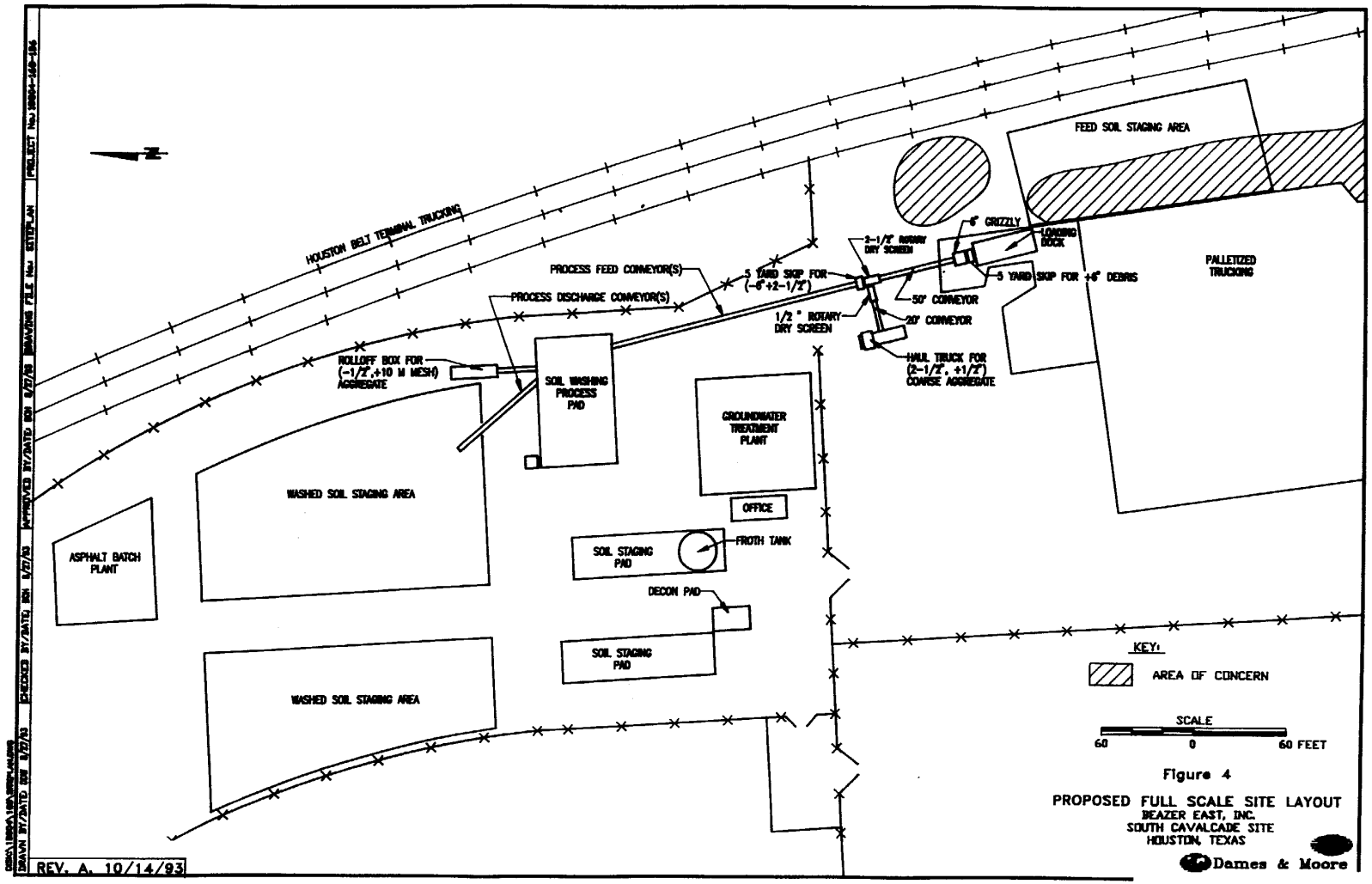

Figure 4

PROPOSED FULL SCALE SITE LAYOUT
BEAZER EAST, INC.
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

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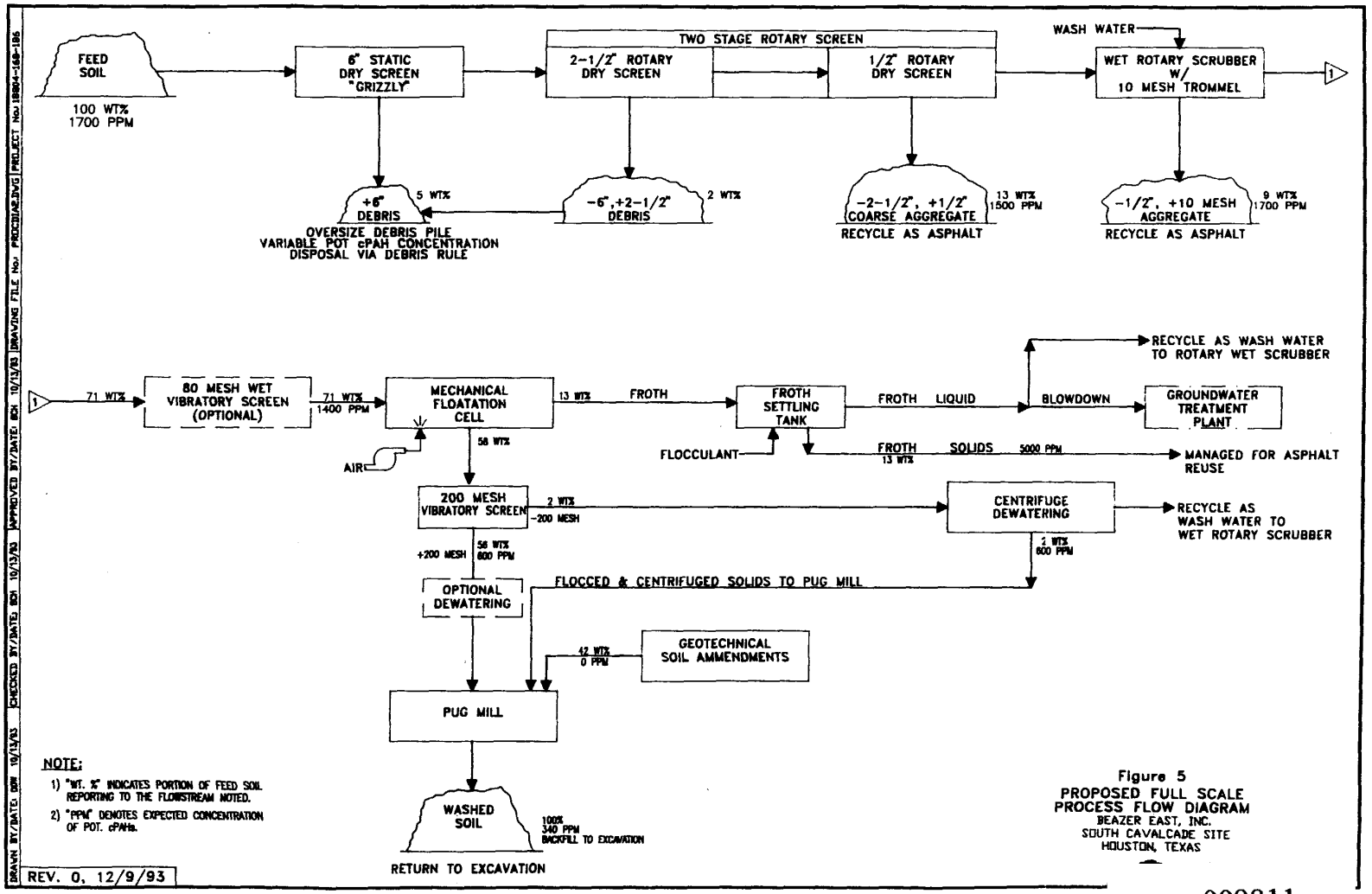

Figure 5
PROPOSED FULL SCALE PROCESS FLOW DIAGRAM
BEAZER EAST, INC.
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

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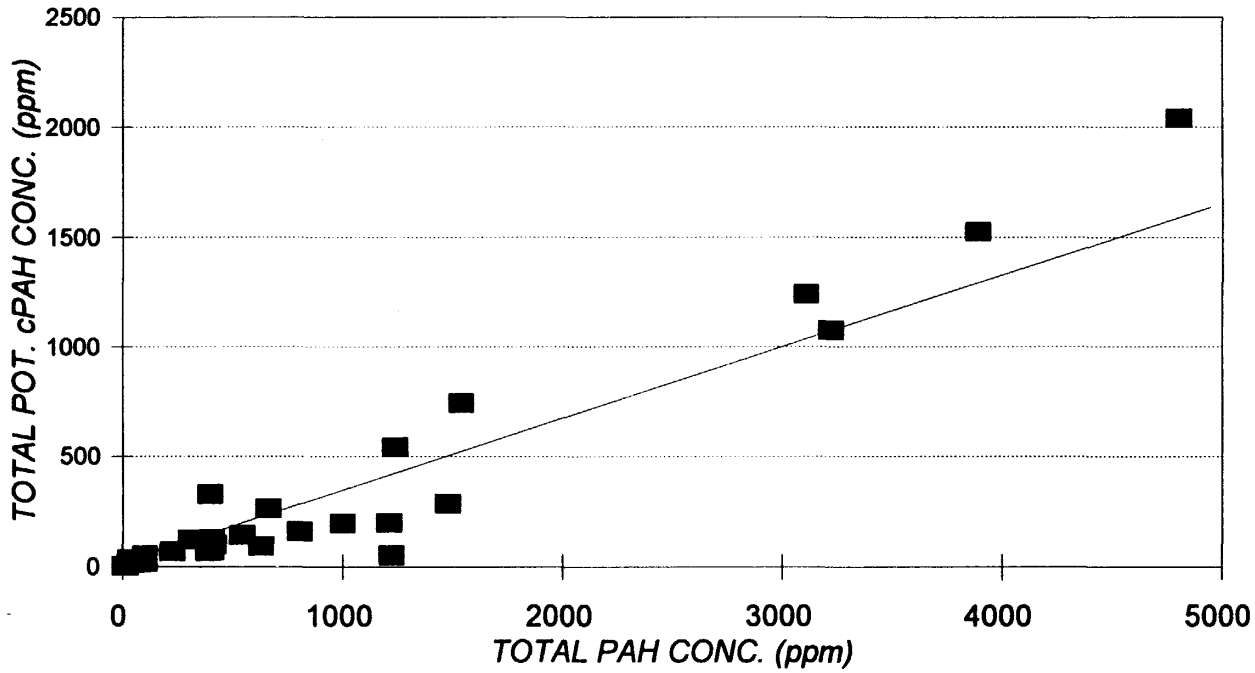
BEAZER - S. CAVALCADE SITE
PRE-WASHED SOIL - PAH vs. POT. cPAH



- DATA PLOTTED FROM TABLE 5
-SOIL ANALYSIS DATA FROM
CHESTER LABS

[redacted]

PSRFIG6.BZR

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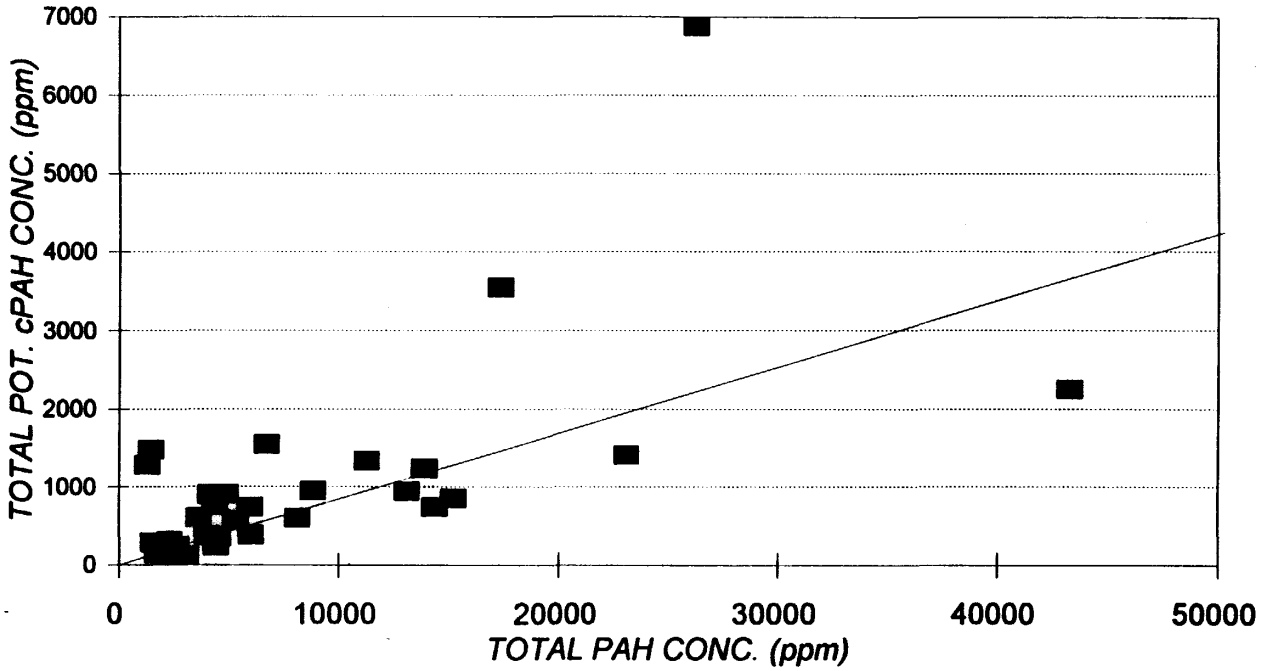
BEAZER - S. CAVALCADE SITE
WASHED SOIL - PAH vs. POT. cPAH



-DATA PLOTTED FROM TABLE 6
-SOIL ANALYSIS DATA FROM
CHESTER LABS

[redacted]

PSRFIG7.BZR

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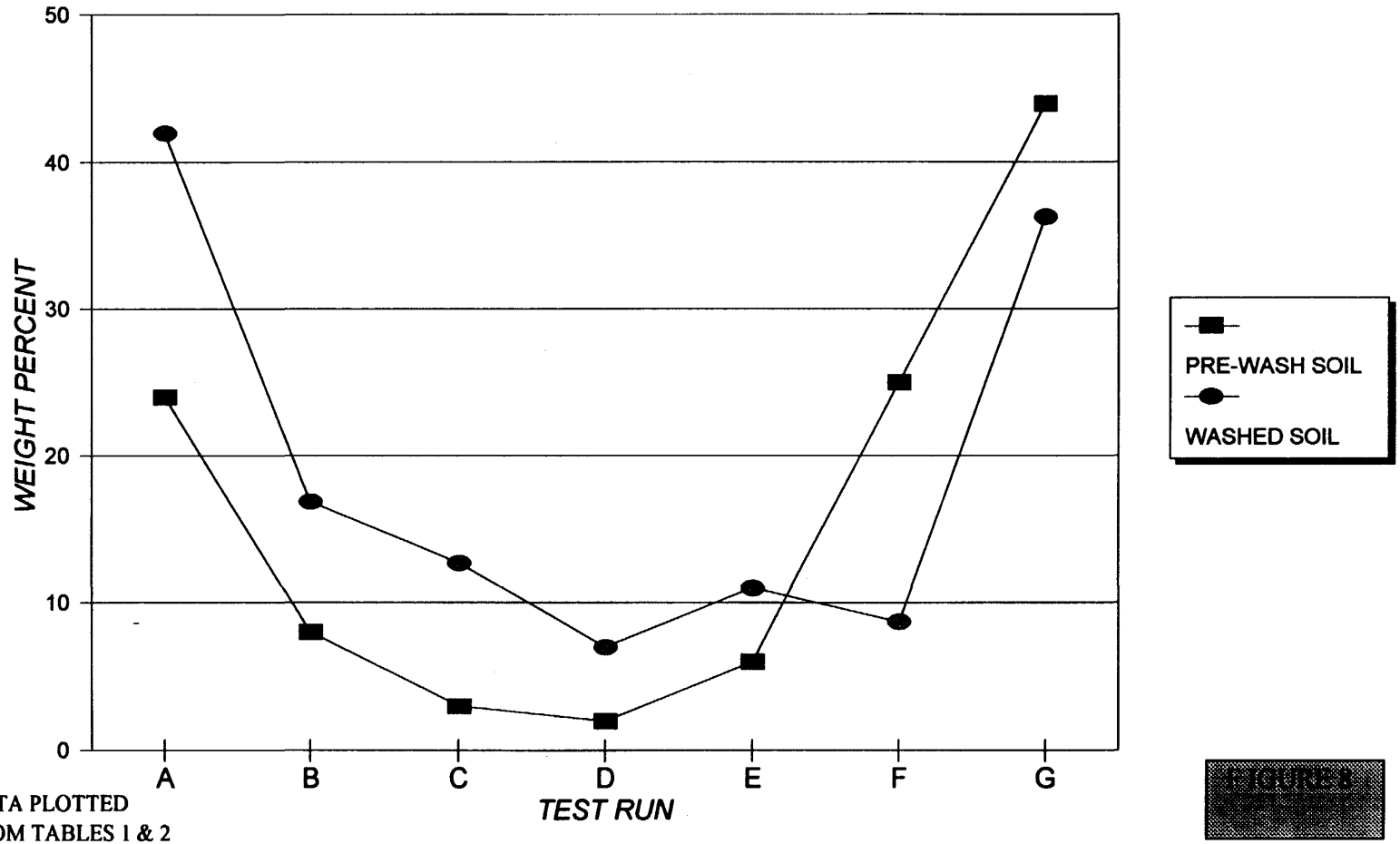
BEAZER - S. CAVALCADE SITE

PARTICLE SIZE COMPARISON

-1", +10 MESH



DATA PLOTTED
FROM TABLES 1 & 2

FIGURE 8

PSRFIG8.BZR

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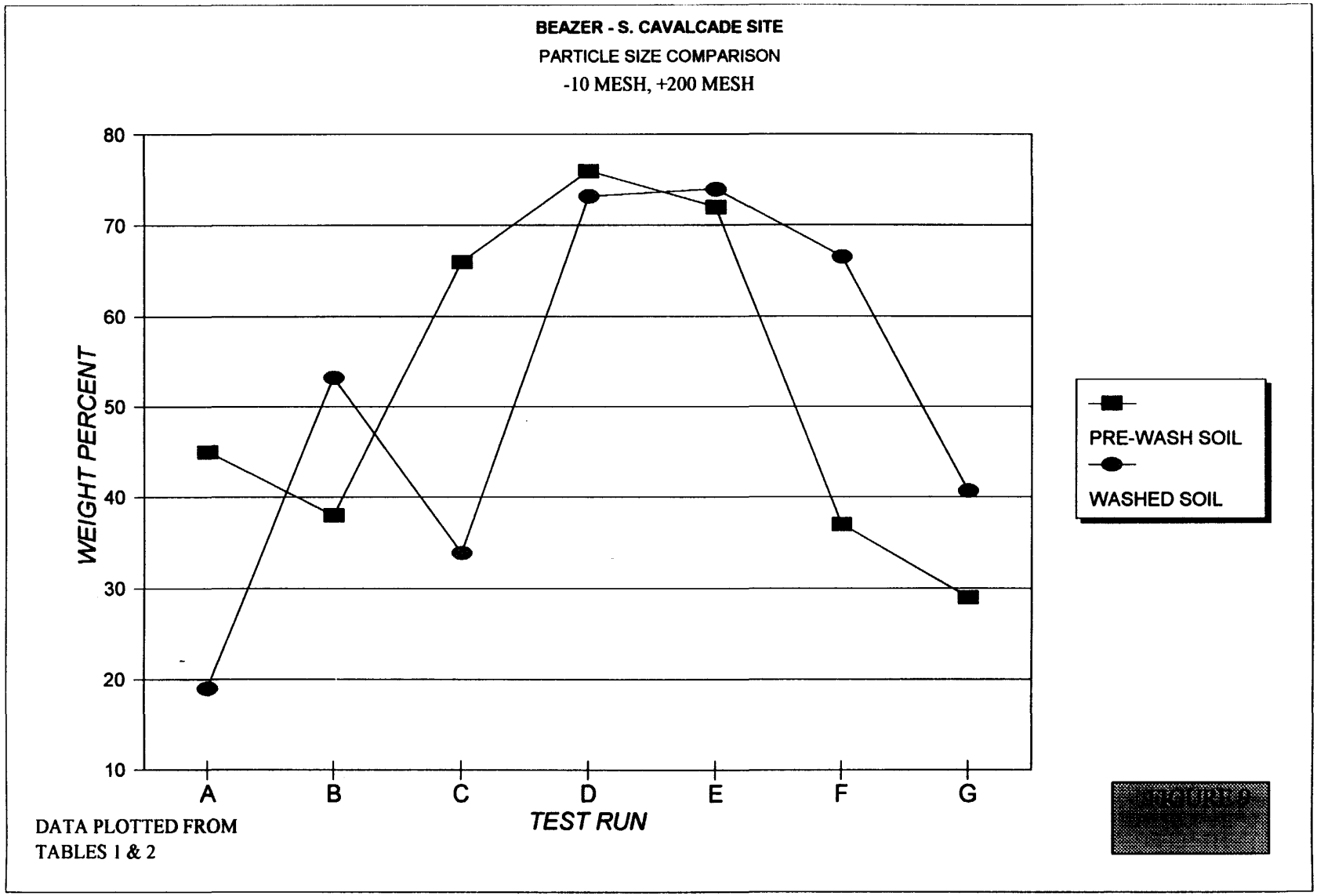

PSRFIG9.BZR

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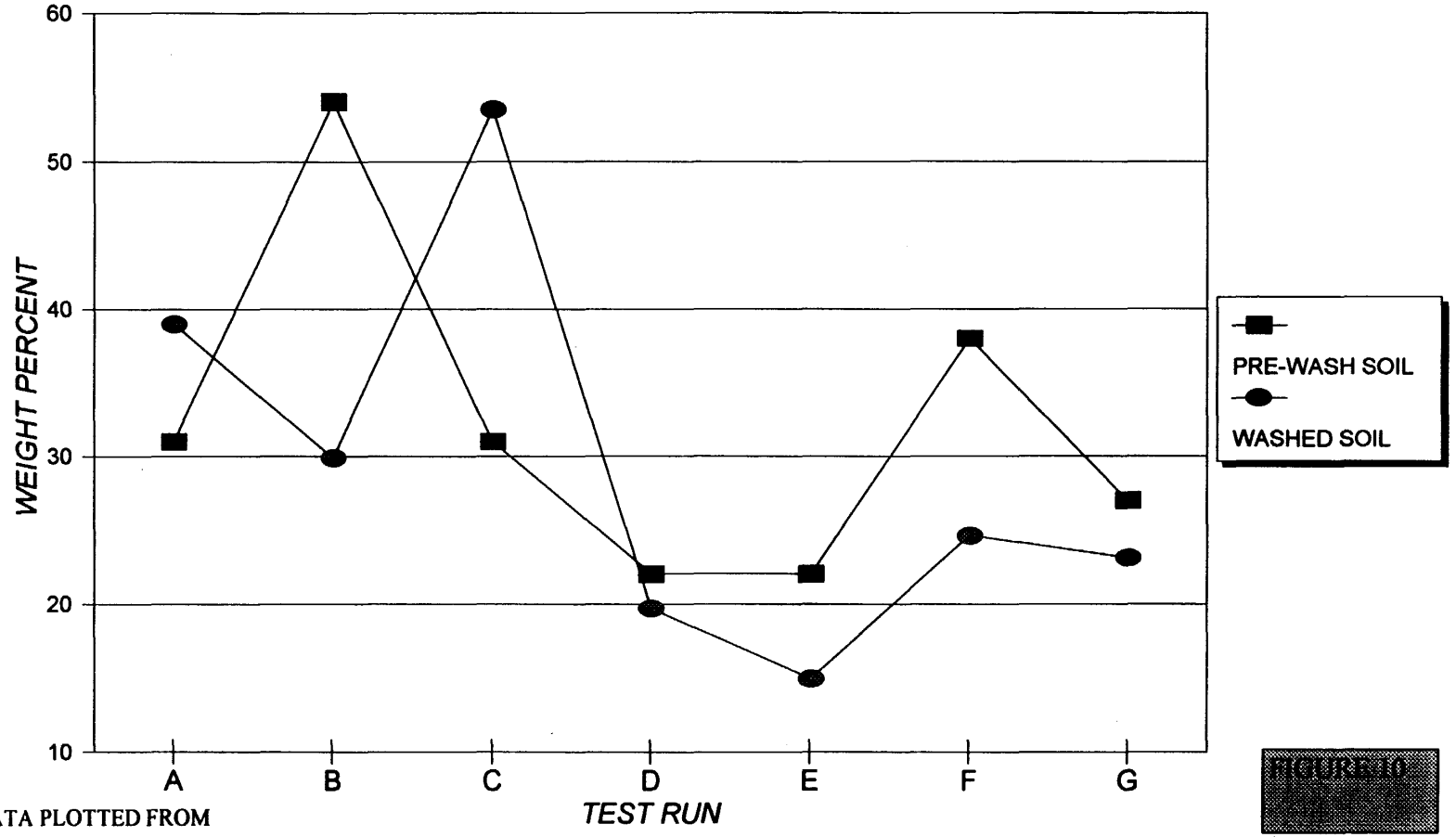
BEAZER - S. CAVALCADE SITE

PARTICLE SIZE COMPARISON

- 200 MESH

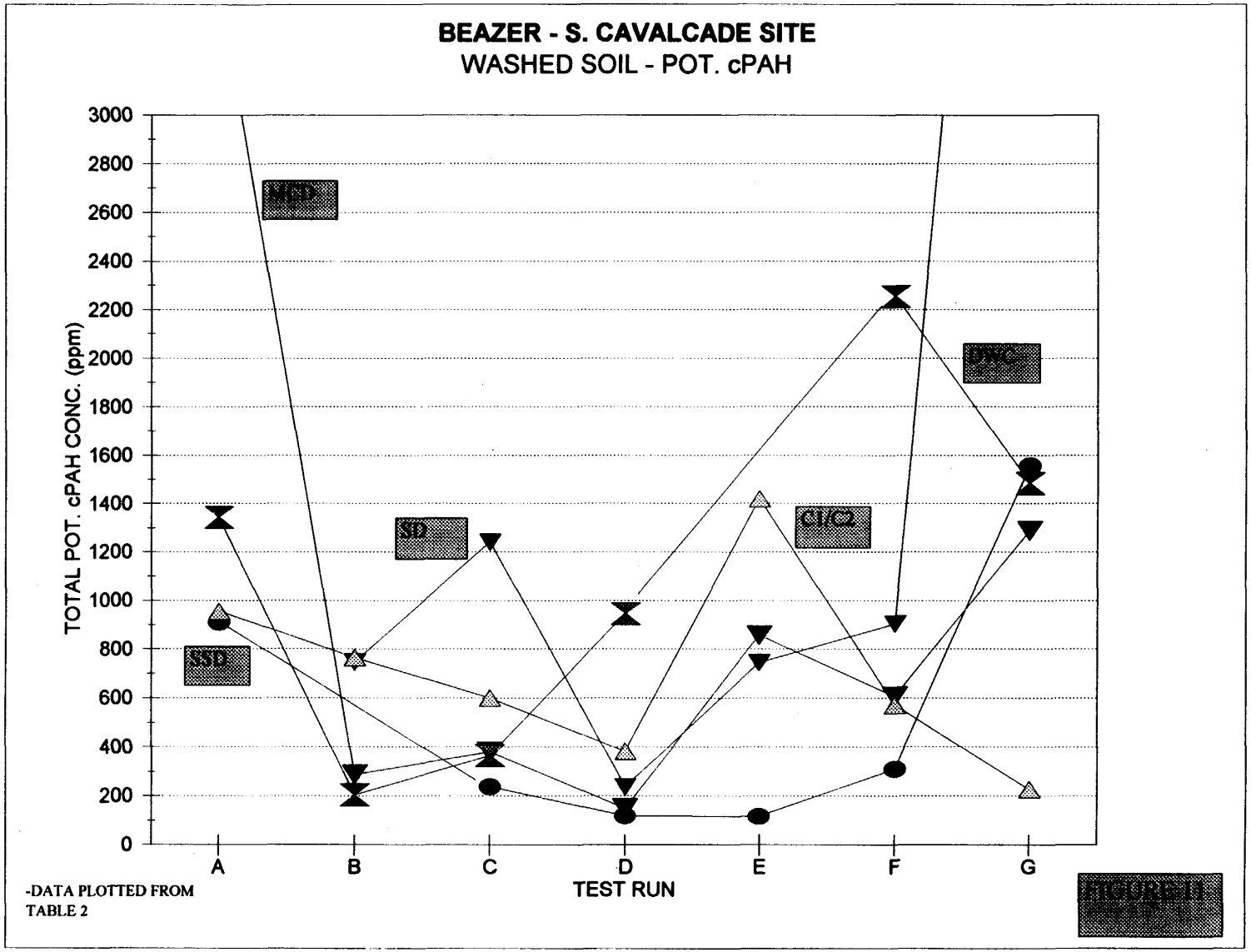


DATA PLOTTED FROM
TABLES 1 & 2

FIGURE 10

PSRFIG10.BZR

009816



PSRFIG11.BZR

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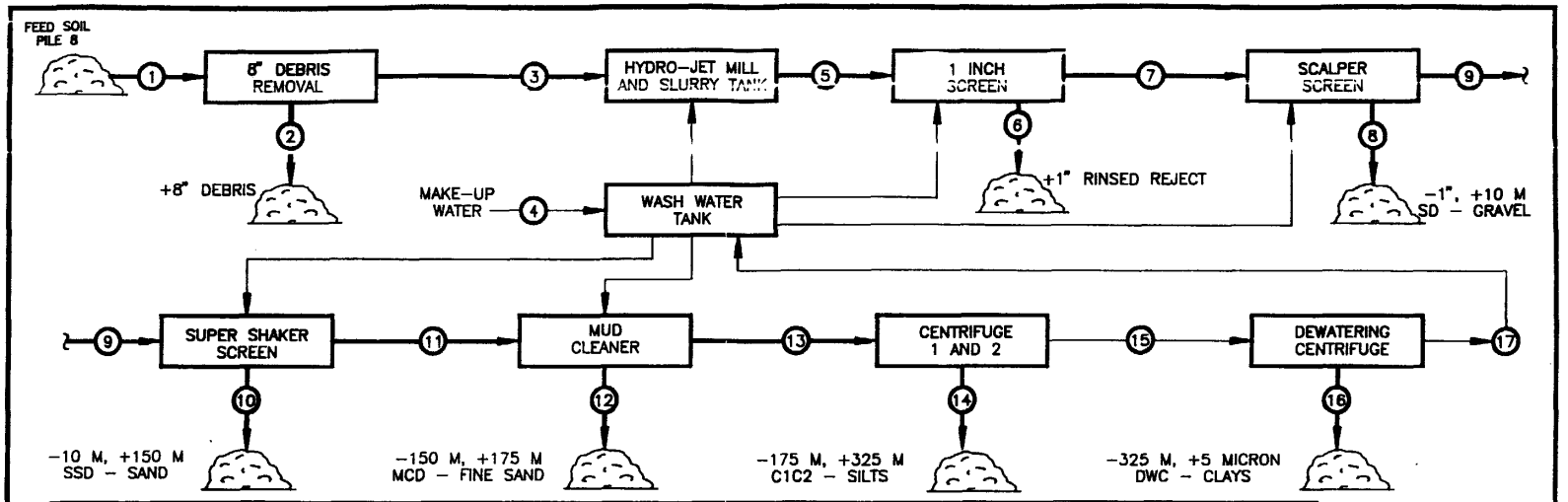

FLOW STREAM	DESCRIPTION	PERCENT SOLIDS (%)	DRY SOLIDS (TONS)	WATER WEIGHT (TONS)	NET WEIGHT (TONS)
1	FEED SOIL	90.1	9.96	1.00	10.96
2	+8" DEBRIS	100.0	0.64	0.00	0.64
3	-8" SOIL	90.3	9.32	1.00	10.32
4	MAKE UP WATER	0.0	0.00	3.12	3.12
5	-8" SOIL SLURRY	25.0	9.32	27.96	37.28
6	-8", +1" SOIL (1" RINSED REJECT)	99.0	1.00	0.01	1.01
7	-1" SOIL SLURRY	22.9	8.32	27.95	36.27
8	-1", +10 MESH SCALPER DISCARD (SD)	84.1	0.90	0.17	1.07
9	-10 MESH SOIL SLURRY	21.1	7.42	27.78	35.20
10	-10 MESH, +150 MESH SUPER SHAKER DISCARD (SSD)	80.0*	3.84	0.96	4.80
11	-150 MESH SOIL SLURRY	11.8	3.58	26.82	30.40
12	-150 MESH, +175 MESH MUD CLEANER DISCARD (MCD)	79.8	2.33	0.59	2.92
13	-175 MESH SOIL SLURRY	4.6	1.25	26.73	27.48
14	-175 MESH, +325 MESH CENTRIFUGE 1&2 DISCARD (C1C2)	63.7	0.72	0.41	1.13
15	-325 MESH SOIL SLURRY	2.0	0.53	25.82	26.35
16	-325 MESH, +5 MICRON DEWATERING CENTRIFUGE DISCARD (DWC)	35.0	0.53	1.52	1.51
17	RECYCLED WASH WATER	TRACE	TRACE	24.30	24.84

* Test data indicated 96.2% solids. However, we estimate the typical value to be 80% solids.

LEGEND
SOIL
WATER
150 M 150 MESH

REV.	DATE	BY	DESCRIPTION	REV.	DATE	BY	DESCRIPTION
0	12/8/93	JEF	ISSUED FOR EPA REVIEW				

Dames & Moore

DRAWN BY /OFFICE: JEF/CLT
DESIGNED BY: BKH
DATE 12/8/93

TITLE FIGURE 12
MASS BALANCE - SWACO TEST RUN E
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
JOB NO. 18804-168
REV. 0

009818

Tables

Beazer East
South Cavalcade Superfund Site

Table 1

Pre–Washed Soil
Pot. cPAHs

SAMPLE ID	SAMPLE DESCRIPTION	TOTAL Pot. cPAH (ppm) w/REPORTED VALUES (1)	WEIGHT (2) PERCENT (%)
SC–PW–1(+10)	PILE 1 GRAVEL	543	42%
SC–PW–1(–10+200)	PILE 1 SAND	742	26%
SC–PW–1(–200)	PILE 1 FINES	34	34%
COMPOSITE CONC. (3)		428	100%
SC–PW–2 (+10)	PILE 2 GRAVEL	1240	79%
SC–PW–2(–10–200)	PILE 2 SAND	2043	13%
SC–PW–2(200)	PILE 2 FINES	329	8%
COMPOSITE CONC.(3)		1271	100%
SC–PW–3(+10)	PILE 3 GRAVEL	553	44%
SC–PW–3(10+200)	PILE 3 SAND	1526	29%
SC–PW–3(–200)	PILE 3 FINES	265	27%
COMPOSITE CONC.(3)		757	100%
SC–PW–4(+10)	PILE 4 GRAVEL	21	10%
SC–PW–4(–10+200)	PILE 4 SAND	25	44%
SC–PW–4(–200)	PILE 4 FINES	20	46%
COMPOSITE CONC.(3)		22	100%
SC–PW–5(+10)	PILE 5 GRAVEL	123	8%
SC–PW–5(–10+200)	PILE 5 SAND	52	38%
SC–PW–5(–200)	PILE 5 FINES	5	54%
COMPOSITE CONC.(3)		32	100%
SC–PW–6(+10)	PILE 6 GRAVEL	15.51	3%
SC–PW–6(–10+200)	PILE 6 SAND	125	61%
SC–PW–6(–200)	PILE 6 FINES	77	36%
COMPOSITE CONC.(3)		104	100%
SC–PW–7(+10)	PILE 7 GRAVEL	3.553	2%
SC–PW–7(–10+200)	PILE 7 SAND	70	76%
SC–PW–7(–200)	PILE 7 FINES	200	22%
COMPOSITE CONC.(3)		97	100%
SC–PW–8(+10)	PILE 8 GRAVEL	94	6%
SC–PW–8(–10+200)	PILE 8 SAND	197	72%
SC–PW–8(–200)	PILE 8 FINES	1075	22%
COMPOSITE CONC.(3)		383	100%
SC–PW–9(+10)	PILE 9 GRAVEL	23	3%
SC–PW–9(–10+200)	PILE 9 SAND	99	66%
SC–PW–9(–200)	PILE 9 FINES	288	31%
COMPOSITE CONC.(3)		155	100%
SC–PW–10(+10)	PILE 10 GRAVEL	144	7%
SC–PW–10(–10+200)	PILE 10 SAND	72	49%
SC–PW–10(–200)	PILE 10 FINES	162	44%
COMPOSITE CONC.(3)		116	100%

Notes:

(1) Assumed ND = 0 and BQL = Reported Concentration.

(2) As provided by Chester Labs, excludes particles larger than 1" nominal diameter.

(3) Composite concentration as calculated from particle size distribution.

b:BZRTBLS.WK3\Beazer

10/22/93

b:scwa.wq1/beazer

BEAZER EAST INC
SOUTH CAVALCADE

Table 2

Washed Soil
Pot. cPAHs

[illegible]	[illegible]	[illegible]
SC-W-3-6(6" Reject)A	NS (3)	
SC-W-3-6(1" Reject)A	NS	
SC-W-3-6(SD)A	NS	41.7%
SC-W-3-6(SSD)A	910	2.1%
SC-W-3-6(MCD)A	3550	16.7%
SC-W-3-6(C1/C2)A	955	35.4%
SC-W-3-6(DWC)A	1344	4.1%
COMPOSITE CONC. (5,6)	1005	100.0%
SC-W-5(6" Reject)B	NS	
SC-W-5(1" Reject)B	NS	
SC-W-5(SD)B	746	16.9%
SC-W-5(SSD)B	NS	0.0%
SC-W-5(MCD)B	288	53.2%
SC-W-5(C1/C2)B	765	27.3%
SC-W-5(DWC)B	204.9	2.6%
COMPOSITE CONC.	493	100.0%
SC-W-9(6" Reject)C	NS	
SC-W-9(1" Reject)C	NS	
SC-W-9(SD)C	1241	12.7%
SC-W-9(SSD)C	238	8.4%
SC-W-9(MCD)C	381.1	25.4%
SC-W-9(C1/C2)C	600	36.6%
SC-W-9(DWC)C	366	16.9%
COMPOSITE CONC.	556	100.0%
SC-W-7(6" Reject)D	NS	
SC-W-7(1" Reject)D	NS	
SC-W-7(SD)D	238	7.0%
SC-W-7(SSD)D	119.2	21.0%
SC-W-7(MCD)D	149	52.3%
SC-W-7(C1/C2)D	383	11.6%
SC-W-7(DWC)D	947	8.1%
COMPOSITE CONC.	241	100.0%

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SC-W-8(6" Reject)E		NS		
SC-W-8(1" Reject)E		NS		
SC-W-8(SD)E		744		10.8%
SC-W-8(SSD)E		117		46.2%
SC-W-8(MCD)E		857		28.0%
SC-W-8(C1/C2)E		1420		8.6%
SC-W-8(DWC)E		NS		6.4%
COMPOSITE CONC. (7)		496		100.0%
SC-W-1-10(6" Reject)F		NS		
SC-W-1-10(1" Reject)F		NS		
SC-W-1-10(SD)F		904		8.7%
SC-W-1-10(SSD)F		308		33.3%
SC-W-1-10(MCD)F		607		33.3%
SC-W-1-10(C1/C2)F		571		16.0%
SC-W1-10(DWC)F		2253		8.7%
COMPOSITE CONC.		671		100.0%
SC-W-2-4(6" Reject)G		NS		
SC-W-2-4(1" Reject)G		NS		
SC-W-2-4(SD)G		6882		36.3%
SC-W-2-4(SSD)G		1556		27.4%
SC-W-2-4(MCD)G		1289		13.2%
SC-W-2-4(C1/C2)G		227		18.7%
SC-W-2-4(DWC)G		1484		4.4%
COMPOSITE CONC.		3202		100.0%

Notes:
(1) Assumed ND = 0 and BQL = Reported Concentration
(2) Computed without particles > 1"
(3) NS = Not Sampled
(4) Values are in ppm, unless otherwise noted.
(5) Composite concentration as calculated from particle size distribution.
(6) The scalper discharge concentration is not included in this value.
(7) The dewatering centrifuge discharge concentration is not included in this valu

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South Cavalcade Superfund Site

Table 3

Wash Water Analytical Results

	Total Pot. cPAHs (ppm)	Total BTEX (ppm)	Arsenic (ppb)	Chromium (ppb)	Ph	TSS (ppm)	TDS (ppm)	COD (ppm)	TOC (ppm)
Run No									
B	.110	75	<37	7.0	7.18	300	1020	3400	362
C	<.070	<0.55	<37	7.4	7.32	50	2160	2600	419
D	<70	<0.55	<37	19	7.22	300	2740	5400	634
E	<70	<0.55	<37	5.1	5.73	200	2860	4620	547
G	.459	<11.0	72	36	7.43	400	1940	6000	723

b:BZRTBLS.WK3\Beazer

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Table 4

Results of Hazen Floatation Tests

Hazen Test No.	SWACO Test Run	Soil Feed Stream	(1) Calculated Feed Conc. Pot. cPAH (ppm)	(2) Analyzed Feed Conc. Pot. cPAH (ppm)	Treated Conc. Pot. cPAH (ppm)
FT-1	Run E	C1/C2	616	1420	57
FT-2	Run E	C1/C2	724	1420	101
FT-3	Run E	C1/C2	284	1420	98
FT-4	Run E	C1/C2	784	1420	324
FT-5	Runs F&G	SSD/MCD/C1/C2	307	256	151
FT-6	Runs F&G	SSD/MCD/C1/C2	333	256	98
FT-7	Runs F&G	SSD/MCD/C1/C2	312	256	138
FT-8	Runs F&G	Minus 80 mesh	445	276	ND
FT-9	Runs F&G	Minus 80 mesh	433	276	ND
FT-10	Runs F&G	Minus 80 mesh	332	276	121

Notes:
(1) Calculated values are the sum of the floatation test end product concentrations.
(2) Analyzed values are based on feed sample analysis tests. These may be suspect due to uneven distribution of contaminants in samples.
(3) Soil process stream designations:
SSD – Super Shaker Discard
MCD – Mud Cleaner Discard
C1, C2 – Centrifuge Discards

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Table 5
Pre–Washed Soil
Pot. cPAHs vs. PAHs

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	Gravels (+10m)		Sands (–10m, +200m)		Fines (–200m)	
1	543		742		34	
		1236		1537		40
2	1240		2043		329	
		3108		4804		401
3	553		1526		265	
		1223		3891		666
4	21		25		20	
		45		86		72
5	123		52		5	
		312		108		20
6	15.51		125		77	
		47.1		408		409
7	3.553		70		200	
		12.333		233		1210
8	94		197		1075	
		635		1002		3225
9	23		99		288	
		108		417		1478
10	144		72		162	
		546		393		808

Notes:
(1) Values are in ppm.

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South Cavalcade Superfund Site

Table 6

Washed Soil Samples
Pot. cPAHs vs. PAHs

	Scalper Discharge (−1", +10m)		Super Screen Discharge (−10, +150m)		Mud Cleaner Discharge (−10m, +150m)		Centrifuge Discharge (−150m, +325m)		Dewatering Centrifuge (−325m)	
Run No.	Total Pot. cPAHs	Total PAHs	Total Pot. cPAHs	Total PAHs	Total Pot. cPAHs	Total PAHs	Total Pot. cPAHs	Total PAHs	Total Pot. cPAHs	Total PAHs
A	NS (1)		910		3550		955		1344	
		NS		4886		17334		8886		11316
B	746		NS		288		765		204.9	
		6010		NS		1573		4429		1998.4
C	1241		238		381.1		600		366	
		13944		2646.3		4043.6		8183		4568
D	238		119.2		149		383		947	
		4465		2097.3		1768.8		6056		13137
E	744		117		857		1420		NS	
		14400		3103		15237		23143		NS
F	904		308		607		571		2253	
		4196		2349.5		3660.4		5349		43303
G	6882		1556		1289		227		1484	
		26312		6741		1289		1796		1484

Notes:
(1) NS = Not Sampled.
(2) M Denotes Mesh Size – U.S. Standard Sieve Numbers.
(3) Particle size ranges are approximate.
(4) Values are in ppm.

b:BZRTBLS.WK3\Beazer

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Table 7
Before and After Soil Concentrations
Based on Calculated Composites
(ppm Pot. cPAH's)

Test Run	Pile No(1)	Pre-Wash Calculated Composite Concentration(2)	Washed Calculated Composite Concentration(3)
A	3 6	757 104	1005
B	5	32	493
C	9	155	556
D	7	97	241
E	8	383	496
F	1 10	428 116	671
G	2 4	1271 22	3202

Notes

(1) Test Runs A, F, and G used two soil piles as noted.
(2) Refer to Section 5.2.1 for discussion of these data points.
(3) Soil concentrations after discharge from the SWACO process.

Table 8
Before and After Soil Concentrations for Gravels, Sands, and Fines for SWACO Tests and Hazen Floatation Tests (ppm Pot. cPAHs)

Test Run	Pile No.	Soil Fraction(1)	Starting Conc.(2)	Washed Conc.(3)	Floated Soil(5)
A	3,6	Gravel	521	NS	NA
	3,6	Sand	573	3260	NA
	3,6	Fines	158	994	NA
B	5	Gravel	123	746	NA
	5	Sand	52	288	NA
	5	Fines	5	714	NA
C	9	Gravel	23	1241	NA
	9	Sand	99	346	NA
	9	Fines	288	525	NA
D	7	Gravel	4	238	NA
	7	Sand	70	141	NA
	7	Fines	200	614	NA
E	8	Gravel	94	744	NA
	8	Sand	197	398	NA
	8	Fines	1075	1420	57/101/98/324
F	1,10	Gravel	487	904	NA
	1,10	Sand	307	457	151/98/138/ND/121
	1,10	Fines	106	1160	151/98/138/ND/121
G	2,4	Gravel	1106	6882	NA
	2,4	Sand	489	1470	151/98/138/ND/121
	2,4	Fines	66	466	151/98/138/ND/121

Notes

(1) General soil particle size ranges. The size fraction cuts for pre-washed soils from the pertinent feed soil piles are shown in Table 1 of the PSR. The washed soil cuts are similar but not identical to the pre-washed cuts.

(2) Starting concentrations shown are the calculated composite concentrations also shown on Table 1 of the PSR. Concentrations on those test runs with combined piles have been weight distributed for that fraction.

(3) Washed concentrations are as analyzed for the individual fractions discharged from the SWACO process. Sands concentrations are shown as SSD/MCD data results. Fines are shown as C1C2/DWC data results. The SSD/MCD sand and the C1C2/DWC fine concentrations are based on the weight distribution of each fraction.

(4) Floatation tests were performed by Hazen on soils washed by SWACO for Test Runs E, F, and G only. Data is shown for the treated fractions generated by Hazen during numerous tests for the general size ranges shown. There is not a one to one correlation between the SWACO test runs and the Hazen test runs.

(5) Hazen mixed the sand and fine fractions from SWACO test runs F and G to produce a single feed stock for the noted floatation tests. The composite feed stock concentration was analyzed as 256 ppm pot. cPAH and calculated values ranged from 312 to 445 ppm pot. cPAH.

Table 9
Before and After Soil Concentrations for Gravels, Sands, and Fines During Hazen Gravity Separation Tests (ppm Pot. cPAHs)

Test Run	Pile No.	Soil Fraction(1)	Starting Conc.(2)	Washed Conc.(3)	Floated Soil(4)	Spiraled Soil(5)	Ellutriated Soil(6)	Heavy Medium(7)
E	8	Gravel	94	744	NA	NA	NA	157/354
	8	Sand	197	398	NA	90/54/32	70	NA
	8	Fines	1075	1420	57/101/98/324	NA	NA	NA
F	1,10	Gravel	487	904	NA	NA	NA	670
	1,10	Sand	307	457	151/98/138/ND/121	NA	NA	NA
	1,10	Fines	106	1160	151/98/138/ND/121	NA	NA	NA
G	2,4	Gravel	1106	6882	NA	NA	NA	NA
	2,4	Sand	489	1470	151/98/138/ND/121	NA	NA	NA
	2,4	Fines	66	466	151/98/138/ND/121	NA	NA	NA

Notes

(1) General soil particle size ranges. The size fraction cuts for pre-washed soils from the pertinent feed soil piles are shown in Table 1. The washed soil cuts are similar but not identical to the pre-washed cuts.

(2) Starting concentrations shown are the calculated composite concentrations also shown on Table 1.

(3) Washed concentrations are as analyzed for the individual fractions discharged from the SWACO process. Sands concentrations are shown as SSD/MCD data results. Fines are shown as C1C2/DWC data results.

(4) Floatation tests were performed by Hazen on soils washed by SWACO for Test Runs E, F, and G only. Data is shown for the treated fractions generated by Hazen during numerous tests for the general size ranges shown. There is not a one to one correlation between the SWACO test runs and the Hazen test runs.

(5) Hazen performed spiral concentration tests on soils washed by SWACO for Test Run E only. The results of the treated soil analyses generated by Hazen are shown. There is not a one to one correlation between the SWACO test runs and the Hazen test runs.

(6) Hazen performed two ellutriation column tests on the sands from SWACO Test Run E. Only one of the tests was submitted for analysis and that data point is shown. There is not a one to one correlation between the SWACO test runs and the Hazen test runs.

(7) Hazen performed heavy medium separation tests on gravels from SWACO's test runs E and F. There is not a one to one correlation between the SWACO test runs and the Hazen test runs.

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Appendix A

SWACO Pilot Test Report

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DEMONSTRATION TEST REPORT

SOUTH CAVALCADE SUPERFUND PROJECT
HOUSTON, TEXAS

SWACO GEOLOGRAPH
Project Number E-132

Prepared for
Beazer East, Inc.

Prepared by
Swaco Geolograph

Swaco Geolograph
Lafayette, Louisiana

August 11, 1993
Demonstration Test Report

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1.0 Introduction

Swaco Geolograph was contracted by Beazer East, Inc. to conduct a field soil washing demonstration on affected soils at their South Cavalcade Superfund Site located in Houston, Texas.

The South Cavalcade Superfund Site is located in the northeast section of Houston, Texas about one mile southwest of the intersection of U.S. Highway 59 (north) and the Interstate Highway Loop 610. The site boundaries are Cavalcade Street to the north, Collingsworth Street to the south, the Missouri Pacific Railroad line to the west and the Houston Belt and Terminal lines to the east. The Site is rectangular in shape with a width of approximately six hundred (600) feet and a length of forty eight hundred (4800) feet, encompassing an area of sixty-six (66) acres.

This site was used as a wood preservative treating and distillation facility for coal tar from 1910 until 1962. Creosote and metallic salts were used in the operation. In 1962, the Koppers Company, who was later purchased by Beazer East, Inc., ceased operations and subsequently sold the site to Merchants Fast Motor Lines.

Merchants Fast Motor Lines later subdivided and sold the property. Currently the owners of the occupied areas of the site conduct light industrial operations. The central area of the site is not currently used.

1.1 Purpose

This report presents results from the March 1993 pilot study activities and related testing. The purpose of the pilot study was to test the effectiveness of soil washing in removing contaminants of concern from the soil with the use of surfactants. The intended result of this treatment process would be to produce a clean soil fraction which could be returned to the site. The ultimate goal of the soil washing process was to reduce the volume of contaminated material that must be further treated or disposed of off site.

1.2 Overview

In May of 1992, a bench scale treatability study was conducted with material from the South Cavalcade Superfund Site and focused on soils washing.

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Parameters that were addressed are: soil-to-water ratio, multiple washing stages, chemical additive requirements, dewatering requirements, particle size distribution of the washed soil fraction, particle size distribution of rejected / contaminated fine soil fraction, particle size distribution of solids removed by flocculation, solids concentration, concentration of PCOC's verses grain size before and after treatment, and settling data verses particle fraction.

1.3 Pilot Study Team

Beazer East. Inc.
- Steve Radel - Project Management
- John Helton - Water Treatment Management

Dames and Moore
- Bruce Hickman - Operations Management
- Wes Fiandt - Health And Safety
- Troy Hopper - Construction Management

Swaco Geolograph
- Lawrence Childress - Project Management
- R.T. Braswell - Project Management
- Gary Fout - Project Management
- John Chancey - Project Management
- Derwin Speidel - Health And Safety
- Ray Bradish - Health And Safety
- John Monte - Operations
- Gary Templeton - Operations
- Gerald Creder - Operations
- Gene Welch - Operations
- Mike Deranger - Operations

Environmental Protection Agency
- Glen Clerier - Oversight Management
- Mark McDonald - Oversight Management
- George Farmer - Oversight Management

2.0 Excavation

Dames and Moore Troy Hopper to complete

2.1 Section Overview

2.2 Core Samples

2.3 Excavation Operations

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3.0 Material Handling (storage piles to the loading hopper)

3.1 Section Overview

This section describes material handling activities associated with the material excavated for the pilot tests. The test material, a total of one hundred (100) cubic yards was segregated in ten (10) piles of ten (10) cubic yards each and arranged on two (2) curbed concrete storage pads. All material piles were sampled and carefully covered by waterproof liner material. At the start of the soil washing activities, the material piles were inventoried, inspected, and recovered. See Figure 1 for the arrangement of the excavated material stockpiled for the tests.

The test material, after being washed, was stored on the original two (2) curbed concrete storage pads. Each fraction was systematically segregated, sampled, and catalogued for future reference. Each "washed" pile was covered with waterproof liner material. The only exception being the material from centrifuges #1, #2 and the dewatering centrifuge. This material was stored separately in lined water tight metal containers. These containers were placed on the storage pads and carefully catalogued and then covered with waterproof liner material.

3.2 Equipment and Procedures

Prior to processing in the soil washing system, each test pile was uncovered and monitored for organic vapors by health and safety personnel from Dames and Moore and Swaco Geolograph. Dependent upon the VOC levels, appropriate personal protective equipment was donned prior to the hand sorting of oversize debris. Table 1 details the volatile organic compound levels recorded in the breathing zone when each sample pile was uncovered for processing.

Hand sorting each material pile was not anticipated at the beginning of the pilot study. However, due to the large volume of debris encountered, problems attributed to oversized material at the "grizzly", and pump plugging problems, removing oversized debris became a necessity. As this implies, the process was slow and labor intensive.

A front-end-loader equipped with a one (1) yard bucket loaded to approximately two thirds (2/3) to one half (1/2) capacity moved the material from the storage pad to a stationary

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classifying device. The stationary bar classifier, also known as a "grizzly", was designed to remove plus nine (+9) inch oversized material. This classifying device was equipped with one and one half (1 1/2) inch square bars with a nine (9) inch spacing between the bars. Oversized debris and any material dropped during the loading operation was collected and stockpiled or processed.

The undersized material accumulated in the hopper located below the "grizzly" and was diverted onto a horizontal conveyor belt. The material was then deposited onto an inclined conveyor belt originating at ground level and terminating at the hopper of the hydro-jet/mill.

3.3 Physical Characteristics of Excavated Material

The material for the pilot study consisted of a silty-clay interspersed with considerable amounts of sand. Some material piles contained large quantities of sub base material such as crushed limestone, shell, brick and concrete rubble. Other debris included creosoted and untreated wood; railroad spikes, bolts, tie plates, angle bars, wire, roots, grass, and horse shoes.

The odor of the tar/pitch varied from pile to pile. In some piles, there was little or no trace of an aromatic odor. Other piles had a strong tar/pitch odor.

The quantity and type of black organic tar and pitch varied considerably in the material piles. The consistency of the tar and pitch varied from large, dark, hard, "glassy", weathered fragments to dark, viscous, plastic material through out the pile.

The following is a brief description of the test piles as determined by visual inspection:

Pile #1, test run F;	Sandy dry soil with large fragments of asphalt. Approximately two (2) cubic yards of reject material.
Pile #2, test run G;	Large quantities of gravel, shell, and tar. Approximately seven and one half (7.5) cubic yards of reject material.
Pile #3, test run A;	Sandy soil with tar and approximately five (5) cubic yards of reject material.

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Pile #4, test run G;	Sandy soil with little tar and reject material.
Pile #5, test run B;	Sandy soil with little tar. Approximately one (1) cubic yard of reject material.
Pile #6, test run A;	Sandy soil with some tar and approximately one (1) cubic yard of reject material.
Pile #7, test run D;	Sandy soil with black fragments. Less than one (<1) cubic yard of reject material.
Pile #8, test run E;	Sandy clay, moderate amounts of tar with a black sheen. Less than one (<1) cubic yard of reject material.
Pile #9, test run C;	Sandy clay, soil is stained with moderate amounts of tar. Less than one (<1) cubic yard of reject material.
Pile #10, test run F;	Silty clay, dark brown staining but little black pitch. Approximately two (2) cubic yard of reject material.

3.4 Carcinogenic Polynuclear Aromatic Hydrocarbon Concentrations

Table 2 illustrates the levels of carcinogenic Polynuclear Aromatic Hydrocarbons (PAH's) found in each of the test piles.

3.5 Volatile Organic Compound Concentrations

Table 1 displays the concentration level of volatile organic compounds detected in the breathing zone adjacent to the test material.

4.0 Slurry and Soil Washing Operations

4.1 Section Overview

The soil washing process begins with the removal of all plus nine (+9) inch oversized material. This function was to be

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performed by a stationary bar classifier or "grizzly". Problems developed when piles containing large quantities of oversize debris blocked the reject bars and undersized material dropped from the hopper into the catch tray. The hand picking of visible oversized debris from the material piles reduced the volume of undersized material that was spilled during the loading operations. The undersized material spilled during the loading process is removed from the catch tray and added to the soil washing system.

The undersized, minus nine (-9) inch, material passes to the hopper located below the "grizzly" and is conveyed to the hydro-jet mill. Here the material is reduced in size by a high pressure water and surfactant spray and blended in a rotating paddle mixer.

The slurry is then deposited into the attrition scrubber compartment. The surface contamination is removed by the intense scouring action.

The "scrubbed" material is pumped to the flotation cell. Here a portion of the fine particles and liquid with a specific gravity of less than one (1) are "floated" to the surface. This oil, tar/pitch, and water fraction is removed from the surface of the slurry by means of a mechanical skimmer.

The oil, tar/pitch, and water is collected in a clarifier where the water, tar/pitch, and solids are separated. The oil and tar/pitch is removed and stored in metal containers and the water returned to the soil slurry.

The "washed" soil is then dewatered by means of vibrating screens, hydrocyclones, and centrifuges. Chemical coagulants and flocculants are used to enhance removal of very fine solids. The water is recycled for use as make-up water or treated and discharged.

A process flow diagram of the soil washing operation is shown in Figure 3.

4.2 Stationary Bar Classifier "Grizzly"

The stationary bar classifier device or "grizzly" removes plus nine (+9) inch material that was not removed during the hand picking of the material piles before loading. The plus nine (+9) inch material rejected by the grizzly is removed from the catch tray and stockpiled with the oversized hand picked material. The undersized material dropped during the loading process is removed from the catch tray and added to the soil washing system. The undersized, minus nine (-9) inch, material passes to the hopper located below the "grizzly" and is conveyed to the hydro-jet mill.

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4.3 Hydro-jet / Mill

The soil was prepared for the attrition scrubber by reducing any oversize agglomerated material to very fine particles. This was accomplished by a counter rotating blade mill and high pressure spray jets. The water jets were directed at the soil as the blades shear and mix the soil material. During the pilot tests, Dames and Moore determined that this device was too large and used too much water for the benefit that it provided.

4.4 Classifier

The separation process consists of a vibratory screening device equipped with a one (1) mesh screen. The classifier removed any plus one (+1) inch oversize material from the soil washing system. The rejected material consisted of grass, roots, rocks, wire, creosoted wood debris, railroad spikes rail anchors, and occasional consolidated clays. The volume of reject material was not consistent among the material piles. The reject material varied from trace amounts of debris to debris amounting to one half (1/2) of the material volume.

The majority of the rejected material was free of smaller material and clay particles adhering to the surface. However, the surface of the rejected rocks often retained a dark to medium stain. Some of the material piles that contained large quantities of consolidated clay clumps had too little retention time to be dispersed and resulted in considerable quantities of clay carry over in the reject material after classifying.

4.5 Attrition Scrubber

After the material was blended in the hydro-jet / mill and the oversized material removed, the remaining material was directed to the attrition scrubber.

The attrition scrubber consists of twin concentrically mounted parallel blade turbines. The blades are canted at fifty-five (55) degrees and arrayed to direct the slurry so that the two streams impact violently at their convergence. This provides a scouring and grinding action designed to

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remove any tar/pitch coating from individual particles. Surfactants and abrading particles also aid in the removal of any tar and pitch deposits.

Additions of surfactant accelerates the removal of organic compounds from the soil. Surfactants used in combination with intense scrubbing action creates an efficient washing cycle. The washed slurry then moves to the flotation cell section of the tank by means of an overflow weir.

4.6 Flotation Cell

The slurry consisting of washed soil, weathered creosote particles, liquid creosote, pitch, tar, and undersized debris flows to the flotation compartment. The fraction of the slurry with a specific gravity greater than one (>1) settles to the bottom of the tank while the material with a specific gravity of less than one (<1) floats to the surface.

