REPORT

Mound B Work Plan

OU-2 Drum Removal Riverfront Enhancement and Cover System Enhancement

Kin-Buc Landfill
Edison, New Jersey

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1. Introduction

In response to the United States Environmental Protection Agency's (USEPA's) December 9, 1999 "Conditional Approval Letter" regarding the Conceptual Plan for the Mound B area at the Kin-Buc Landfill, SCA Services, Inc. (SCA) has prepared this Work Plan to implement the major components of the Conceptual Plan. The September 1999 Conceptual Plan, prepared by Blasland, Bouck and Lee, Inc. (BBL), presented an outline for integrating a focused intact drum removal action at the Mound B area with enhancement of the adjacent riverfront and the existing Mound B cover system. This Work Plan provides details for implementation of the work, and addresses the comments contained in USEPA's approval letter.

1.1 Purpose and Scope

The purpose of this Work Plan is to provide engineering detail and construction-related design documents necessary to implement the beneficial reuse approach for Mound B identified in the Conceptual Plan. As requested by USEPA, the Work Plan also addresses the comments in the December 9, 1999 Letter under the general headings: Intact Drum Removal, Riverfront Enhancement, and Cover System Enhancement. Specific USEPA comments on the Conceptual Plan are addressed in the various sections of the Work Plan as indicated in Section 1.2.

Work Plan implementation will also simultaneously integrate the Mound B response action into a comprehensive environmentally-oriented beneficial re-use program for the Kin-Buc site and surrounding area. This beneficial re-use program primarily involves wildlife habitat enhancement, and establishment of a nature trail along the riverfront by Edison Township.

The Work Plan for Mound B involves the following components:

- Intact Drum Excavation;
- Riverfront Enhancement; and
- Cover System Enhancement.

The removal of intact drums from Mound B relies on Weston's magnetometer survey data to identify areas where drums are likely located. Initially, excavation will be conducted in select anomalies where USEPA previously excavated test pits and exploratory trenches and confirmed the presence of buried drums. In addition, SCA and Geosphere have further evaluated the Weston magnetometer survey results, and have selected other anomalies for excavation and removal of intact drums. Drums that do not meet the definition of an intact drum, and any empty intact drums, will be left in place along with other debris and refuse. Intact drums which are not empty will undergo sampling and analysis for characterization and classification for potential off-site transport and disposal. Further details regarding the removal of intact drums from Mound B are provided in Section 2 of this Plan.

The riverfront enhancement work for Mound B involves use of a bioengineering approach which integrates ecological enhancement techniques with engineering stabilization design. The selected riverfront option involves excavating refuse away from the banks and placing it onto Mound B, where it will be covered and integrated into Mound B as part of the cover system enhancement. The shoreline will then be stabilized and re-developed with vegetation to provide a buffer zone between the Raritan River and the refuse. As part of this re-development, a physical barrier, consisting of rip-rap and soil, will be placed between the waste and the re-developed bank. This "armoring" of the waste will provide a physical barrier to erosion should the rest of the bank and vegetation succumb to erosive forces over time. The vegetation along the shoreline will consist of indigenous grasses, herbs, and shrubs. The bioengineering approach to the riverfront will provide a vegetative buffer between the shore and Mound B and a buried redundant physical barrier to prevent re-exposure of waste. In addition, this approach will improve the aesthetics of the riverfront area, enhance habitat for wildlife, and integrate riverfront into the nature trail end-use plan proposed for the neighboring Edison Township Landfill and the surrounding region. Further details regarding the riverfront work are provided in Section 3 of this Plan.

Following removal of intact drums and riverfront enhancement work, a tree cap (Ecolotree® Cap or ECap) will be installed as the new cover system for Mound B to prevent potential direct contact with landfill refuse and control residual subsurface soil and groundwater contamination. The ECap consists of fast-growing, deep-rooted hybrid poplar trees that greatly reduce infiltration of water into contaminated soil or landfill waste, thus minimizing migration of potential constituents of concern to ground water. The hybrid poplars will also help enhance the microbial degradation of subsurface organic compounds by means of their dense root systems, and the resulting rhizosphere, that support large populations of microorganisms. The tree cap also offers valuable secondary benefits such as restricting vehicular access, improving aesthetics, and providing wildlife habitat at the Mound B area. Further details regarding the installation of the ECap are provided in Section 4 of this Plan.

To the extent possible, the intact drum excavation, riverfront beautification, and cap enhancement work will be integrated (conducted concurrently in certain instances) to take advantage of overlapping project tasks. This integration of project components is further discussed in Section 5.

This Work Plan provides the engineering design details to implement the Conceptual Plan and address USEPA's concerns regarding residual subsurface contamination, and shoreline improvements at Mound B. To the extent possible, the Work Plan provides for integration of the scope of work to optimize enhancement activities.

1.2 Work Plan Organization

The remainder of this Work Plan is organized into the following sections:

- Section 2: Intact Drum Excavation Work Plan;
- Section 3: Riverfront Enhancement Work Plan;
- Section 4: Cap Enhancement Work Plan;
- Section 5: Integration of Project Work Plans; and
- Section 6: References.

These sections present the details for implementation of the Mound B project. In addition, engineering design drawings and specifications, a site-specific health and safety plan (HASP), a quality assurance project plan (QAPP) and a Waste Characterization and Sampling Plan (WCSAP) are provided as appendices.

In accordance with the Conditional Approval Letter, specific USEPA comments on the Conceptual Plan are addressed in the following sections of the Work Plan:

- Specific comments on Section 2.1 are addressed in Section 1.4 (page 1-3) of the Work Plan;
- Specific comments on Section 3 are addressed in Section 2.2 (page 2-1) of the Work Plan;
- Specific comments on Section 3.2 are addressed in Section 2.3 (page 2-2) of the Work Plan;
- Specific comments on Section 3.2.1 are addressed in Section 2.2 (page 2-1) of the Work Plan;
- Specific comments on Section 3.2.2 are addressed in Section 2.6.4 (page 2-7) and Appendix F of the Work Plan;
- Specific comments on Section 4.3.3 are addressed in Section 3.5.3 (page 3-2) of the Work Plan; and
- Specific comments on Section 5.4 are addressed in Section 4.4 (page 4-5) and Figure 4 of the Work Plan.

In addition, the Mound B Conceptual Plan has been modified to address USEPA's specific comments on Section 1.1 and 2.2.

The remainder of this section provides background information on the Mound B area and describes the site setting.

1.3 Site Description

Mound B is part of Operable Unit (OU) 2 at the Kin-Buc Landfill Superfund site, Edison Township, Middlesex County, New Jersey. It occupies a narrow strip of land between the OU1 (Kin-Buc I Mound) and the Raritan River (Figure 1). The OU1 Record of Decision (ROD) characterized Mound B as "a low-lying minor Mound which covers approximately nine acres, rises 15 to 20 feet high....and lies west-southwest of Kin-Buc 1, across the Edison Township Municipal Landfill access road and adjacent to the Raritan River." The Kin-Buc Landfill site is listed on the National Priorities List (NPL), and is in the fifth year of operations and maintenance (O&M) of the final site remedial action.

The United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Map of the area indicates an absence of wetlands on top of Mound B and the presence of estuarine intertidal emergent wetlands (E2EM) in association with the adjacent Martins Creek and Raritan River waterfronts. The New Jersey Freshwater Wetlands Map for the area indicates a tidal wetlands limit along the shoreline of Mound B and an absence of wetlands on Mound B. The only structures present within the boundaries of the Mound B area are a lined detention basin in the southeast corner and the Kin-Buc Leachate Treatment Facility underground effluent piping that extends from Meadow Road to the river near the southern boundary of Mound B. Three monitoring well clusters consisting of three wells each are also present on Mound B (total of nine monitoring wells).

A layer of clay approximately 2 feet thick was added to the surface of Mound B as part of the closure process in 1980. The surface area of Mound B is vegetated with low-growing grasses and herbaceous cover across the majority of the site, and a dense stand of gray birch trees and saplings along the western edge near the river. The riverfront area of Mound B consists of gray birches on the higher elevations at the top of the riverbank and *Phragmites* at the lower elevations. Limited emergent wetland areas vegetated with *Spartina* sp. are found along the riverfront below the mean high-water level.

1.4 Site History

Limited information is available regarding historical operations at Mound B, except that the Mound B facility was used for the disposal of municipal waste. The 1991 OU2 RI Report indicates that Mound B area refuse also consists of industrial by-products and waste, and noted "limited control of site operations relevant to type of waste materials landfilled." A compacted clay cap was installed on Mound B in 1980 in accordance with the New Jersey Department of Environmental Protection (NJDEP) landfill capping requirements. More recently, the Mound B area was used as a soil staging area and pug mill (slurry wall mixing) area by Conti Construction during the OU1 remedial action implementation in the mid-1990s, in accordance with the USEPA-approved remedial action design. It is possible that portions of Mound B currently contain less than two feet of cover clay as a result of its use at a staging area during implementation of the OU1 RA, subsequent investigation activities and erosion.

The refuse disposal description is consistent with the results of intrusive investigations at Mound B. Monitoring well installation logs indicated the presence of household refuse, including paper, plastic, metal, wood, glass, and rubber. Construction debris noted in the logs included wood, brick, and metal. More recent test pit and trench logs developed by the USEPA indicate the presence of primarily municipal and construction refuse with some deteriorated metal drums encountered at locations identified as anomalies during a geophysical (magnetic) survey. The presence of drums in Mound B was consistent with the typical historical disposal practices by residential and commercial customers.

The USEPA issued a ROD for Kin-Buc OU1 on September 30, 1988. In general, that ROD addressed containment and control of the waste mass that had been disposed in Kin-Buc 1 and Kin-Buc 2. In addition, the USEPA concluded that additional study was required of Mound B, so on September 21, 1990, the USEPA amended earlier

unilateral orders and required the owner/operators and SCA to implement the OU1 ROD, including the additional study of Mound B. In 1991, Respondents submitted the required OU2 remedial investigation and in 1992 the OU2 feasibility study. The 1991 OU2 RI noted that Kin-Buc is "three separate inactive landfills" (i.e., Kin-Buc 1, Kin-Buc 2, and Mound B) and Mound B is located "100 feet west southwest of Kin-Buc 1."

The USEPA issued the ROD for Mound B on September 28, 1992. It concluded that ground water in Mound B discharges directly into the Raritan River, concentrations of contaminants are present above MCLs, and that MCLs could not be expected to be attained within the Mound B area for well in excess of 50 years. Finally, the ROD concluded that the ground water under Mound B was not a current risk, not a source of potable water, and that no further action was required to reduce contaminants. Based on this information, the USEPA selected a No Action remedy for Mound B with long-term monitoring of ground water, and maintenance of the Mound B cover.

1.5 Surrounding Area

Figure 2 identifies features proximal to Mound B. Immediately to the northwest across Martin's Creek is the Edison Township Municipal Boat Launch beyond which lies an undeveloped stretch of riverbank. Several industrial facilities are located along Meadow Road north of the boat launch. The Kin-Buc Landfill Superfund site (OU1 consisting of Kin-Buc Mounds 1 and 2) is located to the east of Mound B, on the opposite side of Meadow Road, and the inactive Edison Township Landfill is found to the southeast. Edison Township also owns the undeveloped property to the south, which is currently used as a Public Works composting facility. The area to the west and southwest across the river is undeveloped and contains tidal wetlands. Similar tidal wetland areas are found along both sides of the river for at least one mile downstream (to the east and southeast).

Figure 2 identifies three other landfill sites proximal to Mound B. In addition to the adjacent Edison Township Landfill, the northernmost boundary of Edgeboro Landfill is located approximately 0.5 mile to the southwest of Mound B on the opposite side of the river, and the closed IRL Landfill is on the same side of the river approximately one mile to the east.

Plans for these landfills include linkage to a new landfill gas recovery system that is to be used by the Sayreville Municipal Utilities Authority (MUA) to generate electricity. In addition, Edison Township's engineer, Birdsall Engineering, has developed a plan on behalf of the township for beneficial reuse of the inactive Edison Landfill and other adjacent properties, including Mound B, the Edmonds Creek tidal wetlands area, and possibly the IRL Landfill.

In summary, the landfill mounds in the surrounding area are planned to be utilized for resource recovery purposes (landfill gas to energy), and the area surrounding Mound B is currently being seriously considered for beneficial reuse by the Township of Edison. The beneficial reuse envisioned by the Township includes a nature trail connecting various riverfront properties, taking advantage of the natural vistas of the largely undeveloped riverfront in this area. Implementation of this Work Plan will integrate Mound B into this beneficial reuse scheme by providing improved riverfront aesthetics and wildlife habitat enhancement, and a prepared subbase along the riverfront upon which the Township of Edison can construct its nature trail.

2. Intact Drum Excavation Work Plan

2.1 General

The Intact Drum Excavation Work Plan (IDEWP) is a plan for the removal of intact drums from the Mound B area of Kin-Buc Landfill. The IDEWP outlines the removal activities which include:

- the performance of focused test trench excavations in certain anomalies identified by Weston as potentially containing buried drums or other metallic objects;
- the removal of intact drums and associated potentially hazardous source materials (free liquids, solids, or residues) encountered during intact drum removal operations; and,
- the handling, characterization, and disposal of removed drums and associated potentially hazardous source materials.

2.2 Intact Drum Removal Approach

The approach for completing the intact drum removal activities was outlined in the Conceptual Plan document provided to USEPA. The approach involves the performance of trench excavations within specific magnetic anomalies identified by Roy F. Weston (Weston), and the removal of intact drums. An intact drum, as defined by the Resource Conservation and Recovery Act (RCRA) "Debris Rule" (40 CFR Part 268), is a drum with no rips, holes, or tears, and having at least 75 percent of its original holding capacity. During the excavation of intact drums, associated potential hazardous source materials (free liquids, solids, or residues) may be encountered within or immediately surrounding identified drums. Based on visual observations, determinations to remove intact drums and associated material will be made jointly between technical representatives of SCA Services, Inc. and the USEPA On-Scene Coordinator (OSC) or his designee. Ground-water will not be removed from the excavations, and the vertical extent of excavation will be the ground-water table.

The results of the geophysical survey were depicted by Weston in Plate 1-Magnetic Survey Map, which was included as Attachment 1 in the Conceptual Plan for Mound B Area (BBL, 1999). The areas for further investigation have been located on a scaled site map (Figure 3) by BBL and are presented as overlays on Weston's Map in Appendix A.

The majority of the anomalies identified by Weston and investigated by USEPA through intrusive test pit excavation activities were subsequently determined to contain ferromagntic materials that were not buried drums, but were confirmed to be various Municipal Solid Waste (MSW) items commonly found in landfills, such as body shop metal strips, steel I-beams, sheet metal, metal car parts, car axles, car doors, etc. These findings illustrate the inherent limitations associated with the use of magnetometer surveys as the singular means of detection of buried drums, as the survey technique can accurately detect an anomalous signature which represents a measured magnetic flux indicative of ferromagnetic targets in the subsurface, but is not suitable for identifying if the target detected is a drum or simply some other metallic object. The magnetometer survey technique and other geophysical techniques provide an adequate first level of screening, but eventually require intrusive investigation in areas suspected to contain buried debris to confirm what actually caused the anomaly that was detected.

Unfortunately, the use of other supplemental, more sensitive geophysical techniques to further investigate these anomalies, such as Ground Penetrating Radar (GPR) using a propagated signal or impulse, or Electromagnetic Induction (EM) using an induced magnetic field, would have been no more effective. GPR effectiveness would be limited by the presence of the clay cover over the landfilled debris, the ability of the radar impulse to propagate into the subsurface at the anomaly location, and significant interferences to the measurements obtained from the

commingled debris. EM effectiveness would have been limited by the random nature of the drum distribution in the filled materials (as discussed below), and would have possibly been limited by the heterogeneity of the fill materials and the TDS and chloride of the brackish ground water associated with water quality in the adjacent Raritan River. Either technique as a supplemental, non-intrusive investigative approach to the magnetometer survey, would have resulted in a data set which would not be conclusive in identifying whether a drum does or does not exist at a particular location. Both BBL and the independent geophysical subcontractor, Geosphere, Inc., agree with the techniques and results of the Weston survey, and the recommendations made by Weston in the April 28, 1998 Technical Memorandum to Chait Agnihotri of USEPA to subsequently characterize selected anomalies by intrusive means. USEPA's use of intrusive investigations to confirm the source of each anomaly was beneficial in that it focused future efforts related to intact drum removal to specific areas and geophysical anomalies at the site.

The results of the subsequent exploratory excavations by USEPA, however, did identify specific magnetic anomalies where buried drums were discovered commingled with the other buried metallic debris and MSW. These drums were sporadically detected over the length of the trenches, and did not appear to be preferentially deposited in pockets or swarms, as may initially have been suggested by the spatial distribution of anomalies in the initial geophysical survey results. Generally, the existing data from USEPA's excavations indicate that in most instances, less than a dozen drums on average (partial and/or intact) were detected for every 100 lineal feet of excavation performed. These findings suggest that drum disposal did not occur in discrete areas of the landfill, that the drums were interspersed with other metallic debris, and were presumably disposed of with this debris when it was emplaced in the landfill. This is important information when considered in combination with the Weston geophysical survey results, the results of BBL/Geospheres independent technical review, and USEPA's observations during the intrusive excavation activities. Therefore, it has been incorporated into BBL's overall approach for the intact drum removal processes defined below.

2.3 Areas to Be Excavated

The following five magnetic anomalies were confirmed as containing full or partially full drums based on supplemental test pit excavations performed by USEPA in 1998:

- Anomaly A4-3;
- Anomaly A8;
- Anomaly A12;
- Anomaly A13 ; and
- Anomaly A14.

Using this information, and the orientation of each of the magnetic anomaly "couplets" described by Weston and discussed in BBL's Conceptual Plan document, BBL has designed an excavation program focused on the location of these anomalies and the other relevant characteristics of the area designations accompanying them previously assigned by Weston. The locations, lengths, and orientations of the proposed excavations are depicted on Figure 3.

Excavations to be performed within these areas have been spatially located to reflect the general north-south orientation of the "couplets" (where applicable), as this proposed excavation orientation both compliments the previous excavations completed by USEPA, and also encompasses areas where prior excavation by USEPA was not conducted. The proposed excavations consist of a primary excavation conducted through the axes of the highest total magnetic field readings (56,000 nT or greater, or the highest measured anomaly within an Area designation). This primary excavation is coupled with one or more smaller lineal excavations to be conducted perpendicular to the axes of the primary excavation to the edge of the measured anomaly.

Where a set of adjacent anomalies of drastically different magnetic flux was detected (relative to the 57300 nT to 54,050 nT total field "background range" identified by Weston), the axes of at least one secondary excavation would also encompass the extent of the lowest strength anomaly in the "couplet". The orientation of the secondary excavation is proposed to ensure that the magnetometer instrument response at these locations was not actually a reversal of the total magnetic flux. This type of reversal could be due to the presence of a very significant target (or targets) that had an extremely high magnetic flux compared to total magnetic field readings in the adjacent areas. Other survey techniques used in landfilled areas, such as EM, often encounter a similar phenomenon where the strength of the signal associated with an anomaly is so high, the instrument responds by characterizing the signal as a reversal of the magnetic field and an anomalously "low" reading in immediately adjacent areas. This secondary excavation orientation into the low flux portion of the "couplet" will confirm that each portion of the couplet has been adequately investigated, such that any intact drums which may exist on the periphery of the highest recorded anomalies are likely encountered.

2.4 Definition of Site Work Areas

2.4.1 General

The delineation and maintenance of the work areas are critical to ensure health and safety of project personnel and non-project personnel using the site, and to ensure that non-contaminated areas of the site are not impacted by the removal activities. All removal activities will be limited to the Project Work Area indicated on Figure 3, and Drawing 2 (Appendix B). The Project Work Area will be subdivided into the following four areas: the Temporary Access Routes, the Excavation Area, the Material Staging, Handling, and Loading Area, and the Support Area. The approximate location of each work area may be modified as appropriate during implementation of removal activities. A brief description of each site work area is presented below.

2.4.2 Temporary Access Routes

Access to the Project Area will be via the existing Meadow Road Extension shown in Drawing 2. This road leads directly from Meadow Road, and runs along the northeast border of the site property. A Temporary Access Route from the Meadow Road Extension will be identified to direct site traffic to the Project Work Area.

Additional Temporary Access Routes will be identified from the Project Work Area, described below, to areas of the riverfront to allow site traffic to reach areas selected for enhancement activities. All Temporary Access Route locations will be established during mobilization activities.

2.4.3 Excavation Area

The Excavation Area will encompass all areas which are subject to excavation (i.e., the five anomalies to be investigated). The outlines of the areas to be excavated will be identified in the field by a New Jersey licensed surveyor, and will be marked in the field by the Removal Contractor with spray paint, survey flags, or survey tape. All locations will be approved by SCA and the USEPA OSC prior to the commencement of excavation activities. Excavation areas are plotted on Figure 3 and an overlay of these areas onto Weston's Magnetic Survey Map is provided in Appendix A. An original copy of the Magnetic Survey Map can be found in the Conceptual Plan document (BBL, 1999).

To minimize the potential for cross-contamination, non-disposable equipment, machinery, and materials used in the Excavation Area will not be removed or used in non-contaminated areas of the site until they have been properly decontaminated.

2.4.4 Material Staging, Handling, and Loading Area

Upon removal from the Mound B area, all intact drums, as defined in Section 2.2, will be screened with air monitoring equipment, inspected for markings or labels, photographed, and immediately transferred to the Material Staging, Handling, and Loading Area. Drums will be overpacked as necessary. Likewise, materials associated with intact drums removed from Mound B will be placed in appropriate containers (lined roll-off, overpack drums, etc.) which will be transferred to the Staging Area.

The Material Staging, Handling, and Loading Area will consist of one or more individually-lined storage areas that will be used for the temporary staging and handling of intact drums and associated material. The lined storage area(s) will consist of high-density polyethylene (HDPE) liner (20 millimeter or greater) placed within a bermed area to contain excavated materials and prevent surface water run-on from adjacent native soils, and run-off from the excavated materials. The final sizing of the staging areas(s) will be determined in the field based on the quantity of materials encountered during excavation.

Initial sampling for on site hazard categorization (hazcat) analyses and sampling for full RCRA characterization will also be conducted in the Material Staging, Handling, and Loading Area. A mobile trailer, or other adequate work space will be used to perform the hazcat analyses. All sampling procedures are discussed in greater detail in Section 2.6, the QAPP (Appendix D), and the WCSAP (Appendix F).

2.4.5 Support Area

A Support Area will be constructed for the storage of unused or decontaminated equipment, machinery, and other materials, and will also be used to house the office trailer. The Support Area will be considered a "clean zone," thus construction of this area is limited to areas outside of the Excavation Area. Untrained/unauthorized personnel will not be allowed to enter areas other than the Support Area.

2.5 Site Preparation Activities

2.5.1 Site Mobilization

The Removal Contractor will mobilize the necessary labor, field equipment, and field trailer and/or adequate office space for the implementation of site activities. Mobilization activities, at a minimum, will include the following:

- project specific health and safety orientation, and collection of training documentation from all site personnel;
- verification of existing site conditions and identification of the location and staking out of all aboveground and/or underground utility lines and/or structures, and other structures including monitoring well clusters;
- ensuring the arrival of all site construction equipment and materials;
- review of connections to various utilities for on-site facilities, as well as securing any necessary permits;
- construction of the support area (as defined in Section 2.4.5), and mobilization of office trailer and sanitary facilities;
- construction of a decontamination pad with sump;

- delineation of the Excavation Area (as defined in Section 2.4.3 and illustrated in Figure 3) with spray paint, survey flags, or survey tape;
- construction of the Material Staging, Handling, and Loading Area (as defined in Section 2.4.4);
- mobilization of the hazcat mobile trailer (if necessary); and
- identification of Temporary Access Routes to accommodate and direct construction equipment and trucks during site activities.

2.5.2 Fence Installation and Site Security

For site security purposes, the site entrance gate along the Meadow Road Extension will be secured at the end of each work day. In addition, high-visibility fencing will be erected around any excavation area left open during non-work hours, similar to the excavation controls used by USEPA during prior activities at the site.

2.5.3 Site Clearing

Site clearing activities may consist of select removal of trees and shrubs, as necessary, to implement the excavation activities and gain access to work areas at the site. Removed trees and shrubs will be chipped and re-used on site during enhancement and planting operations.

2.5.4 Erosion and Sediment Control Measures

Surface water run-on to the Excavation Area will be minimized to the extent possible. Since the actual areas to be excavated encompass less than 5,000 square feet, a site-wide soil erosion and sediment control plan is not required. However, prior to the excavation within each anomaly, hay bales and silt fence will be placed around the perimeter of the excavation area to serve as area-specific soil erosion and sediment control measures. Details of hay bale and silt fence structures are provided on Drawing 4 in Appendix B.

Municipal debris which, upon removal, is deemed free of intact drums, will be temporarily stockpiled near and up-gradient of the area of excavation, promoting drainage towards the open excavation. If these materials must remain stockpiled on an overnight basis, the piles will be covered with polyethylene sheeting and secured to prevent runoff.

Additional soil erosion and sediment control (SESC) plans will be developed, if necessary, and submitted to USEPA, prior to implementation of site work.

2.6 Excavation and Materials Handling

2.6.1 General

This section presents the procedures for excavation activities and handling of excavated materials. Excavation and material handling operations will be conducted in a manner that allows SCA and/or USEPA to inspect excavation areas to ensure the removal of intact drums and associated materials.

2.6.2 Excavation Sequencing

Excavation operations will begin with the anomalies located at the southern portion of Mound B and proceed northward. After an individual trench has been completed, and all intact drums and associated materials have been successfully removed, the trench will be backfilled prior to the opening of the next trench.

Trenches that may not be completely backfilled due to the amount of material removed will be temporarily secured with high visibility fence. Additional backfill materials may be used from non-hazardous waste materials generated during concurrent riverfront enhancement activities to restore these areas back to grade. Backfill activities are described further in Sections 2.8.2 and 2.8.3.

2.6.3 Excavation Procedures

Excavation activities include the removal of the overlaying clap cap material, refuse immediately beneath the clay cap, and all intact drums and associated materials from the excavation areas shown on Figure 3. The clay cap material removed from the surface of Mound B will be segregated from refuse material, so it can be replaced on top of the excavations following completion of backfilling operations. Excavation activities will be conducted using a tracked excavator operated by certified personnel. Appropriate personnel protective equipment (PPE) shall be worn by all personnel in the designated excavation areas during drum removal operations. Details regarding PPE and other health and safety - related matters are discussed in the site-specific Health & Safety Plan (HASP) included in Appendix C.

If drums are encountered within the excavation, the excavator, to the extent possible, will be used to clear soil or debris away so that spotters can visually observe each drum to determine its condition. If necessary, spotters located outside of the excavation will clear debris from the drums. When a drum is clearly visible, spotters will initially determine whether it meets the definition of an intact drum, as outlined in Section 2.2. All initial determinations regarding intact drums will be made jointly with USEPA's OSC or his designee. All empty and partially intact drums, and other materials which do not meet the definition of an intact drum, will be left in place, or, if necessary, will be temporarily stockpiled outside of the excavation to allow excavation activities to continue. All temporarily stockpiled material will be returned to the excavation after it has been determined that all intact drums and associated materials have been removed from the excavation.

Each intact drum will be removed with a hydraulic grappler or with the excavator bucket and drum slings, if necessary. All removed intact drums will be screened at the area of excavation with a hand-held organic vapor analyzer, explosimeter, and radiation meter. A complete inspection of the exterior of each drum will be conducted. All markings and/or labels, which may indicate the drum's contents or manufacturer will be documented, and each drum will be photographed. Each drum will be transported to the lined, bermed Material Staging, Handling, and Loading Area described in Section 2.4.4 for characterization. Drums will be placed in overpack drums, as necessary.

Likewise, associated materials encountered during intact drum removal operations will be removed based on visual observations. Free liquids will be amended with surrounding soil/debris, removed with the excavator bucket and immediately transported to the Material Staging, Handling, and Loading Area and staged in a lined roll-off. Residues will be removed with the excavator, and either overpacked or placed directly in a lined roll-off. Ground-water will not be removed from the excavations, and the vertical extent of excavation will be the ground-water table. The ground-water elevation will be approximated based on historical depth-to-ground-water measurements and an additional round of measurements collected from shallow monitoring wells on site prior to the commencement of excavation activities.

All observations regarding the intact drums and associated materials will be keyed to the photographic log and written in a bound field book. Each overpack drum generated will be assigned a unique number, which will be written on the overpack drum in weatherproof ink or paint. This number will be used to track the drum throughout characterization, transportation, and disposal. In addition, the date on which the material was removed, and any other information pertaining to its contents (i.e., intact drum label or markings) will be written on the exterior of the overpack.

Perimeter air monitoring will be conducted during all excavation activities. A PID and portable dust monitor will be staged at the personnel decontamination area as well as a location downwind of the excavation area. A detailed procedure pertaining to perimeter air monitoring is presented in the HASP provided in Appendix C.

Any excavation temporarily left open prior to backfill operations will be secured with high-visibility fencing.

2.6.4 Waste Staging, Sampling and Characterization

As presented in Section 2.4.4, the Material Staging, Handling, and Loading Area will consist of one or more individually-lined storage areas that will be used for the temporary staging and handling of drums and other associated materials. In addition, sampling for on-site hazard categorization will also be conducted in this area. A summary of the sampling, segregation, staging, and characterization procedures that will be implemented during excavation activities is discussed below. Details regarding waste characterization sampling and analysis procedures are provided in the QAPP, included as Appendix D of this document, and the WCSAP, included as Appendix F.

Sampling

After intact drums are transported to the designated staging area, the contents of each drum will be sampled. Drums will be opened with non-sparking equipment, such as a bung wrench or drum deheader, or remotely with a backhoe spike. All drum opening procedures will be conducted in accordance with USEPA Environmental Response Team SOP #2009, which is included in the QAPP.

Each intact drum, once opened, will be screened for VOCs and alpha, beta, and gamma radiation. All results will be recorded. Liquids will be sampled using glass pipettes, which will be inserted to the bottom of the drum. The contents of the glass pipette will be inspected to determine if the drum contains multiple phases. Solids and sludges will be sampled with dedicated, disposable plastic scoops, or stainless steel scoops when needed. Separate samples will be obtained from each distinct material within the drum. Unused sample material will be returned to the drum.

Each sample will be placed in an individual glass jar, labeled with its drum designator, and transported to the on-site laboratory for analysis. If space is not available in the laboratory, the samples will be placed in 5-gallon buckets and maintained in the drum staging area. Each 5-gallon bucket may contain more than one sample.

Hazard Categorization

Hazard categorization will be performed on site in order to separate/classify materials contained in intact drums into compatible wastestreams for transportation and disposal. As described above, sampling for hazcat analyses will be performed within the Material Staging, Handling, and Loading Area. All hazcat analyses will be performed either in an on-site laboratory (i.e., mobile trailer) or other adequate work space, depending on the quantity of intact drum recovered.

Following the screening and sampling activities described above, samples will be brought into the hazcat work area for additional testing. These additional tests will include, at a minimum, the following:

- pH;
- water reactivity;
- water and hexane solubility;
- flammability/combustibility;
- oxidation/reduction (Redox) potential;
- specific gravity;
- chlorine hot wire test for halogenated compounds;
- cyanide, sulfide, and organic peroxide determinations; and
- air reactivity.

The results of the screening and hazcat tests will be maintained in a dedicated on-site logbook, and on hazcat test sheets.

Characterization

Based upon the results of the hazcat analyses, all overpacked intact drums will be segregated into waste class groups. For each waste class group, one composite sample will be collected from every group of five drums. Each sample will be sent off site to a NJDEP-certified laboratory for full RCRA characterization analysis. This characterization analysis will include ignitability, corrosivity, sulfur and cyanide reactivity, and toxicity by the Toxicity Characteristic Leaching Procedure (TCLP). Additional analyses will also be performed on each sample for total petroleum hydrocarbons and PCBs.

Additional Characterization

Removed associated materials may be placed in overpack drums or a lined roll-off container. These materials will be characterized by SCA to determine proper disposal options. This will consist of collecting various samples of the material and analyzing the samples for RCRA hazardous characteristics, total petroleum hydrocarbons, and PCBs. Other analyses may be included if required by the disposal facilities. A plan for waste characterization sampling and analysis has been included as Appendix F.

2.7 Waste Transportation and Disposal

2.7.1 General

Waste materials will be generated by excavation activities associated with this removal project. These wastes will be properly managed to minimize environmental impacts and to comply with applicable federal, state, and local regulations. A summary of the transportation and disposal procedures to be implemented for the excavated waste materials is presented below.

2.7.2 Non-Hazardous and Hazardous Waste Transportation

Where required, all waste material slated for off-site disposal will be shipped by a permitted hauler, in accordance with Department of Transportation (DOT) guidelines as stated in 49 CFR, Parts 171 through 179, and any other applicable federal, state, and local regulations.

All waste generated during removal activities requiring off-site disposal will be properly characterized, loaded, and manifested prior to exiting the site. In addition, a copy of all applicable permits will be obtained prior to the shipment of these wastes off site.

All roll-offs leaving the site will be properly secured. Roll-offs will not be loaded beyond their designated capacities or in such a manner that spillage of wastes onto roadways might occur.

2.7.3 Hazardous Waste Manifest / Bill of Lading

A hazardous waste manifest or bill of lading will be prepared and completed for each shipment of hazardous or non-hazardous waste prior to exiting the site. The hazardous waste manifest will be accompanied by additional information that will:

- communicate all of the information that handlers of the waste will need to know to do their job safely and lawfully;
- declare that the generator has characterized the waste properly before asking the transporter to haul the waste; and
- serve as an important source of information for emergency response personnel who would respond to an incident or spill involving the hazardous waste.

The transporter will sign the hazardous waste manifest or bill of lading and record the date when the shipment was received and accepted. It is the responsibility of the transporter to:

- accept the waste only when the hazardous waste manifest or bill of lading has been fully and correctly completed by the generator;
- have the hazardous waste manifest or bill of lading in possession when transporting the waste;
- comply with rules and regulations concerning hazardous and non-hazardous waste;
- transfer a copy of the hazardous waste manifest or bill of lading to the appropriate disposal facility; and
- possess a copy of a related applicable waste transporters permit.

2.7.4 Transportation Route

Empty trucks for loadout operations will enter the site via the Temporary Access Route off of the Meadow Road Extension. Trucks will be loaded near the Material Staging, Handling, and Loading Area. After loading, the trucks will exit the site via the temporary Access Route, and will travel northwest on the Meadow Road Extension. Additionally, a truck route through the commercial/industrial area northeast of the site will be considered to avoid residential areas on Meadow Road to the extent possible. Trucks involved with loadout operations will not travel to other areas of the site. The final route and destination of the loaded trucks will be determined by the disposal facility which will accept the waste.

2.7.5 Waste Disposal

At this time, SCA has not determined which off-site disposal facilities will receive wastes generated from this site. SCA will select disposal facilities that are fully permitted in accordance with all federal, state, and local laws and regulations. The names of the selected facilities will be provided to the USEPA at least seven days prior to shipment of wastes from the site. USEPA approval of all disposal facilities will occur prior to the off-site shipment of waste.

2.8 Excavation Site Restoration

2.8.1 General

In each area designated for excavation, after it has been determined jointly by technical representatives of SCA and the USEPA OSC or his designee, that intact drums and associated materials have been successfully removed, the excavation area will be restored to grade. A summary of the excavation area restoration activities to be implemented is presented below.

2.8.2 Backfill Materials

All excavated areas will be backfilled immediately upon completion of intact drum removal operations. All temporarily stockpiled removed material will be returned to the excavation after it has been determined jointly by SCA and the USEPA that all intact drums and associated materials have been removed. In certain excavation areas, waste materials generated during concurrent riverfront enhancement activities may be used as backfill materials to achieve grades. The clay soil cover removed from the surface of each excavation will constitute the final cover material emplaced to grade at each of the excavations.

2.8.3 Backfilling Procedures

The tracked excavator will be used to return previously removed materials to excavated areas. The bucket of the excavator will be used to compact the materials, as needed. Additional backfill materials may be used from refuse materials generated during concurrent riverfront enhancement activities, once these materials have been deemed free of intact drums, to restore these areas back to grade. Backfill activities related to the refuse excavated along the riverfront are described further in Section 3.5.3. Segregated clay cap material will be replaced on top of the backfilled refuse and compacted with the excavation bucket to meet the existing grades.

2.9 Decontamination Procedures

2.9.1 General

In an effort to prevent or reduce the physical transfer of contaminants by personnel and/or equipment from the site, procedures will be instituted for decontaminating all personnel and field equipment leaving the Excavation Area or the Material Staging, Handling, and Loading Area. These procedures include the decontamination of personnel, protective equipment, monitoring equipment, cleanup equipment, etc.

In general, decontamination at the site will consist of either "dry" decon, or rinsing of equipment, personnel, etc. with a detergent/water solution. A temporary decontamination facility consisting of a bermed area lined with HDPE plastic will be constructed in the approximate location presented in Drawing 2. Liquids will be contained

in a sump and characterized for proper containerization/disposal, or transferred to the on-site wastewater treatment facility on the eastern side of Meadow Road.

2.9.2 Decontamination of Equipment

All equipment coming into contact with contaminated materials on site will be decontaminated prior to leaving the Excavation Area or the Material Staging, Handling, and Loading Area. Decontamination will, at a minimum consist of visual inspection and removal of any visible dirt (which may be related to the site) from the areas that came into contact with hazardous materials (i.e., excavator bucket). A high pressure/low volume wash may be necessary.

All wash and rinse solution generated from the decontamination process will be collected, in a sump and characterized for proper disposal. Following decontamination, all equipment will be inspected.

2.9.3 Personnel Decontamination

At the end of a work shift and/or upon leaving the Excavation Area or the Material Staging, Handling, and Loading Area to enter the Support Area, all personnel will be required to remove their personnel protective equipment, discard their disposable garments, and wash re-usable items such as respirators and protective overboots. All wash water generated from this process will be containerized for proper disposal. A detailed personnel decontamination procedure is presented in the HASP.

2.10 Site Demobilization

2.10.1 General

Upon the completion of enhancement activities, the Removal Contractor will dismantle constructed temporary project facilities (decontamination facility, bermed material staging areas, etc.) and dispose of any and all materials. Equipment, the field trailer, and any other non-disposable equipment, structures, and materials will then be demobilized from the site. All equipment in contact with any contaminated material will be decontaminated before leaving the site.

3. Riverfront Enhancement Work Plan

3.1 General

The proposed riverfront enhancement design for Mound B was developed using a bioengineering approach, or an approach that integrates ecological function into the engineering design. The objectives and basis of design, along with the design approach are presented in the following sections. In addition, the Design Drawings presented in Appendix B indicate the overall enhancement plan for Mound B. SCA believes that potential permitting requirements associated with riverfront enhancement activities should be covered under existing permit equivalencies for the site as discussed in Section 5.4.

3.2 Mobilization

Mobilization for the riverfront enhancement activities will be performed in conjunction with the overall site mobilization activities as described in section 2.5.1 of the Intact Drum Excavation Work Plan.

3.3 Riverfront Enhancement Approach

In general, the riverfront enhancement includes excavating existing soil and limited amounts of waste material from the designated riverfront areas to meet the designed grades, placing of the excavated material into Mound B, and re-developing those riverfront areas by constructing a vegetated buffer zone between the Raritan River and the waste. As part of this re-development, rip-rap will be placed as a physical barrier between the waste and the river bank to protect against potential future erosion. A more detailed discussion of this approach is presented in the remainder of this section.

3.4 Definition of Riverfront Work Area

3.4.1 Riverfront Areas to be Enhanced

BBL visually inspected the riverfront area along Mound B to determine the locations in need of enhancement. Approximately 1,000 linear feet of shoreline along Mound B between Walker's Creek (to the north) and a drainage swale (to the south) may require stabilization and enhancement to eliminate currently-exposed refuse and prevent potential future exposure of refuse. During the inspection, survey data were collected to more accurately delineate these areas and to provide information on existing conditions, including grade breaks, slopes, and elevations. The actual linear footage of shoreline enhancement may be reduced if pre-construction test pits along the riverbank indicate an absence of refuse and/or riverbank conditions that are stable. The areas to be restored, based on the preliminary site inspection, are shown on Drawing 3 in Appendix B. Details for the enhancement work are presented on Drawings 4 and 5.

3.4.2 Temporary Access Routes

Temporary access routes will be identified to provide truck and equipment access to the enhancement areas and allow for transport of materials from the riverfront into Mound B. The access routes will be completed as part of the access route identification associated with the site preparation phase discussed in Section 2.4 and 2.5. The temporary access route locations will be established during site mobilization activities.

3.4.3 Material Staging Area

Prior to excavation activities related to the enhancement of the riverfront, the Contractor will be required to secure and deliver materials, including soil backfill, rip-rap, geotextile and vegetative plantings. Soil and rip-rap materials will be stored in close proximity to the enhancement work to minimize double handing. All other materials will be

will be scheduled by the Contractor based on enhancement progress. In addition, the Contractor will be responsible for implementing all measures necessary to prevent erosion and subsequent migration of the river bank soils and staged soils associated with the enhancement work.

3.5 Excavation and Materials Handling

3.5.1 General

Excavation procedures described in this section are provided for general information purposes. Prior to excavation activities, the contractor will be required to submit an excavation plan that provides a detailed description of the excavation procedures that will be implemented during construction.

3.5.2 Limits of Excavation

The horizontal limit of excavation is depicted on Drawing 2. This limit was established by visual inspection during a site visit. The vertical limits of excavation are shown in cross sections provided on Drawing 4. In general, the existing soil cover will be removed to approximately 2 feet below the current grade. Following this, the existing bank face will be further excavated to allow for installation of the bank protection materials (i.e., rip-rap and vegetation).

3.5.3 Waste Handling and On-Site Transport and Placement

A limited amount of refuse will be excavated from the riverfront and transported onto Mound B where it will be integrated into the drum excavation areas and certain low-lying areas. The refuse will be excavated using a hydraulic excavator and placed into trucks for transportation onto Mound B. The excavation activities will be performed in conjunction with the intact drum removal activities which will allow the refuse from the riverfront to be deposited directly into excavated areas on Mound B where appropriate. The refuse will be placed in the excavations on Mound B in conformance with Section 2.8.3 of the Excavation Work Plan. It is possible that certain excavation areas will be "mounded" during backfill operations to promote drainage in certain areas. In addition, low-lying areas on Mound B may be excavated and surplus refuse from riverfront enhancement activities used as backfill on top of existing refuse to promote stormwater runoff and drainage from the cap. Similar to the drum excavation areas, segregated clay cap material will be replaced on top of the refuse and compacted.

Excavated waste will be transported to the designated areas on Mound B and spread in lifts two to three feet thick. The lifts will be compacted using appropriate sized compaction equipment making a minimum of three passes per layer. Waste in excess of 24-inches in size will be reduced in size, to the extent possible, through the use of a hydraulic excavator or bulldozer. Waste remaining in excess of 24-inches in size will be segregated from other objects to avoid clustering within a layer. The waste shall be placed so that the final grades do not alter or impede the existing site drainage patterns.

All refuse excavated from the riverfront area will be relocated to Mound B with the exception of any intact drums as defined in Section 2.6.3. Intact drums (if encountered) will be removed, segregated from the excavated material, and transported to the appropriate staging area. Drum removal and handling activities are described in detail in the Intact Drum Excavation Work Plan presented in Section 2.

3.6 Enhancement Activities

3.6.1 General

The riverfront will be re-developed with vegetation to provide a buffer zone between the Raritan River and the refuse. This re-development includes the following components:

- the placement of soil backfill along exposed waste resulting from the riverfront excavation;
- placement of geotextile to separate soil backfill and rip-rap; placement of rip-rap (small stone and large stone);
- installation of a geotextile tubes filled with pea gravel;
- placement of smaller stones and soil throughout the surface of the rip-rap; and
- placement of vegetation between the rip-rap and on the soil fill material.

These activities are described further in the following sections.

3.6.2 Enhancement Sequencing

3.6.2.1 Bank Excavation

Excavation of the exposed refuse along the Raritan riverfront will proceed only when the tidally-influenced water level has retreated and is not in contact with the material to be excavated. The existing vertical face of the riverfront will then be excavated back as necessary to provide a uniform bank alignment and to allow for installation of the soil and rip-rap materials. The contractor should only disturb portions of lower elevation shoreline areas which can be fully restored within the time available between the tidal cycle (i.e., before the water level rises). During periods of high tide, the contractor will be able to work in higher elevation areas above the mean high water mark. A typical detail showing general excavation limits is provided on Drawing No. 4.

3.6.2.2 Backfill Materials/Procedures

Soil backfill will be placed against the excavated areas and compacted. A minimum of two feet of soil backfill will be placed over the exposed waste in order to effectively cover the refuse material.

Once the soil backfill material is graded and compacted, a geotextile layer will be installed. The geotextile layer will function mainly as a filter fabric to assist in minimizing the potential loss of fines in the soil backfill.

Large rip-rap stones will be placed along the most outward edge of the enhancement. This rip-rap will be a minimum of 24-inches in smallest diameter. On the bank side of the 24-inch rip-rap, an eight-inch diameter roll of pea gravel will be placed inside a geotextile. The geotextile will be wrapped around the pea gravel forming a "tube" protecting the pea gravel. The purpose of this geotextile tube is to prevent downward gradients from undermining the rip-rap and to minimize the washing away of soils placed on the slope.

A 30-inch minimum layer of graded rip-rap material will be placed from the toe of slope up the slope to a height of approximately 4 feet. This graded rip-rap material will vary in size from 5-inches to 20-inches and will meet the requirement presented on Detail 9 of Drawing 6.

The area between the large (24-inch) rip-rap and the smaller (5 to 20-inch) rip-rap will be filled in with stones ranging in size from one inch to four inches, creating "planting pockets" and reducing the potential of fines washing from the surface. Additional "planting pockets" will be created by placing soil material in the interstitial spaces of the smaller rip-rap on the slope of the riverfront.

3.6.2.3 Vegetation

The proposed habitat enhancement along the Raritan River is to diversify the present mono-culture of gray birch and common reed. The low diversity within the vegetative habitat is the result of historical use. The objective is to diversify the habitat and increase wildlife use. To accomplish this objective a number of native species that are representative of various indigenous habitats expected at different elevations along the riverfront will be introduced. This approach is consistent with the proposed beneficial re-use of this area and will promote the potential environmental education aspect of the proposed nature trail.

There are three major habitats that will be enhanced along the Raritan River frontage of Mound B. The first is the low elevation area (Tidal Zone) adjacent to the Raritan River which is periodically subjected to flooding. This area is to be armored with large rock and rip-rap to protect against erosion. The second is the area between the rip-rap area and the proposed nature trail. This area will be enhanced with soil and shoreline vegetation. The third area is an upland habitat which will form a buffer zone between the proposed nature trail and Ecolotree® cap.

Tidal Zone Vegetation

Periodic flooding and tidal action of the Raritan River will affect this lower elevation habitat. The requisite rip-rapping of the riverfront at lower elevations limits the ability to create a natural riparian habitat, so the proposed habitat enhancement in this zone involves approach naturalizing the rip-rap area with a high diversity of indigenous shrub species. Young plants that have shallow root systems will be selected from the following list for planting in the interstitial spaces:

Species Scientific Name (Common Name, Indicator Status)

Alnus rugosa (Speckler Alder, FACW+)
Alnus serrulata (Smooth Alder, OBL)
Amelanchier intermedia (Shadbush, FACW)
Aronia arbutifolia (Red Chokeberry, FACW)
Cephalanthus occidentialis (Buttonbush, OBL)
Cornus amomum (Silky Dogwood, FACW)
Cornus sericea (Redosier Dogwood, FACW)
Ilex verticillata (Common Winterberry, FACW+)
Leucothoe racemosa (Sweetbells, FACW)
Rhododendron viscosum (Swamp Azalea, OBL)
Rosa palutris (Swamp Rose, OBL)
Sambucus canadensis (Common Elderberry, FACW-)
Vaccinium corymbosum (Highbush Blueberry, FACW)
Viburnum dentatum (Arrow-wood, FAC)

Shoreline Vegetation

The area between the river and nature trail (Shoreline Zone) will be covered with approximately two feet of soil that will provide sufficient substate for a diverse community to be created using young trees. The area will be subjected

to wind blown moisture input along with precipitation. The following is a list of recommended tree and shrub species, for the zone between the high water elevation and the nature trail:

Species Scientific Name (Common Name, Indicator Status)

Trees
Acer negundo (Box-elder, FACU)
Betula nigra (River Birch, FACW)
Capinus caroliniana (Ironwood, FAC)
Cornus florida (Flowering Dogwood, FACU-)
Diospyros virginiana (Common Persimmon, FAC-)
Quercus alba (White Oak, FACU-)
Quercus palustris (Pin Oak, FACW)
Quercus phellos (Willow Oak, FAC+)
Quercus rubra (Red Oak, FACU-)

Shrubs
Aronia melanocarpa (Black Chokeberry FAC)
Cornus racemosa (Gray-stem Dogwood, FAC-)
Hamamelis virginiana (American Witch-hazel, FAC-)
Lindera benzoin (Northern Spicebush, FACW-)
Myrica pensylvanica (Northern Bayberry, FAC)
Prunus maritima (Beach Plum, NI)

Vines
Lonicera japonica (Japanese Honeysuckle, FAC-)
Parthenocissus quinquefolia (Virginia Creeper, FACU)

Buffer Zone Vegetation

The existing growth of gray birch trees will be retained, to the extent possible, in this area. However, access routes will be cut through the stand of gray birch to allow equipment movement from the cap area to the river. In addition, creation of the access routes along the riverfront will result in the clearing of some of these trees. These altered locations will be covered with topsoil to provide areas for enhancement and habitat diversification, and establishment of a buffer zone between the nature trail and cap. The primary selection criteria for the species to be planted will be ability to increase wildlife food sources in the enhancement area and ability to tolerate drier conditions. Moreover, a number of plant species are expected to supplement the habitat from wildlife droppings over the next several years. In addition to the species indicated above, the following species are recommended for planting in this zone:

Species Scientific Name (Common Name, Indicator Status)

Trees
Quercus ilicifolia (Bear Oak, NL)
Quercus marilandica (Blackjack Oak, NL)

Shrubs
Ceanothus americanus (New Jersey Tea, NL)
Rhus copallinum (Dwarf Sumac, NL)
Rhus typhina (Staghorn Sumac, NL)

Vines
Arctostaphylos uva-urai (Bearberry, NL)

Specific species to be planted at the above locations will be selected following completion of rip-rap installation and backfill operations along the shoreline. The intent of the plantings is to increase shoreline stability while simutanueously increasing plant community diversity and enhancing wildlife habitat.

Mound B Cap enhancement activities and planting of hybrid poplar trees on the existing clay cap are discussed in the next section and will be implemented independently.

3.6.2.4 Drainage Features

Proposed drainage features include the construction of a drainage ditch on the inside of the access route/future nature trail. This drainage ditch will collect runoff to the west of the existing topographical ridge and has been designed to accommodate the estimated peak discharge associated with the 10-year, 24-hour storm event. To the extent possible, the ditch (and the related access road/future nature trail) have been located at the lowest elevations of the west slope of Mound B in order to minimize disturbance of existing vegetation and limit the amount of fill required for construction of the access road.

As shown on Drawing 3, the drainage ditch is comprised of two segments each having a minimum 0.5% invert grade from high point to low point. "Quick" TR-55 (Version 5.47) developed by Haestad Methods was used to calculate the estimated peak flow conditions for the drainage ditch. The peak flow used to size the drainage ditch was estimated to be 3 cubic feet per second (cfs). To accommodate this flow condition, the ditch has been designed with a centerline depth of 18 inches, providing a minimum freeboard of 3 inches at the peak flow condition. Velocities associated with the peak flow are estimated to be 0.5 feet per second (fps). Permanent erosion control mat will be installed on the interior of the ditch to provide surface soil stabilization under initial conditions and to enhance the hydraulic capacity of the ditch under fully vegetated conditions.

Stormwater collected in the ditches will be directed to corrugated metal pipe culverts as depicted on Drawing 3. The culverts will be installed under the access road/future nature trail and will outlet into rip rap lined downchutes. The size of the culverts were determined based on the estimated peak discharge of 3 cfs for the drainage ditches. The downchutes will consist of rip rap meeting the specifications presented on Drawing 4. Larger rip rap will be placed at the toe of the downchute to reduce discharge velocities and to aid in distributing concentrated flow prior to discharging into the Raritan River.

4. Cap Enhancement Work Plan

4.1 Technology Overview

The Ecolotree® Cap (E-Cap) is a patented phytoremediation system that serves to meet water management and pollutant control objectives. This cover system is a functional alternative to other landfill capping technologies, such as geosynthetic covers and compacted clay caps. The E-Cap grows tall poplar trees with deep root systems planted into amended soils. The trees and understory grasses pump water from the cover soils, thus dehydrating the soil during the growing season and creating water storage capacity for the dormant winter months. Thus, the E-Cap provides a natural 'sponge and pump' water removal system. The E-Cap has been installed at 15 landfill sites in 7 states since 1990, including municipal, industrial, construction debris, and Superfund hazardous waste landfills.

4.1.1 Benefits

The benefits of the E-Cap were discussed in detail in the September 1999 Conceptual Plan for Mound B (BBL, 1999). These benefits can be summarized as follows:

- Achieve final closure status by creating a vegetative cap that minimizes leachate formation.
- Remove residual contamination from the vadose zone by direct plant uptake and enhanced microbial degradation in the root zone.
- Minimize groundwater recharge by precipitation, thus slowing down groundwater flow and enhancing the natural attenuation of organic contaminants in the saturated zone.
- Minimize 'flush out' of vadose zone contaminants into groundwater supplies.
- Stabilize the landfill cover soils to reduce erosion and generation of wind-blown dust.
- Create an aesthetically pleasing ecosystem for the neighboring community, in contrast to the stark landscape provided by a clay cap or geomembrane.

4.1.2 Documented Performance

A study was performed between November 1995 and October 1996 at the Bluestem Landfill #2 (Cedar Rapids, Iowa) by Ecolotree Inc., Midwest Environmental Engineering Inc., and the Bluestem Solid Waste Agency (Ecolotree and Midwest Environmental Consulting, 1997). This study evaluated the effectiveness of an E-Cap verses a conventional clay cover. Based on the soil moisture data collected, the E-Cap performance was at least equivalent to the clay cap in preventing deep percolation of precipitation into the landfill. The soil moisture in the E-Cap never exceeded field capacity, so percolation into landfill waste was not expected.

A study was also performed to investigate leachate production potential under a conventional grass cover verses a hybrid poplar cover (1 and 2-year old trees) at the Grabhorn Landfill in Beaverton, Oregon (Jarrell et al., 1995). The study found that in general the soil moisture under the poplar cover was less than the soil moisture under grass cover. In addition, moisture in deeper soils under the trees was significantly less than under grass cover, indicating more water uptake from deeper soils by poplar trees than by grass cover. Canopy interception of precipitation by poplars was significant, ranging from 15 to 32 percent.

4.2 E-Cap Design

4.2.1 On-Site Meeting

An on-site meeting is recommended with personnel from SCA, BBL, Ecolotree, USEPA and the designated irrigation subcontractor to collect additional information/data relevant to the ECap installation. The purpose of the meeting is as follows:

- Walk the Site to gain better understanding of site features and topography.
- Review existing Site data, including soil depth over landfill debris.
- Document the location of power poles, power lines, lighting, existing on-site trees marked for salvage, and other immovable objects that could affect E-Cap installation.
- Discuss how vehicle mobility around the Site will be maintained.
- Observe test trenches excavated as part of drum removal activities and/or possibly excavate additional shallow test pits to identify sub-surface conditions of the cap material.
- Perform soil sampling to determine agronomic characteristics and amendment requirements. Approximately 10 samples from across the Site are anticipated.
- Discuss irrigation system layout.

Results of the meeting will be used to refine the site preparation approach and tree installation strategy.

4.2.2 Soil Testing

During riverfront enhancement activities, approximately 10 soil samples will be taken from across the Site and will be used to prepare supplemental composite samples over a 0 to 2 feet sample depth interval. A backhoe or bobcat will remove sections of soil 0 to 2 feet below ground surface. The samples will be placed in supplied containers and analyzed for 11 characteristics (pH, texture, organic matter, etc.) and 13 macro- and micro-nutrients. The output data will also include nutrient addition recommendations specifically for poplar.

4.2.3 Design and Layout

4.2.3.1 Water Model Overview

Two water balance models were prepared for the Site. These models were used to predict leachate generation for a grass-only cover scenario and an E-Cap cover scenario. Variables incorporated into the water balance model include soil type, soil depth, canopy interception (by poplars) and various climatic data. The results of these models are provided in Appendix E.

The soil at the Site is a clay loam with an available water holding capacity of 1.98 inches of water per foot of soil. A two-foot rooting depth was used for both water balance models.

Average monthly precipitation values (1958 to 1987) were obtained from the New Jersey State Climatologist at Rutgers University. The average annual precipitation for this area is 46.32 inches. In general, the Edison area experiences consistent monthly precipitation throughout the year (approximately 4 inches per month), with slightly higher amounts during spring and summer months. July is the wettest month (5.01 inches). February (2.98 inches) is the driest month and the only month with less than 3 inches of precipitation.

Average monthly potential evapotranspiration (PET) values (1980 to 1997) for grass were obtained for Newark, New Jersey. As expected, PET is greatest during the summer months (April through August), and lowest during the dormant winter months (December through February). Average annual PET for this time period was 32.21 inches. This data was obtained by Penman equation calculations performed by the Northeast Regional Climate Center, Ithaca, New York.

4.2.3.2 Water Model Results

The tabular and graphical model results are provided in Appendix E. With an E-Cap cover the model predicts, during an average climatic year, 3.6 inches of water percolation below the root zone and into landfill waste. This result is approximately 50 percent less than the expected infiltration under grass cover conditions. Thus an E-Cap at Mound B is expected to greatly reduce leachate formation from present conditions (7.0 inches). The infiltration occurs only in January (2.6 inches), February (0.9 inches), and December (0.1 inches). The E-Cap model also predicts that the soil will be near its wilt point during the months of May, July and October, thus supporting the use of strategic irrigation during summer months.

4.2.3.3 Location and Planting Density

The E-Cap will be planted to cover the landfill surface of the site as indicated in Drawing 3 of Appendix B. The total tree planting area is estimated to be 13 acres. The E-Cap will be planted in a phased manner over a period of at least 5 years with the initial planting of tree rows along the riverfront (western) edge of Mound B. Tree plantings in subsequent years will progress toward Meadow Road. As indicated in Detail 7 on Drawing 5, trees will be planted with a between-tree spacing of four feet, and a between-row spacing of 10 feet. Approximately 1,090 trees will be planted per acre, with 40 square feet/tree. This spacing will provide maximum water uptake capacity and stabilization of surface soils, while allowing for vehicle and equipment access across the Site (for mechanized mowing, biosolids application, and other operations such as spraying). Harvested trees used for the E-Cap will be bare-root 1-year old trees (4 to 7 feet in height). The total tree planting will consist of an estimated 14,200 poplars. In addition, seeding of the areas between tree rows with grass will be considered for those areas devoid of cover vegetation.

4.2.3.4 Orientation

The tree rows will be oriented across the contours of the landfill in a general north-south direction. Because the grass and weeds between the trees will likely be taller than the mowed between-row areas, this orientation will encourage runoff during heavy rain events by 'tunneling' the water between the rows. In the northwest corner near Martins Creek, several rows will be planted perpendicular to the landfill contours to maintain consistency in layout. However, this relatively small area is not expected to significantly affect areas of runoff.

The area of the Site adjacent to the Meadow Road Extension will be planted with three rows of hybrid poplars as an aesthetic visual barrier. These rows will be planted in the same density as the remainder of the Site and will run the length of the Meadow Road Extension.

4.2.3.5 Tree Species

The E-Cap uses hybrid poplar trees because of their rapid growth rates (3 to 10 feet per year), high water uptake rates (approximately 1 million gallons/acre/year), hardiness, disease resistance, longevity (30+ years), and documented performance with a variety of organic and inorganic contaminants. The hybrid poplar varieties to be planted at the Site have not yet been determined. This decision will be made by Ecolotree staff after reviewing the

historical performance of poplar tree varieties in the northeast. Criteria that will be considered include hardiness, growth rates, insect and pest resistance, and disease resistance. It is possible that the deltoides x nigra (DN-34) variety will be chosen, based on its past performance at Ecolotree projects and reported benefits by researchers (Dickmann and Isebrands, 1999).

Planting of bare-root 1-year old hybrid poplars (4-7 feet in height) is recommended, since 1-year old trees are less susceptible to weed pressure and will create a mature E-Cap more quickly than small cuttings, and have demonstrated better survivability than 3-6 foot unrooted 'whips' at past installations.

4.3 Irrigation System

4.3.1 Irrigation Justification

An irrigation system will serve five purposes at the Site:

- Ensure tree survival during the first two growing seasons, while the trees are becoming established and roots are developing.
- Allow the trees to maintain their vitality and rapid growth rates during dry periods.
- Prevent tree stress that would cause reduced transpiration rates during the important fall months (and thus maintain dormant season water holding capacity of site soils).
- Allow for the development of a lush grass understory, which will minimize erosion and assist the trees with water management.
- Provide a future potential means of leachate or municipal wastewater effluent disposal.

Irrigation will prevent the loss of a large number of trees due to drought conditions in the first two years after planting. After this time, the trees will be less susceptible to dehydration because the roots will have tapped into deeper soil moisture reserves. Irrigation is also important to prevent tree growth from being stunted by dry summer conditions, and to achieve the goal of 'big trees fast'. If trees are too stressed for water during the summer months, they will drop lower leaves and go into a pseudo-dormancy, and will not regain their water uptake capacity until the following growing season. It is imperative to keep the trees vibrant during the summer months, so that they will remove the maximum amount of water during the fall months, and thus create much-needed water holding capacity in the soil for the dormant winter months. Therefore, the irrigation plan will serve to balance the tree requirements for rapid growth, and the need to dehydrate the soil during the fall months to create water-holding capacity.

The irrigation plan will not impact the ability of roots to grow deeply, and it will not encourage leachate formation. If over-irrigation occurred, the trees would not need to tap into deeper soil moisture reserves. However, because the Site will only be irrigated moderately and on an as-need basis, the roots will be prompted to grow to greater depths to access soil moisture. It is expected that the roots will grow below the approximately 2-foot thick clay cover and into near-surface waste, thus reducing the potential for leachate formation even further.

4.3.2 Conceptual Irrigation Plan

A micro-spray irrigation system, consisting of small rotating sprinklers, is recommended for irrigating the E-Cap. Micro-spray systems allow for a uniform distribution of water, are resilient to emitter plugging due to precipitates and bio-fouling, and will give SCA the flexibility to irrigate using wastewater effluent from the site treatment plant.

An example of a micro-spray system that has proven successful with several operational E-Caps consists of sprinklers that spray water in a 12 foot radius. The sprinklers are installed in every other tree row, with a spacing of 24 feet between the sprinklers. The irrigation sprinklers are mounted on support stakes approximately 10 inches above the ground. Irrigation water is distributed to the sprinklers via above ground polyethylene tubing. The irrigation system could be divided into 3-6 zones, with one zone being irrigated at a time.

During typical climatic years, it is expected that between 3 to 6 inches of water (1.1 to 2.1 million gallons over 13 acres) will be irrigated between May and September. An irrigation schedule might consist of 2 inches in May, 2 inches in July, and 1 inch in September. In order to minimize irrigation water loss due to evaporation, irrigation should take place in 1-inch increments, rather than multiple days of smaller water volumes.

The degree of automation chosen for the irrigation system is contingent upon cost, water pressure, water quality, and the availability of local labor. Irrigation system operation can vary from the manual opening and closing of valves, to a completely automated system in which soil moisture sensors relay irrigation prompts to a central controller. The quality of irrigation water will also affect the type of pre-filtration equipment required for operation.

4.4 E-Cap Installation

4.4.1 Site Preparation

The landfill will be prepared for E-Cap installation prior to planting. Tasks associated with preparation are as follows:

- Clearing and grubbing: Mature trees currently on the landfill should be left as is, with hybrid poplars planted around them. Other perennial bushes and weeds will need to be removed, either mechanically or by herbicide.
- Grass mowing: Grass or weeds should be mowed to less than 3 inches in height in those limited areas that currently support a dense growth.
- Tree row layout: Tree rows will be laid out across the Site and marked by an Ecolotree staff member during an early spring 2001 site visit.
- Improve surface drainage: Areas of the landfill that are prone to ponding will need to be graded prior to cap installation to promote existing drainage patterns.

Installation of the proposed tree cap will be performed so as not to alter the current stormwater drainage pattern at the site. The site area designated for cap enhancement work is comprised of two distinct drainage areas. Each of the two areas are bounded to the east by Meadow Road and to the west by a topographic ridge. As evidenced by existing grades, runoff from these drainage areas originates at a common high point located near the center of the site. From there, runoff travels either to the north or to the south as sheet flow and shallow concentrated flow. The northerly flow drains to an existing low lying area which discharges into the Raritan River at its confluence with Walkers Creek. The southerly flow drains to an existing drainage divide which conveys concentrated runoff to the Raritan River.

4.4.2 Trenching

Two equipment operators from Ecolotree will mobilize to the Site approximately two weeks prior to planting. This team will trench 2-foot deep tree rows and will coordinate application of compost across the Phase I area of the site.

The compost will be delivered from a local provider (as yet to be determined) or will be produced on-site in the unplanted area of Mound B. The area will then be ready for planting.

4.4.3 Mobilization

When trenching and compost application have been completed, other necessary personnel will mobilize the trees, a tractor, tree planter, and equipment to the Site. Cold storage arrangements for the trees will be made in advance.

4.4.3.1 Tree Procurement and Delivery

The trees will be obtained from EcoloFarm, Calumus, Iowa. Ecolotree staff will deliver the trees to the Site. Upon arrival at the Site, trees for immediate planting will be removed while the remainder will be placed in local cold storage, if deemed necessary given climatic conditions. The installation crew can then remove trees from cold storage as planting stock runs out. Proper storage is imperative to ensure tree viability. Trees that are stored temporarily on site (awaiting planting) will be placed in the shade, covered with tarps, or iced down, as deemed necessary by Ecolotree staff.

4.4.4 Tree Planting

The trees will be planted in the rows previously established by flagging and staking. Planting will take place after the Phase I area of the Site (near the river) is trenched two feet deep followed by an application of compost beside each open trench. As the trees are planted, the colter wheels behind the planter will push the compost and original soil into the planted trench. Installation laborers will walk the tree rows and step down soil around the trees to ensure adequate tree/soil contact. Other unplanted phased areas (e.g., Phases II through IV) of Mound B progressing toward Meadow Road may be used to produce topsoil through composting operations in the years preceding tree cap installation. It is envisioned that the topsoil/compost produced in this area will be used as soil amendment for each phased planting area as the tree cap installation proceeds over the years.

If the tractor and planter are unable to achieve the required two feet planting depth, due to wet conditions, soil compaction, or other unforeseen conditions, alternate planting methods will be employed. Options include ripping the planting trenches with a bulldozer or other heavy equipment, or hand auguring individual planting holes.

4.4.5 Compost and Mulch Amendments

Compost from an Edison-area provider (including potentially the adjacent Edison Township recycling/compositing facility) will be added to each trenched row during planting to increase root zone organic matter, water holding capacity, and nutrients. The type and amount of compost will be determined after soil analytical work. In addition, a 3-inch thick, two feet wide mulch layer will be added around each tree for moisture control, weed control, and nutrients. Other amendments such as lime, gypsum, and varied micronutrients may be added as needed.

4.4.6 Erosion and Sediment Control Measures

The establishment of the hybrid poplars and a grass understory will stabilize the landfill cover soils, thus minimizing erosion and the generation of wind-blown dust. Because the Site presently supports a thin, inconsistent grass cover, it will be necessary to till the Phase I area of the Site before E-Cap installation. After the trees are planted, soil amendment will be added as necessary and the area surrounding the trees will be heavily seeded, preferably with a blend of warm and cool season grasses, to establish ground cover.

4.4.7 Irrigation System Installation

Preparatory irrigation work, such as providing water to the site and installing controllers, should be completed prior to beginning E-Cap installation. The polyethylene supply lines and sprinkler heads should be installed immediately following E-Cap installation, and the irrigation system should be operational within one week of completing E-Cap installation. If the Site is excessively dry at the time of E-Cap installation, a water truck will be necessary to provide water to the trees until the irrigation system is operational.

Specifications associated with the installation of the Ecap are provided in Appendix B. The specifications address site preparation; Ecap installation; and irrigation of the ECap.

5. Integration of Project Work Plans

This Work Plan for the Mound B area at Kin-Buc Landfill identifies an approach that integrates a focused drum removal action with enhancement of the adjacent riverfront and the existing Mound B cover system. Although the components of the enhancement project are addressed in detail in separate work plans provided in the preceding sections, the work related to each component will be implemented concurrently in many instances and will overlap to varying degrees. Figure 4 indicates a preliminary schedule for project fieldwork and identifies periods (weeks) of overlapping work efforts. The major project components to be integrated include:

- Site Preparation and Mobilization;
- Drum Excavation with Riverfront Enhancement; and
- Riverfront Enhancement with Cap Enhancement.

This section describes the integration of the major project components and briefly discusses the recommended approach to project permitting.

5.1 Site Preparation and Mobilization Integration

Drawing 2 in Appendix B identifies the proposed locations of site preparation features. To the extent possible, work areas will be defined and site preparation activities will be conducted such that locations of temporary access routes, support areas, and material staging and handling areas serve a common purpose for all components of the project. Additionally, mobilization for riverfront enhancement activities will be performed in conjunction with the overall site mobilization for the Drum Excavation work.

A temporary access route from Meadow Road will be identified to enable site traffic to reach the Project Work Area and will link the riverfront enhancement area with the drum excavation and cap enhancement areas. The proposed system of temporary site access routes will allow site traffic to move easily between excavation areas and areas selected for enhancement activities.

5.2 Drum Excavation/Riverfront Enhancement Integration

Implementation of intact drum excavation activities and the riverfront enhancement work will overlap to some extent to allow excavated refuse from the shoreline to be transported and temporarily staged adjacent to drum excavation areas for use as make-up backfill. This staged refuse will be bulldozed or otherwise pushed into open excavations and compacted with an excavator bucket to an elevation slightly below grade, so the original clay cap material can be replaced to grade on top. Because accurate estimates of the amount of refuse to be removed from the shoreline and the potential number (volume) of drums to be removed from Mound B are unavailable, the amount of surplus refuse generated is currently unknown. Surplus refuse, if any, from the shoreline excavation work will be used to fill low-lying areas of Mound B to promote stormwater runoff. The surplus refuse would be placed on top of existing refuse following removal and staging of existing cap material. The cap material would then be replaced on top of the refuse following its integration into the landfill. The system of on-site temporary access routes discussed above will promote the integration of excavated refuse from along the riverfront into drum excavation trenches and low-lying areas of Mound B with minimal transport and handling.