Air is forced into the flotation cell at 600 cubic feet per minute. This air is diffused into micro-fine bubbles in the front half of the tank. The micro-fine air bubbles tumble the solids at the bottom of the tank and become attached to the solids. The weathered tar and pitch particles and other soil particles, due to the increased buoyancy, are then floated to the surface of the tank.

4.7 Skimming System

As stated in section 4.5, the attrition scrubber and flotation cell occupies the front portion of this tank. The remainder of the tank provided a calm area for the liquid oil, tar, pitch, and the solids that were floated to the surface to agglomerate and be removed from the surface by the skimmer. Considerable fibrous material (mostly grass and roots) was among the material floated to the surface.

The skimmer functioned by means of a vacuum pump. A skimmer tray was initially used but soon became blocked from the accumulation of sand, silt, and root particles. A hand actuated collector was then substituted and proved successful. The rental skimmer could be moved to the proximity of material as it floated to the surface.

4.8 Clarifier

The material that was removed from the surface of the

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flotation cell was deposited into the clarifier. The clarifier was equipped with coalescing plates that allowed the material with a specific gravity of less than one (<1) to migrate to the surface of the vessel. Material with a specific gravity greater than one (>1) settled to the bottom of the coalescer.

As the material collected at the top and bottom of the vessel, the material was removed by means of a top and bottom discharge. This material was stored in metal containers. The excess water was returned to the flotation cell.

5.0 Mechanical Dewatering Operations

5.1 Scalping Shaker

The washed soil then advances from the flotation cell and skimming process to further washing cycles and dewatering of the soil. The scalping shaker was equipped with two (2) ten (10) mesh screens. The cut point of the screen was (.0742) inches or one (1910) microns with an open area of (56.3) percent.

The material that was removed at the scalping shaker included considerable quantities of gravel, shells, organic material (roots, grass, wood chips), and wire. The discard material and volume did vary considerably between test piles.

Two problem areas were encountered at the scalping shaker. The first was the overflowing of the shaker reservoir. The second problem was the coating out of tar and pitch on the screen's surface. Addressing the first problem, a bypass line was installed to prevent the accumulation of large material (mostly rocks) in the bottom of the slurry tank. The bypass line began at the attrition cell and ran to the scalper shaker reservoir. The pump feeding the bypass line was a constant volume pump. Any attempt at reducing the volume resulted in material settling in the line. To prevent plugging, this material was pumped to the scalping shaker at very high volumes (600 gallons per minute). With this high volume from the bypass line and the reduced screening area from the screen blinding, the screening efficiency of the scalping shaker was greatly reduced. This bypass line was used only when emptying the rock trap/attrition scrubber compartment.

This screen coating due to the tar and pitch proved to be a problem common to all of the separatory screens.

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5.2 Super Screen Shaker #1

The Super Screen shaker performed the next step in the dewatering process. This vibrating screen shaker was equipped with one hundred seventy five (175) mesh screens having a cut point of 95 microns. The flow from the scalper shaker could be split between Super Screen shakers #1 and #2 with the shakers processing in parallel or the fluid could be processed by the shakers in series.

Super Screen shaker #1 was bypassed in later operations because of the screens coating out from tar and pitch carry over. Also because of the increased efficiency of the desander hydrocyclone installed on Super Screen shaker #2.

5.3 Super Screen Shaker #2

This Super Screen shaker was configured similar to super screen shaker #1. This vibrating screen shaker was equipped with 150 and 175 mesh screens with cut points of 105 microns and 95 microns respectively.

For test run C, this shaker was retrofited with one (1) twelve (12) inch desander hydrocyclone. This configuration facilitated the concentration of solids onto the screen which increased the screen loading and assisted in reducing the screen coating out from tar and pitch. The desander cone was added in an attempt to extend the screen life. This new configuration increased the discard volumes and improved the efficiency of down stream equipment. This however did not reduce the overall screen efficiency because of the "piggy-backing" of smaller solids on the larger solids.

Problems that were encountered centered around the screens coating out from accumulations of tar and pitch. The deposits of tar and pitch reduced the screen's open area and caused excessive liquid in the discard material. Teflon screens were tested but they also coated out. Acetone and alcohol were used as solvents and met with some success. A high pressure washer proved to be most successful in removing this residue from the screens. The best solution would be to increase the efficiency of the skimming system and to remove the free tar and pitch before it reports to the dewatering process.

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5.4 Mud Cleaner

The 8T4 mud cleaner was equipped with eight (8) dual four (4) inch hydrocyclones and 175 or 210 mesh screens. The four (4) inch hydrocyclones produced an average cut point of fifteen (15) microns. The cut point of the screens was 95 and 81 microns respectively. The hydrocyclones facilitate a finer cut point than could by achieved by screens alone. This was accomplished by the hydrocyclones concentrating the solids on the screen which allowed an agglomeration of solids where smaller solids "piggy-backed" on the larger solids.

A problem that persisted through out the pilot study was from tar and pitch coating out on the surface of screens. A number of solvents were used to clean the screens. Acetone appeared to be the most successful; while alcohol appeared to be the least effective. In addition to the screens, the hydrocyclones also experienced accumulations of tar and pitch on their interior surfaces. The hydrocyclones and the screens were cleaned with a high-pressure washer. Again, the result of these deposits was reduced screen and hydrocyclone efficiencies.

Good screen life was consistent through out the project. The most detrimental effect was from the screens being coated by tar and pitch.

5.5 Centrifuge #1 and #2

The 518 centrifuges were high speed high volume centrifuges capable of being configured to process in series or parallel. The centrifuges initially were operated in series, but during test A was changed to operate in parallel to achieve higher processing rates. Both centrifuges operated at 2500 rpm with a gravitational force of 1240 g's. The average cut point of these centrifuges was five (5) microns.

The only difficulty encountered with this equipment was from a malfunction in the electrcial starter system. With this exception, the centrifuge operation was as anticipated.

6.0 Chemically Enhanced Dewatering Operations

6.1 Overview

Dewatering and the recycling of water used in each test was essential to the site operations. The large volume of water

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generated by soil washing would have proved prohibitively expensive to treat and dispose. Therefore, the solids were removed from the wash water after each test by chemical flocculants and the water was recycled. During the tests the only additional make up water that was required was to make up for the volume of water discarded with the solids. The water used to bring the wash water back to volume for the next test was rain water that had been removed from the operations pads and stored in metal tanks. Approximately 11,455 gallons of wash water used in test A. The volume of water varied in each test according to the volume of soil that was slurried. See section 6.5 and 9.0 for water treatment costs and additional information.

6.2 Chemical Additions

Coagulant and polymer additions were accomplished through a flocculation manifold. Chemical dilution was also accomplished in this process. The chemicals were introduced into the mixing manifold by chemical metering pumps. In the mixing manifold, the chemicals and water were thoroughly blended by stationary mixers. Flocks of agglomerated solids were formed as it passed through the manifolding system. These flocks of solids were fed to the flocculation centrifuge and removed.

6.3 Dewatering Centrifuge

The dewatering centrifuge was operated at 2500 rpm with a gravitational force of 1240 g's. The material mixture from the flocculation manifold was fed to the centrifuge for the separation of water and solids. Occasional adjustments to the chemical additions was necessary to maintain flocculation of the material.

Increased difficulty in flocculating the wash water, was encountered during the last two tests, tests F and G. Some of the alternatives that were tried included pH adjustment, reconfiguring the equipment, and adjustments to the processing rate. Changing to another polymer proved to be the solution.

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6.4 Discard

The solids were discharged from the centrifuge and were channeled to the collection container. The discard was viscus and had a "fluffed" appearance. When the flocked solids are left undisturbed, water will leach from the solids.

6.5 Clarified Water

The clarified water from the dewatering process was stored in a holding tank for reuse. The water clarity varied from clear to a light "tea" color. After test E, it was apparent from the foam that there was surfactant being carried over in the clarified water. This carry over became more evident as the field test continued. The wash water in the last two tests was difficult flocculate. It was necessary to purchase an alternate polymer to treat this material. The cost for water treatment was $0.038 per gallon for a total chemical cost of $2526.00. (excludes ancillary charges) See section 9.0 for additional information.

7.0 Other Chemicals Used

7.1 Surfactants

7.1.1 Triton X-100

Triton X-100 was selected to be used in the field test because of the encouraging performance that was observed in the bench study. It was proposed to test this product in one (1) and three (3) percent concentrations. However, due to excessive foaming encountered in test A, the concentrations of Triton X-100 were reduced to 1.0, 0.5, and 1.25 percent by weight of the solids. The cost of Triton X-100 was $1.215 per pound for a total of $3,353.40.

7.1.2 Dowfax 8390

Dowfax 8390 was chosen because the basic chemical composition differs dramatically from Triton X-100. An advertised attribute of this surfactant was that once a target coating was removed it would not be redeposited on other surfaces. This product was tested in concentrations of 1.0, 2.0, and 3.0 percent by weight of the solids. The cost of Dowfax 8390 was $1.14 per

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pound for a total cost of $3,275.00.

7.2 Defoamer

Defoam-A was used to control excessive foaming caused by surfactants. This difficulty was not anticipated and this product was used as part of a contingency plan. This material proved effective in controling the foam but was very expensive. The cost for Defoam-A was $4,945.88. This cost was not a part of the original estimate.

This material was necessary to control excessive foaming associated primarily with Triton X-100.

7.3 Caustic Soda

Caustic soda beads was used where the test matrix specified that a pH adjustment was required. A pH adjustment was specified because of the increased solubility of creosote in the higher pH ranges. This appeared to be verified in the tests. The cost for this additive was $218.50.

7.4 Solvents

7.4.1 Alcohol

Isopropyl alcohol was tested to observe its ability to remove the tar/pitch residue from the surface of the separatory screens. This product was applied directly to the tar/pitch on the screens and scrubbed vigorously with a brush. The alcohol proved ineffective in removing this residue. Five (5) gallons of alcohol was used in this test. The cost for the alcohol was $39.35.

7.4.2 Acetone

Acetone was also examined to test its ability to remove the tar/pitch residue from the surface of the separatory screens. The acetone was applied without dilution directly to the tar/pitch residue and scrubbed vigorously with a brush. The alcohol proved to be ineffective in removing this residue. Five (5) gallons of acetone was used in this test at a cost of $49.45.

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8.0 - Operational Test Review

8.1 Proposed Test Matrix

Test	Pile #	Volume Slurried cu. yds.	Surfactant	Target Concentration	Wash Time	pH
A	3 & 6	14	Triton X-100	3 %	120	7
B	5	9	Triton X-100	1 %	120	11
C	9	8	Dowfax 8390	1 %	120	11
D	7	9	Dowfax 8390	2 %	120	11
E	8	9	Dowfax 8390	2 %	120	11
F	1 & 10	16	Dowfax 8390	3 %	120	11
G	2 & 4	13	Triton X-100	3 %	120	11

8.2 Actual Test Matrix

Test	Pile #	Volume Slurried cu. yds.	Surfactant	Surfactant Conc.	Wash Time	pH
A	3 & 6	14	X-100	1 %	120	7
B	5	9	X-100	0.5 %	136	12.2
C	9	8	Dow 8390	1 %	187	11.4
D	7	9	Dow 8390	2 %	132	11.5
E	8	9	Dow 8390	2 %	80	12.5
F	1 & 10	16	Dow 8390	3 %	348	11.3
G	2 & 4	13	X-100	1.25 %	104	11.3

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8.3 Test Summary

8.3.1 Test A

Test A consisted of test pile three (3) and test pile six (6). The cPAH levels of the test piles were 685.89 mg/kg and 76.76 mg/kg respectively. Test pile three (3) had approximately five (5) cubic yards rejected at the grizzly and classifier and test pile six (6) had one (1) cubic yard. A total of fourteen (14) cubic yards were slurried. The soil to water ratio was fourteen (14) cubic yards of soil 20.9% to 11,454 gallons of water 79.1%. All weight calculations for the test were based on 1.35 tons per cubic yard. Triton X-100 was the surfactant that was used. The target concentration was three (3) percent by weight of solids. However, due to severe foaming problems, the surfactant concentration was reduced to one (1) percent by weight of solids. An alcohol based defoamer was used to help control foaming. The pH was not adjusted for this test and was measured at 7.3. The flotation cell unit and skimmer were in operation.

The wash time was 120 minutes. Wash time started when the last material in the test pile entered the slurry tank and ended when the slurry was pumped to the scalping shaker and dewatering began. When material remained in the slurry tank overnight, the time from when operations ceased and then resumed was not counted.

The classifier shaker was equipped with one (1) mesh screens and the scalper shaker had ten (10) mesh screens. Super screen shakers #1 and #2 and the mud cleaner was equipped with one hundred seventy five (175) mesh screens. During processing, the mud cleaner screens were replaced with two hundred ten (210) mesh screens for a finer cut point. Centrifuge #1 and #2 was configured to operate in series, but was converted to parallel operation to handle the large volume of colloidal solids. The centrifuges were running at 2500 rpm.

Most of the solids were discarded at the scalping shaker and by centrifuges #1 and #2. There was also a large volume of discard at the classifier shaker. The discard container for the classifier shaker was fitted with a removable front closure inorder to contain the solids. A by pass line was installed from the rock trap / attrition scrubber to the scalper shaker to prevent this material from settling in the slurry tank. An arresting bar was retrofited to the grizzly to reduce the loss of undersized material during loading.

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Approximately twenty two thousand (22,000) gallons of rain water was pumped from the operations and storage slabs and stored for use as make-up water.

8.3.2 Test B

Test pile #5 was used for the second test. The cPAH levels of the test pile was 118.16 mg/kg. Test pile five (5) had approximately one (1) cubic yard of reject material at the grizzly and classifier. A total of nine (9) cubic yards of material was slurried. The soil to water ratio was 25% to 75%, nine (9) cubic yards of soil to 5,458 gallons of water. Triton X-100 was the surfactant that was used in a one half (0.5) percent concentration by weight of solids. The target pH was 11 and was actually adjusted to 12.2. The wash time was 136 minutes. The flotation unit and skimmer were in operation.

The classifier shaker was equipped with one (1) mesh screens and the scalper shaker had ten (10) mesh screens. Super screen shakers #1 and #2 were equipped with one hundred seventy five (175) mesh screens. The mud cleaner had two hundred ten (210) mesh screens. During operations, one hundred fifty (150) mesh teflon screens were installed on Super Screen shaker #2. The two hundred ten (210) mesh screens on the mud cleaner were replaced with one hundred seventy-five (175) mesh screens. The screen changes were made to combat screen blinding. Centrifuge #1 and #2 operated in parallel. The centrifuges were running at 2500 rpm.

Most of the solids were discarded at the scalping shaker, mud cleaner, and by centrifuges #1 and #2.

A desander cone was installed on Super Screen shaker #2. This concentrated the solids on the screen and helped in reducing screen blinding from the tar and tar/pitch material. A pressure washer was rented and proved very valuable in removing the tar and tar/pitch residue from the screens.

8.3.3 Test C

Test pile #9 was used in the third test. The cPAH levels of the test pile was 67.03 mg/kg. Test pile nine (9) had approximately two (2) cubic yards of material rejected at the grizzly and classifier. A total of eight (8) cubic yards of material was slurried. The soil to water ratio was eight (8) cubic yards of soil 25% to 4,851 gallons of water 75%. Dowfax 8390 was the surfactant that was used in a

concentration of one (1) percent by weight of solids. The target pH was 11 and was adjusted to 11.4. The wash time was 187 minutes. The flotation unit and skimmer were in operation.

The classifier shaker was equipped with one (1) mesh screens and the scalper shaker was equipped with ten (10) mesh screens. Super Screen shaker #1 was equipped with one hundred seventy-five (175) mesh screens. Super Screen shaker #2 was equipped with a desander hydrocyclone and had one hundred fifty (150) mesh teflon screens. The mud cleaner was equipped with one hundred seventy-five (175) mesh screens. Centrifuges #1 and #2 operated in parallel at 2500 rpm.

The solids discard was distributed among the equipment. The scalper shaker had a heavy discard volume. The desander hydrocyclone on Super Screen shaker #2 concentrated the solids and reduced the burden on the mud cleaner. The discard from Super Screen shaker #2 and the mud cleaner appeared clean and dry. This configuration helped to reduce screen blinding some. Centrifuges #1 and #2 had a dark dry discard.

Acetone and alcohol were tested as solvents to dissolve the screen blinding tar and tar/pitch. The alcohol proved ineffective. However, acetone worked much better than the diesel. The Super Screen shaker #2 (desander) and the mud cleaner hydrocyclones concentrated the solids onto the screen; however, this reduced the overall effectiveness of the screens.

8.3.4 Test D

This test consisted of pile #7. The cPAH level of the test pile was 53.34 mg/kg. Test pile seven (7) had approximately one (1) cubic yard of reject material at the grizzly and classifier. A total of nine (9) cubic yards of material were slurried. The soil to water ratio was 25% to 75%, nine (9) cubic yards of soil to 5,458 gallons of water. Dowfax 8390 was the surfactant used in a two (2.0) percent concentration by weight of solids. The target pH was 11 and was actually adjusted to 11.5. The actual wash time was 132 minutes with a target wash time of 120 minutes. The flotation unit and skimmer were in operation.

The classifier shaker was equipped with one (1) mesh screens and the scalper shaker had ten (10) mesh screens. Super screen shaker #1 was not used because of the increased efficiency of the desander hydrocyclone on Super Screen shaker #2. The Super Screen shaker #2 with desander hydrocyclone was equipped with one hundred fifty (150) mesh teflon screens. The mud cleaner had one hundred seventy-five

(175) mesh screens. Centrifuges #1 and #2 operated in parallel and were running at 2500 rpm.

The scalping shaker had a heavy discard of rocks, shell, and roots. Super Screen shaker #2 and the mud cleaner had light brown dry discard. The discard from centrifuges #1 and #2 was dark and dry. Some surfactant carry over was observed at the dewatering centrifuge.

The slides from centrifuges #1 and #2 were configured to discharge into one container. The diffuser screens were removed from the flotation unit to reduce settling in the slurry tank. A longitudinal jet line was installed in the bottom of the slurry tank to reduce settling and to channel the solids to the suction. Screen blinding continues to be a problem. The pressure washer and acetone works well in removing the tar from the screens.

8.3.5 Test E

Test pile #8 was used in this test. The cPAH levels of the test pile was 43.93 mg/kg. Test pile eight (8) had approximately one (1) cubic yard of material rejected at the grizzly and classifier. A total of nine (9) cubic yards of material was slurried. The soil to water ratio was nine (9) cubic yards of soil 25% to 5,458 gallons of water 75%. Dowfax 8390 was the surfactant that was used in a two (2.0) percent concentration by weight of solids. The target pH was 11 and was actually adjusted to 12.5. The wash time was 80 minutes. The flotation unit and skimmer were in operation.

The classifier shaker was equipped with one (1) mesh screens The scalper shaker was configured with ten (10) mesh screens. Super screen shaker #1 was not used. The Super Screen shaker #2 (desander) was equipped with one hundred fifty (150) mesh screens. The mud cleaner had one hundred seventy-five (175) mesh screens. Centrifuge #1 and #2 operated in parallel and were running a 2500 rpm.

The scalping shaker had a heavy discard consisting of shells, rocks, grass, and wood debris. Super Screen shaker #2 (desander) discard had large volumes of clean dry sand. The discard from the mud cleaner had dry solids with some tar/pitch carry over. Centrifuges #1 and #2 had a dark dry discard. The water from the dewatering centrifuge was lightly stained with some surfactant carry over and a dry discard.

Screen blinding continued to be a problem. The hydrocyclones from the mud cleaner were removed and inspected. Tar/pitch and tar were coating the inside of the hydrocyclones. The cones were cleaned and replaced. The free tar/pitch and tar

must be removed at the slurry tank and not be carried over to the shaker screens.

8.3.6 Test F

Test pile #1 and #10 were used in this test. The cPAH levels were 413.57 mg/kg and 147.62 mg/kg respectively. Test pile one (1) had little or no reject material and pile ten (10) had approximately four (4) cubic yards of material rejected at the grizzly and classifier. A total estimated volume of sixteen (16) cubic yards of material was slurried. The soil to water ratio was 25% / 75%, sixteen (16) cubic yards of soil to 9,703 gallons of water. Dowfax 8390 was the surfactant that was used in a three (3.0) percent concentration by weight of solids. The target pH was 11 and was actually measured at 11.3. The target wash time was 120 minutes but was extended to 348 minutes to allow additional skimming time). The flotation unit and a rental skimmer were in operation.

The classifier shaker was equipped with one (1) mesh screens and the scalper shaker had ten (10) mesh screens. Super screen shakers #1 was not in use. Super Screen shaker #2 (desander) and the mud cleaner was configured with one hundred seventy-five (175) mesh screens. Centrifuge #1 and #2 operated in parallel turning at 2500 rpm.

The solids discarded at the Super Screen shaker #2 (desander) and the mud cleaner was dry and appeared clean. The discard from centrifuges #1 and #2 was dry to medium dry. The water from the dewatering centrifuge was clear with a dry solids discard.

A rented vacuum skimmer was tested in the flotation cell. The skimmer removed large amounts of tar/pitch and tar. There was some plugging from organic material (grass and roots). A higher capacity skimmer was needed. An auxiliary diesel pump was installed to provide higher volumes to the jet line in the slurry tank.

8.3.7 Test G

Test piles #2 and #4 comprised the last test. The cPAH levels of the test piles were 1333.80 mg/kg and 13.11 mg/kg respectively. Test pile two (2) had approximately four (4) cubic yards and test pile four (4) had approximately three (3) cubic yards of material rejected at the grizzly and classifier. A total of thirteen (13) cubic yards of material was slurried. The soil to water ratio was thirteen (13) cubic yards of soil to 7,884 gallons of water for a 25% to

75% ratio. Triton X-100 was the surfactant that was used with a target concentration of three (3) percent by weight of solids. The actual surfactant concentration was reduced to one and one fourth (1.25) percent by weight of solids because of foaming problems. The target pH was 11 and was actually measured at 11.3. The wash cycle time was 104 minutes. The flotation unit and rental skimmer were in operation.

The classifier shaker was equipped with one (1) mesh screens. The scalper shaker had ten (10) mesh screens. Super screen shaker #1 was not used. Super Screen shaker #2 (desander) was equipped with one hundred seventy-five (175) mesh screens. The mud cleaner was equipped with one hundred seventy-five (175) mesh screens. Centrifuge #1 and #2 operated in parallel and were running a 2500 rpm. The water from the dewatering centrifuge was cloudy with considerable surfactant carry over.

A large volume of rock, shell, and weathered tar/pitch was discarded at the scalper shaker. Super Screen shaker #2 (desander) and the mud cleaner discarded large volumes of clean dry sand and silt. Centrifuges #1 and #2 had dark dry discards.

Rainwater collected on the operations and storage slabs were pumped to water storage tanks. Serious foaming problems were encountered. A defoamer was used to control heavy foaming. Rocks and other heavy debris were frequently pumped to the scalping shaker from the rock trap / attrition scrubber compartment. This helped in reducing material settling in the slurry tank. The skimmer could not remove all of the tar/pitch and tar because of its low processing rate. Dewatering of the wash water was becoming increasingly difficult.

9.0 Wastewater Characterization

9.1 Recycled Water

Water from the dewatering operations as well as rainwater were recycled for use in the soil washing operations whenever possible. During the entire field test, fresh make-up water was used the first day only. For the remainder of the tests, water recycled from the dewatering operations was used as make-up water. The volume of water lost with the solids removed from the soil washing operations was made up with rain water removed from the operations pads and stored in holding tanks.

Except for the initial make-up water, fresh water was used only for cleaning and decontamination operations.

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Approximately 66,227 gallons of total slurry volume was dewatered. The total cost for all dewatering chemicals, excluding trucking charges, etc. was $2,547.25. Resulting in a dewatering cost of $0.038 cents per gallon. The actual cost was less because approximately half a drum, (27) gallons, of 90L and half a drum, (27) gallons of TP 504 were remaining at the end of the test.

9.2 Rainwater

Accumulations of rainwater impeded the soil washing operations. Considerable effort and expense was expended in the management and reuse of rainwater accumulated on the operations and material storage pads. Before continuing operations or beginning operations at the start of the day, the rainwater was pumped from the concrete operations pad and the material storage pads to storage tanks. The rainwater from the storage tanks was used as make-up water in the soil washing operations.

Before the approach of rain showers, any open test piles were secured by covering and water proofing each material pile. Good housekeeping practices were also implemented in order to prevent the contamination of rainwater from residue left on slabs.

9.3 Washdown Water

Washdown water from decontamination operations was collected on the decontamination pad. The water that accumulated on the decontamination pad was pumped into storage tanks at the end of each day. Any rainwater that accumulated overnight was pumped into storage tanks at the beginning of each day.

10.0 Ambient Air Monitoring

10.1 Section Overview

Air monitoring was conducted through out the soil washing, dewatering, and material storage operations. These activities were performed by Swaco Geolograph's health and safety personnel. Dames and Moore performed independent monitoring on behalf of Beazer East.

The parameters that were monitored during site operations were volatile organic compounds and dust.

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10.2 On site Monitoring

Site monitoring responsibilities were performed by health and safety representatives from Swaco Geolograph. A systematic schedule of observations were made and recorded. More frequent instrument readings were recorded if conditions demanded. Dames and Moore performed independent monitoring for Beazer East, Inc. See Table 1 for the Volatile Organic Compounds levels in the breathing zone adjacent to the test material and Table 3 for dust levels in the breathing zone.

10.3 Local Weather Conditions

The weather conditions during the field project were generally hot and humid with brief periods of cooler temperatures initiated by the passing of weather fronts. The moderating of temperatures occurred during and immediately following rain showers and if overcast conditions persisted. Most of the inclement weather was the result of passing weather fronts. The passage of these fronts was usually accompanied with heavy showers of one (1) to three (3) inches of rain or more and intense lightning.

To assure the safety of all personnel, soil washing operations ceased in the event of intense lightning. When the danger of lightning had passed, soil washing operations resumed.

11.0 - Test Difficulties

11.1 Debris In Test Material

Extensive debris was found in the test material. This material consisted of treated timbers, sticks, roots, tie plates, angle bars, spikes, wire, etc. The debris that escaped the "grizzly" and the classifier often fouled pump suctions and pump impeller causing down time.

11.2 Stationary Bar Classifier "Grizzly"

Positioning of the grizzly was important to the overall loading operations. It is important for the loader to be perpendicular to the grizzly to reduce material dropped during loading operations.

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11.3 Hydro-jet / Mill

The jets experienced plugging problems caused by grass, roots, and other debris. Another difficulty was from large consolidated clay particles not being degraded to less than one (1) inch. These particles would be rejected at the classifier shaker.

11.4 Classifier

The classifier screen and discharge port had to be cleared occasionally of grass, roots, wire, and wood debris.

11.5 Attrition Scrubber / Rock Trap

The foremost operating concern with this equipment focused on retention time and the circulation pump becoming plugged. The rubber hoses used with this equipment washed out from the abrasive slurry.

11.6 Flotation Cell

The settling of solids in the bottom of the tank was a principal obstacle to continuous soil washing operations. On one occasion this material blocked the suction of the transfer pump.

11.7 Skimmer

The accumulation of solids in the skimmer pan blocked the suction. In addition, the removal rate of the skimmer was insufficient to remove all of the free tar and pitch during the wash cycle time.

11.8 Clarifier

The small capacity of the clarifier prevented removal of all the skimmed tar and pitch. In addition, time was lost from the necessity to remove accumulated tar and pitch soaked roots and grass from the bottom of the clarifier.

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11.9 Scalping Shaker

Screen blinding due to the coating out of tar and pitch.

11.10 Super Screen Shaker #1

Screen blinding due to the coating out of tar and pitch. This resulted in dramatic reductions of screening efficiencies.

11.11 Super Screen Shaker #2 (Desander)

Screen blinding and interior coating of hydrocyclones from tar and pitch. This resulted in dramatic reductions of screening efficiencies.

11.12 Mud Cleaner

Screen blinding and interior coating of hydrocyclones from tar and pitch. This resulted in dramatic reductions of screening efficiencies.

11.13 Centrifuges 1 and 2

A minor electrical malfunction in the starter mechanism occurred. This equipment performed as expected.

11.14 Dewatering Manifold

The chemical injection pump for the polymer became blocked from the polymer "setting up". This was expected and is considered as part of the routine equipment maintenance.

11.15 Dewatering Centrifuge

This equipment performed as expected.

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11.16 Clarified Water

Dewatering became very difficult with reduced water quality during the last two tests, F and G.

12.0 -Conclusions

The screening efficiencies of the scalper shaker, Super Screen shakers 1 and 2, and the mud cleaner were below expectations. Upon closer examination, it was apparent that much of the ultra-fine material carried over in the fines range could be attributed to one of two causes: 1) blinding of the screens from tar and pitch or 2) from the concentrating of the solids on the screen by the hydrocyclones. The screen's blinding reduced the effective opening size and the percent open area of the screen. The twelve (12) inch and four (4) inch hydrocyclones have mean cut points of forty (40) microns and twenty five (25) microns respectively. By concentrating these fine solids on the screen in high volumes, the smaller solids instead of passing through the screens will tend to agglomerate and be discarded with the larger particles. A contributing factor is the tar and pitch bonding the fine and coarse solids. See Table 4 for particle size distribution of the washed soil fraction from the scalping shaker, Super Screen shaker, mud cleaner, and centrifuges 1 and 2.

The carcinogenic Polynuclear Aromatic Hydrocarbons, cPAH, were not concentrated in any particle size range. They were widely distributed through out the washed soil fractions. Therefore, all washed soil discards must be tested. This may translate into an extensive sampling program. See Tables 5 and 6.

No sampling or testing was conducted on the plus one (+1) or the plus six (+6) material. It is expected that the majority of this material will pass the seven hundred (700) ppm cPAH limit. The majority of this material appears to have only a surface coating of tar and pitch and therefore any cPAH's would constitute a small overall percentage. The exception may be the weathered tar/pitch particles and the creosote treated wood debris which conceivably could contain cPAH concentrations greater than the seven hundred (700) ppm limit.

The scalper shaker discard appears to have consistently high cPAH concentrations. Some of this can be attributed to weathered tar/pitch in this particle size range. It is Swaco's opinion that this high concentration resulted from free tar and pitch coating out on the reject material. This tar and pitch was carried over from the flotation cell with

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the solids. Removing the free tar and pitch in the flotation cell by means of a high efficiency, high volume skimming system could reduce these high cPAH levels.

The Super Screen shaker 1, Super Screen shaker 2 (desander), the mud cleaner, centrifuge 1 and 2, and the dewatering centrifuge discards (washed soil) were significantly above the seven hundred (700) limit in test runs A and G. This may be attributed to the high cPAH levels of the contaminated material used in these tests. This contaminated material had the highest cPAH levels encountered during the pilot demonstration. The only exception was the discard from centrifuge 1 and 2 in test G where the cPAH levels were well below 700 ppm. Also, centrifuges 1 and 2 in test run E and the dewatering centrifuge in test run F had cPAH levels above 700 ppm.

Soil washing appears to be an effective method to clean significant portions of contaminated soil and reduce the volume of material that must be treated further or disposed off site. Dowfax 8390 was effective in releasing the tar/pitch and tar from soil particles. Dowfax appeared to be effective in relatively low concentrations of one half (0.5) to one (1) percent. To realize the full benefit from the surfactant a high efficiency skimming system is necessary. A method of dewatering the washed soil without screening would be beneficial. Recycling the water proved to be practical and economical. The water should be discharged periodically to keep the treatment costs treatment volumes with in manageable limits.

13.0 Recommendations For Full Scale Operations

1) Remove large pieces of weathered tar and pitch and oversized debris before slurrying the soil. Mechanical equipment should be used as much as possible. However, some of this material may have to be removed by manual sorting.

2) Install a four (4) foot retaining wall with wing walls on one end of the material storage pads to facilitate loading the material into the front-end loader's bucket. This will also prevent contaminated material from being pushed off of the storage pad during loading operations.

3) Place the "grizzly" on a concrete work pad. The concrete pad should be extend in front of the grizzly inorder to catch any material dropped during loading operations. This would reduce the possibility of the contaminating the soil and facilitate retrieving this material.

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The location of the pad should be in line with the soil washing equipment to facilitate loading.

There should be ample unobstructed area around the pad for the loader to maneuver. A vibrating grizzly should be installed in place of the stationary grizzly to reduce loading time and remove oversize debris. The slope of the grizzly should be reduced to a smaller incline angle.

4) Remove the material that would plug the nozzles in the hydro-jet sprayer. This could be accomplished by utilizing a finer mesh screen on the classifier shaker. However, this finer mesh screen could cause undissolved clay particles to be discarded.

5) More retention time in the mill would provide additional time for the high pressure water and mill blades to decrease the size of large chunks of clay. This could by accomplished by reversing twenty five (25) percent of the blades in the mill. This would greatly reduce the consolidated clay chunks from by passing the soil wash and be deposited in the discard container.

6) Improve residence time in the attrition scrubber could be managed by providing additional attrition scrubber compartments. This would result in a more intense soil washing cycle.

   Another improvement to this system would be to replace the rubber hoses by installing hard piping with long radius 90 degree ells. This would reduce, hopefully eliminate, wash outs and reduce the opportunity for plugged lines.

7) Additional agitation should be installed in the flotation cell to prevent material settling. An auger bottom tank would facilitate removal of material from the tank bottom.

   A jet line was installed in the tank bottom during the field test that significantly reduced the accumulation of solids in the bottom of the tank.

8) A high efficiency, high volume skimming system is needed to remove the total volume of free tar and pitch from the slurry tank. To work in combination with the improved skimmer, a high capacity clarifier with a bottom auger for solids removal would be required.

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This improved skimming system could also prove to be the solution to screen blinding. All of the tar and pitch would be removed from the slurry before processing through the vibrating screen shakers.

9) A possible option to vibrating screen shakers would be to use a sand screw to perform the majority of the dewatering process. This would eliminate the screens entirely.

10) The overall dewatering process performed very well until the end of the test. At the beginning of test run F the wash water became difficult to flocculate. Various remedies were tried and met with little success. The solution proved to be changing the polymer. For the full scale process, I recommend that the clarified water be discharged to the water treatment plant after a set number of times being recycled. This will keep the quality of water high and minimize the water treatment costs.

11) Steve Radel, Mike Tischuk, Bruce Hickman, and Lawrence Childress met on June 7, 1993 and discussed methods to improve the soil washing operations. The current data and the experience gained from the field test was considered and discussed thoroughly. This information was taken into account with alternative equipment and methods. The product of this meeting is depicted in Figure 4, titled "Proposed Equipment Flow Diagram".

14.0 - Cost Of Demonstration Test

The total invoice amount for the field demonstration test was $151,441.00. The project's revised cost estimate from April 24,1992 was for $142,469.00.

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South Cavalcade Superfund Site
Houston, Texas

TABLE 1

VOLATILE ORGANIC COMPOUNDS LEVELS IN THE BREATHING ZONE ADJACENT TO TEST MATERIAL

Test Run	Test Pile	Volatile Organic Compounds in ppm (breathing zone)
A	3	4.7
A	6	3.9
B	5	1.5
C	9	6.2
D	7	7.2
E	8	2.7
F	1	3.7
F	10	3.2
G	2	5.4
G	4	2.4

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South Cavalcade Superfund Site
Houston, Texas

TABLE 2

CARCINOGENIC POLYNUCLEAR AROMATIC HYDROCARBON LEVELS
FROM LABORATORY ANALYSIS ON EACH TEST PILE

Test Run	Test Pile	cPAH in mg/kg
A	3	685.89
A	6	76.76
B	5	118.16
C	9	67.03
D	7	53.34
E	8	43.93
F	1	413.57
F	10	147.62
G	2	1333.80
G	4	13.11

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Houston, Texas

TABLE 3

DUST LEVELS IN THE BREATHING ZONE

Test Run	Test Pile	Dust Levels in ppm (breathing zone)
A	3	0.03
A	6	0.03
B	5	0.06
C	9	0.05
D	7	0.01
E	8	N/A
F	1	N/A
F	10	N/A
G	2	N/A
G	4	N/A

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South Cavalcade Superfund Project
Houston, Texas

TABLE 4

Size Distribution of Washed Soil

Scalper Shaker Discard

Test Run	> 4 Mesh	+4M – 10M	+10M –200M	–200M	TOTAL
A	NS	NS	NS	NS	NS
B	0.0	10.0	72.5	17.5	100.0
C	0.0	2.5	83.5	14.0	100.0
D	0.0	0.0	82.0	18.0	100.0
E	0.0	0.0	92.0	8.0	100.0
F	0.0	10.0	77.0	13.0	100.0
G	0.0	5.0	84.0	11.0	100.0

Super Screen Shaker Discard

Test Run	> 10 Mesh	+10M –150M	<150M	TOTAL
A	2.0	65.5	32.5	100.0
B	NS	NS	NS	0.0
C	0.0	86.0	14.0	100.0
D	0.0	92.0	8.0	100.0
E	0.0	96.0	4.0	100.0
F	2.5	89.5	8.0	100.0
G	0.0	85.0	15.0	100.0

Mud Cleaner Discard

Test Run	> 10 Mesh	+10M –175M	<175M	TOTAL
A	1.0	71.0	28.0	100.0
B	0.0	49.0	51.0	100.0
C	0.0	55.0	45.0	100.0
D	0.0	92.0	8.0	100.0
E	1.0	54.0	45.0	100.0
F	0.0	46.0	54.0	100.0
G	1.0	70.0	29.0	100.0

Centrifuge 1 & 2 Discard

Test Run	> 200 Mesh	+200M –325M	<325M	TOTAL
A	0.0	58.0	42.0	100.0
B	10.0	65.0	25.0	100.0
C	10.0	70.0	20.0	100.0
D	5.0	68.0	17.0	90.0
E	36.0	51.0	13.0	100.0
F	5.0	73.0	22.0	100.0
G	3.0	71.0	26.0	100.0

NS= Not Sampled

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South Cavalcade Superfund Project

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TABLE 5

cPAH Concentration of Pre-Washed Samples

Sample ID	Total cPAH (1) w/Reported Values	Weight (2) Percent (%)
SC-PW-1(+10)	543.00	42%
SC-PW-1(-10+200)	742.00	26%
SC-PW-1(-200)	34.00	33%
TOTAL(WT%* CONC.)	428.32	100%
SC-PW-2(+10)	1240.00	79%
SC-PW-2(-10+200)	2043.00	13%
SC-PW-2(-200)	329.00	8%
SC-PW-2(+10)MS	891.00	
SC-PW-2(+10)MSD	870.00	
TOTAL(WT%* CONC.)	1271.51	100%
SC-PW-3(+10)	553.00	44%
SC-PW-3(-10+200)	1526.00	29%
SC-PW-1(-200)	265.00	27%
TOTAL(WT%* CONC.)	757.41	100%
SC-PW-4(+10)	21.00	10%
SC-PW-4(-10+200)	25.00	44%
SC-PW-4(-200)	20.00	46%
TOTAL(WT%* CONC.)	22.30	100%
SC-PW-5(+10)	123.00	8%
SC-PW-5(-10+200)	52.00	38%
SC-PW-5(-200)	5.00	54%
TOTAL(WT%* CONC.)	32.30	100%
SC-PW-6(+10)	15.51	3%
SC-PW-61(-10+200)	125.00	61%
SC-PW-6(-200)	77.00	36%
TOTAL(WT%* CONC.)	104.44	100%
SC-PW-7(+10)	3.55	2%
SC-PW-7(-10+200)	70.00	76%
SC-PW-7(-200)	200.00	22%
TOTAL(WT%* CONC.)	97.27	100%
SC-PW-8(+10)	94.00	6%
SC-PW-8(-10+200)	197.00	72%
SC-PW-8(-200)	1075.00	22%
TOTAL(WT%* CONC.)	383.96	100%
SC-PW-9(+10)	23.00	3%
SC-PW-9(-10+200)	99.00	66%
SC-PW-9(-200)	288.00	31%
TOTAL(WT%* CONC.)	155.31	100%
SC-PW-10(+10)	144.00	7%
SC-PW-10(-10+200)	72.00	49%
SC-PW-10(-200)	162.00	44%
TOTAL(WT%* CONC.)	116.64	100%
SC-PW-DUP(+10)	88.00	9%
SC-PW-DUP(-10+200)	32.00	40%
SC-PW-DUP(-200)	4.00	51%
TOTAL(WT%* CONC.)	22.76	100%

NOTE:

(1) Assumed ND = 0 and BQL = 0

(2) As provided by Chester Labs, excludes particles larger than 1" nominal diameter.

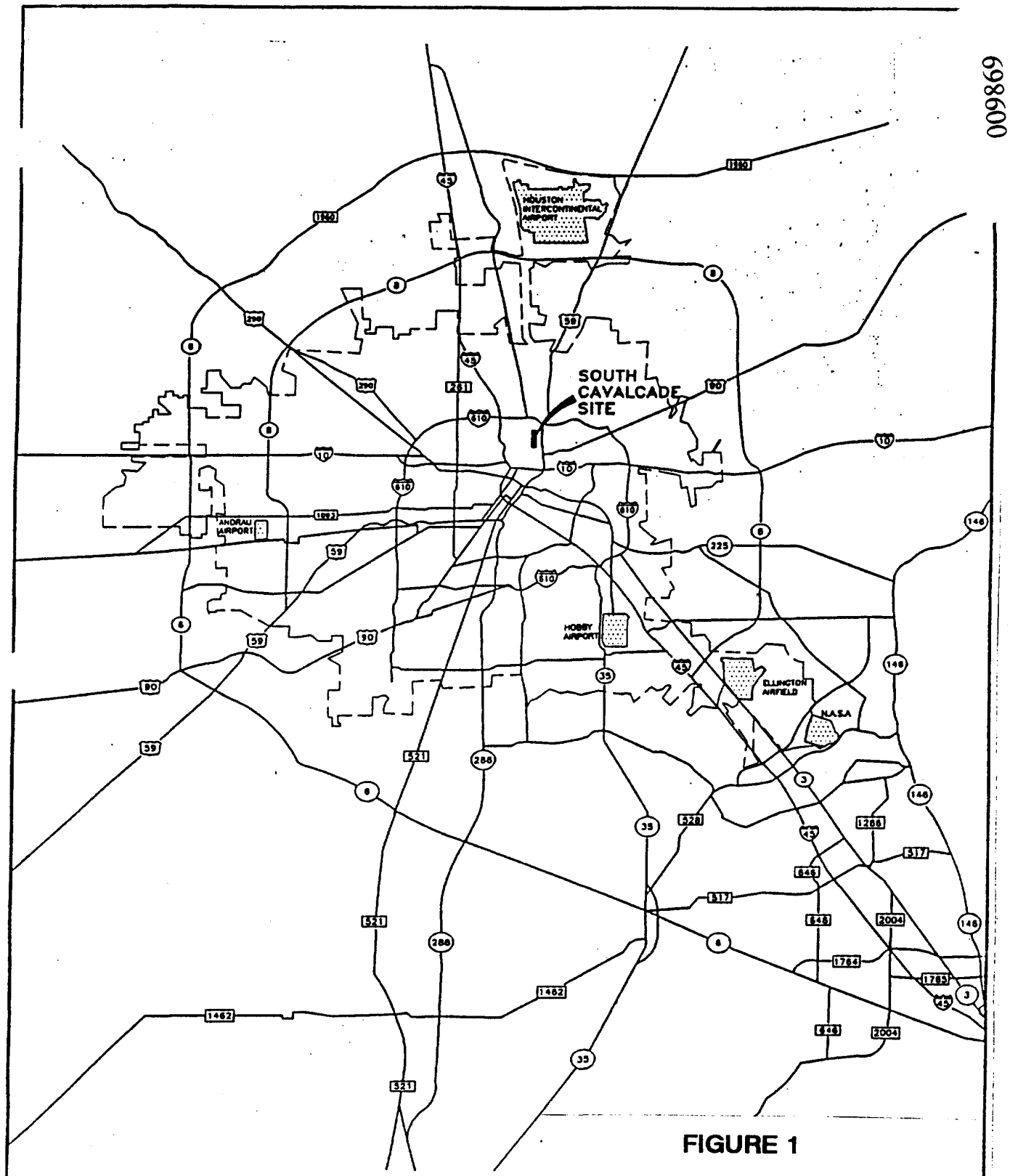

FIGURE 1

SCALE

0 7 14 MILES

South Cavalcade Superfund Site
Houston, Texas

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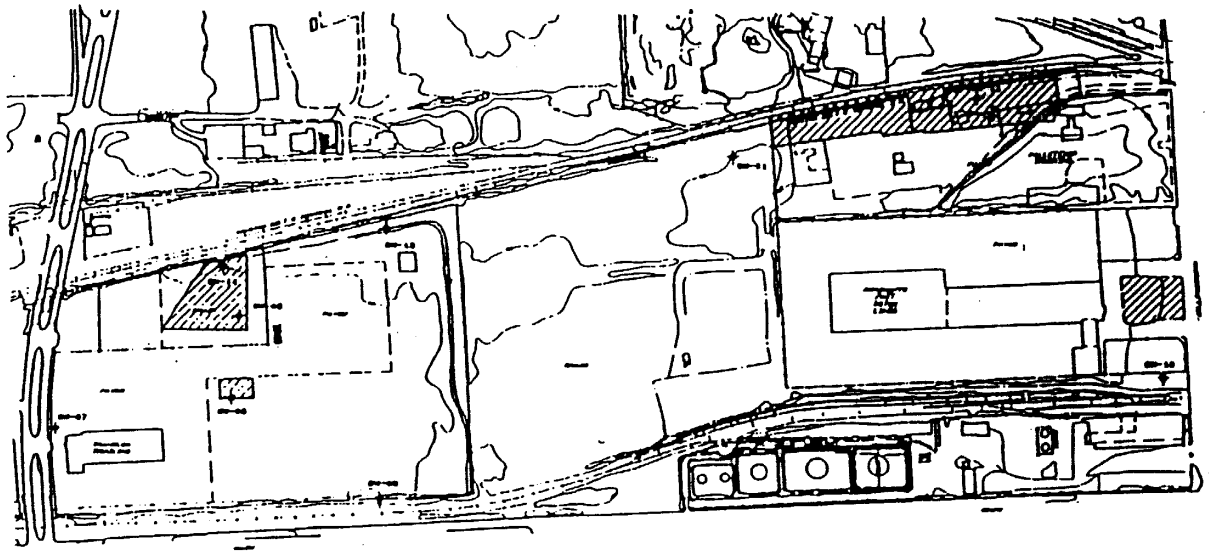

FIGURE 2

South Cavalcade Superfund Site
Houston, Texas

NO SCALE

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FIGURE 3

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ARRANGEMENT OF MATERIAL TEST PILES

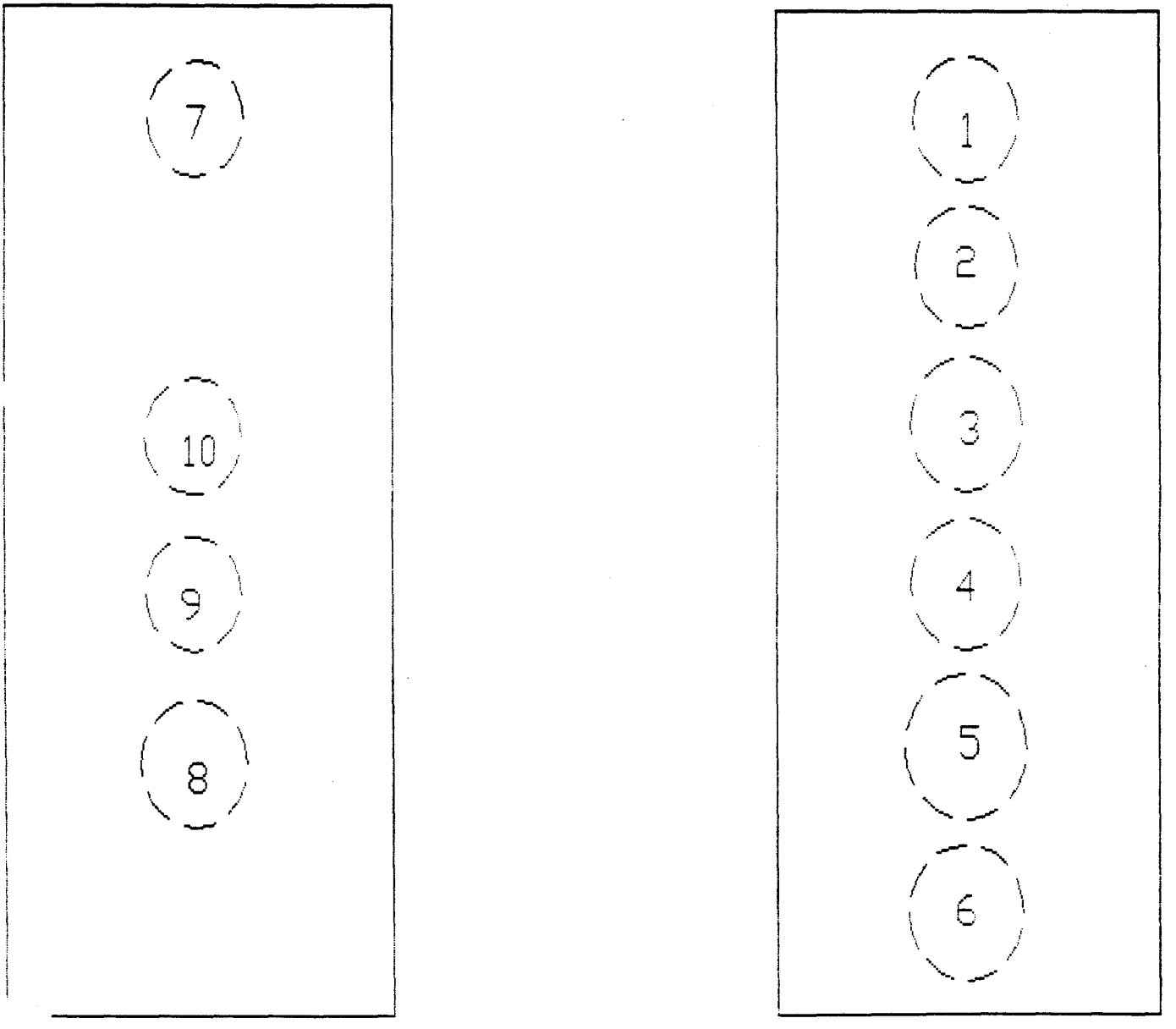
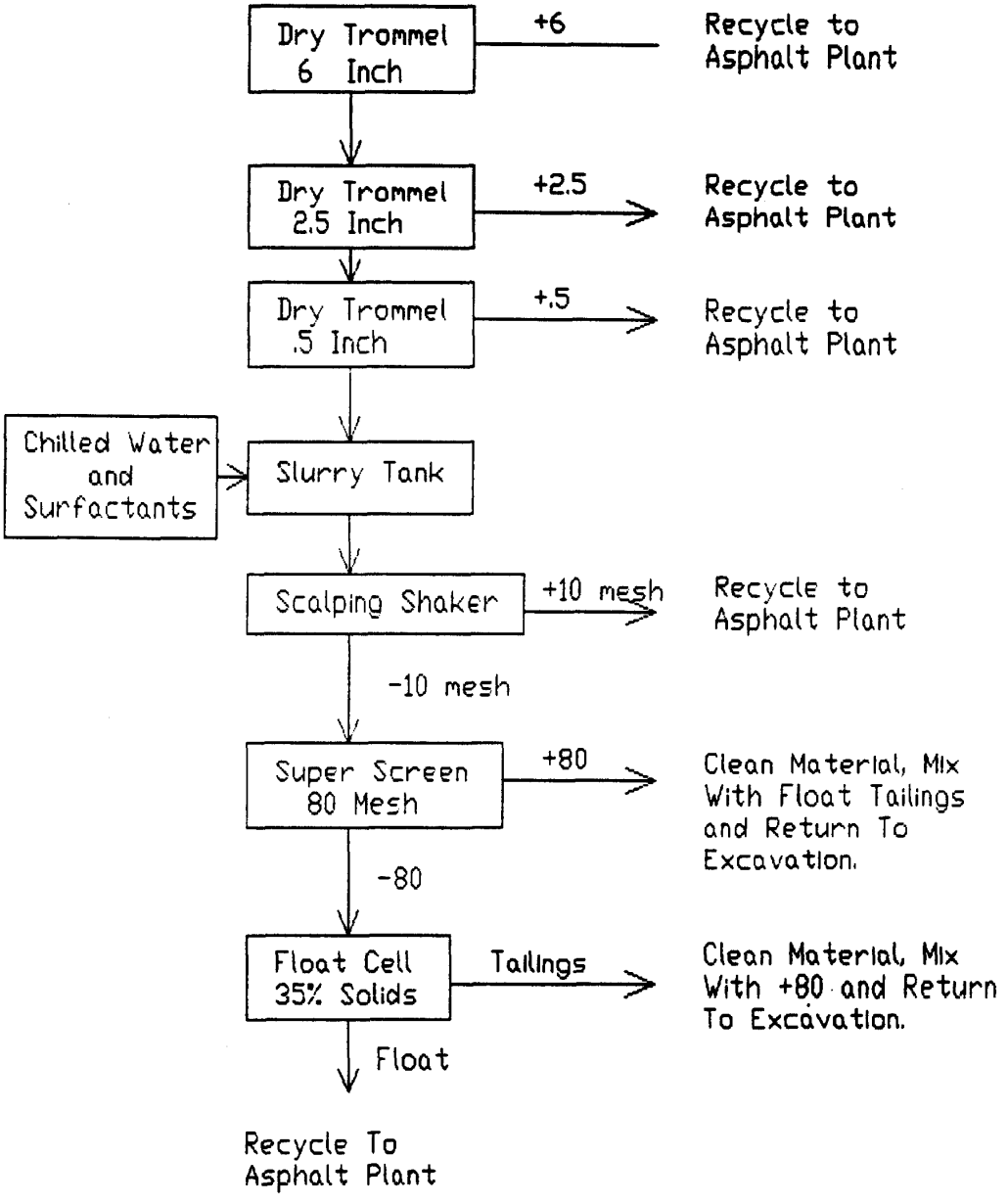


FIGURE 4

Proposed Equipment Flow Diagram



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Appendix B

Hazen Pilot Test Report

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INTRODUCTION

Beazer East, Inc. (BEI) is currently directing a study to develop a soil washing process at the South Cavalcade CERCLA site in Houston, Texas. The site, a former wood-treatment facility, is characterized by soils containing potentially carcinogenic poly aromatic hydrocarbons (c-PAH). As a part of the program BEI has engaged Hazen Research, Inc. (Hazen) to conduct a process response study to generate data that can be applied to the design of a remediation process at the site.

The technical foundation for the work is based upon the results of an exploratory test program conducted earlier on samples from the South Cavalcade site. This preliminary test program identified gravity separation and froth flotation response attributes of the site materials, and provided the impetus for further study. The results of this work were reported in "Bench-Scale Characterization of Soils Contaminated with Wood Treatment Chemicals" (Hazen Project 7932) on September 21, 1992.

During the period from April 20 through July 18, 1993, laboratory and pilot-scale studies were conducted on selected process products collected from field demonstration testing at South Cavalcade. This on-site test work, conducted by SWACO Geolograph (SWACO) in conjunction with BEI and their consultants, consisted of seven soil washing/classification process tests, identified as Runs A through G. Client-directed sampling of the washing system resulted in five particle-size-classified materials from three of the tests (Runs E, F, and G) for subsequent characterization and process response testing at Hazen.

The objectives and initial scope of work for the test program were defined by Messrs. Steve Radel of BEI and Bruce Hickman of Dames & Moore, consultants to BEI at the South Cavalcade site, through telephone conversations, correspondence, and on-site meetings in March 1993, attended by Dr. Arthur Colombo of Hazen. In a subsequent project review meeting at Hazen, on June 6 and 7, 1993, attended by Messrs. Radel, Hickman, and Lawrence Childress of SWACO, modifications to the scope of work were made to address process alternatives which were suggested by the work completed to date.

Additional input regarding the objectives of the project was received from Messrs. Glenn Celerier, project manager for the EPA, and Mark McDonnell of Fluor Daniel, consultants to the EPA at South Cavalcade, during their visits to Hazen. The efforts of all of these gentlemen were appreciated and contributed to the successful and timely completion of the work.

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OBJECTIVES AND SCOPE OF WORK

BEI is evaluating flowsheet alternatives for a soil washing process to remove materials contaminated with c-PAH from the soil at the South Cavalcade site. As a part of the developmental program, field demonstration testing of a soil washing/classification process was conducted by SWACO to disaggregate and characterize the distribution of the contaminants in site reference samples. Client-provided analyses of the process products from this work show a wide range of c-PAH levels, and indicate that in many cases, further treatment will be required to reduce the contaminant level to less than 700 parts per million (ppm) as specified in the record of decision for the site.

Accordingly, the studies at Hazen were conducted to refine and confirm a process concept for removing c-PAH contaminants from the prewashed field-demonstration samples. A test program was designed and conducted to compare the performance of gravity separation and froth flotation for treating the rock/seashell/soil matrix materials at the site. The results of the work were developed to provide comparative mass flow and contaminant-removal performance data that could be applied to the design of a remediation process.

Bench- and pilot-scale testing was conducted on provided samples from Field Demonstration Runs E, F, and G to characterize gravity separation and froth flotation performance. Gravity separation studies included unit operation evaluations of heavy medium separation, hydraulic classification using an elutriation column, and spiral concentrator separation, on appropriately sized feed materials. Froth flotation test work evaluated the concentration response of the c-PAH contaminants in the soils as a function of reagent schemes, kinetics, feed particle size, and feed pulp density. Chemical analyses of all test products from the study were conducted by Chester LabNet in Houston, Texas.

Five particle-size-classified materials from the three field demonstration runs were provided for the test program. Specifically, the process streams are client-identified by name and/or nominal particle size as 1) Minus 4 Plus 1 Inch, 2) Scalper Discharge (SD) -1 Inch +10 Mesh, 3) Super Screen Discharge (SSD) -10 +80 Mesh, 4) Mud Cleaner Discharge (MCD) -80 +200 Mesh, and 5) Centrifuge 1/Centrifuge 2 (C1/C2) Minus 200 Mesh. The process products are referred to by name and particle size, interchangeably, in the test work discussions in the report.

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SUMMARY AND CONCLUSIONS

The process design study of South Cavalcade soils, incorporating laboratory and pilot-scale studies, has been completed. Performance variables for gravity separation and froth flotation processing were explored to furnish an understanding of the process characteristics for the soils contaminated with c-PAH.

- Unit operation testing indicated that the c-PAH contaminants in the South Cavalcade soils show a strong response to gravity separation and froth flotation processing. Flowsheet alternatives were explored to provide comparative contaminant removal and mass flow balance data that can be applied to remediation process design.

- Characterization test work, conducted on field demonstration samples from Runs E, F, and G, identified that the c-PAH contamination was concentrated in the coarse (plus 10 mesh) size fractions. Heavy medium separation testing conducted on a minus 4 plus 1-inch size fraction containing 4,772 ppm c-PAH showed that a clean product (348 ppm c-PAH), representing 51.9 weight percent of the feed, was produced.

- Spiral concentrator test work, conducted on minus 10- plus 200-mesh material from field demonstration Run E (with a computed feed grade of 259 ppm c-PAH), showed that 70.6% of the c-PAH contaminants in the sample were recovered to a tailing product, representing 10.7 weight percent of the feed.

- Froth flotation testing conducted on a range of minus 10-mesh products indicated that the c-PAH contaminated particulates responded well to froth flotation without the addition of chemical reagents.

- Flocculant scan studies showed that a sequential addition of cationic, nonionic, and anionic polymers at low concentrations enhanced liquid/solid separation and produced a clear supernate, containing 66 milligrams per liter of plus 0.45-micron solids, per liter (mg/L).

- Qualitative melting tests showed that the tarlike material in the soils is sensitive to temperature, and will begin to melt and stick to metal surfaces at about 80° F.

- A simulation of flowsheet alternatives, based upon the program test results, indicates that trommel scrubbing and froth flotation will efficiently treat a wide range of contaminated soils at the South Cavalcade site.

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DISCUSSION

PROJECT SAMPLE DESCRIPTION

Approximately 450 kilograms (kg) of samples from the field demonstration testing at South Cavalcade were received at Hazen in two shipments. The first set of samples, consisting of a composite of minus 4- plus 1-inch material from Runs F and G and SD, SSD, MCD and C1/C2 samples from Run E, was received on April 20, 1993. The second shipment comprised SD, SSD, MCD, and C1/C2 materials from Runs F and G and was received on June 6, 1993. Details concerning the weight, percent moisture, and bulk densities of each of the provided materials are recorded in Appendix A of this report.

Laboratory and pilot-scale testing was conducted on materials as received and/or as composites prepared at Hazen for unit operation testing. Details of sample preparation for the test program are discussed under the appropriate headings below.

HEAVY MEDIUM SEPARATION TESTING

In preparation for the heavy medium separation test work conducted on minus 4- plus 1-inch composite from Runs F and G and the minus 1-inch plus 10-mesh (SD) product from Run E, each of the products were batch scrubbed and screened at 10 mesh. The purpose of this work was to evaluate the effect of horizontal scrubbing for further disaggregating the materials and to remove the residual fine particles contained in the sample that would affect the performance of the dense medium separation.