5.3 Riverfront Enhancement/Cap Enhancement Integration

As part of site preparation activities related to riverfront enhancement, the stand of gray birch trees along the western edge of Mound B near the riverfront will be preserved to the extent possible. This narrow stand of trees will serve as a portion of the buffer zone proposed as a visual break on the eastern side of the proposed nature trail (Drawing 3). In addition, the access route to, and along, the river will be cut to retain existing tree growth as much as possible.

The access route installed along the riverfront is also envisioned to function as the subase for the future nature trail in this area. Therefore, it will be graded and grass-seeded as part of cap enhancement activities following completion of the riverfront enhancement work.

Following removal of refuse and installation of stabilization materials (rip-rap, etc.) along the shoreline, additional base material will be placed to provide a substrate for planting indigenous species. A transition zone of diverse vegetation will be established between the riparian waterfront and the upland area at the top of bank. This planted transition zone will continue in an upgradient direction to the access road. Tree and shrub species considered for planting in this zone as part of the riverfront enhancement will also be considered for supplemental planting in the buffer zone along the eastern edge of the proposed nature trail (i.e., western edge of the Mound B Cap). These riverfront enhancement transition zone/cap enhancement buffer zone plantings will be conducted concurrently to minimize disturbance of the area. The Ecolotree Cap (hybrid poplar tree cap) would be planted separately from the above transition zone and buffer zone plantings.

5.4 Permitting

In addition to the soil erosion and sediment control measures indicated in the preceding sections, certain local, state, and/or federal permits are often required for construction activities adjacent to, or in the floodplain of, surface water bodies such as the Raritan River. Based on current site knowledge, permitting associated with wetlands, stream encroachment, and/or waterfront development may need to be addressed prior to initiation of construction activities at Mound B.

SCA believes that potential permitting requirements associated with the activities proposed in this Work Plan are addressed under the existing permit equivalencies for the site because Mound B is part of OU2 at the Kin-Buc Landfill Superfund Site, the work proposed is related to site remediation activities, and previous work of a similar nature has been conducted at the site under permit equivalencies issued by the New Jersey Department of Environmental Protection (NJDEP). As a result, SCA proposes to work with USEPA to identify existing permit equivalencies that can be applied to this project.

Integration of the major project components described above will promote increased coordination of on-site construction activities and allow efficient implementation of field construction work. In addition, it is anticipated that increased coordination of site activities will decrease potential health and safety issues, and limit the timeframe within which the project can be completed.

6. References

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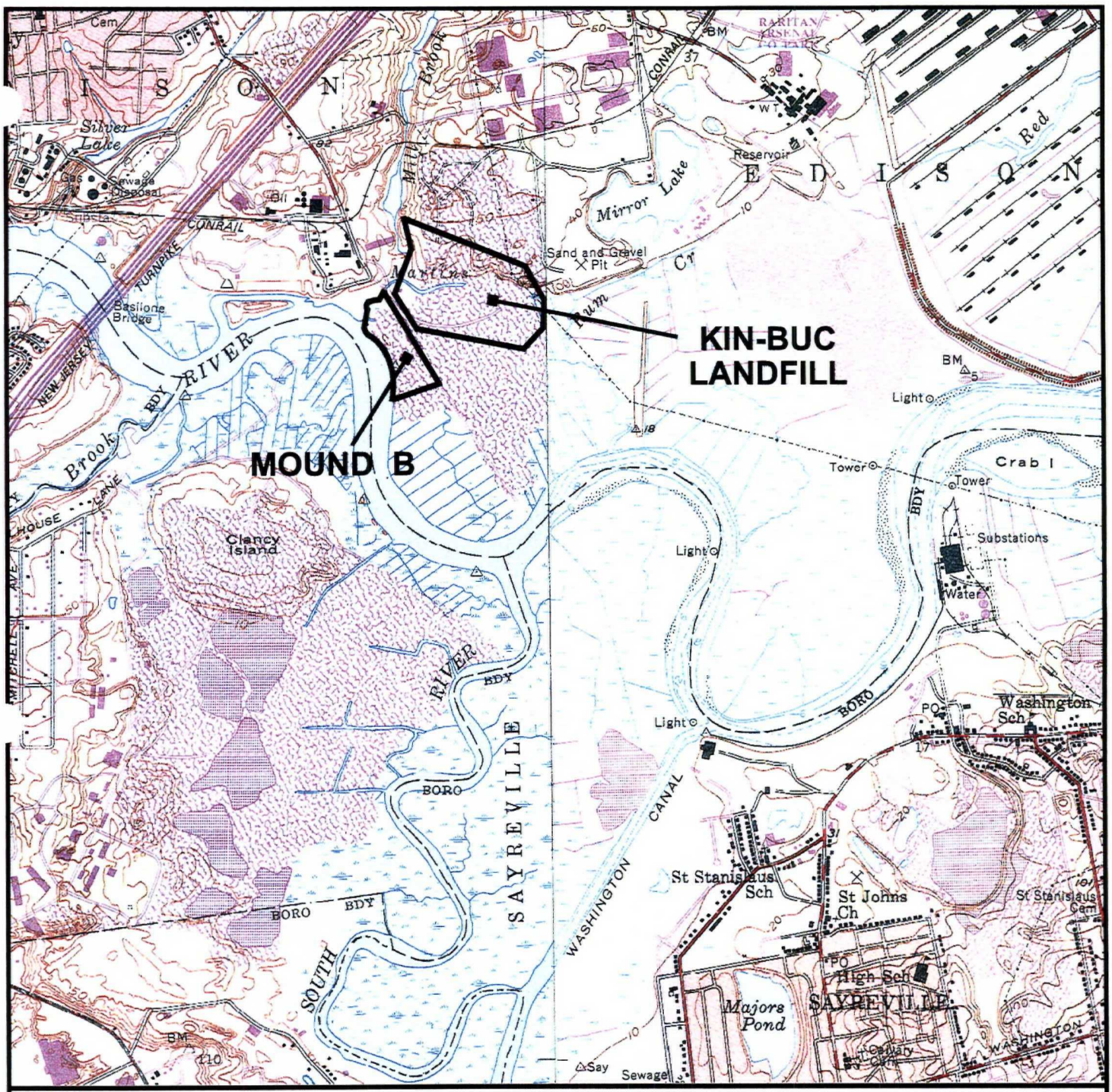
Jarrell, W.M., Qin, Z., Heilman, P., and Grabhorn, H., 1995. *Investigation of Leachate Production under Conventional Grass and Hybrid Poplar in Grabhorn Landfill.* Submitted to the Oregon Department of Environmental Quality, March 1995.



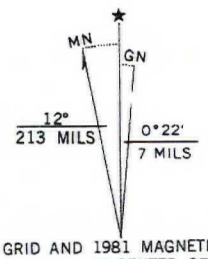
SOURCE:

SOUTH AMBOY/NEW BRUNSWICK, NEW JERSEY
7.5 MINUTE QUADRANGLE
CONTOUR INTERVAL = 10 FEET

2000' 0 2000'

Approximate Scale: In Feet

QUADRANGLE LOCATION



UTM GRID AND 1981 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

2/15/00 EMN - WDN
0979159E.CDR

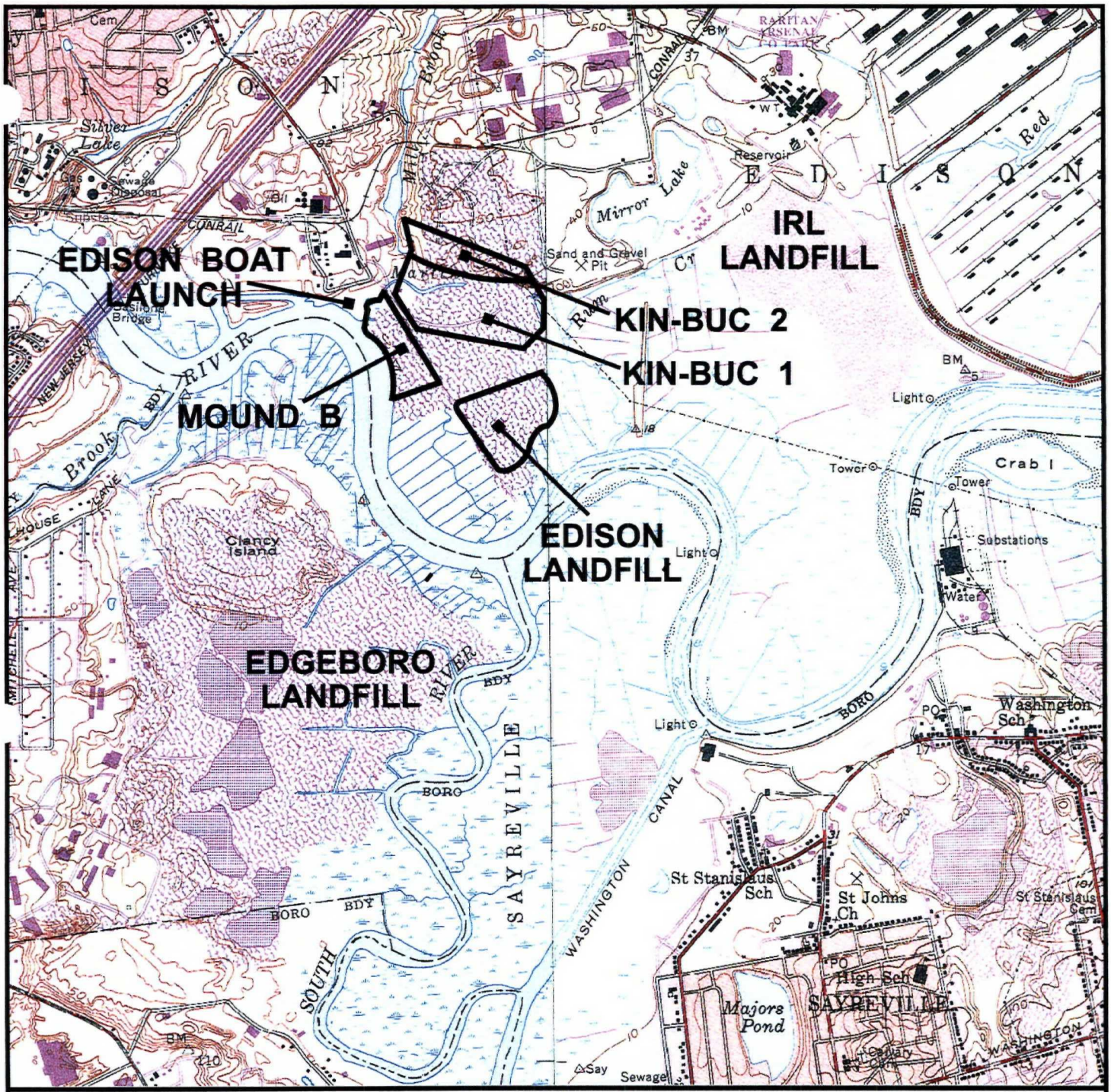
SCA SERVICES, INC.
KIN-BUC LANDFILL SITE
EDISON, NEW JERSEY

MOUND B (OU2) WORK PLAN

SITE LOCATION MAP

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 1



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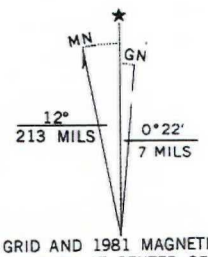
SOUTH AMBOY/NEW BRUNSWICK, NEW JERSEY
7.5 MINUTE QUADRANGLE
CONTOUR INTERVAL = 10 FEET

2000' 0 2000'

Approximate Scale: In Feet

QUADRANGLE LOCATION



UTM GRID AND 1981 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

03/03/00 EMN - WDN
0979159F.CDR

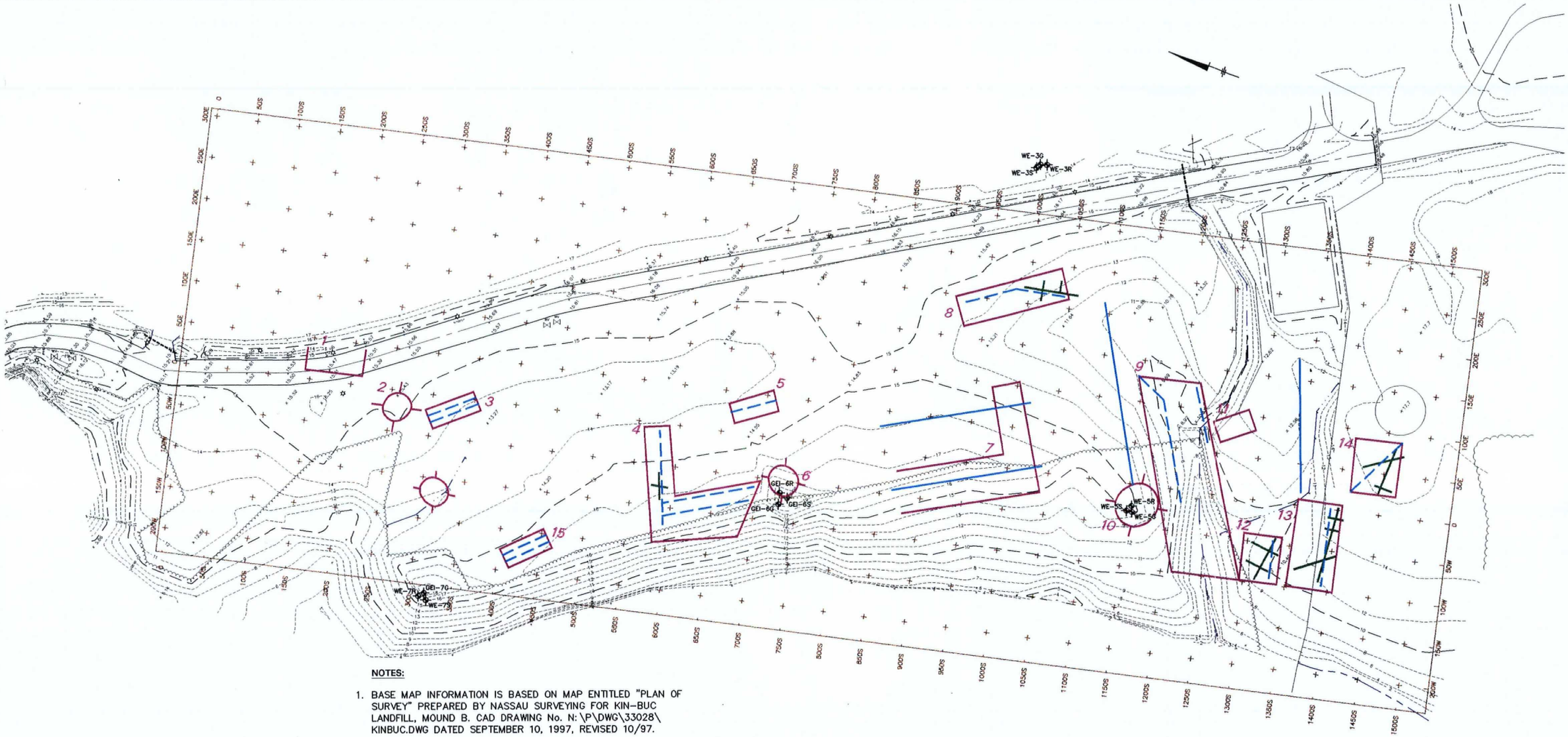
SCA SERVICES, INC.
KIN-BUC LANDFILL SITE
EDISON, NEW JERSEY

MOUND B (OU2) WORK PLAN

SITE AND SURROUNDING AREA

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 2



NOTES:

1. BASE MAP INFORMATION IS BASED ON MAP ENTITLED "PLAN OF SURVEY" PREPARED BY NASSAU SURVEYING FOR KIN-BUC LANDFILL, MOUND B. CAD DRAWING No. N:\P\DWG\33028\KINBUC.DWG DATED SEPTEMBER 10, 1997, REVISED 10/97.
2. ADDITIONAL BASE MAP INFORMATION OBTAINED FROM MAP ENTITLED "FIGURE 1 – SITE PLAN" PREPARED BY THE IT GROUP, CAD FILE # MAKBF-01.DWG DATE UNKNOWN.
3. GEOPHYSICAL SITE GRID TAKEN FROM MAP ENTITLED "PLATE 1 – MAGNETIC SURVEY MAP, TOTAL FIELD COMPONENT" PREPARED FOR KINBUC LANDFILL, MOUND B, EDISON, NEW JERSEY BY ROY F. WESTON, INC., FEDERAL PROGRAMS DIVISION. DATED JANUARY 1998.
4. USEPA EXPLORATORY TRENCHES MAY, 1998 TAKEN FROM A UNTITLED DRAWING, MOUND B SUPPLEMENTAL INVESTIGATION REPORT. UNDATED.
5. USEPA EXPLORATORY TRENCHES NOVEMBER, 1997 TAKEN FROM A MAP ENTITLED "PLATE 1 –MAGNETIC SURVEY MAP, TOTAL FIELD COMPONENT" PREPARED FOR KINBUC LANDFILL, MOUND B, EDISON, NEW JERSEY BY ROY F. WESTON, INC., FEDERAL PROGRAMS DIVISION. DATED JANUARY 1998.
6. HORIZONTAL DATUM:
   NEW JERSEY STATE PLANE COORDINATE SYSTEM NAD 1927.
7. VERTICAL DATUM:
   NATIONAL GEODETIC VERTICAL DATUM NGVD 1929.

LEGEND

- MAGNETIC ANOMALY (SUBSURFACE)
- PROPOSED TRENCH LOCATIONS
- MONITORING WELL
- GEOPHYSICAL GRID
- USEPA EXPLORATORY TRENCHES MAY, 1998 (SEE NOTE 4)
- USEPA EXPLORATORY TRENCHES NOVEMBER, 1997 (SEE NOTE 5)

60' 0 60' 120'
SCALE IN FEET

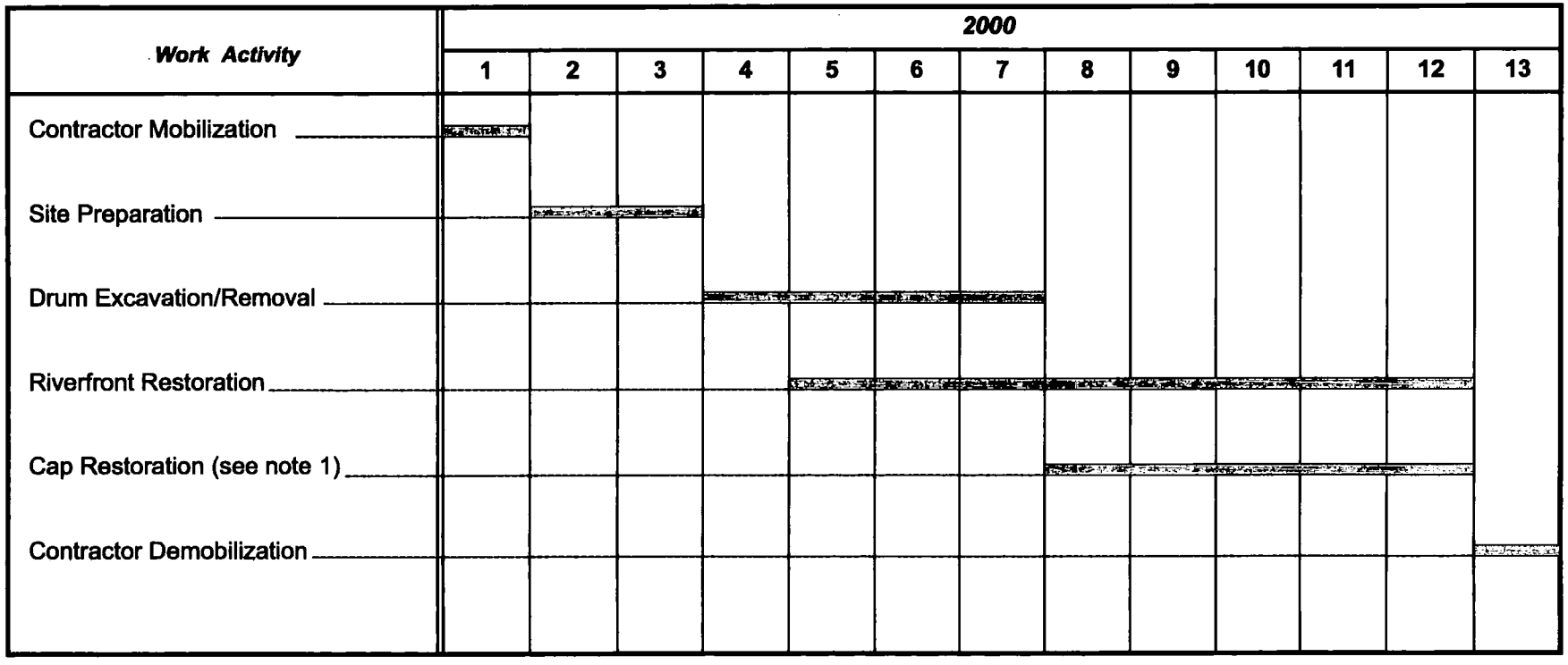
SCA SERVICES, INC.
KIN-BUC LANDFILL SITE
EDISON, NEW JERSEY
MOUND B (OU2) WORK PLAN

PROPOSED AREAS OF EXCAVATION

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3

X: 23701X01.DWG
L: OFF=REF
P: STD-PCP/DL
MARCH 2, 2000 CRA-62-WDN
237\23701050\23701EX1.DWG



Key:

= Activity Duration in weeks.

Note:

1. Cap restoration activities for year 2000 to include regrading of cap soil and establishing vegetation as necessary on drum excavation/removal areas. Initial E Cap tree planting work on remaining site area scheduled for spring 2001 with subsequent phased plantings annually through 2005.

SCA SERVICES, INC.
KIN-BUC LANDFILL SITE
EDISON, NEW JERSEY
MOUND B (OU2) WORK PLAN

ANTICIPATED CONSTRUCTION SCHEDULE

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 4

03/03/00 SYR-D64-DJH CRA-62-WDN

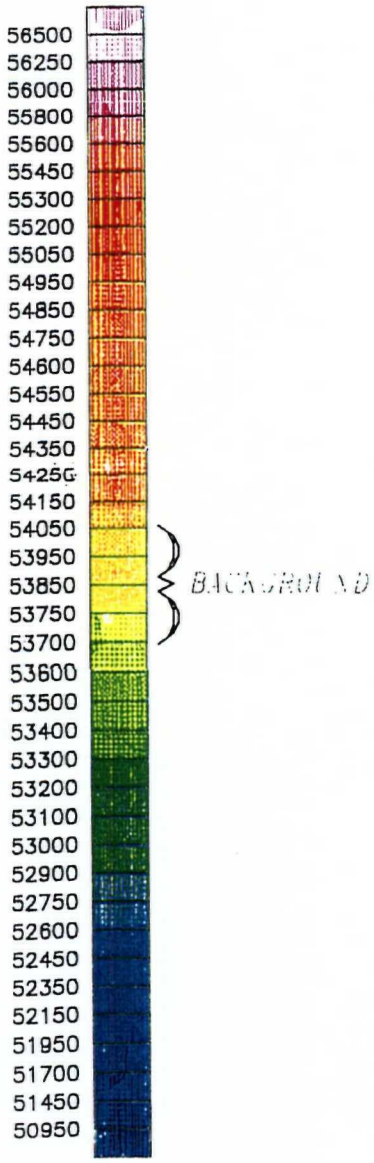
Appendix A

Magnetic Survey Map

NOTE: VERTICAL AND HORIZONTAL DATUMS:
NEW JERSEY PLANE CORDINATES SYSTEM
VERTICAL NGVD 1929
HORIZONTAL NAD 1927

SHEET #: 205
BLOCK: 400
LOTS: 2-A, 4, 5, 6, & 9

- SURVEY LIMITS
- GUIDE RAIL
- 10 — TOPOGRAPHIC CONTOUR
- CENTER LINE OF DITCH
- CENTER LINE OF ROAD
- EDGE OF ROAD
- CONCRETE CURB
- FENCE LINE
- TREE AND HEAVY BRUSH LINE
- STORM SEWER PIPE
- MATCH LINE
- WV — WATER VALVE
- FIRE HYDRANT
- UTILITIES POLE
- BORING LOCATION AND ELEVATION
- FLARED END SECTION
- MONITORING WELL
- x 11.32 — SPOT ELEVATION
- 4 — MAGNETIC ANOMALY (CULTURAL INTERFERENCE)
- 4 — MAGNETIC ANOMALY (SUBSURFACE)
- TP-3 — TEST PIT



Scale 1:960

0 50 100 150 200 250

(feet)

PLATE 1 - MAGNETIC SURVEY MAP
TOTAL FIELD COMPONENT
KINBUC LANDFILL, MOUND B
EDISON, NEW JERSEY
JANUARY 1998

US EPA REMOVAL ACTION BRANCH
SUPERFUND TECHNICAL ASSESSMENT AND RESPONSE TEAM
CONTRACT# 68-W5-0019

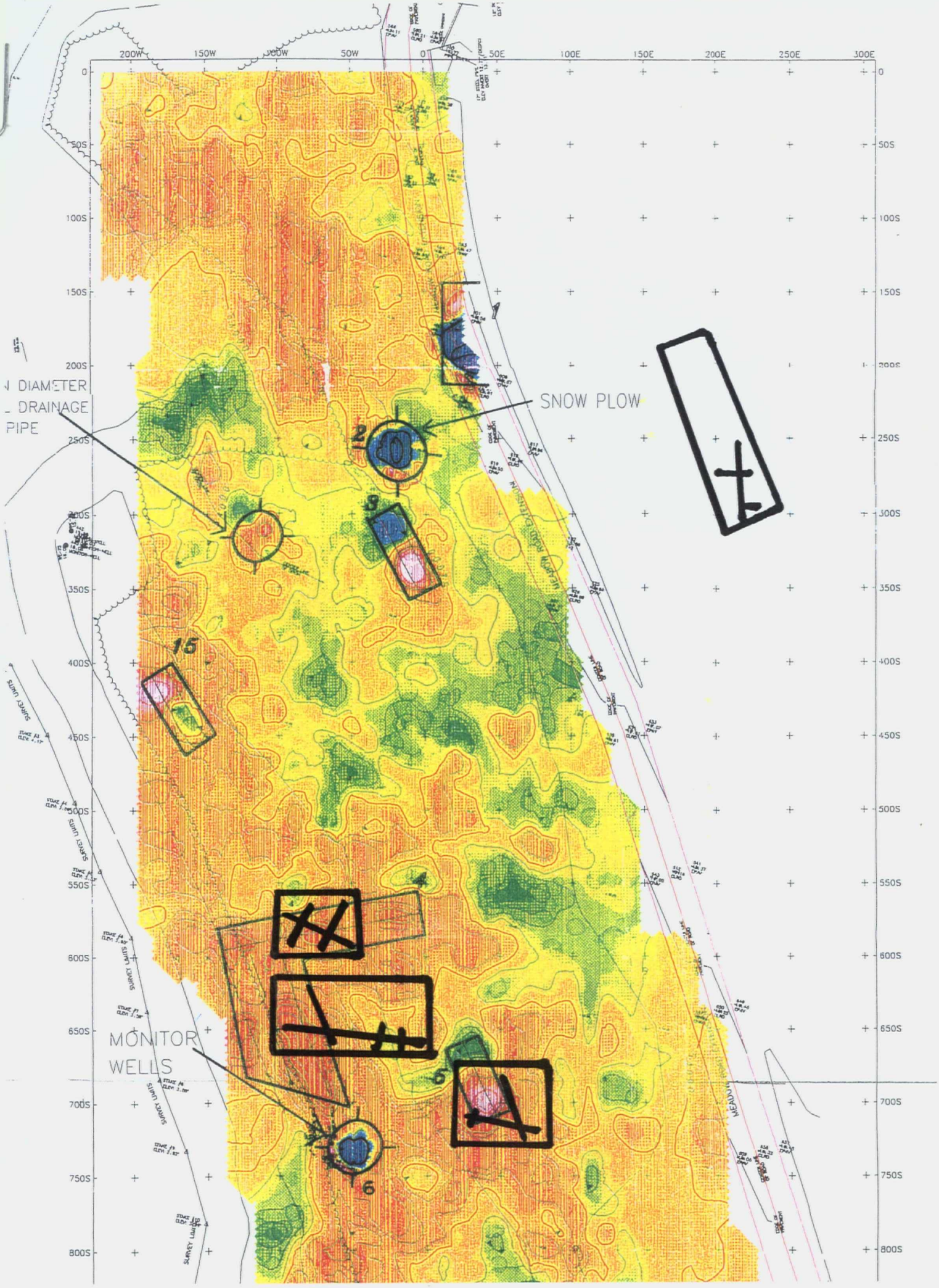
EDITED BY : J. WILLIAMS

EPA TASK MONITOR: C. AGNIHOTRI

START PROJECT MANAGER: C. STANNIK

WESTON MANAGERS DESIGNERS/CONSULTANTS
Roy F. Weston, Inc.
FEDERAL PROGRAMS DIVISION

IN ASSOCIATION WITH PRC ENVIRONMENTAL MANAGEMENT, INC.,
C.C. JOHNSON & MALHOTRA, P.C., RESOURCE APPLICATIONS, INC.,
R.E. SARRIERA ASSOCIATES, AND GRB ENVIRONMENTAL SERVICES, INC.


200W
150W
100W
50W
0
50E
100E
150E
200E
250E
300E
0
50S
100S
150S
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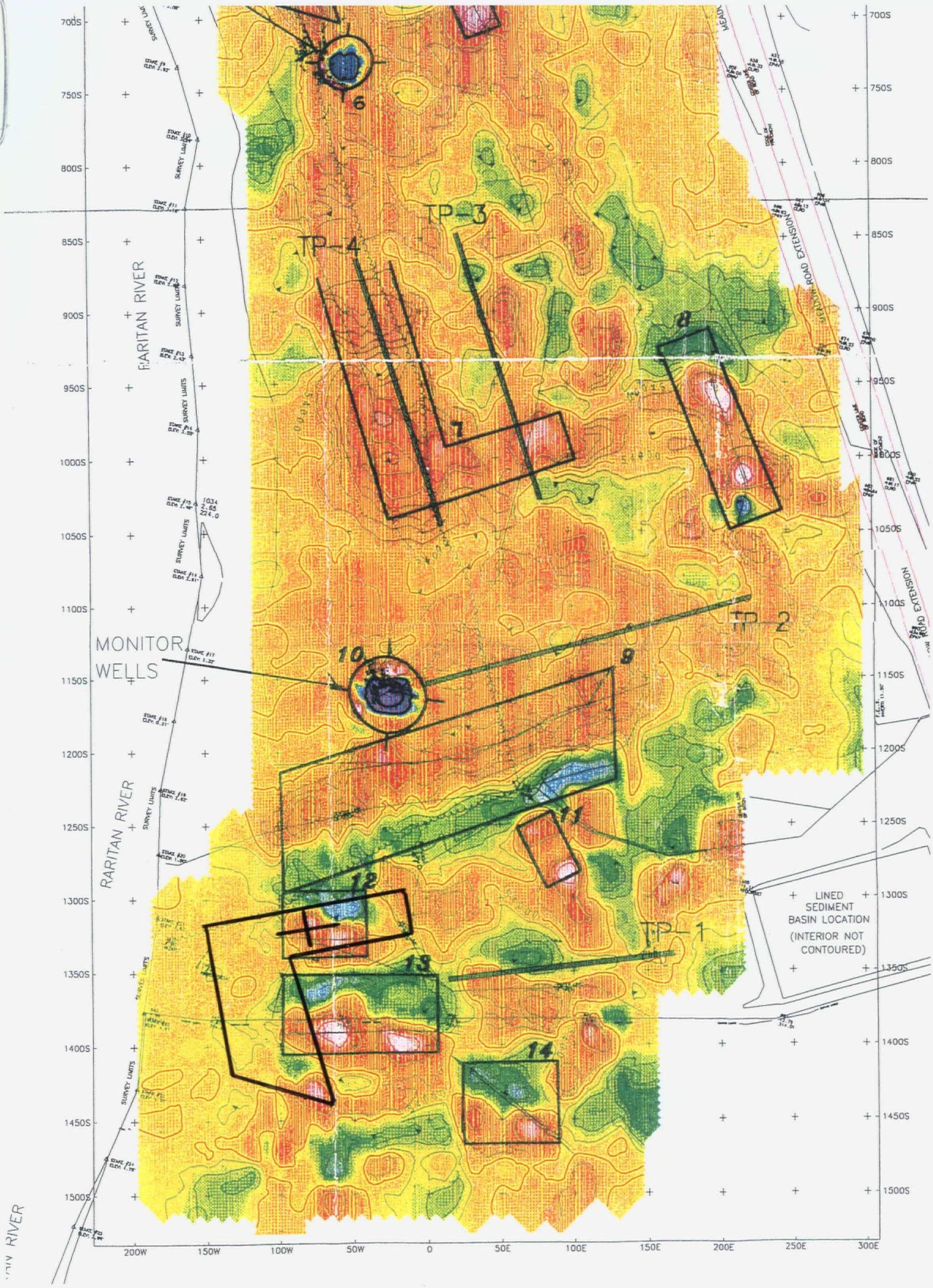
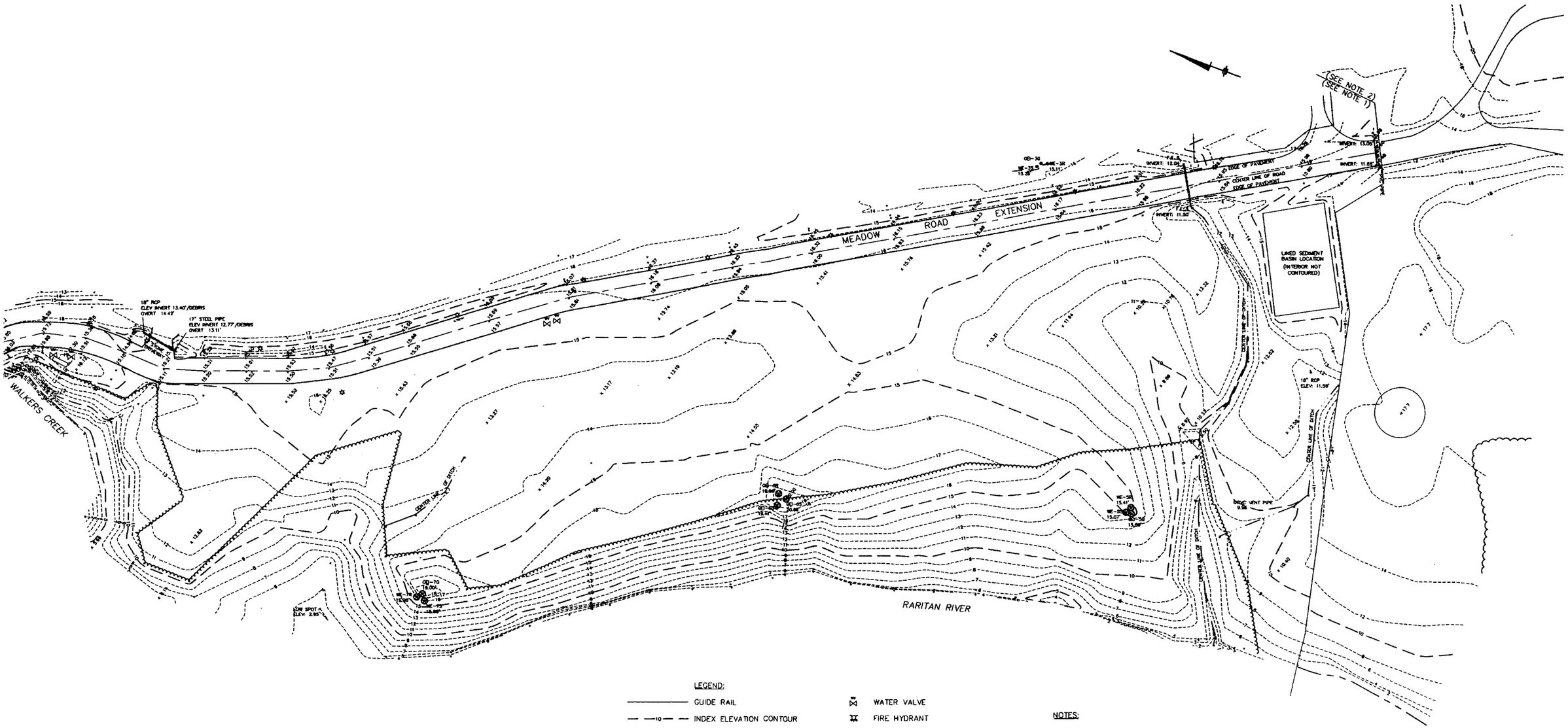
250S
300S
350S
400S
450S
500S
550S
600S
650S
700S
750S
800S
DIAMETER
DRAINAGE
PIPE
SNOW PLOW
MONITOR
WELLS
2
10
9
15
6
6


TP-1
TP-2
TP-3
TP-4
6
7
8
9
10
11
12
13
14
MONITOR WELLS
RARITAN RIVER
RARITAN RIVER
MEADOW ROAD EXTENSION
LINED SEDIMENT BASIN LOCATION (INTERIOR NOT CONTOURED)
SURVEY LIMITS
700S
750S
800S
850S
900S
950S
1000S
1050S
1100S
1150S
1200S
1250S
1300S
1350S
1400S
1450S
1500S
200W
150W
100W
50W
0
50E
100E
150E
200E
250E
300E

Appendix B

Design Drawings and Specifications

Precipitation Maps



LEGEND:

- GUIDE RAIL
- INDEX ELEVATION CONTOUR
- INTERMEDIATE ELEVATION CONTOUR
- CENTER LINE OF DITCH
- CENTERLINE OF ROAD
- EDGE OF ROAD
- CONCRETE CURB
- FENCE LINE
- TREE AND HEAVY BRUSH LINE
- STORM SEWER PIPE
- WATER VALVE
- FIRE HYDRANT
- UTILITIES POLE
- FLARED END SECTION
- MONITORING WELL
- x 11.32 SPOT ELEVATION

NOTES:

1. BASE MAP INFORMATION IS BASED ON MAP ENTITLED "PLAN OF SURVEY" PREPARED BY NASSAU SURVEYING FOR KIN-BUC LANDFILL, MOUND B. CAD DRAWING No. N:\P\DWG\33028\KINBUC.DWG DATED SEPTEMBER 10, 1997, REVISED 10/97.
2. ADDITIONAL BASE MAP INFORMATION OBTAINED FROM MAP ENTITLED "FIGURE 1 – SITE PLAN" PREPARED BY THE IT GROUP, CAD FILE # MAKBF-01.DWG.
3. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM NAD 1927.
4. VERTICAL DATUM: NATIONAL GEODETIC VERTICAL DATUM NGVD 1929.

X: (23701X01.DWG
L: (LAYER)
P: STD-PCP/DL
2/16/00 SYR-54-NES YCC
23701050/CONTRACT/23701G01.DWG

Graphic Scale
60' 0 60' 120'
APPROXIMATE SCALE IN FEET

Project Mgr. _____ Drawn by _____
Designed by _____ Checked by _____

No.	Date	Revisions	Init

Andrew N. Johnson, P.E. Date:
N.J. Professional Engineer Lic. No. 32866

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MOUND B WORK PLAN

EXISTING SITE PLAN

GENERAL

File Number
237.01. F

Date
FEBURARY 2000

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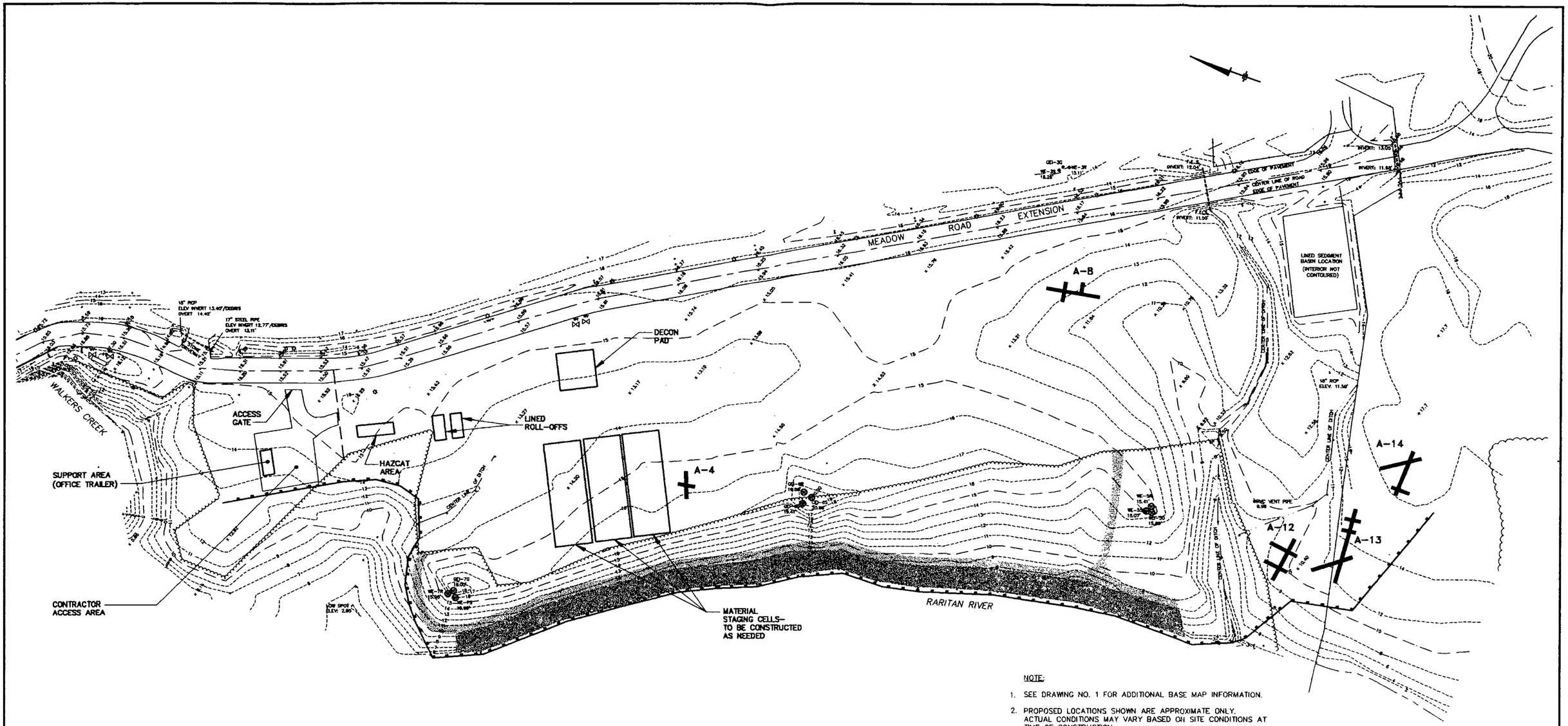
Tele: (609) 860-0590

1



LEGEND:

- PROPOSED RIVER FRONT RESTORATION AREA
- PROPOSED ACCESS ROAD
- PROPOSED SILT FENCE
- A-4 PROPOSED DRUM EXCAVATION TRENCH

NOTE:

1. SEE DRAWING NO. 1 FOR ADDITIONAL BASE MAP INFORMATION.
2. PROPOSED LOCATIONS SHOWN ARE APPROXIMATE ONLY. ACTUAL CONDITIONS MAY VARY BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
3. CONTRACTOR SHALL PROTECT EXISTING MONITORING WELLS DURING CONSTRUCTION ACTIVITIES.
4. ADDITIONAL TEMPORARY ACCESS ROADS (NOT SHOWN) WILL BE IDENTIFIED AS NECESSARY TO ACCESS TRENCH EXCAVATION AREAS.
5. ACCESS ROAD LOCATIONS TO BE DETERMINED AT TIME OF CONSTRUCTION BASED ON SITE SPECIFIC CONDITIONS AND VEHICLE USAGE/TYPE REQUIRED.
6. ALL TEMPORARY FACILITIES AND FEATURES SHALL BE REMOVED AT COMPLETION OF WORK UNLESS OTHERWISE INDICATED ON THESE DRAWINGS. THE SITE GRADING SHALL BE RESTORED TO ORIGINAL CONDITION.

X: 23701X01.DWG
L: (LAYER)
P: STD-PCP/DL
3/03/00 SYR-54-KLN YCC JER
23701050/CONTRACT/23701G02.DWG

Graphic Scale
60' 0 60' 120'
APPROXIMATE SCALE IN FEET

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PROPOSED SITE PREPARATION PLAN

GENERAL

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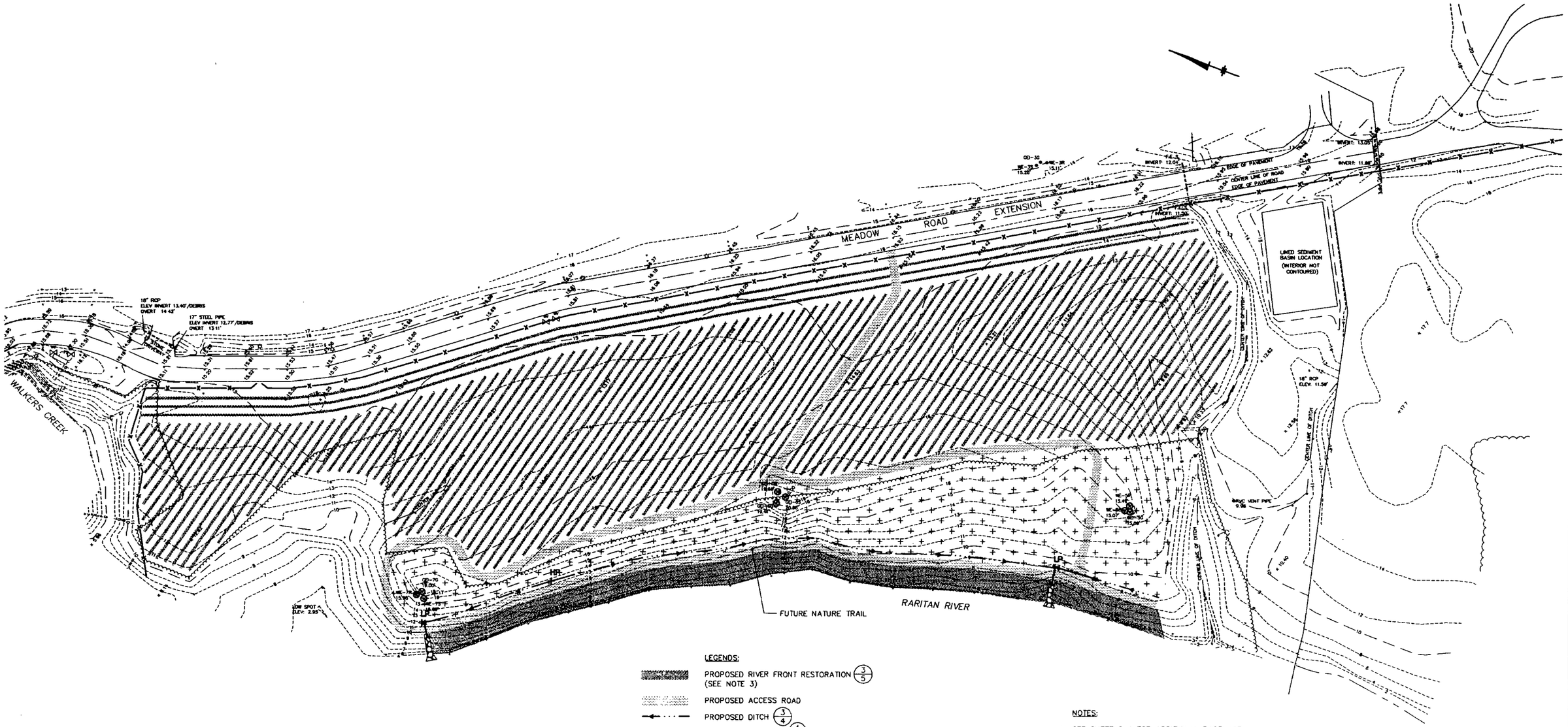
2



LEGENDS:

- PROPOSED RIVER FRONT RESTORATION (3/5) (SEE NOTE 3)
- PROPOSED ACCESS ROAD
- PROPOSED DITCH (3/4)
- PROPOSED CULVERT (4/4)
- PROPOSED TREECAP (1/5)
- HP + HIGH POINT
- LP + LOW POINT
- + + + PROPOSED BUFFER ZONE VEGETATION
- —x— PROPOSED SECURITY FENCE

NOTES:

1. SEE SHEET G-1 FOR ADDITIONAL BASE MAP INFORMATION.
2. PROPOSED LOCATIONS SHOWN ARE APPROXIMATE ONLY. ACTUAL CONSITIONS MAY VARY BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
3. FINAL GRADING CONDITION ON RIVER FRONT RESTORATION NOT SHOWN.

X: (23701X01.DWG
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2/16/00 SYR-54-NES YCC
23701050/CONTRACT/23701G04.DWG

Graphic Scale
60' 0 60' 120'
APPROXIMATE SCALE IN FEET

Project Mgr. _____ Drawn by _____
Designed by _____ Checked by _____

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MOUND B WORK PLAN

PROPOSED FINAL SITE PLAN

GENERAL

File Number
FILE NO. XXX.XXX.XXF

Date
XXXXX

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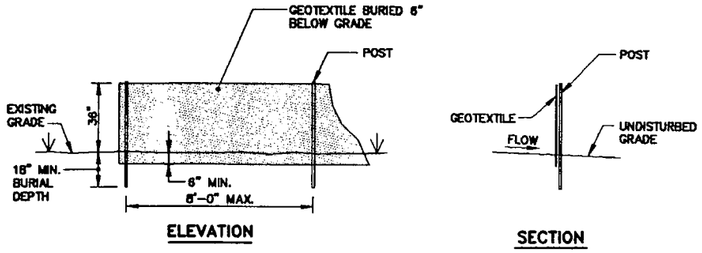
3

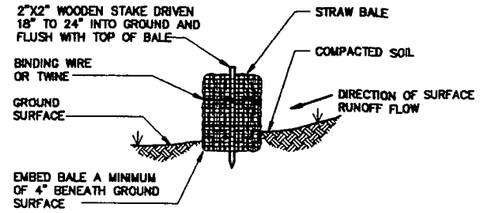


NOTES:

1. SEDIMENT DEPOSITS SHALL BE REMOVED AS NECESSARY TO PREVENT DAMAGE TO THE SILT FENCE.
2. THE SILT FENCE WILL REMAIN IN-PLACE UNTIL GRADED AREAS ARE SUFFICIENTLY STABILIZED.

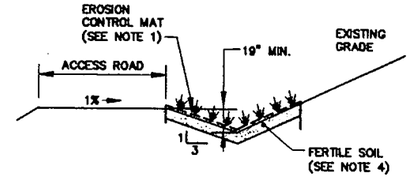
SILT FENCE DETAIL (1)

NOT TO SCALE



STRAW BALE DETAIL (2)

NOT TO SCALE

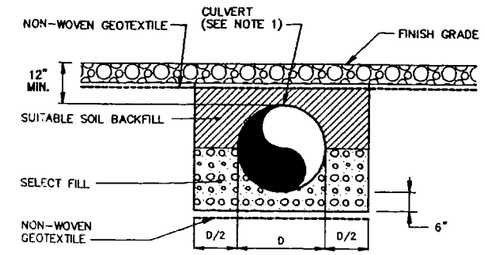


NOTES:

1. EROSION CONTROL MAT SHALL BE P300 MANUFACTURED BY NORTH AMERICAN GREEN OR EQUAL.
2. DISTURBED AREAS SHALL BE REGRADED WITH SOIL CAPABLE OF PROMOTING AND SUSTAINING VEGETATIVE COVER.
3. DRAINAGE DITCH INVERT TO BE CONSTRUCTED AT A MINIMUM 0.5% SLOPE.
4. FERTILE SOIL BACKFILL SHALL BE CAPABLE OF ESTABLISHING AND SUSTAINING VEGETATION INDICATED.

DRAINAGE DITCH DETAIL (3)

NOT TO SCALE

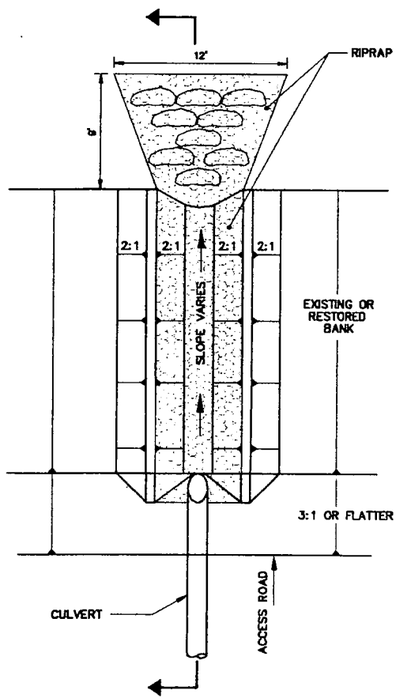


NOTES:

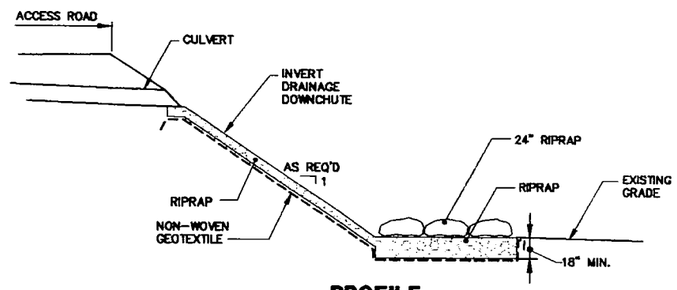
1. CULVERTS SHALL BE CORRUGATED METAL PIPE OR EQUAL.
2. ALL TRENCH SIDE SLOPES TO BE CONSTRUCTED AS NECESSARY FOR SAFE AND PROPER INSTALLATION.

CULVERT SECTION (4)

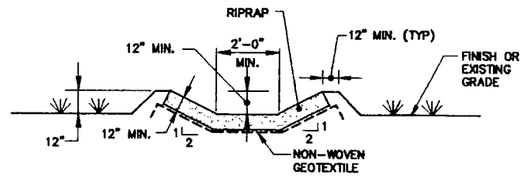
NOT TO SCALE



PLAN



PROFILE



NOTES:

1. RIPRAP SHALL CONSIST OF CRUSHED STONE FREE FROM DELETERIOUS MATERIALS AND HAVE D_{50} = 12", AND D_{100} = 18", D_{15} = 5".
2. ALL RIPRAP SHALL BE PLACED SECURELY IN A MANNER WHICH MINIMIZES VOID SPACES.
3. UPGRADIENT TERMINATION OF GEOTEXTILE SHALL BE ANCHORED SECURELY TO PREVENT UPLIFT OF GEOTEXTILE FABRIC.

SECTION

DRAINAGE DOWNCHUTE DETAIL (5)

NOT TO SCALE

L: ON=* OFF=*REF*
P: STD-PCP/DL
2/16/00 SYR-54 NES KLN YCC
23701050/CONTRACT/23701G05.DWG

Graphic Scale	No.	Date	Revisions	Init

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MOUND B WORK PLAN

SOIL EROSION AND SEDIMENT CONTROL DETAILS

File Number 237.01.XXF
Date FEBRUARY 2000

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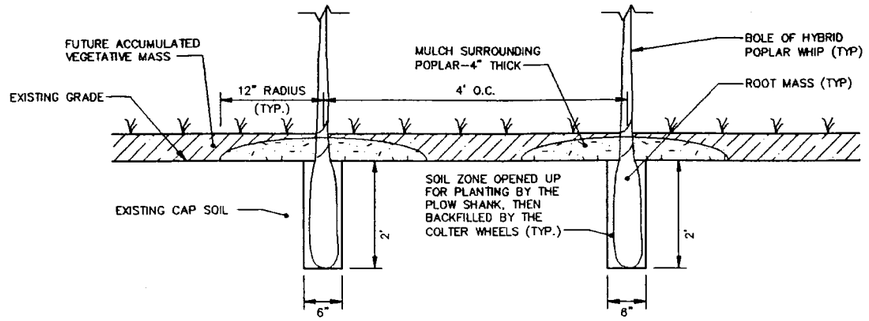
4

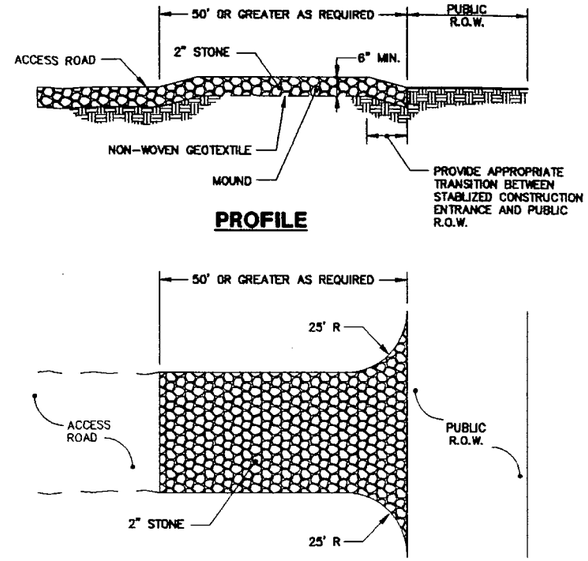


NOTES:

1. TREE DENSITY OF APPROXIMAELY 10 FOOT SPACING BETWEEN ROWS AND 4 FEET BETWEEN TREES. (40 SQ.FT./TREE)
2. TREE ROWS WILL BE ROTOTILLED PRIOR TO TREE INSTALLATION.
3. EXCAVATION FOR INSTALLATION OF TREES SHALL NOT BE BELOW BOTTOM OF EXISTING SOIL CAP.

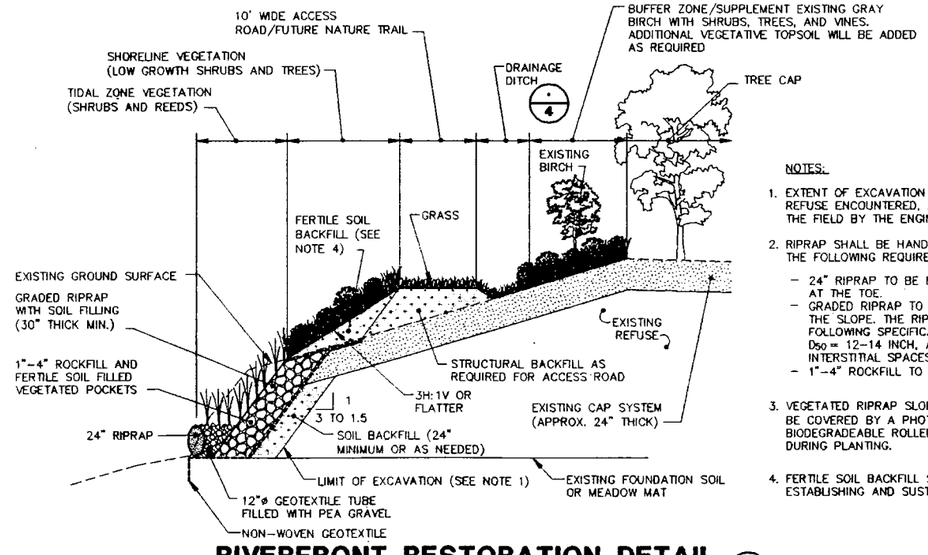
TREE PLANTING DETAIL (1)

NOT TO SCALE



STABILIZED CONSTRUCTION ENTRANCE DETAIL (2)

NOT TO SCALE

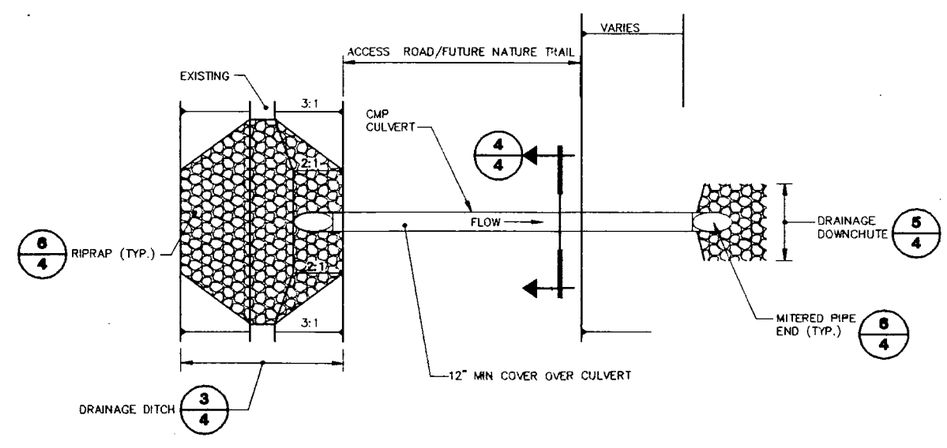


NOTES:

1. EXTENT OF EXCAVATION MAY VARY DEPENDING ON REFUSE ENCOUNTERED, AND MAY BE ADJUSTED IN THE FIELD BY THE ENGINEER.
2. RIPRAP SHALL BE HAND PLACED AND SHALL MEET THE FOLLOWING REQUIREMENTS:
   - 24" RIPRAP TO BE PLACED ON THE OUTSIDE EDGE AT THE TOE.
   - GRADED RIPRAP TO BE PLACED AT TOE AND UP THE SLOPE. THE RIPRAP SHALL MEET THE FOLLOWING SPECIFICATIONS: D_{100} = 18-20 INCH, D_{50} = 12-14 INCH, AND D_{15} = 5-6 INCH. FILL INTERSTITIAL SPACES WITH FERTILE SOIL.
   - 1"-4" ROCKFILL TO BE PLACED AT TOE OF SLOPE.
3. VEGETATED RIPRAP SLOPES STEEPER THAN 2H:1V WILL BE COVERED BY A PHOTODEGRADABLE AND/OR BIODEGRADEABLE ROLLED EROSION CONTROL PRODUCT DURING PLANTING.
4. FERTILE SOIL BACKFILL SHALL BE CAPABLE OF ESTABLISHING AND SUSTAINING VEGETATION INDICATED.

RIVERFRONT RESTORATION DETAIL (3)

NOT TO SCALE



CULVERT CROSSING DETAIL (4)

NOT TO SCALE

L: ON=*, OFF=*REF*
P: STD-PCP/DL
2/16/00 SYR-54 NES YCC KMD
23701050/CONTRACT/23701G06.DWG

Graphic Scale		No.	Date	Revisions	Init
Project Mgr.	Drawn by				
Designed by	Checked by				

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MOUND B WORK PLAN
DETAILS

File Number 237.01.XXF
Date FEBRUARY 2000
Blasland, Bouck & Lee, Inc. 8 South River Road Cranbury, N.J. 08512-9502 Tele: (609) 860-0590

5

MATERIALS AND PERFORMANCE - SECTION 02600

SHRUB AND TREE PLANTING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, equipment, tools, and appurtenances required to complete the seeding of all areas disturbed, regarded or receiving a cover during the course of construction.

B. The Contractor shall comply with all applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 SUBMITTALS

A. A manufacturer's Certificate of Compliance for the origin of the plant material with each shipment. These certificates shall include the guaranteed species, size, and the date of shipment. No plants may be planted until the Contractor has submitted these certifications.

B. The Contractor shall provide analysis of soil suitability to sustain vegetation. Analyze to ascertain percentages of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH by performing Baker or LaMotte Test.

C. Recommendations of the Middlesex County Soil Conservation District.

1.03 QUALITY ASSURANCE

A. The Contractor shall guarantee 90% of the planted plants for a period of one (1) year, as determined by the Owner's Representative. Dead plants will be replaced at the Contractor's expense.

B. Maintain erosion and sediment controls in accordance with the Middlesex County Soil Conservation District.

1.04 QUALITY CONTROL

A. The Contractor shall submit to the Owner's Representative and Quality Control Official evidence of compliance with the testing specified in Article 1.2 at least seven (7) days prior to placement.

PART 2 - PRODUCTS

2.01 SOIL

A. The topsoil shall be organic topsoil free of debris, rocks larger than two (2) inches, wood, roots vegetative matter and clay clods.

2.02 SHRUBS/TREES

A. Individual plants shall be randomly placed in areas to be planted.

B. Planting pits shall be dug with level bottoms, with width twice the diameter of root ball and six (6) inches deeper than the length of root ball. Each plant pit shall be back filled with the following prepared soil mix thoroughly.

1 part peatmoss by volume
1 part cow manure by volume
3 parts topsoil by volume

C. Prepared soil shall be tamped firmly at bottom of pit. Fill prepared soil around ball of plant ½ way, and insert plant tablets (see below). Complete back fill and water thoroughly.

D. All plants shall be set as that, they bear the same relation to the required grade as they bore to the natural grade before being transplanted.

E. Immediately after planting, stake all trees to prevent damage from wind (lodge-pole stakes length as required). Fasten trees to upper end of stake in at least two (2) places using hose type ties.

F. The Owner, through the Owner's Representative, reserves the right to change the shrub and trees species and recommended planting dates based upon the time of the year in which the construction is performed.

2.03 FERTILIZER

A. The individual plants shall be fertilized as follows:
21 gram 'Agriform' planting tablets as follows:

2 tablets per 1 gal plant
3 tablets per 5 gal plant
4 tablets per 15 gal plant
Larger plants two (2) tablets per ½" diameter of trunk caliper

2.04 MULCH

A. Straw mulch shall be oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable. Straw mulch shall be properly anchored.

B. Wood fiber mulch shall consist of wood fiber produced from clean, whole uncooked wood, formed into resilient bundles having a high degree of internal friction and shall be dry when delivered to the Site.

2.05 WATER

MATERIALS AND PERFORMANCE - SECTION 02600

SHRUB AND TREE PLANTING

A. All plants shall be water immediately after planting. Water shall be applied to each tree and shrub in such manner as not to disturb back fill and to the extent that all materials in the planting hole are thoroughly saturated. Water shall be clean, fresh, potable, and free of sub-stances or matter that could inhibit vigorous growth of grass.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall verify that the prepared vegetative layer is ready to receive the plantings for this Section.

3.02 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall deliver shrubs and trees showing origin of material.

B. The Contractor shall deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer. Fertilizer in damaged packaging is not acceptable.

3.03 LIMING

A. When required, ground limestone that has been protected from moisture, and is dry and free flowing, shall be evenly spread over the area to be seeded at a rate that will produce a pH value of the soil of 6.5.

B. The Contractor shall work lime into vegetative layer to a depth of 3 inches with a disc, spring-tooth harrow, or other suitable equipment.

3.04 FERTILIZING

A. The Contractor shall apply fertilizer in accordance with manufacturer's instructions.

B. The Contractor shall apply fertilizer after smoothing of the vegetative layer and prior to roller compaction.

C. The Contractor shall not apply fertilizer at the same time or with the same machine as that will be used to apply seed unless hydroseeding.

D. The Contractor shall mix fertilizer thoroughly into upper 3 inches of the vegetative layer with a disc, spring-tooth harrow, or other suitable equipment.

E. The Contractor shall lightly water ground surface to aid the dissipation of fertilizer.

3.05 CLEANUP

A. Upon the completion of all planting work and before final acceptance, the Contractor shall remove all material, equipment, and debris resulting from the work. The site shall be left in a neat and acceptable condition as approved by the Owner's Representative.

3.06 REPLANTING

A. Where dead plants are identified shall be replaced within one (1) year of initial planting. The Contractor shall place all plants in accordance with this Section, at no additional cost to the Owner.

- END OF SECTION -

MATERIALS AND PERFORMANCE - SECTION 02232

GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall supply all labor, materials, tools, and equipment required to furnish and install non-woven geotextile fabric as specified herein and as shown on the Contract Drawings.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D1777 Thickness
2. ASTM D3776 Unit Weight
3. ASTM D3786 Mullen Burst
4. ASTM D4491 Permittivity
5. ASTM D4533 Trapezoid Tear
6. ASTM D4632 Grab Tensile
7. ASTM D4632 Grab Elongation
8. ASTM D4751 Apparent Opening Size
9. ASTM D4833 Puncture

B. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M 288-96 Geotextile Specification for Highway Applications

1.03 SUBMITTALS

A. Manufacturer's data for geotextile including, at a minimum, physical properties, packaging, and installation techniques.

B. Manufacturer's quality assurance/quality control program.

C. Certified results of all quality control testing.

D. Manufacturer's standard warranty provided for the geotextiles.

PART 2 - PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

A. Synthetics Industries,

B. Amoco, or
C. Approved equal.

2.02 MATERIALS

A. For the purpose of these specifications, construction drawings and Contract Documents, the terms "non-woven geotextile", "geotextile fabric", and "filter fabric" shall be considered synonymous.

B. Geotextile fabric used shall be non-woven geotextiles.

C. The non-woven geotextile shall be of needle-punched construction and consist of long-chain polymeric fibers or filaments composed of polypropylene; shall be free of any chemical treatment which reduces permeability and shall be inert to chemicals commonly found in soil.

D. The non-woven geotextiles indicated on the Design Drawings shall have the minimum physical properties listed below:

Non-Woven Geotextile

Property	Unit of Measure	Test Method	Minimum Test Value
Grab Tensile	N	ASTM D4632	900
Grab Elongation	%	ASTM D4632	50
Mullen Burst	N	ASTM D3786	1700
Puncture	N	ASTM D4833	350
Trapezoid Tear	N	ASTM D4533	350
Apparent Opening Size	mm	ASTM D4751	0.25 (max.)
Permittivity	sec^{-1}	ASTM D4491	0.2

2.03 DELIVERY, STORAGE AND HANDLING

A. The geotextile shall be furnished in a protective wrapping which shall be labeled with the following information: manufacturer's name, product identification, lot #, roll #, and dimensions.

B. The geotextile shall be protected from ultraviolet light, precipitation, mud, soil, excessive dust, puncture, cutting and/or other damaging conditions prior to and during delivery and on-site storage. The geotextile shall be capable of withstanding 30 days of sunlight without measurable deterioration. The geotextile shall be stored on-site at a location approved by the Owner's Representative.

MATERIALS AND PERFORMANCE - SECTION 02232

GEOTEXTILE FABRIC

2.04 QUALITY ASSURANCE

A. The field delivered material shall meet the specification values according to the manufacturer's specification sheet. The Contractor shall submit written certification that the delivered material meets the manufacturer's specifications. The Contractor shall provide the quality control test results conducted by the manufacturer during the manufacturing of the geotextile fabric delivered to the project site. The results shall identify the sections/panels of field delivered fabric they represent. The Contractor shall also provide the lot and roll number for the material delivered to the site.

B. The manufacturer shall have developed and shall adhere to its own quality assurance program in the manufacture of the geotextile.

C. The installer shall verify in writing prior to installation that the geotextile fabric has not been damaged due to improper transportation, handling, or storage.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to installation of the geotextile, placement surfaces shall be leveled and uniformly compacted, as specified, to provide a smooth, stable interface for the geotextile.

3.02 GEOTEXTILE INSTALLATION

The following procedures and requirements shall be followed during the installation of geotextile.