Minus Four Plus One-inch Fraction

The minus 4- plus 1-inch composite sample representing Runs F and G was batch scrubbed in a rolling bottle at 50 weight percent solids. The scrubbed product was screened at 1 inch and 10 mesh, and the resulting size fractions air dried and weighed. The minus 10-mesh material was sampled and screened at 80 and 200 mesh, as described in Particle Size Analysis 1 (PSA) in Appendix B. Plus 1-inch and minus 1-inch plus 10-mesh size fractions were each directed to heavy medium separation (magnetite medium) testing using medium slurry densities of 2.0 and 2.2 kilograms per liter (kg/L).

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The heavy medium separation products were crushed to nominal minus 6 mesh and sampled for analysis, as indicated in Heavy Medium Separation Tests 1 and 2 in Appendix C, and summarized in Table 1.

Examination of the data in Table 1 shows that horizontal scrubbing produced a minus 1-inch fraction comprising 15.4 weight percent of the feed, with 39.0% of the 1-inch material being finer than 10 mesh. The data additionally show that the computed c-PAH level in the sample was 4,752 ppm, and that the contaminants were distributed evenly throughout the particle size fractions. Heavy medium separation testing, conducted on the scrubbed minus 4- plus 1-inch fraction, produced a sink fraction at 2.2 specific gravity with a c-PAH level of 348 ppm, representing 43.9 weight percent of the as-received sample, or 51.9% of the test feed. Similarly, heavy medium test work on the minus 1-inch plus 10-mesh material produced a sink fraction of 2.2 specific gravity with a c-PAH level of 670 ppm, representing 3.3 weight percent of the as-received sample, or 34.5% of the test feed. The computed c-PAH level for the minus 10-mesh fines was 5,741 ppm.

For reference, it is noted that for each of the heavy medium test products, the 2.0 float fraction consisted of large lumps of tar with minor inclusions of rock, sand, and seashells. The intermediate density material (2.0 to 2.2 specific gravity) was characterized as rock and tar agglomerates, and the 2.2 sink material was rocks and shells with a spotty occurrence of tarlike coating.

Table 1

Summary of Results for Minus Four- Plus One-inch Size Fraction

Product	Weight %	c-PAH Analysis (ppm)	c-PAH Distribution %
Feed (Computed)	100.0	4,752	100.0
-4 +1 inch	(84.6)	(4,772)	(84.2)
2.2 Sink	43.9	348	3.2
2.0 Sink	11.9	1,982	5.0
2.0 Float	28.8	12,665	76.7
-1 inch +10 mesh	(9.5)	(3,948)	(7.9)
2.2 Sink	3.3	670	0.5
2.0 Sink	3.3	2,319	1.6
2.0 Float	2.9	9,470	5.8
-10 +80 mesh	2.3	8,080	3.9
-80 +200 mesh	1.2	6,150	1.6
-200 mesh	2.5	3,350	1.7

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Minus One-inch Plus Ten-mesh Fraction

The minus 1 inch plus 10-mesh Scalper Discharge from Run E, characterized as principally fibrous wood chips with sand inclusions and minor amounts of pea-size gravel, was treated in a horizontal scrubber as previously described. The scrubbed product was screened at 10 mesh and the resulting size fractions air dried and weighed. The minus 10-mesh material was sampled and screened at 80 and 200 mesh as described in PSA 2 in Appendix B. Plus 10-mesh material was sampled and a portion directed to heavy medium separation testing using medium slurry densities of 2.0 and 2.2 kg/L using a magnetite medium. Subsequently, a sample of the 2.0 float fraction was treated using water flotation (1.0 sink and float products) to further characterize the sample. Detail results are recorded in Heavy Medium Separation Test 3, and a characterization summary presented in Table 2.

Table 2

Summary of Results for Minus One-inch Plus Ten-mesh Size Fraction

Product	Weight %	c-PAH Analysis ppm	c-PAH Distribution %
Feed (Computed)	100.0	376	100.0
-1 inch +10 mesh	(80.2)	(352)	(93.5)
2.2 Sink	2.8	157	1.2
2.0 Sink	7.3	184	3.6
2.0 Float (Computed)	(70.1)	(476)	(88.7)
1.0 Sink	58.8	354	55.3
1.0 Float	11.3	1113	33.4
-10 +80 mesh	16.7	96	4.3
-80 +200 mesh	1.7	119	0.5
-200 mesh	1.4	483	1.8

The data in Table 2 show that horizontal scrubbing produced a minus 10-mesh fraction comprising 19.8 weight percent of the feed and containing 6.6% of the c-PAH in the sample. The data also show that 70.1 weight percent of the feed, containing 88.7% of the c-PAH, reported to the 2.0 kg/L float

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product. Visual observation identified that this product consisted almost entirely of fibrous wood chips. It is noted here that an analysis conducted on the 2.0 float product identified 2,209 ppm c-PAH in the sample as compared to the 476 ppm computed value shown in Table 2. It is speculated that this discrepancy is the result of the spotty distribution of particulate contaminated with c-PAH in the sample. For comparison, the computed c-PAH grade of the Scalper Discharge product from Run E using the analyzed value (2,209 ppm) for the 2.0 float fraction is 1,591 ppm, resulting in a 97.3% distribution of the c-PAH contaminant in the 2.0 float product. It is noted here that the minus 1-inch plus 10-mesh products from Runs F and G were composited and treated in the horizontal scrubber to characterize their c-PAH levels. The results of this work are presented as Particle Size Analyses 3 and 4.

ELUTRIATION COLUMN TESTING

Elutriation column testing was conducted on samples of Scalper Discharge from Run E and also on a Hazen-prepared composite of Super Screen Discharge and Mud Cleaner Discharge from Run E. The procedure for each test called for the sample to be introduced to a column 3½ inches in diameter with a 4.0 liter per minute (L/min) upward current of water. The column overflow was collected until no particulate were observed in the stream, at which time the flow rate was increased to 7.5 L/min and the exercise repeated. At the conclusion of the test the three products were dewatered, air dried and sampled for c-PAH analysis. Detailed results of the test work are presented in Appendix E and discussed here.

The data for Elutriation Test 1, conducted on SD material from Run E, show that no significant solids reported to the overflow fractions at the flow rates tested. Accordingly, samples from this test were not submitted for analysis. The test results for the SSD/MCD composite material show that 27.3 weight percent of the test feed reported to the combined 4.0 and 7.5 L/min overflow product and contained 57.0% of the c-PAH identified in the test products. It is noted that the analyzed c-PAH grade of the SSD/MCD composite feed was 445 ppm, as compared with a computed grade (based upon the test products) of 118 ppm, both well below the clean-soil standard.

SPIRAL CONCENTRATOR TESTING

Test work to evaluate the potential of a spiral concentrator for removing c-PAH contamination was conducted on the Hazen-prepared composite of SSD/MCD material from Run E, as described under

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the previous heading. Three batch closed-circuit tests compared c-PAH distribution in the spiral product as a function of product cutter settings on the unit, while maintaining a feed rate of about 2.3 tons per hour (tph) and a feed pulp density of approximately 25% solids by weight. Procedural details and results for the work are recorded in Appendix D and summarized graphically in Figure 1.

Figure 1 shows c-PAH recovery as a function of product weight percent and identifies that the contaminants respond very well to gravity concentration on the spiral. Specifically, the results of Spiral Test 2 show that 70.6% of the C-PAH in the test sample reported to the spiral tailing product (outer portion of the concentrating device where particles of lower specific gravity would accumulate) in 10.7 weight percent of the feed.

Finally, it is observed that the computed feed grades for Spiral Tests 1, 2, and 3 were 288, 259, and 180 ppm c-PAH, respectively, as compared to the analyzed feed grade of 445 ppm c-PAH. This result might be due the fact that the sample contained free oily liquid that accumulated on the metal and plastic surfaces of the test unit. It was not possible to collect a representative sample of this oily coating for analysis.

FROTH FLOTATION STUDIES

Froth flotation test work evaluated the concentration response of the c-PAH contaminants in the soils as a function of reagent schemes, kinetics, feed particle size, and feed pulp density. The initial work compared flotation performance as a function of reagent addition and time for the nominal minus 200-mesh C1/C2 product from Run E. Subsequent studies evaluated the variables of feed particle size and feed pulp density, and were conducted using a Hazen-prepared composite of SSD/MCD/C1/C2 (minus 10-mesh) materials from Runs F and G. Detailed results for the test work appear in Appendix F and are summarized here.

Effect of Reagents

The C1/C2 sample from Run E was thoroughly blended as a slurry and sampled to provide feed material for the test program. Representative aliquots of the slurry, at approximately 25 weight percent solids, were conditioned for five minutes in a two-liter flotation cell with 1) no reagents, 2)

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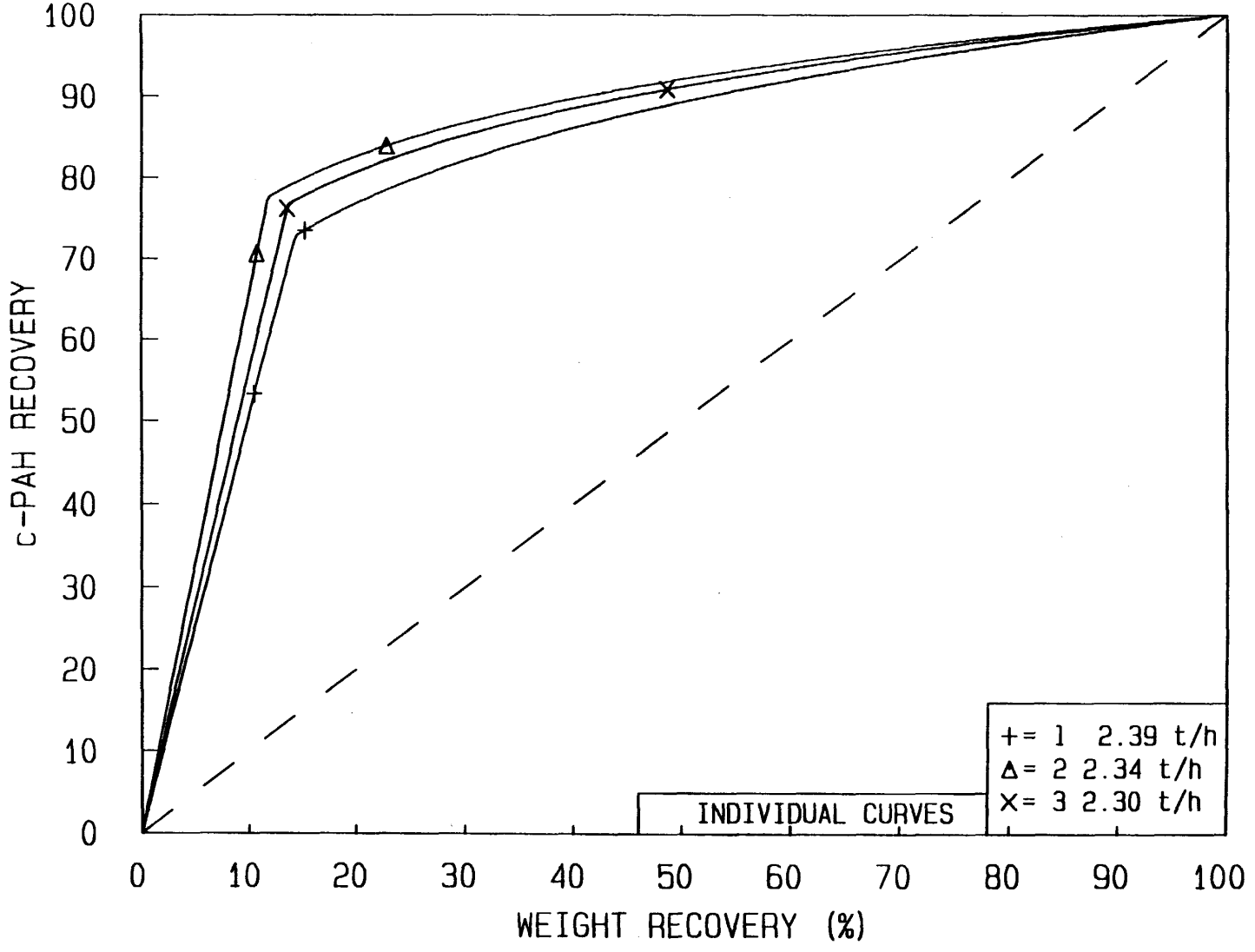
Summary of Spiral Concentrator Test Work



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sodium silicate, 3) sodium hydroxide, and 4) sodium carbonate. The conditioned pulp was floated for a period of 25 minutes, with froth samples collected for analysis at intervals of 5, 15, and 25 minutes. Detailed results of the testing are presented in Flotation Test 1 through 4 and summarized in Figure 2.[1]

The data in Figure 2 show a significant increase in c-PAH concentration performance advantage for Tests 1 and 2, using no reagents and sodium silicate, respectively. Further comparison of these two tests indicate that the addition of sodium silicate increases the selectivity of the process. However, overall recovery of the c-PAH contaminants was best when no reagents were added to the system (Test 1). The data for Flotation Test 1 show that the computed grade of the feed to the test was 616 ppm c-PAH, and that 91.2% of these contaminants were recovered to the 15-minute flotation concentrate in 47.4 weight percent of the feed.

With the exception of Flotation Test 3, in which a feed grade of 284 ppm c-PAH was computed from the test products, the computed grades of the feed samples were quite stable with values of 616, 724 and 784 ppm c-PAH recorded for Tests 1, 2, and 4, respectively.

Effect of Feed Pulp Density and Particle Size

This test work was conducted using a Hazen-prepared composite of the provided SSD/MCD/C1/C2 materials from Field Demonstration Runs F and G. These materials were blended, sampled for analysis, and split into test charges for the flotation studies. Analysis of the composite sample showed that it contained 256 ppm c-PAH. The first suite of tests (Flotation Tests 5, 6, and 7) investigated the response of the minus 10-mesh feed to flotation at variable feed pulp densities. Subsequent work (Tests 8, 9, and 10) compared flotation performance at varying feed densities on a minus 80-mesh fraction screened from the prepared composite.

Flotation Tests 5, 6, and 7 explored the response of the c-PAH to froth flotation at respective feed pulp densities of 50, 35, and 20 weight percent solids. Test work on the minus 10-mesh material was conducted without the addition of reagents. Details of the test conditions and results appear in Appendix F and are summarized graphically in Figure 3.

Comparison of the data in Figure 3 identifies a significant performance advantage realized in Test 6, where a feed pulp density of 35 weight percent solids was employed. Specifically, referring to Test 6, the data show that 62.9% of the c-PAH contaminants were recovered to the five-minute

1 See Response to EPA Comments, December 16, 1993, Appendix G - Item EPA #11

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Summary of Flotation Tests 1 through 4

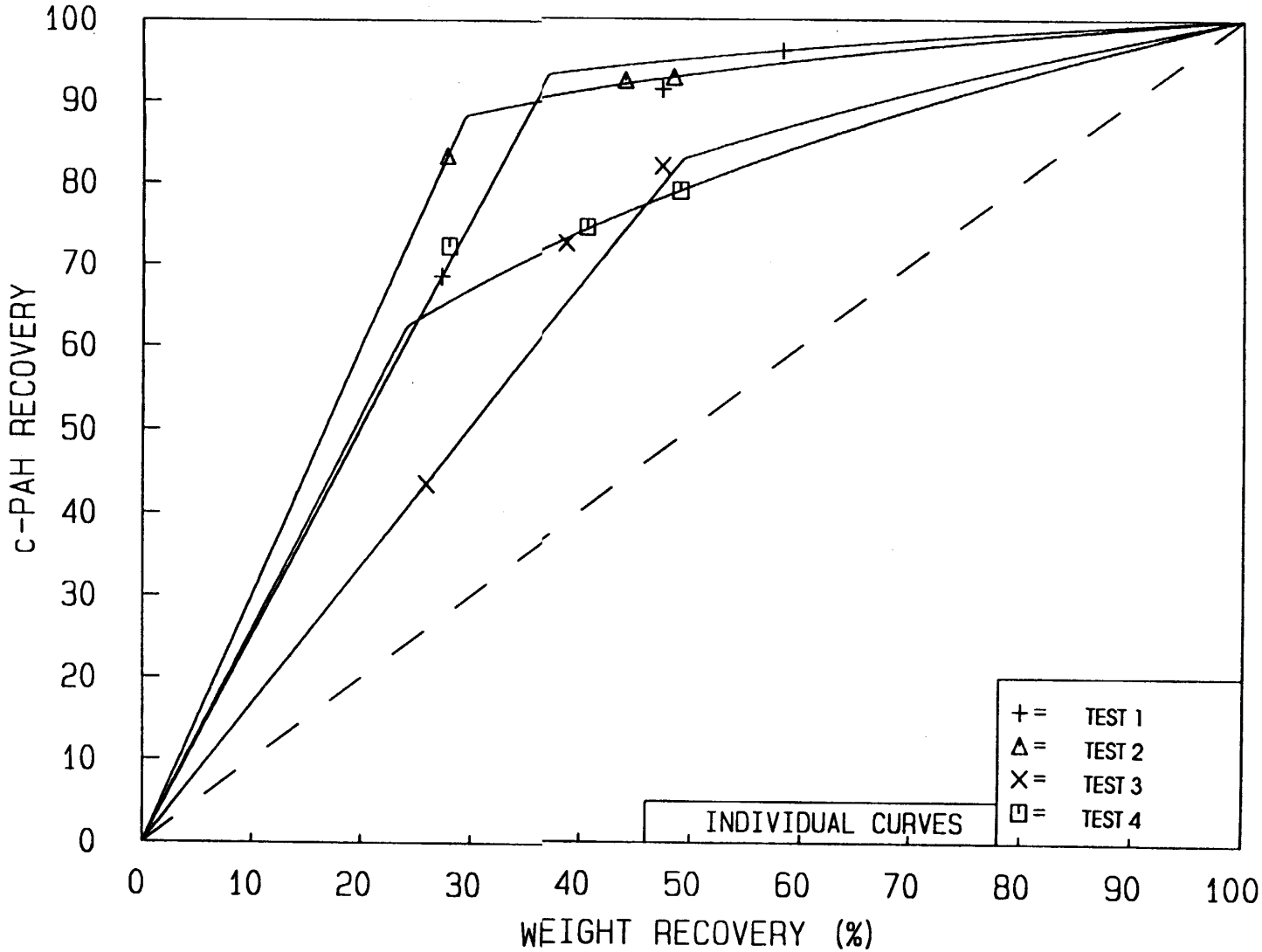

Figure 2

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Summary of Flotation Tests 5, 6 and 7

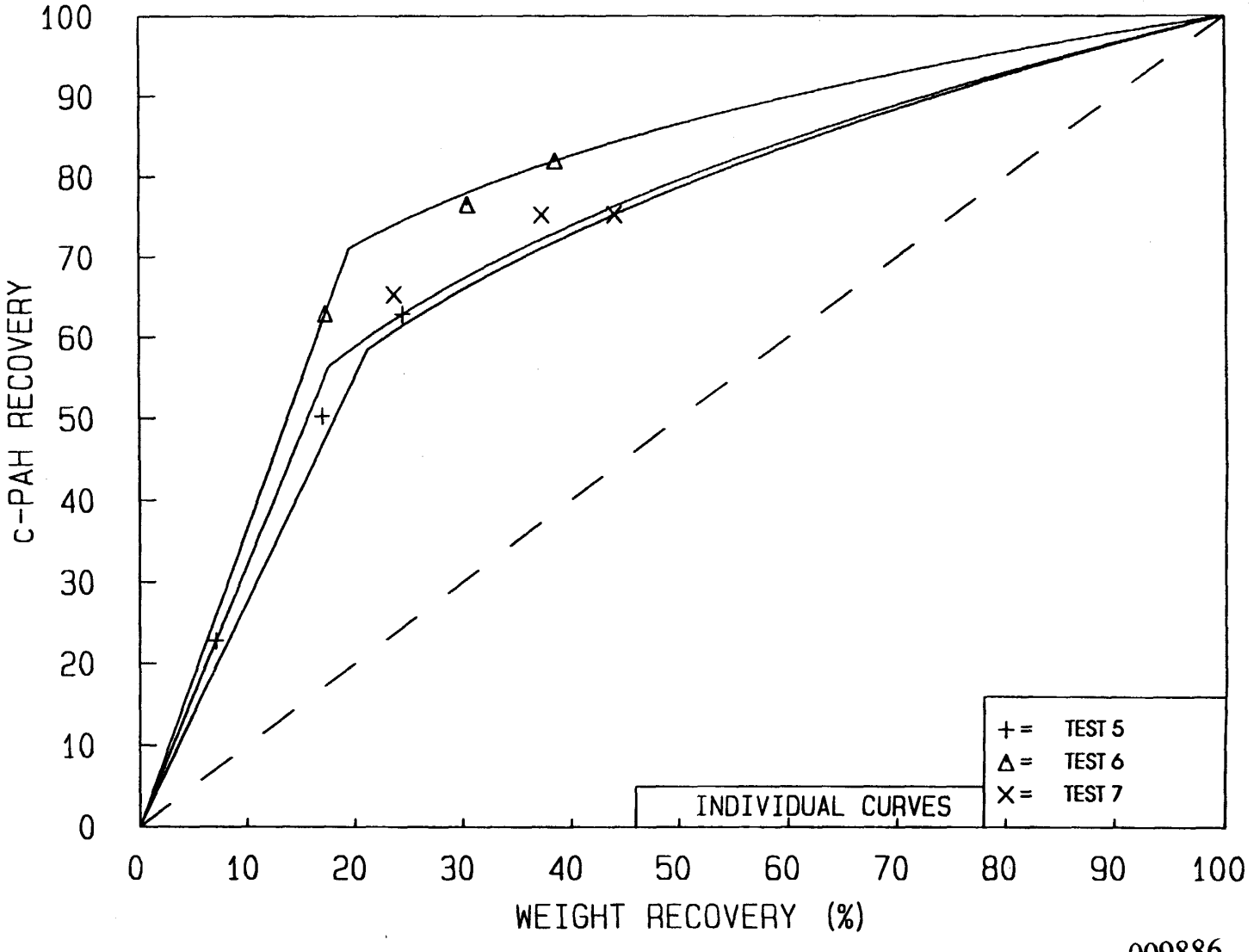

Figure 3

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flotation froth comprising 17.3 weight percent of the feed. The computed feed grades for this test series were comparable at 307, 333, and 312 ppm c-PAH for Tests 5, 6, and 7, respectively.

Flotation Tests 8, 9, and 10 investigated performance at varying feed pulp densities, using a minus 80-mesh material. The feed to the test work was prepared by screening a portion of the SSD/MCD/C1/C2 composite material at 80 mesh. The minus 10- plus 80-mesh screen oversize fraction was collected, dried, and sampled for analysis. The minus 10- plus 80-mesh fraction represented 45.0 weight percent of the composite and contained 232 ppm c-PAH. Accordingly, the grade of the flotation feed was computed by difference from the composite grade, at 276 ppm c-PAH.

The work in the test set evaluated flotation performance at feed densities of 40, 30, and 20 weight percent solids for Tests 8, 9, and 10, respectively. Test details are recorded in Appendix F and summarized graphically in Figure 4.

Examination of the data, represented in Figure 4, identifies that a significant advantage is gained by processing at 30 and 40 weight percent solids in comparison to Test 10, conducted at 20 weight percent solids. Test data for Flotation Tests 8 and 9 show that the C-PAH levels in the flotation tailing product were reported as nondetectable. Further examination of the Test 8 data shows that 96.5% of the c-PAH contamination was concentrated into the 15-minute froth product in 36.7 weight percent of the test feed.

FLOCCULANT SCAN AND SETTLING TEST WORK

The flocculant scan testing was conducted to evaluate the effect of polymer additives for enhancing the liquid/solid separation of fine particulate materials. The feed material to the test series was a sample of flotation tailing from minus 80-mesh feeds diluted to approximately 15 weight percent solids. The polymer scan series investigated the effects of cationic, nonionic, and anionic flocculants, individually and in sequential additions. Details of procedure and results appear in Appendix G and are summarized in Figure 5.

Figure 5 presents the optimum settling rate data for the series of polymer scans and establishes that a sequential addition of cationic/nonionic/anionic flocculant (FlocScan 4D) exhibited significantly better settling characteristics than the remaining combinations tested. Further examination of the Flocculant Scan 4 test data shows that the visually clear supernate for this test contained 66 mg/L

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Summary of Flotation Tests 8, 9 and 10

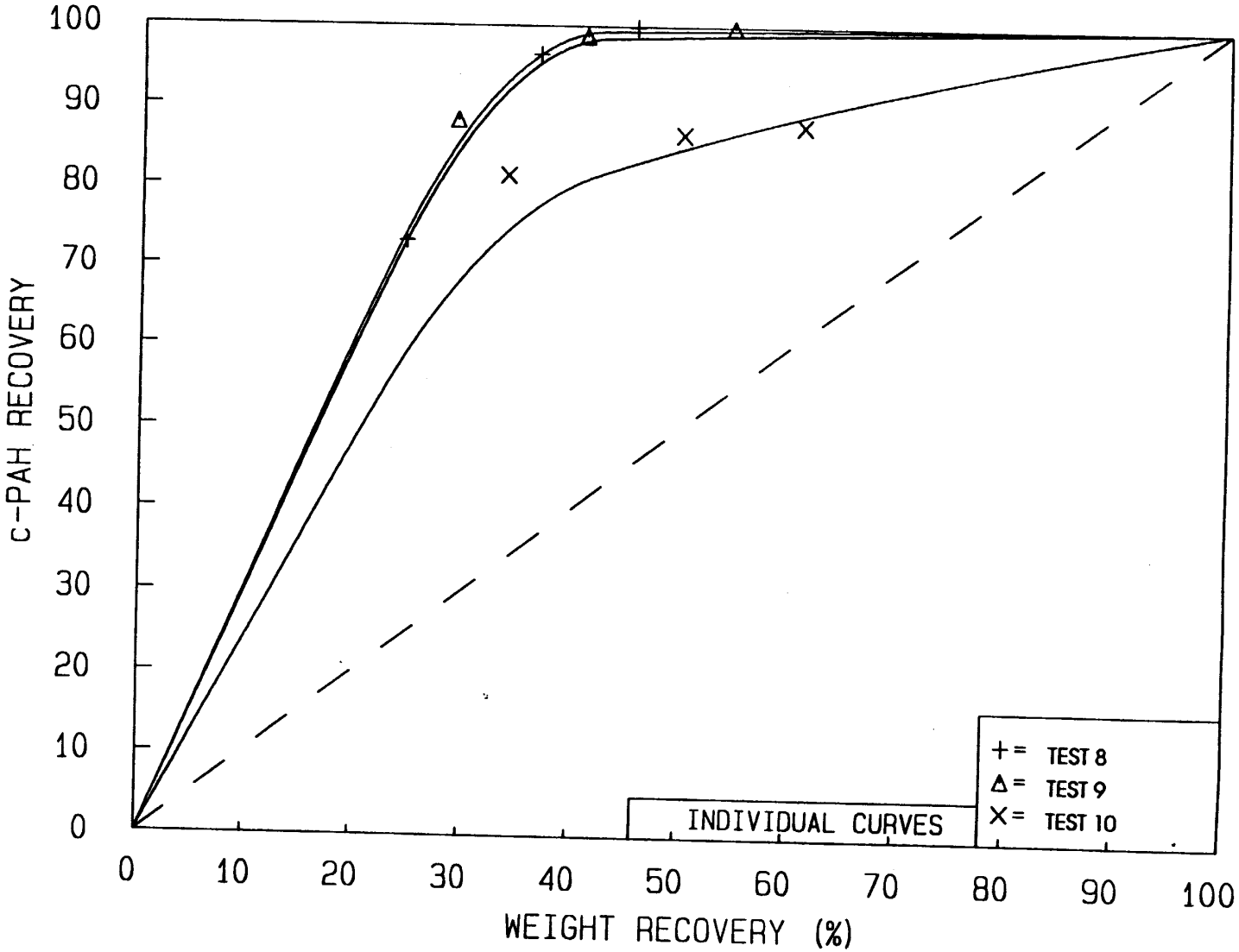

Figure 4

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Comparative Flocculent Scan Data

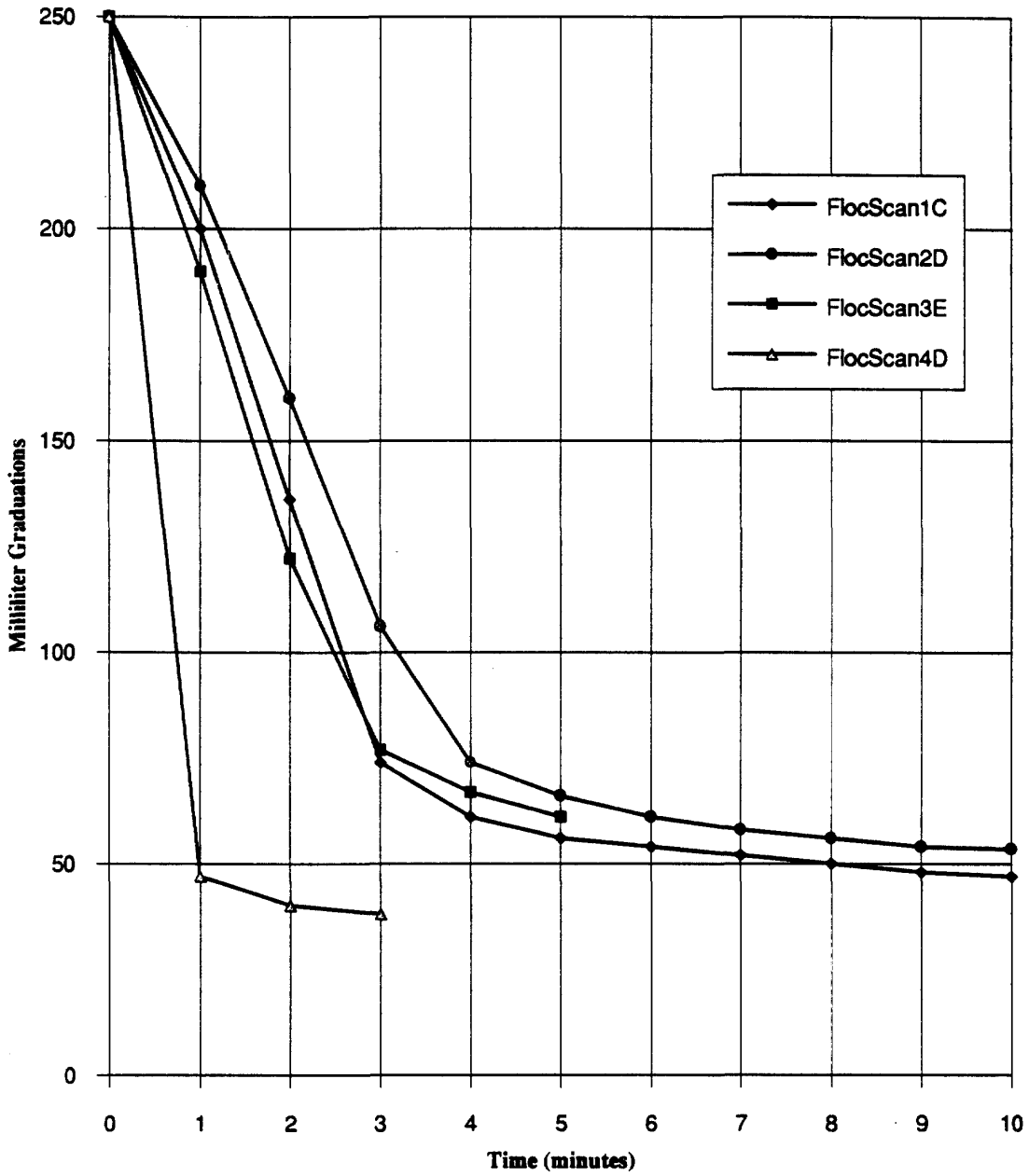

Figure 5

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of solids with a particle size greater than 0.45 microns. Additionally, the data can be used to project the density of the settled solids for this test at about 45 weight percent.

QUALITATIVE MELTING TEST

The client reported that, during field demonstration testing, the tarlike particles in the soil were observed sticking to and smearing on the screen surfaces, a condition that was not encountered in the test work at Hazen. It was speculated that the phenomenon was a function of temperature, and a qualitative melt test was conducted to substantiate the idea.

Approximately 50 grams of the 2.0 float product from Heavy Medium Separation Test 1 crushed to a nominal minus 6 mesh were used for the work. The sample was placed in a stainless steel pan in a mono layer and exposed to temperatures of 60°, 70°, and 80°F for periods of one hour. Examination of the material in the pan showed that many of the tarry particles began to stick to the surface of the pan at 80°F. The data suggest that if the temperature of the contaminated soils was maintained at less than 80°F, the smearing observed on the screens at the field demonstration test could be controlled.

RELATIVE DENSITY ANALYSES

Relative density analyses, to determine the minimum and maximum density per unit weight of cohesionless free-draining soils, were conducted on the two Hazen-prepared composites of SSD/MCD material. Composite samples of the SSD/MCD products from Run E and Run F were directed to Advanced Terra Testing, a subcontractor to Hazen, for the analyses. The testing was conducted in accordance with ASTM 4253-93 and ASTM 4254-91, corresponding to the maximum and minimum density index procedures.

Detailed data for the work, presented in Appendix H, show that the respective minimum and maximum density indices for the Run E sample are 82.6 and 99.6 pounds per cubic foot (lb/ft^3). Similarly, the comparative results for the Run F composite were 84.6 and 95.4 lb/ft^3.

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SUMMARY AND COMPARATIVE FLOWSHEET EVALUATIONS

The results of the process study at Hazen conducted on provided samples from the field demonstration testing show that the c-PAH contamination in the samples are concentrated in the coarse size fractions.

Samples collected from Run E show that c-PAH levels in the plus 10-mesh Scalper Discharge may run as high as 1,591 ppm. Analysis of the minus 10- plus 200-mesh composite of SSD/MCD material indicates a grade of 445 ppm c-PAH, while the average grade of the minus 200-mesh material (C1/C2) was shown to be 602 ppm c-PAH, as computed from the flotation test products.

A similar evaluation of a composite of materials from Runs F and G shows that the minus 4-inch plus 1-inch size fraction contained 4,752 ppm c-PAH, and the minus 1-inch plus 10-mesh fraction 1,563 ppm c-PAH, based upon an analysis of the test products. The minus 10-mesh composite of SSD/MCD/C1/C2 material from Runs F and G showed and analyzed a c-PAH level of 445 ppm.

The process flowsheet suggested by the test work at Hazen would consist of trommel scrubbing and screening at 10 mesh, with the screen oversize fraction directed to heavy medium separation to produce a clean rock/shell product with a c-PAH level of less than 700 ppm, and a contaminated tarlike component requiring further treatment or disposal. The minus 10-mesh process product would be dewatered and combined with the clean oversize material as a backfill.

However, this process scheme may not be realistic, since other analyses (furnished to Hazen in a draft report by the client) of minus 10-mesh field demonstration products indicate c-PAH levels above the 700 ppm level. Accordingly, a comparative flowsheet study based upon higher levels of c-PAH contamination was conducted to evaluate metallurgical and mass flow characteristics of three process alternatives. The basis and results for the modelling exercise are discussed in the following sections.

FLOWSHEET SIMULATION BASIS

The feed material for the simulation work was computed based upon applicable test data from the work at Hazen and client-provided weight distribution and analysis data for Runs E, F, and G, from the field demonstration program. This client-provided information (excerpted from a draft report) is included in Appendix I. Data for the feed sample are presented in Table 3, with appropriate source references.

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Metallurgical performances for the process schemes are based on the results of the unit operation test work at Hazen. That is, the modelled process response data, included in Appendix I, were proportioned to reflect the increased c-PAH levels in the finer size fractions, and used to compute the distribution of the clean and contaminated products. The water balance for each of the systems is based upon simplified but consistent additions of water as required to meet the performance criteria identified by the test work at Hazen. A feed rate of 5 tph was arbitrarily selected for each of the simulations.

Table 3

Simulated Feed for Flowsheet Evaluation

Product	Weight Distribution, % [1]	c-PAH Analysis, ppm
Feed (Computed)	100.0	1687
-4 inch +1 inch	6.0	4772[2]
-1 inch +10 mesh (SD)	19.2	1678[3]
-10 +80 mesh (SSD)	35.2	1556[4]
-80 +200 mesh (MCD)	24.0	1289[4]
-200 mesh (C1/C2)	15.6	1420[4]

[1] Computed average for products from Field Demonstration Runs E, F, and G

[2] Heavy Medium Separation Test 1

[3] Computed from Heavy Medium Separation Test 1 and Particle Size Analysis 3 products

[4] From client-supplied field demonstration analytical data

FLOWSHEET DISCUSSIONS

Mass flow and metallurgical performance were simulated for three integrated gravity separation/froth flotation process systems. Each of the flowsheet alternatives is graphically described with

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accompanying mass and c-PAH metallurgy balances in Figures 6, 7, and 8. Comparative results for the simulation are presented in Table 4 and discussed here.

Process Flowsheet 1 (Figure 6) describes a 5 tph system where minus 4-inch contaminated soils are fed to a horizontal scrubber fitted with a 1-inch trommel screen. The minus 1-inch trommel discharge is further screened at 10 mesh, and the screen oversize is combined with trommel oversize for heavy medium separation processing. The dense medium separation conducted using a 2.2 kg/L slurry specific gravity produces a float (c-PAH-contaminated) and a sink (less than 700 ppm c-PAH clean soil) product. Minus 10-mesh screen undersize is directed to further classification at 200 mesh, with the oversize fraction treated using spiral concentrators, and the minus 200-mesh fraction is directed to froth flotation. The spiral and flotation processes produce clean soil and c-PAH-contaminated products as indicated in Figure 6.

Process Flowsheet 2 (Figure 7) treats the plus 10-mesh fraction as described previously, and the minus 10-mesh product is directed to froth flotation at 50 weight percent solids. Note that water flow to the scrubber trommel was reduced to increase the pulp density in the flotation circuit. The distribution of clean soil and c-PAH contaminated products are described in the figure.

Process Flowsheet 3 is similar to the previous example with the exception that flotation processing is conducted at 35 weight percent solids.

Table 4

Comparative Flowsheet Summary

Process System	Clean Soil Weight % (<700 ppm c-PAH)	Contaminated Soil Weight %	Water Rate[1] tph
Flowsheet 1	76.8	23.2	13.1
Flowsheet 2	52.0	48.0	3.9
Flowsheet 3	73.3	26.7	7.1

[1] Based on solids rate of 5 tph

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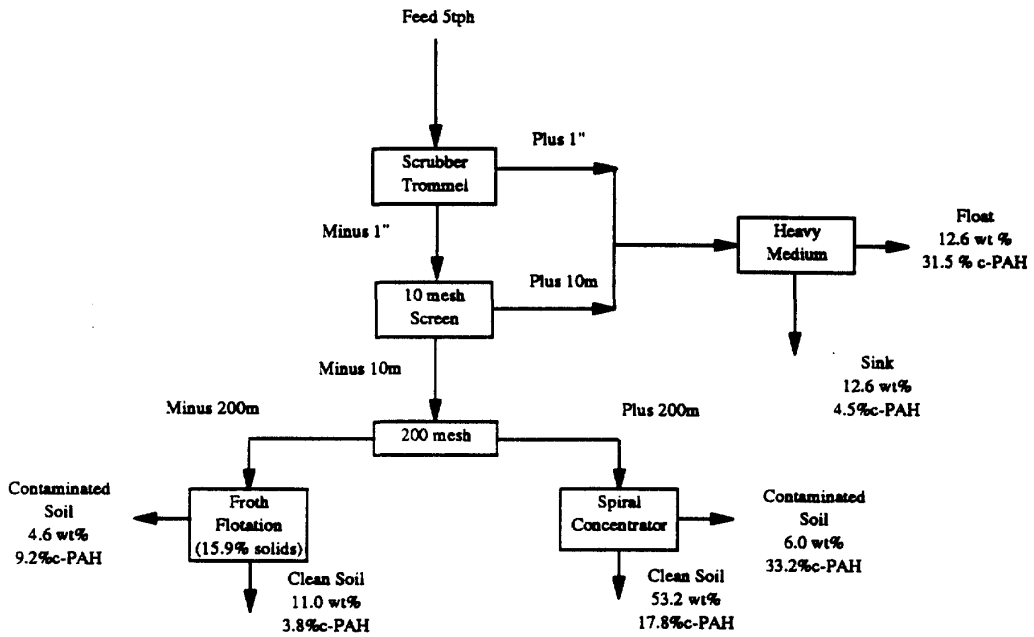
Gravity Separation/Froth Flotation Flowsheet 1



Product	Rate Solids (tph)	Rate Water (tph)	Product Distribution (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	5	5	100.0	1690	100.0
Plus 10 mesh (HMS)	(1.26)	(0.12)	(25.2)	(2415)	(36.0)
Sink	0.63	0.06	12.6	603	4.5
Float	0.63	0.06	12.6	4227	31.5
Minus 10 plus 200 mesh (Spiral)	(2.96)	(8.88)	(59.2)	(1455)	(51.0)
Clean Soil	2.66	3.18	53.2	564	17.8
Contaminated Soil	0.30	5.70	6.0	9356	33.2
Minus 200 mesh (Flotation)	(0.78)	(4.13)	(15.6)	(1408)	(13.0)
Clean Soil	0.55	2.91	11.0	584	3.8
Contaminated Soil	0.23	1.22	4.6	3378	9.2

Total system water for 5 tph of solids processed. (13.1)

Figure 6

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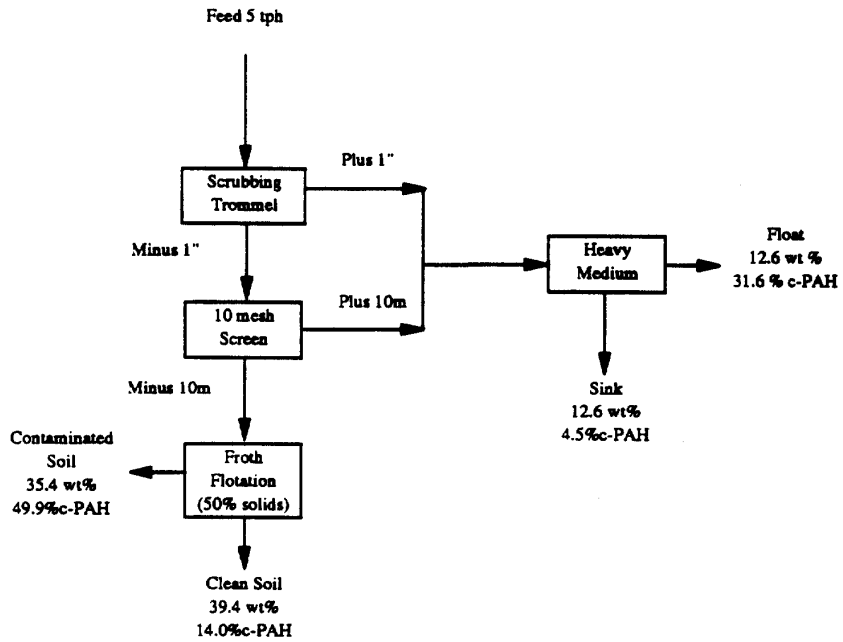
Gravity Separation/Froth Flotation Flowsheet 2



Product	Rate Solids (tph)	Rate Water (tph)	Product Distribution (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	5.00	3.86	100.0	1687	100.0
Plus 10 mesh (HMS)	(1.26)	(0.12)	(25.2)	(2415)	(36.1)
Sink	0.63	0.06	12.6	603	4.5
Float	0.63	0.06	12.6	4227	31.6
Minus 10 mesh (Flotation)	(3.74)	(3.74)	(74.8)	(1442)	(63.9)
Clean Soil	1.97	1.97	39.4	600	14.0
Contaminated Soil	1.77	1.77	35.4	2379	49.9
Total system water for 5 tph of solids processed.		(3.86)			

Figure 7

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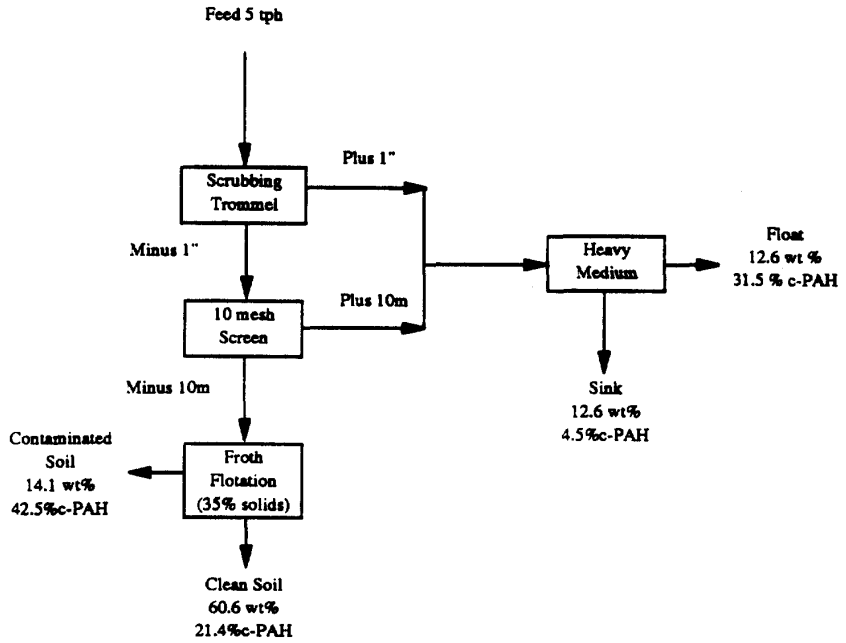
Gravity Separation/Froth Flotation Flowsheet 3



Product	Rate Solids (tph)	Rate Water (tph)	Product Distribution (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	5.00	7.06	100.0	1689	100.0
Plus 10 mesh (HMS)	(1.26)	(0.12)	(25.2)	(2415)	(36.0)
Sink	0.63	0.06	12.6	603	4.5
Float	0.63	0.06	12.6	4227	31.5
Minus 10 mesh (Flotation)	(3.74)	(6.94)	(74.8)	(1444)	64.0
Clean Soil	3.03	5.63	60.7	597	21.4
Contaminated Soil	0.71	1.31	14.1	5081	42.5
Total system water for 5 tph of solids processed.		(7.06)			

Figure 8

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The summary data in Table 4 show that the best metallurgical performance was achieved in Process 1, where 76.8 weight percent of the feed was recovered to a clean soil product with c-PAH contamination of less than 700 ppm. This process required significantly more water than either of the other scenarios, using 13.1 tph water for each 5 tph of solids processed. The reverse of this is seen in Flowsheet 2, which is characterized by the lowest water requirements and poorest metallurgical performance. Of the three process alternatives examined, Flowsheet 3 provided the best metallurgy and water balance, producing a clean soil product comprising 73.3 weight percent of the feed and requiring 7.1 tph water for 5 tph solids processed.

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APPENDIX A

BULK DENSITY ANALYSES

Appendix A
Bulk Density Analysis 1

Project No.: **8074**
Date: **Apr-93**

Purpose: To determine the bulk density of each of the as-received samples.

Sample: Test products from onsite processing of South Cavalcade soils, as indicated below (Hazen Sample 46707).

Procedure: The net weight and volume of each of the as-received materials was recorded. A portion of each of the five samples was collected and the respective weight percent moisture of the sample was determined. The data were used to compute the wet and dry bulk density for each of the products as indicated in the results.

Results:

Sample Identification	Net Wet Weight (kg)	Volume (liters)	Net Dry (1) Weight (kg)	Wt. % Solids	Bulk Density Wet (kg/cubic m)	Bulk Density Dry (kg/cubic m)
Plus 1-inch (Runs F and G)	17.05	15.85	16.93	99.3	1076	1068
SD Run E	25.95	24.65	21.69	83.6	1053	880
SSD Run E	36.24	22.21	34.86	96.2	1632	1570
MCD Run E	34.81	18.02	27.64	79.4	1932	1534
C1/C2 Run E	32.72	20.93	21.01	64.2	1563	1004

(1) The net dry weight is computed from an approximately 300 gram grab sample collected from each of the test products for weight percent moisture analysis.

Appendix A
Bulk Density Analysis 2

Project No.: 8074
Date: June-93

Purpose: To determine the bulk density of each of the as-received samples.

Sample: Test products from onsite processing of South Cavalcade soils, as indicated below (Hazen Sample 46707).

Procedure: The net weight and volume of each of the as-received materials was recorded. A portion of each of the nine samples was collected and the respective weight percent moisture of the sample was determined. The data were used to compute the wet and dry bulk density for each of the products as indicated in the results.

Results:

Sample Identification	Net Wet Weight (kg)	Volume (liters)	Net Dry (1) Weight (kg)	Wt. % Solids	Bulk Density Wet (kg/cubic m)	Bulk Density Dry (kg/cubic m)
SD Run F	33.78	26.69	31.07	91.99	1266	1164
SD Run G	34.04	26.31	32.43	95.26	1294	1232
SSD Run F	44.76	26.52	41.72	93.20	1688	1573
SSD Run G	37.14	22.88	34.33	92.43	1623	1500
MCD Run F	43.83	23.32	36.17	82.53	1880	1551
MCD Run G	38.97	21.55	33.13	85.00	1808	1537
C1/C2 Run F	37.44	21.69	25.93	69.27	1726	1196
C1 Run G	17.77	9.87	13.43	75.55	1800	1360
C2 Run G	18.34	10.19	14.32	78.06	1800	1405

(1) The net dry weight is computed from an approximately 300 gram grab sample collected from each of the test products for weight percent moisture analysis.

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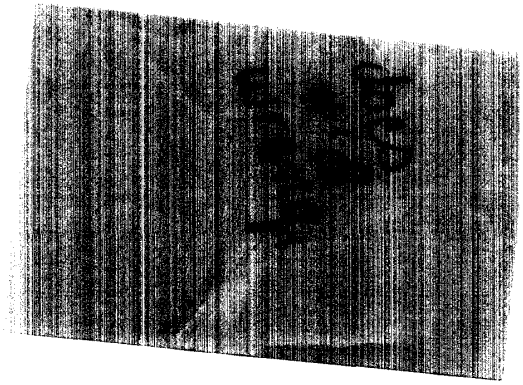
APPENDIX B

PARTICLE SIZE ANALYSES



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Appendix B
Particle Size Analysis 1

Project No.: **8074**
Date: **May-93**

Purpose: To determine the distribution of carcinogenic poly-aromatic hydrocarbons (c-PAH) in the sample with regard to particle size.

Sample: Approximately 380 g of client-identified minus 4 inch plus 1 inch material from test runs F and G (Material passed a 10 mesh screen after scrubbing at Hazen.)

Procedure: The screen fractions from Particle Size Analysis 1 were separated into the following components: Minus 10 mesh plus 80 mesh; minus 80 mesh plus 200 mesh; and, minus 200 mesh.

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	373.4	100.0	5741	100.0
-10, +80m	143.6	38.5	8080	54.1
-80, +200m	76.3	20.4	6150	21.9
-200m	153.5	41.1	3350	24.0

Appendix B
Particle Size Analysis 2

Project No.: **8074**
Date: **May-93**

Purpose: To determine the distribution of carcinogenic poly-aromatic hydrocarbons (c-PAH) in the sample with regard to particle size.

Sample: Approximately 500 g of client-identified minus 1 inch plus 10 mesh material from test run E (Material passed a 10 mesh screen after scrubbing at Hazen.)

Procedure: The screen fractions from Particle Size Analysis 2 were separated into the following components: Minus 10 mesh plus 80 mesh; minus 80 mesh plus 200 mesh; and, minus 200 mesh.

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	490.3	100.0	125	100.0
-10, +80m	413.4	84.3	96	64.8
-80, +200m	42.9	8.7	119	8.3
-200m	34.0	6.9	483	26.8

Appendix B
Particle Size Analysis 3

Project No.: **8074**
Date: **Jun-93**

Purpose: To determine the distribution of carcinogenic poly-aromatic hydrocarbons (c-PAH) in the sample with regard to particle size.

Sample: Approximately 600 g of client-identified minus 10 mesh SD material from test runs F and G (Material passed a 10 mesh screen after scrubbing at Hazen.)

Procedure: The screen fractions from Particle Size Analysis 3 were separated into the following components: Minus 10 mesh plus 80 mesh; minus 80 mesh plus 200 mesh; and, minus 200 mesh.

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	566.7	100.0	1174	100.0
-10, +80m	323.9	57.2	1441	70.1
-80, +200m	70.3	12.4	829	8.8
-200m	172.5	30.4	814	21.1

Appendix B
Particle Size Analysis 4 Computed Summary

Project.: **8074**
Date: **Jul-93**

Purpose: To evaluate the effectiveness of trommel scrubbing for the disaggregation and subsequent separation of the creosote contaminated material from the soil/rock/sea shell matrix.

Sample: Approximately 65 kilograms of client-identified SD material (minus one-inch plus ten mesh) from test runs F and G.

Procedure: The material was washed in a horizontal scrubber at 50% solids for one hour and then screened at 10 mesh. A particle size analysis was conducted on the minus 10 mesh material, screening at 80 and 200 mesh. Process products sampled for c-PAH analysis are indicated in the results.

Results:

Product	Weight (kg)	Weight (%)	Analysis c-PAH (ppm)	% Distribution Based on A (c-PAH)
Feed (computed)	63.50	100.0	1563	100.0
-1",+10m	57.63	90.7	1603	93.1
-10,+80m	3.36	5.3	1441	4.9
-80,+200m	0.73	1.1	829	0.6
-200m	1.79	2.8	814	1.5

APPENDIX C

HEAVY MEDIUM SEPARATION

Appendix C
Heavy Medium Separation -- Test 1

Project No.: **8074**
Date: **May-93**

Purpose: To evaluate the potential of heavy medium separation for producing material free of creosote lumps.

Sample: Approximately 13 kilograms of plus 1 inch material from the original client-identified plus one inch sample from test runs F and G.

Procedure: The client-identified plus 1 inch material was scrubbed for one hour and screened. The minus 4 plus 1 inch fraction was directed to heavy medium separation test work. Specific gravities of the magnetite slurry medium were 2.0 and 2.2.

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	13304	100.0	4772	100.0
-4,+1 inch				
2.2sink	6901	51.9	348	3.8
2.2>2.0float	1873	14.1	1982	5.8
2.0float	4530	34.0	12665	90.4

Appendix C
Heavy Medium Separation -- Test 2

Project No.: **8074**
Date: **May-93**

010007

Purpose: To evaluate the potential of heavy medium separation for producing material free of creosote lumps.

Sample: Approximately 2 kilograms of minus 1 inch plus 10 mesh material from the original client-identified plus one inch sample from test runs F and G.

Procedure: The client-identified plus 1 inch material was scrubbed for one hour and screened. The minus 1 inch plus 10 mesh fraction was directed to heavy medium separation test work. Specific gravities of the magnetite slurry medium were 2.0 and 2.2.

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed)	1488.5	100.0	3948	100.0
-1",+10m				
2.2sink	513.5	34.5	670	5.9
2.2>2.0float	517.6	34.8	2319	20.4
2.0float	457.4	30.7	9470	73.7

Purpose: To evaluate the potential of heavy medium separation for producing material free of creosote lumps.

Sample: Approximately 4 kilograms of minius 1 inch plus 10 mesh material from the client-identified SD (minus 1 inch plus 10 mesh) sample from test run E.

Procedure: The client-identified SD material was scrubbed for one hour and screened at 10 mesh. The minus 1 inch plus 10 mesh fraction was directed to heavy medium separation test work. Specific gravities of the magnetite slurry medium were 2.0 and 2.2. Additional gravity separation test work was conducted on the heavy medium 2.0 float product. Approximately 750 grams of the 2.0 HMS float product were processed using water as the medium for separation. The results of the water separation are presented below the magnetite test data.

Results:

Magnetite as medium

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed) (1)			744	
Feed (computed)	3836	100.0	1953	100.0
-1",+10m				
2.2sink	133.0	3.5	157	0.3
2.2>2.0float	349.3	9.1	184	0.9
2.0float	3354	87.4	2209	98.9

Water as medium

Feed (analyzed) (2)			2209	
Feed (computed)	735	100.0	476	100.0
-1",+10m				
1.0sink	617	83.9	354	62.3
1.0float	119	16.1	1113	37.7

(1) Client-supplied analysis

010009

APPENDIX D

SPIRAL TESTS

010009

Appendix D
Spiral Test 1

Project No.: **8074**
Date: **May-93**

010010

Purpose: To evaluate the separation response of c-PAH contaminants to spiral concentrator testing.

Sample: Approximately 13 kilograms of MCD/SSD blended sample from test run E.

Procedure: At steady state conditions, timed samples were taken. The samples were weighed, filtered, dried, and weighed again. Process products were submitted for c-PAH analysis.

Conditions:

Spiral Identification:	LD-9	Cutter Position Settings	
Feed Rate:	2.4 tons/hr.	Concentrate :	4.5
Sample Time:	5.0 seconds	Middling :	7.375
Feed Pulp Density:	24.5 % solids		
Pump Setting:	55 Hz		

Results:

Product	Solids Rate (lb/hr)	Solids (%)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)				445	
Feed (computed)	4792	24.5	100.0	288	100.0
Concentrate	4063	69.7	84.8	90	26.5
Middlings	225	10.6	4.7	1234	20.2
Tailings	504	4.3	10.5	1458	53.3

Appendix D
Spiral Test 2

Project No.: **8074**
Date: **May-93**

010011

Purpose: To evaluate the separation response of c-PAH contaminants to spiral concentrator testing.

Sample: Approximately 13 kilograms of MCD/SSD blended sample from test run E.

Procedure: At steady state conditions, timed samples were taken. The samples were weighed, filtered, dried, and weighed again. Process products were submitted for c-PAH analysis.

Conditions:

Spiral Identification:	LD-9	Cutter Position Settings	
Feed Rate:	2.3 tons/hr.	Concentrate :	3.5
Sample Time:	6.5 seconds	Middling :	6.75
Feed Pulp Density:	25.5 % solids		
Pump Setting:	55 Hz		

Results:

Product	Solids Rate (lb/hr)	Solids (%)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)				445	
Feed (computed)	4687	25.5	100.0	259	100.0
Concentrate	3621	71.1	77.3	54	16.1
Middlings	563	24.3	12.0	286	13.3
Tailings	503	4.6	10.7	1702	70.6

Appendix D
Spiral Test 3

Project No.: **8074**
Date: **May-93**

010012

Purpose: To evaluate the separation response of c-PAH contaminants to spiral concentrator testing.

Sample: Approximately 13 kilograms of MCD/SSD blended sample from test run E.

Procedure: At steady state conditions, timed samples were taken. The samples were weighed, filtered, dried, and weighed again. Process products were submitted for c-PAH analysis.

Conditions:

		Cutter Position Settings	
Spiral Identification:	LD-9	Concentrate :	2.25
Feed Rate:	2.3 tons/hr.	Middling :	4.5
Sample Time:	6.8 seconds		
Feed Pulp Density:	25.2 % solids		
Pump Setting:	55 Hz		

Results:

Product	Solids Rate (lb/hr)	Solids (%)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)				445	
Feed (computed)	4587	25.2	100.0	180	100.0
Concentrate	2356	71.0	51.4	32	9.1
Middlings	1607	52.1	35.0	75	14.6
Tailings	624	5.3	13.6	1007	76.2

APPENDIX E

ELUTRIATION TESTS

Appendix E
Elutriation Test 1

Project No.: **8074**
Date: **May-93**

Purpose: To determine the distribution of carcinogenic poly-aromatic hydrocarbons (c-PAH) as a function of flow rate of a rising column of water.

Sample: Approximately 1100g of minus 1 plus 10 mesh (SD) material from test run E.

Procedure: Overflows were collected at flow rates of zero,and seven and one-half liters per minute into the elutriation column. The results indicate that the SD material either floated in a static column of water or sank even at a high flow rate of 7.5 l/m.

Results:

	Flow rates (l/m)	Weight (g)	Weight %
Feed (computed)		831.6	100.0
Overflow	0.0	44.7	5.4
Overflow	7.5	5.9	0.7
Underflow		781.1	93.9

Appendix E
Elutriation Test 2

Project No.: **8074**
Date: **May-93**

010015

Purpose: To determine the distribution of carcinogenic poly-aromatic hydrocarbons (c-PAH) as a function of flow rate of a rising column of water.

Sample: Approximately 700 g client-identified SSD/MCD blended material from test run E. The sample is 1:1 mixture of SSD and MCD material with a size distribution of -10 to +175 mesh.

Procedure: Overflows were collected at flow rates of two, four, five, and, seven and one-half liters per minute into the elutriation column. The fractions were combined and classified as less than 4 LPM float, less than 7.5 LPM float, and 7.5LPMsink products. Process products were submitted for c-PAH anaylsis.

Results:

Products	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)			445	
Feed (computed)	606.1	83.6	118	100.0
-10,+175m				
7.5LPMsink	440.8	72.7	70	43.0
7.5LPMfloat	66.1	10.9	143	13.2
4LPMfloat	99.2	16.4	317	43.8

APPENDIX F

FROTH FLOTATION TESTS

Appendix F
Flotation Test 1

Project No.: **8074**
Date: **May-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 440 grams of client-indentified C1/C2 material from test run E.