A. Placement

1. The placement of the geotextile shall not be conducted during adverse weather conditions. The geotextile shall be kept dry during storage and up to the time of deployment. During windy conditions, all geotextiles shall be secured with sandbags or an equivalent approved anchoring system. Removal of the sandbags or equal shall only occur upon placement of an overlying layer.

2. Proper cutting tools shall be used to cut and size the geotextile materials. Extreme care shall be taken while cutting in-place geotextiles.

3. During the placement of geotextiles, all dirt, dust, sand and mud shall be kept off to prevent clogging. If excessive contaminant materials are present on the geotextile, it shall be cleaned or replaced as directed by the Owner's Representative.

4. The geotextile shall be covered within the time period recommended by the manufacturer, and in no case later than two weeks after its placement.

B. Seaming or Joining

1. Geotextiles shall be seamed using a minimum 12-inch overlap.

a. In all cases, seams on side slopes shall be parallel to the line of slope. No horizontal seams shall be allowed on side slopes, except for patching.

2. Repair of tears or holes in the geotextile shall require the following procedures:

a. Sould any tear exceed 10% of the width of the roll, that panel will be removed and replaced..

b. All other tears will be repaired by installing a patch made from the same geotextile over the tear with a minimum of 24 inch overlap in all directions.

3.03 WARRANTY

A. The Contractor shall obtain from the manufacturer and submit to the Owner's Representative, a standard warranty provided for the geotextiles. The Owner's Representative shall review the warranty for completeness prior to accepting its provisions.

- END OF SECTION -

Surface Drainage Calculations

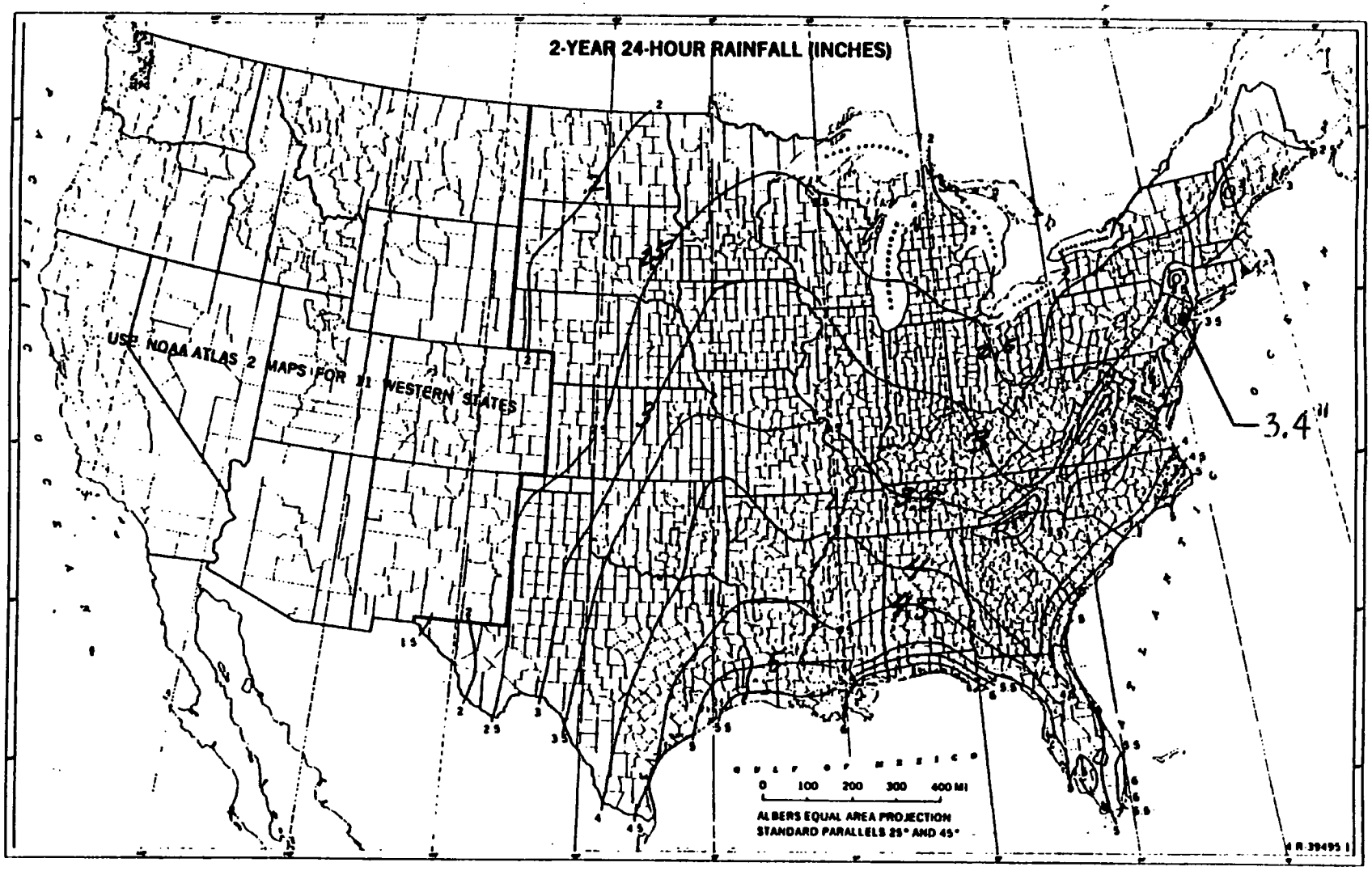


Figure B-3.—Two-year, 24-hour rainfall.

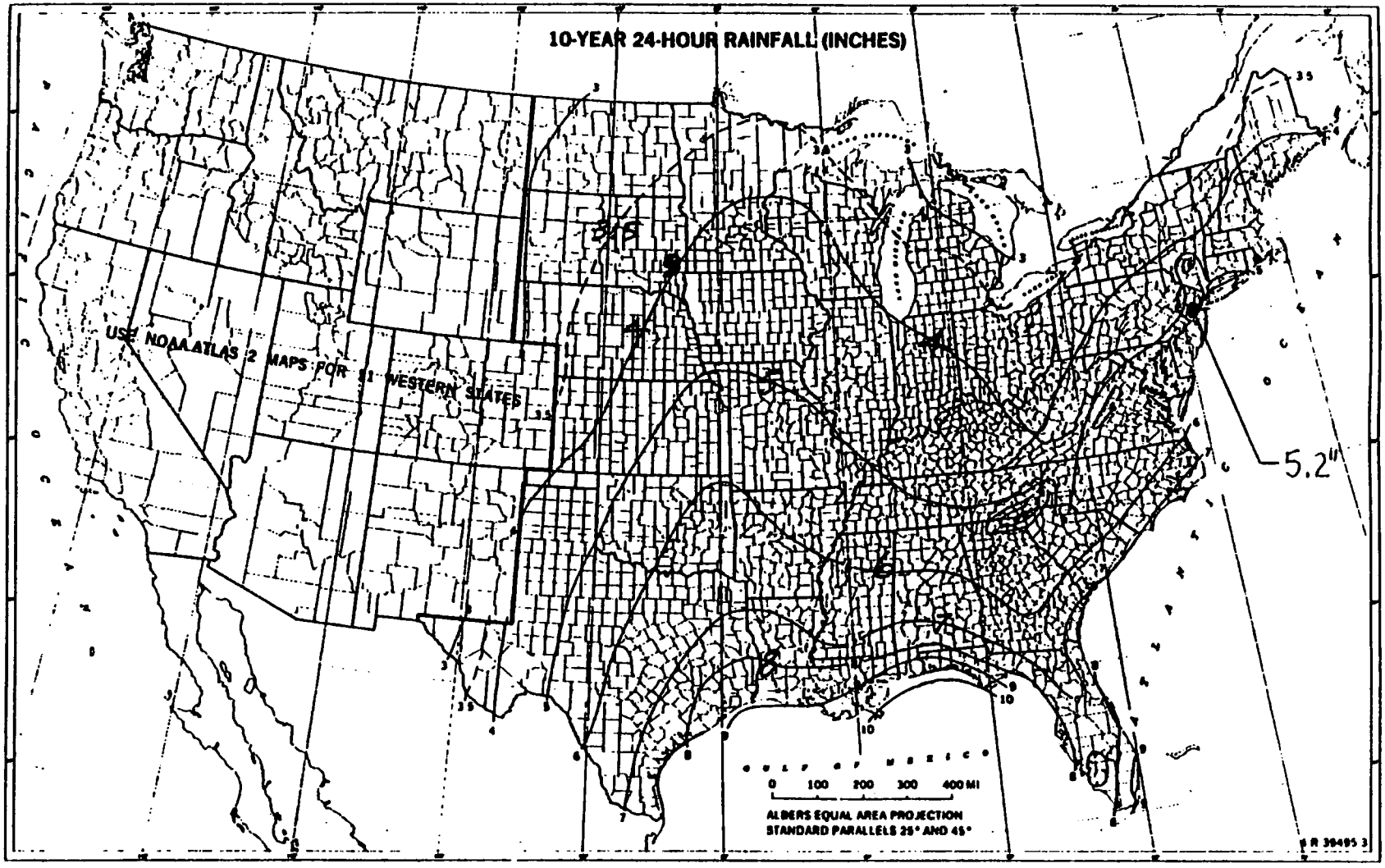


Figure B-5.—Ten-year, 24-hour rainfall.

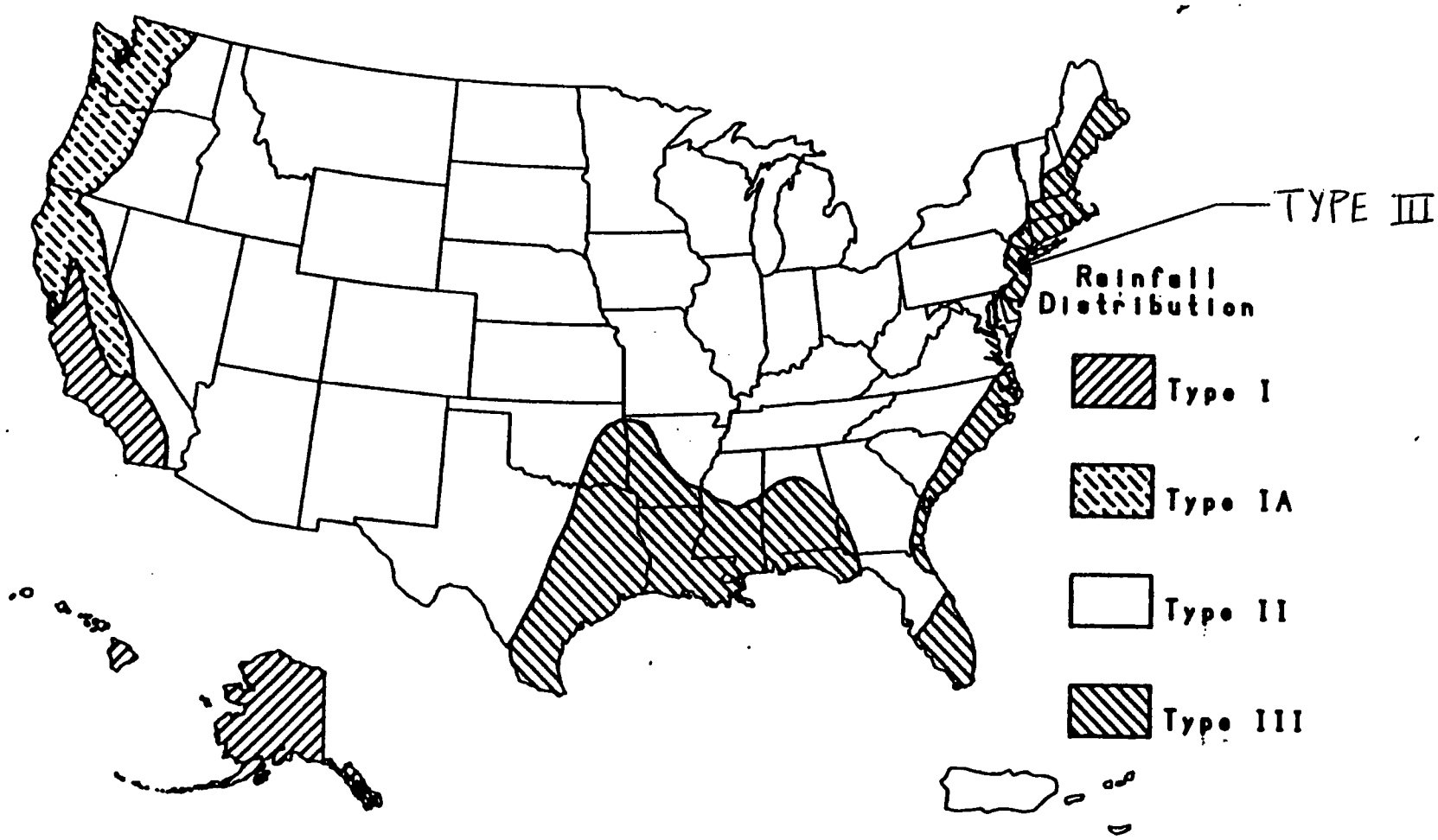


Figure B-2.—Approximate geographic boundaries for SCS rainfall distributions.

Drainage Ditch

CLIENT: S.C.A. Services, Inc. SUBJECT: Kin-Buc Landfill Site, Mound B Prepared By: MDP Date: 02-16-00
Reviewed By: PHB Date: 02-16-00
ROJECT: Work Plan - Drainage Ditch Design

TASK:

Determine required flow capacity and size for drainage ditches based on the estimated peak discharges from a 10-year, 24-hour storm event.

REFERENCES:

1. Soil Conservation Service, "Quick TR-55" Computer Program Software (DOS Version 5.47), Haestad Methods Engineering.
2. North American Green, "Erosion Control Material Design Software" (Windows Version 4.1).
3. Kin-Buc Landfill Site - Mound B Work Plan drawings prepared by Blasland, Bouck & Lee, Inc., dated February, 2000.
4. Standards for Soil Erosion and Sediment Control in New Jersey (April 1987).

ASSUMPTIONS:

1. Minimum invert grade at point of design for drainage ditch is 0.5%.
2. Maximum flow capacity is based on the estimated peak discharge from a 10-year, 24-hour storm event.
3. Manning coefficient of 0.144 for grass ditch lining with permanent synthetic erosion control matting at design flow depth.
4. Minimum freeboard is 3 inches.
5. Surface vegetation within drainage ditch is established.
6. Curve Number (CN) for design watershed is 72.

METHODOLOGY:

1. Determine "worst case" drainage subarea for the drainage ditch (refer to Watershed Area Map).
2. Calculate the peak discharge at the end point of the drainage ditch (point of design) using Quick TR-55.
3. Determine the appropriate geometry/size and hydraulic conditions using Erosion Control Material Design Software.

CLIENT: S.C.A. Services, Inc. SUBJECT: Kin-Buc Landfill Site, Mound B Prepared By: MDP Date: 02-16-00
Reviewed By: PHB Date: 02-16-00
PROJECT: Work Plan - Drainage Ditch Design

CALCULATIONS:

1. Peak Discharge:

The following table provides a summary of the watershed input data and results for the drainage ditch design. Output data for this analysis is included at the end of this section.

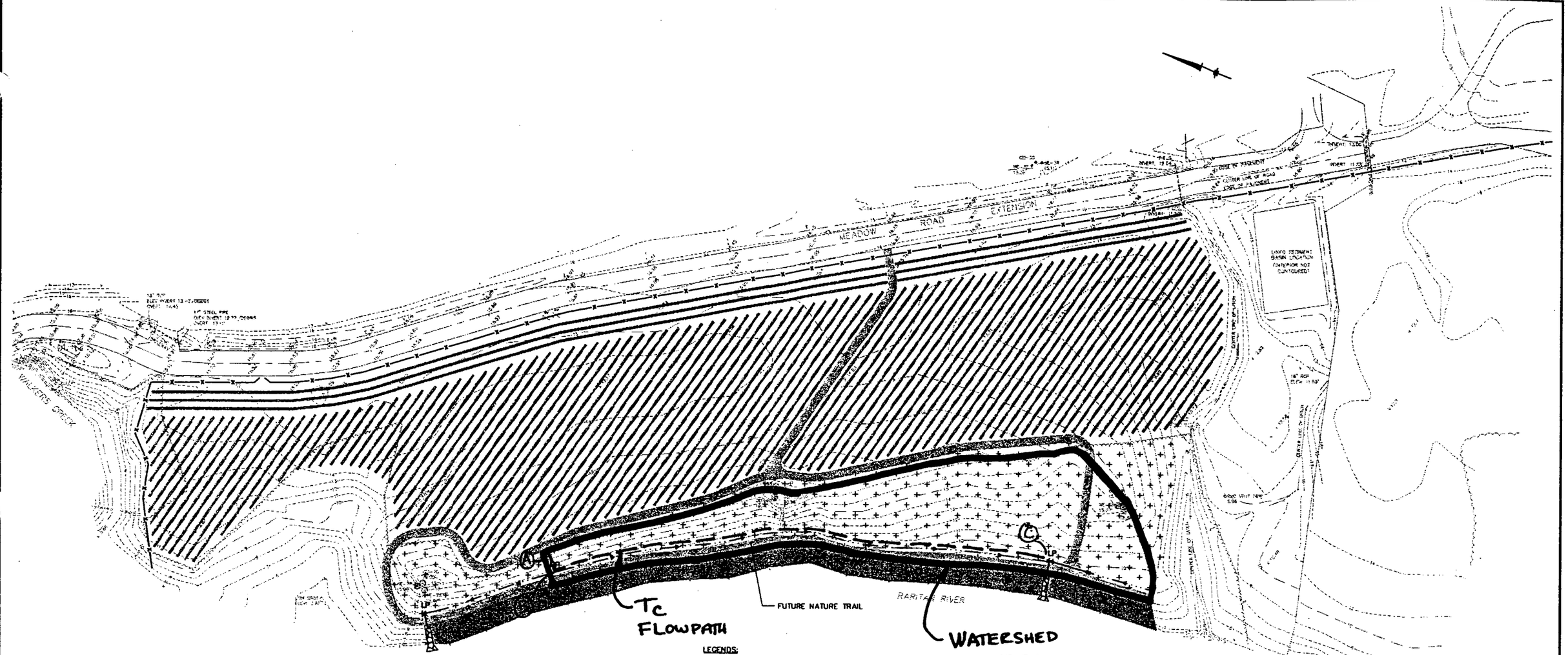
Drainage Area	Area (acres)	Curve Number (CN)	Time of Concentration (Tc in hrs)	25-yr, 24-hr Peak Discharge (cfs)
Drainage ditch	1.52	72	0.36	3

2. Drainage Ditch Flow Capacity and Size:

The following table presents a summary of the required flow capacity and design size based on the estimated peak discharge. Output data for this analysis is included at the end of this section.

10-yr, 24-hr Peak Discharge (cfs)	Maximum Ditch Depth (in)	Flow Depth at Peak Discharge (in)	Freeboard at Peak Discharge (in)	Velocity at Peak Discharge (fps)
3	19	16	3	0.54

Watershed Area Map



LEGENDS:

- PROPOSED RIVER FRONT RESTORATION (3/5) (SEE NOTE 3)
- PROPOSED ACCESS ROAD
- PROPOSED DITCH (3/4)
- PROPOSED CULVERT (4/4)
- PROPOSED TREECAP (1/5)
- HP + HIGH POINT
- LP + LOW POINT
- + + + PROPOSED BUFFER ZONE VEGETATION
- —x— PROPOSED SECURITY FENCE

NOTES:

1. SEE SHEET G-1 FOR ADDITIONAL BASE MAP INFORMATION.
2. PROPOSED LOCATIONS SHOWN ARE APPROXIMATE ONLY. ACTUAL CONSITIONS MAY VARY BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
3. FINAL GRADING CONDITION ON RIVER FRONT RESTORATION NOT SHOWN.

X: (23701X01.DWG
L: (LAYER)
P: STD-PCP/DL
2/16/00 SYR-54-NES YCC
23701050/CONTRACT/23701G04.DWG

WATERSHED AREA MAP - DRAINAGE DITCH

Graphic Scale
60' 0 60' 120'
APPROXIMATE SCALE IN FEET

Project Mgr. _____ Drawn by _____
Designed by _____ Checked by _____

No.	Date	Revisions	Init

Andrew N. Johnson, P.E. Date:
N.J. Professional Engineer Lic. No. 32866

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

SCA SERVICES, INC. • KIN-BUC LANDFILL SITE • EDISON, NEW JERSEY
MOUND B WORK PLAN

PROPOSED FINAL SITE PLAN

GENERAL

File Number
FILE NO. XXX.XXX.XXF

Date
XXXXX

Blasland, Bouck & Lee, Inc.
8 South River Road
Cranbury, N.J. 08512-9502
Tele: (609) 860-0590

3

Quick TR-55 Analysis

Quick TR-55 Ver.5.47 S/N:
Executed: 16:28:50 03-02-2000

Kin Buc - Mound B
Drum Excavation

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
Drainage Ditch	1.52	72	
COMPOSITE AREA --->	1.52	72.0	(72)

::

Quick TR-55 Ver.5.47 S/N:
Executed: 16:14:53 03-02-2000 x:\tmproj\237\23701\drain\TC3.TCT

Kin Buc Mound B
Drum Excavation

Tc COMPUTATIONS FOR: Drainage Ditch

SHEET FLOW (Applicable to Tc only)

Segment ID		AB	
Surface description	grass		
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	25.0	
Two-yr 24-hr rainfall, P2	in	3.400	
Land slope, s	ft/ft	0.1400	
$T = \dfrac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.05	= 0.05

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000	
where: Unpaved Csf = 16.1345			
Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.00	= 0.00

CHANNEL FLOW

Segment ID		BC	
Cross Sectional Flow Area, a	sq.ft	5.50	
Wetted perimeter, Pw	ft	8.60	
Hydraulic radius, r = a/Pw	ft	0.640	
Channel slope, s	ft/ft	0.0050	
Manning's roughness coeff., n		0.1440	
$V = \dfrac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.5431	
Flow length, L	ft	610	
T = L / (3600*V)	hrs	0.31	= 0.31

::

TOTAL TIME (hrs) 0.36

Quick TR-55 Ver.5.47 S/N:
Executed: 16:14:53 03-02-2000 x:\tmproj\237\23701\drain\TC3.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Kin Buc Mound B
Drum Excavation

Subarea descr.	Tc or Tt	Time (hrs)
Drainage Ditch	Tc	0.36

Quick TR-55 Version: 5.47 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

Kin Buc Mound B
Drum Excavation
Drainage Ditch

CALCULATED
DISK FILE: x:\tmproj\237\23701\drain\GP3 .GPD

Drainage Area	(acres)	1.52	--->	0.0024 sq.mi.
Runoff Curve Number	(CN)	72		
Time of Concentration,Tc	(hrs)	.36		
Rainfall Distribution	(Type)	III		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	10		
Rainfall, P, 24-hr (in)	5.2		
Initial Abstraction, Ia (in)	0.778	0.778	0.778
Ia/p Ratio	0.150	0.000	0.000
Unit Discharge, * qu (csm/in)	450	0	0
Runoff, Q (in)	2.35	0.00	0.00
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	3	0	0

Summary of Computations for qu

Ia/p	#1	0.100	0.000	0.000
C0	#1	2.473	0.000	0.000
C1	#1	-0.518	0.000	0.000
C2	#1	-0.171	0.000	0.000
qu (csm)	#1	467.291	0.000	0.000
Ia/p	#2	0.300	0.000	0.000
C0	#2	2.396	0.000	0.000
C1	#2	-0.512	0.000	0.000
C2	#2	-0.132	0.000	0.000
qu (csm)	#2	395.719	0.000	0.000
* qu (csm)		450	0	0

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$

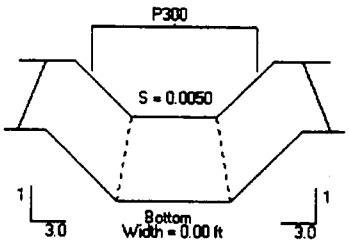
qp (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond & Swamp Adj.)

Calculations

North American Green - Erosion Control Materials Design Software Ver.4.1 - Channel	2/15/200	03:25 PM	COMPUTED BY: MDP
PROJECT NAME: WM / Kin-Buc / Mound B		PROJECT NUMBER: 23701.050	
FROM STATION/REACH: Drainage	TO STATION/REACH:	DRAINAGE AREA: 1.36 Ac.	DESIGN FREQUENCY: 10yr / 24 hr

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft.)	Hydraulic Radius(ft)	Normal Depth (ft)
3.0	12.0	0.54	5.51	0.64	1.36



Not to Scale

LINER RESULTS

Reach	Material Type / Staple Pattern	Phase / Class	Veg. Type / Veg. Density	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
Straight	P300	3	Mix		0.144	4.20	0.42	9.93	STABLE
	Staple E	C	50-75%	Sandy Loam		2.000	0.006	361.52	STABLE

```
"*************************************************************************
NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.1
NORTH AMERICAN GREEN CHANNEL PROTECTION - ENGLISH/S.I.
USER SPECIFIED CHANNEL LINING BACK-UP COMPUTATIONS
*************************************************************************


PROJECT NAME: WM / Kin-Buc / Mound B      PROJECT NO.: 23701.050
COMPUTED BY: MDP                          DATE: 2/15/2000
FROM STATION/REACH: Drainage Ditch        TO STATION/REACH:
DRAINAGE AREA: 1.36 Ac.                   DESIGN FREQUENCY: 10yr / 24 hr

*************************************************************************
                          INPUT PARAMETERS
*************************************************************************

Channel Discharge     : 3.0 cfs  (.08 m^3/s)
Peak Flow Period      : 12  hours
Channel Slope         : 0.005 ft/ft  (0.005 m/m)
Channel Bottom Width  : .0 ft (.00 m)
Left Side Slope       :   3:1
Right Side Slope      :   3:1

Channel Lining : P300 Staple E Mix 50-75%
 Permi. Shear(Tp):4.20 psf (201.1 Pa)
               Phase = 3
               Class = C Vegetation
               Soil  = Sandy Loam
               Allowable Soil Shear(Ta):2psf (95.76 Pa)

*************************************************************************
                           CALCULATIONS
*************************************************************************

Intial Depth Estimate = 0.16*(3.0 /(0.005^0.5))^0.375   = 0.65 ft (.20 m)
Final Channel Depth (after 9 iterations)                = 1.36 ft (0.41 m)
Flow Area = (0.0 * 1.4)+(0.5 *1.36^2 * (3.0+3.0))       = 5.5 sf  (0.5 m^2)
Wet Per. =0.0 +(1.4*(((3.0^2)+1)^.5 +((3.0^2)+1)^.5))   = 8.6 ft  (2.6 m)
Hydraulic Radius = (5.5 / 8.6)                          = 0.6 ft (0.2 m)
Channel Velocity =(1.486/0.144)*(0.6^0.667)*(0.005^.5)  = 0.5 fps (0.2 m/s)

Channel Effective Manning's Roughness                   = 0.144
Calculated Shear (Td) = 62.4 * 1.36 * 0.005             = 0.42 psf (20.2 Pa)
Safety Factor = (Tp/Td) = (4.20 /0.42)                  = 9.93

Effective Stress on Blanket(Te) =0.4*(1-0.60)*(/0.144)^2= 0.01 psf (0.3 Pa)
Safety Factor = (Ta/Te) = (2.00 /0.006)                 = 361.52
```

Quick TR-55 Ver.5.47   S/N:
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Kin Buc Mound B
Drum Excavation

Tc COMPUTATIONS FOR: Sideslope-S

```
SHEET FLOW (Applicable to Tc only)
    Segment ID                                       ab
    Surface description                         grass
    Manning's roughness coeff., n                   0.4000
    Flow length, L (total < or = 300)     ft        25.0
    Two-yr 24-hr rainfall, P2             in       3.400
    Land slope, s                       ft/ft     0.0300
                        0.8
         .007 * (n*L)
    T =  --------------                 hrs        0.10           =   0.10
            0.5    0.4
          P2    *   s

SHALLOW CONCENTRATED FLOW
    Segment ID                                      bc
    Surface (paved or unpaved)?                  Unpaved
    Flow length, L                        ft       100.0
    Watercourse slope, s                ft/ft     0.0450

                          0.5
    Avg.V =  Csf *  (s)                 ft/s      3.4226
    where:   Unpaved Csf = 16.1345
             Paved   Csf = 20.3282

    T = L / (3600*V)                    hrs        0.01           =   0.01

CHANNEL FLOW
    Segment ID
    Cross Sectional Flow Area, a       sq.ft       0.00
    Wetted perimeter, Pw                  ft       0.00
    Hydraulic radius, r = a/Pw            ft      0.000
    Channel slope, s                    ft/ft     0.0000
    Manning's roughness coeff., n                 0.0000

                    2/3     1/2
         1.49  *  r    *  s
    V =  --------------------           ft/s      0.0000
                  n

    Flow length, L                        ft           0

    T = L / (3600*V)                    hrs        0.00           =   0.00
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                        TOTAL TIME (hrs)              0.11
```

Drainage Culvert

CLIENT: S.C.A. Services, Inc. SUBJECT: Kin-Buc Landfill Site, Mound B Prepared By: MDP Date: 02-16-00
Reviewed By: PHB Date: 02-16-00
PROJECT: Work Plan - Drainage Culvert Design

TASK:

Determine required flow capacity and size for drainage culverts based on the estimated peak discharges from a 10-year, 24-hour storm event.

REFERENCES:

1. Soil Conservation Service, "Quick TR-55" Computer Program Software (DOS Version 5.47), Haestad Methods Engineering.
2. North American Green, "Erosion Control Material Design Software" (Windows Version 4.1).
3. Kin-Buc Landfill Site - Mound B Work Plan drawings prepared by Blasland, Bouck & Lee, Inc., dated February, 2000.
4. Standards for Soil Erosion and Sediment Control in New Jersey (April 1987).

ASSUMPTIONS:

1. Minimum invert grade at point of design for drainage culvert is 0.5%.
2. Maximum flow capacity is based on the estimated peak discharge from a 10-year, 24-hour storm event.
3. Manning coefficient of 0.024 for Corrugated Metal Pipe (CMP) at design flow depth.
4. Culverts operating under outlet control.
5. Surface vegetation within drainage ditch is established.
6. Curve Number (CN) for design watershed is 72.

METHODOLOGY:

1. Determine "worst case" drainage subarea for the drainage ditch (refer to Watershed Area Map).
2. Calculate the peak discharge at the inlet point of the drainage culvert (point of design) using Quick TR-55 and NAG software.
3. Determine the appropriate geometry/size and hydraulic conditions using Mannings' Equations.

CLIENT: S.C.A. Services, Inc. SUBJECT: Kin-Buc Landfill Site, Mound B Prepared By: MDP Date: 02-16-00
Reviewed By: PHB Date: 02-16-00
PROJECT: Work Plan - Drainage Culvert Design

CALCULATIONS:

1. Peak Discharge:

The following table provides a summary of the watershed input data and results for the drainage culvert design. Output data for this analysis is included at the end of this section.

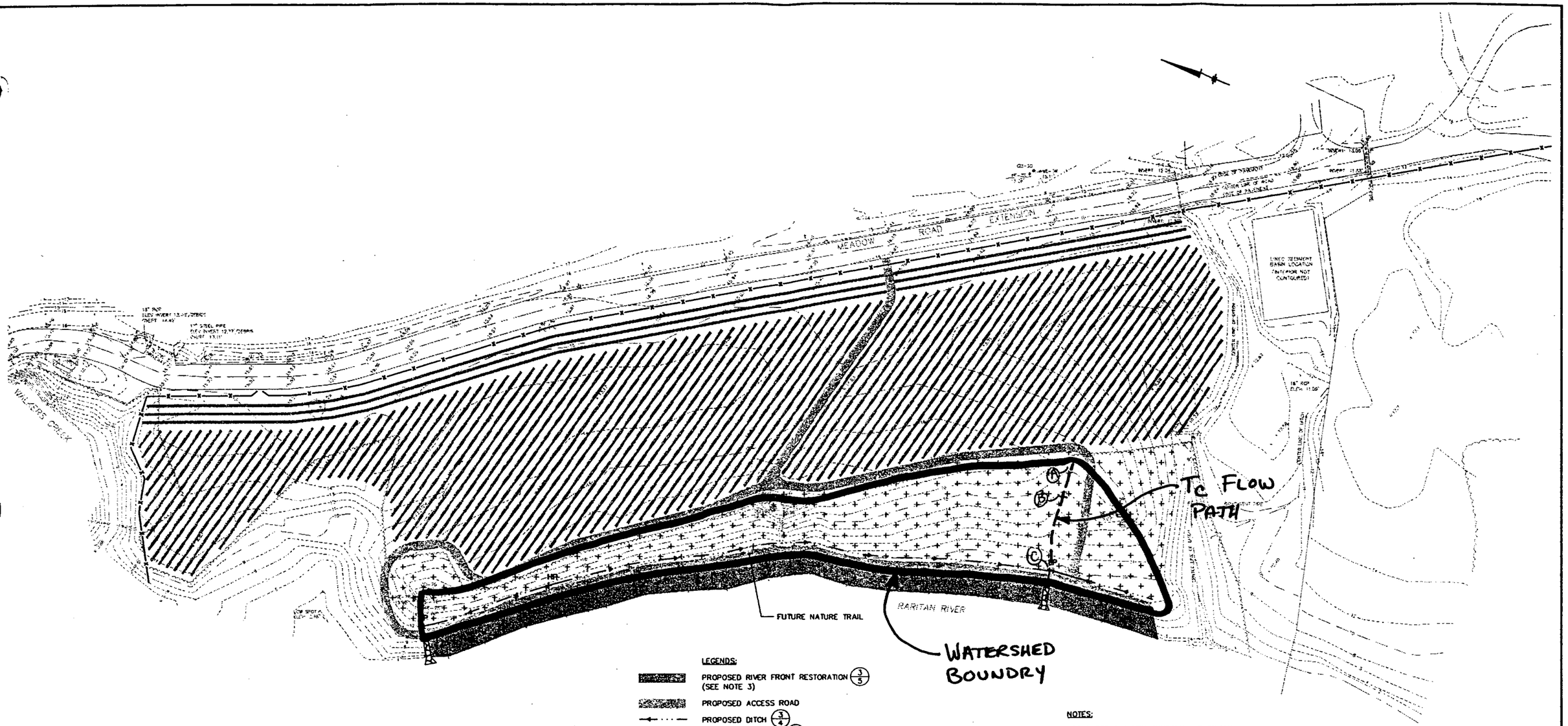
Drainage Area	Area (acres)	Curve Number (CN)	Time of Concentration (Tc in hrs)	25-yr, 24-hr Peak Discharge (cfs)
Drainage ditch	1.52	72	0.12	3

2. Drainage Culvert Flow Capacity and Size:

The following table presents a summary of the required flow capacity and design size based on the estimated peak discharge. Output data for this analysis is included at the end of this section.

10-yr, 24-hr Peak Discharge (cfs)	Computed Pipe Size (in)	Flow Depth at Pipe Outlet (in)	Velocity at Pipe Outlet (fps)	Flow Regime
3	15	8.5	4.3	Subcritical

Watershed Area Map



LEGENDS:

- PROPOSED RIVER FRONT RESTORATION (3/3) (SEE NOTE 3)
- PROPOSED ACCESS ROAD
- PROPOSED DITCH (3/4)
- PROPOSED CULVERT (4/4)
- PROPOSED TREECAP (1/5)
- HP + HIGH POINT
- LP + LOW POINT
- PROPOSED BUFFER ZONE VEGETATION
- PROPOSED SECURITY FENCE

NOTES:

1. SEE SHEET G-1 FOR ADDITIONAL BASE MAP INFORMATION.
2. PROPOSED LOCATIONS SHOWN ARE APPROXIMATE ONLY. ACTUAL CONSITIONS MAY VARY BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
3. FINAL GRADING CONDITION ON RIVER FRONT RESTORATION NOT SHOWN.

X: (23701X01.DWG
L: (LAYER)
P: STD-POP/DL
2/16/00 SYR-54-NES YCC
23701050/CONTRACT/23701G04.DWG

WATERSHED AREA MAP- CULVERT

Graphic Scale: 60' 0 60' 120' — APPROXIMATE SCALE IN FEET

Project Mgr. _____ Drawn by _____
Designed by _____ Checked by _____

No.	Date	Revisions	Init

Andrew N. Johnson, P.E. Date:
N.J. Professional Engineer Lic. No. 32866

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

SCA SERVICES, INC. • KIN-BUC LANDFILL SITE • EDISON, NEW JERSEY
MOUND B WORK PLAN

PROPOSED FINAL SITE PLAN

GENERAL

File Number
FILE NO. XXX.XXX.XXF

Date
XXXXX

Blasland, Bouck & Lee, Inc.
8 South River Road
Cranbury, N.J. 08512-9502
Tele: (609) 860-0590

3

Quick TR-55 Analysis

Quick TR-55 Ver.5.47 S/N:
Executed: 17:15:16 03-02-2000

Kin Buc - Mound B
Drum Excavation

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
Culvert	1.52	72	
COMPOSITE AREA --->	1.52	72.0	(72)

::

```
Quick TR-55 Ver.5.47   S/N:
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                              Kin Buc Mound B
                              Drum Excavation


                        Tc COMPUTATIONS FOR: Culvert

 SHEET FLOW (Applicable to Tc only)
     Segment ID                                       ab
     Surface description                           grass
     Manning's roughness coeff., n                    0.4000
     Flow length, L (total < or = 300)        ft      30.0
     Two-yr 24-hr rainfall, P2                in      3.400
     Land slope, s                           ft/ft    0.0300
                             0.8
          .007 * (n*L)
     T = --------------                      hrs      0.11              =  0.11
              0.5    0.4
           P2    *   s

 SHALLOW CONCENTRATED FLOW
     Segment ID                                       bc
     Surface (paved or unpaved)?                      Unpaved
     Flow length, L                           ft      100.0
     Watercourse slope, s                    ft/ft    0.0450

                               0.5
     Avg.V =  Csf *   (s)                    ft/s     3.4226
     where:   Unpaved Csf = 16.1345
              Paved   Csf = 20.3282

     T = L / (3600*V)                        hrs      0.01              =  0.01


 CHANNEL FLOW
     Segment ID
     Cross Sectional Flow Area, a           sq.ft     0.00
     Wetted perimeter, Pw                     ft      0.00
     Hydraulic radius, r = a/Pw               ft      0.000
     Channel slope, s                        ft/ft    0.0000
     Manning's roughness coeff., n                    0.0000

                        2/3    1/2
          1.49  *  r    *   s
     V = --------------------               ft/s     0.0000
                    n

     Flow length, L                           ft         0

     T = L / (3600*V)                        hrs      0.00              =  0.00

   ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
                                                   TOTAL TIME (hrs)      0.12
```

Quick TR-55 Ver.5.47 S/N:
Executed: 17:14:03 03-02-2000 x:\tmproj\237\23701\drain\TC5.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Kin Buc Mound B
Drum Excavation

Subarea descr.	Tc or Tt	Time (hrs)
Culvert	Tc	0.12

Quick TR-55 Version: 5.47 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

Kin Buc Mound B
Drum Excavation
Culvert

CALCULATED
DISK FILE: x:\tmproj\237\23701\drain\GP4 .GPD

Drainage Area	(acres)	1.52	--->	0.0024 sq.mi.
Runoff Curve Number	(CN)	72		
Time of Concentration,Tc	(hrs)	.12		
Rainfall Distribution	(Type)	III		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	10		
Rainfall, P, 24-hr (in)	5.2		
Initial Abstraction, Ia (in)	0.778	0.778	0.778
Ia/p Ratio	0.150	0.000	0.000
Unit Discharge, * qu (csm/in)	622	0	0
Runoff, Q (in)	2.35	0.00	0.00
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	3	0	0

Summary of Computations for qu

Ia/p	#1	0.100	0.000	0.000
C0	#1	2.473	0.000	0.000
C1	#1	-0.518	0.000	0.000
C2	#1	-0.171	0.000	0.000
qu (csm)	#1	639.364	0.000	0.000
Ia/p	#2	0.300	0.000	0.000
C0	#2	2.396	0.000	0.000
C1	#2	-0.512	0.000	0.000
C2	#2	-0.132	0.000	0.000
qu (csm)	#2	569.446	0.000	0.000
* qu (csm)		622	0	0

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$

qp (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond & Swamp Adj.)

Calculations

Culvert Calculator Report
Drainage Culvert

Solve For: Section Size

Culvert Summary					
Allowable HW Elevation	10.30	ft	Headwater Depth/ Height	0.98	
Computed Headwater Elevation	10.03	ft	Discharge	3.00	cfs
Inlet Control HW Elev	9.91	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev	10.03	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	8.80	ft	Downstream Invert	8.67	ft
Length	25.00	ft	Constructed Slope	0.005200	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.70	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.70	ft
Velocity Downstream	4.27	ft/s	Critical Slope	0.020532	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev	10.03	ft	Upstream Velocity Head	0.13	ft
Ke	0.90		Entrance Loss	0.12	ft

Inlet Control Properties					
Inlet Control HW Elev	9.91	ft	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	1.2	ft^2
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Drainage Downchute

CLIENT: S.C.A. Services, Inc. SUBJECT: Kin-Buc Landfill Site, Mound B Prepared By: MDP Date: 02-16-00
Reviewed By: PHB Date: 02-16-00
PROJECT: Work Plan - Drainage Downchute Design

TASK:

Determine required flow capacity and size for drainage downchute based on the estimated peak discharges from a 10-year, 24-hour storm event.

REFERENCES:

1. Soil Conservation Service, "Quick TR-55" Computer Program Software (DOS Version 5.47), Haestad Methods Engineering.
2. Corel Quattro Pro spreadsheet software (Windows Version 6.03).
3. Kin-Buc Landfill Site - Mound B Work Plan drawings prepared by Blasland, Bouck & Lee, Inc., dated February, 2000.
4. Standards for Soil Erosion and Sediment Control in New Jersey (April 1987).

ASSUMPTIONS:

1. Minimum invert grade at point of design for drainage swale is 25%.
2. Maximum flow capacity is based on the estimated peak discharge from a 10-year, 24-hour storm event.
3. Manning coefficient of 0.040 for riprap lining at design flow depth.
4. Minimum freeboard is 6 inches.
5. Trapezoidal channel section.
6. Curve Number (CN) for design watershed is 72.

METHODOLOGY:

1. Determine "worst case" drainage subarea for the drainage downchute (refer to Watershed Area Map).
2. Calculate the peak discharge at the end point of the drainage downchute (point of design) using Quick TR-55.
3. Determine the appropriate geometry/size and hydraulic conditions using based on Manning's equations for open channel flow.

CLIENT: S.C.A. Services, Inc. SUBJECT: Kin-Buc Landfill Site, Mound B Prepared By: MDP Date: 02-16-00
Reviewed By: PHB Date: 02-16-00
PROJECT: Work Plan - Drainage Downchute Design

CALCULATIONS:

1. Peak Discharge:

The following table provides a summary of the watershed input data and results for the drainage downchute design. Output data for this analysis is included at the end of this section.

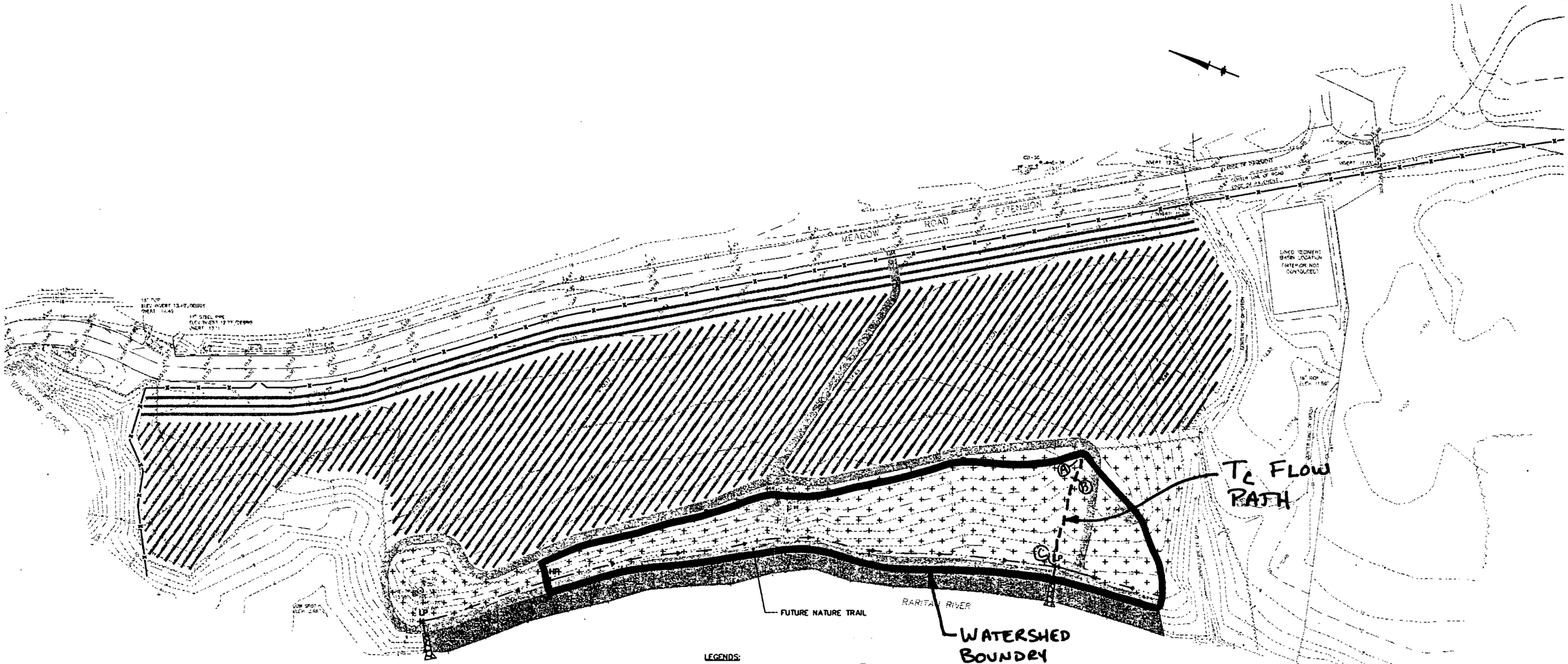
Drainage Area	Area (acres)	Curve Number (CN)	Time of Concentration (Tc in hrs)	10-yr, 24-hr Peak Discharge (cfs)
Drainage Downchute	1.52	72	0.12	3

2. Drainage Downchute Flow Capacity and Size:

The following table presents a summary of the required flow capacity and design size based on the estimated peak discharge. Output data for this analysis is included at the end of this section.

10-yr, 24-hr Peak Discharge (cfs)	Maximum Ditch Depth (in)	Flow Depth at Peak Discharge (in)	Freeboard at Peak Discharge (in)	Velocity at Peak Discharge (fps)
3	12	2.54	9.46	5.8

Watershed Area Map



LEGENDS:

- PROPOSED RIVER FRONT RESTORATION (3/5) (SEE NOTE 3)
- PROPOSED ACCESS ROAD
- PROPOSED DITCH (3/4)
- PROPOSED CULVERT (4/4)
- PROPOSED TREECAP (1/5)
- HP + HIGH POINT
- LP + LOW POINT
- PROPOSED BUFFER ZONE VEGETATION
- PROPOSED SECURITY FENCE

NOTES:

1. SEE SHEET G-1 FOR ADDITIONAL BASE MAP INFORMATION.
2. PROPOSED LOCATIONS SHOWN ARE APPROXIMATE ONLY. ACTUAL CONSITIONS MAY VARY BASED ON SITE CONDITIONS AT TIME OF CONSTRUCTION.
3. FINAL GRADING CONDITION ON RIVER FRONT RESTORATION NOT SHOWN.

X: (23701X01.DWG
L: (LAYER)
P: STD-PCP/DL
2/16/00 SYR-54-NES YCC
23701050/CONTRACT/23701G04.DWG

WATERSHED AREA MAP - RIPRAP DOWNCHUTE

Graphic Scale
60' 0 60' 120'
APPROXIMATE SCALE IN FEET

Project Mgr. _____ Drawn by _____
Designed by _____ Checked by _____

No.	Date	Revisions	Init

Andrew N. Johnson, P.E. Date:
N.J. Professional Engineer Lic. No. 32866

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

SCA SERVICES, INC. • KIN-BUC LANDFILL SITE • EDISON, NEW JERSEY
MOUND B WORK PLAN
PROPOSED FINAL SITE PLAN
GENERAL

File Number
FILE NO. XXX.XXX.XXF
Date
XXXXX
Blasland, Bouck & Lee, Inc.
8 South River Road
Cranbury, N.J. 08512-9502
Tele: (609) 860-0590

3

Quick TR-55 Analysis

Quick TR-55 Ver.5.47 S/N:
Executed: 16:29:47 03-02-2000

Kin Buc - Mound B
Drum Excavation

RUNOFF CURVE NUMBER DATA

::

Composite Area:

SURFACE DESCRIPTION	AREA (acres)	CN	
Riprap Downchute	1.52	72	
COMPOSITE AREA --->	1.52	72.0	(72)

::

Quick TR-55 Ver.5.47 S/N:
Executed: 16:18:32 03-02-2000 x:\tmproj\237\23701\drain\TC1.TCT

Kin Buc Mound B
Drum Excavation

Tc COMPUTATIONS FOR: Downchute

SHEET FLOW (Applicable to Tc only)

Segment ID		ab	
Surface description		grass	
Manning's roughness coeff., n		0.4000	
Flow length, L (total < or = 300)	ft	30.0	
Two-yr 24-hr rainfall, P2	in	3.400	
Land slope, s	ft/ft	0.0300	
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.11	= 0.11

SHALLOW CONCENTRATED FLOW

Segment ID		bc	
Surface (paved or unpaved)?		Unpaved	
Flow length, L	ft	100.0	
Watercourse slope, s	ft/ft	0.0450	
Avg.V = $Csf * (s)^{0.5}$	ft/s	3.4226	
where: Unpaved Csf = 16.1345 Paved Csf = 20.3282			
T = L / (3600*V)	hrs	0.01	= 0.01

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	0.00	
Wetted perimeter, Pw	ft	0.00	
Hydraulic radius, r = a/Pw	ft	0.000	
Channel slope, s	ft/ft	0.0000	
Manning's roughness coeff., n		0.0000	
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000	
Flow length, L	ft	0	
T = L / (3600*V)	hrs	0.00	= 0.00

::

TOTAL TIME (hrs) 0.12

Quick TR-55 Ver.5.47 S/N:
Executed: 16:18:32 03-02-2000 x:\tmproj\237\23701\drain\TC1.TCT

SUMMARY SHEET FOR Tc or Tt COMPUTATIONS
(Solved for Time using TR-55 Methods)

Kin Buc Mound B
Drum Excavation

Subarea descr.	Tc or Tt	Time (hrs)
Downchute	Tc	0.12

Quick TR-55 Version: 5.47 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

Kin Buc Mound B
Drum Excavation
Drainage Downchute

CALCULATED
DISK FILE: x:\tmproj\237\23701\drain\GP1 .GPD

Drainage Area	(acres)	1.52	--->	0.0024 sq.mi.
Runoff Curve Number	(CN)	72		
Time of Concentration,Tc	(hrs)	.12		
Rainfall Distribution	(Type)	III		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	10		
Rainfall, P, 24-hr (in)	5.2		
Initial Abstraction, Ia (in)	0.778	0.778	0.778
Ia/p Ratio	0.150	0.000	0.000
Unit Discharge, * qu (csm/in)	622	0	0
Runoff, Q (in)	2.35	0.00	0.00
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	3	0	0

Summary of Computations for qu

Ia/p	#1	0.100	0.000	0.000
C0	#1	2.473	0.000	0.000
C1	#1	-0.518	0.000	0.000
C2	#1	-0.171	0.000	0.000
qu (csm)	#1	639.364	0.000	0.000
Ia/p	#2	0.300	0.000	0.000
C0	#2	2.396	0.000	0.000
C1	#2	-0.512	0.000	0.000
C2	#2	-0.132	0.000	0.000
qu (csm)	#2	569.446	0.000	0.000
* qu (csm)		622	0	0

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$

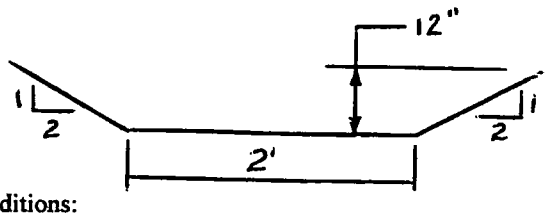
qp (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond & Swamp Adj.)

Calculations

Mound B Kin-Buc
Work PLan
Downchute Design - Established Condition

1. Design capacity required = 13 cfs
(see TR55 printout for 25yr/24hr storm event).

2. Downchute Configuration:



3. Design Conditions:

DESIGN PARAMETERS	DESIGN
BASE WIDTH (FT):	2.00
CHANNEL DEPTH (IN):	12.00
DEPTH OF FLOW (IN):	2.55
AVG. SIDE SLOPE GRADIENT (FT):	2.00
AVG. SIDE SLOPE LENGTH (FT):	0.48
MANNING VALUE, n:	0.040
CHANNEL SLOPE, S (FT/FT):	0.250

DESIGN SPECIFICATIONS	DESIGN
AREA, A (SF):	0.52
WETTED PERIMETER, WP (FT):	2.95
HYDRAULIC RADIUS, R (FT):	0.17

DESIGN PERFORMANCE	DESIGN
DISCHARGE, Q (CFS): Q= A(1.49/n)R^0.67 S^	3.0
VELOCITY, V (FPS): V=Q/A	5.8
FREE BOARD (IN)	9.5

Appendix C

Site-Specific Health & Safety Plan

TECHNICAL REPORT

Site-Specific Health & Safety Plan

Kin-Buc Landfill Site
Edison, New Jersey

March 2000

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

8 South River Road
Cranbury, New Jersey 08512-9502
(609) 860-0590

Approvals and Acknowledgments

Approvals

I have read and approved this HASP with respect to project hazards, regulatory requirements, and BBL procedures.

Project Name:
Project Number:

Project Manager/Date

Regional Health and Safety Coordinator/Date

Project/Site HSS/Date

Acknowledgments

The final approved version of this HASP has been provided to the Site Supervisor. I acknowledge my responsibility to provide the Site Supervisor with the equipment, materials and qualified personnel to implement fully all safety requirements in this HASP. I will formally review this plan with the HS Staff every six months until project completion.

Project Manager

Date

I acknowledge receipt of this HASP from the Project Manager, and that it is my responsibility to explain its contents to all site personnel and cause these requirements to be fully implemented. Any change in conditions, scope of work, or other change that might affect worker safety requires me to notify the Project Manager and/or the Health and Safety Representative.

Site Supervisor

Date

Health and Safety Plan Acknowledgment

I have read this Site-Specific Health and Safety Plan, or its contents have been presented to me, and I understand the contents, and I agree to abide by its requirements.

Name (Print)	Signature	Representing	Date

Table of Contents

Section 1. **Introduction** **1-1**

1.1 Objective 1-1
1.2 Site and Facility Description 1-1
1.3 Policy Statement 1-2
1.4 References 1-2
1.5 Definitions 1-3

Section 2. **Roles and Responsibilities** **2-1**

2.1 All Personnel 2-1
2.2 Health and Safety Supervisor (HSS) 2-1
2.3 Health and Safety Officer (HSO) 2-1
2.4 Project Manager (PM) 2-1
2.5 Site Supervisor (SS) 2-2
2.6 Subcontractors 2-2
2.7 All On-Site Personnel 2-3
2.8 Visitors 2-3

Section 3. **Project Hazards and Control Measurements** **3-1**

3.1 Scope of Work 3-1
3.1.1 Job Hazard Assessment 3-1
3.2 Field Activities, Hazards, Control Procedures 3-1
3.2.1 Mobilization 3-1
3.2.2 Clearing and Grubbing 3-1
3.2.3 Excavation Safety 3-2
3.2.3.1 Soil Excavation 3-2
3.2.3.2 Excavation Entry Procedure 3-4
3.2.4 Drum Handling and Removal 3-5
3.2.4.1 Drum Removal/Handling Areas 3-5
3.2.4.2 Drum Identification and Recordkeeping 3-5
3.2.4.3 Drum Opening/Sampling 3-6
3.2.4.4 Fire and Explosion Protection 3-7
3.2.4.5 Spill and Discharge Prevention 3-7
3.2.5 Cylinder Handling Procedures 3-7
3.2.5.1 Cylinder Inspection 3-8
3.2.5.2 Cylinder Classification 3-8
3.2.5.3 Transport 3-8
3.2.5.4 General Safety Procedures 3-8
3.2.6 Shoreline Restoration 3-9
3.2.6.1 Deposition of Materials into the Mound B Area. 3-9
3.2.7 Mound B Cap Restoration/Re-augmentation 3-9
3.2.7.1 Liner Installation and Backfilling Safety 3-9
3.2.7.2 Heavy Equipment Materials Handling / Site Grading 3-10
3.2.7.3 Cover System Restoration 3-10
3.2.8 Equipment Decontamination 3-11

Section 4. **General Safety Practices** **4-1**

4.1 General Practices 4-1
4.1.1 Safe Performance Self Assessment 4-1
4.1.2 Incident Prevention Observation 4-2
4.1.3 Buddy System 4-2
4.2 Heat Stress 4-3
4.3 Cold Stress 4-5
4.4 Biological Hazards 4-7
4.4.1 Tick-Borne Diseases 4-7
4.4.2 Poisonous Plants 4-8
4.4.3 Snakes 4-8
4.5 Noise 4-9
4.6 Sanitation 4-9
4.6.1 Break Area 4-9
4.7 Electrical Hazards 4-9
4.8 Lifting Hazards 4-10

Section 5. **Personal Protective Equipment** **5-1**

5.1 Levels of Protection 5-1
5.1.1 Level D Protection 5-1
5.1.2 Modified Level D Protection 5-1
5.1.3 Level C Protection 5-2
5.1.4 Level B Protection 5-2
5.1.5 Selection of PPE 5-2
5.2 Site Respiratory Protection Program 5-2
5.3 Using PPE 5-3
5.3.1 Donning Procedures 5-3
5.3.2 Doffing Procedures 5-4
5.4 Selection Matrix 5-4

Section 6. **Site Control** **6-1**

6.1 Authorization to Enter 6-1
6.2 Site Orientation and Hazard Briefing 6-1
6.3 Certification Documents 6-1
6.4 Entry Log 6-1
6.5 Entry Requirements 6-1
6.6 Emergency Entry and Exit 6-1
6.7 Contamination Control Zones 6-2
6.7.1 Exclusion Zone 6-2
6.7.2 Contamination Reduction Zone 6-2
6.7.3 Support Zone 6-2
6.7.4 Posting 6-2
6.8 Site Inspections 6-2

Section 7. **Decontamination** **7-1**

7.1 Personnel Decontamination 7-1
7.2 Equipment Decontamination 7-1
7.3 Personal Protective Equipment Decontamination 7-1

Section 8. **Site Monitoring 8-1**

8.1 Personal Air Monitoring 8-1
8.1.1 Area Air Monitoring 8-1
8.2 Noise Monitoring 8-1
8.3 Monitoring Equipment Maintenance and Calibration 8-1
8.3.1 Action Levels 8-2
8.4 Personal Air Sampling 8-3

Section 9. **Employee Training 9-1**

9.1 General 9-1
9.2 Basic 40-Hour Course 9-1
9.3 Supervisor Course 9-1
9.4 Site-Specific Training 9-2
9.5 Daily Safety Meetings 9-2
9.6 First Aid and CPR 9-2

Section 10. **Medical Surveillance 10-1**

10.1 Medical Examination 10-1
10.1.1 Preplacement Medical Examination 10-1
10.1.2 Other Medical Examination 10-1
10.1.3 Periodic Exam 10-2
10.2 Medical Restriction 10-2

Section 11. **Emergency Procedures 11-1**

11.1 General 11-1
11.2 Emergency Response 11-1
11.2.1 Fire 11-1
11.2.2 Contaminant Release 11-1
11.2.2.1 Spill or Leak Response 11-1
11.3 Medical Emergency 11-3
11.3.1 First Aid - General 11-3
11.3.2 First Aid - Inhalation 11-4
11.3.3 First Aid - Ingestion 11-4
11.3.4 First Aid - Skin Contact 11-4
11.3.5 First Aid - Eye Contact 11-4
11.4 Reporting Injuries and Illnesses and Near Miss Incidents 11-4
11.5 Spill and Release Control 11-4
11.5.1 Spill Response Control Materials and Equipment 11-5
11.5.2 Spill or Leak Response 11-5

11.6 Emergency Information 11-6
11.7 Site Communication 11-7

Tables.

2-1 Key Personnel
3-1 Chemical Hazard Information
4-1 Work/Rest Schedule
4-2 Chill Temperature Chart
5-1 PPE Selection Matrix
8-1 Airborne Contaminant Action Levels
11-1 Emergency Contacts

Appendices.

A Material Safety Data Sheets
B BBL Daily Safety Meeting Log
C Accident/Near Miss Investigation Report
D Incident Prevention Observation Form
E Daily Air Monitoring Log
F Daily Project Report
G Underground/Overhead Utilities Checklist

1. Introduction

1.1 Objective

The purpose of site activities is to complete a focused removal action at the Mound B area with the restoration of the adjacent riverfront and the existing Mound B cover system at the Kin-Buc Landfill, Edison, NJ. This removal action will include:

- Excavation of intact drums and other potentially hazardous source material;
- Observation of riverfront restoration by bioengineering technologies; and
- Cover system restoration involving a tree cap.

The objective of this Health and Safety Plan (HASP) is to provide a mechanism for establishing safe working conditions at the site. The safety organization, procedures, and protective equipment have been established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies have been evaluated and selected to minimize the potential of accident or injury.

1.2 Site and Facility Description

The Kin-Buc Landfill site is an inactive closed municipal solid waste and industrial waste landfill located adjacent to the Raritan River in Edison, NJ. The site occupies approximately 220 acres, and is bounded to the north by an industrial park; to the west by the Raritan River; and to the east by Edmonds Creek.

Landfilling began at the site in about 1947, although it was not until 1968 that Kin-Buc, Inc. Began operating the site. Landfill activities ceased in 1976, and in 1981 the site was added to the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), commonly known as Superfund.

Between 1983 and 1991, Kin-Buc, Inc. and SCA Services, Inc., conducted a Remedial Investigation/Feasibility Study (RI/FS). The findings of the RI/FS resulted in a Record of Decision (ROD) from the United States Environmental Protection Agency (USEPA) which separated the site into two remedial areas known as OU1 and OU2. OU1 consisted of the Kin-Buc Landfill I mound, the Kin-Buc Landfill II mound, the Pool C Area, and portions of the Low-Lying area between Kin-Buc I and Edison Township Landfill. OU2 Consisted of the Edmonds Creek Marsh Area, Mill Brook, Martins Creek, Mound B, and portions of the Low-Lying Area. The remedial action for OU2 involved clean up of polychlorinated biphenyls (PCBs) in sediment to a level of 5 parts per million (ppm).

Mound B is part of Operable Unit (OU-2) 2 at the Kin-Buc Landfill Superfund site, Edison Township, Middlesex County, NJ. It occupies a narrow strip of land between the OU1 (Kin-Buc I Mound) and the Raritan River. Mound B extends 10-16 feet above mean sea level. The only structure present within the boundaries of the Mound B area is a lined detention basin in the southeast corner of the Kin-Buc Leachate Treatment Facility, with underground and effluent piping that extends from Meadow Road to the river near the southern boundary of Mound B.

A layer of clay approximately 2 feet thick was added to the surface of Mound B as part of the closure process in 1980. The surface area of Mound B is vegetated with low-growing grasses and herbaceous cover across the majority of the site, and a dense stand of gray birch trees and saplings along the western edge near the river. The riverfront area of Mound B consists of gray birches on the higher elevations at the top of the riverbank and *Phragmites* at the lower elevations. Emergent wetland areas vegetated with *Spartina* sp. are found along the riverfront below the mean high-water level.

Limited information is available regarding historical operations at Mound B, except that the Mound B facility was used for the disposal of municipal waste from 1947 until 1976. The 1991 OU2 RI Report indicates that Mound B area refuse also consists of industrial by-products and waste, and noted "limited control of site operations to type of waste materials landfilled." A compacted clay cap was installed on Mound B n 1980 in accordance with the New Jersey Department of Environmental Protection (NJDEP) landfill capping requirements. More recently, the Mound B area was used as a soil staging area and pug mill (slurry wall mixing) area by Conti Construction during the OU1 remedial action implementation in the mid-1990s.

Well installation logs indicate the presence of household refuse, including paper, plastic, metal, wood, glass, rubber, wood, brick and metal. Test pits indicated the presence of primarily municipal and construction refuse with some deteriorated drums encountered at locations identified as anomalies during a geophysical (magnetic) survey. The presence of drums in Mound B was anticipated based on typical historical disposal practices by residential and commercial customers.

1.3 Policy Statement

The policy of Blasland, Bouck & Lee, Inc. (BBL) is to provide a safe and healthful work environment for all employees. No aspect of operations is of greater importance than injury and illness prevention. A fundamental principle of safety is that all accidents and injuries are preventable. BBL will take every reasonable step to eliminate or control hazards in order to minimize the possibility of injury, illness, or accident.

This Health and Safety Plan prescribes the procedures that must be followed during site activities outlined in Section 1.1 at the Kin-Buc Landfill. Operational changes that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the Project Manager (PM) and the Health and Safety Officer. This document will be periodically reviewed to ensure that it is current and technically correct. Any changes in site conditions and/or the scope of work will require a review and modification to the HASP. Such changes will be completed in the form of an addendum to this plan or a revision of the plan.

The provisions of this plan are mandatory for all BBL personnel and BBL's subcontractors assigned to the project. Subcontractors may prepare their own HASPs, which must meet the basic requirements of this HASP. All visitors to BBL work areas of the site must also abide by the requirements of the plan. The employees of other contracted organizations working at the site are not covered by this HASP.

1.4 References

This HASP complies with applicable Occupational Safety and Health Administration (OSHA) regulations, United States Environmental Protection Agency (USEPA) regulations, and BBL Health and Safety policies and procedures. This plan follows the guidelines established in the following:

- *Standard Operating Safety Guides*, USEPA (Publication 9285.1-03, June 1992).
- *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, NIOSH, OSHA, USCG, USEPA (86-116, October 1985).
- Title 29 of the Code of Federal Regulations (CFR), Part 1910.120.
- Title 29 of the Code of Federal Regulations (CFR), Part 1926.
- *Pocket Guide to Chemical Hazards*, DHHS, PHS, CDC, NIOSH (1994).

- *Threshold Limit Values*, ACGIH (1999).
- *Quick Selection Guide to Chemical Protective Clothing*, Forsberg, K. and S.Z. Mansdorf, 2nd Ed. (1993).
- *Health and Safety Policies and Procedures Manual*, BBL.

1.5 Definitions

The following definitions are applicable to this HASP:

- ***Site*** - the area where the work is to be performed by BBL personnel and subcontractors. The site includes the Exclusion Zone (EZ), Contamination Reduction Zone (CRZ), and Support Zones (SZ).
- ***Project*** - all on-site work performed under the scope of work.
- ***Subcontractor*** - includes subcontractor personnel hired by BBL.
- ***On-Site Personnel*** - all client personnel, BBL, and subcontractor personnel involved with the project.
- ***Visitor*** - all other personnel, except the on-site personnel. All visitors must receive approval to enter BBL work areas.
- ***Exclusion Zone (EZ)*** - any portion of the site where hazardous substances are, or are reasonably suspected to be, present and pose an exposure hazard.
- ***Contamination Reduction Zone (CRZ)*** - area between the Exclusion Zone and Support Zone that provides a transition between contaminated and clean areas. Decontamination stations are located in this zone.
- ***Support Zone (SZ)*** - all areas of the site excluding the EZ and CRZ. The SZ surrounds the immediate area where project activities are underway. Support equipment is located in this zone.

2. Roles and Responsibilities

2.1 All Personnel

All BBL and subcontractor personnel must adhere to these procedures during the performance of their work. Each person is responsible for completing tasks safely, and reporting any unsafe acts or conditions to the Site Supervisor (SS). No person may work in a manner that conflicts with these procedures. After due warnings, the PM will dismiss from the site any person who violates safety procedures.

All on-site personnel will receive training in accordance with 29 CFR 1910.120, and be familiar with the requirements and procedures contained in this document prior to the beginning of project operations.

The roles of BBL personnel and subcontractors are outlined in the following sections. Key personnel and contacts are summarized in Table 2.1.

2.2 Health and Safety Supervisor (HSS)

The project HSS is responsible for field health and safety issues, including the execution of this HASP. Questions in the field regarding BBL procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. The HSS will advise the Project Manager (PM) on health and safety issues, and will establish and oversee the project air monitoring program. The HSS is the primary site contact on occupational health and safety matters.

It is the responsibility of the HSS to:

- Provide on-site technical assistance, if necessary;
- Conduct site and personal air monitoring, including equipment maintenance and calibration;
- Conduct site safety orientation training and daily safety meetings;
- Verify that on-site personnel have received the required physical examinations and medical certifications;
- Review site activities with respect to compliance with the HASP;
- Maintain required health and safety documents and records; and
- Assist the Site Supervisor (SS) in the instruction of field personnel on project hazards and protective procedures.

2.3 Health and Safety Officer (HSO)

The HSO has overall responsibility for the technical health and safety aspects of the project, including review and approval of this HASP. Inquiries regarding BBL procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. Changes or addenda to this HASP must be approved by the HSO.

2.4 Project Manager (PM)

The PM is ultimately responsible for verifying that project activities are completed in accordance with the requirements of this plan. The PM is responsible to provide the SS with the equipment, materials, and qualified personnel to implement fully the safety requirements in this HASP.

It is the responsibility of the PM to:

- Consult with the HSO on site safety and health issues;
- Review Incident Prevention Observation (IPO) reports;
- Thoroughly investigate accidents, incidents, and near misses;
- Approve, in writing, addenda or modifications of this HASP; and
- Suspend work if health- and/or safety-related concerns arise.

2.5 Site Supervisor (SS)

The SS is responsible for implementation of the HASP, including communication of site requirements to on-site project personnel (including subcontractors). The SS will be responsible for informing the PM of changes in the work plan or procedures so that those changes may be addressed in the HASP. Other responsibilities include:

- Consulting with the HSS on site safety and health issues;
- Conducting an Incident Prevention Observation each day at the site, and completing the IPO form;
- Stopping work, as necessary for personal safety, protection of property, and regulatory compliance;
- Obtaining a site map and determining and posting routes to medical facilities and emergency telephone numbers;
- Notifying local public emergency representatives of the nature of the site operations, and posting of their telephone numbers (for example: local fire department personnel who would respond for a confined space rescue);
- Observing on-site project personnel for signs of health effects;
- Investigating and reporting to the HSO and PM any injuries, illnesses, or near miss incidents;
- Verifying that site personnel have the proper medical clearance and have met applicable training requirements;
- Verifying that on-site personnel are informed of the physical, chemical, and biological hazards associated with the site activities, and the procedures and protective equipment necessary to control the hazards;
- Suspending work if health- and/or safety-related concerns arise; and
- Issuing/obtaining required work permits.