Procedure: The ~25% slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagents:	None	None	None
Pulp pH:	9.1	8.7	8.6
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed) (1)			1420	
Feed (computed)	475.8	100.0	616	100.0
Ro. Conc. 1	129.7	27.3	1550	68.5
Ro. Conc. 2	95.4	20.1	698	22.7
Ro. Conc. 3	51.6	10.8	278	4.9
Rougher tailing	199.1	41.8	57	3.9

(1) Client-supplied analysis

Appendix F
Flotation Test 2

Project No.: **8074**
Date: **May-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 440 grams of client-indentified C1/C2 material from test run E.

Procedure: The ~25% slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 20 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-20
SiO2/Na2(lb/ton):	0.22	0.22	0
Pulp pH:	8.9	8.8	8.8
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed) (1)			1420	
Feed (computed)	436.8	100.0	724	100.0
Ro. Conc. 1	121.3	27.8	2170	83.2
Ro. Conc. 2	71.3	16.3	406	9.2
Ro. Conc. 3	18.8	4.3	68	0.4
Rougher tailing	225.4	51.6	101	7.2

(1) Client-supplied analysis

Appendix F
Flotation Test 3

Project No.: **8074**
Date: **May-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 440 grams of client-indentified C1/C2 material from test run E.

Procedure: The ~25% slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25	
Reagent:	NaOH			Added as 10% solution for pH adjustment
Pulp pH:	10.2	10.3	10.3	
Impeller rpm:	1500	1500	1500	

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed) (1)			1420	
Feed (computed)	436.0	100.0	284	100.0
Ro. Conc. 1	112.8	25.9	477	43.5
Ro. Conc. 2	55.8	12.8	641	28.9
Ro. Conc. 3	37.8	8.7	309	9.4
Rougher tailing	229.6	52.7	98	18.2

(1) Client-supplied analysis

Appendix F
Flotation Test 4

Project No.: **8074**
Date: **May-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 440 grams of client-indentified C1/C2 material from test run E.

Procedure: The ~25% slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25	
Reagent:	Na2CO3			Added as 10% solution for pH adjustment
Pulp pH:	10.2	10.2	10.1	
Impeller rpm:	1500	1500	1500	

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed) (1)			1420	
Feed (computed)	491.4	100.0	784	100.0
Ro. Conc. 1	137.8	28.0	2020	72.3
Ro. Conc. 2	62.0	12.6	130	2.1
Ro. Conc. 3	41.1	8.4	425	4.5
Rougher tailing	250.5	51.0	324	21.1

(1) Client-supplied analysis

Appendix F
Flotation Test 5

Project No.: **8074**
Date: **Jun-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 1430 gram mixture of client-indentified SSD/MCD/C1/C2 material from test runs F and G.

Procedure: The ~ 50% solids slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagent:	No	reagents	
Pulp pH:	7.9	8	8
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)			256	
Feed (computed)	1428.6	100.0	307	100.0
Ro. Conc. 1	101.5	7.1	982	22.7
Ro. Conc. 2	141.2	9.9	851	27.4
Ro. Conc. 3	106.8	7.5	516	12.6
Rougher tailing	1079.1	75.5	151	37.3

Appendix F
Flotation Test 6

Project No.: **8074**
Date: **Jun-93**

010022

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 800 gram mixture of client-indentified SSD/MCD/C1/C2 material from test runs F and G.

Procedure: The ~ 35% solids slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagent:	No	reagents	
Pulp pH:	7.9	7.95	8
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)			256	
Feed (computed)	798.4	100.0	333	100.0
Ro. Conc. 1	137.8	17.3	1213	62.9
Ro. Conc. 2	105.4	13.2	343	13.6
Ro. Conc. 3	64.4	8.1	223	5.4
Rougher tailing	490.9	61.5	98	18.1

Appendix F
Flotation Test 7

Project No.: **8074**
Date: **Jun-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 360 gram mixture of client-indentified SSD/MCD/C1/C2 material from test runs F and G.

Procedure: The ~ 20% solids slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagent:	No	reagents	
Pulp pH:	7.8	7.9	7.9
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (analyzed)			256	
Feed (computed)	355.9	100.0	312	100.0
Ro. Conc. 1	84.5	23.7	859	65.3
Ro. Conc. 2	48.5	13.6	229	10.0
Ro. Conc. 3	24.1	6.8	ND(0)	0.0
Rougher tailing	198.8	55.9	138	24.8

Appendix F
Flotation Test 8

Project No.: **8074**
Date: **Jun-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 850 gram mixture of client-indentified SSD/MCD/C1/C2 material from test runs F and G (material screened at 80 mesh prior to flotation).

Procedure: The ~40% solids slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagent:	No	reagents	
Pulp pH:	7.71	7.87	7.95
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed) (1)			276	
Feed (computed)	852.4	100.0	445	100.0
Ro. Conc. 1	209.3	24.6	1324	73.1
Ro. Conc. 2	103.2	12.1	862	23.4
Ro. Conc. 3	76.2	8.9	174	3.5
Rougher tailing	463.7	54.4	ND(0)	0.0

(1) Calculated value based on analytical results for minus 10 mesh blend and the minus 10, plus 80 mesh screen product.

Appendix F
Flotation Test 9

Project No.: **8074**
Date: **Jun-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 670 gram mixture of client-indentified SSD/MCD/C1/C2 material from test runs F and G (material screened at 80 mesh prior to flotation).

Procedure: The ~30% solids slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagent:	No	reagents	
Pulp pH:	7.71	7.85	8.0
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed) (1)			276	
Feed (computed)	669.5	100.0	433	100.0
Ro. Conc. 1	195.3	29.2	1308	88.2
Ro. Conc. 2	79.1	11.8	390	10.6
Ro. Conc. 3	90.6	13.5	38	1.2
Rougher tailing	304.5	45.5	ND(0)	0.0

(1) Calculated value based on analytical results for minus 10 mesh blend and the minus 10, plus 80 mesh screen product.

Appendix F
Flotation Test 10

Project No.: **8074**
Date: **Jun-93**

Purpose: To evaluate the separation response of c-PAH contaminants to flotation testing and to establish a range of operating conditions for froth flotation.

Sample: Approximately 400 gram mixture of client-indentified SSD/MCD/C1/C2 material from test runs F and G (material screened at 80 mesh prior to flotation).

Procedure: The ~20% solids slurry was conditioned for five minutes prior to flotation. The total flotation time was 25 minutes, divided into the following periods: 0 to 5 minutes; 5 to 15 minutes and, 15 to 25 minutes. Concentrates from the three flotation periods, along with the tailings material, were submitted for c-PAH analysis.

Conditions:

Time (min):	0-5	5-15	15-25
Reagent:	No	reagents	
Pulp pH:	7.7	7.85	7.89
Impeller rpm:	1500	1500	1500

Results:

Product	Weight (g)	Weight (%)	Analysis c-PAH (ppm)	% Distribution (c-PAH)
Feed (computed) (1)			276	
Feed (computed)	399.4	100.0	332	114.2
Ro. Conc. 1	135.3	33.9	910	92.7
Ro. Conc. 2	64.4	16.1	122	5.9
Ro. Conc. 3	44.2	11.1	40	1.3
Rougher tailing	155.5	38.9	121	14.2

(1) Calculated value based on analytical results for minus 10 mesh blend and the minus 10, plus 80 mesh screen product.

APPENDIX G

FLOCCULANT SCANS

Appendix G
Flocculant Scan 1a, b, and c

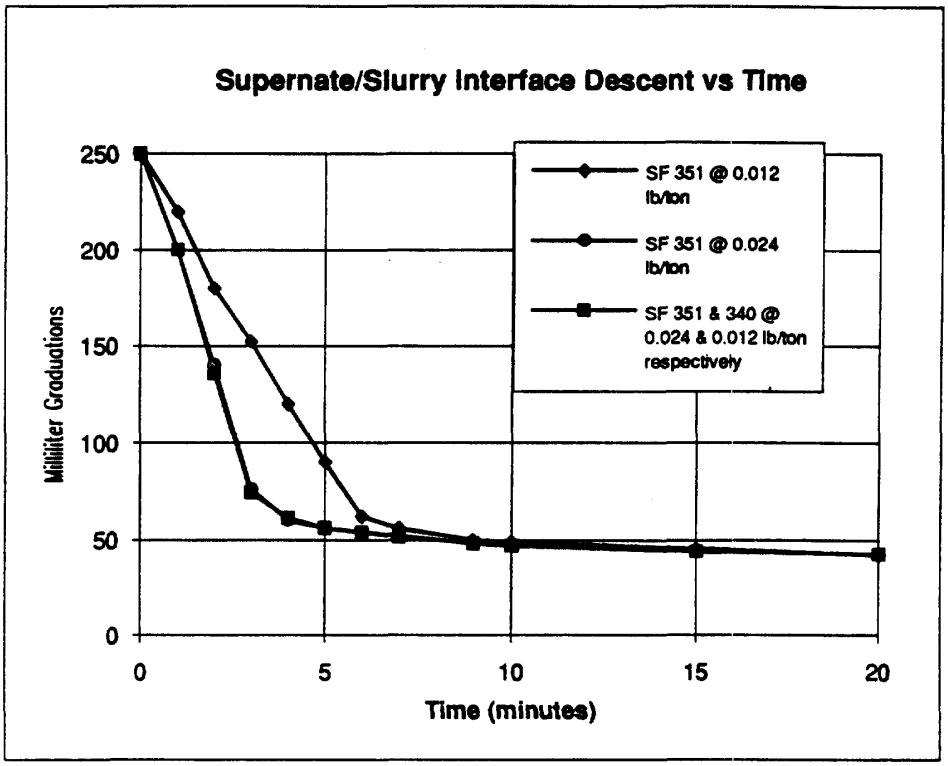
Project No.: **8074**
Date: **Jun-93**

Purpose: Evaluate performance of synthetic flocculants as sedimentation aids for flotation tailings particles.

Sample: Approximately 250 mls of flotation tailings slurry (~ 15% solids) from froth flotation of client-indentified SSD/MCD/C1/C2 F and G mixture (material screened at 80 mesh prior to flotation).

Procedure: The tailings slurry was placed in 250 ml graduated cylinder and agitated for complete mixing. Cyanimid SUPERFLOC 351 nonionic floculant was initially added at ~ 0.012 lb per ton of tailings material (~6 grams per tonne). The slurry was reagitated to ensure mixing of the stable suspended particles with the flocculant. Plotting the distance that the supernate/slurry interface descended versus time yielded a settling rate curve. Another injection of 351 was added to the slurry increasing the flocculant dosage to ~ 0.024 lb per ton. Again, interface descent over time resulted in a settling rate. Finally, SUPERFLOC 340 cationic flocculant was added to the slurry at a dosage rate of 0 .012 lb per ton to settle out suspended fines. All three settling curves are presented below.

Results:



Total Suspended Solids: **288 mg/liter**
(Flocculation test 1c)

Appendix G
Flocculant Scan 2a, b, c, and d

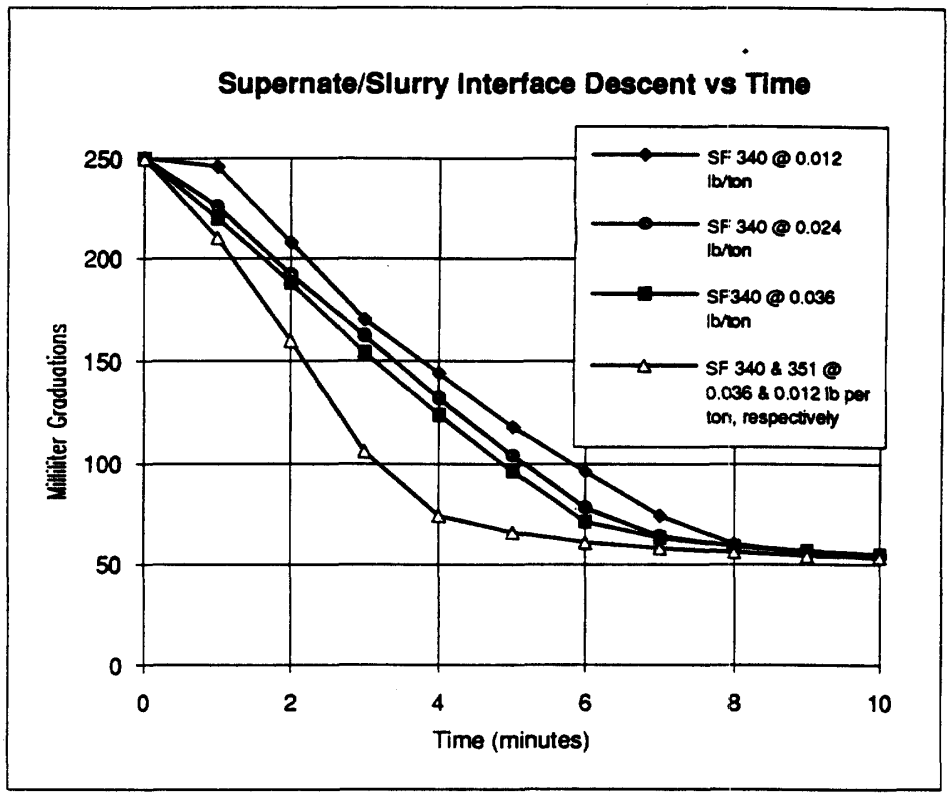
Project No.: **8074**
Date: **Jun-93**

Purpose: Evaluate performance of synthetic flocculants as sedimentation aids for flotation tailings particles.

Sample: Approximately 250 mls of flotation tailings slurry (~ 15% solids) from froth flotation of client-indentified SSD/MCD/C1/C2 F and G mixture (material screened at 80 mesh prior to flotation).

Procedure: The tailings slurry was placed in 250 ml graduated cylinder and agitated for complete mixing. Cyanimid SUPERFLOC 340 cationic floculant was initially added at ~ 0.012 lb per ton of tailings material (~6 grams per tonne). The slurry was reagitated to ensure mixing of the stable suspended particles with the flocculant. Plotting the distance that the supernate/slurry interface descended versus time yielded a settling rate curve. Two additional injections of 340 were added to the slurry increasing the flocculant dosage to ~ 0.024 and 0.036 lb per ton. Again, interface descent over time resulted in a settling rate curve. Finally, SUPERFLOC 351 nonionic flocculant was added to the slurry at a dosage rate of 0 .012 lb per ton to settle out suspended fines. All four settling curves are presented below.

Results:



Total Suspended Solids: **380 mg/liter**
(Flocculation test 2d)

Appendix G | **Project No.:** **8074**
Flocculant Scan 3a, b, c, and d | **Date:** **Jun-93**

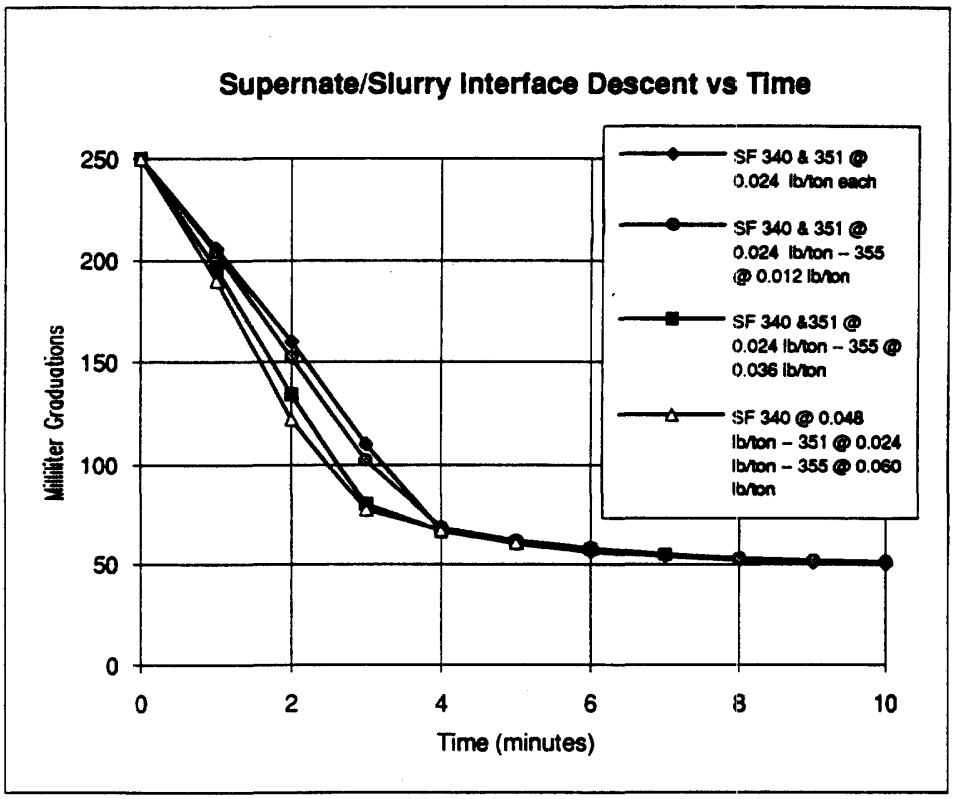
010030

Purpose: Evaluate performance of synthetic flocculants as sedimentation aids for flotation tailings particles.

Sample: Approximately 250 mls of flotation tailings slurry (~ 15% solids) from froth flotation of client-indentified SSD/MCD/C1/C2 F and G mixture (material screened at 80 mesh prior to flotation).

Procedure: The tailings slurry was placed in 250 ml graduated cylinder and agitated for complete mixing. Cyanimid SUPERFLOC 340 cationic and 351 nonionic floculants were each added at ~ 0.024 lb per ton of tailings material (~12 grams per tonne). The slurry was reagitated to ensure mixing of the stable suspended particles with the flocculant. Plotting the distance that the supernate/slurry interface descended versus time yielded a settling rate curve. Two injections of SUPERFLOC 355 were added to the slurry at ~ 0.012 and 0.024 lb per ton. Again, interface descent over time resulted in a settling rate curve. Two more increments of cationic flocculants 340 and 355 were added to the slurry at dosage rates of 0 .024 lb per ton to settle out suspended fines. All four settling curves are presented below.

Results:



Total Suspended Solids: **320 mg/liter**
(Flocculation test 3d)

Appendix G
Flocculant Scan 4a, b, c, d, and f

Project No.: **8074**
Date: **Jun-93**

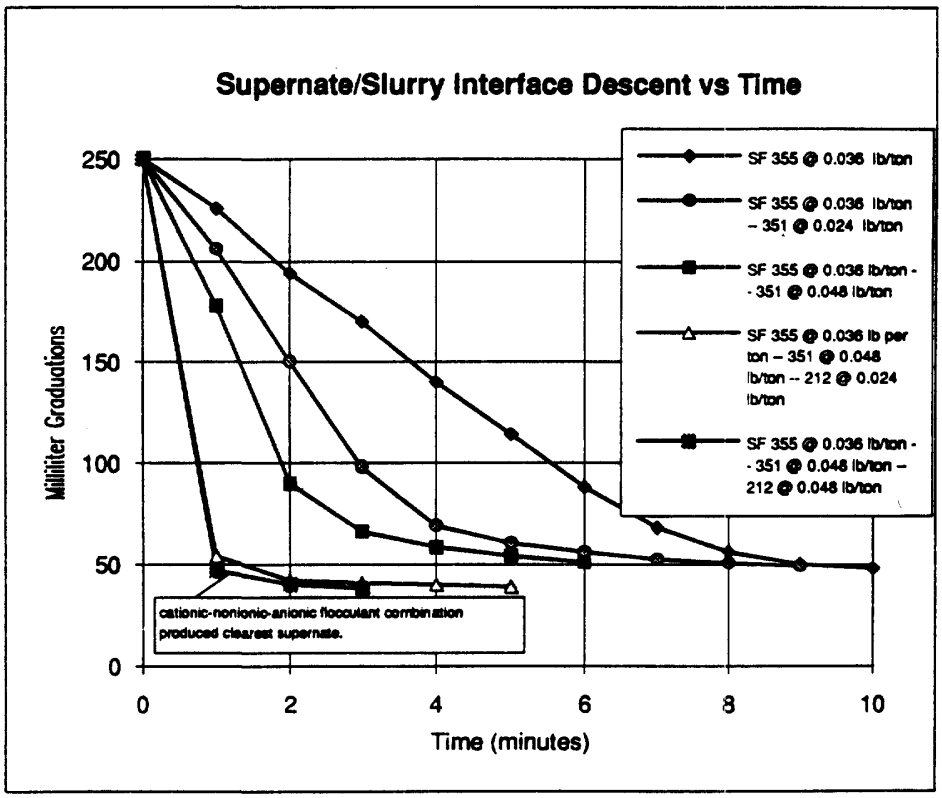
010031

Purpose: Evaluate performance of synthetic flocculants as sedimentation aids for flotation tailings particles.

Sample: Approximately 250 mls of flotation tailings slurry (~ 15% solids) from froth flotation of client-indentified SSD/MCD/C1/C2 F and G mixture (material screened at 80 mesh prior to flotation).

Procedure: The tailings slurry was placed in 250 ml graduated cylinder and agitated for complete mixing. Cyanimid SUPERFLOC 355 cationic floculant was initially added at ~ 0.036 lb per ton of tailings material (~18 grams per tonne). The slurry was reagitated to ensure mixing of the stable suspended particles with the flocculant. Plotting the distance that the supernate/slurry interface descended versus time yielded a settling rate curve. Two injections of 351 nonionic flocculant were added to the slurry at dosage rates of ~ 0.024 lb per ton each. Again, interface descent over time resulted in a settling rate curve. Finally, SUPERFLOC 212 anionic flocculant was added twice to the slurry at dosage rates of 0 .024 lb per ton each. All five settling curves are presented below.

Results:



Total Suspended Solids: **66 mg/liter**
(Flocculation test 4e)

APPENDIX H

RELATIVE DENSITY TESTS

010033

RELATIVE DENSITY TEST
ASTM D 4253 & 4254

RELATIVE DENSITY TEST

PAGE NO.___ OF___

ADVANCED TERRA TESTING inc

010034

Job No. 8148-01 Client HAZEN Research, Inc. Location PO # 2713

Sampled _____ By _____ Tested 5-26-93 By ou Checked _____ By _____

SAMPLE DESCRIPTION	Soil MCD/SIDE HEAD			Sample No. #1	
	Specific Gravity _____			Depth or Elevation Bulk	
	% Passing 3/4" _____			% Passing 1/4" _____	
TEST SPECIFICATIONS ASTM D 4253 METHOD Maximum	Compaction method (F, G)	☐ Proctor	☐ Standard AASHO	☐ Modified AASHO	☐ Calif.
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable
	Rammer - lbs.	5 1/2	5 1/2	10	10
	Drop - inches	18	12	18	18
	Layers	3	3	5	5
	Blows per layer	25	25	25	20 *

	DRY TRIAL #	1 L R	2 L R	3 L R	4 L R	
8 min @ 60 Hz .5# surcharge wt. 0.500" Baseplate. **MOISTURE DETERMINATION**	DIAL READING BEFORE TEST	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	
	DIAL READING AFTER TEST	.580 .598	.539 .562	.521 .503	.518 .544	
	Δ"	1.080 1.098	1.039 1.062	1.021 1.003	1.018 1.044	
	AVERAGE Δ"	1.089	1.0505	1.012	1.031	
	HEIGHT - AVERAGE Δ"	5.021	5.0595	5.098	5.079	
	VOLUME Ft³	.08216	.08279	.08342	.08310	
Mold = D = 6.00" H = 6.11" V = 0.1004 ft³ **DENSITY DETERMINATION**	Wt. of soil & mold #	15.94	16.15	16.21	16.28	
	Wt. of mold only #	7.89	7.89	7.89	7.89	
	Net wt. of wet soil (D) #					
	Net wt. of dry soil (E) #	8.05	~~8.25~~ 8.26	8.32	8.39	
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	98.0	99.8	99.7	101.0	
PENETROMETER	Needle Size					
	Resistance Reading	Average Maximum Dry Density = 99.6 PCF				
	Resistance, lbs/sq in					

57P.1(3)

* Then add piston and seat with 5 blows.

010034

RELATIVE DENSITY TEST

PAGE NO.___ OF___

ADVANCED TERRA TESTING INC

010035

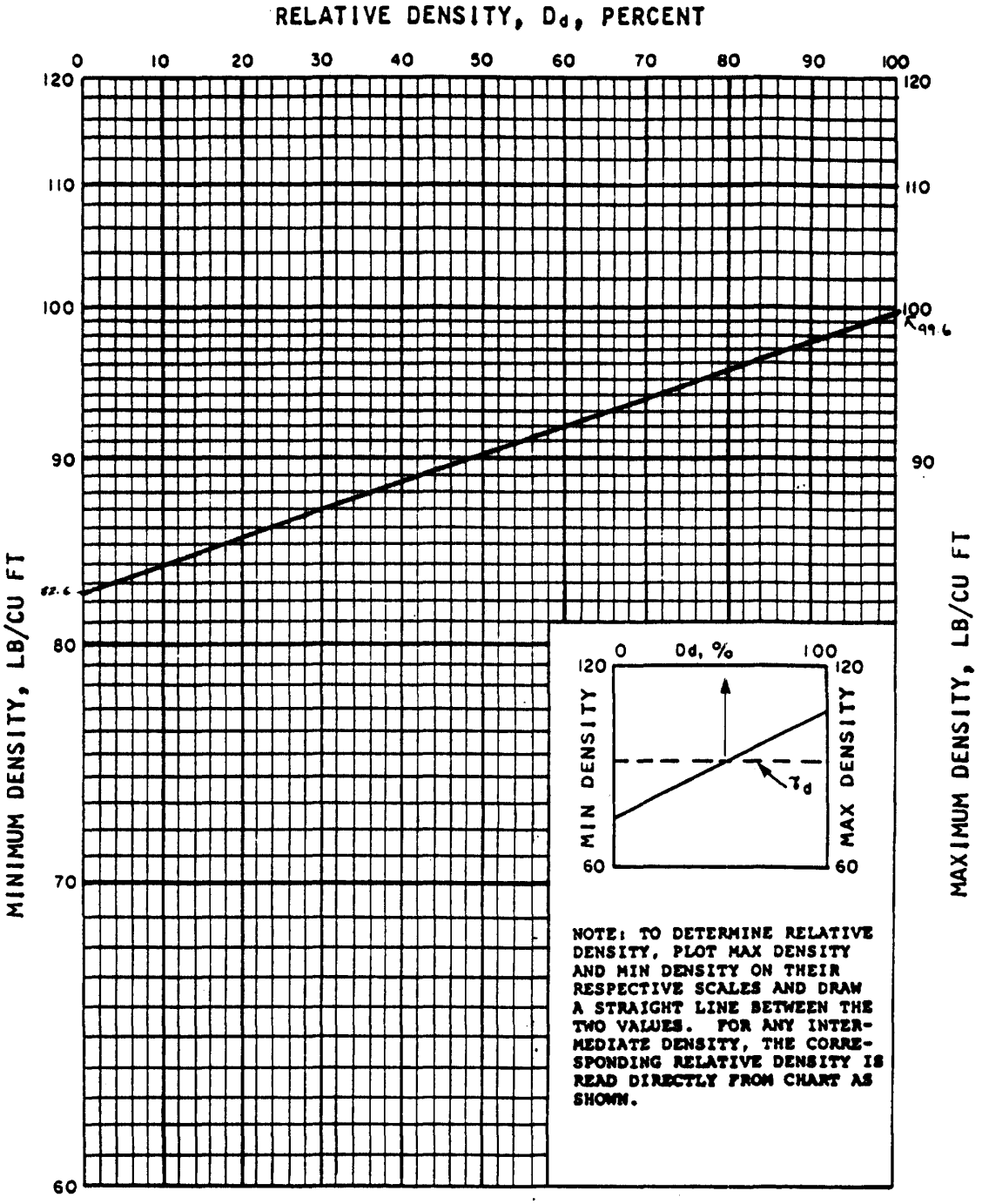
b No. 2148-01 Client HAZEN Research, Inc. Location PO # 2713

Sampled _____ By _____ Tested 5-26-93 By ou Checked _____ By _____

SAMPLE DESCRIPTION	Soil MCD/SSOE HEAD			Sample No. #1		
	Specific Gravity _____			Depth or Elevation Bulk		
	% Passing 3/4" _____			% Passing 1/4" _____		
TEST SPECIFICATIONS ASTM D 4254 METHOD Minimum	Compaction method (F, G)	☐ Proctor	☐ Standard AASHO	☐ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	Dry Trial #1	Dry Trial #2	Dry Trial #3	Dry Trial #4	
MOISTURE DETERMINATION	Dish number					
	Wt. of soil & dish g					
	Dry wt. soil & dish g					
	Net loss of moisture (B) g					
	Wt. of dish only g					
	Net wt. of dry soil (A) g					
	Moisture, % of dry wt. (C)					
~~mold = 6.00 ht height~~ mold = D = 6.00" H = 6.11" V = .100 ft³ **DENSITY DETERMINATION**	Wt. of soil & mold #	15.94	16.13	16.21	16.28	
	Wt. of mold only #	7.89	7.89	7.89	7.89	
	Net wt. of wet soil (D) #		8.26			
	Net wt. of dry soil (E) #	8.05	8.26	8.32	8.39	
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	80.5	82.6	83.2	83.9	
PENETROMETER	Needle Size					
	Resistance Reading	Average Minimum Dry Density = 82.6 PCF				
	Resistance, lbs/sq in					

187P.1(3)

* Then add piston and seat with 5 blows.



GRAPHICAL DETERMINATION OF RELATIVE DENSITY

OWNER: HAZEN Research Inc JOB#: 2148-01 LOCATION: PO# 2713

BORING #: _____ SAMPLE#: #1 DEPTH: Bulk FT.

SOIL TYPE: MCD/SSDE HEAD TESTED BY: Du 5-27-93 CHECKED BY: _____

757.11

010036

ADVANCED TERRA TESTING

010037

RELATIVE DENSITY TEST
ASTM D-4254
Minimum (dry)

Client: Hazen Research, Inc.
Date: June 28, 19[illegible]
Job #: 2148-02
Page 1

Project #: 8074
Soil: SSD/MCD F HEAD
Sample #: 1
Depth: Bulk

Dry Trial #	1	2	[illegible]
Wt. soil & mold (lbs)	16.25	16.36	16.[illegible]
Wt. mold (lbs)	7.90	7.90	7.90
Net Wt. wet soil (lbs)	-	-	-
Net Wt dry soil (lbs)	8.35	8.46	8.57
Dry Density (lbs/cu ft)	83.5	84.6	85.7

Note: mold dimensions = D = 6.00"
H = 6.11"
V = 0.100 cu ft

AVERAGE MINIMUM DRY DENSITY = 84.6 lbs/cu ft

Tested by: DAVID UDEY
ADVANCED TERRA TESTING, INC.

ADVANCED TERRA TESTING Inc.

RELATIVE DENSITY TEST
ASTM D-4253
MAXIMUM

Client: Hazen Research, Inc.

Date: June 28, 1993
Job #: 2148-02
Page 2

Project #: 8074
Soil: SSD/MCD F HEAD

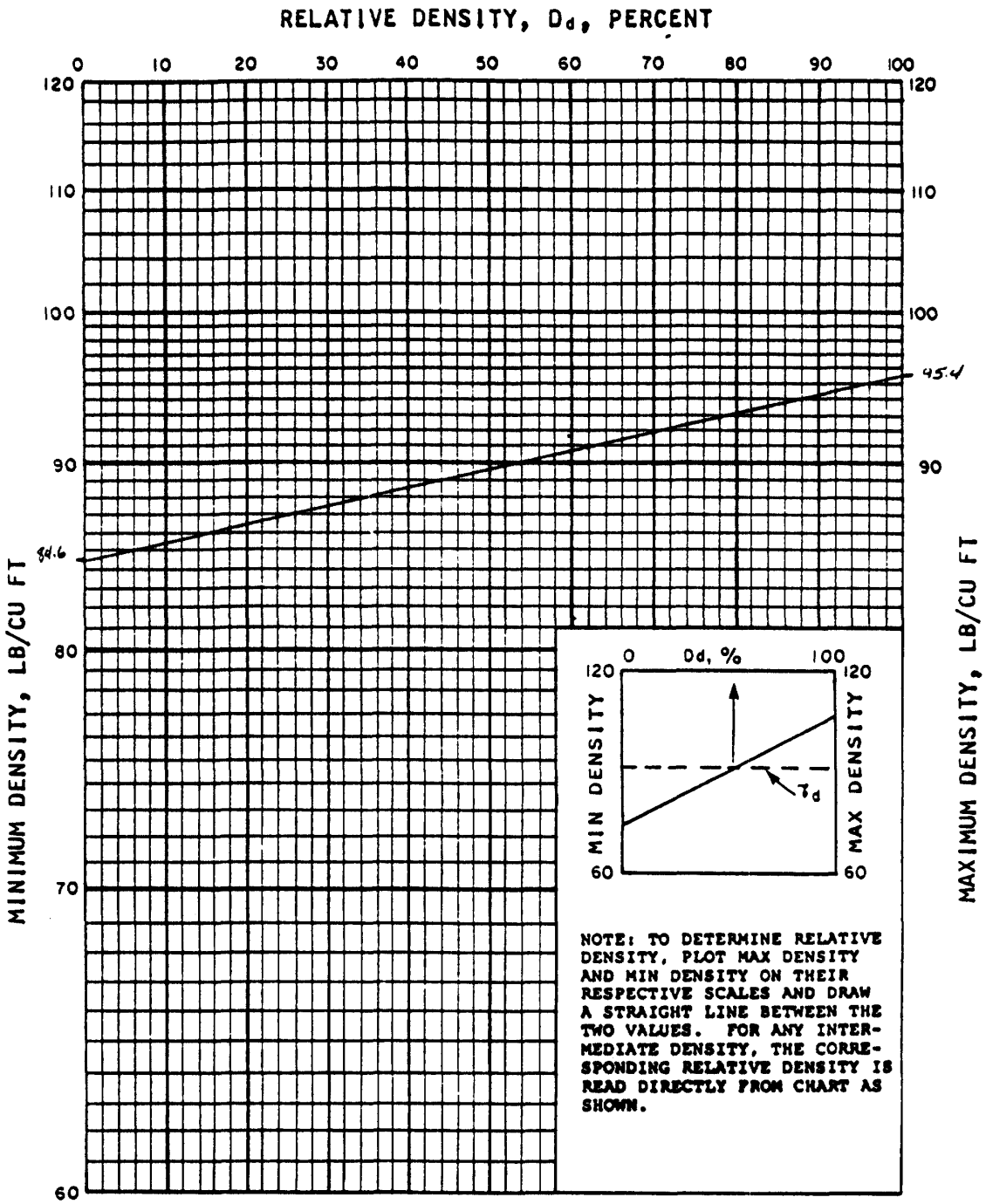
Sample #: 1
Depth: Bulk

Dry Trial #	1		2		3	
	L	R	L	R	L	R
Diff. (in)	0.729	0.692	0.796	0.592	0.676	0.649
Avg Diff. (in)	0.711		0.694		0.663	
Ht - Avg Diff. (in)	5.400		5.416		5.448	
Vol. cu ft	.08836		.08862		.08914	
Wt. soil & mold (lbs)	16.25		16.36		16.47	
Wt. mold (lbs)	7.90		7.90		7.90	
Net Wt. dry soil (lbs)	8.35		8.46		8.57	
Dry Density lbs/cu ft	94.5		95.5		96.1	

Note: 1 cycle = 8 min. @ 60 Hz
surcharge Wt. = 56.5 lbs
base plate = 0.500"
mold dimensions - D = 6.00"
H = 6.11"
V = 0.100 cu ft

AVERAGE MAXIMUM DRY DENSITY = 95.4 lbs/cu ft

Tested by: DAVID UDEY
ADVANCED TERRA TESTING, INC.



010039

GRAPHICAL DETERMINATION OF RELATIVE DENSITY

OWNER: Hazen Research, Inc. JOB#: 2148 02 LOCATION: #8074

BORING #: — SAMPLE#: 1 DEPTH: Bulk FT.

SOIL TYPE: 50/mod F Head TESTED BY: Dw CHECKED BY: _____

787.11

DAMES & MOORE

HAZDENMX

RELATIVE DENSITY TEST

PAGE NO.___ OF___

010040

ADVANCED TERRA TESTING INC

No. 2148-02 Client Hazen Research, Inc. Location # 8074

Sampled _____ By JG Tested 6-28-93 By ell. Checked _____ By _____

SAMPLE DESCRIPTION	Soil SSD/MCD F Head. Sample No. 1					
	Specific Gravity _____ Depth or Elevation Bulk					
	% Passing 3/4" _____ % Passing 1/4" _____					
TEST SPECIFICATIONS ASTM D 4253 METHOD Maximum	Compaction method (F, G)	☐ Proctor	☐ Standard AASHO	☐ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	DRY TRIAL #	L #1 R	L #2 R	L #3 R		
"in @ 60 Hz .5# surcharge WT. 0.500" Base Plate **MOISTURE DETERMINATION**	DIAL READING BEFORE TEST	.000 .000	.000 .000	.000 .000		
	DIAL READING AFTER TEST	.729 .692	.796 .592	.676 .649		
	Δ"	.729 ~~.744~~ .692	.796 .592	.676 .649		
	AVERAGE Δ"	~~.5400~~ .711"	.694	.663		
	HEIGHT - AVERAGE Δ"	5.400	5.416	5.448		
	VOLUME Ft³	.08336	.08862	.08914		
Mold = D = 6.00" H = 6.11" V = .100 cft **DENSITY DETERMINATION**	Wt. of soil & mold #	16.25	16.36	16.47		
	Wt. of mold only #	7.90	7.90	7.90		
	Net wt. of wet soil (D) #					
	Net wt. of dry soil (E) #	8.35	8.46	8.57		
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	94.5	95.5	96.1		
PENETROMETER	Needle Size					
	Resistance Reading			Average Max Density = 95.7 A		
	Resistance, lbs/sq in					

7P.1(3)

* Then add piston and seat with 5 blows.

HAZDENMA

RELATIVE DENSITY TEST

PAGE NO.___ OF_

ADVANCED TERRA TESTING INC

010041

Job No. 2148-02 Client Huzen Research Inc Location #8074

Sampled _____ By JG Tested 6-28-93 By Qu Checked _____ By _____

SAMPLE DESCRIPTION	Soil SSD/MCD F Head			Sample No. 1		
	Specific Gravity _____			Depth or Elevation Bulk		
	% Passing 3/4" _____			% Passing 1/4" _____		
TEST SPECIFICATIONS ASTM D 4254 METHOD Minimum	Compaction method (F, G)	☐ Proctor	☐ Standard AASHO	☐ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	Dry Trial #1	Dry Trial #2	Dry Trial #3		
MOISTURE DETERMINATION	Dish number					
	Wt. of soil & dish g					
	Dry wt. soil & dish g					
	Net loss of moisture (B) g					
	Wt. of dish only g					
	Net wt. of dry soil (A) g					
	Moisture, % of dry wt. (C)					
DENSITY DETERMINATION	Wt. of soil & mold #	16.25	16.36	16.47		
	Wt. of mold only #	7.90	7.90	7.90		
	Net wt. of wet soil (D) #		8.46 ~~8.43~~	8.57		
	Net wt. of dry soil (E) #	8.35	~~8.48~~	~~8.54~~		
	Ht. of sample - Calif. (G)		84.6 ~~84.3~~			
	Dry Density, lbs/cu ft (H)	83.25	84.6 ~~84.6~~	85.7 ~~85.4~~		
PENETROMETER	Needle Size					
	Resistance Reading		Average Minimum Density = 84.6 PCF			
	Resistance, lbs/sq in					

STP.1(3)

* Then add piston and seat with 5 blows.

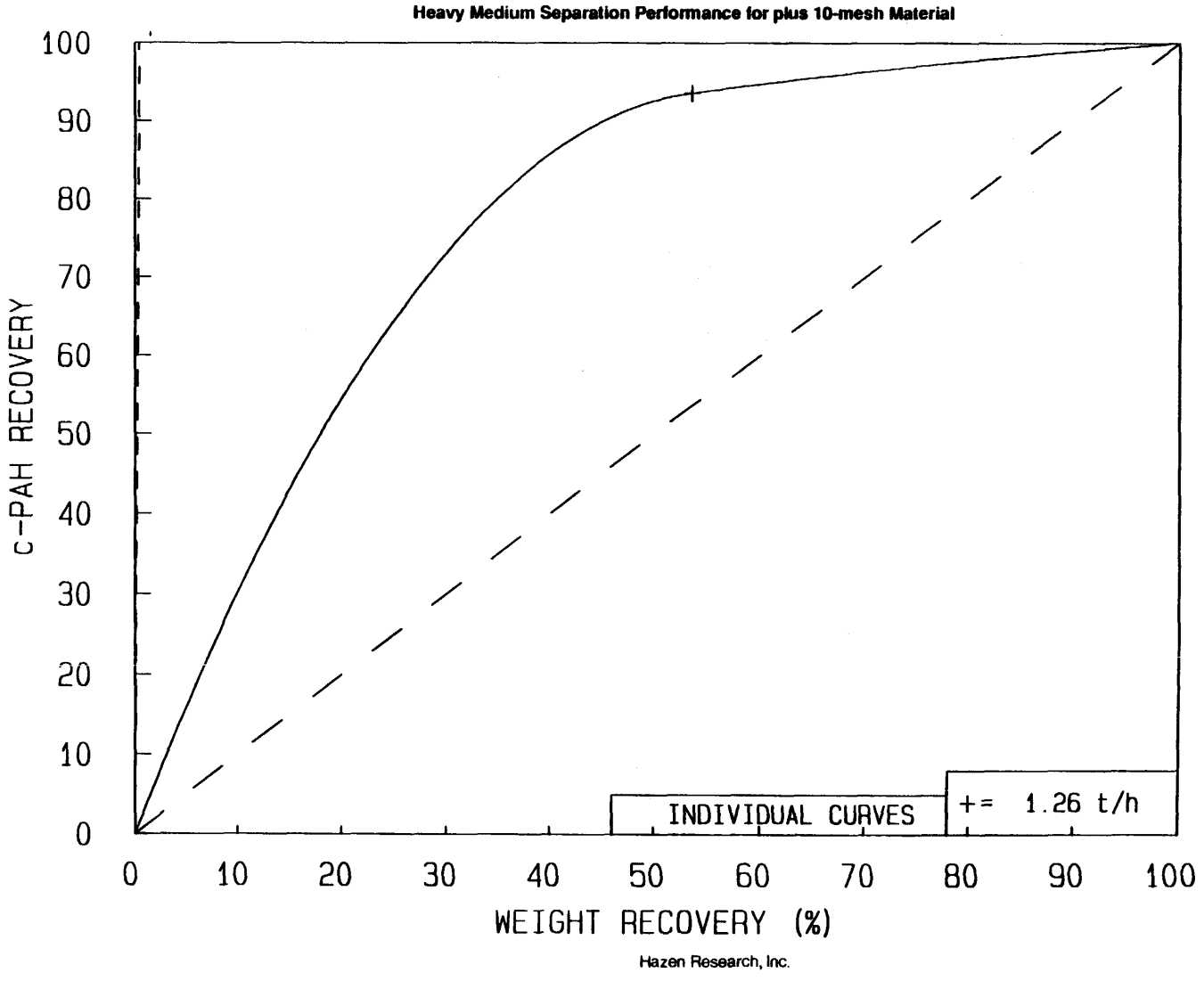
010041

010042

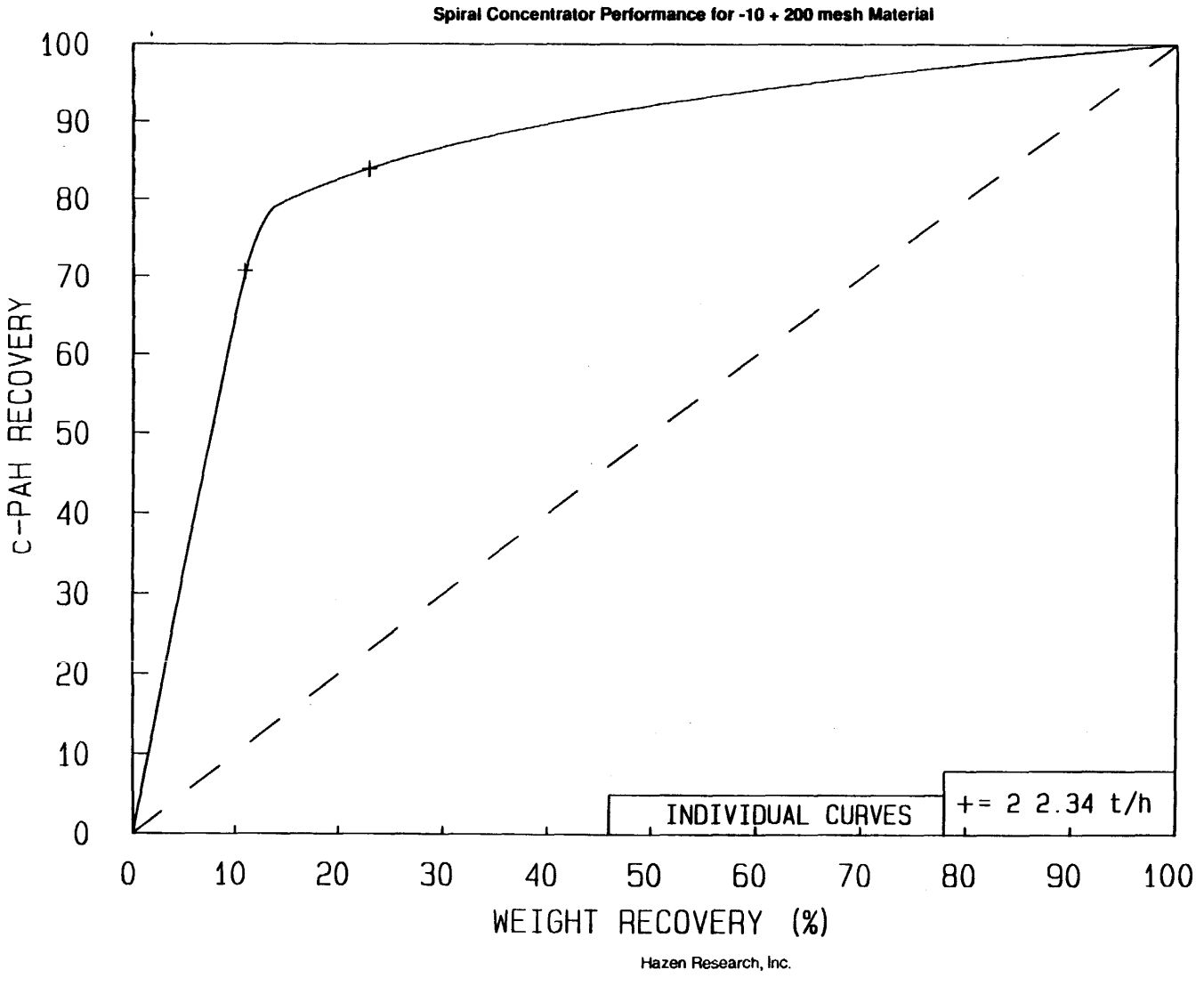
APPENDIX I

MODEL BASIS FOR FLOWSHEET COMPARISONS

010042

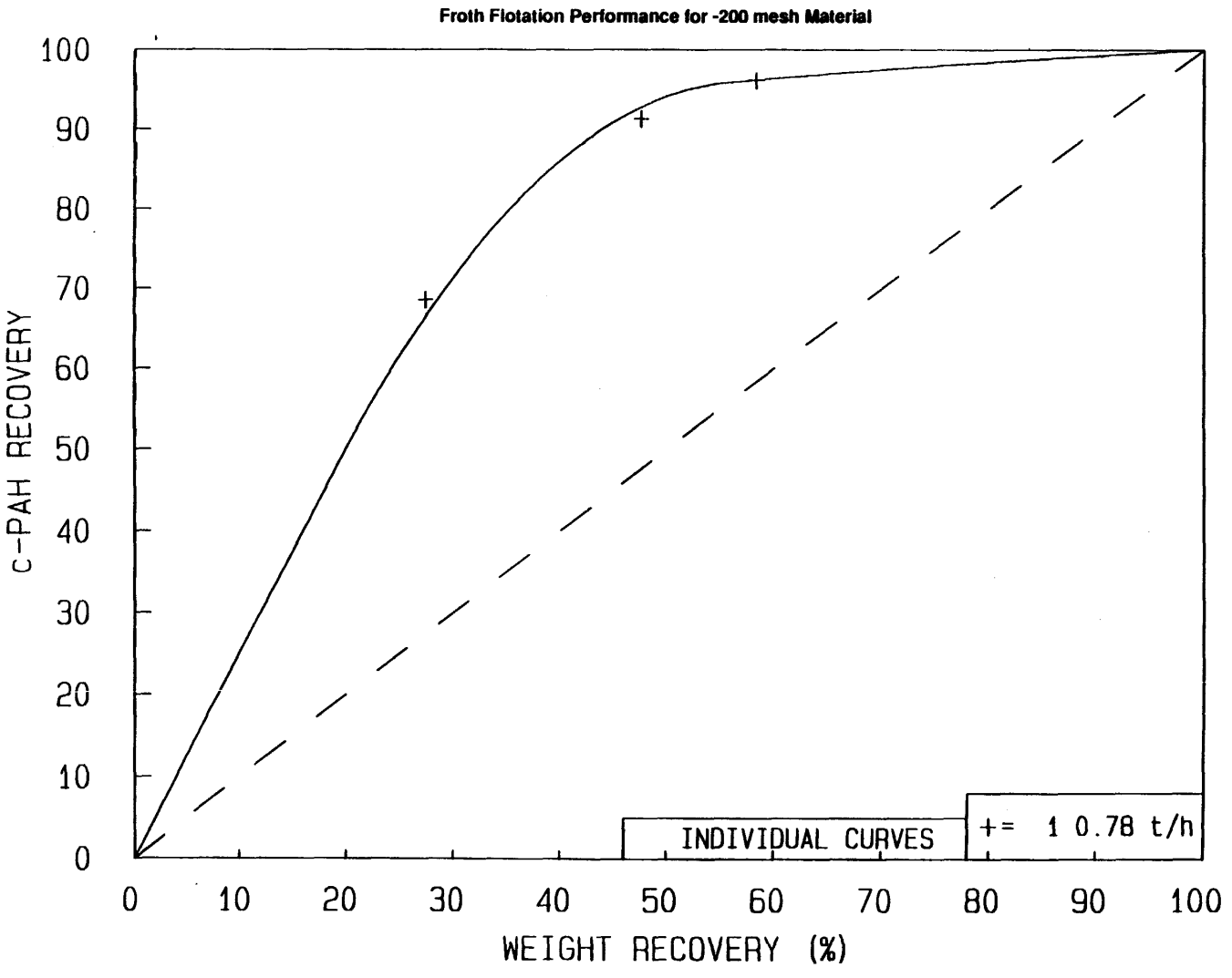

Heavy Medium Separation Performance for plus 10-mesh Material
C-PAH RECOVERY
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
WEIGHT RECOVERY (%)
INDIVIDUAL CURVES
+= 1.26 t/h
Hazen Research, Inc.

010043



010044

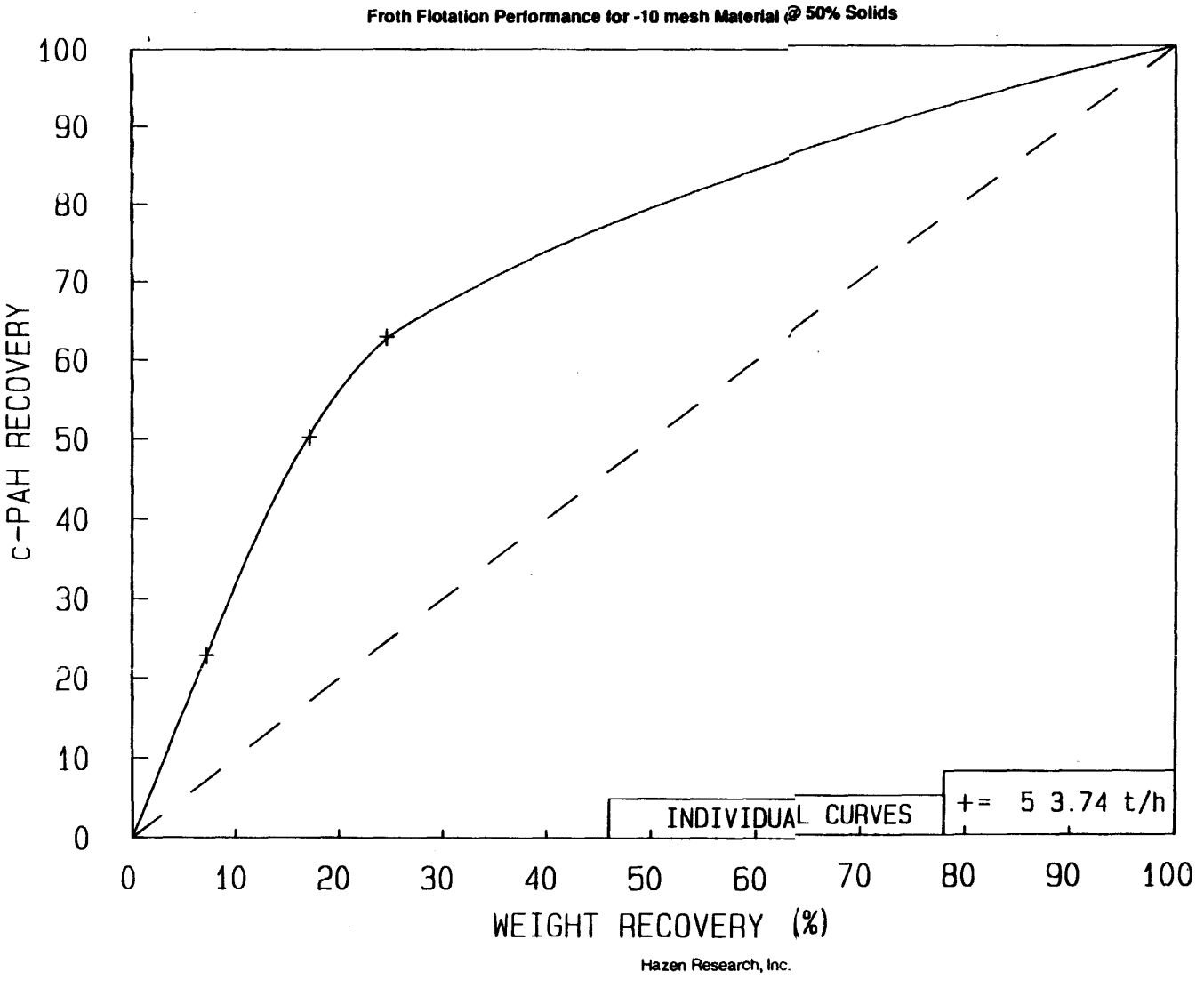
010044



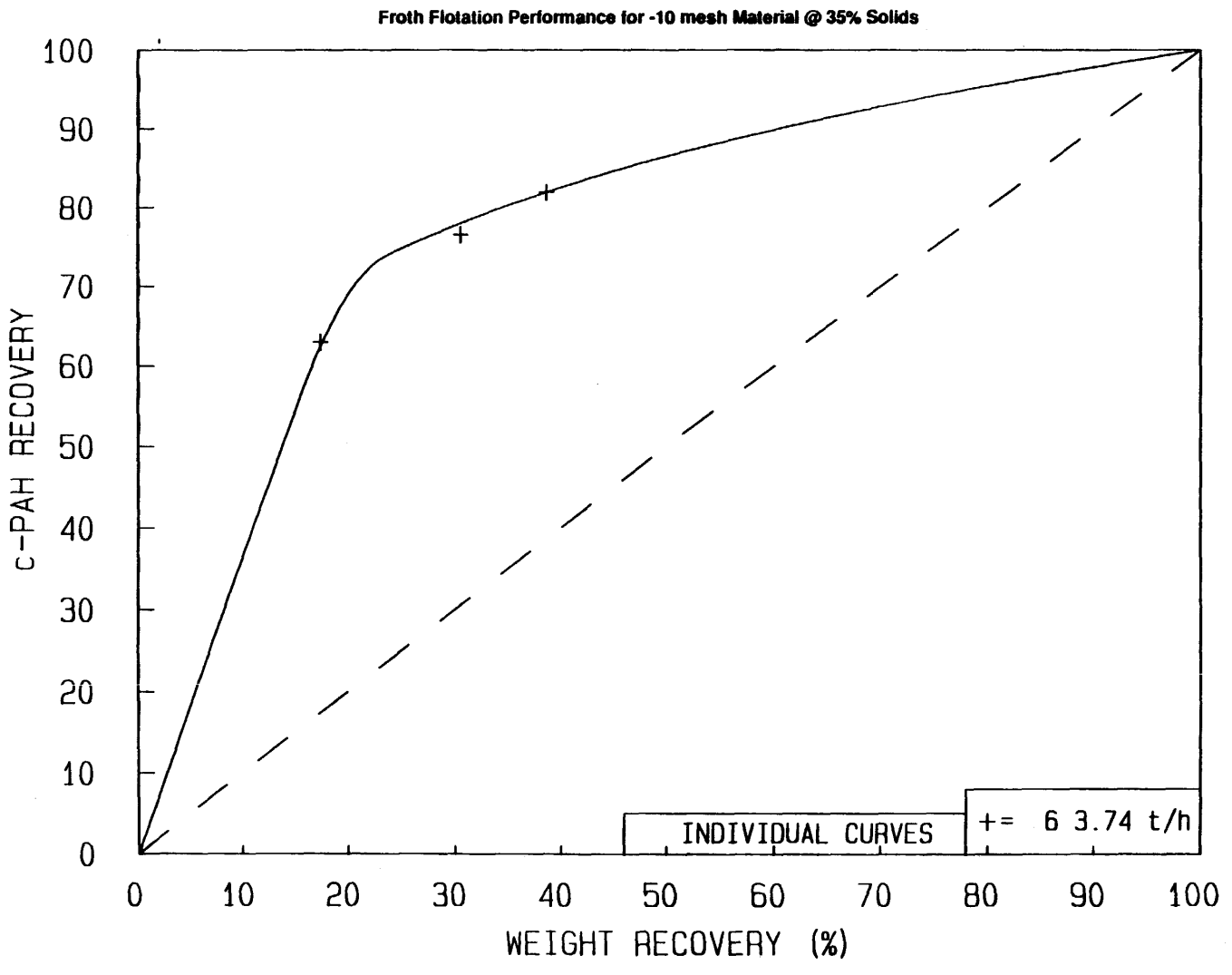
Hazen Research, Inc.

010045

010045


Froth Flotation Performance for -10 mesh Material @ 50% Solids
100
90
80
70
60
50
40
30
20
10
0
C-PAH RECOVERY
0
10
20
30
40
50
60
70
80
90
100
WEIGHT RECOVERY (%)
INDIVIDUAL CURVES
+= 5 3.74 t/h
Hazen Research, Inc.

010046



Hazen Research, Inc.