2.6 Subcontractors

On-site subcontractors and their personnel must understand and comply with the site requirements established in this HASP. Subcontractors may prepare their own task-specific HASPs, which must be consistent with the requirements

of this HASP. Subcontractor personnel must attend and participate in the Daily Safety Meetings and other site safety meetings.

2.7 All On-Site Personnel

All on-site personnel must read and acknowledge their understanding of this HASP, and abide by the requirements of the plan.

All on-site personnel must perform a Safe Performance Self Assessment (SPSA) prior to beginning each activity or task. This three-step process requires each individual to :

- **Assess** the risk of the task to be performed. Ask the following questions:
  - What could go wrong?
  - What is the worst thing that could happen if something does go wrong?

- **Analyze** the ways the risk can be reduced. Ask the following questions:
  - Do I have all the necessary training and knowledge to do this task safely?
  - Do I have all the proper tools and personal protective equipment?

- **Act** to control the risk and perform the task safely.
  - Take the necessary action to perform the job safely
  - Follow written procedures, and ask for assistance if necessary

This process must be performed prior to beginning each task, and must be performed after any near miss or incident in order to determine if it is safe to proceed.

Site personnel will immediately report the following to the SS or HSS:

- Accidents and injuries, and near miss incidents;
- Unexpected or uncontrolled release of chemical substances;
- Symptoms of chemical exposure;
- Unsafe or malfunctioning equipment;
- Changes in site conditions that may affect the health and safety of project personnel;
- Damage to equipment or property; and
- Situations or activities for which they are not properly trained.

2.8 Visitors

All visitors to BBL work areas must check in with the SS. Visitors will be instructed to stay outside the exclusion and contamination reduction zones, and remain within the support zone during the extent of their stay. Visitors must be cautioned to avoid skin contact with surfaces which are contaminated or suspected to be contaminated.

Visitors requesting to observe work in the exclusion zone must don appropriate PPE prior to entry into that zone, and must be meet site worker criteria as evidenced by a complete physical examination; have had 40 hours of hazardous waste operations training; and have had 8 hours of refresher training within the past 12 months. If respiratory protective devices are necessary, visitors who wish to enter the contaminated zone must have been respirator-trained and fit-tested for a respirator within the past 12 months.

TABLE 2-1
KEY PERSONNEL

Agency/Client Personnel		
Title/Role	**Name**	**Address/Telephone No.**
SCA Services, Inc	Carl Januszkiewcz	383 Meadow Rd. Edison, NJ 732-985-4757
Blasland, Bouck & Lee, Inc. Personnel		
Role	**Name**	**Address/Telephone No.**
Project Officer	Steve Cox Vice President	8 South River Rd. Cranbury, NJ 08514 -609-860-0590
Site Supervisor	Kathleen Romaine	8 South River Rd. Cranbury, NJ 08514 609-860-0590
Health and Safety Supervisor	Kathleen Romaine	8 South River Rd. Cranbury, NJ 08514 609-860-0590
Health and Safety Manager	Jay D. Keough, CIH Vice President	8 South River Rd. Cranbury, NJ 08514 609-860-0590
Project Manager	Kris Hallinger	8 South River Rd. Cranbury, NJ 08514 609-860-0590
Other Contractors on Site		
Role	**Name**	**Address/Telephone No.**
Tree Cap Installation	Ecolotree, Inc.	505 E. Washington St. Iowa City, Iowa 52240

3. Project Hazards and Control Measurements

3.1 Scope of Work

The scope of work includes the following field activities:

- Excavation of intact drums and other potentially hazardous source material;
- Observation of riverfront restoration by bioengineering technologies; and
- Cover system restoration involving a tree cap.

3.1.1 Job Hazard Assessment

The following job hazard assessment identifies potential safety, health, and environmental hazards associated with each type of field activity. Because of the complex and changing nature of field projects, supervisors must continually inspect the work site to identify hazards that may affect site personnel, the community, or the environment. The SS must be aware of these changing conditions and discuss them with the PM whenever these changes impact employee health, safety, the environment, or performance of the project. The SS will keep BBL personnel and subcontractors informed of the changing conditions, and the PM will write or approve addenda or revisions to this HASP as necessary.

3.2 Field Activities, Hazards, Control Procedures

3.2.1 Mobilization

Site mobilization may include setting up equipment and establishing a temporary site office. During this initial phase, project personnel will walk the site to confirm the existence of anticipated hazards, and identify safety and health issues that may have arisen since the writing of this plan.

Manual materials handling and manual site preparation may cause blisters, sore muscles, and joint and skeletal injuries; and may present eye, contusion, and laceration hazards. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces, and unstable soil.

Environmental hazards include plants, such as poison ivy and poison oak; aggressive fauna, such as ticks, fleas, mosquitos, wasps, spiders, and snakes; weather, such as sunburn, lightning, rain, and heat-related illnesses; and pathogens, such as rabies, lyme disease, and blood-borne pathogens. Control procedures for these hazards are discussed in Section 4.

3.2.2 Clearing and Grubbing

Site clearing activities involve a potential for exposure to numerous physical and health hazards. The hazards are primarily associated with the equipment used and the debris being removed.

Physical Hazards - The physical hazards involved with clearing relate to work done with heavy equipment, hand tools, and the environment itself. There exists a potential for incidents involving personnel struck by or struck against powered equipment, timber, or materials, resulting in fractures, cuts, punctures, or abrasions. Walking and working surfaces during clearing activities may involve slip, trip, and fall hazards. Working at elevations may create a fall hazard.

Environmental Hazards - Overgrown areas present hazards of uneven walking surfaces, soft terrain, and biological hazards such as insects and snakes.

Working Surfaces - Uneven terrain and slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, and slips and falls. All personnel should frequently inspect the area in which they are working, and keep the area as clear as possible.

Powered Equipment Operations - Site workers are exposed to serious hazards during clearing when using powered equipment. Workers may be struck by blades or by material thrown by powered equipment.

Materials Handling - The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and a finger or toe gets caught between two objects. Extreme care must be taken when loading and unloading material. Proper lifting technique must be employed, and mechanical means must be used to lift objects whenever possible.

Health Hazards - Due to the type of work involved in clearing and construction activities, the primary health hazards involve repetitive motion disorders, lifting, and other ergonomic stressors. Noise may also present a hazard. Operation of heavy equipment and power actuated and pneumatic hand tools frequently results in high noise levels.

Control - Prior to initiating clearing and construction activities, the operation will be explained to all employees. Hazards will be identified and protective measures will be explained. Equipment will be inspected and in proper working condition. Employees should receive training to address the equipment, its operations, and care. Personnel should be scheduled in a manner to reduce the likelihood of performing repetitive tasks for prolonged periods. Mechanical assistance should be provided for large lifting tasks. Hearing protection is required for use when exposed to noise levels exceeding 85 dBA, or a level which commonly results in difficult conversation. Level D PPE will be used when the surface material is not contaminated, Modified Level D PPE will be used when surface material is contaminated.

3.2.3 Excavation Safety

3.2.3.1 Soil Excavation

This task involves the removal of soils for the purpose of drum recovery.

Physical Hazards - The physical hazards involved in the excavation of soils are related to the excavation itself, and the operation of heavy equipment. Excavations pose significant hazards to employees if they are not carefully controlled. There exists a chance for the excavation to collapse in on itself if it is not dug properly, sloped, benched, or shored as required. The excavation is also a fall hazard, and employees must pay careful attention to what they are doing or they risk a fall into the excavation.

In some areas of the site, the presence of overhead utilities, such as power lines, requires careful positioning of the excavating equipment in order to maintain a safe distance between the lines and the closest part of the equipment. The presence of underground utilities, such as gas lines, power lines, water lines, telephone lines, and sewer pipes, must be determined prior to beginning the excavation.

Some field activities may require personnel to enter an excavation. Whenever possible, sampling, drum removal, and other activities should be done remotely, without entering the excavation. If entry is absolutely unavoidable, the BBL procedures for excavation entry shall be followed for each such activity.

All observation and sampling activities will be conducted from outside the excavation. Only under extreme conditions may personnel to enter an excavation.

Noise may also present a hazard. Heavy equipment operation frequently results in noise levels exceeding 85 dBA, requiring the use of hearing protection for exposed personnel.

Chemical Hazards - Airborne concentrations of soil contaminants and the dust from the procedure pose the potential for exposure.

Control - All excavation shall be performed from a stable ground position. Daily inspections of the excavation shall be made by a competent person, one who has received training in excavation safety. The inspector shall determine the likelihood of a cave-in, and corrective action, such as sloping or shoring, shall be taken if the walls appear to be unstable.

All spoil shall be located at least 2 feet from the edge of the excavation to prevent it from falling back into the excavation. The excavation shall be guarded on all sides by barricades or caution tape at least 2 feet from the edge.

Before any digging can be done, all underground utilities must be located and identified. The Underground/ Overhead Utilities Checklist in Appendix B will be used to document this process. PPE for this phase is described in Section 5. As indicated above, any personnel entry into an excavation will be in accordance with BBL procedures for excavation entry.

All project personnel shall participate in the Daily Safety Meetings and be instructed on the following requirements:

- Before excavating, the existence and location of underground pipe, electrical equipment, and gas lines will be determined by contacting the appropriate utility company and/or client representative to mark the location of the lines. If the client's knowledge of the area is incomplete, an appropriate device, such as a cable avoiding tool, will be used to locate the service line.

- A combustible gas indicator will be used to monitor the excavation area if flammable vapors are suspected.

- Operations must be suspended and the area vented if the airborne flammable concentration exceeds 10 percent of the LEL in the area of an ignition source (i.e., sparks from bucket of excavator).

- If excavating equipment is located in the vicinity of overhead power lines, a minimum distance must be maintained between the lines and any point on the equipment. The following table presents these minimum distances.

Nominal System Voltage	Minimum Required Clearance
0-50kV	10 feet
51-100kV	12 feet
101-200kV	15 feet
201-300kV	20 feet
301-500kV	25 feet
501-750kV	35 feet
751-1,000kV	45 feet

When the equipment is in transit, with the boom lowered and no load, the equipment clearance must be at least 4 feet for voltages less than 50kV, 10 feet for voltages of 50kV to 345kV, and 16 feet for voltages above 345kV.

Dust Control - Airborne particulate generation will be controlled during site excavations; dust generation is possible. Dry, dusty soil will be wetted with a water spray from a potable water source to control the generation of dust. Soil will not be wetted to a degree which will cause runoff or soil erosion.

3.2.3.2 Excavation Entry Procedure

Persons entering an excavation must do so under controlled conditions. The excavation must be properly sloped, benched, or shored, and ladders or ramps must be available every 25 feet laterally in the excavation. Each entry shall have an attendant who observes the entrant(s) and is prepared to render assistance.

Duties of Workers Entering an Excavation

- know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of exposure to site contaminants;
- communicate with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space;
- alert the attendant whenever:
  - the entrant recognizes any warning sign or symptom of exposure to a dangerous situation; or
  - the entrant detects a prohibited condition;
- exit from the excavation as quickly as possible whenever:
  - an order to evacuate is given by the attendant or the supervisor;
  - the entrant recognizes any warning sign or symptom of exposure to a dangers situation;
  - the entrant detects a prohibited condition.

Duties of Attendants

- knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of exposure to site contaminants;
- continuously maintains a count of entrants in the excavation;
- remains outside the excavation during entry operations until relieved by another attendant;
- communicates with authorized entrants as necessary to monitor entrant status to alert entrants of the need to evacuate the excavation under any of the following conditions:
  - if the attendant detects a prohibited condition;

- if the attendant detects the behavioral effects of hazard exposure in an entrant;
- if the attendant detects a situation outside the excavation that could endanger the entrants; or
- if the attendant cannot effectively and safely perform his duties;

- summon rescue and other emergency services if the attendant determines that entrants may need assistance to evacuate the excavation.

3.2.4 Drum Handling and Removal

3.2.4.1 Drum Removal/Handling Areas

Temporary drum staging areas will be constructed on an as-needed basis at various locations within the Exclusion Zone. These temporary staging facilities will consist of leveled areas surrounded by earthen berms to be used primarily for the initial inspection and storage of discovered drums prior to sampling. A main staging area may be constructed with impervious synthetic liner surrounded by earthen berms. The location of this main staging area will be field-determined and will be used for the opening and sampling of the drums. Drums or drum carcasses that contain material that are found in the Mound B area will overpacked upon discovery, then transported to the staging area.

All drums encountered will be considered hazardous and handled accordingly until their contents have been positively identified. Only those personnel essential to the investigation activities will be in the area.

3.2.4.2 Drum Identification and Recordkeeping

Visual inspection of exposed drums during investigation activities will be performed to assess the degree of hazard associated with each drum and to determine the proper handling technique to be used. Personnel performing the drum inspection should look for the following information:

- Markings or labels that could potentially indicate drum contents.
- Determine drum type, size, and drumhead configuration.
- Determine contents either liquid or solid, and estimate the quantity of the material.
- Signs of deterioration such as rust, corrosion, and leaks.
- Signs that the drum is under pressure, such as swelling and bulging.

All information will be recorded on a Hazardous Waste Characterization Data Sheet.

Personnel should assume that unlabeled drums contain hazardous materials until their contents are positively characterized. Drums are frequently reused, thus a drum's label will not always indicate its actual contents.

Upon completion of the initial visual inspection, personnel shall classify each drum into one of the following categories:

- Bulging Intact - drum under pressure indicated by swelling and bulging.
- Intact - drums sealed with a lid or bung in fair to poor condition with light to moderate damage.
- Crushed/empty - drums that were crushed prior to burial with no apparent contents.

Crushed, empty drums will not be moved to the staging area. These will be stockpiled and replaced into the landfill. Full, intact drums will be overpacked and transferred to the staging area. Under no circumstances should personnel physically handle the drums. If a loader with a bucket sling is used for drum transfer, a clearly marked loading area should be delineated with barricades or caution tape. Polyethylene sheeting will be placed under the loader bucket to limit any potential contamination migration.

Discovered drums will be handled as outlined in this section.

- When an intact drum is discovered, the SHSC will monitor the atmosphere immediately surrounding the drum with a FID to assess the presence of VOC, an Oxygen/Lower Explosive Limit Meter (LEL) to determine if a potential explosive atmosphere is present and a radiation survey meter to detect ionizing radiation.

- Drum carcasses and other debris encountered during the proposed excavations will not be removed from the site after excavation, as these materials are characteristic of municipal solid waste. If potentially hazardous materials are encountered within or surrounding drum carcasses identified during excavation activities (such as liquids, solids, or residues), and these materials are determined to represent an imminent threat to ground-water quality, the materials will be handled and managed appropriately. Crushed drum carcasses, drum fragments, metallic debris, and other non-hazardous materials that are encountered during the excavations (such as municipal solid waste, trash, construction debris, etc.) will not be removed from the site and will be returned to the excavation as these materials are characteristic of materials commonly encountered in municipal solid waste landfills.

- If the LEL meter indicates a lower explosion limit in excess of 10 percent the SHSC will halt work activities and direct the equipment operator to recover the drum, place it in the temporary drum staging area and contact the HSM. No personnel will be permitted in the exclusion zone without protective shielding or a protective berm, (other than the equipment operator) until the drum has been successfully placed in the temporary drum staging area. Personnel will be in Level B.

- If the radiation survey indicates greater than background levels of ionizing radiation all activity associated with that drum will cease until contact is made with the HSM.

- Suitable quantities of absorbent and overpack drums will be kept available and used for drum overpacking and containing leaks or any spills that may occur. All drum overpacking will occur in the excavation area.

- Drum handling will be performed using a front end loader equipped with a bucket sling. Site operations will be organized to minimize the amount of drum handling.

- After a drum has been isolated and immediate hazards have been eliminated by either overpacking or transferring the drum's contents to a new drum, the drum will be labeled with an identification tag and transported to the main staging area for subsequent sampling.

3.2.4.3 Drum Opening/Sampling

Drums will be opened and sampled within the main staging area. Only those personnel essential to drum opening and sampling operations will be in the active drum opening area. In accordance with 29 CFR 1910.120 (j)(2)(iii) "If workers must work near or adjacent to drums or containers being opened, a suitable shield that does not interfere with the work operation shall be placed between the employee and the drums or containers being opened to protect the employee in case of accidental explosion." Non-essential will not be in the vicinity of the drum opening operation. Essential personnel will use heavy equipment or similar devices to shield themselves as the drums are

being pierced. Extreme caution will be taken when opening drums. Drums will be opened with a trackhoe equipped with a non-sparking spike and the operator will be protected by a clear explosion proof shield mounted on the machine. If the drum shows signs of swelling or bulging, all steps will be performed slowly.

Prior to and immediately after drum opening activities, the SHSC will monitor the atmosphere surrounding the drum and once opened, the drum contents with a FID, LEL meter, and radiation survey meter. Work activities will be halted and the HSM notified if action levels in Section 8 are exceeded.

Any on-site field sampling/screening of any materials will be conducted in Level B. If it is suspected that the material being sampled may be air/water reactive or shock sensitive shielding will be placed between the sampler and the material being sampled.

A unique identification number must be marked on each drum to be sampled. Identical markings will be placed on the drum's overpack after sampling results are obtained.

3.2.4.4 Fire and Explosion Protection

In general, good housekeeping and equipment operation practices will reduce the potential for fire and accidents. Trash, materials, and tools shall be kept in designated areas to avoid accumulation and keep pathways clear. All equipment used on site shall be properly maintained and operated per the manufacturer's recommendations.

Fire protection equipment will be readily available on site and maintained by site personnel. Portable fire extinguishers with a minimum rating of 20 A:B:C shall be provided, as necessary. Each fire extinguisher shall be placed in an accessible area and distinctly identified.

Electrical equipment will not be used to puncture or transfer drum contents. All equipment and tools used to open drums will be made of a non-sparking material to prevent sources of ignition.

Additional task-specific precautions shall be taken as necessary as discussed in the Health and Safety Plan.

3.2.4.5 Spill and Discharge Prevention

This Spill Control Procedure sets forth the guidelines for coordination and response to potential spills and leaks of drums and similar containers. Prior to initiation of field activities, the responsibilities of site personnel during potential spills and discharges will be clearly outlined and coordinated with project personnel and as necessary with local emergency response teams and appropriate agencies.

Significant controls and measures will be taken during field operations to prevent emergency situations and protect site workers and the environment. These measures will include personnel training, fire and/or explosion prevention and protection, spill and release prevention and protection, and practices to avoid personal injury or exposure. General safety measures and training of site personnel are discussed in the Health and Safety Plan for this project. Spill Release and Control Procedures are outlined in Section 11.

3.2.5 Cylinder Handling Procedures

This procedure establishes the safe work practices for the handling of cylinders discovered during the investigation. This procedure is to be used in conjunction with the Health and Safety Plan developed for the site. In the event a cylinder must be moved, the following procedure will apply.

3.2.5.1 Cylinder Inspection

Visual inspection of uncovered cylinders will be performed to assess the degree of hazard associated with each cylinder and to determine its handling procedure/disposition. Personnel performing the cylinder inspection should look for the following information:

- Markings, labels, or color coding that could potentially indicate cylinder contents
- Signs of deterioration such as rust, corrosion, or physical damage.

Personnel should assume that unlabeled intact cylinders contain hazardous materials until the contents are characterized.

3.2.5.2 Cylinder Classification

Upon completion of the inspection, personnel shall classify each cylinder into one of two categories:

- Intact - no signs that the structural integrity of the cylinder has been breached.
- Non-Intact - obvious physical evidence that the structural integrity of the cylinder has been breached.

3.2.5.3 Transport

Non-intact cylinders will be removed. Intact cylinders will be placed into a sand-lined backhoe bucket and transported to a staging area where they will be secured in a upright position. No one will physically handle the cylinders unless given specific direction by the SS to do so.

Special precautions should be taken if intact cylinders are discovered without valve caps. These include either installing a cap or padding the valve prior to transport. Padding could include bubble wrap and duct tape.

3.2.5.4 General Safety Procedures

- All initial cylinder inspections will be performed in Level B protection.
- Slings or chains will not be used to handle intact cylinders.
- Under no circumstance will the cylinder valve be opened to check pressure.
- The backhoe operator must be in constant communication with the SS during intact cylinder handling activities.
- A wind sock must be visible to all personnel involved with intact cylinder handling activities.
- A ruptured cylinder during handling would require immediate evacuation to an upwind point of refuge.

- A designated point of refuge must be established prior to cylinder handling.

- Ground personnel should position themselves so that the backhoe bucket provides a physical barrier during intact cylinder handling activities. No ground personnel should assist with cylinder handling.

3.2.6 Shoreline Restoration

Shoreline Restoration will consist of clearing and grubbing, removing and placing any materials into the Mound B area. Clearing and grubbing activities are covered in Section 3.2.3. Removing and placing materials into the Mound B area. Removing refuse will be considered an excavation and should meet the requirements of Section 3.2.4 Excavation.

3.2.6.1 Deposition of Materials into the Mound B Area.

Moving materials involves a potential for exposure to numerous physical and health hazards. The hazards are primarily associated with the equipment used and the debris being moved.

Physical Hazards - The physical hazards involved with material handling relate to work done with heavy equipment, hand tools, and the environment itself. There exists a potential for incidents involving personnel struck by or struck against powered equipment, timber, or materials, resulting in fractures, cuts, punctures, or abrasions.

Powered Equipment Operations - Site workers are exposed to serious hazards during clearing when using powered equipment. Workers may be struck by blades or by material thrown by powered equipment.

Materials Handling - The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and a finger or toe gets caught between two objects. Extreme care must be taken when loading and unloading material. Proper lifting technique must be employed, and mechanical means must be used to lift objects whenever possible.

Health Hazards - Due to the type of work involved in material handling activities, the primary health hazards involve repetitive motion disorders, lifting, and other ergonomic stressors. Noise may also present a hazard.

Control - Prior to initiating material handling activities, the operation will be explained to all employees. Hazards will be identified and protective measures will be explained. Equipment will be inspected and in proper working condition. Employees should receive training to address the equipment, its operations, and care. Personnel should be scheduled in a manner to reduce the likelihood of performing repetitive tasks for prolonged periods. Mechanical means of lifting and moving material should be substituted for manual movement of material whenever possible. Hearing protection is required for use when exposed to noise levels exceeding 85 dBA, or a level which commonly results in difficult conversation.

3.2.7 Mound B Cap Restoration/Re-augmentation

Mound B cap restoration/re-augmentation will include a reworking or backfilling of the existing clay, but may include liner installation. Additionally, trees and short grasses will be planted on the Mound B area.

3.2.7.1 Liner Installation and Backfilling Safety

This task involves the installation of either a permeable geotextile or impermeable membrane liner, and backfilling and grading activities. Liner installation and backfilling activities involve a potential for exposure to physical and

health hazards. Hazards may be associated with the materials and equipment used in backfilling or the activities themselves. Additionally, plants and short grasses will be planted in the Mound B area.

Physical Hazards: The physical hazards involved with liner installation and backfilling relate to work done with heavy equipment, hand tools, and the site environment itself. There exists a potential for incidents involving personnel struck by or struck against equipment or materials, resulting in fractures, cuts, punctures, or abrasions. Walking and working surfaces during liner installation and backfilling activities may involve slip, trip, and fall hazards due to uneven surfaces and the slippery nature of plastic liner material.

Working Surfaces: Slippery work surfaces (e.g. plastic, gravel, etc.) can increase the likelihood of back injuries, overexertion injuries, and slips and falls. All personnel should frequently inspect working surfaces and keep working surface clear of debris.

Materials Handling: The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and an appendage gets caught between two objects. Extreme care must be taken when loading and unloading material. Proper lifting technique must be employed, and mechanical means must be used to lift objects whenever possible. Compacting backfill material may also present a hazard due to the use on a hand operated compactor. Operators of the compactor may be exposed to back or muscle strain, impact or crushing injuries due to contact with the compactor, or pinch points between the compactor and adjacent objects (e.g. concrete slab, excavation walls, etc.).

Health Hazards: Due to the type of work involved in liner installation and backfilling activities, the primary health hazards involve repetitive motion disorders, lifting, and other ergonomic stressors. During liner installation, contact with soil containing site constituents is a potential hazard. Noise may also present a hazard. Operation of heavy equipment, power tools, and pneumatic hand tools frequently results in high noise levels.

Control: Prior to initiating liner installation and backfilling activity, the operation will be explained to all employees. Hazards will be identified and protective measures will be explained. Equipment will be inspected and in proper working condition. Employees should receive training to address the equipment, its operations, and care. Personnel should be scheduled in a manner to reduce the likelihood of performing repetitive tasks for prolonged periods. Mechanical assistance should be provided for large lifting tasks. Hearing protection is required for use when exposed to noise levels exceeding 85 dBA, or a level which commonly results in difficult conversation. Backfilling activities may include use of heavy equipment for materials handling and site grading. Safety hazards and precautions for heavy equipment materials handling and grading are discussed in the following sections.

3.2.7.2 Heavy Equipment Materials Handling / Site Grading

To protect all on-site personnel against hazards associated with materials handling, and to prevent injury due to unsafe heavy equipment operation, only properly trained and authorized operators will be allowed to operate heavy equipment. All materials handling equipment will be maintained in safe operating condition and inspected daily prior to use.

3.2.7.3 Cover System Restoration

Cover system restoration activities involve a potential for exposure to numerous physical and health hazards. The hazards are primarily associated with the equipment used and the material being moved.

Physical Hazards - The physical hazards involved with clearing and construction relate to work done with heavy equipment, hand tools, and the environment itself. There exists a potential for incidents involving personnel struck

by or struck against powered equipment, timber, or materials, resulting in fractures, cuts, punctures, or abrasions. Walking and working surfaces during construction activities may involve slip, trip, and fall hazards. Working at elevations may create a fall hazard.

Environmental Hazards - Overgrown areas present hazards of uneven walking surfaces, soft terrain, and biological hazards such as insects and snakes.

Working Surfaces - Uneven terrain and slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, and slips and falls. All personnel should frequently inspect the area in which they are working, and keep the area as clear as possible.

Powered Equipment Operations - Site workers are exposed to serious hazards during clearing when using powered equipment. Workers may be struck by blades or by material thrown by powered equipment.

Materials Handling - The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and a finger or toe gets caught between two objects. Extreme care must be taken when loading and unloading material. Proper lifting technique must be employed, and mechanical means must be used to lift objects whenever possible.

Health Hazards - Due to the type of work involved in clearing and construction activities, the primary health hazards involve repetitive motion disorders, lifting, and other ergonomic stressors. Noise may also present a hazard. Operation of heavy equipment and power actuated and pneumatic hand tools frequently results in high noise levels.

Control - Prior to initiating clearing and construction activities, the operation will be explained to all employees. Hazards will be identified and protective measures will be explained. Equipment will be inspected and in proper working condition. Employees should receive training to address the equipment, its operations, and care. Personnel should be scheduled in a manner to reduce the likelihood of performing repetitive tasks for prolonged periods. Mechanical assistance should be provided for large lifting tasks. Hearing protection is required for use when exposed to noise levels exceeding 85 dBA, or a level which commonly results in difficult conversation.

3.2.8 Equipment Decontamination

All equipment will be decontaminated before leaving the site. Personnel involved in decontamination activities may be exposed to skin contact with contaminated materials and chemicals brought to the site as part of the project work. Personnel involved in decontamination activities must wear PPE which is one level below the level worn by personnel working in the EZ.

3.3 Chemical Hazards

The chemical hazards associated with site operations are related to inhalation, ingestion, and skin exposure to site constituents of concern (COCs). Although all possible COCs have not been identified, they may include the following organic compounds: benzene, ethylbenzene, toluene, and xylene. COCs may include the following metals: cadmium, arsenic, chromium, copper, mercury, nickel, zinc, and lead.

Airborne concentrations of constituents of concern during certain site tasks may be significant, and will require air monitoring of potentially toxic and flammable atmospheres during such operations. Air monitoring requirements for site tasks are outlined in Section 8.1

The potential for inhalation of COCs during site operations is moderate. The potential for dermal contact with soil/waste containing COCs during observation and sampling activities in the exclusion zone is moderate to high.

Table 3-1 lists the chemical, physical, and toxicological properties of selected site constituents of concern and materials used during field activities. The Material Safety Data Sheets (MSDSs) for COCs are included in Appendix A.

TABLE 3-1
CHEMICAL HAZARD INFORMATION

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
Benzene [71-43-2]	9.24	34–119	Inh Abs Ing Con	Irritates eyes, nose, respiratory system; giddiness; headache, nausea, staggered gait; fatigue, anorexia, lassitude; dermatitis; bone-marrow depression. Carcinogenic.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	1 ppm (0.5 ppm) NIC–0.1 skin 0.1 ppm	2.5 ppm C1 ppm (Ca)	PEL TLV REL	Ca [1,000 ppm]* *OSHA
Ethylbenzene [100-41-4]	8.76	none	Inh Abs Con	Irritated eyes, skin and mucous membranes; headache, dermatitis, narcosis, coma	Eye: Irrigate immediately Skin: Water flush promptly Breath: Respiratory support Swallow: Immediate medical attention	10 ppm 10 ppm	?	PEL TLV REL	800 ppm
Nickel [7440-02-0]	NA	none	Inh Ing Con	Dermatitis, allergic asthma, pneumonitis, carcinogen.	Skin: Water flush Breath: Respiratory support Swallow: Immediate medical attention	1 mg/m^3 0.05 mg/m^3 0.015 mg/m^3	?	PEL TLV REL	10 mg/m^3
Cadmium [7440-43-9]	NA	NA	Inh Ing	Pulmonary edema, dyspnea, cough, tight chest, headache, chills, muscle aches, nausea, vomiting, diarrhea, anemia, carcinogen.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	0.005 0.002	?	PEL TLV REL	9 mg/m^3
Toluene [108-88-3]	8.82	0.16–37	Inh Abs Ing Con	Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscular fatigue, insomnia; paralysis; dermatitis.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	200 ppm 50 ppm (skin) 100 ppm	300 ppm 150 ppm	PEL TLV REL	500 ppm
Xylene (o-, m-, and p-isomers) [1330-20-7;95-47-6; 108-38-3;106-42-3]	8.56/ 8.56/ 8.44	1.1–20	Inh Abs Ing Con	Dizziness, excitement, drowsiness, incoordination, staggering gait; irritated eyes, nose, throat; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow:: Immediate medical attention	100 ppm 100 ppm 100 ppm	150 ppm 150 ppm 150 ppm	PEL TLV REL	900 ppm
Copper dusts and mists (metal) (copper sulfate) [7440-50-8]	NA	NA	Inh Ing Con	Irritated pharynx and nasal mucous membrane; nasal perforation; eye irritation; metallic taste; dermatitis; in animals: lung, kidney, and liver damage; anemia.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	1 mg/m^3 1 mg/m^3 1 mg/m^3	?	PEL TLV REL	100 mg/m^3

Substance [CAS]	IP[a] (eV)	Odor Threshold (ppm)	Route[b]	Symptoms of Exposure	Treatment	TWA[c]	STEL[d]	Source[e]	IDLH (NIOSH)[f]
Arsenic (Inorganic compounds, as) [7440-38-2]	NA	NA	Inh Abs Con Ing	Ulceration of nasal septum, dermatitis, GI disturbances, per. neuropathy, respiratory irritation, hyperpigmentaion of skin [carcinogen]	Eye: Irrigate immediately Skin: Soap flush promptly Breath: Respiratory support Swallow: Immediate medical attention	0.010 mg/m^3 0.01 mg/m^3	C0.002 mg/m^3	PEL TLV REL	Ca [5 mg/m^3]
Lead inorganic dusts & fumes (as Pb) [7439-92-1]	NA	NA	Inh Ing Con	Weakness, lassitude, insomnia; facial pallor; eye pallor, anorexia, low body weight, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremors; wrist and ankle paralysis; brain damage; kidney damage; irritated eyes; hypotension.	Eye: Irrigate immediately Skin: Soap flush promptly Breath: Respiratory support Swallow: Immediate medical attention	0.05 mg/m^3 0.05 mg/m^3 <0.1 mg/m^3 See 29 CFR 1926.62 Blood lead <50 ug/dl/ 100 g whole blood	?	PEL TLV REL	700 mg/m^3
Mercury [7439-97-6]	?	None	Inh Abs Ing Con	Irritated eyes and skin, cough, chest pain, bronchial numegis, indecision, headache, fatigue, weakness, gidlsorah.	Eye: Irrigate immediately Skin: Soap wash promptly Breath: Respiratory support Swallow: Immediate medical attention	0.1 mg/m^3 0.05 mg/m^3	C0.25	PEL TLV REL	10 mg/m^3
Chromium metal (as Cr) [7440-47-3]	NA	NA	Inh Ing	Histologic fibrosis of lungs.	Eye: Irrigate immediately Skin: Soap wash immediately Breath: Respiratory support Swallow: Immediate medical attention	1 mg/m^3 0.5 mg/m^3 0.5 mg/m^3	?	PEL TLV REL	250 mg/m^3
Zinc (as oxide fume) [1314-13-2]	NA	NA	Inh	Sweet metallic taste; dry throat, cough, chills, fever; tight chest, dyspnea, , reduced pulmonary function; headache; blurred vision; muscular cramps, low back pain; nausea, vomiting; fatigue, lassitude, malaise.	Breath: Respiratory support	5 mg/m^3 5 mg/m^3 5 mg/m^3	10 mg/m^3 10 mg/m^3 10 mg/m^3	PEL TLV REL	NE

[a]IP = Ionization potential (electron volts).
[b]Route = Inh, Inhalation; Abs, Skin absorption; Ing, Ingestion; Con, Skin and/or eye contact.
[c]TWA = Time-weighted average. The TWA concentration for a normal work day (usually 8 or 10 hours) and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day without adverse effect.
[d]STEL = Short-term exposure limit. A 15-minute TWA exposure that should not be exceeded at any time during a workday, even if the TWA is not exceeded.
[e]PEL = Occupational Safety and Health Administration (OSHA) permissible exposure limit (29 CFR 1910.1000, Table Z).
TLV = American Conference of Governmental Industrial Hygiene (ACGIH) threshold limit value—TWA.
REL = National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.
[f]IDLH (NIOSH)—Immediately dangerous to life or health (NIOSH). Represents the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.
NE = No evidence could be found for the existence of an IDLH (NIOSH Pocket Guide to Chemical Hazards, Pub. No. 90-117, 1990).
C = Ceiling limit value which should not be exceeded at any time.
Ca = Carcinogen.
NA = Not applicable.
? = Unknown.
LEL = Lower explosive limits.
LC_{50} = Lethal concentration for 50 percent of population tested.
LD_{50} = Lethal dose for 50 percent of population tested.
NIC = Notice of intended change (ACGIH).

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4. General Safety Practices

4.1 General Practices

General safety procedures for site activities include, but are not limited to the following:

- At least one copy of this plan must be at the project site, in a location readily available to personnel, and reviewed by all project personnel prior to starting work.
- Site personnel must use the buddy system (working in pairs or teams).
- Food, beverages, or tobacco products must not be present or consumed in the exclusion and contamination reduction zones. Cosmetics must not be applied within these zones.
- Contaminated protective equipment, such as respirators, hoses, boots, etc., must not be removed from the regulated area before being cleaned or properly packaged and labeled.
- Emergency equipment such as eyewash, fire extinguishers, portable shower, etc. must be removed from storage areas and staged in readily accessible locations.
- Contaminated waste, debris, and clothing must be properly contained, and legible and understandable precautionary labels must be affixed to the containers.
- Removing sediment/soil containing site COCs from protective clothing or equipment with compressed air, shaking, or any other means that disperses contaminants into the air is prohibited.
- Containers must be moved only with the proper equipment, and must be secured to prevent dropping or loss of control during transport.
- All incidents (injuries, equipment damage, etc.) and near misses must be immediately reported to the SS.

4.1.1 Safe Performance Self Assessment

All on-site personnel must perform a Safe Performance Self Assessment (SPSA) prior to beginning any activity or task. This three-step process requires each individual to :

- Assess the risk of the task to be performed. Ask the following questions:
  - What could go wrong?
  - What is the worst thing that could happen if something does go wrong?
- Analyze the ways the risk can be reduced. Ask the following questions:
  - Do I have all the necessary training and knowledge to do this task safely?
  - Do I have all the proper tools and personal protective equipment?
- Act to control the risk and perform the task safely.
  - Take the necessary action to perform the job safely
  - Follow written procedures, and ask for assistance if necessary

This process must be performed prior to beginning any task, and must be performed after any near miss or incident in order to determine if it is safe to proceed.

4.1.2 Incident Prevention Observation

Incident Prevention Observations (IPOs) will be performed by the Site Supervisor or the Health and Safety Supervisor at least once per week. The purpose of the IPO is to identify and correct potential hazards, and to positively reinforce behaviors and practices that are correct. The SS or HSS must identify potential deviations from safe work practices that could possibly result in an incident, and take prompt corrective action. The IPO process steps are:

- Identify tasks which have the greatest potential for incidents;
- Review the standard procedure for completing the task;
- Discuss with the observed employee the task and the SS/HSS role in observing the task;
- Observe the employee completing the task;
- Reference the IPO form for criteria. Complete the form, documenting positive as well as undesirable activities;
- Discuss the results of the IPO with the employee. Discuss corrective action necessary;
- Implement corrective action; and
- Communicate the results of the IPO and corrective action to the HSP and the PM.

4.1.3 Buddy System

On-site personnel must use the buddy system. Visual contact must be maintained between crew members at all times, and crew members must observe each other for signs of chemical exposure, heat or cold stress. Indications of adverse effects include, but are not limited to:

- Changes in complexion and skin coloration;
- Changes in coordination;
- Changes in demeanor;
- Excessive salivation and pupillary response; and
- Changes in speech pattern.

Team members must also be aware of potential exposure to possible safety hazards, unsafe acts, or noncompliance with safety procedures.

- Field personnel must inform their partners or fellow team members of nonvisible effects of exposure to toxic materials that they may be experiencing. The symptoms of such exposure may include:
  - Headaches
  - Dizziness
  - Nausea
  - Blurred vision
  - Cramps
  - Irritation of eyes, skin, or respiratory tract.

If protective equipment or noise levels impair communications, prearranged hand signals must be used for communication. Personnel must stay within line of sight of another team member.

4.2 Heat Stress

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. Since heat stress is one of the most common illnesses associated with heavy outdoor work conducted with direct solar load and, in particular, because wearing PPE can increase the risk of developing heat stress, workers must be capable of recognizing the signs and symptoms of heat-related illnesses. Personnel must be aware of the types and causes of heat-related illnesses and be able to recognize the signs and symptoms of these illnesses in both themselves and their co-workers.

Heat rashes are the one of the most common problems in hot work environments. Commonly known as prickly heat, a heat rash is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

Heat cramps are usually caused by performing hard physical labor in a hot environment. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused both by too much and too little salt.

Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution (plus or minus 0.3% NaCl), excess salt can build up in the body if the water lost through sweating is not replaced. Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.

Under extreme conditions, such as working for 6 to 8 hours in heavy protective gear, a loss of sodium may occur. Drinking commercially available carbohydrate-electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

Heat exhaustion occurs from increased stress on various body organs due to inadequate blood circulation, cardiovascular insufficiency, or dehydration. Signs and symptoms include pale, cool, moist skin; heavy sweating; dizziness; nausea; headache, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment.

Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke, which is a medical emergency.

Workers suffering from heat exhaustion should be removed from the hot environment, be given fluid replacement, and be encouraged to get adequate rest.

Heat stroke is the most serious form of heat stress. Heat stroke occurs when the body's system of temperature regulation fails and the body's temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict.

Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body

temperature, e.g., a rectal temperature of 41°C (105.8°F). If body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of work load and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

If a worker shows signs of possible heat stroke, professional medical treatment should be obtained immediately. The worker should be placed in a shady area and the outer clothing should be removed. The worker's skin should be wetted and air movement around the worker should be increased to improve evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first aid treatment.

Regardless of the worker's protestations, no employee suspected of being ill from heat stroke should not be sent home or left unattended unless a physician has specifically approved such an order.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or exhaustion, that person may be predisposed to additional heat injuries.

Heat Stress Safety Precautions

Heat stress monitoring and work rest cycle implementation should commence when the ambient adjusted temperature exceeds 72°F. A minimum work rest regimen and procedures for calculating ambient adjusted temperature are described in the Table 4-1.

TABLE 4-1
WORK/REST SCHEDULE

Adjusted Temperature[b]	*Work-Rest Regimen Normal Work Ensemble*[c]	*Work-Rest Regimen Impermeable Ensemble*
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (30.8°-32.2°C)	After each 150 minutes of work	After each 120 minutes of work

[a] For work levels of 250 kilocalories/hour (Light-Moderate Type of Work)
[b] Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)
[c] A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.
[d] The information presented above was generated using the information provided in the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) Handbook.

In order to determine if the work rest cycles are adequate for the personnel and specific site conditions additional monitoring of individuals heart rates will be conducted during the rest cycle. To check the heart rate, count the radial pulse for 30 seconds at the beginning of the rest period. If the heart rate exceeds 110 beats per minute, shorten the next work period by one-third and maintain the same rest period

Additional one or more of the following control measures can be used to help control heat stress and are mandatory if any site worker has a heart rate (measure immediately prior to rest period) exceeding of 115 beats per minute:

- Site workers will be encouraged to drink plenty of water and electrolyte replacement fluids throughout the day.
- On-site drinking water will be kept cool (50 to 60°F).
- A work regimen that will provide adequate rest periods for cooling down will be established, as required.
- All personnel will be advised of the dangers and symptoms of heat stroke, heat exhaustion, and heat cramps.
- Cooling devices, such as vortex tubes or cooling vests, should be used when personnel must wear impermeable clothing in conditions of extreme heat.
- Employees should be instructed to monitor themselves and co-workers for signs of heat stress and to take additional breaks as necessary.
- A shaded rest area must be provided. All breaks should take place in the shaded rest area.
- Employees must not be assigned to other tasks during breaks.
- Employees must remove impermeable garments during rest periods. This includes white Tyvek-type garments.
- All employees must be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress disorders.

4.3 Cold Stress

Cold stress normally occurs in temperatures at or below freezing, or under certain circumstances, in temperatures of 40°F. Extreme cold for a short time may cause severe injury to exposed body surfaces or result in profound generalized cooling, causing death. Areas of the body which have high surface area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible. Two factors influence the development of a cold weather injury: ambient temperature and the velocity of the wind. For instance, 10°F with a wind of 15 miles per hour (mph) is equivalent in chilling effect to still air at -18°F. An equivalent chill temperature chart relating the actual dry bulb temperature and wind velocity is presented in Table 4-2.

TABLE 4-2
CHILL TEMPERATURE CHART

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER Maximum danger of false sense of security.				INCREASING DANGER Danger from freezing of exposed flesh within one minute.			GREAT DANGER Flesh may freeze within 30 seconds.				
	Trench foot and immersion foot may occur at any point on this chart.											

[This chart was developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA (Source: ACGIH Threshold Limit Values for Chemical Substances and Physical Agents)].

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of tissue damage associated with frostbite. Frostbite of the extremities can be categorized into:

- *Frost Nip or Incipient Frostbite* - characterized by suddenly blanching or whitening of skin.
- *Superficial Frostbite* - skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- *Deep Frostbite* - tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. It can be fatal. Its symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and 5) death. Trauma sustained in freezing or sub-zero conditions requires special attention because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues in addition to providing for first aid treatment. To avoid cold stress, site personnel must wear protective clothing appropriate for the level of cold and physical activity. In addition to protective clothing, preventive safe work practices, additional training, and warming regimens may be utilized to prevent cold stress.

Safety Precautions for Cold Stress Prevention

- For air temperature of 0°F or less, the hands should be protected by mittens. For exposed skin, continuous exposure should not be permitted when air speed and temperature results in a wind chill temperature of -25°F.
- At air temperatures of 36°F or less, field personnel who become immersed in water or whose clothing becomes wet must be immediately provided with a change of clothing and be treated for hypothermia.

- If work is done at normal temperature or in a hot environment before entering the cold, the field personnel must ensure that their clothing is not wet as a consequence of sweating. If wet, field personnel must change into dry clothes prior to entering the cold area.

- If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work must be modified or suspended until adequate clothing is made available or until weather conditions improve.

- Field personnel handling evaporative liquid (e.g., gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F must take special precaution to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling.

Safe Work Practices

- Direct contact between bare skin and cold surfaces (≤ 20°F) should be avoided. Metal tool handles and/or equipment controls should be covered by thermal insulating material.

- For work performed in a wind chill temperature at or below 10°F, workers should be under constant protective observation (buddy system). The work rate should be established to prevent heavy sweating that will result in wet clothing. For heavy work, rest periods must be taken in heated shelters and workers should be provided with an opportunity to change into dry clothing if needed.

- Field personnel should be provided the opportunity to become accustomed to cold-weather working conditions and required protective clothing.

- Work should be arranged in such a way that sitting or standing still for long periods is minimized.

During the warming regimen (rest period), field personnel should be encouraged to remove outer clothing to permit sweat evaporation or to change into dry work clothing. Dehydration, or loss of body fluids, occurs insidiously in the cold environment and may increase susceptibility to cold injury due to a significant change in blood flow to the extremities. Fluid replacement with warm, sweet drinks and soups is recommended. The intake of coffee should be limited because of diuretic and circulatory effects.

4.4 Biological Hazards

Biological hazards may include poison ivy, snakes, thorny bushes and trees, ticks, mosquitoes, and other pests.

4.4.1 Tick-Borne Diseases

Lyme disease, erlichiosis, and Rocky Mountain Spotted Fever (RMSF) are diseases transmitted by ticks and occur throughout the United States during spring, summer, and fall.

Lyme Disease - The disease commonly occurs in summer and is transmitted by the bite of infected ticks. "Hot spots" in the United States include New York, New Jersey, Pennsylvania, Massachusetts, Connecticut, Rhode Island, Minnesota and Wisconsin. Few cases have been identified in other states.

Erlichiosis - The disease also commonly occurs in summer and is transmitted by the bite of infected ticks. "Hot spots" in the United States include New York, Massachusetts, Connecticut, Rhode Island, Minnesota and Wisconsin. Few cases have been identified in other states.

These diseases are transmitted primarily by the deer tick, which is smaller and redder than the common wood tick. The disease may be transmitted by immature ticks, which are small and hard to see. The tick may be as small as a period on this page.

Symptoms of Lyme disease include a rash or a peculiar red spot, like a bull's eye, which expands outward in a circular manner. The victim may have headache, weakness, fever, a stiff neck, swelling and pain in the joints, and eventually, arthritis. Symptoms of erlichiosis include muscle and joint aches, flu-like symptoms, but there is typically no skin rash.

Rocky Mountain Spotted Fever - This disease is transmitted via the bite of an infected tick. The tick must be attached 4 to 6 hours before the disease-causing organism (*Rickettsia rickettsii*) becomes reactivated and can infect humans. The primary symptom of RMSF is the sudden appearance of a moderate-to-high fever. The fever may persist for two to three weeks. The victim may also have a headache, deep muscle pain, and chills. A rash appears on the hands and feet on about the third day and eventually spreads to all parts of the body. For this reason, RMSF may be confused with measles or meningitis. The disease may cause death, if untreated, but if identified and treated promptly, death is uncommon.

Control - Tick repellant containing diethyltoluamide (DEET) should be used when working in tick-infested areas, and pants legs should be tucked into boots. In addition, workers should search the entire body every three or four hours for attached ticks. Ticks should be removed promptly and carefully without crushing, since crushing can squeeze the disease-causing organism into the skin. A gentle and steady pulling action should be used to avoid leaving the head or mouth parts in the skin. Hands should be protected with surgical gloves when removing ticks.

4.4.2 Poisonous Plants

Poison ivy may be present in the work area. Personnel should be alerted to its presence, and instructed on methods to prevent exposure.

Control - The main control is to avoid contact with the plant, cover arms and hands, and frequently wash potentially exposed skin. Particular attention must be given to avoiding skin contact with objects or protective clothing that have touched the plants. Treat every surface that may have touched the plant as contaminated, and practice contamination avoidance. If skin contact is made, the area should be washed immediately with soap and water, and observed for signs of reddening.

4.4.3 Snakes

The possibility of encountering snakes exists, specifically for personnel working in wooded/vegetated areas. Snake venoms are complex and include proteins, some of which have enzymatic activity. The effects produced by venoms include neurotoxic effects with sensory, motor, cardiac, and respiratory difficulties; cytotoxic effects on red blood cells, blood vessels, heart muscle, kidneys, and lungs; defects in coagulation; and effects from local release of substances by enzymatic actions. Other noticeable effects of venomous snake bites include swelling, edema, and pain around the bite, and the development of ecchymosis (the escape of blood into tissues from ruptured blood vessels).

Control - To minimize the threat of snake bites and insect hazards, all personnel walking through vegetated areas must aware of the potential for encountering snakes, and the need to avoid actions potentiating encounters, such as turning over logs, etc. If a snake bite occurs, an attempt should be made to kill the snake for identification. The victim must be transported to the nearest hospital within 30 minutes; first aid consists of applying a constriction band, and washing the area around the wound to remove any unabsorbed venom.

4.5 Noise

Exposure to noise over the OSHA action level can cause temporary impairment of hearing; prolonged and repeated exposure can cause permanent damage to hearing. The risk and severity of hearing loss increases with the intensity and duration of exposure to noise. In addition to damaging hearing, noise can impair voice communication, thereby increasing the risk of accidents on site.

Control - All personnel must wear hearing protection - with a Noise Reduction Rating (NRR) of at least 20 - when noise levels exceed 85 dBA. When it is difficult to hear a co-worker at normal conversation distance, the noise level is approaching or exceeding 85 dBA, and hearing protection is necessary. All site personnel who may be exposed to noise must also receive baseline and annual audiograms and training as to the causes and prevention of hearing loss. Noise monitoring is discussed in Section 8.

Whenever possible, equipment that does not generate excessive noise levels will be selected for this project. If the use of noisy equipment is unavoidable, barriers or increased distance will be used to minimize worker exposure to noise, if feasible.

4.6 Sanitation

Site sanitation will be maintained according to OSHA and Department of Health requirements.

4.6.1 Break Area

Breaks must be taken in the SZ, away from the active work area after site personnel go through decontamination procedures. There will be no smoking, eating, drinking, or chewing gum or tobacco in the area other than the SZ.

4.7 Electrical Hazards

Electricity may pose a particular hazard to site workers due to the use of portable electrical equipment. If wiring or other electrical work is needed, it must be performed by a qualified electrician.

General electrical safety requirements include:

- All electrical wiring and equipment must be a type listed by UL, Factory Mutual Engineering Corporation (FM), or other recognized testing or listing agency.
- All installations must comply with the National Electrical Safety Code (NESC), the National Electrical Code (NEC), or United States Coast Guard regulations.
- Portable and semi portable tools and equipment must be grounded by a multiconductor cord having an identified grounding conductor and a multi-contact polarized plug-in receptacle.
- Tools protected by an approved system of double insulation, or its equivalent, need not be grounded. Double insulated tools must be distinctly marked and listed by UL or FM.
- Live parts of wiring or equipment must be guarded to prevent persons or objects from touching them.
- Electric wire or flexible cord passing through work areas must be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, projections, or pinching.

- All circuits must be protected from overload.
- Temporary power lines, switch boxes, receptacle boxes, metal cabinets, and enclosures around equipment must be marked to indicate the maximum operating voltage.
- Plugs and receptacles must be kept out of water unless of an approved submersible construction.
- All extension outlets must be equipped with ground fault circuit interrupters (GFCI).
- Attachment plugs or other connectors must be equipped with a cord grip and be constructed to endure rough treatment.
- Extension cords or cables must be inspected prior to each use, and replaced if worn or damaged. Cords and cables must not be fastened with staples, hung from nails, or suspended by bare wire.
- Flexible cords must be used only in continuous lengths without splice, with the exception of molded or vulcanized splices made by a qualified electrician.

4.8 Lifting Hazards

Back strain or injury may be prevented by using proper lifting techniques. The fundamentals of proper lifting include:

- Consider the size, shape, and weight of the object to be lifted. A mechanical lifting device or additional persons must be used to lift an object if it cannot be lifted safely alone.
- The hands and the object should be free of dirt or grease that could prevent a firm grip.
- Gloves must be used, and the object inspected for metal slivers, jagged edges, burrs, or rough or slippery surfaces.
- Fingers must be kept away from points which could crush or pinch them, especially when putting an object down.
- Feet must be placed far enough apart for balance. The footing should be solid and the intended pathway should be clear.
- The load should be kept as low as possible, close to the body with the knees bent.
- To lift the load, grip firmly and lift with the legs, keeping the back as straight as possible.
- A worker should not carry a load that he or she cannot see around or over.
- When putting an object down, the stance and position are identical to that for lifting; the legs are bent at the knees, and the back is straight as the object is lowered.

5. Personal Protective Equipment

PPE is required to safeguard site personnel from various hazards. Varying levels of protection may be required depending on the level of contaminants and the degree of physical hazard. This section presents the various levels of protection and defines the conditions of use for each level.

5.1 Levels of Protection

Protection levels are determined based on contaminants present in the work area. A summary of the levels is presented in this section.

5.1.1 Level D Protection

The minimum level of protection that will be required of BBL personnel and subcontractors at the site will be Level D, which will be worn when site conditions or air monitoring indicates no inhalation hazard exists. The following equipment will be used:

- work clothing as prescribed by weather;
- steel toe work boots, meeting ANSI Z41;
- safety glasses or goggles, meeting ANSI Z87;
- hard hat, meeting ANSI Z89 when falling object hazards are present; and
- hearing protection (if noise levels exceed 85 dBA, then hearing protection with a US EPA NRR of at least 20 dBA must be used).

5.1.2 Modified Level D Protection

Modified Level D will be used when airborne contaminants are not present at levels of concern, but site activities present an increased potential for skin contact with contaminated materials. Modified Level D consists of:

- Polycoated Tyvek® coveralls (or equivalent) when skin/body contact with contaminated media is anticipated;
- safety toe work boots;
- vinyl or latex booties, or PVC overboots when contact with contaminated media is anticipated;
- safety glasses or goggles;
- hard hat;
- face shield in addition to safety glasses or goggles when projectiles pose a hazard;
- nitrile gloves; and
- hearing protection (if necessary).

5.1.3 Level C Protection

Level C protection will be required when the airborne concentration of site contaminants reaches ½ the OSHA PEL or ACGIH TLV. The following equipment will be used for Level C protection:

- MSA UltraTwin full-face, air purifying respirator with GMC-H cartridges, or equivalent.
- polyethylene coated Tyvek® suit, ankles and cuffs taped to boots and gloves;
- nitrile gloves over nitrile sample gloves;
- safety toe work boots, ANSI approved;
- chemical resistant Neoprene boots with steel toes; or latex/PVC booties over safety toe shoes;
- hard hat, ANSI approved; and
- hearing protection (if necessary).

5.1.4 Level B Protection

Specific levels of protection will be changed whenever site conditions change. They can either be increased to the next higher level or decreased to the next lower level. The SS can request a change in levels of protection by contacting the HSO. If the need arises to protect employees, the SHSC can upgrade protection levels without input from the HSO. will then discuss the decision with the HSO and PM when they are available. Levels of protection will not be downgraded without prior approval from the HSO.

The level of protection required during drum sampling and recovery is Level B. Level B personnel protective equipment will consist of:

- Neoprene steel-toed boots, or equivalent;
- Positive Pressure airline respirator with 5-minute egress bottle;
- Hard hat;
- Neoprene gloves (outer);
- Nitrile gloves (inner);
- Saranex suit or equivalent;
- Duct tape openings (ankles, wrists, and respirators); and
- Hearing protection (if necessary).

5.1.5 Selection of PPE

Equipment for personal protection will be selected based on the potential for contact, site conditions, ambient air quality, and the judgment of supervising site personnel and HS professionals. The PPE used will be chosen to be effective against the compound(s) present on the site.

5.2 Site Respiratory Protection Program

Respiratory protection is an integral part of employee health and safety at the site due to the potential for airborne contaminants.

The site respiratory protection program will consist of the following:

- All site personnel who may use respiratory protection will have an assigned respirator.
- All site personnel who may use respiratory protection will have been fit tested and trained in the use of a full-face air purifying respirator within the past 12 months.
- All site personnel who may use respiratory protection must within the past year have been medically certified as being capable of wearing a respirator. Documentation of the medical certification must be provided to the HSS, prior to commencement of site work.
- Only cleaned, maintained, NIOSH/MSHA-approved respirators are to be used on this site.
- If respirators are used, the respirator cartridge is to be properly disposed of at the end of each work shift, or when load-up or breakthrough occurs.
- Contact lenses are not to be worn when a respirator is worn.
- All site personnel who may use respiratory protection must be clean-shaven. Mustaches and sideburns are permitted, but they must not touch the sealing surface of the respirator.
- Respirators will be inspected, and a negative pressure test performed prior to each use.
- After each use, the respirator will be wiped with a disinfectant, cleansing wipe. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag, away from direct sunlight in a clean, dry location, in a manner that will not distort the face piece.

5.3 Using PPE

Depending upon the level of protection selected, specific donning and doffing procedures may be required. The procedures presented in this section are mandatory if Level C or B PPE is used.

All people entering the EZ must put on the required PPE in accordance with the requirements of this plan. When leaving the EZ, PPE will be removed in accordance with the procedures listed, to minimize the spread of contamination.

5.3.1 Donning Procedures

These procedures are mandatory only if Level C or B PPE is used on the project:

- remove bulky outerwear. Remove street clothes and store in clean location;
- put on work clothes or coveralls;
- put on the required chemical protective coveralls or rain gear;
- put on the required chemical protective boots or boot covers;
- tape the legs of the coveralls to the boots with duct tape;

- put on the required chemical protective gloves;
- tape the wrists of the protective coveralls to the gloves;
- don the required respirator and perform appropriate fit check;
- put hood or head covering over head and respirator straps and tape hood to facepiece; and
- don remaining PPE, such as safety glasses or goggles and hard hat.

When these procedures are instituted, one person must remain outside the work area to ensure that each person entering has the proper protective equipment.

5.3.2 Doffing Procedures

The following procedures are only mandatory if Level C or B PPE is required for this project. Whenever a person leaves a Level C or B work site, the following decontamination sequence will be followed:

- upon entering the CRZ, rinse contaminated materials from the boots or remove contaminated boot covers;
- clean reusable protective equipment;
- remove protective garments, equipment, and respirator. All disposable clothing should be placed in plastic bags, which are labeled with contaminated waste labels;
- wash hands, face and neck or shower (if necessary);
- proceed to clean area and dress in clean clothing; and
- clean and disinfect respirator for next use.

All disposable equipment, garments, and PPE must be bagged in plastic bags, labeled for disposal. See Section 7 for detailed information on decontamination stations.

5.4 Selection Matrix

The level of personal protection selected will be based upon real-time air monitoring of the work environment and an assessment by the SS of the potential for skin contact with contaminated materials. The PPE selection matrix is given in Table 5-1. This matrix is based on information available at the time this plan was written. The Airborne Contaminant Action Levels in Table 8-1 should be used to verify that the PPE prescribed in this matrix is appropriate.

TABLE 5-1
PPE SELECTION MATRIX

Task	Anticipated Level of Protection
Site set up, support zone work,	Level D
Site clearing and grubbing	Level D/Modified Level D
Drum sampling and removal	Level B
Moving a drum after over-packing	Modified Level D
Excavation activities in Mound B	Level B
Dump truck drivers in EZ	Level C
Removing refuse during shoreline restoration	Level C
Placing rip-rap or clean fill at shoreline	Modifield Level D
Mound B Cap Restoration/Re-augmentation	Modified Level D
Mound B Cover System Restoration	Level D/Modified Level D
CRZ workers, equipment decontamination	Modified Level D/Level C

6. Site Control

6.1 Authorization to Enter

All personnel who are potentially exposed to hazardous substances must have completed hazardous waste operations initial training as defined under OSHA Regulation 29 CFR 1910.120, have completed their training or refresher training within the past 12 months, and have been certified by a physician as fit for hazardous waste operations in order to enter a site area designated as an EZ or CRZ. Personnel without such training or medical certification may enter the designated SZ only. The SS will maintain a list of authorized persons; only personnel on the authorized persons list will be allowed within the EZ or CRZ.

6.2 Site Orientation and Hazard Briefing

No person will be allowed in the general work area during site operations without first being given a site orientation and hazard briefing. This orientation will be presented by the HSS, and will consist of a review of this HASP. This review must cover the chemical, physical, and biological hazards, protective equipment, safe work procedures, and emergency procedures for the project. In addition to this meeting, Daily Safety Meetings will be held each day before work begins.

All people on the site, including visitors, must document their attendance to this briefing as well as the Daily Safety Meetings on the forms included with this plan.

6.3 Certification Documents

A training and medical file may be established for the project and kept on site during all site operations. The 24 or 40-hour training, update, and specialty training [first-aid/cardiopulmonary resuscitation (CPR)] certificates, as well as current medical clearance for all project field personnel, will be maintained within that file. All BBL and subcontractor personnel must provide their training and medical documentation to the HSS prior to the start of field work.

6.4 Entry Log

A log-in/log-out sheet will be maintained at the site by the SS. Personnel must sign in and out on a log sheet as they enter and leave the CRZ, and the SS may document entry and exit in the field notebook.

6.5 Entry Requirements

In addition to the authorization, hazard briefing and certification requirements listed above, no person will be allowed on any BBL field site unless he or she is wearing the minimum SZ PPE as described in Section 5. Personnel entering the EZ or CRZ must wear the required PPE for those locations.

6.6 Emergency Entry and Exit

People who must enter the site on an emergency basis will be briefed of the hazards by the SS. All hazardous activities will cease in the event of an emergency and any sources of emissions will be controlled, if possible.

People exiting the site because of an emergency will gather in a safe area for a head count. The SS is responsible for ensuring that all people who entered the work area have exited in the event of an emergency.

6.7 Contamination Control Zones

Contamination control zones are maintained to prevent the spread of contamination and to prevent unauthorized people from entering hazardous areas.

6.7.1 Exclusion Zone

The EZ consists of the specific work area, or may be the entire area of suspected contamination. All employees entering the EZ must use the required PPE, and must have the appropriate training and medical clearance for hazardous waste work. The EZ is the defined area where there is a possible respiratory and/or contact health hazard. The location of each exclusion zone will be identified by cones, caution tape, or other appropriate means.

6.7.2 Contamination Reduction Zone

The CRZ or transition area will be established, if necessary, to perform decontamination of personnel and equipment. All personnel entering or leaving the EZ will pass through this area to prevent any cross-contamination. Tools, equipment, and machinery will be decontaminated in a specific location. The decontamination of all personnel will be performed on site adjacent to the EZ. Personal protective outer garments and respiratory protection will be removed in the CRZ and prepared for cleaning or disposal. This zone is the only appropriate corridor between the EZ and the SZ.

6.7.3 Support Zone

The SZ is a clean area outside the CRZ located to prevent employee exposure to hazardous substances. Eating and drinking will be permitted in the support area only after proper decontamination. Smoking may be permitted in the SZ, subject to site requirements.

6.7.4 Posting

The EZ, CRZ, and SZ will be prominently marked and delineated using cones, caution tape, or other suitable means.

6.8 Site Inspections

The site supervisor will conduct a daily inspection of site activities, equipment, and zone set up to verify that the required elements are in place. The inspection form in Appendix G may be used as a guide for daily inspections. The form must be completed weekly, and forwarded to the HSS and PM for review.

7. Decontamination

7.1 Personnel Decontamination

All personnel wearing Modified Level D or Level C protective equipment in the contaminated zone must undergo personal decontamination prior to entering the SZ. The personnel decontamination area will consist of the following stations.

Station 1: Personnel leaving the contaminated zone will remove the gross contamination from their outer clothing and boots.

Station 2: Personnel will remove their outer garment and gloves and deposit them in the lined waste receptacles. Personnel will then decontaminate their hard hats, and boots with an aqueous solution of detergent or other appropriate cleaning solution. These items are then hand carried to the next station.

Station 3: Personnel will thoroughly wash their hands and face before leaving the decontamination zone. Respirators will be sanitized and then placed in a clean plastic ziplock bag.

7.2 Equipment Decontamination

All vehicles that have entered the contaminated zone will be decontaminated at the decontamination pad prior to leaving the zone. If the level of vehicle contamination is low, decontamination may be limited to rinsing of tires and wheel wells with water. If the vehicle is significantly contaminated, steam cleaning or pressure washing of vehicles and equipment may be required.

7.3 Personal Protective Equipment Decontamination

Where and whenever possible, single use, external protective clothing must be used for work within the EZ or CRZ. This protective clothing must be disposed of in properly labeled containers.

Reusable protective clothing will be rinsed at the site with detergent and water. The rinsate will be collected for disposal.

When removed from the CRZ, the respirator will be thoroughly cleaned with soap and water. The respirator face piece, straps, valves and covers must be thoroughly cleaned at the end of each work shift, and ready for use prior to the next shift. Respirator parts may be disinfected with a solution of bleach and water, or by using a spray disinfectant.

8. Site Monitoring

8.1 Personal Air Monitoring

Air monitoring will be conducted by BBL or a sub-contractor in order to evaluate airborne constituent levels. The monitoring devices to be used will be a combustible gas/oxygen (LEL/O_2) meter and hydrogen sulfide/carbon monoxide monitor, Miniram dust/particular meter (or equivalent), a flame ionozation detector (FID), and a radiation survey meter. The radiation survey meter (which detects alpha, beta, and gamma radiation) will be used to screen any drums removed from the excavation and to monitor ambient levels of radiation. A photoionization detector (PID) may also be employed for air monitoring if field personnel believe that methane is a significant component of any VOC's detected in the ambient air.

Air monitoring for radiation, flammable vapors, hydrogen sulfide, carbon monoxide, and total organic vapors will be conducted continuously during excavation activities. Carbon monoxide must be monitored for in any area where internal combustion engines are utilized in or near excavations and the enclosed areas. Monitoring for organic vapors and total dust/particulate for the purpose of estimating worker exposure level will be conducted in the breathing zone with the FID or particulate meter during field activities (i.e. excavation, materials handling, debris removal) with the potential for organic vapor, hydrogen sulfide, and dust generation. At a minimum readings will be recorded at least hourly or more frequently as determined by the HSS. Air monitoring data must be recorded on an air monitoring log (Appendix D) or in the field notebook by the HSS.

All work activity must stop where tests indicate the concentration of flammable vapors exceeds 10% of the Lower Explosive limit (LEL) at a location with a potential ignition source. Such an area must be ventilated to reduce the concentration to an acceptable level.

BBL must coordinate with the removal contractor to review air monitoring results on a continuous basis. The BBL HSS will be responsible for utilizing the air monitoring results to determine appropriate health and safety precautions for BBL personnel.

8.1.1 Area Air Monitoring

Area air monitoring will also be conducted downwind and at the Decontamination/Support Zone area. It will consist of a particulate meter (with a data log function), and an FID with a data log function. A photoionization detector (PID) may also be employed for air monitoring if field personnel believe that methane is a significant component of any VOC's detected in the ambient air.

8.2 Noise Monitoring

Noise monitoring may be conducted as required. Hearing protection is mandatory for all employees in noise hazardous areas, such as around heavy equipment. As a general rule, sound levels that cause speech interference at normal conversation distance should require the use of hearing protection.

8.3 Monitoring Equipment Maintenance and Calibration

All direct-reading instrumentation calibrations should be conducted under the approximate environmental conditions the instrument will be used. Instruments must be calibrated before and after use, noting the reading(s) and any adjustments which are necessary. All air monitoring equipment calibrations, including the standard used for calibration, must be documented on a calibration log or in the field notebook. All completed HS documentation/forms must be reviewed by the HSS and maintained by the SS.

All air monitoring equipment will be maintained and calibrated in accordance with the specific manufacturers' procedures. Preventive maintenance and repairs will be conducted in accordance with the respective manufacturers' procedures. When applicable, only manufacturer-trained and/or authorized personnel will be allowed to perform instrument repairs or preventive maintenance.

If an instrument is found to be inoperative or suspected of giving erroneous readings, the HSS must be responsible for immediately removing the instrument from service and obtaining a replacement unit. If the instrument is essential for safe operation during a specific activity, that activity must cease until an appropriate replacement unit is obtained. The HSS will be responsible for ensuring a replacement unit is obtained and/or repairs are initiated on the defective equipment.

8.3.1 Action Levels

Table 8-1 presents airborne contaminant action levels that will be used to determine the procedures and protective equipment necessary based on conditions as measured at the site. Note that all drum excavation and sampling activities will be in Level B.

TABLE 8-1
AIRBORNE CONTAMINANT ACTION LEVELS

Parameter	Reading	Action
Total Hydrocarbons (non-methane)	0 ppm to ≤ 1 ppm	Normal operations; continue hourly breathing zone monitoring
	> 1 ppm to 5 ppm	Upgrade to Level C; increase monitoring frequency to every 15 minutes
	≥ 5 ppm	Upgrade to Level B
Airborne Particulates (while excavating drums or refuse)	0 to 0.1 mg/m^3	Normal operations
	> 0.1 mg/m^3	Initiate wetting of work area to control dust; upgrade to Level C if dust control measures do not control dust within 15 minutes. Initiate work area perimeter monitoring.
Airborne Particulates (while handling non-contaminated clay material, rip/rap)	0 to 1 mg/m^3	Normal operations
	> 1 mg/m^3	Initiate wetting of work area to control dust; upgrade to Level C if dust control measures do not control dust within 15 minutes. Initiate work area perimeter monitoring.
Radiation	<1 millirems/hr	Continue operations, continue to screen trench and each container.
	>1 millirem/hr	Stop work. Move all personnel 25 feet away from container or area. Call HSS.
Carbon monoxide	0-25 ppm	Normal operations
	>25 ppm	Stop work; ventilate area; re-sample

Hydrogen sulfide	0 to 10 ppm >10ppm	Normal operations Stop work; ventilate area; re-sample
Oxygen	19.5%-23.5% <19.5% or >23.5%	Normal operations Stop work; ventilate area; investigate source of readings.
Flammable Vapors (LEL)	< 10% LEL ≥ 10% LEL	Normal operations Stop work; ventilate area; investigate source of vapors

8.4 Personal Air Sampling

If VOC levels in ambient air are consistently greater than 1 ppm, integrated personal time-weighted average air sampling may be conducted. At a minimum colourmetric tubes for benzene will be collected when VOC levels exceed 1 ppm. Integrated personal time weighted average air sampling may be conducted for benzene, xylene, toluene, and ethylbenzene if ambient concentrations exceed 1 ppm.

Integrated personal time weighted average air sampling will also be conducted if airborne particulate levels consistently exceed 0.50 mg/m^3 for 8 hours. These samples will be analyzed for Nickel, Cadmium, Copper, Arsenic, Lead, Mercury, Chromium, and Zinc.

9. Employee Training

9.1 General

All on-site project personnel who work in areas where they may be exposed to site contaminants must be trained as required by OSHA Regulation 29 CFR 1910.120. Such field employees also receive a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. Personnel who completed their training more than 12 months prior to the start of the project must have completed an 8-hour refresher course within the past 12 months. The BBL SS must have completed an additional 8 hours of training for supervisors, and must have a current first-aid/CPR certificate.

9.2 Basic 40-Hour Course

The following is a list of the topics typically covered in a 40-hour training course:

- general safety procedures;
- physical hazards (fall protection, noise, heat stress, cold stress);
- names and job descriptions of key personnel responsible for site HS;
- safety, health, and other hazards typically present at hazardous waste sites;
- use, application and limitations of PPE;
- work practices by which employees can minimize risks from hazards;
- safe use of engineering controls and equipment on site;
- medical surveillance requirements;
- recognition of symptoms and signs which might indicate overexposure to hazards;
- worker right-to-know (Hazard Communication OSHA 1910.1200);
- routes of exposure to contaminants;
- engineering controls and safe work practices;
- components of a site HS program and HASP;
- decontamination practices for personnel and equipment;
- confined-space entry procedures; and
- general emergency response procedures.

9.3 Supervisor Course

Management and supervisors receive an additional eight hours of training which typically includes:

- general site safety and health procedures;
- PPE programs; and
- air monitoring techniques.

9.4 Site-Specific Training

Site-specific training will be accomplished by each site worker reading this HASP, or through a site briefing by the PM, SS, or HSS on the contents of this HASP before work begins. The review must include a discussion of the chemical, physical, and biological hazards, the protective equipment and safety procedures, and emergency procedures.

9.5 Daily Safety Meetings

Daily Safety Meetings will be held to cover the work to be accomplished, the hazards anticipated, the protective clothing and procedures required to minimize site hazards, and emergency procedures. These meetings should be presented by the SS or HSS prior to beginning the day's field work. No work will be performed in an EZ before the Daily Safety Meeting has been held. The Daily Safety Meeting must also be held prior to new tasks, and repeated if new hazards are encountered. The Daily Safety Meeting Log is included in Appendix C.

9.6 First Aid and CPR

At least two employees current in first aid/CPR will be assigned to the work crew and will be on the site during operations. Refresher training in first aid (triennially) and CPR (annually) is required to keep the certificate current. These individuals must also receive training regarding the precautions and protective equipment necessary to protect against exposure to blood-borne pathogens.

10. Medical Surveillance

10.1 Medical Examination

All personnel who are potentially exposed to site contaminants must participate in a medical surveillance program as defined by OSHA at 29 CFR 1910.120 (f).

10.1.1 Preplacement Medical Examination

All potentially exposed personnel must have completed a comprehensive medical examination prior to assignment, and periodically thereafter as defined by applicable OSHA Regulations. The preplacement and periodic medical examinations typically include the following elements:

- medical and occupational history questionnaire;
- physical examination;
- complete blood count, with differential;
- liver enzyme profile;
- chest X-ray, at a frequency determined by the physician;
- pulmonary function test;
- audiogram;
- electrocardiogram for persons older than 45 years of age, or if indicated during the physical examination;
- drug and alcohol screening, as required by job assignment;
- visual acuity; and
- follow-up examinations, at the discretion of the examining physician or the corporate medical director.

The examining physician provides the employee with a letter summarizing his findings and recommendations, confirming the worker's fitness for work and ability to wear a respirator. Documentation of medical clearance will be available for each employee during all project site work.

Subcontractors will certify that all their employees have successfully completed a physical examination by a qualified physician. The physical examinations must meet the requirements of 29 CFR 1910.120 and 29 CFR 1910.134. Subcontractors will supply copies of the medical examination certificate for each on-site employee.

10.1.2 Other Medical Examination

In addition to pre-employment, annual, and exit physicals, personnel may be examined:

- at employee request after known or suspected exposure to toxic or hazardous materials;
- at the discretion of the client, HS professional, or occupational physician in anticipation of, or after known or suspected exposure to toxic or hazardous materials; and

- at the discretion of the occupational physician.

10.1.3 Periodic Exam

Following the placement examination, all employees must undergo a periodic examination, similar in scope to the placement examination. For employees potentially exposed over 30 days per year, the frequency of periodic examinations will be annual. For employees potentially exposed less than 30 days per year, the frequency for periodic examinations will be 18 months.

10.2 Medical Restriction

When the examining physician identifies a need to restrict work activity, the employee's supervisor must communicate the restriction to the employee and the HSS. The terms of the restriction will be discussed with the employee and the supervisor.

11. Emergency Procedures

11.1 General

Prior to the start of operations, the work area will be evaluated for the potential for fire, contaminant release, or other catastrophic event. Unusual conditions or events, activities, chemicals, and conditions will be reported to the SS/HSS immediately.

The SS/HSS will establish evacuation routes and assembly areas for the site. All personnel entering the site will be informed of this route and the assembly area.

11.2 Emergency Response

If an incident occurs, the following steps will be taken:

- the SS/HSS will evaluate the incident and assess the need for assistance and/or evacuation;
- the SS/HSS will call for outside assistance as needed;
- the SS/HSS will ensure the PM is notified promptly of the incident; and
- the SS/HSS will take appropriate measures to stabilize the incident scene.

11.2.1 Fire

In the case of a fire on the site, the SS/HSS will assess the situation and direct fire-fighting activities. The SS/HSS will ensure that the client site representative (as appropriate) is immediately notified of any fires. Site personnel will attempt to extinguish the fire with available extinguishers, if safe to do so. In the event of a fire that site personnel are unable to safely extinguish, the local fire department will be summoned.

11.2.2 Contaminant Release

In the event of a contaminant release, the following steps will be taken:

- notify SS/HSS immediately;
- evacuate immediate area of release;
- conduct air monitoring to determine needed level of PPE; and
- don required level of PPE and prepare to implement control procedures.

The SS/HSS has the authority to commit resources as needed to contain and control released material and to prevent its spread to off-site areas.

11.2.2.1 Spill or Leak Response

If a spill or material release to the air, soil or water at the site is noted, information regarding the spill will be relayed to the SHSC. The following actions shall be taken:

- All operations on site will cease except those necessary for spill response;

- A site worker notifies the HSS/SS;
- The HSS/SS shall notify the PM;
- Isolate the spill area;
- Set up boundaries around discharge area;
- Evacuate low-lying areas;
- Keep people away who are not involved in spill response, and deny entry to unauthorized personnel;
- Set up command post upwind of spill area;
- Avoid contact with spill material;
- All spill response activities will be directed by the SHSC; and
- If appropriate, use noncombustible material (i.e., sand, soil, water) to suppress gasses and vapors.

Hazards will be identified based on available information from witnesses and/or available documents (placards, MSDSs, logs). Observations will be made to evaluate and identify hazards and to determine the proper personal protection levels, methods and equipment necessary for response.

- The spill or release area will be approached cautiously while performing real-time air monitoring.
- Attempts to contain the spill will initially be made without entering the immediate hazard area.
- Site entry will be made with emergency response personnel, the personal protective equipment, control methods, and equipment necessary to perform the work. Hazardous spill containment and collection will be performed in four steps as follows:
    - Containment of the spill: With absorbent socks, granules and/or construction of temporary dikes
    - Control at the source: By plugging leaks, up righting containers, overpacking containers, pumping out a leaking container
    - Collection of liquid and/or sludge spills: Absorb with sand, clean fill, or other noncombustible absorbent material
    - Collection of the solid spill material: Remove and place with shovels or heavy equipment as necessary into 55-gallon polyethylene drums
    - Storage of the spill material: After an emergency involving cleanup of released materials, the stored materials will be temporarily held on site
    - Disposal of spill materials and decontamination residues: Treatment and/or disposal options of the material will depend on the amount of and type of material. These options will be discussed with the PM and the appropriate action taken.

11.3 Medical Emergency

All employee injuries must be promptly reported to the HSS/SS, who will:

- ensure that the injured employee receives prompt first aid and medical attention;
- in emergency situations, the worker is to be transported by appropriate means to the nearest urgent care facility (normally a hospital emergency room); and
- Notify Continuum Healthcare, BBL's medical surveillance consultant, as soon as possible after an injured BBL worker has left the site. The caller should dial 1-800-229-3674 and follow the instructions for reaching the Injury Management office. When the Case Manager answers, the caller should provide the information requested by the Case Manager.

11.3.1 First Aid - General

All persons must report any near-miss incident, accident, injury, or illness to their immediate supervisor or the SS. First aid will be provided by trained personnel. Injuries and illnesses requiring medical treatment must be documented. The SS must conduct an accident investigation as soon as emergency conditions no longer exist and first-aid and/or medical treatment has been ensured. These two reports must be completed and submitted to the PM within 24 hours after the incident.

If first-aid treatment is required, first aid kits are kept at the CRZ. If treatment beyond first aid is required, the injured should be transported to the medical facility. If the injured is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedics should be summoned. If there is any doubt as to the injured worker's condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

- *Survey the scene.* Determine if it is safe to proceed. Try to determine if the conditions which caused the incident are still a threat. Protect yourself from exposure before attempting to rescue the victim.
- *Do a primary survey of the victim.* Check for airway obstruction, breathing, and pulse. Assess likely routes of chemical exposure by examining the eyes, mouth, nose, and skin of the victim for symptoms.
- *Phone Emergency Medical Services (EMS).* Give the location, telephone number used, caller's name, what happened, number of victims, victims' condition, and help being given.
- *Maintain airway and perform rescue breathing* as necessary.
- *Perform cardiopulmonary resuscitation (CPR)* as necessary.
- *Do a secondary survey of the victim.* Check vital signs and do a head-to-toe exam.
- *Treat other conditions as necessary.* If the victim can be moved, take the victim to a location away from the work area where EMS can gain access.

11.3.2 First Aid - Inhalation

Any employee complaining of symptoms of chemical overexposure as described in Section 3 will be removed from the work area and transported to the designated medical facility for examination and treatment.

11.3.3 First Aid - Ingestion

Call EMS and consult a poison control center for advice. If available, refer to the MSDS for treatment information, if recommended. If unconscious, keep the victim on their side and clear the airway if vomiting occurs.

11.3.4 First Aid - Skin Contact

Project personnel who have had skin contact with contaminants will, unless the contact is severe, proceed through the decontamination zone, to the wash-up area. Personnel will remove any contaminated clothing, and then flush the affected area with water for at least 15 minutes. The worker should be transported to the medical facility if he shows any sign of skin reddening, irritation, or if he requests a medical examination.

11.3.5 First Aid - Eye Contact

Project personnel who have had contaminants splashed in their eyes or who have experienced eye irritation while in the contaminated zone, must immediately proceed to the eyewash station, set up in the decontamination zone. Do not decontaminate prior to using the eyewash. Remove whatever protective clothing is necessary to use the eyewash. Flush the eye with clean running water for at least 15 minutes. Arrange prompt transport to the designated medical facility.

11.4 Reporting Injuries and Illnesses and Near Miss Incidents

Injuries and illnesses, however minor, will be reported to the SS immediately. The SS will complete an injury report and submit it to the HSO and the PM within 24 hours.

Near miss incidents are situations in which no injury or property damage occurred, but under slightly different circumstances an injury or property damage could have occurred. Near misses are caused by the same factors as injuries, therefore they must be reported and investigated in the same manner. All near miss situations must be reported to the HSO within two days of the occurrence. A Safe performance Self Assessment (SPSA) must be done immediately after a near miss or an injury to determine if it is safe to proceed with the work.

11.5 Spill and Release Control

Due to the nature of the field activities to be performed, spills of hazardous liquids or releases of hazardous gasses to the atmosphere are possible. The following measures will be taken to minimize this possibility:

- Site controls will be in place so that only authorized personnel have access to work areas.
- Site personnel will be advised of appropriate spill and release control measures.
- Appropriate containment and secondary containment structures will be used for facilities involved with storage and transfer of hazardous materials and wastes on site.

- Air monitoring will be performed during response activities to identify potential contaminant migration.

During the course of daily operations, incidental minor leaks or drips may occur during drum or materials handling. Spill control materials will be stationed inside the EZ to facilitate access. Portable spill kits will be located in the Support Zone.

11.5.1 Spill Response Control Materials and Equipment

BBL will mobilize the following equipment and materials to the site for use during spill response activities. No drum handling will occur until this equipment is present.

- Absorbent pillows and pads;
- Granular absorbent material (noncombustible);
- Polyethylene sheeting;
- 85-gallon overpack drums for collection of spill materials;
- 55-gallon recovery drums for collection of spill materials;
- Shovels, other hand tools, and scrub brushes;
- Solutions, (detergent and water) for decontamination of personnel;
- Decontamination facility and high pressure washer for equipment; and
- Front-end loader or skid steer loader.

11.5.2 Spill or Leak Response

If a spill or material release to the air, soil or water at the site is noted, information regarding the spill will be relayed to the SHSC. The following actions shall be taken:

- All operations on site will cease except those necessary for spill response
- A site worker notifies the SHSC
- The SHSC shall notify the PM
- Isolate the spill area
- Set up boundaries around discharge area
- Evacuate low-lying areas
- Keep people away who are not involved in spill response, and deny entry to unauthorized personnel

- Set up command post upwind of spill area
- Avoid contact with spill material
- All spill response activities will be directed by the SHSC
- If appropriate, use noncombustible material (i.e., sand, soil, water) to suppress gasses and vapors
- Hazards will be identified based on available information from witnesses and/or available documents (placards, MSDSs, logs). Observations will be made to evaluate and identify hazards and to determine the proper personal protection levels, methods and equipment necessary for response.
- The spill or release area will be approached cautiously while performing real-time air monitoring
- Attempts to contain the spill will initially be made without entering the immediate hazard area
- Site entry will be made with emergency response personnel, the personal protective equipment, control methods, and equipment necessary to perform the work. Hazardous spill containment and collection will be performed in four steps as follows:
  - Containment of the spill: With absorbent socks, granules and/or construction of temporary dikes
  - Control at the source: By plugging leaks, up righting containers, overpacking containers, pumping out a leaking container
  - Collection of liquid and/or sludge spills: Absorb with sand, clean fill, or other noncombustible absorbent material
  - Collection of the solid spill material: Remove and place with shovels or heavy equipment as necessary into 55-gallon polyethylene drums
  - Storage of the spill material: After an emergency involving cleanup of released materials, the stored materials will be temporarily held on site
  - Disposal of spill materials and decontamination residues: Treatment and/or disposal options of the material will depend on the amount of and type of material. These options will be discussed with the PM and the appropriate action taken.

11.6 Emergency Information

The means to summon local public response agencies such as police, fire, and ambulance will be reviewed in the Daily Safety Meeting. These agencies are identified in the following table.

TABLE 11-1
EMERGENCY CONTACTS

Agency/Contact	Telephone Number
Police Department: Edison, NJ	911

Fire Department: Edison, NJ	911
Ambulance: Edison, NJ	911
Hospital: Robert Wood Johnson, New Brunswick, NJ	911
PROJECT EMERGENCY CONTACTS	
NJ Department of Environmental Protection	
Chemical Transportation Emergency Center (Chemtrec)	800-424-9300
USEPA Regional Office	
Emergency Client Contact	(800) 424-8802
BBL Project Manger- Kris Hallinger	(609) 860-0590

Directions to Hospital: Will be verified by the HSS at the beginning of the project.

11.7 Site Communication

Whenever possible, site personnel will remain in visual and verbal contact with one another at all times. The buddy system will be employed in accordance with Section 4.1.1. Universal hand signals will be used to communicate when personnel will be out of verbal contact but not visual contact. Universal hand signals are as follows:

Hand Signal	Meaning
Grip partners wrist or both hands around	Leave area immediately
Hands on top of head	Need help, emergency
Hand gripping throat	Cannot breath, respirator difficulties
Thumbs down	No, negative

At least one portable cellular phone will be available on site for emergencies. If personnel must be out of visual range from the other personnel for more than 10 minutes, radios will be used to maintain communication.

APPENDIX A
MATERIAL SAFETY DATA SHEETS

Genium Publishing Corp.
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Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Mercury
Chemical Formula: Hg
CAS No.: 7439-97-6
Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver
Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.
General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL
Ceiling: 0.1mg/m^3 (vapor and inorganic Hg)
8-hr TWA: 0.05 mg/m^3 (vapor), skin; (Vacated 1989 Final Rule Limit)

ACGIH TLVs
TWA: 0.025 mg/m^3 (inorganic compounds), skin

NIOSH REL
10-hr TWA: 0.05 mg/m^3 (vapor), skin

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m^3)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 ppm (1 mg/m^3), 30 min. average value, 1/shift

IDLH Level
28 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Wilson Risk Scale
R 1
I 4
S 2*
K 1
*Skin absorption

HMIS
H 4*
F 0
R 0
*Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.
Acute Effects
Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonitis. Acrodynia (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still *infrequently* seen in workers.
Eye: Irritation and corrosion.
Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.
Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the blood stream with subsequent mercury poisoning is possible.
Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. paresthesia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and hallucinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine cessation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular muscles may be damaged. This syndrome has been termed *Asthenic-Vegetative Syndrome* or *Micromercurialism.* Chronic symptoms occur increasingly with exposures to 0.1 mg/m^3 or higher. *Mutation:* Aneuploidy and other chromosomal aberrations

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have been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. *Reproductive:* Mercury has been detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed (occupationally) to mercury levels as high as 44 mg/m^3, all suffered impaired sexual function. Repeated skin contact may cause allergic dermatitis in some individuals.

NOTE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water and then wash exposed area with soap. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. In general, mercury will pass through the digestive tract uneventfully.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI: *blood* (15 µg/L), *urine*: (35 µg/g creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are indicative of polyneuropathy. 0.4 to 22 µg/L is reported to be the human lethal blood level. Obtain urinalysis including at a minimum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid as chelators. *Do not* use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures

Genium

Flash Point: Nonflammable

Autoignition Temperature: Nonflammable

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use agents suitable for surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic mercury vapor and mercuric oxide.

Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.

Small and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a mercury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a surface coating of mercury sulfide which will reduce mercury vapor dispersion into the air.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when working with mercury. *Do not* use on porous work surfaces (wood, unsealed concrete, etc.) to prevent spills from lodging in cracks.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with most metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion into work area.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103]

Administrative Controls: Consider pre-placement and periodic medical exams of exposed workers with emphasis on the skin, eyes, central nervous system, liver, and kidneys.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 0.5 mg/m^3, use any chemical cartridge respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For ≤ 1.25 mg/m^3, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For ≤ 2.5 mg/m^3, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical

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cartridges providing protection against mercury, and equipped with an ESLI. For ≤28 mg/m^3, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and operated in pressure-demand or other positive pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid metal
Appearance and Odor: Silvery-white, odorless
Vapor Pressure: 0.0018 mm Hg at 77 F (25 C)
Formula Weight: 200.59
Density (H_2O=1): 13.534 g/cm^3 at 77 F (25 C)
Boiling Point: 674.09 F (356.72 C)
Freezing Point: -37.97 F (-38.87 C)
Viscosity: 15.5 mP at 77 F (25 C)
Electrical Resistivity: 95.76 µohm at 68 F (20 C)
Water Solubility: 0.28 µmol/L at 77 F (25 C)
Other Solubilities: Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.
Surface Tension: 484 dyne/cm at 77 F (25 C)
Critical Temperature: 2664 F (1462 C)
Critical Pressure: 1587 atm

Section 10 - Stability and Reactivity

Stability: Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylsilane + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylenic compounds (explosive), ammonia (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

Conditions to Avoid: Exposure to high temperatures, metal surfaces or incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of mercury can produce mercuric oxide.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive:
Rat, inhalation: 890 ng/m^3/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

Acute Dermal Toxicity:
Man, skin, TD_{Lo}: 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

Acute Oral Toxicity:
Man, oral, TD_{Lo}: 43 mg/kg caused tremor and jaundice or other liver changes.

Acute Inhalation Effects:
Woman, inhalation, TC_{Lo}: 150 µg/m^3/46 days caused anorexia, diarrhea, and wakefulness.
Man, inhalation, TC_{Lo}: 44300 µg/m^3/8 hr caused muscle weakness, liver changes, and increased body temperature.

Chronic Effects:
Rat, inhalation: 1 mg/m^3/ 24 hr for 5 continuous weeks caused proteinuria.

* See NIOSH, *RTECS* (OV4550000), for additional toxicity data.

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Section 12 - Ecological Information

Ecotoxicity: Catfish, LC_{50} = 0.35 mg/L/96 hr; mollusk (*Modiolus carvalhoi*), LC_{50} = 0.19 ppm/96 hr: tadpole (*Rana exadactyla*), LC_{50} = 0.051 ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

Environmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can be transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and revolatilized several times.

Section 13 - Disposal Considerations

Disposal: Incineration is *not* an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium borohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using *Pseudomonas putida*, has also been suggested. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Mercury
Shipping Symbols: A, W
Hazard Class: 8
ID No.: UN2809
Packing Group: III
Label: Corrosive
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: 173.164
b) Non-bulk Packaging: 173.164
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 35 kg
b) Cargo Aircraft Only: 35 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40, 97

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U151
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1, 2
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

Prepared By ..... M Gannon, BA
Industrial Hygiene Review ..... RE Langford, PhD, CIH
Medical Review ..... T Thoburn, MD, MPH

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Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 **Revision: B, 9/92**

Section 1. Material Identification

Ethylbenzene ($C_6H_5C_2H_5$) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA
3 / 2 / 0 / -

HMIS
H 2†
F 3
R 0
PPE - Sec. 8
† Chronic effects

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosivemixtures with air.

Section 2. Ingredients and Occupational Exposure Limits

Ethylbenzene, ca >99.0%. Impurities include ~ 0.1% *meta & para* xylene, ~ 0.1% cumene, and ~ 0.1% toluene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m³)
15-min STEL: 125 ppm (545 mg/m³)
Action Level: 50 ppm (217 mg/m³)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m³)
STEL: 125 ppm (545 mg/m³)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m³)
STEL: 125 ppm (545 mg/m³)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m³)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 days/wk, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.[179]

* See NIOSH, *RTECS* (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 277 F (136 C)
Melting Point: -139 F (-95 C)
Surface Tension: 31.5 dyne/cm
Ionization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 F (25 C)
Refraction Index: 1.4959 at 68 F (20 C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 F (25 C)
Critical Temperature: 651 F (343.9 C)
Critical Pressure: 35.6 atm

Molecular Weight: 106.16
Density: 0.863 at 77 F (25 C)
Water Solubility: Slightly, 14 mg/100 mL at 59 F (15 C)
Other Solubilities: Miscible in alcohol, ether; soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 F (20 C); 10 mmHg at 78.62 F (25.9 C); 100 mm Hg 165.38 F (74.1 C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0768 lb/ft³ or 1.2298 kg/m³

Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: 64 F (18 C) CC	Autoignition Temperature: 810 F (432 C)	LEL: 1.0% v/v	UEL: 6.7% v/v

Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or 'alcohol-resistant' foam. For large fires, use fog or 'alcohol-resistant' foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. **Unusual Fire or Explosion Hazards:** Burning rate = 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool container sides with water until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately if you hear rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB alone rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 56 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretion of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

Continue on next page

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ection 6. Health Hazard Data

Iedical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive irway disease). **Target Organs:** Eyes, respiratory system, skin, CNS, blood. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute ffects:** Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed apidly); 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was le and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. sed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm²/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr 118 & 215.7 µg/cm²/hr, respectively. **Chronic Effects:** Repeated skin contact may cause dryness, scaling, and fissuring. Workers ally exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor halation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

IRST AID

yes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of ater until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse ith flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **halation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or onvulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water dilute. *Do not* induce vomiting! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface nsion will cause it to spread over a large area of the lung tissue.

fter first aid, get appropriate in-plant, paramedic, or community medical support.

ote to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks end. Since this test is not specific, st for EB in expired air for confirmation.

ection 7. Spill, Leak, and Disposal Procedures

ill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should otect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible mate- l and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable SHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, EB partially evaporates into the atmosphere, with a half-life hrs to wks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 ys. Some EB may absorb to sediment or bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with otochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. **Ecotoxicity Values:** rimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow *imephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 08 to 2912 F (820 to 1600 C), liquid injection incineration at 1202 to 2912 F (650 to 1600 C), and fluidized bed incineration at 842 to 1796 F 50 to 980 C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

'A Designations
sted as a RCRA Hazardous Waste (40 CFR 261.21): No. D001
sted as a SARA Toxic Chemical (40 CFR 372.65)
xtremely Hazardous Substance (40 CFR 355), TPQ: Not listed
CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4) & ec. 307 (a)]

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

ction 8. Special Protection Data

ggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because ntact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to selection and use. Follow SHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered -purifying respirator with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with ropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning lls, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmo- eres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, iodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective ves, boots, aprons, and gauntlets made of Viton or polyvinylchloride to prevent skin contact. **Ventilation:** Provide general and local exhaust tilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents taminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency wash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from et clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work as. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

ction 9. Special Precautions and Comments

rage Requirements: Store in a cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detatched storage is ferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure-vacuum venting. To prevent ic sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class 1, Group D electrical equipment. **Engineering ntrols:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain els as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleanup. **Administrative ntrols:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

T Shipping Name: Ethylbenzene
T Hazard Class: 3
UN1175
king Group: II
l: Flammable liquid
ovisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60 L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: —

DS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179
pared by: M Gannon, BA, Industrial Hygiene Review: D Wilson, CIH; Medical Review: W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a construction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	0
I	4
S	-
K	0

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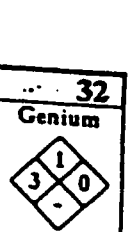

HMIS
H 3
F 1
R 0
PPG*
* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 μg/m³
Action Level TWA*: 30 μg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 μg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 μg/m³

1988 NIOSH REL
10-hr TWA: <100 μg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 μg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*
Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival um) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, kle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

ction 8. Special Protection Data

les: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
irator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source![10]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
O Hazard Class: 6.1
UN2291
bel: St. Andrews Cross (X, Stow away from foodstuffs)
Packaging Group: III

MSDS Collection References: 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS, Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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Material Safety Data Sheets Collection:
Sheet No. 317
Toluene
Issued: 8/79 Revision: E, 9/92 Errata: 2/94

Section 1. Material Identification

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.
Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

R 1
I 3
S 2*
K 3
* Skin absorption

NFPA: 3 / 2 / 0 / -

HMIS
H 2- Chronic effects
F 3
R 0
PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m^3)
15-min STEL: 150 ppm (560 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m^3)
STEL: 150 ppm (560 mg/m^3)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m^3)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m^3)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinations, and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 F (110.6 C)
Melting Point: -139 F (-95 C)
Molecular Weight: 92.15
Density: 0.866 at 68 F (20/4 C)
Surface Tension: 29 dyne/cm at 68 F (20 C)
Viscosity: 0.59 cP at 68 F (20 C)
Refraction Index: 1.4967 at 20 C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 F (20 C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 F (20 C); 36.7 mm Hg at 86 F (30 C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0797 lb/ft^3 or 1.2755 kg/m^3
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 F (4.4 C) CC	Autoignition Temperature: 896 F (480 C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/min and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact with heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm^2/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia with biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page

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Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** CNS, liver, kidney, skin. **Primary Entry Routes:** Inhalation, skin contact/absorption. **Acute Effects:** Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. **Chronic Effects:** Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and [illegible]l intolerance. Repeated heavy exposure may result in encephalopathies (cerebellar ataxia and cognitive dysfunction), liver enlargement, and [illegible]y dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. **Note to Physicians:** Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/g creatinine); Toluene in venous blood, sample at shift end (1.0 mg/L).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dike far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 F (450 to 980 C), rotary kiln incineration at 1508 to 2912 F (820 to 1600 C), or liquid injection incineration at 1202 to 2912 F (650 to 1600 C). Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Blue gill, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 36.2 mg/L/96 hr. **Environmental Degradation:** If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photochemically produced hydroxyl radicals. **Disposal:** Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
[* per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307 (a)]
[illegible]s a SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

[illegible]on 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 2000 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facepiece, or any air-purifying respirator with a full facepiece having a chin-style, front or back mounted organic vapor canister. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove toluene from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquids warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, wells, storage tanks). Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Toluene
DOT Hazard Class: 3
I[illegible] UN1294
[illegible]acking Group: II
D[illegible]Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 150
b) Non-bulk Packaging: 202
c) Bulk Packaging: 242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
Vessel Stowage: B
Other: --

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MD, MPH

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Section 1. Material Identification

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] with the largest proportion being *m*- xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics; as a general solvent for adhesives, a cleaning agent in microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, and the leather industry; in the production of phthalic anhydride, isophthalic, and terephthalic acids and their dimethyl esters which are used in the manufacture of polyester fibers; and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

R	1
I	2
S	2
K	3

NFPA

HMIS
H 2
F
R 0
PPE ‡
† Chronic Effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% *m*-xylene; 20% each of *o*-xylene, *p*-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 150 ppm (655 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m^3)
STEL: 150 ppm (655 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 150 ppm (651 mg/m^3)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 F (137 to 140 C)*
Boiling Point: *ortho:* 291 F (144 C); *meta:* 281.8 F (138.8 C); *para:* 281.3 F (138.5 C)
Freezing Point/Melting Point: *ortho:* -13 F (-25 C); *meta:* -53.3 F (- 47.4 C); *para:* 55 to 57 F (13 to 14 C)
Vapor Pressure: 6.72 mm Hg at 70 F (21 C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.23 kg/m^3, 0.077 lbs/ft^3
Appearance and Odor: Clear, sweet-smelling liquid.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 C/4 C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

* Materials with wider and narrower boiling ranges are commercially available.

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 F (17 to 25 C) CC	Autoignition Temperature: 982 F (527 C) (*m*-)	LEL: 1.1 (*m*-, *p*-); 0.9 (*o*-)	UEL: 7.0 (*m*-, *p*-); 6.7 (*o*-)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid flow sufficient to cause ignition. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. **Chemical Incompatibilities:** Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidindione (dichlorohydrantoin). Xylene attacks some forms of plastics, rubber, and coatings. **Conditions to Avoid:** Avoid heat and ignition sources and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list xylene as a carcinogen. **Summary of Risks:** Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. Kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated mild reversible decrease in red and white cell counts as well as increases in platelet counts.

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Section 6. Health Hazard Data, *continued*

Menstrual irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. **Medical Conditions Aggravated by Long-Term Exposure:** CNS, respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders. **Target Organs:** CNS, eyes, GI tract, liver, kidneys, and skin. **Primary Entry Routes:** Inhalation, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid [illegible]ng); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensa[illegible]n the oropharynx and stomach and transient CNS depression. **Chronic Effects:** Repeated or prolonged skin contact may cause drying and [illegible]tting of the skin leading to dermatitis. Repeated eye exposure to high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

FIRST AID *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% per day. Xylenes are resistant to hydrolysis. **Soil Absorption/Mobility:** Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into groundwater. **Disposal:** As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

SARA Extremely Hazardous Substance (40 CFR 355): Not listed
[illegible]d as a SARA Toxic Chemical (40 CFR 372.65)
[illegible]d as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times > 8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I, Group D electrical equipment. **Administrative Controls:** Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes
DOT Hazard Class: 3
ID No.: UN1307
[illegible] **Packing Group:** II
[illegible] **Label:** Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging : 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification

31

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	1
I	4
S	2
K	0

Genium

HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C(sublimes)

Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.

Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.

Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.

Target Organs: Liver, kidneys, skin, lungs, lymphatic system.

Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.

Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).

Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]

Listed as a Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.

‡ Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs; ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[10]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
Label: Poison
Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

MSDS Collection References: 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD

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Material Safety Data Sheets Collection:
Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[173] for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA
3 / 2 / 0 / -

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for thexcepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
% Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

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Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
Label: Flammable liquid
Packaging Exceptions: 173 118
DOT Packaging Requirements: 173 119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection References: 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS. Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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Section 1. Material Identification

Cadmium Metal/Powder (Cd) Description: Occurs naturally in the mineral greenockite (cadmium sulfide). This form is rare and most cadmium is obtained by extraction from other ores containing it as a mineral (lead, copper, and zinc). Zinc sulfide ores are the main source; by direct distillation or recovery from the electrolytic process. Used in electroplating other metals, fire protection systems, nickel-cadmium storage batteries, power transmission wire, TV phosphors, pigments for ceramic glazes, machinery enamels, baking enamels, photography and lithography, selenium rectifiers, electrodes for cadmium-vapor lamps, and photoelectric cells; as a fungicide and a Weston standard cell control of atomic fission in nuclear reactors.
Other Designations: CAS No. 7440-43-9, colloidal cadmium.
Manufacturer: Contact your supplier/distributor. Consult latest *Chemical Week Buyers' Guide*[73] for suppliers list.

Cautions: Cadmium is a highly toxic metal. Symptoms may be delayed several hours and include pulmonary edema (fluid in lungs) which can be fatal. Chronic effects include kidney damage. Cd is considered a carcinogen by several government agencies. The powder is pyrophoric and presents a significant fire/explosion hazard.

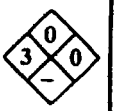
Powder

HMIS			
H	3*	R	3
F	1	I	4
R	3	S	2
		K	3

Genium

Solid

HMIS			
H	3*	R	1
F	0	I	4
R	0	S	2
		K	1



*Chronic effects PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cadmium, ca 100%

1992 OSHA PEL
8-hr TWA: 5 μg/m³

1992 OSHA SECAL*
TWA: 15 or 50 μg/m³

1990 IDLH Level
50 mg/m³

1993-94 ACGIH TLVs
TWA: 0.01 mg/m³ (total dust), Class A2 carcinogen
TWA: 0.002 mg/m³ (respirable fraction)

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
Carcinogen, keep as low as possible

1992 Toxicity Data†
Human, inhalation, LC_{Lo}: 39 mg/m³/20 min caused cardiac changes, thrombosis, and respiratory depression.
Rat, oral, LD_{50}: 225 mg/kg; details not reported.
Woman, inhalation, LC_{Lo}: 129 μg/m³ for 20 continuous years produced lung tumors.
Man, TC_{Lo}: 88 μg/m³/8.6 years caused kidney and ureter toxicity with protein in the urine.

* Separate engineering control limit: to be achieved in processes and work places where it is not possible to achieve the PEL through engineering and work practices alone. The SECAL for Cd is 15 or 50 μg/m³ depending on the processes involved. See Federal Register 57 (178): 42222, Table VIII-B1, 9/14/92.
†See NIOSH, *RTECS* (EU9800000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 1409 F (765 C)
Melting Point: 610 F (321 C)
Vapor Pressure: 0.095 mm Hg at 609.6 F (320.9 C)
Refraction Index: 1.13
Mohs Hardness: 2.0
Molecular Weight: 112.4

Density: 8.642
Water Solubility: Insoluble
Other Solubilities: Soluble in nitric (rapidly), hydrochloric (slowly), and other acids. The solid is soluble in ammonium nitrate solution, but the powdered form undergoes an explosive reaction.

Appearance and Odor: Silver-white, blue-tinged, lustrous, odorless, soft metal that is easily cut with a knife. The powder is grayish-white.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: The solid metal is not flammable, but the finely divided powder is pyrophoric. As a rule, the more finely divided the powder is, the greater the potential for explosion. Use carbon dioxide, dry chemical, or sand. **Unusual Fire or Explosion Hazards:** Processes that create cadmium dust such as cutting, grinding, or welding present a serious explosion hazard in presence of ignition sources. Avoid creation of cadmium dust clouds. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Cadmium easily tarnishes in moist air as it is oxidized to cadmium oxide. The solid is stable in dry air. The powder is pyrophoric. Cd becomes brittle at 176 F (80 C). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include ammonium nitrate (powdered Cd), hydrazoic acid, tellurium, zinc, ammonia, sulfur, selenium, nitryl fluoride, and oxidizing agents. **Conditions to Avoid:** Creation of Cd dust clouds, exposure to heat and ignition sources, and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of Cd can produce toxic cadmium oxide (CdO) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies list Cd as a carcinogen: IARC Class 2A (probably carcinogenic in humans),[183] NTP Class 2 (reasonably anticipated to be a carcinogen),[169] and NIOSH Class X (carcinogen defined without further categorization),[183] ACGIH TLV-A2 (suspected human carcinogen),[183] EPA-B1 (Probable human carcinogen) and DFG MAK-A2 (unmistakably carcinogenic in animal experimentation only).[183]
Summary of Risks: Dust or fume inhalation generally results in acute symptoms delayed up to 24 hr. Effects include a flu-like syndrome similar to metal fume fever with chills, fever, and muscle pain in the back and limbs. Pulmonary edema (fluid in lungs) can develop after severe exposure and may result in death. If victim recovers, residual changes may include lung fibrosis (thickening) and vascular changes. Long-term exposure to Cd damages the liver and kidneys (accumulates, half-life = 7 to 30 yr). Proteinuria (protein in urine) of low molecular weight is the first sign of tubular dysfunction. Excess urinary glucose is also seen. Bone demineralization similar to osteoporosis (decreased bone density)...

Continue on next page

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Section 6. Health Hazard Data, *continued*

occurs *not* as a direct effect of Cd exposure, but indirectly by altering kidney regulation of calcium and phosphorus which are needed for strong, healthy bones. Some studies show a correlation between anemia (low hemoglobin in blood) and high Cd levels. Selenium (Se) and zinc (Zn) appear to suppress Cd toxicity; Se binds up Cd, preventing it from entering body tissue and Zn may compete for the same metabolic site. **Medical Conditions Aggravated by Long-Term Exposure:** Kidney, blood, or respiratory disorders. **Target Organs:** Blood, kidney, liver, respiratory system. **Primary Entry Routes:** Inhalation, ingestion. **Acute Effects:** Inhalation may cause irritation of the eyes, nose, and throat, nausea and vomiting, abdominal colic, diarrhea, chest tightness, cough, headache, and weakness. Pulmonary edema could develop up to 24 hr post exposure. Kidney damage may occur after acute exposures, but is more likely with chronic exposure. **Chronic Effects:** Symptoms may be delayed several years after last exposure and include perforation of the nasal septum (tissue between the nostrils), loss of smell, chronic bronchitis, severe progressive emphysema, anorexia, insomnia, fatigue, pallor, anemia, kidney damage, bone demineralization, lung fibrosis and possible cancer of the respiratory tract.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Wash exposed area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of cadmium's irritating nature.

Note to Physicians: ß-2 microglobulin excretion of > 200 µg/g creatinine indicates kidney dysfunction as does a renal cortex [Cd] of 180 to 220 µg/g of wet kidney cortex. Blood Cd levels are *not* indicative of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation. Carefully scoop up small spills and place in sealed impermeable containers. *Do not* disperse dust by sweeping. Remember that Cd powder can be pyrophoric and must be handled carefully. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.24): D006, Characteristic of Toxicity; regulatory level = 1.0 mg/L

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg)† [* per CWA, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1027)

† No reporting of releases of this substance is required if the diameter of the pieces of the solid metal is equal to or exceeds 100 µm (0.004 in.)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied air respirator (with auxiliary SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear gloves, boots, aprons, and gauntlets to prevent Cd dust from contacting skin. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL or SECAL (Sec. 2). Lunchroom facilities should not have concentrations above 2.5 µg/m^3 at any time. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes; launder before reuse. Remove Cd from shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Cd, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Do not allow cadmium dust to build up in storage area.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Prohibit workers from removing Cd from protective clothing and equipment by blowing, shaking, or any other means that disperses Cd into the air. Employees must not enter eating facilities while wearing PPE unless it is vacuumed with a HEPA. Consider preplacement and periodic medical exams of exposed workers emphasizing the blood, kidneys, liver, and respiratory system. Educate workers on Cadmium's carcinogenicity.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Poisonous solids, n.o.s.*, Pyrophoric metals, n.o.s.†

DOT Hazard Class: 6.1*, 4.2†

ID No.: UN2811*, UN1383†

DOT Packing Group: III*, I†

DOT Label: Keep away from food*, Spontaneously Combustible†

Special Provisions (172.102): —*, B11†

* Solid metal, † Powder

Packaging Authorizations

a) Exceptions: 173.153*, None†

b) Non-bulk Packaging: 173.213*, .187†

c) Bulk Packaging: 173.240*, .242†

Quantity Limitations

a) Passenger Aircraft or Railcar: 100 kg*, Forbidden†

b) Cargo Aircraft Only: 200 kg*, Forbidden†

Vessel Stowage Requirements

a) Vessel Stowage: A*, D†

b) Other: –

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 159, 167, 169, 183, 185, 186

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

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MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker

24 Hour Emergency Telephone: [illegible]
CHEMTREC: 1-[illegible]

National Response in Canada
CANUTEC: [illegible]

Outside U.S. and Canada
Chemtrec: [illegible]

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

Copper

MSDS Number: C5170 — *Effective Date: 12/08/96*

1. Product Identification

Synonyms: Bronze Powder; C.I. 77400; Arwood Copper
CAS No.: 7440-50-8
Molecular Weight: 63.55
Chemical Formula: Cu
Product Codes: 1714, 1720, 1732, 1736

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Copper	07440-50-8	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES EYE IRRITATION. CHRONIC EXPOSURE MAY CAUSE TISSUE DAMAGE.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Irritation of upper respiratory tract, headache, nausea, vomiting, diarrhea, chills, fever, aching muscles.

Ingestion:
Nausea, vomiting, diarrhea.

Skin Contact:
Irritation.

Eye Contact:
Irritation.

Chronic Exposure:
Damage to liver, kidneys, lungs.

Aggravation of Pre-existing Conditions:
Wilson's disease.

4. First Aid Measures

Inhalation:
If a person breathes in large amounts, move the exposed person to fresh air.

Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.

Skin Contact:
In case of contact, immediately wash skin with plenty of soap and water for at least 15 minutes.

Eye Contact:
In case of eye contact, immediately flush with plenty of water for at least 15 minutes.

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.

Explosion:
Dust may form explosive mixture with air.

Fire Extinguishing Media:
Use extinguishing media appropriate for surrounding fire. WARNING - Application of water to hot metal may generate steam.

Special Information:
Firefighters should wear proper protective equipment and self-contained breathing apparatus with full facepiece operated in positive pressure mode.

6. Accidental Release Measures

Wear suitable protective clothing. Carefully sweep up and remove.

7. Handling and Storage

Keep container tightly closed. Suitable for any general chemical storage area. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL): 1.0 mg/m3 (TWA) PEL is for Copper dust and mist, as Cu. -ACGIH Threshold Limit Value (TLV): 1.0 mg/m3 (TWA) TLV is for Copper, Dusts and mists, as Cu.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
For conditions of use where exposure to the substance is apparent, consult an industrial hygienist. For emergencies, or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Red metal.

Odor:
Odorless.

Solubility:
Negligible (<0.1%)

Specific Gravity:
8.92

pH:
No information found.

% Volatiles by volume @ 21C (70F):
0

Boiling Point:
2595C (4703F)

Melting Point:
1083C (1981F)

Vapor Density (Air=1):
Not applicable.

Vapor Pressure (mm Hg):
Not applicable.

Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
Copper fumes.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
Strong acids, strong oxidizing agents, strong bases, acetylene, acetaldehyde, magnesium.

Conditions to Avoid:
Heat, dusting.

11. Toxicological Information

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Copper (07440-50-8)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.

Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Copper (07440-50-8)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Copper (07440-50-8)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\--------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Copper (07440-50-8)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\--------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Copper (07440-50-8)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: No information found.
Poison Schedule: No information found.

WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

Label Hazard Warning:

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES EYE IRRITATION. CHRONIC EXPOSURE MAY CAUSE TISSUE DAMAGE.

Label Precautions:
During use avoid contact with eyes, skin, clothing. Wash thoroughly after handling. When not in use keep in tightly closed container.

Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If a person breathes in large amounts, move the exposed person to fresh air. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes.

Product Use:
Laboratory Reagent.

Revision Information:
Pure. New 16 section MSDS format, all sections have been revised.

Disclaimer:
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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

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MSDS Material Safety Data Sheet

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 202-483-7616

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT J.T.Baker

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

ZINC OXIDE

MSDS Number: Z3705 — *Effective Date: 06/30/98*

1. Product Identification

Synonyms: Chinese white; zinc white; flowers of zinc; calamine
CAS No.: 1314-13-2
Molecular Weight: 81.38
Chemical Formula: ZnO
Product Codes:
J.T. Baker: 4358, 4360, 5070
Mallinckrodt: 3419, 7030, 8824, 8825, 8832, 8843

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Zinc Oxide	1314-13-2	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY IRRITATE RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 1 - Slight

Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath. Inhalation can cause a flu-like illness (metal fume fever). This 24- to 48-hour illness is characterized by chills, fever, aching muscles, dryness in the mouth and throat and headache.
Ingestion:
Large oral doses may cause irritation to the gastrointestinal tract.
Skin Contact:
Not expected to be a health hazard from skin exposure.
Eye Contact:
Not expected to be a health hazard.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
Persons with a pre-existing heart condition or impaired respiratory function may be more susceptible to the effects of this substance.

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4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Not expected to require first aid measures. If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact:
Not expected to require first aid measures. Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Not expected to require first aid measures. Wash thoroughly with running water. Get medical advice if irritation develops.

---

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Finely divided powder presents an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Zinc oxide fume may be released when heated.

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6. Accidental Release Measures

Clean-up personnel require protective clothing and respiratory protection from dust. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

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7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
Zinc oxide:
-OSHA Permissible Exposure Limit (PEL):
fume: 5 mg/m3 (TWA)
respirable fraction: 5 mg/m3 (TWA)
total dusts: 15 mg/m3 (TWA)

-ACGIH Threshold Limit Value (TLV):
dusts: 10 mg/m3 (TWA), for inhalable (total) particulate
matter containing no asbestos and < 1% crystalline silica.
fumes: 5 mg/m3 (TWA); 10 mg/m3 (STEL)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices* , most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator.
WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White to yellowish-white amorphous powder.
Odor:
Odorless.
Solubility:
Insoluble in water, alcohol; soluble in dilute acids.
Specific Gravity:
5.67
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
Sublimes.
Melting Point:
1975C (3587F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Absorbs carbon dioxide from air.
Hazardous Decomposition Products:
When heated to very high temperatures, zinc oxide sublimes to produce toxic fumes.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Has exploded when mixed with chlorinated rubber. Reacts violently with magnesium, linseed oil. Zinc oxide and magnesium can react explosively when heated.
Conditions to Avoid:
Heat, incompatibles.

11. Toxicological Information

Investigated as a mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Zinc Oxide (1314-13-2)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\--------

Ingredient	TSCA	EC	Japan	Australia
Zinc Oxide (1314-13-2)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Zinc Oxide (1314-13-2)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\--------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Zinc Oxide (1314-13-2)	No	No	No	Zinc compoun

--------\Federal, State & International Regulations - Part 2\--------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Zinc Oxide (1314-13-2)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: No information found.
Poison Schedule: No information found.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY IRRITATE RESPIRATORY TRACT.
Label Precautions:
Avoid breathing dust.
Keep container closed.
Use with adequate ventilation.
Label First Aid:
If inhaled, remove to fresh air. Get medical attention for any breathing difficulty.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 1, 2.
Disclaimer:
****

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

CERAC -- CHROMIUM METAL
MATERIAL SAFETY DATA SHEET
NSN: 681000N052881
Manufacturer's CAGE: 67027
Part No. Indicator: A
Part Number/Trade Name: CHROMIUM METAL

General Information

Company's Name: CERAC INC
Company's P. O. Box: 1178
Company's City: MILWAUKEE
Company's State: WI
Company's Country: US
Company's Zip Code: 53201
Company's Emerg Ph #: 800-562-8236;800-424-9300(CHEMTREC)
Company's Info Ph #: 414-289-9800
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 08JUN88
Safety Data Review Date: 12SEP94
MSDS Serial Number: BVPDR
Hazard Characteristic Code: NK

Ingredients/Identity Information

Proprietary: NO
Ingredient: CHROMIUM (SARA III)
Ingredient Sequence Number: 01
Percent: 99.9
NIOSH (RTECS) Number: GB4200000
CAS Number: 7440-47-3
OSHA PEL: 1 MG/M3
ACGIH TLV: 0.5 MG/M3

Proprietary: NO
Ingredient: EXPLAN OF CARCIN:HUMAN/ANIMAL:LUNG CANCER, SKIN ULCERS.
Ingredient Sequence Number: 02
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Physical/Chemical Characteristics

Appearance And Odor: STEEL-GREY METALLIC PIECES, POWDER, AND FLAKES. ODORLESS.
Boiling Point: 4842F,2672C
Melting Point: 3434F,1890C
Vapor Pressure (MM Hg/70 F): 1 @ 1616C
Vapor Density (Air=1): 7.1(GM CC)
Evaporation Rate And Ref: N/A
Solubility In Water: INSOLUBLE.
Percent Volatiles By Volume: N/A

Fire and Explosion Hazard Data

Flash Point: N/A
Lower Explosive Limit: N/A
Upper Explosive Limit: N/A
Extinguishing Media: POWDER FORM IS COMBUSTIBLE. USE WATER SPRAY OR FOG, DRY CHEMICAL, CO2, OR SAND. CLASS D.
Special Fire Fighting Proc: FIRE MAY BE ISOLATED & ALLOWED TO BURN ITSELF

OUT. WHEN POWDERED, FIREFIGHTERS SHOULD USE NIOSH/MSHA APPRVD SCBA & FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire And Expl Hazrds: WHEN POWDERED CHROMIUM IS EXPSD TO HEAT/ IGNIT SOURCES, IT IS A MODERATE FIRE & EXPLO HAZ. INDEX OF EXPLOSIBILITY (<0.1 WEAK, >10 SEVERE) = 0.1.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE.
Materials To Avoid: STRONG OXIDIZERS, MINERAL ACIDS, AMMONIUM NITRATE, HYDROGEN PEROXIDE, CHLORATES, SULFUR DIOXIDE.
Hazardous Decomp Products: RXN W/MINERAL ACIDS MAY LIBERATE HYDROGEN GAS. REACTS READILY W/DILUTE ACIDS(NOT NITRIC) TO FORM CHROMOUS SALTS. (SUPDAT)
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INHAL:CHROMIUM METAL IS RELATIVELY NONTOX. INHAL HAZ OF PWDRS DEPENDENT UPON PARTICLE SIZE. CHROMIUM METAL & INSOLUBLE SALTS SAID TO BE INVOLVED IN HISTOLOGICAL FIBROSIS OF LUNGS. WHEN METAL HEATED TO HIGH TEMP, FUMES PRDCED MAY BE DAMAGING TO LUNGS WHEN INHALED (POSS PNEUMOCONIOSIS). (SEE EFTS OF OVEREXP)
Carcinogenicity - NTP: YES
Carcinogenicity - IARC: YES
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: CHROMIUM:IARC MONOGRAPHS, VOL 49, PG 49, 1990:GRP 1. NTP 7TH ANNUAL RPT ON CARCINS, 1994:KNOWN TO BE CARCIN. (ING 2)
Signs/Symptoms Of Overexp: HLTH HAZ:EYE/SKIN:CAN CAUSE EYE & SKIN IRRIT. HEXAVALENT CHROMIUM CMPDS ARE CARCINOGENIC (OSHA) & CORROSIVE ON TISSUE, RESULTING IN ULCERS & DERM ON PRLNGD CNTCT. IARC HAS DETERMINED A "CAUSAL" ASSOC BETWEEN OCCUPATIONAL EXPOS TO CHROMIUM & CERTAIN CHROMIUM CMPDS & CANCER IN HUMANS. THIS DETERMINATION WAS (SUPP DATA)
Med Cond Aggravated By Exp: NONE.
Emergency/First Aid Proc: INGEST:GIVE WATER TO DRINK; INDUCE VOMIT & SEEK PROMPT MED ATTN FOR FURTHER TREATMENT, SUPPORT & OBSERVATION. INHAL: REMOVE TO FRESH AIR. RESTORE AND/OR SUPPORT BRTHG AS REQUIRED. SKIN:BRUSH OFF CHROMIUM DUST. WASH WELL W/SOAP & WATER. EYE:FLUSH W/RUNNING WATER FOR 15 MINUTES, INCLUDING UNDER EYELIDS.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: NOTIFY SAFETY PERSONNEL OF LARGE SPILLS. REMOVE SOURCES OF HEAT/IGNIT. PROVIDE ADEQ VENT. KEEP AIRBORNE DUST TO MINIMUM BY USING VACUUM TO CLEAN UP DRY SPILLS/DUST. CLEAN UP PERSONNEL TO WEAR PROT CLTHG & NIOSH APPRVD RESP. REMOVE SPILL (SUPP DATA)
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: RECLAIM SALVAGEABLE METAL. PLACE WASTE IN AN APPROVED SECURE HAZARDOUS WASTE LANDFILL SITE. OR INCINERATE W/APPROVED AIR POLLUTION CONTROLS. FOLLOW FEDERAL, STATE, AND LOCAL REGULATIONS.
Precautions-Handling/Storing: STORE MATL IN COOL, DRY, WELL-VENT AREA AWAY FROM HEAT/IGNIT SOURCES. STORE AWAY FROM OXIDIZING AGENTS.
Other Precautions: USE GOOD HOUSECLEANING TECHNIQUES THAT WILL KEEP AIRBORNE PARTICLES AT MINIMUM. USE NONSPARKING TOOLS & GROUND ELEC EQUIP & MACHINERY.

Control Measures

Respiratory Protection: NIOSH/MSHA APPROVED FULL FACE RESPIRATOR REQUIRED

FOR HIGH EXPOSURE AREAS.
Ventilation: LOCAL & MECHANICAL EXHAUST NECESSARY TO MEET TLV REQUIREMENTS.
Protective Gloves: RUBBER OR LIGHT PLASTIC REQUIRED.
Eye Protection: SAFETY GLASSES OR GOGGLES REQURIED.
Other Protective Equipment: WEAR PROTECTIVE CLOTHING APPROPRIATE FOR THE WORK SITUATION TO MINIMIZE SKIN CONTACT.
Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER.
Suppl. Safety & Health Data: HAZ DECOMP PROD:PWDR INCOMPAT W/STRONG OXIDIZING AGENTS, INCLDG HIGH O*2 CONC. EVAP OF HG FROM CR AMALGAM LEAVES PYROPHORIC CHROMIUM. EFTS OF OVEREXP:BASED ON EVID WHERE EXPOS WERE ESSENTIALLY TO HEXAVALENT CHROMIUM CMPDS. SPILL PROCS:QUICKLY & PLACE IN APPROPRIATE CONTAINERS FOR DISPOSAL OR REUSE.

Transportation Data

Disposal Data

Label Data

Label Required: YES
Technical Review Date: 15SEP94
Label Status: G
Common Name: CHROMIUM METAL
Chronic Hazard: YES
Signal Word: CAUTION!
Acute Health Hazard-Slight: X
Contact Hazard-Slight: X
Fire Hazard-None: X
Reactivity Hazard-None: X
INHALATION HAZARD OF POWDERS DEPENDENT UPON PARTICLE SIZE. CHROMIUM METAL & INSOLUBLE SALTS SAID TO BE INVOLVED IN HISTOLOGICAL FIBROSIS OF LUNGS. WHEN METAL HEATED TO HIGH TEMPERATURE, FUMES PRODUCED MAY BE DAMAGING TO LUNGS WHEN INHALED (POSSIBLY PNEUMOCONIOSIS). EYE/SKIN:CAN CAUSE EYE & SKIN IRRITATION. CHRONIC:CANCER HAZARD. CONTAINS CHROMIUM WHICH IS LISTED AS A LUNG CARCINOGEN (FP N).
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: CERAC INC
Label P.O. Box: 1178
Label City: MILWAUKEE
Label State: WI
Label Zip Code: 53201
Label Country: US
Label Emergency Number: 800-562-8236;800-424-9300(CHEMTREC)

INTERNATIONAL NICKEL -- INCO NICKEL POWDER TYPE 287, NA 9188
MATERIAL SAFETY DATA SHEET
NSN: 343900N059228
Manufacturer's CAGE: 76617
Part No. Indicator: A
Part Number/Trade Name: INCO NICKEL POWDER TYPE 287, NA 9188

General Information

Company's Name: INTERNATIONAL NICKEL INC
Company's Street: PARK 80 WEST, PLAZA TWO
Company's City: SADDLE BROOK
Company's State: NJ
Company's Country: US
Company's Zip Code: 07662
Company's Emerg Ph #: 201-843-8600
Company's Info Ph #: 201-843-8600
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 31MAY89
Safety Data Review Date: 09JUN95
MSDS Serial Number: BXVHM

Ingredients/Identity Information

Proprietary: NO
Ingredient: NICKEL (SARA 313) (CERCLA) MP:1453C, 2647F. PB:2732C, 4950F. SOL IN H*2O:0 G/100 ML LD50(ORAL,RAT):>9000 MG/KG (ING 2)
Ingredient Sequence Number: 01
Percent: 97.9
NIOSH (RTECS) Number: QR5950000
CAS Number: 7440-02-0
OSHA PEL: 1 MG/M3
ACGIH TLV: 1 MG/M3

Proprietary: NO
Ingredient: ING 1:SPEC GRAV:8.9 G/CM
Ingredient Sequence Number: 02
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: NICKEL (II) OXIDE (1:1); (NICKEL OXIDE) MP:1990C, 3614F. SOL IN H*2O:0 G/100 ML. LD50(ORAL,RAT):>5000 MG/KG. (ING 4)
Ingredient Sequence Number: 03
Percent: 0.3
NIOSH (RTECS) Number: QR8400000
CAS Number: 1313-99-1
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Proprietary: NO
Ingredient: ING 3:SPEC GRAV:6.67 G/CM
Ingredient Sequence Number: 04
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: NICKEL CARBIDE SPEC GRAV:7.96 G/CM
Ingredient Sequence Number: 05

Percent: 1.6
NIOSH (RTECS) Number: 1005785NC
CAS Number: 12167-08-7
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Proprietary: NO
U.S. NATL INSTITUTE FOR OCCUP SFTY & HLTH (NIOSH) (ING 7)
Ingredient Sequence Number: 06
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 6:CONCLUDED THAT NICKEL & ITS INORG CMPDS ARE NOT CARCIN
WHEN INGEST. U.S. DRUG ADMIN HAS AFFIRMED (ING 8)
Ingredient Sequence Number: 07
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 7:THAT NICKEL IS GENERALLY RECOGNIZED AS SAFE (GRAS) AS
DIRECT HUMAN FOOD ING. ING 2:INHAL:EPIDEMIOLOGICAL (ING 9)
Ingredient Sequence Number: 08
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 8:STUDIES OF WORKERS EXPOSED TO NICKEL POWDER & TO DUST &
FUME GENERATED IN PRODUCTION OF NICKEL ALLOYS & OF(ING 10)
Ingredient Sequence Number: 09
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 9:STAINLESS STEEL HAVE NOT INDICATED PRESENCE OF
SIGNIFICANT RESP CANCER HAZ. RPTD INTRATRACHEAL (ING 11)
Ingredient Sequence Number: 10
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 10:INSTILLATION OF ING 2 PRDCED INCREASED INCIDENCE OF
MALIGNANT LUNG TUMORS IN RATS. INHAL OF ING 2 AT (ING 12)
Ingredient Sequence Number: 11
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 11:CONCS 50 TIMES PEL, PRDCES PNEUMOCONIOSIS IN HAMSTERS.
WOUNDS:ING 2 HAS CAUSED TUMORS AT SITE OF (ING 13)
Ingredient Sequence Number: 12
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 12:INJECTION IN PODENTS. INGEST:U.S. NATL INSTITUTE FOR
OCCUP SFTY & HLTH (NIOSH) CONCLUDED THAT NICKEL & (ING 14)

Ingredient Sequence Number: 13
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: ING 13:ORG CMPDS ARE NOT CARCINOGENIC WHEN INGESTED.
Ingredient Sequence Number: 14
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: SPILL PROC:TO CAUSE THE CONCENTRATION OF AIRBORNE NICKEL TO EXCEED THE PEL.
Ingredient Sequence Number: 15
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: MATLS TO AVOID:PERCHLORATES, PHOSPHOROUS, SELENIUM AND SULFUR , ETC.
Ingredient Sequence Number: 16
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: HAZ DECOMP PRODS:EXTREMELY TOXIC GAS.
Ingredient Sequence Number: 17
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Physical/Chemical Characteristics

Appearance And Odor: GRAY, ODORLESS POWDER WITH AN AVERAGE PARTICLE SIZE OF 2.6 TO 3.3 MICRONS.
Boiling Point: SEE INGS
Melting Point: SEE INGS
Specific Gravity: SEE INGS
Solubility In Water: SEE INGREDIENTS

Fire and Explosion Hazard Data

Extinguishing Media: MEDIA SUITABLE FOR SURROUNDING FIRE (FP N).
Special Fire Fighting Proc: WEAR NIOSH/MSHA APPROVED SCBA & FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire And Expl Hazrds: METAL POWDERS HEAT TREATED IN REDUCING ATMS MAY BECOME PYROPHORIC.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE SPECIFIED BY MANUFACTURER.
Materials To Avoid: LIKE OTHER METAL POWDERS, PROD CAN REACT EXPLOSIVELY/ INCANDESCENTLY W/SUBSTANCES SUCH AS AMMONIUM NITRATE, (ING 16)
Hazardous Decomp Products: UNDER SPECIAL CNDTNS PROD CAN REACT W/CARBON MONOXIDE IN REDUCING ATMS TO FORM NICKEL CARBONYL, NI(CO) AN (ING 17)
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

==========
LD50-LC50 Mixture: SEE INGREDIENTS
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: NO
Health Haz Acute And Chronic: ING 1:INHAL:EPIDEMIOLOGICAL STUDIES OF WORKERS EXPOSED TO NICKEL POWDER & TO DUST & FUMES GENERATED IN PRODUCTION OF NICKEL ALLOYS OF STAINLESS STEEL HAVE NOT INDICATED PRESENCE OF SIGNIFICANT RESP CANCER HAZ. REPEATED INTRATRACHEAL INSTILLATION OF NICKEL POWDER PRDCED AN INCREASED INCIDENCE OF (EFTS OF OVEREXP)
Carcinogenicity - NTP: YES
Carcinogenicity - IARC: YES
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NICKEL:IARC MONOGRAPHS ON EVAL OF CARCIN RISK OF CHEMS TO MAN, VOL 49, PG 257, 1990:GROUP 2B. (SUPP DATA)
Signs/Symptoms Of Overexp: HLTH HAZS:MALIGNANT LUNG TUMORS IN RATS. SINGLE INTRATRACHEAL INSTILLATIONS OF NICKEL POWDER IN HAMSTERS @ DOSES NEAR LD50 PRDCED AN INCREASED INCINDENCE OF FIBROSARCOMAS, MESOTHELIOMAS & RHABDOMYOSARCOMAS. SKIN:RPTD CONT W/METALLIC NICKEL CAN CAUSE NICKEL SENSITIVITY & ALLERGIC SKIN RXNS. WOUNDS:NICKEL METAL (SUP DAT)
Med Cond Aggravated By Exp: ING 1:SKIN CONTACT CAN CAUSE AN ALLERGIC SKIN RASH IN PREVIOUSLY SENSITIZED INDIVIDUALS.
IMMEDIATELY FLUSH W/POTABLE WATER FOR A MINIMUM OF 15 MINUTES, SEEK ASSISTANCE FROM MD (FP N). SKIN:FOR RASHES SEEK MEDICAL ATTENTION. CLEANSE WOUNDS THOROUGHLY TO REMOVE ANY PARTICLES. INHALATION:IF EXPOSURE TO NICKEL CARBONYL IS SUSPECTED, SEEK MEDICAL ATTENTION IMMEDIATELY.
==========

Precautions for Safe Handling and Use

==========
Steps If Matl Released/Spill: COLLECT SPILLS BY WET SWEEPING/BY VACUUMING W/VACUUM EXHST PASSING THROUGH HIGH EFFICIENCY PARTICULATE ARRESTING (HEPA) FILTER IF EXHST IS DISCHARGED INTO WORKPLACE. WEAR APPROP NIOSH/MSHA APPRVD RESPS IF COLLECTION & DISP OF SPILLS IS LIKELY(ING 13)
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: DISPOSAL MUST BE I/A/W FEDERAL, STATE & LOCAL REGULATIONS (FP N). NICKEL-CONTAINING WASTE IS NORMALLY COLLECTED TO RECOVER NICKEL VALUES. SHOULD WASTE DISPOSAL BE DEEMED NECESSARY FOLLOW EPA AND LOCAL REGULATIONS.
Precautions-Handling/Storing: DO NOT INHALE POWDER. KEEP CNTNR CLSD WHEN NOT IN USE. AVOID RPTD SKIN CONT. DO NOT STORE NEAR ACIDS/REACTIVE SUBSTANCES.
Other Precautions: NONE SPECIFIED BY MANUFACTURER.
==========

Control Measures

==========
Respiratory Protection: IF VENTILATION ALONE CANNOT SO CONTROL EXPOSURES, USE NIOSH/MSHA APPROVED RESPIRATORS SELECTED ACCORDING TO OSHA 29 CFR 1910.134. MAINTAIN AIRBORNE NICKEL LEVELS AS LOW AS POSSIBLE.
Ventilation: VENTILATION IS NORMALLY REQUIRED WHEN HANDLING OR USING PROD TO KEEP EXPOS TO AIRBORNE NICKEL BELOW PEL.
Protective Gloves: IMPERVIOUS GLOVES (FP N).
Eye Protection: ANSI APPROVED CHEM WORKERS GOGGS (FP N).
Other Protective Equipment: EMERGENCY EYE WASH & DELUGE SHOWER WHICH MEET ANSI DESIGN CRITERIA (FP N).
Work Hygienic Practices: WASH SKIN THOROUGHLY AFTER HANDLING. LAUNDER CLOTHING AND GLOVES AS NEEDED.
Suppl. Safety & Health Data: EXPLAN OF CARCIN:NTP 7TH ANNUAL RPT ON CARCINS. 1994:ANTIC TO BE CARCIN. HUMAN:LUNGS, NASAL CAVITIES. NICKEL MUSCULOSKELETAL. EFTS OF OVEREXP:POWDER HAS CAUSED TUMORS AT SITE OF INJECTION IN RODENTS. HOWEVER, STUDIES DO NOT SUGGEST SIGNIFICANT(ING 4)
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Transportation Data

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 09JUN95
Label Status: G
Common Name: INCO NICKEL POWDER TYPE 287, NA 9188
Chronic Hazard: YES
Signal Word: CAUTION!
Acute Health Hazard-Slight: X
Contact Hazard-Slight: X
Fire Hazard-None: X
Reactivity Hazard-None: X
Special Hazard Precautions: ACUTE:REPEATED CONTACT CAN CAUSE NICKEL SENSITIVITY AND ALLERGIC SKIN REACTIONS. CHRONIC:CANCER HAZARD. CONTAINS NICKEL AND NICKEL COMPOUNDS WHICH ARE LISTED AS RESPIRATORY TRACT CARCINOGENS (FP N).
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: INTERNATIONAL NICKEL CO
Label Street: PARK 80 WEST, PLAZA TWO
Label City: SADDLE BROOK
Label State: NJ
Label Zip Code: 07662
Label Country: US
Label Emergency Number: 201-843-8600

APPENDIX B
DAILY SAFETY MEETING LOG

BBL DAILY SAFETY MEETING LOG

PROJECT: LOCATION:

DATE/TIME: ACTIVITY:

1. Work Summary
2. Physical/Chemical Hazards
3. Protective Equipment/Procedures
4. Emergency Procedures
5. Signatures of Attendees

APPENDIX C
ACCIDENT/NEAR MISS INVESTIGATION REPORT

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

ACCIDENT/NEAR MISS INVESTIGATION REPORT

Type of Incident _____

Date of Report _____ Date of Incident _____ Time of Incident _____

Employee's Name _____ Title _____

Address _____ Employee # _____

City _____ State _____ Zip Code _____

Age _____ Sex _____ Marital Status _____

Date of Hire _____ Social Security # _____ # of Dependents _____

Description of Accident: _____

Description of Injuries: _____

Witnesses: _____

Injuries Required:

☐ First Aid (At Scene) ☐ Emergency Room Treatment ☐ Hospitalization

Location of Accident _____

First Aid Provided By _____

Medical Facility/Address _____

Attending Physician _____

Did Employee Return to Work?

☐ Yes ☐ No If Yes, Give Date _____

Did Employee Lose Time at Work?

☐ Yes ☐ No If Yes, Give Amount _____

Actions or Conditions Causing Accident: _____

Corrective Actions: _____

Further Comments: _____

Employee Signature _____ Date _____

H&S Review _____ Date _____

APPENDIX D
INCIDENT PREVENTION OBSERVATION REPORT

BLASLAND, BOUCK LEE, INC.
INCIDENT PREVENTION OBSERVATION FORM

Project #_____

Site Name:_____ Date:_____

Auditor:_____

HSS on Site_____

SEND A COPY OF COMPLETED FORM TO THE HEALTH AND SAFETY MANAGER

GENERAL	YES	NO	N/A	COMMENTS
HASP on Site?				
HASP finalized and approved?				
OSHA poster displayed?				
Emergency phone numbers posted?				
Emergency eyewash immediately available?				
Emergency shower immediately available?				
Stretcher on site?				
First-aid emergency kit immediately available?				
Adequately stocked?				
Proper sanitation facility on-site?				
DOCUMENTATION AND RECORDKEEPING				
Only personnel listed and approved in HASP on-site?				
All personnel properly trained? (Check 40-hour certificates)				
All personnel in health monitoring program? (Check company issued wallet cards)				
Daily field log kept by the Site Manager?				
Levels of PPE recorded?				
Contaminant levels recorded?				
Site surveillance records kept by HSS?				
Copy of current fit test records on-site?				
Calibration records maintained for air monitoring equipment?				
Accident/incident forms on-site?				
Field team review sheets signed?				
Additional hospital route directions available?				
Visitors logbook being accurately maintained?				
MSDSs available for all chemicals on-site?				
HASP revisions recorded?				
First-aid kit inspected weekly?				
Are daily safety meetings held?				
Emergency procedures discussed during safety meetings?				

COMMENTS:_____

N/A-Not applicable

BLASLAND, BOUCK LEE, INC.

Project #_____

INCIDENT PREVENTION OBSERVATION FORM

EMERGENCY RESPONSE	YES	NO	N/A	
/ehicle available on-site for transpiration to the hospital?				
Fire extinguishers on-site and immediately available at designated work areas?				
At least one person trained in CPR and first-aid on-site				
at all times during work activities?				
All personnel know who is trained in CPR/First Aid?				
PERSONAL PROTECTIVE EQUIPMENT (PPE)				
Proper PPE being worn as specified in the HASP? Level of PPE being worn				
PPE adequate for work conditions? (If not give reason) Upgrade/downgrade to PPE level				
Does any employee have facial hair that would interfere with fit of respirators? If yes, willing to shave as necessary?				
Fit tested within the last year? (Documentation present)				
If level B, back-up emergency person suited up? (except for air)				
HSS periodically inspects PPE and equipment?				
PPE not in use properly stored?				
Air Monitoring Equipment				
All equipment required in HASP on-site?				
Properly calibrated?				
In good condition?				
Used properly?				
Other equipment needed?				
List				
Monitoring equipment covered with plastic to minimize contamination?				
PERSONAL AND EQUIPMENT DECONTAMINATION				
Decon area properly designated?				
Appropriate cleaning fluid used for known or suspected contaminants?				
Appropriate decon procedures used?				
Decon personnel wearing proper PPE?				
Equipment decontaminated?				
Sample containers decontaminated?				
Disposable items replaced as required?				