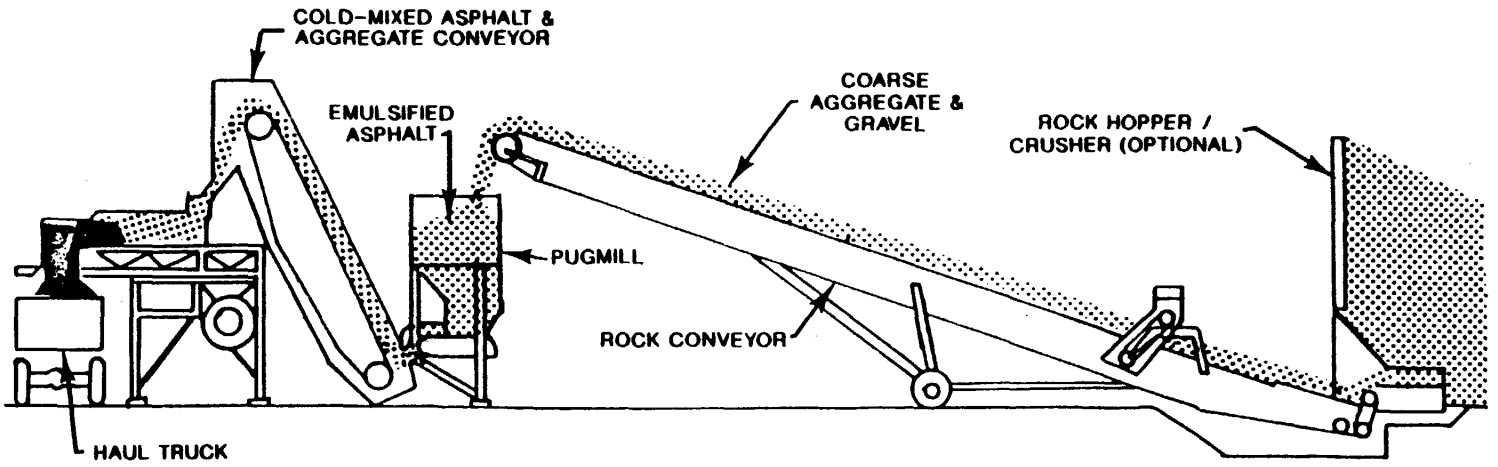
010047

010047

BEAZER EAST INC
SOUTH CAVALCADE
cPAH vs PAH
WASHED SAMPLES

Sample ID	Total cPAH (1) w/ND=BQL=0	Total cPAH (2) w/ND=BQL=1/2	Total cPAH (3) w/Reported Values	Wt. % (4) All Fractions	Wt % (5) Less 1"	Wt % (6) Less 1" & DWC
SC-W-1-6(F Rejects)A	NS	NS	NS	15.0%		
SC-W-1-6(1" Rejects)A	NS	NS	NS	33.0%		
SC-W-1-6(D)A	NS	NS	NS	20.0%		
SC-W-1-6(MD)A	900	900	910	1.0%	3.0%	3.0%
SC-W-1-6(MCD)A	3420	3640	3330	5.0%	28.0%	30.0%
SC-W-1-6(C)A	490	1000	995	17.0%	48.7%	63.4%
SC-W-1-6(DWC)A	1200	1210	1240	3.0%	7.1%	
TOTAL (WT% * CONC.) (4)	Not Calculated	Not Calculated	Not Calculated	100.0%	100.0%	100.0%
TOTAL (WT% * CONC.) (5)	1300.50	1605.50	1732.65			
TOTAL (WT% * CONC.) (6)	1400.40	1675.50	1751.73			
SC-W-3(F Rejects)B	NS	NS	NS	17.0%		
SC-W-3(1" Rejects)B	NS	NS	NS	3.0%		
SC-W-3(D)B	680	730	745	13.0%	16.0%	17.3%
SC-W-3(MD)B	NS	NS	NS	0.0%	0.0%	0.0%
SC-W-3(MCD)B	270	284.5	300	41.0%	53.3%	54.7%
SC-W-3(C)CB	734	757	765	32.0%	27.3%	28.0%
SC-W-3(DWC)B	157	239	204.0	3.0%	3.0%	
TOTAL (WT% * CONC.) (4)	Not Calculated	Not Calculated	Not Calculated	100.0%	100.0%	100.0%
TOTAL (WT% * CONC.) (5)	467.00	465.30	499.30			
TOTAL (WT% * CONC.) (6)	471.80	496.30	500.05			
SC-W-5(F Rejects)C	NS	NS	NS	13.0%		
SC-W-5(1" Rejects)C	NS	NS	NS	17.0%		
SC-W-5(D)C	950	1430	1241	9.0%	12.7%	15.3%
SC-W-5(MD)C	0	302.5	330	6.0%	6.3%	10.2%
SC-W-5(MCD)C	280	452	361.5	18.0%	25.4%	30.3%
SC-W-5(C)CC	340	715	600	36.0%	36.0%	44.1%
SC-W-5(DWC)C	300	402	340	12.0%	16.0%	
TOTAL (WT% * CONC.) (4)	1870.00	2902.50	2872.50	100.0%	100.0%	100.0%
TOTAL (WT% * CONC.) (5)	360.00	454.00	331.00			
TOTAL (WT% * CONC.) (6)	302.00	507.00	596.30			
SC-W-7(F Rejects)D	NS	NS	NS	10.0%		
SC-W-7(1" Rejects)D	NS	NS	NS	4.0%		
SC-W-7(D)D	0	394	330	6.0%	7.0%	7.0%
SC-W-7(MD)D	0	300	119.2	10.0%	20.0%	22.0%
SC-W-7(MCD)D	0	302.5	149	43.0%	32.3%	37.0%
SC-W-7(C)CD	130	300	360	10.0%	11.0%	12.7%
SC-W-7(DWC)D	310	1100	947	7.0%	8.1%	
TOTAL (WT% * CONC.) (4)	Not Calculated	Not Calculated	Not Calculated	100.0%	100.0%	100.0%
TOTAL (WT% * CONC.) (5)	60.35	316.32	341.12			
TOTAL (WT% * CONC.) (6)	14.45	201.30	178.50			
SC-W-9(F Rejects)E	NS	NS	NS	7.0%		
SC-W-9(1" Rejects)E	NS	NS	NS	0.0%		
SC-W-9(D)E	0	945	744	10.0%	N/A	11.3%
SC-W-9(MD)E	0	365	117	40.0%	N/A	49.4%
SC-W-9(MCD)E	310	1000	657	26.0%	N/A	28.9%
SC-W-9(C)CE	1140	1000	1420	8.0%	N/A	9.2%
SC-W-9(DWC)E	NS	NS	NS	6.0%	N/A	
TOTAL (WT% * CONC.) (4)	Not Calculated	Not Calculated	Not Calculated	100.0%	N/A	100.0%
TOTAL (WT% * CONC.) (5)	Not Calculated	Not Calculated	Not Calculated			
TOTAL (WT% * CONC.) (6)	193.07	765.30	330.60			
SC-W-1-10(F Rejects)F	NS	NS	NS	22.0%		
SC-W-1-10(1" Rejects)F	NS	NS	NS	5.0%		
SC-W-1-10(D)F	877	994	986	6.0%	6.7%	8.3%
SC-W-1-10(MD)F	190	377.5	300	23.0%	33.3%	36.1%
SC-W-1-10(MCD)F	320	650.5	607	23.0%	33.3%	36.1%
SC-W-1-10(C)CF	420	660	570	11.0%	15.0%	17.3%
SC-W-1-10(DWC)F	1320	2700	2330	6.0%	6.7%	
TOTAL (WT% * CONC.) (4)	Not Calculated	Not Calculated	Not Calculated	100.0%	100.0%	100.0%
TOTAL (WT% * CONC.) (5)	404.07	704.00	670.30			
TOTAL (WT% * CONC.) (6)	414.00	577.00	510.00			
SC-W-3-12(F Rejects)G	NS	NS	NS	3.0%		
SC-W-3-12(1" Rejects)G	NS	NS	NS	6.0%		
SC-W-3-12(D)G	600	6900	4002	33.0%	36.3%	37.9%
SC-W-3-12(MD)G	1400	1300	1310	23.0%	27.3%	28.7%
SC-W-3-12(MCD)G	1190	1300	1300	13.0%	13.3%	13.9%
SC-W-3-12(C)CG	152	344	227	17.0%	18.7%	19.5%
SC-W-3-12(DWC)G	1370	1300	1400	4.0%	4.4%	
TOTAL (WT% * CONC.) (4)	Not Calculated	Not Calculated	Not Calculated	100.0%	100.0%	100.0%
TOTAL (WT% * CONC.) (5)	873.35	3370.70	3300.30			
TOTAL (WT% * CONC.) (6)	654.07	3364.32	3270.40			

Note:
(1) Assumed ND = 0 and BQL = 0
(2) Assumed ND = 1/2 * Concentration and BQL = 1/2 * Concentration
(3) Assumed ND = 0 and BQL = Reported Concentration
(4) Computed with all Fractions
(5) Computed with out particles > 1"
(6) Computed with out particles > 1" and from DWC
(7) NS = Not Sampled
(8) See the Appendex for a complete listing of data.



Flow diagram of a typical cold mix plant

FIGURE A
CMA PLANT FLOW DIAGRAM

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Appendix C

Recycling of Rock and Gravel

010050

RECYCLING OF ROCK AND GRAVEL FROM THE SOIL WASHING PROCESS INTO A COLD-MIXED BITUMINOUS PAVING MIXTURE

1.0 BACKGROUND

Beazer East, Inc. performed pilot soil washing tests in Houston on soils containing constituents of concern (COCs), tars, and pitch. The soil washing process discharged a rinsed coarse aggregate fraction (1" to 2-1/2" diameter) and a rinsed gravel fraction (10 mesh to 1" diameter).

The rinsed coarse aggregate and gravel fractions included stones and oyster shells, some coated with tars, as well as black, brittle pieces of pitch and balls of tar. The viscous, adhesive, thick coating on the coarse aggregates and gravels can not be removed by soil washing.

The coarse aggregate and gravel fractions were each estimated to constitute 10 percent by weight of the excavated material. For an excavated quantity of 10,000 tons, the anticipated weight of coarse aggregate and gravel is a total of 2,000 tons.

2.0 OBJECTIVE

The objective of this discussion is to describe how the rinsed coarse aggregate, gravel, pitch and tar can be beneficially and safely recycled into a cold-mixed bituminous paving mixture, or asphalt, which can be used to pave or cap selected areas at the site after remediation. The type of process proposed is a small on-site batch plant which will combine the rinsed rock and an emulsified asphalt into a cold-mixed paving mixture. The cold-mixed asphalt (CMA) plant will combine the rock and bitumen using a mix formula designed to produce an environmentally and structurally sound paving base. Mix formula development and testing of the pavement to confirm satisfactory characteristics will be conducted based on ASTM standards. TCLP testing of compacted paving cores will be used to confirm the absence of hazardous characteristics.

3.0 THEORY OF CMA RECYCLING

Asphalt is a naturally occurring bituminous material which can also be derived from the separation of petroleum fractions. It contains aliphatic, mononuclear aromatic and polynuclear aromatic hydrocarbons. There are two types of asphalt: asphalt cement and liquid asphalt. Asphalt cement is the heaviest fraction and liquid asphalts are the lighter fractions. The liquid asphalts are graded by viscosity, and may be produced by dissolving asphalt cements in solvents or emulsifying cements in water.

In the cold-mixed asphalt process, aggregate and liquid asphalt are mixed to form the paving material. Surfactants are used to emulsify the asphalt cement in water. The asphalt particles are suspended in the liquid and separated from each other (and the aggregate) by a film of water. During paving, pressure forces out the film of water,

bringing the asphalt particles together and in contact with the aggregate. Anionic, cationic and non-polar asphalt emulsions are available in a variety of viscosities and cure times.

EPA's publication number EPA 600/R-92/096, "Potential Reuse of Petroleum-Contaminated Soil: A Directory of Permitted Recycling Facilities" indicates that considerable testing has been done on the environmental effects of asphalt paving made with petroleum-impacted soil. The tests conclude that the soil can be combined with the asphalt in such a way that it will not separate. The hydrocarbons contained in the petroleum-impacted soils upon which the tests were conducted were found not to damage the asphalt mixture. The lighter fractions act as a asphalt solvent. The heavier fractions are chemically similar to the asphalt and do not negatively impact the mix.

Applied Environmental Sciences (AES) Corporation, an asphalt recycling contractor, recently completed a successful aggregate recycling program for a former coal gasification site being remediated by the State of California. The impacted soils contained PAHs of 10,000 to 15,000 ppm. The rock rejects contained PAHs on the order of 8,000 ppm. The rock, consisting of stones (+2"), aggregate (-2" to + 200 mesh) and "fines" (-200 mesh), was made into a cold-mixed asphalt paving material. The rock available at the site was separated by size, supplemented with 3/4" diameter Class 2 aggregate, and then combined with water-based asphalt emulsions. The resulting paving mixture had a Marshall Stability of 3,000 psi. The stability of an asphalt paving is its ability to provide resistance to traffic load. In the "Asphalt Cold-Mix Manual", the Asphalt Institute recommends a minimum of 2,224 psi stability as a design parameter for CMA. AES has successfully performed similar work in California, Arkansas, Texas and New Mexico, where PAH-impacted rock, gravel and soils have been beneficially and safely recycled by incorporation into asphalt paving mixtures.

The targeted soils at the South Cavalcade site are impacted with contaminants of chemically similar composition to asphalt hydrocarbon fractions. These soil contaminants include coal tar derived constituents, coal tar residuals and creosote oil, and are similarly composed of aromatic hydrocarbons. It is anticipated, therefore, that the use of the washed soils at the South Cavalcade site as asphalt aggregate would meet with similar success.

4.0 CMA RECYCLING BENEFITS

There are several benefits associated with the on-site recycling of the rinsed rock fractions into a paving mixture. Primarily, it is an environmentally safe alternative that avoids the potential liability of disposal in a landfill. It also eliminates the cost and potential liability associated with transportation of the waste to a landfill or other disposal facility.

Another important benefit is associated with the overall cost. Other alternatives could cost as much as $1,500 per ton, without producing any reusable product such as paving or capping material. The recycling of rock into CMA is anticipated to cost $50

per ton and produces a valuable asphalt, which would have to be purchased elsewhere and constructed with rock brought onto the site if not made from recycled materials.

The cold-mixed, cold-laid method of paving offers additional benefits. CMA processes have the advantage over hot methods in that they do not generate significant odors or fumes, and produce pavement with a higher stability than their hot-mixed counterparts. The cold-mixed method is also a less expensive paving alternative because the equipment used to heat and dry the aggregate is not required in the cold process.

5.0 REGULATORY STATUS

The recycling of impacted soil and debris into asphalts, cements, bricks and other beneficial construction materials is increasing in frequency. The USEPA recently published a list of over 50 permitted recycling facilities located throughout the nation which are permitted to recycle petroleum impacted soil. The majority of those firms are engaged in the recycling of impacted soil into asphalt paving mixtures.
There are major efforts by both State and Federal authorities to encourage recycling activities versus land disposal as a viable and economical alternative. The limits of our land disposal capacity combined with the potential liability associated with land disposal provide incentives for both the regulator and the responsible party to seek out, and make feasible, safe and economical alternatives to landfilling.

STATE: From a State regulatory perspective, recycling is considered a preferred waste management technique by Texas. The Texas Solid Waste Disposal Act (TSWDA) Sec 361.023 (a) states that preference and lists recycling with the other preferred methods of source reduction, reuse, and treatment to destroy or reduce hazardous characteristics. In Sec. 361.0234 (a), the TSWDA encourages applicants for solid waste disposal permits to include recycling and recovery components where appropriate. The TSWDA also grants preference to recycling over land disposal for several classes of applicants (Sec. 361.022).

FEDERAL: The recycling of petroleum impacted soil into asphalt, cement and brick is the subject of recent studies by the Superfund Demonstration Division of EPA. In a paper published in June 1992 (EPA/600/R-92/096), EPA's Risk Reduction Engineering Laboratory supports incorporation of impacted soil into asphalt as an environmentally safe recycling method. Referring to data published by Karl Eklund in Incorporation of Contaminated Soils into Bituminous Concrete, *Petroleum Contaminated Soils*, Vol.1, Lewis Publishers, Chelsea, MI, 1989, the EPA researchers state:

> "These tests confirm that the petroleum contamination in the soil is combined with the asphalt in the emulsion to produce a mixture that will not separate." and "... the incorporation of soils contaminated with petroleum products as aggregate in a cold-mix-emulsion bituminous paving is an environmentally benign method of recycling the contaminated soil."

CERCLA/RCRA: Based on the physical characteristics of the washed aggregate and gravel, the wastes are not expected to be ignitable, corrosive, or reactive. In addition,

the Asphalt Institute has collected samples of asphalt for testing by the Toxicity Characteristic Leaching Procedure (TCLP). The asphalt passed the TCLP criteria, with few exceptions, and was not considered characteristically hazardous. TCLP testing of the CMA recycled materials will be conducted.

A recent EPA proposal to promote recycling of hazardous wastes into useful products explains that recycling will not have to meet the "full requirements" of RCRA (see September 10, 1993, Environmental Reporter, attached). The CMA recycled materials will be subject to TCLP testing. If the CMA process is shown to effectively bind the constituents of concern, then CMA should be considered an appropriate treatment method for this waste.

6.0 COLD-MIXED, COLD-LAID BITUMINOUS PAVING MIXTURES

GENERAL: The typical cold-mix process equipment train is depicted in Figure A, "Flow Diagram of Typical Cold Mix Plant." The diagram should be considered generic in nature because a variety of equally suitable equipment types are available to carry out cold-mixed construction. The actual equipment furnished will depend on the selection of the CMA sub-contractor.

The cold mix plant typically consists of a mixer and feeders for delivering the asphalt, aggregate and fillers to the mixer. In batch-type plants, mixing usually is accomplished by a twin-shafted pugmill. Typically these plants operate in a batch mode and have a minimum capacity of 2,000 LB. The correct amount of asphalt and aggregate, generally determined by weight, are fed into the pugmill. The batch is then mixed and discharged into a haul truck before another batch is produced. Equipment for heating the asphalt is used, even in the cold mix plant, to maintain the viscosity required for pouring. The plant is also generally equipped with a vibratory hopper or dump conveyor for loading haul trucks.

SOUTH CAVALCADE BATCH PLANT: As shown on Figure 4, "Proposed Full Scale Site Layout", the asphalt batch plant will be located to the north of the site, immediately adjacent to the eastern Washed Soil Staging Area. The two rock fractions, coarse aggregate (-2 1/2", +1/2") and gravel (-1/2", + 10 mesh), will be transported separately to the batch plant area. There they will be weighed and fed into the pugmill according to the ASTM-based mix formula. Then emulsified asphalt will be added to the pugmill in the amount specified by the mix formula. The emulsified asphalt will be kept at the proper viscosity for mixing by heating based on ASTM standards, but at no time will it exceed 180 °F, the limit defined for emulsified asphalts in ASTM D 4215 - 82.

The CMA batch plant equipment will be brought to the site on a trailer and off-loaded into the proposed Asphalt Batch Plant (ABP) area. The equipment will be used to produce an asphalt pad for approximately 1/10th the ABP area, using commercial aggregate brought onto the site. Then the pugmill and conveyors will be moved onto the asphalted portion, and used to produce the asphalt to cover the remaining ABP area. At that time the ABP will be ready to be begin the recycling of the rinsed rock fraction from the adjacent soil washing facility into CMA for use in other areas of the site.

Each of the two rock sources, coarse aggregate and gravel, will be stockpiled separately within the ABP area, and will be blended at the pugmill to produce the required aggregate mix size distribution. It may be necessary to use other aggregate fillers in sizes not readily available at the site to achieve the proper mix size distribution. As an alternative, crushing may be used to size or top-size on-site materials. Different size classes will be stockpiled separately before weighing and blending occurs at the pugmill.

The emulsified asphalt proposed for use at the site is a dispersion of asphalt cement in water that contains a small amount of emulsifying agent. The emulsifying agent can be selected to make the asphalt mixture negatively charged (anionic), positively charged (cationic) or neutrally charged (non-polar). The emulsions are further classified by the cure time or rate of setting. There are thirteen grades of medium and slow setting viscosities commonly used which are specified in ASTM standards: ASTM D 977, Standard Specification for Emulsified Asphalt, and ASTM D 2397, Standard Specification for Cationic Emulsified Asphalt.

The emulsion for use at the South Cavalcade site will be selected based on one of these standards. The determination of cationic or anionic species will be made to obtain the required coating ability and water resistance. Viscosity determination will be based on the desired cure time. The asphalt product will be purchased from a local paving contractor and brought onto the site in an asphalt tank truck. It will be dispensed directly from the tanker into the pugmill or will be stored in a heated tank and then pumped into the pugmill, according to the prescribed mix formula.

The estimated cost of mobilizing a CMA sub-contractor onto the South Cavalcade site is $5,000. The cost of CMA processing is expected to be $50/ton. The available washed aggregate quantity resulting from full scale soil washing operations is estimated to be 1,600 to 2,000 tons. This will produce approximately 1,800 to 2,500 tons of CMA. The processing cost will be $90,000 to $125,000. Adding $5,000 for demobilization, the CMA recycling is estimated to cost from $100,000 to $135,000. This cost does not reflect the cost to prepare the surface, lay or compact the resultant 48,000 square feet, 6-inch thick CMA produced. The amount of time required to process the CMA will not be driven by the asphalt batch plant rate but by the soil washing process rate, and CMA activities would be best implemented as the soil washing task nears completion.

7.0 PROPOSED CMA USAGE AT THE SITE

The recycled rock is expected to produce approximately 48,000 square feet of 6-inch thick pavement. The area to be paved will be graded to a predetermined contour. All loose and foreign material will be removed. Holes and depressions will be filled with asphalt-aggregate patching material. If necessary, a tack coat of emulsified asphalt will be sprayed onto the area to be paved that day. The CMA mixture will be placed with an asphalt paver or similar equipment to a nominal thickness of 6 inches and will be compacted immediately after placement. Core samples of the compacted pavement will be taken for TCLP analysis at a specified frequency. The area to be paved will be determined during development of the RA Work Plan.

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REFERENCES

Nash, James H. and Rosenthal, Seymour, et. al.; "Petroleum-Contaminated Soil: A Directory of Permitted Recycling Facilities"; EPA/600/R-92/096; June 1992.

Asphalt Institute; "Asphalt Cold Mix Manual"; MS-14; 1989.

"Recycling That Fails to Satisfy RCRA Would Be Allowed Under Agency Proposal", Environmental Reporter, September 10, 1993.

American Society For Testing and Materials (ASTM) Standard Specifications:

ASTM D 946 - 82	Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 955 - 88	Mixing Plants for Hot-Mixed, Hot Laid Bituminous Paving Mixtures
ASTM D 977 - 91	Emulsified Asphalt
ASTM D 2172 - 92	Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
ASTM D 2397 - 91	Cationic Emulsified Asphalt
ASTM D 3381 - 92	Viscosity-Graded Asphalt Cement for Use in Pavement
ASTM D 3515 - 89	Hot-Mixed, Hot Laid Bituminous Paving Mixtures
ASTM D 4215 - 82	Cold-Mixed, Cold-Laid Bituminous Paving Mixture
ASTM D 4552 - 92	Classifying Hot-Mix Recycling Agents

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APPENDICES

ASTM	D 977 - 91	Emulsified Asphalt
ASTM	D 3515 - 89	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM	D 4215 - 87	Cold-Mixed, Cold-Laid Bituminous Paving Mixture
ASTM	D 4552 - 92	Classifying Hot-Mix Recycling Agents
EPA/600/R-92/096		Potential Reuse of Petroleum-Contaminated Soil: A Directory of Permitted Recycling Facilities

"Recycling That Fails to Satisfy RCRA Would Be Allowed Under Agency Proposal", Environmental Reporter, September 10, 1993.

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010058

Standard Specification for Emulsified Asphalt[1]

This standard is issued under the fixed designation D 977; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This specification has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This specification covers twelve grades of emulsified asphalt for use in pavement construction in the manner designated.

2. Referenced Documents

2.1 *ASTM Standards:*
D 140 Practice for Sampling Bituminous Materials[2]
D 244 Test Methods for Emulsified Asphalts[2]

3. Requirements

3.1 The emulsified asphalt shall be tested within 14 days of delivery. The emulsified asphalt shall be homogeneous after thorough mixing provided separation has not been caused by freezing. Emulsified asphalts separated by freezing shall not be tested.

3.2 Emulsified asphalt shall conform to the requirements prescribed in Table 1.

4. Sampling

4.1 Samples of emulsified asphalt shall be taken in accordance with Practice D 140.

4.2 Samples shall be stored in clean, airtight sealed containers as specified in Practice D 140 at a temperature of not less than 40°F (4.5°C) until tested.

5. Test Methods

5.1 The properties of the emulsified asphalts given in Table 1 shall be determined in accordance with Test Methods D 244.

[1] This specification is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.41 on Emulsified Asphalt Specifications.

Current edition approved March 11, 1991. Published May 1991. Originally published as D 977 – 48 T. Last previous edition D 977 – 86.

[2] *Annual Book of ASTM Standards*, Vol 04.03.

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TABLE 1 Requirements for Emulsified Asphalt

	Rapid-Setting						Medium-Setting					
Type	RS-1		RS-2		HFRS-2		MS-1		MS-2		MS-2h	
Grade	min	max	min	max	min	max	min	max	min	max	min	max
Tests on emulsions:												
Viscosity, Saybolt Furol at 77°F (25°C), s	20	100	...	...	...	...	20	100	100	...	100	...
Viscosity, Saybolt Furol at 122°F (50°C), s	...	...	75	400	75	400	...	...	...	...	...	...
Storage stability test, 24-h, %[A]	...	1	...	1	...	1	...	1	...	1	...	1
Demulsibility, 35 ml, 0.02 *N* $CaCl_2$, %	60	...	60	...	60	...	...	...	...	...	...	...
Coating ability and water resistance:												
Coating, dry aggregate	...		...		...		good		good		good	
Coating, after spraying	...		...		...		fair		fair		fair	
Coating, wet aggregate	...		...		...		fair		fair		fair	
Coating, after spraying	...		...		...		fair		fair		fair	
Cement mixing test, %	...	...	...	...	...	...	...	...	...	...	...	...
Sieve test, %[A]	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10
Residue by distillation, %	55	...	63	...	63	...	55	...	65	...	65	...
Oil distillate by volume of emulsion, %	...	...	...	...	...	...	...	...	...	...	...	...
Tests on residue from distillation test:												
Penetration, 77°F (25°C), 100g, 5 s	100	200	100	200	100	200	100	200	100	200	40	90
Ductility, 77°F, (25°C), 5 cm/min, cm	40	...	40	...	40	...	40	...	40	...	40	...
Solubility in trichloroethylene, %	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...
Float test, 140°F (60°C), s	...	...	...	...	1200	...	...	...	...	...	...	...

	Medium-Setting						Slow-Setting					
Type	HFMS-1		HFMS-2		HFMS-2h		HFMS-2s		SS-1		SS-1h	
Grade	min	max	min	max	min	max	min	max	min	max	min	max
Tests on emulsions:												
Viscosity, Saybolt Furol at 77°F (25°C), s	20	100	100	...	100	...	50	...	20	100	20	100
Viscosity, Saybolt Furol at 122°F (50°C), s	...	...	...	...	...	...	...	...	...	...	...	...
Storage stability test, 24-h, %[A]	...	1	...	1	...	1	...	1	...	1	...	1
Demulsibility, 35 ml, 0.02 *N* $CaCl_2$, %	...	...	...	...	...	...	...	...	...	...	...	...
Coating ability and water resistance:												
Coating, dry aggregate	good		good		good		good		...		...	
Coating, after spraying	fair		fair		fair		fair		...		...	
Coating, wet aggregate	fair		fair		fair		fair		...		...	
Coating, after spraying	fair		fair		fair		fair		...		...	
Cement mixing test, %	...	...	...	...	...	...	...	...	...	2.0	...	2.0
Sieve test, %[A]	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10
Residue by distillation, %	55	...	65	...	65	...	65	...	57	...	57	...
Oil distillate by volume of emulsion, %	...	...	...	...	...	...	1	7	...	...	...	...
Tests on residue from distillation test:												
Penetration, 77°F (25°C), 100 g, 5 s	100	200	100	200	40	90	200	...	100	200	40	90
Ductility, 77°F, (25°C), 5 cm/min, cm	40	...	40	...	40	...	40	...	40	...	40	...
Solubility in trichloroethylene, %	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...
Float test, 140°F (60°C), s	1200	...	1200	...	1200	...	1200	...	...	...	...	...

[A] This test requirement on representative samples is waived if successful application of the material has been achieved in the field.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

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010060

Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures[1]

This standard is issued under the fixed designation D 3515; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers hot-mixed, hot-laid asphalt, tar, emulsified asphalt, and recycled bituminous paving mixtures for base, binder, leveling, and surface courses.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are for information only.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate[2]
C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate[2]
C 136 Method for Sieve Analysis of Fine and Coarse Aggregates[2]
D 5 Test Method for Penetration of Bituminous Materials[3]
D 75 Practice for Sampling Aggregates[2]
D 140 Methods of Sampling Bituminous Materials[3]
D 242 Specification for Mineral Filler for Bituminous Paving Mixtures[3]
D 448 Classification for Sizes of Aggregate for Highway Construction[3]
D 490 Specification for Road Tar[3]
D 546 Method for Sieve Analysis of Mineral Filler for Road and Paving Materials[3]
D 692 Specification for Coarse Aggregate for Bituminous Paving Mixtures[3]
D 946 Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction[3]
D 977 Specification for Emulsified Asphalt[3]
D 979 Methods of Sampling Bituminous Paving Mixtures[3]
D 995 Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures[3]
D 1073 Specification for Fine Aggregate for Bituminous Paving Mixtures[3]
D 1856 Test Method for Recovery of Asphalt from Solution by Abson Method[3]
D 2171 Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer[3]
D 2172 Test Method for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures[3]
D 2489 Test Method for Degree of Particle Coating of Bituminous-Aggregate Mixtures[3]
D 3381 Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction[3]
D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[4]
D 4552 Practice for Classifying Hot-Mix Recycling Agents[3]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard:*

3.1.1 *bitumen aggregate for recycling*—bituminous pavement or paving mixture removed from its original location and reduced by suitable means to such particle size as may be required for use in hot-mixed, hot-laid recycled bituminous paving mixtures.

NOTE—Alternative terminology may be used for bitumen aggregate for recycling so long as the terms are defined or understood to refer to the same material. Reclaimed asphalt pavement (RAP) that has been removed from its original location and reduced in size as may be required.

3.1.2 *hot-mixed, hot-laid paving mixtures*—mixtures of coarse and fine aggregate or fine aggregate alone, with or without mineral filler, uniformly mixed with asphalt, tar, or emulsified asphalt.

3.1.3 *hot-mixed, hot-laid recycled bituminous paving mixtures*—mixtures of bitumen aggregate for recycling with or without mineral aggregates and mineral filler, mixed at elevated temperatures with or without additional bitumen.

4. Ordering Information

4.1 Orders for bituminous paving mixtures under this specification shall include the following information:

4.1.1 Type of bitumen (asphalt cement, tar cement, emulsified asphalt),

4.1.2 Grade of bitumen,

[1] This specification is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.23 on Plant-Mix Bituminous Surfaces and Bases.

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[2] *Annual Book of ASTM Standards*, Vols 04.02 and 04.03.

[3] *Annual Book of ASTM Standards*, Vol 04.03.

[4] *Annual Book of ASTM Standards*, Vol 04.08.

* A Summary of Changes section appears at the end of this specification.

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4.1.3 The composition of the bituminous paving mixture (dense mixture, mix designation, and nominal maximum size; open mixture, mix designation, and nominal maximum size; open graded friction course mixture, mix designation, and nominal maximum size),

4.1.4 The maximum percentage of bitumen aggregate for recycling permitted in the mixture when limited, and

4.1.5 The percentage of crushed particles required in the aggregate if different from that specified in Specification D 692.

5. Aggregates

5.1 The aggregates shall be crushed stone, crushed slag, crushed gravel, and natural or manufactured sand conforming to the quality and crushed particle requirements of the appropriate ASTM specifications as follows:

5.1.1 *Coarse Aggregate*—Specification D 692.

5.1.2 *Fine Aggregate*—Specification D 1073.

NOTE 1—Other mineral aggregates, such as uncrushed gravel, crushed shell, and various synthetic aggregates, may be specified, provided that local experience or tests have demonstrated their ability to produce satisfactory bituminous paving mixtures.

5.2 Recommended grading requirements for coarse and fine aggregate may be selected from Specifications D 448 and D 1073, respectively. Other aggregate gradations may be used, provided that the combined coarse and fine aggregates, and filler, when used, produce a mixture that conforms to the requirements for grading of total aggregate prescribed in Table 1.

5.3 When hot-mixed, hot-laid recycled bituminous mixtures are produced, aggregates conforming to 5.1 may be blended with the bitumen aggregate for recycling as necessary to produce the result required by 5.2.

6. Mineral Filler

6.1 The mineral filler shall conform to Specification D 242.

7. Bitumen

7.1 When asphalt cement is used, it shall conform to either Specification D 3381 or Specification D 946.

NOTE 2—The viscosity grade or the penetration grade to be used depends on the type of construction, climatic conditions, and amount and nature of traffic. The required viscosity grade or penetration grade should be specified.

7.2 When tar cement is used, it shall conform to Specification D 490.

NOTE 3—The grade to be used shall be RT-10, RT-11, or RT-12, depending upon the type of construction, climatic conditions, and the amount and nature of traffic. The required grade should be specified.

7.3 When emulsified asphalt is used it shall conform to Specification D 977, Grade HFMS-2h or MS-2h.

7.4 When specifically approved by the purchaser, other types of emulsified asphalt may be used, if experience has shown that satisfactory performance will result.

7.5 When hot-mixed hot-laid recycled bituminous paving mixtures are produced, bitumen conforming to Specification D 946, D 977, or D 3381 or recycling agents with or without bitumen conforming to Practice D 4552 shall be added to the asphalt bitumen for recycling as necessary.

8. Composition of Bituminous Paving Mixtures

8.1 The mixture shall conform to one of the composition by weight given in Table 1 or Table 2.

NOTE 4—The nominal top size aggregate (mix designation) selected should be determined by the intended use, thickness of paving courses, and desired texture.

8.1.1 Compositions shown in Table 1 or Table 2 are based on the use of fine and coarse aggregates having approximately the same bulk specific gravities; grading of the total aggregate, therefore, would be the same on either a weight or bulk volume basis. If the bulk specific gravities of coarse and fine aggregates differ by more than 0.20, it may be necessary to adjust the job mix aggregate grading slightly to account for the differences in volume.

8.2 A job mixture shall be selected that comes within the specification limits and that is suitable for the traffic, climatic conditions, and specific gravities of the aggregates used. Below the No. 8 (2.36-mm) sieve size, the job-mix formula grading curve shall be reasonably parallel to the curves of the grading limits as selected from Table 1.

8.3 Any variation from the job-mix formula in the grading of the aggregate, as shown by the sieve analyses of materials in the plant (Note 5) or, any variation from the job-mix formula in the bitumen content, as indicated by extraction tests of the finished mixture, greater than the percentage shown in Table 3, shall be investigated, and the conditions causing such variation shall be corrected (Note 6).

NOTE 5—It is recognized that the extraction test is a generally accepted and approved method for determining the composition of bituminous concrete mixture. However, due to the relatively wide difference in the bitumen content and aggregate gradation sometimes found in individual samples of mixture taken from the same batch, as shown by extraction tests, it is recommended that the extraction test results on individual small samples be used as an indication of the mix composition, and not as the sole basis for acceptance or rejection of the product. Unless the mixing plant has automatic batching and recording equipment, it may be necessary to determine both aggregate gradation and bitumen content from extraction test samples.

NOTE 6—Application of tolerances may result in a gradation outside the composition limits in Table 1 or Table 2. This will not be cause for investigation.

9. Mixing Plant

9.1 The mixing plant shall conform to Specification D 995. When emulsified asphalt is used, the pugmill shall be adequately vented to allow for the escape of steam.

10. Mixing Plant Operation

10.1 *Aggregate Storage*—Aggregates furnished in different sizes or from different sources shall be kept separate, and adequate provision shall be made to keep them from becoming mixed or otherwise contaminated. Stockpiles shall be built and the materials removed therefrom in such a manner as to minimize size segregation.

10.2 *Old Bituminous Pavement*—Bitumen aggregate for recycling shall be reduced in size so that the maximum aggregate particle size conforms with 8.1 and shall be kept separate from aggregate stockpiles. Adequate provisions shall be made to keep bitumen aggregate for recycling from bein mixed with aggregates or otherwise contaminated.

10.3 *Preparation of Bitumen*—The bitumen shall be maintained at a temperature at which it can be properly

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TABLE 1 Composition of Bituminous Paving Mixtures

Sieve Size	Dense Mixtures								
	Mix Designation and Nominal Maximum Size of Aggregate								
	2 in. (50 mm)	1½ in. (37.5 mm)	1 in. (25.0 mm)	¾ in. (19.0 mm)	½ in. (12.5 mm)	⅜ in. (9.5 mm)	No. 4 (4.75 mm) (Sand Asphalt)	No. 8 (2.36 mm)	No. 16 (1.18 mm) (Sheet Asphalt)
	Grading of Total Aggregate (Coarse Plus Fine, Plus Filler if Required) Amounts Finer Than Each Laboratory Sieve (Square Opening), Weight %								
2½ in. (63-mm)	100	...	...	...	...	...	...	...	...
2 in. (50-mm)	90 to 100	100	...	...	...	...	...	...	...
1½ in. (37.5-mm)	...	90 to 100	100	...	...	...	...	...	...
1 in. (25.0-mm)	60 to 80	...	90 to 100	100	...	...	...	...	...
¾ in. (19.0-mm)	...	56 to 80	...	90 to 100	100	...	...	...	...
½ in. (12.5-mm)	35 to 65	...	56 to 80	...	90 to 100	100	...	...	...
⅜ in. (9.5-mm)	...	...	...	56 to 80	...	90 to 100	100	...	...
No. 4 (4.75-mm)	17 to 47	23 to 53	29 to 59	35 to 65	44 to 74	55 to 85	80 to 100	...	100
No. 8 (2.36-mm)[A]	10 to 36	15 to 41	19 to 45	23 to 49	28 to 58	32 to 67	65 to 100	...	95 to 100
No. 16 (1.18-mm)	...	...	...	...	...	...	40 to 80	...	85 to 100
No. 30 (600-µm)	...	...	...	...	...	...	25 to 65	...	70 to 95
No. 50 (300-µm)	3 to 15	4 to 16	5 to 17	5 to 19	5 to 21	7 to 23	7 to 40	...	45 to 75
No. 100 (150-µm)	...	...	...	...	...	...	3 to 20	...	20 to 40
No. 200 (75-µm)[B]	0 to 5	0 to 6	1 to 7	2 to 8	2 to 10	2 to 10	2 to 10	...	9 to 20

Sieve Size	Open Mixtures								
	Mix Designation and Nominal Maximum Size of Aggregate								
	2 in. (50 mm)	1½ in. (37.5 mm)	1 in. (25.0 mm)	¾ in. (19.0 mm)	½ in. (12.5 mm)	⅜ in. (9.5 mm)	No. 4 (4.75 mm) (Sand Asphalt)	No. 8 (2.36 mm)	No. 16 (1.18 mm) (Sheet Asphalt)
	Base and Binder Courses						Surface and Leveling Courses		
2½ in. (63-mm)	100	...	...	...	...	...	...	...	...
2 in. (50-mm)	90 to 100	100	...	...	...	...	...	...	...
1½ in. (37.5-mm)	...	90 to 100	100	...	...	...	...	...	
1 in. (25.0-mm)	40 to 70	...	90 to 100	100	...	...	...	...	...
¾ in. (19.0-mm)	...	40 to 70	...	90 to 100	100	...	...	...	...
½ in. (12.5-mm)	18 to 48	...	40 to 70	...	85 to 100	100	...	...	...
⅜ in. (9.5-mm)	...	18 to 48	...	40 to 70	60 to 90	85 to 100	...	...	...
No. 4 (4.75-mm)	5 to 25	6 to 29	10 to 34	15 to 39	20 to 50	40 to 70	...	100	...
No. 8 (2.36-mm)[A]	0 to 12	0 to 14	1 to 17	2 to 18	5 to 25	10 to 35	...	75 to 100	...
No. 16 (1.18-mm)	...	...	...	...	3 to 19	5 to 25	...	50 to 75	...
No. 30 (600-µm)	0 to 8	0 to 8	0 to 10	0 to 10	...	...	...	28 to 53	...
No. 50 (300-µm)	...	...	...	...	0 to 10	0 to 12	...	8 to 30	...
No. 100 (150-µm)	...	...	...	...	...	...	...	0 to 12	...
No. 200 (75-µm)[B]	...	...	...	...	...	...	...	0 to 5	...
	Bitumen, Weight % of Total Mixture[C]								
	2 to 7	3 to 8	3 to 9	4 to 10	4 to 11	5 to 12	6 to 12	7 to 12	8 to 12
	Suggested Coarse Aggregate Sizes								
	3 and 57	4 and 67 or 4 and 68	5 and 7 or 57	67 or 68 or 6 and 8	7 or 78	8			

[A] In considering the total grading characteristics of a bituminous paving mixture, the amount passing the No. 8 (2.36-mm) sieve is a significant and convenient field control point between fine and coarse aggregate. Gradings approaching the maximum amount permitted to pass the No. 8 sieve will result in pavement surfaces having comparatively fine texture, while coarse gradings approaching the minimum amount passing the No. 8 sieve will result in surfaces with comparatively coarse texture.

[B] The material passing the No. 200 (75-µm) sieve may consist of fine particles of the aggregates or mineral filler, or both but shall be free of organic matter and clay particles. The blend of aggregates and filler, when tested in accordance with Test Method D 4318, shall have a plasticity index of not greater than 4, except that this plasticity requirement shall not apply when the filler material is hydrated lime or hydraulic cement.

[C] The quantity of bitumen is given in terms of weight % of the total mixture. The wide difference in the specific gravity of various aggregates, as well as a considerable difference in absorption, results in a comparatively wide range in the limiting amount of bitumen specified. The amount of bitumen required for a given mixture should be determined by appropriate laboratory testing or on the basis of past experience with similar mixtures, or by a combination of both.

handled through the pumping system and uniformly distributed throughout the mixture. At no time during the processing, from storage to mixing, will temperature of the bitumen be allowed to exceed the following:

Bitumen	Temperature °F	Temperature °C
Asphalt cement	350	176.6
Tar cement	225	107.2
Emulsified asphalt	180	82.2

10.4 *Preparation and Handling of Mineral Aggregates*—Each size aggregate shall be separately fed by feeders to the cold elevator or elevators in proper proportion and at a rate to permit correct and uniform temperature control of the heating and drying operation. The aggregate shall be dried and delivered to the mixer at a temperature such that the mixture will be produced at a temperature within the range suited to the bitumen used, as follows:

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TABLE 2 Composition of Open Graded Friction Course Mixtures

NOTE—Mix Designation and Nominal Maximum Size of Aggregate

Sieve Size	Type I—⅜-in. (9.5 mm)	Type II—½-in. (12.5 mm)
	Percent Passing	
¾ in. (19.0 mm)	100	100
½-in. (12.5 mm)	100	90 to 100
⅜-in. (9.5 mm)	90 to 100	60 to 100
No. 4 (4.75 mm)	30 to 50	15 to 40
No. 8 (2.36 mm)[A]	5 to 15	4 to 12
No. 200 (75 µm)[B]	2 to 5	2 to 5
	Bitumen, weight % of total mixture[C]	
	5–8½	4½–8
	Suggested Aggregate Sizes from Specification D 448	
	8 and 9 or 89	7 and 89 or 7 and 8

[A] In considering the total grading characteristics of the bituminous paving mixture, the amount passing the 2.36-mm (No. 8) sieve is a significant and convenient field control point between fine and coarse aggregate. In open-graded friction course mixtures, the amount passing the No. 8 shall be limited to that required to provide a chocking of the coarser particles.

[B] The material passing the No. 200 (75-µm) sieve may consist of fine particles of the aggregates or mineral filler, or both but shall be free of organic matter and clay particles. The blend of aggregates and filler, when tested in accordance with Test Method D 4318, shall have a plasticity index of not greater than 4, except that this plasticity requirement shall not apply when the filler material is hydrated lime or hydraulic cement.

[C] The quantity of bitumen is given in terms of weight % of the total mixture and is applicable to a variety of aggregates of conventional specific gravities, approximately 2.50–2.80. The wide difference in the specific gravity of some aggregates, as well as a considerable difference in absorption, may require bitumen contents outside the range shown. The amount of bitumen required for a given mixture should be determined by appropriate laboratory testing or on the basis of past experience with similar mixtures, or by a combination of both.

TABLE 3 Tolerances from Job-Mix Formula

Sieve Size	Tolerances, %
½ in. (12.5 mm) and larger	± 8
⅜ in. (9.5 mm) and No. 4 (4.75 mm)	± 7
No. 8 (2.36 mm) and No. 16 (1.18 mm)	± 6
No. 30 (600 µm) and No. 50 (300 µm)	± 5
No. 200 (75 µm)	± 3
Bitumen content, weight % of total mixture	± 0.5

Bitumen	Temperature Range °F	°C
Asphalt cement (conventional mixes)	250 to 325	121.1 to 162.7
Asphalt cement (open graded friction mixes)	220–260	104.5–126.6
Tar cement	175 to 225	79.4 to 107.2
Emulsified asphalt	220 to 260	104.5 to 126.6

The temperature between those limits shall be regulated according to the grade and viscosity characteristics of the bitumen, ambient temperature, and workability of the mixture. Aggregates in the hot bins shall not contain moisture to such an extent as to cause the mixture to foam, slump, or segregate during hauling and placing operations.

10.5 *Preparation and Handling of Bitumen Aggregate for Recycling*—Bitumen aggregate for recycling shall be fed into the plant in proper proportion at a location and rate to permit correct and uniform temperature control of the heating and drying operation. It shall be delivered to the mixer at a temperature such that the mixture will be produced within the range specified in 10.4.

10.6 *Preparation of Mixture*—The proportions of the components of the mixture, within the limits specified, shall be regulated so as to produce a satisfactory mixture. The sequence in which the several aggregates or the several aggregates and asphalt aggregate for recycling shall be drawn or weighed may vary under different conditions. The bitumen shall be added in an evenly spread sheet over the length of the mixer box in a batch plant, or shall be spread evenly across the mixer box in a continuous mix plant.

10.6.1 The mixing shall be accomplished in the shortest time that will produce a satisfactory mixture. Mixing time shall be specified within the following limits, except that the minimum may be determined as provided in 10.6.2 and the maximum dry mixing time may be determined as provided by 10.6.3:

10.6.1.1 *Batch Plants*—0 to 10-s dry mixing followed by 25 to 50-s additional mixing after the addition of the bitumen.

10.6.1.2 *Continuous Mix Plants*—25 to 60 s based on the following equation:

$$\text{Mix time, s} = \frac{\text{pugmill capacity, lb (kg)}}{\text{pugmill output, lb/s (kg/s)}}$$

10.6.2 Minimum mixing time may be established on the percentage of coated particles as determined by Method D 2489. The minimum values for percentage of coated particles used to establish the minimum mixing time shall be set by the engineer. These values will vary with aggregate gradation, particle shape, and surface texture, and with the bitumen content and use for which the mix is intended.

10.6.3 When any component of the mixture except bitumen is not heated in the dryer, the dry mixing period may be extended as necessary so that the mixture will be produced at a uniform temperature within the range specified in 10.4.

10.7 *Mixing Plant Inspection*—The engineer or his authorized representatives shall have access at any time to all parts of the mixing plant in order to ensure the manufacture of the mixture in strict accordance with this specification. In order that accurate and sufficiently large samples of aggregate may be obtained from the hot aggregate bins, easy and safe access shall be provided to the location on the plant where such samples may be taken.

10.8 *Special Requirements for Asphalt Mix from Surge or Storage Bins*—Asphalt cement recovered from the mix shall comply with Alternative 1 or 2 as follows:

Alternative 1
for Penetration Graded Asphalt Cement, Specification D 946

Grade	Penetration Equal to or More Than
200–300	74
120–150	50
85–100	40
60–70	31
40–50	22

Alternative 2
for Viscosity Graded Asphalt Cement, Specification D 3381

Grade	Viscosity 140°F(60°C), P Equal to or Less Than
AC-2.5 and AR-1000	1 250
AC-5 and AR-2000	2 500
AC-10 and AR-4000	5 000
AC-20 and AR-8000	10 000
AC-40 and AR-16000	20 000

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Samples for these tests shall be taken from trucks loaded from the bin. The addition of solvent according to procedures of Test Method D 2172 shall be started within 4 h of sampling or the samples shall be placed in a cold storage facility and maintained at 32°F (0°C) or lower until testing is started. Where delivery to cold storage will take more than 4 h, one of the following procedures shall be used:

(*a*) Chill the samples by placing in plastic coolers containing dry ice. Maintain dry ice in coolers during delivery to the laboratory.

(*b*) Place the sample in a gallon can containing dry ice. Cap the can immediately with a lid that has a pinhole in it. When pressure buildup ceases, solder the pinhole. Keep the can tight during delivery to laboratory.

10.8.1 The following storage times will be permitted until the results of tests on the recovered asphalt are available. The times may be increased or decreased on the basis of the test results.

	Time, h	
	Fine Mix[A]	Coarse Mix[B]
Untreated asphalt, air in bin	12	6
Treated asphalt,[C] air in bin; untreated asphalt, inert gas in bin	36	18
Treated asphalt,[C] inert gas in bin	96	72

[A] Dense Mixtures: ¼ in., ½ in., ⅜ in., No. 4, and No. 16.

[B] Dense Mixtures: 2 in., 1½ in., and 1 in.

[C] Treated with Dow-Corning Fluid DC-200 at rate of approximately 1 oz (30 cm^3)/5000 gal (18.93 m^3) of asphalt.

NOTE 9—An arbitrary separation point has been made above, based on ASTM Composition Requirements for Dense Mixtures, between the coarse and fine mixes. It has been observed that the coarser mixes undergo a faster rate of hardening when stored due to a higher volume of voids in those mixes. In addition, "open mixtures" generally harden faster than "dense mixtures" and, therefore, the storage time limits given above for coarse mixes should also be used for "open mixtures." The arbitrary separation point should be adjusted as data on percent air voids of laboratory compacted specimens become available. A value of 10 % air void content is suggested as an arbitrary separation point between coarse and fine mixes, with coarse mixes having an air void content above 10 % and fine mixes having an air void content less than 10 %. This value is arbitrary and may also require adjustment as additional mix design data becomes available.

11. Methods of Sampling and Testing

11.1 Sample all material and determine the properties enumerated in this specification in accordance with the following ASTM standards:

11.1.1 *Sampling Mineral Aggregates*—Practice D 75.

11.1.2 *Sampling Bituminous Mixtures*—Methods D 979.

11.1.3 *Sieve Analysis of Aggregates*—Method C 136.

11.1.4 *Sieve Analysis of Mineral Filler*—Test Method D 546.

11.1.5 *Determination of Bitumen Content*—Test Method D 2172. Determine the tar content in accordance with explanatory note appended to Test Method D 2172.

11.1.6 *Sampling Bituminous Materials*—Methods D 140.

11.1.7 *Specific Gravity of Coarse Aggregate*—Method C 127.

11.1.8 *Specific Gravity of Fine Aggregate*—Test Method C 128.

11.1.9 *Plasticity Index*—Test Method D 4318.

11.1.10 *Percentage of Coated Particles*—Test Method D 2489.

11.1.11 *Recovery of Extracted Asphalt*—Test Method D 1856.

11.1.12 *Penetration of Recovery Asphalt*—Test Method D 5.

11.1.13 *Air Voids*—Test Method D 3203.

11.1.14 *Absolute Viscosity of Asphalts*—Test Method D 2171.

SUMMARY OF CHANGES

This section identifies the location of changes to this specification that have been incorporated since the last issue. Committee D-4 has highlighted those changes that affect the technical interpretation or use of this specification.

(1) A note was added to the Terminology Section,

(2) The term asphalt was changed to bitumen in Sections 1, 3, 5, 7, and 10, and,

(3) Sections 3, 4, and 5 were revised.

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Standard Specification for Cold-Mixed, Cold-Laid Bituminous Paving Mixture[1]

This standard is issued under the fixed designation D 4215; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers cold-mixed, cold-laid and recycled cold-mixed, cold-laid bituminous paving mixtures for base, binder, leveling, and surface courses.

2. Referenced Documents

2.1 *ASTM Standards:*

C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate[2]
C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate[2]
C 136 Method for Sieve Analysis of Fine and Coarse Aggregates[2]
D 75 Practice for Sampling Aggregates[3]
D 140 Methods of Sampling Bituminous Materials[3]
D 242 Specification for Mineral Filler for Bituminous Paving Mixtures[3]
D 448 Classification for Sizes of Aggregate for Road and Bridge Construction[3]
D 490 Specification for Road Tar[3]
D 546 Method for Sieve Analysis of Mineral Filler for Road and Paving Materials[3]
D 692 Specification for Coarse Aggregate for Bituminous Paving Mixtures[3]
D 977 Specification for Emulsified Asphalt[3]
D 979 Methods for Sampling Bituminous Paving Mixtures[3]
D 1073 Specification for Fine Aggregate for Bituminous Paving Mixtures[3]
D 2026 Specification for Cutback Asphalt (Slow-Curing Type)[3]
D 2027 Specification for Cutback Asphalt (Medium-Curing Type)[3]
D 2028 Specification for Cutback Asphalt (Rapid-Curing Type)[3]
D 2172 Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures[3]
D 2397 Specification for Cationic Emulsified Asphalt[3]
D 2399 Practice for Selection of Cutback Asphalts[3]
D 2489 Test Method for Degree of Particle Coating of Bituminous-Aggregate Mixtures[3]
D 2728 Practice for Paving Uses and Application Temperatures for Road Tars[3]
D 3515 Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures[3]
D 3628 Practice for Selection and Use of Emulsified Asphalts[3]
D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[4]

3. Description of Term Specific to this Standard

3.1 cold-mixed, cold-laid bituminous paving mixtures—mixtures of coarse and fine aggregates, or coarse or fine aggregate alone, with or without mineral filler, uniformly mixed and laid at or near ambient temperature.

3.2 *cold-mixed, cold-laid recycled bituminous paving mixtures*—mixtures of bitumen aggregate for recycling with additional mineral aggregate as necessary, with or without mineral filler, mixed at or near ambient temperatures with additional bitumen.

3.3 *bitumen-aggregate for recycling*—bituminous pavement or paving mixture removed from its original location and reduced by suitable means, after removal or in place, to such particle size as may be required for use in cold-mixed, cold-laid recycled bituminous paving mixtures.

4. Ordering Information

4.1 Orders for cold bituminous paving mixtures under this specification shall include the following information:

4.1.1 Type of bitumen (emulsified asphalt, cutback asphalt, or tar),

4.1.2 Grade of bitumen,

4.1.3 The composition of the bituminous paving mixture (dense mixture, mix designation, and nominal maximum size; open mixture, mix designation, and nominal maximum size; open graded friction course mixture, mix designation, and nominal maximum size),

4.1.4 The maximum percentage of bitumen aggregate for recycling permitted in the mixture, and

4.1.5 The percentage of crushed particles required in the aggregate if different from that specified in 5.2.

5. Aggregates

5.1 The aggregates shall be crushed stone, crushed slag, crushed gravel, or sand conforming to the quality requirement of the appropriate ASTM specifications as follows:

5.1.1 *Coarse Aggregate*—Specification D 692.

5.1.2 *Fine Aggregate*—Specification D 1073.

NOTE 1—Other mineral aggregates, such as uncrushed gravel and crushed shell, may be specified, provided that local experience or tests have demonstrated their ability to produce satisfactory bituminous paving mixtures.

[1] This specification is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.23 on Plant-Mix Bituminous Surfaces and Bases.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 04.03.

[4] *Annual Book of ASTM Standards*, Vol 04.08.

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5.2 The aggregates for open-graded friction course mixture described in Table 2 of Specification D 3515 shall meet all the requirements of 5.1 with the added requirement that (*1*) the coarse particles, retained on the No. 4 sieve, be crushed so that at least 90 weight percent have one or more fractured faces and 75 weight percent have two or more fractured faces, and (*2*) the coarse aggregate, or if a blend is used, the coarsest fraction be of a type known to possess adequate resistance to the polishing action of the anticipated traffic.

5.3 Recommended grading requirements for coarse and fine aggregate may be selected from Classification D 448 and Specification D 1073, respectively. Other aggregate gradations may be used, provided that the combined coarse and fine aggregates, and filler, when used, produce a mixture that conforms to the requirements for grading of total aggregate as described in Table 1 of Specification D 3515.

5.4 When cold-mixed, cold-laid recycled mixtures are produced, aggregates conforming to 5.1 may be blended with the bitumen aggregate for recycling as necessary to produce the results required by 5.3.

6. Mineral Filler

6.1 The mineral filler shall conform to Specification D 242.

7. Bitumen

NOTE 2—Practices D 2399, D 2728, and D 3628 provide guidance in selecting types and grades of bitumen.

7.1 When cutback asphalt is used it shall conform to Specifications D 2026, D 2027, or D 2028.

7.2 When emulsified asphalt is used it shall conform to Specifications D 977 or D 2397.

7.3 When tar is used it shall conform to Specification D 490.

7.4 When cold-mixed, cold-laid recycled mixtures are produced, bitumen conforming to 7.1 or 7.2 shall be added to the bitumen aggregate for recycling as necessary.

NOTE 3—Various bituminous modifiers or recycling agents have been used on a number of cold-mixed, cold-laid recycled bituminous paving projects. Specifications for these materials are being developed.

8. Composition of Bituminous Paving Mixtures

8.1 The mixture shall conform to one of the compositions by weight given in Table 1 of Specification D 3515.

NOTE 4—The nominal top size aggregate (mix designation) selected should be determined by the intended use, thickness of paving courses, and desired texture. The required mix should be specified.

8.1.1 Compositions shown in Table 1 of Specification D 3515 are based on the use of fine and coarse aggregates having approximately the same bulk specific gravities; grading of the total aggregate, therefore, would be the same on either a weight or bulk volume basis. If the bulk specific gravities of coarse and fine aggregates differ greatly, it may be desirable to change the grading limitations to compensate for these differences.

8.2 A job mix formula shall be selected that comes within the specification limits and that is suitable for the traffic, climatic conditions, and specific gravities of the aggregates used. Below the No. 8 (2.36-mm) sieve size, the job-mix formula grading curve shall be reasonably parallel to the curves of the grading limits as selected from Table 1 of Specification D 3515.

8.3 Any variation from the job-mix formula in the grading of the aggregate, as shown by the sieve analyses of materials (Note 5) or, any variation from the job-mix formula in the bitumen content, as indicated by extraction tests of the finished mixture (Note 6) greater than the tolerances shown in Table 3 of Specification D 3515, shall be investigated, and the conditions causing such variation shall be corrected (Note 7).

NOTE 5—It is recognized that the extraction test is a generally accepted and approved method for determining the composition of a bituminous mixture. However, due to the relatively wide difference in the bitumen content and aggregate gradation sometimes found in individual samples of mixture taken from the same lot, as shown by extraction tests, it is recommended that the extraction test results on individual small samples be used as an indication of the mix composition, and not as the sole basis for acceptance or rejection of the product. It may be necessary to determine both aggregate gradation and bitumen content from extraction tests samples.

NOTE 6—Cold mixtures require special preparation in the form of curing prior to performing the extraction test. One recommended curing procedure is to place the mixture to be extracted into a suitably large metal pan with a large spoon such that the mixture, in a loose state, is from 1 to 1½ in. (25 to 38 mm) in depth. Place the mixture, pan, and spoon in an oven, conforming to Specification E 145, Type 1B, the temperature of which has been adjusted to 250 + 5°F (121 + 3°C), for 3 h. At the end of each hour remove the pan and stir the mixture thoroughly for 1 min. Replace in the oven, except after the third hourly stirring, allow to cool to room temperature. The extraction test is then performed on this cured mixture. (Other curing procedures may be used provided local experience demonstrates their ability to prepare mixtures prope for the extraction test.)

NOTE 7—Application of tolerances may result in a gradation outside the composition limits in Table 1 of Specification D 3515. This will not be cause for investigation.

9. Mixing Equipment

9.1 The equipment for mixing shall be one of the following:

9.1.1 *Central Plant*—Batch, continuous, or drum mixer.

9.1.2 *Travel Plant*, with own bituminous spray system or with separate distributor.

9.1.3 *Grader or Drag*, with separate distributor.

10. Mixing Operation

10.1 *Aggregate Storage*—Aggregates furnished in different sizes or from different sources shall be kept separate, and adequate provisions shall be made to keep them from becoming mixed or otherwise contaminated. Preblending of aggregates for travel plants and road mixing is permissible so long as grading requirements are maintained. Stockpiles shall be built and the materials removed therefrom in such a manner as to minimize size segregation.

10.2 *Old Bituminous Pavement*—Bitumen aggregate for recycling shall be reduced in size as may be required. Adequate provisions shall be made to keep bitumen aggregate for recycling from being mixed with aggregates or otherwise contaminated.

10.3 *Preparation of Bitumen*—The bitumen shall be maintained at a temperature at which it can be properly handled through the pumping system and uniformly distribut throughout the mixture. At no time will the temperature o the bitumen be allowed to exceed the following:

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Bitumen	Temperature °F	°C
Cutback asphalt	250	121
Emulsified asphalt	180	82
Road tar	225	107

NOTE 8—The flash point of some grades of cutback asphalt is below 250°F; therefore, caution must be used when applying heat to cutbacks.

10.4 *Preparation and Handling of Mineral Aggregates*—Each aggregate shall be separately fed by feeders, except in the case of preblended aggregates where only one feeder is required, in proper uniform proportion to produce a satisfactory mixture within the limits specified. In the case of road mixing a known uniform volume or weight of a single aggregate, several aggregates, or preblended aggregate shall be windrowed or otherwise placed on the road or mixing area.

10.5 *Preparation and Handling of Bitumen Aggregate for Recycling*—Bitumen aggregate for recycling shall be separately fed by a feeder, except in the case of preblended aggregates where only one feeder is required, in proper uniform proportions to produce a satisfactory mixture within the limits specified. In the case of road mixing, a known volume or weight shall be windrowed or otherwise placed on the road or mixing area.

10.6 *Preparation of Mixture*—The proportions of the components of the mixture, within the limits specified, shall be regulated so as to produce a satisfactory mixture. The sequence in which the bituminous material is proportioned with the aggregate, aggregate and bitumen aggregate for recycling, or bitumen aggregate for recycling may vary under different mixing procedures.

10.6.1 The mixing shall be accomplished in the shortest time that will produce a satisfactory mixture.

10.6.2 Minimum mixing time may be established on the best coating obtainable or percentage of coated particles as determined by Test Method D 2489. These values will vary with aggregate gradation, particle shape, and surface texture, and with the type of bitumen, bitumen content, and use for which the mix is intended.

NOTE 9—All the coarse particles may not be coated, particularly in dense graded mixtures.

10.7 *Mixing Plant Inspection*—The engineer or his authorized representatives shall have access at any time to all parts of the mixing plant in order to ensure the manufacture of the mixture in strict accordance with this specification.

11. Methods of Sampling and Testing

11.1 Sample all material and determine the properties enumerated in this specification in accordance with the following ASTM standards:

11.1.1 *Sampling Mineral Aggregates*—Practice D 75.

11.1.2 *Sampling Bituminous Mixtures*—Methods D 979.

11.1.3 *Sieve Analysis of Aggregates*—Method C 136.

11.1.4 *Sieve Analysis of Mineral Filler*—Method D 546.

11.1.5 *Determination of Bitumen Content*—Test Methods D 2172. Determine the tar content in accordance with explanatory note appended to Test Methods D 2172.

11.1.6 *Sampling Bituminous Materials*—Methods D 140.

11.1.7 *Specific Gravity of Coarse Aggregate*—Test Method C 127.

11.1.8 *Specific Gravity of Fine Aggregate*—Test Method C 128.

11.1.9 *Plasticity Index*—Test Method D 4318.

11.1.10 *Percentage of Coated Particles*—Test Method D 2489.

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Standard Practice for Classifying Hot-Mix Recycling Agents[1]

This standard is issued under the fixed designation D 4552; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers a standardized method whereby petroleum product additives to be used in hot recycling of asphalt concrete can be identified. The products are classified by viscosity in centistokes measured at 140°F (60°C). This practice does not apply to emulsified materials.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 70 Test Method for Specific Gravity and Density of Semi-Solid Bituminous Materials[2]

D 92 Test Method for Flash and Fire Points by Cleveland Open Cup[3]

D 140 Practice for Sampling Bituminous Materials[2]

D 946 Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction[2]

D 1298 Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method[3]

D 1754 Test Method for Effect of Heat and Air on Asphaltic Materials (Thin-Film Oven Test)[2]

D 2007 Test Method for Characteristic Groups in Rubber Extender and Processing Oils by the Clay Gel Adsorption Chromatographic Method[4]

D 2170 Test Method for Kinematic Viscosity of Asphalts (Bitumens)[2]

D 2171 Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer[2]

D 2872 Test Method for Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test)[2]

D 3381 Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction[2]

3. Significance and Use

3.1 Recycling of deteriorated asphalt pavements is being used with increasing frequency for its economy and benefit of conserving raw materials. The objective of recycling is to reuse the two ingredients of asphalt concrete-aggregate and asphalt and to restore the desired properties to the mixture. Recycling is carried out hot or cold, depending on the condition of the deteriorated pavement, construction procedure, availability of equipment, and cost. This practice is for classifying recycling agents to be used in hot recycling.

4. Classification

4.1 This practice describes recycling agents (RA) as belonging to one of the following six groups: RA 1, RA 5, RA 25, RA 75, RA 250, or RA 500, as shown in Table 1. The viscosity ranges are designed to avoid overlap and to provide sufficient flexibility to satisfy a wide range of mix proportions. Other properties specified include flash point (handling), weight percent of saturates (compatibility), selected properties of the RTF or TF oven residue (durability), and specific gravity.

4.2 The choice of RA grade will depend on the amount and hardness of the asphalt in the aged pavement. In general, the lower viscosity RA types can be used to restore aged asphalts of high viscosity and vice versa. Additionally, grades RA 1, RA 5, RA 25, and RA 75 will generally be most appropriate for hot-mix recycling of salvaged asphalt concrete when no more than 30 % virgin aggregate is added, while grades RA 250 and RA 500 will generally be most appropriate when more than 30 % virgin aggregate is incorporated into the mix.

5. Physical Properties

5.1 All recycling agents must be homogeneous, free-flowing at pumping temperature, and must conform to the requirements shown in Table 1.

5.2 The final acceptance of recycling agents meeting the requirements shown in Table 1 is subject to the compliance of the reconstituted asphalt blends with current asphalt specifications.

6. Sampling

6.1 All sampling shall be carried out in accordance with Practice D 140.

[1] This practice is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.37 on Modifier Agents for Binders in Bituminous Mixtures.

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[2] *Annual Book of ASTM Standards*, Vol 04.03.

[3] *Annual Book of ASTM Standards*, Vol 05.01.

[4] *Annual Book of ASTM Standards*, Vol 05.02.

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TABLE 1 Physical Properties of Hot-Mix Recycling Agents

NOTE—Compliance requires the asphalt be extracted from the pavement to be recycled and combined with the recycling agent being tested. This combination should be in accordance with ratio of recycling agent to recovered asphalt used in the mix. The resulting mixture must meet all specifications for the appropriate grade within Specification D 946 or Table 1, 2 or 3 of Specification D 3381.

Test	ASTM Test Method	RA 1		RA 5		RA 25		RA 75		RA 250		RA 500	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity • 140°F, cSt	D 2170 or D 2171	50	175	176	900	901	4500	4501	12500	12501	37500	37501	60000
Flash Point,COC,F	D 92	425	...	425	...	425	...	425	...	425	...	425	...
Saturates,wt,%	D 2007	...	30	...	30	...	30	...	30	...	30	...	30
Tests on Residue from RTFO or TFO oven 325°F	D 2872 or D 1754												
Viscosity Ratio[A]	•	...	3	...	3	...	3	...	3	...	3	...	3
Wt Change,±,%	•	...	4	...	4	...	3	...	3	...	3	...	3
Specific Gravity	D 70 or D 1298	Report		Report		Report		Report		Report		Report	

[A] Viscosity Ratio = $\frac{\text{Viscosity of Residue from RTFO or TFO Oven Test • 140°F,cST}}{\text{Original Viscosity • 140°F,cSt}}$

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POTENTIAL REUSE OF PETROLEUM-CONTAMINATED SOIL: A DIRECTORY OF PERMITTED RECYCLING FACILITIES

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural resources to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for planning, implementing, and managing research, development, and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

The health impacts associated with uncontrolled releases of petroleum hydrocarbons from underground storage tanks present an area of major concern. The responsible parties, whether large corporations or small businessmen must find an appropriate means of remediating any soil contaminated by such releases. This document will assist them in finding solutions that will not only clean the soil contaminated by such tanks, but also reuse it in an environmentally safe method. It identifies facilities that have, at this date, been approved in the United States as recyclers of petroleum-contaminated soil.

E. Timothy Oppelt, Director
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ABSTRACT

Soil contaminated by virgin petroleum products leaking from underground storage tanks is a pervasive problem in the United States. Economically feasible disposal of such soil concerns the responsible party (RP), whether the RP is one individual small businessman, a group of owners, or a large multinational corporation. They may need a starting point in their search for an appropriate solution, such as recycling.

This report provides initial assistance in two important sections: a clear discussion of the potential recycling technologies and a user-friendly, quick-reference table listing the names and locations of recycling companies in each state that allows such services, supplemented by a detailed directory of specific contacts for further information.

Four types of technologies manufacture marketable products from recycled petroleum-contaminated soil: hot asphalt processes, cold mix asphalt systems, brick (vitrification) techniques, and cement-production.

Table 3, which forms the core of this report, lists recycling facilities alphabetically by location within each state, organized by U.S. Environmental Protection Agency (EPA) Region. The facilities shown have each reported that they are operating either under a permit or another required vehicle of formal state approval, at the time of the survey (Status: A); that they have temporarily ceased previously approved operations (Status: I); or that they are in the final stages of the permit/approval cycle and expect to shortly begin operations (Status: P).

Table 4 is an alphabetical directory of these companies, providing detailed address, recycling location, telephone number, and contact for the RP who may wish to gather even more specific information.

The scope of the survey project and report concern only fixed facilities or small mobile facility owners that recycle soil contaminated by virgin petroleum products into marketable commodities. This project does not address site-specific remediation facilities. Other EPA documents address such recycling for commercial hazardous waste facilities [1,2].

This report was submitted in fulfillment of Contract Number 68-C9-0033 by Foster Wheeler Enviresponse, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers a period from 1990 to 1991, and work was completed as of February, 1992.

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ABBREVIATIONS AND SYMBOLS

A	Active (recycling facility)
ASTM	American Society for Testing and Materials
BTEX	Benzene, toluene, ethyl benzene, xylene (combined analysis)
COLIS	Computerized On-Line Information System
D	Diesel
dia	Diameter
EPA	U.S. Environmental Protection Agency
G	Gasoline
I	Inactive (recycling facility)
K	Kerosene
lb	Pound (weight)
LUST	Leaking underground storage tank
NA	Not available
P	Permitting (application being processed for the recycling facility)
RP	Responsible Party
RCRA	Resource Conservation and Recovery Act
t/d	Tons per day
t/h	Tons per hour
t/m	Tons per month
t/yr	Tons per year
TCLP	Toxicity characteristic leaching procedure
TPH	Total petroleum hydrocarbons
TSDs	Transportation/storage/disposal facilities (for hazardous waste)
VOC	Volatile organic compounds
UST	Underground storage tank
$/t	Dollars per ton
#2	Number 2 fuel oil
#4	Number 4 fuel oil
#6	Number 6 fuel oil
ADEM	Alabama Department of Environmental Management
DE DNR	Delaware Department of Natural Resources
FL DER	Florida Department of Environmental Regulation
KS DH&E	Kansas Department of Health & Environment
MA DEP	Massachusetts Department of Environmental Protection
ME DEP	Maine Department of Environmental Protection
MDE	Maryland Department of the Environment
MPCA	Minnesota Pollution Control Agency
NC DEM, AQP	North Carolina Division of Environmental Management, Air Quality Permitting
NH ARD	New Hampshire Air Resources Division
NJ DEP	New Jersey Department of Environmental Protection
NY DEC	New York Department of Environmental Conservation

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PA DER	Pennsylvania Department of Environmental Resources
RI DEM	Rhode Island Department of Environmental Management
SC GW Div.	South Carolina Ground Water Division
VA DAPC	Virginia Division of Air Pollution Control
WA DE	State of Washington, Department of Ecology
WI DNR	Wisconsin Department of Natural Resources

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Stage I of this project report was conducted by Chapman, Inc. for Foster Wheeler Enviresponse, Inc., which then conducted Stage II. This work proceeded under the supervision and guidance of Anthony N. Tafuri, Chief of the RCB Releases Technology Section and Chien T. Chen, Technical Project Monitor for the Work Assignment No. 0-R032 under EPA Contract No. 68-C9-0033.

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SECTION 1
INTRODUCTION

THE PROBLEM OF PETROLEUM-CONTAMINATED SOIL

Soil contaminated by virgin petroleum products leaking from underground storage tanks is a pervasive problem in the United States. Economically feasible disposal of such soil concerns the responsible party (RP), whether the RP is an individual small businessman, a group of owners, or a large multinational corporation. Disposal of such soil is costly, both in terms of money and landfill resources.

Federal legislation makes the generator responsible for soil contaminated by chemical materials, even if the contaminants are virgin products rather than processed waste [40 CFR 261.3(a)(92)]. In the case of a large corporate site, the responsible party may need a starting point for a competent technical team that can explore the appropriate remedies and implement them. At the other extreme, however, for a small businessman, finding an economically feasible remedy may be more difficult. A typical example is the gasoline station owner who has arranged to have an old tank removed/replaced, but is left with a substantial pile of contaminated soil, which has been excavated and covered by a tarpaulin pending cleanup.

Regardless of cleanup volume, the RP should investigate environmentally and financially advantageous recycling options. This report will provide initial assistance in finding an environmentally responsible solution. It contains two key resources: a clear discussion of the potential recycling technologies (Section 2) and a user-friendly, quick-reference table listing the names and locations of recycling companies in each state that allows such services, supplemented by a detailed directory of specific contacts for further information (Section 3).

LEVELS OF REGULATION

Public Law 98:616 (the reauthorization of the Resource Conservation Recovery Act, called RCRA, published in 1984) mandates the development and implementation of an extensive regulatory plan for underground storage tanks (USTs) The U.S. Environmental Protection Agency (EPA) must promulgate the agency regulations that protect human health and the environment. Therefore, EPA must define long-term corrective actions for the treatment of petroleum-contaminated soils at UST sites regulated under RCRA Subtitle I.

Under the federal Resource Conservation and Recovery Act (RCRA), soil contaminated by virgin petroleum product is not considered a hazardous waste. However, the individual states -- and even individual communities -- have the right to legislate standards that are more restrictive than federal statutes. Such regulations, peculiar to a particular state or community, can -- and do -- change rapidly. Past trends indicate that the future may bring even more restrictive statutes on a state-by-state basis, or even on the federal level [42 USC 6901 et seq., RCRA Section 3006(a)]. Therefore, the persons or companies

responsible for the disposal or recycling of petroleum-contaminated soil must periodically familiarize themselves with any applicable legislation, and any changes to such legislation, on the national, state, county, and municipal level.

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Due to differing statutes and random changes, the concept of a permitted facility cannot be uniform. For the purposes of this report, "permitted" will mean that the facility operates with formal governmental authorization. This may take the form of an air permit, a RCRA permit, certification, or some other vehicle from the appropriate governing body which formally authorizes the facility's operation. In some cases the permitting is required for the manufacturing process, regardless of whether petroleum-contaminated soil is part of the raw material.

This report summarizes information on fixed recycling facilities that are authorized to accept soils contaminated by virgin petroleum products. It does not address facilities that handle hazardous wastes. Similar documents address recycling at commercial hazardous waste facilities [1,2]. Since most states consider petroleum-contaminated soil only a solid waste, these recycling facilities neither require RCRA Part B permitting nor listing in RCRA data bases as TSDs.

SURVEY METHODOLOGY AND REPORT PREPARATION

The project survey contacted authorities and private companies in each state to identify its facilities for recycling petroleum-contaminated soil into a marketable product (e.g., asphalt, bricks, and cement). It progressed in two stages: Stage I, during 1991, established initial parameters and contacts; Stage II refined the scope of the survey, supplemented the listings, and reviewed some of the earlier information.

Stage I

This stage contained four segments:

1. A brief review of some extant listings of treatment facilities, including the EPA COLIS LUST Corrective Action Case Histories Data Base, to determine whether they address the survey requirement,

2. Telephone interviews of selected permit personnel in EPA regional offices to identify region-specific facilities and knowledgeable state contacts,

3. Requests to each state UST and LUST office for information on facilities,

4. A telephone survey of recycling operators to gather basic information about their operations.

The first two segments provided limited information and verified the need for the project. Even sources such as the Asphalt Recycling and Reclaiming Association and the EPA Regional Offices did not have a specific list of facilities that are permitted to recycle petroleum-contaminated soil.

The third segment provided additional information from the following offices and the contacts they provided: state UST Program offices, Air Quality Management Branch, Solid Waste Management Branch, and regional or county counterparts to state offices.

The fourth segment provided the first draft of Table 3, which forms the core of this document.

[Note: Information provided by the permitted facilities was not verified by site inspection, copy

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of permit, or performance testing. Any reader planning to let contracts for future work must require proof of permit/approval.]

Information from the Stage I survey provided sufficient material for a first draft of the report and its core table. A review of this draft revealed that, while it contained valuable information, it required revision to become a user-friendly document. It also identified needs for a refined definition of recycling facilities and a more comprehensive listing.

The concept of a marketable product (e.g., asphalt, brick, or cement) received added attention because it lowers the recycling cost and increases the environmental value of the selection. Also, the targeted application (i.e., universal assistance to RPs with widely varying volumes of contaminated soil) eliminated the relevance of site-specific remediation facilities. To clarify the scope of the report, the governing definition of "recycling" in the report was limited to the reuse of petroleum-contaminated soil for another purpose. Therefore, it also precluded the listing of on-site "treat and dispose" operations.

Stage II

The Stage II plan evolved from the Stage I review and ensuing discussions. It outlined the preparation of the revised report and the continuation of the survey in 5 areas:

1. A more streamlined table, divided not only by EPA Region, but also by state, would pinpoint for ready access the primary user's first concerns: location and identity. It would then tabulate the capacity, cost, product, and contaminant issues that would help the RP make a "first cut" of potential resources. This streamlined format would also provide a better overview for a researcher seeking a general understanding of recycling opportunities.

2. A detailed directory would follow the table, enabling the user to easily find all the necessary information for follow-up inquiries after initial identification.

3. These better-defined needs would in turn determine the form of a new telephone survey form to elicit information from recyclers. (See Table 1.) This form would be further adapted to fashion the more streamlined table (Table 3).

4. Additional telephone surveying would verify and supplement the original information due to the volatility of the regulatory scene and the rapid emergence of new recyclers.

5. A more thorough discussion of the four targeted products, supplemented with additional illustrations would aid the RP in better understanding the potential of recycling technologies.

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TABLE 1. TELEPHONE SURVEY FORM

Recycling Facilities											Acceptable Contaminants						
State	Company	Recycling Location	Status	Capacity t/d	Cost $/t	Hot Asphalt	Cold Asphalt	Cement	Aggregate	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments

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SECTION 2
RECYCLING TECHNOLOGIES

TECHNOLOGIES ADDRESSED IN THIS REPORT

Under the scope of this report, four technologies recycle petroleum-contaminated soil into marketable products: hot mix asphalt processes, cold mix asphalt systems, cement-production, and brick manufacturing techniques.

Asphalt is a bituminous material which occurs naturally or derives from the separation of petroleum fractions. It is categorized as asphalt cement or liquid asphalt. Asphalt contains aliphatic, mononuclear aromatic, and polynuclear aromatic hydrocarbons. Asphalt cement is the heaviest fraction. Liquid asphalts are lighter fractions, which are graded by viscosity. Liquid asphalts may also be produced by dissolving asphalt cements in solvent or emulsifying asphalt cements in water [10]. There are two groups of asphalt-producing technologies: hot and cold mix processes.

- Hot mix asphalt processes use asphalt cement and can incorporate petroleum-contaminated soils. Aggregate, also marketable, is an intermediate product in this process. It consists of crushed stone, crushed slag, crushed gravel or sand (natural or manufactured) that conforms to the quality and crushed particle requirements of the appropriate ASTM specifications.

- Cold mix asphalt processes use liquid asphalts and can incorporate petroleum-contaminated soil. Cold mix plants blend liquid asphalts with aggregate to produce patching material or a lower grade pavement which may be suitable for light duty use.

Unlike asphalt, cement and brick products consist of non-bituminous materials that include clay, shale, and other ingredients, based on their respective product specifications and manufacturing processes.

- Hydraulic cement is the basic binding agent in concrete and masonry construction. Portland cement accounts for approximately 95% of the total hydraulic cement production. It is a finely ground mixture of calcium aluminates and silicates, capable of setting and hardening by chemical reaction with water [25].

- Brick manufacturing processes blend clay and shale into plasticized mixtures, which are then extruded and molded into green bricks, which are later fired. A typical ASTM-defined-brick is a ceramic product. It is a solid masonry unit of clay or shale, usually formed into a rectangular prism (while plastic) and burned or fired in a kiln [22].

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HOT-MIX ASPHALT PLANTS

The hot mix process employs both mixing and heating to make the pavement material. It blends and dries mineral aggregates like sand, gravel, and crushed stone (with a diameter as large as 3/4-in), heating them to 300-350°F. Mixing hot asphalt (5-10% by weight) with the hot aggregate produces paving material.

A hot mix temperature of 300-350°F does not destroy the hydrocarbons vaporizing from the soil. Secondary combustion chambers have modified the process in some hot asphalt plants used for recycling. The recycling of petroleum-contaminated soil takes place in the aggregate preparation process. Exhaust treatment by cloth filters (baghouses) provide a means of controlling particulate emissions. Two plants report high-temperature destruction prior to either a baghouse or a secondary combustion chamber.

Theory

A dryer heats the petroleum-contaminated soil and aggregate prior to mixture with the asphalt. Volatilization and low temperature thermal destruction of the organic compounds occur in the dryer [12]. The process incorporates the remaining heavy-hydrocarbon contaminants into the asphalt/aggregate mix, which may then be utilized for construction purposes such as road building.

Equipment

A typical batch mixing process requires the storage of aggregate material, held in cold bins. An additional cold bin holds the petroleum-contaminated soil. Metered amounts of contaminated soil and aggregate travel by cold elevator to the dryer, where the temperature can range from 500 to 800°F. When the aggregate mix is heated in the dryer for a period up to five minutes, the lighter organic contaminants volatilize. A dust collector and exhaust treatment system, such as a baghouse, treats the gases from the dryer [9].

The mixture leaves the dryer at a temperature of approximately 300°F. A hot elevator conveys it to a screening unit for size separation and subsequent storage in hot bins according to aggregate size . The process formula specifies a measured amount of each size fraction which is weighed and then dropped into the mixing unit containing hot asphalt. After mixing, the process carries the aspbalt to heated storage containers or to trucks for immediate use [5,9].

Product

A typical hot asphalt mix contains the following components[11]:

- 50% coarse aggregate or gravel (size range from 1.5" to U.S. Sieve #4)
- 40% fine aggregate or sand (size range from <U.S. Sieve #4 to >U.S. Sieve #200)
- 5% mineral fill, such as crushed stone dust or lime (size <U.S. Sieve #200)

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o 5% asphalt cement

Asphalt cements used in the hot mix technology typically contain high concentrations of aromatics (both mononuclear and polynuclear rings), nitrogen, sulfur, oxygen, and trace amounts of metals or organo-metallic compounds.

The hot asphalt mix is used in paving roads. To maintain product quality, the recycler adds only a small percentage of petroleum-contaminated soil to the aggregate feed. This also minimizes air emissions resulting from volatilization of organics in the dryer. Asphalt plants limit the clay and silt content in soil feed to 15-20%. However, some plants produce road bedding aggregate and daily landfill cover in addition to asphalt. In addition, the aggregate formed during hot mix asphalt production (described above) is also a marketable product. Some companies produce this intermediate product and, rather than making asphalt, sell it to other enterprises that use it for road base or an asphalt component. Some prepare the recycled aggregate in one location and ship it to another (asphalt-producing) facility.

Application

The feasibility of using asphalt incorporation as a recycling technology depends on the physical and chemical characteristics of the contaminated soil. The soil must be free from large rocks, wood, and debris. Since the strength and durability of the asphalt mix depend on the aggregate size, type, and volume, soil particle size may also influence the application. The contaminated soil particle size must be compatible with the asphalt mix requirements. This usually limits the fine material to a small percentage (normally 2-10%) of the mixture. Weather can potentially limit this application; most asphalt plants do not operate during cold weather.

The lighter contaminant fractions -- fuel oil, kerosene, or gasoline -- that are not burned off in the dryer can act as solvents, softening the final asphalt mix and affecting curing time. The heavier fractions, which are chemically similar to asphalt, will not damage the product.

The cost to retrofit an asphalt batch plant for the incorporation of petroleum-contaminated soil would range from $10,000 to $100,000. The capital costs cover soil storage, feed, conveying, and metering systems. These costs would be offset by the fees paid by RPs.

The average cost of asphalt incorporation has been estimated at $80/yd^3 of soil (Kostecki et al. 1989) exclusive of excavation and transportation costs. Operators contacted in the survey quoted a range of costs from $ 40 to $ 100 per ton, excluding transportation and storage.

Data from tests on asphalt plant and modified asphalt plant efficiency in recycling soil are limited. One study shows increases in hydrocarbon emissions for a feed mixture of clean aggregate and contaminated soil [3]. This particular approach is not recommended since the petroleum volatilizes and leaves the system prior to combustion. (See Figure 1.) Volatile emissions rose from 20 lb/hr to 64 and 67 lb/hr for mixtures of soil contaminated by diesel fuel and gasoline, respectively.

COLD MIX ASPHALT PLANTS

Cold mix plants blend liquid asphalt with aggregate in small open pugmills or revolving drums. It is normally compacted and spread at the job-site where the mixture is at or near ambient temperature. The cold mix asphalt process produces a lower grade pavement which may be suitable for light duty use.

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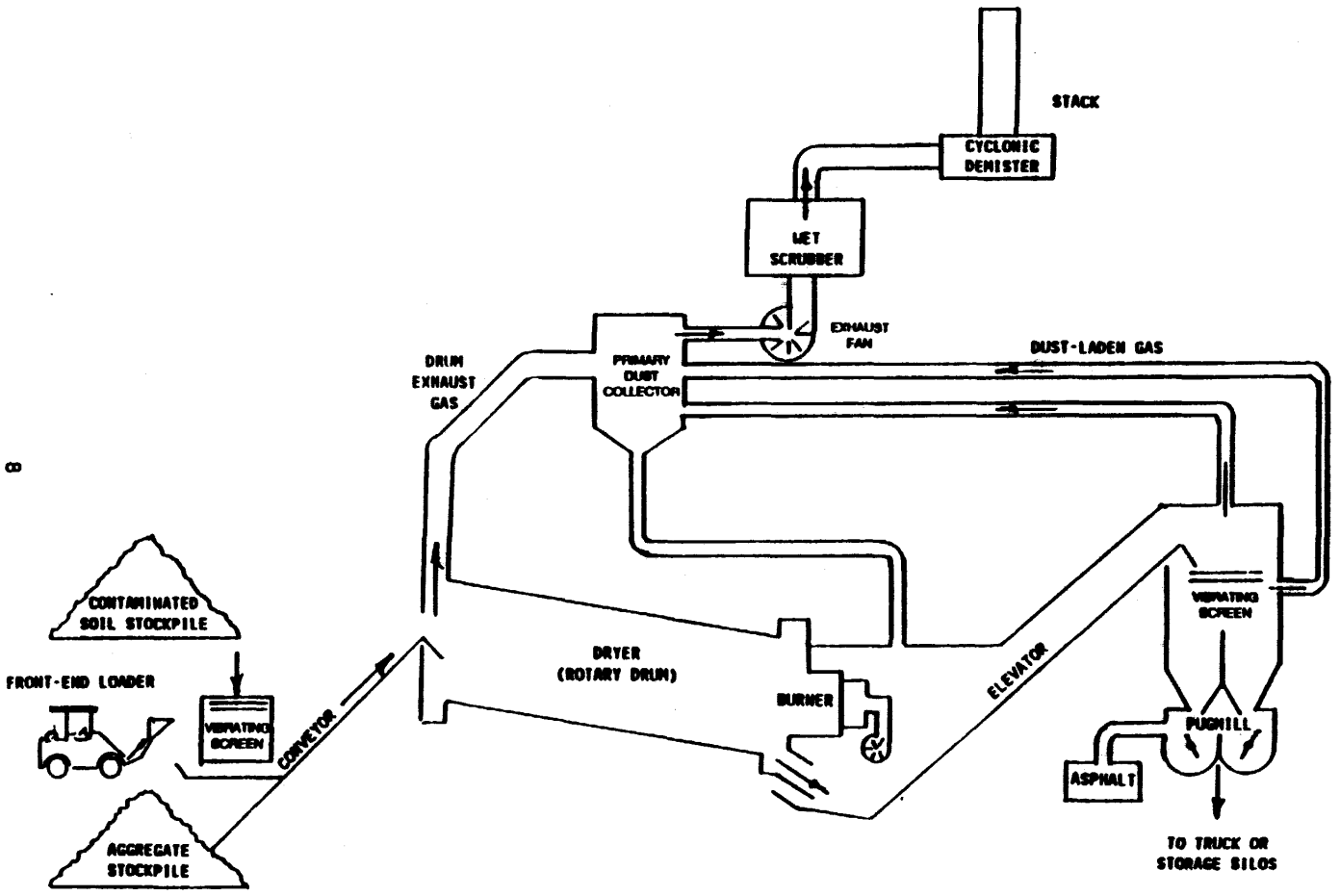

Figure 1. Batch hot-mix asphalt plant.

SOURCE: EPA 1986

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Theory

The cold process mixes aggregate and liquid asphalt to form the paving material. It uses surfactant to emulsify asphalt cement in water. Anionic, cationic, and nonpolar asphalt emulsions are available. These materials may contain polynuclear aromatic hydrocarbons, depending on the grade of asphalt cement from which they are derived. The resulting emulsions are relatively nonvolatile [10]. The asphalt particles are suspended in the liquid and separated from each other (and the aggregate) by a film of water. During paving, pressure expels the film of water, bringing the asphalt particles together in contact with the aggregate [9]. (See Figure 2.)

Equipment

The equipment used in the cold process varies from a small open pugmill or revolving drum to a complete plant. The pugmill or drum blends the aggregate, the petroleum-contaminated soil, and the asphalt emulsion. The selected asphalt viscosity controls the viscosity of the asphalt mix, its curing time, and its application.

Product

Asphalt from the cold process is suitable for jobs where a considerable interval of time may elapse between its manufacture and use. The selection of the proper liquid asphalt can adjust the curing time. Therefore, these mixtures can be effective for patching and spreading over small areas. They also provide the surface course of pavements carrying medium or low volume of traffic.

In addition, the aggregate formed during asphalt production (as described in the preceding pages) is also a marketable product. Some companies produce this intermediate product and, rather than making asphalt, sell it to other enterprises that use it for road base or an asphalt component.

Preliminary tests have been conducted on the environmental effects of asphalt paving [26]. These tests confirmed that the petroleum contamination in the soil is combined with the asphalt in the emulsion to produce a mixture that will not separate. The researcher concluded that the incorporation of soils contaminated with petroleum products as aggregate in a cold-mix-emulsion bituminous paving is an environmentally benign method of recycling the contaminated soil.

Application

The cold process is an application suited to the heavier petroleum-contaminated soils, such as those containing Numbers 2 to 6 fuel oil and most lubricating oils. The heavier fractions, chemically similar in nature to asphalt, do not damage the asphalt mix [14]. Soils contaminated with lighter petroleum products, such as kerosene and gasoline, can emit hydrocarbon vapors when they are mixed with asphalt and applied in hot ambient conditions. They have limited application for winter-service cold patch.

The liquid asphalt binder works best when the aggregate has been wetted with asphalt. If a particle has been coated with water or a clay film prior to mixing, the asphalt may not adhere to it. As a result, this technology has limited application for treating petroleum-contaminated soils with high clay fractions and with a high capacity for water retention [10].

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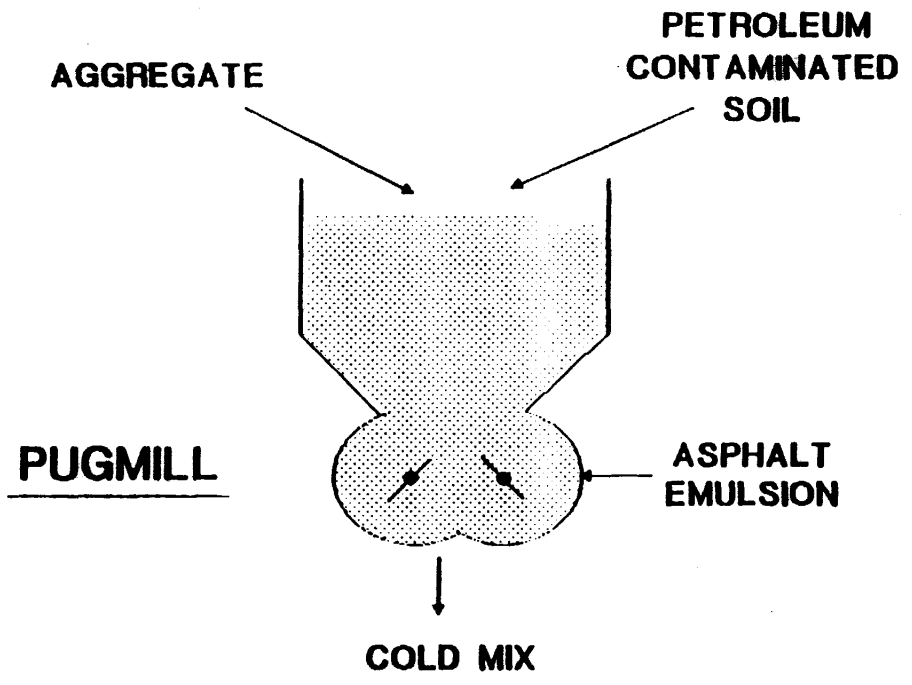

Figure 2. Cold mix asphalt process.

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CEMENT MANUFACTURING FACILITIES

Hydraulic cement is the basic binding agent in concrete and masonry construction. Approximately 95% of the cement produced in the United States is Portland cement -- a product of high temperature burning of calcareous material (e.g., limestone, oyster shells), argillaceous material (e.g., clay), and siliceous material (e.g., sand, shale) to produce clinker. Portland cement consists of pulverized clinker blended with water and/or untreated calcium sulfate (gypsum).

Theory

The cement manufacturing process employs raw materials such as limestone, clay, and sand which are usually fed to a rotary kiln. The raw materials enter the raised end of the kiln and travel down the incline to the lower end, which is heated by coal, oil, or gas. Petroleum-contaminated soils may enter the process as part of the raw material or drop into the hot part of the kiln. As the raw materials move through the inclined, rotating kiln, they heat to extremely high temperatures -- up to 2,700°F. These temperatures cause physical and chemical reactions such as evaporation of free water, evolution of combined water, evolution of carbon dioxide from carbonates, and combination of lime with silica, alumina, and iron to form the desired compounds in the clinker. The petroleum-contaminated soil also breaks apart chemically. At extremely high temperatures, the organic compounds burn, producing heat, carbon dioxide, and water vapor. The inorganic components recombine with the raw materials and are incorporated with the clinker. The clinker leaves the kiln in golf-ball-sized lumps. The rapidly cooled clinker, mixed with gypsum and ground to a fine powder, produces Portland cement. (See Figure 3.)

Equipment

There are three major types of cement-manufacturing processes: the wet process, the dry process, and the dry process with preheating and/or precalcining.

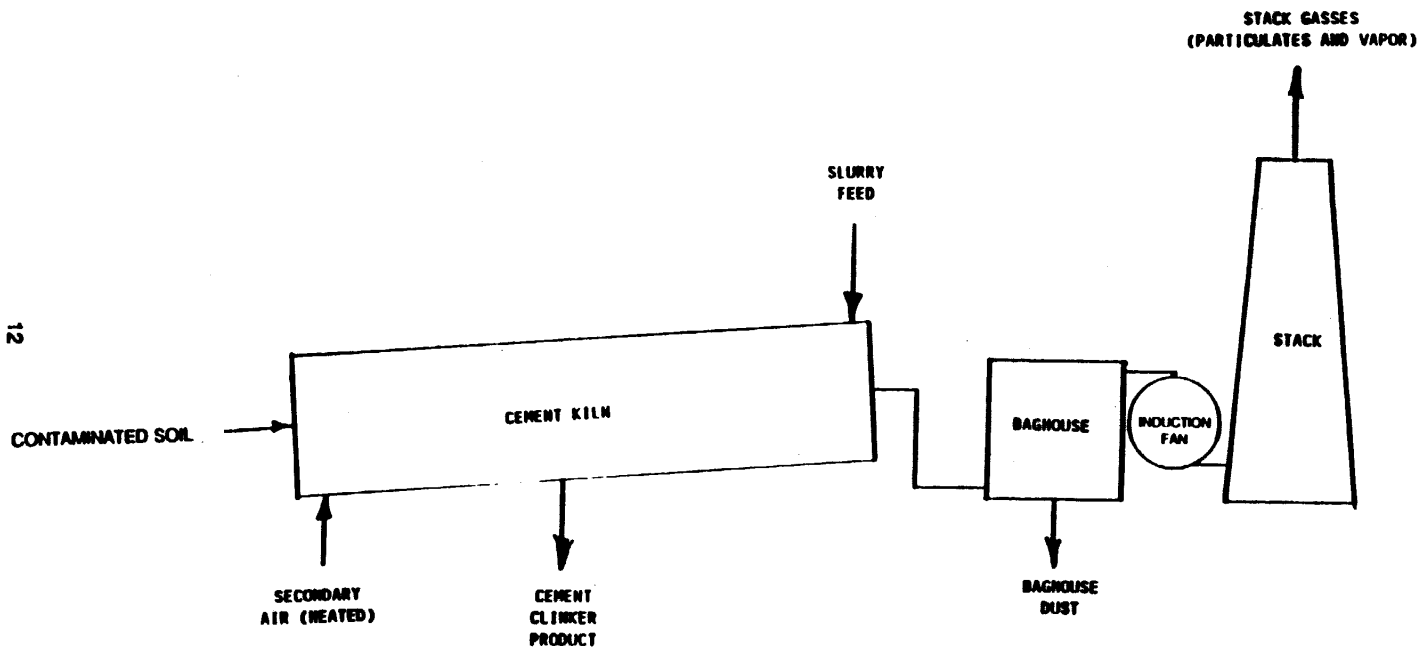
In the wet process, finely ground raw materials, mixed with water, form a slurry feed containing 30 to 40% moisture.

The dry process uses raw materials that are typically quarried and crushed to an approximately 5-in diameter. The materials travel through direct-contact rotary driers to a rotating raw mill where they are ground to approximately 200-mesh. In the preheater, this dry powder passes through a series of heat exchangers before it enters the kiln. The precalcining system uses a secondary firing process within the preheater to increase thermal preparation of the feed.

In each process, the ground and blended raw materials travel through a rotary kiln. The kiln is a large, inclined, rotating cylindrical furnace from 10 to 20 ft in diameter and from 350 to 760 ft long. Raw materials enter the raised end of the kiln and travel down the incline to the other end, which is heated by burning fuel. The retention time in the kiln spans roughly 1 to 4 hours; the temperature at the hot end ranges from 2,500 to 3,500°F.

The kiln produces dark, hard nodules called clinker. The temperature of these 3/4-inch (or smaller) nodules is reduced by air in a clinker cooler. The air from the clinker cooler, along with combustion gases and water vapor, rises through the high (cool) end of the kiln to a dust collection system and out the stack.

An open or closed circuit mill grinds the clinker, adding about 3 to 6% gypsum (calcium sulfate) to retard the cement's setting time. Other additives may include air-entraining, dispersing, and waterproofing



SOURCE: EPA 1986

Figure 3. A basic cement kiln process.

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agents. The final product measures about 10 microns in diameter.

The dry process system may use a suspension preheater upstream of the kiln. The preheater consists of a series of cyclones connected by pipes, through which gases from the kiln pass upward and counter-current to the dry raw material flowing down and around the cyclones. Suspension preheaters transfer the heat from the gas into the raw material feed dust. This leads to roughly 40% calcination of the feed before it enters the kiln. Some new preheater systems use a small direct-fired furnace located between the air suspension preheater and the kiln. This system can calcinate roughly 90% of the raw materials. Such systems can reduce the size of the rotary kiln required or increase the production capacity of an existing kiln.

Product

According to ASTM Specification C150-89, Portland cement is:

> A hydraulic cement produced by pulverizing clinker consisting essentially of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulfate as an interground addition.

The five basic types of Portland cement vary according to their strength and hardening time; they comprise the basic binding agents used in concrete and masonry construction.

Industrial process rotary kilns, which are located throughout the United States, manufacture cement and lime. Based on survey results, the petroleum-contaminated soil treated in these kilns can be used for daily cover in landfills. (See Figure 3.)

Application

Cement kilns can recycle petroleum-contaminated soil as solid material in various ways. Solid material suspended in liquids can be pumped into the hot end of the kiln. In another process, the solids are repackaged and injected into the kiln area where gas temperatures range from 1,800 to 2,150°F. In a third process, preprocessed solids and sludges are dried, ground into powder, and conveyed by air into the hot end of the kiln. Cement manufacturers have a wide choice of raw materials. Lime, silica, and alumina are the most important ingredients. Any materials that will supply these components can be used in cement manufacture, provided that they do not contain excessive amounts of other oxides [25].

The contaminated soils must be characterized and then blended to meet process specifications covering organic makeup, energy value, and compatibility with cement-making. Cement costs vary according to the types of soil and contaminants; producers reported costs from $30 to $100 per ton, exclusive of transportation and storage.

BRICK MANUFACTURING PLANTS

The brick manufacturing process blends clay and shale into a plasticized mixture, which is then extruded and molded into green brick. It dries and fires the green brick in a kiln where temperatures reach approximately 2,000°F during a three-day residence period.

Theory

The brick-making process blends the petroleum-contaminated soil with the clay and shale. It molds

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this raw material into a green brick. Once the green brick is dried and preheated, the kiln fires it at 1,700 to 2,000°F for approximately 12 hours. The temperature and residence time in the kiln destroy the organics, incorporating the inorganics in the vitrified brick product. (See Figure 4.)

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Equipment

The blending of mined clay and shale with contaminated soil occurs in large stockpiles. Grinders reduce this raw material to particles of an acceptable size for brick formation. The raw material, mixed with water in a pugmill, increases in plasticity. The pugmill extrudes a continuous ribbon of clay which is cut into green bricks. These bricks are stacked on rail cars that travel through a tunnel kiln. The green bricks first dry out at a temperature of 600°F. The next temperature stage (1,200 to 1,600°F) preheats them. At the peak temperature of 1,700 to 2,000°F, the kiln fires them for a period of 12 hours. The kiln travel time is approximately 2-1/2 days. After cooling, the bricks are ready for shipment.

Product

In order to provide the strength and durability requirements of a brick product, the manufacturing process must develop a fired bond between the particulate constituents. These requirements will vary, depending on the intended product use and the applicable ASTM specification. The study identified brick-manufacturing facilities in Virginia, North Carolina, and South Carolina. One brick manufacturer has five facilities in North Carolina that recycle petroleum-contaminated soil.

Application

The brick manufacturing process can recycle various petroleum-contaminated soil fractions including silts, sands, loams, and clays. This process can reuse highly plastic clays that are difficult to treat with other methods. Sand reduces firing shrink and improves moisture absorption from mortar (important during brick laying). Some shales and sedimentary rock are also appropriate feedstock. Soils that contain large quantities of debris, concrete, stone, or asphalt require prescreening.

The cost to the RP of sending petroleum-contaminated soil to a brick-manufacturing recycler depends on the contamination level, the blendability of the soil, and the debris content. Cost estimates range from $30 to $45 per ton, exclusive of transportation and storage.

OTHER TECHNOLOGIES

This report contains a summary of information on certain types of facilities that are permitted, where permits are required, to accept soils contaminated by virgin petroleum products. It concerns only fixed facilities or small mobile facility owners that recycle soil contaminated by virgin petroleum products into marketable commodities. There are other technologies that can treat petroleum-contaminated soil at large sites and dispose of the cleaned soil in the areas from which it was excavated or in an on-site landfill. Technologies such as low temperature thermal desorption, incineration, extraction, and bioremediation are the subjects of intensive reports for the RP seeking a large-scale remediation of a site. EPA's Center for Research Information at the Risk Reduction Engineering Laboratory in Cincinnati can provide further information on such documents and lists them in the *Office of Research and Development (ORD) Publications Announcement Quarterly*.

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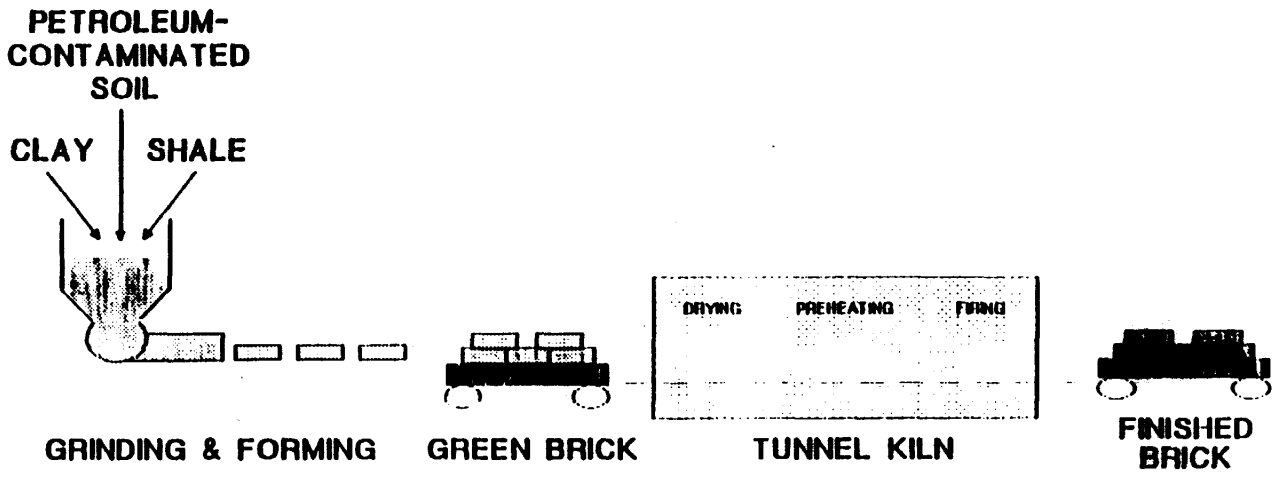

Figure 4. The brick manufacturing process.

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SECTION 3
A DIRECTORY OF PERMITTED RECYCLING FACILITIES

USING THE TABLE AND DIRECTORY

Table 3 lists permitted, or otherwise formally state-approved, recycling facilities. It is organized by U.S. EPA Region. (See Table 2 for a list of states in each region.) Within the region, it lists facilities alphabetically by location within each state.

The facilities shown have each reported that they are operating either under a permit or another required vehicle of formal state approval, at the time of the survey (Status: A); that they have temporarily ceased previously approved operations (Status: I); or that they are in the final stages of the permit/approval cycle and expect to shortly begin operations (Status: P).

Once an RP has selected potential recycling locations from Table 3, they can find all the details necessary to obtain further information in Table 4 -- the Directory of Recycling Facilities. This Directory provides specific address, recycling location, telephone number, and contact for the RP who may wish to follow up with individual queries.

Each facility has its own analytical requirements.. Because these requirements (total hydrocarb flashpoint, pH, etc.) respond to the local state regulations as well as an individual permit, they are subject to change. During the follow-up query, the RP should request a written list of requirements that apply at that time from the selected facility.

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TABLE 2. U.S. EPA REGIONS

Region	State code	State name	Region	State code	State name
1	CT	Connecticut	6	AR	Arkansas
1	ME	Maine	6	LA	Louisiana
1	MA	Massachusetts	6	NM	New Mexico
1	NH	New Hampshire	6	OK	Oklahoma
1	RI	Rhode Island	6	TX	Texas
1	VT	Vermont	7	IA	Iowa
2	NJ	New Jersey	7	KS	Kansas
2	NY	New York	7	MI	Missouri
3	DE	Delaware	7	NE	Nebraska
3	DC	District of Columbia	8	CO	Colorado
3	MD	Maryland	8	MT	Montana
3	PA	Pennsylvania	8	ND	North Dakota
3	VA	Virginia	8	SD	South Dakota
3	WV	West Virginia	8	UT	Utah
4	AL	Alabama	8	WY	Wyoming
4	FL	Florida	9	AZ	Arizona
4	GA	Georgia	9	CA	California
4	KY	Kentucky	9	HI	Hawaii
4	MS	Mississippi	9	NV	Nevada
4	NC	North Carolina	10	AK	Alaska
4	SC	South Carolina	10	ID	Idaho
4	TN	Tennessee	10	OR	Oregon
5	IL	Illinois	10	WA	Washington
5	IN	Indiana			
5	MI	Michigan			
5	MN	Minnesota			
5	OH	Ohio			
5	WI	Wisconsin			

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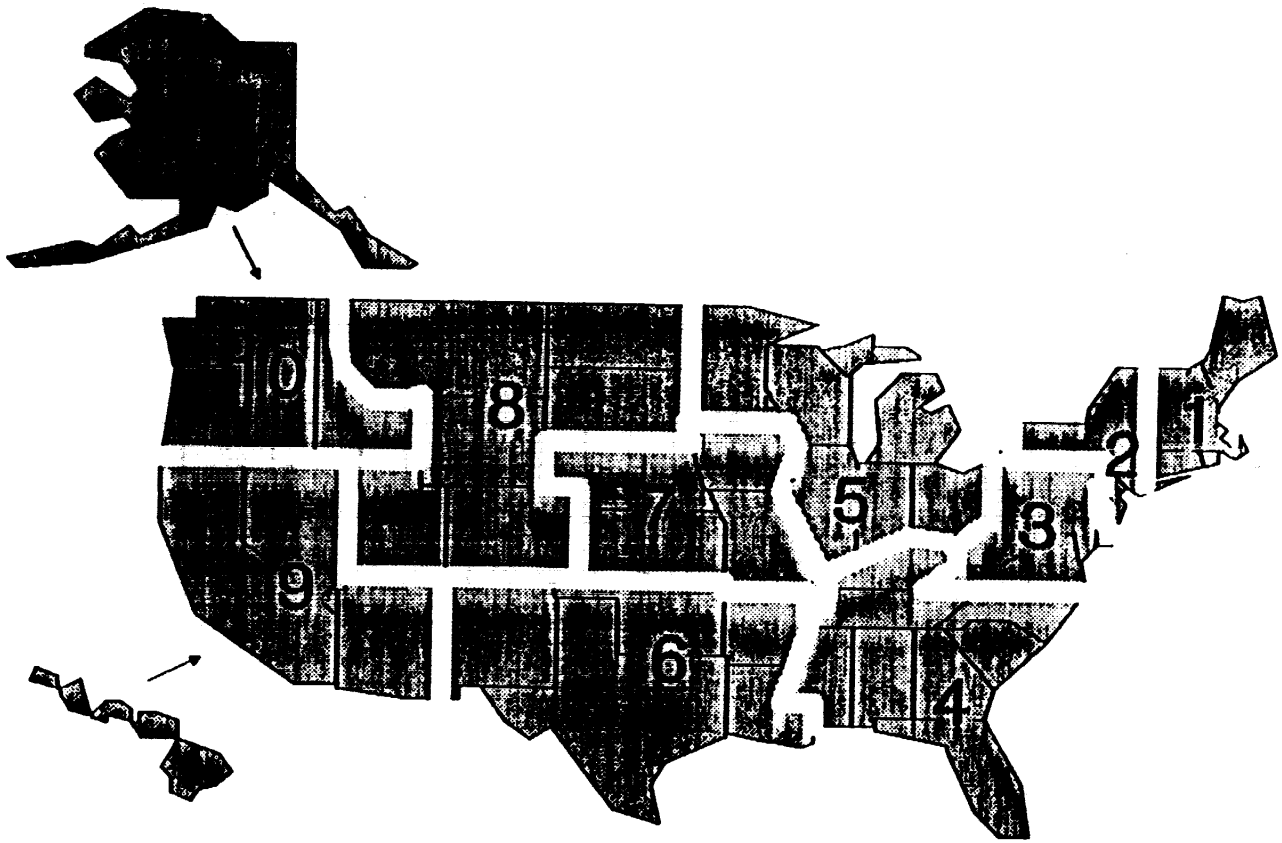

Figure 5. U.S. EPA Regions

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 1

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
ME	Brunswick	Harry Crooker & Sons, Inc.	I	N/A	N/A	X					X	X	X	X	X	X	No clays or fines	ME DEP
ME	Fairfield	Tilcon Maine, Inc.	A	1,500	25	X					X	X	X	X	X	X		ME DEP
ME	Medway	Tilcon Maine, Inc.	A	800	30	X					X	X	X	X	X	X		ME DEP
ME	Norridgewock	Aggregate Recycling	A	1,000	<50			X			X	X	X	X	X	X	No maximum TPH	MEDEP
ME	Portland	Tilcon Maine, Inc.	A	1,200	35	X					X	X	X	X	X	X	No clay or debris	ME DEP
ME	Washington	Mariners, Inc.	A	100	40			X			X	X	X	X	X	X	No clay or debris	ME DEP
MA	Dracut	Brox Industries	A	180(a) 400(b)	40-50	X (a)	X (b)				X	X	X	X	X	X		MA DEP
MA	Charlton	American Reclamation Corp.	A	1,000	45-50		X				X	X	X	X	X	X	<60,000 ppm TPH	MA DEP
MA	Marlboro	Brox Industries	A	180	40-50	X	X					X	X	X	X	X	<50,000ppm TPH $250.00 minimum	MA DEP
MA	North Adams	Clean Berkshires	A	800	50-60	X					X	X	X	X			<3,000 ppm TPH	MA DEP
MA	Shrewsbury	Bardon Trimount	A	1,000	50	X	X				X	X	X	X	X	X		MA DEP
MA	Stoughton	Bardon Trimount	A	1,000	50	X	X				X	X	X	X	X	X		MA DEP
NH	Bath	AmRec New Hampshire	A	1,000	45-50		X				X	X	X	X	X	X		NH ARD
NH	Chichester	Merrimack Timber Service	A	350	N/A		X				X	X	X	X	X	X	<3,000 ppm TPH	NH ARD
NH	Hudson	Brox Industries	A	180	40-50	X					X	X	X	X	X	X	<30,000 ppm TPH	NH ARD

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 1 (continued)

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
NH	Littleton	Merrimack Timber Service	A	350	N/A	X					X	X	X	X	X	X	<3,000 ppm TPH	NH ARD
NH	Londonderry	Continental Paving	A	400	50-60	X					X	X	X	X	X	X	<30,000 ppm TPH	NH ARD
NH	Loudon	DaCato Sand & Gravel	A	1,200	50-55		X				X	X	X	X	X	X	<20,000 ppm TPH	NH ARD
NH	Plaistow	Beede Waste Oil	A	200	60-65		X				X	X	X	X	X	X	<50,000 ppm TPH <2" diameter particles	NH ARD
RI	Warwick	Cardi Construction Corp.	A	650	50-60	X					X	X	X	X	X	X	No maximum TPH	RI DEM
RI	Warwick	D'Ambra Construction	A	780	N/A	X					X	X	X	X	X	X	<100,000 ppm TPH	RI DEM
VT	Hartland	Merrimack Timber Service	P	N/A	N/A		X				X	X	X	X	X	X	<3,000 ppm TPH	

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 2

Recycling Facilities				Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Acceptable Contaminants						Comments	Ref.
State	Recycling Location	Company	Status								Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6		
NJ	Jackson	Earle Asphalt Corp.	P	600	N/A	X		X			X	X	X	X	X	X	<30,000 ppm TPH	NJ DEP
NY	Albany	American Reclamation Corp.	P	1,000	45-50		X				X	X	X	X	X	X		NY DEC
MA	Lanesboro, MA	Clean Berkshires	A	600	50-60	X					X	X	X	X	X	X	Permitted to transport NY soil to MA facility	NY DEC MA DEP

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 3

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
DE	New Castle	Clean Earth of New Castle	A	1,000	55-75			X			X	X	X	X	X	X	<15,000 ppm TPH	DE DNREC
MD	Baltimore	Soil Safe, Inc.	A	5,000	35-45			X			X	X	X	X	X	X	<25, 000 ppm TPH	MDE
MD	Beltsville	Cherokee Sanford	A	2,000	32-45					X	X	X	X	X	X	X		MDE
MD	Chestertown	Recycling Alternatives, Inc.	P	500	40-45					X	X	X	X	X	X	X		MDE
MD	Eden	Kary Asphalt	P	300-500	32-50	X					X	X	X	X	X	X		MDE
MD	Finksburg	Soil Recycling Technologies	A	2,000	55	X	X				X	X	X	X	X	X	<20,000 ppm TPH <14% moisture	MDE
PA	Sinking Springs	Keystone Black Transport	A	500	50-60	X					X	X	X	X	X	X	<21,000 ppm TPH	PA DER
VA	Arvonia Cascade	M&M Chemical & Equipment Co	A	1,000				X			X	X	X	X	X	X		VA DAPC
VA	Exmore	Recycling Alternatives, Inc.	A	500	40-45	X					X	X	X	X	X	X	<20,000 ppm TPH	VA DAPC
VA	Fredericksburg	Envirotech	A	1,000	55-70			X			X	X	X	X	X	X		VA DAPC
VA	Richmond	Recycling Alternatives, Inc.	A	500	40-45					X	X	X	X	X	X	X	<25,000 ppm TPH	VA DAPC

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 4

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
AL	Birmingham	Recycling Alternatives	P	500	40-50	X					X	X	X	X	X	X		ADEM
FL	Green Cove Springs	M&M Chemical & Equipment Company	A	1,000	100			X			X	X	X	X	X	X		FL DER
FL	Jacksonville	Anderson-Columbia Environmental	A	400	35-50	X					X	X	X	X	X	X	No maximum TPH <2" diameter particles	FL DER
FL	Miami	Rinker Materials Corporation	A	2,000	40-100			X	X	X	X	X	X	X				FL DER
FL	Orlando	C.A. Meyer Paving	A	800	25-35						X	X	X	X	X	X	No maximum TPH	FL DER
FL	Tallahassee	Sonas Systems of Florida, Ltd.	A	1,000	35-65	X					X	X	X	X	X			FL DER
GA	Trenton	M&M Chemical & Equipment Company	A	1,000	100			X			X	X	X	X	X	X		GA EPD
KY	Brooks	M&M Chemical & Equipment Company	A	1,000	100				X		X	X	X	X	X	X		KY DEP
NC	Gulf	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM
NC	Moncure	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM
NC	Norwood	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM
NC	Norwood	M&M Chemical & Equipment Company	A	1,000	100			X			X	X	X	X	X	X		NC DEM
NC	Sanford	Cherokee Sanford Group	A	2,000	32-45					X	X	X	X	X	X	X		NC DEM

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TABLE 3. LIST OF PERMITTED FACILITIES

REGION 4 (CONTINUED)

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
NC	Sanford	Soil Reclaiming, Inc.	A	2,500	25-40					X	X	X	X	X	X	X		NC DEM
NC	Thomasville	Cunningham Brick Co., Inc.	A	1,000	30-55					X	X	X	X	X	X	X		NC DEM
SC	Charleston	Southeastern Soil Recovery, Incorporated	A	500	55-75	X					X	X	X	X	X	X		SC GW Div
SC	Harleyville	Giant Resources Recovery	A	400	45-100				X	X	X	X	X	X	X			SC GW Div
SC	Harleyville	M&M Chemical Equipment Company	A	1,000	100			X			X	X	X	X	X	X		SC GW Div
SC	Santee	M&M Chemical Equipment Company	A	1,000	100			X			X	X	X	X	X	X		SC GW Div

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 5

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
MN	Maple Grove	McCrossan	A	400	50-70	X		X			X	X	X	X	X	X	<30,000 ppm TPH	MPCA
MN	Rochester	Johnson Blacktop	A	800	N/A	X												MPCA
OH	Lowellville	Gennaro Paving	A	600	30-60	X		X			X	X	X	X	X	X	<20,000 ppm TPH	
WI	Eau Clair	Eau Clair Asphalt Corp.	A	150	40-60	X					X	X	X	X	X	X	No maximum TPH on applications approved by DNR	WI DNR
WI	Green Bay	Payne & Dolan	A	400	35-100	X												WI DNR
WI	Lake Delton	American Asphalt of Wisconsin Plant #8	A	100	38-50	X												WI DNR
WI	Madison	Payne & Dolan	A	200	35-60													WI DNR
WI	Mosinee	American Asphalt of Wisconsin Plants #2 and #22	A	150 (each)	38-50 (each)	X											<2" particle diameter	WI DNR
WI	Onalaska	Mathy Construction Co.	A	1,600	40-100	X	X				X	X	X	X	X	X	Maximum TPH subject to WI DNR approval	WI DNR
WI	Neillsville	Clark County highway Dept.	A	N/A	N/A	X												WI DNR
WI	Superior	Lakehead Blacktop & Materials	A	430	35-45	X		X										WI DNR
WI	Sussex	Payne & Dolan	A	400	35-100	X												WI DNR
WI	Wausau	American Asphalt of Wisconsin Plant #5	A	150	38-50	X											No maximum TPH	WI DNR

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 6

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
TX	Fort Worth	Recycling Alternatives	P	500	40-50	X					X	X	X	X	X	X		

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 7

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
KS	Independence	Hartland Cement	A	300	30-60				X								No maximum TPH	KS DHE
KS	Wichita	Ritchie Paving Co.	A	350	50-80	X											< 2" diameter, no heavy clays	KS DHE
MO	Hannibal	Riedel Corporation	A	200	400				X		X	X	X	X	X	X	Soil must contain calcium, silica, alumina, or iron	

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TABLE 3. LIST OF PERMITTED FACILITIES
REGION 10

Recycling Facilities											Acceptable Contaminants							
State	Recycling Location	Company	Status	Capacity tons/day	Cost $/ton	Hot Asphalt	Cold Asphalt	Aggregate/base	Cement	Brick	Gasoline	Kerosene	Diesel	Fuel #2	Fuel #4	Fuel #6	Comments	Ref.
AK	Anchorage	Alaska Interstate Construction	A	N/A	N/A			X			X	X	X	X	X	X		ADEC
WA	Everett	Assoc. Sand & Gravel	A	N/A	N/A	X					X	X	X	X	X	X		WA Dept. of Ecology
WA	Kenmore	Sterling Asphalt	A	1,000	75	X					X	X	X	X	X	X	<50 ppm TPH	WA Dept. of Ecology
WA	Port Angeles	Shotwell Precast Co.	A P	650	35-60			X			X	P	X	P	P	P	<30,000 ppm TPH	WA Dept of Ecology
WA	Tacoma	Woodworth & Co.	A	100	56	X											<30,000 ppm TPH	WA Dept. of Ecology

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TABLE 4. DIRECTORY OF RECYCLING FACILITIES

Recycling company	Facility location/s	Contact	Telephone
Aggregate Recycling 100 Middle St. Portland, ME 04101	Norridgewock, ME	Bill Mitchell	(207) 634-3652
Alaska Interstate Construction 649 West 54th Avenue Anchorage, AK 99518	Anchorage, AK	Dave Thomas	(907) 562-2792
American Reclamation Corp. P.O. Box 263 Ashland, MA 01721	Charlton, MA Albany, NY (See also AmRec New Hampshire.)	George Camougis Frank Perry	(508) 624-7006
AmRec New Hampshire RFD 1 Box 330 Haverhill, NH 03765	Bath, NH (See also American Reclamation Corp.)	George Camougis	(508) 624-7006
American Asphalt of Wisconsin P.O. Box 1726 Wausau, WI 54402	Lake Delton, WI Mosinee, WI Wausau, WI	Jim Tryba	(715) 693-5200
Anderson-Columbia Environmental P.O. Box 1386 Lake City, FL 32056-1386	Jacksonville, FL	Mike McRae	(904) 752-7585
Bardon Trimount 70 Blanchard Road Burlington, MA 01894	Shrewsbury, MA Stoughton, MA	David Peter	(617) 221-8400
Beede Waste Oil P.O. Box 127 Plaistow, NH 03865	Plaistow, NH	Bob LaFlanne	(603) 382-5761
Brox Industries 85 Greely St. Hudson, NH	Hudson, NH Dracut, MA Marlboro, MA	George Hall Erik Stevenson	(603) 886-8077

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TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
C.A. Meyer Paving 4978 McLeod Road Orlando, FL 32805	Orlando, FL	Frank Cox	(407) 849-0770
Cardi Construction Corp. 400 Lincoln Ave. Warwick, RI 02888	Warwick, RI	Steve Cardi, Jr.	(401) 739-8300
Cherokee Sanford Group, Inc. 1600 Colon Road Sanford, NC 27330	Beltsville, MD Gulf, NC Moncure, NC Norwood, NC Sanford, NC	Rocky Springer Don Grigg	(919) 775-2121
Clark County Highway Dept. 801 Clay Street Neillsville, WI 54456	Neillsville, WI	Randy Anderson	(715) 743-3680
Clean Berkshires 86 S. Main St. Lanesboro, MA 01237	North Adams, MA (Permitted to transport soil from N.Y. State)	John Anthony	(413) 499-3050
Clean Earth of New Castle P.O. Box 1049 New Castle, DE 19720	New Castle, DE	George Dalphon	(302) 427-6633
Continental Paving 1 Continental Drive Londonderry, NH 03053	Londonderry, NH	Mark Charbonneau	(603) 437-5387
Crooker's	Brunswick, ME	See Harry Crooker & Sons	
Cunningham Brick Co., Inc. Route 2 Thomasville, NC 27360	Thomasville, NC	R. Cunningham	(919) 472-6181

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TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
D'Ambra Construction 800 Jefferson Blvd. Warwick, RI 02887	Warwick, RI	Jenny Parker	(401) 737-1300
DeCato Sand and Gravel RFD15 Box 52 Concord, NH 03301	Loudon, NH	Roger DeCato	(603) 798-5452
Earle Asphalt Corp. P.O. Box 757 Farmingdale, NJ 07727	Jackson, NJ	Walter Earle, Jr. R. Czarnecki	(908) 657-8551 (908) 938-5038
Eau Clair Asphalt Corp. P.O. Box 326 Eau Clair, WI 54702	Eau Clair, WI	Louie Thune	(715) 835-4858
Envirotech P.O. Drawer 72 Chatham, VA 24531	Fredericksburg, VA	Richard Harris	(804) 432-1901
Gennaro Pavers 1721 Pine St. Warren, OH 44483	Lowellville, OH	David Gennaro Frank Naples	(216) 394-5557 (216) 536-6825
Giant Resources Recovery P.O. Box 352 Harleyville, SC 29448	Harleyville, SC	Al Asaro	(803) 496-7676
Harry Crooker & Sons, Inc. Old Bath Rd. RFD 4 Box 4079 Brunswick, ME 04011	Brunswick, ME	Dick Morgan	(207) 729-3331
Johnson Blacktop 2320 14th Avenue, NW Rochester, MN 55901	Rochester, MN	Royal J. Johnson	(507) 254-1854

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TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
Kary Asphalt, Inc. Eden Road Eden, MD 21822	Eden, MD	Steve Lambrose	(301) 543-0200
Keystone Block Transport P.O. Box 9 Temple, PA 19560	Sinking Springs, PA	Laura Lubahn Alice Brown	(215) 926-6915
Lakehead Blacktop and Materials of Superior 6327 Tower Avenue Superior, WI 54880	Superior, WI	Joe Kimmes	(715) 392-3844
M&M Chemical & Equipment Co. 1229 Valley Drive Attalla, AL 35954	Green Cove Springs, FL Trenton, GA Brooks, KY Norwood, NC Harleyville, SC Santee, SC Arvonia, VA Cascade, VA	D. Burds	(205) 538-3800
Marriners, Inc. P.O. Box 600 Rockport, ME 04856	Washington, ME	David Andrus Gilbert Marriner	(207) 845-2313
Mathy Construction 915 Commercial Court Onalaska, WI 54650	Onalaska, WI	Jim Kirschner Gail Jensen	(608) 783-6411
McCrossan 7865 Jefferson Highway Maple Grove MN 55369	Maple Grove, MN	Bob Dongoske	(612) 425-4167
Merrimack Timber Service P.O. Box 359 Epsom, NH 03234	Chichester, NH Littleton, NH Hartland, VT	Jim Langille	(603) 798-4557

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TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
Meyer Paving	Orlando, FL	See C.A. Meyer Paving.	
Payne & Dolan P.O. Box 781 Waukesha, WI 53187	Green Bay, WI Madison, WI Sussex, WI	Kurt Bechthold	(414) 524-1769
Recycling Alternatives, Inc.* P.O. Box 1896 Salisbury, MD 21802	Birmingham, AL Chestertown, MD Exmore, VA Richmond, VA Fort Worth, TX	Don Mitchell Jerry Turner	~~(301)~~ 410 860-0268
Riedel Industrial Waste Waste Management, Inc. 22 North Euclid, Suite 213 St. Louis, MO 63108	Hannibal, MO	Robert Schreiber	(314) 361-3838
Rinker Materials Corp. P. O. Box 650679 Miami, FL 33265-0679	Miami, FL	Dave Marple	(305) 221-7645
Ritchie Paving Co. P.O. Box 4048 Wichita, KS 67204	Wichita, KS	Jim Jordan	(316) 838-9301
Shotwell Precast Company P.O. Box 2081 Port Angeles, WA 98362	Port Angeles, WA	J. Shotwell	(206) 457-1417
Soil Reclaiming P.O. Box 12248 Sanford, NC 27331-1248	Sanford, NC	W. Wornom	(919) 774-3077
Soil Recycling Technologies, Inc.* 3300 Childs St. Baltimore, MD 21226	Finksburg, MD	Joe Connor	(301) 526-6696

* Exclusive agent or broker

TABLE 4. (continued)

Recycling company	Facility location/s	Contact	Telephone
Soil Recycling Technologies, Inc.* 3300 Childs St. Baltimore, MD 21226	Finksburg, MD	Joe Connor	(301) 526-6696
Soil Safe, Inc. 4600 E. Fayette Baltimore, MD 21224	Baltimore, MD	Walter Kennell	(301) 327-5753
Sonas Systems of Florida P. O. Box 7387 Tallahassee, FL 32314	Tallahassee, FL	George Atkins	(904) 575-8102
Southeastern Soil Recovery, Inc. P.O. Box 70253 Charleston, SC 29415	Charleston Heights, SC	Bob Willms Reid Banks	(803) 566-7065
Sterling Asphalt 6431 NE 175th Kenmore, WA 98028 Tacoma, WA 98421	Kenmore, WA	Sam Johnson	(206) 485-5667
Tilcon Maine, Inc. P.O. Box 209 Fairfield, ME 04937	Fairfield, ME Medway, ME Portland, ME	Rhaeto Pfister Dave Bess Jonathan Oaks	(207) 746-9381 (207) 746-5636 (207) 676-9973
Trimount	Shrewsbury, MA Stoughton, MA	See Bardon Trimount.	
Woodworth & Company 1200 East D. St. Tacoma, WA 98421	Tacoma, WA	Mike Tollkuehn John Woodworth	(206) 383-3585

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SECTION 4
CONCLUSIONS

CONCLUSIONS DRAWN FROM THIS STUDY:

- This study identified 77 facilities in the U.S. that recycle petroleum-contaminated soil into marketable products. They are not, however, evenly distributed among the 10 EPA regions or the 50 states.