COMMENTS: _____

N/A-Not applicable

BLASLAND, BOUCK LEE, INC.

Project #_____

INCIDENT PREVENTION OBSERVATION FORM

WORK PRACTICES	YES	NO	N/A	
Proper collection and disposal of potentially contaminated PPE?				
Proper collection and disposal of decon fluid?				
Water available for decon?				
Buddy system used?				
Equipment kept off drums and ground?				
Kneeling or sitting on drums or ground prohibited?				
Personnel avoid standing or walking through puddles or stained soil?				
Work Zones established?				
If night work is conducted is there adequate illumination?				
Smoking, eating, or drinking in the exclusion or CRZ prohibited?				
To the extent feasible, contaminated materials handled remotely?				
Contact lenses not allowed on-site?				
Entry into excavations not allowed unless properly shored or sloped?				
Competent person on-site during excavation?				
All unusual situations on-site listed in HASP?				
If not, what?				
Action taken?				
HASP revised?				
CONFINED SPACE ENTRY				
Employees Trained According to 1910.146				
All confined spaces identified?				
If not list.				
All appropriate equipment available and in good working order?				
Equipment properly calibrated?				
Confined space permits used?				
Confined space permits completely and correctly filled out?				

Comments: _____

N/A-Not applicable

APPENDIX E
DAILY AIR MONITORING LOG

DAILY AIR MONITORING LOG

Project: **Date:**

Monitoring Instruments:

Air Monitor: **Activity:**

Level of Protection:

Time	Location	Instrument Reading	Comments

APPENDIX F
DAILY PROJECT REPORT

DAILY PROJECT REPORT

SHT___ OF ___

	DAY: DATE:
	NAME:
	SIGNATURE:

ACTIVITIES PERFORMED:

	TOTAL:_____HOURS
	CK'D BY:

GENHASP.WPD

APPENDIX G
UNDERGROUND/OVERHEAD UTILITIES CHECKLIST

UNDERGROUND/OVERHEAD UTILITY CHECKLIST

Project Name/Number_____ **Date**_____
Location_____
Prepared By_____ **Project Manager**_____

This checklist must be completed for any intrusive subsurface work such as excavation or drilling. It documents that overhead and underground utilities in the work are identified and located. The Project Manager shall request utility markouts before the start of field operations to allow the client and utility companies sufficient time to provide them. If complete information is not available, a magnetometer or other survey shall be performed to locate obstacles prior to intrusive subsurface activities.

Procedure

A diagram of the work area depicting the proposed location of intrusive subsurface work sites (i.e., boring locations, excavation locations) must be attached to this form. The diagram must clearly indicate the areas checked for underground structures/utilities, and overhead power lines. This form and the diagram must be signed by the BBL Project Manager (if present), the BBL Site Supervisor, and the client representative.

Checklist

Type of Structure	Present	Not Present	Method of Markout
Electric Power Line			
Natural Gas Line			
Telephone Line			
Water Line			
Product Line			
Sewer Line			
Steam Line			
Drain Line			
Underground Tank			
Underground Cable			
Overhead Power Line			
Overhead Product Line			
Other (Specify)			

Client Representative_____ Date_____

BBL Project Manager_____ Date_____

BBL Site Supervisor_____ Date_____

TABLE 1-3

MOUND B, KIN-BUC LANDFILL
EDISON, MIDDLESEX COUNTY, NEW JERSEY

METHOD-SPECIFIED DETECTION LIMITS

Parameter	Limit (mg/L)*
TCLP	
Volatile Organics	
Benzene	0.0010
Carbon Tetrachloride	0.0020
Chlorobenzene	0.0050
Chloroform	0.0050
1,2-Dichloroethane	0.0020
1,1-Dichloroethene	0.0020
Methyl Ethyl Ketone	0.0050
Tetrachloroethene	0.0010
Trichloroethene	0.0010
Vinyl Chloride	0.0050
Semivolatiles	
O-Cresol	0.080
M&P-Cresol	0.080
1,4-Dichlorobenzene	0.080
2,4-Dinitrotoluene	0.0080
Hexachlorobenzene	0.0040
Hexachlorobutadiene	0.0080
Hexachloroethane	0.0040
Nitrobenzene	0.0040
Pentachlorophenol	0.16
Pyridine	0.080
2,4,5-Trichlorophenol	0.080
2,4,6-Trichlorophenol	0.080
Metals	
Arsenic	0.0038
Barium	0.0014
Cadmium	0.0004
Chromium	0.0010
Lead	0.0025
Mercury	0.0001
Selenium	0.0048
Silver	0.0014

TABLE 1-3 (CONTINUED)

MOUND B, KIN-BUC LANDFILL
EDISON, MIDDLESEX COUNTY, NEW JERSEY

METHOD-SPECIFIED DETECTION LIMITS

Parameter	Limit (mg/L)*
TCLP	
Pesticides	
Chlordane	0.0050
Endrin	0.0010
Gamma-BHC (Lindane)	0.0010
Heptachlor	0.0010
Heptachlor epoxide	0.0010
Methoxychlor	0.0010
Toxaphene	0.010
Herbicides	
2,4-D	0.080
2,4,5-TP (Silvex)	0.080
2,4,5-T	0.080
Other RCRA Parameters	
pH	NA
Ignitability	NA
Reactive Cyanide	25 mg/kg
Reactive Sulfide	20 mg/kg
Additional Parameters	
PCBs (All Aroclors)	67
TPH	25 mg/kg

Notes:
* Limits are in mg/L, unless otherwise specified.
NA - Not applicable.

Stephen A. Cox, P.G.
Project Officer

Mr. Cox is a registered professional geologist with more than 15 years of technical and management experience in the areas of hazardous waste site investigation, CERCLA RI/FS, and Remedial Action implementation in USEPA Regions 1, 2, and 3. His fields of expertise also include hydrogeologic investigation/analysis, including aquifer pump testing and computer modeling; surface and borehole geophysical investigations; contaminant source characterization investigations; due diligence assessments; and expert witness testimony/litigation support for ECRA/ISRA, CERCLA Section 107 cost recovery claims, and NCP compliance.

Project Manager for a hydrogeologic investigation of the Brunswick Formation in New Brunswick, New Jersey for a confidential client. Perchloroethylene (PCE) and No. 2 fuel oil are evident in ground water at levels that suggest a three-phase (DNAPL-PCE, dissolved phase volatile organics, LNAPL-fuel oil) problem in fractured bedrock. BBL is implementing a RI under an ACO with the NJDEP in conformance with 7:26-E protocols. The key to our RI strategy is the use of a predictive solute transport model of the Brunswick Formation to estimate the extent of off-site dissolved-phase transport of volatile organics.

Project Manager for a New Jersey Pollutant Discharge Elimination System (NJPDES) permitting project at a confidential client's facility located in New Jersey. Activities included an expedited permit application package preparation, including a pre-application conference, to properly register a series of non-hazardous wastewater discharges to Class V injection wells at the facility.

Assisting Martin-Marietta Corporation, Aerospace Division as a technical expert in a settlement negotiation resulting from litigation. The litigation was initiated by an adjacent property owner due to alleged ground-water contamination with trichloroethylene. The solvent release allegedly was related to prior facility operations. The project was initiated under the ECRA program.

Project Manager for RI/FS/RD and oversight of an $8 million RA under a NJDEP directive at a former chemical manufacturing facility in New Jersey where on-site and off-site soils and ground water are contaminated with organochlorine pesticides and VOCs. Project included a preliminary human health risk assessment and a risk-based determination of appropriate cleanup levels, complete source characterization investigation including a detailed review of historical aerial photographs and extensive soil sampling/analysis using a field GC/MS instrument; source mass volume determination; source removal oversight; and post-removal investigations to demonstrate that applicable regulatory standards were achieved. Project activities also involved extensive regulatory liaison/negotiation and litigation support services as a technical expert in cost recovery litigation against the client's insurance carrier, and in a motion of stay pending appeal regarding the NJDEP cleanup levels for the compounds of interest at the site.

Project Manager for a $1.8 million Removal Action (RA) under a USEPA Region 2 CERCLA Administrative Order for an inactive industrial facility in Andover, New Jersey. Project involved excavation, transportation, and disposal of 9,000 tons of lead-bearing inorganic wastes; hydrogeologic investigations; a qualitative ecological assessment of environmentally sensitive areas including an intermittent stream, wetlands, and a nearby lake; and a complete site restoration effort including slope stabilization measures. Project was successfully completed, allowing the client to receive full AO approval from USEPA Region 2, under an expedited completion schedule.

Remedial Investigation Manager for the $1.68 million RI/FS of the PJP Landfill NPL site in Jersey City, New Jersey, under a NJDEP directive. Managed a field investigation including monitoring well installations, a ground-penetrating radar survey using specially shielded antennae to locate buried drums adjacent to footings for a highway superstructure, test pit excavations to characterize GPR anomalies, remote-controlled drum sampling and excavation/removal, and sampling of soil, ground water, air, sediments, surface water, and leachate. Surface water and sediment sampling was conducted in the Hackensack River and an associated tributary, both tidally influenced.

Project Manager for a Remedial Investigation/Feasibility Study (RI/FS) at an inactive asphalt products manufacturing facility located in East Rutherford, New Jersey under the New Jersey ECRA/ISRA program. Obtained regulatory approvals for all work completed to date in anticipation of implementing a Remedial Action costing approximately $750,000 to mitigate site soils. Providing litigation support services as a technical expert in cost recovery claim filed in U.S. District Court on behalf of client.

Project Manager for the $950,000 RI/FS successfully completed at the Pinettes Salvage Yard NPL site in Washburn, Maine (USEPA Region 1), under a REM III Superfund contract. Had overall responsibility for technical and financial management of the project through ROD signing. Project activities included a two-phased RI on a fast-track schedule to perform a contaminant source characterization related to a prior spill of transformer dielectric fluid containing a PCB (Aroclor-1260) and VOCs including chlorobenzene, ethylbenzene, dichlorobenzene isomers, and trichlorobenzene. An on-site dual gas chromatograph mobile laboratory was used to screen surface and subsurface soil samples to delineate the extent of contamination. A detailed Public Health Evaluation and Endangerment Assessment was performed to assess risks to human health and to evaluate impacts to ecological receptors in adjacent wetlands and the Aroostook River due to off-site migration of contaminants. A subsequent FS identified the preferred alternatives of off-site incineration and on-site solvent extraction for soils, and collection and treatment of ground water by carbon adsorption.

Task Manager for a hydrogeological assessment, under a USEPA REM II contract, of the D'Imperio Property NPL site in Hamilton, Township, New Jersey. On-site coordinator for field investigation activities, wrote technical specifications and bid packages, conducted long-term aquifer pump testing of the Upper and Lower Cohansey aquifers, and participated in three-dimensional finite element flow and contaminant transport modeling.

Task Manager for UST closure program at the Naval Weapons Station - Earle in Colts Neck, New Jersey, under an indefinite delivery contract with the U.S. Navy. Ground-penetrating radar was used to locate 60 USTs, possible releases were investigated, a UST Closure Plan was developed including a model for the Discharge Investigation and Corrective Action Report (DICAR). A comprehesive site characterization/subsurface investigation was conducted, sampling/corrective action plans were developed, and the USTs were properly closed and replaced

with aboveground storage tanks, for which a detailed design/technical specifications/bid documents were prepared.

Managed and supervised the geophysical and hydrogeological phases and on-site coordination for the Department of Defense (DOD) RI/FS at the Fort Dix Sanitary Landfill NPL site in Pemberton Township, New Jersey. Work included surface geophysical investigations involving electromagnetic induction and resistivity techniques, monitoring well installation, open-hole geophysical logging, and field permeability testing.

Served as Project Manager for a number of Environmental Assessments in New Jersey and Connecticut.

Assisted in the development of a New Jersey Water Supply Authority regional water quality monitoring program for the Manasquan River Reservoir Project.

Managed or performed geophysical surveys at the Industrial Excess Landfill NPL site, Canton, Ohio; Lipari Landfill NPL site, Pitman, New Jersey; Seymour Johnson Air Force Base, Greensboro, North Carolina; Cinnaminson Ground Water Contamination Study Area NPL site, Cinnaminson, New Jersey; Hawkes Point Controlled Hazardous Waste Landfill, Baltimore, Maryland; Stafford Township contaminated well field, Manahawkin, New Jersey; Oakwood Beach WPCI Project, Staten Island, New York; and numerous other sites.

Provided expert witness services in U.S. Federal Bankruptcy Court during litigation involving the applicability of New Jersey ECRA regulations to an asset purchase agreement. Supported case strategy development including document file review, case file review, and regulatory agency interviews to determine validity of a petition for Negative Declaration and a Full Compliance letter for an incomplete remedial program undertaken by Plaintiffs. Attended four-day trial and provided expert witness testimony including direct and cross-examination on behalf of Defendants.

Education

- BS/Geology, 1981, Lafayette College

Registrations

Professional Geologist - South Carolina, 1987, #173
Professional Geologist - Tennessee, 1988, #0546
Professional Geologist - Florida, 1992, #1047

Selected Publications/ Presentations

Saunders, W.R., and Cox, S.A. "Use of an Electromagnetic Induction Technique in Subsurface Hydrocarbon Investigations". Presented at the NWWA First National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, Nevada, 1987.

Saunders, W.R., and Cox, S.A. "Technical and Logistical Problems Associated With the Implementation and Integration of Surface Geophysical Methods in Inactive Hazardous Waste Site Investigations". Presented at the NWWA Second National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, Nevada, 1988.

Cox, S.A., "Use of Field GC/MS Screening Techniques for Assessing Remedial Action Implementation Effectiveness." Presented at the NGWA Seventh National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, Nevada, May 1993.

Cox, S.A., and Haasbeck, J., "Effects of Cosolvency on the Fate and Transport of PCBs in Soils - a Case History". Presented at the HMCRI Hazardous Materials Control '91 Superfund Conference, Washington, D.C., December 1991.

Saunders, W.R., Smith, S., Gilmore, P., and Cox, S.A., "The Innovative Application of Surface Geophysical Techniques for Remedial Investigations". Presented at the NWWA Fifth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, Nevada, May 1991.

Cox, S.A., and Saunders, W.R., "Application of Electromagnetic and Ground Penetrating Radar Geophysical Techniques for Identifying Zones of Potential Subsurface Contamination". Presented at the NWWA Fourth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, Nevada, May 1990.

Kris D. Hallinger
Project Manager

Mr. Hallinger has more than 12 years of experience in environmental consulting, with an emphasis on risk assessment and environmental evaluation projects. His fields of competence include site investigation/remediation; property transfer assessments; risk assessment; ecological evaluations; and wetlands work. Project experience includes management of, and participation in, projects involving biomonitoring, human health and ecological risk assessment, aquatic toxicology, sampling and analysis plan development and implementation, environmental impact assessments, environmental permitting, and indirect exposure (food chain) assessments.

Ecological Evaluations / Wetlands

Participated in a variety of biomonitoring assessment projects involving field and laboratory work. Collected and identified aquatic macro-invertebrates as part of ecological assessment projects. Conducted biomonitoring projects to determine effects of sediment and suspended solids on uptake and bioaccumulation of heavy metals in freshwater and estuarine organisms. Assessed fate and mobility of metals in acidified lakes. Evaluated biofouling control methodologies and technologies for power generating industry.

Conducted a Habitat Assessment at the Dixie Auto Salvage Site in Danville, Illinois to characterize the plant and animal communities that exist on site, and identify species of special concern and/or critical habitats on site and in the surrounding area. The habitat assessment involved a site visit and walkover, and field reconnaissance within a one-half mile radius of the site; discussions with Illinois Department of Natural Resources (IDNR) and Natural Resource Conservation Service (NRCS) personnel regarding natural environmental conditions in the area of the site; and written requests to the U.S. Fish and Wildlife Service (USFWS) and the IDNR for information related to threatened/endangered species and critical habitats within two miles of the site. Information collected from the field evaluation was used to develop a Vegetation/Habitat Coverage Map for the Site. Based on the baseline information generated by the assessment, actions were identified that reduced the potential for adverse ecological impacts from physical disturbance associated with site remediation activities.

Provided oversight of wetlands mitigation project to ensure compliance with New Jersey Department of Environmental Protection (NJDEP) regulatory requirements. Project involved wetlands delineation, excavation of impacted wetlands area, and restoration of the area by replanting with indigenous wetland species.

Coordinated permitting project for site development along a tidal creek in northern New Jersey. Project involved Pre-application Meeting with NJDEP, development of Jurisdictional Letter to NJDEP, Wetlands Restoration File Review, LOI Application Preparation, and Waterfront Development Permit Application preparation. Assisted client in positioning site improvements to avoid wetland areas and transition zones, thus avoid wetland permitting requirements. Development of the WDP involved preparation of a Compliance Statement addressing specific issues of the Coastal Zone Management Regulations (N.J.A.C. 7:7E), including: Coastal High Hazard Areas, Filled Water's Edge, Flood Hazard Area, Wetlands and Buffers, Endangered Species/Critical Habitats, Water Quality, Stormwater Management, and others.

Managed wetland delineation and mitigation bank evaluation project at a closed landfill site in Cape May County, New Jersey. Project involved preparation of a Letter of Interpretation (LOI) for on-site wetlands, mapping of delineation lines and transition areas, evaluation of technical and economic feasibility of wetland bank development, identification of permitting requirements, preparation of a conceptual plan for construction of the wetland mitigation bank, and presentation of the plan to appropriate resource trustees and regulatory agencies.

Prepared Detailed Wetlands Mitigation Plan, based on a Conceptual Wetlands Mitigation Study, for restoration of freshwater and tidal wetlands at a Landfill Superfund Site in northern New Jersey. Conceptual Study was used to develop feasible mitigation alternatives and to select an appropriate alternative acceptable to USEPA, NJDEP, and other natural resource trustees. Mitigation Plan included a summary of wetland delineation work at the site, summary of Conceptual Study, and detailed plans for implementing freshwater wetlands replacement and tidal wetlands enhancement at selected mitigation sites. Freshwater wetlands mitigation involved selection of hydrologically acceptable locations for seeding/planting, and modification of the Operations and Maintenance Plan for the site to allow natural recolonization at selected areas. The tidal wetlands mitigation work involved construction of a boundary ditch around the mitigation area, implementation of a Phragmites eradication program, and enhancement of the area through natural recolonization. A contingency plan involving seeding/planting of emergent tidal wetland species, and a restoration monitoring program were also developed as part of the mitigation plan. The plan was accepted by USEPA Region 2, and was implemented in 1997. Wetlands mitigation monitoring was initiated in 1997 and will continue for a 5-year period.

Conducted an upland habitat assessment at the Caldwell Trucking Site in Fairfield, New Jersey to characterize the plant community in an area scheduled for remediation. The purpose of the assessment was to identify tree, shrub, and herbaceous species for post-remediation site restoration purposes. The upland habitat assessment involved establishment of longitudinal transect lines across the wooded upland area, and use of the Point-Quarter Method to gather representative data on tree and shrub species. Information/data collected from the field evaluation was used to perform statistical analyses which identified the dominant tree and shrub species. Based on the evaluation, tree and shrub species were selected for post-remediation planting that would allow restoration of the original upland community.

Evaluated biofouling control methodologies and technologies for China Light & Power, the largest power generating company in China. The project involved a review of the existing outfall structures and nature of existing discharge; screening available technologies based on site-specific infrastructure and environmental conditions; selecting technologies that would best achieve biofouling control given site conditions; and performing a cost-benefit analysis for the selected technologies. Based on the evaluation, recommendations regarding the most efficient, cost-effective alternatives were provided to the client.

Prepared a work plan for submission to the Michigan Department of Environmental Quality (MDEQ) to conduct a sediment evaluation and aquatic habitat assessment at Holnam, Inc.'s Dundee facility. The work plan focused on the procedures for evaluating potential point source and non-point source impacts to benthic macroinvertebrate communities in accordance with MDEQ's GLEAS Procedure #51 entitled Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers (MDEQ, 1997). Components of the sediment evaluation included establishment of sampling stations along Macon Creek based on limited historical sampling work and field reconnaissance, collection and identification of benthic macroinvertebrates from designated stations, and collection of surface water and sediment samples in accordance with MDEQ protocol for inorganic parameter analyses, and a habitat assessment to identify and document the various habitat types found along Macon Creek in proximity to the site. An integrated evaluation of data was proposed to gain an understanding of the nature of impacts to the biota, if any, and to identify specific source areas of potential impacts for targeted remedial action.

Site Investigation/Remediation

Supervised the preparation of a Conceptual Plan and subsequent Work Plan for restoration activities at the Mound B area at Kin-Buc Landfill Superfund site in Edison, New Jersey. The Conceptual Plan presented an outline for integrating a focused drum removal action with restoration of the adjacent riverfront and the existing Mound B cover system. A vegetative cap called the Ecolotree Cap (ECap) was proposed as the new cover system to control potential direct contact with refuse, and manage the potential for residual subsurface soil acting as a potential future source of ground-water contamination. BBL worked closely with Ecolotree, Inc. to design an ECap consisting of fast-growing, deep-rooted hybrid poplar trees that use evapotranspiration to prevent water from penetrating into contaminated soil or landfill waste. Hybrid poplars were selected for this phytoremediation application because they are easily propagated, develop deep root systems, exhibit high water uptake rates, and are tolerant of high concentrations of organic contaminants. Additionally, research has shown that hybrid poplar trees develop dense root systems, or rhizospheres, that support large populations of microorganisms capable of enhancing the biodegradation of organic contaminants. Ancillary benefits of the tree cap, such as creation of a carbon dioxide sink for greenhouse gas sequestration and creation of wildlife habitat, helped gain approval of this alternative approach from USEPA Region 2.

Managed remedial investigation (RI) involving soil borings and test pits to identify the horizontal and vertical extent of a former industrial wastewater lagoon. Investigation included soil sampling and analysis to characterize residual soil/sludge material, and installation and sampling of a monitoring well network surrounding the former lagoon. Investigation results indicated the presence of polychlorinated biphenyls (PCBs) in residual lagoon sludge, but an absence of PCBs in ground water. Conducted preliminary feasibility study and developed order-of-magnitude remediation cost estimates based on results. Also, developed

approach for managing material in place using an alternative direct exposure criterion for PCBs and institutional/engineering controls.

Supervised numerous ISRA projects including soil and ground-water remedial investigations, cleanup strategy development, and remedial action plan preparation and implementation. Obtained regulatory approval for remedial actions at ISRA sites based on natural attenuation and degradation of contaminants in ground water, as well as for remedies involving active treatment.

Managed and participated in permitting effort in support of soil/sediment remediation activities at an industrial facility in northern New Jersey. Permit work involved completion of applications for a combined wetlands/stream encroachment permit as well as preparation of a Soil Erosion and Sediment Control Plan (SESCP) to obtain certification from the local Soil Conservation District. Project also involved meetings with NJDEP personnel and the Township Engineer to confirm permitting requirements.

Prepared a sediment sampling plan for Cytec Industries Inc.'s Warners facility to evaluate the nature and extent of constituents of concern in river sediments adjacent to the site. Developed strategy to evaluate alternative assessment methodologies in support of site-specific sediment quality criteria. Approach considered shifting from bulk sediment chemical analyses to evaluation of bioavailability of constituents. Sediment data was evaluated based on statistical comparison between sampling locations within the Rahway River and background data for the Newark Bay complex (New Jersey/New York). Assisted in developing remedial approach for Rahway river sediments based on statistical data evaluation.

Developed and implemented a Pre-Design Investigation (PDI) Work Plan for the Oliver Landfill site in accordance with the Consent Order Agreement (COA) between Waste Management of Pennsylvania (WMPA) and the Pennsylvania Department of Environmental Protection (PADEP). Investigation activities included a visual inspection of the existing landfill cover; an intrusive physical inspection (grid soil sampling) of the landfill cell to evaluate the thickness of the cover; test pit excavations to identify a potential low permeability layer of silt and clay; visual inspection of the existing diversion pipe, culverts, and field tile drain; installation of overburden monitoring wells to enhance the existing ground-water monitoring network and to serve as "sentinel" wells to monitor ground-water quality along the principal flow direction as it exits the site; collection of ground-water samples from the nine existing and three newly installed site monitoring wells for analysis of Target Compound List (TCL) volatile organic compounds (VOCs), Target Analyte List (TAL) metals, Total Dissolved Solids (TDS), and site-specific indicator parameters to assess the potential for intrinsic remediation; aquifer permeability tests (slug tests) on five monitoring wells; two-dimensional fate and transport modeling for three VOC constituents; and wetland delineation work. Results of the PDI were used to refine the design of a ballfield recreational facility; drainage features; a tree cap on the waste cells; and a constructed wetland basin as part of the final remedial design for the site.

Appendix D

Quality Assurance Project Plan

TECHNICAL REPORT

Quality Assurance Project Plan

Kin-Buc Landfill Site
Edison, New Jersey

March 2000

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

8 South River Road
Cranbury, New Jersey 08512-9502
(609) 860-0590

Table of Contents

Section 1. **Project Description 1-1**

1.1 Introduction 1-1
1.2 Objectives 1-2
1.3 Data Quality Objectives and Criteria for Measurement Data 1-2
1.3.1 General 1-2
1.3.2 DQO Summary for Intact Drum Sampling and On-Site Hazcat Analysis 1-3
1.3.3 DQO Summary for Composite Sampling and Analysis of Wastestream Materials 1-4
1.3.4 DQO Summary for Sampling and Analysis of Removed Associated Materials 1-5

Section 2. **Project Organization and Responsibilities 2-1**

2.1 Project Organization 2-1
2.1.1 Overall Project Management 2-1
2.1.2 Task Managers 2-1
2.1.3 Analytical Laboratory and Data Validation 2-1
2.1.4 Quality Assurance Staff 2-1
2.2 Team Member Responsibilities 2-2
2.2.1 Blasland, Bouck & Lee, Inc. 2-2
2.2.2 Analytical Laboratory 2-3
2.2.3 Other Contractors 2-4
2.2.4 United States Environmental Protection Agency 2-5

Section 3. **Analytical Methods and Quality Control Requirements 3-1**

3.1 Selection of Measurement Parameters, Laboratory Methods and Field Testing Methods 3-1
3.1.1 Field Parameters and Methods 3-1
3.1.2 Laboratory Parameters and Methods 3-1
3.2 Quality Assurance Objectives 3-1
3.2.1 Representativeness 3-1
3.2.2 Comparability 3-2
3.2.3 Completeness 3-2
3.2.4 Precision 3-2
3.2.5 Accuracy 3-2

Section 4. **Field Procedures 4-1**

4.1 Sample Containers and Preservation 4-1
4.2 Packing, Handling, and Shipping Requirements 4-1

Section 5. **Sample and Document Custody 5-1**

5.1 Field Procedures 5-1

5.2 Laboratory Procedures 5-1
5.2.1 General 5-1
5.2.2 Sample Receipt and Storage 5-1
5.2.3 Sample Analysis 5-1
5.2.4 Laboratory Project Files 5-2
5.3 Project File 5-2

Section 6. **Calibration Procedures 6-1**

6.1 Field Equipment Calibration Procedures and Frequency 6-1
6.2 Laboratory Equipment Calibration Procedures and Frequency 6-1

Section 7. **Analytical Procedures 7-1**

7.1 Field Analytical Procedures 7-1
7.2 Laboratory Analytical Procedures 7-1
7.2.1 General 7-1

Section 8. **Data Reduction, Review, and Reporting 8-1**

8.1 Field Data Reduction, Review and Reporting 8-1
8.1.1 Field Data Reduction 8-1
8.1.2 Field Data Review 8-1
8.1.3 Field Data Reporting 8-1
8.2 Laboratory Data Reduction, Review and Reporting 8-1
8.2.1 Laboratory Data Reduction 8-1
8.2.2 Laboratory Data Review 8-2
8.2.3 Laboratory Data Reporting 8-2

Section 9. **Field and Laboratory Quality Control Checks 9-1**

9.1 Field Quality Control Checks 9-1
9.1.1 Field Measurements 9-1
9.1.2 Sample Containers 9-1
9.1.3 Field Duplicates 9-1
9.1.4 Rinse Blanks 9-1
9.1.5 Trip Blanks 9-1
9.2 Laboratory Quality Control Checks 9-2
9.2.1 Method Blanks 9-2
9.2.2 Matrix Spikes/Matrix Spike Duplicates 9-2
9.2.3 Surrogate Spikes 9-2
9.2.4 Laboratory Duplicates 9-2
9.2.5 Calibration Standards 9-2
9.2.6 Internal Standards 9-3
9.2.7 Reference Standards 9-3

Section 10. **Performance and System Audits** **10-1**

10.1 Field Audits 10-1
10.1.1 Performance Audits 10-1
10.1.2 Internal Systems Audits 10-1
10.1.3 External Audits 10-1
10.2 Laboratory Audits 10-1
10.2.1 Performance Evaluations 10-2
10.2.2 External Audits 10-2

Section 11. **Preventative Maintenance** **11-1**

11.1 Field Instruments and Equipment 11-1
11.2 Laboratory Instruments and Equipment 11-1

Section 12. **Data Assessment Procedures** **12-1**

12.1 Data Precision Assessment Procedures 12-1
12.2 Data Accuracy Assessment Procedures 12-1
12.3 Data Completeness 12-1

Section 13. **Corrective Action** **13-1**

13.1 Field Procedures 13-1
13.2 Laboratory Procedures 13-1
13.2.1 General 13-1
13.2.2 Laboratory Procedures 13-1

Section 14. **Quality Assurance Report** **14-1**

14.1 Final Report 14-1

Section 15. **References** **15-1**

Tables.

1-1 Environmental and Quality Control Samples and Analyses
1-2 Parameters, Methods, Sample Containers, Preservation Methods And Holding Time Requirements
1-3 Method-Specified Detection Limits

Attachments.

A Resumes
B USEPA Environmental Response Team SOP #2009
C USEPA Environmental Response Team SOP #2017
D USEPA Environmental Response Team SOP #2006
E Sample Chain-Of-Custody Form
F FID Maintenance and Calibration Procedures
G Corrective Action Form

1. Project Description

1.1 Introduction

This Quality Assurance Project Plan (QAPP) is to be used to support the implementation of the field activities described in the Mound B Work Plan (Work Plan) for the Mound B Area of the Kin-Buc Landfill Site in Edison, Middlesex County, New Jersey. This QAPP presents sampling and analytical methods and procedures to be used throughout the implementation of the Work Plan. The Work Plan and this QAPP are integrated and cross-referenced where applicable to minimize redundancy.

This QAPP was prepared in a manner consistent with the following documents:

- Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures, OSWER Directive Number 9360.4-01;
- Environmental Response Team Standard Operating Procedures, OSWER Directive Numbers 9360.4-02 through 9360.4-08;
- Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring, USEPA, Office of Water Regulations and Standards, May 1984; and
- SW-846, Section 10.

Information contained in the QAPP has been organized into the following sections:

Section	Content
1	Project Description
2	Project Organization and Responsibilities
3	Analytical Method and Quality Control Requirements
4	Sampling Procedures
5	Sample and Document Custody
6	Calibration Procedures and Frequency
7	Analytical Procedures
8	Data Reduction, Validation, and Reporting
9	Field and Laboratory Quality Control Checks
10	Performance and System Audits
11	Preventive Maintenance
12	Data Assessment Procedures
13	Corrective Action
14	Quality Assurance Reports to Management
15	References

Details are provided in the subsequent sections. This document also contains pertinent information from the Work Plan related to the measurement and evaluation of analytical data.

1.2 Objectives

The purpose of the QAPP is to present the quality assurance/quality control (QA/QC) procedures to be implemented during sampling and analysis activities. The QAPP has been developed to provide data quality which is sufficient to meet the objectives of the Work Plan. The overall purpose of the Work Plan is to remove intact drums and associated materials in the landfill, enhance the portion of the Raritan Riverfront which borders the Mound B property, and to install an Ecolotree Cap in a phased approach for final closure cover over the Mound B area. To meet these objectives, intact drums and associated materials will be removed from the landfill area. Data will be obtained from the potentially hazardous materials to ascertain proper transportation and disposal options.

1.3 Data Quality Objectives and Criteria for Measurement Data

1.3.1 General

Data quality objectives (DQOs) are statements, in either qualitative or quantitative terms, regarding the appropriate data quality for an investigation. DQOs are typically determined through an iterative process and are refined as additional information becomes available; they are initially established based on the intended end use of the data to be obtained. General project DQOs for the Work Plan are summarized in this section, with detailed information provided throughout the QAPP and the Work Plan.

Generally, the data generated during the implementation of the Work Plan will be used to characterize wastes generated during removal activities to determine proper transportation and disposal options.

To obtain information necessary to meet the objective stated above, the following field activities will be conducted:

- Intact Drum Sampling and On-Site Hazard Categorization (Hazcat) Analysis;
- Composite Sampling and Analysis of Wastestream Materials; and
- Sampling and Analysis of Removed Associated Materials.

Preliminary DQOs were identified and incorporated into the development of the Work Plan and QAPP to ensure that the data generated during field investigations will be of adequate quality and sufficient quantity to form a sound basis for decision-making purposes relative to the above objectives. Data quality objectives have been specified for each data collection activity or investigation. The DQOs presented herein address investigation efforts only and do not cover health and safety issues, which are addressed in detail in the Health and Safety Plan for this project.

A wide range of data quality is achieved through the use of various analytical methods. There are three analytical categories that address various data uses and the QA/QC effort and methods required to achieve the desired level of quality. These categories are:

- Screening Data: Screening data affords a quick assessment of site characteristics or conditions. This objective for data quality is available for data collection activities that involve rapid, non-rigorous methods of analysis and quality assurance. This objective is generally applied to physical and/or chemical properties of samples, degree of contamination relative to concentration differences and preliminary health and safety assessment.

- Screening Data with Definitive Confirmation: Screening data provides rapid identification and quantitation, however, since screening generally involves the use of less precise methods of analysis with less rigorous sample preparation, the quantitation may be relatively imprecise. Generally, at least 10 percent of the data are confirmed using analytical methods and QA/QC procedures and criteria associated with definitive data. This objective can

also be used to verify less rigorous laboratory-based methods. This objective of data quality is available for data collection activities that require qualitative and/or quantitative verification of a select portion of sample findings.

- Definitive Data: Definitive data are generated using rigorous analytical methods, such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data (e.g. chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For data to be definitive, either analytical or total measurement error must be determined. Definitive data are used for site characterization, environmental monitoring, confirmation of field data and to support engineering studies or risk assessments. Definitive data are used for the confirmation of lower level data, risk assessment and to obtain highly documented data.

It is anticipated that both the screening and definitive data categories will be used during the removal activities.

For the purposes of the implementation of the Work Plan, three levels of data reporting have been defined. They are as follows:

- Level 1 - Minimal Reporting: Minimal or "results only" reporting is used for analyses which, either due to their nature (i.e., field monitoring) or the intended data use (i.e. preliminary screening), do not generate or require extensive supporting documentation.

- Level 2 - Limited Reporting: Limited reporting is used when some additional QC information is required. The documentation includes sample analytical results as well as summarized QC sample results.

- Level 3 - Expanded Reporting: Modified reporting is used for analyses which are performed following standard USEPA-approved methods and QA/QC protocols and which, based on the intended data use, require some supporting documentation but not, however, full "Contract Laboratory Program (CLP)-type" reporting.

The reporting level for the sampling effort described herein and a DQO summary for the Mound B field activities are presented below. The summary consists of stated DQOs relative to the following items:

- Data Uses;
- Data Types;
- Data Quality;
- Data Quantity;
- Sampling and Analytical Methods; and
- Measurement Performance Criteria - Data Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC Parameters).

1.3.2 DQO Summary for Intact Drum Sampling and On-Site Hazcat Analysis

Data Uses

Samples of all materials contained in removed intact drums will be collected. On-site hazard categorization will be conducted on all samples to separate/classify materials into compatible wastestreams.

Data Types

Following sampling activities, all samples will be subjected to the following hazcat tests:

- pH;
- water reactivity;
- water and hexane solubility;
- flammability/combustibility;
- oxidation/reduction (Redox) potential;
- specific gravity;
- chlorine hot wire test for halogenated compounds;
- cyanide sulfide, and organic peroxide determinations; and
- air reactivity.

Data Quality

Screening data will be generated for the on-site hazard categorization. Data reporting will be Level 1.

Data Quantity

One sample will be collected for each intact drum removed from the landfill. If a drum contains material in multiple phases, each phase will be sampled.

The total number of samples collected is pending results of excavation activities.

Sampling and Analytical Methods

Initial drum samples will be analyzed on-site only. The hazcat tests are listed above, and are advocated by the Chemical Manufacturers Association.

1.3.3 DQO Summary for Composite Sampling and Analysis of Wastestream Materials

Data Uses

Following hazcat analyses, removed intact drums will be segregated into various wastestreams. Composite sampling will be conducted for full RCRA characterization to determine proper disposal options.

Data Types

All composite samples will be sent to a NJDEP-certified laboratory for full RCRA characterization analysis. This characterization analysis will include ignitability, corrosivity, sulfur and cyanide reactivity, and toxicity by the Toxicity Characteristic Leaching Procedure (TCLP).

Additional analyses will also be performed on each sample for total petroleum hydrocarbons and PCBs.

Data Quality

Definitive data will be generated for all data. For these parameters, standard USEPA analytical methods and associated detection limits are used. Reporting will be Level 3.

Data Quantity

One composite sample will be collected from every five drums per wastestream. The total number of samples is pending the results of the excavation activities.

The associated QA/QC samples and the constituents to be analyzed for are summarized in Table 1-1.

Sampling and Analytical Methods

Sampling methods will be as specified in the Waste Characterization Sampling and Analysis Plan (WCSAP), which is provided as Appendix F of the Work Plan.

All analytical methods are summarized in Table 1-1.

Measurement Performance Criteria

Reporting limits are presented in Table 1-3 - Method Specified Detection Limits.

Data representativeness will be addressed by the sample quantities identified in the Work Plan. Data comparability will be achieved through the use of standard USEPA-approved methods. Data completeness will be assessed at the conclusion of the implementation of the Work Plan, as discussed in Section 12.

1.3.4 DQO Summary for Sampling and Analysis of Removed Associated Materials

Data Uses

During the course of removal activities, it may become necessary to remove other potentially hazardous material (i.e., free liquids or solid residues) associated with intact drums. As described in the Work Plan, this material may be placed in overpack drums, or in a lined roll-off. Composite sampling will be conducted for full RCRA characterization to determine proper disposal options.

Data Types

All composite samples will be sent to a NJDEP-certified laboratory for full RCRA characterization analysis. This characterization analysis will include ignitability, corrosivity, sulfur and cyanide reactivity, and toxicity by the Toxicity Characteristic Leaching Procedure (TCLP).

Additional analyses will also be performed on each sample for total petroleum hydrocarbons and PCBs other analyses may be included if required by the disposal facilities.

Data Quality

Definitive data will be generated for all data. For these parameters, standard USEPA analytical methods and associated detection limits are used. Reporting will be Level 3.

Data Quantity

Composite sampling will be collected per the requirements of the disposal facility, which is yet to be determined. The total number of samples is pending the results of the excavation activities.

The associated QA/QC samples and the constituents to be analyzed for are summarized in Table 1-1.

Sampling and Analytical Methods

Sampling methods will be as specified in the WCSAP, which has been included as Appendix F to the Work Plan.

All analytical methods are summarized in Table 1-1.

Measurement Performance Criteria

Reporting limits are presented in Table 1-3 - Method Specified Detection Limits.

Data representativeness will be addressed by the sample quantities identified in the Work Plan. Data comparability will be achieved through the use of standard USEPA-approved methods. Data completeness will be assessed at the conclusion of the implementation of the Work Plan, as discussed in Section 12.

2. Project Organization and Responsibilities

2.1 Project Organization

The implementation of the Work Plan will require integration of personnel from the organizations identified below, collectively referred to as the project team. A detailed description of the responsibilities of each member of the project team is presented below.

2.1.1 Overall Project Management

BBL, on behalf of SCA, has overall responsibility for the implementation of the Work Plan and will perform the field activities. In addition, BBL will be responsible for evaluating the analytical data, and determining whether additional data is warranted. Project direction will be provided by SCA personnel. A listing of key project management personnel is provided below. Resumes of BBL personnel listed below are presented in Attachment A of this QAPP.

Project Title	Company/Organization	Name	Phone Number
Project Coordinator	SCA	Carl Januszkiewcz	732-985-4757
Project Officer	BBL	Stephen A. Cox	609-860-0590
Project Manager	BBL	Kris D. Hallinger	609-860-0590
On-Scene Coordinator	USEPA	James Haklar	732-321-6730

2.1.2 Task Managers

The staff performing the investigative activities of the Work Plan will be directed by representatives of BBL. The personnel responsible for each of the Work Plan tasks are listed below.

Project Title	Company	Name	Phone Number
Field Sampling Program Task Manager	BBL	Kathleen A. Romaine	609-860-0590
Health and Safety Manager	BBL	Jay D. Keough	609-860-0590

2.1.3 Analytical Laboratory and Data Validation

Laboratory analytical services for environmental media samples associated with the implementation of the Work Plan will be provided by a NJDEP-certified laboratory. The laboratory providing services has yet to be determined.

Laboratory management personnel will be identified prior to the commencement of the implementation of the Work Plan.

Title	Company	Name	Phone Number
Laboratory Project Manager	To Be Determined		

2.1.4 Quality Assurance Staff

The QA aspects of the Mound B field activities will be conducted by BBL, representatives of the analytical laboratories, and representatives of the USEPA. To date, the following personnel have been assigned to this project component:

Title	Company/Organization	Name	Phone Number
Quality Assurance Officer	BBL	Laurie Indick	315-446-9120
Quality Assurance Officer	Laboratory TBD	TBD	
Quality Assurance Officer	USEPA	TBD	

2.2 Team Member Responsibilities

This section of the QAPP discusses the responsibilities and duties of the project team members.

2.2.1 Blasland, Bouck & Lee, Inc.

Project Officer

Responsibilities and duties include:

1. oversight of the BBL work products during the implementation of the Work Plan; and
2. provide BBL approval for major project deliverables.

Project Manager

Responsibilities and duties include:

1. management and coordination of all aspects of the project as defined in the Work Plan with an emphasis on adhering to the objectives;
2. review all documents prepared by BBL; and
3. assure corrective actions are taken for deficiencies cited during audits of Mound B sampling activities.

Task Managers

The Mound B operations will be managed by Task Managers as set forth in Section 2.1.2. Responsibilities and duties of each Task Manager include:

1. manage relevant day-to-day Work Plan implementation activities;
2. develop, establish, and maintain files on relevant Work Plan implementation activities;
3. review data reductions from the relevant Work Plan implementation activities;
4. perform final data review of field data reductions and reports on relevant Work Plan implementation activities;
5. assure corrective actions are taken for deficiencies cited during audits of relevant Work Plan implementation activities;
6. overall QA/QC of the relevant portions of the Work Plan implementation;

7. review all relevant field records and logs;

8. instruct personnel working on relevant Work Plan implementation activities;

9. coordinate field and laboratory schedules pertaining to relevant Work Plan implementation activities;

10. request sample containers from laboratories;

11. review the field instrumentation, maintenance, and calibration to meet quality objectives;

12. prepare sections of the final report pertaining to relevant Work Plan implementation activities; and

13. maintain field and laboratory files of notebooks and logs, data reductions and calculations, and transmit originals to the Project Manager.

Field Personnel

Responsibilities and duties include:

1. perform field procedures associated with the investigations as set forth in the Work Plan;

2. perform field analyses and collect QA samples;

3. calibrate, operate, and maintain field equipment;

4. reduce field data;

5. maintain sample custody; and

6. prepare field records and logs.

Quality Assurance Officer (QAO)

Responsibilities and duties include:

1. review laboratory data packages;

2. oversee and interface with the analytical laboratories as needed;

3. coordinate field QA/QC activities with task managers, including audits of Work Plan implementation activities, concentrating on field analytical measurements and practices to meet data quality objectives;

4. prepare interim QA/QC compliance reports; and

5. prepare a project QA/QC report which includes an evaluation of field and laboratory data.

2.2.2 Analytical Laboratory

General responsibilities and duties of the analytical laboratory include:

1. perform sample analyses and associated laboratory QA/QC procedures;
2. supply sampling containers and shipping cartons;
3. maintain laboratory custody of samples; and
4. strictly adhere to all protocols in the QAPP.

Project Manager

Responsibilities and duties include:

1. serve as primary communication link between BBL and laboratory technical staff;
2. monitor work loads and ensure availability of resources;
3. oversee preparation of analytical reports; and
4. supervise in-house chain-of-custody.

Quality Assurance Officer

Responsibilities and duties include:

1. supervise the group which reviews and inspects all project-related laboratory activities; and
2. conduct audits of all laboratory activities.

Sample Custodian

Responsibilities and duties include:

1. receive all samples; and
2. maintain custody of the samples and all documentation.

2.2.3 Other Contractors

General responsibilities and duties include:

1. perform excavation operations;
2. perform drum overpack and staging activities; and
3. perform hazcat analyses.

2.2.4 United States Environmental Protection Agency

Remedial Project Manager

Responsibilities and duties include:

1. provide USEPA approval of the Work Plan and supporting documents, and future Work Plan implementation deliverables;

2. provide oversight during implementation of the Work Plan.

Quality Assurance Officer

Responsibilities and duties include:

1. review and approval of the QAPP;

2. review of the QA/QC portion of the final report; and

3. field and laboratory audit responsibilities, if determined necessary.

3. Analytical Methods and Quality Control Requirements

3.1 Selection of Measurement Parameters, Laboratory Methods and Field Testing Methods

3.1.1 Field Parameters and Methods

Measurements of volatile organic vapors will be made in the field using a hand-held FID instrument. This parameter will be analyzed at each intact drum, prior to sampling. In addition, FID readings will be collected and recorded during all composite sampling activities.

3.1.2 Laboratory Parameters and Methods

Table 1-1 presents the chemical constituents slated for analysis and selected analytical methods. Method reporting limits are provided in Table 1-3.

3.2 Quality Assurance Objectives

The overall quality assurance objective for the implementation of the Work Plan is to develop and implement procedures for sampling, chain-of-custody, laboratory analysis, instrument calibration, data reduction and reporting, internal quality control, audits, preventive maintenance, and corrective action such that valid data will be generated for site evaluation purposes. These procedures are presented or referenced in the following sections of the QAPP. Specific QC checks are discussed in Section 9.0 of this QAPP.

Quality assurance objectives are generally defined in terms of five parameters:

1. representativeness;
2. comparability;
3. completeness;
4. precision; and
5. accuracy.

Each parameter is defined below. Specific QA objectives for the implementation of the Work Plan are set forth in other sections of this QAPP as referenced below.

3.2.1 Representativeness

Representativeness is the degree to which sample data accurately and precisely represent site conditions, and is dependent on sampling and analytical variability and the variability (or homogeneity) of the site itself. The Work Plan has been designed to assess the presence of the chemical constituents and supplemental parameters at the time of sampling. The Work Plan presents the rationale for sample quantities and locations. The Work Plan and this QAPP present field sampling methodologies and laboratory analytical methodologies, respectively. The use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements is intended to provide representative data. Field duplicate samples will be obtained as indicated in Table 1-1, and will verify that field sampling methods produce representative samples. Further discussion of QC checks is presented in Section 9.0 of this QAPP.

3.2.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between phases of the current work at Mound B (if additional phases are required), and to the extent possible, between new and existing data will be maintained through consistent use of the sampling and analytical methodologies set forth in the Work Plan and this QAPP, and through stringent application of established QA/QC procedures, and through utilization of appropriately-trained personnel.

3.2.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the total amount that was obtained. This will be determined upon final assessment of the analytical results, as discussed in Section 12 of this QAPP.

3.2.4 Precision

Precision is a measure of the reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the objectives of the Work Plan. To maximize precision, sampling and analytical procedures will be strictly followed; all work performed at Mound B will adhere to established protocols presented in the QAPP and Work Plan. Checks for analytical precision will include the analysis of laboratory duplicates. Field measurement precision will be monitored by obtaining duplicate field measurements. Further discussion of precision QC checks is provided in Sections 9 and 12 of this QAPP.

3.2.5 Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. Further discussion of these QC samples is provided in Sections 9 and 12 of this QAPP.

4. Field Procedures

Sampling requirements are presented in the Work Plan and further discussed in the WCSAP. The appropriate detailed SOPs are presented in Attachments B, C and D of this QAPP. Included in these attachments are the following SOPs:

- USEPA Environmental Response Team SOP #2009: Drum Sampling Standard Operation Procedure;
- USEPA Environmental Response Team SOP #2017: Waste Pile Sampling; and
- USEPA Environmental Response Team SOP #2006: Sampling Equipment Decontamination.

4.1 Sample Containers and Preservation

The analytical laboratory will supply appropriate sample containers in sealed cartons or coolers, as well as sample labels and preservatives. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate). Appropriate sample containers, preservation methods, and laboratory holding times for solid and liquid samples are summarized in Table 1-2.

4.2 Packing, Handling, and Shipping Requirements

Sample custody seals and packing materials for filled sample containers will also be provided by the analytical laboratory. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage. Trip blank(s) of analyte-free water will be provided by the laboratory and included in each cooler containing soil samples to be analyzed for VOCs.

All samples will be packaged by the field personnel and transported as low-concentration environmental samples. The packaged samples will be either shipped via express overnight carrier (Federal Express or courier) or hand delivered by a courier to the laboratory within 24 to 48 hours of sample collection.

5. Sample and Document Custody

5.1 Field Procedures

The objective of field sample custody is to assure that samples are not tampered with from the time of collection through transport to the analytical laboratory. Persons will have "custody of samples" when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel. Both discussion of sample custody and directions for the field use of chain-of-custody forms are provided. An example field chain-of-custody form is provided in Attachment E.

5.2 Laboratory Procedures

5.2.1 General

Upon sample receipt, laboratory personnel will take responsibility for sample custody by signing each chain-of-custody form in the designated space. The original field chain-of-custody form will accompany all samples requiring laboratory analysis. The laboratory will follow internal chain-of-custody guidelines described in the USEPA guidance documents. Requirements which pertain specifically to USEPA contracts (i.e., USEPA Traffic Reports, etc.) are not relevant to this project. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for documenting and maintaining sample integrity at all stages of sample processing.

5.2.2 Sample Receipt and Storage

Immediately upon sample receipt, the laboratory sample custodian will verify the package seal, open the package, and compare the contents against the field chain-of-custody. At this time, the laboratory sample custodian will also be responsible for logging the samples in, assigning a unique laboratory identification number to each, and labeling the sample bottle with the laboratory identification number. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory logbook. If a sample container is broken, in an inappropriate container, has not been preserved by appropriate means, or if any discrepancy between the samples received and the chain-of-custody documentation is found, BBL's Project Manager will be notified immediately for resolution of the problem(s) prior to analysis.

5.2.3 Sample Analysis

Analysis of an acceptable sample will be initiated by a work sheet which will contain all pertinent information for analysis. The routing sheet will be forwarded to the analyst, and the sample will be moved into an appropriate storage location to await analysis. The analyst will sign and date the laboratory chain-of-custody form when removing the samples from storage. The document control officer will file all chain-of-custody forms in the project file.

Samples will be organized into sample delivery groups (SDGs) by the laboratory according to both matrix and analysis parameter. A SDG may contain up to 20 field samples (field duplicates, rinse blanks, and trip blanks are considered field samples for the purposes of SDG assignment). All field samples assigned to a single SDG must be received by the laboratory over a maximum of fourteen calendar days (less when seven-day holding times for extraction must be met) and must be processed through the laboratory (preparation, analysis, and reporting) as a group.

All parameters within a SDG will be extracted and analyzed together in the laboratory. These rules for analysis will ensure that the quality control samples for an SDG are applicable to the field samples of the same SDG and that the best possible comparisons may be made.

Information regarding the sample, analytical procedures performed, and the results of the testing will be recorded in a laboratory notebook by the analyst. These notes will be dated, and also identify the analyst, the instrument used, and the instrument conditions.

5.2.4 Laboratory Project Files

During the implementation of the Work Plan, the laboratory will establish a file for all pertinent data. These files will include the chain-of-custody forms, raw data, chromatograms (required for all constituents analyzed by chromatography), and sample preparation information. The laboratories will retain project records until the conclusion of the work conducted at Mound B.

Sample Storage Following Analysis

Once an analysis is complete, the unused portion of sample and all identifying tags and laboratory records will be maintained by the laboratory conducting the analyses. Samples will be retained at the laboratory for a period of three months, after which they will be discarded unless SCA or USEPA personnel request their continued storage.

5.3 Project File

Mound B work documentation will be placed in a single project file at the BBL office in Cranbury, New Jersey. This file will consist of the following components:

1. Agreements (filed chronologically);
2. Correspondence (filed chronologically);
3. Memos (filed chronologically); and
4. Notes and Data (filed by topic).

Reports (including QA reports) will be filed with correspondence. Analytical laboratory documentation (when received) and field data will be filed with notes and data. Filed materials may be removed and signed out by personnel on a temporary basis only.

6. Calibration Procedures

6.1 Field Equipment Calibration Procedures and Frequency

Field instrumentation to be used during the Mound B sampling includes:

- Use of a FID to determine the potential presence or absence of VOCs.

Field personnel are responsible for documenting calibration following the procedures specified for each measuring device. Documentation will include, at a minimum where applicable, the following:

- Name of device and/or instrument calibrated;
- Device/instrument serial/identification number;
- Frequency of calibration;
- Date(s) of calibration(s);
- Results of calibration(s); and
- Name of person(s) performing calibration(s).

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Equipment to be used during the field sampling will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manual to ensure that all maintenance requirements are being observed.

Calibration of field instruments will be performed at the intervals specified by the manufacturer, or more frequently as conditions dictate. In the event that an internally-calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service.

Calibration of field instruments is governed by the specific SOP for the applicable field analysis method, and such procedures take precedence over the general procedures presented in this QAPP and the Work Plan. BBL's SOPs for performing and documenting calibration and maintenance for the FID will be followed. Calibration checks will be performed daily. Calibration and maintenance procedures for the FID are provided in Attachment F.

6.2 Laboratory Equipment Calibration Procedures and Frequency

Instrument calibration will follow the specifications provided by the instrument manufacturer and specific analytical method used. When analyses are conducted according to the USEPA SW-846 methods, the calibration procedures and frequencies specified in the applicable method will be followed.

For analyses governed by SOPs, see the appropriate SOP for the required calibration procedures and frequencies. Records of calibrations will be filed and maintained by the laboratory. These records will be subject to a QA audit. For all instruments, the laboratory will maintain trained repair staff with in-house spare parts or will maintain service contracts with vendors.

All standards used in the calibration of equipment will be traceable, directly or indirectly, to the National Institute of Science and Technology (NIST). All standards received will be logged into standard receipt logs maintained by the individual analytical groups. Each group will maintain a standards log that tracks the preparation of standards used for calibration and QC purposes.

7. Analytical Procedures

7.1 Field Analytical Procedures

Field data will be collected during intact drum sampling for hazcat analysis, and during composite sampling for disposal analysis, and will include the measurement of the following field monitored parameters:

- Samples will be field screened using a FID instrument.

7.2 Laboratory Analytical Procedures

Laboratory analytical requirements presented in the subsections below include a general summary of requirements, specifics related to each sample medium to be analyzed, and details of the methods to be used for this project. Current SW-846 methods will be used for all applicable parameters (TCLP) and sample media (liquid, solid).

7.2.1 General

The following tables summarize general analytical requirements:

Table	Title
Table 1-1	Environmental and Quality Control Samples and Analyses
Table 1-2	Parameters, Methods, Sample Containers, Preservation Methods and Holding Time Requirements
Table 1-3	Method-Specified Detection Limits

The primary sources for methods used for this investigation are provided in Test Methods for Evaluating Solid Waste, SW-846 Third Edition, Update 3, USEPA, December 1996.

All analyses of environmental media will be performed by a laboratory to be determined.

8. Data Reduction, Review, and Reporting

After field and laboratory data are obtained, these data will be subject to:

1. reduction or manipulation mathematically or otherwise into meaningful and useful forms; and

2. organization, interpretation, and reporting.

8.1 Field Data Reduction, Review and Reporting

8.1.1 Field Data Reduction

Information which is collected in the field through visual observation, manual measurement and/or field instrumentation will be recorded in field notebooks, data sheets, and/or forms. Such data will be reviewed by the appropriate Task Manager for adherence to the Work Plan and consistency. Any concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and as necessary incorporated into the data evaluation process.

8.1.2 Field Data Review

Field data calculations, transfers, and interpretations will be performed by the field personnel and reviewed for accuracy by the appropriate Task Manager and the QAO. Task Managers will recalculate at least five percent of all data reductions. All logs and documents will be checked for:

1. general completeness;
2. readability;
3. usage of appropriate procedures;
4. appropriate instrument calibration and maintenance;
5. reasonableness in comparison to present and past data collected;
6. correct sample locations; and
7. correct calculations and interpretations.

8.1.3 Field Data Reporting

Where appropriate, field data forms and calculations will be processed and included in appendices to the final report. The original field logs, documents, and data reductions will be kept in the project file at the BBL office in Cranberry, New Jersey.

8.2 Laboratory Data Reduction, Review and Reporting

8.2.1 Laboratory Data Reduction

Laboratory analytical data will be transferred from the instrument to the computer or the data reporting form (as applicable) by the analyst. Calculation of sample concentrations are performed using the calculation procedures specified by the analytical method used including, as applicable, use of regression analysis, response factors, and dilution factors. Soil values will be reported on a dry weight basis. Unless otherwise specified, values will be reported uncorrected for blank contamination.

8.2.2 Laboratory Data Review

Raw data will be examined to assess compliance with quality control guidelines specified in the analytical methods. In addition, data will be evaluated for indication of possible contamination, carryover, or interferences. In the event that sample signals exceed the documented calibration range for any constituent, the sample will be reanalyzed at a dilution that results in a signal for the constituent within the mid- to upper-range of the calibration curve.

The laboratory will respond to any observations regarding method control. The response will include, at a minimum, all corrective actions and associated reanalysis specified in the analytical method.

Once a report is complete, it will be reviewed for discrepancies, errors or omissions. The data will then be submitted to the laboratory QAO for review. The QAO will review the package, see that any necessary corrections are made, and give the package to the Project Manager, who will review it for completeness and compliance. A copy of the package will be filed in the project file. The mailed package(s) will be sealed in an appropriate shipping container with a custody seal and logged into a document mailing log.

8.2.3 Laboratory Data Reporting

Each laboratory is responsible for reporting sample data both in tabular form and in data packages containing Level III deliverables. Tabulated data will be organized by method and sample with reference to the sample by both field and laboratory identifications. Analytical results provided by the laboratory will generally be available in both digital and a hard copy format. The electronic data deliverable (EDD) supplied by the laboratory will be in BBL table format (a Quattro Pro Version 6.0 or a Microsoft Excel 97 worksheet).

9. Field and Laboratory Quality Control Checks

Both field and laboratory quality control checks are proposed for the implementation of the Work Plan. In the event that there are any deviations from these checks, the BBL Project Manager will be notified. The proposed field and laboratory control checks are discussed below.

9.1 Field Quality Control Checks

9.1.1 Field Measurements

To verify the quality of data using field instrumentation, duplicate measurements will be obtained and reported for all field measurements. A duplicate measurement will involve obtaining measurements a second time at the same sampling location.

9.1.2 Sample Containers

Sample containers cleaned and quality controlled in accordance with OSWER Directive No. 9240.0-05, "Specifications and Guidance for Obtaining Contaminant-Free Sample Containers" (7/91) will be supplied by the laboratory.

9.1.3 Field Duplicates

Field duplicates will be collected for liquid and solid samples to check reproducibility of the sampling methods. Field duplicates will be prepared as discussed in the WCSAP. In general, sample field duplicates will be analyzed at a 5 percent frequency (every 20 samples) for the chemical constituents. Table 1-1 provides an estimated number of field duplicates to be prepared for each applicable parameter and matrix.

9.1.4 Rinse Blanks

Rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Rinse blanks will be collected at the beginning of the day prior to the sampling event and the blank must accompany those samples which were taken that day to ensure that the blank will be associated with the proper samples during data validation.

Dedicated sampling equipment will be initially decontaminated. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory) which has been routed through a cleaned sampling device. When sample containers are used to collect the samples, or if dedicated, disposable sampling equipment is used to collect the samples, rinse blanks will not be necessary. Table 1-1 provides an estimated number of rinse blanks to be collected in association with sampling during the implementation of the Work Plan.

9.1.5 Trip Blanks

Trip blanks will be used to assess whether cross-contamination has occurred during sample storage and transport. Trip blanks will be analyzed at a frequency of once per day, per cooler containing soil samples to be analyzed for volatile organic constituents. A trip blank will consist of a container filled with analyte-free water (supplied by the laboratory) which remains unopened with field samples throughout the sampling event. Trip blanks will only be analyzed for volatile organic constituents. Table 1-1 provides an estimated number of trip blanks to be collected for each matrix and parameter during implementation of the Work Plan.

9.2 Laboratory Quality Control Checks

Internal laboratory quality control checks will be used to monitor data integrity. These checks will include all requirements set forth in the methods, including method blanks, blank spikes, internal standards, surrogate standards, calibration standards, and reference standards.

9.2.1 Method Blanks

Sources of contamination in the analytical process, whether specific analytes or interferences, need to be identified, isolated, and corrected. The method blank is useful in identifying possible sources of contamination within the analytical process. For this reason, it is necessary that the method blank be initiated at the beginning of the analytical process and encompass all aspects of the analytical work. As such, the method blank would assist in accounting for any potential contamination attributable to glassware, reagents, instrumentation, or other sources which could affect sample analysis. One method blank will be analyzed with each analytical series associated with no more than 20 samples. The method blank specifications in the analytical methods will be used.

9.2.2 Matrix Spikes/Matrix Spike Duplicates

Matrix spikes and matrix spike duplicates will not be collected or analyzed for waste characterization sampling activities.

9.2.3 Surrogate Spikes

Surrogates are compounds unlikely to be found in nature that have properties similar to the analytes of interest. This type of control is primarily used for samples analyzed for organic compounds by GC/MS and GC methods and is added to the samples prior to purging or extraction. The surrogate spike is utilized to provide broader insight into the proficiency and efficiency of an analytical method on a sample specific basis.

If surrogate spike recoveries exceed specified QC limits, then the analytical results need to be evaluated thoroughly in conjunction with other control measures and corrective actions taken, for example, reanalysis, as specified in the analytical methods.

9.2.4 Laboratory Duplicates

For inorganic compounds and other supplemental parameters, laboratory duplicates will be analyzed to assess analytical precision. A laboratory duplicate is defined as a second aliquot of an individual field sample which is analyzed as a separate sample. Table 1-1 provides an estimated number of laboratory duplicates for each applicable matrix and parameter.

9.2.5 Calibration Standards

Calibration standards will be analyzed according to the specifications of each analytical method to establish linearity and to monitor the instruments' stability on a regular basis.

Laboratory instrument calibration standards will be analyzed following the guidance provided in the analytical methods summarized in Table 1-1.

9.2.6 Internal Standards

Internal standard areas and retention times are monitored for organic analyses performed by GC/MS methods. Method-specified internal standards compounds are spiked into all field samples, calibration standards, and QC samples after preparation and prior to analysis. The internal standard nearest the retention time of each analyte of interest is used by the laboratory in quantitation of the analyte.

The use and frequency of internal standard analyses will be determined using the guidance provided within the analytical methods summarized in Table 1-1.

9.2.7 Reference Standards

Reference standards are standards of known concentration, and independent in origin from the calibration standards. Reference standards, are generally available through the USEPA, the National Bureau of Standards, or are specified in analytical methods. Reference standards are included in the analytical process, although in some aspects of sample handling and preparation, these standards may not reflect the analytical process. The intent of reference standard analysis is to provide insight into the analytical proficiency within an analytical series. This includes the preparation of calibration standards, the validity of calibration, sample preparation, instrument set-up, and the premises inherent in quantitation. Reference standards are utilized in every analytical series with the exception of GC/MS and certain GC methods for which reference standards do not exist. Reference standards will be analyzed at the frequencies specified within the analytical methods summarized in Table 1-1.

10. Performance and System Audits

Performance and systems audits will be completed in the field and the laboratory during the implementation of the Work Plan as described below.

10.1 Field Audits

The following field performance and systems audits will be completed during this project.

10.1.1 Performance Audits

The appropriate Task Manager will monitor field performance. Field performance audit summaries will contain an evaluation of field measurements and field meter calibrations to verify that measurements are taken according to established protocols. The BBL QAO will review all field reports and communicate concerns to the BBL Project Manager and/or Task Managers, as appropriate. In addition, the BBL QAO will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures.

10.1.2 Internal Systems Audits

A field internal systems audit is a qualitative evaluation of all components of field QA/QC. The systems audit compares scheduled QA/QC activities from this document with actual QA/QC activities completed. The appropriate Task Manager and QAO will periodically confirm that work is being performed consistent with this QAPP, the Work Plan, and the HASP.

10.1.3 External Audits

USEPA representatives may conduct audits of field operations, if determined necessary.

10.2 Laboratory Audits

Internal system audits are conducted by the laboratory QAO. The audit is a qualitative evaluation of all components of the laboratory quality control measurement system. The audit serves to determine if all measurement systems are being used appropriately. The system audits are conducted to evaluate the following:

- sample handling procedures;
- calibration procedures;
- analytical procedures;
- QC results;
- safety procedures;
- record keeping procedures; and
- timeliness of analysis and reporting.

In addition, as participants in various state and federal programs, laboratories are subject to external audits by the associated regulatory agencies. The focus of these audits is to assess general laboratory practices and conformance to specific program protocol.

SCA reserves the right to conduct an on-site audit of the laboratory prior to the start of analyses for this project. Additional audits may be performed during the course of the project as deemed necessary.

Laboratory performance is also reviewed by the laboratory QAO. The laboratory QAO evaluates laboratory precision and accuracy through comparison of results of duplicate samples and analyses, and through review of QC samples,

spikes, and blanks. Whenever a beyond-control limit situation is found, analytical results are checked by the laboratory manager or other client services individual prior to distribution.

A review of laboratory performance and results of check samples analyzed as part of the USEPA and/or state certification requirements will be performed annually. In addition, SCA may conduct performance audits by sending "double blind" performance evaluation (PE) samples (e.g., samples which are not discernable from routine field samples) to the analytical laboratory. The PE samples will consist of water containing a known amount of analyte of interest.

10.2.1 Performance Evaluations

Performance evaluations in which the selected laboratory participates will be provided for review prior to the commencement of sampling and analysis activities.

10.2.2 External Audits

As a participant in State and federal certification programs, the laboratory sections at the laboratory are audited by representatives of the regulatory agency issuing certification. Audits focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification. In addition, the USEPA may conduct audits of laboratory operations, if deemed necessary.

11. Preventative Maintenance

Preventive maintenance schedules have been developed for both field and laboratory instruments. A summary of the maintenance activities to be performed is presented below.

11.1 Field Instruments and Equipment

Prior to any field sampling, each piece of field equipment will be inspected to assure it is operational. If the equipment is not operational, it must be serviced prior to use. All meters which require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, it is the responsibility of the appropriate Task Manager or field team to follow the maintenance schedule and arrange for prompt service.

Liquid and solid samples will be field screened using a FID instrument. The BBL Task Managers will review calibration and maintenance logs.

Field equipment returned from a site will be inspected to confirm it is in working order. This inspection will be recorded in the logbook or field notebooks as appropriate. It will also be the obligation of the last user to record any equipment problems in the logbook.

Non-operational field equipment will be either repaired or replaced. Appropriate spare parts will be made available for field meters. A summary of preventive maintenance requirements for the FID is provided below.

Maintenance	Frequency
Flame Ionization Detector	
-Store in protective casing	Daily
-Inspect equipment after use	Daily
-Check and re-charge batteries	Daily
-Clean ion chamber	Monthly, or as needed
-Update instrument log book	Daily
-Calibrate	Daily, prior to use and after ten samples
-Return to manufacturer for service	Operator's discretion

11.2 Laboratory Instruments and Equipment

Instruments and equipment will be serviced only by qualified personnel. All repairs, adjustments and calibrations will be documented in dedicated logbooks. Documentation includes details of any observed problems, corrective measure(s), routine maintenance, and instrument repair (which will include information regarding the repair and the individual who performed the repair).

Preventive maintenance of laboratory equipment generally will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired immediately by in-house staff or through a service call from the manufacturer.

The laboratory will maintain a sufficient supply of spare parts to minimize downtime. Whenever possible, back-up instrumentation will be maintained.

A summary of required equipment maintenance will be provided by the selected laboratory prior to waste characterization sampling and analysis activities.

12. Data Assessment Procedures

The analytical data generated during the Mound B activities will be evaluated with respect to precision, accuracy, and completeness and compared to the data quality objectives set forth in Sections 1.0 and 3.0 of this QAPP.

The procedures utilized when assessing data precision, accuracy, and completeness are presented below.

12.1 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision will be monitored through the use of field duplicates and/or laboratory duplicates as identified in Table 1-1.

12.2 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs.

Laboratory accuracy will be assessed via the use of surrogate spikes and reference standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy.

12.3 Data Completeness

Completeness of a field or laboratory data set will be calculated by comparing the number of valid (or usable) sample results generated to the total number of results generated:

$$\text{Completeness} = \frac{\text{No. Valid Results}}{\text{Total No. Results Generated}} \times 100$$

As a general guideline, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgement to determine data useability for intended purposes.

13. Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QAPP or the Work Plan. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the implementation of the Work Plan are described below.

13.1 Field Procedures

When conducting the Mound B field work, if a condition is noted that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action implemented will be documented on a Corrective Action Report Form (Attachment G) and reported to the appropriate BBL Task Manager, QAO, and Project Manager.

Examples of situations which would require corrective actions are provided below:

1. protocols as defined by the QAPP and the Work Plan have not been followed;
2. equipment is not in proper working order or properly calibrated;
3. QC requirements have not been met; and
4. issues resulting from performance or systems audits.

Project personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

13.2 Laboratory Procedures

13.2.1 General

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action to be taken will be documented, and reported to the appropriate project manager and QAO.

Corrective action may be initiated, at a minimum, under the following conditions:

1. protocols as defined by this QAPP have not been followed;
2. predetermined data acceptance standards are not obtained;
3. equipment is not in proper working order or calibrated;
4. sample and test results are not completely traceable;
5. QC requirements have not been met; and
6. issues resulting from performance or systems audits.

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities. Additional details of corrective action procedures used by each laboratory are provided below.