- More than half of the recycling facilities (41) are located in Region 1 and Region 4 (22 and 19, respectively). Region 5 has thirteen approved facilities; Region 3, eleven; and Region 10, five. The remaining facilities are spread among the other five EPA regions.

- Most facilities in this study accepted soil with all six typical contaminants (gasoline, kerosene, diesel, fuel oil #2, fuel oil #4, and fuel oil #6).

- Hot mix asphalt appears to be the most commonly manufactured product at these facilities. Other commonly used technologies are cold mix asphalt, aggregate, hydraulic cement, and brick.

- Regulations and requirements pertinent to recycling of petroleum-contaminated soil lie almost entirely within the jurisdiction of individual states. They vary significantly among the various states.

- The cost per ton for recycling petroleum-contaminated soil ranged from a low of $25/ton to a high of $100/ton. The majority of the plants surveyed reported a high of $50/ton.

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Project Officer: Chien T. Chen Comm: (908) 906-6985

16. ABSTRACT

Soil contaminated by virgin petroleum products leaking from underground storage tanks is a pervasive problem in the United States. Economically feasible disposal of such soil concerns the responsible party (RP), whether the RP is one individual small business owner, a group of owners, or a large multinational corporation. They may need a starting point in their search for an appropriate solution, such as recycling.

This report provides initial assistance in two important areas. First it discusses four potential recycling technologies that manufacture marketable products from recycled petroleum-contaminated soil: the hot mix asphalt process, the cold mix asphalt system, cement production, and brick manufacturing. The report also presents the results of a project survey designed to identify recycling facilities. It lists recycling facilities alphabetically by location within each state, organized by U.S. Environmental Protection Agency (EPA) Region. The facilities shown have each reported that they are operating either under a permit or another required vehicle of formal state approval, at the time of the survey; that they have temporarily ceased previously approved operations; or that they are in the final stages of the permit/approval cycle and expect to shortly begin operations. The report also includes detailed addresses, recycling locations, telephone numbers, and contacts for these facilities. The scope of the project limits listings to fixed facilities or small mobile facility owners that recycle soil contaminated by virgin petroleum products into marketable commodities. It does not address site-specific or commercial hazardous waste remediation facilities.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
petroleum products underground storage tanks asphalt plants recycling technologies permitted recycling facilities contaminated soils		

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hexavalent chromium, nickel, and complex cyanides from electroplating operations into an unlined landfill and lagoon (21 ER 1257).

This practice, EPA said, provided "a probable migration pathway" for the chemicals to migrate into ground water, the Little Calumet River, Burns Ditch, and Lake Michigan. The landfill and lagoons, EPA said, abut Indiana Dunes National Lakeshore.

Bethlehem said it believed that neither the landfill nor the lagoons presented any risk of harm to the environment.

Air Pollution

OPT-IN PROPOSAL ANNOUNCED BY EPA TO ALLOW NON-UTILITIES INTO ACID RAIN TRADING PROGRAM

Industrial sources of sulfur dioxide emissions other than utilities would be able to cash in on the financial opportunities of the acid rain trading program under a proposal announced Sept. 8 by Environmental Protection Agency Administrator Carol M. Browner.

The opt-in program rules for non-utilities set no caps and do not force any reductions over time, according to Julie Rosenberg, an official in EPA's Acid Rain Division. Rather, the program is a way to add flexibility and reduce the costs of the existing allowance trading program.

She said the proposed rules would apply to combustion sources and process sources, those that emit sulfur dioxide during the processing of a product.

The agency would rely on an emissions baseline determined from the facilities' emission averages in 1985, 1986, and 1987, Rosenberg said. The company would submit its emission data from those years to EPA, which would then evaluate them to ensure they are credible and quantify them.

"There would be no limit on their emissions," Rosenberg said. "They would get allowances equivalent to their baseline."

Under the existing acid rain program, utilities are required to meet specific emission limits in two phases to achieve an overall goal of cutting sulfur dioxide pollution 10 million tons from 1990 levels by 2000.

In phase I of the program, 110 of the oldest, dirtiest units must meet SO_2 emission limits specified in the Clean Air Act beginning in 1995. By 2000, when phase II begins, the rest of the utilities will enter the program and will be subject to limits set by the agency.

Emissions are gauged in terms of allowances, which equal one ton of sulfur dioxide. By setting only a cap, the Clean Air Act allows utilities to decide for themselves how to meet it. One way is to control emissions. Another is to buy allowances to cover any anticipated excess emissions.

The opt-in program, by making more allowances available, could enable utilities to increase their emissions, Rosenberg said. However, she added that the increase would be offset by decreases in the other industries.

Because the program is entirely voluntary, and no reductions are required, the only incentive, Rosenberg said, is financial.

In the event that a plant has already reduced its emission since the mid-1980s, from which the baseline is taken, EPA would then allocate the allowances based on the lower emission levels, Rosenberg said.

At most, she said, the program is expected to bring about an additional 500,000 ton reduction in sulfur dioxide emissions.

She said the proposal will be published in the *Federal Register* soon.

Hazardous Waste

RECYCLING THAT FAILS TO SATISFY RCRA WOULD BE ALLOWED UNDER AGENCY PROPOSAL

Environmentally beneficial hazardous waste recycling would be allowed to continue without meeting the full requirements of the Resource Conservation and Recovery Act under an Environmental Protection Agency proposal announced Aug. 31.

The proposal was included in a proposed rule addressing phase II land disposal restrictions for hazardous waste. The proposal also incorporated the first phase of an Aug. 24 settlement agreement on the remanded issues in the "third-third" lawsuit.

The recycling modifications were proposed amid ongoing negotiations among EPA, industry, and environmental groups on how to revise the definition of solid waste to abolish disincentives to recycling.

The Definition of Solid Waste roundtable met Aug. 30-31 in Chicago, one of many meetings scheduled before the end of the year. An EPA task force was expected to sift through the issues of the roundtable and develop a proposal in early 1994.

In the Aug. 31 proposal, EPA said it would broaden the "closed-loop" recycling exclusion from the definition of solid waste to allow residues from a secondary process to be reinserted into the manufacturing process without prior reclamation.

EPA said the proposal to broaden the closed-loop exclusion was justified in the wake of two court opinions on the subject: *American Petroleum Institute v. EPA* (906 F2d 729, 31 ERC 1667, CA DC, 1990) and *American Mining Congress v. EPA* (907 F2d 1179, 31 ERC 1035, CA DC, 1990), also known as *AMC II*.

These two cases gave the agency some discretion in deciding how secondary materials should be managed.

The agency acknowledged the work of the Definition of Solid Waste roundtable and said it plans to consider broader changes later.

As expected, the first phase implementing the thirdthird settlement agreement and the mega-deadline settlement agreement were included in the Aug. 31 proposed rule.

Wastes that exhibit 10 percent or greater total organic carbon at the point of generation and certain pesticide wastes toxic at the point of generation would be prohibited from being managed in Class I non-hazardous underground injection wells without treatment standards, according to the proposal.

EPA agreed to propose this prohibition in the third-third settlement agreement with the Hazardous Waste Treatment Council and three environmental groups (*Chemical Waste Management v. EPA*, CA DC, 90-1230, 8/24/93).

A settlement agreement with the Environmental Defense Fund on the mega-deadline suit also required that the agency address land disposal restrictions for chlorinated aromatic wastes, coke by-product wastes, and organic wastes exhibiting toxicity that are not managed in surface impoundments, Class I injection wells, or zero-discharge facilities (*EDF v. EPA*, DC DC, No. 89-0598, 8/12/93).

All the above provisions were attached to the long-awaited proposed rule on Phase II land disposal restrictions, required under the 1984 Hazardous and Solid Waste Amendments.

The 382-page proposal also contains alternative standards for soil contaminated with prohibited hazardous wastes that will encourage the use of non-combustion treatment technologies in treating contaminated soil.

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0013-9211/93/$0+$1.00

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010117

Universal treatment standards also were proposed, a move to require all waste streams to be treated with best demonstrated available technology, rather than risk-based treatment standards.

Chemical Manufacturers Association officials are interested in the dilution proposal, but are more concerned that they were not part of the settlement agreement between EPA and the treatment council.

Walter McLeod, CMA pollution prevention manager, said the association has concerns that HWTC stands to benefit financially from the third-third settlement agreement, while CMA members could be disadvantaged with having to comply with different, more stringent waste management standards.

"We are very concerned about not being at the negotiating table," McLeod said.

As for the contents of the injection well proposal, few CMA members would be affected, McLeod said. Wastes with 10 percent total organic carbon at the point of generation usually are not injected into wells, he said.

EPA plans to allow 60 days for comments to be submitted to EPA RCRA Docket (OS-305), EPA, 401 M St. S.W., Washington, D.C. 20460. The docket number is F-92-CS2P-FFFF.

More information is available from the capacity branch of the Office of Solid Waste by calling (703) 308-8440. Technical information on the recycling provisions can be obtained by calling (202) 260-8551.

The proposal will be published in the *Federal Register*, EPA said.

Enforcement

FOUR APPROACHES PROPOSED BY TASK FORCE IN EPA ENFORCEMENT REORGANIZATION PLAN

Four proposed approaches to consolidate enforcement within the Environmental Protection Agency were presented Sept. 2 to EPA Administrator Carol Browner.

An early draft of the task force report outlined three organizational approaches. However, the final report included four options and also presented advantages and disadvantages of keeping several functions within program offices, rather than shifting them to an enforcement office.

In announcing the decision July 22 to reorganize the Office of Enforcement, Browner said the move was necessary to return authority to a single office, rather than dividing it among program and regional offices, as was done in the Reagan and Bush administrations (24 ER 547).

The final report from a 40-member task force made few recommendations but analyzed several options.

The four approaches outlined in the report are:

- Media approach, organizing enforcement by media—water, waste, toxics and pesticides, air, and multimedia offices;
- Economic sector approach, segmenting enforcement by energy and transportation, manufacturing, and other economic sectors;
- Functional approach, dividing enforcement by enforcement policy, compliance assurance and evaluation, litigation and administrative action, and enforcement capacity building, with these offices further divided along media lines; and
- Bio-resource approach, separating enforcement by coastal areas, land resources and watersheds, and urban area offices, with each office further segmented by media.

Under this approach, a media program office would also be created to develop legislation and regulations and coordinate overall activities.

Functional Approach Added As Option

The functional approach was not included in earlier drafts and was added to present an option based on established areas of enforcement activities, EPA said.

Many elements are common to all options. For instance, all have a staff office of Resource Management and Administrative Support to handle budget, extramural resource management, training, and other functions. All would include an enforcement capacity office, to include the National Enforcement Training Institute and liaison with national organizations of state, tribal, and local officials. Also, a separate office of criminal investigations would be established under all approaches.

The report presented the advantages and disadvantages of keeping several elements within the program offices.

These are: the remedial programs currently in the Office of Solid Waste, and include superfund, Resource Conservation and Recovery Act corrective action, leaking underground storage tanks, and Oil Pollution Act; elements of the wetlands, underground injection, and ocean dumping programs currently in the Office of Water; and the Mobile Source Office's enforcement elements currently in the Office of Air and Radiation.

The report also said some activities in the Office of Enforcement are not entirely enforcement and could be moved out of the office, such as activities involving the National Environmental Policy Act, Indians, and contractors.

A preliminary decision is expected by Browner the week of Sept. 20, and a management decision team should be created to determine structure and make detailed decisions on implementing the transition, EPA said.

At the July announcement, Browner said the transition should be completed within 90 days. EPA sources said then that the only confirmed assistant administrator affected by the plan was Stephen Herman, head of the Enforcement Office, which would gain staff through the change.

Sources said Browner could face difficulties in stripping other assistant administrators of staff. A similar proposal was presented to the Bush administrator but blocked within EPA.

Budget

SENATE PANEL ADVANCES MEASURE TO PROVIDE $6.7 BILLION FOR AGENCY IN FISCAL 1994

A Senate appropriations subcommittee Sept. 8 approved a bill (HR 2491) that would provide the Environmental Protection Agency $6.67 billion in fiscal 1994.

The funding would be included in a bill to provide $87.94 billion in fiscal 1994 for the Department of Veterans Affairs, the Department of Housing and Urban Development, and other independent agencies, including EPA.

EPA's fiscal 1994 funding would be approximately $253 million lower than the fiscal 1993 appropriation. The budget, however, would be $308 million greater than the Clinton administration's request and $39 million more than the level approved by the House (24 ER 379).

Sen. Barbara Mikulski (D-Md) said during the markup that lower-than-usual funding and increasing demands forced the subcommittee to "make tough and sobering choices."

The Senate Appropriations Subcommittee on VA, HUD, and Independent Agencies made several modifications to the House-passed version of HR 2491.

The full Senate Appropriations Committee was scheduled to consider the bill Sept. 9.

0013-9211/93/$0+$1.00

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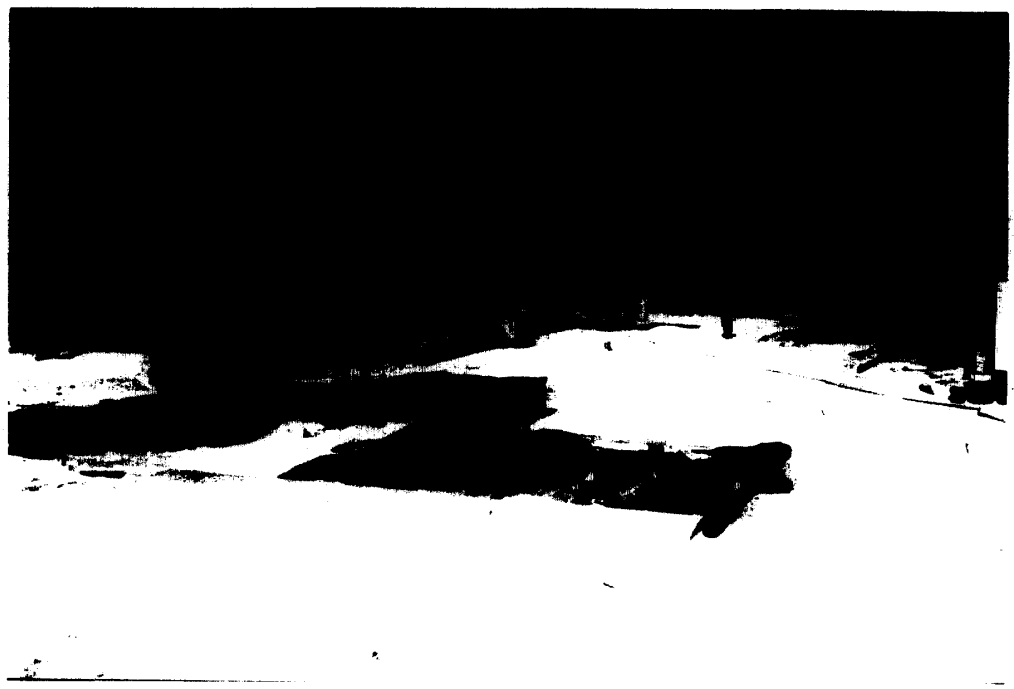
Appendix D

Pilot Test Photographs

010119

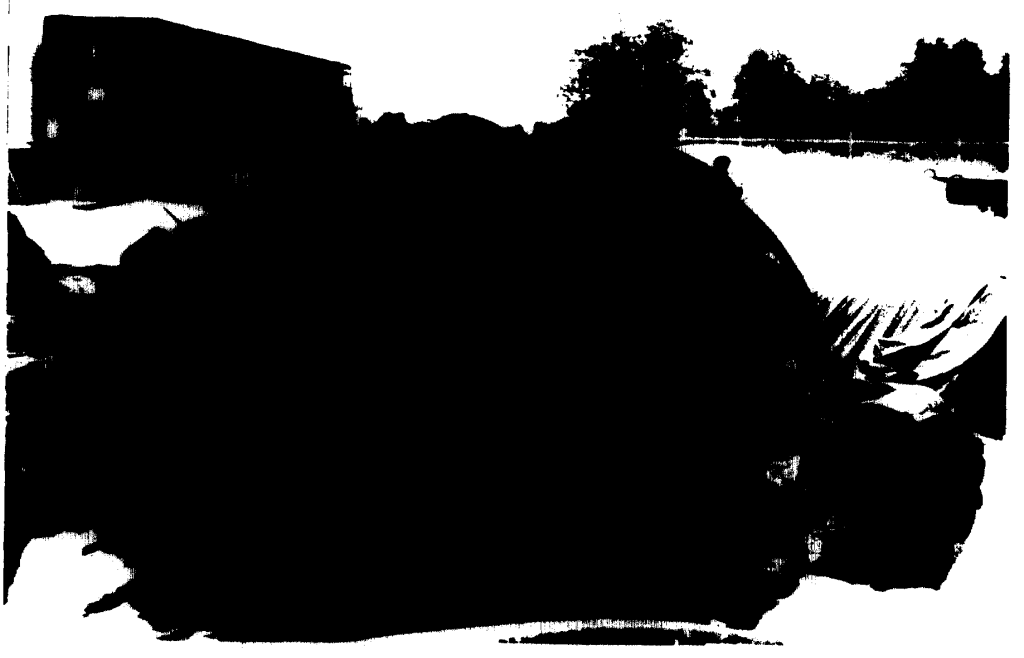


1. **PILOT TEST AREA** – SOIL STAGING PAD IN FOREGROUND. PROCESS FEED CONVEYOR ON LEFT. WASHED SOIL DISCARD CHUTES ARE IN FRONT OF BOBCAT AND BACKHOE.

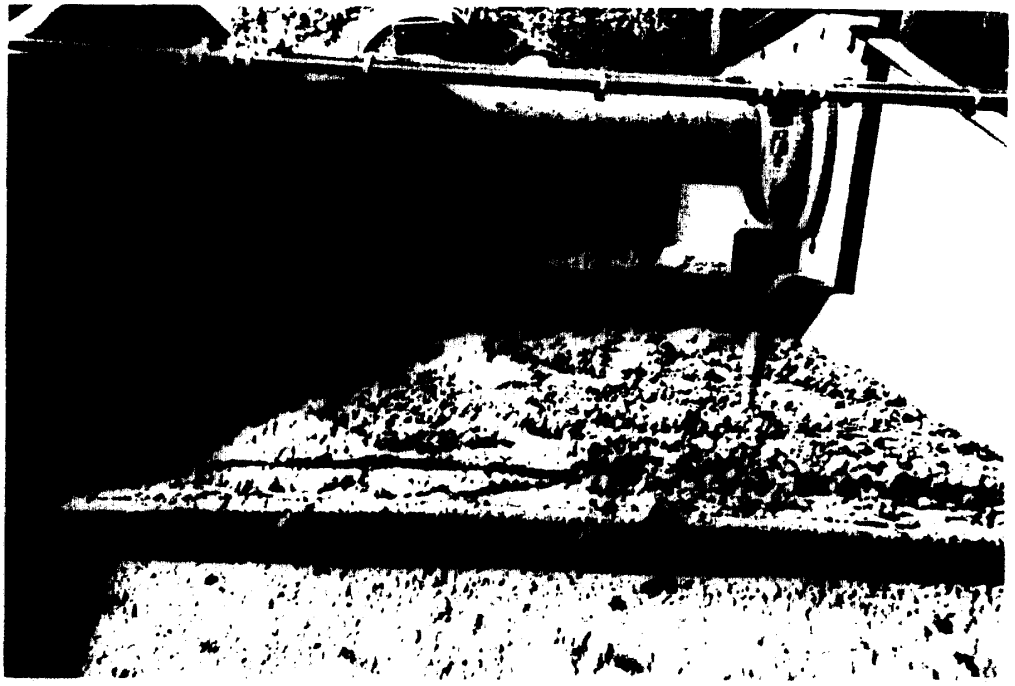
2. **SWACO SOIL WASHING UNIT** – LEFT TO RIGHT: FEED CONVEYOR DISCHARGES INTO PUG MILL, PUG MILL DISCHARGES INTO 1" VIBRATORY SCREEN (CLASSIFIER), MIX TANK AND SLURRY CIRCULATION/FILTRATION TANK IN BACKGROUND, 10 MESH VIBRATORY SCREEN IN LEFT FOREGROUND (SCALPER), SUPER SHAKER SCREEN, MUD CLEANER SCREEN WITH HYDROCYCLONES AND CENTRIFUGES 1 AND 2 FAR RIGHT.

Dames & Moore

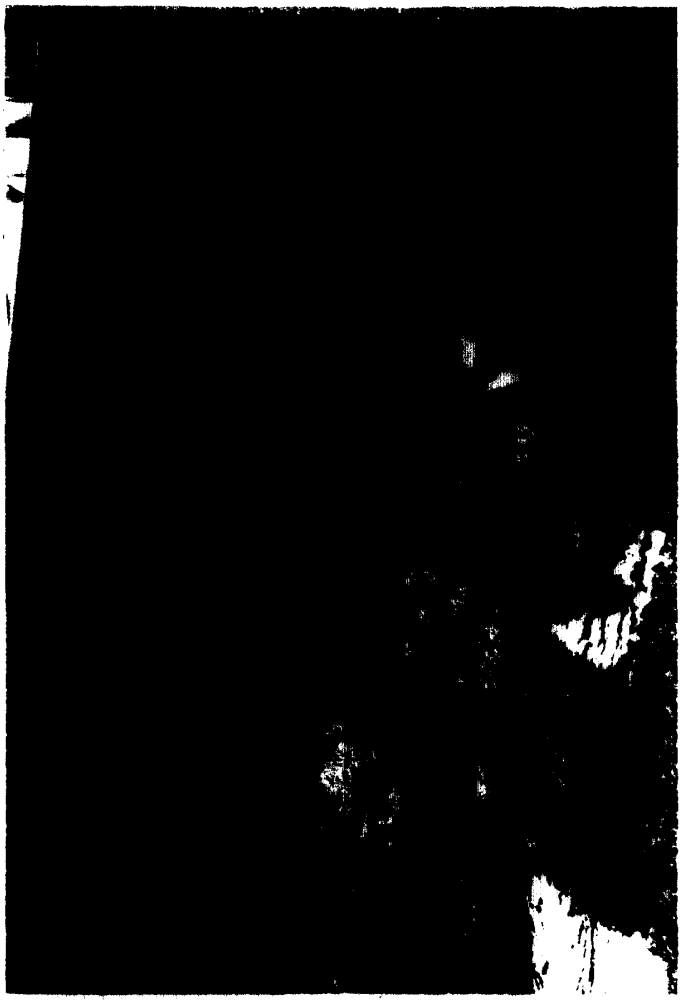
3. **TEST SOIL** BEING PLACED ON 8" STATIC BAR SCREEN (GRIZZLY).



4. **OVERSIZE DEBRIS** REMOVED FROM THE TEST SOIL BY THE GRIZZLY AND BY HAND–PICKING.



5. SUPER SHAKER SCREEN (TOP PHOTO) WASHED SAND BEING SCREENED TO REMOVE ROUGHLY 150 TO 200 MESH PARTICLES.

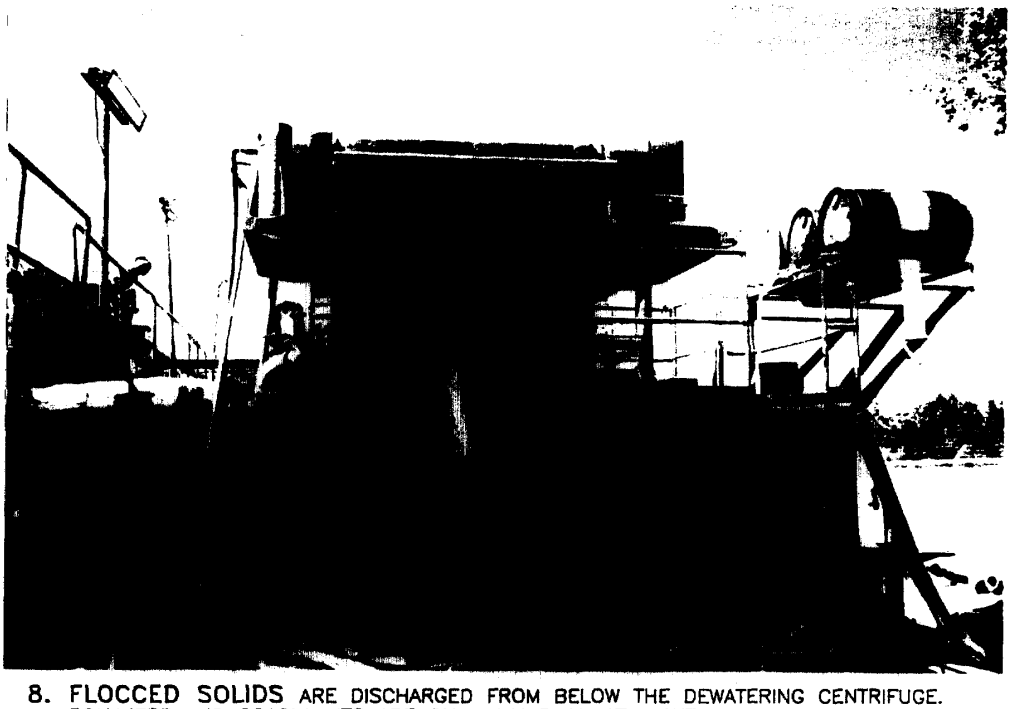


6. CENTRIFUGE NO. 1 & 2 DISCHARGE (LEFT PHOTO) – WASHED FINE SOIL (ROUGHLY –175 MESH, +325 MESH) AS IT IS DISCHARGED FROM THE CENTRIFUGE.

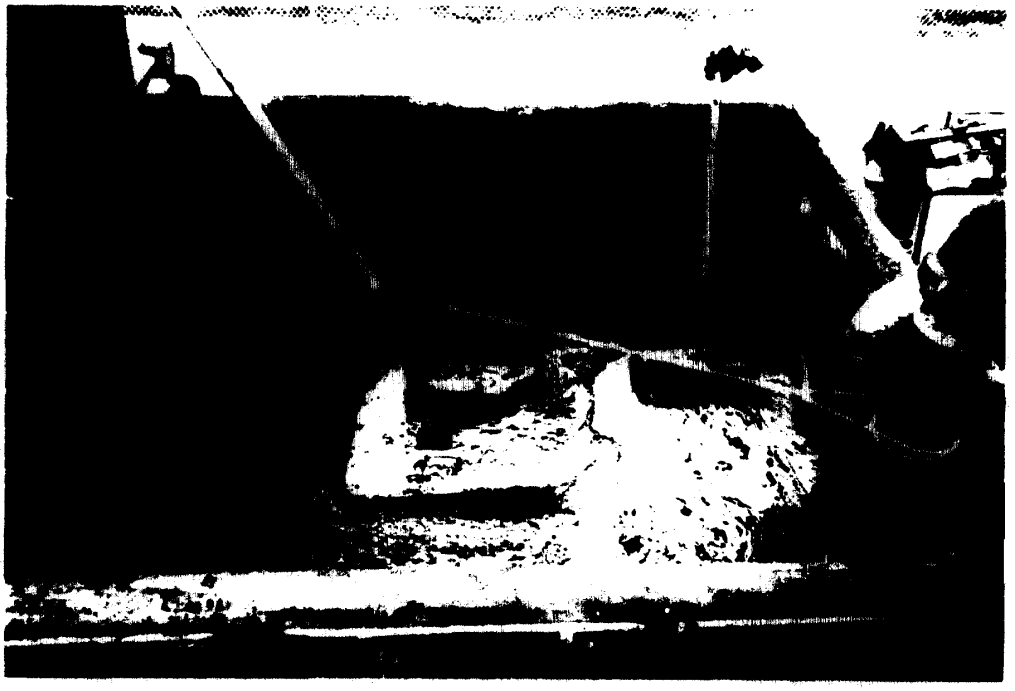
Dames & Moore

010122

7. **FLOC BOX** – FLOCCULANT INJECTION SYSTEM FOR REMOVAL OF SUSPENDED SOLIDS FROM THE WASH WATER. INJECTION PUMPS IN LEFT FOREGROUND, DEWATERING CENTRIFUGE IN CENTER, AND THE CLARIFIER/SETTLER IS BELOW THE GRATING.



8. **FLOCCED SOLIDS** ARE DISCHARGED FROM BELOW THE DEWATERING CENTRIFUGE. POLYMERS AND COAGULANTS ARE ON DRUM RACK AT RIGHT.



9. **VACUMM SKIMMER** REMOVES EMULSIFIED AND PARTICULATE MATTER FROM THE SURFACE OF THE QUIESCENT ZONE IN THE SLURRY CIRCULATION/FLOATATION TANK.

10. **WASH WATER** STORAGE TANKS (FRAC TANKS) ARE AT RIGHT.

010125

Appendix F

Daily Field Log Notes

010125

010126

Property of Bruce Hickman

Address CLT NC

Phone 704 522 0330

This Book is manufactured of a High Grade 50% Rag Ledger Paper having a Water Resistant Surface, and is sewed with Nylon Waterproof Thread.

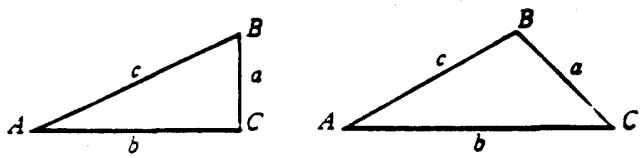
Made in U. S. A.

INDEX PAGE

010127

JOB NO.	PROJECT	PAGE NUMBER
	Sue 222-2910	
	(713)	

FORMULAE FOR SOLVING RIGHT TRIANGLES



$$\text{Sin } A = \frac{a}{c} = \text{Cos } B \qquad \text{Cot } A = \frac{b}{a} = \text{Tan } B$$

$$\text{Cos } A = \frac{b}{c} = \text{Sin } B \qquad \text{Sec } A = \frac{c}{b} = \text{Cosec } B$$

$$\text{Tan } A = \frac{a}{b} = \text{Cot } B \qquad \text{Cosec } A = \frac{c}{a} = \text{Sec } B$$

Given	Required	Solution
A, c	B, a, b	$B = 90° - A, a = C \sin A, b = C \cos A.$
A, b	B, a, c	$B = 90° - A, a = b \tan A, C = \frac{b}{\cos A}.$
A, a	B, b, c	$B = 90° - A, b = a \cot A, C = \frac{a}{\sin A}.$
a, c	A, B, b	$\sin A = \frac{a}{c}, \cos B = \frac{a}{c}, b = \sqrt{(c+a)(c-a)}$
a, b	A, B, c	$\tan A = \frac{a}{b}, \cot B = \frac{a}{b}, c = \sqrt{a^2 + b^2}$

FORMULAE FOR SOLVING OBLIQUE TRIANGLES

Given	Required	Solution
A, a, b	B, c	$\sin B = \frac{b \sin A}{a}, c = \frac{a \sin C}{\sin A}$
A, B, a	b	$b = \frac{a \sin B}{\sin A}$
a, b, C	A, c	$A + B = 180° - C, C = \frac{a \sin C}{\sin A}$
a, b, c	Area	side $\frac{a+b+c}{2}$, area $= \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	area $= \frac{bc \sin A}{2}$
A, B, C, a	Area	area $= \frac{a^2 \sin B \sin C}{2 \sin A}$

3/12/95

Arrive on site 7:30. Supers mtg in progress. No lab data or sample bottles in sight.

Chester said they were delivered Friday and results were overnited to CLT. Bobby will hand deliver to office

PW sample data shows only 1 [illegible] TCE over

SWSCO waited on data & then moved Gravity to facilitate loading. Rain threatened @ 3:30 so we chose not to operate today

Discussed PW results w/ Shannon & Tschuda, they will advise [illegible]

Core: Arrive on-site 10 AM, Leave 3:30
Want 4 hr Travel Time,
Don't Include Van Breakdown

010129

3/23/93

Pumped Pilot unit - Feed Tanks caused of foaming

Prep'd feeding area w/ Limestone

Prepared Unit for 10 cy load

Began Test @ Noon, pile #3

DAT ran for 20 sec, lots of bubbles

Grizzly fouled, lots of pitch & rock

6 cy out of 10 cy wouldn't rock & pitch.

∴ Emptied rock water in Slurry Tank & empty and since it was pre-charged for 10 cy of soil

Slurried for 120 min, started processing produced much foam, shut down

Stop: 6:30 Noon to 5:30 PM

010130

3/24/93

Selected Pile 6 for the "second half" of Test #1.

Spoke w/ Shannon Re: 20 yard test, foaming problems, and stormwater discharge requirements. Shd steve will call back so we can talk to Glenn Celenar together.

She asked that I review NPDES permit and GWTP Workplan to see if pre-treat is req'd for the stormwater and what QA needs to be done on stormwater sample prior to discharge. Tim W. is reviewing docs for me.

Tim & I inspected Pile #6 & it was more soil than rock. Oddly, we got higher HNO hits (17 ppm) than we got on [illegible] (<[illegible] ppm)

~~SWACO delivered (10) 5gal pails of alcohol based defoamer~~

010131

SWACO ran the agitator tank all night
foam was known through out the
system

10:20, began loading Pile #6
with grizzly. This soil is
combined with Pile #3 already
in the system

Finished Loading @ 12:30

Tracked up site w/ black soil, will
modify loading method to reduce mess.

Began Slurrying 12:45, were able
to aerate & control foam w/ defoamer

Circulated till ~2:30 and started
processing still no discharge
from screens. Slurry appeared
very dilute. SWACO's % solids
test showed 1.57% solids

Road - calc 27000# soil / 268 BBLS water
is 28.87% solids

∴ solids are not being
suspended in slurry tank

SWACO continued to pump
60BBL from slurry tank.

Shut down to replace pump at 3:00 and
to pump foam out of FPS tank

Began pumping from slurry tank about 4:30

SWACO wants to continue to process
until slurry tank is empty

I advised that we will operate till 6:00
and then shut down on circ only,
with 2 men to stay all nite

Centrifuge discharge is very wet & will not crack

J. Montie advised he did not need operator
so I sent him home @ 4:30

At 5:00 a SWACO operator began w/ Bobcat
to collect Cent #2 discard & placed it
in gage bermed area next to Pile #3 rocks

Took samples C1/C2 & MCD from Pile 3-6 Combo.
Did not take water samples per Bruce Heckman
Time ±1800)

CORE 7:00 TO 4:30

010133

3/25/93

7:20 Held Super's mtg

Charles, Laurence, John Ron T.

I advised we would not be loading today but would be processing. No worries about dust as expected.

Charles advised his crew would not need access by exclusion zone anymore & his crew would be off site in a couple days.

His workers had asked about the foam we explained it was no danger to them

I told Chas we would move exclusion zone when he no longer needed access on the N side of the plant.

010134

I advised we would not proceed until rock was out

Mtg w/ SWACO regarding today activities

Bones, Gary, Lawrence, John Martin

To remove rock in Slurry Tank:

① will jet sand to far pump suction & will use water from FA so no more is generated. Dewatering will also begin today.

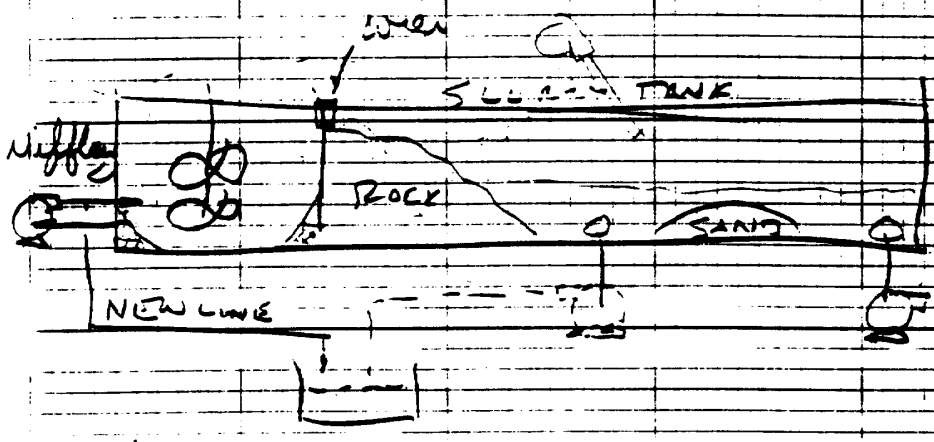
② Will move Bailey pump suction to middle of slurry tank and blast rocks from above w/ a 4" nozzle. This material will be pumped to scalper

③ If blast nozzle fails, will proceed w/ manual removal after review & approval by EPA (verbal) w/ the confined space entry procedures. Doug Henick will be consulted as well as Reagan.

010135

To process next Batch:

1. Wifflay pump discharge will be routed directly to scalper
2. Sand & clay will spill over weir and will be run @ a higher % solids and the blaster nozzle will be kept on to keep it slurried
3. The mix tank will be run @ higher % solids & a screen will be placed over the weir to prevent rocks from carrying over



010136

Gundle Lining Mark 45 N Toll to Rolling Meadows Tolleson, Blanchard

Fax 230-8616 Paul Joplin

PIS 443-9564 x695 160.00

22½ x 30' x 40 mil 13.20

173.20

Jack Stevenson x2718

8:30 Jack will fax a PO to Paul Directly

M.+ w/ Rick Butler (QA) on site to discuss QA deficiencies.

① SWACO HSP posted - Done 3/25/93

② Utility Map Posted - Troy & Paul 3/25/93

③ Sample Log - Karen to produce 3/25/93

④ Lab / Data QA - Performed by DEMOCEX Sally Lewis

10:00 SWACO began wasting rock out of slurry tank

2:30 SWACO decides to enter tank & manually remove rocks.

010137

DiMi's Site Safety Officer (SSO)
advised SWACO of our
specific requirements & concerns

SWACO's lead SSO arrived @ 2000
w/ SCBA
O_2 Meter
Harness

DiMi's (Wes) witnessed operations
along w/ SWACO's SSO assistant

500 SWACO gallons manual rock
removed

Began clean-up, swept soil pads
moved equipment to soil wash pad in AM

Picked up (12) Poly drums
& 22x30 40 mil liners

010138

Burbank Drums 675.0941

Dorn Act

Russel Stanley 672-0588

57gal 30gal - H NE Holmes Delin

All Poly 471 9545 45 Ann 159

Eagle Dra 227 0909

2 exit of 59

Exit on 610 N

Kelly Humstead Exit

Rt to 4004 Holmstead Rd

1/2 mi on left

Ag.

Check

CORE: 300 to 530

010139

Planned activities for 3/26/93
Supervisor Meeting
Inspect & select sand
pits

Spread Lime
Scrub pads
Rent Drum Forks
Brace discard boxes

SCUSCO stoppage work at 6:15
Slurry Tank is empty
FAS is full
Agitator will run overnite

010140

3/26/93

Supers Mtg

Chas Lawrence, Troy, Bruce

Advised of SWACO's activities.

Odor may occur when we open piles but we are down wind of Chas.

Chas has 2 welders @ N edge of GWTP they will be out today

Cherry Picker is off site

Chas say we can occupy area @ N edge of GWTP (ie Exclusion zone can be redefined now)

Inspected Piles

Pile 10 2 yards wood debris from concrete
8 yard dark brown clay silty
Not alot of sheen pitch

✓ Pile 2 2½ yd wood debris
[illegible] + much tar
Sandy clay

Pile 3 Dirty Pile 9 more tar
black sheen on sand

010142

Pile 7 Sandy black chunks
20 cm @ pile
0@052
<1 cy debris

Pile 1 Sandy dry soil
Large asphalt chunk
2 cy reject

Pile 2 Much gravel & stell
Much tar
75% reject & scalper
[illegible] we can
[illegible] screening

Pile 4 Sandy soil
Very little tar
[illegible] reject

Pile 5 Sandy soil
[illegible] tar [illegible]

1130 Took samples of Pile 3/6 washed
liquids

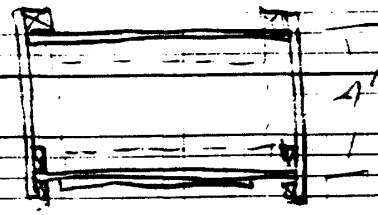
SWSCO spent the day
processing the FPS fluids
and dewatering

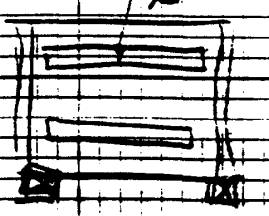
No new cell in Locked

CORE & BKII decon'd & Lined
the East Cell Pad

The C1/C2 & DWC sludges
were put in 12 boxes

Too many boxes in use
Must build boxes, line & ~~emp~~
dump sludges directly into these
>> Build a hinged front so after
the solids dry they can be
dumped & shoveled out





Build Silt fence

010143

PM. of Activities

Rent Hydro Water for pad decon

Build Mud Boxes

Build Silt Fence

Calculate Washed Soil Volumes

Go to Chester to discuss procedures

⇒ Pile 4 is clean per Total PAH data

010144

5/28/93

010145

Supervisory

Advised Chas of wash operations & traffic @ discard chutes

Chas is playing nothing unusual

Procurement

Ordered Fork lift @ Prime $500/wk } delivered 300
" power washer @ " 500 [redacted]/mo

Purchased Vegmesh @ "
(2) 30x100x6 mil
(6) 20x100x6 mil
(30) Sand bags 18"x30" } Delivered 400

(delivered 3/30/93) } (1) roll silt fence 24"x100' w/ stakes

Ordered Dumpster Containers for mud
Star Disposal @ 38/mo, 6 mo lease
(4) 2cy (40"x36"x72")
René 861-4499

(Green on site w/ contract @ GCX will deliver in AM, 3/30/93)

SWACO

900 began dewatering cisn mix

900 began pumping rocks out of mixtank

Will use pile #5 for Test Run B

Spoke w/ Hagen

Art Columbo + Ernie Spilla

Art will arrive on site

on Tues 3/30/93 to

witness operations

Run B samples collected

Gave Site Orientation to SSB

to 2 of Chas' new workers

010146

Loaded unit on pile #5 @ 1100
took 1 hour

Began Slurry tank @ 12:30

Decon'd pad w/ hydroblaster &
set vacuum down for
washed soils from Run B.

Started flow thru FT-5 @ 230

Started C1/C2 @ 400

Finished Drum [illegible]

Finished clean up by 7:15

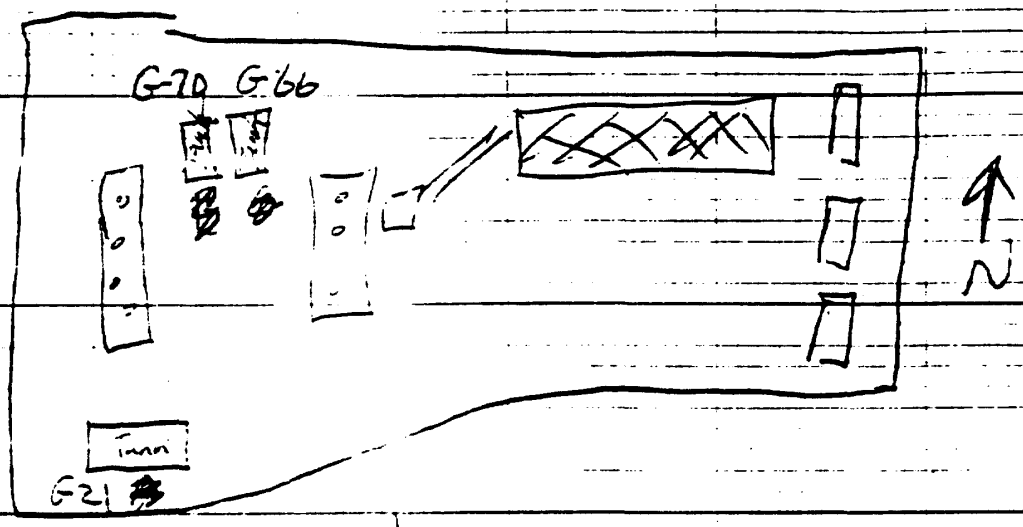
All walls moved thru system
[illegible]

Drum Depths for Pile 3-6 muds

C2 / 25	C1 / 10	DWC / 16	(22 3/4" DIA)
24	25	21	
26	15	19	
14	12		

Tank Volumes 16:10 on 3/29/93

010148



G21 Tank Water Level 4' from bottom

G-70 Tank W/L 3' from Top (Almost Full)

G-66 Tank W/L 1' from bottom (Almost Emp

COLLE

3/30/93

Will Process Pile 9 w/ Dowfax trap

CORE Emptied Reject Box & ~~[illegible]~~ it

Ordered (4) shovels & (30) sandbags

Supers Mtg

Activities same as monday

Advised that anyone on site not part of Johns or Chas's crew must [illegible] 11:00 to come for briefing

BKH moved exclusion zone S by 5 ft @ Soil Wash pad, no prob for Chas

Lawrence is keeping 4 ps process logs

010149

Req'd Activities

Decon, Line & Place Mud Containers

Decon Soil Pad @ Pile 3

Empty Rack Box

Sample Storm Tank G-70

Send Run 3, Run C, & G-70 samples to Bobby Today

Estimate Run B soil volumes

"Reject	52"x32"x7"
Scalper	~~74x30x6~~ 82x30x10
MCD	88 x84x10
C1/C2	100 x 56 x12
	+110 x 56 x7

010150

Began Loading Pile 9 . 9:45

Stopped loading @ 10:30
due to elec failure on
Wiffley circ pump motor

Dewatering started @ 10:30, placed
in berm on West pad

Motor received & installed by 5 PM

Will restart in AM

Visited Chester Lab

1. Bobby will advise on
cost to filter PW - 200
samples & re-analyze

2. Chester will squeeze &
composite SD's prior
to extraction

3. [illegible] hold period, must
be re-sampled

010151

Art Columbo arrived on site
3:30. BKH gave his safety
briefing & we toured the site
[illegible] into Tanks
SLOSCO hand (Bones) nearly
took a spill. I advised
SLOSCO to have an electrician
if they are not near a
solution, they will
advise
BKH sprayed water from decon
[illegible] on [illegible] well
trying to prime the pumps.
[illegible] discuss both during safety mtg
[illegible]

CORE 7 to 4:30

010152

Started loading @ 8:10 Pile 9
Set (3) lined dumpsters

Wet site down to control minor dust problem, Advised SWACO to do same

Performed Site Orientation for (2) more new contractors

Met w/ Lawrence, John Chancey & Art Columbo to develope alternate flowsheet

2:00 Most of the Pile 9 has discharged. Slurry tank scrubbed up, had to be blasted out w/ hose
Screens were blinded at 1pm
5:00 System emptied, only 8" mud from C2 and 17" mud from C1
SWACO will mod C1/C2 chutes to allow use of only one dumpster

CORE 7-5

010153

I also asked SWSCO to
take the slurry tank
out of service & use only
the mix tank process
two 5 CY batches
then it.

Estimate Run C Soil Vols

1" Reject	54 x 80 x 10
SD	80 x 42 x 8
~~SSD~~	~~90 x 30 x 1~~
MCD	90 x 50 x 7

010154

4/1/93

010155

Proposed Pile Mixes for Remaining Tests

A.1-93 Pile 7

A.2-93 Pile 8

Monday — Pile 1 & Pile 10

Pile 4 & Pile 2

Surgeis Mtg: Lawrence, Dimmi, Chas, John H

BXN Advised that WASCO will make some agency mods & perform a confirmatory entry

Also that were are hanging dust down for his workers comfort w/ that we are were in action levels

Chas suggested we have our HSO speak w/ them & show them the readings & instruments & explain the letter

Met w/ Glen Celeni on-site

Discussed Ops Progress:

410 CY washed to date

4-5 runs left to do

Range of soil types

Mech failure

Screen Blinding

Hayes Visit

Process model flowsheet

Site Design

[illegible]

Showed Glen Run B washed soils

Want to Therm Tech for 2 hrs for Epson

Rewashed Run D 1st reject to remove excess clay

Run A soil results were received showing 1000's of ppm SPAHs

I contacted Bobby @ Chester Lab & re-requested that the filtered solids (-CC, PAH) from Trigen be analyzed immediately.

As a back-up I requested that Wes Re-sample the pre-wash piles that remain

Estimate Run D Soil Vols

1" Rejects 74 x 30 x 6

SD 28 x 76 x 9 plus 1 bobcat load

SSD 96 x 31 x 9 " 3 " "

MCD 90 x 70 x 16 " 7 " "

CORE 7-7

010157

4/2/93

010158

Supers Meeting

Advised Chas of (2) pumps stolen last nite, came over W fence.

Same activities as usual for SWACO

Ditto for Chas.

Asked SWACO to police water cooler area better

Performed site orientation for (3) new workers for Chas.

800 Opened Pile 8 for washing

Was sampled feed matl

Prime requires a Police report for insurance

Decon water from Pile 7 was pumped into Tank G66 by error

Will transfer this water to G21 today

SWACO will keep watch on weather this weekend for stormwater & will pump into FPS1 Slurry Tank as req'd.

~~Tank G66 will be used for~~ treated wash water & treated decon water from soil wash pad clean-up

3" Pump not stolen ~~# 94R3?? Engraved~~ 214 Serial No 501702718 (Nameplate)

3" pump @ fence NW corner stolen (fence cut)

2" pump @ G49 fractank stolen

Ordered (6) more Dumpsters from STAR

010159

BKH Contacted Pol. Dept about theft
11:40 LPD called for a phone
report

$11,000 total est value

Case No 032854993-C

Call Burglary ⇒ 247-8400
Theft call 247-8300
w/ questions for a copy of the
report

010160

[illegible] Instructions

- Pump stormwater from soil [illegible] ground after confirmation that no [illegible] in shaker present

- Pump stormwater from soil wash pad into Stable Day water tank, slurry tank, FPS, and/or Fractank G-66

- Order 2 4 dumpsters req'd for a Tuesday delivery

- Collect samples as req'd

- ~~Wash all dumpsters w/ contents ID~~

- Drain rear of any new soil placed on pad, then [illegible] measure them for volume estimates,

- Do housekeeping as req'd

- Note Superior MEs on 1/21

- Patrolled in Gross SSB

- Decon soil pad where most [illegible] [illegible] remove & pump the con water [illegible]

- Return Forklift & Pump by Noon if [illegible] forks are working ok. (CONT'D)

010161

[illegible] equip worth stealing

- keep notes in this log book
- Note Core's hours in log

CORE [illegible] ÷ 5:30

010162

4/5/93 Pump water from Decon Pad & Soil Containment Pads. To G-21 N end to G66 S end to ground and then to G2

Held Supervisors meeting
— SWACO will Process Piles 1 & 10 today
— Ditto activities for Charles (McGowen)

Held Safety meeting

Called Prime Equipment to pick up Fork Lift Rental stopped on Monday (1 wk)
Called Chester Labs to pick up soil samples (Friday's)

8:30 Start to pump water off containment pads into Frac Tanks

SWACO working w/ System, won't be ready til Noonish (installed a new skimmer)

12:00 SWACO still not ready, storm water has all been pumped to Frac Tanks

1:30 Decission to not run piles made w/ phone call to Bruce Hickman (too late to operate)

working on picking Debris from Pile 10

Pile 1 looks like it has very little debris

Preparing all systems to start loading at 7:00 AM Tuesday Morning

4:30 Covered Soil Containment pads w/ Plastic
Picked up trash

500 PM Took Sample of Recycle Water (SC-RW-E)
Took Sample to Lab

Leave 7 to 5

010163

4/6/93

Order (5) dumpsters, replace (1) w/weak bottom

Began loading Pile 1&10 @ 8 AM

Rain is threatening

Much large debris was removed from pile 10

SWSCO added a floating skimmer w/ gas powered diaphragm pump and a 4x6 diesel powered air pump to keep sand moving in the slurry tank (these mods were made on Monday 5th)

9:30 Gave S. Radel update by phone

10:00 Conf Call w/ M. McDonnal per his request

Discussed process mod's to slurry tank

" pile 1 & 10 activities

" flow sht mods w/ Hazen ops.

" analytical results being higher after washing

[illegible] issued [illegible] - SOS regarding our ops.

[illegible] was not [illegible] to the lab data & cases that it is not due to error in our procedures

010164

010164

Wilfley sluicing pump [illegible] from
[illegible] to 35%

O&G 128 ppm
Total iron 8 ppm
DALL 55 PANS
No TSS agee of influent

Dimensions of Friday Test Discharge

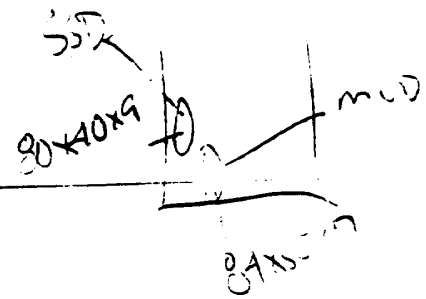
1" Reject

SD 38 x 52 x 12

SSD 77 x 52 x 12 + 80 x 49 x 9 + 80 x 75 x 10

MCD 80 x 80 x 8 + 84 x 55 x 7

DWC



1:00 Slurry tank empty except
for 6" sand
Mix tank still plugged
~~Fluid will stay in FPS overnite~~
Storm on its way
BXN left site @ 7:00

FPS
emptied
same day

010166

4/7/93

010167

Supers Mtg

Chas will be surface prepping for painting some fumes may be noticed

GWSCO activities will be same as normal

Will processes Piles 2 & 4 today as one batch

I advised GWSCO's John Montie to keep men off of slurry tank edge or build a scaffold.

NW Grainger 675-2544
sugar bag

Rick's Weaver 672-1100 610 @ lb

Tracy Caporti Building supplies
Wilson Supply 277 3700
Donny

Grandle Paul Sopkin 143 OSGA
230 8695

30 x 120 x 20 mil
25 7/64 $900

Stan still hasn't delivered
dumpsters. Fisher says
they don't have em & will
have to build em. Will
call Mel (2) by noon Tody,
(4) by Noon Tomorrow

Prime Ordered Back hoe Tire Repair
Swap 2" centrif for
3" Diaphram
Replace 3" suction hose
Buy (50) sandbags
(40) T posts
~~Sept Salt & fuel~~

Run F Vol Estimates

1" Reject	96 x 76 x 10
SD	34 x 66 x 10
SSD	94 x 66 x 13
MCD	124 x 90 x 13

Began loading Pile 2 & 4

Rain began during Pile 4 load

Covered all open piles &
waited for rain to stop

3:00 Rain & lightning has settled
down, covering pads &
vac engineer & pump storm water
to frac tanks

O'Brien & Gundle 300 premium to
get him to Thurs night

SWACO crew left @ 500

BRH & CORE stayed till 6:00
to pump down pads

4/8/93

010170

Supervisor mtg.

Ordered new 3" diagh pump &
return two 3" centrif's to Pecos

300 BBL left in G 22 and
300 BBL left in East Tank

SWASCO will pump recycled water
in to East tank

Will order 1 addl tank for Monday

JACK STEVENSON x2718

Venture Trucking 915 7777 will
deliver liners & bill to
SWASCO, SWASCO will
bill Bean

010170

Met w/ Lorenz to Discuss
Discussed Final Report

Discussed which samples to
Hagen
C
F
G Tar not to be
~~composited~~

Discussed naphthalene in water and
surf build up, may need
to group soap and carbon
for orgs.

Requested Ray to check dirty water
tank for HNO & O_2 meter
readings

010171

Conference Call w/ Redel, Hoppe,
" McDonnel & Ellerson

010172

N Cav. clean-up is being
reversed to 30ppm from 1ppm
by way of ESD or Amendment
Elbasco is prime

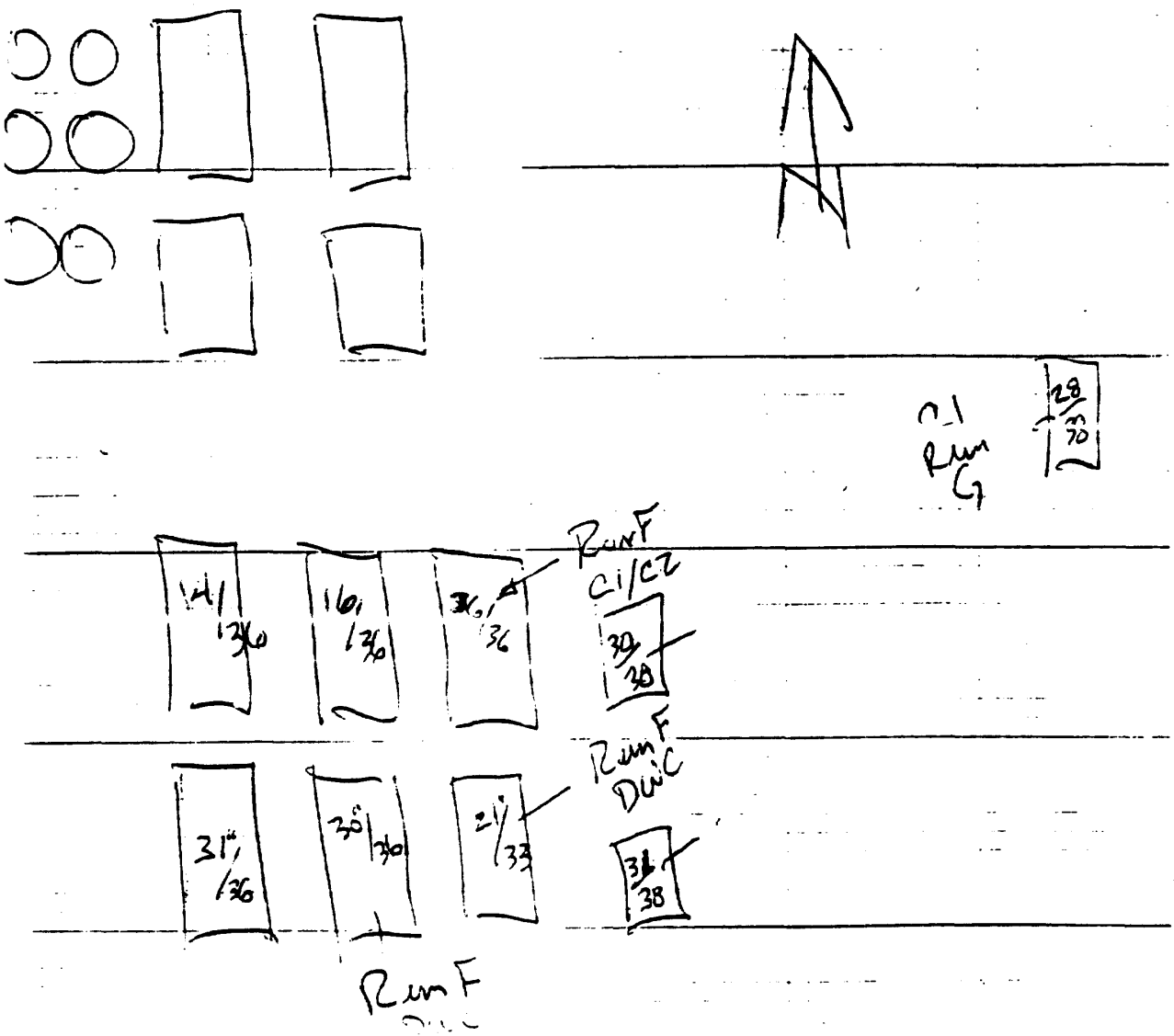
Discussed before wash data,
filtered solids & big chunk/
hand auger problems.

Discussed Hazen samples.

Discussed decon/demob schedule
EPA is pleased that we are
confident & moving forward
w/ each obstacle

SWACO unit operating as normal,
fire closed slurry tank to
remove remaining sand

Clear weather all day



010173

6:30 Near completion CORE 1
BKH Home

CORE MASON 7-6:30
Roland 7-12 2:30-6:30

010174

4/9/93

010175

Planned Activities

Collect Hazer Samples

Gage dumpsters

Measure Run G Volumes

Begin Decon

Liners on Pads

Empty sand from sumps

Order Frac tank for monday

Order shiny bucket backhoe

Make Vol Measurements on ~~the~~ mud tanks and rubble piles

Overnite filled boots to CLT

Supers Mtg

Advised Chas of wash down, flange breaks, etc during decon

Chas will have to shut off fresh water @ 2 PM to 4 PM today

Roland not in today

Gathered Hazer Samples

Pump ~~Sample~~ Volumes

1" Regen 48 x 90 x 14

SD 143 x 120 x 18

SSD 72 x 105 x 17

MGD 67 x 100 x 11

+6" Vol Est

17 cy for all sort combined

010176

Monday Activities

Remove sand from sumps ✓

Order Frac tank if req'd

Order dumpsters (5) if req'd — Star Dumpsters 861-4999

Hold Supers meeting ✓

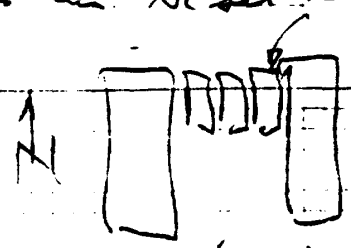
Hold SSB ✓

Forward bruces file box & boots to CLT ✓

Add sand bags to soil pads as req'd ✓

Police site for dropped soil ✓

Decon plywood soil boxes & wagon. ✓
like others but more en
so frac tank can be set there



Get Hagen Supply ready for shipment ✓

010177

Gage all dumpsters/drums that aren't done yet

Stock pile more soil on soil pads & estimate volume

Stock pile more debris on soil pads & estimate volume

Once the soil pads are "done", drive T-posts & put up temp fencing

Make sure all equip is brushed/blasted and pumps are flushed internally same for all hoses

Regrade the area just N of GWTP and leading to the Sea Tran containers, do not dig, there are water lines in there!

Use crane hands to help SWSCO Turn them over [illegible] if appropriate

Move vesquam pile off of SWSCO pad, ~~decon the bam stuff & put it in [illegible] where it is going~~

Stock pile dirty organics in burrito on soil pads, clean stuff will be removed

Hold the line on Exclusion Zone Violations, eating, smoking, dust control etc.

Insist on splash shields where appropriate

010179

Monday 4/12/93 Weather Overcast, warm

700Am Arrived at Site

Held SSM, Supervisors Meeting

Calib. PID

2 New Hands from DKM Lone Services

730 AM Started to Clean Sumps & pump water from DeLon Pad

Put Dirty Plastic in southern end of eastern soil containment pad (wrapped in Burrito)

SWACO's Activities ⇒ Remove some equipment & run DWC until no soil Rests in system

Charles Group - Ditto from last week

Called Bobby Barientos to have Samples picked up (will pick up around 5PM)

Called Star to order two more dumpster

Called Baker Tanks to order 1 more Frac Tank (should be here around Noontom

Called Mobile to set a Vacuum Truck out to site for tomorrow

(Set-after 2pm)

Hands took plywood boxes & cleaned them up & wrapped em in plastic

Also More boxes to make room for frac tank

010180

Monday [illegible]

5 PM Weather sunny, hot

locking up pumps & preparing to leave site

4:45 (Chester picked up samples from site)

Tomorrow Activities

Put up fence

Grade ruts from site

[illegible]

Robert, Todd & Roland

010181

4/13/93 Tuesday weather overcast, muggy

010182

700 Am Arrived at site

Held SSM, Sup. Meeting

Calib. PID

Talked to Bruce Hickman in Charlotte

→ Divide up Hazen Samples

→ put 1/2 of water & bottom sludge from Decon Area frac tank to another tank so SWACO can floc. the solids from it

→ take pictures of DeMob.

→ Bill vac-truck directly to Beazer

SWACO cont. to Decon equipment & run flock system to remove solids from water

(713) 932-9021

900 Am J.H. Walker truck arrives to pick up pallet of 5 Gallon Plastic Buckets

In Conversation w/ Clyde of J.H. Walker & Steve Radell w/ Beazer it is decided that the shipment does not need placards.

1130 Am Truck Leaves w/ 8 Buckets of Run E Material & bucket of Reject Material

1 pm Called Prime Equipment to come fix pressure washer

2 pm Mobley Vacuum Truck Arrives

1145 Am Baker Tanks delivers one Frac Tank (G-28) & sets it between 2 soil containment Pads

Cont. 7 — 530

1st → Mobley will transfer water from Tank G-21 to Tank G-28

Need to Talk to Bruce about
→ Water that will contain Muratic Acid on water treatment pad (How to dispose?)
should only be 5-6 Barrels
(TWC Permit pH 6-9 (Range))

→ Cove Hands who to keep & how long?

→ transfer Free Tanks ~~to~~ (2 Sprint tanks) to Beazer's Name from SWACO's Account

→ MI Drilling Fluids (DeFoamer) Empty buckets How to dispose of?

530 Left Site

Tomorrow's Activities

→ Make room on soil cont. pad for soil being expelled from SWACO's Decon procedures

→ Move Dumpsters as needed for DWC material

→ Finish Fence around Eastern Soil Cont. pad

→ Grade soil north of water treatment area

→ Help SWACO Hands

010183

Weather Overcast & windy

Aug 6 Wednesday Arrived at Site 700AM

Held SSM, Calib. PID, Held supervisors meeting

To Do → Pump water from DeCon Pad Sump before storm

→ Regrade Site

→ Move plywood boxes to area where they won't be in the way

→ open all Defoamer buckets & rinse & throw away

→

SWACO → Crane & Trucks removing equipment
All equipment has been pressure washed outside & flushed w/ clean water prior to removal from site (Good DeCon)

GOWEN → Acid etching concrete water & acid will be pumped into Frac Tank

→ Painters DeMob

→ Heat Tracing

→ running pipe

Mobley Onsite at 730 AM
Pumping water from DeCon Pad Frac Tank into (G-28)
~~Then~~ Very little sand in bottom of tank G-21.
Now will pump all water from Frac Tank G-49 into Tanks G-28, & G & Tank G-21, to make room for Swaco to transfer water from their

010184

1200: Left Site to eat & get disposable camera to take pictures of DeMob

1200: Back to Site

John meeting w/ Flow, Daniel (EPA-Rep.) visits Site to inspect water treatment unit

1300 Beazer Folks visit site

~~John Helton, Steve Rudelly & Mike Salinski~~

Steve is concerned with heavy metals from Tank G-49 (only stormwater that was analyzed) being spread to other tanks with moving liquids w/ Mobley Vacuum Unit

He thought treatment unit would not remove metals

17:00 Mobley Done w/ ~~Pro~~ transferring fluid from G-49 to G-21

15:30 Mobley Decon tank & hoses prior to leaving site

Released Mobley (730-530) 10 hours wed

Tuesday hours 200 → 530 3.5 hours Tues

Mobley → 13.5 total hours

SWACO still Deconing System

SWACO ~~[illegible]~~ a good floc this afternoon

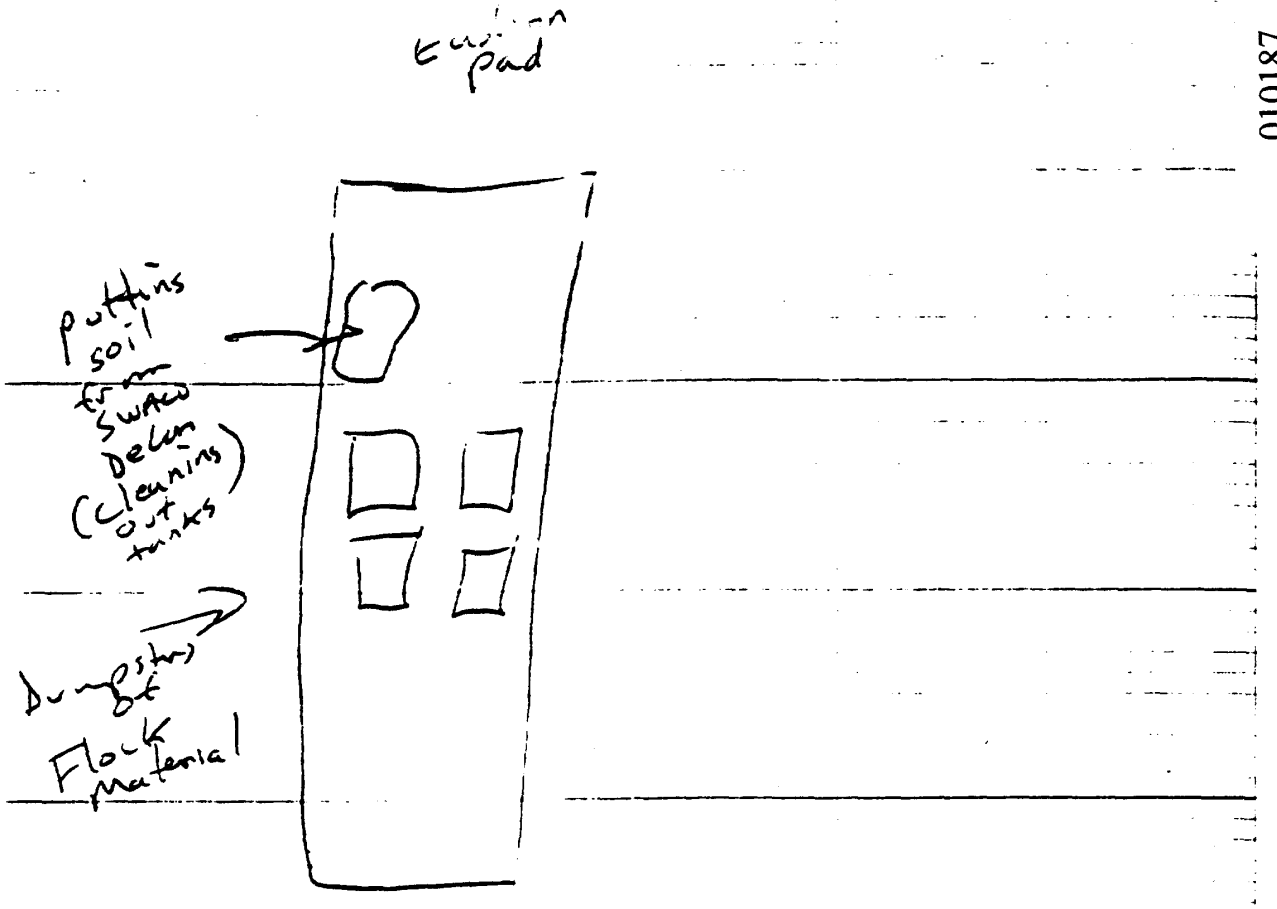
Collected Recycle water Sample at 430 to submit to Chester Labs

Core Service 7 – 1:30

010185

SWACO Flocking water from Sprint
Frac tank & putting water fraction
into Baker Frac Tank G-49.
Will continue to Flock tomorrow.
Estimated finishing of complete De Mob
Friday.

010186


Excavation pad
putting soil from swale Delan (cleaning out tanks)
Dumpsters of Flock material

010187

Thursday 4/15/93 Arrived 700AM

Held SSM (Met Todd w/ Lane Service)

Held Sup. meeting

SWACO Acts. ⇒ Demob

Gowen ⇒ Ditto

Calib. PID

Todays Activities Move Trash Dumpsters w/ Flock Material to Soil Cont. Pad (Eastern)

Use Bobcat to move soil from SWACO's De Con to Eastern Soil Cont. Pad

Talked to Nathan Youtsley, who will replace me for tomorrow (Fridays) activities

400PM Glenn w/ EPA visits, No problems

500PM Left Site

010188

010189

Friday 4-16-93 N.O.4 on site 0700

Weather: clear, cool, calm 65° F

0710 Hold Site Safety Meeting

Todays activities:

- Decon Pumps
- Remove conveyer belt
- ~~Remove large frac. tank~~
- Mob out large crane
- Clean up area (exclusion zone)
- Finish fence around soil pad
- Paint water treatment equipment

0720 Safty meeting completed.

Begin preforming today activities

Calibrate OVM

0900 Large crane operator arrives

1000 Move large process unit over

pick up slurry mix tank

placed on tractor trailer rig

1130 Setting process unit on trailer

& ~~conveyor belt~~ conveyor belt

1145 } lunch
1245

1245 SWACO & Cole Todd } scrape up

excess ~~dry~~ soil & place on soil pad

1445 NO 4 & Todd } safety fence around

~~soil pad~~

SWACO begins pressure

washing soil washing pad

1700 ~~Equipment~~ ~~soil washing~~ 3/4 clean soil covered, NO EXITS

Monday 4/19/93 Arrived at site 715.
Weather = overcast, warm, humid ±70°F

Held SSM, Calib PID, Held Supervisors Meeting

Todays Activities

- Finish Flocking water in Frac Tanks
- Clean soil washing Pad
- Put up Fence around eastern soil Cont. Pa
- Return Prime Equipment (Need to determine which equipment is leased to whom)
- Sample Frac Tanks

7:40 Begin performing todays activities

(Bobcat has flat tire)

10:00AM SWACO arrives & organizing pumps & hoses

10:30 Sampling 3 Frac Tanks for TWC permit
Analysis G-21, G-70, G-66

11:30 Finished Sampling 3 Frac Tanks

Talked w/ Bobby Barrentos & said Sample kits will be ready around 3PM.

Talked w/ Eric w/ (Prime Equipment Rental) to organize equipment return.

Prime will pick up equipment tomorrow morning.

* (Need to measure piles that Todd made on eastern soil containment pad)

2:30 Delivered Frac Tank Water Samples to Chester

3:00 Returned to site → De Lon Decon Pad
Put up equipment (in Sea Train)

From Left Site
SWACO left site at 4:30PM

010190

Notes

SWACO waiting on chemicals to Flock rest of water, so SWACO hand Gerald left until Wednesday Morning when they will start to Flock

Tomorrow will sample rest of Frac Tanks

Storm water

Total costs →

Tuesday 4/20/93 Weather cloudy warm humid

7:30 AM Arrived at site
Gave Safety orientation talk to two new workers on treatment system (pipe insulators)

8:00 AM Preparing sample containers for Frac Tank Samples
Will sample Frac Tank G-28,

Calibrated PID (99.9 ppm)
Talked with John Helton & Charles, I need to clean out DeCon Pad Sump better.

9:00 AM Visually inspected Frac Tanks FM-13, FM-36, & G-49. (Tanks at rear of site)
All appeared to contain sludgy material (water with high solids content). Need to talk to Bruce about sampling needs & requirements at present time for these tanks. (Probably need to wait til SWACO is done Flocking all material.

11:00 AM Worked on Removing all remaining water & soil from DeCon Pad Sump.

1:45 PM Left site to take samples to Chester Lab

010192

[illegible] Tuesday [illegible] Weather [illegible] mild

720Am Arrived at Site

Talked w/ John Helton about Frac Tank Samples

In Conversation he said Steve Radell wants to test the Frac Tank contents for only VOC's & metals.

730 Am Put in Call to Bobby Barrentos to tell Chester Lab. Left a message for Bobby to call me.

Held Safety Meeting, Calib. PID.

Todays Activities SWACO Flocking contents of their 2 Frac Tanks

cleaning western sump of soil washing pad.

8:00Am Talked w/ Bobby Barrentos (w/ Chester) about Sampling Frac Tank Water. Operations plan Appendix A Table 2 has list of analytes needed for soil washing water.

8:20Am Talked w/ Bruce about sampling & he said he will talk to Steve Radell about what analyses are needed.

9:[illegible]Am Talked w/ Bruce & w/ Bobby Need to find out what chemicals & polymers SWACO has used & test for those constituents

10:00Am Called John Monte w/ SWACO & was informed SWACO is still experimenting w/ flock polymers

010194

10:30 Left site [redacted] to office
weather sunny mild

Decided that Dust Monitoring was
unnecessary + will return ~~Dust~~ Meter
Thursday

Thursday 4/22/93 weather sunny mild

6:45 Arrived on site.

Today's Activities:

[illegible] 2 Frac Tanks

clean out sump

Water Treatment System start up work

7:00 Am spoke w/ Joe Wilky w/ Chester about safety precautions around acid & caustic pumps & systems in water treatment system. He suggested a plexiglass shield in front of the three pump systems which introduced Acid, Caustic, & Polymer into system. Also spoke of protective covers over flanges to prevent spray of substances when flanges leak.

7:15 Held Safety Meeting, Calib. PID

Waiting for SWACO.

8:30 went to return dust meter & run by office

9:30 Returned to Site

10:30 SWACO Arrives. Talking w/ Gerald he informs me that → the chemicals for flocking will arrive around 3PM. SWACO hands & Gerald have come up with chemical balances for good flock. The time to flock each tank will be approximately 1 Day / Tank. That puts SWACO finished around Monday Evening.

010195

11:30 Pumped water from western sump of soil washing pad to eastern sump of that same pad.

13:00 Shoveled dirt from bottom of sump into back hoe & placed in pile 121 on eastern soil containment pad. (1 bucket load of soil (backhoe))

15:00 RT. w/SWACO arrives. Transferring fluids.

15:00 Chemical arrives for flock (polymer) from Clark Chem. Co. David Clark wants 14 Gallons of typical water system would be flocking

18:00 Took PID Readings

18:30 Left Site

Tomorrow

- SWACO to Flock Frac Tank contents
- I will clean out sump
- " " measure & find soil piles discussed w/D.
- Prepare soil cont. pad for dumpsters as flock material is put into dumpsters.

w/ John Helton

Discussed the need for PID & Dust Readings for start up of water treatment system. Beazer's HASP reads that Monitoring will be done at start up of system. If no readings are detected, then further monitoring is not necessary

No Dust Monitoring 7.13

8.0 Site work zones

Met w/ Dfm Core Services - Keith Luttrell & James Knight.

Starting Friday they will have several Core Service hands installing a water pipe system from the collection trench to the treatment system

4/23/93 Friday

Arrived 7:00 A.M.

Held SSM Calib. PID

Drill Crew Service Hands

— James Knight

— Todd Towns

— Kevin Dowdy

Need to have certificates for files

James will have them faxed to the trailer

Held Supervisors Meeting

SWACO - will get pump to add Gel to Flock system - Prob. start to flock around noon -

Peters - (water treatment) - running city water through system (start up work)

Charles leaving site around 9AM for weekend

7:30 AM measured soil piles; information on next page →

8:00 AM SWACO cleaning one frac tank (Southern Sprint) to prepare it for the water generated from Flocking Northern Sprint Tank.

9:00 AM Pump arrives (to load gel into Flock system)

13:00 Move 1 trash dumpster from Flock Unit to Eastern Soil Containment Pad (material is DWC from Frac Tank (Southern Sprint))

14:00 SWACO rinseing out southern Sprint Frac Tank to prepare.

16:00 Cleaned out sump on ~~east~~ western end of soil Washing Pad

010198

1" Rec. Run for pile 29

70" x 40" x 16"

Pile 1 Runs into other piles

70" x 35" x 18"

Pile 1 & 3 one in one pile 86" x 80" x 20"
Reject from
Run A
Run E

pile 9 86" x 42" x 5"

pile (2)
152" x 65" x 20"

Now all storm water that falls on to the soil washing pad can be pumped out onto the ground.

Talked w/ Bruce Hickman + John Helton about SWACO working on the weekend. Bruce thought that since they are 40 hour trained, a DPM rep. does not need to be present. John said it was our call. I left my phone # w/ SWACO in case they need me.

010199

20:00 Left site

painters are paintin concrete pad.

Note: The PID (OVM) was turned in today because no readings have detected any OVM's present anywhere on the site since the soil washing process (loading dirty soil into system) has been finished. According to Beazer's HASP once this is established, there is no longer a need for Air Monitoring. The next Air monitoring will be needed when the water treatment systems starts processing water from the frac tanks on site the water from the collection trench.

010200

4/25/93 Sunday weather overcast warm

13:00 Arrived at Site, Gerald was DeConing surface equipment hoses etc. He had finished flushing earlier that morning. Water pressure was lower than normal, making the pressure washer less effective.

13:30 Left Site

4/26/93 Monday weather sunny mild

700AM Arrived at site

7:30 Held Safety Meeting

Discussed w/ Cure Service about using care when around frac tanks.

They are laying pipe from collection trench to water treatment system.

SWACO To Finish De Con & De Mob all equipment - Informed of low water pressure.

Peters start up water treatment system

8:00AM Pumped water off soil washing pad: western end. That sump had been DeConed on Friday. Water was pumped off north end of fence line & had very little to no sudzing. Water on pad & being discharged appeared clear & clean.

~~Informed~~

8:30AM Talked to Bruce Hickman & then Troy Hopper about water pressure. John Mantle w/ SWACO will look for problem in the water lines.

9:00AM Troy Hopper calls plumbers to fix. Will be to site at 300pm.

10:00AM SWACO cleaning out Flow Tanks w/ dirty water from soil washing pad

11:00 AM SWACO Disconnects power supply to soil washing pad

010201

12:00 Water pressure on soil washing pad is good enough to clean truck & equipment, so Gerald is cleaning equipment.

14:30 D&M Core service is finished w/ laying pipe. We use two core laborers for 1 hour to help SWACO move equipment barrels, & Trash Dumpsters. Last Dumpster on soil containment pad

15:30 Dea McDonald informs me that plumber that came to site was not qualified to work on back flow preventers (our proable problem). So the availability of water is unknown. We need to decide weather to have crane & trucks ordered for tomorrow.

16:00 Status of water (for tomorrow) unknown. City has been contacted & may address situation tomorrow. SWACO says they can have cranes & trucks here within ±3 hours notice, so tomorrow SWACO will use cutting torch & cut equipment. Then there is nothing else they can do without water source.

15:30 Left site.

Weather sunny warm

010202

4/27/93 780 Am Arrived at Site ; weather Sunny mild

SWACO Cutting equipment w/ Torch

DeCunning Equipment

cleaning eastern sump & pad of soil washing pad

Peters Start up

Cure Service Hands were released at 330 yesterday

8:30 Cleaned out Sump & put soil on eastern soil containment pads pile 125 see map

11:00 Am Finished with cleaning sump. Waiting for city water to be turned on.

Note: Dea McDonald talked to City of Houston Water Dept. at about 930 AM & they informed him the water dept. worked on the system at the road over the weekend & did not turn the water back on. They informed Dea that a crew would fix very soon (emergency status).

13:30 water back on. Gerald called SWACO shop to line up crane & trucks. SWACO will call back in 20 minutes.

weather partly cloudy, warm

Gerald starting to DeCon Equipment & Pad

15:00 Crane arrives

15:15 First Truck Arrives

Start loading equipment

18:00 SWACO Completed scale

~~18:30 Left Site weather overcast warm~~

010203

4/28/93 730 AM Arrived at site
weather overcast mild

Todays Activities

Clean soil washing pad
Finish Fence around eastern soil Cont. Pad.

Talked to Bruce about Barrels on Washing Pad
- He Suggested I put them on the soil cont. pad -

10:00 AM 3" Diaphram Pump Springs leaks
Called Prime Equipment to replace & also to have Prime pick up all hoses, pumps & pressure washer.

11:00 AM Put extra samples (soil & water) on containm pile. Put 4 drums of process waste, and 3 half empty drums of surfactant, and assorted 5 gallon pails (2 w/ Bent. Gel) under plastic on eastern soil containment Pile

12:00 AM De Loning Soil Washing Pad & hoses, & 2" pump. (Getting ready to return to Prime).

13:30 Talked w/ Gordon at Star to have him pick up the extra dumpster. He said we have a total of 15 dumpsters.

16:00 Finished De Lon Soil Washing Pad
Sampled Collection Trench Well

16:30 Left Site

Tele con Mike Borst 4/2/93

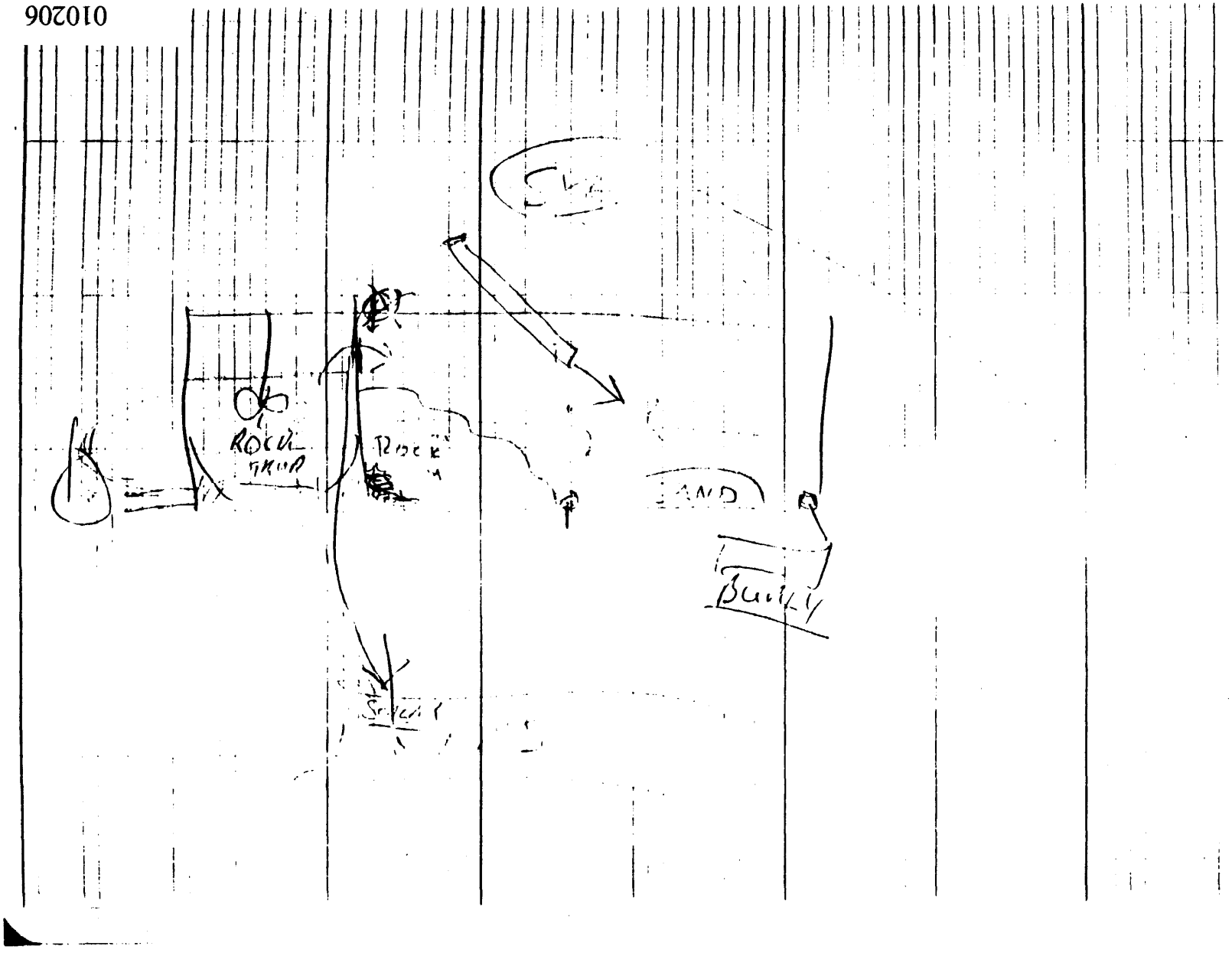
MB needs only 5 data pts
U are valid & data
& that [illegible] with
results don't add to
what we already knew

Liked my idea of grouping separate
processes

Agreed to be active in on
process selections

Mike wants to see our flowsht
soon

010205


010206
ROCK
TRAP
ROCK
LAND
BUNKY

010207

Piles	Associated Run
3 + 6	A
5	B
9	C
7	D
8	E
1 + 10	F
2 + 4	G

Measurements of 4 Dumpsters & 12 Barrels

all Barrels Run A piles 3-6

DWC DWC DWC

23 18 16

C-1 C-2

DWC

DW 19 20 24

C-1 C-1 C-2

23 13 16

C-2 C-2 C-2

12 23 24

pile 9 C-2 12/33

29/33 ?

14/42 pile 9 C-1

25/33 DWC Rand

(23) totals inches of soil in Barrels

(28) Soil Pile from Dumps 12" x 12" x 6"

Measurements	of Dumpsters
120	31/36
123	30/40
124	20/33
125	18/36

126

010208

Design Comments

Pour concrete apron near trash chutes.

Longer Decon pad

Better solution than vinyl "burritos"

010209

5 Gallon Buckets Sent to Frozen

Run	Collect	# of Buckets
Run E	SD	2
"	SSD	2
"	MCD	2
"	C1/C2	2
F	SD	2
"	SSD	2
"	C1/C2	2
"	MCD	2
G	SD	2
	SSD	2
	C1/C2	2
	MCD	2

1st Reject [illegible] Fig 1

010210

Pile 100

150" x 102" x 23"

Misc Soil from surface cleaning out Tanks (Sandy)

010211

CLEAN SOIL LOCATIONS

(1) +1" from reject screen to Pile #3 + 1" reject Run E

(2) Hand picked debris from Pile #6 } Pile 5

(3) C1/C2 stockpile Pile 3 & 6 22' x 55' x 13'

(4) +8 mesh, pile 6-13 [illegible]

(5) Run A Drum + 1" pile is 16'x12'x8'

(6) Drum [illegible] Drum [illegible] marked

(7) MCD, Run A 9'x52'x5'

(8) SSD, Run A [illegible]

(9) DWC, Run B

(10) C-1 Run B

(11) C-2 Run C

(12) DWC Run C

(13) DWC Run D

(14) C1/C2 Run D

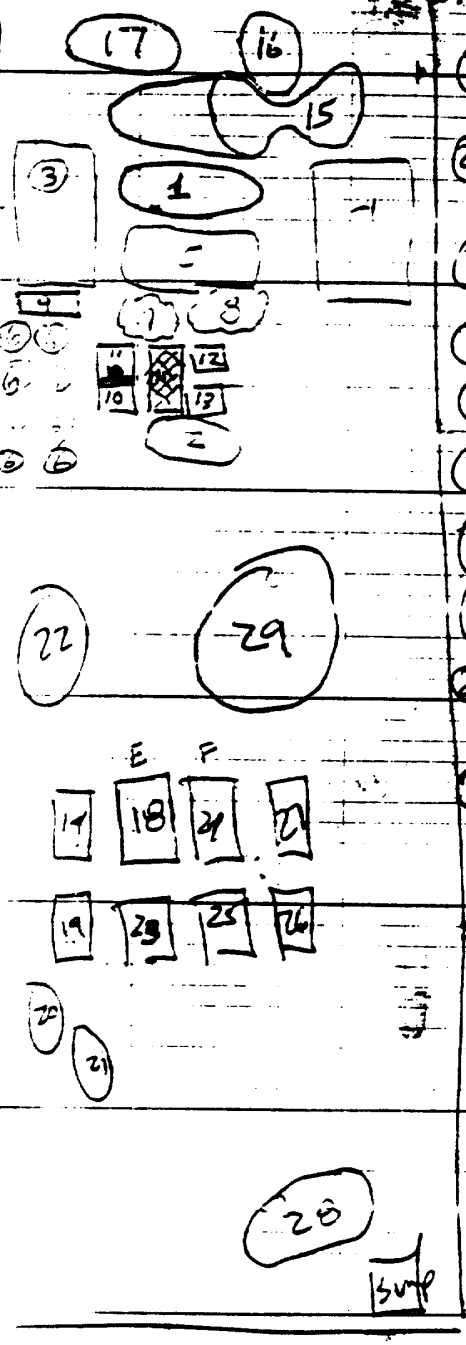
(15) SSD Run E

(16) SD Run E

(17) MCD Run E

(18) C1/C2 Run E

(19) DWC Run E



(20) SSD Run E samples

(21) MCD Run E samples

(22) Run G, SD

(23) Run F, DWC

(24) Run F, C1/C2

(25) Run F DWC

(26) Run G DWC

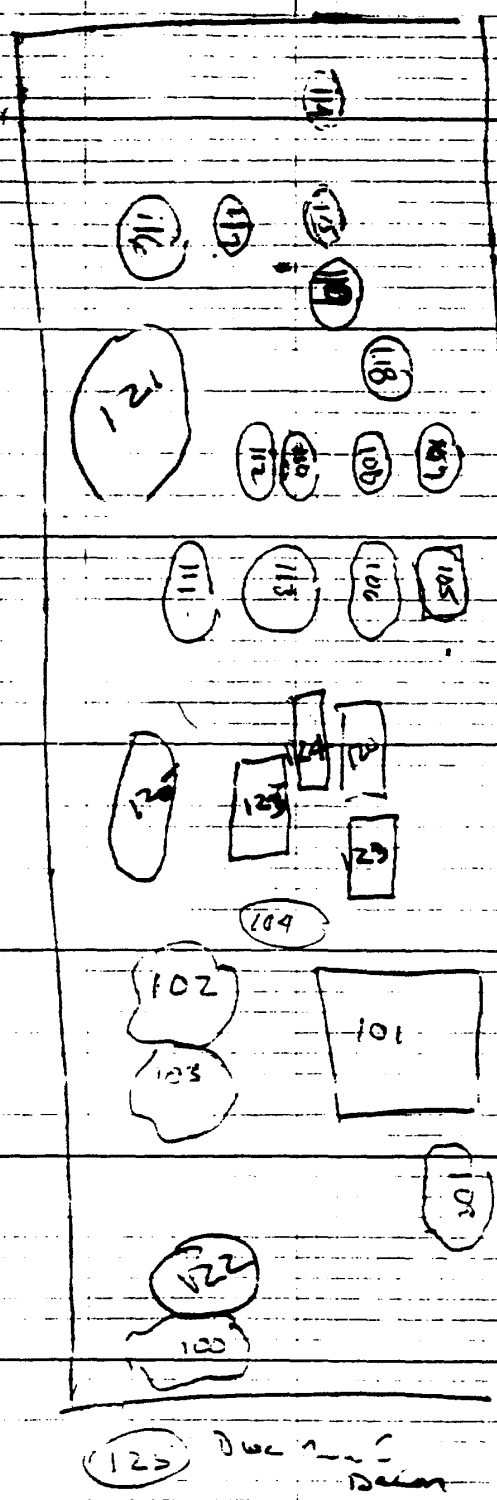
(27) Run G, C?

(28) Misc. soil from sumps

(29) 1" Reject Run G

010212

CLEAN SOIL LOCATIONS



(100) Misc. used plastic
(101) CI/CD Dust Run B
(102) SD, Run B
(103) MCD, Run B
(104) 1" Reject Run B
(105) 1" Reject Run C
(106) SD Run C
(107) [illegible]
(108) MCD Run C
(109) Multiple overlap
(110) Run D, SD
(111) Run D, 1" reject
(112) SSD, run D
(113) MCD, Run D
(114) MCD Run F
(115) SD Run F
(116) 1" Reject Run F
(117) SSD Run F
(118) SSD Run G
(119) MCD Run G
(120) Run G, CI
(121) Soil from decon procedures (Soil washing Pad)
(122) Used plastic
(123) DWC Run C Decon
(124) DWC Run G
(125) [illegible]

010213

	+10 mesh		-10m+200m		-200m	
	PPM	Wt%	PPM	Wt%	PPM	Wt%
1	543	12	742	25	.043	33
	260.00		185.5		.014	
2	1369	81	2043	11	2310	8
	1108.89		224.73		.1992	
3	553	44	1526	29	0.111	27
	243.32		442.54		.029	
4	21	10	25	44	.023	46
	2.1		11.0		.013	
5	123	8	52	38	NA	54
	9.84		19.76			
6	15.51	3	125	61	0.117	36
	.465		76.25		.042	
7	3.553	2	70	76	0.310	22
	.071		53.2		.069	
8	94	6	197	72	0.634	22
	5.64		141.84		.134	
9	23	3	99	67	0.040	30
	.69		66.33		.012	
10	144	6	72	44	0.023	45
	8.64		35.28		.010	

010214

Total PPM

415.5

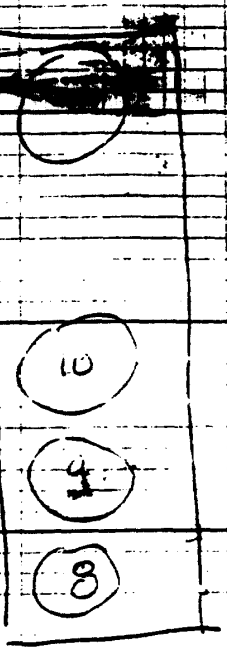
1333.80

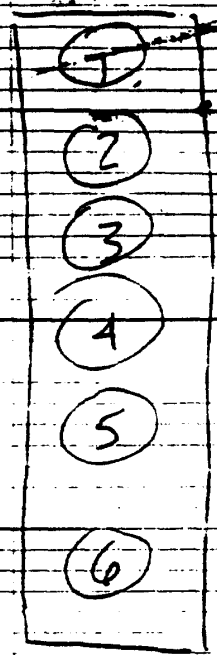
685.99

13.11

~118.16

76.76





10x10x3 @ BORING 26

10x10x3 @ BORING 23

10x10x3 @ BORING 22

CALL 10:00 EST

53.34

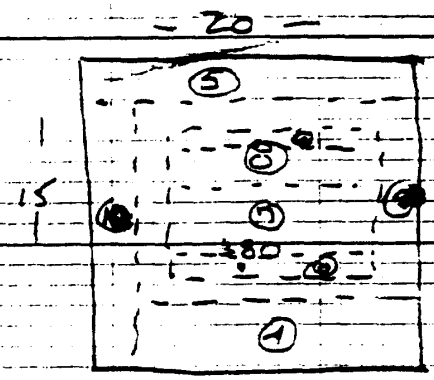
SAMPLE #:

<C - DIT - (DILE #)

147.62

67.03

43.93



6 ft deep

010215

010216

Appendix G

Response to EPA Comments, December 16, 1993

010216

Response to EPA Comments
Soil Washing Pilot Study Report
REV O December 16, 1993
Beazer South Cavalcade Superfund Site

EPA Comment No. 1

We could not draw any conclusions regarding the SWACO process because we did not find a correlation of the influent cPAH concentrations to effluent cPAH concentrations or a mass balance (In the RDWP, "Treatability Study Work Plan", BEI agreed to perform a mass balance, page 4-14). Concentrating contaminants into a soil fraction(s) is a fundamental soil washing objective; however, from the data BEI submitted, we could not conclude that contaminants were concentrated into any soil fraction(s). Please further explain how BEI selected the proposed aggregate classification shown on Figure 5.

The difficulties in obtaining reliable starting soil concentrations is discussed in Section 5.2.1 of the PSR. In response to your comment, we have prepared three additional tables to present before and after data as described below.

Table 7: **Before and after concentrations of the soil after washing by SWACO. Based on calculated composite concentrations using the lab data for the individual soil fractions.**

Table 8: **Before and after concentrations of the individual soil fractions. Resulting concentrations for SWACO's washed soil and Hazen's "floated" soil are presented.**

Table 9: **Before and after concentrations of the individual soil fractions associated with SWACO's Test Runs E, F, and G and with all of Hazen's gravity separation tests.**

As required by the RDWP, mass balances were performed. Three treatment scenarios were compared and the mass balances are presented as Figures 6, 7, and 8 in Appendix B of the PSR. These mass balances were used to select the preferred treatment flow scheme shown in Figure 5, Revision 0 (attached). As further response to EPA's question about mass balance, a mass balance has been prepared for SWACO's Test Run E (Figure 12) as an example of what the SWACO tests produced.

EPA Comment No. 2

We did not find where the report described the management and disposal of all contaminated material such as oversize debris, gravel, soil extracted during each process. In the 30% design, please specifically describe how material will be managed and disposed of. Is it BEI's intent to use all contaminated soil fractions in a cold mix bituminous paving mixture?

The management and disposition of the debris, gravel, and other washed soil fractions, discussed briefly in Sections 6.9 and 6.10 of the PSR, will be further addressed in the 30% design phase. In response to your comment, we have revised Figure 5 (attached) to indicate the destination for each stream. The coarse aggregate (minus 2½", plus ½"), washed aggregate (minus ½", plus 10 mesh) and froth solids fractions are proposed to be used in a cold mix bituminous asphalt mixture.

EPA Comment No. 3

Reference Table 1. Why was the gravel fraction not included for sample SC-PW-2?

The gravel fraction was inadvertently omitted. The missing data is provided below and the revised Table 1 is attached:

Sample ID	**SC-PW-2(+10)**
Sample Description	**Pile 2 Gravel**
Total Pot. cPAH (ppm)	**1240**
Weight %	**79**

EPA Comment No. 4

Reference Table 5 and 6. Does the "pile number" in Table 5 correlate to the "run number" in Table 6.

Ten test soil piles were created during the test soil excavation for use in the soil wash pilot testing. Due to varying quantities of oversize materials in some of the piles, the piles were grouped as noted below for the test runs to ensure sufficient soil entered the process.

Run A	**Piles 3 & 6**
Run B	**Pile 5**
Run C	**Pile 9**
Run D	**Pile 7**
Run E	**Pile 8**
Run F	**Piles 1 & 10**
Run G	**Piles 2 & 4**

EPA Comment No. 5

Reference Section 5.1.1, "Particle Size Distribution". We are not sure we agree with BEI's conclusion regarding the "skewed" results shown in Figures 8, 9 and 10. Please further explain the significance of Figures 8, 9 and 10.

We believe Figures 8, 9 and 10 graphically present the problem of attaining accurate data from the pre-washed soils. Figures 8, 9 and 10 present a comparison of the pre-washed and washed soil particle size fractions. The pre-washed soils vary significantly in particle size distribution from the washed fractions. We feel that the particle size distribution of the pre-washed soils is skewed due to the tarry nature of the soil and its tendency to agglomerate. Sieving of this material was very difficult and unreliable.

Consequently, we believe the data generated from the pre-washed sampling, including soil fraction weight distributions and analytical data, should be used with caution. We believe the washed fractions yield more accurate data and the remedial design process, civil and mechanical activities will be based on this data.

EPA Comment No. 6

6a. *Reference Section 5.2.1, "Pre-Washed Soil". During full scale operation, will BEI characterize feed soils as described in Section 5.2.1? Also, please explain how BEI will ensure the difficulties encountered during laboratory testing will not be repeated.*

No, Beazer will not characterize the soils from the full scale operations as performed for the pilot study. No sieving will be performed and feed soil analyses will likely be performed only when necessary, using field test kits or an onsite laboratory. The details of the sampling and analytical procedures will be presented in the RD submittals. Analysis of the washed soils was not difficult as noted in Section 5.2.1.

6b. *Please further explain why the report concludes that the "....analytical data from the pilot testing demonstrates that many of the washed soils meet ROD goals...," reference the last sentence on page 16. Since it does not appear that a mass balance was performed, how was the fate of the contaminants accounted for? Since there is no correlation to the influent concentration, is it possible that the results indicate that there may not have been any real contaminate reduction in any fraction?*

The most important data used in our concluding the success of the tests is presented in the new Table 8, in the last two columns. These data show the significant reduction of COC's from the SWACO washed material after floatation tests by Hazen. Potentially cPAH reductions of 70% to over 90% were achieved in the floatation tests. Also, as noted in our response to EPA Comment No. 15, three mass balances were performed on alternate process flow schemes as presented in Figures 6, 7, and 8 of Appendix B. Contaminant fate and reduction of constituents is presented in Figures 6 and 7 of the PSR, in Appendices C, D, and F of Appendix B,

in Table 4 of the PSR, and now in new Tables 7, 8, and 9 prepared in response to EPA Comment No. 1.

EPA Comment No. 7

Reference Figure 4. We do not approve of the areas proposed for loading dock and conveyors. We have not confirmed that these areas are free of contamination since the limits of the contaminated soil were arbitrarily set halfway between contaminated and uncontaminated sampling points. We will require BEI to relocate any equipment or material which prevents the excavation of contaminated soil.

The conceptual layout presented in Figure 4, Rev A of the PSR represents the concept of efficient transport, minimized traffic, minimum labor, and keeps heavy equipment and unwashed soil handling in the areas closest to the impacted areas. These same concepts will be used in the final site design, but may result in a different configuration.

Regarding delineation of the impacted areas, D&M is currently preparing geostatistically generated delineation maps using the 265 soil data points produced during the RI. The geostatistical mapping will be performed using Theissen polygons as well as indicator probabilities to produce delineations of total cPAH's at three depths (0' to 2', 2' to 4', and 4' to 6').

The geostatistical delineation maps will be used to produce excavation plans for the RD. The site layout can then be finalized based on these pre-defined excavation cut lines. We will not locate equipment and materials in the excavation areas.

EPA Comment No. 8

Reference Figure 5, "Proposed Full Scale Process Flow Diagram". Please revise the diagram to show the expect cPAH concentration for each flow stream. It was not clear to us which of the debris and aggregate piles remain contaminated and how contaminated these piles are.

Figure 5 has been revised to include our anticipated potential cPAH concentrations in each stream. This figure has also undergone general revisions reflecting revised weight percent solids concentrations on various streams and an <u>optional</u> 80 mesh wet vibratory screen process. We feel this revised flow diagram more closely reflects what will be observed in the full scale remedial action. Note that the starting concentration of the feed soil is a "worst case" value.

EPA Comment No. 9

Reference Section 6.3, "Proposed Soil Washing Equipment Train," page 22. Please describe how the slurry discharged to the "55-gallon drums" will be reused.

The froth solids slurry discharged from the settling tank bottoms will be reused in an asphalt emulsion. The selection of containers for this material will be finalized by the RA Contractor during RD. Please refer to our response to EPA comment no. 12 regarding our position on the use of this and other soil fractions in a cold mixed asphalt.

EPA Comment No. 10

We did not find where the washed soils were tested for leaching potential. In the RDWP, page 4-14, BEI agreed to perform TCLP tests.

No TCLP tests were performed as part of the soil washing pilot test as indicated in Table 1 of the EPA approved Pilot Soil Washing Sampling and Analysis Plan. This deletion of the TCLP tests is fully supported by the results of the RI, wherein 265 TCLP tests were performed on the soil samples and none failed TCLP criteria.

EPA Comment No. 11

Reference the Hazen Research, Inc. report, Page 10. Request you further explain the data presented on Figure 2. Specifically, please provide an example showing how each of the data points was calculated. It was not apparent how the points on the graph correlate to the data in Appendix F.

The data presented in Appendix F, Tests 1 through 4, are presented in a graphical format in Figure 2. The floatation froth or recovered concentrate (Ro. Conc.) was collected at 5, 15 and 25 minute intervals during the run. The froth weight percent solids and pot. cPAH concentration were determined for each period. The data points graphed are simply cumulative values of the weight percent of the feed soil recovered in the froth (wt %) versus pot. cPAH concentration recovered. The following are the three data points for the Test 1 curve.

Data Point	Time (min.)	Cumm. Wt% of Feed	Cumm. % Pot. cPAH
1	5	25.9 (in froth)	43.5
2	15	38.7 (25.9+12.8)	72.4 (43.5+28.9)
3	25	47.4 (38.7+8.7)	81.8 (72.4+9.4)

The floatation data is the most important evidence presented in the PSR demonstrating the effective removal of potential cPAHs from the impacted soil sand fraction. The mechanical floatation bench scale tests indicate that from 50 to 90 percent of the potential cPAHs can be removed from the sand and silt fractions and concentrated in a floated froth.

EPA Comment No. 12

Reference Appendix C, "Recycling of Rock and Gravel". We commend your efforts to propose innovative disposal alternatives; however, we must be assured that any disposal meets the requirements of §300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy", Paragraph (a) "General" and Paragraph (e) "Feasibility Study", subparagraph (C) "Long-Term Effectiveness and Permanence". Paragraph (a) states "The purpose of the remedy selection process is to implement remedies that eliminate, reduce, or control risks to human health and the environment" and Paragraph (e) subparagraph (C) states "Alternatives shall be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful". Unfortunately, we do not believe that there is any means, over time, to prevent traffic from stripping the binder from the aggregate and releasing cPAH. Therefore, since permanence is not assured, we will not allow recycling contaminated aggregate into a cold mix bituminous paving mixture as a means to dispose of contaminated soil.

What is critical to the successful application of soil washing at the South Cavalcade site is recognizing that the process is most effective on the sand and silt fractions which make up a total average of 58 wt.% of the test soils. This 58 wt.% washed soil will be returned to the excavation as specified in the ROD. An additional 13 wt.% was present as clays in the test soils, 9 wt.% as gravel, 13 wt.% as rock and shells, and 7 wt.% as debris. These fractions totalling 42 wt.% cannot be returned directly to the excavation.

From these values it is evident that economical management of the remaining 42 wt.% of the soils is paramount to implementing a feasible remedial action. The proposed asphalt recycle option is based on this need for feasibility, combined with sound engineering judgment regarding asphalt design.

Regarding the permanence of the recycled asphalt and the binder it is important to understand the similarity of traditional asphalt components and the proposed recycled aggregate at the site. Both are produced from fossil fuels. Typical asphalts are a residual product of crude oil processing and are produced as "bottoms" (heavy hydrocarbon chains) in catalytic cracker columns and distillation columns in refineries.

Typical bottoms fractions from the refineries are used a fuel oils and asphalts, and are heavily laden with PAHs. Typical feedstocks for wood treating operations are crude coal tars from coke plants. The crude coal tar is a residual material produced in the coke plant from the thermal distillation of coal.

From information on the feed stocks and associated by-products from crude oils and coal tars it is evident that the components of asphalts used throughout the country for highway construction, parking lots, roofing, etc., are similar to those present in soils at wood treating plants such as the South Cavalcade site. Further, most highways are hot mix asphalts which use stoddard solvents to shorten cure times. The proposed recycle process employs cold mix technology whereby a water based asphalt emulsion is used in lieu of solvent based. Consequently, because of the absence of solvent additions to the asphalt emulsion, the risk imposed by the recycled material is as low or lower than the typical asphalt parking lot.

Regarding the EPA's concerns on the effects of aging, it is again important to compare typical asphalt with the proposed recycle plan. The primary indicator for asphalt integrity is the Marshall Stability Test. Cold mix asphalts such as proposed for the recycled material produces asphalts with 125 to 150% higher Marshall Stability results than hot mix asphalt.

To further ensure permanence of the recycled material, Beazer is evaluating final use options that minimize long term degradation of the paving made from the recycled aggregate. Options being considered include subgrade preparation for the access road at the site, paving the area around the water treatment plant, and use as paving for recreational uses rather than truck traffic.

Beazer is also evaluating alternate management such as landfilling the material offsite and biotreating the material on site. Beazer will issue a letter to EPA presenting the preferred management method prior to the 30% RD submittal and invite EPA's comments and input.

In summary the following items support the proposed recycling plan:

- **Soil washing is not a feasible solution without the recycling option.**
- **The recycled material is of the similar origin as the typical highway asphalt.**
- **The proposed cold mix process does not use the addition of light end solvents found in hot mix asphalt used predominantly in highway construction.**
- **The proposed cold mix process produces a more durable (higher Marshall Stability) asphalt than typical hot mix processes.**
- **Beazer will submit a description of the preferred use/disposition of the recycled material to the EPA prior to the 30% RD submittal to ensure concurrence.**

<u>EPA Comment No. 13</u>

During the March 25, 1993, "Operations Progress Meeting," BEI agreed to provide a log of daily events as an appendix to the pilot study report (March 30, 1993, Memorandum "South Cavalcade Superfund Site, Site Visit and Pilot Plant Construction and Operations Progress Meeting, March 25, 1993"). We did not find such an appendix included with the report.

A copy of the D&M daily field log is attached as requested.

<u>TNRCC Comment No. 1</u>

Section 3.2, "Test Soil Excavation", Paragraph 1. Referenced Figures 3-1 and 3-2 do not exist.

These figures can be found in the Keystone Soil Delineation Report of August 1992 and are attached for reference.

TNRCC Comment No. 2

Section 5.2.2, "Washed Soil", Final Paragraph. Please specify which sample discards/discharges were used to measure the different soil classification categories.

Scalper Discharge (SD)	**Washed gravels were discharged as oversize material from the scalper shaker (approximately minus 1", plus 10 mesh)**
Super Shaker Discharge (SSD)	**Washed sands were discharged as oversize material from the SS screen (approximately minus 10 mesh, plus 150 mesh)**
Mud Cleaner Discharge (MCD)	**Washed sands were discharged as oversize material from the MC screen (approximately minus 10 mesh, plus 150 mesh)**
Centrifuge Discharge (C1/C2)	**Fines were discharged as solids from the centrifuge (approximately minus 150 mesh, plus 325 mesh)**
Dewatering Centrifuge (DWC)	**Fines were discharged as solids from the centrifuge (approximately minus 325 mesh)**

TNRCC Comment No. 3

Section 5.3.1, "Characterization", Paragraph 1. Change "Ph" to "pH".

Acknowledged

TNRCC Comment No. 4

Section 5.5, "Hazen Equipment Performance, Paragraph 1. It is difficult to determine the total number of test runs that were conducted from the information provided in the Hazen Appendices. Please provide the total number of test runs conducted and contrast these numbers with the numbers of test runs that produced "clean" soils.

Hazen Research performed additional bench scale testing of various washed soil fractions to determine the effectiveness of heavy medium separation, spiral concentration, elutriation and froth flotation. The following is a synopsis of the tests performed by Hazen.

Test Performed	Run No.	Soil Fraction	Result
Heavy Medium	1	Rock	Clean
Heavy Medium	2	Gravel	Clean
Heavy Medium	3	Gravel	Clean (both sink and dense float material)
Spiral Concentrator	1	Sand	Clean
Spiral Concentrator	2	Sand	Clean (both concentrate and middlings)
Spiral Concentrator	3	Sand	Clean (both concentrate and middlings)
Elutriation	2	Sand	Clean, however, method was not as effective in removing pot. cPAHS from sand as floatation.
Floatation	1	Fines	Clean
Floatation	2	Fines	Clean
Floatation	3	Fines	Clean
Floatation	4	Fines	Clean
Floatation	5	Fines	Clean
Floatation	6	Fines	Clean
Floatation	7	Fines	Clean
Floatation	8	Fines	Clean
Floatation	9	Fines	Clean
Floatation	10	Fines	Clean

Note: "Clean" results indicate analyzed pot. cPAH concentrations less than 700 ppm. Please refer to new Tables 8 and 9 for more detailed data.

It should be noted that many of the previously washed fractions tested were clean prior to Hazen testing. The testing was performed to obtain quantitative data for alternative washing processes, and to incorporate these results in the full scale remedial design.

TNRCC Comment No. 5

Section 6.9, "Residual Streams", Final Paragraph. If hydroblasting is anticipated as the process which will be used to treat the debris that is larger than 2½ inches, then this treatment method should be evaluated well before the RA planning phase begins. In fact, a hydroblasting pilot test may be necessary in order to verify the process' applicability.

Hydroblasting was identified in the PSR as an option for treating the 6" debris because there are no other practical management alternatives for the variety of materials present in this fraction. The purpose of the hydroblasting would be to remove smaller particles and agglomerations from the surface of the debris. It is not necessary to test the ability of high pressure washing to meet this objective.

The final disposition of the debris and whether or not surficial hydroblasting is necessary, is primarily a regulatory issue that Beazer is investigating. The outcome of their investigation will be incorporated into the RD for the EPA's review.

TNRCC Comment No. 6

Figure 1 and Figure 2. Neither of these figures are consistent with each other, nor are they consistent with the current site layout. The North arrow orientation depicted in Figure 2 also is erroneous.

The north arrow shown on Figure 2 is in error. Future expansion will be to the north or top of the page on Figure 2. Figure 2 will be corrected. As you have noted, there is an inconsistency in the orientation of the office trailer in Figures 1 and 2. The orientation shown on Figure 1 is correct.