13.2.2 Laboratory Procedures

If, as a result of audits or QC sample analyses, methods systems prove to be unsatisfactory, corrective action shall be implemented. The Laboratory Project Manager, Department Manager, Quality Assurance Officer, Supervisor, and Analyst may be involved in the corrective action. If previously reported data are affected by a situation requiring correction or if the corrective action impacts a project budget or schedule, the action will directly involve the Project Manager (and Quality Assurance Manager).

For immediate or long-term corrective actions, steps comprising a closed-loop corrective action system are as follows:

1. Define the problem.

2. Assign responsibilities for problem investigation.

3. Investigate and determine the cause of the problem:

   a. check all calculations;
   b. reanalyze the sample;
   c. verify the integrity of the spiking solution, laboratory control sample, or calibration standard; and
   d. check instrument and operating conditions to preclude the possibility of malfunctions or operator error.

4. Determine the corrective action(s) necessary to eliminate the problem.

5. Assign and accept responsibilities for implementing the corrective action.

6. Establish the effectiveness of the corrective action and implement the correction.

7. Verify and document that the corrective action has eliminated the problem.

Depending upon the nature of the problem, the corrective action implemented may be formal or informal. In either case, occurrence of the problem, the corrective action employed, and verification that the problem has been eliminated must be documented.

In addition, if the corrective action mandates the preparation of a new standard or calibration solution(s), a comparison study between the new solution versus the old solution will be performed. The results are supplied with the weekly QC submittal as verification of problem elimination.

14. Quality Assurance Report

14.1 Final Report

When the Work Plan has been implemented, the results will be presented in a final report. This final report will contain QA sections that summarize data quality information collected during the project. Quality control reports may be submitted as documentation of compliance with QA/QC objectives. The reports also serve to update the status of the project and to indicate any changes or deviations from the initial plan. Items in the report may include:

- changes in QA Project Plan;
- summary of QA/QC programs;
- results of system and performance audits;
- significant QA/QC problems, recommended solutions and results of corrective action;
- data quality assessment;
- evaluation of compliance with data quality objectives and the resulting impact on decision making; and
- limitations on the use of measurement data.

Records will be maintained to provide evidence of the QA activities. A QA records index will be initiated at the beginning of the project, and all information received from outside sources or developed during the project will be retained by BBL. Upon termination of an individual task or work assignment, working files will be forwarded to the project files.

15. References

Quality Assurance/Quality Control Guidance for Removal Activities: Sampling QA/QC Plan and Data Validation Procedures, OSWER Directive Number 9360.4-01;

Environmental Response Team Standard Operating Procedures, OSWER Directive Numbers 9360.4-02 through 9360.4-08;

Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring, USEPA, Office of Water Regulations and Standards, May 1984; and

SW-846, Section 10.

TABLE 1-1

MOUND B, KIN-BUC LANDFILL
EDISON, MIDDLESEX COUNTY, NEW JERSEY

ENVIRONMENTAL AND QUALITY CONTROL SAMPLES AND ANALYSES

Environmental Sample Matrix/ Laboratory Parameters	Estimated Environmental Sample Quantity	Field QC Analyses							Laboratory QC Analyses						Non Filter	Filter	Estimated Overall Total
		Trip Blank[1]/ Field Blank		Field Duplicate		Rinse Blank[2]		Est. Matrix Total	MS/MSD/DUP		LCS		Lab Duplicate				
		Freq.	No.	Freq.	No.	Freq.	No.		Freq.	No.	Freq.	No.	Freq.	No.			
Drum Sampling																	
TCLP Volatile Organic Compounds SW-846 Methods 1311 and 8260	TBD	1/cooler	TBD	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	---	---	TBD
TCLP Semivolatile Organic Compounds, Pesticides, and Herbicides SW-846 Methods 1311, 8270, and 8151	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD
TCLP Metals SW-846 Methods 1311, 6010, and 7471	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD
Ignitability SW-846 Method 1020	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD
Corrosivity SW-846 Method 9045C	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD
Reactivity SW-846 Chapter 7.3	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD
PCBs SW-846 Method 8082	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD
Total Petroleum Hydrocarbons 418.1	TBD	--	--	1/20	TBD	1/day	TBD	TBD	--	--	1/20	TBD	1/20	TBD	--	--	TBD

Notes:

DUP = Duplicate.
LCS = Laboratory control samples measure of laboratory performance in the absence of matrix.
MS = Matrix spike.
MSD = Matrix spike duplicate.
TBD = To be determined.
The number of laboratory QC analyses is based on the frequencies given for the number of environmental samples estimated not including field QC analyses.
-- = none.
[1] Trip blank submitted at the rate of one per day per cooler containing samples to be analyzed for volatile organic constituents.
[2] If dedicated disposable sampling equipment is used for drum sampling, equipment blanks will not be collected.

TABLE 1-2

MOUND B, KIN-BUC LANDFILL
EDISON, MIDDLESEX COUNTY, NEW JERSEY

PARAMETERS, METHODS, SAMPLE CONTAINERS, PRESERVATION METHODS, AND LABORATORY HOLDING TIME REQUIREMENTS

Parameter	Method	Bottle Type	Preservation	Holding Time
TCLP Volatile Organic Compounds	SW-846 Methods 1311 and 8260	Four ounce glass with teflon-lined septum	Cool to 4°C	14 days from collection to extraction; 14 days to analysis
TCLP Semivolatile Organic Compounds, Pesticides, and Herbicides	SW-846 Methods 1311, 8270, 8081, and 8151	500 mL glass	Cool to 4°C	14 days from collection to extraction; 40 days to analysis
TCLP Metals	SW-846 Methods 1311, 6010, and 7471	500 mL glass	Cool to 4°C	180 days from collection to extraction; 180 days to analysis[1]
Ignitability	SW-846 Method 1020	500 mL glass	Cool to 4°C	None
Corrosivity	SW-846 Method 9045C	500 mL glass	Cool to 4°C	None
Reactivity	SW-846 Chapter 7.3	500 mL glass	Cool to 4°C	None
PCBs	SW-846 Method 8082	500 mL glass	Cool to 4°C	14 days from collection to extraction; 40 days to analysis
Total Petroleum Hydrocarbons	418.1	500 mL glass	Cool to 4°C	28 days

Notes:

TCLP - Toxicity Characteristic Leaching Procedure
PCBs - Polychlorinated Biphenyls
1 - Except mercury (28 days from collection to extraction; 28 days to analysis)

Managed and participated in ECRA/ISRA remedial investigation/remedial action projects at three chemical distribution sites in New Jersey. Fieldwork at Kramer Chemical's Clifton facility involved geophysical surveying using ground-penetrating radar (GPR) and soil sampling at multiple areas of concern (AOC) including diesel and waste oil underground storage tanks (USTs); installation of bedrock monitoring wells inside the warehouse building as well as in the outdoor chemical storage area; and sampling of bedrock ground water. The remedial action included development and successful negotiation of an alternative remediation criterion for total petroleum hydrocarbons (TPH) in soil; development of a Declaration of Environmental Restriction (i.e., deed restriction) to allow TPH concentrations in excess of 30,000 mg/kg to remain in place; and capping the outdoor storage area with pavement.

Fieldwork at the Camden facility involved soil sampling at multiple AOC; installation of an overburden monitoring well network across the site; sampling of ground water; a ground-water tidal influence study involving the use of automated Hermit data loggers; a dye tracer study to identify the discharge locations of several floor drains and stormwater drains; and an evaluation of light non-aqueous phase liquid (LNAPL) present on the water table in several wells. Interim remedial action included installation of recovery wells and the recovery of LNAPL using automated belt skimmers. Because ground water was venting to the surface of the Delaware River, fate and transport modeling was conducted to demonstrate the assimilation capacity of the surface water body and to develop alternative ground-water criteria for constituents of concern. This approach was accepted by NJDEP and a ground-water monitoring program was established at the site.

Investigation at the Paterson facility involved geophysical surveying using GPR and soil sampling at multiple AOCs including No. 4 fuel oil and gasoline USTs; installation of an overburden monitoring well network across the site; sampling of ground water; dye tracer studies to confirm the connection floor drains and floor trenches to the on-site pre-treatment system; and an evaluation of dense non-aqueous phase liquid (DNAPL) present on top of a clay layer at several well locations. Interim remedial action included removal of USTs and abandonment of a 10,000 gallon UST in place due to its proximity to a building foundation; installation of recovery sumps for passive collection of DNAPL and periodic monitoring of DNAPL levels in monitoring wells. Because ground water was venting to the surface water of the Passaic River, fate and transport modeling was conducted to demonstrate the assimilation capacity of the River and to develop alternative ground-water criteria for constituents of concern. This approach was accepted by NJDEP and a ground-water monitoring program was established at the site.

Risk Assessment (Human Health and Ecological)

Managed and participated in a site-specific risk assessment at an abandoned industrial site to identify the nature and magnitude of potential risks associated with potential constituents of concern (PCOC) in soil. Based upon the results of the data evaluation the following conclusions were made: potential contaminants of concern at the site were limited to seven PAHs, one pesticide, two PCBs, and

three metals; site characterization data indicates that horizontal and vertical characterization of PCOC is complete. The exposure assessment portion of the risk assessment identified future on-site workers as the potential maximally-exposed receptor population. Routes of exposure to PCOC for potential on-site workers included ingestion and dermal contact (direct contact with soil), and inhalation of fugitive dust particles from surface soil. Risk calculations for these exposure scenarios indicated a Total Overall hazard index for non-carcinogens that is less than one, and a Total Potential risk value for potential carcinogens of less than a one- in-one-million excess cancer risk. Based on the risk assessment, no additional soil sampling was proposed for the site, and the project moved forward to the Focused Feasibility Study phase.

Managed a Preliminary Exposure Assessment/Receptor Analysis (PEA/RA) project for the Safety-Kleen Envirosystems Company site in Newark, New Jersey. Project involved identification of potential receptors in proximity to the site, based on field reconnaissance and review of census data, zoning maps, aerial photographs, and local land use/planning information. A review of potential ecological receptors was conducted, based on information provided by the New Jersey Natural Heritage Program. Alternative soil and ground-water quality criteria (GWQC) were calculated for the site, based on the primary exposure route of concern: discharge of ground water to surface water. Fate and transport modeling results were used to calculate alternative GWQC which will meet NJDEP surface water quality criteria in Newark Bay. Alternative Impact to Ground Water (IGW) soil criteria were developed in order to meet the alternative GWQC.

Supervised and participated in development of human health and ecological risk assessments for numerous industrial sites as part of hazardous materials/waste remediation projects. Responsible for selection of indicator constituents, exposure pathway analyses, sensitive receptor identification, dose-response evaluation, toxicological profile development, and characterization of risks for a variety of risk assessment projects. Developed alternative cleanup levels (ACLs) for soil and ground water in support of New Jersey Industrial Site Recovery Act (ISRA) environmental evaluation and remediation projects.

Conducted a transportation risk assessment (TRA) associated with transport of hazardous materials. The TRA involved an analysis of pesticide transportation methods and routes in order to determine the safest means of shipping material. Due to the extreme aquatic toxicity of the material, an in-depth evaluation of potential impacts to streams/rivers of various sizes and classifications was conducted. The surface water body analyses involved fate and transport modeling of releases and comparisons of potential impacts to selected aquatic indicator species. An appropriate method and route for transportation of the material was selected based on the results of the assessment.

Managed and conducted a Baseline Ecological Evaluation in accordance with the New Jersey Department of Environmental Protection (NJDEP) Technical Requirements for Site Remediation (N.J.A.C. 7:26E-3.11, Site Investigation - Ecological Evaluation) at the Mar-Tee Landfill Site in Cape May County, New

Jersey. The evaluation was performed as part of supplemental remedial investigation activities and involved identification of potential constituents of ecological concern (COEC), environmentally sensitive areas, and potential constituent migration pathways to environmentally sensitive areas. Remedial investigation data were reviewed to identify potential COEC in ground water and surface water at the 82-acre site. Work effort involved evaluation of fate and transport of COEC in ground water as the primary potential migration pathway to downgradient wetlands and surface water. Analytical results for various organic and inorganic constituents were screened by comparison to aquatic life-based surface water quality standards and ecotoxicological threshold values (benchmarks) as well as background concentrations. Results of the screening indicated iron, manganese and selenium as potential COEC; however, results of the site inspection indicated an absence of visible effects on the ecosystem. Based on the above results, it was concluded that additional ecological evaluation was not required, and that limited surface water monitoring would be conducted as part of ongoing operations and maintenance (O&M) at the site.

Conducted human health and ecological risk assessment for an active ISRA site with organic compound and metal contamination in soil. Human health evaluation considered on-site soil ingestion and dermal contact exposure routes. Ecorisk assessment looked at potential impacts to aquatic life in an adjacent stream due to soil contaminant erosion and runoff. Sediment toxicity to aquatic organisms was also evaluated based on site-specific surface water and sediment parameters. Results of the analysis were used to select an appropriate remedial action for the site.

Conducted an Indirect Exposure Assessment (IEA) in accordance with United States Environmental Protection Agency (USEPA) protocol for a new rotary kiln incinerator. The IEA involved air dispersion and deposition modeling, identification of organic constituents and PICs, evaluation of site-specific exposure pathways, and food chain modeling in order to evaluate human health risks. The evaluation also involved analyses of upset conditions, worker exposure, subsistence fisherman exposure, and reduced operation conditions. A population risk assessment was conducted as part of the project in order to determine potential impacts to surrounding communities.

At the Cytec Industries Inc. Carteret Impoundments site in Carteret, New Jersey, assisted in the preparation of alternative GWQC based on BBL's successful petitioning for reclassification of the aquifer of concern from Class II-A to Class III. Class III GWQC were developed from fate and transport modeling for the discharge of ground water to the Rahway River. Currently responsible for overseeing the ground-water monitoring program to confirm compliance with the alternative GWQC.

Managed and participated in a human health and ecological risk assessment in support of an open-burning facility's Subpart X permit. Focus was on selected trace metals anticipated as emissions products from the open burning of explosives. The level of effort required both dispersion and deposition modeling. For the human health assessment, inhalation and soil ingestion exposure routes

were evaluated. The ecological risk assessment involved evaluation of impacts on critical habitats and key indicator species.

Managed and participated in a baseline ecological evaluation in support of a Greenway Project which involved conversion of an old Conrail railway bed to a recreational trail extending for approximately 5 miles from Metuchen to Woodbridge, New Jersey. The evaluation was performed in accordance with N.J.A.C. 7:26E-3.11 as part of remedial investigation activities to identify potential ecological impacts from former railroad operations. Potential constituents of ecological concern (COEC) including polynuclear aromatic hydrocarbons (PAHs) and metals were identified by reviewing soil sampling data from the railroad bed and adjacent intermittent stormwater drainage ditches. Environmentally sensitive areas including off-site surface water (streams) and wetlands adjacent to the site were identified by reviewing specialized maps of the area and performing site reconnaissance. Based on the location of the site in a suburban/urban area and numerous stormwater inputs to the railway area from surrounding urbanized areas, BBL used an urban background soil database for soil data screening comparisons and evaluated depositional soils in the drainage ditches within the context of regional stormwater inflow from the surrounding areas. The depositional soil sampling results were compared to NJDEP sediment criteria and Ecotox Threshold Values (ETVs) within the framework of evaluating background concentrations. Because the railroad bed material was intact with limited potential for migration to the drainage ditches and the majority of flow in the drainage ditches resulted from off-site stormwater inputs, the potential for impact to downgradient surface water and wetland receptors from the railroad bed was considered negligible. The result of BBL's approach, which was accepted by NJDEP, was to limit the scope of soil remediation activities to those small areas previously identified based on potential human health concerns, and to eliminate the need for further ecological evaluation.

Currently managing and conducting a Baseline Ecological Evaluation at the Patterson Avenue Landfill Site in Hamilton Township, Mercer County, New Jersey. The evaluation is being performed as part of a remedial investigation/remedial action program under a Memorandum of Agreement (MOA) with the New Jersey Department of Environmental Protection (NJDEP). The project involves evaluation of potential ecological effects from migration of low levels of constituents of ecological concern (COEC) including tetrachloroethene (PCE) and trichloroethene (TCE) in ground water to surface water and wetlands. Two aquifers, the Quartenary (shallow) and Sayreville (intermediate), are being evaluated for the fate and transport of COEC. Preliminary results indicate an absence of sensitive ecological receptors within the area of detectable COEC concentrations. Based on this information, it is anticipated that potential ecological impacts are absent at this site and further ecological evaluation will not be required.

Managed and performed a human health and ecological risk assessment (HHERA) to identify potential adverse effects of Cement Kiln Dust (CKD) on human and ecological receptors proximal to an active cement production site in Charlevoix, Michigan. The assessment focused on estimating potential human

health effects associated with exposure to ground-water seeps and surface water in Lake Michigan adjacent to CKD Pile 4, and a screening-level analysis to identify potential site-related risks to ecological receptors. A statistical evaluation of the existing seep/surface water data demonstrated significant decreases in pH levels between the shoreline seep area samples and the surface water samples collected from Lake Michigan, and a strong neutralization capacity of the Lake Michigan surface water. Results of the HHERA indicated that adverse health effects for ecological receptors are not expected to occur from exposure to surface water in Lake Michigan adjacent to CKD Pile 4 based on current site conditions. There was no pH value measured in surface water which exceeded the chronic exposure to pH value of 10.0 believed to be harmful to aquatic species based on the literature. Additionally, no pH value measured in the surface water adjacent to the shoreline of the lake exceeded the Michigan Water Quality Standard of 9.0. Although the assessment indicated that direct contact with ground-water seeps along the shoreline has the potential to cause adverse health effects (primarily skin irritation) to trespassers, this exposure scenario was deemed highly unlikely due to the limited size and isolated locations of the seeps. Based on the above information, the Risk Characterization process lead to the conclusion that exposure of potential human and ecological receptors to elevated pH levels is unlikely, and CKD Pile 4 is not anticipated to cause human or ecological health effects based on current site conditions.

Property Transfer Assessments

Conducted numerous Phase 1 and Phase 2 Property Transfer Assessments in association with banks and lending institutions as part of the loan and mortgage application process as well as property foreclosure process. Phase 1 projects typically involved application of ASTM Standard E 1527-93/97 which includes site inspections, searching commercial environmental databases for records on the subject facility as well as surrounding sites, interviews with facility managers and employees, conversations with local/county regulatory personnel, review of regulatory environmental records, review of facility files, and review of aerial photographs and Fire Insurance Maps. The focus of the Phase 1 assessments was identification of potential areas of environmental concern at the facilities. Phase 2 assessments typically involved soil and/or ground-water sampling and analysis at potential areas of environmental concern, and evaluation of data based on state and/or federal criteria. Results of the Phase 1 and Phase 2 assessments were presented in written reports to the client.

Conducted multiple Phase I Property Transfer Assessments for prospective purchaser of a commercial furniture restoration company. Projects involved site inspections, interviews with facility managers and employees, conversations with local/county regulatory personnel, review of regualtory environmental records, review of facility files, and identification of potential areas of environmental concern at the facilities. Commercial environmental databases were also searched for records on the subject facility as well as surrounding sites. Results of the assessments were presented in written reports.

Coordinated and participated in Phase I and Phase II environmental assessments at sites owned by a chemical packaging and distribution company. Phase I

assessments were conducted in accordance with ASTM Standard E 1527-93. The Phase I work included records reviews, site reconnaissance, interviews with site personnel, and preparation of reports. The Phase II investigations involved soil borings and sample collection, ground-water monitoring well installation and sampling, and ground-penetrating radar (GPR) investigations. Results of the Phase II Investigations were presented in reports of findings which included recommendations for further action.

Assisted Cytec Industries with divestiture of their alum production division which involved multiple facilities in eight states in the eastern United States. Project involved development of Phase 2 soil and ground-water sampling plans based on review of existing Phase 1 reports; site reconnaissance to augment existing Phase 1 information; concurrent implementation of Phase 2 sampling plans at various facilities in accordance with State and/or federal guidance; soil and ground-water data assimilation and evaluation based on State and regional USEPA criteria; and preparation of separate Phase 2 reports for each facility. The $500,000 project was implemented within a limited time frame, and the project was finished on time and under budget.

Managed and conducted Phase 1 environmental assessments and focused compliance audits at multiple sites being considered for acquisition by a specialty chemicals company. Phase 1 assessments were conducted in accordance with ASTM Standard E 1527-93 and included records reviews, database searches, site reconnaissance, interviews with site personnel, and preparation of reports. The focused compliance audits involved a review of compliance with RCRA, SARA/CRTK, OSHA, TSCA, UST regulations, stormwater and wastewater regulations, and off-site CERCLA liability. Information/data gathered as a result of the assessments were used to identify environmental issues and actions, and to develop cost estimates for bringing the facilities into compliance. Results of the Phase 1 Assessments/Modified Compliance Reviews were presented in reports of findings which included recommendations for further action.

Education

- MS/Environmental Science, 1989, Rutgers University
  BS/Ecology, 1985, The Pennsylvania State University

Professional Affiliations/Awards

- Society of Environmental Toxicology and Chemistry
- Water Environmental Federation
- Society of Risk Analysis
- American Society for Testing and Materials

Selected Publications/ Presentations

Phase I/Phase II Property Transfer Assessments: Optimizing the Process. Presented: Mid-Atlantic Bankers Association Regional Meeting, October 1990.

The Bioaccumulation of Heavy Metals From Urban Stormwater Runoff and Sediments by Mercenaria mercenaria in Lakes Bay, New Jersey. Presented: Society of Environmental Toxicology and Chemistry Annul Meeting, November 1991.

A Risk Assessment of Direct and Indirect Exposure to Emissions From a Proposed Hazardous Waste Incinerator. Abstract accepted by Society of Environmental Toxicology and Chemistry, November 1995.

Jay D. Keough, C.I.H.
Health and Safety Manager

Mr. Keough is a Certified Industrial Hygienist with 17 years of experience in industrial hygiene, process safety, hazardous waste site safety, and environmental compliance. He has designed and implemented industrial hygiene programs and conducted compliance audits at locations in the United States, Brazil, Switzerland, and the Netherlands. His technical experience includes chemical processes, incineration, chemical exposure monitoring, ventilation design, and radiation protection. He has written more than 250 health and safety plans for such activities as solid waste site sampling; hazardous waste site investigation and remediation; and emergency response. He has served as Health and Safety officer for a number of large-scale projects.

Specialized Expertise: As the Corporate Manager of Health and Safety, Mr. Keough is responsible for all health and safety programs developed and implemented by BBL. In this capacity, Mr. Keough is responsible for the following tasks:

- Supervises a professional staff of industrial hygienists and safety specialists;
- Conducts indoor air quality assessments, employee exposure assessments, noise surveys, radiation surveys, and ventilation assessments;
- Conducts facility audits;
- Conducts monitoring surveys;
- Prepares and executes industrial hygiene surveys;
- Develops and conducts health and safety training programs; and,
- Prepares and approves Health and Safety Work Plans and Industrial Hygiene Plans for various projects.

Specific Experience

Conducted site safety and environmental compliance audits at two newspaper printing operations in California. Reviewed all operations for potential chemical exposure, ergonomic issues, confined space issues, personal protective equipment usage, medical monitoring, hearing conservation, lockout/tagout, laser safety, machine guarding, forklift safety, and hazard communication.

Conducted an investigation following the deaths of two workers in a tank truck. Led a sample team to the site hours after the incident, inspected the site, collected samples, interviewed witnesses, and submitted a report.

Conducted an industrial hygiene and safety audit of a college's research and teaching laboratory facilities. Evaluated the facility's chemical hygiene plan, observed research and teaching laboratory activities, reviewed chemical storage and handling procedures, laboratory safety policies, observed emergency equipment inspection and maintenance records, reviewed fire, chemical spill, and personal injury and exposure procedures, and provided recommendations to improve safety for students, faculty, and staff.

Conducted an investigation into an exposure incident at a major automobile transport yard. Collected samples of an air contaminant and reported the material's identity and toxicity. Recommended an action plan to address the situation during site clean up. Conducted an exposure survey to identify and quantify possible airborne contaminants present at the site.

Conducted an exposure monitoring survey to evaluate worker exposure to solvents in a manufacturing plant. Real-time instrumentation and personal samplers were used to identify areas and equipment which produced significant airborne concentrations of process chemicals. Reviewed engineering drawings

of ventilation systems and provided recommendations for improvements to the engineering controls present at the facility.

Conducted environmental and HS compliance audits at Union Carbide Corporation facility in Aratu, Brazil. Examined vinyl chloride and ethylene oxide handling and storage, rail car unloading, air/water emissions, personal protective equipment, and personnel exposures. Recommended revisions to procedures, equipment upgrades, and training programs.

Led a compliance audit of a laboratory facility in Geneva, Switzerland. Reviewed laboratory practices, environmental issues, health and safety issues, emissions, spill control, and ventilation. Provided recommendations to parent company management.

Managed health and safety program for construction activities at a municipal waste water treatment plant. Wrote a Health and Safety Plan, provided training, industrial hygiene monitoring, and project oversight.

Participated in a preacquisition audit of Amerchol, Inc. prior to purchase by Union Carbide Corporation. Examined environmental and H&S practices, facilities, equipment, safety records, emissions records, and procedures. Recommended revisions to procedures and equipment upgrades.

Led a compliance audit of a laboratory facility in Liederdorp, the Netherlands. Reviewed laboratory practices, environmental issues, health and safety issues, emissions, spill control, and ventilation. Provided recommendations to facility management and parent company representatives.

Conducted annual audits of catalyst manufacturer in Delfzijl, the Netherlands. Examined facilities, equipment, procedures, emissions, spill control plans, personnel exposure, and training programs. Recommended changes to equipment, emissions control systems, and training programs. Participated in a meeting with local residents and plant management regarding noise issues. Conducted a noise survey and recommended noise reduction measures.

Conducted preacquisition audit of foam manufacturing facilities in Chicago, Illinois and Mountaintop, Pennsylvania. Examined environmental practices, facilities, equipment, health and safety practices, and raw material storage. Provided recommendations to prospective buyer.

As Health and Safety Manager for a major chromium site remediation project in Jersey City, New Jersey, wrote the Health and Safety Plan, conducted project training, and conducted compliance audits and air monitoring. Evaluated exposure pathways and health risks associated with chromium exposure.

As Health and Safety Officer for the Fresh Kills Landfill Leachate Mitigation Project in New York, prepared Health and Safety Plans and conducted compliance audits/inspections and air monitoring during an investigation which involved the drilling of more than 300 wells.

Prepared a Health and Safety Plan for all Remedial Investigation (RI) site activities conducted at the Mattiace Petrochemical Superfund site in New York. Activities included air, soil, ground-water, sediment, and test pit sampling, and site characterization.

Wrote a Health and Safety Plan for Edgemere Landfill Investigation work in New York. The program included procedures for well drilling, soil borings, and sediment and leachate sampling. Interacted with New York State Department of Environmental Conservation (NYSDEC) personnel and developed programs in compliance with NYSDEC regulations.

Health and Safety Officer for the Chemical Insecticide Corporation Superfund site during the implementation of an interim remedial measure for the U.S. Army Corps of Engineers. Wrote Health and Safety Plan and conducted audits.

Designed and executed a polychlorinated biphenyl (PCB) sampling program at a chemical manufacturing facility in northern New Jersey. Air sampling was conducted as part of an Environmental Cleanup and Responsibility Act (ECRA) site investigation at the facility.

Prepared a Health and Safety Plan and performed health and safety audits for the RI/Feasibility Study (FS) project at the Naval Air Warfare Center in Trenton, New Jersey. Conducted air sampling during deep well installation in an area of contaminated soils, and determined the proper level of protection for site activities.

Prepared a Health and Safety Plan for an RI/FS project at the Anacostia Naval Station in Washington, D.C. Developed site-specific procedures and air monitoring program for field sampling activities.

Health and Safety Officer for unexploded ordinance surveys and removal projects at the former Raritan Arsenal in New Jersey and at Ft. Meade, Maryland. Wrote Health and Safety Plan and conducted periodic audits.

Wrote a Health and Safety Plan for an RI/FS at a BP Chemicals waste site with mixed chemical and radioactive waste materials.

Managed the implementation of a Corporate Total Quality Management program. Conducted project and facility Quality Assurance audits, and prepared and approved Quality Assurance Plans. Wrote and implemented corporate standard quality practices. Supported quality assurance officers in regional locations.

While with Union Carbide Corporation, managed Environmental Protection and Industrial Hygiene programs at the Union Carbide Technical Center in New Jersey. Also responsible for program development and support at five other locations. Managed asbestos removal projects at Union Carbide facilities; provided expert testimony at a USEPA hearing in Washington, D.C. regarding premanufacture notice under the Toxic Substances Control Act (TSCA); designed and conducted a trial burn for permitting of a chemical waste incinerator;

designed and implemented programs in hearing conservation, exposure monitoring, ventilation design and evaluation, radiation protection, and chemical hazards; negotiated a U.S. Nuclear Regulatory Commission license covering the use of various isotopes; participated in numerous environmental and safety audits of plants in the United States and abroad; managed a chemical waste incineration program; and designed systems for waste treatment.

Education

BS/Environmental Science, Rutgers University, 1979

Registrations

Certified Industrial Hygienist, American Board of Industrial Hygiene #4685

Professional Affiliations/Awards

American Industrial Hygiene Association (AIHA), National and Local Section
American Academy of Industrial Hygiene (AAIH)
Sigma Xi, Scientific Research Society
American Society for Quality Control (ASQC).

Technical Training/ Seminars

OSHA 500 Certified Instructor in Construction Safety
Occupational and Environmental Radiation Protection Training
DuPont Safety Management Training
Radiation Protection Officer Training
Emergency Response Training
Engineering Project Management Training
Confined Space Entry Instructor
Drill Rig Safety Training
Hazardous Chemical Handling Training
Hazardous Waste Operations Training (40-hour) 29 CFR 1910.120
Hazardous Waste Operations Supervisor Training (8-hour) 29 CFR 1910.120

Selected Publications/ Presentations

Keough, Jay D., C.I.H. "A Combined Approach for Health and Safety, Quality Assurance, and Total Quality Management." Published in Proceedings of the IT Technical Symposium, August 1995.

Keough, Jay D., C.I.H. "A Computerized Standard Health and Safety Plan and Hazard Modules." Presented at the American Industrial Hygiene Conference, IT Technical Symposium, May 1995.

Keough, Jay D., C.I.H. "Evaluation and Control of Hazardous Gases During Intrusive Subsurface Investigation at a Municipal Landfill." Presented at the American Industrial Hygiene Conference, IT Technical Symposium, May 1992.

Laurie A. Indick

Senior Scientist I/Manager, Quality Assurance

Ms. Indick has more than 15 years of experience in the operation, management, and quality assurance/quality control (QA/QC) of environmental analytical laboratories and related services. Ms. Indick is responsible for the management, quality assurance, and validation of analytical data being collected at BBL client hazardous waste sites and has served as on-site field processing laboratory manager. She is also responsible for managing the firm's subcontracts with analytical laboratories.

Special Expertise

Serves as Quality Assurance Officer (QAO) for investigations of multiple hazardous waste sites. Sites include impacted aquatic systems, industrial facilities, landfills, and wastewater effluent discharges. As QAO, Ms. Indick serves as the primary communication link between analytical subcontractors and BBL and is responsible for the management of site sample analyses and coordination between field managers and analytical subcontractors. She also has acted as field oversight manager for an on-site field processing laboratory.

Current responsibilities include the development of Quality Assurance Project Plans (QAPPs) that are consistent with project data quality objectives (DQOs) and federal and state guidelines. On a project-specific basis, also is involved with: selection of sampling and analytical approaches to solve specific project requirements and regulatory needs; development and review of contracts and bid documents for analytical services; and evaluation and audit of laboratory performance.

Field Services

Has been responsible for the set-up and oversight of an on-site processing laboratory for biota collection activities associated with natural resources damages assessment. Specific responsibilities included: laboratory layout and design, development and implementation of field processing system, and procurement of materials and supplies. Also included were the supervision of processing staff, tracking of multiple field crews, and coordination with regulatory agencies. Sample and document control was established through the use of custom designed processing and tracking logs.

Data Validation/Data Quality Services

Oversees the validation of mixed media (soil, sediment, water, biota, wipes, building material and air) data from investigations of multiple hazardous waste sites, including data validation pursuant to USEPA Functional Guidelines, and provides guidance on data usability. Manages and performs data validation efforts pursuant to USEPA Regional and individual State guidelines. As such, is proficient in USEPA-CLP, EPA SW-846, 40 CFR Part 136, NJDEP and NYSDEC ASP procedures.

Representative data quality projects throughout the country include the following:

- Critical review of analytical methods for determining PCB levels in industrial waste streams for the pulp and paper industry.

- Data validation in support of the RI at Monsanto Chemical Company's Indian Orchard Plant in Springfield, Massachusetts, pursuant to USEPA Region 1 guidelines.

- Data quality services as part of ECRA compliance activities for GEI International Corporation in Lansing, New Jersey, pursuant to NJDEP guidelines.

- Data validation in support of the RI/FS at the Rosen Brothers Scrapyard Superfund Site for a PRP Group in Cortland, New York, pursuant to USEPA Region 2 guidelines.

- Data validation in support of the RI/FS at the Kalamazoo River Superfund Site for a Paper Manufacturing PRP Group in Kalamazoo and Allegan Counties, Michigan, pursuant to USEPA Region 5 guidelines.

- Data quality services as part of remedial oversight for Chemical Control Corporation in Fairfield, New Jersey, pursuant to USEPA Region 2 guidelines.

- Data validation in support of the sediment sampling and engineering evaluation at Manistique River and Harbor Superfund Site for Manistique Harbor PRP Group, in Upper Peninsula, Michigan, pursuant to USEPA Region 5 guidelines.

- For American Cyanamid's Bound Brook, New Jersey facility, responsible for data validation pursuant to NJDEP guidance. Data validation efforts supported the implementation of a RCRA Corrective Action Program being implemented by BBL at the site.

- For Cytec Industries Inc.'s Warners Plant responsible for data validation pursuant to NJDEP guidance.

Laboratory Audits

Laboratory audits have been performed in support of:

- Remedial design/remedial action at a Superfund site in Massena, New York;
- River and sediment investigation at the Grasse River in Massena, New York;
- RI/FS for the Kalamazoo River Superfund Site in Kalamazoo, Michigan;
- Site investigation at an industrial facility in Michigan;
- Discharge permit negotiations for an industrial facility in Bay City, Michigan;
- Corrective measures in-situ stabilization program for an industrial facility in New York;
- River and sediment investigation in Russellville, Kentucky; and
- BBL corporate analytical contract program.

Other Related Experience

Was instrumental in the development of the framework for the BBL corporate analytical contract program and in the review and selection of potential subcontractors.

Prior to joining BBL, held the positions of GC/MS Department Manager and Analytical Quality Assurance/Quality Control Coordinator at laboratories in the northeast. Prior responsibilities included client contact for industrial and consulting firms regarding analytical services for a major CLP laboratory. Was responsible for the daily operation of the GC/MS department for an analytical laboratory. Participated in the development of software to manage, track, and report analytical data.

Education

- BA/Environmental Science, 1984, State University of New York at Plattsburgh
- Graduate Studies/Environmental Science, 1984, University of Massachusetts at Boston

Registrations

- Inorganic Data Validation - State University of New York, Westchester Community College, March 1994
- Organic Data Validation - State University of New York, Westchester Community College, October 1994

Technical Training/ Seminars

- 40-Hour OSHA Training
- 8-Hour OSHA Supervisory Training
- CPR/First Aid
- Leadership
- Negotiation Skills

Selected Publications/ Presentations

- 40-Hour OSHA Training
- 8-Hour OSHA Supervisory Training
- CPR/First Aid
- Leadership
- Negotiation Skills

DRUM SAMPLING STANDARD OPERATION PROCEDURE: SOP #2009

1.0 SCOPE AND APPLICATION

The purpose of this procedure is to provide technical guidance on implementing safe and cost-effective response actions applicable to hazardous waste sites containing drums. Container contents are sampled and characterized for disposal, bulking, recycling, grouping, and/or classification purposes.

2.0 METHOD SUMMARY

Prior to sampling, drums must be inventoried, staged, and opened. Inventory entails recording visual qualities of each drum and any characteristics pertinent to the contents' classification. Staging involves the organization, and sometimes consolidation of drums which have similar wastes or characteristics. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and required no decontamination.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

- No preservatives shall be added to the sample
- Place sample container in two Ziploc plastic bags
- Place each bagged container in a 1-gallon covered can containing absorbent packaging material. Place lid on can
- Mark the sample identification number on the outside of the can
- Place the marked cans in a cooler and fill remaining space with absorbent packing material
- Fill out chain of custody record for each cooler, place in plastic, and affix to inside of lid of the cooler
- Secure and custody seal the lid of the cooler
- Arrange for the appropriate transportation-mode consistent with the type of hazardous waste involved

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The practice of tapping drums to determine their contents is neither safe nor effective and should not be used if the drums are visually over pressurized or if shock-sensitive materials are suspected.

Drums that have been over pressurized to the extent that the head is swollen several inches above the level of the chime should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid, hooking device attached to the tube goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum wall. A sharp blow on the end of the spear drives the sharpened tip through the drum and the gas vents along the grooves. The venting should be done from behind a wall or barricade. This device could be cheaply and easily designed and constructed where needed. Once the pressure has been relieved, the bung can be removed and the drum sampled.

5.0 EQUIPMENT/APPARATUS

The following are standard materials and equipment required for sampling:

- Health and Safety Plan
- Personnel protection equipment
- Wide-mouth glass jars with teflon cap liner, approximately 500 ml. volume
- Uniquely numbered sample identification labels with corresponding data sheets
- One-gallon covered cans half-filled with absorbent
- Chain of custody sheets
- Decontamination plan and materials
- Glass thieving tubes and materials
- Drum opening devices:

Bung Wrench

common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium, non-sparking alloy formulated to reduce the likelihood of sparks.

The use of a "NON-SPARKING" wrench does not completely eliminate the possibility of a spark being produced.

Drum Deheader

One means be which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums. Drums with removable heads must be opened by other means.

Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Hydraulic Drum Opener

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device used hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump which pressurize soil through a length of hydraulic line.

Pneumatic Devices

A pneumatic bung remover consists of a compressed air supply that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill, which is adapted to turn a bung fitting selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

6.0 REAGENTS

Decontamination of sampling equipment should follow site specific work plan.

7.0 PROCEDURE

7.1 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

During staging, the drums should be physically separated into the following categories: those containing liquids, those containing solids, lab packs, gas cylinders, and those which are empty. This is done because the strategy for sampling and handling drums/containers in each of these categories will be different.

This may be achieved by:

- Visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open top drums. Closed head drums with a bung opening generally contain liquid.

- Visual inspection of the contents of the drum during sampling, followed by restaging, if needed.

Once a drum has been excavated and any immediate hazard has been eliminated by overpacking or transferring the drum's contents, the drum is affixed with a numbered tag and transferred to a staging area. Color-coded tags, labels or bands should be used to mark similar waste types. A description of each drum, it's condition, any unusual marking, and the location where it was buried or stored are recorded on a drum data sheet. This data sheet becomes the principal record keeping tool for tracking the drum on site.

Where there is good reason to suspect that drums containing radioactive, explosive, and shock-sensitive materials are present, these materials should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effected of any premature detonation of explosives.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyer.

7.2 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches
- Drum deheading
- Remote drum puncturing or bung removal

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and physical condition. Remote drum opening equipment should always be considered in order to protect worker safety. Under OSHA 1910.120, manual drum opening with bung wrenches or deheaders should be performed ONLY with structurally sound drums and waste contents that are known to be not shock sensitive, non-reactive, non-explosive, and non-flammable.

7.2.1 Manual Drum Opening

7.2.1.1 Bung Wrench

Manual drum opening with bung wrenches should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be nonexplosive. If opening the drum with bung wrenches is deemed reasonable cost-effective and safe, then certain procedures should be implemented to minimize the hazard:

- Field personnel should be fully outfitted with protective gear
- Drums should be positioned upright with the bung up, or, for drums with bungs on the side, laid on their sides with the bung plugs up
- The wrenching motion should be a slow, steady pull across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, a "cheater bar" can be attached to the handle to improve leverage.

7.2.1.2 Drum Deheading

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote method prior to using the deheader. Self-propelled drum openers which are either electrically or pneumatically driven are available and can be used for quicker and more efficient deheading.

7.2.2 Remote Opening

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but provides a high degree of safety compared to manual methods of opening.

7.2.2.1 Backhoe Spike

Drums should be "staged" or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This combined with the normal personal protection gear should be sufficient to protect the operator.

Additional respiratory protection can be afforded by providing the operator with an on-board airline system.

7.2.2.2 Hydraulic Devices

A piercing device with a metal point is attached to the end of a hydraulic line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head of the drum.

Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port.

The piercer is designed to establish a tight seal after penetrating the container.

7.2.2.3 Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely.

7.3 Drum Sampling

After the drum has been opened, preliminary monitoring of headspace gases should be performed using an explosimeter and organic vapor analyzer, In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

When sampling a previously sealed vessel, a check should be made for the presence of a bottom sludge. This is easily accomplished by measuring the depth to apparent bottom then comparing it to the known interior depth.

7.3.1 Glass Thief Sampler

The most widely used implement for sampling is a glass tube (Glass thief, 6mm to 16mm I.D. x 48 in. length). This tool is simple, cost effective, quick, and collects a sample without having to decontaminate.

Specific Sampling Procedure Using a Glass Thief

1. Remove cover from sample container.

2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About 1 ft. of tubing should extend above the drum.

3. Allow the waste in the drum to reach its natural level in the tube.

4. Cap the top of the sampling tube with a tapered stopper or thumb, ensuring liquid with stopper.

5. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container. Do not spill liquid on the outside of the sample container.

6. Release stopper and allow the glass thief to drain completely into the sample container. Fill the container to about 2/3 of capacity.

7. Remove tube from the sample container, break it into pieces and

place the pieces in the drum.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.

9. Replace the bung or place the pieces in the drum.

10. Transport sample to decontamination zone for preparation for transport to analytical laboratory.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube down into this layer and then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. The use of this technique should be cleared with the project officer or other disposal techniques evaluated.

7.3.2 COLIWASA Sampler

Designs exist for equipment that will collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. These designs include primarily the Composite Liquid Waste Sampler (COLIWASA) and modifications thereof. The COLIWASA is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other container-ized wastes. On configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached by a rod running the length of the rube to a locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

The major drawbacks associated with using a COLIWASA concern decontamination and costs. The sampler is difficult if not impossible to decontaminate in the field and its high cost in relation to alternative procedures (glass tubes) make it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use:

1. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

2. Slowly lower the sampler into the liquid waste. (Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result ia non-representative sample.)

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.

5. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container with a Teflon-lined cap; attach label and seal; and record on sample data sheet.

7. Unscrew the T-handle of the sampler and disengage the locking block. Clean sampler.

8.0 CALCULATIONS

.here are no specific calculations for these procedures.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

The following general quality assurance procedures apply:

1. All data must be documented on standard chain-of-custody forms, field data sheets, or within field/site log books.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

3. All deliverables will receive peer review prior to release.

The following specific quality assurance activity will apply:

Generally, one duplicate sample is collected for every ten samples collected. Other duplicates and spikes may be required depending on particular analytical parameter requested. See the site specific sampling plan for further QA/QC considerations.

10.0 DATA VALIDATION

The data generated will be reviewed according to the QA/QC considerations included in Section 9.0.

11.0 HEALTH AND SAFETY

The opening of closed containers is one of the most hazardous site activities. Maximum efforts should be made to ensure the safety of the sampling team. Proper protective equipment and a general awareness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

Most drum sampling activities are performed in level B with additional splash protection. This includes:

- Protective coverall (saran Tyvek, PVC, acid suit, etc.)
- Hard hat
- SCBA
- Steel toe, steel shank boot (or latex booties covering steel tow work boots)
- Surgical gloves
- Solvent/acid resistant gloves
- Splash apron
- Face splash shield

For detailed descriptions of required levels of protection, see EPA/REAC Standard Operating Procedure #3012, "Hazardous Waste Site Investigations" and the site specific safety plan.

12.0 REFERENCES

Guidance Document for Cleanup of Surface Tank and Drum Sites, OSWER Directive 9380.0-3

Drum Handling Practices at Hazardous Waste Sites, EPA-600/2-86-013.

1.0 SCOPE AND APPLICATION

The objective of this standard operating procedure (SOP) is to outline the equipment and methods used in collecting representative samples from waste piles, sludges or other solid or liquid waste mixed with soil.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Stainless steel shovels, trowels, or scoops should be used to clear away surface material before samples are collected. For depth samples, a decontaminated auger may be required to advance the hole, then another decontaminated auger used for sample collection. For a sample core, thin-wall tube samplers or grain samplers may be used. Near surfaces, samples can be collected with a clean stainless steel spoon or trowel.

All samples collected, except those for volatile organic analysis, should be placed into a Teflon lined or stainless steel pail and mixed thoroughly before transfer to appropriate sample container.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Chemical preservation of solids is generally not recommended. Refrigeration to 4°C is usually the best approach, supplemented by a minimal holding time, depending on contaminants of concern.

Wide mouth glass containers with Teflon lined caps are typically used for waste pile samples. Sample volume required is a function of the analytical requirements and should be specified in the work plan.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are several variables involved in waste sampling, including shape and size of piles, compactness, and structure of the waste material. Shape and size of waste material or waste piles vary greatly in areal extent and height. Since state and federal regulations often require a specified number of samples per volume of waste, the size and shape must be used to calculate volume and to plan for the correct number of samples. Shape must also be accounted for when planning physical access to the sampling point and the equipment necessary to successfully collect the sample at that location.

Material to be sampled may be homogeneous or heterogeneous. Homogeneous material resulting from known situations may not require an extensive sampling protocol. Heterogeneous and unknown wastes require more extensive sampling and analysis to ensure the different components (i.e. layers, strata) are being represented.

The term "representative sample" is commonly used to denote a sample that has the properties and composition of the population from which it was collected and in the same proportions as found in the population. This can be misleading unless one is dealing with a homogenous waste from which one sample can represent the whole population.

The usual options for obtaining the most "representative sample" from waste piles are simple random sampling or stratified random sampling. Simple random sampling is the method of choice unless: (1) there are known distinct strata; (2) one wants to prove or disprove that there are distinct

strata; or (3) one is limited in the number of samples and desires to statistically minimize the size of a "hot spot" that could go unsampled. If any of these conditions exist, stratified random sampling would be the better strategy.

Stratified random sampling can be employed only if all points within the pile can be accessed. In such cases, the pile should be divided into a three-dimensional grid system with, the grid cubes should be numbered, and the grid cubes to be sampled should be chosen by random number tables or generators. The only exceptions to this are situations in which representative samples cannot be collected safely or where the investigative team is trying to determine worst case conditions.

If sampling is limited to certain portions of the pile, a statistically based sample will be representative only of that portion, unless the waste is homogenous.

5.0 EQUIPMENT/APPARATUS

Waste pile solids include powdered, granular, or block materials of various sizes, shapes, structure, and compactness. The type of sampler chosen should be compatible with the waste. Samplers commonly used for waste piles include: stainless steel scoops, shovels, trowels, spoons, and stainless steel hand augers, sampling triers, and grain samplers.

Waste pile sampling equipment check list:

- Sampling plan
- Maps/plot plan
- Safety equipment, as specified in the Health and Safety Plan
- Compass
- Tape measure
- Survey stakes or flags
- Camera and film
- Stainless steel, plastic, or other appropriate homogenization bucket or bowl
- Appropriate size sample jars
- Ziplock plastic bags
- Logbook
- Labels
- Chain of Custody records and seals
- Field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Canvas or plastic sheet
- Spade or shovel
- Spatula
- Scoop
- Plastic or stainless steel spoons
- Trowel
- Continuous flight (screw) augers
- Bucket auger
- Post hole auger
- Extension rods
- T-Handle
- Thin-wall tube sampler with cutting tips
- Sampling trier
- Grain sampler

6.0 REAGENTS

No chemical reagents are used for the preservation of waste pile samples; however, decontamination solutions may be required. If decontamination of equipment is required, refer to the Sampling Equipment Decontamination SOP, and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Review all information available on the waste pile and expected or unknown contaminants.

2. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies required.

3. Obtain necessary sampling and monitoring equipment.

4. Decontaminate or pre-clean equipment, and ensure that it is in working order.

5. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.

6. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.

7. Use stakes or flagging to identify and mark

all sampling locations. Specific site factors, including extent and nature of contaminant should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

7.2.1 Sampling with Shovels and Scoops

Collection of samples from surface portions of the pile can be accomplished with tools such as spades, shovels, and scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop, or equivalent can be used to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by sample team members. Use of a flat, pointed mason trowel to cut a block of the desired material can be helpful when undisturbed profiles are required. A stainless steel scoop, lab spoon, plastic spoon, or equivalent will suffice in most other applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with implements such as garden trowels.

The following procedure is used to collect the surface samples:

1. Carefully remove the top layer of material to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned stainless steel scoop, plastic spoon, trowel, or equivalent remove and discard a thin layer of material from the area which came in contact with the spade.

3. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent, and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.2 Sampling with Bucket Augers and Thin-Wall Tube Samplers

These samplers consist of a series of extensions, a "T" handle, and a bucket auger or thin-wall tube sampler (Appendix A, Figure 1). The auger is used to bore a hole to a desired sampling depth, and is then withdrawn. The sample may be collected directly from the bucket auger. If a core sample is to be collected, the auger tip is then replaced with a thin-wall tube sampler. The sampler is then lowered down the borehole, and driven into the pile to the completion depth. The sampler is withdrawn and the core collected from the thin-wall tube sampler.

Several augers are available. These include: bucket, continuous flight (screw), and post hole augers. Bucket augers are better for direct sample recovery since they provide a large volume of sample in a short time. When continuous flight augers are used, the sample can be collected directly from the flights, which are usually at five (5) foot intervals. The continuous flight augers are satisfactory for use when a composite of the complete waste pile column is desired. Post hole augers have limited utility for sample collection as they are designed to cut through fibrous, rooted, swampy areas.

The following procedure will be used for collecting waste pile samples with the bucket augers and thin-wall tube samplers:

1. Attach the auger bit to a drill rod extension, and attach the "T" handle to the drill rod.

2. Clear the area to be sampled of any surface debris. It may be advisable to remove the first three to six inches of surface material for an area approximately six inches in radius around the drilling location.

3. Begin augering, periodically removing and depositing accumulated materials onto a plastic sheet spread near the hole. This prevents accidental brushing of loose

material back down the borehole when removing the auger or adding drill rod extensions. It also facilitates refilling the hole, and avoids possible contamination of the surrounding area.

4. After reaching the desired depth, slowly and carefully remove the auger from the borehole. When sampling directly from the auger, collect the sample after the auger is removed from the borehole and proceed to Step 10.

5. Remove auger tip from drill rods and replace with a pre-cleaned thin-wall tube sampler. Install proper cutting tip.

6. Carefully lower the tube sampler down the borehole. Gradually force the tube sampler into the pile. Care should be taken to avoid scraping the borehole sides. Avoid hammering the drill rod extensions to facilitate coring as the vibrations may cause the borehole walls to collapse.

7. Remove the tube sampler, and unscrew the drill rod extensions.

8. Remove the cutting tip and the thin-wall tube sampler.

9. Discard the top of the core (approximately one-inch), as this represents material collected before penetration of the layer of concern. Place the remaining core into the appropriate labeled sample container. Sample homogenization is not required.

10. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

11. If another sample is to be collected in the same hole, but at a greater depth, reattach the bucket auger to the drill and assembly, and follow steps 3 through 11, making sure to decontaminate the bucket auger and thin-wall tube sampler between samples.

7.2.3 Sampling with a Trier

This sampling device consists of a trier, and a "T" handle. The trier is driven into the waste pile and used to extract a core sample from the appropriate depth.

The following procedure will be used to collect waste pile samples with a sampling trier:

1. Insert the trier (Appendix A, Figure 2) into the material to be sampled at a 0° to 45° angle from horizontal. This orientation minimizes spillage of the sample. Extraction of the samples might require tilting of the sample containers.

2. Rotate the trier once or twice to cut a core of material.

3. Slowly withdraw the trier, making sure that the slot is facing upward.

4. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are being collected, place samples from the other sampling intervals into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and secure the caps tightly.

7.2.4 Sampling with a Grain Sampler

The grain sampler (Appendix A, Figure 3) is used for sampling powdered or granular wastes or materials in bags, fiber drums, sacks, similar containers or piles. This sampler is most useful when the solids are no greater than 0.6 cm (1/4") in diameter.

This sampler consists of two slotted telescoping brass or stainless steel tubes. The outer tube has a conical, pointed tip at one end that permits the sampler to penetrate the material being sampled. The sampler is opened and closed by rotating the inner tube. Grain samplers are generally 61 to 100 cm (24 to 40 in.) long by 1.27 to 2.54 cm (1/2 to 1 in.) in diameter and are commercially available at laboratory supply houses.

The following procedures will be used to collect waste pile samples with a grain sampler:

1. With the sampler in the closed position, insert it into the granular or powdered material or waste being sampled from a point near a top edge or corner, through the center, and to a point diagonally opposite the point of entry.

2. Rotate the sampler inner tube into the open position.

3. Wiggle the sampler a few times to allow material to enter the open slots.

4. Place the sampler in the closed position and withdraw from the material being sampled.

5. Place the sampler in a horizontal position with the slots facing upward.

6. Rotate the outer tube and slide it away from the inner tube.

7. If volatile organic analysis is to be performed, transfer the sample into an appropriate, labeled sample container with a stainless steel lab spoon, plastic lab spoon, or equivalent and secure the cap tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogenous sample representative of the entire sampling interval. Then, either place the sample into appropriate, labeled containers and secure the caps tightly; or, if composite samples are to be collected, place a sample from another sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into appropriate, labeled containers and

secure the caps tightly.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA/OSHA and corporate health and safety procedures.

12.0 REFERENCES

Test Methods for Evaluating Solids Waste (SW-846), Third Edition, Vol. II Field Manual U.S. EPA Office of Solid Waste and Emergency Response, Washington, D.C. November, 1986.

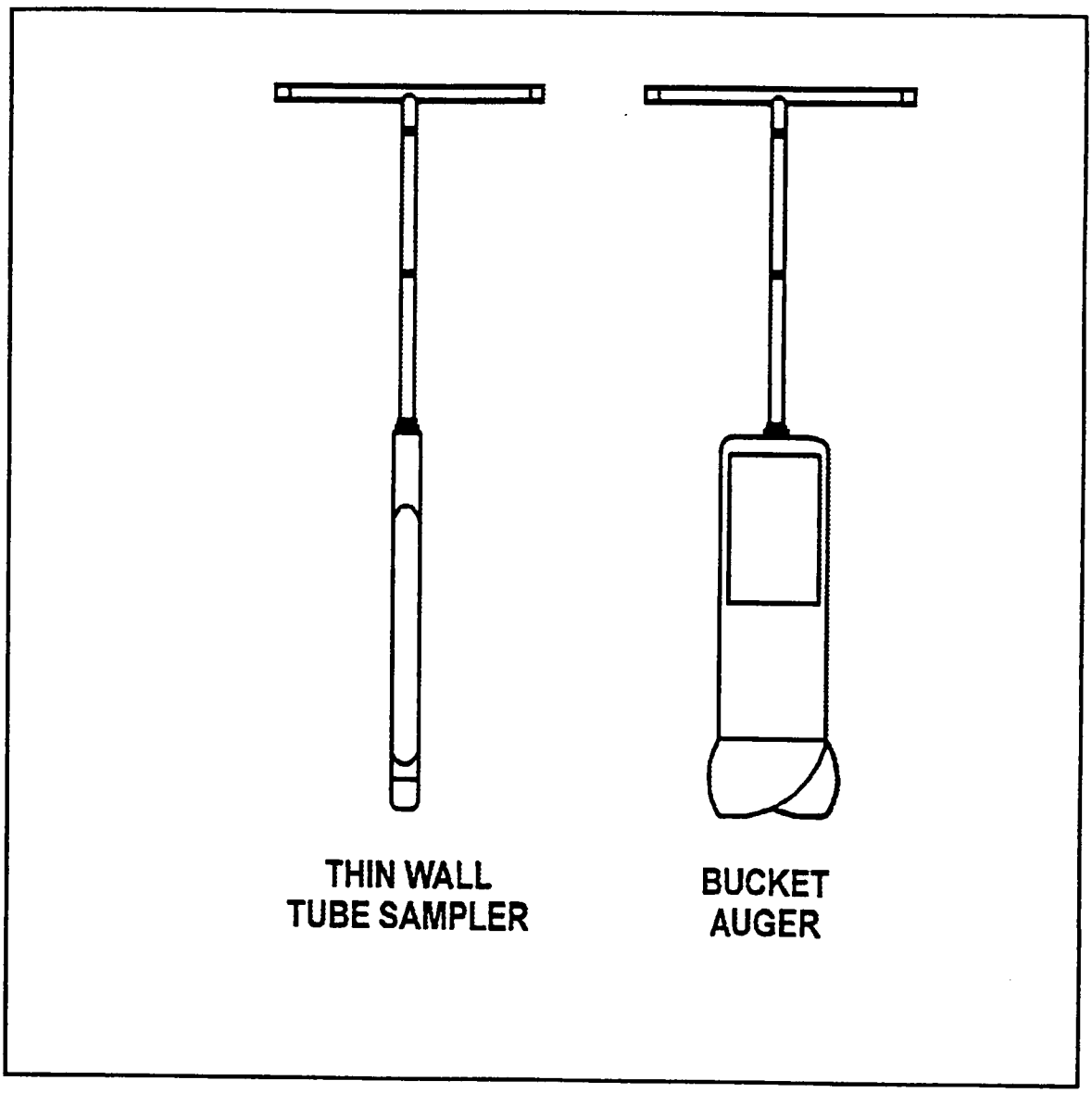
Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, April 1, 1986.

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

APPENDIX A

Figures

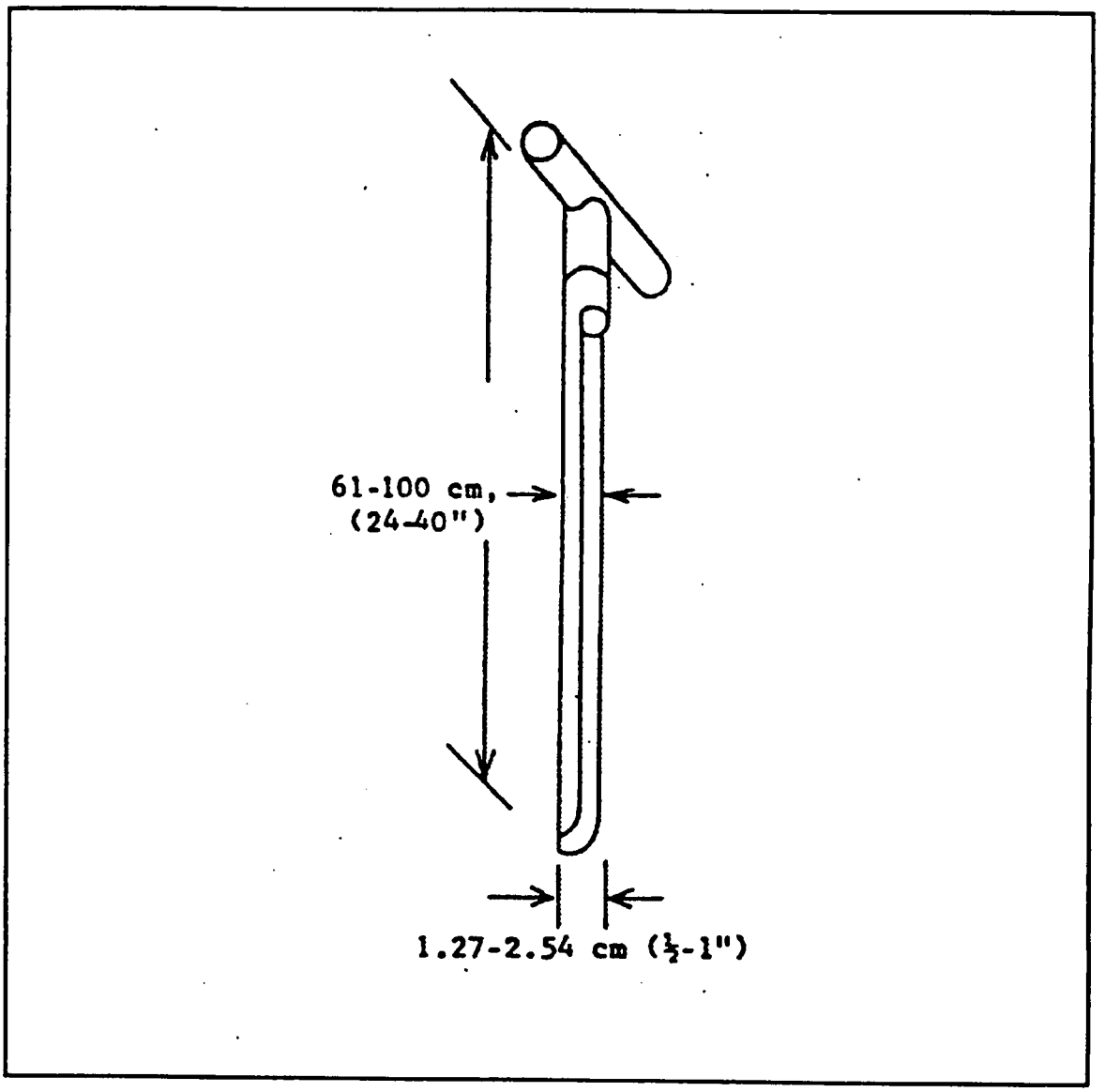
FIGURE 1. Sampling Augers



APPENDIX A (Cont'd)

Figures

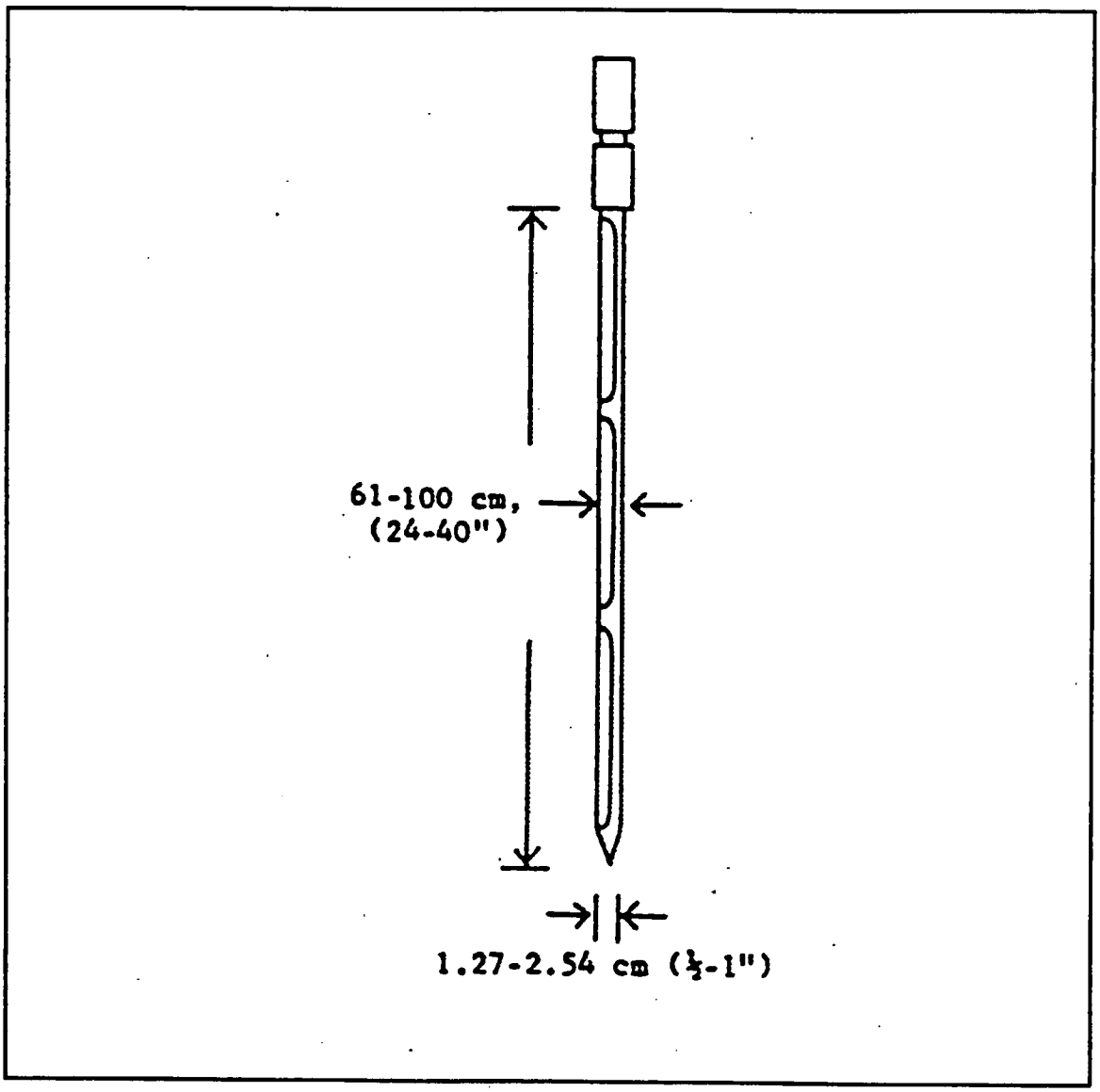
FIGURE 2. Sampling Trier



APPENDIX A (Cont'd)

Figures

FIGURE 3. Grain Sampler



SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of

concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).

- The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.

- If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.

- Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can

also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- Non-phosphate detergent
- Selected solvents (acetone, hexane, nitric acid, etc.)
- Tap water
- Distilled or deionized water

5.2 Decontamination Tools/Supplies

- Long and short handled brushes
- Bottle brushes
- Drop cloth/plastic sheeting
- Paper towels
- Plastic or galvanized tubs or buckets
- Pressurized sprayers (H_2O)
- Solvent sprayers
- Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- Trash bags
- Trash containers
- 55-gallon drums
- Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In general, the following solvents are typically utilized for decontamination purposes:

- 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- Acetone (pesticide grade)[1]
- Hexane (pesticide grade)[1]
- Methanol[1]

[1] - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- The number, location, and layout of decontamination stations.
- Decontamination equipment needed.
- Appropriate decontamination methods.
- Methods for disposal of contaminated clothing, equipment, and solutions.
- Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure

Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.
Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station . Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10 : Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.

2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

3. Empty soap and water liquid wastes from basins and buckets and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for

neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.

5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.

6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.

7. Empty low-pressure sprayer water onto the ground.

8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITYASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1 Soluble Contaminants and Recommended Solvent Rinse		
SOLVENT[1]	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents [2]	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent[2]	Hexane	PCBs

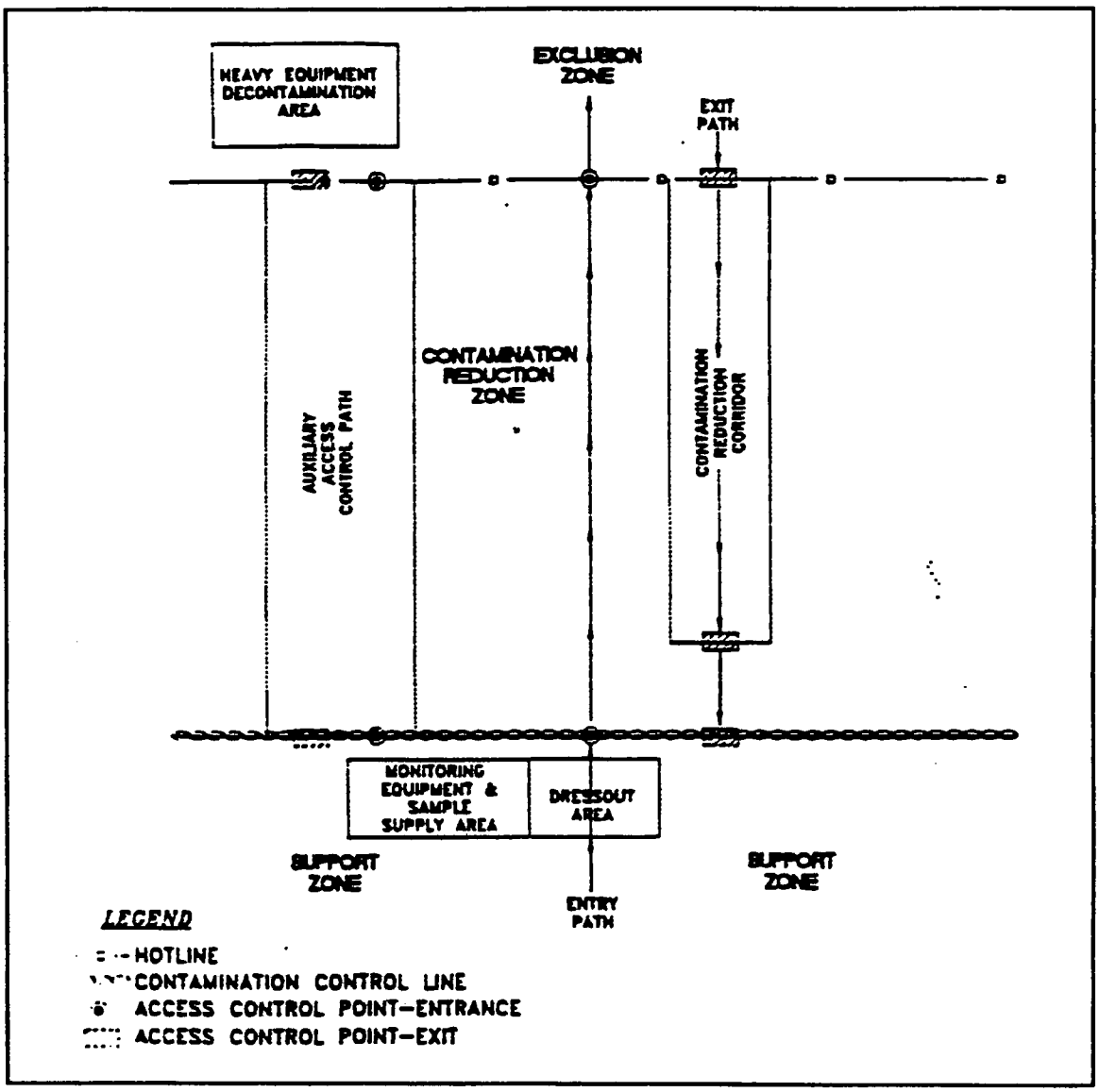
[1] - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

[2] - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

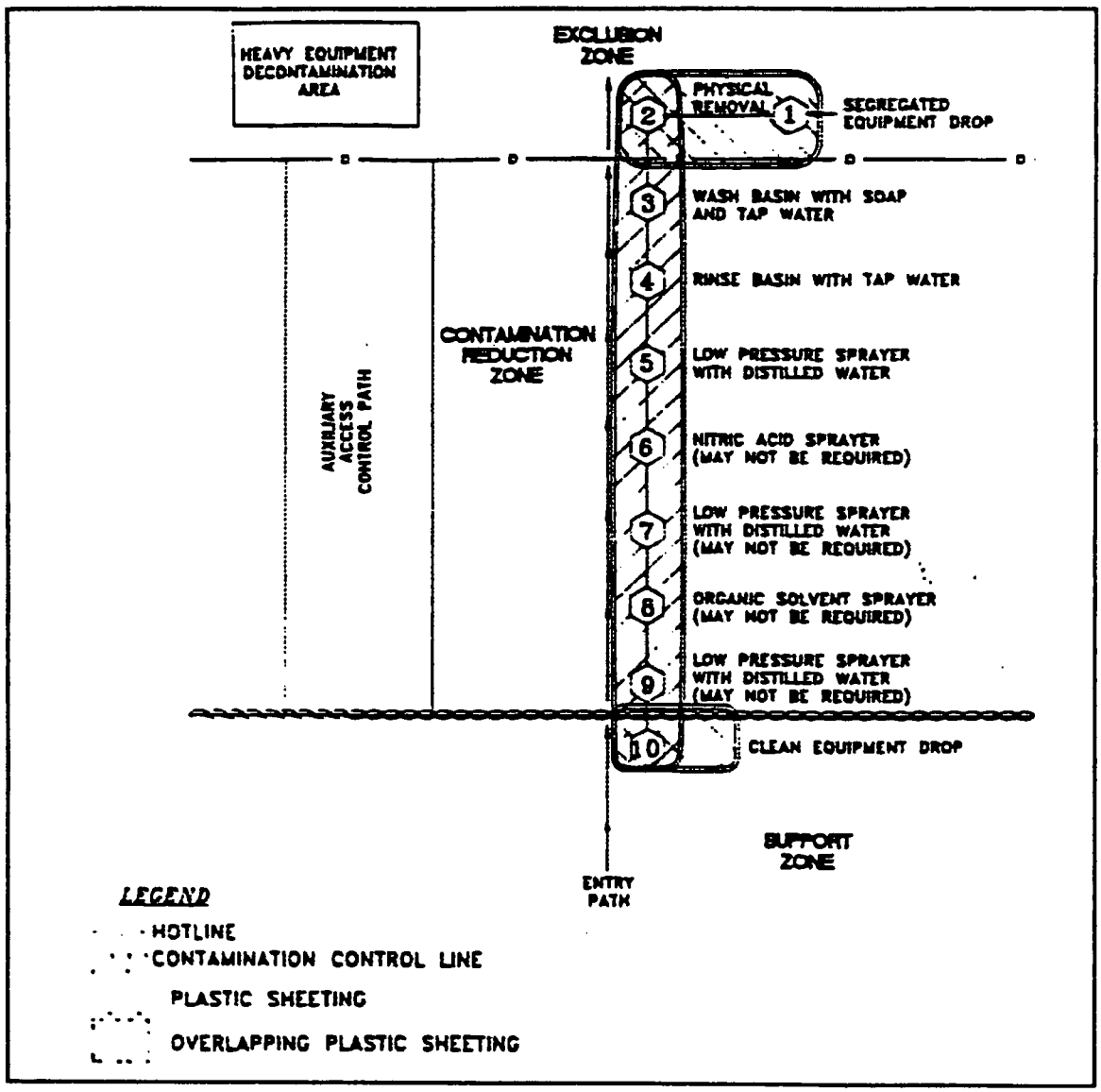
Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout



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CHAIN OF CUSTODY RECORD

☐ 24-Hour Turnaround ☐ 48- to 72-Hour Turnaround ☐ 1-Week Turnaround ☐ Standard Turnaround ☐ Other: _____

Project No.:						Project Name:									
Lab ID	Jar ID	Date	Time	Comp.	Grab	Sample Type				No. of Containers					Remarks
						Solid	Wipe	Water	Oil						

Sampled & Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)	Relinquished By: (Signature)	Date:	Time:	Received By: (Signature)
Relinquished By: (Signature)	Date:	Time:	Received for Laboratory By: (Signature)		Date:	Time:	
Remarks:							

MicroFID Flame Ionization Detector

User's Manual

PE PHOTOVAC

Warning: Limitation of Liability

The ultimate responsibility of the consequences of use of toxic compounds rests with the user. Photovac's role is as a supplier of instrumentation to assist in the early detection of hazardous conditions involving such compounds.

MicroFID represents a major advance in this field and, as with all complex instruments, it is vitally important to ensure that MicroFID is maintained in accordance with Photovac's instructions and that proper calibration is regularly performed.

As with any complex device, MicroFID is subject to failure and, while Photovac has taken, and continues to take, all possible precautions to (a) reduce the possibility of failure, and (b) warn the user in the event of failure, circumstances may occasionally occur in which there is a failure despite such precautions on Photovac's part. Photovac regrets that it cannot accept liability for damages of any kind caused as a result of either failure of the user to follow instructions or of MicroFID to perform.

microFID

Flame Ionization Detector

User's Manual

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Part 396003 Rev. F

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Reference No. 600757

3. Detailed Operation

3.1. Calibration

3.1.1. General Information

MicroFID must be calibrated in order to display concentration in ppm units equivalent to the calibration gas. First a supply of zero air, which contains no ionizable gases or vapors, is used to set MicroFID's zero point. Then, calibration gas, containing a known concentration of an ionizable gas or vapor, is used to set the sensitivity

Occasionally clean ambient air will be suitable as zero air. Due to MicroFID's sensitivity, outdoor air is usually unsuitable for calibration. A charcoal filter (Photovac Part No. 396021, 396022) may be connected to the instrument to produce clean air from otherwise unsuitable ambient air. For best results, use a commercial source of zero grade air and a second sampling bag. Zero air should have not more than 0.1 ppm total hydrocarbons (THC).

Methane in air is recommended as span gas. The concentration of the calibration gas will depend on your application. When ordering calibration gas, specify methane in hydrocarbon free air. Balance air should have not more than 0.1 ppm total hydrocarbons (THC).

Method 21 protocol requires that commercial cylinders of calibration gas be analyzed and certified to be within +/- 2% accuracy and that a shelf life must be specified on the cylinder. At the end of the shelf life, the cylinder must be replaced or re-analyzed.

3.1.2. Preparing the Calibration Gas Bag and the Zero Air Bag

Use the calibration kit (Photovac Part No. 396011) as follows:

> **Warning:** Observe proper handling techniques for all gases! See Section 1.2.

1. Connect the regulator to the calibration gas cylinder.

   If you are using a portable tank of calibration gas, connect the regulator supplied with the calibration kit.

   If you are using a large cylinder of calibration gas, you must obtain a high purity regulator as specified in Section 1.4. Methane in air is usually supplied with a standard CGA 590 cylinder valve outlet. Obtain a regulator with the matching fitting. Connect the regulator to the tank of calibration gas. See Section 1.2.1.

> **Note:** Do not force the connection.
>
> Do not use Teflon tape with CGA fittings. In general, these fittings are designed for metal to metal sealing.
>
> Do not use adapters to connect one CGA fitting to another type of CGA fitting. If the regulator does not match the outlet on your calibration tank, contact your specialty gas supplier.

2. Tighten the regulator onto the tank with a wrench. Do not over-tighten.

3. Attach the knurled nut on the gas bag adapter to the regulator. Finger-tighten the fitting.

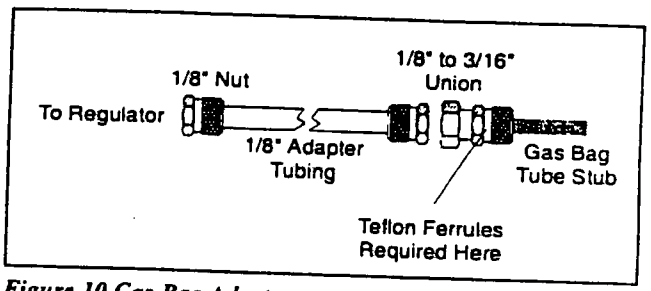


Figure 10 Gas Bag Adapter

4. Loosen the knurled nut on the reducing union of the gas bag adapter.

Note: Do not remove the nut from the union as the Teflon ferrules contained inside the nut may be lost. See Figure 10.

5. Insert the tube stub from the gas bag into the knurled nut. Tighten the knurled nut and ensure the tube stub is secure. If the gas bag is not secure, ensure you have inserted the tube stub far enough into the knurled nut. Do not over tighten the fitting.

Note: Over-tightening the Teflon ferrules will result in damage to the ferrules!

6. The union should be connected to the gas bag adapter. If it is not, then tighten the nut on the adapter tube to the union.

7. Open the gas bag valve. Turn the knurled plastic knob counterclockwise to loosen it, then use the knurled collar on the valve tube to gently push the valve tube toward the bag.

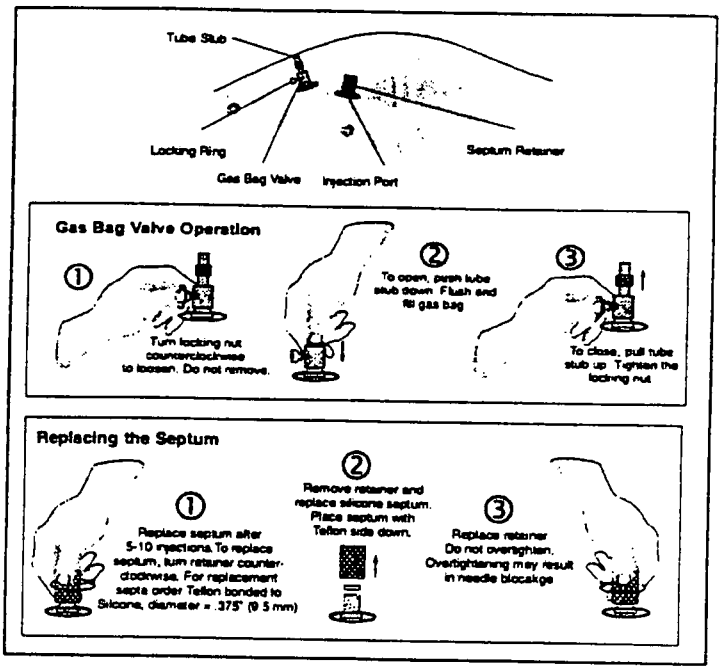


Figure 11 Using the Gas Bag

8. Turn the regulator knob counterclockwise about half a turn to start the flow of gas. Fill the gas bag about half full and then close the regulator.

9. Disconnect the gas bag from the gas bag adapter and empty the bag. Flush the bag a few times with the calibration gas and then fill it.

10. Close the gas bag valve. Gently pull the valve tube away from the bag, then turn the knurled plastic knob clockwise to tighten it against the valve tube.

11. Remove the knurled nut on the adapter tube from the regulator.

12. Repeat this procedure, if necessary, to prepare a bag of zero air.

Note: Do not use the same gas bag or gas bag adapter for the bag of zero air. You will contaminate the bag of zero air.

3.1.3. Calibrating MicroFID

1. Press CAL and select the desired Cal Memory. MicroFID has 10 Cal Memories and can be calibrated with 10 different span gases or response factors if desired. Only one Cal Memory can be used at a time. Each Cal Memory stores a different response factor, zero point, sensitivity, and alarm level

2. Enter the desired response factor and press ENTER. Refer to Appendix 8.6 for a list of Response Factors. If the compound is not in Appendix 8.6 or you measuring gas mixtures then enter a value of 1.00. The concentration detected by MicroFID will be multiplied by the response factor before it is displayed and logged.

3. Select Low Range or High Range and press ENTER. Use Low Range if you are sampling concentrations between 0.5 and 2000 ppm (methane equivalents). Use High Range if you are sampling concentrations between 10 and 50,000 ppm (methane equivalents)

4. Connect the supply of zero air. If you are using room air press ENTER.

5. If you are using a charcoal filter, connect the filter as outlined in Section 4.5. Press ENTER and MicroFID will set its zero point.

> **Note:** The charcoal filter does not filter methane or ethane. If these compounds are present, use a gas bag with a supply of commercial zero air.

6. If you are using a gas bag with zero air, connect the gas bag adapter to the inlet. Open the bag and press ENTER. MicroFID sets its zero point.
7. MicroFID then asks for the span gas concentration. Enter the known span gas concentration and then connect the gas bag adapter to the inlet. Open the bag.
8. Press ENTER and MicroFID sets its sensitivity.

> **Note:** Readings may fluctuate slightly as the gas bag empties. Do not allow the MicroFID to evacuate the bag completely.

9. When MicroFID's display reverts to normal, it is calibrated and ready for use. Remove the span gas bag from the inlet.
10. Press the ALARM key and enter the alarm level for the selected Cal Memory.

3.1.4. Programming the Cal Memories

MicroFID has 10 Cal Memories and can be calibrated with 10 different span gases or response factors if desired. To program the Cal Memories:

1. Prepare the bags of calibration gas as outlined in Section 3.1.2. Use a different gas bag and gas bag adapter for each concentration and for each type of calibration gas.

   You can use the same gas bag to zero all the Cal Memories, however, you must refill the bag for each Cal Memory.
2. Press CAL and select the desired Cal Memory (1 to 10) with the ARROW keys.
3. Enter the desired response factor and press ENTER. See Appendix 8.6.

> **Note:** It does not matter which Cal Memory is selected or which response factor is entered, MicroFID's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

4. Select the Low Range or High Range and press ENTER. The range will depend on the concentration of the calibration gas. Use Low range if you are sampling concentrations between 0.5 and 2000 ppm (methane equivalents). Use High Range if you are sampling concentrations between 10 and 50,000 ppm (methane equivalents).

5. You will now be prompted to connect a supply of zero air. You can use ambient air, a charcoal filter (Photovac Part No. 396021, 396022) to clean ambient air or, for best results, use a clean sampling bag filled with zero grade air.

6. After MicroFID has set its zero point, you then enter the concentration of the calibration gas and then connect the calibration gas. MicroFID sets its sensitivity for the specified Cal Memory. The span gas concentration, response factor and alarm level entered here are specific to the selected Cal Memory only.

When the calibration is completed it is automatically stored in the selected Cal Memory.

7. Press the ALARM key and enter the alarm level for the selected Cal Memory.

8. Repeat this procedure for each Cal Memory you need.

When calibrating MicroFID, ensure the instrument is level. If MicroFID is tilted side to side, gravity will affect the flame height and cause erroneous readings

Whenever the instrument is calibrated, MicroFID updates the selected Cal Memory only. Each Cal Memory must be calibrated at least once a day. Frequency of calibration will depend on ambient conditions and instrument response. If ambient conditions change or the response has drifted, a calibration must be performed for each Cal Memory to ensure reliable operation.

3.2. High Sensitivity Operation

MicroFID can be used as a high sensitivity leak detector. In high sensitivity operation, MicroFID does not read in ppm units equivalent to the calibration gas, but displays a reading proportional to the total concentration of ionizable gases and vapors detected.

During calibration, no span gas is required. MicroFID zeros its reading with zero air and then sets itself to maximum sensitivity.

1. Press SETUP. Select the 0-20 ppm display range with the ARROW keys and press ENTER.
2. Press CAL. Under Cal Memory, use the ARROW keys to select High Sensitivity and press ENTER.
3. Press EXIT. Select the bar graph with the DISPLAY key.
4. Press CAL and calibrate MicroFID with zero air. You should use a supply of commercial zero grade air and a gas sampling bag when zeroing MicroFID for high sensitivity operation.

As MicroFID samples air closer to the leak, the length of the shaded area on the display increases.

MicroFID's 3 second response time and detection limit of 0.5 ppm methane permit fast detection of small leaks.

3.3. Method 21 Operation

Method 21 is a US EPA protocol for the determination of volatile organic compound (VOC) leaks in process equipment. MicroFID has a Method 21 mode that facilitates Method 21 measurements. The STAR 21 Software (Photovac Part No. 396027) provides more comprehensive data management consistent with the Method 21 protocol. Contact Photovac for more information.

You must be familiar with the Method 21 protocol to use MicroFID for Method 21 monitoring. You must use the specifications outlined in the Method 21 documentation for programming MicroFID's Cal Memories and monitoring the sites.

As part of Method 21 operation, you must setup MicroFID to monitor various locations. Since each location may contain different compounds and concentration ranges you will store a Cal Memory and the associated response factor and alarm level as part of each event. In this way you can sample numerous locations without having to re-calibrate MicroFID at each location.

You can enter the monitoring schedule in one of two methods. Regardless of the method you use to enter the monitoring schedule, you must calibrate the required Cal Memories before you enter the monitoring schedule.

3.3.2. Programming the Monitoring Schedule in the Field

The easiest way of entering the Method 21 information is to go to each site and enter the required information. In this way, the schedule will be entered into the instrument in the exact manner in which it will be used.

1. Press the SETUP key. Press ENTER until "Interval" is displayed. Use the ARROW keys to select Method 21 as the Interval. Press ENTER.

2. You will be prompted to clear the datalogger. If you want to save the contents of the datalogger, press EXIT. You must print or save the data to disk. See Section 2.15, 2.16 or 4.2 for details of printing or saving your data. Press ENTER to clear the datalogger.

3. Go to the first site to be monitored. You can enter the sites in any order, however, using the schedule after it has been stored is easier if the sites are stored in the order in which they will be monitored.

4. Press the EVENT key. Use the ARROW keys to select "Insert". Press ENTER. Use the keypad to enter an event name up to 16 characters long. To obtain alphabetic characters you must use the STAR 21 software (Photovac Part No. 396027).

   If your site is bar coded, use the ARROW keys to select "Scan". Press ENTER to activate the bar code reader. The bar code reader will remain activated until you scan a code. If no bar code is scanned within 15 seconds the bar code reader will be deactivated. See Section 4.8 for details of connecting the bar code reader to MicroFID.

   It is possible to enter an event name that already exists in the datalogger. When you select "Insert" or "Scan" you can enter the name of an event that already exists in the datalogger. MicroFID will not overwrite the existing event. It will insert an event with the same name. In this way you can create multiple copies of the same schedule in the datalogger. You can see the duplicate events when you print the contents of the datalogger.

5. Press the CAL key and select the calibration memory to be used for this site. Press ENTER and then press EXIT.

6. Press SETUP and enter a 2 digit repair code for this location. See Section 2.12 for a description of Repair code. This step is optional.

7. When you return to the default display, the instrument status will be "Locate". You should be at the site. If not, locate the site. If the event name is greater than 3 characters the bottom line of the display will scroll from right to left.

8. Once you have located the designated site, press ENTER. The instrument status will change to "BkGnd". A background measurement must be made, as specified in the Method 21 protocol. When you have an accurate background, press ENTER. MicroFID will record the maximum background concentration when you press the ENTER key.

9. The instrument status will now be "Sample". Take a sample measurement, as specified in the Method 21 protocol. When you have an accurate sample, press ENTER. MicroFID will record the maximum sample concentration when you press the ENTER key.

10. The instrument status will again be Locate. At this time, since there are no other locations stored in the datalogger the same event will be displayed.

11. Press EXIT at anytime to return to the beginning of the current event and repeat the readings.

12. To store the next location, go the next site and press the EVENT key. Select "Insert" or "Scan" to enter an event name.

13. Press the CAL key and select the calibration memory to be used for this site.

14. Press SETUP and enter a repair code for this location.

15. When you return to the default display, the instrument status will be "Locate". Record a background and sample reading for this site. You will now have two events recorded in the datalogger.

16. Repeat this procedure for all sites that must be monitored. You can record data for up to 250 sites.

17. Once all event entries have been recorded in the datalogger, you may want to download them to a computer to perform your own calculations.

3.3.3. Programming the Monitoring Schedule before Field Operation

Use this method of programming the schedule if you are unable to go into the field. You will create a monitoring schedule with place-holders for the data.

1. Press the SETUP key. Press ENTER until "Interval" is displayed. Use the ARROW keys to select Method 21 as the Interval. Press ENTER.

2. You will be prompted to clear the datalogger. If you want to save the contents of the datalogger, press EXIT. You must print or save the data to disk. See Section 2.15, 2.16 or 4.2 for details of printing or saving your data. Press ENTER to clear the datalogger.

3. You can enter the sites in any order, however, using the schedule after it has been stored is easier if the sites are stored in the order in which they will be monitored.

4. Press the EVENT key. Use the ARROW keys to select "Insert". Press ENTER. Use the keypad to enter an event name up to 16 characters long. To obtain alphabetic characters you must use the STAR 21 software. (Photovac Part No. 396027)

   If your site is bar coded and you have a list of the bar codes, use the ARROW keys to select "Scan". Press ENTER to activate the bar code reader. The bar code reader will remain activated until you scan a code. If no bar code is scanned within 15 seconds the bar code reader will be deactivated. See Section 4.8 for details of connecting the bar code reader to MicroFID.

   It is possible to enter an event name that already exists in the datalogger. When you select "Insert" or "Scan" you can enter the name of an event that already exists in the datalogger. MicroFID will not overwrite the existing event. It will insert an event with the same name. In this way you can create multiple copies of the same schedule in the datalogger. You can see the duplicate events when you print the contents of the datalogger.

5. Press the CAL key and select the calibration memory to be used for this site. Press ENTER and then press EXIT.

6. Press SETUP and enter a 2 digit repair code for this location. See Section 2.12 for a description of repair code. This step is optional.

7. When you return to the default display, the instrument status will be "Locate". If the event name is greater than 3 characters the bottom line of the display will scroll from right to left.

8. Press ENTER. The instrument status will change to "BkGnd". Press ENTER to create a placeholder and to move to the next step.

9. The instrument status will now be "Sample". Press ENTER to create a placeholder and to move to the next step. The instrument status will again be Locate. At this time, since there are no other locations stored in the datalogger the same event will be displayed.

10. Press EXIT at any time to return to the beginning of the current event.

11. To store the next location, press the EVENT key. Select "Insert" or "Scan" to enter an event name.

12. Press the CAL key and select the Cal Memory to be used for this site.

13. Press SETUP and enter a repair code for this location.

14. Press ENTER. The instrument status will change to "BkGnd". Press ENTER to create a placeholder and to move to the next step.

15. The instrument status will now be "Sample". Press ENTER to create a placeholder and to move to the next step. The instrument status will again be "Locate".

16. Repeat this procedure for all sites that must be monitored. You can record data for up to 250 sites.

Once all event entries have been recorded in the datalogger, you are ready to use the schedule for monitoring the sites. You may want to print the schedule to ensure all you sites have been entered correctly.

3.3.4. Using the Schedule

Once you have programmed the schedule you can use it at any time to perform Method 21 monitoring. Frequency of monitoring is determined from percentage leaker calculations. Refer to the Method 21 documentation for details.

1. Calibrate MicroFID as outlined in section 3.1.

2. If the first event of the schedule is not displayed, you can find a specific event in the datalogger using the "Find" option. Press SETUP and use the ARROW keys to scroll through the list of events. Select the desired event. When you press ENTER, the selected event will be displayed.

3. Locate the specified site and press ENTER.

4. The instrument status will change to "BkGnd". A background measurement must be made, as specified in the Method 21 protocol. When you have an accurate background, press ENTER. MicroFID will record the displayed concentration when you press the ENTER key.

5. The instrument status will now be "Sample". Take a sample measurement, as specified in the Method 21 protocol. When you have an accurate sample, press ENTER. MicroFID will record the displayed concentration when you press the ENTER key.

6. The instrument status will again be "Locate". If you recorded the sites in order, the next site will be displayed. You can move through the stored list. If the sites were not entered in order or the order of sites has changed, use the "Find" option to locate the next site.

7. Press EXIT at any time to return to the beginning of the current event and repeat the readings.

8. To repeat a measurement recorded previously in the datalogger, press the EVENT key and use the ARROW keys to select "Find". Select the event you need to repeat and press ENTER.

If you change from Method 21 operation to a set averaging interval, you will lose your Method 21 schedule and associated programming. Print or save the data to disk before changing the interval. See Sections 2.15, 2.16 or 4.2 for printing and saving logged data.

Note: The datalogger will be cleared when you change from Method 21 to Interval mode.

3.4. Response Factors for Gases and Vapors

In situations where only a single pure compound is present in air, MicroFID should be calibrated with a standard of that specific compound as span gas. MicroFID's 10 Cal Memories can be used to store calibration information for 10 different span gases.

MicroFID's reading will always be influenced by any other ionizable compounds present in the air sample. Even if MicroFID has been calibrated with a specific compound, its response is not specific and the presence of another ionizable impurity may render the numerical result invalid.

It is often impractical to carry a range of different standards into the field. Approximate results can be obtained by calibrating MicroFID with the recommended span gas and entering the appropriate response factor. The response factor is based on the ratio of the response of the specific compound to the response of the span gas. The response factor multiplies MicroFID's reading then displays and records it (if the datalogger is on).

Appendix 8.6 provides response factors from which approximations can be made for guidance purposes. Data extrapolated from the use of response factors must be regarded as interim and approximate only. The response factors in Appendix 8.6 should be used only for concentrations up to 500 ppm of the specific compound, as response factors change with concentration.

To use the data in Appendix 8.6:

1. Press the CAL key and enter the response factor for the specific compound.
2. Calibrate MicroFID with zero air and 500 ppm methane as described in Section 3.1.
3. Expose MicroFID to the sample. The displayed reading is the approximate concentration of the specific compound.

The response factors in Appendix 8.6 serve as a guide to concentrations measured by MicroFID.

Results are expected to be accurate to within +/-10 ppm or +/-25% of result, whichever is greater. Accuracy of response factors to other gases and vapors may differ from that stated.

> **Note:** It does not matter which Cal Memory is selected or which response factor is entered, MicroFID's response is not specific to any one compound. The displayed reading represents the total concentration of all ionizable compounds in the sample.

3.5. Preparing for Field Operation

3.5.1. Field Check List

The following items should be carried into the field to reduce or eliminate instrument down time. If you will be in the field for a single 8-10 hour day, you should include the following accessories:

- Spare battery pack (Photovac Part No. 396005 or 396006)
- Long sample probe (Photovac Part No. 396018)
- Calibration kit(s) (Photovac Part No. 396011)
- Tank(s) of calibration gas (Photovac Part No. 396028)
- Spare gas bag for zero air (Photovac Part No. 396017)
- Gas bag adapter for zero air (Photovac Part No. 396010)
- Supply of commercial zero air
- Charcoal filters (Photovac Part No. 396021, 396022)
- Shoulder strap (Photovac Part No. 395002)
- Spare inlet filters (Photovac Part No. 396020)
- Bar code reader and interface module (Photovac Part No. 396054)
- Spare 9 volt battery for bar code reader
- Carrying case (Photovac Part No. 396007)
- Headset (Photovac Part No. 396053)
- User's manual (Photovac Part No. 396003)

Table 3 Check List for Field Operation

If you will be in the field for more than one day you should include the following additional items:

- Battery chargers (Photovac Part No. 396013 or 396014). Take one charger for each battery pack.
- Hydrogen and refill adapter (Photovac Part No. 396004)
- Printer (Photovac Part No. 380120)
- Printer cable (Photovac Part No. 396051)
- Computer and associated cables

Table 4 Additional Field Items

3.5.2. Operational Check List

Before beginning field work, set up and calibrate MicroFID for your particular application. Ensure the instrument is in working order before heading into the field.

1. Ideally, you should not transport MicroFID with the hydrogen cylinder filled. If it is possible to fill the internal hydrogen cylinder when you arrive at your destination then do so. If not, then you must fill the cylinder before you leave and observe all precautions for handling compressed, flammable gases. See Section 1.2.1.

   If you are traveling by passenger aircraft, you must make arrangements to fill the hydrogen cylinder when you arrive at your destination. You cannot transport MicroFID by passenger aircraft unless the internal hydrogen cylinder is empty. See Section 5.2 for instructions on emptying the internal cylinder.

2. Press the BATT key and ensure the battery pack is fully charged. The voltage should be 9 volts.

3. Press the SETUP key and ensure the correct date and time are entered.

4. Program and calibrate all the Cal Memories you will be using. See Section 3.1. After calibration is complete, sample the bag of calibration gas and the bag of zero air to ensure MicroFID has been calibrated correctly.

5. Press the MAX key and clear the Max register if necessary.

6. If you are using an averaging interval, you may also want to delete all events from the datalogger to avoid confusion between different days' data and to avoid running out of space in the datalogger. See Section 2.13.

7. If you are performing Method 21 monitoring ensure you have programmed and calibrated all the Cal Memories. See Section 3.3.1. You must also program your monitoring schedule. See Section 3.3.2 or 3.3.3.

5. Routine Maintenance

5.1. Battery Charging

A fully charged battery powers MicroFID for approximately 15 hours. If the instrument is to be used for more than 15 hours, carry a spare battery pack (Photovac Part No. 396005 or 396006). When the first one has been discharged, replace it with the spare. Battery life is reduced if the instrument is turned off and then on again repeatedly.

When the instrument status displays "LoBatt", the battery pack requires charging. When the "LoBatt" status is displayed, you have a few minutes of operation left. MicroFID will turn itself off before the battery pack becomes critically low.

Note: Do not remove the battery pack in a hazardous location.

Do not connect the battery charger to MicroFID in a hazardous location.

Upon return from field work, charge the battery packs as outlined in Section 1.5. You will need one charger for each battery pack. Use only the MicroFID battery charger.

You can connect the charger to the battery pack without removing the battery pack from the instrument. If you do not require portable operation, you can use MicroFID while the battery pack is connected to the battery charger

Note: Do not leave battery packs uncharged for an extended period of time. This will result in damage to the battery packs.

The charger automatically charges at a high charge rate until the battery pack is fully charged. It then maintains the full charge with a low continuous charge rate indefinitely so there is no danger of over-charging. A red LED on the battery pack indicates that the battery is charging. When the LED turns green, the battery is fully charged and ready for use.

> **Note:** Leaving MicroFID for more than 3 months without turning it on may result in the loss of recorded data and setup parameters. If MicroFID is not used for long periods of time, turn the instrument on for a few hours every month to avoid loss of data.

The battery pack is 57% lead. (Pb) by weight. This battery pack must be disposed of properly. Check with local codes for special disposal instructions. Alternatively, you can return the battery pack to the nearest PE Photovac facility for recycling.

5.2. Emptying the Hydrogen Cylinder

When you transport MicroFID, you should empty the internal hydrogen cylinder and then refill it when you arrive at your destination.

If you are traveling by passenger aircraft, you must empty the cylinder.

> **Warning:** Do not vent the hydrogen cylinder in a hazardous location. Move to an open, well ventilated area away from possible ignition sources before emptying the cylinder.
>
> Hydrogen gas is a fire and explosion hazard when exposed to heat or flame. The lower explosive limit is 4%.

To empty the cylinder:

1. Turn MicroFID off and open the hydrogen shut-off valve.
2. Remove the battery pack as outlined in Section 1.5.
3. Locate the purge outlet. It is located on the underside of the instrument.
4. Use the MicroFID multi-tool to turn the screw counterclockwise. Loosen the screw but do not remove it.

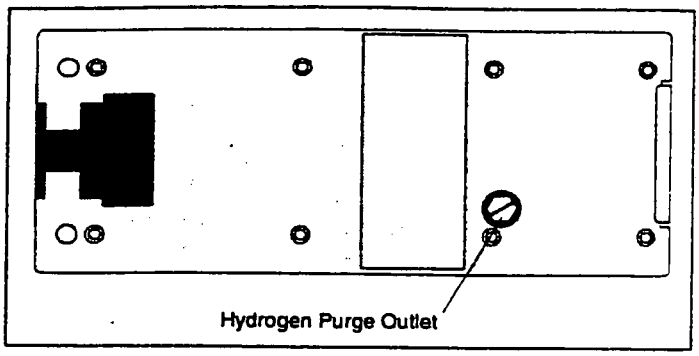


Figure 19 Hydrogen Purge Outlet

5. Leave the instrument so that the purge outlet is facing up. If the purge outlet is facing down, hydrogen will vent into MicroFID's case.
6. If the cylinder is full, it will take approximately 15 minutes to empty.
7. Watch the Contents Gauge. When the cylinder is empty, close the purge outlet. Use the MicroFID multi-tool to turn the screw clockwise.
8. Replace the battery pack as outlined in Section 1.5.

5.3. Replacing the Sample Inlet Filter

MicroFID is equipped with a combined dust and water filter to reduce detector contamination. As the filter collects dust, MicroFID's inlet flow rate and sensitivity decrease. The filter will not allow water to pass through, but the filter will not stop all solvents.

Note: Do not aspirate liquid samples with MicroFID!

Replace the filter on a weekly basis, or more frequently if MicroFID is used in a dusty or wet environment. You must replace the filter if MicroFID has been exposed to liquid water. The pump will sound labored when the filter requires replacement.

Note: Do not replace the inlet filter in a hazardous location.

1. Turn the instrument off. Unscrew the filter housing from the detector housing. Be careful not to lose the O-ring seal. See Figure 20.

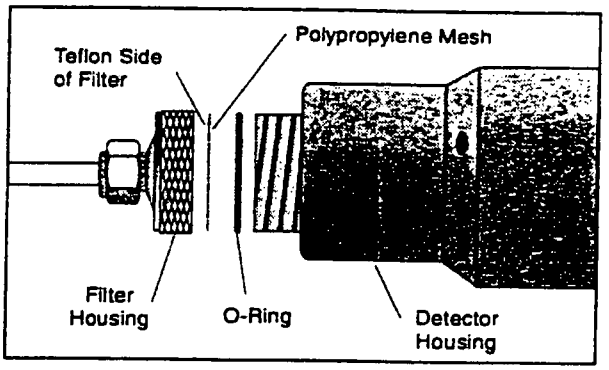


Figure 20 Inlet Filter

2. Remove the Teflon/Polypropylene filter and install the new filter (Photovac Part No. 396020). Place the filter in the filter housing with the Teflon side facing down in the filter housing and the mesh side facing the MicroFID. Handle the filter disk only by the edges. The mesh may be damaged or contaminated by excessive handling. Use forceps if possible.

Note: Each filter is protected by a piece of blue plastic. Remove the plastic before installing the filter in MicroFID.

3. Replace the filter housing.
4. Calibrate all Cal Memories, that you are using, before continuing operation.

Note: Do not operate MicroFID without an inlet filter.

MOUND B
KIN-BUC LANDFILL SITE

QUALITY ASSURANCE PROJECT PLAN
CORRECTIVE ACTION FORM

Car No.:_____ Date:_____

To:_____ cc: Task Manager

You are hereby requested to take corrective actions indicated below and as otherwise determined by you (A) to resolve the noted condition, and (B) to prevent it from reoccurring. Your written response is to be returned to the Quality Assurance Officer (QAO).

_____

Condition

_____

Reference Document

_____

Recommended Corrective Actions

_____

Originator	Date	QAO Approval	P.M.
Approval Date		Date	

_____

Response

_____

Corrective Action

A. Resolution
B. Prevention
C. Affected Documents

Signature:_____ Date:_____

_____

Follow Up

Corrective Action Verified:

By:_____ Date:_____

Appendix E

Water Balance Model Results

Water Balance for the Kin-Buc Landfill, Mound B

Year 3 Theoretical Water Balance per Acre: Grass Over 2 Feet of Clay Loam Soil

Parameter			January	February	March	April	May	June	July	August	September	October	November	December	Totals
Mean Precipitation															
Precipitation/month	(inches)	[1]	3.54	2.98	3.81	4.08	4.10	3.36	5.01	4.23	4.15	3.19	3.99	3.88	46.32
Volume	(gal/acre)	[2]	96,139	80,931	103,472	110,805	111,348	91,251	136,062	114,878	112,706	86,634	108,360	105,373	1,257,959
Irrigation Water Supply															
Irrigation	(inches)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Volume	(gal/acre)		0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs	(inches)		3.54	2.98	3.81	4.08	4.10	3.36	5.01	4.23	4.15	3.19	3.99	3.88	46.32
Volume	(gal/acre)		96,139	80,931	103,472	110,805	111,348	91,251	136,062	114,878	112,706	86,634	108,360	105,373	1,257,959
Surface Runoff	(inches)	[3]	0.33	0.56	0.61	0.82	0.99	0.33	0.67	0.73	1.34	0.79	0.56	0.76	8.49
Volume	(gal/acre)		8,962	15,208	16,566	22,270	26,886	8,962	18,196	19,825	36,392	21,455	15,208	20,640	230,571
Uptake by Trees and Grass (Year 3)															
Potential Evapotranspiration (PET) for Grass	(inches)	[4]	0.63	1.54	2.64	3.97	4.28	4.19	4.12	3.33	2.71	2.66	1.18	0.96	32.21
Field Capacity of Soil	(inches)	[5]	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	
Available Water Holding Capacity (AWHC) of Soil	(inches)	[6]	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	
Wilt Point of Soil	(inches)	[7]	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	
Soil Water Depletion Fraction, f		[8]	1.00	1.00	0.78	0.65	0.65	0.65	0.65	0.70	1.00	0.78	1.00	1.00	
Breakpoint Moisture Level in Soil, BML	(inches)	[9]	5.40	5.40	6.27	6.79	6.79	6.79	6.79	6.59	5.40	6.27	5.40	5.40	
Effective Evapotranspiration for Grass and Poplar	(inches)	[10	0.63	1.54	2.64	3.97	4.28	4.19	2.73	3.33	2.71	2.66	1.18	0.96	30.82
Volume	(gal/acre)		17,110	41,823	71,697	107,817	116,236	113,792	74,271	90,436	73,598	72,240	32,046	26,072	837,139
Total Outputs	(inches)		0.96	2.10	3.25	4.79	5.27	4.52	3.40	4.06	4.05	3.45	1.74	1.72	39.31
Volume	(gal/acre)		26,072	57,032	88,264	130,087	143,123	122,754	92,467	110,261	109,990	93,695	47,255	46,712	1,067,711
Soil Profile Balance (for a 2' soil depth)															
Soil Moisture in 2' Depth	(inches)	[11	9.36	9.36	9.36	9.36	8.65	7.48	6.32	7.93	8.10	8.20	7.94	9.36	
Calculated Ending Soil Moisture	(inches)	[12	9.36	9.36	9.36	8.65	7.48	6.32	7.93	8.10	8.20	7.94	9.36	9.36	
Percolation Below Root Zone	(inches)	[13	2.58	0.88	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	2.16	7.01
Percolation Below Root Zone	(gal/acre)		70,068	23,899	15,208	0	0	0	0	0	0	0	22,411	58,661	190,248

Notes & Assumptions:

[1] Values are the average precipitation results for Newark, New Jersey between 1958-1987 (provided by the New Jersey State Climatologist).
[2] To convert inches to gallons/acre, multiply times 27,158.
[3] Runoff values estimated from historic storm data (National Climate Data Center) and the SCS runoff method.
[4] Values are the average (1980-1997) grass potential evapotranspiration rates for Newark, New Jersey (provided by the Northeast Regional Climate Center, Cornell University, New York).
[5] Field capacity of soil estimated at 9.36" of water for 2 feet of clay loam (4.68" water/ft).
[6] AWHC of soil estimated at 3.96" of water for 2 feet of clay loam (1.98" water/ft).
[7] Wilt point = field capacity - AWHC
[8] Soil Water Depletion Fraction, f, is a function of PET and crop type (Dootenbos, J., and Kassam, A.H., 1979. Yield Response To Water, Food and Agriculture Organization Irrigation and Drainage Paper, Table 20, p. 28). It is assumed that the grass/poplar crop is analogous to alfalfa.
[9] BML = field capacity - (f*AWHC).
[10] For moisture contents above the BML, effective ET = PET. Below the BML, effective ET < PET (decreases linearly to ET = 0 at the wilt point). From Yield Respose To Water.
[11] January beginning soil moisture = field capacity.
[12] Calculated ending soil moisture = beginning soil moisture + precipitation + irrigation - surface runoff - canopy interception - effective ET - percolation.
[13] Percolation past the soil/root zone to the near-surface groundwater occurs when soil moisture content exceeds field capacity.

* Carrow, RnN., R.C. Shearman, and R.J. Watson. 1990. "Turfgrass." In Irrigation of Agricultural Crops, eds. B.A. Stewart and D.R. Nelson. Number 30 in Agronomy Monograph Series, American Society of Agronomy. Table 30-3, p. 909.

Water Balance for the Kin-Buc Landfill, Mound B

Year 3 Theoretical Water Balance per Acre: Poplar Trees and Grass Over 2 Feet of Clay Loam Soil

Parameter			January	February	March	April	May	June	July	August	September	October	November	December	Totals
Mean Precipitation															
Precipitation/month	(inches)	[1]	3.54	2.98	3.81	4.08	4.10	3.36	5.01	4.23	4.15	3.19	3.99	3.88	46.32
Volume	(gal/acre)	[2]	96,139	80,931	103,472	110,805	111,348	91,251	136,062	114,878	112,706	86,634	108,360	105,373	1,257,959
Irrigation Water Supply															
Irrigation	(inches)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Volume	(gal/acre)		0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inputs	(inches)		3.54	2.98	3.81	4.08	4.10	3.36	5.01	4.23	4.15	3.19	3.99	3.88	46.32
Volume	(gal/acre)		96,139	80,931	103,472	110,805	111,348	91,251	136,062	114,878	112,706	86,634	108,360	105,373	1,257,959
Surface Runoff	(inches)	[3]	0.33	0.56	0.61	0.82	0.99	0.33	0.67	0.73	1.34	0.79	0.56	0.76	8.49
Volume	(gal/acre)		8,962	15,208	16,566	22,270	26,886	8,962	18,196	19,825	36,392	21,455	15,208	20,640	230,571
Canopy Interception	(inches)	[4]	0.00	0.00	0.38	0.61	0.62	0.50	0.75	0.63	0.62	0.48	0.40	0.00	5.00
Volume	(gal/acre)		0	0	10,347	16,621	16,702	13,688	20,409	17,232	16,906	12,995	10,836	0	135,736
Uptake by Trees and Grass (Year 3)															
Potential Evapotranspiration (PET) for Grass	(inches)	[5]	0.63	1.54	2.64	3.97	4.28	4.19	4.12	3.33	2.71	2.66	1.18	0.96	32.21
PET for Grass and Poplar	(inches)	[6]	0.63	1.54	2.90	4.76	5.56	5.45	5.36	4.33	3.52	3.19	1.30	0.96	39.51
Field Capacity of Soil	(inches)	[7]	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36	
Available Water Holding Capacity (AWHC) of Soil	(inches)	[8]	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	3.96	
Wilt Point of Soil	(inches)	[9]	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	5.40	
Soil Water Depletion Fraction, f		[10]	1.00	1.00	0.75	0.60	0.52	0.53	0.54	0.63	0.75	0.75	1.00	1.00	
Breakpoint Moisture Level in Soil, BML	(inches)	[11]	5.40	5.40	6.39	6.98	7.30	7.26	7.22	6.87	6.39	6.39	5.40	5.40	
Effective ET for Grass and Poplar	(inches)	[12]	0.63	1.54	2.90	4.76	4.06	0.57	5.36	1.14	3.52	2.51	1.30	0.96	29.25
Volume	(gal/acre)		17,110	41,823	78,867	129,381	110,261	15,419	145,458	30,871	95,678	68,126	35,251	26,072	794,317
Total Outputs	(inches)		0.96	2.10	3.90	6.20	5.67	1.40	6.78	2.50	5.49	3.78	2.26	1.72	42.74
Volume	(gal/acre)		26,072	57,032	105,780	168,271	153,850	38,069	184,063	67,928	148,975	102,576	61,296	46,712	1,160,624
Soil Profile Balance (for a 2' soil depth)															
Beginning Soil Moisture	(inches)	[13]	9.36	9.36	9.36	9.28	7.16	5.59	7.55	5.78	7.51	6.18	5.59	7.32	
Calculated Ending Soil Moisture	(inches)	[14]	9.36	9.36	9.28	7.16	5.59	7.55	5.78	7.51	6.18	5.59	7.32	9.36	
Percolation Below Root Zone	(inches)	[15]	2.58	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	3.58
Percolation Below Root Zone	(gal/acre)		70,068	23,899	0	0	0	0	0	0	0	0	0	3,368	97,335

Notes & Assumptions:

[1] Values are the average precipitation results for Newark, New Jersey between 1958-1987 (provided by the New Jersey State Climatologist).
[2] To convert inches to gallons/acre, multiply times 27,158.
[3] Runoff values estimated from historic storm data (National Climate Data Center) and the SCS runoff method.
[4] Canopy interception is assumed to be 15% of monthly precipitation for April through October, 10% for March and November, and zero for Dec. through February.
[5] Values are the average (1980-1997) grass potential evapotranspiration rates for Newark, New Jersey (provided by the Northeast Regional Climate Center, Cornell University, New York).
[6] Conversion factors for converting grass PET to grass and poplar PET: 1.0 for January - February and December; 1.1 for March and November; 1.2 for April and October; and 1.3 for May - September.
[7] Field capacity of soil estimated at 9.36" of water for 2' of clay loam (4.68" water/ft).
[8] AWHC of soil estimated at 3.96" of water for 2 feet of clay loam (1.98" water/ft).
[9] Wilt point = field capacity - AWHC
[10] Soil Water Depletion Fraction, f, is a function of PET and crop type (Doorenbos, J., and Kassam, A.H., 1979. Yield Response To Water, Food and Agriculture Organization Irrigation and Drainage Paper, Table 20, p. 28). It is assumed that the grass/poplar crop is analogous to alfalfa.
[11] BML = field capacity - (f*AWHC).
[12] For moisture contents above the BML, effective ET = PET. Below the BML, effective ET < PET (decreases linearly to ET = 0 at the wilt point). From Yield Respose To Water.
[13] January beginning soil moisture = field capacity.
[14] Calculated ending soil moisture = beginning soil moisture + precipitation + irrigation - surface runoff - canopy interception - effective ET - percolation.
[15] Percolation past the soil/root zone to the near-surface groundwater occurs when soil moisture content exceeds field capacity.

* Carrow, RnN., R.C. Shearman, and R.J. Watson. 1990. "Turfgrass." In Irrigation of Agricultural Crops, eds. B.A. Stewart and D.R. Nelson. Number 30 in Agronomy Monograph Series, American Society of Agronomy. Table 30-3, p. 909.

Figure : Water Balance Results for Grass-Only Cover and a 2-Foot Rooting Depth

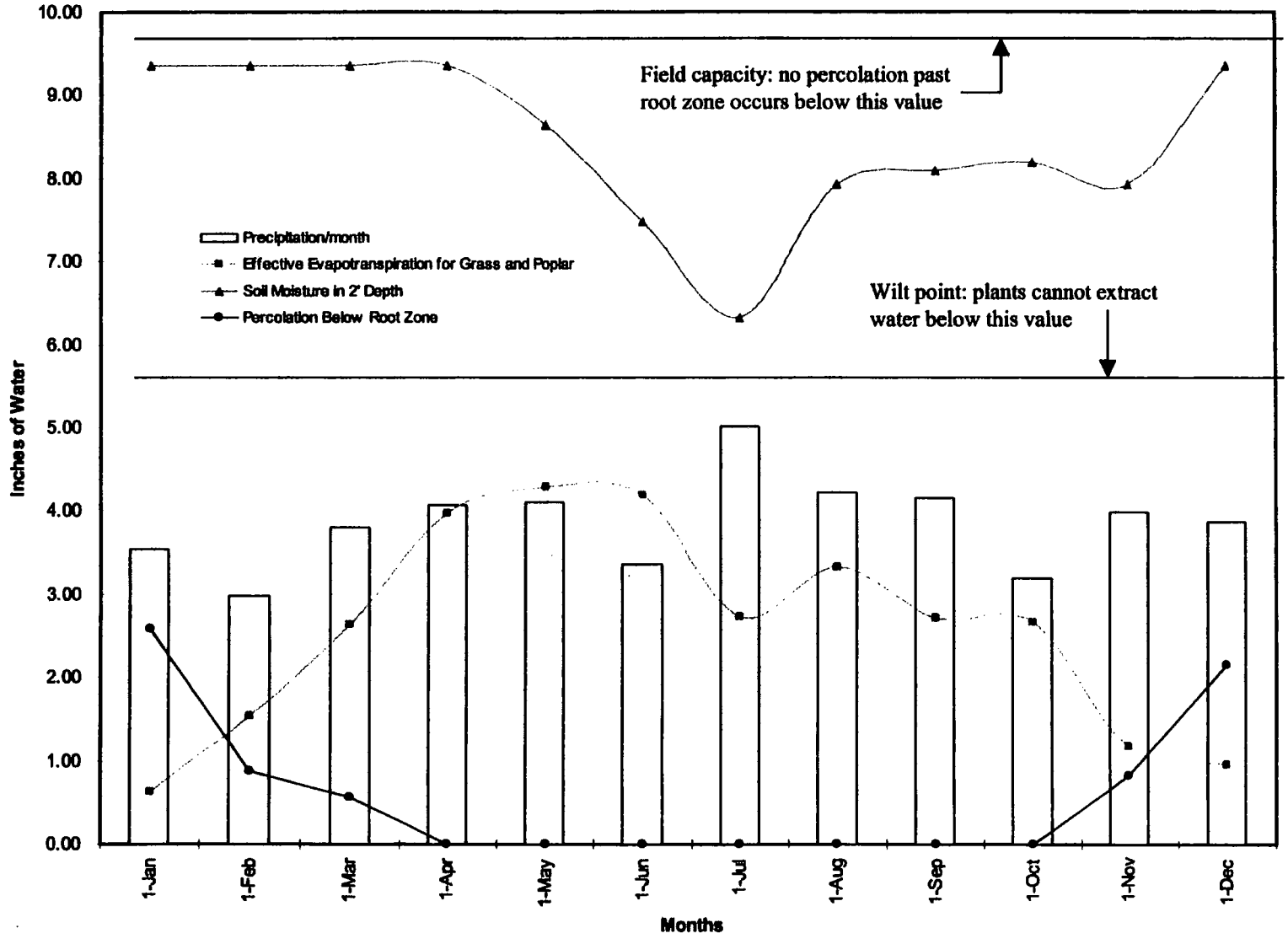
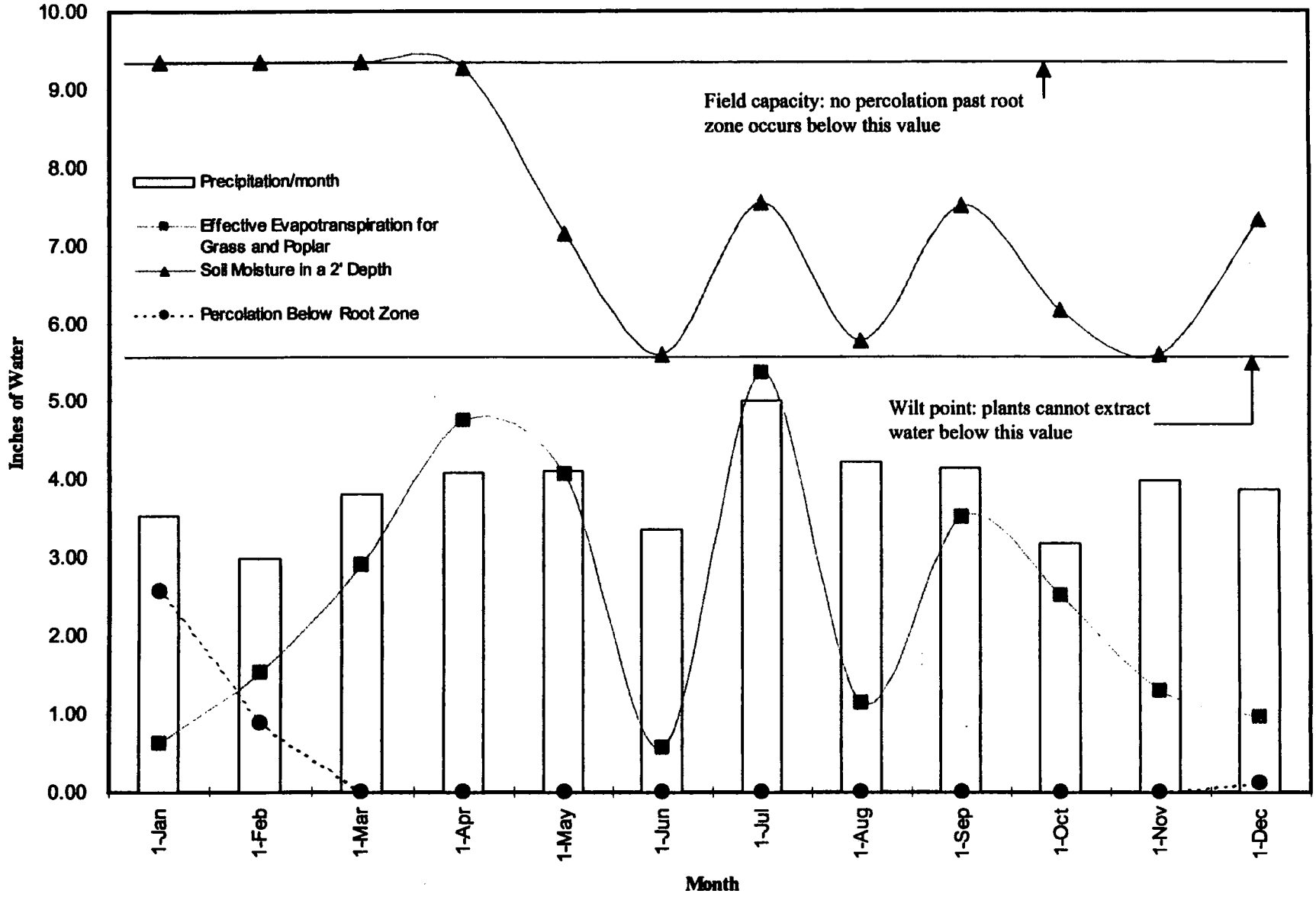


Figure : Water Balance Results for the Ecolotree Cap and a 2-Foot Rooting Depth



Appendix F

Waste Characterization Sampling and Analysis Plan

TECHNICAL REPORT

Waste Characterization Sampling and Analysis Plan

Kin-Buc Landfill
Edison, New Jersey

March 2000

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

8 South River Road
Cranbury, New Jersey 08512-9502
(609) 860-0590

Table of Contents

Section 1. **Introduction** **1-1**

1.1 Scope and Objectives 1-1
1.2 Overview of Waste Characterization Sampling and Analysis 1-1

Section 2. **Waste Characterization Sampling Procedure** **2-1**

2.1 General 2-1
2.2 Sampling Frequency 2-1
2.3 Sampling Procedures 2-1
2.4 Sample Analysis 2-2
2.5 Decontamination Procedures 2-2
2.5.1 Sampling Equipment Decontamination 2-2
2.5.2 Storage of Used Decontaminated Fluids 2-3

Section 3. **Sample Designation System** **3-1**

Section 4. **Sample Handling and Documentation** **4-1**

4.1 Sample Containers and Preservation 4-1
4.2 Packing, Handling, and Shipping Requirements 4-1
4.3 Documentation 4-1

Section 5. **Management of Investigation-Derived Materials and Wastes** . . **5-1**

5.1 Excess Material 5-1
5.2 Disposable Equipment and Debris 5-1
5.3 Decontamination Rinsate 5-1

Section 6. **Quality Assurance/Quality Control** **6-1**

6.1 Field Instrument Calibration and Preventative Maintenance 6-1
6.2 QA/QC Sample Collection 6-1

Attachment. A Sample Labeling, Handling, Packing, and Shipping Procedures

1. Introduction

1.1 Scope and Objectives

This Waste Characterization Sampling and Analysis Plan (WCSAP) supports the Mound B Work Plan (Work Plan) for the activities at Mound B, Kin-Buc Landfill (the site) in Edison, Middlesex County, New Jersey. The WCSAP addresses the field procedures, sample collection methods, and analytical procedures to be used during waste characterization sampling following the removal of intact drums and materials associated with intact drums removed from the Mound B area. The excavation and all associated tasks (such as waste handling, off-site transportation and disposal, and site restoration) will be conducted in accordance with the applicable sections of the Work Plan.

The objectives of the waste characterization sampling are to determine if waste material generated during excavation activities is deemed hazardous by the Resource Conservation and Recovery Act (RCRA) or by the Toxic Substances Control Act (TSCA), and to determine appropriate disposal options. This WCSAP will ensure that the proper procedures are employed during collection and analysis of waste characterization samples so that the data are representative and the results are reliable. The waste characterization sampling and analysis will be conducted in accordance with the requirements of the Quality Assurance Project Plan (QAPP, Appendix D to the Work Plan) and the site-specific Health and Safety Plan (HASP, Appendix C to the Work Plan).

1.2 Overview of Waste Characterization Sampling and Analysis

The waste characterization sampling will commence on site after intact drums and associated materials have been removed from the landfill and transported to the Material Staging, Handling, and Loading Area. The contents of each intact drum will be sampled and subjected to on-site hazard categorization tests to determine compatible wastestreams.

Once drums have been segregated into compatible wastestreams, composite samples will be collected from each wastestream. All samples will be sent off site to a certified laboratory for full RCRA characterization analysis. This characterization analysis will include ignitability, corrosivity, sulfur and cyanide reactivity, and toxicity by the Toxicity Characteristic Leaching Procedure (TCLP). Additional analyses will also be performed on each sample for total petroleum hydrocarbons (TPH) and polychlorinated biphenyls (PCBs).

For all other removed associated materials, samples will be collected and analyzed for full RCRA characterization, TPH and PCBs. Other analyses may be included if required by the disposal facilities.

2. Waste Characterization Sampling Procedure

2.1 General

This section presents the details associated with collecting and analyzing the waste characterization samples from the materials generated during the excavation activities. The following information is provided:

- sampling frequency;
- sampling procedures; and
- a summary of the data to be generated during the sampling efforts.

2.2 Sampling Frequency

Once drums have been segregated into compatible wastestreams through hazard categorization analyses, composite samples will be collected. For full RCRA characterization, one five-part composite sample will be collected from every five drums within each wastestream (i.e., one part collected from each of the five drums).

For all other removed associated materials, samples will be collected at a frequency determined by the disposal facility, which will be selected prior to the implementation of this WCSAP.

2.3 Sampling Procedures

Each waste characterization sample from removed, intact drums will be a five-part composite. The five aliquots will be obtained with dedicated, disposable sampling equipment. Liquids will be sampled with glass pipettes (i.e., drum thieves). If more than one phase is present in the drum, the pipette will be inserted to collect the appropriate material. Solids and sludges will be collected with polyethylene scoops.

Drums will be opened with non-sparking equipment, such as a bung wrench or drum deheader, or remotely with a backhoe spike. After a drum is opened, the headspace will be screened with a FID instrument. If liquids are sampled, a pipette will be used to obtain each aliquot, which will be immediately transferred to the required glassware. Each aliquot will fill approximately one-fifth of the glassware. The sample for TCLP volatile organic compounds (VOCs) will have no headspace. When solids are sampled for VOCs, each aliquot will be removed with a scoop and immediately transferred to a glass jar, with each aliquot filling approximately one-fifth of the glassware. Remaining sample volume from each aliquot will be transferred to a disposable aluminum pan. The aliquots will be composited and transferred to the appropriate glassware for analysis. One blind duplicate sample will be prepared for every 20 waste characterization samples collected.

Other materials associated with intact drums removed during excavation operations, which will be subsequently overpacked or placed in a lined roll-off, will likewise be sampled. Sample frequency will be determined by the disposal facility. All sampling will be conducted in accordance with USEPA

Environmental Response Team Standard Operating Procedures #2009 and #2017, which have been included as Attachments B and C of the QAPP.

All field observations during sampling will be recorded in a bound field notebook. The field notes will include all drum numbers which were included in each composite sample.

2.4 Sample Analysis

All samples will be sent off site to a certified laboratory for full RCRA characterization analysis. This characterization analysis will include ignitability, corrosivity, sulfur and cyanide reactivity, and toxicity by the TCLP. Additional analyses will also be performed on each sample for TPH and PCBs.

Additional analyses may be necessary, pending the selection of the disposal facility.

2.5 Decontamination Procedures

To the extent practicable, dedicated, disposable sampling equipment will be used during all waste characterization operations. However, if it becomes necessary to utilize non-dedicated, non-disposable equipment, such as stainless steel scoops or bucket augers, this equipment will be decontaminated prior to each use.

All decontamination will take place in the decontamination pad described in the Work Plan. Decontamination procedures will meet USEPA requirements as presented in Attachment D of the QAPP (USEPA Environmental Response Team SOP #2006). The following summarizes these procedures.

2.5.1 Sampling Equipment Decontamination

Non-dedicated equipment will be decontaminated prior to each use to mitigate the potential for cross-contamination of the samples collected for laboratory analysis. The decontamination procedures to be utilized during the waste characterization sampling activities are presented below:

1. Physical removal of gross contamination;
2. Non-phosphate detergent solution wash;
3. Tap water rinse;
4. Distilled water rinse;
5. 10 percent nitric acid rinse;
6. Distilled water rinse;
7. Solvent rinse (i.e., hexane);

8. Distilled water rinse; and

9. Allow to air dry.

The distilled water will be demonstrated to be analyte-free. The volume of distilled water used in steps 6 and 8 will be five times the volume of solvent used in the previous step of the decontamination procedure. Any decontaminated equipment that is not in use will be wrapped in aluminum foil for storage.

2.5.2 Storage of Used Decontaminated Fluids

All used water and other used decontamination fluids will be contained in a site sump, characterized, and disposed in accordance with the procedures in the Work Plan.

3. Sample Designation System

A unique 10-digit alphanumeric sample designation will be assigned to each waste characterization sample. The designation consists of two parts: a four-digit sequence code, and a six-digit date code.

The four-digit sequence code will begin with the letters "WC" to indicate a waste characterization sample. The next two digits will indicate the sequence of the sample during the removal action. For example, the first waste characterization sample will be designated WC01, the second will be WC02, and so on. Should more than 99 waste characterization samples be required, the sequence code will be expanded to five digits.

The six-digit date code will be in a month-day-year (mm-dd-yy) format. For example, a waste characterization sample obtained on July 13, 2000 would have the date sequence 071300.

The designation system allows each sample to be differentiated, but also tracks the day of collection. Samples collected on the same day are distinguished by their sequence codes. For example, if the 25th waste characterization sample collected during the removal action is obtained July 13, 2000, it would be designated WC25-071300. If another waste characterization sample is collected later that day, it will be designated WC26-071300.

4. Sample Handling and Documentation

4.1 Sample Containers and Preservation

The analytical laboratory will supply appropriate sample containers in sealed cartons or coolers, as well as sample labels and preservatives. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate). Sample labeling procedures are described in Attachment A of this WCSAP. Appropriate sample containers, preservation methods, and laboratory holding times for soil samples are summarized in the QAPP.

4.2 Packing, Handling, and Shipping Requirements

Sample custody seals and packing materials for filled sample containers will also be provided by the analytical laboratory. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage. Trip blank(s) of analyte-free water will be provided by the laboratory and included in each cooler containing soil samples to be analyzed for VOCs.

All samples will be packaged by field personnel and transported as low-concentration environmental samples. The packaged samples will be either shipped via express overnight carrier (Federal Express) or hand delivered by a courier to the laboratory within 24 to 48 hours of sample collection. General procedures for packing, handling, and shipping environmental samples are included in Attachment A.

4.3 Documentation

Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis, and sample chain-of-custody. This documentation constitutes a record which allows reconstruction of all field events to aid in the data review and interpretation process. All documents, records, and information relating to the performance of the field work will be retained in the project file.

The various forms of documentation to be maintained throughout the waste characterization sampling include:

- Daily Production Documentation - A field notebook consisting of a waterproof, bound notebook which will contain a record of all activities performed at the site.

- Sampling Information - Detailed notes will be made as to the exact site of sampling, physical observations, sample depths, and weather conditions.

- Sample Chain-of-Custody - Chain-of-custody forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. Chain-of-custody forms will be filled out in ink at each sampling site, at a group of sampling sites, or at the end of each day of sampling by one of the field personnel designated to be responsible for sample custody. A sample chain-of-custody is included as Attachment E of the QAPP. In the event that the samples are relinquished by the designated sampling person to other sampling or field personnel, the chain-of-custody form will be signed and dated by the appropriate personnel to document the sample transfer. The original chain-

of-custody form will accompany the samples to the laboratory and copies will be forwarded to the project files.

Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

- Field Equipment, Calibration, and Maintenance Logs - To document the calibration and maintenance of field instrumentation, calibration and maintenance logs will be maintained for each piece of field equipment (which is not factory calibrated). Calibration and maintenance procedures for the FID are provided in Attachment F of the QAPP.

5. Management of Investigation-Derived Materials and Wastes

5.1 Excess Material

The proposed waste characterization sampling program should generate only minor amounts of excess material. However, any excess material from individual drum or roll-off sampling activities will be placed back into the drum or roll-off. Excess material from composite samples will be containerized in laboratory glassware and stored on site in 5-gallon buckets until analytical results are received and disposal options are implemented.

5.2 Disposable Equipment and Debris

Disposable equipment and debris, such as health and safety equipment, plastic sheeting, sampling equipment, and other equipment not reused during waste characterization sampling will be collected in DOT-approved 55-gallon steel drums. The drums will be stored in the Material Staging, Handling, and Loading Area and disposed of in accordance with the procedures in the Work Plan.

5.3 Decontamination Rinsate

Field sampling equipment will be decontaminated by following the procedures discussed in Section 2.5.1 and in SOP #2006 (Attachment D of the QAPP). Decontamination rinsate will be containerized in the decontamination area and properly disposed of in accordance with the procedures in the Work Plan.

6. Quality Assurance/Quality Control

This section summarizes the QA/QC requirements for all field investigation activities associated with the waste characterization sampling. The QAPP discusses these procedures in detail.

6.1 Field Instrument Calibration and Preventative Maintenance

Field personnel are responsible for assuring that a master calibration/maintenance log will be maintained following procedures specified for each measuring device. Each log will include at a minimum where applicable:

- Name of device and/or instrument calibrated (i.e., FID);
- Device/instrument serial/I.D. number;
- Frequency of calibration;
- Date(s) of calibration(s);
- Results of calibration(s);
- Name of person(s) performing calibration(s); and
- Identification of calibration gas (i.e., isobutylene or methane).

Equipment to be used each day shall be calibrated prior to the commencement of the day's activities or as suggested by the manufacturer.

Health and safety monitoring equipment will be calibrated and maintained in general accordance with the manufacturer's specifications.

6.2 QA/QC Sample Collection

An estimate of the QA/QC field samples to be collected is provided in Table 1-1 of the QAPP. The total number of QA/QC samples collected will be determined pending results of removal activities. Guidance on the collection of the QA/QC samples is presented below.

Trip Blanks

A trip blank will accompany any sample shipment that includes samples for VOC analysis. A trip blank is an aliquot of analyte-free water which is sealed in 40-millimeter glass vials with Teflon septum caps prior to initiation of field work. This blank is applied in sample validation to determine if any cross-contamination has occurred between samples during shipment. These sealed bottles will be prepared by the laboratory and included with each shipment of sample bottles to and from the laboratory site.

Rinse Blanks

Rinse blanks will be prepared only if decontaminated non-dedicated sampling equipment is used. The blanks will be prepared by pouring analyte-free water over decontaminated sampling equipment to ensure that the decontamination procedure has been adequately performed and that cross contamination of samples will not occur due to the equipment.

If necessary, one rinse blank will be collected for each type of equipment used each day. Rinse blanks will be performed on sampling equipment such as stainless steel scoops or bucket augers.

Rinse blanks will be prepared in the field. Laboratory supplied analyte-free water will be poured into or over the sampling equipment and then directly into the laboratory supplied sample bottles. The intent is for the water making up the blank to follow the same path, and therefore, come in contact with the same equipment as the samples.

Duplicate Samples

Duplicate samples will be sent for laboratory analysis to evaluate the reproducibility of the sampling technique used. Five percent (i.e., one for every 20 samples) of each matrix will be duplicated.

Duplicate samples will be collected using methods to maximize the compatibility of the samples. For example, solid material will be homogenized in a dedicated, disposable aluminum pan and will be divided between the sample and duplicate sample laboratory containers, with the exception of samples for TCLP VOC analysis. TCLP VOC sample volumes will not be homogenized prior to collection to minimize undue volatilization of the sample.

SAMPLE LABELING, HANDLING, PACKING, AND SHIPPING PROCEDURES

I. LABELING AND HANDLING

1. Fill in sample label with:

   a. Sample type (soil, surface water, sediment, debris, ground-water);

   b. Project number and site name;

   c. Sample identification code and other sample identification information, if applicable;

   d. Analysis required;

   e. Date;

   f. Time sampled;

   g. Name, affiliation, and contact phone number;

   h. Sample type (composite or grab); and

   i. Preservative added, if applicable.

2. Cover the label with clear packing tape to secure the label onto the container.

3. Check the caps on the sample containers to ensure that they are tightly sealed.

4. Mark the level of the sample in the container using an indelible ink marker or grease pencil.

5. Wrap the sample container cap with clear packing tape to prevent it from becoming loose.

6. Place a signed custody seal label over the cap such that the cap cannot be removed without breaking the custody seal.

7. Initiate chain-of-custody by designated sampling personnel responsible for sample custody (Exhibit 3) (after sampling or prior to sample packing). Note: If the designated sampling person relinquishes the samples to other sampling or field personnel for packing or other purposes, the samplers will complete the chain-of-custody prior to this transfer. The appropriate personnel will sign and date the chain-of-custody form to document the sample custody transfer.

II. PACKING

1. Using duct tape, secure the outside and inside of the drain plug at the bottom of the cooler that is used for sample transport.

2. Place each sample container or package in individual polyethylene bags (Ziploc[R]-type) and seal.

3. Place 1 to 2 inches of cushioning material at the bottom of the cooler (i.e., bubble pack or vermiculite).

4. Package the sealed sample containers upright in the cooler.

5. Repackage ice (if required) in small Ziploc[R]-type plastic bags and place loosely in the cooler. Do not pack ice so tightly that it may prevent addition of sufficient cushioning material.

6. Fill the remaining space in the cooler with cushioning material.

7. Place the completed chain-of-custody forms in a large Ziploc[R]-type bag and tape the forms to the inside of the cooler lid.

8. Close the lid of the cooler and fasten with duct tape.

9. Wrap strapping tape around both ends of the cooler at least twice.

10. Mark the cooler on the outside with the following information: shipping address, return address, "Fragile" labels on the top and on one side, and arrows indicating "This Side Up" on two adjacent sides.

11. Place custody seal evidence tape over front right and back left of the cooler lid and cover with clear plastic tape.

III. SHIPPING

1. All samples will be hand delivered or delivered by an express carrier within 48 hours or less from the date of sample collection.

2. The following chain-of-custody procedures will apply to sample shipping:

   a. Relinquish the sample containers to the laboratory via express carrier. The signed and dated forms should be included in the cooler. The express carrier will not be required to sign the chain-of-custody forms. The sampler should retain the express carrier receipt or bill of lading.

   b. When the samples are received by the laboratory, the laboratory personnel shall complete the chain-of-custody forms by recording receipt of samples, measure and record the internal temperature of the shipping container, and then check the sample identification numbers on the containers to the chain-of-custody forms.